# Map and data for Quaternary faults and folds in Oregon

By Stephen F. Personius, Richard L. Dart, Lee-Ann Bradley, and Kathleen M. Haller



**Open-File Report 03-095**

U.S. Department of the Interior
U.S. Geological Survey

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United States Geological Survey

Prepared as part of the U.S. Geological Survey's
Earthquake Reduction Program (ERP) project
*UNITED STATES MAP OF QUATERNARY FAULTS AND FOLDS*
In cooperation with the International Lithosphere Program's
Task Group II-2, World Map of Major Active Faults
Michael N. Machette, Co-chairman

## Introduction

The "World Map of Major Active Faults" Task Group is compiling a series of digital maps for the United States and other countries in the Western Hemisphere that show the locations, ages, and activity rates of major earthquake-related features such as faults and fault-related folds; the companion database includes published information on these seismogenic features. The Western Hemisphere effort is sponsored by International Lithosphere Program (ILP) Task Group II-2, whereas the effort to compile a new map and database for the United States is funded by the Earthquake Reduction Program (ERP) through the U.S. Geological Survey. The maps and accompanying databases represent a key contribution to the new Global Seismic Hazards Assessment Program (ILP Task Group II-0) for the International Decade for Natural Disaster Reduction. This compilation, which describes evidence for surface faulting and folding in Oregon, is the ninth in a series of State and regional compilations that are planned for the U.S. The compilations of West Texas, New Mexico, Wyoming, Montana, and the central and Eastern U.S. are available from the U.S. Geological Survey (Collins and others, 1996 #993; Machette and others, 1998 #2848; Haller and others, 2000 #1750; Crone and Wheeler, 2000 #4359; Machette and others, 2001 #5030), Arizona is available from the Arizona Geological Survey (Pearthree, 1998 #2945), Colorado is available from the Colorado Geological Survey (Widmann and others, 1998 #3441), and Utah is available from the Utah Geological Survey (Black and others, 2003 #5828).

This compilation is presented as a digital map product and catalog of data in @Adobe Acrobat pdf format. The catalog provides referenced data on a variety of geographic, geologic, and paleoseismologic parameters. The fault data were compiled by the senior author as part of ongoing studies of Quaternary faulting in Oregon. The authors are responsible for organizing and integrating State and regional products under the national project, including the coordination and oversight of contributions from others (Personius), digitization and manipulation of map data (Dart), map design and layout (Bradley), and database design and management (Haller). Project members are currently working on a web-based version of the database (Machette and others, 1999 #4783; Haller and others, 1999 #4784), into which the current data from Oregon has been ported.

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## Strategy for Map and Database

The primary intention of this compilation is for use in seismic-hazard evaluations. Paleoseismic studies, which evaluate the history of surface faulting or deformation along structures with evidence of Quaternary movement, provide a long-term perspective that augments the short historic records of seismicity in many regions. In particular, the frequency and location of large-magnitude earthquakes in many parts of the U.S. is poorly defined by the historic record of seismicity. An understanding of the seismogenic characteristics of prehistoric faults is vital to improving seismic-hazard assessments in all regions, not just those having low to moderate levels of historic seismicity.

The map and database formats were designed for the few well-studied faults that are present in the United States. But because the bulk of seismogenic structures have not been thoroughly studied, the database is incomplete (*i.e*., unnamed faults, fields that have no data or sparse descriptions). Nevertheless, the fault map and database provide the best presently available basis for assessing potential seismic sources. Because most of our fault data come from reconnaissance studies, future detailed field studies will require modification of the current compilation. Such changes will probably be made to the soon-to-be implemented web-based database, rather than in subsequent Open-File Reports.

The map shows faults and folds with evidence of Quaternary deformation, and includes data on timing of most recent movement, sense of movement, slip rate, and continuity of surface expression. Most fault and fold traces were taken from existing compilations (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Weldon and others, 2002 #5648). A few traces were derived from detailed studies at larger scales, and compiled on 1/2° x 1° (1:100,000-scale) or 1° x 2° (1:250,000-scale) quadrangles. The traces were digitized for use in [*]Arc/Info—Geographic Information System (GIS) software that permits rescaling, output in a wide variety of projections, and attribution (assigning colors, line weights, and symbols). In addition to location and style of faulting, the map shows the time of most recent movement and slip-rate category for each structure. These data, as well as name and affiliation of the compiler, date of compilation, and geographic and other paleoseismologic parameters are included in the database. Published or publicly available (NEHRP contract reports, theses, etc.) data are the primary sources of data used to compile this report. Citations are in standard USGS format, with the exception that we include a database reference number (e.g., Haller and others, 1993 #644). This reference number allows us to omit the traditional alpha character for authors having multi-year publications (*e.g.*, 1988a, b).

For purposes of map presentation, the timing of most recent fault movement (*i.e*., surface rupture) is depicted on plate 1 as one of five categories: historic (none in Oregon to date), Holocene and latest Pleistocene (<15 ka), late Quaternary (<130 ka), late and middle Quaternary (<750 ka), and Quaternary (<1.6 Ma). These categories permit defining a maximum time of movement without constraining the minimum time, which typically requires more detailed studies. This strategy allows estimates to be made where published data are sparse or where there are conflicts in evidence for timing. For example, if Holocene (<10 ka) movement is suspected but only late Pleistocene (10-130 ka) movement can be documented, then the inclusive late Quaternary (<130 ka) category is used for the time of the most recent movement. No faults or folds in Oregon are known to have had surface-rupturing earthquakes in historic time. In addition to known surface faults, some Quaternary faults that are suspected or inferred from subsurface or other data are shown as dotted lines (*i.e*., buried structures). Conversely, structures with known late Tertiary (or older) movement are not shown unless there is sufficient evidence of Quaternary movement (geomorphology, offset surficial deposits, etc.). This conservative depiction of faults yields a map with defensible potential sources of future ground rupturing based on Quaternary history (1.6 million years), whereas a less conservative depiction would yield a "neotectonic" map that may or may not be of use for seismic-hazards analyses. The occurrence of seismicity aligned with pre-Quaternary (*i.e.,* Neogene) faults or buried faults is not compelling enough evidence to add these structures to our map and database.

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We use slip rate as a graphical representation on the map. Fault slip rates and uplift rates for folds are depicted by categories delineated by line thickness that encompass all geologic rates on a national scale. Four slip-rate categories have been defined for this project: less than 0.2 mm/yr, 0.2-1 mm/yr, 1-5 mm/yr, and greater than 5 mm/yr. These broad categories segregate most intraplate structures (<1 mm/yr) from major plate-bounding structures (generally >5 mm/yr). In Oregon, faults and folds that fall in the 5 mm/yr and 1-5 mm/yr categories are those associated with the Cascadia subduction zone plate boundary offshore of northern California, Oregon, and Washington. All other intraplate faults/folds have published or inferred rates of less than 1.0 mm/yr, and most have inferred rates of <0.2 mm/yr. If no published slip rates exist (*i.e*., "unknown"), we assign the fault to a slip-rate category as determined from less precise data, such as geomorphic expression or similarity to nearby structures. This assignment to a unique slip-rate category is necessitated by the map's line-thickness portrayal of fault activity. Where available, the length of time for which the estimated slip rate applies is listed in the database. The absence or presence of recent movement over some time interval may be a basis for estimating a slip rate; one can use a variety of geomorphic and geologic relations to place a fault in its most likely age category. For example, a normal fault that does not cut latest Pleistocene (10-15 ka) deposits probably has an average slip rate of less than 1 mm/yr because during this elapsed time interval (10-15 k.y.) at least 10-15 m of potential slip would be expected to accumulate at a rate of 1 mm/yr. Exceptions to this generalization are faults that show evidence of temporal clustering; that is, several closely spaced surface-faulting events separated by longer intervals of tectonic quiescence. In such cases, the average slip rate could be considerably less than that calculated for an intra-cluster interval of time. Cases such as this are becoming more frequent in the literature as researchers conduct more detailed paleoseismic studies.

The database includes fields for supporting information on the previously mentioned parameters, as well as descriptive information on geologic and paleoseismologic parameters not depicted on the map. The descriptive information includes fault/fold name and number, a brief synopsis, compilation information, and physical location of the structure. Because the project will integrate data from the entire United States, the database requires that each structure have a unique number (in the text, fault numbers are enclosed by square brackets, such as [785]). Names are determined from the literature and from common usage. Although some structures in different regions have the same or similar names, no attempt was made to avoid duplications. Geologic data include geologic setting, geomorphic expression, and age of faulted deposits, all in descriptive form. Additional paleoseismologic data include descriptions of published detailed studies (*i.e.*, trenching) and estimates of recurrence intervals. Field names are shown in bold and are defined in Definition of Terms and Glossary (see also, general guidelines published in Haller and others (1993 #655)).

We define four categories of faults and folds included in the database (Classes A-D; see definition of "structure category" in Definition of Database Terms and Glossary), based on demonstrable evidence of Quaternary tectonic movement. Class A and B features are shown on the map and described in the database. Class A features are structures of tectonic origin with demonstrable Quaternary displacement. Class B features are either (1) structures of nontectonic origin, such as faults associated with volcanic activity, or (2) tectonic faults with equivocal evidence of Quaternary displacement. A third group of structures include faults or other geologic features that we have intentionally excluded from the national map and database. These include Class C features, which are those where geologic evidence is insufficient to demonstrate (1) the existence of a tectonic fault, or (2) Quaternary slip or deformation associated with a known fault. Eighteen features in Oregon have been included in this category; they are briefly described in the text and listed in Table 2, but are not shown on the map. These features are mostly structures associated with volcanic activity or faults included in previous compilations where no evidence of displacement in Quaternary deposits has been demonstrated. Class "D" features are those where geologic evidence demonstrates that the feature is not a tectonic fault; this category includes features such as joints or joint zones, landslides, erosional or fluvial scarps, and lacustrine shorelines. No examples of Class D features are included in this compilation.

Compilations such as this one allow comparisons of spatial and temporal patterns of faulting at local, regional, and national scales. However, a database is a useful tool only if it represents a systematic collection of data. With this in mind, we favor published or publicly accessible data and reference it as completely as possible. We try to include all pertinent data, especially where data conflict. Where multiple interpretations exist in the literature, we use a hierarchy that defines what data will be presented in the primary database fields in order to achieve consistency. We give highest priority to fault-related studies, particularly those addressing the Quaternary history of a fault (*i.e.*, paleoseismic investigations), over general geologic studies (*i.e.*, bedrock mapping). In most cases, more recent studies are given priority, although older studies can be quite helpful. Faults and folds based on detailed mapping (*e.g.*, 1:24,000 scale) are given priority over structures mapped with less detail (*e.g.*, 1:250,000 scale). Even though we give the most weight to recent studies of Quaternary faulting (*i.e*., paleoseismology), interpretations based on other types of studies are summarized in the "Comments" fields.

The vast majority of the 131 Quaternary structures or groups of structures in Oregon (table 1) are characterized by limited investigations. In order to accommodate large differences in the level of study from fault to fault, we established three types of fault descriptions to simplify data compilation and readily convey the level of current knowledge (Haller and others, 1993 #655). All structures are described as either simple faults, faults having sections, or faults having segments. In general, simple faults are poorly known, have few or no paleoseismologic studies, are characterized by a single time datum and slip-rate category for most of their length, and are typically less than 20-30 km in length. At the other end of the spectrum are segmented faults—those comprised of multiple seismogenic or structural parts that may act independently of one another during large surface-rupturing earthquakes. By our standards and definitions (Haller and others, 1993 #655), the timing of surface-rupturing events on segments of a fault must be well established through trenching and dating studies or the presence of historical surface ruptures, and there should be supporting geomorphologic and geologic data (scarp morphology, stratigraphic control on times of faulting, geologic structures that may control physical segmentation, etc.). In some cases, pronounced contrasts in the geomorphic expression of faulting along strike combined with paleoseismic studies that define the chronology of the youngest events on the fault are sufficient to permit discussion of the structure in terms of segments. However, many historic surface-rupturing earthquakes appear to rupture multiple segments, so we instead categorize all longer, more complex faults zones in Oregon as sectioned faults. This third category is used to characterize faults into discrete groups or pieces, without the inference of rupture independence. Sections may be defined on the basis of relative-age criteria, fault geometry, the presence or absence of morphologic differences in fault scarps, trench paleoseismic data, or from other geologic or geophysical (i.e. gravity, etc.) data. Thirteen of the 131 faults in this compilation are described as sectioned faults. The simple faults are shown on the map and listed in the database by a three-digit numeric identifier (*e.g.*, [785]); the sectioned faults are identified by an additional lowercase alpha character (*e.g.*, [831a, 831b, 831c], etc.). The alpha characters (a,b,c etc.) are unique to each of the sections; "a" is assigned to the northernmost or westernmost section and sequentially lettered.

## Synopsis of Quaternary Faulting and Folding in Oregon

### Sources of Data

Some Quaternary faults and folds in Oregon are included in nationwide compilations of Howard and others (1978 #312) and Nakata and others (1982 #147), and most others are included in statewide compilations of Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), Madin and Mabey (1996 #3575), and Weldon and others (2002 #5648). These compilations are traditional map products that show location and estimated age of youngest displacement. The compilation of Pezzopane (1993 #3544) is based primarily on interpretation of landforms on small-scale aerial photographs and limited field work; the compilations of Geomatrix Consultants, Inc. (1995 #3593) and Madin and Mabey (1996 #3575) were primarily office compilations based on the results of Pezzopane (1993 #3544). The compilation of Weldon and others (2002 #5648) is an update of Pezzopane (1993 #3544) based on evaluation of 1:100,000-scale DEMs of central and eastern Oregon. Offshore faults mapped with geophysical techniques are included in the compilation of Goldfinger and others (1992 #464). Other regional compilations are focused primarily on seismic hazard assessment studies of the Portland metropolitan area (Wong and others, 1999 #4073; 2000 #5137) and dams for the U.S Army Corps of Engineers (1981 #3481; 1981 #3483; 1982 #3482; 1983 #3480; 1983 #3484; 1983 #3485) and the U.S. Bureau of Reclamation

(Geomatrix Consultants Inc., 1988 #1311; Hawkins and others, 1988 #2946; Geomatrix Consultants Inc., 1989 #1310; Hawkins and others, 1989 #2947; Geomatrix Consultants Inc., 1989 #3546; Hawkins and others, 1989 #3548; Hawkins and others, 1989 #3551; Hawkins and others, 1990 #3731; Geomatrix Consultants Inc., 1990 #5550; Hawkins and others, 1992 #3730; Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594; Wong and others, 1999 #5654; Ake and others, 2001 #5035). A few detailed studies have been conducted on faults in Oregon, but our descriptions of most faults come from reconnaissance compilations of Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Weldon and others (2002 #5648).

**Overview of Quaternary Tectonic Setting**

Oregon has one of the most complex tectonic settings of any state in the Union. Numerous complex folds and faults associated with the plate-bounding Cascadia subduction zone dominate the structural setting offshore of western Oregon. In western Oregon, forearc uplifts of the Oregon Coast Range and Klamath Mountains, the forearc downwarp that forms the Willamette Valley, and the western part of the Cascade volcanic arc contain few mapped Quaternary faults, but dense forest cover in these regions obscures evidence of unmapped structures. A few faults mark north-striking grabens along the crest of the active High Cascades volcanic arc. The back-arc region of central and eastern Oregon is characterized by complex interactions between southward directed thrusting and strike-slip faulting associated with the Yakima fold belt, east-west extension associated with Basin-and-Range style normal faulting, and northwest striking dextral shear related to translation along the North American/Pacific plate boundary (Wells and Heller, 1988 #4334; Pezzopane and Weldon, 1993 #149; Mann and Meyer, 1993 #3535; Hemphill-Haley, 1999 #4338).

Historical seismicity in Oregon is diffuse and shows little relationship to most mapped Quaternary faults; no surface-rupturing earthquakes have occurred since European settlement of the region began in the early 1800's (e.g. Ludwin and others, 1991 #4183; Rogers and others, 1996 #4191). The largest recorded earthquakes in onshore Oregon include the 1936 Milton-Freewater earthquake along the Oregon/Washington border (M 5.8-6.4, Noson and others, 1988 #4335), the 1968 earthquake swarm near Adel in southern Oregon (Mb 5.1, Patton, 1985 #3515), the 1993 Scotts Mills earthquake south of Portland (ML 5.7, Thomas and others, 1996 #4002), and the 1993 earthquake swarm near Klamath Falls (ML 5.9, 6.0, Sherrod, 1993 #3510). Perhaps the most unusual pattern of historical seismicity is the lack of earthquakes along the Cascadia subduction zone in western and offshore Oregon (Ludwin and others, 1991 #4183; Rogers and others, 1996 #4191), despite abundant geologic evidence of multiple large to great megathrust earthquakes in the Holocene (e.g. Atwater and others, 1995 #4215; Clague, 1997 #5042).

This database includes 131 described Quaternary folds, faults, fault zones, and groups of faults having similar characteristics which collectively consist of hundreds of individual structures with surface expression. Nearly half of the faults and folds in this compilation have most-recent displacements in the late or latest Quaternary (<130 ka). The most active structures are concentrated offshore along the Cascadia subduction zone [781 through 799]. Most of the other young faults are located in eastern Oregon, where they form northeast-and northwest-striking horst and graben systems in southern Oregon (e.g. Klamath graben faults [843], Winter Rim fault system [831], Abert Rim fault [829], Steens fault zone [856], and Santa Rosa fault system [1508]), and northwest-striking systems (e.g. Grande Ronde Valley faults [709, 802, and 803], Juniper Mountain fault [805], and Cottonwood Mountain fault [806]) in northeastern Oregon. Unfortunately, the lack of detailed studies on most of these younger faults prevents detailed discussion of slip rates and recurrence intervals.

Faults and folds classified as Quaternary (<1.6 Ma) or middle and late Quaternary (<750 Ma) are scattered throughout the state. Some probably represent structures with little Quaternary displacement; most of these are classified as class B structures. Other faults may owe their apparent quiescence to a lack of detailed studies and/or to poor preservation of fault-related landforms, particularly in the wet environment of western Oregon and in volcanic terrains with little Quaternary cover in central and eastern Oregon. Further detailed field studies of Quaternary faults are needed to expand our knowledge of seismic hazards throughout the state.

## Acknowledgments

This work was supported by the National Earthquake Hazards Reduction Program (NEHRP). The authors appreciate the assistance of numerous individuals who either supplied information for or reviewed parts of the report. In particular, we are grateful to Ian Madin for a careful and constructive review of the entire manuscript, Bob Yeats, Harvey Kelsey, and Alan Nelson for reviews of faults in western Oregon, Fred Hawkins and Ray Weldon for reviews of faults in central and eastern Oregon, Chris Goldfinger, Pat McCrory, and Ralph Haugerud for assistance with the offshore or DEM data, Silvio Pezzopane for providing a copy of his thesis map, and Rus Wheeler for numerous helpful suggestions on the application of the map data to hazards investigations.

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## Definition of Database Terms and Glossary

Specialized fields provide abstracted data, most of which will be in searchable fields when the digital database is implemented. In addition to the specialized fields, more detailed information is provided in the "Comments" sections. If no pertinent information was found in the published literature for a field, we show "None" or "Not Reported". The following descriptions provide definitions of fields (in alphabetic order) and indicates where various information, if known, can be found. We have also included definitions of commonly used geologic and seismologic terms. However, not all terms shown listed are used herein, since the glossary was assembled for descriptions of faults and folds in the entire United States. Definitions are derived from modern English-language dictionaries, the AGI Glossary of Geology, the Encyclopedia of Geomorphology, Southern California Earthquake Center (SCEC) web pages, and other sources.

**1° x 2° (AMS) sheet [database field]** Name of the Army Map Service (AMS)/U.S. Geological Survey map where structure is located. If the structure is mapped in more than one quadrangle, the name of the quadrangle in which the majority of the structure is located is listed first, followed by quadrangle name(s) for the remainder of the structure. These sheets were used as base maps because they cover the entire United States at a convenient regional scale of 1:250,000. Within the conterminous United States, the sheets are 1° x 2° (N-S and W-E); however, in Alaska the sheets are 1° x 3°.

**Age of faulted or folded deposits [database field]** This field includes the ages of faulted or folded deposits *found at the surface*. These ages mostly are from geologic mapping studies, but in a few cases they may be from descriptions in published reports. In some cases, the age of faulted deposits may not agree with the time of the most recent paleoevent. This inconsistency may arise because of the manner in which particular studies are given preferable citation based on recency and scope of the study.

**alluvium** Loose sediment composed of clay, silt, sand, and gravel. Material is transported from upland areas (hills and mountains) and deposited in low areas by streams.

**alluvial fan** A low, gently sloping mass of alluvium that is shaped like an open fan. Commonly deposited where streams issue from steep, narrow mountain valleys onto broad, gently sloping valley floors. Similar terms are bajada (coalesced alluvial fans) and piedmont slope (broad gently sloping surface mantled by relatively thin alluvium).

**Alquist-Priolo Act** California seismic zoning act passed in 1972 in response to the 1971 San Fernando earthquake in order to prevent building across the traces of active faults. More information about the Alquist-Priolo Earthquake Fault Zoning Act and Earthquake Fault Zone maps is available from the California Division of Mines and Geology (http://www.consrv.ca.gov/dmg/rghm/a-p/ap-intro.htm).

**anticline** A fold, usually convex upward, in which rocks in the core are older than those on the flanks.

**Average strike [database field]** The average strike of the trace of the structure in degrees is computed from GIS software and is recorded for faults and fold axes. The strikes are confined to the northwest and northeast quadrants of the compass and are reported as -90° to 90° values, respectively.

**Basin-and-Range structure** A type of geologic structure characterized by generally subparallel normal-fault-bounded mountains separated by broad alluvium-filled basins. The ranges have been uplifted relative to the valleys along range-front and related intrabasin faults.

**blind thrust fault** A thrust fault that does not rupture all the way to the ground surface. Movement along the fault produces uplift in the form of an anticline, but a clear or continuous surface rupture is not recognized. Many Quaternary blind thrust faults are thought to be present in southern California, and some have been inferred in coastal and offshore Oregon.

**Comments [database field]** Narrative comments are provided for many of the database fields that are limited to numerical data or prescribed choices.

**Compiler and affiliation [database field]** The name and affiliation of the person(s) primarily responsible for compilation or revision of the database record of the subject structure. Full names and address of these compilers are shown in the list of contributors.

**County [database field]** County or counties in which the structure is located. If the structure is in more than one county, the county containing the majority of the structure is listed first, followed by county name(s) for the remainder of the structure. In cases where the features encompass numerous counties, the counties are listed alphabetically by state.

**creep** Relatively slow movement along a fault. It is sometimes called "seismic creep" to distinguish it from the slumping of rock or soil on slopes, which is also known as creep. It is sometimes called "aseismic creep", since it does not trigger events greater than microearthquakes. Creep is only known to occur on strike-slip faults.

**Date of compilation [database field]** This field shows when data were compiled or revised for this project (*e.g*., 03/13/98; month/day/year).

**detachment fault** A low-angle to sub-horizontal fault into which more steeply dipping fault(s) commonly merge. The term originally applied to the sole fault of thrust-fault systems in compressional terrains, however, the term is now generally associated with normal-fault systems in extensional terrains.

**Dip [database field]** The angle at which a planer feature (bedding or fault) is inclined from horizontal. Listed as a numerical value of dip or range of dip values. These data may represent near-surface measurements at specific locations or theoretical (based on cross sections or geophysical modeling) subsurface dips. Additional data, such as approximate location and the type of material in which the fault is exposed, may be included in "Comments". (See also **Main dip direction.**)

**dip-slip fault** A fault characterized by predominantly vertical displacement in which the hanging wall moves parallel to the dip of the fault. On normal faults, the hanging wall moves downward with respect to the footwall, and on reverse faults, the hanging wall moves upward with respect to the footwall of the fault. (Compare strike-slip fault.)

**dip-slip fault movement** Slip that is parallel to the dip of the fault. Normal slip and reverse slip are opposite senses of dip-slip movement and describe movement of the hanging wall block down and up the fault plane, respectively. (Compare strike-slip fault movement.)

**dextral** Horizontal displacement along a fault such that, in plan view, the side opposite the viewer appears to have moved to the right. This term is also known as right-lateral.

**early Quaternary** The early part of the Quaternary era, between 1,600,000 years and 750,000 years ago.

**epicenter** The point on the Earth's surface directly above the subterranean point of origin (hypocenter) of an earthquake; typically located by latitude and longitude.

**faceted spur** A planar surface that truncates a spur (narrow ridge) as a result of normal faulting and subsequent erosion. Also know as a triangular facet or triangular spur. These features are commonly regarded as neotectonic features, although the rates and actual processes of their formation are poorly understood.

**fault** A fracture or zone of fractures along which there has been displacement of the adjacent blocks relative to one another. There are three major types of faults: normal, reverse, and strike-slip.

**fault line** A commonly used term that is synonymous with the surface trace of a fault.

**fault strand or splay** One of several closely spaced parallel or subparallel faults in a fault zone.

**focal mechanism** The three dimensional description of the seismic waves that radiate outward from the focus (hypocenter) of an earthquake. The focal mechanism contains information on the orientation and slip on two perpendicular planes, either of which could represent the fault that ruptured to produce the earthquake. Additional information is needed to select which of the two orientations is correct.

**focus** Also known as the hypocenter, the focus of an earthquake is the point on the fault plane where rupture begins. Latitude, longitude, and depth below the ground surface define this point.

**footwall** The underlying side of a fault. If you walked on the fault plane, your foot would be on this wall. (See also hanging wall.)

**Geologic setting [database field]** This description provides a generalized perspective of the fault or fold in terms of its regional geologic setting, amount of total offset, and general age of offset strata.

**Geomorphic expression [database field]** General description of the structure's geomorphic expression including the trend, size, and shape of fault scarps, offset streams, sag ponds, shutter ridges, grabens, faceted spurs, monoclines, associated landslides, etc.

**GIS** An acronym for geographic information systems, which includes all computer software programs that allow the creation, manipulation, and output of geographically referenced data.

**GMT** An acronym for Greenwich Mean Time, which is used as the basis for a standard time scale throughout the world. The Greenwich Meridian (or prime meridian of the World) is taken as 0° longitude and is the line from which all other lines of longitude are measured. Local time in most locations of the United States is 5-9 hours earlier than GMT. Seismologists may refer to UTC (Universal Coordinated Time), which is the same as GMT.

**graben** An elongate downdropped block bounded by faults on its long sides.

**hanging wall** The overlying side of a fault: this is the part that "hangs" above the fault plane. (See also foot-wall.)

**Holocene** The most recent epoch of the Quaternary period of geologic time. The Holocene was preceded by the Pleistocene epoch. For this report, the Holocene is considered to span the time interval from 10,000 years ago to the present.

**horst** An elongate uplifted block bounded by faults on its long sides.

**hypocenter** Also known as the focus, the hypocenter of an earthquake is the point on the fault plane where rupture begins. This point is defined by latitude, longitude, and depth below the ground surface.

**intensity** A measure of the level of earthquake shaking at a specific location. The dominant intensity system used in the U.S. is the Modified Mercalli intensity (MMI) scale. The magnitude of an earthquake is related to the total energy released by the event; an earthquake has only a single magnitude value. The shaking at the earth's surface produced by an earthquake decreases with distance form the epicenter and, therefore, an earthquake has many different intensities.

**isoseismal map** A contour map showing the distribution of intensities for an earthquake. Isoseismal lines divide areas of equal intensity from one another on an isoseismal map.

**isoseisms (or isoseismal lines**) Lines connecting points at which the intensity for an earthquake is the same.

**ka** An abbreviation for kilo-annum, which is the Latin term for "thousand years" ago. This abbreviation is commonly used when referring to the age of a geologic unit or time of an event with respect to the present time (for example, the event occurred between 2 ka and 4 ka). Note that "ago" is implied by ka, and need not be stated (contrast k.y.).

**k.y.** An abbreviation for kilo-years or "thousands of years." This abbreviation is commonly used when referring to an interval of time; for example, the event occurred 10 k.y. after deposition of the alluvium (contrast ka).

**late Quaternary** The latter part of the Quaternary era. Late Quaternary refers to the time between 130,000 years ago and the present.

**lateral fault or lateral-slip fault** A fault that slips in such a way that the two sides move laterally or horizontally with respect to one another. These terms are generally synonymous with strike-slip faults.

**latitude** The angular distance (in degrees) north or south from the equator to a point on the earth's surface, measured on a meridian (north-south line) to the point (compare longitude).

**left lateral** Horizontal displacement along a fault such that, in plan view, the side opposite the viewer appears to have moved to the left. This term is also known as sinistral.

**Length [database field]** Two types of length data are included: (1) end-to-end length of the Quaternary-age fault or fold axis as measured along a straight line from the most distal ends of the surface trace and (2) the trace length, which is the sum of the lengths of the actual map traces. If a trace is curved, end-to-end length cuts across the curve, whereas trace length follows it. Faults with overlapping strands may have trace lengths that exceed the end-to-end length by a factor of 1.5 or more. In cases where numerous faults are collected under one description, this reported value is a "cumulative length." In cases where numerous faults are collected under one description, length is shown as "not applicable".

**lineament** A linear topographic feature, or an alignment of topographic features or other surficial features that may reflect control by the underlying geology. Some lineaments are defined by alignments of vegetation, patterns in drainage systems, subtle color changes visible on aerial photographs, or cultural features such as fence lines or power lines. Some lineaments are associated with disturbance of the ground surface by faults and folds, but others may reflect bedding, groundwater phenomenon, etc.

**liquefaction** The transformation of loose sediment or soil into a fluid state as a result of increasing the pressure of the fluid in between the grains due to strong ground shaking. Liquefaction typically occurs in poorly consolidated, water-saturated sediment, and can cause significant earthquake-related damage because structures located on ground that liquefies can collapse or sink into the ground.

**longitude** The angular distance (in degrees) east or west on the earth's surface, measured as the angle between the meridian (north-south line) of that point and the prime meridian (at Greenwich, England) (compare latitude). See also GMT.

**Ma** An abbreviation for mega-annum, which is the Latin term for "millions years" ago. This abbreviation is commonly used when referring to the age of a geologic unit or time of an event with respect to the present time (for example, the event occurred between 2 Ma and 4 Ma). Note that “ago” is implied by Ma, and need not be stated (contrast m.y.).

**magnitude** A general term for a measure of the total size of an earthquake (contrast with intensity). The size of an individual earthquake can be measured by the strength of the shaking or the duration of the shaking, both of which are directly related to the energy that is released by the earthquake. In modern seismology, the magnitude is determined from seismographic records of an earthquake. Commonly used magnitude measurements include $M_L$, $M_S$, mb, and Mw (see below).

**mb (body-wave magnitude)** The magnitude of an earthquake determined by measuring the maximum amplitude of the P-wave on a seismogram of the event. P-waves, or primary waves, are compressional waves that have the highest velocity of all waves generated by earthquakes.

**Main dip direction [database field]** General down-dip direction(s) of the structure, defined by compass octants: north (N), west (W), south (S), east (E), northwest (NW), northeast (NE), southwest (SW), southeast (SE), or vertical (V). If separate faults dip in different directions, multiple directions may be listed.

**mainshock** The largest earthquake in a series of earthquakes that cluster, both geographically and in time. To be definitively called a mainshock, it should generally be at least half a magnitude unit larger than the next largest earthquake in the series. Otherwise, the series of earthquakes may be more accurately characterized as an earthquake swarm.

**middle Quaternary** The middle part of the Quaternary era. Middle Quaternary refers to the time between 750,000 and 130,000 years ago.

**ML (local magnitude)** A numerical calculation that defines the strength (magnitude) of an earthquake based on seismograms from stations within 600 km; also commonly known as Richter magnitude. As initially defined by Charles Richter, ML represented the largest deflection of the needle on a standard seismograph at a distance of 100 km from the epicenter of a shallow earthquake recorded in southern California.

**Modified Mercalli intensity (MMI) scale** An earthquake intensity scale, originally developed by Italian seismologist Giuseppi Mercalli in 1902, which was later modified in 1931 to reflect conditions in the United States. The scale describes the effects of an earthquake in twelve categories, from I (not felt by people) to XII (total damage) (see intensity).

**MS (surface-wave magnitude)** The magnitude of an earthquake determined from surface waves on a seismogram from a teleseismic earthquake (one located more than 20° away). Surface waves are seismic waves that travel over the surface of the Earth versus than those that travel through the Earth, such as P-waves and S-waves. Ms magnitudes are measured from surface waves that have a period of about 20 seconds.

**MW (moment magnitude)** The magnitude calculated from an earthquake's total energy (seismic moment). The seismic moment is a function of the amount of slip on a fault, the area of the fault that slips, and the average strength of the rocks that are faulted. Because Mw is directly related to the energy released by an earthquake, it is a uniform means of measuring earthquake magnitude and has become the standard measure of earthquake magnitude in modern seismology.

**m.y.** An abbreviation for "millions of years." This abbreviation is commonly used when referring to an interval of time; for example, the Quaternary period lasted 1.6 m.y. (contrast Ma).

**Name** (**Structure or Section name**) **[database field]** The earliest referenced name for a fault, fold, liquefaction feature, or fault section (where appropriate) generally is given preference, except in cases where a more commonly accepted name is widely used in the recent literature. "Comments" also contains other names and references where they are used, the geographic limits of the structure as shown in this compilation; different geographic limits used in other studies are also included. Minor changes in original name may be made for reasons of clarity or consistency where appropriate.

**Neogene** A geologic time period corresponding to the later part of the Tertiary era (0-26 Ma); includes the Miocene (26-5 Ma) and Pliocene (5-1.6 Ma) epochs.

**neotectonic** The study of post Miocene (<5 Ma) structures and structural history of the Earth's crust. Commonly considered to be the study of deformation related to the current stress regime.

**normal fault** A fault characterized by predominantly vertical displacement in which the hanging wall moves downward with respect to the footwall of the fault. Generally, this type of fault is a sign of tectonic extension.

**Number [database field] Structure number** The structure (fault or fold) is assigned a number. All faults referred to by number are shown in brackets (*i.e*., [821]). References to numbers assigned to the structure in other compilations are included in "Comments". If sectioned, a lower-case alpha character is assigned to the northernmost or westernmost section of a structure (*e.g.*, 827 has three sections: 827a, 827b, and 827c).

**Number of sections [database field]** (only used for structures with sections) Numerical value for number of sections (*e.g.*, 4) defined in this compilation. "Comments" include references in which sections are discussed; if the term "segment" is used in the literature, an explanation of why "section" is used in the database is provided.

**oblique slip (also oblique fault)** Describes fault or fault motion that has a combination of lateral and vertical slip.

**Paleogene** A geologic time period corresponding to the early part of the Tertiary era (65-26 Ma); includes the Paleocene, Eocene, and Oligocene epochs.

**paleoseismology** The geologic study of prehistoric earthquakes.

**Paleoseismology studies [database field]** Includes a synopsis of detailed site-specific studies, typically those involving exploratory trenching, detailed coring, etc. Sites of morphologic studies or detailed mapping (without trenching) are not included. Study sites are numbered sequentially from north to south or west to east in the format of fault number, section letter, and site number (*e.g.*, 831a-1).

**playa** A term used primarily in the southwestern United States to describe a dry, vegetation-free, flat area at the lowest part of an undrained desert basin, underlain by stratified clay, silt, or sand, and commonly by soluble salts. Playa surfaces are occasionally covered by shallow lakes in the wettest parts of the year.

**Physiographic province [database field]** Identifies the physiographic province in which the structure is located as defined for the conterminous United States by Fenneman and Johnson (1946 #461).

**Pleistocene** The earlier of two epochs in the Quaternary period. For the purpose of this compilation, the Pleistocene epoch is considered to have begun about 1.6 million years ago and ended at the beginning of the Holocene epoch, about 10,000 years ago.

**Quaternary** The period of geologic time starting about 1.6 million years ago and continuing to the present. It is divided into two epochs: the Pleistocene and the Holocene. Pre-Quaternary refers to any time before 1.6 million years ago.

**Recurrence interval [database field]** Time interval between deformation events (faulting, folding, or liquefaction), based on historical data, or calendric or calibrated radiocarbon ages. Intervals may be reported in $^{14}C$ years, based on radiocarbon ages, or in k.y. (thousands of years), based on non-numerical methods such as stratigraphy or geomorphology. Also may include the time period for which this recurrence interval is valid (*e.g.*, 10-130 ka). Other published recurrence intervals, starting with the one that applies to the most recent time interval, are included in "Comments."

**References [database field]** Complete bibliographic citations for all references are included for each structure, and collectively for all structures in the cumulative reference list. In-text citations of references are presented in a standard USGS format with the exception of the addition of a reference-specific number. This reference number eliminates the need for the traditional alpha character for authors having multiple publications in the same year (*e.g.*, 1988a, b).

**Reliability of location [database field]** Refers to the scale of the source map from which the trace of the structure was taken and to the method by which the trace of the structure was mapped. Choices are Good or Poor. To qualify as a "Good" location, either (1) the trace of the structure was shown on a topographic base map at a scale of 1:250,000 or more detailed and was accurately located on the original map using photogrammetry or similar methods, or (2) the trace of the structure was published on a topographic base map at a scale of 1:100,000 or more detailed, but transferred without photogrammetric methods. Traces that do not meet the above standards (less detailed/smaller scale, planimetric base, transfer by inspection, etc.) constitute a "Poor" location. Judgments of reliability may not directly relate to line symbols (solid, dashed, dotted) that are used to represent the structure on geologic maps; however, all concealed or inferred faults are considered poorly located.

**reverse fault** A fault in which the displacement is predominantly vertical, and the hanging wall moves up with respect to the footwall. If the fault has a dip angle of less than 45 degrees, it is called a thrust fault. Generally, this type of fault is a sign of tectonic compression.

**Richter scale** Introduced in 1935 by Charles F. Richter, the Richter scale is based on a logarithmic expression that quantifies earthquake magnitude—typically it refers to local magnitude, but for large earthquakes, it commonly refers to surface-wave magnitude. Since the Richter scale is logarithmic, very small earthquakes (microearthquakes) can have a negative magnitude. Although the scale has no theoretical upper limit, the practical upper limit, given the strength of materials in the crust, is just below 9 for local or surface-wave magnitudes and just below 10 for moment magnitudes. (See also $M_L$, local magnitude.)

**riedel shear** A slip surface that develops in the early stage of shearing (faulting). Such shears are typically arranged en echelon, usually at inclinations of 10°-30° to the direction of relative movement.

**right lateral** Horizontal displacement along a fault such that, in plan view, the side opposite the viewer appears to have moved to the right. This term is also known as dextral.

**sag pond** A small body of water (pond) that occupies an enclosed depression or sag formed where recent fault movement has impounded drainage. Most common along strike-slip faults and in normal-fault grabens.

**scarp** A prominent, fairly linear slope or escarpment. Scarps are often produced by faulting, especially that which involves a significant amount of dip slip. However, scarps can also be caused by stream erosion, wave erosion (lake shorelines) or landsliding. Fault scarps separate adjacent ground surfaces that are at different elevations.

**Section name** (see **Name**)

**Section number** (see **Number**)

**seismic moment** A measure of the strength of an earthquake computed from the product of the area of fault rupture, the average amount of slip, and the shear modulus (rigidity) of the rocks offset by faulting. The moment can also be calculated from the amplitude spectra of seismic waves. (See also $M_W$.)

**seismic zone (or seismic belt)** A region of the Earth's crust, generally an elongated region, associated with active seismicity. It may not be associated with a particular structure.

**seismicity** Usually for a specific geographic area, the seismicity describes the geographic, depth, and magnitude distribution of earthquakes.

**seismograph** An instrument that detects, magnifies, and records earthquake and other ground motions.

**seismograms** The recording made by a seismograph in response to ground motions caused by an earthquake, explosion, or other source. Old records were recorded mechanically on paper, but modern records are recorded digitally. The seismogram's x-axis usually represents time, whereas the y-axis records ground amplitude, velocity, or acceleration.

**Sense of movement [database field]** Fault definitions based on the angle of dip of and relative movement across the fault plane: normal fault (N)—a fault in which the hanging wall moves down relative to the footwall; reverse fault (R)—a fault of greater than 45° dip in which the hanging wall moves up relative to the footwall; thrust fault (T)—a fault of less than 45° dip in which the hanging wall moves up relative to the footwall; strike-slip fault—a near-vertical fault along which the slip motion is parallel to the strike of the fault, in either a right-lateral (D, dextral) or left-lateral (S, sinistral) sense. Oblique slip faults are combinations of the above, and can be specified where the principle sense of movement is known (*e.g.*, dextral>normal). Ratios of oblique-slip components are included, where known, in order to better characterize sense of movement (*e.g.*, dextral/normal 3:1). Folds are described by their geometry (anticline, syncline, monocline) and possible relationships to underlying blind thrust or reverse faults.

**shutter ridge** A ridge formed by vertical, lateral or oblique displacement on a fault that crosses an area having ridge and valley topography, with the displaced part of the ridge "shutting in" the valley.

**sinistral** Horizontal displacement along a fault such that, in plan view, the side opposite the viewer appears to have moved to the left. This term is also known as left-lateral.

**slip rate** The rate of motion (velocity) across a fault or fold, calculated by amount of offset divided by time interval. The common units of measure are mm/yr or m/k.y. (equivalent units). The average slip rate at a point along a fault is commonly determined from geodetic measurements, displacement of manmade features, or from offset geologic features whose age can be estimated or measured. Offset is measured parallel to the predominant slip direction or estimated from the vertical or horizontal separation of geologic features.

**Slip-rate category [database field]** The primary field shows one of four slip-rate categories as determined by the compiler or based on reported slip rates: <0.2 mm/yr, 0.2-<1 mm/yr, 1-5 mm/yr, >5 mm/yr. "Unknown" precedes the suspected slip-rate category if no data on slip rates has been published. "Comments" include a synopsis of published slip rates and pertinent documentation. Generally, two types of slip rates are reported. The first type is herein termed a "geologic slip rate" and is typically derived from the age and amount of offset of geologic features. These rates are averages of slip over several to many earthquake cycles. The second type defines an interval or paleoseismic slip rate that is calculated on the basis of known times and amounts of slip for two or more prehistoric earthquakes. The latter type of data is sparse in the published literature.

**State [database field]** State or states where the structure is located. If the structure is located in more than one state, then the state in which the majority of the structure is located is listed first, followed by state name(s) in which the remainder of the structure is found.

**strike** Trend or bearing of the line marking the intersection of a fault plane or fold axis with a horizontal surface. Strike is always 90° from the direction of dip.

**strike-slip fault** A fault in which the dominant sense of motion is horizontal, parallel to the strike of the fault. Also known as a lateral-slip fault. Motion is commonly described as left-lateral (sinistral) or right-lateral (dextral). (Compare dip-slip fault.)

**strike-slip fault movement** Slip that is horizontal, parallel to the strike of the fault. Two kinds of strike slip occur: right-lateral (also referred to as dextral) and left-lateral (also referred to as sinistral). Also known as lateral-slip fault movement. (Compare dip-slip fault movement.)

**structure category** We defined four categories of faults and folds in this database (Classes A-D) based on demonstrable evidence of tectonic movement during the Quaternary. Class A and B features are shown on the map and described in the database; Class C and D features are briefly described but are not shown on the map.

| Category | Definition |
|---|---|
| A | Geologic evidence demonstrates the existence of a Quaternary fault or fold of tectonic origin, whether the structure is exposed by mapping or inferred from liquefaction or other deformational features. |
| B | Geologic evidence demonstrates the existence of Quaternary deformation, but either (1) the structure might not extend deeply enough to be a potential source of significant earthquakes, or (2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A. |
| C | Geologic evidence is insufficient to demonstrate (1) the existence of tectonic faulting or folding, or (2) Quaternary slip or deformation associated with the feature. |
| D | Geologic evidence demonstrates that the feature is not a tectonic fault or fold; this category includes features such as joints, landslides, erosional or fluvial scarps, or other landforms resembling fault scarps but of demonstrable non-tectonic origin. |

**Structure name (**see **Name)**

**Structure number (**see **Number)**

**surface rupture** The breakage of ground along the surface trace of a fault, caused by the intersection of the part of the fault that ruptured during an earthquake with the Earth's surface.

**surface trace** The intersection of a fault with the surface of the Earth.  It is sometimes, but not always, expressed at the surface by geomorphic evidence such as scarps, ridges, valleys, saddles, sag ponds, etc. Also called fault line or fault trace.

**syncline** A fold, usually concave upward, in which rocks in the core are younger than those on the flanks.

**Synopsis [database field]** Contains a concise summary of information that serves as a thumbnail sketch of what is known about the structure.

**Time of most recent prehistoric faulting or folding [database field]** The primary field shows one of four time categories in which the most recent prehistoric surface-rupturing or surface-deforming earthquake occurred based on geologically recognizable evidence of faulting, folding, or liquefaction.  The categories are (1) latest Quaternary (<15 ka), (2) late Quaternary (<130 ka), (3) late and middle Quaternary (<750 ka), and (4) Quaternary (<1.6 Ma).

**Tertiary** The earliest of two periods in the Cenozoic era of geologic time.  The Tertiary period begins at the end of the Cretaceous period (about 65 million years ago) and ends at the beginning of the Quaternary period (about 1.6 million years ago).

**thrust fault** A reverse fault of less than 45° dip in which the hanging wall moves up relative to the footwall.

**triggered slip** A poorly understood process which involves slippage on a fault located in the same region as, but not directly associated with, another fault which ruptures during a major earthquake.

**tsunami** A gravitational sea wave caused by dislocation of the seafloor, primarily triggered by earthquakes and less commonly by landslides and volcanic eruptions.

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#4335 Noson, L.L., Qamar, A., and Thorsen, G.W., 1988, Washington State earthquake hazards: State of Washington Division of Geology and Earth Resources Information Circular 85, 77 p.

#3515 Patton, H.J., 1985, P-wave fault-plane and the generation of surface waves by earthquakes in the western United States: Geophysical Research Letters, v. 12, no. 8, p. 518-521.

#2945 Pearthree, P.A., 1998, Quaternary fault data and map for Arizona: Arizona Geological Survey Open-File Report 98-24, 122 p., 1 sheet, scale 1:750,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#4191 Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., 1996, Assessing earthquake hazards and reducing risk in the Pacific Northwest—Volume 1: U.S. Geological Survey Professional Paper 1560, 306 p.

#3510 Sherrod, D.R., 1993, Historic and prehistoric earthquakes near Klamath Falls, Oregon: Earthquakes and Volcanoes, v. 24, no. 3, p. 106-120.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3942 Stickney, M.C., Haller, K.M., and Machette, M.N., 1999, Quaternary faults and seismicity in western Montana: Montana Bureau of Mines and Geology Special Publication 114, 1 sheet, scale 1:750,000.

#4002 Thomas, G.C., Crosson, R.S., Carver, D.L., and Yelin, T.S., 1996, The 25 March 1993 Scotts Mills, Oregon, earthquake and aftershock sequence—Spatial distribution, focal mechanisms, and the Mount Angel fault: Bulletin of the Seismological Society of America, v. 86, no. 4, p. 925-935.

#3481 U.S. Army Corps of Engineers, 1981, Lookout Point, Dexter Hills Creek and Fall Creek Lakes earthquake and fault study—Design memorandum 6: U.S. Army Corps of Engineers, Portland District, 100 p., 18 pls.

#3483 U.S. Army Corps of Engineers, 1981, Fern Ridge, Cottage Grove and Dorena Lakes earthquake and fault study—Design memorandum 9: U.S. Army Corps of Engineers, Portland District, 108 p., 15 pls.

#3482 U.S. Army Corps of Engineers, 1982, Lost Creek Lake earthquake and fault study—Design memorandum 24: U.S. Army Corps of Engineers, Portland District, 62 p., 12 pls.

#3480 U.S. Army Corps of Engineers, 1983, The Dalles and John Day Lakes earthquake and fault study—Design memorandum 26: U.S. Army Corps of Engineers, Portland District, 66 p., 19 pls.

#3484 U.S. Army Corps of Engineers, 1983, Cougar and Blue River Lakes earthquake and fault study—Design memorandum 19: U.S. Army Corps of Engineers, Portland District, v. 19, 90 p., 11 pls.

#3485 U.S. Army Corps of Engineers, 1983, Detroit and Big Cliff Lakes earthquake and fault study—Design memorandum 4: U.S. Army Corps of Engineers, Portland District, 93 p., 13 pls.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#4334 Wells, R.E., and Heller, P.L., 1988, The relative contribution of accretion, shear, and extension to Cenozoic tectonic rotation in the Pacific Northwest: Geological Society of America Bulletin, v. 100, p. 325-338.

#3441 Widmann, B.L., Kirkham, R.M., and Rogers, W.P., 1998, Preliminary Quaternary fault and fold map and database of Colorado: Colorado Geological Survey Open-File Report 98-8, 331 p., 1 pl., scale 1:500,000.

#5654 Wong, I., Dober, M., Hemphill-Haley, M., Naugler, W., Silva, W.J., and Li, S., 1999, Probabilistic seismic hazard analysis and safety evaluation earthquake ground motions—Bully Creek Dam, Vale Project, eastern Oregon: U.S. Department of the Interior, Bureau of Reclamation Technical Memorandum D8330-99-28.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

## Fault and Fold Database

The following discussions of Quaternary faults and folds in Oregon are organized by the number we have assigned to the structure. If a fault or fold is present in more than one state, the number was assigned from that state in which the majority of the structure lies. For example, the East Pueblo Valley fault [1490] is located primarily in Nevada, so it retains the number assigned to the fault in the Nevada compilation.

## 580, Faults near The Dalles

**Structure Number** 580

Comments:

**Structure Name** Faults near The Dalles

Comments: Several northwest-striking faults have been mapped by various authors near The Dalles in southern Washington and northern Oregon (Beaulieu, 1977 #3726; Swanson and others, 1981 #3496; Bela, 1982 #3584; U.S. Army Corps of Engineers, 1983 #3480; Anderson, 1987 #3492; Walsh and others, 1987 #3579; Tolan and Reidel, 1989 #3765; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). Two of these faults are named. The Warwick fault is the easternmost fault included in this group, and the two westernmost faults are part of the Little White Salmon River fault zone (Bela, 1982 #3584; Anderson, 1987 #3492; Tolan and Reidel, 1989 #3765).

**Synopsis** Faults near The Dalles in northern Oregon and southern Washington are northwest-trending, right-lateral strike-slip and minor normal faults. These faults offset Miocene and Pliocene volcanic and sedimentary rocks near the southern margin of the Yakima fold belt. No scarps on Quaternary deposits have been described, but these faults form prominent regional lineaments that suggest they may have undergone Quaternary displacement.

**Date of compilation** December 13, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Washington and Oregon

**County** Skamania, Klickitat (WA), Hood River, Wasco, and Sherman (OR)

**1° x 2° sheet** The Dalles

**Province** Columbia Plateaus (Walla Walla Plateau); Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale compilations of Korosec (1987 #4658) and Weldon and others (2002 #5648).

**Geologic setting** Faults near The Dalles are northwest-trending, right-lateral strike-slip and minor normal faults formed in Miocene Columbia River basalts and Miocene and Pliocene sedimentary rocks near the southern margin of the Yakima fold belt (Beaulieu, 1977 #3726; Swanson and others, 1981 #3496; Bela, 1982 #3584; Anderson, 1987 #3492; Walsh and others, 1987 #3579; Tolan and Reidel, 1989 #3765; Walker and MacLeod, 1991 #3646).

**Sense of movement** D, N?

Comments: Northwest-striking structures near The Dalles are mapped as right-lateral strike-slip faults (Anderson, 1987 #3492; Pezzopane, 1993 #3544), although some of these faults were mapped as normal faults in earlier compilations (Swanson and others, 1981 #3496; Bela, 1982 #3584; Walsh and others, 1987 #3579).

**Dip** 90°?

Comments: No actual dip measurements have been published, but these faults have very straight map traces that are suggestive of near-vertical dips.

**Main dip direction** None

**Geomorphic expression** No data on the geomorphic expression of these faults has been published, but they form prominent lineaments in the landscape that may suggest some Quaternary displacement.

**Age of faulted deposits at the surface** Faults near The Dalles offset Miocene and Pliocene volcanic and volcaniclastic sedimentary rocks (Beaulieu, 1977 #3726; Swanson and others, 1981 #3496; Bela, 1982 #3584; Walsh and others, 1987 #3579; Korosec, 1987 #4658; Walker and MacLeod, 1991 #3646). Anderson (1987 #3492) described possible faulting of 0.84 Ma intracanyon basalt flows across the Warwick fault, but no other details of offset Quaternary deposits have been published.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: No evidence of Quaternary displacement has been described along faults near The Dalles in Oregon, but in Washington, Anderson (1987 #3492) described possible faulting of 0.84 Ma intracanyon basalt flows across the Warwick fault. U.S. Army Corps of Engineers (1983 #3480) used regional structural relationships to infer early Quaternary (0.5-2.0 Ma) displacement on some of these faults in Washington. Geomatrix Consultants, Inc. (1990 #3550) inferred that most faults near The Dalles were not active. Pezzopane (1993 #3544) and two subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) classified these and several other faults with similar trend in the area as active in the Quaternary (<1.6-1.8 Ma). In a more recent compilation, Weldon and others (2002 #5648) assigned Quaternary (<1.6 Ma) ages to four faults in this area. The mapping of Weldon and others (2002 #5648) is used herein until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip data in Quaternary deposits are available for the faults near The Dalles. The lack of unequivocal evidence of faulting in Quaternary deposits suggests low rates of Quaternary slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 54.3 |
| | Cumulative trace (km): | 96.7 |

Comments:

**Average strike** (azimuth) N 38° W

**References**

#3492 Anderson, J.L., 1987, The structural geology and ages of deformation of a portion of the southwest Columbia Plateau, Washington and Oregon: University of Southern California, unpublished Ph. D dissertation, 283 p., 7 pls., scale 1:24,000.

#3726 Beaulieu, J.D., 1977, Geologic hazards of parts of northern Hood River, Wasco, and Sherman Counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 91, 95 p., 11 pls., scale 1:125,000.

#3584 Bela, J.L., 1982, Geologic and neotectonic evaluation of north-central Oregon—The Dallas 1 x 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geologic Map Series GMS-27, 2 sheets, scale 1:250,000.

#3550 Geomatrix Consultants Inc., 1990, Seismotectonic evaluation of Wasco Dam site: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, under Contract 6-CS-81-07310, 115 p., 2 pls., scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#4658 Korosec, M.A., 1987, Geologic map of the Hood River Quadrangle, Washington and Oregon: Washington Division of Geology and Earth Resources Open-File Report 87-6, 42 p., scale 1:100,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

#3765 Tolan, T.L., and Reidel, S.P., 1989, Structure map of a portion of the Columbia River flood-basalt Province, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, 1 sheet, scale 1:500,000.

#3480 U.S. Army Corps of Engineers, 1983, The Dalles and John Day Lakes earthquake and fault study—Design memorandum 26: U.S. Army Corps of Engineers, Portland District, 66 p., 19 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3579 Walsh, T.J., Korosec, M.A., Phillips, W.M., Logan, R.L., and Schasse, H.W., 1987, Geologic map of Washington-southwest quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-34, 28 p. pamphlet, 2 sheets, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**708, Unnamed faults near Jaussaud Creek**

**Structure Number** 708

Comments:

**Structure Name** Unnamed faults near Jaussaud Creek

Comments: These two unnamed faults are located near Jaussaud Creek in the Blue Mountains of northeastern Oregon.

**Synopsis** The unnamed faults near Jaussaud Creek are north-northeast-trending, down-to-the-east? normal faults, primarily mapped in Miocene Columbia River Basalt Group rocks in the Blue Mountains of northeastern Oregon. No evidence of fault scarps on Quaternary deposits has been described, but airphoto and DEM analysis has been used to infer middle to late Quaternary displacement.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Wallowa, Union

**1° x 2° sheet** Grangeville

**Province** Columbia Plateaus (Blue Mountain section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** Faults near Jaussaud Creek are mapped mostly in Miocene basalts of the Columbia River Basalt Group (Walker, 1979 #3576; Swanson and Wright, 1983 #5037; Walker and MacLeod, 1991 #3646). The fault traces mapped by Pezzopane (1993 #3544) and Weldon and others (2002 #5648) are similar to but do not precisely coincide with several mapped faults in this area; Walker (1979 #3576), Swanson and Wright (1983 #5037), and Walker (1991 #3646) map north-trending faults with both east and west dips in this area.

**Sense of movement** N

Comments: Faults near Jaussaud Creek are mapped as high-angle or normal faults (Walker, 1979 #3576; Swanson and Wright, 1983 #5037; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544).

**Dip** Not Reported

Comments:

**Main dip direction** E?

Comments: Pezzopane (1993 #3544) maps these faults down-east, but similar faults mapped in the same general location have both east and west dips (Walker, 1979 #3576; Swanson and Wright, 1983 #5037; Walker and MacLeod, 1991 #3646).

**Geomorphic expression** The geomorphic expression of these faults has not been described, and the fault traces as mapped by Pezzopane (1993 #3544) and Weldon and others (2002 #5648) are not marked by significant escarpments or linear features on 1:24,000-scale topographic maps.

**Age of faulted deposits at the surface** Faults near Jaussaud Creek are mapped mostly in Miocene basalts of the Columbia River Basalt Group, and are not shown offsetting Quaternary deposits on existing geologic maps (Walker, 1979 #3576; Swanson and Wright, 1983 #5037; Walker and MacLeod, 1991 #3646).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle to late Quaternary (<750 ka)

Comments: No existing geologic maps show these faults cutting Quaternary deposits (Walker, 1979 #3576; Swanson and Wright, 1983 #5037; Walker and MacLeod, 1991 #3646) but Pezzopane (1993 #3544) used airphoto reconnaissance and Weldon and others (2002 #5648) used reconnaissance of airphotos and 1:100,000-scale DEMs to infer middle to late Quaternary (<700-780 ka) displacement.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip data have been published on these faults. Their lack of significant geomorphic expression in Miocene bedrock suggests low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 5.8 |
| | Cumulative trace (km): | 11.1 |

Comments:

**Average strike** (azimuth) N 18° E

**References**


#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5037 Swanson, D.A., and Wright, T.L., 1983, Geologic map of the Wenaha Tucannon Wilderness, Washington and Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-1536, 1 sheet, scale 1:48,000.

#3576 Walker, G.W., 1979, Reconnaissance geologic map of the Oregon part of the Grangeville quadrangle, Baker, Union, Umatilla, and Wallowa Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1116, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**709, South Grande Ronde Valley faults**

**Structure Number** 709

Comments: These structures are part of fault number 13 of Pezzopane (1993 #3544).

**Structure Name** South Grande Ronde Valley faults

Comments: Numerous northwest-striking faults in the southern Grande Ronde Valley were originally mapped by Hampton and Brown (1964 #3491), and later summarized by Newcomb (1970 #3761), Walker (1979 #3576; 1991 #3646), and Barrash and others (1980 #3570). Named faults include the High Valley, Catherine Creek, and Pyle Canyon faults of Hampton and Brown (1964 #3491). Faults in the southern Grande Ronde Valley have been included in numerous reconnaissance Quaternary fault investigations and compilations (Geomatrix Consultants Inc., 1989 #1310; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594).

**Synopsis** These faults form several northwest-striking fault blocks with escarpments up to 200 m high on Miocene volcanic rocks in the southern part of the Grande Ronde Valley. No details of the geomorphic expression of these faults have been published, but they are mapped in places juxtaposing Quaternary alluvial deposits against bedrock. The limited available data have been used to infer middle and late Quaternary movement on some faults, and Quaternary movement on other faults in this part of the Grande Ronde Valley.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Union

**1° x 2° sheet** Grangeville

**Province** Columbia Plateaus (Blue Mountains section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Simpson and others (1993 #3596) and Weldon and others (2002 #5648).

**Geologic setting** These faults form several northwest-trending fault blocks in Miocene volcanic rocks in the southern part of the Grande Ronde Valley (Hampton and Brown, 1964 #3491; Walker, 1979 #3576; Barrash and others, 1980 #3570; 1991 #3646).

**Sense of movement** N

Comments: Although horizontal striations or other evidence of horizontal displacement has been observed on faults in the region (Hampton and Brown, 1964 #3491; Gehrels and others, 1980 #3774), these faults are mapped as high-angle, presumably normal faults (Hampton and Brown, 1964 #3491; Walker, 1979 #3576; Geomatrix Consultants Inc., 1989 #1310; 1991 #3646; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594).

**Dip** Not Reported

Comments:

**Main dip direction** SE

**Geomorphic expression** These faults form several northwest-trending fault blocks with escarpments up to 200 m high on Miocene volcanic rocks in the southern part of the Grande Ronde Valley (Hampton and Brown, 1964 #3491; Walker, 1979 #3576; 1991 #3646). No details of the geomorphic expression of these faults have been published, but Weldon and others (2002 #5648) observed lineaments across Quaternary units on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** These faults are mostly shown offsetting Miocene volcanic rocks on published geologic maps of the region, but in some places are shown juxtaposing Quaternary alluvial deposits against bedrock (Hampton and Brown, 1964 #3491; Newcomb, 1970 #3761; Walker, 1979 #3576; Barrash and others, 1980 #3570; 1991 #3646).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544) and Weldon and others (2002 #5648) show some of these faults as active in the middle and late Quaternary (<700-780 ka) and others as active in the Quaternary (<1.6-1.8 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No Quaternary slip rate data are available for the South Grande Ronde Valley faults, but Hampton and Brown (1964 #3491) describe offsets of 90-460 m of Miocene volcanic rocks along the High Valley, Catherine Creek, and Pyle Canyon faults. These offsets suggest low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 20.1 |
| | Cumulative trace (km): | 98.3 |

Comments:

**Average strike** (azimuth) N 39° W

**References**


#3570 Barrash, W., Bond, J.G., Kauffman, J.D., and Venkatakrishnan, R., 1980, Geology of the La Grande Area, Oregon: State of Oregon, Department of Geology and Mineral Industries Special Paper 6, 47 p., 5 pls., scale 1:24,000.

#3774 Gehrels, G.E., White, R.R., and David, G.A., 1980, The La Grande pull-apart basin, northeastern Oregon: Geological Society of America Abstracts with Programs, v. 12, no. 3, p. 107.

#1310 Geomatrix Consultants Inc., 1989, Final report seismotectonic evaluation for Mann Creek Dam site and Mason Dam site: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, Colorado, under Contract 6-CS-81-07310, October 1989, 118 p., 2 pls.

#3491 Hampton, E.R., and Brown, S.G., 1964, Geology and ground-water resources of the Upper Grande Ronde River Basin Union County, Oregon: U.S. Geological Survey Water-Supply Paper 1597, 99 p., 6 pls.

#3594 Knudsen, K.L., Wong, I.G., Bott, J.D.J., Weber, G.E., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Agency Valley and Bully Creek Dams, Vale Project, east-central Oregon: Draft Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 171 p., 4 pls.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3576 Walker, G.W., 1979, Reconnaissance geologic map of the Oregon part of the Grangeville quadrangle, Baker, Union, Umatilla, and Wallowa Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1116, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**710, Ukiah Valley faults**

**Structure Number** 710

Comments:

**Structure Name** Ukiah Valley faults

Comments: These faults are named after and form the northern and southern margins of the Ukiah Valley in north-central Oregon. The two prominent faults that form the margins of the valley were informally named the North Ukiah fault and the South Ukiah fault by Piety and others (1990 #3733).

**Synopsis** The Ukiah Valley faults form a northwest-striking graben filled with Tertiary and Quaternary sediment in Miocene Columbia River Basalt Group rocks in north-central Oregon. The ages of these faults is poorly known, but linear features and possible drainage anomalies have been observed in airphoto reconnaissance of these faults. No field studies have been described, but the limited available data have been used to infer middle and late Quaternary displacement.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Umatilla

**1° x 2° sheet** Pendleton

**Province** Columbia Plateaus (Blue Mountains)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648).

**Geologic setting** The Ukiah Valley faults form a northwest-striking graben filled with Tertiary and Quaternary sediment in Miocene Columbia River Basalt Group rocks in north-central Oregon (Newcomb, 1970 #3761; Walker, 1973 #3756; Walker and MacLeod, 1991 #3646; Ferns and others, 2001 #5135).

**Sense of movement** N

Comments: These faults are shown as high-angle, presumably normal faults on maps of the region (Newcomb, 1970 #3761; Walker, 1973 #3756; Geomatrix Consultants Inc., 1989 #3546; Piety and others, 1990 #3733; Walker and MacLeod, 1991 #3646; Simpson and others, 1993 #3596; Ferns and others, 2001 #5135).

**Dip** Not Reported

Comments:

**Main dip direction** SW, NE

**Geomorphic expression** The North Ukiah and South Ukiah faults form the margins of the Ukiah Valley and form 100- to 200-m-high escarpments on Miocene volcanic rocks. Piety and others (1990 #3733) observed clearly visible linear features and possible drainage anomalies on 1:58,000-scale airphotos, but no field reconnaissance of these faults has been described.

**Age of faulted deposits at the surface** No detailed studies of these faults have been published, so the ages of faulted deposits are poorly known. The faults mostly are mapped in rocks of the Miocene Columbia River basalt Group, but in a few places may juxtapose either Quaternary or Tertiary sediment against bedrock (Newcomb, 1970 #3761; Walker, 1973 #3756; Walker and MacLeod, 1991 #3646; Ferns and others, 2001 #5135).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: The age of most-recent faulting on the Ukiah Valley faults is poorly known because no field studies of these faults have been described. Based on airphoto reconnaissance, Piety and others (1990 #3733) considered these faults possible seismic sources, and Weldon and others (2002 #5648) used analysis of airphotos and 1:100,000-scale DEMs to infer middle and late Quaternary (<780 ka) displacement.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No Quaternary slip rate data are available for the Ukiah Valley faults, but offsets of a few hundred meters of Miocene volcanic rocks suggest low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 32.0 |
| | Cumulative trace (km): | 56.7 |

Comments:

**Average strike** (azimuth) N 61° W

**References**


#5135 Ferns, M.L., Madin, I.P., and Taubeneck, W.H., 2001, Reconnaissance geologic map of the La Grande 30' X 60' quadrangle, Baker, Grant, Umatilla, and Union counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Reconnaissance Map Series RMS-1, 1 pl., scale 1:100,000.

#3546 Geomatrix Consultants Inc., 1989, Seismotectonic evaluation of Mann Creek and Mason Dam sites: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, under Contract 6-CS-81-07310, 118 p., 2 pls., scale 1:250,000.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3733 Piety, L.A., LaForge, R.C., and Foley, L.L., 1990, Seismic sources and maximum credible earthquakes for Cold Springs and McKay Dams, Umatilla Project, north-central Oregon: U.S. Bureau of Reclamation Seismotectonic Report 90-1, 62 p., 1 pl.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3756 Walker, G.W., 1973, Reconnaissance geologic map of the Pendleton quadrangle, Oregon and Washington: U.S. Geological Survey Miscellaneous Geologic Investigations I-727, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 711, Sumpter Valley faults

**Structure Number** 711

Comments:

**Structure Name** Sumpter Valley faults

Comments: These faults are named after Sumpter Valley, a small northwest-trending valley in north-central Oregon (Geomatrix Consultants Inc., 1989 #1310).

**Synopsis** These normal faults appear to offset Quaternary alluvium on the north flank of Sumpter Valley, which is formed in Mesozoic and Paleozoic metamorphic rocks and Tertiary volcanic and volcaniclastic rocks in northeastern Oregon. The faults form an en echelon series of scarps with as much as 25 m of relief on inferred Tertiary or Quaternary gravels north of the Powder River. The age of most-recent faulting on the Sumpter Valley faults is poorly known. Possible Holocene displacement has been inferred on the westernmost of the Sumpter Valley faults, based on airphoto analysis of possible faulted deposits now covered by Phillips Lake. Other studies infer middle and late Quaternary (<700-780 ka) displacement.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Baker

**1° x 2° sheet** Canyon City

**Province** Columbia Plateaus (Blue Mountains)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based in part on 1:250,000-scale mapping of Geomatrix Consultants Inc. (1989 #1310).

**Geologic setting** These faults appear to offset Quaternary alluvium on the north flank of Sumpter Valley (Geomatrix Consultants Inc., 1989 #1310), which is formed in Mesozoic and Paleozoic metamorphic rocks and Tertiary volcanic and volcaniclastic rocks (Brown and Thayer, 1966 #3577; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: These faults are shown as high-angle, presumably normal faults on maps of the region (Brown and Thayer, 1966 #3577; Geomatrix Consultants Inc., 1989 #1310; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Knudsen and others, 1994 #3594).

**Dip** Not Reported

Comments:

**Main dip direction** SW

**Geomorphic expression** The faults form an en echelon series of scarps with as much as 25 m of relief on inferred Tertiary or Quaternary gravels north of the Powder River (Geomatrix Consultants Inc., 1989 #1310). Weldon and others (2002 #5648) observed lineaments across Quaternary units on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Geomatrix Consultants Inc. (1989 #1310) conducted airphoto and limited field reconnaissance of the Sumpter Valley faults. The faults offset an extensive inferred Tertiary or Quaternary gravel deposit characterized by significant soil reddening and extensive secondary clay accumulation. The prominent westernmost scarp may also offset latest Pleistocene and Holocene sediments in Deer Creek Valley, which flows southeasterly into the Powder River; this offset was observed on airphotos flown before this part of Sumpter Valley was covered by the filling of Phillips Lake.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: The age of most-recent faulting on the Sumpter Valley faults is poorly known. Geomatrix Consultants Inc. (1989 #1310) inferred possible Holocene displacement on the westernmost of the Sumpter Valley faults, based on airphoto analysis of possible faulted deposits now covered by Phillips Lake. Pezzopane (1993 #3544) used airphoto analysis and Weldon and others (2002 #5648) used analysis of airphotos and 1:100,000-scale DEMs to infer middle and late Quaternary (<700-780 ka) displacement on the two prominent Sumpter Valley faults.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No Quaternary slip rate data are available for the Sumpter Valley faults, but offsets of 25 m in inferred Tertiary or Quaternary gravel suggest low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 12.3 |
| | Cumulative trace (km): | 22.3 |

Comments:

**Average strike** (azimuth) N 44° W

**References**

#3577 Brown, E.C., and Thayer, T.P., 1966, Geologic map of the Canyon City quadrangle northeastern Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-447, 1 sheet, scale 1:250,000.

#1310 Geomatrix Consultants Inc., 1989, Final report seismotectonic evaluation for Mann Creek Dam site and Mason Dam site: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, Colorado, under Contract 6-CS-81-07310, October 1989, 118 p., 2 pls.

#3594 Knudsen, K.L., Wong, I.G., Bott, J.D.J., Weber, G.E., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Agency Valley and Bully Creek Dams, Vale Project, east-central Oregon: Draft Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 171 p., 4 pls.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**712, Unnamed East Baker Valley faults**

**Structure Number** 712

Comments:

**Structure Name** Unnamed East Baker Valley faults

Comments: The unnamed East Baker Valley faults border the eastern margin of Baker Valley in northeastern Oregon.

**Synopsis** Several northwest-striking, down-to-the-southwest normal faults form the eastern margin of Baker Valley in northeastern Oregon. These faults juxtapose Miocene volcanic rocks and Mesozoic and Paleozoic igneous and metamorphic rocks against Quaternary alluvial deposits in Baker Valley. These faults form escarpments less than 100 m high along the eastern margin of the valley, but no detailed descriptions of these faults have been published.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Baker

**1° x 2° sheet** Baker

**Province** Columbia Plateaus (Payette and Blue Mountains sections)

**Quality of location** Good

Comments: The fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648).

**Geologic setting** Several northwest-striking, down-to-the-southwest normal faults form the eastern margin of Baker Valley in northeastern Oregon. These faults juxtapose Miocene volcanic rocks and Mesozoic and Paleozoic igneous and metamorphic rocks against Quaternary alluvial deposits in Baker Valley (Brooks and others, 1976 #3573; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments:

**Dip** Not Reported

Comments:

**Main dip direction** SW

**Geomorphic expression** These faults form escarpments less than 100 m high along the eastern margin of Baker Valley. Weldon and others (2002 #5648) observed lineaments across Quaternary units on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** These faults juxtapose Miocene volcanic rocks and Mesozoic and Paleozoic igneous and metamorphic rocks against Quaternary alluvial deposits in Baker Valley (Brooks and others, 1976 #3573; Walker and MacLeod, 1991 #3646).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Several compilations do not show these faults as active in the late Quaternary (Geomatrix Consultants Inc., 1989 #3546, Simpson, 1993 #3596; Knudsen and others, 1994 #3594; Madin and Mabey, 1996 #3575). However, Pezzopane (1993 #3544) inferred middle to late Quaternary displacement on a small section of one of these faults, and Weldon and others (2002 #5648) used airphotos and 1:100,000 scale DEMs to infer fault activity in the Quaternary (<1.6 Ma) along the length of these faults.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed East Baker Valley faults. However, <100-m-high escarpments on Miocene and younger rocks indicate low rates of long-term slip.

**Length** End to end (km): 27.3
Cumulative trace (km): 30.2

Comments:

**Average strike** (azimuth) N 40° W

**References**

#3573 Brooks, H.C., McIntyre, J.R., and Walker, G.W., 1976, Geology of the Oregon part of the Baker 1 by 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-7, 25 p. pamphlet, 1 sheet, scale 1:250,000.

#3546 Geomatrix Consultants Inc., 1989, Seismotectonic evaluation of Mann Creek and Mason Dam sites: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, under Contract 6-CS-81-07310, 118 p., 2 pls., scale 1:250,000.

#3594 Knudsen, K.L., Wong, I.G., Bott, J.D.J., Weber, G.E., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Agency Valley and Bully Creek Dams, Vale Project, east-central Oregon: Draft Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 171 p., 4 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 713, Powder River Peninsula fault zone

**Structure Number** 713

Comments: Some of these structures may be part of fault number 16 of Pezzopane (1993 #3544).

**Structure Name** Powder River Peninsula fault zone

Comments: The four most prominent faults in this zone have informally been named, from west to east, the Peninsula, Juniper, Coyote, and Tarter Gulch faults (J.E. Essman, written commun., 2002). These faults may be included in the West Pine Valley Seismic Zone of Zollweg and Wood (1993 #780).

**Synopsis** The Powder River Peninsula fault zone is a zone of numerous short northwest- and north-striking sinistral-oblique normal faults with both east and west dips. The faults are located on the steep western flank of Hells Canyon, which now forms the western bank of Brownlee Reservoir, a large impoundment on the Snake River. Individual fault strands have dip-slip separations of 5-75 m across basalts of the Columbia River Basalt Group. The fault zone appears to be a transfer zone between the northwest-striking, northeast dipping Sturgill Peak and Halfway/Posy Valley normal faults. These larger faults have been included in the Olympic-Wallowa lineament, a regional-scale, northwest-trending alignment of topographic and geologic features. However, the tectonic significance of this alignment is controversial, so herein all these faults are simply considered a continuation of Basin-and-Range extension into western Idaho and northeastern Oregon. Some of the recent seismicity in the region may be related to the Powder River Peninsula fault zone. Most faults in the zone are located exclusively in Miocene bedrock, but four faults (Peninsula, Juniper, Coyote, and Tarter Gulch faults) offset Quaternary deposits. Two of these structures (Coyote and Tarter Gulch faults) offset Bonneville flood gravels that have been dated elsewhere at about 14 ka.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Jim E. Essman, Oregon State University and Stephen F. Personius, U.S. Geological Survey

**State** OR, ID

**County** Baker (OR); Washington (ID)

**1° x 2° sheet** Baker

**Province** Columbia Plateaus (Payette section)

**Quality of location** Good

Comments: Fault traces are from 1:12,000-scale mapping of Essman (written commun., 2002).

**Geologic setting** The Powder River Peninsula fault zone is a zone of numerous short northwest- and north-striking sinistral-oblique normal faults with both east and west dips. The faults are located on the steep western flank of Hells Canyon, which now forms the western bank of Brownlee Reservoir, a large impoundment on the Snake River. The area is underlain by basalts of the Columbia River Basalt Group (Brooks and others, 1976 #3573; Walker and MacLeod, 1991 #3646); these rocks have dip-slip separations of 5-75 m across individual fault strands. The fault zone appears to be a transfer zone between the northwest-striking, northeast dipping Sturgill Peak (Idaho) and Halfway/Posy Valley [809b] normal faults (Essman and others, 2001 #5073). The Sturgill Peak and Halfway/Posy Valley faults have been included in the Olympic-Wallowa lineament, a regional-scale, northwest-trending alignment of topographic and geologic features (Mann and Meyer, 1993 #3535). However, the tectonic significance of this alignment is controversial (Reidel and Tolan, 1994 #3536; Mann, 1994 #3537), so herein these faults are simply considered a continuation of Basin-and-Range extension into western Idaho and northeastern Oregon. Some of the recent seismicity in the region may be related to this fault zone. Zollweg and Jacobson (1986 #3518) reported two magnitude 3.6 earthquakes which occurred south of the Wallowa Mountains and 15 associated aftershocks clustered near the mouth of the Powder River. Zollweg and Wood (1993 #780) constructed composite focal mechanisms for the Powder River events; their focal mechanisms indicate both normal and sinistral-oblique events occurring on north to northwest striking faults located in the vicinity of the Powder River Peninsula fault zone (Zollweg and Jacobson, 1986 #3518).

**Sense of movement** SN

Comments: Sinestral normal-oblique sense of displacement is based on the attitudes of exposed slickensides found on the Coyote, Tarter Gulch, and Peninsula faults**.** In addition, field relationships on the Coyote and Tarter faults suggest the hanging wall has moved out of the slope, indicating sinistral slip (J.E. Essman, written commun., 2002). Sinestral normal-oblique sense of displacement is also consistent with composite focal mechanisms from an earthquake swarm in the area (Zollweg and Wood, 1993 #780).

**Dip** 60-85°

Comments: Dips are from direct measurements of exposed fault planes and projections based on fault surface traces (J.E. Essman, written commun., 2002).

**Main dip direction** SW, NE

**Geomorphic expression** The steep topography of Hells Canyon inhibits the preservation of fault scarps and significant deposits of Quaternary deposits are thin to nonexistent. However, where the Coyote and Tarter Gulch faults cross the plateau above Hells Canyon they each form 10- to 15-m- high, 1-km-long escarpments on Miocene Columbia River Basalt Group bedrock. The entire fault zone consists of about twenty short traces, but only the four longest faults (Peninsula, Juniper, Coyote, and Tarter Gulch faults) demonstrably offset Quaternary deposits (J.E. Essman, written commun., 2002) and thus are the only structures shown on the map.

**Age of faulted deposits at the surface** Most faults in this zone are only developed in basalt flows of the Miocene Columbia River Basalt Group. However, four exposures of faults in the zone show offsets in Quaternary deposits (J.E. Essman, written commun., 2002). Approximately 1 km southwest of Tarter Gulch on the north shore of Brownlee Reservoir, the Coyote fault offsets gravels deposited by the Bonneville flood (Essman and others, 2001 #5073) which have been dated elsewhere at about 14 ka (O'Connor, 1993 #5078). The Tarter Gulch fault also offsets Bonneville flood gravels and poorly bedded colluvium located on the south shore of Brownlee Reservoir about 0.9 km southwest of Cottonwood Creek. The Peninsula fault truncates a carbonate soil horizon formed in a Quaternary colluvial deposit 1.4 km southwest of Tarter Gulch on the north shore of Brownlee Reservoir. The Juniper fault cuts and deforms Quaternary soils and truncates an ash bed of unknown age on the south shore of Brownlee Reservoir about 1 km southwest of Cottonwood Creek. In addition, a thick (>20 m) section of late Pleistocene fine grained clastic sediments, interpreted to be lacustrine deposits, and interbedded ash layers are located in the hanging wall of the Juniper fault on the south shore of Brownlee Reservoir, about 1.5 km southwest of Cottonwood Creek. The fine grained clastic deposits contain two ash beds which have been correlated to the Mount Mazama Llao Rock East tephra (65-72 ka) and the St. Helens set Cw (approximately 46 ka) (I. P. Madin, personal commun., 1999, Essman and others, 2001 #5073), and are tilted 25-30° to the northeast. This deformation is probably related to slip on the Juniper fault whos trace projects just to the northeast of the fine grained clastic sediments and associated ash layers (J.E. Essman, written commun., 2002).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: The four most prominent faults in the zone (Tarter Gulch, Coyote, Peninsula, and Juniper faults) offset Quaternary deposits in exposures along Brownlee Reservoir (J.E. Essman, written commun., 2002). The best constrained of these deformed deposits is the offset of Bonneville flood gravels along the Coyote and Tarter Gulch faults; these deposits have been dated elsewhere at about 14 ka (O'Connor, 1993 #5078).

The Bonneville gravels offset by the Tarter Gulch fault are less homogeneous and less well bedded than those deformed by the Coyote fault, and are intercalated with poorly bedded, 1.5-m-thick colluvial deposits. These stratigraphic relations indicate that the Tarter Gulch gravels have been reworked and thus the youngest movement on this fault may be even younger than on the other faults in the zone. The Juniper fault appears to deform fine grained clastic deposits containing two late Pleistocene volcanic ashes, but does not appear to deform the Bonneville flood gravels (J.E. Essman, written commun., 2002) so it appears to have been active in the late Quaternary. The latest movement on the Peninsula fault is poorly constrained, but the fault has similar geomorphology to the Juniper fault and truncates a soil carbonate horizon in Quaternary colluvium, so it has also probably been active in the late Quaternary.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip data are available for faults in the zone, but most faults have individual vertical displacements of <130 m in rocks of the Miocene Columbia River basalt Group. The 30° rake of slickensides on the Coyote fault and net offsets of the Imnaha/Grande Ronde basalt contact suggest post-Miocene slip rates of 0.01-0.06 mm/yr for the Coyote, Juniper, Peninsula and Tarter Gulch faults (J.E. Essman, written commun., 2002).

| | | |
|---|---|---|
| **Length** | End to end (km): | 5.4 |
| | Cumulative trace (km): | 16.9 |

Comments:

**Average strike** (azimuth) N 28° W

**References**


#3573 Brooks, H.C., McIntyre, J.R., and Walker, G.W., 1976, Geology of the Oregon part of the Baker 1 by 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-7, 25 p. pamphlet, 1 sheet, scale 1:250,000.

#5073 Essman, J.E., Meigs, A., and Madin, I.P., 2001, Late Pleistocene faulting in a transtensional transfer zone, Hells Canyon, Oregon-Idaho border: Geological Society of America Abstracts with Programs, v. 33, no. 6, p. A-392.

#3537 Mann, G.M., 1994, Late Cenozoic structure and correlation to seismicity along the Olympic-Wallowa Lineament, northwestern United States—Reply: Geological Society of America Bulletin, v. 106, p. 1639-1641.

#3535 Mann, G.M., and Meyer, C.E., 1993, Late Cenozoic structure and correlations to seismicity along the Olympic-Wallowa Lineament, northwest United States: Geological Society of America Bulletin, v. 105, p. 853-871.

#5078 O'Connor, J.E., 1993, Hydrology, hydraulics, and geomorphology of the Bonneville flood: Geological Society of America Special Paper 274, 83 p.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3536 Reidel, S.P., and Tolan, T.L., 1994, Late Cenozoic structure and correlation to seismicity along the Olympic-Wallowa Lineament, northwestern United States—Discussion and reply: Geological Society of America Bulletin, v. 106, p. 1634-1638.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3518 Zollweg, J.E., and Jacobson, R.S., 1986, A seismic zone on the Oregon-Idaho border—The Powder River earthquakes of 1984: Bulletin of the Seismological Society of America, v. 76, no. 4, p. 985-999.

#780 Zollweg, J.E., and Wood, S.H., 1993, Faulting relationships, seismicity, design earthquakes, and peak ground accelerations at hydroelectric facilities in Hells Canyon of the Snake River, Idaho-Oregon: Report prepared for Idaho Power Company, 158 p., 3 pls.

## 714, Helvetia fault

**Structure Number** 714

Comments: This is fault number 28 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Helvetia fault

Comments: The Helvetia fault was named after its location near Helvetia in the northern Tualatin basin of northwestern Oregon by Yeats and others (1991 #3953; 1996 #4291).

**Synopsis** The northwest-striking Helvetia fault forms part of the northeastern margin of the Tualatin basin in northwestern Oregon. The fault primarily is mapped in the subsurface on the basis of water well data, and has little aeromagnetic expression. The fault is expressed in the subsurface with down-to-the-southwest separation, but no data on fault dip or direction have been described. Most of the fault trace is covered by a thick sequence of silty sediment deposited by the Missoula floods which may bury evidence of pre-latest Quaternary displacement.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Washington

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:100,000-scale compilation of Yeats and others (1996 #4291).

**Geologic setting** The northwest-striking Helvetia fault forms part of the northeastern margin of the Tualatin basin in northwestern Oregon. The fault primarily is mapped in the subsurface on the basis of water well data, and has little aeromagnetic expression (Yeats and others, 1991 #3953; Blakely and others, 1995 #4021; 1996 #4291; Popowski, 1996 #4677; Blakely and others, 2000 #4333).

**Sense of movement** N? R? D?

Comments: The fault is expressed in the subsurface with down-to-the-southwest separation, but no data on fault dip or direction have been described (Yeats and others, 1991 #3953; 1996 #4291; Popowski, 1996 #4677). However, the fault is parallel with nearby faults [#873-877] that have probable right-lateral/reverse senses of displacement., so some lateral displacement is also possible.

**Dip** Not Reported

Comments:

**Main dip direction** Not Reported

**Geomorphic expression** No fault scarps on Quaternary deposits have been described anywhere along the Helvetia fault (Geomatrix Consultants Inc., 1995 #3593). Unruh and others (1994 #3597) found no geomorphic evidence of faulting, and mapped the structure as Tertiary in age. Most of the fault trace is covered by a thick sequence of silty sediment deposited by the Missoula floods, which may bury evidence of pre-latest Quaternary displacement.

**Age of faulted deposits at the surface** No unequivocal evidence of displacement in Quaternary deposits has been described (Geomatrix Consultants Inc., 1995 #3593). However, well data indicate that the Helvetia fault offsets rocks of the Miocene Columbia River Basalt Group and basin-fill sediments overlying the basalt

(Yeats and others, 1991 #3953; 1996 #4291; Popowski, 1996 #4677). Seismic reflection data show reflectors in the upper part of the basin-fill sediments are offset about 20 m (Yeats and others, 1991 #3953; Yeats and Popowski, 1992 #4016). Recent work in the Tualatin basin shows that the upper part of these deposits are Pleistocene in age (Wilson, 1997 #5065; 1998 #5058), so the fault may offset Pleistocene deposits beneath the sedimentary cover of the Missoula flood deposits.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Some Quaternary fault compilations do not include the Helvetia fault (Pezzopane, 1993 #3544; Unruh and others, 1994 #3597), but Geomatrix Consultants, Inc. (1995 #3593) and Madin and Mabey (1996 #3575) compiled these faults as active in the middle and late Quaternary (<780 ka). Given the lack of geomorphic expression and equivocal evidence of Quaternary displacement, the fault is herein classified as Quaternary (<1.6 Ma) until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) assigned slip rates of 0.005-0.05 mm/ yr to the Helvetia fault. Given the equivocal evidence of displacement in Quaternary deposits, low rates of slip are assumed.

**Length** End to end (km): 7.4
Cumulative trace (km): 7.4

Comments:

**Average strike** (azimuth) N 26° W

**References**

#4333 Blakely, R.J., Wells, R.E., Tolan, T.L., Beeson, M.H., Trehu, A.M., and Liberty, L.M., 2000, New aeromagnetic data reveal large strike-slip (?) faults in the northern Willamette Valley, Oregon: Geological Society of America Bulletin, v. 112, p. 1225-1233.

#4021 Blakely, R.J., Wells, R.E., Yelin, T.S., Madin, I.P., and Beeson, M.H., 1995, Tectonic setting of the Portland-Vancouver area, Oregon and Washington—Constraints from low-altitude aeromagnetic data: Geological Society of America Bulletin, v. 107, no. 9, p. 1051-1062.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4677 Popowski, T.A., 1996, Geology, structure, and tectonic history of the Tualatin Basin, northwestern Oregon: Corvallis, Oregon State University, unpublished M.S. Thesis, 126 p.

#3597 Unruh, J.R., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Scoggins Dam, Tualatin Project, northwestern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 206 p., 4 pls., scale 1:500,000.

#5065 Wilson, D.C., 1997, Post-middle Miocene geologic history of the Tualatin basin, Oregon with hydrogeologic implications: Portland, Oregon, Portland State University, unpublished Ph. D. dissertation, 431 p.

#5058 Wilson, D.C., 1998, Post-middle Miocene geologic evolution of the Tualatin basin, Oregon: Oregon Geology, v. 60, no. 5, p. 99-116.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#3953 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T., 1991, Tectonics of the Willamette Valley, Oregon: U.S. Geological Survey Open-File Report 91-441-P, 47 p., 3 pls.

#4291 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T.A., 1996, Tectonics of the Willamette Valley, Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 183-222.

#4016 Yeats, R.S., and Popowski, T.A., 1992, Crustal faults in the Willamette and Tualatin Valleys: Geological Society of America Abstracts with Programs, v. 24, no. 5, p. 92.

**715, Beaverton fault zone**

**Structure Number** 715

Comments:

**Structure Name** Beaverton fault zone

Comments: The Beaverton fault zone was named after its location near Beaverton in northwestern Oregon by Yeats and others (1991 #3953; 1996 #4291), based on subsurface mapping of Hammond and others (1974 #4050), Madin (1990 #4067), and Popowski (1996 #4677).

**Synopsis** The east-west-striking Beaverton fault zone forms the southern margin of the main part of the Tualatin basin, an isolated extension of the Willamette lowland forearc basin in northwestern Oregon. The Beaverton fault zone is not shown on most published geologic maps of the area, but is marked by a linear aeromagnetic anomaly and has been mapped in the subsurface where it offsets Miocene Columbia River Basalt Group rocks and overlying Pliocene to Pleistocene sediments. The late Neogene Tualatin basin may be a pull-apart basin, with subsidence driven by dextral shear on the nearby Gales Creek fault zone. The fault trace is buried by a thick sequence of sediment deposited by the 12.7-13.3 ka Missoula floods, but offsets middle Pleistocene and possibly younger sediments in the subsurface.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Washington

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:100,000-scale mapping of Popowski (1996 #4677) and 1:100,000-scale compilation of Yeats and others (1996 #4291).

**Geologic setting** The east-west-striking Beaverton fault zone forms the southern margin of the main part of the Tualatin basin, an isolated extension of the Willamette lowland forearc basin in northwestern Oregon (Yeats and others, 1996 #4291; Popowski, 1996 #4677; Wilson, 1997 #5065; 1998 #5058). The Beaverton fault zone is not shown on most published geologic maps of the area (Warren and others, 1945 #4076; Hart and Newcomb, 1965 #4063; Schlicker and others, 1967 #4068; Walker and MacLeod, 1991 #3646; Gannett and Caldwell, 1998 #4066), but is marked by a linear aeromagnetic anomaly (Blakely and others, 1995 #4021; 2000 #4333) and has been mapped in the subsurface, where it offsets Miocene Columbia River Basalt Group rocks (Hammond and others, 1974 #4050; Madin, 1990 #4067; Yeats and Popowski, 1992 #4016; Yeats and others, 1996 #4291; Popowski, 1996 #4677; Wilson, 1997 #5065; 1998 #5058). Popowski (1996 #4677) suggests that the late Neogene Tualatin basin is a pull-apart basin, with subsidence driven by dextral shear on the Gales Creek fault zone.

**Sense of movement** N? R?

Comments: Seismic and well data clearly indicate down-to-the-north displacement across the Beaverton fault zone, but the subsurface data are not detailed enough to determine fault dip direction (Madin, 1990 #4067; Yeats and others, 1996 #4291; Popowski, 1996 #4677; Wilson, 1997 #5065; 1998 #5058).

**Dip** Not Reported

Comments:

**Main dip direction** Not Reported

**Geomorphic expression** The central part of the Beaverton fault zone is mapped along the northern base of Cooper Mountain, an anticlinal ridge held up by resistant Columbia River Basalt Group rocks in the south-central part of the Tualatin basin, but the rest of the fault zone has no apparent geomorphic expression. No fault scarps on Quaternary deposits have been described anywhere along the fault zone, but a thick sequence of sediment deposited by the Missoula floods (Willamette Silt) covers all of the fault trace.

**Age of faulted deposits at the surface** Several hundred meters of vertical separation of Miocene Columbia River Basalt Group rocks are apparent across the Beaverton fault zone (Hammond and others, 1974 #4050; Madin, 1990 #4067; Yeats and Popowski, 1992 #4016; Yeats and others, 1996 #4291; Popowski, 1996 #4677; Wilson, 1997 #5065; 1998 #5058). The fault also truncates post-basalt fluvial and lacustrine sediments in the subsurface (Yeats and others, 1996 #4291; Popowski, 1996 #4677; Wilson, 1997 #5065; 1998 #5058). These younger sediments are mapped as the Hillsboro Formation, the upper part of which is at least middle Pleistocene in age (Wilson, 1997 #5065; 1998 #5058). These sediments post-date the 0.78 Ma age of the Brunhes/Matuyama paleomagnetic boundary, in places are interbedded with and overlain by Boring Lava flows dated at 0.26-0.96 Ma, and have yielded a piece of wood radiocarbon dated at >43.7 ka from near the top of the formation (Wilson, 1997 #5065; 1998 #5058). No evidence of offset of the sediments deposited by the 12.7-15.3 ka Missoula floods (Willamette Silt) has been described.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: No recent active fault compilations include the Beaverton fault zone as a Quaternary fault. Pezzopane (1993 #3544), Madin and Mabey (1996 #3575), and Wong and others (1999 #4073; 2000 #5137) do not include this fault zone in their compilations. Unruh and others (1994 #3597) mapped this fault zone as most-recently active in the Tertiary, and Geomatrix Consultants (1995 #3593) found no evidence for late Quaternary displacement and concluded that the Beaverton fault zone is not active. Recent subsurface work by Popowski (1996 #4677) and Wilson (1997 #5065; 1998 #5058) indicate that Pleistocene sediments of the Hillsboro Formation are offset by the Beaverton fault zone. Madin and others (2001 #5051) inferred late Quaternary offset on the Beaverton fault. Age information from Wilson (1997 #5065; 1998 #5058) support a middle Pleistocene or younger age for these offset deposits, so a late and middle Quaternary age (<750 ka) is assigned herein.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Well and geophysical data indicate vertical separation of as much as 360 m of Miocene Columbia River Basalt Group rocks across the Beaverton fault zone (Hammond and others, 1974 #4050; Madin, 1990 #4067; Yeats and Popowski, 1992 #4016; Yeats and others, 1996 #4291; Popowski, 1996 #4677). Such data suggest low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 14.7 |
| | Cumulative trace (km): | 15.1 |

Comments:

**Average strike** (azimuth) N 86° E

**References**

#4333 Blakely, R.J., Wells, R.E., Tolan, T.L., Beeson, M.H., Trehu, A.M., and Liberty, L.M., 2000, New aeromagnetic data reveal large strike-slip (?) faults in the northern Willamette Valley, Oregon: Geological Society of America Bulletin, v. 112, p. 1225-1233.

#4021 Blakely, R.J., Wells, R.E., Yelin, T.S., Madin, I.P., and Beeson, M.H., 1995, Tectonic setting of the Portland-Vancouver area, Oregon and Washington—Constraints from low-altitude aeromagnetic data: Geological Society of America Bulletin, v. 107, no. 9, p. 1051-1062.

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#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

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#4063 Hart, D.H., and Newcomb, R.C., 1965, Geology and ground water of the Tualatin Valley, Oregon: U.S. Geological Survey Water-Supply Paper 1697, 172 p., 3 pls., scale 1:48,000.

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#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4677 Popowski, T.A., 1996, Geology, structure, and tectonic history of the Tualatin Basin, northwestern Oregon: Corvallis, Oregon State University, unpublished M.S. Thesis, 126 p.

#4068 Schlicker, H.G., Deacon, R.J., and Newhouse, C.J., 1967, Engineering geology of the Tualatin Valley Region, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 60, 103 p., 4 pls., scale 1:48,000.

#3597 Unruh, J.R., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Scoggins Dam, Tualatin Project, northwestern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 206 p., 4 pls., scale 1:500,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4076 Warren, W.C., Grivetti, R.M., and Norbisrath, H., 1945, Geology of northwestern Oregon, west of Willamette River and north of latitude 45 degrees 15': U.S. Geological Survey Oil and Gas Investigations Map OM-0042, 1 sheet, scale 1:145,728.

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#5058 Wilson, D.C., 1998, Post-middle Miocene geologic evolution of the Tualatin basin, Oregon:  Oregon Geology, v. 60, no. 5, p. 99-116.

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#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area:  State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

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#4291 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T.A., 1996, Tectonics of the Willamette Valley, Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest:  U.S. Geological Survey Professional Paper 1560, v. 1, p. 183-222.

#4016 Yeats, R.S., and Popowski, T.A., 1992, Crustal faults in the Willamette and Tualatin Valleys: Geological Society of America Abstracts with Programs, v. 24, no. 5, p. 92.

**716, Canby-Molalla fault**

**Structure Number** 716

Comments:

**Structure Name** Canby-Molalla fault

Comments: The Canby-Molalla fault was originally named (and misspelled) the "Mollala-Canby lineament", and identified on the basis of a series of discontinuous aeromagnetic anomalies that extend from the vicinity of Tigard south through the towns of Canby and Molalla in northern Oregon (Blakely and others, 1995 #4021). Wong and others (1999 #4073; 2000 #5137) elevated this group of anomalies to the Mollala-Canby or Molalla-Canby fault. Blakely and others (2000 #4333) renamed the structure the Canby-Molalla lineament or fault; this name is used in the most current literature (Blakely and others, 2001 #5044; Blakely and others, 2002 #5147) so is retained herein.

**Synopsis** The mapped trace of the north-northwest-striking Canby-Molalla fault is based on a linear series of northeast-trending discontinuous aeromagnetic anomalies that probably represent significant offset of Eocene basement and volcanic rocks of the Miocene Columbia River Basalt beneath Neogene sediments that fill the northern Willamette River basin. The fault has little geomorphic expression across the gently sloping floor of the Willamette Valley, but a small, laterally restricted berm associated with the fault may suggest young deformation. Deformation of probable Missoula flood deposits in a high-resolution seismic reflection survey conducted across the aeromagnetic anomaly east of Canby suggests possible Holocene deformation. Sense of displacement of the Canby-Molalla fault is poorly known, but the fault shows apparent right-lateral separation of several transverse magnetic anomalies, and down-west vertical displacement is also apparent in water well logs.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Clackamas

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:100,000-scale compilation of Burns and others (1997 #4079) and 1:62,500-scale compilations of Wong and others (1999 #4073; 2000 #5137); trace is based on 1:100,000-scale aeromagnetic data (Snyder and others, 1993 #4000) interpreted by Blakely and others (1995 #4021; 2000 #4333).

**Geologic setting** The mapped trace of the north-northwest-striking Canby-Molalla fault is based on a linear series of northeast-trending discontinuous aeromagnetic anomalies (Snyder and others, 1993 #4000) that probably represent significant offset of Eocene basement and volcanic rocks of the Miocene Columbia River Basalt Group (Blakely and others, 2000 #4333) beneath the Neogene sediments that fill the northern Willamette River basin.

**Sense of movement** DR

Comments: The actual sense of displacement of the Canby-Molalla fault is poorly known. The fault shows apparent right-lateral separation of several transverse magnetic anomalies, and down-west vertical displacement is also apparent in water well logs (Blakely and others, 2000 #4333; 2001 #5044; 2002 #5147). Given the compressional setting of other faults in the area and lack of significant topographic expression

(Blakely and others, 1995 #4021; 2000 #4333), the fault probably is a right-lateral strike-slip fault with lesser amounts of reverse(?) displacement (Blakely and others, 2000 #4333; 2001 #5044; 2002 #5147).

**Dip** Not Reported

Comments:

**Main dip direction** Not Reported

**Geomorphic expression** The Canby-Molalla fault has little geomorphic expression across the gently sloping floor of the northern Willamette Valley. The fault is not marked by escarpments or higher topography except at its north end where it may project to faults mapped in Columbia River Basalt Group rocks. Blakely and others (2001 #5044; 2002 #5147) describe a small, laterally restricted berm associated with the fault that may suggest young deformation.

**Age of faulted deposits at the surface** The fault is not shown on most existing geologic maps (Piper, 1942 #4064; Warren and others, 1945 #4076; Hart and Newcomb, 1965 #4063; Schlicker and others, 1967 #4068; Hampton, 1972 #4065; Schlicker and Finlayson, 1979 #4166; Beeson and others, 1989 #4047; Walker and MacLeod, 1991 #3646; Yeats and others, 1996 #4291; Gannett and Caldwell, 1998 #4066), so the age of faulted deposits is poorly known. Blakely and others (2002 #5147) noted deformation of probable Missoula flood deposits in a high-resolution seismic reflection survey conducted across the aeromagnetic anomaly east of Canby.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Blakely and others (2002 #5147) noted deformation of probable Missoula flood deposits in a high-resolution seismic reflection survey conducted across the aeromagnetic anomaly east of Canby, and used this deformation to infer possible Holocene displacement. Pezzopane (1993 #3544), Unruh and others (1994 #3597), Geomatrix Consultants (1995 #3593), and Madin and Mabey (1996 #3575) do not include this fault in their compilations of Quaternary faults in the region. Wong and others (1999 #4073; 2000 #5137) include the Canby-Molalla fault as potential seismogenic fault in their analysis of earthquake hazards in the Portland area, and Madin and others (2001 #5051) infer late Quaternary offset on the Canby fault.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Blakely and others (2000 #4333; 2001 #5044; 2002 #5147) infer as much as 4 km of right-lateral separation of aeromagnetic anomalies in the underlying Eocene bedrock, and used water well data to infer a minimum of 150 m of vertical offset of Miocene Columbia River Basalt Group volcanic rocks across the fault. The poor geomorphic expression suggests low rates of slip in the late Quaternary.

| | | |
|---|---|---|
| **Length** | End to end (km): | 50.0 |
| | Cumulative trace (km): | 52.5 |

Comments:

**Average strike** (azimuth) N 34° W

**References**

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#5044 Blakely, R.J., Madin, I.P., Stephenson, W.J., and Popowski, T., 2001, The Canby-Molalla fault, Oregon: Eos, Transactions of the American Geophysical Union, Fall Meet. Suppl., Abstract S22D-01, v. 82, no. 47.

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#4079 Burns, S., Lawrence, G., Brett, B., Yeats, R.S., and Popowski, T.A., 1997, Map showing faults, bedrock geology, and sediment thickness of the western half of the Oregon City 1:100,000 quadrangle, Washington, Multnomah, Clackamas, and Marion Counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-4, 1 sheet, scale 1:100,000.

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#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4064 Piper, A.M., 1942, Ground-water resources of the Willamette Valley, Oregon: U.S. Geological Survey Water-Supply Paper 890, 194 p., 2 pls., scale 1:125,000.

#4068 Schlicker, H.G., Deacon, R.J., and Newhouse, C.J., 1967, Engineering geology of the Tualatin Valley Region, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 60, 103 p., 4 pls., scale 1:48,000.

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#4000 Snyder, S.L., Felger, T.J., Blakely, R.J., and Wells, R.E., 1993, Aeromagnetic map of the Portland-Vancouver metropolitan area, Oregon and Washington: U.S. Geological Survey Open-File Report 93-211, 1 pl., scale 1:100,000.

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#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4076 Warren, W.C., Grivetti, R.M., and Norbisrath, H., 1945, Geology of northwestern Oregon, west of Willamette River and north of latitude 45 degrees 15': U.S. Geological Survey Oil and Gas Investigations Map OM-0042, 1 sheet, scale 1:145,728.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

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**717, Newberg fault**

**Structure Number** 717

Comments: This is fault number 30 of Geomatrix Consultants, Inc. (1995 #3593) and part of fault number 6 of Pezzopane (1993 #3544).

**Structure Name** Newberg fault

Comments: The Newberg fault was mapped on the basis of water well data and named by Werner (1990 #3946) after the town of Newberg in the northern Willamette Valley; this fault is included in the Gales Creek-Mount Angel structural zone of Beeson and others (1985 #4022; 1989 #4023).

**Synopsis** The Newberg fault is part of the Gales Creek-Mount Angel structural zone, a northwest-striking zone of dextral-reverse faults that has been active at least since the Miocene when they controlled the emplacement of Miocene Columbia River Basalt Group lava flows in the northern Willamette Valley. The fault primarily is mapped in the subsurface on the basis of water well, aeromagnetic, and gravity data. No unequivocal evidence of displacement in Quaternary deposits has been described, but most of the fault trace is covered by a thick sequence of silty sediment deposited by the Missoula floods which may have buried evidence of pre-latest Quaternary displacement.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Yamhill, Marion

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:100,000-scale compilation of Yeats and others (1996 #4291).

**Geologic setting** The Newberg fault is part of the Gales Creek-Mount Angel structural zone, a northwest-striking zone of dextral-reverse faults that has been active at least since the Miocene when they controlled the emplacement of Miocene Columbia River Basalt Group lava flows in the northern Willamette Valley (Beeson and others, 1985 #4022; 1989 #4023). The fault primarily is mapped in the subsurface on the basis of water well, aeromagnetic, and gravity data (Werner, 1990 #3946; Yeats and others, 1991 #3953; 1996 #4291; Blakely and others, 2000 #4333).

**Sense of movement** D, R?

Comments: The fault is part of the Gales Creek-Mount Angel structural zone, a dextral-reverse fault zone (Beeson and others, 1985 #4022; 1989 #4023).

**Dip** Not Reported

Comments:

**Main dip direction** Not Reported

**Geomorphic expression** No fault scarps on Quaternary deposits have been described anywhere along the Newberg fault (Geomatrix Consultants Inc., 1995 #3593). However, S.K. Pezzopane (pers. commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) describes lineaments in fluvial terraces and bedrock notches along a northwest trend to the east of Newberg, based on reconnaissance of small-scale (1:20,000 to 1:60,000) aerial photography. Unruh and others (1994 #3597) conducted the most comprehensive study of possible Quaternary activity on the Newberg fault; they examined large-scale (1:12,000) aerial photography, and conducted aerial and field reconnaissance along the trace of the fault. Unruh and others (1994 #3597) found no geomorphic evidence of faulting, and mapped the structure as Tertiary in age. Most of the fault trace is covered by a thick sequence of silty sediment deposited by the Missoula floods (O'Connor and others, 2001 #5121) which may have buried evidence of pre-latest Quaternary displacement.

**Age of faulted deposits at the surface** No unequivocal evidence of displacement in Quaternary deposits has been described (Geomatrix Consultants Inc., 1995 #3593).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Unruh and others (1994 #3597) found no geomorphic evidence of faulting, and mapped the structure as Tertiary in age. Pezzopane (1993 #3544) mapped the fault as active in the Quaternary (<1.8 Ma). Geomatrix Consultants, Inc. (1995 #3593) and Madin and Mabey (1996 #3575) compiled these faults as active in the middle and late Quaternary (<780 ka), based on similar trend and possible connection to the Mount Angel fault [873]. Given the equivocal evidence of Quaternary displacement, the Newberg fault is herein classified as Quaternary (<1.6 Ma) until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Geomatrix Consultants, Inc. (1995 #3593) assigned slip rates of 0.005-0.01 mm/ yr and Wong and others (1999 #4073; 2000 #5137) assigned rates of 0.1-0.4 mm/yr to the Newberg fault. Given the lack of evidence of displacement in Quaternary deposits, low rates of slip are assumed.

**Length** End to end (km): 5.0
Cumulative trace (km): 5.0

Comments:

**Average strike** (azimuth) N 42° W

**References**


#4022 Beeson, M.H., Fecht, K.R., Reidel, S.P., and Tolan, T.L., 1985, Regional correlations within the Frenchman Springs member of the Columbia River Basalt Group—New insights into the middle Miocene tectonics of northwestern Oregon: Oregon Geology, v. 47, no. 8, p. 87-96.

#4023 Beeson, M.H., Tolan, T.L., and Anderson, J.L., 1989, The Columbia River Basalt Group in western Oregon–Geologic structures and other factors that controlled flow emplacement patterns, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 223-246.

#4333 Blakely, R.J., Wells, R.E., Tolan, T.L., Beeson, M.H., Trehu, A.M., and Liberty, L.M., 2000, New aeromagnetic data reveal large strike-slip (?) faults in the northern Willamette Valley, Oregon: Geological Society of America Bulletin, v. 112, p. 1225-1233.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#5121 O'Connor, J.E., Sarna-Wojcicki, A.M., Wozniak, K.C., Polette, D.J., and Fleck, R.J., 2001, Origin, extent, and thickness of Quaternary geologic units in the Willamette Valley, Oregon: U.S. Geological Survey Professional Paper 1620, 52 p., 1 pl., scale 1:250,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3597 Unruh, J.R., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Scoggins Dam, Tualatin Project, northwestern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 206 p., 4 pls., scale 1:500,000.

#3946 Werner, K.S., 1990, I. Direction of maximum horizontal compression in western Oregon determined by borehole breakouts II. Structure and tectonics of the northern Willamette Valley, Oregon: Oregon State University, unpublished M.S. thesis, 159 p., 5 pls., scale 1:100,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#3953 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T., 1991, Tectonics of the Willamette Valley, Oregon: U.S. Geological Survey Open-File Report 91-441-P, 47 p., 3 pls.

#4291 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T.A., 1996, Tectonics of the Willamette Valley, Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 183-222.

## 718, Gales Creek fault zone

**Structure Number** 718

Comments: This is fault number 31 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Gales Creek fault zone

Comments: The Gales Creek fault zone is named after its location in the valley of Gales Creek west of Forest Grove in northwestern Oregon (Warren and others, 1945 #4076; Hart and Newcomb, 1965 #4063; Schlicker and others, 1967 #4068; Unruh and others, 1994 #3597; Wells and others, 1994 #3988; Yeats and others, 1996 #4291), and is included in the Gales Creek-Mount Angel structural zone of Beeson and others (1985 #4022; 1989 #4023). Herein we include nearby faults mapped in the Carpenter Creek and Scoggins Creek valleys (Carpenter Creek and Scoggins faults of Unruh and others, 1994 #3597) in this description of the Gales Creek fault zone.

**Synopsis** The northwest-striking Gales Creek fault zone forms the boundary between the Oregon Coast Range and the Willamette Valley in northwestern Oregon. At its southern end, the fault zone forms the southwestern margin of the Tualatin basin. The fault zone has been active at least since the Miocene, when it controlled the emplacement of Miocene Columbia River Basalt Group lava flows. These faults are shown on numerous maps of the area, mostly based on juxtaposition of Miocene Columbia River Basalt Group rocks against Eocene volcanic rocks. No unequivocal evidence of deformation of Quaternary deposits has been described, but a thick sequence of silty sediment deposited by the Missoula floods covers much of the southern part of the fault trace.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Yamhill, Washington

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:62,500-scale mapping of Wells and others (1994 #3988), 1:100,000-scale mapping of Popowski (1996 #4677) 1:100,000-scale compilation of Yeats and others (1996 #4291), and 1:250,000-scale mapping of Wells and others (1983 #3583).

**Geologic setting** The northwest-striking Gales Creek fault zone forms the boundary between the Oregon Coast Range and the Willamette Valley in northwestern Oregon. At its southern end, the fault zone forms the southwestern margin of the Tualatin basin (Popowski, 1996 #4677; Wilson, 1997 #5065; Wilson, 1998 #5058). The fault zone has been active at least since the Miocene, when it controlled the emplacement of Miocene Columbia River Basalt Group lava flows (Beeson and others, 1985 #4022; 1989 #4023). These faults are shown on numerous maps of the area, mostly based on juxtaposition of Miocene Columbia River Basalt Group rocks against Eocene volcanic rocks (Warren and others, 1945 #4076; Hart and Newcomb, 1965 #4063; Schlicker and others, 1967 #4068; Unruh and others, 1994 #3597; Wells and others, 1994 #3988; Yeats and others, 1996 #4291; Blakely and others, 2000 #4333).

**Sense of movement** D, R?

Comments: Both dextral strike-slip and vertical separation are apparent along the Gales Creek fault zone. If the fault is part of a larger Gales Creek-Mount Angel structural zone (Beeson and others, 1985 #4022; 1989 #4023), then by analogy the vertical separation may have a reverse sense of displacement (Geomatrix Consultants Inc., 1995 #3593).

**Dip** Not Reported

Comments:

**Main dip direction** Not Reported

**Geomorphic expression** No fault scarps on Quaternary deposits have been described anywhere along the fault zone (Geomatrix Consultants Inc., 1995 #3593). However, a thick sequence of silty sediment deposited by the Missoula floods covers much of the southern part of the fault trace, and older stream terraces at 100-120 m elevation along Gales Creek are largely confined to the upthrown side of the fault zone (R.E. Wells, pers. commun., 2001).

**Age of faulted deposits at the surface** The fault zone is mapped in Eocene through Miocene bedrock, but no unequivocal evidence of displacement in Quaternary deposits has been described (Warren and others, 1945 #4076; Hart and Newcomb, 1965 #4063; Schlicker and others, 1967 #4068; Unruh and others, 1994 #3597; Wells and others, 1994 #3988; Geomatrix Consultants Inc., 1995 #3593; Yeats and others, 1996 #4291; Blakely and others, 2000 #4333).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Unruh and others (1994 #3597) used airphoto, aerial, and field reconnaissance to determine that latest movement on these faults predates the late Pleistocene; they mapped the faults as Tertiary and concluded that they are not active. Geomatrix Consultants (1995 #3593) inferred possibly activity in the Quaternary, based on alignment with and possible connection to the Mount Angel fault [873]. Madin and Mabey (1996 #3575) compiled this fault zone as active in the middle and late Quaternary (<780 ka) or Quaternary (<1.6 Ma). Given the equivocal evidence of Quaternary displacement, the Gales Creek fault zone is herein classified as Quaternary (<1.6 Ma) until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Recent geologic mapping suggests a couple of kilometers of vertical separation and as much as 12 km of dextral separation of Paleogene bedrock; these offsets yield vertical and horizontal rates of 0.1 and 0.3 mm/yr, respectively (R.E. Wells, pers. commun., 2001). Wong and others (1999 #4073; 2000 #5137) assigned rates of 0.1-0.4 mm/yr to the Gales Creek fault in their analysis of earthquake hazards in the Portland area. Given the lack of evidence of displacement in Quaternary deposits, lower rates of slip are assumed.

| | | |
|---|---|---|
| **Length** | End to end (km): | 72.7 |
| | Cumulative trace (km): | 152.1 |

Comments:

**Average strike** (azimuth) N 41° W

**References**

#4022 Beeson, M.H., Fecht, K.R., Reidel, S.P., and Tolan, T.L., 1985, Regional correlations within the Frenchman Springs member of the Columbia River Basalt Group—New insights into the middle Miocene tectonics of northwestern Oregon: Oregon Geology, v. 47, no. 8, p. 87-96.

#4023 Beeson, M.H., Tolan, T.L., and Anderson, J.L., 1989, The Columbia River Basalt Group in western Oregon–Geologic structures and other factors that controlled flow emplacement patterns, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 223-246.

#4333 Blakely, R.J., Wells, R.E., Tolan, T.L., Beeson, M.H., Trehu, A.M., and Liberty, L.M., 2000, New aeromagnetic data reveal large strike-slip (?) faults in the northern Willamette Valley, Oregon: Geological Society of America Bulletin, v. 112, p. 1225-1233.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#4063 Hart, D.H., and Newcomb, R.C., 1965, Geology and ground water of the Tualatin Valley, Oregon: U.S. Geological Survey Water-Supply Paper 1697, 172 p., 3 pls., scale 1:48,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4677 Popowski, T.A., 1996, Geology, structure, and tectonic history of the Tualatin Basin, northwestern Oregon: Corvallis, Oregon State University, unpublished M.S. Thesis, 126 p.

#4068 Schlicker, H.G., Deacon, R.J., and Newhouse, C.J., 1967, Engineering geology of the Tualatin Valley Region, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 60, 103 p., 4 pls., scale 1:48,000.

#3597 Unruh, J.R., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Scoggins Dam, Tualatin Project, northwestern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 206 p., 4 pls., scale 1:500,000.

#4076 Warren, W.C., Grivetti, R.M., and Norbisrath, H., 1945, Geology of northwestern Oregon, west of Willamette River and north of latitude 45 degrees 15': U.S. Geological Survey Oil and Gas Investigations Map OM-0042, 1 sheet, scale 1:145,728.

#3583 Wells, R.E., Niem, A.R., MacLeod, N.S., Snavely, P.D., Jr., and Niem, W.A., 1983, Preliminary geologic map of the west half of the Vancouver (Washington-Oregon) 1 x 2 quadrangle: U.S. Geological Survey Open-File Report 83-591, 1 sheet, scale 1:250,000.

#3988 Wells, R.E., Snavely, P.D., MacLeod, N.S., Kelly, M.M., and Parker, M.J., 1994, Geologic map of the Tillamook Highlands, northwest Oregon Coast Range: U.S. Geological Survey Open-File Report 94-21, 24 p., 2 pls., scale 1:62,500.

#5065 Wilson, D.C., 1997, Post-middle Miocene geologic history of the Tualatin basin, Oregon with hydrogeologic implications: Portland, Oregon, Portland State University, unpublished Ph. D. dissertation, 431 p.

#5058 Wilson, D.C., 1998, Post-middle Miocene geologic evolution of the Tualatin basin, Oregon: Oregon Geology, v. 60, no. 5, p. 99-116.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#4291 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T.A., 1996, Tectonics of the Willamette Valley, Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest:  U.S. Geological Survey Professional Paper 1560, v. 1, p. 183-222.

## 719, Salem-Eola Hills homocline

**Structure Number** 719

Comments:

**Structure Name** Salem-Eola Hills homocline

Comments: The Salem-Eola Hills homocline was originally mapped as two folds, the Eola Hills homocline and the Bunker Hills homocline (Beeson and others, 1989 #4023); these folds were combined and renamed the Salem-Eola Hills homocline after its location near the Salem Hills and Eola Hills in the northern Willamette Valley (Yeats and others, 1993 #5057; Crenna and Yeats, 1994 #4129).

**Synopsis** The northwest-striking Salem-Eola Hills homocline deforms Miocene rocks of the Columbia River Basalt Group along the Salem Hills and Eola Hills in the central Willamette Valley, at the southwestern margin of deposition of these rocks in this part of Oregon. In the late Miocene, the fold acted as a tectonic dam, causing the obstruction of the ancestral Willamette River and deposition of a thick sequence of basin-fill sediment in the southern Willamette Valley. Older undated gravels of probable Quaternary age that occupy a bedrock channel in the Salem water gap slope northward about 25 times steeper than the present channel of the Willamette River; this increase in slope probably reflects uplift or faulting in the Salem Hills and Eola Hills. A broad convexity in the modern channel profile of the Willamette River that is roughly coincident with the location of the Salem and Eola Hills may also be caused by deformation on the Salem-Eola Hills homocline, but the channel convexity could also be caused by differential channel incision due to varying channel lithology and be unrelated to ongoing tectonism.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Marion, Polk

**1° x 2° sheet** Salem

**Province** Pacific Border (Puget Trough section)

**Quality of location** Poor

Comments: The fold traces are from a 1:500,000-scale figure of Crenna and others (1994 #4129).

**Geologic setting** The northwest-striking Salem-Eola Hills homocline deforms Miocene rocks of the Columbia River Basalt Group along the Salem Hills and Eola Hills in the central Willamette Valley (Beeson and others, 1989 #4023; Yeats and others, 1993 #5057; Crenna and Yeats, 1994 #4129), and is located at the southwestern margin of deposition of Columbia River Basalt Group rocks in this part of Oregon. In the late Miocene, the fold acted as a tectonic dam, causing the obstruction of the ancestral Willamette River and deposition of a thick sequence of basin-fill sediment in the southern Willamette Valley (Yeats and others, 1993 #5057; Crenna and Yeats, 1994 #4129). The fold is not shown on most geologic maps of the region (Walker and Duncan, 1989 #3581; Walker and MacLeod, 1991 #3646; Yeats and others, 1996 #4291; Gannett and Caldwell, 1998 #4066). The fold appears to be significantly offset across The Mill Creek fault (Yeats and others, 1993 #5057; Crenna and Yeats, 1994 #4129).

**Sense of movement** monocline

Comments: The Salem-Eola Hills homocline is mapped as a northeast-dipping homocline or monocline (Beeson and others, 1989 #4023; Yeats and others, 1993 #5057; Crenna and Yeats, 1994 #4129).

**Dip** 2-4.5°

Comments: Dip of Columbia River Basalt Group rocks is from Crenna and others (1994 #4129).

**Main dip direction** NE

**Geomorphic expression** The Salem-Eola Hills homocline is coincident with the southwestern margins of the Salem Hills and the Eola Hills. Crenna and others (1994 #4129) describe older undated gravels of probable Quaternary age that occupy a bedrock channel in the Salem water gap that slopes northward about 25 times steeper than the present channel of the Willamette River. This increase in slope probably reflects uplift or faulting in the Salem Hills and Eola Hills (Crenna and Yeats, 1994 #4129). Yeats and others (1993 #5057) and Crenna and others (1994 #4129) also identified a broad convexity in the modern channel profile of the Willamette River that is roughly coincident with the location of the Salem and Eola Hills, and an increase in channel gradient of the river north of Salem. However, the channel convexity could simply be caused by differential channel incision due to varying channel lithology (Crenna and Yeats, 1994 #4129), and the increase in channel gradient is many kilometers downstream of the location of the fold trace.

**Age of folded deposits at the surface** The Salem-Eola Hills homocline may deform older Quaternary(?) deposits along the Salem water gap, and also may deform the modern channel of the Willamette River (Yeats and others, 1993 #5057; Crenna and Yeats, 1994 #4129).

**Paleoseismology studies** None

**Time of most recent prehistoric folding** Quaternary (<1.6 Ma)

Comments: None of the Quaternary fault compilations in the region include this structure (Pezzopane, 1993 #3544; Unruh and others, 1994 #3597; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Wong and others, 1999 #4073; 2000 #5137). The older gravels that may be deformed by the fold are undated, but may be of Quaternary age (Yeats and others, 1993 #5057; Crenna and Yeats, 1994 #4129). The evidence of deformation of the modern channel of the Willamette River is equivocal, so the Salem-Eola Hills homocline is mapped herein as Quaternary (<1.6 Ma) until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip or uplift rate data have been published, but Crenna and others (1994 #4129) describe 320 m of uplift of Miocene Columbia River Basalt Group rocks across the Salem-Eola Hills homocline; these data suggest low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 31.2 |
| | Cumulative trace (km): | 34.3 |

Comments:

**Average strike** (azimuth) N 26° W

**References**


#4023 Beeson, M.H., Tolan, T.L., and Anderson, J.L., 1989, The Columbia River Basalt Group in western Oregon–Geologic structures and other factors that controlled flow emplacement patterns, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 223-246.

#4129 Crenna, P.A., and Yeats, R.S., 1994, Late Cenozoic tectonics and paleogeography of the Salem metropolitan area, central Willamette Valley, Oregon: Oregon Geology, v. 56, no. 6, p. 129-136.

#4066 Gannett, M.W., and Caldwell, R.R., 1998, Geologic framework of the Willamette lowland aquifer system, Oregon and Washington: U.S. Geological Survey Professional Paper 1424-A, 32 p., 8 pls., scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3597 Unruh, J.R., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Scoggins Dam, Tualatin Project, northwestern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 206 p., 4 pls., scale 1:500,000.

#3581 Walker, G.W., and Duncan, R.A., 1989, Geologic map of the Salem 1 by 2 quadrangle, western Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1893, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#4291 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T.A., 1996, Tectonics of the Willamette Valley, Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 183-222.

#5057 Yeats, R.S., Levi, S., and Crenna, P., 1993, Active faults and folds in the Salem metropolitan area, Oregon: Technical report to U.S. Geological Survey, Reston, Virginia, under Contract 14-08-0001-G2131, August 14, 1993, 22 p.

**781, Cascadia subduction zone**

**Structure Number** 781

Comments:

**Structure Name** Cascadia subduction zone

Comments: This structure is a megathrust that forms the plate boundary between the subducting Explorer, Juan de Fuca, and Gorda Plates and the overriding North America Plate. The existence of the zone was established in the late 1960's and early 1970's (Byrne and others, 1966 #4273; McKenzie and Parker, 1967 #4270; Tobin and Sykes, 1968 #4256; Morgan, 1968 #4271; Silver, 1969 #4268; Atwater, 1970 #1199; Silver, 1971 #4240). The zone was originally referred to as the Juan de Fuca (e.g. Ando and Balazs, 1979 #4184; Heaton and Kanamori, 1984 #4231) or Oregon subduction zone (Kulm and others, 1986 #4272), but the term Cascadia subduction zone, named after the adjacent Cascadia basin, came into use because subduction of other plates (Explorer Plate and Gorda Plate or block) takes place along the northern and southern ends of the zone (Heaton and Hartzell, 1986 #4230; Rogers, 1988 #4179). The latter name is in common usage today. In the literature, "Cascadia subduction zone" is sometimes used in a more general sense to mean the region above the plate interface as well as the interface itself. Herein we restrict the term to the east-dipping zone of deformation along the interface (plate boundary) and do not include, for example, shallow structures in the upper plate.

**Synopsis** The Cascadia subduction zone is a megathrust (regional-scale thrust fault) that forms the collisional plate boundary between the subducting Explorer, Juan de Fuca, and Gorda Plates and the overriding North America Plate, and it extends 1200 km from offshore northern California to southern British Columbia. Subduction is driven by westward migration of the North America Plate and eastward migration of the Explorer, Juan de Fuca, and Gorda Plates due to spreading of the Gorda-Juan de Fuca-Explorer Ridge system. The latter three plates are the remnants of the Farallon Plate, which originally underlay much of the eastern Pacific and has been converging with the North America Plate since at least the Jurassic. Tectonic elements associated with the subduction zone include: 1) an accretionary wedge of Eocene(?) through Quaternary sediments deformed by a broad fold and thrust belt and several easterly-striking strike-slip faults; 2) a forearc of sedimentary and igneous rocks that accumulated during plate collision, broken in places by minor Quaternary faults and folds; and 3) a volcanic arc (Cascade Range) consisting of Eocene through Quaternary volcanic rocks, several active andesitic volcanoes, and numerous, mostly extensional Quaternary faults. Few if any historical earthquakes have been located on the interface between the subducting and overriding plates, but geological studies show that great earthquakes have occurred in the past 4,000 years, and geodetic studies indicate strain accumulation consistent with the assumption that the Cascadia subduction zone is locked beneath offshore northern California, Oregon, Washington, and southern British Columbia. Numerous geological and geophysical studies suggest that the Cascadia subduction zone may be segmented, but the most recent studies suggest that, at least for the most recent great earthquake on January 26, 1700, much of the subduction zone ruptured in a single Mw 9 earthquake.

**Date of compilation** May 16, 2002

**Compiler and affiliation** Stephen F. Personius and Alan R. Nelson, U.S. Geological Survey

**State** OR (offshore), WA (offshore), CA (offshore)

**County** Clallum (offshore), Jefferson (offshore), Grays Harbor (offshore), Pacific (offshore), Clatsop (offshore), Tillamook (offshore), Lincoln (offshore), Lane (offshore), Douglas (offshore), Coos (offshore), Curry (offshore), Del Norte (offshore)

**1° x 2° sheet** Cape Flattery (offshore), Copalis Beach (offshore), Cape Disappointment (offshore), Newport (offshore), Coos Bay (offshore), Cape Blanco (offshore), Eureka (offshore)

**Province** offshore of Pacific Border (Oregon Coast Range and Klamath Mountains sections)

**Quality of location** Poor

Comments: The mapped trace of the subduction zone is defined by the western margin of the deformation front of the accretionary wedge, which is taken from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** This structure is a megathrust that forms the collisional plate boundary between the subducting Explorer, Juan de Fuca, and Gorda Plates and the overriding North America Plate, and extends from offshore northern California to southern British Columbia. Subduction is driven by westward migration of the North America Plate and eastward migration of the Explorer, Juan de Fuca, and Gorda Plates due to spreading of the Gorda-Juan de Fuca-Explorer Ridge System. The latter three plates are the remnants of the Farallon Plate, which originally underlay much of the eastern Pacific and has been converging with the North America Plate since at least the Jurassic (Atwater, 1970 #1199; Duncan and Kulm, 1989 #4242). Tectonic elements associated with the subduction zone include: 1) an accretionary wedge of Eocene(?) through Quaternary sediments deformed by a broad fold and thrust belt [784] and several easterly-striking strike-slip faults [structures #785-799]; 2) a forearc of sedimentary and igneous rocks that accumulated during plate collision, broken in places by minor Quaternary faults and folds [859-861, 869-898]; and 3) a volcanic arc (Cascade Range) consisting of Eocene through Quaternary volcanic rocks, several active andesitic volcanoes, and numerous, mostly extensional Quaternary faults. Few if any historical earthquakes have been located on the interface between the subducting and overriding plates (Weaver and Shedlock, 1996 #4293), but geological studies show that great earthquakes have occurred in the past 4,000 years (e.g. Atwater and others, 1995 #4215; Clague, 1997 #5042), and geodetic studies (e.g. Hyndman and Wang, 1995 #4228; Savage and others, 2000 #4274) indicate strain accumulation consistent with the assumption that the Cascadia subduction zone is locked beneath offshore northern California, Oregon, Washington, and southern British Columbia. Numerous geological and geophysical studies suggest that the Cascadia subduction zone may be segmented (Hughes and Carr, 1980 #4173; Weaver and Michaelson, 1985 #4222; Guffanti and Weaver, 1988 #4174; Goldfinger, 1994 #3972; Kelsey and others, 1994 #4110; Mitchell and others, 1994 #4227; Personius, 1995 #4130; Nelson and Personius, 1996 #4128; Witter, 1999 #4194), but the most recent studies suggest that at least for the last great earthquake in A.D. 1700, much of the subduction zone ruptured in a single $M_w$ 9 earthquake (Satake and others, 1996 #4281; Atwater and Hemphill-Haley, 1997 #4216; Clague and others, 2000 #4332).

**Sense of movement** T

Comments: The subduction zone is a gently dipping megathrust (regional-scale thrust fault) (Atwater, 1970 #1199; Silver, 1971 #4240).

**Dip** 9-11°

Comments: Earthquake (Taber and Smith, 1985 #4229; Michaelson and Weaver, 1986 #4226; Crosson and Owens, 1987 #4224; Weaver and Baker, 1988 #4186; Rasmussen and Humphreys, 1988 #4220; Rieken and Thiessen, 1992 #4225), geodetic (Savage and Lisowski, 1991 #4180; Savage and others, 1991 #4181; Dragert and others, 1994 #4185; Mitchell and others, 1994 #4227; Dragert and Hyndman, 1995 #4177; Hyndman and Wang, 1995 #4228) and seismic reflection and refraction data (Taber and Lewis, 1986 #4223; Trehu and others, 1994 #4234; Trehu and others, 1995 #4236; Parsons and others, 1998 #4175) indicate that the Juan de Fuca Plate is being subducted beneath the Oregon continental margin with a dip of 9-11°.

**Main dip direction** E

**Geomorphic expression** The geomorphology of the continental shelf and slope above the subduction zone has been studied with submersible dives, bathymetric, sidescan sonar, and seismic reflection data, and widely scattered coring and drilling investigations. The area is marked by the juxtaposition of an active fold and thrust belt marked by linear ridges and benches in the accretionary wedge at the base of the continental slope, against the flat topography of the abyssal plain that characterizes much of the eastern margin of the subducting Juan de Fuca Plate (Kulm and others, 1986 #4272; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972). The leading edge of the deformation front of the subduction zone is not marked by a bathymetric trench as is typical of many other subduction zones, because the subducting plate is covered by turbidite sediments hundreds of meters thick that were deposited from submarine fans emanating from large coastal rivers (Duncan, 1968 #4245; Nelson and others, 1970 #4262; Nelson, 1984 #4243; Peterson and others, 1986 #4133; Carlson and Nelson, 1987 #4251; Yeats and others, 1998 #4085; McNeill and others, 2000 #5060).

**Age of faulted deposits at the surface** Little detailed information on the ages of faulted deposits at the deformation front of the subduction zone has been described, but the Cascadia subduction zone appears to offset late Pleistocene and Holocene sediments of the accretionary wedge against late Pleistocene and Holocene submarine fan sediments (Kulm and Embley, 1988 #4267; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972).

**Paleoseismology studies** Because the surface trace of the subduction zone megathrust is located many tens of kilometers offshore in hundreds to thousands of meters of water, paleoseismic studies have been focused on “off fault” signs of earthquakes, such as coseismic uplift and subsidence, earthquake-induced turbidite and tsunami records, and liquefaction features caused by seismic shaking. Some of these paleoseismic features may be related to displacements on crustal faults, which may or may not deform synchronously with subduction zone earthquakes (McNeill and others, 1998 #4089; Yeats and others, 2001 #5050). From north to south, detailed studies of sites in Oregon include:

Lower Columbia River Site [781-1]. Atwater (1994 #4248), Peterson and Madin (1997 #5062), and Obermeier and Dickenson (1997 #4266) studied paleoliquefaction features along the lower reach of the Columbia River in Washington and Oregon that were probably formed during the most recent great earthquake on the Cascadia subduction zone. Atwater (1994 #4248) compiled geologic and geotechnical data collected from exposures along six islands in the Columbia River, and concluded that most of the observed features probably were caused by lateral spread failure and/or forceful injection induced by shaking during a subduction zone earthquake about 300 years ago. Obermeier and Dickenson (1997 #4266) compared the size, number, location, and geotechnical properties of Columbia River intrusion features with similar features associated with other large earthquakes, and concluded that the most recent large earthquake on the subduction zone was likely no larger than M 8 and was accompanied by only moderate levels of ground shaking. However, the banks of the Columbia River have retreated 100-600 m since nautical charting began in the 1870’s, so the presently exposed features may not reflect the most intense liquefaction that occurred during the earthquake (Atwater, 1994 #4248). Preliminary results of more recent investigations of large cores in this area support the interpretation that the liquefaction features formed as a result of great subduction zone earthquakes (Takada and others, 2001 #5046; Atwater and others, 2001 #5053; Takada and others, 2002 #5047).

Upper Columbia River Site [781-2]. Volker and others (1994 #5075), Siskowic and others (1994 #5074), and Peterson and Madin (1997 #5062) studied liquefaction features along the upper reach of the Columbia River upstream of Portland. Peterson and Madin (1997 #5062) found small dikes and sills of intruded sand that did not reach the modern ground surface along cut banks at Government, North and South McGuire, East and West Reed, and Pierce Islands and the Sandy River delta. They used limited radiocarbon ages and tephra correlations to tentatively correlate these features to the A.D. 1700 Cascadia earthquake, and noted generally decreasing maximum size and abundance of liquefaction features up from the lower Columbia River.

Necanicum River Site [781-3]. Darienzo (1991 #4294), Darienzo and others (1994 #4287), and Darienzo and Peterson (1995 #4286) used gouge-core stratigraphy and qualitative diatom analyses in the estuary of the Necanicum River and Neawanna Creek and other estuaries in northern Oregon to identify and correlate six buried marsh soils. They attributed the sudden burial of each soil to regional coseismic subsidence during great subduction-zone earthquakes in the late Holocene.  Sandy beds that cap three of the soils in the Necanicum/Neawanna estuary are evidence for accompanying tsunamis.  Seven 14C ages on bulk peat loosely constrain the ages of five of the six buried soils.  Barnett (1997 #5068) used lithologic and quantitative diatom analyses to justify the amounts of subsidence estimated for some of the younger subsidence events.

Ecola Creek Site [781-4].  Darienzo and Peterson (1995 #4286) used stratigraphic data of P.J. Galloway and others (unpublished report, 1992 referenced in Darienzo and Peterson, 1995 #4286) from the estuary of Ecola Creek to identify six buried marsh soils. (unpublished report, 1992 referenced in Darienzo and Peterson, 1995 #4286) attributed the sudden burial of each soil to regional coseismic subsidence during great subduction-zone earthquakes in the late Holocene.  Sandy beds that cap three of the soils along Ecola Creek are evidence for accompanying tsunamis.  Three 14C ages on bulk peat loosely constrain the ages of three of the six buried soils.

Nehalem River Site [781-5]. Grant and McLaren (1987 #4283) and Grant (1989 #4284; written communication, 1994) studied four buried wetland soils in extensive outcrops and gouge-core transects in the estuary of the Nehalem River.  Rapidly buried growth-position fossils at the tops of the youngest and oldest soils and similarities with better exposed soils in Washington led these authors to infer at least two and probably four great subduction-zone earthquakes in the past 2000 years.  Additional supporting archeological and stratigraphic data from this estuary include that of (Grant and McLaren, 1987 #4283; Grant, 1989 #4284; Grant and Minor, 1991 #4282; Goldfinger and others, 1992 #464).  The original 29 14C ages of Grant (1989 #4284; written communication, 1994) that were used to estimate the times of soil burial have been supplemented by 22 ages on plants rooted in buried soils (Nelson and others, (1995 #4196).

Netarts Bay Site [781-6].  A series of stratigraphic and biostratigraphic studies in the marshes of the Netarts Bay estuary has not led to a consensus on the number of great subduction-zone earthquakes recorded there.  Darienzo and Peterson (1990 #4209), Darienzo (1991 #4294), and Darienzo and Peterson (1995 #4286) used gouge-core stratigraphy and qualitative diatom analyses in the estuary of Netarts Bay and other estuaries in northern Oregon to identify and correlate six buried marsh soils.  They attributed the sudden burial of each soil to regional coseismic subsidence during great subduction-zone earthquakes in the late Holocene.  Sandy beds that cap four of the soils at Netarts Bay are evidence for accompanying tsunamis.  Darienzo and Peterson (1995 #4286) loosely constrained the ages of four of the six buried soils with six 14C ages on bulk peat, and Nelson and others (1995 #4196; 1996 #4199) better defined the ages of three soils with 17 additional 14C ages on plants rooted in the tops of soils.  In the most detailed coastal biostratigraphic study in Oregon, Shennan and others (1998 #4201) used quantitative pollen, diatom, and foraminiferal data to question a coseismic subsidence origin for four of the six buried soils at Netarts Bay.

Nestucca Bay Site [781-7]. Darienzo (1991 #4294), Darienzo and others (1994 #4287), and Darienzo and Peterson (1995 #4286) used gouge-core stratigraphy and qualitative diatom analyses in the estuary of Nestucca Bay to identify as many as 12 buried marsh soils, the six most recent of which they correlated to similar soils in other estuaries in northern Oregon.  They attributed the sudden burial of the six soils to regional coseismic subsidence during great subduction-zone earthquakes in the late Holocene.  A sandy bed that caps the most recent soil is evidence for an accompanying tsunami.  Five 14C ages on bulk peat loosely constrain the ages of three of the six buried soils.

Salmon River Site [781-8].  Grant and McLaren (1987 #4283) and Grant (1989 #4284; written communication, 1994) studied a prominent buried wetland soil in extensive outcrops and gouge-core transects and 3-4 older buried soils in two transects in the estuary of the Salmon River.  Rapidly buried growth-position fossils at the top of the prominent soil, 9 14C ages, and a thick overlying bed of tsunami-deposited sand led these authors to attribute burial of the prominent soil to a great subduction-zone earthquakes in the past 300-500 years. Additional supporting archeological and stratigraphic data from this estuary include that of (Grant and McLaren, 1987 #4283; Grant, 1989 #4284; Grant and Minor, 1991 #4282; Goldfinger and others, 1992 #464). Nelson and others (1995 #4196;) used eight 14C ages on plants rooted in the prominent soil to date soil burial to about 300 years ago. Because of limited stratigraphic data, no earthquake origin was claimed for the three older soils identified by Grant (1989 #4284; written communication, 1994). But in a later biostratigraphic study by Asquith (1996 #5064), pollen data was used to infer sudden, probably coseismic subsidence for two of the older soils and gradual nonseismic submergence for the third.

Siletz River Site [781-9]. Darienzo (1991 #4294), Darienzo and others (1994 #4287), and Darienzo and Peterson (1995 #4286) used gouge-core stratigraphy and qualitative diatom analyses in the estuary of the Siletz River to identify as many as seven buried marsh soils. They correlated six of the soils to other estuaries in northern Oregon and attributed the sudden burial of each soil to regional coseismic subsidence during great subduction-zone earthquakes in the late Holocene. Sandy beds that cap five of the six soils in the Siletz River estuary are evidence for accompanying tsunamis. Nine 14C ages on bulk peat loosely constrain the ages of the six buried soils. Barnett (1997) used lithologic and quantitative diatom analyses to justify the amounts of subsidence estimated for some of the younger subsidence events.

Yaquina Bay Site [781-10]. Darienzo (1991 #4294), Darienzo and others (1994 #4287), and Darienzo and Peterson (1995 #4286) used gouge-core stratigraphy and qualitative diatom analyses in the estuary of the Yaquina River to identify as many as twelve buried marsh soils. They correlated six of the soils to other estuaries in northern Oregon and attributed the sudden burial of each soil to regional coseismic subsidence during great subduction-zone earthquakes in the late Holocene. Nine 14C ages on bulk peat loosely constrain the ages of the six buried soils.

Alsea Bay Site [781-11]. Darienzo (1991 #4294), Darienzo and Peterson (1995 #4286), and Peterson and Darienzo (1996 #4304) studied extensive outcrops and 21 gouge and vibracores from the marshes of the Alsea River estuary. They identified as many as ten buried marsh soils and four tsunami-deposited sheets of sand. Through correlation of six of the soils to other estuaries in northern Oregon, Darienzo and Peterson (1995 #4286) attributed the sudden burial of each of the six soils to regional coseismic subsidence during great subduction-zone earthquakes in the late Holocene. Nine 14C ages on bulk peat loosely constrain the ages of nine of the ten buried soils. Nelson et al. (2000; written communication, 2000) studied the five most recent buried soils, four capped by extensive sheets of tsunami-deposited sand, in more detail (40 cores). They used 13 14C ages to date four of the five buried soils to the past 3000 years and inferred minimal coseismic subsidence just prior to the deposition of three of the four tsunami sand sheets through study of foraminiferal assemblages above and within buried soils.

Siuslaw River Site [781-12]. Nelson (1992 #4277) and Nelson and Personius (1996 #4128) interpreted the nearly 4 m of continuous peat and the gradual boundaries between peat and mud beneath the marshes of the Siuslaw River estuary as evidence of slow submergence, rather than sudden coseismic rises in relative sea level. Briggs (1994 #4189) identified as many as five possible buried marsh soils and one liquefaction feature in gouge cores in the upper Siuslaw River estuary. Cores from the lower estuary contained as many as three anomalous sand layers that he interpreted as possible evidence of tsunamis.

Umpqua River Site [781-13]. Reconnaissance coring by Nelson (1992 #4277) in the lower estuary of the Umpqua River did not allow him to preclude repeated coseismic subsidence during subduction-zone earthquakes, but gradual boundaries between most units were more typical of slow changes in relative sea level. Briggs (1994 #4189) interpreted interbedded sand, mud, and peat in gouge cores in the lower estuary near the coast as evidence of coseismic uplift; further inland he found continuous peaty sediment in the lower estuary and interbedded peats and muds with sharp boundaries in the upper estuary. From this evidence he inferred as many as four coseismic subsidence events, three accompanied by the deposition of anomalous sand beds probably by tsunamis.

Eastern Coos Bay Site [781-14]. From reconnaissance gouge coring in thirteen marshes in the eastern part of the Coos Bay estuary, Nelson (1992 #4200; 1992 #4277) concluded that inconsistencies in the distinctness of late Holocene peat-mud contacts were more consistent with displacements on local folds and faults than with regional subsidence during subduction zone earthquakes. Nor did he find evidence of tsunami-deposited sand, probably because all sites were in the middle and upper reaches of the estuary >15 km from the coast. Briggs (1994 #4189) described both continuous peaty sediment and interbedded peat and mud in the Coos Bay estuary, with sharp contacts being more common in the eastern part of the estuary. He inferred as many as six times of subsidence during subduction zone earthquakes, with as many as two accompanying tsunamis.

South Slough Site [781-15]. Nelson (1992 #4200; 1992 #4277), Ota and others (1995 #5066), Nelson and others (1996 #4198; 1998 #4197), and Nelson and others (1998 #4197) summarized detailed (over 100 gouge and vibracores) studies of tidal marsh stratigraphy at 16 sites in the South Slough arm of Coos Bay. Quantitative diatom studies and detailed radiocarbon dating (48 ages) supplemented with thorough lithologic descriptions of selected cores. Although the sequence of interbedded peat and mud in South Slough records as many as ten times of rapid submergence in the late Holocene, only three of these events were extensive enough for Nelson et al. (1998) to conclude that they were the result of subduction zone earthquakes. Correlation of the South Slough sequence with more recent detailed studies along the Coquille and Sixes rivers (below) suggests that at least seven of the rapid submergence events in South Slough were caused by great earthquakes. In reconnaissance studies at several sites in South Slough, Briggs (1994 #4189) inferred that as many as six buried marsh soils and two tsunami deposits were evidence for coseismic subsidence on either local structures or the subduction zone.

Coquille River Site [781-16]. Nelson (1992 #4277), Nelson and others (1995 #4196), Witter and others (1997 #4193), and Witter (1999 #4194) have studied the stratigraphy of the Coquille River estuary. Nelson (1992 #4277) and Nelson and others (1995 #4196) used 12 14C ages to date rooted plants at the top of a prominent buried soil that marks regional subsidence and tsunami deposition during a great subduction zone earthquake about 300 years ago. In a far more detailed study of the estuary employing 46 gouge and vibracores, quantitative diatom analyses, and 36 14C ages, Witter and others (1997 #4193), and Witter (1999 #4194/ pers. commun., 2003) identified sudden subsidence from as many as 12 great subduction zone earthquakes and sandy beds from as many as 11 accompanying tsunamis in the past 6700 years.

Bradley Lake Site [781-17]. Detailed stratigraphic studies (14 piston cores, 13 vibracores) at Bradley Lake (Nelson and others, 1996 #4263; Kelsey and others, 1998 #4275; Nelson and others, 1998 #4278) identified deposits from 17 times of lake disturbance in the past 7500 years caused by shaking from offshore earthquakes or inundation by tsunamis generated at the Cascadia subduction zone. Detailed lithologic analyses and quantitative diatom studies (Hemphill-Haley et al., 2000) of the 6.7-m section of largely laminated lake sediment indicate that 12 of the disturbance events were probably due to inundation by local tsunamis. Nelson and others (2000) compared ages determined for each of the 17 disturbance events (57 14C ages) with independently derived sedimentation-rate ages calculated from varve counts to obtain the most precise ages for past great earthquake in Oregon. The longest interval between inferred tsunamis is about 800 years and the shortest is as little as 11 years.

Sixes River Site [781-18]. Detailed stratigraphy (two outcrops and 49 gouge and vibracores), quantitative diatom analyses, and extensive 14C dating (46 ages) in the lower reaches of the Sixes River documented 11 times of sudden coseismic subsidence, nine accompanied by tsunamis, in the past 6000 years (Kelsey and others, 1996 #4188; Kelsey and others, 1998 #4187; Kelsey and others, 2002 #5043).

Euchre Creek Site [781-19]. Witter (1999 #4194) identified four storm or tsunami-deposited sand beds dating from the last 600 years in a small marsh at the mouth of Euchre Creek. Although none of the beds are evidence for coseismic subsidence, the thickest was probably deposited by the tsunami of the AD 1700 great earthquake.

Cascadia and Astoria submarine channels site [781-20] (offshore—locations not shown on map). Although it has been recognized for many years that some of the turbidites in submarine channels of the continental shelf and slope offshore of Oregon and Washington (c.f. Griggs and Kulm, 1970 #4244) may have been earthquake induced, Adams (1984 #4120) first suggested that the timing of turbidite sequences might yield recurrence intervals from great earthquakes on the Cascadia subduction zone. Adams (1990 #4238; 1996 #4289) used the presence of thirteen post-Mazama-eruption (<6850 yr B.P.) turbidites along much of the Cascadia margin to calculate an average recurrence interval of about 600 years for great subduction-zone earthquakes. Preliminary data from more recent studies support the 13 turbidite scenario in the Cascadia Channel, but indicate a more complicated turbidite history in the Astoria and other channels offshore of Oregon and northern California (Nelson and others, 1996 #4264; Nelson and others, 1999 #4279; Nelson and others, 2000 #5084). Preliminary results of the latest studies indicate 13 events since deposition of the Mazama ash about 7.6 ka, and 18 events since deposition of a 12.7 ka biostratigraphic marker; these records yield average recurrence intervals of about 600 years and 690 years, respectively (Goldfinger and others, 2002 #5140).

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Numerous detailed studies indicate coastal subsidence, tsunamis, liquefaction, and turbidite triggering consistent with a large earthquake on the Cascadia subduction zone about 300 years ago (see summaries in Atwater and others, 1991 #4211; Nelson and others, 1995 #4196; Atwater and others, 1995 #4215; Atwater and Hemphill-Haley, 1997 #4216; Clague and others, 2000 #4332). Historic records from a tsunami in Japan strongly suggest a Mw >8.5 earthquake occurred on the Cascadia zone on January 26, 1700, "probably about 9 PM" (Satake and others, 1996 #4281); studies of the rings of trees disturbed or killed during this earthquake are consistent with this season and year (Yamaguchi and others, 1997 #4203; Jacoby and others, 1997 #4276).

**Recurrence interval** 500-600 years (average for the past 2-7 k.y.)

Comments: Numerous detailed studies of coastal subsidence, tsunamis, and turbidites yield a wide range of recurrence intervals, but the most complete records (>4000 years) indicate average intervals of 500-600 years between great earthquakes on the Cascadia subduction zone (Adams, 1990 #4238; Witter and others, 1997 #4193; Atwater and Hemphill-Haley, 1997 #4216; Witter, 1999 #4194; Clague and others, 2000 #4332; Goldfinger and others, 2002 #5140). Individual intervals range from 11 years (Nelson et al., 2000; written communication, 2000) to more than 1000 years (Witter and others, 1997 #4193; Atwater and Hemphill-Haley, 1997 #4216; Witter, 1999 #4194; Kelsey and others, 2002 #5043).

**Slip-rate category** >5 mm/yr

Comments: Studies of magnetic anomalies in the Juan de Fuca Plate and geodetic studies suggest a rate of oblique convergence of about 35-45 mm/yr in a NE direction across the Cascadia subduction zone (Riddihough, 1984 #4176; DeMets and others, 1990 #3186; DeMets and others, 1994 #4285; McCaffrey and Goldfinger, 1995 #4232).

| | | |
|---|---|---|
| **Length** | End to end (km): | >535.6 |
| | Cumulative trace (km): | >547.1 |

Comments: Lengths are minimums because the structure extends beyong the borders of the map.

**Average strike** (azimuth) N 28° W

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## 782, Blanco transform fault zone

**Structure Number** 782

Comments:

**Structure Name** Blanco transform fault zone

Comments: The Blanco transform fault zone is a transform fault system that forms the southwestern margin of the Juan de Fuca Plate. The zone was first identified by Menard (1959 #4254), who subsequently informally named the zone the "Cape Blanco" fracture zone (Menard, 1962 #4252). The zone was studied in more detail and renamed the "Blanco fracture zone" by McManus (1965 #4253). The name "Blanco transform fault zone" appears to be widely used in more recent reports (Embley and others, 1987 #4257; Dziak and others, 1991 #4301; Embley and Wilson, 1992 #4303; Dziak, 1997 #4295) and is retained herein.

**Synopsis** The Blanco fracture zone is a northwest-striking system of strike-slip faults and associated pull apart basins that form the southwestern transform margin of the Juan de Fuca Plate offshore Oregon. The zone apparently offsets the Juan de Fuca Ridge and Gorda Ridge spreading centers in a left-lateral sense, but delineation of seafloor magnetic anomalies, establishment of the concept of seafloor spreading at ocean ridges, and earthquake focal mechanism studies helped establish the presently accepted configuration of the Blanco fracture zone as a complex right-lateral transform fault zone. Little detailed information on the ages of faulted deposits along the fracture zone has been described, but Pleistocene and Holocene turbidite sediments, including some containing the Mazama ash, are deformed in some of the pull apart basins, so latest movement occurred in the latest Quaternary.

**Date of compilation** April 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Curry (offshore)

**1° x 2° sheet** Cape Blanco (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range and Klamath Mountains sections)

**Quality of location** Good

Comments: The mapped trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464); only the easternmost part of the zone is shown on the map.

**Geologic setting** The Blanco fracture zone is a northwest-striking system of strike-slip faults and associated pull apart basins that form the southwestern transform margin of the Juan de Fuca Plate offshore Oregon. The zone apparently offsets the Juan de Fuca Ridge and Gorda Ridge spreading centers in a left-lateral sense, but delineation of seafloor magnetic anomalies (Vine and Wilson, 1965 #4259), establishment of the concept of seafloor spreading at ocean ridges (Wilson, 1965 #4260), and earthquake focal mechanism studies (Tobin and Sykes, 1968 #4256) helped establish the presently accepted configuration of the Blanco fracture zone as a complex right-lateral transform fault zone (Atwater, 1970 #1199; Embley and others, 1987 #4257; Dziak and others, 1991 #4301; Embley and Wilson, 1992 #4303; Dziak, 1997 #4295).

**Sense of movement** DN, N, T

Comments: The Blanco fracture zone is a northwest-striking system of strike-slip faults and associated pull-apart basins that form a right-lateral transform fault zone along the southwestern margin of the Juan de Fuca Plate (Atwater, 1970 #1199; Embley and others, 1987 #4257). Focal mechanism studies suggest a slight component of normal oblique slip, down-to-the-northeast (Dziak, 1997 #4295). The faults shown on the map plate are mostly thrust and normal faults mapped in the Gorda basin, east of the Gorda Ridge (Goldfinger and others, 1992 #464), at the eastern end of the Blanco fracture zone.

**Dip** 58°-89°

Comments: Dip data from focal mechanism studies of Dziak (1997 #4295).

**Main dip direction** NE

**Geomorphic expression** The geomorphology of the fracture zone has been studied with submersible dives, bathymetric, sidescan sonar, and seismic reflection data, and widely scattered coring and drilling investigations. The zone is marked by a series of long, right-stepping linear strike ridges, separated by shorter pull apart basins (Embley and others, 1987 #4257; Embley and Wilson, 1992 #4303; Dziak, 1997 #4295). These topographic features were used by Embley and others (1987 #4257) and Embley and Wilson (1992 #4303) to delineate three major segments, a western segment, a middle Cascadia segment, and an eastern segment. The Cascadia segment is bifurcated by the Cascadia submarine channel, which shows right-lateral separation across the fracture zone (Dziak, 1997 #4295). Holocene subsidence in the Cascadia depression no longer allows sediment to cross the fracture zone (Duncan, 1968 #4245; Griggs and Kulm, 1970 #4244; Griggs and Kulm, 1973 #4246; Embley and others, 1987 #4257). Herein the informal segments of Embley and others (1987 #4257) and Embley and Wilson (1992 #4303) are discussed together because little is known about their earthquake histories, and only the eastern end of the eastern segment is located on the map.

**Age of faulted deposits at the surface** Little detailed information on the ages of faulted deposits along the fracture zone has been described, but Pleistocene and Holocene turbidite sediments, including some containing the Mazama ash, are deformed in some of the pull apart basins (Griggs and Kulm, 1970 #4244; Griggs and Kulm, 1973 #4246; Embley and others, 1987 #4257).

**Paleoseismology studies** Because the surface trace of the Blanco fracture zone is located entirely under water, no detailed paleoseismic studies have been conducted along the zone.

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Deformation of Pleistocene and Holocene turbidite sediments, including those containing the Mazama ash (Griggs and Kulm, 1970 #4244; Griggs and Kulm, 1973 #4246; Embley and others, 1987 #4257) indicate most recent displacement in the latest Quaternary along some parts of the Blanco fracture zone. Goldfinger and others (1992 #464) map these structures as active in the late Pleistocene and Holocene.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably >5 mm/yr

Comments: Studies of magnetic anomalies in the Juan de Fuca Plate indicate sea-floor spreading rates of 30-50 mm yr in the last 4 Ma (Vine, 1966 #4258), and convergence rate of 35-45 mm/yr in a NE direction across the Cascadia subduction zone (Riddihough, 1984 #4176; DeMets and others, 1990 #3186; DeMets and others, 1994 #4285; McCaffrey and Goldfinger, 1995 #4232). Such high rates of deformation of the Juan de Fuca Plate suggest high rates of slip on the Blanco fracture zone.

| | | |
|---|---|---|
| **Length** | End to end (km): | >106.5 |
| | Cumulative trace (km): | >362.6 |

Comments: Lengths are minimums because the structure extends beyong the borders of the map.

**Average strike** (azimuth) N 11° E

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**784, Cascadia fold and thrust belt**

**Structure Number** 784

Comments: Some of these folds and faults are included in fault number 21 of Pezzopane (1993 #3544).

**Structure Name** Cascadia fold and thrust belt

Comments: This is a group of folds and faults in the forearc of the Cascadia subduction zone [781] offshore Oregon; two of these structures have been named and described in the literature (Stonewall anticline/Newport syncline [786]; Bald Mountain-Big Lagoon fault zone [787]); these structures are discussed separately.

**Synopsis** This group of north-striking folds and faults form a broad fold and thrust belt that deforms sediments underlying the continental shelf and slope in the forearc of the Cascadia subduction zone [781]. The fold and thrust belt consists of two primary domains, differentiated on the basis of fold wavelength: a continental slope domain, underlain by a thick sequence of accretionary wedge sediments deformed by closely spaced thrust faults and short-wavelength folds, and a continental shelf domain underlain by a rigid basement of Siletz River Volcanics (Siletzia terrane) deformed by more broadly spaced folds and thrusts. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these structures are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** April 19, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore), WA (offshore), CA (offshore)

**County** Clallum (offshore), Jefferson (offshore), Grays Harbor (offshore), Pacific (offshore), Clatsop (offshore), Tillamook (offshore), Lincoln (offshore), Lane (offshore), Douglas (offshore), Coos (offshore), Curry (offshore), Del Norte (offshore)

**1° x 2° sheet** Cape Flattery (offshore), Copalis Beach (offshore), Cape Disappointment (offshore), Newport (offshore), Coos Bay (offshore), Cape Blanco (offshore), Eureka (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range and Klamath Mountains sections)

**Quality of location** Poor

Comments: The fault traces are from 1:500,000-scale mapping of Goldfinger and others (1992 #464); fold traces of Goldfinger and others (1992 #464) are not shown.

**Geologic setting** This group of north-striking folds and faults form a fold and thrust belt that deforms sediments underlying the continental shelf and slope in the forearc of the Cascadia subduction zone [781] (Goldfinger and others, 1992 #464; MacKay and others, 1992 #4299; Goldfinger, 1994 #3972; MacKay, 1995 #4235; Goldfinger and others, 1997 #4090; McNeill and others, 2000 #5060). The fold and thrust belt consists of two primary domains, differentiated on the basis of fold wavelength: a continental slope domain, underlain by a thick sequence of accretionary wedge sediments deformed by closely spaced thrust faults and short-wavelength folds, and a continental shelf domain underlain by a rigid basement of Siletz River Volcanics (Siletzia terrane) deformed by more broadly spaced folds and thrusts (Trehu and others, 1994 #4234; Yeats and others, 1998 #4085; Fleming and Trehu, 1999 #4237; McNeill and others, 2000 #5060). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these structures are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Goldfinger and others, 1997 #4090; Yeats and others, 1998 #4085; McNeill and others, 1998 #4089).

**Sense of movement** Thrust

Comments: These faults are mapped as east and west-verging thrust faults, and synclines and anticlines (Goldfinger and others, 1992 #464; MacKay and others, 1992 #4299; Goldfinger, 1994 #3972; MacKay, 1995 #4235; Goldfinger and others, 1997 #4090; McNeill and others, 2000 #5060).

**Dip** Not Reported

Comments: Seismic-reflection data and sinuous fault traces indicate moderate fault dips (Goldfinger and others, 1992 #464; MacKay and others, 1992 #4299; Goldfinger, 1994 #3972; MacKay, 1995 #4235; McNeill and others, 2000 #5060).

**Main dip direction** Not Reported

**Geomorphic expression** No detailed information is available on the geomorphic expression of most individual structures, but side-scan sonar, bathymetric, and seismic-reflection data show that most of these structures form elongate, en echelon anticlinal ridges in the sea floor (Snavely, 1987 #4086; Goldfinger and others, 1992 #464; MacKay and others, 1992 #4299; MacKay, 1995 #4235; Snavely and Wells, 1996 #4290; McNeill and others, 2000 #5060).

**Age of faulted deposits at the surface** No detailed information on the ages of deformed deposits has been published, but many offshore structures in the Cascadia forearc offset late Pleistocene and Holocene sediment (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Snavely and Wells, 1996 #4290; Goldfinger and others, 1997 #4090; McNeill and others, 2000 #5060).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting or folding** latest Quaternary (<15 ka)

Comments: No detailed information on the ages of most recent movement on these structures has been published, but many offshore structures offset late Pleistocene and Holocene sediments and thus have been active in the latest Quaternary (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090). Most of these folds and faults are mapped as active in the Holocene or late Pleistocene, but some are mapped as active in the middle and late Quaternary (<700-780 ka) or as Plio-Pleistocene (Goldfinger and others, 1992 #464; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; McNeill and others, 2000 #5060).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably 1-5 mm/yr

Comments: No detailed information on the slip rates associated with these structures has been published, but similar offshore structures such as the Stonewall anticline [786] have slip rates of 1-5 mm/yr (Yeats and others, 1998 #4085).

| | | |
|---|---|---|
| **Length** | End to end (km): | >483.4 |
| | Cumulative trace (km): | >3188.0 |

Comments: Lengths are minimums because the structure extends beyong the borders of the map.

**Average strike** (azimuth) N 30° W

**References**

#4237 Fleming, S.W., and Trehu, A.M., 1999, Crustal structure beneath the central Oregon convergent margin from potential-field modeling—Evidence for a buried basement ridge in local contact with a seaward dipping backstop: Journal of Geophysical Research, v. 104, no. B9, p. 20,431-20,447.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

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#5060 McNeill, L.C., Goldfinger, G., Kulm, L.D., and Yeats, R.S., 2000, Tectonics of the Neogene Cascadia forearc basin: Investigations of a deformed late Miocene unconformity: Geological Society of America Bulletin, v. 112, no. 8, p. 1209-1224.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4086 Snavely, P.D., Jr., 1987, Chapter 14-Tertiary geologic framework, neotectonics, and petroleum potential of the Oregon-Washington continental margin, *in* Scholl, D.W., Grantz, A., and Vedder, J.G., eds., Geology and resource potential of the continental margin of Western North America and adjacent ocean basins—Beaufort Sea to Baja, California: Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, Volume 6, p. 305-335, 3 pls.

#4290 Snavely, P.D., and Wells, R.E., 1996, Cenozoic evolution of the continental margin of Oregon and Washington, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 161-182.

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#4085 Yeats, R.S., Kulm, L.D., Goldfinger, C., and McNeill, L.C., 1998, Stonewall anticline—An active fold on the Oregon continental shelf: Geological Society of America Bulletin, v. 110, no. 5, p. 572-587.

**785, Unnamed offshore faults**

**Structure Number** 785

Comments: Some of these structures are included in fault number 21 of Pezzopane (1993 #3544).

**Structure Name** Unnamed offshore faults

Comments: This is a group of faults mapped by Goldfinger and others (1992 #464) offshore Oregon; none of these faults have been named in the literature.

**Synopsis** This group of faults offset accretionary wedge sediments that underlie the continental shelf and slope in the forearc of the Cascadia subduction zone [781]; some faults also offset the overlying sedimentary section and the underlying oceanic basalts of the subducting Juan de Fuca Plate. These faults are mapped as left-and right-lateral strike-slip faults and normal and reverse faults, but most have strikes oblique to the Cascadia deformation front, suggesting a strong lateral component of slip. No detailed information on age of offset deposits is available, but similarities with better-studied offshore faults suggest latest movement in the latest Quaternary on most of these structures. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** April 19, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore), WA (offshore), CA (offshore)

**County** Clallum (offshore), Jefferson (offshore), Grays Harbor (offshore), Pacific (offshore), Clatsop (offshore), Tillamook (offshore), Lincoln (offshore), Lane (offshore), Douglas (offshore), Coos (offshore), Curry (offshore), Del Norte (offshore)

**1° x 2° sheet** Cape Flattery (offshore), Copalis Beach (offshore), Cape Disappointment (offshore), Newport (offshore), Coos Bay (offshore), Cape Blanco (offshore), Eureka (offshore)

**Province** offshore of Pacific Border (Oregon Coast Range and Klamath Mountains sections)

**Quality of location** Poor

Comments: The fault traces are from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** This group of faults offset accretionary wedge sediments that underlie the continental shelf and slope in the forearc of the Cascadia subduction zone [781]; some faults offset the overlying sedimentary section and the underlying oceanic basalts of the subducting Juan de Fuca Plate (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** S, D, R, N

Comments: These faults are mapped as left-and right-lateral strike-slip faults, and normal and reverse faults; most have strikes oblique to the Cascadia deformation front, suggesting a strong lateral component of slip (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Dip** Not Reported

Comments: Sense of slip data suggest that most of these faults have steep dips (Goldfinger and others, 1992 #464).

**Main dip direction** Not Reported

**Geomorphic expression** No detailed information on the geomorphic expression of these faults has been published, but similar offshore structures form scarps, offset channels, and deform Quaternary sediments in seismic-reflection profiles (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Age of faulted deposits at the surface** No detailed information on the ages of faulted deposits has been published, but similar offshore structures offset late Pleistocene and Holocene sediments (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: No detailed information on the ages of most recent movement has been published, but similar offshore structures offset late Pleistocene and Holocene sediment, and thus have been active in the latest Quaternary (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090). Most of these faults are mapped as active in the Holocene or late Pleistocene, but some are mapped as active in the middle and late Quaternary (<700-780 ka) or as Pliocene-Pleistocene (Goldfinger and others, 1992 #464; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably 1-5 mm/yr

Comments: No detailed information on the slip rates associated with these faults has been published, but similar offshore structures have slip rates of 1-5 mm/yr (Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090).

| | | |
|---|---|---|
| **Length** | End to end (km): | >196.3 |
| | Cumulative trace (km): | >334.6 |

Comments: Lengths are minimums because the structure extends beyong the borders of the map.

**Average strike** (azimuth) N 11° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4088 Goldfinger, C., Kulm, L.D., Yeats, R.S., Hummon, C., Huftile, G.J., Niem, A.R., and McNeill, L.C., 1996, Oblique strike-slip faulting of the Cascadia Submarine Forearc—The Daisy Bank fault zone off central Oregon, *in* Bebout, G.E., Scholl, D.W., Kirby, S.H., and Platt, J.P., eds., Subduction top to bottom: Geophysical Monograph 96, p. 65-74.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

**786, Stonewall anticline**

**Structure Number** 786

Comments:

**Structure Name** Stonewall anticline

Comments: The Stonewall anticline is a north-northwest-striking, west-verging anticline mapped, named, and described in detail by Yeats and others (1998 #4085). The Newport syncline is located in the hanging wall of an inferred east-dipping reverse fault that underlies the anticline (Yeats and others, 1998 #4085; McNeill and others, 2000 #5060). Wong and others (1999 #4073; 2000 #5137) included the Stonewall Bank fault in their analysis of earthquake hazards in the Portland area.

**Synopsis** The north-northwest-striking, west-verging, doubly plunging Stonewall anticline is one of numerous structures in a fold and thrust belt [784] that deforms sediments underlying the continental slope and shelf in the forearc of the Cascadia subduction zone [781]. The fold is located on the continental shelf, in an area underlain by a rigid basement of Siletz River Volcanics (Siletzia terrane); folds in this region have longer wavelengths than the closely spaced folds and faults in the accretionary wedge underlying the continental slope. The Stonewall anticline folds Miocene through Pleistocene sediment, and warps a late Pleistocene sea-level lowstand wave-cut platform and an antecedent drowned stream channel of the Yaquina River. An age range of 11-14.5 ka was assumed for the latter features, so the youngest deformation occurred in the latest Quaternary. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic deformation on this structure is always related to great megathrust earthquakes on the subduction zone, or whether some deformation is related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** April 19, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Lincoln (offshore), Tillamook (offshore)

**1° x 2° sheet** Newport (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The axial traces are from ~1:1,250,000-scale figure of Yeats and others (1998 #4085).

**Geologic setting** The north-northwest-striking, west-verging, doubly plunging Stonewall anticline is one of numerous structures in a fold and thrust belt [784] that deforms sediments underlying the continental slope and shelf in the forearc of the Cascadia subduction zone [781] (Goldfinger and others, 1992 #464; Yeats and others, 1998 #4085). The Stonewall anticline is located on the continental shelf, in an area underlain by the Siletz River Volcanics (Siletzia terrane). Folds in this region have longer wavelengths than the closely spaced folds and faults in the accretionary wedge underlying the continental slope; this pattern is probably controlled by the more rigid basement of the Siletzia terrane (Trehu and others, 1994 #4234; Yeats and others, 1998 #4085; Fleming and Trehu, 1999 #4237; McNeill and others, 2000 #5060). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic deformation on this structure is always related to great megathrust earthquakes on the subduction zone, or whether some deformation is related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; Yeats and others, 1998 #4085; McNeill and others, 1998 #4089).

**Sense of movement** Anticline

Comments: The Stonewall anticline plunges to the north and south. Yeats and others (1998 #4085) and McNeill and others (2000 #5060) infer the presence of an east-dipping blind reverse fault beneath the anticline, with the Newport syncline in the hanging wall of the inferred reverse fault.

**Dip** Anticline; blind reverse fault 65°-70° E

Comments: The Stonewall anticline plunges to the north and south and is west-vergent, with dips of 25° on the west flank and 15-18° on the east flank (Yeats and others, 1998 #4085). Yeats and others (1998 #4085) infer the presence of a blind reverse fault dipping 65°-70° east beneath the anticline. Wong and others (1999 #4073; 2000 #5137) used an inferred dip of 70° northeast in their analysis of earthquake hazards associated with their Stonewall Bank fault.

**Main dip direction** anticline: E and W, N and S plunge; blind reverse fault: E

**Geomorphic expression** The Stonewall anticline folds Miocene through Pleistocene sediments on the continental shelf; the fold also warps a submerged wave cut platform associated with a late Pleistocene sea-level lowstand, and an antecedent drowned stream channel of the Yaquina River (Yeats and others, 1998 #4085).

**Age of folded deposits at the surface** The Stonewall anticline folds Miocene through Pleistocene sediments on the continental shelf; the fold also warps a submerged wave cut platform associated with a late Pleistocene sea-level lowstand, and an antecedent drowned stream channel of the Yaquina (Yeats and others, 1998 #4085; McNeill and others, 2000 #5060). Yeats and others (1998 #4085) used an assumed age range of 11-14.5 ka for these features.

**Paleoseismology studies** none

**Time of most recent prehistoric folding** latest Quaternary (<15 ka)

Comments: The Stonewall anticline warps features associated with the late Pleistocene sea-level lowstand, which Yeats and others (1998 #4085) assigned ages of 11-14.5 ka, indicating most recent deformation in the latest Quaternary.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 1-5 mm/yr

Comments: Yeats and others (1998 #4085) used vertical uplift of 10-13 m of the submerged thalweg of the Yaquina River, assumed ages of 11-12 ka, and estimated dip of 65°-70° to calculate a post-latest Pleistocene slip rate of 0.9-1.3 mm/yr on the inferred east-dipping blind reverse fault beneath the Stonewall anticline. These short-term rates are comparable to long-term slip rates of 0.4-0.6 mm/yr or 1.0-1.1 mm/yr, depending on when deformation of the prominent Pliocene-Miocene unconformity was initiated. Wong and others (1999 #4073; 2000 #5137) used slip rates of 0.4-1.3 mm/yr in their analysis of earthquake hazards associated with their Stonewall Bank fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 80.2 |
| | Cumulative trace (km): | 124.9 |

Comments:

**Average strike** (azimuth) N 13° W

**References**

#4237 Fleming, S.W., and Trehu, A.M., 1999, Crustal structure beneath the central Oregon convergent margin from potential-field modeling—Evidence for a buried basement ridge in local contact with a seaward dipping backstop: Journal of Geophysical Research, v. 104, no. B9, p. 20,431-20,447.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington:  Oregon State University, unpublished Ph.D thesis, 246 p.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc:  Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain:  State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics:  Geological Society Special Publication No. 146, p. 321-342.

#5060 McNeill, L.C., Goldfinger, G., Kulm, L.D., and Yeats, R.S., 2000, Tectonics of the Neogene Cascadia forearc basin: Investigations of a deformed late Miocene unconformity:  Geological Society of America Bulletin, v. 112, no. 8, p. 1209-1224.

#4234 Trehu, A.M., Asudeh, I., Brocher, T.M., Luetgert, J.H., Mooney, W.D., Nabelek, J.L., and Nakamura, Y., 1994, Crustal architecture of the Cascadia forearc:  Science, v. 265, p. 237-243.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area:  Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area:  State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#4085 Yeats, R.S., Kulm, L.D., Goldfinger, C., and McNeill, L.C., 1998, Stonewall anticline—An active fold on the Oregon continental shelf:  Geological Society of America Bulletin, v. 110, no. 5, p. 572-587.

**787, Bald Mountain-Big Lagoon fault zone**

**Structure Number** 787

Comments: This structure is fault number 40 of Pezzopane (1993 #3544) and fault number 11 of Geomatrix Consultants, Inc, (1995 #3593).

**Structure Name** Bald Mountain-Big Lagoon fault zone

Comments: The Bald Mountain-Big Lagoon fault zone includes the Bald Mountain and Big Lagoon faults, which are mapped onshore in northern California (Kelsey and Carver, 1988 #4094). The northern end of the fault zone extends into offshore Oregon (Goldfinger and others, 1992 #464).

**Synopsis** The north-northwest-striking, thrust or reverse Bald Mountain-Big Lagoon fault zone is one of numerous structures in a fold and thrust belt [784] that deforms sediment underlying the continental slope and shelf in the forearc of the Cascadia subduction zone [781] in offshore northern California and southern Oregon. The Bald Mountain-Big Lagoon fault zone may form the boundary between Cretaceous and Jurassic rocks of the Central belt of the Franciscan Complex and Tertiary and Cretaceous rocks of the Coastal belt of the Franciscan Complex. Deformation of Quaternary sediment onshore and offsets of upper Quaternary sediment apparent in seismic reflection profiles offshore indicate most recent movement in the late Quaternary. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault zone are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** April 19, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore), CA (offshore)

**County** Curry (offshore), Del Norte (offshore)

**1° x 2° sheet** Cape Blanco (offshore), Eureka (offshore)

**Province** Offshore of Pacific Border (Klamath Mountains section)

**Quality of location** Poor

Comments: The fault trace in Oregon is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The north-northwest-striking, thrust or reverse Bald Mountain-Big Lagoon fault zone is one of numerous structures in a fold and thrust belt [784] that deforms sediment underlying the continental slope and shelf in the forearc of the Cascadia subduction zone [781] in offshore northern California and southern Oregon [784] (Goldfinger and others, 1992 #464; Clarke and Carver, 1992 #4091; Clarke, 1992 #4092). In northernmost offshore California and southern Oregon, Clarke (1992 #4092) interprets the Bald Mountain-Big Lagoon fault zone as the boundary between Cretaceous and Jurassic rocks of the Central belt of the Franciscan Complex in the hanging wall, and Tertiary and Cretaceous rocks of the Coastal belt of the Franciscan Complex in the foot wall. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** T or R

Comments: The Bald Mountain-Big Lagoon fault zone has been described as a right-lateral strike-slip fault (Cashman and others, 1986 #4095; Clarke, 1987 #4087; Kelsey and Carver, 1988 #4094), but most recent data indicates the structure is an east-dipping thrust or reverse fault zone (Clarke, 1990 #4143; Goldfinger and others, 1992 #464; Clarke, 1992 #4092; Geomatrix Consultants Inc., 1995 #3593).

**Dip** Not Reported

Comments:

**Main dip direction** East

**Geomorphic expression** The Bald Mountain-Big Lagoon fault zone is mapped in seismic reflection profiles as multiple fault strands and anticlinal axes in Jurassic through upper Quaternary sediment on the upper slope and continental shelf (Clarke, 1990 #4143; Goldfinger and others, 1992 #464; Clarke, 1992 #4092; Geomatrix Consultants Inc., 1995 #3593). In onshore northern California, the Big Lagoon fault offsets and folds Quaternary sediment near Big Lagoon, but no evidence of faulting in Quaternary deposits has been described along the Bald Mountain fault (Kelsey and Carver, 1988 #4094).

**Age of faulted deposits at the surface** The Bald Mountain-Big Lagoon fault zone is mapped in seismic reflection profiles as offsetting upper Quaternary sediment on the upper slope and continental shelf; these sediments are equivalent in age to onshore deposits that post-date the Pliocene to the late Pleistocene Wildcat Group (Clarke, 1992 #4092).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: Offset of post-late Pleistocene sediment on the continental slope and shelf (Clarke, 1992 #4092) suggests most recent movement in the late Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), and in the middle and late Quaternary (<700-780 ka) by Pezzopane (1993 #3544), Geomatrix Consultants, Inc, (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably 0.2-1.0 mm/yr

Comments: No data on slip rates have been published, but Geomatrix Consultants, Inc, (1995 #3593) used estimated slip rates of 0.01-1.0 mm/yr in their analysis of earthquake hazards associated with the Bald Mountain-Big Lagoon fault zone.

| | | |
|---|---|---|
| **Length** | End to end (km): | 95.0 |
| | Cumulative trace (km): | 96.7 |

Comments:

**Average strike** (azimuth) N 27° W

**References**

#4095 Cashman, S.M., Cashman, P.H., and Longshore, J.D., 1986, Deformational history and regional tectonic significance of the Redwood Creek schist, northwestern California: Geological Society of America Bulletin, v. 97, p. 35-47.

#4087 Clarke, S.H., Jr., 1987, Chapter 15-Geology of the California continental margin north of Cape Mendocino, *in* Scholl, D.W., Grantz, A., and Vedder, J.G., eds., Geology and resource potential of the continental margin of Western North America and adjacent ocean basins—Beaufort Sea to Baja, California: Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, Volume 6, p. 337-351, 1 pl.

#4143 Clarke, S.H., Jr., 1990, Map showing geologic structures of the northern California continental margin: U.S. Geological Survey Miscellaneous Field Studies Map MF-2130, 1 sheet, scale 1:250,000.

#4092 Clarke, S.H., Jr., 1992, Geology of the Eel River Basin and adjacent region—Implications for Late Cenozoic tectonics of the southern Cascadian subduction zone and Mendocino Triple Junction: The America Association of Petroleum Geologists Bulletin, v. 76, no. 2, p. 199-224.

#4091 Clarke, S.H., Jr., and Carver, G.A., 1992, Late Holocene tectonics and paleoseismicity, southern Cascadia subduction zone: Science, v. 255, p. 188-192.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4094 Kelsey, H.M., and Carver, G.A., 1988, Late Neogene and Quaternary tectonics associated with northward growth of the San Andreas transform fault, northern California: Journal of Geophysical Research, v. 93, no. B5, p. 4797-4819.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

## 788, Fault "J"

**Structure Number** 788

Comments: This structure is included in fault number 21 of Pezzopane (1993 #3544) and is fault number 10 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Fault "J"

Comments: The fault zone was originally mapped by Goldfinger and others (1992 #446; 1992 #464) and named fault "J" by Geomatrix Consultants, Inc. (1995 #3593).

**Synopsis** The northwest-striking fault "J" offsets sediments that underlie the upper slope and continental shelf in the forearc of the Cascadia subduction zone [781]. The fault is mapped as a pair of parallel fault strands that appear to form a horst in sediments of unknown age on the upper slope and shelf. Similarities with other faults suggest most-recent movement in the latest Pleistocene and Holocene. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore), WA (offshore)

**County** Clatsop (offshore), Pacific (offshore)

**1° x 2° sheet** Cape Disappointment (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The northwest-striking fault "J" offsets sediment that underlies the upper slope and continental shelf in the forearc of the Cascadia subduction zone [781] (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** N, S?

Comments: Fault "J" is mapped as a pair of normal faults by Goldfinger and others (1992 #446; 1992 #464). Geomatrix Consultants, Inc. (1995 #3593) inferred left-lateral strike-slip displacement, based on similarity with other northwest-striking faults in the Cascadia forearc.

**Dip** Not Reported

Comments:

**Main dip direction** north and south

**Geomorphic expression** The pair of parallel fault strands that comprise fault "J" appear to form a horst in sediment on the upper slope and continental shelf (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593). No details of their geomorphic expression has been described.

**Age of faulted deposits at the surface** Fault “J” offsets sediment of unknown age on the upper slope and continental shelf (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Fault “J” offsets sediment of unknown age on the upper slope and continental shelf (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593). However, its similarity to other active faults in the accretionary wedge suggests that the most-recent movement is in the latest Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably 1-5 mm/yr

Comments: No detailed slip data has been described, but Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 1.0-8.0 mm/yr and a preferred rate of 5 mm/yr in their analyses of earthquake hazards associated with fault “J”.

| | | |
|---|---|---|
| **Length** | End to end (km): | 7.6 |
| | Cumulative trace (km): | 10.5 |

Comments:

**Average strike** (azimuth) N 69° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

**789, Nehalem Bank fault**

**Structure Number** 789

Comments: The fault is included in fault number 21 of Pezzopane (1993 #3544) and is fault number 9 of Geomatrix Consultants, Inc, (1995 #3593).

**Structure Name** Nehalem Bank fault

Comments: The fault zone was originally mapped by Goldfinger and others (1992 #446; 1992 #464) and named the Nehalem Bank fault by Goldfinger (1994 #3972). Goldfinger (1994 #3972) correlates this fault with offshore faults “F” and “C” in cross sections of Niem and others (1990 #4149) and Niem and others (1992 #4148), respectively. Geomatrix Consultants, Inc, (1995 #3593) used Nehalem Bank fault and Fault “I” interchangeably. The Nehalem Bank fault may also correlate with the Happy Camp fault [882] onshore near Netarts Bay (Goldfinger, 1994 #3972; McNeill and others, 1998 #4089), but herein we retain these names as separate faults until better data establishing this correlation is available.

**Synopsis** The north-and northwest-striking, right-lateral reverse Nehalem Bank fault offsets Miocene through Holocene sediment that underlies the continental shelf in the forearc of the Cascadia subduction zone [781]. The fault may form the boundary between Eocene basalts of the Siletzia terrane to the east and Miocene and younger accretionary wedge sediment to the west. Offsets of Holocene sediment on the continental shelf and sea floor offsets of 10-20 m that probably post-date the late Pleistocene sea-level lowstand suggest most recent movement in the latest Quaternary. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore), WA (offshore)

**County** Clatsop (offshore), Tillamook (offshore), Pacific (offshore)

**1° x 2° sheet** Cape Disappointment (offshore)

**Province** offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The north-and northwest-striking, right-lateral reverse Nehalem Bank fault offsets Miocene through Holocene sediment that underlies the continental shelf in the forearc of the Cascadia subduction zone [781] (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; McNeill and others, 1998 #4089). Niem and others (1992 #4148) interpret a major fault in the same location as the Nehalem Bank fault as the boundary between Eocene basalts of the Siletzia terrane to the east and Miocene and younger accretionary wedge sediment to the west. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** D, R

Comments: Sense of displacement on the Nehalem Bank fault is inferred as right-lateral strike slip along the north-striking section, and steeply northeast-dipping reverse displacement on the northwest-striking (Goldfinger, 1994 #3972; McNeill and others, 1998 #4089).

**Dip** Not Reported

Comments:

**Main dip direction** Vertical to E, NE

**Geomorphic expression** The Nehalem Bank fault is mapped as multiple fault strands and anticlinal axes in Miocene through Holocene sediment on the continental shelf (Niem and others, 1990 #4149; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; McNeill and others, 1998 #4089). Vertical offsets or 10-20 m of the sea floor are apparent in sidescan and seismic records (Goldfinger, 1994 #3972; McNeill and others, 1998 #4089).

**Age of faulted deposits at the surface** The Nehalem Bank fault offsets Miocene through Holocene sediment on the continental shelf (Niem and others, 1990 #4149; Goldfinger, 1994 #3972; McNeill and others, 1998 #4089), and is marked by sea floor offsets of 10-20 m that probably post-date the late Pleistocene sea-level lowstand (Goldfinger, 1994 #3972; McNeill and others, 1998 #4089).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Offsets of Holocene sediment on the continental shelf (Niem and others, 1990 #4149; Goldfinger, 1994 #3972; McNeill and others, 1998 #4089), and sea floor offsets that probably post-date the late Pleistocene sea-level lowstand (Goldfinger, 1994 #3972; McNeill and others, 1998 #4089) suggest most recent movement in the latest Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Pezzopane (1993 #3544), Geomatrix Consultants, Inc, (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably 1-5 mm/yr

Comments: No data on slip rates have been collected, but Geomatrix Consultants, Inc, (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 0.5-5.0 mm/yr in their analyses of earthquake hazards associated with the Nehalem Bank fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 101.0 |
| | Cumulative trace (km): | 113.2 |

Comments:

**Average strike** (azimuth) N 15° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#4148 Niem, A.M., MacLeod, N.S., Snavely, P.D., Jr., Huggins, D., Fortier, J.D., Meyer, J.H., Seeling, A., and Niem, W.A., 1992, Onshore-offshore geologic cross section, northern Oregon Coast Range to continental slope: State of Oregon, Department of Geology and Mineral Industries Special Paper 26, 10 p., 1 pl.

#4149 Niem, A.R., Snavely, P.D., Jr., and Niem, W., A., 1990, Onshore-offshore geologic cross section from the Mist Gas Field, Northern Oregon Coast Range, to the northwest Oregon continental shelf: State of Oregon, Department of Geology and Mineral Industries Oil and Gas Investigations 17, 46 p., 1 pl.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

## 790, Fault “H”

**Structure Number** 790

Comments: The fault is included in fault number 21 of Pezzopane (1993 #3544) and is fault number 8 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Fault “H”

Comments: The fault zone was originally mapped by Goldfinger and others (1992 #446; 1992 #464) and named Fault “H” by Geomatrix Consultants, Inc. (1995 #3593).

**Synopsis** The northwest-striking, normal and/or left-lateral(?) Fault “H” offsets accretionary wedge sediment that underlies the continental shelf in the forearc of the Cascadia subduction zone [781]. The fault is mapped as multiple fault strands in poorly consolidated accretionary wedge sediments on the shelf. Similarities with other faults suggest most recent movement in the late Pleistocene and Holocene. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Clatsop (offshore)

**1° x 2° sheet** Cape Disappointment (offshore), Vancouver (offshore)

**Province** offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The northwest-striking, normal and/or left-lateral(?) Fault “H” offsets accretionary wedge sediments that underlie the continental shelf in the forearc of the Cascadia subduction zone [781] (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** N, S

Comments: Fault “H” is mapped as a normal fault by Goldfinger and others (1992 #464); Goldfinger and others (1992 #446) mapped the westernmost part of the zone as a left-lateral strike slip fault, which is consistent with other northwest-striking faults in the accretionary wedge.

**Dip** Not Reported

Comments:

**Main dip direction** South

**Geomorphic expression** Fault “H” is mapped as multiple fault strands in poorly consolidated accretionary wedge sediment on the continental shelf (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593). The fault is mapped as crossing the north-trending Nehalem

Bank fault [789], and herein includes several discontinuous northwest-striking normal faults mapped on the inner continental shelf.

**Age of faulted deposits at the surface** Fault “H” offsets poorly consolidated accretionary wedge sediment of unknown age (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Fault “H” offsets accretionary wedge sediment of unknown age (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593). However, its similarity to other active faults in the accretionary wedge suggesthat the most recent movement was in the latest Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably >5 mm/yr

Comments: No data on slip rates have been collected, but Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 1.0-8.0 mm/yr in their analyses of earthquake hazards associated with Fault “H”.

| | | |
|---|---|---|
| **Length** | End to end (km): | 48.7 |
| | Cumulative trace (km): | 81.3 |

Comments:

**Average strike** (azimuth) N 49° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics:  Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon:  Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area:  Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area:  State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

## 791, Fault "G"

**Structure Number** 791

Comments: The fault is included in fault number 21 of Pezzopane (1993 #3544) and is fault number 7 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Fault "G"

Comments: Fault "G" was originally mapped by Goldfinger and others (1992 #446; 1992 #464) and named Fault "G" by Geomatrix Consultants, Inc. (1995 #3593).

**Synopsis** The northwest-striking, left-lateral Fault "G" offsets accretionary wedge sediment that underlies the continental shelf in the forearc of the Cascadia subduction zone [781]. The fault is mapped as multiple fault strands and aligned and offset fold axes in poorly consolidated accretionary wedge sediment on the shelf. Similarities with other faults suggest most recent movement in the late Pleistocene and Holocene. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Tillamook (offshore)

**1° x 2° sheet** none (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The northwest-striking, left-lateral Fault "G" offsets accretionary wedge sediment that underlies the continental shelf in the forearc of the Cascadia subduction zone [781] (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the over-riding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** S

Comments: Fault "G" is mapped as a left-lateral strike slip fault (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593).

**Dip** 90°

Comments: Probably vertical or near vertical

**Main dip direction** Vertical

**Geomorphic expression** Fault "G" is mapped as multiple fault strands and aligned and offset fold axes in poorly consolidated accretionary wedge sediment on the continental shelf (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593).

**Age of faulted deposits at the surface** Fault "G" offsets poorly consolidated accretionary wedge sediment of unknown age (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Fault "G" offsets accretionary wedge sediment of unknown age (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Geomatrix Consultants Inc., 1995 #3593). However, its similarity to other active faults in the accretionary wedge suggest most recent movement in the latest Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably >5 mm/yr

Comments: No data on slip rates have been collected, but Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 1.0-8.0 mm/yr in their analyses of earthquake hazards associated with Fault "G".

| | | |
|---|---|---|
| **Length** | End to end (km): | 56.7 |
| | Cumulative trace (km): | 138.3 |

Comments:

**Average strike** (azimuth) N 74° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon:  Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area:  Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area:  State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

**793, Thompson Ridge fault**

**Structure Number** 793

Comments: This structure is included in fault number 21 of Pezzopane (1993 #3544) and is fault number 6 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Thompson Ridge fault

Comments: The Thompson Ridge fault was originally mapped by Goldfinger and others (1992 #464), and named the Thompson Ridge fault by Goldfinger (1994 #3972).

**Synopsis** The northwest-striking, left-lateral Thompson Ridge fault offsets poorly consolidated accretionary wedge sediments incorporated in the Coos Basin slide, a super-scale submarine landslide thought to have formed about 450 ka. These sediments underlie the continental slope in the forearc of the Cascadia subduction zone [781]. The fault appears to offset the active deformation front, but evidence of offset of the subducting Juan de Fuca Plate is equivocal. The Thompson Ridge fault is the best expressed bathymetrically of all the strike-slip faults mapped in the accretionary wedge, and is mapped as multiple surficial scarps and aligned and offset fold axes in poorly consolidated sediments of unknown age on the lower continental slope. Similarities with other faults suggest most recent movement in the late Pleistocene and Holocene. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Coos (offshore)

**1° x 2° sheet** Coos Bay (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The northwest-striking, left-lateral Thompson Ridge fault offsets poorly consolidated accretionary wedge sediments incorporated in the Coos Basin slide, a super-scale submarine landslide thought to have formed about 450 ka (Goldfinger and others, 2000 #5041). These sediments underlie the continental slope in the forearc of the Cascadia subduction zone [781]. The fault appears to offset the active deformation front, but evidence of offset of the subducting Juan de Fuca Plate is equivocal (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** S

Comments: The Thompson Ridge fault is mapped as a left-lateral strike slip fault (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Dip** 90°

Comments: Dip estimate based on geophysical data (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Main dip direction** Vertical

**Geomorphic expression** The Thompson Ridge fault is the best expressed bathymetrically of all the strike-slip faults mapped in the accretionary wedge; the fault is mapped as multiple surficial scarps and aligned and offset fold axes in poorly consolidated landslide sediments on the lower continental slope (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; Goldfinger and others, 2000 #5041).

**Age of faulted deposits at the surface** The Thompson Ridge fault offsets poorly consolidated accretionary wedge sediments incorporated in the Coos Basin slide, a super-scale submarine landslide thought to have formed about 450 ka (Goldfinger and others, 2000 #5041).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: The Thompson Ridge fault offsets poorly consolidated landslide deposits thought to have formed about 450 ka (Goldfinger and others, 2000 #5041). However, its similarity to other active faults in the accretionary wedge suggests most recent movement in the latest Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably >5 mm/yr

Comments: No data on slip rates have been collected (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090), but Goldfinger (1994 #3972) used values from other similar faults to estimate a slip rate of 5.5 mm/yr, and Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 1.0-8.0 mm/yr in their analysis of earthquake hazards associated with the Thompson Ridge fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 48.6 |
| | Cumulative trace (km): | 34.5 |

Comments:

**Average strike** (azimuth) N 56° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#5041 Goldfinger, C., Kulm, L.D., McNeill, L.C., and Watts, P., 2000, Super-scale failure of the southern Oregon Cascadia margin: Pure and Applied Geophysics, v. 157, p. 1189-1226.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

## 794, Coos Basin fault

**Structure Number** 794

Comments: This structure is fault number 5 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Coos Basin fault

Comments: The Coos Basin fault was originally mapped by Goldfinger and others (1992 #464). The fault was named the Coos Basin fault by Goldfinger (1994 #3972) for its proximity to Coos Bay Basin.

**Synopsis** The northwest-striking, left-lateral Coos Basin fault offsets poorly consolidated accretionary wedge sediments incorporated in the Coos Basin slide, a super-scale submarine landslide thought to have formed about 450 ka. These sediments underlie the continental slope in the forearc of the Cascadia subduction zone [781]. The fault appears to offset the active deformation front, but evidence of offset of the subducting Juan de Fuca Plate is equivocal. The Coos Basin fault is mapped as multiple surficial scarps and aligned and offset fold axes in poorly consolidated sediments of unknown age on the lower continental slope; two surficial features are offset 125 m and 158 m left-laterally across the fault. Similarities with other faults suggest most recent movement in the late Pleistocene and Holocene. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Coos (offshore)

**1° x 2° sheet** Coos Bay (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The northwest-striking, left-lateral Coos Basin fault offsets poorly consolidated accretionary wedge sediments incorporated in the Coos Basin slide, a super-scale submarine landslide thought to have formed about 450 ka (Goldfinger and others, 2000 #5041). These sediments underlie the continental slope in the forearc of the Cascadia subduction zone [781]. The fault appears to offset the active deformation front, but evidence of offset of the subducting Juan de Fuca Plate is equivocal (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** S

Comments: The Coos Basin fault is mapped as a left-lateral strike slip fault (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Dip** 90°

Comments: Dip estimate based on geophysical data (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Main dip direction** Vertical

**Geomorphic expression** The Coos Basin fault is mapped as multiple surficial scarps and aligned and offset fold axes in poorly consolidated landslide sediments on the lower continental slope; two surficial features are offset 125 m and 158 m left-laterally across the fault (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Age of faulted deposits at the surface** offsets poorly consolidated accretionary wedge sediments incorporated in the Coos Basin slide, a super-scale submarine landslide thought to have formed about 450 ka (Goldfinger and others, 2000 #5041).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: The Coos Basin fault poorly consolidated landslide deposits thought to have formed about 450 ka (Goldfinger and others, 2000 #5041). However, its similarity to other active faults in the accretionary wedge suggests most recent movement in the latest Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably >5 mm/yr

Comments: No data on slip rates have been collected (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090), but Goldfinger (1994 #3972) used values from other similar faults to estimate a slip rate of 5.5 mm/yr, and Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 1.0-8.0 mm/yr in their analysis of earthquake hazards associated with the Coos Basin fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 35.4 |
| | Cumulative trace (km): | 67.5 |

Comments:

**Average strike** (azimuth) N 74° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#5041 Goldfinger, C., Kulm, L.D., McNeill, L.C., and Watts, P., 2000, Super-scale failure of the southern Oregon Cascadia margin: Pure and Applied Geophysics, v. 157, p. 1189-1226.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

## 795, Heceta Bank structure

**Structure Number** 795

Comments: The structure is included in fault number 4 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Heceta Bank structure

Comments: The Heceta Bank structure was originally mapped and included in the Heceta South fault [796] by Goldfinger and others (1992 #464) and Goldfinger (1994 #3972). Goldfinger and others (1997 #4090) used subsequent data to delineate and name the Heceta Bank structure as a separate structure.

**Synopsis** The northwest-striking Heceta Bank structure deforms accretionary wedge sediments that underlie the continental slope in the forearc of the Cascadia subduction zone [781]. The structure is mapped as a very linear scarp that abruptly truncates the southern margin of Heceta Bank, and appears to tilt and offset >200 m a submerged, late Pleistocene sea-level lowstand shoreline that fringes the bank. The Heceta Bank structure was originally mapped as a left-lateral strike slip fault, but subsequent studies revealed little evidence of surface faulting, so the structure may be a monocline overlying a buried fault. Deformation of the late Pleistocene shoreline indicates most recent movement in the late Pleistocene and Holocene. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this structure are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Lane (offshore), Douglas (offshore)

**1° x 2° sheet** Coos Bay (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The northwest-striking Heceta Bank structure deforms accretionary wedge sediments that underlie the continental slope in the forearc of the Cascadia subduction zone [781] (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this structure are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** S?, monocline?

Comments: The Heceta Bank structure was originally mapped as a left-lateral strike slip fault (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972), but subsequent studies revealed little evidence of surface faulting, so the structure may be a monocline overlying a buried fault (Goldfinger and others, 1997 #4090).

**Dip** Not Reported

Comments:

**Main dip direction** Not Reported

**Geomorphic expression** The Heceta Bank structure is mapped as a very linear scarp that abruptly truncates the southern margin of Heceta Bank, and appears to tilt and offset a submerged shoreline that fringes the bank (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Age of faulted or folded deposits at the surface** The Heceta Bank structure appears to tilt and offset a submerged, late Pleistocene sea-level lowstand shoreline that fringes the bank (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting or folding** latest Quaternary (<15 ka)

Comments: The Heceta Bank structure appears to tilt a submerged, late Pleistocene sea-level lowstand shoreline that fringes Heceta Bank (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090), so latest deformation must have occurred in the late Pleistocene or Holocene. The structure is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably >5 mm/yr

Comments: No data on horizontal slip rates has been collected (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090), but Goldfinger (1994 #3972) included this structure in the Heceta South fault [796] and used slip rates from similar faults to estimate a slip rate of 5.5 mm/yr. Goldfinger and others (Goldfinger and others, 1997 #4090) estimated >200 m of vertical displacement of a submerged late Pleistocene shoreline across the structure.

| | | |
|---|---|---|
| **Length** | End to end (km): | 18.2 |
| | Cumulative trace (km): | 18.2 |

Comments:

**Average strike** (azimuth) N 58° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

**796, Heceta South fault**

**Structure Number** 796

Comments: The fault is fault number 4 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Heceta South fault

Comments: The Heceta South fault was originally mapped by Goldfinger and others (1992 #464). The fault was named the Heceta South fault by Goldfinger (1994 #3972) for its proximity to Heceta Bank. The Heceta South fault, as originally mapped and described (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Geomatrix Consultants Inc., 1995 #3593), included the Heceta Bank structure [795], but subsequent work indicates that these are separate structures (Goldfinger and others, 1997 #4090). Goldfinger and others (2000 #5041) used the name "Heceta fault" for this structure, but herein we retain the name "Heceta South fault" to distinguish it from the Heceta Bank structure [795].

**Synopsis** The northwest-striking, left-lateral Heceta South fault offsets poorly consolidated accretionary wedge sediments incorporated in the Heceta slide, a super-scale submarine landslide thought to have formed about 110 ka. These sediments underlie the continental slope in the forearc of the Cascadia subduction zone [781]. The fault extends across the active deformation front of the subduction zone, offsetting the overlying sedimentary section and the underlying oceanic basalts of the subducting Juan de Fuca Plate. The Heceta South fault is mapped as multiple fault traces in poorly consolidated landslide sediments; the fault trace is marked by linear alignments and truncations of landslide debris on the lower continental slope and abyssal plain. Similarities with other faults suggest most recent movement in the late Pleistocene and Holocene. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Lane (offshore)

**1° x 2° sheet** Newport (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464), and from ~1:200,000-scale figure of Goldfinger and others (1997 #4090).

**Geologic setting** The northwest-striking, left-lateral Heceta South fault offsets poorly consolidated accretionary wedge sediments incorporated in the Heceta slide, a super-scale submarine landslide thought to have formed about 110 ka (Goldfinger and others, 2000 #5041). These sediments underlie the continental slope in the forearc of the Cascadia subduction zone [781]. The fault extends across the active deformation front of the subduction zone, offsetting the overlying sedimentary section and the underlying oceanic basalts of the subducting Juan de Fuca Plate (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090). As with other folds and faults in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the Cascadia subduction zone [781], or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** S

Comments: The Heceta South fault is mapped as a left-lateral strike slip fault (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Dip** 90°

Comments: Dip estimate based on geophysical data (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Main dip direction** Vertical

**Geomorphic expression** The Heceta South fault is mapped as multiple fault traces in poorly consolidated accretionary wedge sediments; the fault trace is marked by linear alignments and truncations of landslide debris on the lower continental slope and abyssal plain (Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; Goldfinger and others, 2000 #5041).

**Age of faulted deposits at the surface** The Heceta South fault offsets poorly consolidated accretionary wedge sediments incorporated in the Heceta slide, a super-scale submarine landslide thought to have formed about 110 ka (Goldfinger and others, 2000 #5041).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: The Heceta South fault offsets poorly consolidated landslide deposits thought to have formed about 110 ka (Goldfinger and others, 2000 #5041). However, its similarity to other active faults in the accretionary wedge suggests most recent movement in the latest Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably >5 mm/yr

Comments: No data on slip rates have been collected (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090), but Goldfinger (1994 #3972) used values from other similar faults to estimate a slip rate of 5.5 mm/yr, and Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 1.0-8.0 mm/yr in their analysis of earthquake hazards associated with the Heceta South fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 60.3 |
| | Cumulative trace (km): | 84.3 |

Comments:

**Average strike** (azimuth) N 54° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#5041 Goldfinger, C., Kulm, L.D., McNeill, L.C., and Watts, P., 2000, Super-scale failure of the southern Oregon Cascadia margin: Pure and Applied Geophysics, v. 157, p. 1189-1226.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4088 Goldfinger, C., Kulm, L.D., Yeats, R.S., Hummon, C., Huftile, G.J., Niem, A.R., and McNeill, L.C., 1996, Oblique strike-slip faulting of the Cascadia Submarine Forearc—The Daisy Bank fault zone off central Oregon, *in* Bebout, G.E., Scholl, D.W., Kirby, S.H., and Platt, J.P., eds., Subduction top to bottom: Geophysical Monograph 96, p. 65-74.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

**797, Alvin Canyon fault**

**Structure Number** 797

Comments: The fault is included in fault number 21 of Pezzopane (1993 #3544) and is fault number 3 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Alvin Canyon fault

Comments: The Alvin Canyon fault was originally mapped and named “fault C” by Goldfinger and others (1992 #446; 1992 #464). The fault was renamed the Alvin Canyon fault by Goldfinger (1994 #3972), for its proximity to a series of Alvin submersible dive sites; that name has been used in subsequent papers (Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090) and is retained herein.

**Synopsis** The northwest-striking, left-lateral Alvin Canyon fault offsets accretionary wedge sediments that underlie the continental shelf and slope in the forearc of the Cascadia subduction zone [structure #781]. The fault extends across the active deformation front of the subduction zone, offsetting the overlying sedimentary section and the underlying oceanic basalts of the subducting Juan de Fuca Plate, and may die out eastward near the inferred western limit of the Siletzia terrane on the continental shelf. The Alvin Canyon fault is marked by multiple fault traces, fault scarps, pressure ridges and pop-ups, and aligned fold axes in poorly consolidated accretionary wedge sediments on the continental shelf and slope; the fault also appears to uplift an unnamed submarine bank, a structural high on the upper continental slope. Offset of Holocene sediment on the abyssal plain indicate most recent movement in the latest Quaternary. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Lincoln (offshore), Lane (offshore)

**1° x 2° sheet** Newport (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The northwest-striking, left-lateral Alvin Canyon fault offsets accretionary wedge sediments that underlie the continental shelf and slope in the forearc of the Cascadia subduction zone [structure #781]; the fault extends across the active deformation front of the subduction zone, offsetting the overlying sedimentary section and the underlying oceanic basalts of the subducting Juan de Fuca Plate (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090), and may die out eastward near the inferred western limit of the Siletzia terrane on the continental shelf (Goldfinger and others, 1997 #4090). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** S

Comments: The Alvin Canyon fault is mapped as a left-lateral strike slip fault, manifested as a complicated zone of folds and multiple fault strands (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090).

**Dip** 90°

Comments: Dip estimate based on geophysical data (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Main dip direction** Vertical

**Geomorphic expression** The Alvin Canyon fault is marked by multiple fault traces, pressure ridges and pop-ups, and aligned fold axes in poorly consolidated accretionary wedge sediments on the continental shelf and slope; the fault also appears to uplift an unnamed submarine bank, a structural high on the upper continental slope (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090).

**Age of faulted deposits at the surface** The Alvin Canyon fault offsets Holocene sediments on the abyssal plain, west of the deformation front (Goldfinger and others, 1997 #4090).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Offsets of Holocene sediments on the abyssal plain (Goldfinger and others, 1997 #4090) indicate most recent movement in the latest Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** >5 mm/yr

Comments: Slip rate estimates of 6.2±2 mm/yr to 6.6 mm/yr are based on offset bedrock isopachs and age estimates based on sedimentation rates (Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090). Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 4.2-8.2 mm/yr in their analyses of earthquake hazards associated with the Alvin Canyon fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 71.2 |
| | Cumulative trace (km): | 60.0 |

Comments:

**Average strike** (azimuth) N 68° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

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#4292 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Cochrane, G.R., 1996, Active strike-slip faulting and folding of the Cascadia subduction-zone plate boundary and forearc in central and northern Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 223-256.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

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#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

## 798, Daisy Bank fault

**Structure Number** 798

Comments: The fault is included in fault number 21 of Pezzopane (1993 #3544) and is fault number 2 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Daisy Bank fault

Comments: The Daisy Bank fault was originally mapped and named “fault B” by Goldfinger and others (1992 #446; 1992 #464). The fault was renamed the Daisy Bank fault by Goldfinger (1994 #3972); that name has been used in subsequent papers (Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090) and is retained herein.

**Synopsis** The northwest-striking, left-lateral Daisy Bank fault offsets accretionary wedge sediments that underlie the continental shelf and slope in the forearc of the Cascadia subduction zone [781]. The fault extends across the active deformation front of the subduction zone, offsetting the overlying sedimentary section and the underlying oceanic basalts of the subducting Juan de Fuca Plate, and may die out eastward near the inferred western limit of the Siletzia terrane on the continental shelf. The Daisy Bank fault is marked by multiple fault traces, fault scarps, pressure ridges and pop-ups, aligned fold axes, and pull-apart basins in poorly consolidated accretionary wedge sediments on the continental shelf and slope; the fault also appears to uplift Daisy Bank, a structural high on the upper continental slope. Offsets of the sea floor indicate most recent movement in the late Pleistocene and Holocene. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Lincoln (offshore)

**1° x 2° sheet** Newport (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The northwest-striking, left-lateral Daisy Bank fault offsets accretionary wedge sediments that underlie the continental shelf and slope in the forearc of the Cascadia subduction zone [781]; the fault extends across the active deformation front of the subduction zone, offsetting the overlying sedimentary section and the underlying oceanic basalts of the subducting Juan de Fuca Plate (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090), and may die out or terminate eastward near the inferred western limit of the Siletzia terrane on the continental shelf (Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090; McNeill and others, 2000 #5060). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** S

Comments: The Daisy Bank fault is mapped as a left-lateral strike-slip fault, manifested as a complicated zone of folds, pull-apart basins, and multiple fault strands (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090).

**Dip** vertical

Comments: Dip estimate based on geophysical data (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090).

**Main dip direction** None; vertical

**Geomorphic expression** The Daisy Bank fault is marked by multiple fault traces, fault scarps, pressure ridges and pop-ups, aligned fold axes, and pull-apart basins in poorly consolidated accretionary wedge sediments on the continental shelf and slope; the fault also appears to uplift Daisy Bank, a structural high on the upper continental slope (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090).

**Age of faulted deposits at the surface** The Daisy Bank fault forms fault scarps on the sea floor that offset late Pleistocene and Holocene sediments (Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090; Yeats and others, 1997 #5123).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Offsets of the sea floor in late Pleistocene and Holocene sediments (Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090) indicate most recent movement in the latest Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** >5 mm/yr

Comments: A slip rate estimate of 5.7 ± 2.0 mm/yr is based on offset bedrock isopachs and age estimates based on sedimentation rates (Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4088; Goldfinger and others, 1997 #4090). Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 3.7-7.7 mm/yr in their analyses of earthquake hazards associated with the Daisy Bank fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 80.1 |
| | Cumulative trace (km): | 91.0 |

Comments:

**Average strike** (azimuth) N 63° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#4292 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Cochrane, G.R., 1996, Active strike-slip faulting and folding of the Cascadia subduction-zone plate boundary and forearc in central and northern Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 223-256.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4088 Goldfinger, C., Kulm, L.D., Yeats, R.S., Hummon, C., Huftile, G.J., Niem, A.R., and McNeill, L.C., 1996, Oblique strike-slip faulting of the Cascadia Submarine Forearc—The Daisy Bank fault zone off central Oregon, *in* Bebout, G.E., Scholl, D.W., Kirby, S.H., and Platt, J.P., eds., Subduction top to bottom: Geophysical Monograph 96, p. 65-74.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#5060 McNeill, L.C., Goldfinger, G., Kulm, L.D., and Yeats, R.S., 2000, Tectonics of the Neogene Cascadia forearc basin: Investigations of a deformed late Miocene unconformity: Geological Society of America Bulletin, v. 112, no. 8, p. 1209-1224.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#5123 Yeats, R.S., Sieh, K., and Allen, C.R., 1997, The geology of earthquakes: New York, Oxford University Press, Inc., 568 p.

**799, Wecoma fault**

**Structure Number** 799

Comments: The fault is included in fault number 21 of Pezzopane (1993 #3544) and is fault number 1 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Wecoma fault

Comments: The Wecoma fault was originally mapped and named the Wecoma fault or fault "A" by Appelgate and others (1992 #4100) and Goldfinger and others (1992 #446; 1992 #464). The name Wecoma fault has been used in subsequent papers (Goldfinger and others, 1996 #4088; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090) and is retained herein.

**Synopsis** The northwest-striking, left-lateral Wecoma fault offsets accretionary wedge sediments that underlie the continental shelf and slope in the forearc of the Cascadia subduction zone [781]. The fault extends across the active deformation front of the subduction zone, offsetting the overlying sedimentary section and the underlying oceanic basalts of the subducting Juan de Fuca Plate, and may die out eastward near the inferred western limit of the Siletzia terrane on the continental shelf. The Wecoma fault zone is a zone of multiple fault traces, pressure ridges and pop-ups, and aligned fold axes in poorly consolidated accretionary wedge sediments on the continental shelf and slope; the fault also offsets a late Quaternary submarine channel associated with the Astoria Fan, which emanates from the mouth of the Columbia River. Apparent offsets of the sea floor and the late Quaternary submarine channel indicate substantial offsets in the late Pleistocene and Holocene. However, as with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate.

**Date of compilation** May 17, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Tillamook (offshore), Lincoln (offshore)

**1° x 2° sheet** Newport (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale mapping of Goldfinger and others (1992 #464).

**Geologic setting** The northwest-striking, left-lateral Wecoma fault offsets accretionary wedge sediments that underlie the continental shelf and slope in the forearc of the Cascadia subduction zone [781]; the fault extends across the active deformation front of the subduction zone, offsetting the overlying sedimentary section and the underlying oceanic basalts of the subducting Juan de Fuca Plate (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Appelgate and others, 1992 #4100; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090), and may die out eastward near the inferred western limit of the Siletzia terrane on the continental shelf (Goldfinger and others, 1997 #4090). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some independent displacements are related to smaller earthquakes in the overriding North American Plate (Goldfinger and others, 1992 #446; Goldfinger, 1994 #3972; Goldfinger and others, 1997 #4090; McNeill and others, 1998 #4089).

**Sense of movement** S

Comments: The Wecoma fault is mapped as a left-lateral strike slip fault, manifested as a complicated zone of folds and multiple fault strands (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Appelgate and others, 1992 #4100; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090).

**Dip** 90°

Comments: Dip estimate based on geophysical data (Goldfinger and others, 1992 #446; Appelgate and others, 1992 #4100; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090).

**Main dip direction** Vertical

**Geomorphic expression** The Wecoma fault is marked by multiple fault traces, pressure ridges and pop-ups, and aligned fold axes in poorly consolidated accretionary wedge sediments on the continental shelf and slope; the fault also offsets a late Quaternary submarine channel associated with the Astoria Fan, which emanates from the mouth of the Columbia River (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Appelgate and others, 1992 #4100; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090).

**Age of faulted deposits at the surface** The Wecoma fault appears to offset the sea floor in many places (Goldfinger and others, 1992 #446; Appelgate and others, 1992 #4100; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090), and offsets a submarine channel associated with the Astoria Fan, which Goldfinger and others (Goldfinger and others, 1992 #446) estimated was formed 10-24 ka.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Offsets of the sea floor and the latest Quaternary submarine channel (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Appelgate and others, 1992 #4100; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090) indicate most recent movement in the latest Quaternary. The fault is mapped as active in the Holocene or late Pleistocene by Goldfinger and others (1992 #464), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** >5 mm/yr

Comments: Published slip rate estimates are 7-10 mm/yr based on offset bedrock isopachs and age estimates based on sedimentation rates, and 5-12 mm/yr based on offset of a late Quaternary submarine fan located west of the deformation front (Goldfinger and others, 1992 #446; Goldfinger and others, 1992 #464; Appelgate and others, 1992 #4100; Goldfinger, 1994 #3972; Goldfinger and others, 1996 #4292; Goldfinger and others, 1997 #4090). Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used slip rates of 6.5-10.5 mm/yr in their analyses of earthquake hazards associated with the Wecoma fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 96.0 |
| | Cumulative trace (km): | 178.5 |

Comments:

**Average strike** (azimuth) N 66° W

**References**


#4100 Appelgate, B., Goldfinger, C., MacKay, M.E., Kulm, L.D., Fox, C.G., Embley, R.W., and Meis, P.J., 1992, A left-lateral strike-slip fault seaward of the Oregon convergent margin: Tectonics, v. 11, no. 3, p. 465-477.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#4292 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Cochrane, G.R., 1996, Active strike-slip faulting and folding of the Cascadia subduction-zone plate boundary and forearc in central and northern Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 223-256.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#4088 Goldfinger, C., Kulm, L.D., Yeats, R.S., Hummon, C., Huftile, G.J., Niem, A.R., and McNeill, L.C., 1996, Oblique strike-slip faulting of the Cascadia Submarine Forearc—The Daisy Bank fault zone off central Oregon, *in* Bebout, G.E., Scholl, D.W., Kirby, S.H., and Platt, J.P., eds., Subduction top to bottom: Geophysical Monograph 96, p. 65-74.

#4090 Goldfinger, C., Kulm, L.D., Yeats, R.S., McNeill, L., and Hummon, C., 1997, Oblique strike-slip faulting of the central Cascadia submarine forearc: Journal of Geophysical Research, v. 102, no. B4, p. 8217-8243.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

## 801, Wallowa fault

**Structure Number** 801

Comments: This structure is fault number 14 of Pezzopane (1993 #3544) and fault number 65 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Wallowa fault

Comments: The geology of the Wallowa Mountains and Wallowa fault are summarized in Walker (1979 #3576). The fault has been the subject of numerous reconnaissance Quaternary fault investigations and compilations (Newcomb, 1970 #3761; Pezzopane and Weldon, 1993 #149; Zollweg and Wood, 1993 #780; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Wood, 1999 #4042; Weldon and others, 2002 #5648). The fault is apparently named after the Wallowa Mountains.

**Synopsis** The Wallowa Mountains consist of a core of Jurassic and Triassic sedimentary and volcanic rocks that comprise an allocthonous island arc terrane, unconformably overlain by Miocene Columbia River basalts. The Wallowa fault forms a linear, steep range front between the northeastern flank of the Wallowa Mountains and the upper Wallowa River valley, but no fault scarps offsetting Quaternary deposits have been described along its trace. The most-recent surface-faulting event predates the approximately 140 ka age of Bull Lake-equivalent glacial moraines which lie unfaulted across the trace of the Wallowa fault.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Wallowa

**1° x 2° sheet** Grangeville

**Province** Columbia Plateaus (Blue Mountains section)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** The Wallowa Mountains consist of a core of Jurassic and Triassic sedimentary and volcanic rocks (Walker, 1979 #3576) that comprise an allocthonous island arc terrane. These rocks are unconformably overlain by Miocene Columbia River basalts. The Wallowa fault forms a steep, linear range front in these rocks.

**Sense of movement** N

Comments: Most studies show the Wallowa fault as a down-to-the-northeast normal fault. Mann and Meyer (1993 #3535) include the Wallowa fault in a regional scale right-lateral shear zone, the Olympic-Wallowa lineament, but they do not present any evidence of lateral displacement on the Wallowa fault.

**Dip** 70°

Comments: No actual dip measurements have been published, but Geomatrix Consultants, Inc. (1995 #3593) modeled the Wallowa fault as a 70° dipping normal fault in their analysis of paleo-earthquake magnitudes.

**Main dip direction** NE

**Geomorphic expression** The Wallowa fault forms a linear, steep range front between the northeastern flank of the Wallowa Mountains and the upper Wallowa River valley, but no fault scarps offsetting Quaternary deposits have been described along its trace (Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Geomatrix Consultants Inc., 1995 #3593).

**Age of faulted deposits at the surface** The Wallowa fault offsets Miocene Columbia River basalts along most of its length. In places, the fault is mapped as juxtaposing bedrock against Quaternary fanglomerate (Walker, 1979 #3576; Walker and MacLeod, 1991 #3646), but despite offsets of many hundreds of meters of Miocene rocks, no evidence of offset Quaternary deposits has been described. These relations are especially evident at Wallowa Lake, where extensive glacial moraines lie unfaulted across the trace of the Wallowa fault (Hampton and Brown, 1964 #3491; Weis and others, 1976 #3490; Simpson and others, 1993 #3596). Unfaulted moraines include those correlated to the Pinedale and Bull Lake Glaciations; the latter are thought to have formed about 140 ka in the Rocky Mountains (Crandell, 1967 #3785; Pierce and others, 1976 #3783; Forman and others, 1993 #3784).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: The most recent event predates the age of Bull Lake-equivalent glacial moraines thought to have been deposited about 140 ka (Crandell, 1967 #3785; Pierce and others, 1976 #3783; Simpson and others, 1993 #3596; Forman and others, 1993 #3784). Pezzopane (1993 #3544) used airphoto analysis to determine possible middle or late Quaternary (<700 ka) displacement on the northern part of the Wallowa fault, and more recent compilations follow suit (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: Zollweg and Wood (1993 #780) and Wood (1999 #4042) used a minimum offset of 2200 m of Miocene Columbia River basalts to determine long-term average slip rates of 0.14-0.16 mm/yr. The apparent lack of displacement in the last 140 ka also supports low rates of Quaternary slip.

**Length** End to end (km): 56.4
Cumulative trace (km): 118.8

Comments:

**Average strike** (azimuth) N 51° W

**References**


#3785 Crandell, D.R., 1967, Glaciation at Wallowa Lake, Oregon: U.S. Geological Survey Professional Paper 575-C, 145-153 p.

#3784 Forman, S.L., Smith, R.P., Hackett, W.R., Tullis, J.A., and McDaniel, P.A., 1993, Timing of late Quaternary glaciations in the western United States based on the age of loess on the eastern Snake River Plain, Idaho: Quaternary Research, v. 40, p. 30-37.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3491 Hampton, E.R., and Brown, S.G., 1964, Geology and ground-water resources of the Upper Grande Ronde River Basin Union County, Oregon: U.S. Geological Survey Water-Supply Paper 1597, 99 p., 6 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3535 Mann, G.M., and Meyer, C.E., 1993, Late Cenozoic structure and correlations to seismicity along the Olympic-Wallowa Lineament, northwest United States: Geological Society of America Bulletin, v. 105, p. 853-871.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3783 Pierce, K.L., Obradovich, J.D., and Friedman, I., 1976, Obsidian hydration dating and correlation of Bull Lake and Pinedale glaciations near west Yellowstone, Montana: Geological Society of America Bulletin, v. 87, p. 703-710.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3576 Walker, G.W., 1979, Reconnaissance geologic map of the Oregon part of the Grangeville quadrangle, Baker, Union, Umatilla, and Wallowa Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1116, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3490 Weis, P.L., Gualtieri, J.L., Cannon, W.F., Tucher, E.T., McMahan, A.B., and Federspiel, F.E., 1976, Mineral resources of the Eagle Cap Wilderness and adjacent areas, Oregon: U.S. Geological Survey Bulletin 1385-E, 100 p., 2 pls.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#4042 Wood, S.H., 1999, Quaternary faulting in southwest Idaho and adjacent Oregon, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 9, p. 1-5.

#780 Zollweg, J.E., and Wood, S.H., 1993, Faulting relationships, seismicity, design earthquakes, and peak ground accelerations at hydroelectric facilities in Hells Canyon of the Snake River, Idaho-Oregon: Report prepared for Idaho Power Company, 158 p., 3 pls.

**802, West Grande Ronde Valley fault zone**

**Structure Number** 802

Comments: This structure is part of fault number 13 of Pezzopane (1993 #3544) and fault number 68a of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** West Grande Ronde Valley fault zone

Comments: The fault zone along the western margin of the Grande Ronde Valley was originally mapped by Hampton and Brown (1964 #3491), and later summarized by Walker (1979 #3576). Parts of the fault zone north of La Grande were named the Ruckel Ridge and Indian Rock faults (Kienle and others, 1979 #3728); faults near La Grande were named the Mount Emily, La Grande, Foothill Road, and Hot Lake faults (Barrash and others, 1980 #3570), and the La Grande fault (Geomatrix Consultants Inc., 1989 #1310). The fault traces included herein were informally grouped as the West Grande Ronde Valley fault by Simpson and others (1993 #3596). Faults along the west side of the Grande Ronde Valley have been included in numerous reconnaissance Quaternary fault investigations and compilations (Kienle and others, 1979 #3728; U.S. Army Corps of Engineers, 1983 #3480; Geomatrix Consultants Inc., 1989 #1310; Piety and others, 1990 #3733; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; 1995 #3593; Madin and Mabey, 1996 #3575; Personius, 1998 #3508; Wood, 1999 #4042).

**Synopsis** The West Grande Ronde Valley fault forms the western margin of a large graben system that confines the Grande Ronde Valley in northeastern Oregon. The graben is formed in Miocene and Pliocene volcanic rocks, and is floored by a thick sequence of Neogene and Quaternary alluvial sediments. The Grande Ronde Valley may be a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system. The West Grande Ronde Valley fault zone is divided into three sections herein; from north to south, these are the Mount Emily, La Grande, and Craig Mountain sections. All of these sections form steep, en echelon range fronts, which are intermittently marked by tonal contrasts, linear depressions, range front facets, springs, and scarps. Most fault studies in the region infer late Pleistocene and perhaps Holocene displacement on the Mount Emily and La Grande sections, and somewhat older late Quaternary displacement on the Craig Mountain section.

**Date of compilation** February 3, 2003

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Union

**1° x 2° sheet** Grangeville

**Province** Columbia Plateaus (Blue Mountains section)

**Geologic setting** The West Grande Ronde Valley fault zone forms the western margin of a large graben system that forms the Grande Ronde Valley. The graben is formed in volcanic rocks of the Miocene Columbia River Group and the Mio-Pliocene Powder River volcanic field, and is floored by a thick sequence of Neogene and Quaternary alluvial sediments (Hampton and Brown, 1964 #3491; Walker, 1979 #3576; Barrash and others, 1980 #3570; Ferns and Madin, 1999 #5160, Ferns, 2001 #5135; Van Tassell and others, 2001 #5166). Numerous northwest-trending faults are present throughout the region; some workers attribute graben formation to a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system (Gehrels and others, 1980 #3774). However, no evidence of significant lateral displacement in the Quaternary has been found along the West Grande Ronde Valley fault zone (Ferns and Madin, 1999 #5160).

**Number of sections** 3

Comments: The West Grande Ronde Valley fault zone is divided into three sections herein, slightly modified from the divisions of Simpson and others (1993 #3596); from north to south, these are the Mount Emily section, the La Grande section, and the Craig Mountain section.

| | | |
|---|---|---|
| **Length** | End to end (km): | 48.5 |
| | Cumulative trace (km): | 86.5 |

Comments:

**Average strike** (azimuth) N 19° W

***802a, Mount Emily section***

**Section number** 802a

**Section name** Mount Emily section

Comments: This section includes the Thimbleberry and Mount Emily segments of the West Grande Ronde Valley fault zone of Simpson and others (1993 #3596). Previously named faults in this section include the Ruckel Ridge and Indian Rock faults of Kienle and others (1979 #3728) the Mount Emily fault of Barrash and others (1980 #3570), and the Owlsey Canyon fault of Ferns and Madin (1999 #5160).

**Quality of location** Good

Comments: Fault traces are from 1:24,000-scale mapping of Ferns and Madin (1999 #5160) and 1:100,000-scale compilation of Ferns and others (2001 #5135).

**Sense of movement** N

Comments: Faults in this section are mapped as a normal or high-angle faults (Hampton and Brown, 1964 #3491; Walker, 1979 #3576; Barrash and others, 1980 #3570; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Ferns and Madin, 1999 #5160; Ferns and others, 2001 #5135). Some workers attribute formation of the Grande Ronde graben to a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system, and horizontal striations have been observed on some faults in the area (Gehrels and others, 1980 #3774). However, no evidence of significant lateral displacement in the Quaternary has been found along the West Grande Ronde Valley fault zone (Ferns and Madin, 1999 #5160).

**Dip** 60-70°

Comments: No dip measurements have been published, but Ferns and Madin (1999 #5160) used mapped outcrop patterns to estimate dips of 60-70° on the Mount Emily section. Simpson and others (1993 #3596) and Geomatrix Consultants, Inc. (1995 #3593) modeled the West Grande Ronde Valley fault as a 70° dipping normal fault in their analyses of paleo-earthquake magnitudes. These values are substantiated by a dip of 68-70° that can be estimated from the interception depth of the Hot Lake fault in a geothermal test well (Barrash and others, 1980 #3570) along the Craig Mountain section [#802c].

**Main dip direction** E

**Geomorphic expression** The Mount Emily section forms a steep, en echelon range front, from the vicinity of Thimbleberry Mountain on the north to the mouth of the Grande Ronde River canyon north of La Grande. Simpson and others (1993 #3596) described the fault as intermittently marked by tonal contrasts, linear depressions, range front facets, and scarps, and a geomorphic expression that suggested a lower rate of activity than the La Grande section. However, Ferns and Madin (1999 #5160) and Ferns and others (2001 #5135) describe much of the fault section as marked by pronounced scarps where very little colluvial material has been deposited, and abrupt topographic inflections at the fault zone.

**Age of faulted deposits at the surface** Faults in the Mount Emily section offset volcanic rocks of the Miocene Columbia River Group and Mio-Pliocene Powder River volcanic field, and also offset Quaternary surficial deposits (Ferns and Madin, 1999 #5160; Ferns and others, 2001 #5135). Simpson and others (1993 #3596) could not clearly demonstrate offsets in Quaternary surficial deposits (Simpson and others, 1993 #3596), but Ferns and Madin (1999 #5160) and Ferns and others (2001 #5135) map faults in Quaternary deposits and describe geomorphic evidence of Holocene displacement.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Simpson and others (1993 #3596) did not find evidence of repeated late Quaternary displacement on the Mount Emily section. Pezzopane (1993 #3544) and Geomatrix Consultants, Inc. (1995 #3593) infer middle and late Quaternary displacement on this part of the West Grande Ronde Valley fault zone. Recent detailed mapping by Ferns and Madin (1999 #5160) revealed geomorphic evidence of Holocene displacement on the southern half of the section; Weldon and others (2002 #5648) also infer latest Quaternary displacement on this part of the section.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but several vertical displacement estimates across the fault zone suggest low rates of long-term slip. Such estimates include vertical offset of Miocene Columbia River basalts of about 1000 m near Mount Emily (Hampton and Brown, 1964 #3491; Simpson and others, 1993 #3596), and >1000 m of vertical displacement of the ~13.4 Ma dacite of Mount Emily (Ferns and Madin, 1999 #5160). Geomatrix Consultants, Inc. (1995 #3593) use offset data from Simpson and others (1993 #3596) to estimate slip rates of 0.01-0.05 mm/yr for all of the West Grande Ronde Valley fault zone. Rates may be higher than those estimated by Geomatrix Consultants, Inc. (1995 #3593) because Van Tassell and others (2000 #5161) used regional mapping and well data to calculate a subsidence rate of 0.2 mm/yr for the last 9 Ma for the southwestern part of the La Grande basin.

| | | |
|---|---|---|
| **Length** | End to end (km): | 29.0 |
| | Cumulative trace (km): | 44.9 |

Comments:

**Average strike** (azimuth) N 02° W

### ***802b, La Grande section***

**Section number** 802b

**Section name** La Grande section

Comments: This section includes the La Grande and Foothill segments of the West Grande Ronde Valley fault zone of Simpson and others (1993 #3596) and Personius (1998 #3508). Previously named faults in this section include the La Grande, Foothill Road, and Hot Lake faults of Barrash and others (1980 #3570) and the La Grande fault (Geomatrix Consultants Inc., 1989 #1310).

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale compilation of Ferns and others (2001 #5135).

**Sense of movement** N

Comments: Faults in this section are mapped as a normal or high-angle faults (Hampton and Brown, 1964 #3491; Walker, 1979 #3576; Barrash and others, 1980 #3570; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Ferns and others, 2001 #5135). Some workers attribute formation of the Grande Ronde graben to a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system, and horizontal striations have been observed on some faults in the area (Gehrels and others, 1980 #3774). However, no evidence of significant lateral displacement in the Quaternary has been found along the West Grande Ronde Valley fault zone (Ferns and Madin, 1999 #5160).

**Dip** 60-70°

Comments: No dip measurements have been published, but Ferns and Madin (1999 #5160) used mapped outcrop patterns to estimate dips of 60-70° on the Mount Emily section [#802a]. Simpson and others (1993 #3596) and Geomatrix Consultants, Inc. (1995 #3593) modeled the West Grande Ronde Valley fault as a 70° dipping normal fault in their analyses of paleo-earthquake magnitudes. These values are substantiated by a dip of 68-70° that can be estimated from the interception depth of the Hot Lake fault in a geothermal test well (Barrash and others, 1980 #3570) along the Craig Mountain section [#802c].

**Main dip direction** E

**Geomorphic expression** The La Grande section forms a complex, steep, en echelon range front, from the vicinity of the mouth of the Grande Ronde River canyon on the north to the mouth of Ladd Canyon on the south. The section consists of two primary fault strands, a complex strand adjacent to La Grande (La Grande segment of Simpson and others, 1993 #3596) and a strand parallel to Foothill Road (Foothill segment of Simpson and others, 1993 #3596); these strands are separated by a left step south of La Grande, but appear to intersect further south near Ladd Marsh (Ferns and others, 2001 #5135). The Foothill strand is marked by alignment of topographic benches, linear benches, springs, tonal contrasts, and vegetation lineaments along the range (Simpson and others, 1993 #3596; Ferns and others, 2001 #5135). Simpson and others (1993 #3596) and Personius (1998 #3508) describe a 2-5-m-high scarp in an older fluvial terrace near the north end the of the Foothill strand. The La Grande strand is expressed as a steep linear range front, with small (1-3 m) fault scarps on late Quaternary alluvial deposits at several canyon mouths, and larger scarps (~20 m) in older landslide deposits near the southern end of the strand (Simpson and others, 1993 #3596; Personius, 1998 #3508). The minor strand (the “eastern splay”) identified by Personius (1998 #3508) lies a few hundred meters east of the La Grande range front north of La Grande. This 11-12 m high fault scarp is about 1.5 km long, is developed in middle Pleistocene or older hillslope and landslide deposits, and has scarp-slope angles of 24°-27° (Personius, 1998 #3508). The possible relationship of the eastern splay to either of the more prominent strands in the La Grande section is open to question; the eastern splay could be a splay of the La Grande strand that has been isolated by Holocene alluvial deposits, or it could be a northern continuation of the Foothill strand. The latter possibility may be supported by a possible connection between the Foothill strand and a lineament mapped north of the Grande Ronde River (Barrash and others, 1980 #3570; Simpson and others, 1993 #3596).

**Age of faulted deposits at the surface** Faults in the La Grande section offset volcanic rocks of the Miocene Columbia River Group and Mio-Pliocene Powder River volcanic field, and also offset Quaternary surficial deposits (Ferns and others, 2001 #5135). Simpson and others (1993 #3596) describe tonal contrasts and vegetation lineaments in young (late Pleistocene or Holocene) valley-fill sediments along the southern end of the Foothill strand. Personius (1998 #3508) used limited soils data to infer an age of 60-140 ka for the fluvial deposits offset near the northern end of the Foothill strand; Simpson and others assign a late Pleistocene or older age, based on the hummocky and dissected expression of these deposits. Alluvial deposits that lie 5-10 m above modern drainages are offset in several places along the La Grande strand; these deposits are thought to be late Pleistocene in age (Simpson and others, 1993 #3596; Personius, 1998 #3508). Landslide deposits with larger displacements are offset near the southern end of the La Grande strand; these deposits are probably middle Pleistocene or older (Personius, 1998 #3508). The colluvial and landslide deposits offset by the eastern splay are probably middle Pleistocene or older (Personius, 1998 #3508). Ferns and others (2001 #5135) describe Z-shaped benches that mark faulted bedrock alluvial-fan contacts in late Quaternary deposits.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: No detailed information on age of most recent faulting has been published. However, Simpson and others (1993 #3596) and Ferns and others (2001 #5135) used the presence of scarps on young alluvium to infer late Pleistocene and perhaps Holocene displacement on the La Grande and Foothill strands of the La Grande section. Personius (1998 #3508) used limited fault scarp profiles on the eastern splay and the presence of fault scarps on the La Grande strand to infer late Pleistocene (10-128 ka) displacement on the La Grande section. Geomatrix Consultants, Inc. (1989 #1310; 1995 #3593), Pezzopane (1993 #3544), and Weldon and others (2002 #5648) also infer latest Quaternary (<10-20 ka) displacement on the La Grande section of the West Grande Ronde Valley fault zone.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown, probably <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but displacement across the fault zone in Miocene Columbia River basalts is 430-700 meters (Barrash and others, 1980 #3570), and Ferns and others (2001 #5135) showed similar offsets in Miocene Powder River volcanic field rocks across the La Grande section. Fault scarps are 2-5 m high in middle or late Pleistocene alluvium, so both long and short term offset measurements yield low rates of slip. Geomatrix Consultants, Inc. (1995 #3593) use offset data from Simpson and others (1993 #3596) to estimate slip rates of 0.01-0.05 mm/yr for all of the West Grande Ronde Valley fault zone. Rates may be higher than those estimated by Geomatrix Consultants, Inc. (1995 #3593) because Van Tassell and others (2000 #5161) used regional mapping and well data to calculate a subsidence rate of 0.2 mm/yr for the last 9 Ma for the southwestern part of the La Grande basin.

| | | |
|---|---|---|
| **Length** | End to end (km): | 14.5 |
| | Cumulative trace (km): | 25.8 |

Comments:

**Average strike** (azimuth) N 30° W

### *802c, Craig Mountain section*

**Section number** 802c

**Section name** Craig Mountain section

Comments: This section consists of the Craig Mountain segment of the West Grande Ronde Valley fault zone of Simpson and others (1993 #3596) and Personius (1998 #3508) and the Hot Lake fault of Barrash and others (1980 #3570).

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648).

**Sense of movement** N

Comments: Faults in this section are mapped as a normal or high-angle faults (Hampton and Brown, 1964 #3491; Walker, 1979 #3576; Barrash and others, 1980 #3570; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Ferns and others, 2001 #5135). Some workers attribute formation of the Grande Ronde graben to a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system, and horizontal striations have been observed on some faults in the area (Gehrels and others, 1980 #3774). However, no evidence of significant lateral displacement in the Quaternary has been found along the West Grande Ronde Valley fault zone (Ferns and Madin, 1999 #5160).

**Dip** 60-70°

Comments: No dip measurements have been published, but Ferns and Madin (1999 #5160) used mapped outcrop patterns to estimate dips of 60-70° on the Mount Emily section [#802a]. Simpson and others (1993 #3596) and Geomatrix Consultants, Inc. (1995 #3593) modeled the West Grande Ronde Valley fault as a 70° dipping normal fault in their analyses of paleo-earthquake magnitudes. Dip can be estimated from the mapped trace of the fault and the intersection of the fault in the Magma-LaGrande No. 1 well near Hot Lake. The fault is intersected in the well at a depth of 503 m (Barrash and others, 1980 #3570), suggesting a dip of 68-70°.

**Main dip direction** E

**Geomorphic expression** The Craig Mountain section forms a steep, en echelon. linear range front along the east flank of Craig Mountain. The fault is intermittently marked by linear fronts and numerous springs; Hot Lake hot springs is located near the northern end of the section. The geomorphic expression of the Craig Mountain section may suggest a lower rate of faulting than the La Grande section faults (Simpson and others, 1993 #3596), but the mountain front is comprised of numerous landslide complexes (I.P. Madin, pers. commun., 2001) which may be masking evidence of young faulting.

**Age of faulted deposits at the surface** Faults in the Craig Mountain section offset volcanic rocks of the Miocene Columbia River Group and Mio-Pliocene Powder River volcanic field (Ferns and others, 2001 #5135). Offsets in Quaternary surficial deposits have not been clearly demonstrated, but scarps may be present in landslide deposits of unknown age (Simpson and others, 1993 #3596; Ferns and others, 2001 #5135) at the northern end of the section.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Simpson and others (1993 #3596) did not find evidence of repeated late Quaternary displacement on the Craig Mountain section. Pezzopane (1993 #3544) and Geomatrix Consultants, Inc. (1995 #3593) infer middle and late Quaternary (<700-780 ka) displacement on the Craig Mountain section. Weldon and others (2002 #5648).infer latest Quaternary displacement on this part of the West Grande Ronde Valley fault zone, so that age is retained herein until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown, probably <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but based on well correlations, displacement of Miocene Columbia River basalts across the Craig Mountain section is about 730 m southeast of Hot Lake (Barrash and others, 1980 #3570); such offset data suggest low rates of long-term slip. Geomatrix Consultants, Inc. (1995 #3593) use offset data from Simpson and others (1993 #3596) to estimate slip rates of 0.01-0.05 mm/yr for all of the West Grande Ronde Valley fault zone. Rates may be higher than those estimated by Geomatrix Consultants, Inc. (1995 #3593) because Van Tassell and others (2000 #5161) used regional mapping and well data to calculate a subsidence rate of 0.2 mm/yr for the last 9 Ma for the southwestern part of the La Grande basin.

| | | |
|---|---|---|
| **Length** | End to end (km): | 9.6 |
| | Cumulative trace (km): | 15.7 |

Comments:

**Average strike** (azimuth) N 49° W

**References**


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#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3508 Personius, S.F., 1998, Surficial geology and neotectonics of selected areas of western Idaho and northeastern Oregon: U.S. Geological Survey Open-File Report 98-771, 25 p.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

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#3733 Piety, L.A., LaForge, R.C., and Foley, L.L., 1990, Seismic sources and maximum credible earthquakes for Cold Springs and McKay Dams, Umatilla Project, north-central Oregon: U.S. Bureau of Reclamation Seismotectonic Report 90-1, 62 p., 1 pl.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3480 U.S. Army Corps of Engineers, 1983, The Dalles and John Day Lakes earthquake and fault study—Design memorandum 26: U.S. Army Corps of Engineers, Portland District, 66 p., 19 pls.

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#4042 Wood, S.H., 1999, Quaternary faulting in southwest Idaho and adjacent Oregon, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 9, p. 1-5.

**803, East Grande Ronde Valley fault zone**

**Structure Number** 803

Comments: This structure is part of fault number 13 of Pezzopane (1993 #3544) and fault number 68b of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** East Grande Ronde Valley fault zone

Comments: The fault zone along the eastern margin of the Grande Ronde Valley was originally mapped by Hampton and Brown (1964 #3491), and later summarized by Newcomb (1970 #3761) and Walker (1979 #3576). The fault trace as included herein was informally named the East Grande Ronde Valley fault by Simpson and others (1993 #3596). Faults along the east side of the Grande Ronde Valley have been included in numerous reconnaissance Quaternary fault investigations and compilations (U.S. Army Corps of Engineers, 1983 #3480; Geomatrix Consultants Inc., 1989 #3546; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; 1995 #3593; Madin and Mabey, 1996 #3575; Personius, 1998 #3508; Wood, 1999 #4042; Weldon and others, 2002 #5648).

**Synopsis** The East Grande Ronde Valley fault zone forms the eastern margin of a large graben system that forms the Grande Ronde Valley in northeastern Oregon. The graben is formed in Miocene and Pliocene volcanic rocks, and is floored by a thick sequence of Neogene and Quaternary alluvial sediments. The Grande Ronde Valley may be a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system. The southern third of the East Grande Ronde Valley fault zone forms a steep, linear range front, from Mount Fanny north to Mount Harris. The fault trace is marked in this area by intermittent fault scarps in Quaternary deposits. North of Mount Harris, the range front decreases in height and linearity, and the fault projects across the Grande Ronde River as a series of discontinuous scarps, tonal lineaments, and linear drainages. The most active, southern third of the fault zone may have moved as recently as the latest Pleistocene or Holocene.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Union

**1° x 2° sheet** Grangeville

**Province** Columbia Plateaus (Blue Mountains section)

**Quality of location** Good

Comments: Fault traces are from 1:250,000-scale mapping of (Walker, 1979 #3576), 1:100,000-scale mapping of Simpson and others (1993 #3596) and Weldon and others (2002 #5648), and 1:24,000-scale figure of Personius (1998 #3508).

**Geologic setting** The East Grande Ronde Valley fault zone forms the eastern margin of a large graben system that forms the Grande Ronde Valley. The graben is formed in Miocene and Pliocene volcanic rocks, and is floored by a thick sequence of Neogene and Quaternary alluvial sediments (Hampton and Brown, 1964 #3491; Walker, 1979 #3576; Walker and MacLeod, 1991 #3646; Ferns and others, 2001 #5135). Numerous northwest-trending faults are present throughout the region; some workers attribute graben formation to a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system (Gehrels and others, 1980 #3774). However, no evidence of significant lateral displacement in the Quaternary has been found along the West Grande Ronde Valley fault zone (Ferns and Madin, 1999 #5160), so herein the East Grande Ronde Valley fault zone is assumed to be a normal fault.

**Sense of movement** N

Comments: Although horizontal striations and other evidence of horizontal displacement have been observed on faults in the region (Hampton and Brown, 1964 #3491; Gehrels and others, 1980 #3774), no evidence of significant lateral displacement has been described along the West Grande Ronde Valley fault zone (Ferns and Madin, 1999 #5160) or the East Grande Ronde Valley fault zone (U.S. Army Corps of Engineers, 1983 #3480; Geomatrix Consultants Inc., 1989 #3546; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; 1995 #3593; Personius, 1998 #3508), so herein the East Grande Ronde Valley fault zone is assumed to be a normal fault.

**Dip** 60-70°

Comments: No dip measurements have been published, but Simpson and others (1993 #3596) and Geomatrix Consultants, Inc. (1995 #3593) modeled the East Grande Ronde Valley fault zone as a 70° dipping normal fault in their analyses of paleo-earthquake magnitudes. Map and well data along the West Grande Ronde Valley fault zone [802] (Barrash and others, 1980 #3570; Ferns and Madin, 1999 #5160) support a dip of 60-70°.

**Main dip direction** SW

**Geomorphic expression** The East Grande Ronde Valley fault zone forms a steep, linear range front from Mount Fanny north to Mount Harris. The fault trace is marked in this area by intermittent fault scarps in Quaternary deposits (Simpson and others, 1993 #3596; Personius, 1998 #3508). North of Mount Harris, the range front decreases in height and linearity, and the fault projects across the Grande Ronde River as a series of discontinuous scarps, tonal lineaments, and linear drainages (Simpson and others, 1993 #3596). Simpson and others (1993 #3596) divided the East Grande Ronde Valley fault zone into three segments, the Cove, Mount Harris, and Rhinehart segments, based on apparent differences in geomorphic expression. However, these segments are only 12-15 km long, could rupture together (Simpson and others, 1993 #3596), and are not based on detailed paleoseismic investigations, so herein these segments are discussed together.

**Age of faulted deposits at the surface** Hampton and Brown (1964 #3491) map a short fault in Quaternary colluvium about 8 km north of Cove, but this feature is probably a landslide headscarp (Personius, 1998 #3508). Simpson and others (1993 #3596) described low scarps, typically <3 m in height, in late Pleistocene alluvial deposits, and locally higher scarps in older deposits. Personius (1998 #3508) measured surface offsets of 6-11 m in late Pleistocene alluvial deposits, but he found no evidence of faulting in Holocene alluvium.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Simpson and others (1993 #3596) and Personius (1998 #3508) described fault scarps in late Pleistocene alluvial deposits, and Personius (1998 #3508) used fault-scarp morphology to infer that some scarps along the East Grande Ronde Valley fault zone may be latest Pleistocene in age. U.S. Army Corps of Engineers (1983 #3480), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Weldon and others (2002 #5648) show the southern third of the fault as having latest Pleistocene or Holocene displacement.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: Hampton and Brown (1964 #3491) estimate about 1,200 m of displacement of 15-17 Ma (Walker and MacLeod, 1991 #3646) Columbia River basalts across the East Grande Ronde Valley fault; such offsets suggest low rates of long-term slip. No Quaternary slip rate data are available for the East Grande Ronde Valley fault zone, but the relatively small scarps in late Pleistocene deposits suggest low rates of

Quaternary slip. Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.05-0.005 mm/yr in their analysis of earthquake hazards associated with the fault.

**Length** End to end (km): 49.9
Cumulative trace (km): 79.6

Comments:

**Average strike** (azimuth) N 35° W

**References**

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#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3480 U.S. Army Corps of Engineers, 1983, The Dalles and John Day Lakes earthquake and fault study—Design memorandum 26: U.S. Army Corps of Engineers, Portland District, 66 p., 19 pls.

#3576 Walker, G.W., 1979, Reconnaissance geologic map of the Oregon part of the Grangeville quadrangle, Baker, Union, Umatilla, and Wallowa Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1116, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#4042 Wood, S.H., 1999, Quaternary faulting in southwest Idaho and adjacent Oregon, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 9, p. 1-5.

## 804, West Baker Valley fault

**Structure Number** 804

Comments: This structure is fault number 15 of Pezzopane (1993 #3544) and fault number 67 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** West Baker Valley fault

Comments: The West Baker Valley fault borders the western margin of Baker Valley in northeastern Oregon. The fault zone has been give various names, such as Baker fault, Baker Valley fault, and the Baker zone or fault zone (Geomatrix Consultants Inc., 1989 #1310; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544). Herein we retain the name "West Baker Valley fault" of Simpson and others (1993 #3596) to distinguish this major range-bounding structure from other faults in the Baker Valley. Parts of the fault have been mapped by Gilluly (1937 #3489), Newcomb (1970 #3761), Brooks and others (1976 #3573), and Brooks and McIntyre (1977 #3751).

**Synopsis** The West Baker Valley fault is a major zone of northwest-striking, down-to-the-northeast normal faults that form the western margin of Baker Valley in northeastern Oregon. Rocks exposed in the uplifted Elkhorn Ridge consist of an allochthonous terrane consisting of Mesozoic and Paleozoic igneous and metamorphic rocks. The valley margin fault trace is marked in places by linear range fronts, faceted spurs, benches, springs, tonal and vegetation lineaments, and fault scarps in late Quaternary alluvial-fan deposits. No detailed Quaternary stratigraphic studies have been performed along the West Baker Valley fault, but the fault is buried by probable middle to late Holocene fan deposits, so the most-recent surface-faulting event probably occurred in the late Quaternary. Larger scarps in older Quaternary deposits indicate probable recurrent late Quaternary displacement.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Baker

**1° x 2° sheet** Baker

**Province** Columbia Plateaus (Payette and Blue Mountains sections)

**Quality of location** Good

Comments: The fault traces are from 1:250,000-scale mapping of Simpson and others (1993 #3596) and 1:100,000-scale mapping of Weldon and others (2002 #5648).

**Geologic setting** The West Baker Valley fault is a major zone of northwest-striking, mostly down-to-the-northeast normal faults that form the western margin of Baker Valley in northeastern Oregon. Rocks exposed in the uplifted Elkhorn Ridge consist of an allochthonous terrane consisting of Mesozoic and Paleozoic igneous and metamorphic rocks (Brooks and others, 1976 #3573; Ferns and others, 1987 #3753; Walker and MacLeod, 1991 #3646; Ferns and others, 2001 #5135).

**Sense of movement** N

Comments:

**Dip** 40°-70°

Comments: Lindgren (1901 #4172) (also reproduced in Gilluly, 1937 #3489), measured a dip of 40° on the main trace of the West Baker Valley fault exposed in a 30 m deep placer mine at the mouth of Salmon Creek Canyon; Simpson and others (1993 #3596) and Geomatrix Consultants, Inc. (1995 #3593) modeled the West Baker Valley fault as a 70° dipping normal fault in their analyses of paleo-earthquake magnitudes.

**Main dip direction** NE

**Geomorphic expression** The West Baker Valley fault forms a large, steep range front along the western margin of Baker Valley. The fault trace is marked in places by linear range fronts, faceted spurs, benches, springs, tonal and vegetation lineaments, and fault scarps in older alluvial-fan deposits (Geomatrix Consultants Inc., 1989 #1310; Simpson and others, 1993 #3596). Simpson and others (1993 #3596) divided the West Baker Valley into two segments, the Washington Gulch and Hunt Mountain segments, based on apparent differences in geomorphic expression. However, they interpret late Quaternary movement on both segments and did not conduct detailed paleoseismic investigations, so herein these segments are discussed together. We also include several short faults mapped at the southern end of the Baker Valley (Brooks and others, 1976 #3573; Walker and MacLeod, 1991 #3646), although the most-recent faulting along these structures is older than elsewhere along the West Baker Valley fault (Geomatrix Consultants Inc., 1989 #1310; Simpson and others, 1993 #3596; Weldon and others, 2002 #5648).

**Age of faulted deposits at the surface** No detailed Quaternary stratigraphic studies have been performed along the West Baker Valley fault. Brooks and others (1976 #3573) and Walker and MacLeod (1991 #3646) map Quaternary terrace and fan gravels faulted against Quaternary alluvium along one strand of the West Baker Valley fault. Geomatrix Consultants, Inc. (1989 #1310) describe scarps of probable fault origin in late Pleistocene to Holocene valley-fill deposits. Simpson and others (1993 #3596) describe fault scarps in late Quaternary fan deposits, but found no offset in probable middle to late Holocene fan deposits. Simpson and others (1993 #3596) also observed larger scarps in older Quaternary deposits, indicating recurrent late Quaternary displacement.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: Simpson and others (1993 #3596) describe fault scarps in late Quaternary fan deposits, but found no offset in probable middle to late Holocene fan deposits; in contrast, Geomatrix Consultants, Inc. (1989 #1310) described scarps of probable fault origin in late Pleistocene to Holocene valley-fill deposits. Such relations suggest the most-recent surface-faulting event occurred in the late Quaternary. Several short faults at the south end of Baker Valley are thought to have been active in the Quaternary (Weldon and others, 2002 #5648).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: Despite the 400-1,300 m of relief along the West Baker Valley fault, no slip data are available. Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.005-0.05 mm/yr in their analysis of earthquake hazards associated with the West Baker Valley fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 32.6 |
| | Cumulative trace (km): | 68.5 |

Comments:

**Average strike** (azimuth) N54° W

**References**

#3751 Brooks, H.C., McIntyre, J.R., and Eisele, K.A., 1977, Preliminary geologic map of the Baker quadrangle, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report 77-6, 1 sheet, scale 1:24,000.

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#5135 Ferns, M.L., Madin, I.P., and Taubeneck, W.H., 2001, Reconnaissance geologic map of the La Grande 30' X 60' quadrangle, Baker, Grant, Umatilla, and Union counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Reconnaissance Map Series RMS-1, 1 pl., scale 1:100,000.

#1310 Geomatrix Consultants Inc., 1989, Final report seismotectonic evaluation for Mann Creek Dam site and Mason Dam site: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, Colorado, under Contract 6-CS-81-07310, October 1989, 118 p., 2 pls.

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#3489 Gilluly, J., 1937, Geology and mineral resources of the Baker quadrangle, Oregon: U.S. Geological Survey Bulletin 879, 116 p.

#4172 Lindgren, W., 1901, The gold belt of the Blue Mountains of Oregon—Part 2: U.S. Geological Survey Annual Report, vol. 22, 551-776 p., 1 pl.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

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#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 805, Juniper Mountain fault

**Structure Number** 805

Comments: This structure is part of fault number 17 of Pezzopane (1993 #3544) and fault number 65 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Juniper Mountain fault

Comments: Originally mapped by Brooks and others (1976 #3573), the fault was informally named the Juniper Mountain fault by Geomatrix Consultants, Inc. (1989 #1310) after nearby Juniper Mountain. The fault has been the subject of numerous reconnaissance Quaternary fault investigations and compilations (Geomatrix Consultants Inc., 1989 #1310; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594; 1995 #3593; Madin and Mabey, 1996 #3575; Wood, 1999 #4042; Weldon and others, 2002 #5648).

**Synopsis** The Juniper Mountain fault is a roughly east-west striking, down-to-the-north normal fault located along the northern margin of Juniper Mountain. The fault juxtaposes Miocene Columbia River basalts against Miocene and Pliocene ash-flow tuffs and tuffaceous lacustrine rocks. The fault trace is marked by prominent fault scarps across alluvial fans north of Juniper Mountain. Small scarps in late Pleistocene to Holocene(?) deposits and larger scarps in older surficial deposits indicate recurrent late Quaternary movement on the Juniper Mountain fault.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Malheur

**1° x 2° sheet** Baker

**Province** Columbia Plateaus (Payette section)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** The Juniper Mountain fault lies along the north flank of Juniper Mountain, a low relief highland consisting of Miocene to Pliocene volcanic and sedimentary rocks that unconformably overlie an allocthonous Devonian to Jurassic island arc basement terrane consisting of volcanic and sedimentary rocks (Brooks and others, 1976 #3573; Walker and MacLeod, 1991 #3646). The Cenozoic tectonic pattern of the region is dominated by numerous northwest-striking normal faults (the Vale zone) that have been attributed to deep seated dextral shear between east-west extension in the Basin and Range province to the south and more stable terranes to the north and west (Lawrence, 1976 #3506), driven by interactions of the Juan de Fuca and North American plates (Robyn and Hoover, 1982 #3781; Pezzopane and Weldon, 1993 #149; Mann and Meyer, 1993 #3535). A more recent interpretation is that these faults are simply northwest-striking normal faults that do not represent regional shearing (Knudsen and others, 1994 #3594; 1996 #3529).

**Sense of movement** N

Comments: The fault has been mapped as a high-angle, presumable normal fault by Brooks and others (1976 #3573), Walker and MacLeod (1991 #3646), Geomatrix Consultants, Inc. (1989 #1310; 1995 #3593); Simpson and others (1993 #3596), Pezzopane (1993 #3544), and Knudsen and others (1994 #3594).

**Dip** 60°-70°

Comments:  No data on fault dip have been published.  Knudsen and others (1994 #3594) and Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° and Wong and others (1999 #5654) used an estimated dip of 60° in their analyses of paleo-earthquake magnitudes on the Juniper Mountain fault.

**Main dip direction** N

**Geomorphic expression** The Juniper Mountain fault is marked by short, discontinuous scarps and tonal and topographic lineaments along the northern flank of Juniper Mountain (Geomatrix Consultants Inc., 1989 #1310; Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594; 1995 #3593).  Scarps and lineaments are present in late Pleistocene and Holocene(?) deposits; scarps are larger in older deposits, suggesting recurrent Quaternary displacement (Knudsen and others, 1994 #3594).

**Age of faulted deposits at the surface** The Juniper Mountain fault offsets late Pleistocene to Holocene(?) fan deposits north of Juniper Mountain (Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments:  Offset age estimates are based on geomorphic similarity to better studied Cottonwood Mountain fault [806] to the south, and presence of fault scarps on late Pleistocene to Holocene(?) fan deposits (Geomatrix Consultants Inc., 1989 #1310; Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594; 1995 #3593).  Weldon and others (2002 #5648) also inferred latest Quaternary displacement on most of the Juniper Mountain fault.

**Recurrence interval** Not reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments:  The low slip category is based on lack of a prominent range front along north flank of Juniper Mountain.  Geomatrix Consultants, Inc. (1995 #3593) used fault geomorphic expression to estimate preferred slip rates of 0.01-0.05 mm/yr on the Juniper Mountain fault.  Wong and others (1999 #5654) estimated a vertical slip rate of 0.05 mm/yr for the Juniper Mountain fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 17.4 |
| | Cumulative trace (km): | 23.8 |

Comments:

**Average strike** (azimuth) N 81° W

**References**


#3573 Brooks, H.C., McIntyre, J.R., and Walker, G.W., 1976, Geology of the Oregon part of the Baker 1 by 2 quadrangle:  State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-7, 25 p. pamphlet, 1 sheet, scale 1:250,000.

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#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3535 Mann, G.M., and Meyer, C.E., 1993, Late Cenozoic structure and correlations to seismicity along the Olympic-Wallowa Lineament, northwest United States: Geological Society of America Bulletin, v. 105, p. 853-871.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3781 Robyn, T.L., and Hoover, J.D., 1982, Late Cenozoic deformation and volcanism in the Blue Mountains of central Oregon—Microplate interactions?: Geology, v. 10, p. 572-576.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#5654 Wong, I., Dober, M., Hemphill-Haley, M., Naugler, W., Silva, W.J., and Li, S., 1999, Probabilistic seismic hazard analysis and safety evaluation earthquake ground motions—Bully Creek Dam, Vale Project, eastern Oregon: U.S. Department of the Interior, Bureau of Reclamation Technical Memorandum D8330-99-28.

#4042 Wood, S.H., 1999, Quaternary faulting in southwest Idaho and adjacent Oregon, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 9, p. 1-5.

**806, Cottonwood Mountain fault**

**Structure Number** 806

Comments: This structure is part of fault number 17 of Pezzopane (1993 #3544) and fault number 64 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Cottonwood Mountain fault

Comments: Parts of the Cottonwood Mountain fault were mapped by Brooks and others (1976 #3573) and Brown and others (1980 #3571); previously used names include the Bully or Bully Creek fault (Brown and others, 1980 #3571; Hawkins and others, 1989 #3551) and the Hope Butte fault (Geomatrix Consultants Inc., 1989 #1310), but herein we retain the name "Cottonwood Mountain fault" used by Simpson and others (1993 #3596) after nearby Cottonwood Mountain. The fault has been the subject of numerous reconnaissance Quaternary fault investigations and compilations (Geomatrix Consultants Inc., 1989 #1310; Hawkins and others, 1989 #3551; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594; 1995 #3593; Madin and Mabey, 1996 #3575; Wood, 1999 #4042; Weldon and others, 2002 #5648).

**Synopsis** The Cottonwood Mountain fault is a northwest-striking, down-to-the-northeast normal fault located along the gently sloping eastern margin of Cottonwood Mountain. The fault offsets Miocene and Pliocene ash-flow tuffs and tuffaceous lacustrine rocks. The fault trace is marked by prominent fault scarps that offset alluvial fans east of Cottonwood Mountain. Small scarps (0.5-1 m high) on Holocene deposits and larger scarps (2-13 m high) on mid to late Pleistocene deposits indicate recurrent late Quaternary movement. The most recent surface faulting event on the Cottonwood Mountain fault may have occurred in the late Holocene.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Malheur

**1° x 2° sheet** Baker

**Province** Columbia Plateaus (Payette section)

**Quality of location** Good

Comments: The fault trace is from 1:100,000-scale mapping of Knudson and others (1994 #3594) and Weldon and others (2002 #5648).

**Geologic setting** The Cottonwood Mountain fault lies along the east flank of Cottonwood Mountain, a broad highland consisting of Miocene to Pliocene volcanic and sedimentary rocks that unconformably overlie an allocthonous Devonian to Jurassic island arc basement terrane consisting of volcanic and sedimentary rocks (Brooks and others, 1976 #3573; Walker and MacLeod, 1991 #3646). Numerous northwest-striking normal faults in the vicinity of the Cottonwood Mountain fault have been included in the Vale zone; these structures have been attributed to deep seated dextral shear between east-west extension in the Basin and Range province to the south and more stable terranes to the north and west (Lawrence, 1976 #3506), driven by interactions of the Juan de Fuca and North American plates (Robyn and Hoover, 1982 #3781; Pezzopane and Weldon, 1993 #149; Mann and Meyer, 1993 #3535). A more recent interpretation is that these faults are simply northwest-striking normal faults that do not represent regional shearing (Knudsen, 1994 #3527; 1994 #3594; 1996 #3529).

**Sense of movement** N

Comments: Knudsen and others (1994 #3594) observed that some differences in scarp preservation were suggestive of a left-lateral component of slip, but examination of an exposure of the Cottonwood Mountain fault at Morrison Reservoir led Knudsen and others (1994 #3527; 1994 #3594) to conclude that the primary sense of slip on the fault has been normal dip-slip displacement.

**Dip** 40-70°

Comments: Geomatrix Consultants, Inc. (1989 #1310) used the irregular trend of the fault trace to infer a shallow to moderate dip of 40°. An exposure of the fault zone in surficial deposits near Morrison Reservoir yielded dip measurements of 57°, 65°, and 67° on several strands, and had an average dip of 60 ± 10° (Knudsen and others, 1994 #3594). Simpson and others (1993 #3596) used an estimated dip of 70° and Knudsen and others (1994 #3527; 1994 #3594) and Wong and others (1999 #5654) used an estimated dip of 60° in their analyses of paleo-earthquake magnitudes on the Cottonwood Mountain fault.

**Main dip direction** NE

**Geomorphic expression** The Cottonwood Mountain fault is located on the gently sloping east flank of Cottonwood Mountain. The fault trace is marked by discontinuous, en echelon fault scarps and lineaments from Pole Creek to about 3 km south of Bully Creek Dam; scarps are about 0.5-1 m high on younger, Holocene(?) deposits and 2-13 m on older, mid to late Pleistocene deposits (Knudsen and others, 1994 #3594). Larger escarpments located a few kilometers to the west of the most recently active trace may represent an older trace of the Cottonwood Mountain fault (Knudsen and others, 1994 #3594), although other investigators have mapped these traces as active in the latest Quaternary (Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Weldon and others, 2002 #5648).

**Age of faulted deposits at the surface** No radiometric dating of faulted deposits has been conducted along the Cottonwood Mountain fault, but the youngest faulted alluvial fan deposits have been assigned Holocene (Geomatrix Consultants Inc., 1989 #1310), probable Holocene (Simpson and others, 1993 #3596), or mid to late Holocene (1994 #3527; Knudsen and others, 1994 #3594) ages, based on geomorphic expression. Scarps are well preserved across all alluvial fan and terrace deposits except the active stream channels (Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594). Larger scarps are also present in older Quaternary fan deposits, indicating recurrent Quaternary displacement.

**Paleoseismology studies** No trench investigations have been conducted along the Cottonwood Mountain fault, but a natural exposure of the active trace of the fault near Morrison reservoir was briefly described by Simpson and others (1993 #3596), and logged and described in more detail by Knudsen and others (1994 #3594). The following description is from Knudsen and others (1994 #3594).

Site 806-1. The south wall of a gully exposure of part of a 13-m-high fault scarp on the north side of Morrison reservoir was examined and logged by Knudsen and others (1994 #3594) in September, 1993. The gully exposed a fault zone consisting of three subparallel fault strands dipping 60 ± 10° to the southeast. Miocene aged, fossiliferous sandstone and siltstone bedrock overlain by Quaternary alluvium and colluvium were exposed in the footwall. The hanging wall consisted of Quaternary alluvium overlying mixed Quaternary colluvium and alluvium; these two units were separated by a buried calcic soil developed in the underlying colluvium and alluvium. Knudsen and others (1994 #3594) interpret the relations exposed in the gully as evidence of at least one fault displacement event since the deposition of and soil formation in the late Pleistocene to Holocene(?) colluvial and alluvial unit.

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: No radiometric dating has been conducted along the Cottonwood Mountain fault, but most studies have concluded that the latest faulting event along the fault probably occurred in the Holocene (Geomatrix Consultants Inc., 1989 #1310; Simpson and others, 1993 #3596). Knudsen and others (1994 #3594) concluded that the youngest event, with an average vertical offset of 0.75 ± 0.25 m, probably occurred in the late Holocene.  Weldon and others (2002 #5648) mapped most of these faults as active in the Holocene or post-glacial (<18 ka).

**Recurrence interval** 3,750-25,000 years

Comments:  Knudsen and others (1994 #3527) used estimated slip rates of 0.03-0.2 mm/yr and an average dip-slip displacement of 1.2 ± 0.25 m to estimate a range in recurrence intervals of 3,750-25,000 years.

**Slip-rate category** <0.2 mm/yr

Comments:  Knudsen and others (1994 #3594) used numerous fault scarp profiles and estimated ages of late Quaternary deposits to determine a maximum Holocene slip rate of 0.2 mm/yr and long-term slip rates of 0.03-0.15 mm/yr for the Cottonwood Mountain fault.  Wong and others (1999 #5654) used a preferred slip rate of 0.15 mm/yr for their analysis of the Cottonwood Mountain fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 41.9 |
| | Cumulative trace (km): | 69.4 |

Comments:

**Average strike** (azimuth) N 33° W

**References**


#3573 Brooks, H.C., McIntyre, J.R., and Walker, G.W., 1976, Geology of the Oregon part of the Baker 1 by 2 quadrangle:  State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-7, 25 p. pamphlet, 1 sheet, scale 1:250,000.

#3571 Brown, D.E., McLean, G.D., Black, G.L., and Riccio, J.F., 1980, Preliminary geology and geothermal resource potential of the western Snake River Plain, Oregon:  State of Oregon, Department of Geology and Mineral Industries Open-File Report O-80-5, 114 p., 4 pls., scale 1:62,500.

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#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3535 Mann, G.M., and Meyer, C.E., 1993, Late Cenozoic structure and correlations to seismicity along the Olympic-Wallowa Lineament, northwest United States: Geological Society of America Bulletin, v. 105, p. 853-871.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3781 Robyn, T.L., and Hoover, J.D., 1982, Late Cenozoic deformation and volcanism in the Blue Mountains of central Oregon—Microplate interactions?: Geology, v. 10, p. 572-576.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#5654 Wong, I., Dober, M., Hemphill-Haley, M., Naugler, W., Silva, W.J., and Li, S., 1999, Probabilistic seismic hazard analysis and safety evaluation earthquake ground motions—Bully Creek Dam, Vale Project, eastern Oregon: U.S. Department of the Interior, Bureau of Reclamation Technical Memorandum D8330-99-28.

#4042 Wood, S.H., 1999, Quaternary faulting in southwest Idaho and adjacent Oregon, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 9, p. 1-5.

## 807, faults near Unity Valley

**Structure Number** 807

Comments: One of these structures, the King Mountain fault, is fault number 66 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Faults near Unity Valley

Comments: This group of west to northwest trending normal faults was originally mapped by Brown and Thayer (1966 #3577); the faults were informally named, from north to south, the King Mountain, Bullrun Mountain Foothills, Bullrun Mountain Frontal, and Ironside Mountain (Border fault of Thayer and Brown, 1973 #3782) faults in subsequent seismotectonic studies (Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594; Wood, 1999 #4042).

**Synopsis** A group of west to northwest-striking normal faults form dissected range fronts in the vicinity of Unity Valley. Only one of these structures, the King Mountain fault, exhibits fresh expression of Quaternary faulting. Most studies conclude that late Quaternary displacements have occurred on the King Mountain fault, and the other structures in this zone have undergone Quaternary displacement.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Grant and Malheur

**1° x 2° sheet** Canyon City

**Province** Columbia Plateaus (Blue Mountains section)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544), and 1:250,000-scale mapping of Brown and Thayer (1966 #3577) and Simpson and others (1993 #3596).

**Geologic setting** Faults near Unity Valley are formed in Oligocene to Miocene and Pliocene volcanic and sedimentary rocks that unconformably overlie Triassic and Jurassic sedimentary rocks (Brown and Thayer, 1966 #3577; Walker and MacLeod, 1991 #3646) that comprise an allocthonous island arc terrane. The northwest-striking faults in the valley are included in the Vale zone, a northwest-striking set of faults that have been attributed to deep seated dextral shear (Lawrence, 1976 #3506; Robyn and Hoover, 1982 #3781; Pezzopane and Weldon, 1993 #149; Mann and Meyer, 1993 #3535). A more recent interpretation is that these faults are simply northwest-striking normal faults that do not represent regional shearing (Knudsen and others, 1994 #3594; 1996 #3529).

**Sense of movement** N

Comments:

**Dip** 60°-70°

Comments: No data on fault dip have been published. Simpson and others (1993 #3596), Knudsen and others (1994 #3594), and Geomatrix Consultants, Inc. (1995 #3593) used estimated dips of 70° and Wong and others (1999 #5654) used estimated dips of 60° in their analyses of paleo-earthquake magnitudes on the King Mountain fault.

**Main dip direction** NE, SW

**Geomorphic expression** Faults near Unity Valley form linear range fronts in Jurassic to Miocene bedrock; these features are marked by faceted spurs, springs, and tonal and vegetation lineaments (Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594). However, the range fronts are dissected, and the adjacent basins are filled with Tertiary sedimentary rocks rather than Quaternary valley-fill (Brown and Thayer, 1966 #3577); these relations may be attributable to low rates of Quaternary slip (Simpson and others, 1993 #3596). The King Mountain fault, which bounds the northeastern margin of Unity Valley, is the only structure in the area that exhibits geomorphic evidence (prominent scarps, grabens, and lineaments) of late Quaternary faulting activity (Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594; Geomatrix Consultants Inc., 1995 #3593).

**Age of faulted deposits at the surface** No fault scarps have been identified in late Quaternary deposits along any of the faults near Unity Valley (Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594). Youngest offset bedrock may be Miocene (Brown and Thayer, 1966 #3577) or Pliocene (Walker and MacLeod, 1991 #3646) in age.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Simpson and others (1993 #3596) used the prominent geomorphic expression of the fault trace to infer late Quaternary movement along the King Mountain fault; the other faults show little evidence of late Quaternary displacement (Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594). Geomatrix Consultants Inc. (1995 #3593) mapped the King Mountain fault as active in the middle and late Quaternary (<780 ka); Weldon and others (2002 #5648) mapped the King Mountain fault as active in the latest Quaternary (<18 ka), and the other faults as active in the Quaternary (<1.6 Ma). Wong and others (1999 #5654) considered the King Mountain fault to be possibly active, with assigned probabilities of 0.5 based on equivocal evidence for Quaternary displacement. Herein we use the most recent age classifications of Weldon and others (2002 #5648) to infer latest Quaternary displacement on the King Mountain fault and Quaternary displacement on the rest of the faults near Unity Valley.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip data are available for any faults near Unity Valley, but the poor geomorphic expression and lack of scarps in Quaternary deposits suggests low rates of Quaternary slip. Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.05-0.005 mm/yr in their analysis of earthquake hazards associated with the King Mountain fault; other faults near Unity Valley presumably have similar low rates of slip. Wong and others (1999 #5654) estimated a vertical slip rate of 0.01 mm/yr for the King Mountain fault.

**Length** End to end (km): 46.3
Cumulative trace (km): 151.5

Comments:

**Average strike** (azimuth) N 61° W

**References**


#3577 Brown, E.C., and Thayer, T.P., 1966, Geologic map of the Canyon City quadrangle northeastern Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-447, 1 sheet, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

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#3594 Knudsen, K.L., Wong, I.G., Bott, J.D.J., Weber, G.E., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Agency Valley and Bully Creek Dams, Vale Project, east-central Oregon: Draft Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 171 p., 4 pls.

#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3535 Mann, G.M., and Meyer, C.E., 1993, Late Cenozoic structure and correlations to seismicity along the Olympic-Wallowa Lineament, northwest United States: Geological Society of America Bulletin, v. 105, p. 853-871.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3781 Robyn, T.L., and Hoover, J.D., 1982, Late Cenozoic deformation and volcanism in the Blue Mountains of central Oregon—Microplate interactions?: Geology, v. 10, p. 572-576.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3782 Thayer, T.P., and Brown, C.E., 1973, Ironside Mountain, Oregon—A late Tertiary volcanic and structural enigma: Geological Society of America Bulletin, v. 84, p. 489-498.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#5654 Wong, I., Dober, M., Hemphill-Haley, M., Naugler, W., Silva, W.J., and Li, S., 1999, Probabilistic seismic hazard analysis and safety evaluation earthquake ground motions—Bully Creek Dam, Vale Project, eastern Oregon: U.S. Department of the Interior, Bureau of Reclamation Technical Memorandum D8330-99-28.

#4042 Wood, S.H., 1999, Quaternary faulting in southwest Idaho and adjacent Oregon, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 9, p. 1-5.

**808, Faults near Owyhee Dam (Class B)**

**Structure Number** 808

Comments:

**Structure Name** Faults near Owyhee Dam

Comments: This collection of faults near Owyhee Dam include the informally named Oxbow Basin, Sand Hollow, and Owyhee Ridge faults of Hawkins and others (1989 #3551). Several other unnamed faults in this area are included in recent fault compilations (Pezzopane, 1993 #3544; Knudsen and others, 1994 #3594; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648).

**Synopsis** Faults near Owyhee Dam are located in a structurally complex region between the Blue Mountains to the north, the Basin and Range to the south, and the Snake River Plain to the east. Structural features in this area are dominated by generally north-striking normal faults that form narrow basins and ranges superposed on plateau topography. Bedrock in the region is predominantly Miocene sedimentary and volcanic rocks. The most prominent of the faults near Owyhee Dam, the Oxbow Basin and Sand Hollow faults, are expressed as lineaments, scarps, vegetation linears, and springs in Miocene bedrock, but neither exhibit good geomorphic evidence of Quaternary offset. Scarps are best preserved in resistant Tertiary volcanic bedrock, but are very subdued in Tertiary sedimentary rocks. Evidence of Quaternary displacement is restricted to a single location about 3 km north of Owyhee Reservoir, where the Oxbow Basin fault crosses a minor unnamed drainage. At this location, a 1-m-high scarp is present in bouldery debris-flow alluvium of unknown age in the channel. This scarp may be fault related, but could also be a depositional feature formed in the debris-flow deposit. Given the lack or corroborative evidence anywhere else along any of these faults, we herein classify these structures as Class B until further studies are conducted.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Malheur

**1° x 2° sheet** Boise

**Province** Columbia Plateaus (Payette section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Ferns and others (1993 #3582) and Weldon and others (2002 #5648), based on compilations of Hawkins and others (1989 #3551), Pezzopane (1993 #3544), Knudsen and others (1994 #3594), and Geomatrix Consultants, Inc. (1995 #3593).

**Geologic setting** Faults near Owyhee Dam are located in a structurally complex region between the Blue Mountains to the north, the Basin and Range to the south, and the Snake River Plain to the east. Structural features in this area are dominated by generally north-trending normal faults that form narrow basins and ranges superposed on plateau topography (Knudsen and others, 1994 #3594). Bedrock in the region is predominantly Tertiary sedimentary and volcanic rocks (Walker and MacLeod, 1991 #3646; Ferns and Cummings, 1992 #5164; Ferns and others, 1993 #3582).

**Sense of movement** N

Comments:

**Dip** 60°-70°

Comments: No data on fault dip have been published. Knudsen and others (1994 #3594) used an estimated dip of 70° and Wong and others (1999 #5654) used an estimated dip of 60° in their analyses of paleo-earthquake magnitudes on the Oxbow Basin and Sand Hollow faults.

**Main dip direction** E and W

**Geomorphic expression** The most prominent of these faults, the Oxbow Basin and Sand Hollow faults, are expressed as lineaments, scarps, vegetation linears, and springs in Miocene bedrock, but neither exhibit good geomorphic evidence of Quaternary offset (Hawkins and others, 1989 #3551). Scarps are best preserved in resistant Tertiary volcanic bedrock, but are very subdued in Tertiary sedimentary rock (Hawkins and others, 1989 #3551). Evidence of Quaternary displacement is restricted to a single location about 3 km north of Owyhee Reservoir, where the Oxbow Basin fault crosses a minor unnamed drainage. At this location, a 1-m-high scarp is present in bouldery debris-flow alluvium of unknown age in the channel. Hawkins and others (1989 #3551) concluded that the scarp was fault related, but acknowledged that the scarp could also be a depositional feature formed in the debris-flow deposit. Given the lack or corroborative evidence anywhere else along the fault, we herein classify the Oxbow Basin fault as a Class B structure until further studies are conducted.

**Age of faulted deposits at the surface** A possible fault scarp along the Oxbow Basin fault was identified in bouldery alluvium that Hawkins and others (1989 #3551) assumed was late Quaternary in age. Detailed mapping in the region (Ferns and Cummings, 1992 #5164; Ferns and others, 1993 #3582) map these faults entirely in Miocene bedrock.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Knudsen and others (1994 #3594) and Geomatrix Consultants, Inc. (1995 #3593) inferred that the Oxbow Basin and Sand Hollow faults had undergone middle and late Quaternary displacement, based on the possible fault scarp described by Hawkins and others (1989 #3551). These investigations suggested that the other faults in this area, including middle and late Quaternary faults mapped by Pezzopane (1993 #3544) to the north and west, had undergone Tertiary or Quaternary, but probably not late Quaternary displacement. Wong and others (1999 #5654) considered these faults to be possibly active, with assigned probabilities of 0.5 based on equivocal evidence for Quaternary displacement. Weldon and others (2002 #5648) map the Oxbow Basin fault as active in the Holocene or latest Quaternary, but do not describe the evidence for this age assignment. Given the poor documentation of Quaternary displacement at a single location along the Oxbow Basin fault, these faults are herein classified as Class B structures until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No offset Quaternary deposits have been dated, so Quaternary slip rates are unknown. Slip measurements in bedrock yield generally low, albeit widely divergent, slip rates. Lillie and Crouch (1979 #3778) used Bouguer gravity data to estimate offset of as much as 1980 m of the 17 Ma Sucker Creek Formation along a fault that may be the Oxbow Basin fault. In contrast, Hawkins and others (1989 #3551) described 10-25 m high fault scarps in 13-16 Ma Owyhee basalt, and a 1-m-high scarp on alluvium with an assumed late Quaternary age. Wong and others (1999 #5654) used this slip data to assign preferred slip rates of 0.001 mm/yr on the Oxbow Basin and Sand Hollow faults.

| | | |
|---|---|---|
| **Length** | End to end (km): | 37.4 |
| | Cumulative trace (km): | 59.5 |

Comments:

**Average strike** (azimuth) N 13° W

**References**

#3582 Ferns, M.L., Brooks, H.C., Evans, J.G., and Cummings, M.L., 1993, Geologic map of the Vale 30 X 60 minute quadrangle, Malheur County, Oregon, and Owyhee County, Idaho: State of Oregon, Department of Geology and Mineral Industries Geologic Map Series GMS-77, 12 p. pamphlet, 1 sheet, scale 1:100,000.

#5164 Ferns, M.L., and Cummings, M.L., 1992, Geology and mineral resources map of the Elbow Quadrangle, Malheur County, Oregon: State of Oregon, Department of Geology and Mineral Industries Geologic Map Series GMS-62, 2 sheets, scale 1:24,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3551 Hawkins, F.F., Gilbert, J.D., and LaForge, R.C., 1989, Seismotectonic study for Warm Springs Dam-Vale Project and Owyhee Dam-Owyhee Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 89-6, 35 p., 2 pls.

#3594 Knudsen, K.L., Wong, I.G., Bott, J.D.J., Weber, G.E., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Agency Valley and Bully Creek Dams, Vale Project, east-central Oregon: Draft Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 171 p., 4 pls.

#3778 Lillie, R.J., and Couch, R.W., 1979, Geophysical evidence of fault termination of the Basin and Range Province in the vicinity of the Vale, Oregon, geothermal area, *in* Newman, G.W., and Goode, H.D., eds., Basin and Range symposium and Great Basin field conference: Rocky Mountain Association of Geologists, p. 175-184.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#5654 Wong, I., Dober, M., Hemphill-Haley, M., Naugler, W., Silva, W.J., and Li, S., 1999, Probabilistic seismic hazard analysis and safety evaluation earthquake ground motions—Bully Creek Dam, Vale Project, eastern Oregon: U.S. Department of the Interior, Bureau of Reclamation Technical Memorandum D8330-99-28.

**809, Pine Valley graben fault system**

**Structure Number** 809

Comments: These structures are part of fault number 16 of Pezzopane (1993 #3544) and fault numbers 70 and 71 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Pine Valley graben fault system

Comments: The fault zones that define the northern and southern margins of Pine Valley were originally mapped by Brooks and others (1976 #3573) and Swanson and others (1981 #3496). Faults that define the southern margin were called the Pine Valley fault by Geomatrix Consultants, Inc. (1989 #1310) and Simpson and others (1993 #3596); more detailed work by Mann (1989 #3542) and Zollweg and Wood (1993 #780) identified more faults in this area; the two structures likely to control this margin of the graben are the Halfway-Deer Creek (Halfway fault of Mann, 1989 #3542) and Posey Valley faults. Parts of the northern margin of the graben, the Brownlee fault of Mann (1989 #3542) were originally mapped by Swanson and others (1981 #3496).

**Synopsis** The Pine Valley graben fault system forms a complex northwest-trending graben that confines Pine Valley. The graben is formed in Miocene Columbia River basalts, and is floored by Quaternary alluvial sediments. Numerous northwest-trending faults are present throughout the region; some workers attribute graben formation to a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system, but others see little evidence for late Cenozoic strike-slip faulting in this area. The Pine Valley graben fault system is divided into two sections herein, the Brownlee section defines the northern margin of the graben, and the Halfway-Posey Valley section defines the southern margin of the graben. Both of these sections form intermittent linear range fronts, but no fault scarps in Quaternary deposits have been described along either section. Most fault studies in the region infer probable Quaternary displacement on the Brownlee section, and middle or late Quaternary displacement on the Halfway-Posey Valley section.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Baker (OR); Adams and Washington (ID)

**1° x 2° sheet** Baker

**Province** Columbia Plateaus (Harney and Blue Mountains sections)

**Geologic setting** The Pine Valley graben fault system forms a complex northwest-trending graben that confines Pine Valley. The graben is formed in Miocene Columbia River basalts, and is floored by Quaternary alluvial sediments (Brooks and others, 1976 #3573; Swanson and others, 1981 #3496; Walker and MacLeod, 1991 #3646). Numerous northwest-trending faults are present throughout the region; some workers attribute graben formation to a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system (Mann, 1989 #3542; Mann and Meyer, 1993 #3535), but others see little evidence for late Cenozoic strike-slip faulting in this area (Simpson and others, 1993 #3596; Knudsen and others, 1996 #3529).

**Number of sections** 2

Comments: The Pine Valley graben fault system is divided into two sections herein. The Brownlee section consists of the Brownlee fault, and defines the northern margin of the graben. The Halfway-Posey Valley section consists of the Halfway-Deer Creek and Posey Valley faults and defines the southern margin of the graben.

| | | |
|---|---|---|
| **Length** | End to end (km): | 35.2 |
| | Cumulative trace (km): | 57.2 |

Comments: N 44° W

**Average strike** (azimuth)

***809a, Brownlee section***

**Section number** 809a

**Section name** Brownlee section

Comments: This section consists of the Brownlee fault of Mann (1989 #3542); parts of this fault have been mapped by Swanson and others (1981 #3496), Mann (1989 #3542), Mann and Meyer (1993 #3535), and Zollweg and Wood (1993 #780).

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults (Swanson and others, 1981 #3496; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596). Some workers attribute formation of the Pine Valley graben to a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system (Mann, 1989 #3542; Mann and Meyer, 1993 #3535), but others see little evidence for late Cenozoic strike-slip faulting in this area (Simpson and others, 1993 #3596; Knudsen and others, 1996 #3529).

**Dip** 55°-70°

Comments: Mann (1989 #3542) and Zollweg and Wood (1993 #780) map a fault attitude of 55° near the southern end of the Brownlee fault in western Idaho; Simpson and others (1993 #3596) and Geomatrix Consultants, Inc. (1995 #3593) modeled the Brownlee fault as a 70° dipping normal or normal-oblique fault in their analyses of paleo-earthquake magnitudes.

**Main dip direction** SW

**Geomorphic expression** Recent work (Zollweg and Wood, 1993 #780; Simpson and others, 1993 #3596) describes faults in the Brownlee section as discrete, 4-6 km long fault strands, rather than the continuous fault trace shown in Mann (1989 #3542) and Mann and Meyer (1993 #3535). Faults in the section offset rocks of the Miocene Columbia River Basalt Group, in an area of sparse Quaternary deposits. Most of the trace has poor geomorphic expression of Quaternary faulting, and no evidence of fault scarps in Quaternary deposits has been described (Zollweg and Wood, 1993 #780; Simpson and others, 1993 #3596; Geomatrix Consultants Inc., 1995 #3593). The best geomorphic expression of late Cenozoic faulting is found between Black Canyon and Pine Creek Canyon near the northern end of the fault, where a 2.5 km long faceted mountain front is formed in Miocene basalt (Zollweg and Wood, 1993 #780).

**Age of faulted deposits at the surface** Faults in the Brownlee section offset Miocene Columbia River basalts, but no offsets in Quaternary surficial deposits have been described (Zollweg and Wood, 1993 #780; Simpson and others, 1993 #3596; Geomatrix Consultants Inc., 1995 #3593).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Simpson and others (1993 #3596) did not find evidence of Quaternary displacement on the Brownlee section. Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Weldon and others (2002 #5648) infer probable Quaternary (<1.6-1.8 Ma) displacement on this part of the Pine Valley graben fault system.

**Recurrence interval** 10,000-100,000 years

Comments: The average recurrence time estimate on most active faults in the southern Hells Canyon region is based on low rates of Quaternary slip (Zollweg and Wood, 1993 #780).

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but displacement across the fault zone in Miocene Columbia River basalts is about 170 m northwest of Brownlee Dam (Zollweg and Wood, 1993 #780); such offset yields a long-term slip rate of 0.01 mm/yr. Geomatrix Consultants, Inc. (1995 #3593) use offset data from Zollweg and Wood (1993 #780) to estimate slip rates of 0.005-0.05 mm/yr for the Brownlee section.

| | | |
|---|---|---|
| **Length** | End to end (km): | 17.1 |
| | Cumulative trace (km): | 18.9 |

Comments:

**Average strike** (azimuth) N 45° W

***809b, Halfway-Posey Valley section***

**Section number** 809b

**Section name** Halfway-Posey Valley section

Comments: This section includes the Pine Valley (Geomatrix Consultants Inc., 1989 #1310; Simpson and others, 1993 #3596), Halfway (Mann, 1989 #3542), or Halfway-Deer Creek (Zollweg and Wood, 1993 #780) faults, and the Posey Valley fault (Zollweg and Wood, 1993 #780). These faults form the southern margin of the Pine Valley graben.

**Reliability of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults (Swanson and others, 1981 #3496; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596). Some workers attribute formation of the Pine Valley graben to a pull apart basin related to displacement along a regional scale right-lateral strike-slip fault system (Mann, 1989 #3542; Mann and Meyer, 1993 #3535), but others see little evidence for late Cenozoic strike-slip faulting in this area (Simpson and others, 1993 #3596; Knudsen and others, 1996 #3529).

**Dip** 70°

Comments: No dip measurements have been published. Zollweg and Jacobson (1986 #3518) determined focal mechanisms from the 1981-1984 earthquake sequence that yielded a likely dip of 70° on northwest-trending faults that may be part of the Halfway-Posey Valley section. Simpson and others (1993 #3596) and Geomatrix Consultants, Inc. (1995 #3593) modeled faults in the Halfway-Posey Valley section as 70° dipping normal or normal-oblique faults in their analyses of paleo-earthquake magnitudes.

**Main dip direction** NE

**Geomorphic expression** Faults in the section form several 200- to 500-m-high escarpments in rocks of the Miocene Columbia River Basalt Group; most of the traces have poor geomorphic expression of Quaternary faulting, and no evidence of fault scarps in Quaternary deposits has been described (Zollweg and Wood, 1993 #780; Simpson and others, 1993 #3596; Geomatrix Consultants Inc., 1995 #3593; Wood, 1999 #4042). The best geomorphic expression of late Cenozoic faulting is found west of Halfway on the Halfway fault and south of Pine on the Posey Valley fault; in both places the faults are marked by linear range fronts, and the Posey Valley strand is also marked by well developed facets and spring lines in Miocene basalts (Zollweg and Wood, 1993 #780; Simpson and others, 1993 #3596).

**Age of faulted deposits at the surface** Faults in the Halfway-Posey Valley section offset Miocene Columbia River basalts, but no offsets in Quaternary surficial deposits have been described (Zollweg and Wood, 1993 #780; Simpson and others, 1993 #3596; Geomatrix Consultants Inc., 1995 #3593).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: No detailed information on age of most recent faulting has been published. However, Simpson and others (1993 #3596) used the geomorphic expression of the Posey fault to infer possible late Quaternary activity on this part of the section. Pezzopane (1993 #3544) used airphoto analysis to infer Holocene movement on the Posey fault and the Halfway-Deer Creek fault southeast of Pine, and middle and late Quaternary deformation (<700,000 ka) on the rest of the section. Weldon and others (2002 #5648) inferred Holocene and latest Pleistocene, middle and late Quaternary, and Quaternary displacement on various parts of the Halfway-Posey Valley section. Zollweg and Jacobson (1986 #3518) used the 1981-1984 earthquake sequence to infer recent activity on northwest-trending faults that may be part of the Halfway-Posey Valley section. Herein we use the most recent age classifications of Weldon and others (2002 #5648) to infer latest Quaternary, middle and late Quaternary, and Quaternary displacements on various parts of the Pine Valley graben fault system.

**Recurrence interval** 10,000-100,000 years

Comments: The average recurrence time estimate on most active faults in the southern Hells Canyon region is based on low rates of Quaternary slip (Zollweg and Wood, 1993 #780).

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but displacements across the Halfway and Posey Valley faults in Miocene Columbia River basalts is 200-400 m (Zollweg and Wood, 1993 #780); such offsets yield long-term slip rates of 0.02-0.03 mm/yr. Geomatrix Consultants, Inc. (1995 #3593) use offset data from Zollweg and Wood (1993 #780) to estimate slip rates of 0.005-0.05 mm/yr for the Halfway-Posey Valley section.

| | | |
|---|---|---|
| **Length** | End to end (km): | 25.4 |
| | Cumulative trace (km): | 38.2 |

Comments:

**Average strike** (azimuth) N 43° W

**References**

#3573 Brooks, H.C., McIntyre, J.R., and Walker, G.W., 1976, Geology of the Oregon part of the Baker 1 by 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-7, 25 p. pamphlet, 1 sheet, scale 1:250,000.

#1310 Geomatrix Consultants Inc., 1989, Final report seismotectonic evaluation for Mann Creek Dam site and Mason Dam site: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, Colorado, under Contract 6-CS-81-07310, October 1989, 118 p., 2 pls.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3529 Knudsen, K.L., Simpson, G.D., Sawyer, T.L., Wong, I.G., Bott, J.D., and Lettis, W.R., 1996, Late Quaternary faulting and seismotectonics of east-central Oregon and west-central Idaho: Geological Society of America Abstracts with Programs, v. 28, no. 5, p. 82.

#3542 Mann, G.M., 1989, Seismicity and late Cenozoic faulting in the Brownlee Dam Area—Oregon and Idaho: U.S. Geological Survey Open-File Report, 46 p., 4 pls., scale 1:24,000.

#3535 Mann, G.M., and Meyer, C.E., 1993, Late Cenozoic structure and correlations to seismicity along the Olympic-Wallowa Lineament, northwest United States: Geological Society of America Bulletin, v. 105, p. 853-871.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3596 Simpson, G.D., Hemphill-Haley, M.A., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Burnt River Project Unity Dam, Baker Project Thief Valley Dam, northeastern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 167 p., 2 pls.

#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#4042 Wood, S.H., 1999, Quaternary faulting in southwest Idaho and adjacent Oregon, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 9, p. 1-5.

#3518 Zollweg, J.E., and Jacobson, R.S., 1986, A seismic zone on the Oregon-Idaho border—The Powder River earthquakes of 1984: Bulletin of the Seismological Society of America, v. 76, no. 4, p. 985-999.

#780 Zollweg, J.E., and Wood, S.H., 1993, Faulting relationships, seismicity, design earthquakes, and peak ground accelerations at hydroelectric facilities in Hells Canyon of the Snake River, Idaho-Oregon: Report prepared for Idaho Power Company, 158 p., 3 pls.

### 810, Unnamed faults near Murderers Creek

**Structure Number** 810

Comments: These faults are included in fault number 18 of Pezzopane (1993 #3544).

**Structure Name** Unnamed faults near Murderers Creek

Comments: These normal faults form the northern margin of the Murderers Creek basin in central Oregon. They were informally referred to as the Murders Creek zone or fault zone by Pezzopane (1993 #3544).

**Synopsis** The east-trending, down-to-the-south Murderers Creek faults are parallel to and may structurally control the north flank of the Murderers Creek basin in central Oregon. No detailed information on Quaternary offset are available, but limited airphoto analysis suggests possible middle to late Quaternary displacement.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Grant

**1° x 2° sheet** Canyon City

**Province** Columbia Plateaus (Walla Walla Plateau section)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** The Murderers Creek faults are parallel to and may structurally control the north flank of the Murderers Creek basin (Brown and Thayer, 1966 #3577). This area is underlain by Miocene Columbia River Basalt Group rocks and Plio-Pleistocene Rattlesnake Formation sediments (Thayer and Brown, 1966 #3591).

**Sense of movement** N, R?

Comments: These structures as depicted as normal faults on most maps (Brown and Thayer, 1966 #3577; Thayer and Brown, 1966 #3591; Newcomb, 1970 #3761), but their orientation may suggest reverse slip (Nakata and others, 1992 #3524).

**Dip** Not Reported

Comments:

**Main dip direction** S

**Geomorphic expression** No information on geomorphic expression is available. Pezzopane (1993 #3544) and Nakata and others (1992 #3524) used airphoto analysis to include the Murderers Creek faults in a group of potentially active faults in central Oregon.

**Age of faulted deposits at the surface** Most maps show the Murderers Creek faults buried by Plio-Pleistocene Rattlesnake Formation along the northern margin of Murderers Creek basin (Brown and Thayer, 1966 #3577; Thayer and Brown, 1966 #3591).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Most maps show the Murderers Creek faults buried by Plio-Pleistocene Rattlesnake Formation sediments (Brown and Thayer, 1966 #3577; Thayer and Brown, 1966 #3591), but Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) show these faults as active in the middle and late Quaternary (<700-780 ka).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the Murderers Creek faults, but the possible burial of the faults by Plio-Pleistocene sediments suggests low rates of slip.

**Length** End to end (km): 10.8
Cumulative trace (km): 15.9

Comments:

**Average strike** (azimuth) N 71° W

**References**


#3577 Brown, E.C., and Thayer, T.P., 1966, Geologic map of the Canyon City quadrangle northeastern Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-447, 1 sheet, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3524 Nakata, T., Weldon, R.J.I., Pezzopane, S., Rosenfeld, C., and Yeats, R.S., 1992, Preliminary aerial photo-interpretation of active faults in Oregon: Geological Society of America Abstracts with Programs, v. 24, no. 5, p. 72.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3591 Thayer, T.P., and Brown, C.E., 1966, Geologic map of the Aldrich Mountain quadrangle Grant County, Oregon: U.S. Geological Survey Geologic Quadrangle Map GQ-438, 3 p. pamphlet, 1 sheet, scale 1:62,500.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**811, Unnamed fault in Fox Basin (Class B)**

**Structure Number** 811

Comments:

**Structure Name** Unnamed fault in Fox Basin

Comments: This unnamed normal fault may form the northern margin of the Fox basin in central Oregon.

**Synopsis** The east-trending, fault in Fox basin is parallel to and may structurally control the north flank of the Fox basin in central Oregon. No detailed information on Quaternary offset are available, and the fault is not shown on geologic maps of the area. The fault is herein classified as a Class B structure until further studies are conducted.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Grant

**1° x 2° sheet** Canyon City

**Province** Columbia Plateaus (Blue Mountains section)

**Quality of location** Good

Comments: Fault location is from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** The unnamed Fox basin fault of Pezzopane (1993 #3544) is parallel to and may structurally control the north flank of the Fox basin. This area is underlain by Miocene Columbia River Basalt Group rocks, Upper Miocene to Pliocene Mascall Formation sedimentary rocks, and lower Pleistocene alluvial deposits that are equivalent in part to the Plio-Pleistocene Rattlesnake Formation, but no existing geologic maps show a fault in this location (Brown and Thayer, 1966 #3577; Newcomb, 1970 #3761; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: This structure is depicted as a normal or high angle fault by Pezzopane (1993 #3544).

**Dip** Not Reported

Comments:

**Main dip direction** S

**Geomorphic expression** No information on the geomorphic expression of this fault has been described.

**Age of faulted deposits at the surface** No information on the age of faulted deposits has been described. Existing geologic maps show an unfaulted contact between Miocene Columbia River Basalt Group rocks and lower Pleistocene alluvial deposits at the location mapped by Pezzopane (1993 #3544).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) infer middle and late Quaternary displacement (<700-780 ka), but did not describe the evidence used to infer this age. A recent compilation (Weldon and others, 2002 #5648) classifies this fault as possible Quaternary.  Herein we classify this fault as a Class B structure until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments:  No published slip data are available for the unnamed Fox basin fault, but the fact that it is not included on existing geologic maps suggests low rates of slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 6.1 |
| | Cumulative trace (km): | 6.1 |

Comments:

**Average strike** (azimuth) N64° W

**References**

#3577 Brown, E.C., and Thayer, T.P., 1966, Geologic map of the Canyon City quadrangle northeastern Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-447, 1 sheet, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon:  Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon:  State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho:  U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon:  Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon:  U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon:  U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 812, Unnamed fault in Logan Valley

**Structure Number** 812

Comments:

**Structure Name** Unnamed fault in Logan Valley

Comments: This unnamed normal fault forms the eastern margin of Logan Valley in east-central Oregon.

**Synopsis** This northwest-striking, down-to-the-southwest normal fault is parallel to and structurally controls the east flank of Logan Valley in central Oregon. Logan Valley is located at the northern end of the 25-km-long Logan Valley graben; the unnamed fault described herein is the eastern bounding fault of the graben, and a parallel, down-to-the-northeast fault forms the western margin of the graben. This area is underlain by Miocene and Pliocene(?) Strawberry Volcanics; Logan Valley is filled with Miocene and Pliocene tuffaceous sedimentary rocks and Quaternary alluvium. No detailed information on Quaternary offset are available, but limited airphoto analysis suggests possible middle or late Quaternary displacement.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Grant

**1° x 2° sheet** Canyon City

**Province** Columbia Plateaus (Blue Mountains section)

**Quality of location** Good

Comments: Fault location is from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** The Logan Valley fault is parallel to and structurally controls the east flank of Logan Valley (Brown and Thayer, 1966 #3577). Logan Valley is located at the northern end of the 25-km-long Logan Valley graben; the unnamed fault described herein is the eastern bounding fault of the graben. A parallel, down-to-the-northeast fault forms the western margin of Logan Valley and graben. This area is underlain by Miocene and Pliocene(?) Strawberry Volcanics; Logan Valley is filled with Miocene and Pliocene tuffaceous sedimentary rocks and Quaternary alluvium (Brown and Thayer, 1966 #3577; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: This structure is depicted as a normal fault on the geologic maps of Brown and Thayer (1966 #3577) and Walker and MacLeod (1991 #3646).

**Dip** Not Reported

Comments:

**Main dip direction** SW

**Geomorphic expression** No information on geomorphic expression of this fault has been described, but the fault is coincident with 100-m-high escarpments in Miocene and Pliocene(?) Strawberry Volcanics along the eastern margin of Logan Valley (Brown and Thayer, 1966 #3577; Walker and MacLeod, 1991 #3646).

**Age of faulted deposits at the surface** Brown and Thayer (1966 #3577) show the eastern Logan Valley fault buried by Holocene alluvium; Walker and MacLeod (1991 #3646) dash the fault across Miocene and Pliocene tuffaceous sedimentary rocks and Holocene alluvium in Logan Valley.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Existing small-scale geologic maps do not discuss evidence of Quaternary displacement, but Pezzopane (1993 #3544) used airphoto analysis to infer middle and late Quaternary (<700,000 ka) displacement. Subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also show the unnamed eastern Logan Valley fault as active in the middle and late Quaternary (<780,000 ka).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed eastern Logan Valley fault. The fault is coincident with 100-m-high escarpments in Miocene and Pliocene(?) Strawberry Volcanics; such displacements suggest low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 9.4 |
| | Cumulative trace (km): | 9.4 |

Comments:

**Average strike** (azimuth) N 57° W

**References**


#3577 Brown, E.C., and Thayer, T.P., 1966, Geologic map of the Canyon City quadrangle northeastern Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-447, 1 sheet, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**813, Unnamed faults near Polk Butte (Class B)**

**Structure Number** 813

Comments:

**Structure Name** Unnamed fault near Polk Butte

Comments: These unnamed faults are located near Polk Butte in central Oregon (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593).

**Synopsis** These east-striking, down-to-the-north faults parallel the northern flank of the Maury Mountains in central Oregon. The area is underlain by Eocene to Oligocene volcanic and volcaniclastic rocks of the Clarno Formation. These faults are not shown on any existing geologic maps, and no detailed information on geomorphic expression or Quaternary offset is available. Herein we classify these faults as Class B structures until further studies are conducted.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Crook

**1° x 2° sheet** Bend

**Province** Columbia Plateaus (Walla Walla Plateau section)

**Quality of location** Good

Comments: Fault location is from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** The east-striking, down-to-the-north faults near Polk Butte parallel the northern flank of the Maury Mountains in central Oregon. The area is underlain by Eocene to Oligocene volcanic and volcaniclastic rocks of the Clarno Formation (Swanson, 1969 #3592). These faults are not shown on any published geologic maps (Waters, 1968 #3558; Swanson, 1969 #3592; Newcomb, 1970 #3761; Walker and MacLeod, 1991 #3646), or included in older earthquake hazards studies (U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946) in the region.

**Sense of movement** N?, R?

Comments: These structures as depicted as normal or high-angle faults on the map of Pezzopane (1993 #3544), but their orientation may suggest reverse slip (Nakata and others, 1992 #3524).

**Dip** Not Reported

Comments:

**Main dip direction** N

**Geomorphic expression** No information on geomorphic expression is available. Nakata and others (1992 #3524) used airphoto analysis to include faults south of Crooked River in a group of potentially active faults in central Oregon.

**Age of faulted deposits at the surface** Not Reported

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Existing geologic maps do not show these faults. Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer middle and late Quaternary displacement (<700-780 ka), but do not describe the evidence used to infer this age. Herein we classify these faults as Class B structures until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed faults near Polk Butte, but the omission of these faults on existing geologic maps suggests low rates of long-term slip.

**Length** End to end (km): 5.5
Cumulative trace (km): 8.6

Comments:

**Average strike** (azimuth) N 80° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#2946 Hawkins, F.F., LaForge, R.C., Templeton, M., and Gilbert, J.D., 1988, Seismotectonic study for Arthur R. Bowman and Ochoco Dams, Crooked River Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 88-10, 57 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3524 Nakata, T., Weldon, R.J.I., Pezzopane, S., Rosenfeld, C., and Yeats, R.S., 1992, Preliminary aerial photo-interpretation of active faults in Oregon: Geological Society of America Abstracts with Programs, v. 24, no. 5, p. 72.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3592 Swanson, D.A., 1969, Reconnaissance geologic map of the east half of the Bend quadrangle, Crook, Wheeler, Jefferson, Wasco, and Deschutes Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-568, 1 sheet, scale 1:250,000.

#3484 U.S. Army Corps of Engineers, 1983, Cougar and Blue River Lakes earthquake and fault study—Design memorandum 19: U.S. Army Corps of Engineers, Portland District, v. 19, 90 p., 11 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3558 Waters, A.C., 1968, Reconnaissance geologic map of the Post quadrangle Crook County, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-542, 1 sheet, scale 1:62,500.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon:  U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**814, Unnamed faults northwest of Condon (Class B)**

**Structure Number** 814

Comments:

**Structure Name** Unnamed faults northwest of Condon

Comments: These unnamed northwest-striking faults are mapped northwest of Condon in north-central Oregon (Swanson and others, 1981 #3496; Bela, 1982 #3584; Tolan and Reidel, 1989 #3765; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648).

**Synopsis** Faults northwest of Condon are predominantly northwest-striking oblique strike-slip faults. These faults offset volcanic rocks of the Miocene Columbia River Basalts Group, but no scarps in Quaternary deposits have been described along these faults. Herein we classify these faults as Class B structures until further studies are conducted.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Gilliam, Sherman

**1° x 2° sheet** The Dalles

**Province** Columbia Plateaus (Walla Walla Plateau)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544), and 1:250,000-scale mapping of Swanson and others (1981 #3496) and Bela (1982 #3584).

**Geologic setting** Faults northwest of Condon are predominantly northwest-striking, normal and/or strike-slip faults. These faults offset volcanic rocks of the Miocene Columbia River Basalts Group (Swanson and others, 1981 #3496; Bela, 1982 #3584; Walker and MacLeod, 1991 #3646).

**Sense of movement** N?, R?, D?, S?

Comments: The two southernmost structures northwest of Condon are mapped as northwest-striking oblique faults with strike-slip displacement of unknown sense; the northernmost fault is mapped as two high-angle faults, a northern fault that strikes north and is down-to-the-east, and a southern fault that strikes northeast and is down-to-the-southwest (Swanson and others, 1981 #3496; Bela, 1982 #3584). Pezzopane (1993 #3544) inferred that these other nearby faults with northwest strikes have right-lateral strike-slip displacements.

**Dip** 90°?

Comments: No actual dip measurements have been published, but most strike-slip faults in the region are modeled as vertical faults (Geomatrix Consultants Inc., 1995 #3593). The high-angle faults probably have shallower dips.

**Main dip direction** NE, SW

**Geomorphic expression** No information on the geomorphic expression of these faults has been described, but Quaternary deposits are sparse in this part of Oregon.

**Age of faulted deposits at the surface** These faults offset volcanic rocks of the Miocene Columbia River Basalts Group (Swanson and others, 1981 #3496; Bela, 1982 #3584; Walker and MacLeod, 1991 #3646); no evidence of faulted Quaternary deposits has been described.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Despite the lack of documentation of Quaternary displacement, the faults northwest of Condon have been mapped as probable Quaternary (<1.6-1.8 Ma) faults by Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648). Herein we classify these faults as Class B structures until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip data are available for the faults northwest of Condon, but the lack of documentation of scarps in Quaternary deposits suggests low rates of Quaternary slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 21.8 |
| | Cumulative trace (km): | 43.3 |

Comments:

**Average strike** (azimuth) N 52° W

**References**

#3584 Bela, J.L., 1982, Geologic and neotectonic evaluation of north-central Oregon—The Dallas 1 x 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geologic Map Series GMS-27, 2 sheets, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

#3765 Tolan, T.L., and Reidel, S.P., 1989, Structure map of a portion of the Columbia River flood-basalt Province, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, 1 sheet, scale 1:500,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**817, Unnamed faults on Dry Mountain (Class B)**

**Structure Number** 817

Comments:

**Structure Name** Unnamed faults on Dry Mountain

Comments: These unnamed high-angle faults are located on the southeast flank of Dry Mountain, northwest of Riley in central Oregon (Greene and others, 1972 #3560; Hawkins and others, 1988 #2946; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648).

**Synopsis** These two northwest-trending high-angle faults form an inset graben in a swarm of faults that form a larger graben in Oligocene to Miocene andesitic rocks on the southeast flank of the Dry Mountain shield volcano northwest of Riley in central Oregon. These faults are parallel to and may be included in the northern margin of the Brothers fault zone, but they are localized in volcanic rocks and thus may be related to volcanic processes associated with formation of the Dry Mountain shield volcano. Given their short length, association with an andesitic shield volcano, and poor documentation of offset in Quaternary deposits, the faults are herein classified as Class B structures until further studies are conducted.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Harney

**1° x 2° sheet** Burns

**Province** Columbia Plateaus (Harney section)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Greene and others (1972 #3560) and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** These two northwest-striking high-angle faults form an inset graben in a swarm of faults that form a larger graben in Oligocene to Miocene andesitic rocks on the southeast flank of the Dry Mountain shield volcano (Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646) northwest of Riley in central Oregon. These faults are parallel to and may be included in the northern margin of the Brothers fault zone (Lawrence, 1976 #3506), but they are localized in volcanic rocks and thus may be related to volcanic processes associated with formation of the Dry Mountain shield volcano.

**Sense of movement** N?

Comments: These structures as depicted as high-angle, presumably normal faults on maps of Greene and others (1972 #3560), Hawkins and others (1988 #2946), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544). If these faults are part of the Brothers fault zone, they may represent part of the surface manifestations of a regional right-lateral shear zone (Lawrence, 1976 #3506).

**Dip** Not Reported

Comments:

**Main dip direction** SW and NE

**Geomorphic expression** No details on the geomorphic expression of these faults has been reported. However, linear scarps less than 5 meters high in Quaternary deposits on 1:24,000-scale maps of the area may be coincident with the southeastern ends of the mapped fault traces.

**Age of faulted deposits at the surface** Greene and others (1972 #3560), Hawkins and others (1988 #2946), and Walker and MacLeod (1991 #3646) show these faults buried by Quaternary (Pleistocene and Holocene) sedimentary deposits consisting primarily of lacustrine and minor fluvial sediments. No offsets in Quaternary deposits have been described.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer middle or late Quaternary (<700 ka) displacement on the faults on Dry Mountain. Subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also show these faults as active in the middle or late Quaternary (<780 ka). However, given their short length, association with an andesitic shield volcano, and poor documentation of offset in Quaternary deposits, the faults are herein classified as Class B structures until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed faults on Dry Mountain.

**Length** End to end (km): 6.2
Cumulative trace (km): 9.8

Comments:

**Average strike** (azimuth) N 44° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3560 Greene, R.C., Walker, G.W., and Corcoran, R.E., 1972, Geologic map of the Burns quadrangle, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-680, 2 sheet, scale 1:250,000.

#2946 Hawkins, F.F., LaForge, R.C., Templeton, M., and Gilbert, J.D., 1988, Seismotectonic study for Arthur R. Bowman and Ochoco Dams, Crooked River Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 88-10, 57 p., 2 pls.

#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**819, Brothers fault zone**

**Structure Number** 819

Comments:

**Structure Name** Brothers fault zone

Comments: These unnamed faults are amongst hundreds of fault strands in a northwest-striking fault zone located in central Oregon (Piper and others, 1939 #3488; Walker, 1969 #4296; Greene and others, 1972 #3560; Stewart and others, 1975 #3769; Lawrence, 1976 #3506; Brown and others, 1980 #3572; Walker and Nolf, 1981 #4310; 1981 #4311; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648). The fault zone was apparently named after the small community of Brothers, Oregon by Walker (1969 #4296). The zone is also included in the Oregon-Nevada lineament of Stewart and others (1975 #3769), but “Brothers fault zone” is in common usage and is retained herein.

**Synopsis** These northwest-striking high-angle faults are located along the southern edge of the Brothers fault zone, a 250- to 300-km-long zone of high-angle faulting that may be the surface manifestation of a regional-scale right-lateral shear zone. The area is underlain by Miocene and Pliocene basalts and welded tuffs. The faults described herein are just a few of the hundreds of fault strands that comprise the Brothers fault zone in central Oregon. No information on the geomorphic expression of these faults has been described, but the faults apparently are mapped on the basis of steep escarpments in Miocene and Pliocene bedrock. The northwestern strand forms northeast-facing bedrock escarpments as much as 80 m high along its middle and southern parts; the northern part forms southwest-facing bedrock escarpments as much as 40 m high and ponds Quaternary sediment in a fault-bounded basin. The southeastern strand forms northeast-facing bedrock escarpments as much as 240 m high. No detailed information on Quaternary offset is available, but limited airphoto analysis suggests possible Quaternary displacement.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Harney

**1° x 2° sheet** Burns

**Province** Columbia Plateaus (Harney section); Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Greene and others (1972 #3560) and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** These northwest-striking high-angle faults are located along the southern edge of the Brothers fault zone, a 250- to 300-km-long zone of high-angle faulting that may be the surface manifestation of a regional-scale right-lateral shear zone (Walker, 1969 #4296; Stewart and others, 1975 #3769; Lawrence, 1976 #3506; Walker and Nolf, 1981 #4310; 1981 #4311). The area is underlain by Miocene and Pliocene basalts and welded tuffs (Greene and others, 1972 #3560; Brown and others, 1980 #3572; Walker and MacLeod, 1991 #3646).

**Sense of movement** N?, D?

Comments: These structures as depicted as normal or high-angle faults on maps of Piper and others (1939 #3488), Greene and others (1972 #3560), Brown and others (1980 #3572), Hawkins and others (1988 #2946), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544). The northwestern strand mapped as down-to-the-northeast by Pezzopane (1993 #3544) is mapped as several fault strands with both down-northeast and down-southwest directions of displacement by Greene and others (1972 #3560) and Walker and MacLeod (1991 #3646). If they are part of the Brothers fault zone, then they may represent part of the surface manifestations of a regional right-lateral shear zone (Lawrence, 1976 #3506).

**Dip** Not Reported

Comments:

**Main dip direction** NE, SW

**Geomorphic expression** No information on the geomorphic expression of these faults has been described, but the faults apparently are mapped on the basis of steep escarpments in Miocene and Pliocene bedrock. The northwestern strand forms northeast-facing bedrock escarpments as much as 80 m high along its middle and southern parts; the northern part forms southwest-facing bedrock escarpments as much as 40 m high and ponds Quaternary sediment in a fault-bounded basin. The southeastern strand forms northeast-facing bedrock escarpments as much as 240 m high.

**Age of faulted deposits at the surface** The northwestern strand in one place is mapped as juxtaposing volcanic bedrock against undifferentiated Quaternary alluvium, but these faults are otherwise restricted to Miocene and Pliocene bedrock on existing small-scale geologic maps (Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646). No offsets in Quaternary deposits have been described.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary (<1.6 Ma) displacement. Subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also show these strands of the Brothers fault zone as active in the Quaternary (<1.6-1.8 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for these strands of the Brothers fault zone, but escarpments 40-240-m-high in Miocene and Pliocene bedrock suggest low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 62.4 |
| | Cumulative trace (km): | 56.5 |

Comments:

**Average strike** (azimuth) N 43° W

**References**


#3572 Brown, D.E., Black, G.L., Mclean, G.D., and Petros, J.R., 1980, Preliminary geology and geothermal resource potential of the Powell Buttes Area, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report O-80-8, 117 p., 1 pl., scale 1:62,500.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3560 Greene, R.C., Walker, G.W., and Corcoran, R.E., 1972, Geologic map of the Burns quadrangle, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-680, 2 sheet, scale 1:250,000.

#2946 Hawkins, F.F., LaForge, R.C., Templeton, M., and Gilbert, J.D., 1988, Seismotectonic study for Arthur R. Bowman and Ochoco Dams, Crooked River Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 88-10, 57 p., 2 pls.

#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3488 Piper, A.M., Robinson, T.W., and Park, C.F., Jr., 1939, Geology and ground-water resources of the Harney Basin, Oregon: U.S. Geological Survey Water-Supply Paper 841, 189 p., 2 pls.

#3769 Stewart, J.H., Walker, G.W., and Kleinhampl, F.J., 1975, Oregon-Nevada lineament: Geology, v. 3, no. 5, p. 265-268.

#4296 Walker, G.W., 1969, Geology of the High Lava Plains Province, *in* Mineral and water resources of Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 64, p. 77-79.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4310 Walker, G.W., and Nolf, B., 1981, High Lava Plains, Brothers fault zone to Harney Basin, Oregon, *in* Johnston, D.A., and Donnelly-Nolan, J., eds., Guides to some volcanic terranes in Washington, Idaho, Oregon, and northern California: U.S. Geological Survey Circular 838, p. 105-111.

#4311 Walker, G.W., and Nolf, B., 1981, Roadlog for High Lava Plains, Brothers fault zone to Harney Basin, Oregon, *in* Johnston, D.A., and Donnelly-Nolan, J., eds., Guides to some volcanic terranes in Washington, Idaho, Oregon, and northern California: U.S. Geological Survey Circular 838, p. 113-140.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 820, Unnamed faults near Diamond Craters (Class B)

**Structure Number** 820

Comments:

**Structure Name** Unnamed faults near Diamond Craters

Comments: These unnamed high-angle faults are located southeast of Harney Lake in central Oregon. They are shown on some maps (Greene and others, 1972 #3560; Brown and others, 1980 #3572; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648), but not others (Piper and others, 1939 #3488; Walker and MacLeod, 1991 #3646).

**Synopsis** These short, northwest-striking high-angle faults form a narrow graben on the east flank of the Diamond Craters volcano, a late Quaternary basalt volcanic field in southeastern Oregon. These faults are parallel to and may be part of the Brothers fault zone, a 250- to 300-km-long zone of high-angle faulting that may be the surface manifestation of a regional-scale right-lateral shear zone. Herein these faults are classified as Class B structures because they are restricted to rocks of the volcanic field and form large escarpments in relation to their short length, and thus are likely related to late Quaternary volcanism associated with the Diamond Craters volcanic field rather than to tectonic processes.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Harney

**1° x 2° sheet** Burns

**Province** Columbia Plateaus (Harney section)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000 scale mapping of Greene and others (1972 #3560) and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** These short, northwest-striking high-angle faults form a narrow graben on the east flank of the Diamond Craters volcano, a late Quaternary basalt volcanic field in southeastern Oregon. These faults are parallel to and may be part of the Brothers fault zone, a 250- to 300-km-long zone of high-angle faulting that may be the surface manifestation of a regional-scale right-lateral shear zone (Lawrence, 1976 #3506). However, the faults are short and restricted to rocks of the volcanic field, and thus probably are related to late Quaternary volcanism associated with the Diamond Craters volcanic field, rather than to tectonic processes.

**Sense of movement** N? D?

Comments: These structures as depicted as high-angle, presumably normal faults on maps of Greene and others (1972 #3560), Brown and others (1980 #3572), Pezzopane (1993 #3544), and Geomatrix Consultants, Inc. (1995 #3593). If they are part of the Brothers fault zone, they may represent part of the surface manifestations of a regional right-lateral shear zone (Lawrence, 1976 #3506).

**Dip** Not Reported

Comments:

**Main dip direction** SW, NE

**Geomorphic expression** No details on the geomorphic expression of these faults has been reported. However, these faults form 20- to 40-m-high escarpments in late Quaternary rocks of the Diamond Craters volcanic field.

**Age of faulted deposits at the surface** These faults offset volcanic rocks of the Diamond Craters volcanic field. These rocks are variously categorized as Pleistocene and Holocene (Piper and others, 1939 #3488; Greene and others, 1972 #3560), Holocene (Brown and others, 1980 #3572), and Holocene or upper Pleistocene (Walker and MacLeod, 1991 #3646). Peterson and Groh (1964 #4029) used the freshness of volcanic features to infer an age within the last 1,000 years. A hydration-rind age of 17,000 ± 2,000 years on the basalts in the volcanic field has been reported by Friedman and Groh (1971 #3992).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer middle and late Quaternary (<700 ka) displacement. Subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also show these faults as active in the middle or late Quaternary (<780 ka). However, if the offset rocks at Diamond Craters are latest Pleistocene or Holocene in age (Friedman and Peterson, 1971 #3992; Brown and others, 1980 #3572; Walker and MacLeod, 1991 #3646), then the youngest event occurred in the latest Quaternary.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for these faults, but 20-to 40-m-high escarpments in late Quaternary rocks suggest higher rates of slip than would be expected from such short faults. These relations support a volcanic origin for these features.

| | | |
|---|---|---|
| **Length** | End to end (km): | 4.8 |
| | Cumulative trace (km): | 7.0 |

Comments:

**Average strike** (azimuth) N 37° W

**References**


#3572 Brown, D.E., Black, G.L., Mclean, G.D., and Petros, J.R., 1980, Preliminary geology and geothermal resource potential of the Powell Buttes Area, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report O-80-8, 117 p., 1 pl., scale 1:62,500.

#3992 Friedman, I., and Peterson, N., 1971, Obsidian hydration dating applied to dating of basaltic volcanic activity: Science, v. 172, p. 1028.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3560 Greene, R.C., Walker, G.W., and Corcoran, R.E., 1972, Geologic map of the Burns quadrangle, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-680, 2 sheet, scale 1:250,000.

#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4029 Peterson, N.V., and Groh, E.A., 1964, Diamond craters, Oregon: The ORE BIN, v. 26, no. 2, p. 17-34.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3488 Piper, A.M., Robinson, T.W., and Park, C.F., Jr., 1939, Geology and ground-water resources of the Harney Basin, Oregon: U.S. Geological Survey Water-Supply Paper 841, 189 p., 2 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**821, Donner und Blitzen fault**

**Structure Number** 821

Comments:

**Structure Name** Donner und Blitzen fault

Comments: This fault was first mapped and named by Piper and others (1939 #3488), presumably after the nearby Donner und Blitzen River. Subsequent maps of the area have left the fault unnamed or associated it with Jackass Mountain or Blitzen Valley (Walker and Repenning, 1965 #3559; Sherrod and Johnson, 1994 #3563; Johnson, 1996 #3494). The original name is retained herein.

**Synopsis** The Donner und Blitzen fault is marked by a prominent, 300- to 400-m-high escarpment that separates the western margin of Blitzen Valley from the east flank of Jackass Mountain in the Basin and Range of southeastern Oregon. A fault splay that extends to the southwest from the latitude of Frenchglen may be part of this fault zone. The fault offsets Miocene volcanic and tuffaceous sedimentary rocks 300 m to more than 450 m, but no fault scarps in Quaternary deposits have been described along its trace.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Harney

**1° x 2° sheet** Adel

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault traces are from approximately 1:118,000-scale mapping of Madin and others (1996 #3479), and 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** This north-striking normal fault forms the eastern margin of Jackass Mountain and the western margin of Donner und Blitzen (now Blitzen) Valley, in the Basin and Range of southeastern Oregon. The area is underlain by Miocene volcanic and tuffaceous sedimentary rocks (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646; Sherrod and Johnson, 1994 #3563; Johnson, 1996 #3494).

**Sense of movement** N

Comments: This fault is mapped as a normal or high-angle fault zone by Piper and others (1939 #3488), Walker and Repenning (1965 #3559), Hawkins and others (1988 #2946), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), Sherrod and Johnson (1994 #3563), and Johnson (1996 #3494). Both Piper and others (1939 #3488) and Sherrod and Johnson (1994 #3563) note the presence of significant monoclinal folding of the overlying bedrock along the trace of the fault. At its northern end, the fault may merge with northwest-striking faults associated with the right-lateral(?) Brothers fault zone (Greene and others, 1972 #3560; Brown and others, 1980 #3572; Walker and MacLeod, 1991 #3646).

**Dip** Not Reported

Comments:

**Main dip direction** E

**Geomorphic expression** The Donner und Blitzen fault is marked by a prominent 300- to 400-m-high range-front escarpment that separates the western margin of Blitzen Valley from the east flank of Jackass Mountain (Piper and others, 1939 #3488; Sherrod and Johnson, 1994 #3563; Johnson, 1996 #3494). Piper and others

(1939 #3488) note the peculiar z-shaped crenulations in the trace of the escarpment, and attribute them to interactions between northwest-trending faults (associated with the Brothers fault zone) and the north-trending Donner und Blitzen range front fault. A fault splay that extends to the southwest from the latitude of Frenchglen (Piper and others, 1939 #3488; Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646; Sherrod and Johnson, 1994 #3563) may be part of this fault zone; Madin and others (1996 #3479) map this splay as active in the Quaternary. No fault scarps in Quaternary deposits have been described along the fault trace (Sherrod and Johnson, 1994 #3563; Johnson, 1996 #3494).

**Age of faulted deposits at the surface** The Donner und Blitzen fault forms a prominent range-front escarpment, but no fault scarps in Quaternary deposits have been described along its trace; bedrock fault exposures are poor, but the fault is assumed to post-date all the Miocene rock units along its trace (Sherrod and Johnson, 1994 #3563; Johnson, 1996 #3494). In places, the fault is mapped as juxtaposing Miocene bedrock against Quaternary alluvium (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary displacement. Subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also show the Donner und Blitzen fault as active in the Quaternary (<1.6-1.8 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the Donner und Blitzen fault. However, Piper and others (1939 #3488) and Sherrod and Johnson (1994 #3563) infer 300 m to >450 m of structural relief across the fault. The youngest well dated bedrock offset by the fault, the Devine Canyon Tuff, has been dated at about 9.5 Ma (Sherrod and Johnson, 1994 #3563). Such slip data indicate low long-term rates of slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 25.8 |
| | Cumulative trace (km): | 34.0 |

Comments:

**Average strike** (azimuth) N 18° E

**References**


#3572 Brown, D.E., Black, G.L., Mclean, G.D., and Petros, J.R., 1980, Preliminary geology and geothermal resource potential of the Powell Buttes Area, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report O-80-8, 117 p., 1 pl., scale 1:62,500.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3560 Greene, R.C., Walker, G.W., and Corcoran, R.E., 1972, Geologic map of the Burns quadrangle, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-680, 2 sheet, scale 1:250,000.

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#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3488 Piper, A.M., Robinson, T.W., and Park, C.F., Jr., 1939, Geology and ground-water resources of the Harney Basin, Oregon: U.S. Geological Survey Water-Supply Paper 841, 189 p., 2 pls.

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#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 822, Unnamed fault near V Lake

**Structure Number** 822

Comments:

**Structure Name** Unnamed fault near V Lake

Comments: This fault was mapped by Walker and Repenning (1965 #3559); Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), Madin and Mabey (1996 #3575), and Weldon and others (2002 #5648) include this fault in their compilations of Quaternary faults in Oregon.

**Synopsis** The unnamed fault near V Lake is a northwest-striking down-to-the-southwest fault that lies between and may connect the large normal faults that form the Catlow Valley [824] to the west and Steens Mountain [856] to the east. The fault offsets Miocene basalt and andesite, but no fault scarps in Quaternary deposits have been described along its trace.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Harney

**1° x 2° sheet** Adel

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault trace is from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and Repenning (1965 #3559) and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** This northwest-striking down-to-the-southwest fault lies between and may connect the large normal faults that form the Catlow Valley [824] to the west and Steens Mountain [856] to the east. The area is underlain by Miocene basalt and andesite (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646).

**Sense of movement** N?, D?

Comments: This fault is mapped as a normal or high-angle fault by Walker and (1965 #3559), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544). However, the northwest strike suggests a possible association with the nearby right-lateral(?) Brothers fault zone, so some oblique motion is possible.

**Dip** Not Reported

Comments:

**Main dip direction** SW

**Geomorphic expression** The unnamed fault near V Lake is marked by a prominent, 300-m-high escarpment in Miocene bedrock. No Quaternary deposits have been mapped along its trace (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646).

**Age of faulted deposits at the surface** The unnamed fault near V Lake forms a prominent escarpment in bedrock, but no fault scarps in Quaternary deposits have been reported along its trace. Offset bedrock is primarily Miocene Steens Basalt; these rocks have radiometric ages of 15-17 Ma (Sherrod and Johnson, 1994 #3563).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary (<1.6 Ma) displacement, and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also show the unnamed fault near V Lake as active in the Quaternary (<1.6-1.8 Ma). Madin and others (1996 #3479) map the western half of the fault as age uncertain.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed fault near V Lake. However, the fault is marked by a 300-m-high escarpment in 15-17 Ma volcanic rocks. Such slip data indicate low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 12.8 |
| | Cumulative trace (km): | 13.0 |

Comments:

**Average strike** (azimuth) N 69° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company — Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3563 Sherrod, D.R., and Johnson, J.A., 1994, Geologic map of the Irish Lake quadrangle, Harney County, south-central Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-2256, 1 sheet, scale 1:24,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 823, Unnamed fault near Dry Valley

**Structure Number** 823

Comments:

**Structure Name** Unnamed fault near Dry Valley

Comments: This fault in Dry Valley was mapped by Walker and Repenning (1965 #3559) and Greene and others (1972 #3560); Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), Madin and Mabey (1996 #3575), and Weldon and others (2002 #5648) include this fault in their compilations of Quaternary faults in Oregon.

**Synopsis** This unnamed, down-to-the-west normal fault forms the Dry Valley Rim, a 100- to 300-m-high escarpment that bounds the eastern margin of Dry Valley in central Oregon. The fault offsets Pliocene to Miocene ash-flow tuffs, but no fault scarps in Quaternary deposits have been described along its trace.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Harney

**1° x 2° sheet** Burns and Adel

**Province** Basin and Range (Great Basin section), Columbia Plateaus (Harney section)

**Quality of location** Good

Comments: Fault trace is from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and Repenning (1965 #3559) and Greene and others (1972 #3560), and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** This north-striking down-to-the-west normal fault lies at the northern boundary of the Basin and Range province in southeastern Oregon, just south of the Brothers fault zone. The area is underlain by Pliocene to Miocene ash-flow tuffs (Walker and Repenning, 1965 #3559; Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: This fault is mapped as a normal or high-angle fault by Walker and Repenning (1965 #3559), Green and others (1972 #3560), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544).

**Dip** Not Reported

Comments:

**Main dip direction** W

**Geomorphic expression** The unnamed Dry Valley fault is marked by a prominent, 100- to 300-m-high escarpment (Dry Valley Rim) that separates the eastern margin of Dry Valley from a volcanic plateau consisting of Pliocene to Miocene ash flow tuffs (Walker and Repenning, 1965 #3559; Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646). No fault scarps in Quaternary deposits have been described along its trace.

**Age of faulted deposits at the surface** The unnamed Dry Valley fault forms a prominent escarpment in bedrock, but no fault scarps in Quaternary deposits have been reported along its trace. Offset bedrock is primarily lower Pliocene to upper Miocene ash-flow tuffs; these rocks have radiometric ages of 4-10 Ma (Walker and MacLeod, 1991 #3646).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary (<1.6 Ma) displacement on the unnamed Dry Valley fault, and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also show the fault as active in the Quaternary (<1.6-1.8 Ma). Madin and others (1996 #3479) map the southern half of the fault as age uncertain.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed Dry Valley fault. However, the fault is marked by a 300-m-high escarpment in 4-10 Ma volcanic rocks. Such slip data indicate low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 19.2 |
| | Cumulative trace (km): | 20.7 |

Comments:

**Average strike** (azimuth) N 21° E

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3560 Greene, R.C., Walker, G.W., and Corcoran, R.E., 1972, Geologic map of the Burns quadrangle, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-680, 2 sheet, scale 1:250,000.

#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company — Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 824, Unnamed Catlow Valley faults

**Structure Number** 824

Comments:

**Structure Name** Unnamed Catlow Valley faults

Comments: These faults were mapped in the Catlow and Hawksy Walksy valleys by Walker and Repenning (1965 #3559) and Walker (1991 #3646). Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), Madin and Mabey (1996 #3575), and Weldon and others (2002 #5648) include these faults in their compilations of Quaternary faults in Oregon.

**Synopsis** The unnamed Catlow Valley faults are marked by prominent, 20- to 450-m-high escarpments that separate the eastern margin of Catlow Valley from the west flanks of Steens Mountain and the Pueblo Mountains, and form the western margin of the Hawksy Walksy Valley. The faults in places offset Miocene volcanic rocks more than 450 m, but no fault scarps on Quaternary deposits have been described along the fault traces.

**Date of compilation** December 4, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Harney

**1° x 2° sheet** Adel

**Province** Basin and Range (Great Basin section)

**Geologic setting** These north-striking normal faults lie near the northern boundary of the Basin and Range province in southeastern Oregon. They form the eastern margin of the Catlow Valley and the western margin of the Hawksy Walksy Valley. The area is underlain by Miocene volcanic rocks (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646).

**Number of sections** 2

Comments: Two sections are delineated herein: the Catlow Valley section, a down-to-the-west normal fault that forms the eastern margin of the Catlow Valley, and the Hawksy Walksy Valley section, a down-to-the-east normal fault that forms the western margin of the Hawksy Walksy Valley.

| | | |
|---|---|---|
| **Length** | End to end (km): | 77.0 |
| | Cumulative trace (km): | 76.4 |

Comments:

**Average strike** (azimuth) N 00°

### *824a, Catlow Valley section*

**Section number** 824a

**Section name** Catlow Valley section

Comments:

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and Repenning (1965 #3559) and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments: This fault is mapped as a normal or high-angle fault by Walker and Repenning (1965 #3559), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544).

**Dip** Not Reported

Comments:

**Main dip direction** W

**Geomorphic expression** The Catlow Valley section is marked by a prominent, 100- to 450-m-high escarpment (the Catlow Rim) that separates the eastern margin of Catlow Valley from the west flanks of Steens Mountain and the Pueblo Mountains; the bedrock that underlies these highlands primarily consists of Miocene basalt and andesite (Walker and Repenning, 1965 #3559; Vander Meulen and others, 1989 #3500; Vander Meulen and others, 1989 #3501; Walker and MacLeod, 1991 #3646). No fault scarps in Quaternary deposits have been described along the fault trace, although Weldon and others (2002 #5648) describe lineaments across Quaternary deposits on 1:100,000-scale DEMs of the fault trace.

**Age of faulted deposits at the surface** The Catlow Valley section forms prominent escarpments in Miocene Steens Basalt; these rocks have radiometric ages of 15-17 Ma (Sherrod and Johnson, 1994 #3563). In places, bedrock is mapped as juxtaposed against Pliocene or Pleistocene lacustrine or fluvial sediments (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646), but no fault scarps on Quaternary deposits have been reported along the fault trace.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary (<1.6 Ma) displacement on the Catlow Valley section, and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and others, 1996 #3479; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also show the fault as active in the Quaternary (<1.6-1.8 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the Catlow Valley section. However, the fault is marked by a 450-m-high escarpment in 15-17 Ma volcanic rocks. Such slip data indicate low rates of long-term slip.

**Length** End to end (km): 55.8
Cumulative trace (km): 61.1

Comments:

**Average strike** (azimuth) N 02° W

***824b, Hawksy Walksy Valley section***

**Section number** 824b

**Section name** Hawksy Walksy Valley section

Comments:

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648) }, based on 1:250,000-scale mapping of Walker and Repenning (1965 #3559).

**Sense of movement** N

Comments: This fault is mapped as a normal or high-angle fault by Walker and Repenning (1965 #3559) and Walker and MacLeod (1991 #3646).

**Dip** Not Reported

Comments:

**Main dip direction** E

**Geomorphic expression** The Hawksy Walksy Valley section is marked by prominent, 20- to 180-m-high escarpments that form the western margin of the Hawksy Walksy Valley, but no fault scarps in Quaternary deposits have been described along its trace.

**Age of faulted deposits at the surface** The Hawksy Walksy Valley section forms prominent escarpments in Miocene rhyolitic tuffs and vent rocks (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646). In places, bedrock is mapped as juxtaposed against Quaternary alluvium (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646). No fault scarps in Quaternary deposits have been reported along the fault trace, although Weldon and others (2002 #5648) describe lineaments across Quaternary deposits on 1:100,000-scale DEMs of the fault trace.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Weldon and others (2002 #5648) used analysis of airphotos and 1:100,000-scale DEMs to infer Quaternary displacement on these faults. No other fault compilation in the region includes these faults as potential seismic sources (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the Hawksy Walksy Valley section. However, 180-m-high escarpments in Miocene volcanic rocks indicate low rates of long-term slip.

**Length** End to end (km): 11.3
Cumulative trace (km): 15.4

Comments:

**Average strike** (azimuth) N 08° E

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company — Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3563 Sherrod, D.R., and Johnson, J.A., 1994, Geologic map of the Irish Lake quadrangle, Harney County, south-central Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-2256, 1 sheet, scale 1:24,000.

#3500 Vander Meulen, D.B., Griscom, A., King, H.D., Vercoutere, T.L., and Moyle, P.R., 1989, Mineral resources of the Home Creek Wilderness study area, Harney County, Oregon: U.S. Geological Survey Bulletin 1740, 12 p.

#3501 Vander Meulen, D.B., Plouff, D., King, H.D., Mayerle, R.T., and Rains, R.L., 1989, Mineral resources of the Rincon Wilderness study area, Harney County, Oregon: U.S. Geological Survey Bulletin 1740, 14 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 826, Guano Valley faults

**Structure Number** 826

Comments: Some of these faults are included in fault V6 of dePolo (1998 #2845).

**Structure Name** Guano Valley faults

Comments: These faults were originally mapped in the Guano Valley by Russell (1884 #5099) and later in more detail by Walker and Repenning (1965 #3559), Pezzopane (1993 #3544), and Geomatrix Consultants, Inc. (1995 #3593) in Oregon, and by Slemmons (1967 #156), Bonham (1969 #2999), and Dohrenwend and Moring (1991 #281) in Nevada. dePolo (1998 #2845) referred to the fault along the Guano Rim in Nevada as the Eastern Guano Valley fault.

**Synopsis** This group of faults includes north-striking normal faults that form a graben that confines Guano Valley in southern Oregon and northern Nevada, and a cross-cutting network of northeast-and northwest-striking intra-plateau faults in Nevada. The range-bounding faults are marked by prominent 100- to 300-m-high escarpments in Miocene and Pliocene volcanic and volcaniclastic sedimentary rocks; other faults are mostly expressed as topographic lineaments on Tertiary basalt, although Quaternary deposits are juxtaposed against basalt along some of the more prominent lineaments. Some northeast-striking faults are expressed as scarps on piedmont-slope deposits in Nevada, but no fault scarps on Quaternary deposits have been described along these faults in Oregon.

**Date of compilation** December 4, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey, and Thomas L. Sawyer, Piedmont Geosciences, Reno, NV

**State** OR, NV

**County** Lake (OR), Washoe (NV)

**1° x 2° sheet** Adel, Vya

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and Repenning (1965 #3559) and 1:500,000-scale mapping of Pezzopane (1993 #3544) in Oregon, and from 1:250,000-scale mapping of Dohrenwend and Moring (1991 #281) in Nevada.

**Geologic setting** These north-striking normal faults form a graben that confines Guano Valley. The range-bounding faults are marked by prominent 100- to 300-m-high escarpments in Miocene and Pliocene volcanic and volcaniclastic sedimentary rocks (Walker and Repenning, 1965 #3559; Bonham, 1969 #2999; Walker and MacLeod, 1991 #3646; Sawlan and others, 1995 #3502). In Nevada, the fault zone is also marked by a cross-cutting network of northeast- and northwest-striking intra-plateau faults (Slemmons, 1967 #156; Bonham, 1969 #2999; Dohrenwend and Moring, 1991 #281). Intra-plateau faults with these orientations are mapped in Oregon (Walker and Repenning, 1965 #3559), but these faults are either not shown on Quaternary fault compilations (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) or are mapped as possible Quaternary faults (Weldon and others, 2002 #5648) and are not included herein.

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Slemmons (1967 #156), Bonham (1969 #2999), Dohrenwend (1991 #281), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Sawlan and others (1995 #3502). Sawlan and others (1995 #3502) describe east-stepping fault patterns that suggest a small right-lateral component of slip in Oregon, and dePolo (1998 #2845) listed his Eastern Guano Valley fault as having an oblique dextral component.

**Dip** Not Reported

Comments:

**Main dip direction** W and E

**Geomorphic expression** The Guano Valley faults are marked by prominent, 100- to 300-m-high escarpments. The highest escarpment, the Guano Rim, marks the trace of the eastern fault; the Shirk Rim marks the trace of the most prominent western fault in the graben. Sawlan and others (1995 #3502) attributed the conical shape of small alluvial fans along the Guano Rim scarp to Quaternary displacement. No fault scarps on Quaternary deposits have been described in Oregon, although Weldon and others (2002 #5648) describe lineaments across Quaternary deposits on 1:100,000-scale DEMs. In Nevada, dePolo (1998 #2845) listed his Eastern Guano Valley fault as having no fault scarps on Quaternary deposits, but several short scarps have been mapped along northeast-striking faults on piedmont-slope deposits near Rye Creek Reservoir, at the mouth of Catnip Creek, along the west front of Guano Mountain and possibly southwest of Racetrack Reservoir, and Quaternary deposits are juxtaposed against basalt along some of the more prominent topographic lineaments (Slemmons, 1967 #156; Dohrenwend and Moring, 1991 #281).

**Age of faulted deposits at the surface** The Guano Valley faults form prominent escarpments in Miocene bedrock (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646), but no fault scarps on Quaternary deposits have been reported along the fault traces in Oregon, and only a few scarps have been described on Quaternary piedmont deposits on the floor of Guano Valley in Nevada (Slemmons, 1967 #156; Bonham, 1969 #2999; Dohrenwend and Moring, 1991 #281).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary (<1.6 Ma) displacement, and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also infer Quaternary (<1.6-1.8 Ma) displacement on these faults in Oregon and northern Nevada. Sawlan and others (1995 #3502) describe the conical shape of small alluvial fans along the Guano Rim scarp in Oregon as evidence of Quaternary displacement. Reconnaissance photogeologic mapping of Dohrenwend and Moring (1991 #281) and Slemmons (1967 #156) also indicates Quaternary displacement in Nevada.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip-rate data are available for the Guano Valley faults. Sawlan and others (1995 #3502) describe a tentative correlation of mesa-forming basalts across the fault zone that indicate about 150 m of displacement in the last 5 Ma near Rocky Canyon in Oregon, and offsets of at least 100-300 m in Miocene volcanic rocks are evident along the prominent Guano Rim. Such data indicate low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 49.2 |
| | Cumulative trace (km): | 130.3 |

Comments:

**Average strike** (azimuth) N 09° E

**References**

#2999 Bonham, H.F., 1969, Geology and mineral deposits of Washoe and Storey Counties, Nevada: Nevada Bureau of Mines and Geology Bulletin 70, 140 p., 1 pl., scale 1:250,000.

#2845 dePolo, C.M., 1998, A reconnaissance technique for estimating the slip rate of normal-slip faults in the Great Basin, and application to faults in Nevada, U.S.A.: Reno, University of Nevada, unpublished Ph.D. dissertation, 199 p.

#281 Dohrenwend, J.C., and Moring, B.C., 1991, Reconnaissance photogeologic map of young faults in the Vya 1° by 2° quadrangle, Nevada, Oregon, and California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2174, 1 sheet, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5099 Russell, I.C., 1884, A geological reconnaissance in southern Oregon: U.S. Geological Survey Fourth Annual Report, p. 431-464.

#3502 Sawlan, M.G., King, H.D., Plouff, D., and Miller, M.S., 1995, Mineral resources of the Spaulding Wilderness study area, Lake and Harney Counties, Oregon: U.S. Geological Survey Bulletin 1738, 18 p.

#156 Slemmons, D.B., 1967, Pliocene and Quaternary crustal movements of the Basin-and-Range province, USA: Journal of Geosciences, Osaka City University, v. 10, p. 91-103.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 827, Warner Valley faults

**Structure Number** 827

Comments: These structures are included in fault number 46 of Pezzopane (1993 #3544), fault number 61 of Geomatrix Consultants, Inc. (1995 #3593), and fault numbers V1 and V3 of dePolo (1998 #2845).

**Structure Name** Warner Valley faults

Comments: These faults are named after Warner Valley, a large graben system in the Basin and Range Province of southern Oregon and northern Nevada. These faults were originally mapped and named the Warner Valley fault by Russell (1884 #5099); they were later mapped in more detail by Walker and Repenning (1965 #3559), Bonham (1969 #2999), Walker and MacLeod (1991 #3646), and Dohrenwend and Moring (1991 #281). Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) included these faults in their Warner Valley Graben faults or Warner Valley fault zone. Geomatrix Consultants, Inc. (1995 #3593) informally named individual faults the West Warner Valley, the East Warner Valley north, and the East Warner Valley south faults; dePolo (1998 #2845) included the western margin fault in Coleman Valley in Nevada in his Coleman Valley fault zone V1. In northern Nevada, the southern extension of these faults is informally known as the Northeast Long Valley fault (V3 of dePolo, 1998 #2845). Herein we retain the fault groupings of Geomatrix Consultants, Inc. (1995 #3593) as the informally named West Warner Valley, East Warner Valley, and Coleman Valley sections, respectively.

**Synopsis** These north-striking normal faults form a large, complex graben system that confines Warner Valley, Coleman Valley, and the northeast part of Long Valley in the Basin and Range province of southern Oregon and northern Nevada. The area is underlain by Pliocene and Miocene volcanic and volcaniclastic sedimentary rocks. No fault scarps on Quaternary deposits have been described along the range bounding faults, but several lineaments (fault scarps?) appear to control the locations of young playas, and stream courses, and interrupt latest Pleistocene pluvial shorelines on the floor of Warner Valley, thus suggesting Quaternary movement. Broad deformation of late Pleistocene pluvial shorelines has also been documented throughout Warner Valley. Faults juxtapose Quaternary alluvium or landslide deposits against Miocene to Pliocene volcanic rocks along the eastern and western margins of Coleman Valley.

**Date of compilation** December 4, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey, and Thomas L. Sawyer, Piedmont Geosciences, Reno, NV

**State** Oregon, Nevada

**County** Lake (OR), Washoe (NV)

**1° x 2° sheet** Adel, Vya

**Province** Basin and Range (Great Basin section)

**Geologic setting** These north-striking normal faults form a large, complex graben system that confines the Warner Valley, Coleman Valley, and the northeast part of Long Valley in the Basin and Range province of southern Oregon and northern Nevada. The area is underlain by Pliocene and Miocene volcanic and volcaniclastic sedimentary rocks (Walker and Repenning, 1965 #3559; Bonham, 1969 #2999; Walker and MacLeod, 1991 #3646).

**Number of sections** 3

Comments: The three earthquake source zones delineated by Geomatrix Consultants, Inc. (1995 #3593), the West Warner Valley, the East Warner Valley north, and the East Warner Valley south faults, are retained herein as separate sections, the West Warner Valley, East Warner Valley, and Coleman Valley sections, respectively.  The Coleman Valley section extends south into the northeast part of Long Valley in northern Nevada.

**Length** End to end (km): 132.0
Cumulative trace (km): 259.8

Comments:

**Average strike** (azimuth) N 09° E

***827a, East Warner Valley section***

**Section number** 827a

Comments:  This section is part of fault number 46 of Pezzopane (1993 #3544) and fault number 61a of Geomatrix Consultants, Inc. (1995 #3593).

**Section name** East Warner Valley section

Comments:  This section is the East Warner Valley north fault of Geomatrix Consultants, Inc. (1995 #3593).

**Quality of location** Good

Comments:  Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and Repenning (1965 #3559) and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments:  These faults are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544).  Focal mechanism studies of the 1986 Adel earthquake swarm (Schaff, 1976 #3505; Patton, 1985 #3515) may suggest a small component of right-oblique motion on faults in this section (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544).

**Dip** Not Reported

Comments:  No structural data on the dip of these faults have been published, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential on faults in the Warner Valley.

**Main dip direction** W, E

**Geomorphic expression** Faults in the East Warner Valley section are marked by prominent escarpments in Pliocene and Miocene volcanic rocks (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646) from the north end of Warner Valley south to Greaser Canyon.  Most of this section is comprised of down-to-the-west faults that form Orejana Rim, Poker Jim Ridge, the west flank of Hart Mountain, and an unnamed rim east of Greaser Reservoir; the down-to-the-east fault that bounds the east flank of Hart Mountain is also included in this section.  No young fault scarps have been recognized along the range bounding faults, but tilted late Pleistocene pluvial shorelines are evidence of vertical deformation in the basin (Weide, 1974 #3503; Craven, 1988 #3519; Craven, 1991 #3951; Weldon and others, 1992 #3540; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544).  However, Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) used airphoto analysis to identify lineaments (fault scarps?) that appear to control the locations of young playas and stream courses or interrupt pluvial shorelines on the floor of Warner Valley north of Stone Corral Lake and northeast of Greaser Reservoir.  Weldon and others (2002 #5648) describe lineaments across Quaternary deposits on 1:100,000-scale DEMs of some of the fault traces.

**Age of faulted deposits at the surface** No fault scarps have been recognized on Quaternary deposits along the range bounding faults of this section, but Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) used airphoto analysis to identify lineaments (fault scarps?) presumably on Holocene or latest Pleistocene deposits that appear to control the locations of young playas and stream courses or interrupt pluvial shorelines on the floor of Warner Valley north of Stone Corral Lake and east of Greaser Reservoir. Weide (1974 #3503) and Craven (1988 #3519; 1991 #3951) documented broad deformation of late Pleistocene pluvial shorelines throughout Warner Valley.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) used airphoto analysis to identify lineaments (fault scarps?) that appear to control the locations of young playas and stream courses or interrupt pluvial shorelines on the floor of Warner Valley, and Weide (1974 #3503) and Craven (1988 #3519; 1991 #3951) documented broad deformation of late Pleistocene pluvial shorelines throughout Warner Valley. However, no fault scarps on Quaternary deposits have been described along the range bounding faults of this section. Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer Quaternary (<1.6-1.8 Ma) or middle or late Quaternary (<700-780 ka) displacement along most fault strands in this section.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: Long-term slip rates of 0.08-0.2 mm/yr based on offset of Miocene bedrock were estimated by Pezzopane (pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593) along this section. Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.01-0.2 mm/yr in their analysis of earthquake hazards associated with faults in the East Warner Valley section.

| | | |
|---|---|---|
| **Length** | End to end (km): | 89.0 |
| | Cumulative trace (km): | 135.2 |

Comments:

**Average strike** (azimuth) N 09° E

### *827b, West Warner Valley section*

**Section number** 827b

Comments: This section is part of fault number 46 of Pezzopane (1993 #3544), and fault number 61c of Geomatrix Consultants, Inc. (1995 #3593).

**Section name** West Warner Valley section

Comments: This section is the West Warner Valley fault of Geomatrix Consultants, Inc. (1995 #3593).

**Quality of location** Good

Comments: Fault trace is from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and Repenning (1965 #3559) and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments: This fault is mapped as a normal or high-angle fault by Walker and Repenning (1965 #3559), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544). Focal mechanism studies of the 1986 Adel earthquake swarm (Schaff, 1976 #3505; Patton, 1985 #3515) suggest a small component of right-oblique motion on faults in this section (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544). Schaff (1976 #3505) inferred that this earthquake swarm occurred on the West Warner Valley fault, although most of the earthquakes appear to be located in the footwall block. Craven (1991 #3951; 1999 #4043) used data on deformed pluvial shorelines and a focal mechanism on earthquakes associated with the Adel swarm (Schaff, 1976 #3505) to infer compressional movement on faults along the western margin of Warner Valley.

**Dip** Not Reported

Comments: No structural data on the dip of this fault have been published, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential on faults in the Warner Valley.

**Main dip direction** E

**Geomorphic expression** The West Warner Valley fault is marked by prominent escarpments (South Warner and Lynches Rims) in Miocene volcanic rocks (Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646), from north of Plush to the southern end of Warner Valley. No young fault scarps have been recognized along the range bounding fault, but tilted late Pleistocene pluvial shorelines are evidence of vertical deformation in the basin (Weide, 1974 #3503; Craven, 1988 #3519; Craven, 1991 #3951; Weldon and others, 1992 #3540; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544). Weldon and others (2002 #5648) describe lineaments across Quaternary deposits on 1:100,000-scale DEMs of the fault trace.

**Age of faulted deposits at the surface** No fault scarps have been recognized on Quaternary deposits along the West Warner Valley fault section, but Weide (1974 #3503) and Craven (1988 #3519; 1991 #3951) documented broad deformation of late Pleistocene pluvial shorelines throughout Warner Valley.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: No fault scarps on Quaternary deposits have been described along the West Warner Valley fault section, although Weide (1974 #3503) and Craven (1988 #3519; 1991 #3951) documented broad deformation of late Pleistocene pluvial shorelines throughout Warner Valley. Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer Quaternary (<1.6-1.8 Ma) displacement along the West Warner Valley fault section.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: Estimated slip rates of 0.08-0.2 mm/yr (S.K. Pezzopane, pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593), and 0.18-0.2 mm/yr (Craven, 1991 #3951) are long-term rates of offset of Miocene bedrock. Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.001-0.2 mm/yr in their analysis of earthquake hazards associated with the West Warner Valley fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 42.1 |
| | Cumulative trace (km): | 45.8 |

Comments:

**Average strike** (azimuth) N 03° E

### *827c, Coleman Valley section*

**Section number** 827c

Comments: This section is part of fault number 46 of Pezzopane (1993 #3544), fault number 61b of Geomatrix Consultants, Inc. (1995 #3593), and fault V3 of dePolo (1998 #2845).

**Section name** Coleman Valley section

Comments: This section is the East Warner Valley south fault of Geomatrix Consultants, Inc. (1995 #3593). The section is herein informally named after the Coleman Valley fault zone (fault number V1) of dePolo (1998 #2845), which is mapped along the western margin of Coleman Valley and extending as the Long Valley fault of dePolo (1998 #2845) along the eastern border of Long Valley in northern Nevada from east of Alkali Lake to Coleman Canyon, and along the east side of Macy Flat and Antelope Flat north of Bald Mountain.

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and Repenning (1965 #3559) and 1:500,000-scale mapping of Pezzopane (1993 #3544) in Oregon. In Nevada, the fault traces are from 1:250,000-scale mapping of Dohrenwend and Moring (1991 #281). The location of the range-bounding fault south of Calcutta Lake in Nevada is inferred (Slemmons, 1967 #156).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Bonham (1969 #2999), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544). Sense of movement was not studied in detail in Nevada, and is inferred from topography (Slemmons, 1967 #156).

**Dip** Not Reported

Comments: No structural data on the dip of these faults have been published, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential on faults in the Warner Valley in Oregon.

**Main dip direction** W, E

**Geomorphic expression** Faults in this section are marked by prominent escarpments in Pliocene and Miocene volcanic rocks (Walker and Repenning, 1965 #3559; Bonham, 1969 #2999; Walker and MacLeod, 1991 #3646) along east-and west-facing escarpments that define a graben in Coleman Valley. No young fault scarps have been described along the range-bounding faults, although Weldon and others (2002 #5648) describe lineaments across Quaternary deposits on 1:100,000-scale DEMs of the fault traces. Craven (1991 #3951) described deformation of older Pleistocene fan deposits along the western flank of Coleman Valley. Several of the faults in Long Valley north of Calcutta Lake are mapped as juxtaposing piedmont-slope deposits against Tertiary rock (Slemmons, 1967 #156; Dohrenwend and Moring, 1991 #281).

**Age of faulted deposits at the surface** No fault scarps have been described in Quaternary deposits along the range-bounding faults in this section, but Walker and Repenning (1965 #3559), Bonham (1969 #2999), Walker and MacLeod (1991 #3646), and Dohrenwend and Moring (1991 #281) mapped faults on the eastern and/or western margins of Coleman Valley in Oregon and the eastern margin of Long Valley in Nevada that juxtapose Quaternary alluvium or landslide deposits against Miocene to Pliocene volcanic rocks. Craven (1991 #3951) described deformation of older Pleistocene fan deposits of unknown age along the western flank of Coleman Valley.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: No fault scarps on Quaternary deposits have been described along the range-bounding faults in this section. Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also infer Quaternary (<1.6-1.8 Ma) displacement along faults in this section in Oregon, and Quaternary movement was suggested based on reconnaissance photogeologic mapping of Slemmons (1967 #156) and Dohrenwend and Moring (1991 #281) along faults in this section in Nevada.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: Long-term slip rates of 0.08-0.2 mm/yr have been estimated from offset of Miocene bedrock (S.K. Pezzopane, pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593). Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.01-0.2 mm/yr in their analysis of earthquake hazards associated with the East Warner Valley faults. dePolo (1998 #2845) estimated a vertical slip rate of 0.001 mm/yr for the fault section in Nevada (his fault V3) based on the presence or absence of scarps on alluvium and basal facets.

| | | |
|---|---|---|
| **Length** | End to end (km): | 43.5 |
| | Cumulative trace (km): | 78.8 |

Comments:

**Average strike** (azimuth) N 07° W

**References**


#2999 Bonham, H.F., 1969, Geology and mineral deposits of Washoe and Storey Counties, Nevada: Nevada Bureau of Mines and Geology Bulletin 70, 140 p., 1 pl., scale 1:250,000.

#4043 Craven, G., 1999, Holocene deformation of shorelines in Warner Valley correlated with 1968 earthquake swarm epicenters and Miocene structural control, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 11, p. 1-5.

#3519 Craven, G.F., 1988, Tectonic deformation of late Pleistocene shorelines in Warner Valley, Lake County, Oregon: Geological Society of America Abstracts with Programs, v. 20, no. 3, p. 152.

#3951 Craven, G.F., 1991, The tectonic development and late Quaternary deformation of Warner Valley south of Hart Mountain, Oregon: Arcata, California, Humboldt State University, unpublished M.S. thesis, 94 p., 10 pls.

#2845 dePolo, C.M., 1998, A reconnaissance technique for estimating the slip rate of normal-slip faults in the Great Basin, and application to faults in Nevada, U.S.A.: Reno, University of Nevada, unpublished Ph.D. dissertation, 199 p.

#281 Dohrenwend, J.C., and Moring, B.C., 1991, Reconnaissance photogeologic map of young faults in the Vya 1° by 2° quadrangle, Nevada, Oregon, and California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2174, 1 sheet, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3515 Patton, H.J., 1985, P-wave fault-plane and the generation of surface waves by earthquakes in the western United States: Geophysical Research Letters, v. 12, no. 8, p. 518-521.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#5099 Russell, I.C., 1884, A geological reconnaissance in southern Oregon: U.S. Geological Survey Fourth Annual Report, p. 431-464.

#3505 Schaff, S.C., 1976, The 1968 Adel, Oregon, earthquake swarm: Reno, Nevada, University of Nevada, unpublished Master's thesis, 63 p.

#156 Slemmons, D.B., 1967, Pliocene and Quaternary crustal movements of the Basin-and-Range province, USA: Journal of Geosciences, Osaka City University, v. 10, p. 91-103.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#3503 Weide, D.L., 1974, Postglacial geomorphology and environments of the Warner Valley - Hart Mountain Area, Oregon: Los Angeles, California, University of California, unpublished Ph. D dissertation, 293 p.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#3540 Weldon, R.J., II, Pezzopane, S.K., Stimac, J.P., and McDowell, P.F., 1992, Guidebook to active faulting in south-central Oregon: Geological Society of America, Cordilleran Meeting Fieldtrip #5, May 8-10, 1992, Guidebook,.

**828, Goose Lake graben faults**

**Structure Number** 828

Comments: These structures are fault number 43 of Pezzopane (1993 #3544), fault number 59 of Geomatrix Consultants, Inc. (1995 #3593), and fault number 7A of Jennings (1994 #2878).

**Structure Name** Goose Lake graben faults

Comments: These faults are named after Goose Lake and the Goose Lake basin, a large graben system in the Basin and Range of southern Oregon and northeastern California. These faults were originally mapped by Walker (1963 #3565) in Oregon and by Gay and Aune (1958 #4890) in California, with additions from Peterson and McIntyre (1970 #3791), Peterson and others (1980 #3562), Pezzopane (1993 #3544), and Klinger and others (1996 #3729). Gay and Aune (1958 #4890) name the fault that forms the eastern margin of the graben the Goose Lake fault.

**Synopsis** These north-trending normal faults form a large graben that confines the Goose Lake basin. The basin-margin faults are marked by faceted spurs and fault-related ridges along oversteepened mountain fronts in Miocene to Oligocene volcanic and volcaniclastic sedimentary rocks. Only one short fault scarp on Quaternary deposits has been described along these faults, but high rates of colluvial deposition may obscure geomorphic evidence of most young fault scarps. Pleistocene(?) lake deposits are offset by small faults on the valley floor, and Plio(?)-Pleistocene lake sediments and terrace deposits that may be remnants of lake shorelines may be uplifted along the eastern graben fault near Lakeview. Gravity and well-log data indicate that the Goose Lake basin may be filled with as much as 1,500 m of unconsolidated sediment. Latest movement probably occurred in the middle and late Quaternary on the eastern graben faults, and mostly in the Quaternary on the western graben faults.

**Date of compilation** December 4, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR, CA

**County** Lake (OR), Modoc (CA)

**1° x 2° sheet** Klamath Falls, Alturas

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault traces in Oregon are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker (1963 #3565), 1:62,500 mapping of Peterson and others (1980 #3562), and 1:500,000-scale mapping of Pezzopane (1993 #3544). Fault traces in California are from 1:750,000-scale mapping of Jennings (1994 #2878), based on 1:250,000-scale mapping of Gay and Aune (1958 #4890).

**Geologic setting** These north-trending normal faults form a graben that confines the Goose Lake basin. The faults are marked by prominent escarpments on Miocene to Oligocene volcanic and volcaniclastic sedimentary rocks (Walker, 1963 #3565; Walker and MacLeod, 1991 #3646). Gravity and well-log data indicate that the Goose Lake basin may be filled with as much as 1,500 m of unconsolidated sediment (Peterson and others, 1980 #3562).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Walker (1963 #3565), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Klinger and others (1996 #3729). Klinger and others (1996 #3729) describe a west-dipping fault exposure in a gravel pit just south of Lakeview with well preserved slickensides that indicate dip-slip motion.

**Dip** 51°

Comments: Peterson and McIntyre (1970 #3791) and Peterson and others (1980 #3562) describe “near vertical” exposures of the east Goose Lake graben fault near Lakeview; Klinger and others (1996 #3729) describe a fault exposure on their Goose Lake fault in a gravel pit just south of Lakeview with a westerly dip of 51°.

**Main dip direction** W and E

**Geomorphic expression** The range-bounding Goose Lake graben faults are marked by faceted spurs and fault-related ridges along oversteepened mountain fronts (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). These workers do not describe fault scarps on Quaternary deposits along these faults, but high rates of colluvial deposition may obscure geomorphic evidence of young fault scarps (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). Pleistocene(?) lake deposits are offset by small faults on the valley fronts (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544). Klinger and others (1996 #3729) describe a 1- to 2-m-high fault scarp in a small alluvial fan about 1 km south of Warner Canyon near the northern end of the eastern graben fault. They also describe the prominent mountain front that parallels the eastern graben fault as more sinuous and dissected than the range front along the nearby (and more active) Surprise Valley fault in northeastern California.

**Age of faulted deposits at the surface** Fault scarps on Quaternary deposits have only been described in one location along the eastern Goose Lake graben fault (Klinger and others, 1996 #3729), but high rates of colluvial deposition may obscure geomorphic evidence of young fault scarps (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). Pleistocene(?) lake deposits are offset by small faults on the valley floor, and Plio(?)-Pleistocene lake sediments and terrace deposits (Peterson and others, 1980 #3562) that may be remnants of lake shorelines may be uplifted along the eastern graben fault near Lakeview (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544), and subsequent compilations (Jennings, 1994 #2878; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer middle and late Quaternary (<700-780 ka) displacement on the eastern graben faults, and mostly Quaternary (<1.6-1.8 Ma) displacement on the western graben faults in the Goose Lake Valley. Klinger and others (1996 #3729) infer late Quaternary displacement on the eastern graben fault, based on the presence of a 1- to 2-m-high fault scarp in a small alluvial fan near the northern end of the eastern Goose Lake graben fault. Sherrod (1993 #3510) assigned an age of <35 ka for activity on the eastern graben fault, but did not discuss the basis for this age assignment.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: Geomatrix Consultants, Inc. (1995 #3593) used an estimate of 100 m of uplift and an estimated age of 1-2 Ma of possibly offset lacustrine features identified by Peterson and others (1980 #3562), Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149), to estimate a long-term slip rate of 0.05-0.1 mm/yr.

| | | |
|---|---|---|
| **Length** | End to end (km): | 55.4 |
| | Cumulative trace (km): | 107.2 |

Comments:

**Average strike** (azimuth) N 09° W

**References**


#4890 Gay, T.E., and Aune, Q.A., 1958, Alturas Sheet: California Division of Mines and Geology Geologic Atlas of California, GAM001, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#2878 Jennings, C.W., 1994, Fault activity map of California and adjacent areas, with locations of recent volcanic eruptions: California Division of Mines and Geology Geologic Data Map 6, 92 p., scale 1:750,000.

#3729 Klinger, R.E., Vetter, U.R., and Ryter, D.W., 1996, Seismotectonic study for Gerber Dam Klamath Project, California-Oregon: U.S. Bureau of Reclamation Seismotectonic Report 96-1, 51 p., 1 pl.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3562 Peterson, N.V., Brown, D.E., and McLean, G.D., 1980, Preliminary geology and geothermal resource potential of the Lakeview Area, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report O-80-9, 108 p., 2 pls., scale 1:62,500.

#3791 Peterson, N.V., and McIntyre, J.R., 1970, The reconnaissance geology and mineral resources of eastern Klamath County and western Lake County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 66, 70 p., 1 pl., scale 1:250,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3510 Sherrod, D.R., 1993, Historic and prehistoric earthquakes near Klamath Falls, Oregon: Earthquakes and Volcanoes, v. 24, no. 3, p. 106-120.

#3565 Walker, G.W., 1963, Reconnaissance geologic map of the eastern half of the Klamath Falls (AMS) quadrangle, Lake and Klamath Counties, Oregon: U.S. Geological Survey Mineral Investigations Field Studies Map MF-260, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 829, Abert Rim fault

**Structure Number** 829

Comments: This structure is fault number 44 of Pezzopane (1993 #3544) and fault number 58 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Abert Rim fault

Comments: This fault was originally mapped and named the Lake Abert fault by Russell (1884 #5099); the fault was later mapped in more detail by Walker (1963 #3565), Walker and Repenning (1965 #3559), Greene and others (1972 #3560), and Madin and others (1996 #3479); the fault was renamed the Abert Rim fault by Pezzopane (1993 #3544) after the prominent topographic escarpment, the Abert Rim, that marks the trace of the fault. The latter name is in common usage and is retained herein.

**Synopsis** This north-northeast-trending normal fault forms the eastern margin of a half graben that confines the Lake Abert basin. The fault is marked by prominent escarpments on Pliocene and Miocene volcanic rocks. The Abert Rim fault is divided into two sections herein, primarily based on recency of movement—a southern section, the Lake Abert section, most of which exhibits evidence of Holocene displacement, and the northern section, which exhibits no evidence of latest Pleistocene or Holocene displacement.

**Date of compilation** December 4, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake

**1° x 2° sheet** Klamath Falls, Adel, Burns

**Province** Basin and Range (Great Basin section)

**Geologic setting** This north-northeast-striking normal fault forms the eastern margin of a half graben that confines the Lake Abert basin in the Basin and Range province of southeastern Oregon. The fault is marked by prominent escarpments on Pliocene to Miocene to Oligocene volcanic rocks (Walker, 1963 #3565; Walker and Repenning, 1965 #3559; Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646).

**Number of sections** 2

Comments: The Abert Rim fault is divided into two sections herein, primarily based on recency of movement—a southern section, the Lake Abert section, most of which exhibits evidence of Holocene displacement, and the northern section, which exhibits no evidence of latest Pleistocene or Holocene displacement.

| | | |
|---|---|---|
| **Length** | End to end (km): | 77.1 |
| | Cumulative trace (km): | 84.8 |

Comments:

**Average strike** (azimuth) N 15° E

### *829a, Lake Abert section*

**Section number** 829a

**Section name** Lake Abert section

Comments:

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker (1963 #3565), and 1:500,000-scale mapping of Walker and MacLeod (1991 #3646) and Pezzopane (1993 #3544).

**Sense of movement** N

Comments: This section is mapped as a normal or high-angle fault by Walker (1963 #3565) and Walker and MacLeod (1991 #3646). Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) note fault patterns that suggest a small component of left-lateral displacement.

**Dip** 70°

Comments: No structural data on fault dip have been published, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of the Abert Rim fault.

**Main dip direction** W

**Geomorphic expression** The range-bounding Abert Rim fault is coincident with a prominent 300- to 700-m-high escarpment (Abert Rim) on Miocene bedrock along its length. The fault exhibits nearly continuous fault scarps on late Pleistocene and Holocene deposits along most of the section adjacent to Abert Lake, from the latitude of Valley Falls, northward to near Highway Spring (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and others, 1996 #3479; Weldon and others, 2002 #5648). Fault-scarp profiles along this section show scarps are 4- to 5-m-high on Holocene debris flows and as much as 8 m high on latest Pleistocene deposits; maximum scarp-slope angles of approximately 30° are near the angle of repose, and in places a scarp free face is preserved (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544).

**Age of faulted deposits at the surface** No radiometric ages have been obtained on deposits along the Abert Lake section, but relations with latest Pleistocene pluvial lake deposits in the region indicate that the fault offsets Holocene colluvium and alluvium, and latest Pleistocene (approximately 16 ka) pluvial lake sediments (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544).

**Paleoseismology studies** No detailed investigations have been conducted, but Pezzopane (1993 #3544) conducted detailed airphoto reconnaissance and measured scarp profiles at several places along the Abert Lake section.

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Fault scarps on Holocene deposits, steep (30°) scarp-slope angles, and the presence of a scarp free face in places along the fault support a Holocene age of most-recent movement on the Abert Lake section of the Abert Rim fault (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544). Geomatrix Consultants, Inc. (1995 #3593), Madin and Mabey (1996 #3575), Madin and others (1996 #3479), and Weldon and others (2002 #5648) also infer Holocene displacement along most of the Abert Lake section.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1 mm/yr

Comments: Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) used an estimated age of 16 ka and offset measurements of 8 m in latest Pleistocene pluvial deposits to calculate a slip rate of 0.5 mm/yr for the Abert Lake section of the Abert Rim fault. They also used a differential elevation of 14 m of latest Pleistocene shorelines across the basin to calculate a deformation rate (mostly fault slip) of 0.5-1 mm/yr.

**Length** End to end (km): 41.5
Cumulative trace (km): 46.8

Comments:

**Average strike** (azimuth) N 14° E

***829b, Northern section***

**Section number** 829b

**Section name** northern section

Comments:

**Reliability of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker (1963 #3565), Walker and Repenning (1965 #3559), Greene and others (1972 #3560), and 1:500,000-scale mapping of Walker and MacLeod (1991 #3646) and Pezzopane (1993 #3544).

**Sense of movement** N

Comments: This section is mapped as a normal or high-angle fault by Walker (1963 #3565), Walker and Repenning (1965 #3559), Greene and others (1972 #3560), and Walker and MacLeod (1991 #3646). Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) note fault patterns that suggest a small component of left-lateral displacement.

**Dip** 70°

Comments: No structural data on fault dip have been published, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of the Abert Rim fault.

**Main dip direction** W

**Geomorphic expression** The range-bounding Abert Rim fault is coincident with a prominent 200- to 300-m-high escarpment (Abert Rim) on Pliocene and Miocene bedrock along its length. No fault scarps on Quaternary deposits have been described along the northern section, although Weldon and others (2002 #5648) describe lineaments across Quaternary deposits on some of the fault traces on 1:100,000-scale DEMs.

**Age of faulted deposits at the surface** The northern section of the Abert Rim fault forms a prominent escarpment on Pliocene and Miocene bedrock, but no fault scarps on Quaternary deposits have been reported along its trace. Offset bedrock is primarily ash-flow tuff with radiometric ages of 4-10 Ma (Walker and MacLeod, 1991 #3646).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary (<1.6 Ma) displacement, and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) also infer Quaternary (<1.6-1.8 Ma) displacement on this section.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip rates are available for the northern section of the Abert Rim fault. However, the fault is marked by a 200- to 300-m-high escarpment on 4-10 Ma volcanic rocks. Such slip data indicate low rates of long-term slip.

**Length** End to end (km): 35.4
Cumulative trace (km): 38.0

Comments:

**Average strike** (azimuth) N 17° E

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3560 Greene, R.C., Walker, G.W., and Corcoran, R.E., 1972, Geologic map of the Burns quadrangle, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-680, 2 sheet, scale 1:250,000.

#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company — Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#5099 Russell, I.C., 1884, A geological reconnaissance in southern Oregon: U.S. Geological Survey Fourth Annual Report, p. 431-464.

#3565 Walker, G.W., 1963, Reconnaissance geologic map of the eastern half of the Klamath Falls (AMS) quadrangle, Lake and Klamath Counties, Oregon: U.S. Geological Survey Mineral Investigations Field Studies Map MF-260, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**830, Unnamed faults north of Abert Lake**

**Structure Number** 830

Comments:

**Structure Name** Unnamed faults north of Abert Lake

Comments: This group of northwest-trending faults was originally mapped by Walker (1963 #3565), with additions from Pezzopane (1993 #3544), Madin and others (1996 #3479), and Weldon and others (2002 #5648).

**Synopsis** These northwest-striking normal faults form a complex of low (<100-m-high) escarpments on Pliocene and Miocene volcanic rocks. No fault scarps on Quaternary deposits have been described along these faults, but travertine mounds deposited by mineralized springs emanating into Pleistocene Lake Chewaucan are aligned along some faults, suggesting latest Pleistocene or Holocene activity on several faults at the southern end of this group of faults. Most faults in this group are inferred to have been active in the middle and late Quaternary.

Date of compilation December 4, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake

**1° x 2° sheet** Klamath Falls, Crescent

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault traces are from approximately 1:120,000 mapping of Madin and others (1996 #3479) and 1:100,000-scale mapping of Weldon and others (2002 #5648).

**Geologic setting** These northwest-trending normal faults form a complex of low escarpments on Pliocene and Miocene volcanic rocks in the Basin and Range of southeastern Oregon (Walker, 1963 #3565; Walker and MacLeod, 1991 #3646; Madin and others, 1996 #3479).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Walker (1963 #3565), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Madin and others (1996 #3479).

**Dip** Not Reported

Comments:

**Main dip direction** SW and NE

**Geomorphic expression** These northwest-striking normal faults form a complex of low (10- to 100-m-high) escarpments on Pliocene and Miocene volcanic rocks (Walker, 1963 #3565; Walker and MacLeod, 1991 #3646; Langridge and others, 1996 #3531). No fault scarps on Quaternary deposits have been described along these faults, although Weldon and others (2002 #5648) describe lineaments across Quaternary deposits on some of the fault traces on 1:100,000-scale DEMs. However, travertine mounds deposited by mineralized springs emanating onto the floor of Pleistocene Lake Chewaucan are aligned along some faults (Madin and others, 1996 #3479; Langridge and others, 1996 #3531).

**Age of faulted deposits at the surface** These northwest-trending normal faults form a complex of low escarpments on Pliocene and Miocene bedrock (Walker, 1963 #3565; Walker and MacLeod, 1991 #3646;

Langridge and others, 1996 #3531), but no fault scarps on Quaternary deposits have been described along their traces. The travertine mounds aligned along some faults were deposited by mineralized springs emanating onto the floor of Pleistocene Lake Chewaucan (Madin and others, 1996 #3479; Langridge and others, 1996 #3531); in the Abert Lake area, this late Pleistocene pluvial lake dates to 12-18 ka (Pezzopane, 1993 #3544).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer middle and late Quaternary (<700-780 ka) displacement, and Madin and others (1996 #3479) infer Quaternary displacement on most of these faults. Langridge and others (1996 #3531) used the occurrence of tufa mounds at a low pluvial shoreline of pluvial lake Chewaucan to infer a period of latest Pleistocene to Holocene movement on these faults, but do not describe offsets of Quaternary deposits. Weldon and others (2002 #5648) infer (but do not describe evidence for) latest Quaternary displacement on three faults at the southern end of the zone; these faults correspond with the young faults identified by Langridge and others (1996 #3531).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed faults north of Abert Lake. However, these faults are marked by low (<100 m high) escarpments on Pliocene and Miocene volcanic rocks. Such slip data indicate very low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 28.6 |
| | Cumulative trace (km): | 86.2 |

Comments:

**Average strike** (azimuth) N 36° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3531 Langridge, R.M., Weldon, R.J.I., Pezzopane, S.K., and Jellinek, A.M., 1996, Active faulting and Tufa formation at Sawed Horn, central Oregon—A possible kinematic link between the Abert Rim and viewpoint faults: Geological Society of America Abstracts with Programs, v. 28, no. 5, p. 84.

#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company — Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3565 Walker, G.W., 1963, Reconnaissance geologic map of the eastern half of the Klamath Falls (AMS) quadrangle, Lake and Klamath Counties, Oregon: U.S. Geological Survey Mineral Investigations Field Studies Map MF-260, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 831, Winter Rim fault system

**Structure Number** 831

Comments: This group of structures consists of fault numbers 34, 35, and 36 of Pezzopane (1993 #3544) and fault number 57 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Winter Rim fault system

Comments: The Winter Rim fault system is a group of normal faults that bound the western flank of the Chewaucan-Summer Lake basin. These faults were originally mapped and named the Summer Lake fault by Russell (1884 #5099); they were later mapped in more detail by Walker (1963 #3565) and Walker and others (1967 #3564). Pezzopane (1993 #3544) named the northern parts of this fault system the Winter Ridge and Ana River faults, and the southern part the Slide Mountain fault. Klinger and others (1996 #3729) used the names Winter Ridge and Summer Lake faults for the northern and southern parts of this system. Herein we retain the names of Pezzopane (1993 #3544) as sections of the informally named Winter Rim fault system of Simpson (1990 #3504).

**Synopsis** This north and northwest-striking, down-to-the-east normal fault system forms the western margin of a large graben or half graben that confines the Chewaucan-Summer Lake basin. The fault is marked by prominent escarpments (Winter Rim) on Miocene volcanic and volcaniclastic sedimentary rocks. The Winter Rim fault system is divided into three sections herein, a southern section, the Slide Mountain section, and two northern sections, the Winter Ridge section and the Ana River section. All sections show evidence of latest Quaternary displacement.

**Date of compilation** December 5, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake

**1° x 2° sheet** Klamath Falls, Crescent

**Province** Basin and Range (Great Basin section)

**Geologic setting** This north and northwest-striking, down-to-the-east normal fault system forms the western margin of a graben or half graben that confines the Chewaucan-Summer Lake basin in the Basin and Range of south-central Oregon. The fault zone is marked by prominent escarpments (Winter Rim)on Miocene volcanic and volcaniclastic sedimentary rocks (Walker, 1963 #3565; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646).

**Number of sections** 3

Comments: The Winter Rim fault system is divided into three sections herein, primarily based on mapping of Pezzopane (1993 #3544)—a southern section, the Slide Mountain section, and two northern sections, the Winter Ridge section and the Ana River section; all sections in part show evidence of latest Quaternary displacement.

| | | |
|---|---|---|
| **Length** | End to end (km): | 57.9 |
| | Cumulative trace (km): | 122.3 |

Comments:

**Average strike** (azimuth) N 38° W

### *831a, Slide Mountain section*

**Section number** 831a

Comments:  This section is fault number 36 of Pezzopane (1993 #3544).

**Section name** Slide Mountain section

Comments:  This part of the fault was informally named the Slide Mountain fault by Pezzopane (1993 #3544).  The southern part of the fault zone was informally referred to as the Hot Springs fault by Weldon and others (2002 #5648).

**Quality of location** Good

Comments:  Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker (1963 #3565) and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments:  This section is mapped as a normal or high-angle fault by Walker (1963 #3565) and Walker and MacLeod (1991 #3646).  Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) note fault patterns that suggest a small component of left-lateral motion.

**Dip** 70°

Comments:  No structural data on the dip of this fault have been published, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of the Winter Rim fault system.

**Main dip direction** NE

**Geomorphic expression** The range-bounding Slide Mountain section of the Winter Rim fault system is coincident with a prominent 1,000-m-high escarpment (Winter Rim) on Miocene bedrock along its length.  This part of the mountain front is disrupted by numerous large landslides, some of which may have been seismically generated (Badger and Watters, 2002 #5148).  The fault exhibits intermittent 6- to 7-m-high fault scarps on latest Pleistocene pluvial lake deposits and younger (Holocene?) deposits along the northern part of the section near Slide Mountain (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544).  The section has a curving form:  the northern part strikes generally east-west, and then curves to a generally north strike at it southern end.  Youngest fault movement is restricted to the northern part of the section (Pezzopane, 1993 #3544; Weldon and others, 2002 #5648).

**Age of faulted deposits at the surface** No radiometric ages have been obtained on faulted deposits along the Slide Mountain section, but regional relations indicate that the fault offsets latest Pleistocene (approximately 16 ka) pluvial lake sediments (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544).

**Paleoseismology studies** Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) conducted trench investigations along the Slide Mountain section between Wooley Creek and Kelley Creek, about 1.5 km south of the south shore of Summer Lake.  The following description is from Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149).

Sites 831a-1 and 831a-2.  The trench located about 100 m west of Kelly Creek (831a-1) was logged and described; apparently no log of the trench located about 100 m east of Wooley Creek (831a-2) was published (Pezzopane, 1993 #3544).  These trenches exposed a fault zone in late Quaternary pluvial lake deposits, fluvial and debris-flow deposits, and colluvium.  The lowermost deposits in the hanging wall were intensely folded, faulted, and interlayered with fault-derived colluvium; they probably represent evidence of multiple events that occurred while pluvial Lake Chewaucan stood at a level above the trench site.  At least two units of post-lacustrine colluvium suggest multiple late Quaternary events.  No datable materials were obtained from the Kelley Creek trench, but an exposure of an alluvial-fan deposit that buried the fault scarp at Kelley Creek yielded a radiocarbon age on charcoal of 2,130 ± 90 yr B.P.  A radiocarbon age of 35,920 ± 820 yr

B.P. on carbon from near the base of the lacustrine section in the footwall block of the Wooley Creek trench provides a maximum age for the offset lacustrine deposits.

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Fresh fault scarps that offset latest Pleistocene pluvial shorelines and deposits support a Holocene age of most-recent movement on the Slide Mountain section of the Winter Rim fault system; the latest event predates 2130 ± 90 yr B.P., the radiocarbon-dated age of alluvial-fan deposits that bury the youngest scarps (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544). Sherrod (1993 #3510) assigned an age of <35 ka for activity on the Slide Mountain section, but did not discuss the basis for this age assignment.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1 mm/yr

Comments: Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) used an estimated age of 16 ka and offset estimates of 6-10 m in latest Pleistocene pluvial deposits to calculate an average slip rate of 0.4-0.6 mm/yr for the Slide Mountain section of the Winter Rim fault system. Geomatrix Consultants, Inc. (1995 #3593) used slip rates of 0.3-0.6 mm/yr in their analysis of earthquake hazards associated with the Slide Mountain section.

| | | |
|---|---|---|
| **Length** | End to end (km): | 32.8 |
| | Cumulative trace (km): | 75.8 |

Comments:

**Average strike** (azimuth) N 57° W

***831b, Winter Ridge section***

**Section number** 831b

Comments: This section is fault number 35 of Pezzopane (1993 #3544).

**Section name** Winter Ridge section

Comments: This part of the fault was informally named the Winter Ridge fault by Pezzopane (1993 #3544). Simpson (1990 #3504) described three short (1-4 km) segments at the north end of the Winter Ridge section, the Jacks Lake, Summer Lake, and White Rock segments; these faults, and the Grange Hall fault of Langridge (1998 #3970) are included in the Winter Ridge section described herein.

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker (1963 #3565), and 1:500,000-scale mapping of Pezzopane (1993 #3544). The trace of the Grange Hall fault, which lies on the valley floor at the northern end of Summer Lake, is from the approximately 1:440,000 scale figure of Langridge (1998 #3970).

**Sense of movement** N

Comments: This section is mapped as a normal or high-angle fault by Walker (1963 #3565), Walker and others (1967 #3564), Simpson (1990 #3504), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544). Simpson (1990 #3504) noted the lack of pull-apart or compressional features as evidence of normal displacement.

**Dip** 70°

Comments: No structural data on the dip of this fault have been published, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of the Winter Rim fault system.

**Main dip direction** E

**Geomorphic expression** The range-bounding Winter Ridge section of the Winter Rim fault system is coincident with a prominent 1,000-m-high escarpment (Winter Rim) on Miocene bedrock along its length. The southern part of the mountain front is disrupted by numerous large landslides. The fault exhibits intermittent 5- to 40-m-high fault scarps on Quaternary deposits where not buried by extensive landslide deposits (Simpson, 1990 #3504; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544). However, if some of these slides were seismically generated (Badger and Watters, 2002 #5148), then some scarps might be related to or enhanced by landslide deformation rather than faulting.

**Age of faulted deposits at the surface** No radiometric ages have been obtained on faulted deposits along the Winter Ridge section, but regional relations indicate that the fault offsets latest Pleistocene (approximately 16 ka) pluvial lake sediments and Holocene(?) alluvial deposits (Simpson, 1990 #3504; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Despite extensive landsliding and pluvial reworking along the fault trace, Simpson (1990 #3504) used field mapping and analysis of fault-scarp profiles to infer latest Pleistocene or Holocene(?) displacement on the Winter Ridge section of the Winter Rim fault system. In addition, Simpson (1990 #3504; 2001 #5093) used the pluvial lake history of the region and the presence of extensive tephras to determine an age of 12-19 ka for compressional deformation located on the basin floor near the southern end of the Ana River section; he attributed this deformation to large-scale mass movements and/or soft-sediment deformation associated with range-front faulting along the Winter Ridge section. Pezzopane (1993 #3544) interpreted these compressional features as possibly being associated with landsliding induced by movement on the nearby Ana River fault, and Langridge (1998 #3970) and Langridge and others (2001 #5092) interpreted these features as soft-sediment deformation associated with the Ana River fault. Pezzopane (1993 #3544) used airphoto analysis and field study to infer middle or late Quaternary (<700 ka) or Holocene displacement, but shows the entire section as middle or late Quaternary on his fault map. Subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) also infer middle or late Quaternary (<780 ka) displacement. Sherrod (1993 #3510) assigned an age of <35 ka for activity on the southern part of the Winter Ridge section, but did not discuss the basis for this age assignment. Herein we follow Weldon and others (2002 #5648), who assign an age of Holocene or post-glacial (<18 ka) for all of the Winter Ridge section, based on offset of latest Pleistocene pluvial lake sediments and Holocene(?) alluvial deposits (Simpson, 1990 #3504; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1 mm/yr

Comments: Simpson (1990 #3504) and Langridge (1998 #3970) calculated long term (Miocene) slip rates of 0.35-0.44 mm/yr and >0.4 mm/yr, respectively, on this section. Geomatrix Consultants, Inc. (1995 #3593) inferred slip rates of 0.3-0.6 mm/yr in their analysis of earthquake hazards associated with the fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 25.9 |
| | Cumulative trace (km): | 38.2 |

Comments:

**Average strike** (azimuth) N 04° W

***831c, Ana River section***

**Section number** 831c

Comments: This section is fault number 34 of Pezzopane (1993 #3544).

**Section name** Ana River section

Comments: This part of the fault system was named the Klippel Point fault by Simpson (1990 #3504), but was renamed the Ana River fault by Pezzopane (1993 #3544); Langridge (1998 #3970) added a southern extension, the Schoolhouse Lake segment, to the Ana River fault of Pezzopane (1993 #3544). The name Ana River section is used herein for all of the mapped trace of the Ana River fault of Simpson (1990 #3504), Pezzopane (1993 #3544), Langridge (1998 #3970), and Langridge and others (2001 #5092).

**Quality of location** Good

Comments: The northern part of the fault trace is from 1:24,000-scale mapping of Simpson (1990 #3504) and Pezzopane (1993 #3544); the southern part of the fault (Schoolhouse Lake segment) is from the approximately 1:30,000 scale figure of Langridge (1998 #3970). All traces are summarized at 1:100,000-scale by Weldon and others (2002 #5648).

**Sense of movement** N

Comments: This section is mapped as a normal or high-angle fault by Donath (1962 #3771), Walker (1963 #3565), Walker and others (1967 #3564), Walker and MacLeod (1991 #3646), Simpson (1990 #3504), Pezzopane (1993 #3544) Madin and others (1996 #3479), and Langridge (1998 #3970). Pezzopane and Weldon (1993 #149) interpret the steep dip and anastomosing character of the fault in a trench exposure as evidence of a minor oblique component of slip, and Langridge (1998 #3970) noted the apparent left-lateral offset of bedrock and lacustrine shorelines along the fault trace.

**Dip** 70°

Comments: No structural data on the dip of this fault have been published, but trench exposures show steep east dips (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Langridge, 1998 #3970). Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of the Winter Rim fault system.

**Main dip direction** E

**Geomorphic expression** The Ana River section of the Winter Rim fault system extends for 3-5 km along the prominent east-facing escarpment of Klippel Point. The fault extends southward across the basin floor as a 2- to 5-m-high fault scarp on pluvial lake deposits (Simpson, 1990 #3504; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Langridge, 1998 #3970; Langridge and others, 2001 #5092). The fault scarp is beveled in places, suggesting recurrent late Quaternary displacement, and in places has been repeatedly eroded during pluvial lake highstands (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Langridge, 1998 #3970; Langridge and others, 2001 #5092). The short length of this fault suggests that it may connect to or be a splay of other parts of the Winter Rim fault system (Pezzopane, 1993 #3544) or other faults in the region (Langridge, 1998 #3970; Langridge and others, 2001 #5092). Simpson (1990 #3504; 2001 #5093), Langridge (1998 #3970), and Langridge and others (2001 #5092) described extensive compressional folds and faults in pluvial lake sediments in an uplifted(?) area exposed by incision of the Ana River near the southern end of the Ana River section. Simpson (1990 #3504; 2001 #5093) attributed these features to large-scale mass movements and/or soft-sediment deformation associated with range-front faulting along the Winter Ridge section. Pezzopane (1993 #3544) suggested a possible relationship between these features and fault movements along the Ana River fault; this latter relationship is explained in detail by Langridge (1998 #3970).

**Age of faulted deposits at the surface** Faulted deposits exposed in the Ana River (Klippel) trench of Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) include pluvial lake sediments that contain numerous Pleistocene tephra, the youngest of which was identified as the 22-23 ka Trego Hot Springs ash. Regional relations indicate that the fault offsets latest Pleistocene (approximately 16 ka) pluvial lake sediments, and deposits that may have been reworked during desiccation of pluvial Lake Chewaucan about 13 ± 3 ka (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Pezzopane and others, 1996 #3532). Faulted deposits described in natural exposures and the River trench by Langridge (1998 #3970) and Langridge and others (2001 #5092) consist of shallow to deep water lacustrine sediments and include numerous middle and late Quaternary tephra. Youngest faulted sediments include detrital Mazama ash, and thus were deposited <7 ka (Langridge, 1998 #3970; Langridge and others, 2001 #5092).

**Paleoseismology studies** Pezzopane (1993 #3544), Pezzopane and Weldon (1993 #149), and Pezzopane and others (1996 #3532) conducted a trench investigation on the Ana River section near the southern end of Klippel Point (site 831c-1). Langridge (1998 #3970) conducted two trench investigations at the southern end of the fault near the Ana River (sites 831c-2 and 831c-3). The following descriptions are from Pezzopane (1993 #3544), Pezzopane and Weldon (1993 #149), Pezzopane and others (1996 #3532), Langridge (1998 #3970), and Langridge and others (2001 #5092).

Site 831c-1. The Ana fault (Klippel) trench of Pezzopane (1993 #3544), Pezzopane and Weldon (1993 #149), Pezzopane and others (1996 #3532), and Langridge and others (2001 #5092) was excavated in 1992, and exposed a broad deformation zone but relatively narrow fault zone in beveled and deformed pluvial lake deposits which contained four late Pleistocene tephras; projections of these tephras across the fault zone suggest offsets of 5-18 m during multiple events that occurred underwater when pluvial Lake Chewaucan stood at some level above the trench site. These deposits are overlain by two units of scarp colluvium separated by a caliche soil horizon; the older of these deposits appears to have been reworked and eroded during the waning stages of desiccation of Lake Chewaucan, 13 ± 3 ka. The youngest wedge post-dates the highstand of Lake Chewaucan, and predates the 4200-foot shoreline that cuts alluvial-fan deposits dated at 2,130 ± 90 yr B.P. along the Slide Mountain section to the south.

Site 831c-2. The River trenches (RT1 and RT2) of Langridge (1998 #3970) and Langridge and others (2001 #5092) were excavated in July 1997 and September 1999, respectively, across the Ana River fault near the southern end of the trace mapped by Pezzopane (1993 #3544); the trenches exposed a broad, complexly deformed fault zone in a shallow to deep water lacustrine section containing numerous late Quaternary tephra. Lacustrine erosion prevented determination of precise offsets, but evidence for multiple late Quaternary faulting events was described in the River trenches. The interpreted number and ages of events appears to have evolved; The following data for event timing are from the most recent summary of Langridge and others (2001 #5092). The two youngest events post-date the latest Pleistocene desiccation of pluvial Lake Chewaucan, and have inferred ages of 4-7.6 ka and 12-13 ka. Calculated sedimentation rates and tephra correlations were used to date four previous sublacustrine events: 29 ± 2.0 ka, 49 ± 5 ka, and 70 ± 6 ka, and 81 ± 6 ka.

Site 831c-3. The Lower trench of Langridge (1998 #3970) was excavated near the trace of a northwest-trending fault that crosses the southern end of the Ana River fault as mapped by Pezzopane (1993 #3544), about 35 m east of the River trenches. The trench was located near the base of a southwest-facing escarpment thought to be related to secondary, down-southwest faulting, but no evidence of faulting was found in the exposure. The trench exposed an undeformed sequence of post-Lake Chewaucan (Holocene) colluvium, alluvium, and pond deposits associated with Holocene periods of lacustrine regression and readvance.

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: The Ana River section of the Winter Rim fault system offsets Trego Hot Springs tephra (22-23 ka); most recent faulting must post-date the desiccation of pluvial Lake Chewaucan (13 ± 3 ka), and predates the formation of the 4200-foot shoreline of the lake, which post-dates 2,130 ± 90 yr B.P. (Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Pezzopane and others, 1996 #3532). Langridge (1998 #3970) inferred an age of 4-7.6 ka for the latest event, based on faulting of Mazama-ash-bearing sediments. Madin and others (1996 #3479) also infer Holocene displacement on the Ana River fault.

**Recurrence interval** 7-21 ky; 15 ky (average)

Comments: Langridge (1998 #3970) used calculated sedimentation rates and tephra correlations from trench and natural exposures to determine the ages of eleven middle and late Quaternary faulting events that he assigned to the Ana River section: 4-7.6 ka, 7.6-14 ka, 12-15 ka, 25.5 ± 1.0 ka, 27-31 ka, 51 ± 5 ka, 73 ± 7 ka, 81 ± 6 ka, 130 ± 5 ka, 160 ± 10 ka, and 167 ± 10 ka. Langridge (1998 #3970) interpreted the first eight events as a probable complete record of faulting; these events yielded an average recurrence interval of about 11 ka, with evidence of shorter (5-6 ka) and longer (19-20 ka) intervals between events. Langridge and others (2001 #5092) modified these results somewhat, to infer 6 paleoseismic events (4-7.6 ka, 12-13 ka, 29 ± 2.0 ka, 49 ± 5 ka, and 70 ± 6 ka, and 81 ± 6 ka), which yield five intervals of about 7-21 ky and an average recurrence interval of about 15 ky. The latter results are the most recently published and thus are used herein.

**Slip-rate category** 0.2-1 mm/yr

Comments: Pezzopane (1993 #3544), Pezzopane and Weldon (1993 #149), and Pezzopane and others (1996 #3532) projected tephra across the fault zone exposed in the Ana River trench to calculate a range of slip rates of 0.1-0.6 mm/yr, and a preferred rate of 0.3 mm/yr. Langridge (1998 #3970) calculated a long-term (<87 ka) slip rate of about 0.12 mm/yr, based on assumed offsets of 1.2-1.4 m per event, and interval slip rates of about 0.07-0.3 mm/yr. Langridge and others (2001 #5092) modified these results somewhat to estimate a slip rate of 0.2 ± 0.1 mm/yr for the Ana River fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 7.5 |
| | Cumulative trace (km): | 8.4 |

Comments:

**Average strike** (azimuth) N 15° W

**References**

#5148 Badger, T.C., and Watters, R.J., 2002, Seismogenic landslide modification of fault scarps, Summer Lake basin, Lake County, Oregon: Geological Society of America Abstracts with Programs, v. 34, no. 5, p. A-107.

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#5093 Simpson, G., 2001, Latest Pleistocene soft-sediment deformation of lacustrine sediments in the northwestern part of the Summer Lake basin, Oregon, *in* Negrini, R., Pezzopane, S., and Badger, T., eds., Quaternary studies near Summer Lake, Oregon: Friends of the Pleistocene, Ninth Annual Pacific Northwest Cell Field Trip, September 28-30, 2001, p. GS 1.

#3504 Simpson, G.D., 1990, Late Quaternary tectonic development of the northwestern part of the Summer Lake Basin, south-central Oregon: Humboldt State University, unpublished Master's thesis, 121 p., 2 pls., scale 1:24,000.

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**832, Faults east of Summer Lake**

**Structure Number** 832

Comments:

**Structure Name** Faults east of Summer Lake

Comments: This group of faults is located east of the Chewaucan-Summer Lake basin or graben; parts of these faults were originally mapped by Russell (1884 #5099), Donath (1962 #3771), Walker (1963 #3565), Walker and others (1967 #3564), and Walker and MacLeod (1991 #3646); two of these faults, the Diablo Mountain and Sand Canyon faults, were named by Donath (1962 #3771). These faults are included in but are not described in Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648).

**Synopsis** These northwest-striking normal faults form a complex of escarpments along the eastern margin of the Chewaucan-Summer Lake basin or graben. Some of the more prominent faults along Coglan Buttes and Diablo Rim form escarpments up to 400 m high on Pliocene and Miocene volcanic rocks. No fault scarps on Quaternary deposits have been described along these faults.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake

**1° x 2° sheet** Klamath Falls, Crescent

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker (1963 #3565) and Walker and others (1967 #3564), and 1:500,000-scale mapping of Walker and MacLeod (1991 #3646) and Pezzopane (1993 #3544).

**Geologic setting** These northwest-striking normal faults form a complex of escarpments on Pliocene and Miocene volcanic rocks along the eastern margin of the Chewaucan-Summer Lake basin or graben, in the Basin and Range of south central Oregon (Donath, 1962 #3771; Walker, 1963 #3565; Walker and others, 1967 #3564; Diggles and others, 1990 #3589; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Donath (1962 #3771), Walker (1963 #3565), Walker and others (1967 #3564), Diggles and others (1990 #3589), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544).

**Dip** Not Reported

Comments:

**Main dip direction** SW and NE

**Geomorphic expression** These northwest-striking normal faults form a complex of northeast- and southwest-facing escarpments on Pliocene and Miocene volcanic rocks (Donath, 1962 #3771; Walker, 1963 #3565; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646); escarpments are as much as 400 m high on the more prominent faults along Coglan Buttes and Diablo Rim. No fault scarps on Quaternary deposits have been described along these faults, but Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** These northwest-striking normal faults form a complex of escarpments on Pliocene and Miocene bedrock, but no fault scarps on Quaternary deposits have been described along their traces.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer Quaternary (<1.6-1.8 Ma) or middle or late Quaternary (<700-780 ka) displacement on these faults; Madin and others (1996 #3479) map the southernmost fault in this zone as age uncertain.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed faults east of Summer Lake. The largest of these faults are marked by 400-m-high escarpments on Pliocene and Miocene volcanic rocks; such slip data suggest low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 62.1 |
| | Cumulative trace (km): | 96.7 |

Comments:

**Average strike** (azimuth) N 16° W

**References**


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#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 833, Faults north of Summer Lake

**Structure Number** 833

Comments:

**Structure Name** Faults north of Summer Lake

Comments: This group of faults is located north the Chewaucan-Summer Lake basin or graben; some of these faults were originally mapped by Russell (1884 #5099), Donath (1962 #3771), Walker (1963 #3565), Hampton (1964 #3790), Walker and others (1967 #3564), Walker and MacLeod (1991 #3646), and Simpson (1990 #3504); six of these faults, from east to west, the Christmas Lake Valley, Sheep Rock, Sagebrush Flat, Juniper Canyon, Watson Draw, and Sheep Lick Draw faults, were named by Donath (1962 #3771). This group of faults is included in but not described in Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648).

**Synopsis** These northwest- and northeast-striking normal faults form a complex of prominent escarpments on a volcanic highland of Pliocene and Miocene volcanic rocks that lies between the north end of the Chewaucan-Summer Lake basin or graben and the south end of the Fort Rock and Christmas Lake Valley basins in the Basin and Range of south-central Oregon. No fault scarps on Quaternary deposits have been described, but Quaternary displacement is inferred, probably based on the prominent bedrock escarpments associated with these faults.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake

**1° x 2° sheet** Crescent

**Province** Basin and Range (Great Basin section); Columbia Plateaus (Harney section)

**Quality of location** Good

Comments: Fault traces in Oregon are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and others (1967 #3564), and 1:500,000-scale mapping of Walker and MacLeod (1991 #3646) and Pezzopane (1993 #3544).

**Geologic setting** These northwest- and northeast-striking normal faults form a complex of prominent escarpments on a volcanic highland of Pliocene and Miocene volcanic rocks that lies between the north end of the Chewaucan-Summer Lake basin and the south end of the Fort Rock and Christmas Lake Valley basins in the Basin and Range of south-central Oregon (Walker, 1963 #3565; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Donath (1962 #3771), Walker (1963 #3565), Walker and others (1967 #3564), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544). Donath (1962 #3771) used a variety of structural relations to infer that the faults developed as strike-slip faults and later became primarily dip slip.

**Dip** >60°

Comments: Donath (1962 #3771) used map patterns to infer that fault dips were greater than 60°, and most were near vertical.

**Main dip direction** W and E

**Geomorphic expression** These northwest- and northeast-striking normal faults form a complex of 100- to 300-m-high escarpments (Dead Indian, Egli, Burma Rims) and fault-bound blocks on Pliocene and Miocene volcanic rocks (Walker, 1963 #3565; Walker and others, 1967 #3564; Simpson, 1990 #3504; Walker and MacLeod, 1991 #3646). No fault scarps on Quaternary deposits have been described along these faults, but a lineament on airphotos extends several hundred meters northward onto the playa floor on the fault that forms the Burma Rim (I.P. Madin, pers. commun., 2001). Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** These northwest- and northeast-striking normal faults form a complex of prominent escarpments on Pliocene and Miocene bedrock (Walker, 1963 #3565; Walker and others, 1967 #3564; Simpson, 1990 #3504; Walker and MacLeod, 1991 #3646), but no fault scarps on Quaternary deposits have been described along their traces.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer Quaternary (<1.6-1.8 Ma) or middle or late Quaternary (<700-780 ka) displacement on these faults, probably based on the prominent bedrock escarpments associated with these faults. Madin and others (1996 #3479) infer Holocene displacement on the Sheep Rock fault, but do not discuss the basis for this age assignment.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed faults north of Summer Lake. The largest of these faults are marked by 300-m-high escarpments on Pliocene and Miocene volcanic rocks; such slip data indicate low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 25.7 |
| | Cumulative trace (km): | 270.6 |

Comments:

**Average strike** (azimuth) N 10° W

**References**


#3771 Donath, F.A., 1962, Analysis of Basin-Range structure, south-central Oregon: Geological Society of America Bulletin, v. 73, p. 1-16.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3790 Hampton, E.R., 1964, Geologic factors that control the occurrence and availability of ground water in the Fork Rock Basin Lake County, Oregon: U.S. Geological Survey Professional Paper 383-B, 29 p., 2 pls., scale 1:62,500.

#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company — Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5099 Russell, I.C., 1884, A geological reconnaissance in southern Oregon: U.S. Geological Survey Fourth Annual Report, p. 431-464.

#3504 Simpson, G.D., 1990, Late Quaternary tectonic development of the northwestern part of the Summer Lake Basin, south-central Oregon: Humboldt State University, unpublished Master's thesis, 121 p., 2 pls., scale 1:24,000.

#3565 Walker, G.W., 1963, Reconnaissance geologic map of the eastern half of the Klamath Falls (AMS) quadrangle, Lake and Klamath Counties, Oregon: U.S. Geological Survey Mineral Investigations Field Studies Map MF-260, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3564 Walker, G.W., Peterson, N.V., and Greene, R.C., 1967, Reconnaissance geologic map of the east half of the Crescent quadrangle Lake, Deschutes, and Crook Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-493, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**834, Paulina Marsh faults**

**Structure Number** 834

Comments: This zone includes fault number 30 of Pezzopane (1993 #3544) and fault number 56 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Paulina Marsh faults

Comments: These faults are located in and along the margins of Paulina Marsh, a large wetland located north of Silver Lake in central Oregon; one fault on the floor of the marsh was named the Paulina Marsh fault by Pezzopane (1993 #3544).

**Synopsis** These northwest-striking faults are located in and along the margins of Paulina Marsh, a large wetland occupying an internally drained basin in the southwestern corner of the Fort Rock Valley that is underlain by Pleistocene and Holocene alluvial and lacustrine deposits. Most faults in the zone offset Miocene to Pliocene volcanic rocks in uplands around the marsh, but the Paulina Marsh fault is marked on the floor of the marsh by a <2-m-high, down-to-the-southwest fault scarp on deposits that may contain Mazama ash. Airphoto analysis suggests possible right-lateral displacement of stream channels on the Paulina Marsh fault, but the other faults are mapped as normal or high-angle faults. Most faults in the zone are inferred to have Quaternary (<1.6 Ma) or middle and late Quaternary (<780 ka) displacement, but the Paulina Marsh fault may have been active in the Holocene.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake

**1° x 2° sheet** Crescent

**Province** Columbia Plateaus (Harney section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and others (1967 #3564) and MacLeod and Sherrod (1992 #3566), and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** These northwest-striking faults are located in and along the margins of Paulina Marsh, a large wetland occupying an internally drained basin in the southwestern corner of the Fort Rock Valley that is underlain by Pleistocene and Holocene alluvial and lacustrine deposits; most faults offset Miocene to Pliocene volcanic rocks in uplands around the marsh (Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566).

**Sense of movement** N, S?

Comments: Airphoto analysis suggests possible right-lateral displacement of stream channels across the Paulina Marsh fault (Pezzopane, 1993 #3544), but Pezzopane (1993 #3544) and Geomatrix Consultants, Inc. (1995 #3593) map the fault as a normal or high angle fault. Other faults in the zone are mapped as normal or high-angle faults (Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566).

**Dip** 90° (Paulina Marsh fault only)

Comments: Geomatrix Consultants, Inc. (1995 #3593) used a near vertical dip in their analysis of earthquake hazards associated with the Paulina Marsh fault. Other faults in the zone are mapped as normal or high angle faults of unknown dip.

**Main dip direction** SW, NE

**Geomorphic expression** The Paulina Marsh fault is marked by a <2-m-high, down-to-the-southwest fault scarp on late Quaternary alluvial and lacustrine deposits on the floor of Paulina Marsh; airphoto analysis suggests possible right-lateral displacement of stream channels (Pezzopane, 1993 #3544). No descriptions of the geomorphic expression of the other faults in the zone have been published, but they appear to form low (<100-m-high) escarpments and shallow grabens on volcanic bedrock. Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** The Paulina Marsh fault has been mapped using airphoto analysis (Pezzopane, 1993 #3544) in Pleistocene and Holocene alluvial and lacustrine deposits (Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566). Pezzopane (1993 #3544) observed yellowish Mazama(?) pumice in stream cut exposures along the base of the scarp, suggesting a Holocene age for some of the offset deposits. The other faults in the zone are mapped as offsetting Miocene to Pliocene volcanic rocks; no fault scarps on Quaternary deposits have been described along these faults, although some of these faults are mapped as juxtaposing Quaternary sediment against volcanic bedrock (Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer latest Quaternary displacement on the Paulina Marsh fault, based on probable presence of Mazama ash in offset deposits along the scarp. Weldon and others (2002 #5648) infer Quaternary (<1.6 Ma) displacement on most of the other faults in the zone, with the exception of the three southernmost faults, for which they infer middle and late Quaternary (<780 ka) displacement.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1 mm/yr (Paulina fault only); other faults unknown; probably < 2 mm/yr

Comments: Geomatrix Consultants, Inc. (1995 #3593) used the maximum scarp height of 2 m measured along the fault and a maximum age of 6.8 ka, based on the probable presence of the Mazama ash in offset deposits (Pezzopane, 1993 #3544), to calculate a slip rate of 0.3 mm/yr for the Paulina Marsh fault. The other faults in the zone have no published slip data, but the low escarpments formed on Miocene to Pliocene volcanic bedrock imply low rates of long-term slip.

**Length** End to end (km): 34.6
Cumulative trace (km): 131.0

Comments:

**Average strike** (azimuth) N 25° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3790 Hampton, E.R., 1964, Geologic factors that control the occurrence and availability of ground water in the Fork Rock Basin Lake County, Oregon: U.S. Geological Survey Professional Paper 383-B, 29 p., 2 pls., scale 1:62,500.

#3566 MacLeod, N.S., and Sherrod, D.R., 1992, Reconnaissance geologic map of the west half of the Crescent 1° by 2° quadrangle, central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2215, 1 sheet, scale 1:250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3564 Walker, G.W., Peterson, N.V., and Greene, R.C., 1967, Reconnaissance geologic map of the east half of the Crescent quadrangle Lake, Deschutes, and Crook Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-493, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 835, Southeast Newberry fault zone

**Structure Number** 835

Comments: This group of structures consists of fault numbers 32 and 33 of Pezzopane (1993 #3544) and fault number 48 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Southeast Newberry fault zone

Comments: This fault zone was named by Pezzopane (1993 #3544) for a group of northwest-striking faults that lie southeast of Newberry Volcano; named faults in this zone include Crack-In-The-Ground, Viewpoint (or Viewpoint Ranch), and Fandango Canyon faults (Donath, 1962 #3771; Peterson and Groh, 1964 #3777; Pezzopane, 1993 #3544).

**Synopsis** This northwest-striking fault zone is a group of relatively short, mostly normal faults that form small escarpments and fault scarps on Plio-Pleistocene volcanic rocks and Pleistocene and Holocene sediments on the floor of Fort Rock Valley. The most-recent events on at least two faults in the zone, the Viewpoint and Crack-In-The-Ground faults, occurred in the Holocene.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake, Deschutes

**1° x 2° sheet** Crescent

**Province** Columbia Plateaus (Harney section)

**Quality of location** Poor

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** This northwest-striking fault zone is a group of relatively short, mostly normal faults that offset Plio-Pleistocene volcanic rocks and Pleistocene and Holocene sediments on the floor of Fort Rock Valley (Donath, 1962 #3771; Peterson and Groh, 1964 #3777; Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544).

**Sense of movement** NS

Comments: These faults are presumed to be primarily normal, with a component of left-lateral strike slip apparent on some faults in the zone (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593).

**Dip** 70-90°

Comments: Dip based on exposures of Viewpoint fault (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593); Geomatrix Consultants, Inc. (1995 #3593) used a dip of 70° in their analysis of earthquake hazards associated with faults in the Southeast Newberry fault zone.

**Main dip direction** SW, NE

**Geomorphic expression** Individual faults in the Southeast Newberry fault zone form small escarpments and fault scarps on Plio-Pleistocene volcanic rocks and late Quaternary alluvial and lacustrine deposits on the floor of Fort Rock basin (Weldon and others, 1992 #3540; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Fault scarps are formed on Pleistocene and Holocene alluvial and lacustrine deposits, and Holocene volcanic rocks of the Four Craters volcanic center (Peterson and Groh, 1964 #3777; Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544). Crack-In-The-Ground offsets 740 ± 59 ka Green Mountain lava flows but offset of post-Mazama Four Corners lava flows is equivocal (Jordan and others, 2002 #5167). Pezzopane (1993 #3544), and Pezzopane and Weldon (1993 #149) infer Holocene movement based on offset of the Four Corners lava.

**Paleoseismology studies** Three trenches at one site on the Viewpoint fault (location 835-1) near the southern end of the Southeast Newberry fault zone were excavated by Weldon and others (1992 #3540), Pezzopane (1993 #3544), and Pezzopane and Weldon (1993 #149). Apparently only one of these trenches (trench 3) was logged (Pezzopane, 1993 #3544). The following description is from Weldon and others (1992 #3540), Pezzopane (1993 #3544), and Pezzopane and Weldon (1993 #149).

Site 835-1. All the trenches exposed anastomosing, high-angle fault zones that juxtapose late Quaternary lacustrine, eolian, and colluvial sediments against basalt bedrock. The lowest units in the hanging wall are deep-water lacustrine sediments that have been intensely deformed and liquefied during earlier faulting events when the trench site was under water. The deformed lacustrine deposits are overlain by several packages of eolian sand and colluvium; the lower two units are faulted deposits of eolian sand, the lower of which contained a camel bone which yielded a radiocarbon age of 11,050 ± 160 yr B.P. These faulted units are overlain by two thin unfaulted deposits of colluvium, possibly reworked by lake waters. The sequence is capped by an eolian deposit containing possible fragments of reworked Mazama pumice. Pezzopane (1993 #3544) and (S.K. Pezzopane, written commun., 1994, in Geomatrix Consultants Inc., 1995 #3593) interprets these relations as evidence of several late Pleistocene surface-faulting events; the most recent event occurred in the early to middle Holocene.

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Pezzopane (1993 #3544) and (S.K. Pezzopane, written commun., 1994, in Geomatrix Consultants Inc., 1995 #3593) found evidence for Holocene displacement on the Viewpoint fault; displacement along the Crack-In-The-Ground fault is equivocal in Holocene volcanic rocks of the Four Craters volcanic center (Peterson and Groh, 1964 #3777; Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Jordan and others, 2002 #5167). Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) infer middle or late Quaternary (<700-780 ka) displacements on the rest of the faults in the Southeast Newberry fault zone. Weldon and others (2002 #5648) infer late Quaternary (<120 ka) displacement on most faults in this zone.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1 mm/yr

Comments: Slip rate estimates of 0.1-0.5 mm/yr across the Viewpoint and Crack-In-The-Ground faults have been determined by Pezzopane and Weldon (1993 #149). Geomatrix Consultants, Inc. (1995 #3593) used the same rates for the entire Southeast Newberry fault zone, but herein only those strands of the fault zone with demonstrated latest Quaternary displacement are assigned slip rates >0.2 mm/yr.

| | | |
|---|---|---|
| **Length** | End to end (km): | 66.3 |
| | Cumulative trace (km): | 204.5 |

Comments:

**Average strike** (azimuth) N 34° W

## References


#3771 Donath, F.A., 1962, Analysis of Basin-Range structure, south-central Oregon: Geological Society of America Bulletin, v. 73, p. 1-16.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3790 Hampton, E.R., 1964, Geologic factors that control the occurrence and availability of ground water in the Fork Rock Basin Lake County, Oregon: U.S. Geological Survey Professional Paper 383-B, 29 p., 2 pls., scale 1:62,500.

#5167 Jordan, B.T., Streck, M.J., and Grunder, A.L., 2002, Bimodal volcanism and tectonism of the High Lava Plains, Oregon, *in* Moore, G.W., ed., Field guide to geologic processes in Cascadia: State of Oregon, Department of Geology and Mineral Industries Special Paper 36, p. 23-46.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3777 Peterson, N.V., and Groh, E.A., 1964, Crack-in-the-ground, Lake County, Oregon: The ORE BIN, v. 26, no. 9, p. 158-167.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3564 Walker, G.W., Peterson, N.V., and Greene, R.C., 1967, Reconnaissance geologic map of the east half of the Crescent quadrangle Lake, Deschutes, and Crook Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-493, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#3540 Weldon, R.J., II, Pezzopane, S.K., Stimac, J.P., and McDowell, P.F., 1992, Guidebook to active faulting in south-central Oregon: Geological Society of America, Cordilleran Meeting Fieldtrip #5, May 8-10, 1992, Guidebook,.

**836, Unnamed faults near Antelope Mountain**

**Structure Number** 836

Comments:

**Structure Name** Unnamed faults near Antelope Mountain

Comments: These faults offset the volcanic complex near Antelope Mountain, located west of Silver Lake in south-central Oregon (MacLeod and Sherrod, 1992 #3566; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593).

**Synopsis** This series of northwest-striking normal or high-angle faults offset Miocene to early Pliocene mafic volcanic rocks at Antelope Mountain and a large basalt complex in the surrounding region in south-central Oregon. The fault cutting Antelope Mountain is marked by a southwest facing, 60- to 80-m-high escarpment; other faults in the zone form shallow grabens (Antelope Flat, Bear Flat, and Sellers Marsh) filled with Quaternary sediment. No fault scarps on Quaternary deposits have been described, but Quaternary displacement is inferred, probably based on the presence of the prominent escarpment at Antelope Mountain and the presence of grabens filled with Quaternary sediment.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake, Klamath

**1° x 2° sheet** Crescent

**Province** Columbia Plateaus (Harney section); Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of MacLeod and Sherrod (1992 #3566) and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** These northwest-striking faults offset the mafic volcanic vent complex at Antelope Mountain and a large basalt complex in the surrounding region; these rocks are Miocene to Pliocene in age (MacLeod and Sherrod, 1992 #3566).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by MacLeod and Sherrod (1992 #3566), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544).

**Dip** Not Reported

Comments:

**Main dip direction** SW and NE

**Geomorphic expression** The fault cutting Antelope Mountain is marked by a southwest facing, 60- to 80-m-high escarpment; other faults in the zone form several shallow, northwest-trending grabens (Antelope Flat, Bear Flat, and Sellers Marsh) filled with Quaternary sediment. No fault scarps on Quaternary deposits have been described along these faults, but Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** These faults are mapped as offsetting Miocene to Pliocene volcanic rocks at Antelope Mountain and the surrounding basalt complex (MacLeod and Sherrod, 1992 #3566). No fault scarps on Quaternary deposits have been described along these faults, although Walker and MacLeod (1991 #3646) map some of these faults juxtaposing Quaternary sediment against volcanic bedrock.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer Quaternary (<1.6-1.8 Ma) displacement on the faults near Antelope Mountain, probably based on the presence of the prominent escarpment at Antelope Mountain and the presence of grabens filled with Quaternary sediment.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data is available for the unnamed faults near Antelope Mountain. However, the prominent fault at Antelope Mountain is marked by a 60- to 80-m-high escarpment on late Miocene to early Pliocene volcanic rocks; such slip data indicate low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 37.6 |
| | Cumulative trace (km): | 80.3 |

Comments:

**Average strike** (azimuth) N 36° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3566 MacLeod, N.S., and Sherrod, D.R., 1992, Reconnaissance geologic map of the west half of the Crescent 1° by 2° quadrangle, central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2215, 1 sheet, scale 1:250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**837, Southwest Newberry fault zone**

**Structure Number** 837

Comments: This group of structures consists of fault number 27 of Pezzopane (1993 #3544) and fault number 49 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Southwest Newberry fault zone

Comments: This fault zone was named by Pezzopane (1993 #3544) and Geomatrix Consultants, Inc. (1995 #3593) for a group of northeast-striking faults that lie southwest of Newberry Volcano. MacLeod and Sherrod (1992 #3566) included some of these faults in their Walker Rim fault zone.

**Synopsis** This northeast-striking fault zone is a group of relatively short, mostly normal faults that form small escarpments and fault scarps on Plio-Pleistocene volcanic rocks and late Quaternary sediments on the southwest flank of Newberry Volcano. Holocene(?) and Pleistocene cinder cones and fissure-vent deposits associated with Newberry Volcano are aligned parallel to the trends of these faults. These faults are mapped as having undergone middle and late Quaternary displacement.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake, Klamath

**1° x 2° sheet** Crescent

**Province** Columbia Plateaus (Harney section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and others (1967 #3564) and MacLeod and Sherrod (1992 #3566), and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** This northeast-striking fault zone is a group of relatively short, mostly normal faults that offset Plio-Pleistocene volcanic rocks and late Quaternary sediments southwest of Newberry volcano in central Oregon (Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Pezzopane, 1993 #3544; MacLeod and others, 1995 #3557).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Walker and others (1967 #3564), MacLeod and Sherrod (1992 #3566), Walker and MacLeod (1991 #3646), and Pezzopane (1993 #3544).

**Dip** Not Reported

Comments: No detailed dip data are available, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their analysis of earthquake hazards associated with faults in the Southwest Newberry fault zone.

**Main dip direction** NW, SE

**Geomorphic expression** Individual faults in the Southeast Newberry fault zone form small escarpments and fault scarps on Pliocene through Holocene(?) volcanic rocks (Hampton, 1964 #3790; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). Holocene(?) and Pleistocene cinder cones and fissure-vent deposits associated with Newberry Volcano are aligned parallel to the trends of these faults (MacLeod and Sherrod, 1988 #3770). Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Fault scarps are formed on Holocene(?), middle to late Pleistocene, and Pliocene volcanic rocks on the southwest flank of Newberry Volcano (Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Pezzopane, 1993 #3544; MacLeod and others, 1995 #3557).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Most faults in this zone cut poorly dated middle to late Pleistocene volcanic rocks (MacLeod and Sherrod, 1992 #3566; MacLeod and others, 1995 #3557). Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer middle and late (<700-780 ka) Quaternary displacement on most faults in this zone.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip data are available, but Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.01-0.1 mm/yr in their analysis of earthquake hazards associated with the Southwest Newberry fault zone.

| | | |
|---|---|---|
| **Length** | End to end (km): | 35.6 |
| | Cumulative trace (km): | 121.9 |

Comments:

**Average strike** (azimuth) N 41° E

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3790 Hampton, E.R., 1964, Geologic factors that control the occurrence and availability of ground water in the Fork Rock Basin Lake County, Oregon: U.S. Geological Survey Professional Paper 383-B, 29 p., 2 pls., scale 1:62,500.

#3770 MacLeod, N.S., and Sherrod, D.R., 1988, Geologic evidence for a magma chamber beneath Newberry Volcano, Oregon: Journal of Geophysical Research, v. 93, no. B9, p. 10,067-10,079.

#3566 MacLeod, N.S., and Sherrod, D.R., 1992, Reconnaissance geologic map of the west half of the Crescent 1° by 2° quadrangle, central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2215, 1 sheet, scale 1:250,000.

#3557 MacLeod, N.S., Sherrod, D.R., Chitwood, L.A., and Jensen, R.A., 1995, Geologic map of Newberry Volcano, Deschutes, Klamath, and Lake Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2455, 2 sheets, scale 1:24,000 and 1:62,500.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3564 Walker, G.W., Peterson, N.V., and Greene, R.C., 1967, Reconnaissance geologic map of the east half of the Crescent quadrangle Lake, Deschutes, and Crook Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-493, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**838, La Pine graben faults**

**Structure Number** 838

Comments: This group of structures is fault number 50 of Geomatrix Consultants, Inc. (1995 #3593) and is included in fault number 28 of Pezzopane (1993 #3544).

**Structure Name** La Pine graben faults

Comments: These faults are located in the La Pine basin near the town of La Pine in central Oregon (MacLeod and Sherrod, 1992 #3566; Geomatrix Consultants Inc., 1995 #3593; Sherrod and Smith, 2000 #5165). Hawkins and others (1989 #2947) named the most prominent of these faults the Wampus fault, after nearby Wampus Butte. Ake and others (2001 #5035) renamed this structure the Wampus fault zone, and include in this zone the Dilman Meadows fault; the latter was informally referred to as the Haner Park fault in earlier internal Bureau of Reclamation documents (Ake and others, 2001 #5035). The Gilchrist Butte fault (Hemphill-Haley, 2001 #5036) or Gilchrist Butte faults (Ake and others, 2001 #5035) are also included in the Wampus fault zone. Four other possible faults inferred from gravity data (La Pine Basin I, II, III, and IV faults) have no topographic expression or demonstrated offset in Quaternary deposits, but probably form the margins of the composite La Pine graben (Ake and others, 2001 #5035).

**Synopsis** These structures are a group of normal faults located in the La Pine graben or basin in central Oregon. The basin is filled with Quaternary sediments which bury a composite graben structure bisected by a north-striking horst block coincident with a chain of aligned volcanic vents (Gilchrist, Wampus, and Pringle Buttes). The subsurface structure is inferred from regional gravity data, which shows the horst block dividing the basin into two subbasins. Four possible faults that may bound the basin margins inferred from gravity data now have no topographic expression and have no demonstrated offset in Quaternary deposits. In contrast, numerous traces of the Wampus fault zone offset Plio-Pleistocene volcanic rocks and may uplift middle Pleistocene sediments in the horst block. The Dilman Meadows fault offsets middle and late Quaternary alluvial and lacustrine sediments in a cutbank of the Deschutes River. The distributed fault pattern and association with young volcanic rocks may indicate some of these faults are volcanic in origin.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Deschutes, Klamath

**1° x 2° sheet** Crescent

**Province** Columbia Plateaus (Harney section); Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of MacLeod and Sherrod (1992 #3566), 1:500,000-scale mapping of Pezzopane (1993 #3544), and Sherrod and Smith (2000 #5165), and 1:350,000-scale mapping of Ake and others (2001 #5035). The trace of the Dilman Meadows fault is from approximately 1:67,000-scale mapping of Lyon (2001 #5061).

**Geologic setting** These structures are a group of normal faults located in the La Pine graben or basin in central Oregon. The basin is filled with Quaternary sediments which bury a composite graben structure bisected by a north-striking horst block coincident with a chain of aligned volcanic vents (Gilchrist, Wampus, and Pringle Buttes). The subsurface structure is inferred from regional gravity data (Pitts and Couch, 1978 #5038; Couch and Foote, 1985 #3772). The horst block divides the basin into two subbasins; the western subbasin is referred to as the Shukash basin and the eastern subbasin is referred to as the La Pine basin (Couch and Foote, 1985 #3772; Ake and others, 2001 #5035). Structural relief is 600-800 m across the composite graben (MacLeod and Sherrod, 1992 #3566). Four possible faults that may bound the basin margins are inferred from gravity but have no topographic expression and no demonstrated offset in Quaternary deposits (Ake and others, 2001 #5035). In contrast, numerous traces of the Wampus fault zone offset Plio-Pleistocene volcanic rocks of the horst block (Hawkins and others, 1989 #2947; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Scott and Gardner, 1992 #3569; Sherrod and Smith, 2000 #5165; Sherrod and others, 2002 #5169), and appear to offset Quaternary sediments in at least one location. The distributed fault pattern and association with young volcanic rocks may indicate some of these faults are volcanic in origin (Couch and Foote, 1985 #3772; Ake and others, 2001 #5035; Hemphill-Haley, 2001 #5036). Lyon (2001 #5061) inferred possible temporal association of displacement on the Dilman Meadows fault with emplacement of the Mount Bachelor volcanic chain (Scott and Gardner, 1992 #3569).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Hawkins and others (1989 #2947), Walker and MacLeod (1991 #3646), MacLeod and Sherrod (1992 #3566), Scott and Gardner (1992 #3569), Pezzopane (1993 #3544), Sherrod and Smith (2000 #5165), Ake and others (2001 #5035), and Lyon (2001 #5061).

**Dip** 60°-70°

Comments: Ake and others (2001 #5035) report a dip of 68° on an exposure of the Dilman Meadows fault of the Wampus Butte fault zone. Sherrod and Pickthorn (1989 #3599) estimated dips of 60° on the La Pine graben faults, and Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of faults in the La Pine graben.

**Main dip direction** W, E

**Geomorphic expression** This fault zone consists of numerous 1- to 6-km-long fault strands with both east and west dips. The most conspicuous structure in this group of faults, the Wampus fault, is expressed as a 6-km-long, 5- to 25-m-high scarp on Miocene(?) (Hawkins and others, 1989 #2947) or early to middle Pleistocene basaltic andesites (Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Scott and Gardner, 1992 #3569; Sherrod and Smith, 2000 #5165; Ake and others, 2001 #5035; Sherrod and others, 2002 #5169). Other scarps with both east and west dips offset similar volcanic rocks to the north in the Round Mountain/Lookout Mountain area, and to the south on Gilchrist Butte; none of these faults are mapped in adjacent Quaternary sediments. The Dilman Meadows fault is the only strand of the Wampus fault zone that demonstrably offsets Quaternary sediments (Ake and others, 2001 #5035; Lyon, 2001 #5061). This fault is exposed in a cutbank of the Deschutes River, which exposed faulted middle and late Quaternary alluvial and lacustrine deposits; the fault is difficult to trace in the forested terrain, but apparently is marked by a 3-km-long, 1- to 4.6-m-high scarp on middle and late Quaternary lacustrine and fluvial sediments and terraces, the youngest of which contains the Mazama ash (Lyon, 2001 #5061). The graben margin faults inferred from the gravity data by Ake and others (2001 #5035) have no topographic expression or demonstrated offset in Quaternary deposits.

**Age of faulted deposits at the surface** Hawkins and others (1989 #2947) obtained several late Miocene K/Ar ages on the volcanic rocks offset by these faults; however, they acknowledge that low potassium contents make dating these rocks difficult, and others agree that these ages are too old (Sherrod and others, 2002 #5169). The youngest offset bedrock is mapped as Plio-Pleistocene by Walker and MacLeod (1991 #3646) and MacLeod and Sherrod (1992 #3566), and as lower to upper Pleistocene by Scott and Gardner (1992 #3569). The faulted shield volcano of Gilchrist Butte, near the southern end of the fault zone, yielded a K/Ar age of 0.61 ± 0.05 Ma (MacLeod and Sherrod, 1992 #3566). No fault scarps are mapped on Quaternary sediments (Hawkins and others, 1989 #2947; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Scott and Gardner, 1992 #3569; Sherrod and Smith, 2000 #5165), except the two faults near the southern end of the basin mapped by Pezzopane (1993 #3544) and Weldon and others (2002 #5648). The newly discovered Dilman Meadows fault offsets middle Pleistocene lacustrine deposits that contain a distinctive lapilli tephra that has been correlated with the Pringle Falls tephra layer (Ake and others, 2001 #5035; Lyon, 2001 #5061), which has been argon/argon dated nearby at 218 ± 10 ka (Herrero-Bervera and others, 1994 #5040). The Dilman Meadows fault also offsets last-glacial-maximum outwash deposits, several younger fluvial (outwash?) terraces, and deposits containing the 7.6 ka Mazama ash (Lyon, 2001 #5061). The middle Pleistocene sediments containing the Pringle Falls tephra may also be uplifted in the Pringle Butte-Gilchrist Butte horst block (Sherrod and others, 2002 #5169).

**Paleoseismology studies** One trench (location 838-1) and one natural stream exposure (location 838-2) of the Dilman Meadows fault were described by Lyon (2001 #5061). The following descriptions are from Lyon (2001 #5061).

Site 838-1. A nine-meter-long, 2-m-deep trench (trench TT-00-1 of Lyon (2001 #5061)) was excavated in Pleistocene glacial outwash deposits across a 4-m-high fault scarp about 50 m north of the Deschutes River exposure described at site 838-2. The south wall of the trench exposed Pleistocene lacustrine silt overlain by glacial outwash gravel in the footwall, faulted against glacial outwash gravel, overlain by a root-stirred deposit of Mazama ash with bedded ash at its base. The north wall showed similar relations, with the bedded Mazama ash faulted about 60 cm against the lacustrine deposits in the footwall.

Site 838-2. A fifty-meter-long, 12-m-high exposure of the Dilman Meadows fault along the north bank of the Deschutes River was described by Lyon (2001 #5061). The cutbank exposed a thick sequence of lacustrine silt, overlain by glacial outwash gravel and a mantle of Mazama ash in the footwall. The lacustrine silt contains a 30-cm-thick bed of the Pringle Falls D tephra, which has been argon/argon dated nearby at 218 ± 10 ka (Herrero-Bervera and others, 1994 #5040). The footwall deposits are faulted against lacustrine silt in the hanging wall that does not contain the Pringle Falls D tephra; these deposits in turn are overlain by two packages of outwash gravel and a mantle of Mazama ash. The exposure records several faulting events, only a few of which are recorded as colluvial wedges, interspersed with fluvial (glacial outwash) events that planed off some of the hanging wall and footwall deposits.

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) classified these faults as middle and late (<700-780 ka) Quaternary, based primarily on offset of the 0.61 Ma shield volcano of Gilchrist Butte. Hawkins and others (1989 #2947) found no evidence of late Quaternary displacement on faults near Wampus Butte. Ake and others (2001 #5035) describe evidence of offset of middle and late Quaternary alluvial and lacustrine deposits along the newly discovered Dilman Meadows fault. In a more detailed study, Lyon (2001 #5061) inferred Holocene movement on the Dilman Meadows fault, based on offset of deposits containing the Mazama ash. Weldon and others (2002 #5648) mapped most of these faults, including the inferred basin margin faults, as active in the late Quaternary (<120 ka), but do not discuss the evidence for this age assignment; they also mapped several previously unmapped faults to the south and west as active in the middle and late Quaternary (<780 ka). The graben margin faults inferred from the gravity data by Ake and others (2001 #5035) have no topographic expression or demonstrated offset in Quaternary deposits; although they probably began forming the La Pine and Shukash subbasins in the Pliocene or early Pleistocene (Sherrod and others, 2002 #5169) and are herein mapped as Quaternary (<1.6 Ma) until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.01-0.3 mm/yr in their analysis of earthquake hazards associated with the La Pine graben faults. Pezzopane (1993 #3544) inferred an average slip rate of about 0.5-1 mm/yr across the La Pine graben, presumably distributed across several faults. Ake and others (2001 #5035) estimated a preferred slip rate of .04 mm/yr on the Wampus fault zone in their analysis of earthquake hazards in the vicinity of Wickiup Dam. Lyon (2001 #5061) inferred slip rates of 0.04-0.31 mm/yr on the Dilman Meadows fault for various intervals from about 140 ka to the late Holocene. However, the best documented slip data suggest long-term slip rates on the Dilman Meadows fault of <0.2 mm/yr.

| | | |
|---|---|---|
| **Length** | End to end (km): | 45.6 |
| | Cumulative trace (km): | 149.3 |

Comments:

**Average strike** (azimuth) N 20° E

**References**

#5035 Ake, J., LaForge, R., and Hawkins, F., 2001, Probabilistic seismic hazard analysis for Wickiup Dam—Deschutes project, central Oregon: U.S. Bureau of Reclamation Seismotectonic Report 2000-04, 71 p.

#3772 Couch, R., and Foote, R., 1985, The Shukash and Lapine Basins—Pleistocene depressions in the Cascade Range of central Oregon: Eos, Transactions of the American Geophysical Union, v. 66, no. 3, p. 24.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#2947 Hawkins, F.F., LaForge, R.C., and Gilbert, J.D., 1989, Seismotectonic study for Wickiup and Crane Prairie Dams, Deschutes Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 89-2, 38 p., 1 pl.

#5036 Hemphill-Haley, M., 2001, Appendix A - Summary of studies on the Sisters fault zone, *in* Ake, J., LaForge, R., and Hawkins, F., eds., Probabilistic seismic hazard analysis for Wickiup Dam—Deschutes project, central Oregon: Seismotectonic Report 2000-04, p. A1-B16.

#5040 Herrero-Bervera, E., Helsley, C.E., Sarna-Wojcicki, A.M., Lajoie, K.R., Meyer, C.E., McWilliams, M.O., Negrini, R.M., Turrin, B.D., Donnelly-Nolan, J.M., and Liddicoat, J.C., 1994, Age and correlation of a paleomagnetic episode in the Western United States by 40Ar/39Ar dating and tephrochronology—The Jamaica, Blake, or a new polarity episode?: Journal of Geophysical Research, v. 99, no. B12, p. 24,091-24,103.

#5061 Lyon, E.W., Jr., 2001, Late Quaternary geochronology and recent faulting along the eastern margin of the Shukash basin, central Cascadia range, Oregon: Boise State University, unpublished M.S. thesis, 99 p.

#3566 MacLeod, N.S., and Sherrod, D.R., 1992, Reconnaissance geologic map of the west half of the Crescent 1° by 2° quadrangle, central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2215, 1 sheet, scale 1:250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5038 Pitts, S., and Couch, R., 1978, Complete Bouguer gravity anomaly map, Cascade Mountain range, central Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-8, 1 sheet, scale 1:125,000.

#3569 Scott, W.E., and Gardner, C.A., 1992, Geologic map of the Mount Bachelor volcanic chain and surrounding area, Cascade Range, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1967, 1 Sheet, scale 1:50,000.

#5169 Sherrod, D.R., Gannett, M.W., and Lite, K.E., Jr., 2002, Hydrogeology of the upper Deschutes basin, central Oregon—A young basin adjacent to the Cascade volcanic arc, *in* Moore, G.W., ed., Field guide to geologic processes in Cascadia: State of Oregon, Department of Geology and Mineral Industries Special Paper 36, p. 109-144.

#3599 Sherrod, D.R., and Pickthorn, L.G., 1989, Some notes on the Neogene structural evolution of the Cascade Range in Oregon, *in* Muffler, P.L.J., Weaver, C.S., and Blackwell, D.D., eds., Geological, geophysical, and tectonic setting of the Cascade Range: U.S. Geological Survey Open-File Report 89-178, p. 351-368.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**839, Chemult graben fault system**

**Structure Number** 839

Comments: This group of structures consists of fault numbers 28 and 29 of Pezzopane (1993 #3544) and fault numbers 51a and 51b of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Chemult graben fault system

Comments: The Chemult graben fault system is a group of faults that bound the Chemult graben in central Oregon. Numerous authors use the names Chemult graben or fault zone and Walker Rim fault or fault zone for these structures (Higgins, 1973 #3764; Sherrod and Pickthorn, 1989 #3599; Goles and Lambert, 1990 #3763; MacLeod and Sherrod, 1992 #3566, 1988; Pezzopane, 1993 #3544); Geomatrix Consultants, Inc. (1995 #3593) used the name Chemult Graben-Walker Rim fault zone. Herein we informally include the primarily east-down faults that bound the western margin of the graben in a western section, and the primarily west-down faults that bound the eastern margin of the graben in the Walker Rim section.

**Synopsis** This north- and northeast-striking normal fault system forms the Chemult graben in central Oregon at the intersection of the northwestern Basin and Range and the Cascade Range. The fault system is marked by prominent escarpments (Walker Rim) on upper Miocene to lower Pliocene volcanic rocks; much of the southern part of the graben is covered with pyroclastic deposits of Holocene Mount Mazama. Faults in the western section form small scarps on middle Pleistocene alluvial deposits along the Little Deschutes River, and perhaps on latest Pleistocene(?) glacial moraines that are buried by Mazama pyroclastic debris south of Little Walker Mountain. No scarps in Quaternary deposits have been described along faults in the Walker Rim section, which forms the eastern margin of the graben.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Klamath

**1° x 2° sheet** Crescent, Klamath Falls,

**Province** Basin and Range (Great Basin section); Columbia Plateaus (Harney section); Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Geologic setting** This north- and northeast-striking normal fault system forms the Chemult graben in central Oregon at the intersection of the northwestern Basin and Range and the Cascade Range. The fault is marked by prominent escarpments (Walker Rim) on upper Miocene to lower Pliocene volcanic rocks; much of the southern part of the graben is covered with pyroclastic deposits of Holocene Mount Mazama (Sherrod and Smith, 1989 #3498; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Sherrod and Smith, 2000 #5165).

**Number of sections** 2

Comments: Following Geomatrix Consultants, Inc. (1995 #3593), the Chemult graben fault system is divided into two sections herein, a western section that consists of the mostly east-down faults that bound the western margin of the graben, and the Walker Rim section that consists of the mostly west-down faults that bound the eastern margin of the graben; the primary structures in the latter section are associated with the Walker Rim fault zone.

| | | |
|---|---|---|
| **Length** | End to end (km): | 69.6 |
| | Cumulative trace (km): | 514.6 |

Comments:

**Average strike** (azimuth) N 07° E

***839a, Western section***

**Section number** 839a

Comments: This section is fault number 51a of Geomatrix Consultants, Inc. (1995 #3593).

**Section name** western section

Comments: This part of the fault system is part of the Chemult fault zone of Goles and Lambert (1990 #3763), and was informally named the Chemult graben (western margin) by Geomatrix Consultants, Inc. (1995 #3593).

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of MacLeod and Sherrod (1992 #3566) and 1:500,000-scale mapping of Pezzopane (1993 #3544) and Sherrod and Smith (2000 #5165).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Walker and MacLeod (1991 #3646), MacLeod and Sherrod (1992 #3566), Pezzopane (1993 #3544), Bacon and others (1997 #3516), and Sherrod and Smith (2000 #5165).

**Dip** 60-70°

Comments: No structural data on the dip of these faults have been published, but Sherrod and Pickthorn (1989 #3599) estimated dips of 60° on the Chemult graben faults, and Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of the Chemult graben fault system.

**Main dip direction** E, W

**Geomorphic expression** Faults in the western section form small scarps on middle Pleistocene alluvial deposits along the Little Deschutes River north of Little Walker Mountain (MacLeod and Sherrod, 1992 #3566). South of Little Walker Mountain, faults in this section form escarpments on upper Miocene to Pleistocene volcanic rocks, but are covered with pyroclastic deposits from the eruption of Holocene Mount Mazama (Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Sherrod and Smith, 2000 #5165). However, S.K. Pezzopane (personal commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) describes 5- to 6-m-high fault scarps on latest Pleistocene(?) glacial moraines that are buried by Mazama pyroclastic debris, presumably along faults in the western section. Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Faults in the western section offset lava flows as young as 0.88 ± 0.03 Ma (MacLeod and Sherrod, 1992 #3566). No radiometric ages have been obtained on faulted Quaternary sediments along the western section. However, Walker and MacLeod (1991 #3646), MacLeod and Sherrod (1992 #3566), and Sherrod and Smith (2000 #5165) mapped faults in middle Pleistocene (>150 ka) alluvial deposits along the Little Deschutes River, and S.K. Pezzopane (personal commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) describes fault scarps on latest Pleistocene(?) glacial moraines that are buried by Mazama pyroclastic debris along faults in the western section. Ake and others (2001 #5035) used airphoto analysis to question the interpretation of Pezzopane.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) classified these faults as middle and late (<700-780 ka) Quaternary. Weldon and others (2002 #5648) map some of these faults as active in the middle and late Quaternary (<780 ka), and others as active in the late Quaternary (<120 ka). The most-recent event must predate 6,845 ± 50 radiocarbon yr B.P. (Bacon, 1983 #3787), because all faults south of Little Walker Mountain are buried by pyroclastic debris from the climactic eruption of Mount Mazama (MacLeod and Sherrod, 1992 #3566).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: No age-calibrated slip-rate data have been published, but Geomatrix Consultants, Inc. (1995 #3593) used age and slip estimates of 5-6 m in approximately 15 ka deposits from S.K. Pezzopane (personal commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) to calculate a slip rate of 0.4 mm/yr, but used a lower range in slip rates of 0.01-0.3 mm/yr in their analysis of earthquake hazards along the western section. Pezzopane (1993 #3544) inferred an average slip rate of about 0.5-1 mm/yr across the Chemult graben, although this slip must be accommodated on many faults. Ake and others (2001 #5035) used the subdued geomorphic development to conclude that slip rates across the fault zone are probably <0.1 mm/yr.

| | | |
|---|---|---|
| **Length** | End to end (km): | 48.8 |
| | Cumulative trace (km): | 226.0 |

Comments:

**Average strike** (azimuth) N 14° E

### *839b, Walker Rim section*

**Section number** 839b

Comments: This section is fault number 51b of Geomatrix Consultants, Inc. (1995 #3593).

**Section name** Walker Rim section

Comments: This section includes the Walker Rim fault zone of Higgins (1973 #3764), MacLeod and Sherrod (1988 #3770; 1992 #3566), Sherrod and Pickthorn (1989 #3599), and Pezzopane (1993 #3544), parts of the Sellers Creek fault zone of Goles and Lambert (1990 #3763), and the Walker Rim faults (eastern margin of Chemult graben) of Geomatrix Consultants, Inc. (1995 #3593).

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of MacLeod and Sherrod (1992 #3566) and 1:500,000-scale mapping of Pezzopane (1993 #3544) and Sherrod and Smith (2000 #5165).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Walker and MacLeod (1991 #3646), MacLeod and Sherrod (1992 #3566), Pezzopane (1993 #3544), Bacon and others (1997 #3516), and Sherrod and Smith (2000 #5165).

**Dip** 70°

Comments: No structural data on the dip of these faults have been published, but Sherrod and Pickthorn (1989 #3599) estimated dips of 60° on the Chemult graben faults, and Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of the Chemult graben fault system.

**Main dip direction** W, E

**Geomorphic expression** The most prominent structure in this section, the range-bounding Walker Rim fault zone, is coincident with a prominent 300-m-high escarpment (Walker Rim) on upper Miocene to lower Pliocene volcanic rocks. Further south, the section bifurcates into a series of predominantly down-west faults marked by lower escarpments (<100 m high) on bedrock; all of these escarpments are partially buried by pyroclastic debris from the Mount Mazama eruptions. No fault scarps on Quaternary deposits have been described along the faults included in this section. These faults appear to be less active than faults in the western section (MacLeod and Sherrod, 1992 #3566; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Ake and others, 2001 #5035). Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Faults in the Walker Rim section offset lava flows as young as 2.33 ± 0.09 Ma (Sherrod and Pickthorn, 1989 #3599; Sherrod and others, 2002 #5169). No fault scarps on Quaternary deposits have been described along faults included in this section.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Most faults in this section are classified as active in the Quaternary (<1.6-1.8 Ma) by Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575). Pezzopane (1993 #3544) used geomorphic and airphoto analysis to infer middle and late Quaternary (<780 ka) movement on a few of the faults in the Walker Rim section. Weldon and others (2002 #5648) map most of these faults as active in the middle and late Quaternary (<780 ka) and a few as active in the late Quaternary (<120 ka).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category <**0.2 mm/yr

Comments: No age-calibrated slip-rate data have been published for faults in the Walker Rim section of the Chemult graben fault system. However, 300-m-high escarpments in 4.5-7 Ma volcanic rocks along the Walker Rim fault zone suggest low rates of long-term slip. Geomatrix Consultants, Inc. (1995 #3593) used the poor geomorphic expression of faults in the section to infer a range in slip rates of 0.01-0.1 mm/yr in their analysis of earthquake hazards along the Walker Rim section. Pezzopane (1993 #3544) inferred an average slip rate of about 0.5-1 mm/yr across the Chemult graben, although this slip must be accommodated on many faults. Ake and others (2001 #5035) used the subdued geomorphic development to conclude that slip rates across the fault zone are probably <0.1 mm/yr.

| | | |
|---|---|---|
| **Length** | End to end (km): | 60.4 |
| | Cumulative trace (km): | 288.5 |

Comments:

**Average strike** (azimuth) N 01° E

**References**

#5035 Ake, J., LaForge, R., and Hawkins, F., 2001, Probabilistic seismic hazard analysis for Wickiup Dam—Deschutes project, central Oregon: U.S. Bureau of Reclamation Seismotectonic Report 2000-04, 71 p.

#3787 Bacon, C.R., 1983, Eruptive history of Mount Mazama and Crater Lake Caldera, Cascade Range, USA: Journal of Volcanology and Geothermal Research, v. 18, p. 57-115.

#3516 Bacon, C.R., Mastin, L.G., Scott, K.M., and Nathenson, M., 1997, Volcano and earthquake hazards in the Crater Lake region, Oregon: U.S. Geological Survey Open-File Report 97-487, 30 p., 1 pl., scale 1:100,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3763 Goles, G., and Lambert, R.S.J., 1990, A strontium isotopic study of Newberry volcano, central Oregon—Structural and thermal implications: Journal of Volcanology and Geothermal Research, v. 43, p. 159-174.

#3764 Higgins, M.W., 1973, Petrology of Newberry Volcano, central Oregon: Geological Society of America Bulletin, v. 84, p. 455-488.

#3770 MacLeod, N.S., and Sherrod, D.R., 1988, Geologic evidence for a magma chamber beneath Newberry Volcano, Oregon: Journal of Geophysical Research, v. 93, no. B9, p. 10,067-10,079.

#3566 MacLeod, N.S., and Sherrod, D.R., 1992, Reconnaissance geologic map of the west half of the Crescent 1° by 2° quadrangle, central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2215, 1 sheet, scale 1:250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5169 Sherrod, D.R., Gannett, M.W., and Lite, K.E., Jr., 2002, Hydrogeology of the upper Deschutes basin, central Oregon—A young basin adjacent to the Cascade volcanic arc, *in* Moore, G.W., ed., Field guide to geologic processes in Cascadia: State of Oregon, Department of Geology and Mineral Industries Special Paper 36, p. 109-144.

#3599 Sherrod, D.R., and Pickthorn, L.G., 1989, Some notes on the Neogene structural evolution of the Cascade Range in Oregon, *in* Muffler, P.L.J., Weaver, C.S., and Blackwell, D.D., eds., Geological, geophysical, and tectonic setting of the Cascade Range: U.S. Geological Survey Open-File Report 89-178, p. 351-368.

#3498 Sherrod, D.R., and Smith, J.G., 1989, Preliminary map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Open-File Report 89-14, 20 p., 1 pl., scale 1:500,000.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 840, Faults on the Modoc Plateau

**Structure Number** 840

Comments:

**Structure Name** Faults on the Modoc Plateau

Comments: These faults are located east of the Klamath Falls graben in the northwestern part of the Modoc Plateau. They have been mapped by Peterson and McIntyre (1970 #3791) and Sherrod and Pickthorn (1992 #3567). Klinger and others (1996 #3729) included some of these faults in the East Klamath Lake fault zone.

**Synopsis** These north-northwest-striking, down-to-the-southwest and down-to-the-northeast normal faults offset late Miocene and Pliocene volcanic rocks of the Modoc Plateau in south-central Oregon. They may represent a less active eastern extension of the Klamath Falls graben system [843]. These faults form escarpments up to 450 m high on Pliocene bedrock, and some form small grabens or half grabens filled with Miocene through Quaternary sediment. No fault scarps on Quaternary deposits have been described along these faults.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Klamath (OR)

**1° x 2° sheet** Klamath Falls

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Sherrod and Pickthorn (1992 #3567) and 1:500,000-scale mapping of Pezzopane (1993 #3544) and Sherrod and Smith (2000 #5165).

**Geologic setting** These north-northwest-striking, down-to-the-southwest and down-to-the-northeast normal faults offset late middle Pliocene (Sherrod and Pickthorn, 1992 #3567) or Plio-Pleistocene (Walker and MacLeod, 1991 #3646) volcanic rocks and Miocene to Pliocene volcaniclastic rocks of the Modoc Plateau in south-central Oregon. They may represent a less active eastern extension of the Klamath Falls graben system [843]. Young faults with similar trends are present across the border in the Modoc Plateau in northern California (Gay and Aune, 1958 #4890; Jennings, 1994 #2878).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Walker and MacLeod (1991 #3646), Sherrod and Pickthorn (1992 #3567), Pezzopane (1993 #3544), Klinger and others (1996 #3729), and Sherrod and Smith (2000 #5165). Sherrod and Pickthorn (1992 #3567) note that slip indicators on faults in the Klamath basin region plunge directly down dip, indicating normal displacement.

**Dip** 50-60°

Comments: Fault dips are from exposures of fault planes in the Klamath basin (Sherrod and Pickthorn, 1992 #3567).

**Main dip direction** SW, NE

**Geomorphic expression** These faults form prominent, steep, linear escarpments (Swan Lake Rim, Chiloquin Ridge) as much as 450 m high on Plio-Pleistocene (Walker and MacLeod, 1991 #3646) or middle Pliocene (Sherrod and Pickthorn, 1992 #3567) volcanic rocks and Miocene to Pliocene volcaniclastic rocks; the faults form grabens or half grabens filled with Pliocene through Quaternary sedimentary deposits (Walker and MacLeod, 1991 #3646; Sherrod and Pickthorn, 1992 #3567; Klinger and others, 1996 #3729). No fault scarps on Quaternary deposits have been described along these faults, and no obvious lineaments on Quaternary deposits are apparent on 1:24,000-scale topographic maps of the area. However, Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** These normal faults offset Plio-Pleistocene (Walker and MacLeod, 1991 #3646) or middle Pliocene (Sherrod and Pickthorn, 1992 #3567) volcanic rocks and Miocene to Pliocene volcaniclastic rocks. No fault scarps on Quaternary deposits have been described, but Walker and MacLeod (1991 #3646) show Quaternary fanglomerate in fault contact with Plio-Pleistocene volcanic rocks and Pleistocene fluvial and lacustrine deposits along some of these faults. Sherrod and Pickthorn (1992 #3567) and Sherrod and Smith (2000 #5165) show the same fault sections concealed beneath Quaternary deposits.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) classified these faults as active in the Quaternary (<1.6-1.8 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for most faults on the Modoc Plateau. One of the largest of these faults, along the eastern margin of Swan Lake Valley, has a minimum vertical separation of 450 m, based on the height of the Swan Lake Rim, in middle Pliocene (Sherrod and Pickthorn, 1992 #3567) or Plio-Pleistocene (Walker and MacLeod, 1991 #3646) volcanic rocks. Such slip data indicate relatively low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 39.5 |
| | Cumulative trace (km): | 83.5 |

Comments:

**Average strike** (azimuth) N 20° W

**References**


#4890 Gay, T.E., and Aune, Q.A., 1958, Alturas Sheet: California Division of Mines and Geology Geologic Atlas of California, GAM001, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#2878 Jennings, C.W., 1994, Fault activity map of California and adjacent areas, with locations of recent volcanic eruptions: California Division of Mines and Geology Geologic Data Map 6, 92 p., scale 1:750,000.

#3729 Klinger, R.E., Vetter, U.R., and Ryter, D.W., 1996, Seismotectonic study for Gerber Dam Klamath Project, California-Oregon: U.S. Bureau of Reclamation Seismotectonic Report 96-1, 51 p., 1 pl.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3791 Peterson, N.V., and McIntyre, J.R., 1970, The reconnaissance geology and mineral resources of eastern Klamath County and western Lake County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 66, 70 p., 1 pl., scale 1:250,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3567 Sherrod, D.R., and Pickthorn, L.B.G., 1992, Geologic map of the west half of the Klamath Falls 1° by 2° quadrangle, south-central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2182, 1 sheet, scale 1:250,000.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**841, Unnamed faults near Millican Valley**

**Structure Number** 841

Comments:

**Structure Name** Unnamed faults near Millican Valley

Comments: These unnamed normal faults are located near Millican Valley in central Oregon (Walker and others, 1967 #3564; MacLeod and Sherrod, 1992 #3566; Pezzopane, 1993 #3544; MacLeod and others, 1995 #3557; Geomatrix Consultants Inc., 1995 #3593; Sherrod and Smith, 2000 #5165).

**Synopsis** This northwest-striking group of faults offsets upper Miocene to Pleistocene volcanic rocks in south-central Oregon. They are located near the northwestern end of the Brothers fault zone, a 250- to 300-km-long zone of high-angle faulting that may be the surface manifestation of a regional-scale right-lateral shear zone. Individual faults in this zone form 150- to 200-m-high escarpments on Miocene through Pleistocene volcanic rocks. No fault scarps on Quaternary sediments have been described along these faults.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Deschutes

**1° x 2° sheet** Crescent

**Province** Columbia Plateaus (Walla Wall Plateau and Harney sections)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and others (1967 #3564) and MacLeod and Sherrod (1992 #3566), and 1:500,000-scale mapping of Pezzopane (1993 #3544) and Sherrod and Smith (2000 #5165).

**Geologic setting** This northwest-striking group of faults offsets late Miocene to Pleistocene volcanic rocks in south-central Oregon (Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Pezzopane, 1993 #3544; MacLeod and others, 1995 #3557; Sherrod and Smith, 2000 #5165). They are located near the northwestern end of the Brothers fault zone, a 250- to 300-km-long zone of high-angle faulting that may be the surface manifestation of a regional-scale right-lateral shear zone (Walker, 1969 #4296; Stewart and others, 1975 #3769; Lawrence, 1976 #3506; Walker and Nolf, 1981 #4310; 1981 #4311).

**Sense of movement** N, D?

Comments: These faults are mapped as normal or high-angle faults by Walker and others (1967 #3564), Walker and MacLeod (1991 #3646), MacLeod and Sherrod (1992 #3566), Pezzopane (1993 #3544), MacLeod and others (1995 #3557), and Sherrod and Smith (2000 #5165). If they are part of the Brothers fault zone, then they may represent part of the surface manifestations of a regional right-lateral shear zone (Lawrence, 1976 #3506)

**Dip** Not Reported

Comments:

**Main dip direction** SW, NE

**Geomorphic expression** These faults can be broken into two groups, a northwest group near Horse Ridge and a southeast group near Pine Mountain. Individual faults in the group near Horse Ridge form escarpments as much as 150 m high on upper Miocene to lower Pliocene volcanic rocks, and faults near Pine Mountain form escarpments as much as 200 m high on Pliocene through Pleistocene volcanic rocks (Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; MacLeod and others, 1995 #3557; Sherrod and Smith, 2000 #5165). No fault scarps on Quaternary sediments have been described along these faults, but Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** These faults offset late Miocene to Pleistocene volcanic rocks (Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Pezzopane, 1993 #3544; MacLeod and others, 1995 #3557; Sherrod and Smith, 2000 #5165), but fault scarps on Quaternary sediments have not been described.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) classified the group of faults near Horse Ridge as active in the middle and late Quaternary (<700-780 ka) and the group of faults near Pine Mountain as active in the Quaternary (<1.6-1.8 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed faults near Millican Valley. However, the most prominent faults near Pine Mountain at the southeastern end of the zone are marked by 200-m-high escarpments on Plio-Pleistocene volcanic rocks (Walker and others, 1967 #3564). Such slip data indicate low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 39.7 |
| | Cumulative trace (km): | 50.9 |

Comments:

**Average strike** (azimuth) N 54° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3566 MacLeod, N.S., and Sherrod, D.R., 1992, Reconnaissance geologic map of the west half of the Crescent 1° by 2° quadrangle, central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2215, 1 sheet, scale 1:250,000.

#3557 MacLeod, N.S., Sherrod, D.R., Chitwood, L.A., and Jensen, R.A., 1995, Geologic map of Newberry Volcano, Deschutes, Klamath, and Lake Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2455, 2 sheets, scale 1:24,000 and 1:62,500.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3769 Stewart, J.H., Walker, G.W., and Kleinhampl, F.J., 1975, Oregon-Nevada lineament: Geology, v. 3, no. 5, p. 265-268.

#4296 Walker, G.W., 1969, Geology of the High Lava Plains Province, *in* Mineral and water resources of Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 64, p. 77-79.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4310 Walker, G.W., and Nolf, B., 1981, High Lava Plains, Brothers fault zone to Harney Basin, Oregon, *in* Johnston, D.A., and Donnelly-Nolan, J., eds., Guides to some volcanic terranes in Washington, Idaho, Oregon, and northern California: U.S. Geological Survey Circular 838, p. 105-111.

#4311 Walker, G.W., and Nolf, B., 1981, Roadlog for High Lava Plains, Brothers fault zone to Harney Basin, Oregon, *in* Johnston, D.A., and Donnelly-Nolan, J., eds., Guides to some volcanic terranes in Washington, Idaho, Oregon, and northern California: U.S. Geological Survey Circular 838, p. 113-140.

#3564 Walker, G.W., Peterson, N.V., and Greene, R.C., 1967, Reconnaissance geologic map of the east half of the Crescent quadrangle Lake, Deschutes, and Crook Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-493, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**842, Unnamed faults near Kiwa Butte**

**Structure Number** 842

Comments:

**Structure Name** Unnamed faults near Kiwa Butte

Comments: These unnamed faults are located south of Kiwa Butte in central Oregon (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Weldon and others, 2002 #5648).

**Synopsis** These north-striking faults parallel the trend of eruptive centers in the late Quaternary Mount Bachelor volcanic chain in central Oregon. No detailed information on Quaternary offset are available, but limited airphoto and DEM analysis suggests possible Quaternary displacement.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Deschutes

**1° x 2° sheet** Crescent

**Province** Columbia Plateaus (Walla Walla Plateau section)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** These north-striking faults parallel the trend of eruptive centers in the late Quaternary Mount Bachelor volcanic chain in central Oregon. The area is underlain by lower to upper Pleistocene volcanic rocks (Scott and Gardner, 1992 #3569). The eastern of these two faults is shown on small-scale geologic compilations of the area cutting Plio-Pleistocene basaltic andesite (Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566).

**Sense of movement** N

Comments:

**Dip** Not reported

Comments:

**Main dip direction** NE

**Geomorphic expression** No information on geomorphic expression has been described. Pezzopane (1993 #3544) apparently used airphoto analysis to infer Quaternary displacement, and Weldon and others (2002 #5648) observed lineaments across Quaternary units on 1:100,000-scale DEMs along the eastern of these two faults.

**Age of faulted deposits at the surface** The eastern of these two faults is shown on small-scale geologic compilations of the area, cutting Plio-Pleistocene basaltic andesite (Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) inferred late and middle Quaternary (<700-780 ka) displacement. However, a follow-up compilation (Weldon and others, 2002 #5648) inferred Quaternary (<1.6 Ma) displacement on a similar set of faults, so the older age is retained herein.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed faults near Kiwa Butte.

| | | |
|---|---|---|
| **Length** | End to end (km): | 6.9 |
| | Cumulative trace (km): | 5.1 |

Comments:

**Average strike** (azimuth) N 45° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3566 MacLeod, N.S., and Sherrod, D.R., 1992, Reconnaissance geologic map of the west half of the Crescent 1° by 2° quadrangle, central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2215, 1 sheet, scale 1:250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3569 Scott, W.E., and Gardner, C.A., 1992, Geologic map of the Mount Bachelor volcanic chain and surrounding area, Cascade Range, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1967, 1 Sheet, scale 1:50,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 843, Klamath graben fault system

**Structure Number** 843

Comments: This group of structures is included in fault number 37 of Pezzopane (1993 #3544) and fault number 52 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Klamath graben fault system

Comments: The overall fault system is generally referred to as the Klamath graben in maps of the region; individual fault names include the East Klamath Lake fault zone (Klinger and others, 1996 #3729; Bacon and others, 1997 #3516; 1999 #3499) and the West Klamath Lake fault zone (Hawkins and others, 1989 #3548; Klinger and others, 1996 #3729). Geomatrix Consultants, Inc. (1995 #3593) informally include faults in the southern part of the graben system in their South Klamath graben source zone. Herein we retain the following names as sections of the Klamath graben fault system: the West Klamath Lake section, the East Klamath Lake section, and the south Klamath Lake section.

**Synopsis** The Klamath graben fault system is a group of north- and northwest-striking normal faults that form a complex graben system that confines the Klamath Lake basin at the intersection of the northwestern Basin and Range and Cascade Mountains in southern Oregon. These faults offset upper Miocene to Holocene volcanic rocks and Pleistocene and Holocene valley-fill sediments. The Klamath graben fault system is divided into three sections—the West Klamath Lake section, the East Klamath Lake section, and the south Klamath Lake section. The West Klamath Lake and south Klamath Lake sections in part show evidence of latest Quaternary displacement; youngest displacement on the East Klamath Lake section occurred in the Quaternary.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Klamath, Douglas (OR); Siskiyou (CA)

**1° x 2° sheet** Klamath Falls, Medford, Crescent, Roseburg, Alturas

**Province** Basin and Range (Great Basin section); Cascade-Sierra Mountains (Southern and Middle Cascade Mountains sections)

**Geologic setting** The Klamath graben fault system is a group of north- and northwest-striking normal faults that form a complex graben system at the intersection of the northwestern Basin and Range and Cascade Mountains in southern Oregon. Mount Mazama and Crater Lake may be localized at the intersection of the Klamath graben with the Cascades volcanic province (Bacon, 1983 #3787; Bacon and Nathenson, 1996 #3541; Bacon and others, 1997 #3516). Parts of this fault system were originally mapped by Peterson and McIntyre (1970 #3791), Smith and others (1982 #3493), Smith (1983 #3556; 1988 #3555), Moring (1983 #3554), Hawkins and others (1989 #3548), Walker and MacLeod (1991 #3646), Sherrod and Pickthorn (1992 #3567), Bacon and others (1997 #3516), and Sherrod and Smith (2000 #5165). These faults offset upper Miocene to Holocene volcanic rocks and Pleistocene and Holocene valley-fill sediments.

**Number of sections** 3

Comments: The Klamath graben fault system is divided into three sections herein, following the subdivisions of Geomatrix Consultants, Inc. (1995 #3593)—the West Klamath Lake section, the East Klamath Lake section, and the south Klamath Lake section of the Klamath graben fault system.

| | | |
|---|---|---|
| **Length** | End to end (km): | 147.7 |
| | Cumulative trace (km): | 446.6 |

Comments:

**Average strike** (azimuth) N 17° W

***843a, West Klamath Lake section***

**Section number** 843a

This is fault number 52a of Geomatrix Consultants, Inc. (1995 #3593).

**Section name** West Klamath Lake section

Comments: This section includes the West Klamath Lake fault zone of Hawkins and others (1989 #3548), and Klinger and others (1996 #3729); Bacon and others (1997 #3516; 1999 #3499) included the Annie Spring, Red Cone Spring, Sevenmile, Threemile, and Cherry Creek faults in the West Klamath Lake fault zone of Hawkins and others (1989 #3548) and Klinger and others (1996 #3729).

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Smith and others (1982 #3493), 1:100,000-scale mapping of Hawkins and others (1989 #3548) and Bacon and others (1997 #3516), and 1:500,000-scale mapping of Pezzopane (1993 #3544) and Sherrod and Smith (2000 #5165).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Peterson and McIntyre (1970 #3791), Smith and others (1982 #3493), Smith (1983 #3556; 1988 #3555), Moring (1983 #3554), Hawkins and others (1989 #3548), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), Bacon and others (1997 #3516), and Sherrod and Smith (2000 #5165).

**Dip** 70°

Comments: No structural data on the dip of these faults have been published, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of faults in the West Klamath Lake section.

**Main dip direction** E, W

**Geomorphic expression** The West Klamath Lake section consists of a series of fault strands marked by fault scarps on Quaternary deposits. The southern part of the section is marked by en echelon fault strands with 1- to 25-m-high scarps on middle Pleistocene to Holocene surficial deposits (Hawkins and others, 1989 #3548). The lack of extensive alluvial fans at the mouths of canyons that empty into Upper Klamath Lake may indicate late Quaternary subsidence (downfaulting) along the margins of the upper Klamath basin (Smith, 1983 #3556; Sherrod and Pickthorn, 1992 #3567). Some faults in the northern part of the section are marked by 11- to 160-m-high scarps on middle and late Pleistocene volcanic rocks (Bacon and others, 1997 #3516; 1999 #3499).

**Age of faulted deposits at the surface** Faults in the southern part of the section offset middle and late Pleistocene (10-150 ka) glacial moraines 12-25 m and early Holocene (pre-Mazama, 7-10 ka) alluvium 1-2 m (Hawkins and others, 1989 #3548). Faults in the northern part of the section (Annie Spring and Red Cone Spring faults) offset volcanic rocks that have K-Ar or Ar/Ar ages of 24-205 ka (Bacon and others, 1997 #3516).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Bacon and others (1997 #3516) used K-Ar or Ar/Ar ages of offset lava flows to determine that the youngest event on faults in the northern part of the section (Annie Spring and Red Cone Spring faults) occurred sometime after 24 ± 9 ka. Hawkins and others (1989 #3548) used geomorphic position, regional correlations, soils analysis, and the presence or absence of Mazama ash to determine that the youngest event on faults in the southern part of the section occurred 7-10 ka. Sherrod (1993 #3510) assigned an age of <35 ka for activity on faults in the West Klamath Lake section. The September 1993 Klamath Falls earthquakes swarm, with maximum magnitudes of 5-6, probably occurred on faults in the West Klamath Lake section, but no measurable surface rupture accompanied these earthquakes (Qamar and Meagher, 1993 #3384; Sherrod, 1993 #3510). Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) inferred a variety of ages of faulting, including latest Quaternary (<10-20 ka) for the youngest faults in the section.

**Recurrence interval** 3-10 ka

Comments: Bacon and others (1997 #3516) used calculated slip rates and a displacement per event of 1-3 m to estimate an average recurrence interval of about 3-10 ka for the West Klamath Lake fault zone; Bacon and others (1999 #3499) used similar slip rates and a displacement per event of 1-2 m to estimate an average recurrence interval of about 3-7 ka.

**Slip-rate category** 0.2-1 mm/yr

Comments: Hawkins and others (1989 #3548) used regional correlations to estimate the ages of offset glacial deposits (130-150 ka) and measured offsets of 21-25 m to estimate a long term slip rate of 0.17 mm/yr for faults on the southern part of the West Klamath Lake fault zone. Pezzopane (1993 #3544) inferred an average slip rate of about 0.5-1 mm/yr across the Klamath graben. Geomatrix Consultants, Inc. (1995 #3593) used preferred slip rates of 0.15-0.5 mm/yr in their analysis of earthquake hazards associated with various sections of the Klamath graben fault system. Bacon and others (1997 #3516; 1999 #3499) used K-Ar and Ar/Ar ages of displaced volcanic rocks (24-205 ka) and measured offsets of >11 m and <160 m to calculate a long term average slip rate of about 0.3 mm/yr. Herein only those strands of the fault zone with demonstrated latest Quaternary displacement are assigned slip rates >0.2 mm/yr.

| | | |
|---|---|---|
| **Length** | End to end (km): | 90.6 |
| | Cumulative trace (km): | 220.5 |

Comments:

**Average strike** (azimuth) N 05° W

***843b, East Klamath Lake section***

**Section number** 843b

This is fault number 52c of Geomatrix Consultants, Inc. (1995 #3593).

**Section name** East Klamath Lake section

Comments: This part of the fault system is included in the East Klamath Lake fault zone by Klinger and others (1996 #3729) and Bacon and others (1997 #3516; 1999 #3499), and in the East Klamath graben fault by Geomatrix Consultants, Inc. (1995 #3593).

**Quality of location** Good

Comments: Fault trace is from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:100,000-scale mapping of Bacon and others (1997 #3516), 1:250,000-scale mapping of Sherrod and Pickthorn (1992 #3567), and 1:500,000-scale mapping of Pezzopane (1993 #3544) and Sherrod and Smith (2000 #5165).

**Sense of movement** N

Comments: This section is mapped as a normal or high-angle fault by Peterson and McIntyre (1970 #3791), Walker and MacLeod (1991 #3646), Sherrod and Pickthorn (1992 #3567), Pezzopane (1993 #3544), Bacon and others (1997 #3516), and Sherrod and Smith (2000 #5165).

**Dip** 70°

Comments: No structural data on the dip of this fault have been published, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of their East Klamath graben fault.

**Main dip direction** W

**Geomorphic expression** The northwest-striking East Klamath Lake section is coincident with a prominent 70- to 250-m-high escarpment on middle Pliocene basalt along its length (Sherrod and Pickthorn, 1992 #3567). No fault scarps on Quaternary surficial deposits have been described, but Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area. This section extends from Crater Lake National Park south to the vicinity of Agency Lake. Further south, the more active eastern margin of the Klamath graben steps eastward and is included in the South Klamath Lake section.

**Age of faulted deposits at the surface** The East Klamath Lake section offsets middle Pliocene basalt along the eastern margin of the Klamath graben (Sherrod and Pickthorn, 1992 #3567). The fault is mapped as buried by Plio-Pleistocene sediments, Quaternary surficial deposits, and Holocene ash-flow deposits of the climactic eruption of Mount Mazama (Walker and MacLeod, 1991 #3646; Sherrod and Pickthorn, 1992 #3567; Sherrod and Smith, 2000 #5165).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: No detailed information on age of most recent faulting has been described, but Pezzopane (1993 #3544) and two subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) infer middle and late Quaternary (<700-780 ka) displacement on the East Klamath Lake section. A more recent compilation (Weldon and others, 2002 #5648) inferred Quaternary (<1.6 Ma) displacement. Given the lack of evidence of displacement in Plio-Pleistocene and Quaternary surficial deposits, the latter age is retained herein until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown, probably **<**0.2 mm/yr

Comments: No detailed slip rate data have been published for this section, but Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.15-0.5 mm/yr in their analysis of earthquake hazards associated with the various parts of the Klamath graben fault system. Given the lack of evidence of displacement in Quaternary surficial deposits and the 70- to 250-m-high escarpment that marks the fault in middle Pliocene rocks, lower rates of slip seem more likely.

| | | |
|---|---|---|
| **Length** | End to end (km): | 25.3 |
| | Cumulative trace (km): | 25.7 |

Comments:

**Average strike** (azimuth) N 15° W

***843c, South Klamath Lake section***

**Section number** 843c

This is fault number 52b of Geomatrix Consultants, Inc. (1995 #3593).

**Section name** South Klamath Lake section

Comments: This part of the fault was informally named the South Klamath graben zone by Geomatrix Consultants, Inc. (1995 #3593). Two faults mapped by Sherrod and Pickthorn (1992 #3567) south of Klamath Falls were named the Klamath Hills and Stuckel Mountain faults by Klinger and others (1996 #3729).

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Sherrod and Pickthorn (1992 #3567), and 1:500,000-scale mapping of Pezzopane (1993 #3544) and Sherrod and Smith (2000 #5165). Fault traces under Upper Klamath Lake are from approximately 1:230,000-scale figure of Colman and others (2000 #4131).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Peterson and McIntyre (1970 #3791), Walker and MacLeod (1991 #3646), Sherrod and Pickthorn (1992 #3567), Pezzopane (1993 #3544), Colman and others (2000 #4131), and Sherrod and Smith (2000 #5165).

**Dip** 51°-58°

Comments: Sherrod and Pickthorn (1992 #3567) show dips of 51°, 52°, and 58° on fault strands in the South Klamath Lake section. Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake potential of the South Klamath Lake section.

**Main dip direction** W, E

**Geomorphic expression** Faults in the South Klamath Lake section form composite grabens in the vicinity of Klamath Falls. To the north, large escarpments on Miocene and Pliocene bedrock define a graben that confines Upper Klamath Lake; fault scarps are formed on Holocene and Pleistocene talus deposits along these escarpments; apparent 6- to 12-m-deep troughs thought to be fault scarps are also present on the floor of Upper Klamath Lake (Sherrod and Pickthorn, 1992 #3567; Colman and others, 2000 #4131). The lack of extensive alluvial fans at the mouths of canyons that empty into Upper Klamath Lake may indicate late Quaternary subsidence (downfaulting) along the margins of the upper Klamath basin (Smith, 1983 #3556; Sherrod and Pickthorn, 1992 #3567). South of Klamath Falls, the graben system widens into a series of fault blocks and grabens; fault scarps are present on Holocene and Pleistocene talus deposits and Pleistocene landslides, mostly on down-to-the-west faults in this part of the South Klamath Lake section (Sherrod and Pickthorn, 1992 #3567).

**Age of faulted deposits at the surface** No radiometric ages have been obtained on faulted surficial deposits, but Sherrod and Pickthorn (1992 #3567) inferred Holocene movement on faults in Holocene and Pleistocene talus deposits along several fault strands in the South Klamath Lake section. Probable 6- to 12-m-high fault scarps that form bathymetric troughs on the floor of Upper Klamath Lake are thought to at least in part offset post-Mazama (<6,845 ± 50 radiocarbon years B.P., Bacon, 1983 #3787) sediments, because the lake is shallow and such features should have been filled by pyroclastic debris from the Mazama eruption (Sherrod and Pickthorn, 1992 #3567). Such a relationship has been recently confirmed by coring and shallow seismic reflection data (Colman and others, 2000 #4131).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Sherrod and Pickthorn (1992 #3567) inferred Holocene movement on some faults in Holocene and Pleistocene talus deposits along several fault strands in the South Klamath Lake section, and inferred post-Mazama (<6,845 ± 50 radiocarbon years B.P., Bacon, 1983 #3787) displacements along fault scarps that form bathymetric troughs on the floor of Upper Klamath Lake. Colman and others (2000 #4131) used coring and shallow seismic reflection data to demonstrate offset of the Mazama ash across several faults on the floor of Upper Klamath Lake. Sherrod (1993 #3510) assigned an age of <35 ka for activity on faults in the South Klamath Lake section, but did not discuss the basis for these age assignments. Klinger and others (1996 #3729) discuss evidence for possible Holocene displacement exposed in a gravel pit near the north end of the Stuckel Mountain fault south of Klamath Falls, but conclude that late Cenozoic displacement on this structure appears to be small.

**Recurrence interval** 3 events in 7 ka

Comments: Colman and others (2000 #4131) observed evidence of at least three faulting events that postdate the 7 ka age of the Mazama ash on faults on the floor of Upper Klamath Lake.

**Slip-rate category** 0.2-1 mm/yr

Comments: Pezzopane (1993 #3544) inferred an average slip rate of about 0.5-1 mm/yr across the Klamath graben. Geomatrix Consultants, Inc. (1995 #3593) used data from Sherrod and Pickthorn (1992 #3567) to calculate a post-Pliocene slip rate of 0.14-0.2 mm/yr and a post-Mazama maximum rate of 0.9-1.8 mm/yr; they used preferred slip rates of 0.15-0.5 mm/yr in their analysis of earthquake hazards associated with various sections of the Klamath graben fault system. Colman and others (2000 #4131) calculated a slip rate of 0.43 mm/yr from displacement of about 3 m of the 7 ka Mazama ash across faults on the floor of Upper Klamath Lake. Herein only those strands of the fault zone with demonstrated latest Quaternary displacement are assigned slip rates >0.2 mm/yr.

| | | |
|---|---|---|
| **Length** | End to end (km): | 59.3 |
| | Cumulative trace (km): | 200.4 |

Comments:

**Average strike** (azimuth) N 31° W

**References**


#3787 Bacon, C.R., 1983, Eruptive history of Mount Mazama and Crater Lake Caldera, Cascade Range, USA: Journal of Volcanology and Geothermal Research, v. 18, p. 57-115.

#3499 Bacon, C.R., Lanphere, M.A., and Champion, D.E., 1999, Late Quaternary slip rate and seismic hazards of the West Klamath Lake fault zone near Crater Lake, Oregon Cascades: Geology, v. 27, no. 1, p. 43-46.

#3516 Bacon, C.R., Mastin, L.G., Scott, K.M., and Nathenson, M., 1997, Volcano and earthquake hazards in the Crater Lake region, Oregon: U.S. Geological Survey Open-File Report 97-487, 30 p., 1 pl., scale 1:100,000.

#3541 Bacon, C.R., and Nathenson, M., 1996, Geothermal resources in the Crater Lake Area, Oregon: U.S. Geological Survey Open-File Report 96-663, 34 p.

#4131 Colman, S.M., Rosenbaum, J.G., Reynolds, R.L., and Sarna-Wojcicki, A.M., 2000, Post-Mazama (7 KA) faulting beneath Upper Klamath Lake, Oregon: Bulletin of the Seismological Society of America, v. 90, no. 1, p. 243-247.

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#3548 Hawkins, F.F., Foley, L.L., and LaForge, R.C., 1989, Seismotectonic study for Fish Lake and Fourmile Lake Dams, Rogue River Basin Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 89-3, 26 p., 2 pls.

#3729 Klinger, R.E., Vetter, U.R., and Ryter, D.W., 1996, Seismotectonic study for Gerber Dam Klamath Project, California-Oregon: U.S. Bureau of Reclamation Seismotectonic Report 96-1, 51 p., 1 pl.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3554 Moring, B., 1983, Reconnaissance surficial geologic map of the Medford 1 x 2 quadrangle, Oregon-California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1528, 2 sheets, scale 1:125,000.

#3791 Peterson, N.V., and McIntyre, J.R., 1970, The reconnaissance geology and mineral resources of eastern Klamath County and western Lake County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 66, 70 p., 1 pl., scale 1:250,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3384 Qamar, A., and Meagher, K.L., 1993, Precisely locating the Klamath Falls, Oregon, earthquakes: Earthquakes and Volcanoes, v. 24, p. 129-139.

#3510 Sherrod, D.R., 1993, Historic and prehistoric earthquakes near Klamath Falls, Oregon: Earthquakes and Volcanoes, v. 24, no. 3, p. 106-120.

#3567 Sherrod, D.R., and Pickthorn, L.B.G., 1992, Geologic map of the west half of the Klamath Falls 1° by 2° quadrangle, south-central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2182, 1 sheet, scale 1:250,000.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3556 Smith, J.G., 1983, Geologic map of the Sky Lakes Roadless Area and Mountain Lakes Wilderness, Jackson and Klamath Counties, Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-1507-A, 1 sheet, scale 1:62,500.

#3555 Smith, J.G., 1988, Geologic map of the Pelican Butte quadrangle, Klamath County, Oregon: U.S. Geological Survey Geologic Quadrangle Map GQ-1653, 1 sheet, scale 1:62,500.

#3493 Smith, J.G., Page, N.J., Johnson, M.G., Moring, B.C., and Gary, F., 1982, Preliminary geologic map of the Medford 1x2 quadrangle, Oregon and California: U.S. Geological Survey Open-File Report 82-955, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 844, Sky Lakes fault zone

**Structure Number** 844

Comments: This group of structures is included in fault number 38 of Pezzopane (1993 #3544) and in fault number 53 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Sky Lakes fault zone

Comments: The Sky Lakes fault zone has been mapped by Carver (1972 #5190), Smith and others (1982 #3493), Moring (1983 #3554), Smith (1983 #3556; 1988 #3555), Sherrod and Pickthorn (1992 #3567), and Sherrod and Smith (2000 #5165), and mapped and named by Hawkins and others (1989 #3548). Following Hawkins and others (1989 #3548) and Weldon and others (2002 #5648), herein we include Lake of the Woods fault, the longest and most prominent fault in this zone, and the Mount McLoughlin fault in the Sky Lakes fault zone; we also include other primarily east-down normal faults that continue on a southeasterly trend to the Oregon-California border.

**Synopsis** These north- and northwest-striking, mostly down-to-the-east normal faults offset late Miocene and Pliocene to Pleistocene volcanic rocks, and probably are older structures related to the western margin of the Klamath graben. These faults form prominent escarpments on late Tertiary and Quaternary volcanic rocks. Scarps range in height from less than 10 m to as much as 300 m; most are less than 30 m high and have slope angles of less than 25°. Scarps are formed in bedrock, and in most places are covered by late Pleistocene (approximately 10-30 ka) glacial deposits and Holocene colluvium. Although most faults in the zone have been active in the middle and late Quaternary, at least one fault strand near the northern end of the zone has apparently been active in the latest Quaternary.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR, CA

**County** Klamath (OR), Siskiyou (CA)

**1° x 2° sheet** Medford, Klamath Falls

**Province** Cascade-Sierra Mountains (Southern and Middle Cascade Mountains sections)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Smith and others (1982 #3493), 1:125,000-scale mapping of Moring (1983 #3554), approximately 1:100,000-scale mapping of Hawkins and others (1989 #3548), and 1:500,000-scale mapping of Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Sherrod and Smith (2000 #5165).

**Geologic setting** These north- and northwest-striking, mostly down-to-the-east normal faults offset late Miocene and Pliocene to Pleistocene volcanic rocks (Smith, 1988 #3555; Sherrod and Pickthorn, 1989 #3599; Walker and MacLeod, 1991 #3646), west of the Klamath graben. These faults reflect the north- and northeast-striking fault pattern of the Klamath graben, and probably are older structures related to the western margin of the graben (Smith, 1983 #3556). Young faults with similar trends are present across the border in northern California (Gay and Aune, 1958 #4890; Jennings, 1994 #2878).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Smith and others (1982 #3493), Moring (1983 #3554), Smith (1983 #3556; 1988 #3555), Sherrod and Pickthorn (1992 #3567), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Sherrod and Smith (2000 #5165).

**Dip** 70°

Comments: No detailed structural data have been published, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their analysis of earthquake hazards associated with faults in the Sky Lakes fault zone.

**Main dip direction** E, W

**Geomorphic expression** These faults form prominent escarpments on late Tertiary and Quaternary volcanic rocks. Scarps range in height from less than 10 m to as much as 300 m; most are less than 30 m high and have slope angles of less than 25° (Hawkins and others, 1989 #3548). Scarps are formed in bedrock, and in most places are covered by late Pleistocene (approximately 10-30 ka) glacial deposits and Holocene colluvium (Hawkins and others, 1989 #3548).

**Age of faulted deposits at the surface** Individual faults in the zone offset Pleistocene volcanic rocks; these rocks are poorly dated but are probably lower Pleistocene (0.78-2.0 Ma) in age (Sherrod and Smith, 2000 #5165). Walker and MacLeod (1991 #3646) map some fault strands at the southern end of the fault zone in Holocene(?) and Pleistocene volcanic rocks. Most of the most prominent faults are covered by late Pleistocene (approximately 10-30 ka) glacial deposits and Holocene colluvium (Hawkins and others, 1989 #3548).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Hawkins and others (1989 #3548) indicate that latest movements on faults in the northern part of the Sky Lakes fault zone predate the latest Pleistocene (>10-30 ka). Pezzopane (1993 #3544) and Geomatrix Consultants, Inc. (1995 #3593) classified most of these faults as middle and late Quaternary (<700-780 ka) or probable Quaternary (<1.6-1.8 Ma), but they map two fault strands with latest Pleistocene or Holocene (<10-20 ka) displacement. The age constraints on the northernmost of these two young faults is based on work of G.A. Carver (Carver, 1972 #5190) and (written commun., 1994, in Geomatrix Consultants Inc., 1995 #3593); this part of the Lake of the Woods fault apparently offsets late Pleistocene moraines, and thus has undergone latest Quaternary (<20 ka) movement. Weldon and others (2002 #5648) infer a variety of ages of latest movement, including latest Quaternary (<18 ka) on a long fault strand near the northern end of the Sky Lakes fault zone.

**Recurrence interval** >10-30 ky

Comments: Hawkins and others (1989 #3548) used the lack of scarps on latest Pleistocene (10-30 ka) glacial deposits and Holocene colluvium to suggest that recurrence intervals must be longer than 10-30 ky.

**Slip-rate category** <0.2 mm/yr

Comments: No detailed slip rate data have been published, but Geomatrix Consultants, Inc. (1995 #3593) used offsets of 300 m in 0.73-2.0 Ma rocks to calculate possible long-term slip rates of 0.15-0.4 mm/yr, but used preferred slip rates of 0.01-0.2 mm/yr in their analysis of earthquake hazards associated with the Sky Lakes fault zone.

| | | |
|---|---|---|
| **Length** | End to end (km): | 77.3 |
| | Cumulative trace (km): | 198.3 |

Comments:

**Average strike** (azimuth) N 18° W

**References**


#5190 Carver, G.A., 1972, Glacial geology of the Mountain Lakes Wilderness and adjacent parts of the Cascade Range, Oregon: Seattle, University of Washington, unpublished Ph.D. dissertation, 75 p.

#4890 Gay, T.E., and Aune, Q.A., 1958, Alturas Sheet: California Division of Mines and Geology Geologic Atlas of California, GAM001, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

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#2878 Jennings, C.W., 1994, Fault activity map of California and adjacent areas, with locations of recent volcanic eruptions: California Division of Mines and Geology Geologic Data Map 6, 92 p., scale 1:750,000.

#3554 Moring, B., 1983, Reconnaissance surficial geologic map of the Medford 1 x 2 quadrangle, Oregon-California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1528, 2 sheets, scale 1:125,000.

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#3567 Sherrod, D.R., and Pickthorn, L.B.G., 1992, Geologic map of the west half of the Klamath Falls 1° by 2° quadrangle, south-central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2182, 1 sheet, scale 1:250,000.

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#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3556 Smith, J.G., 1983, Geologic map of the Sky Lakes Roadless Area and Mountain Lakes Wilderness, Jackson and Klamath Counties, Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-1507-A, 1 sheet, scale 1:62,500.

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#3493 Smith, J.G., Page, N.J., Johnson, M.G., Moring, B.C., and Gary, F., 1982, Preliminary geologic map of the Medford 1x2 quadrangle, Oregon and California: U.S. Geological Survey Open-File Report 82-955, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 845, Hite fault system

**Structure Number** 845

Comments: Some of these structures are included in fault number 76 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Hite fault system

Comments: The Hite fault system is a complex zone of faulting that parallels the northeast-trending western flank of the Blue Mountains uplift. The Hite fault was named after U.S. Soil Conservation Service scientist Thomas Hite (Kuehn, 1995 #3478). Faults included in the system herein include the Hite, Thorn Hollow, and Kooskooskie faults (Kienle and others, 1979 #3728); most faults have been mapped by Swanson and others (1981 #3496).

**Synopsis** The Hite fault system is a complex zone of faulting that parallels the northeast-trending western flank of the Blue Mountains uplift in northeastern Oregon and southeastern Washington; the fault system may overlie the suture zone between accreted terranes in the Blue Mountains and the stable craton. Sense of slip on structures included in this zone has been described as normal, left-lateral, and right-lateral strike slip, but recent work is most consistent with a left-lateral oblique (down-to-the-west or northwest) sense of slip. Most structures in the Hite fault system are found exclusively in rocks of the Miocene Columbia River Basalt Group, so determination of Quaternary activity is difficult. The Hite fault system is divided into four sections, from northeast to southwest, the Hite, Kooskooskie, Thorn Hollow, and Agency sections. Possible offset of Quaternary surficial deposits has only been described on the Thorn Hollow section.

**Date of compilation** December 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Umatilla

**1° x 2° sheet** Pendleton (OR); Walla Walla, Pullman (WA)

**Province** Columbia Plateaus (Walla Walla Plateau section)

**Geologic setting** The Hite fault system is a complex zone of faulting that parallels the northeast-trending western flank of the Blue Mountains uplift in northeastern Oregon and southeastern Washington; the fault system may overlie the suture zone between accreted terranes in the Blue Mountains and the stable craton (Reidel and others, 1994 #3539). Sense of slip on structures included in this zone has been described as normal, left-lateral, and right-lateral strike slip (Newcomb, 1970 #3761; Kienle and others, 1979 #3728; Tolan and Reidel, 1989 #3765). Most structures in the Hite fault system are found exclusively in rocks of the Miocene Columbia River Basalt Group (Walker, 1973 #3756; Swanson and others, 1981 #3496; Walker and MacLeod, 1991 #3646; Schuster and others, 1997 #3760), so determination of Quaternary activity is difficult.

**Number of sections** 4

Comments: The Hite fault system is divided into four sections herein; from northeast to southwest, these are the Hite section, the Kooskooskie section, the Thorn Hollow section, and the Agency section.

| | | |
|---|---|---|
| **Length** | End to end (km): | 140.7 |
| | Cumulative trace (km): | 184.0 |

Comments:

**Average strike** (azimuth) N 20° E

### *845a, Hite section*

**Section number** 845a

**Section name** Hite section

Comments: This section consists of the Hite fault, the primary structure in the Hite fault system.

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale compilation of Schuster (1993 #4656; 1994 #4655) in Washington, and 1:100,000-scale compilation of Weldon and others (2002 #5648) in Oregon, based on 1:110,000-scale mapping of Kuehn (1995 #3478), 1:125,000-scale mapping of Kienle and others (1979 #3728), and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** SN

Comments: Sense of slip on the Hite fault has been mapped or described as normal, left-lateral, and right-lateral strike slip (Newcomb, 1970 #3761; Kienle and others, 1979 #3728; Myers and others, 1979 #5175; Swanson and others, 1980 #3574; 1981 #3496; Tolan and Reidel, 1989 #3765; Schuster, 1993 #4656; 1994 #4655; Schuster and others, 1997 #3760). However, recent detailed work on faults in the Hite section (Kuehn, 1995 #3478) indicate left-lateral oblique (down-to-the-northwest) slip; this sense of slip probably characterizes the entire Hite fault system (Reidel and others, 1994 #3539).

**Dip** 70°-90°

Comments: Limited dip measurements, mostly on subsidiary structures in the Hite section, indicate steeply northwest-dipping attitudes (Kuehn, 1995 #3478). Geomatrix Consultants, Inc. (1995 #3593) modeled the Hite fault as a steeply dipping strike-slip to normal-oblique fault in their analyses of earthquake hazards associated with the Hite fault.

**Main dip direction** NW

**Geomorphic expression** Structures in the Hite section form a complex, up to 1.5 km wide zone of folding and faulting in rocks of the Miocene Columbia River Basalt Group; in some places the fault zone is cemented with silica and stands in positive relief, and elsewhere forms topographic swales, saddles, and alignments of vegetation and drainages (Kienle and others, 1979 #3728; Sandness and others, 1982 #3788; Piety and others, 1990 #3733; Kuehn, 1995 #3478). Most geomorphic expression of these faults is related to differential erosion, rather than primary tectonic control on topography (Kienle and others, 1979 #3728). No fault scarps on Quaternary surficial deposits have been described, but Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Structures in the Hite section offset Miocene Columbia River basalts, but no offsets in Quaternary surficial deposits have been described (Kienle and others, 1979 #3728; Rigby and Othberg, 1979 #3738; Piety and others, 1990 #3733; Geomatrix Consultants Inc., 1995 #3593).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Piety and others (1990 #3733) suggest that the latest event on the Hite fault predates the late Quaternary, and thus occurred >125 ka. Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer Quaternary (<1.6-1.8 Ma) displacement on this part of the Hite fault system.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but maximum vertical displacement across the fault zone in Miocene Columbia River basalts is 200-300 m (Kienle and others, 1979 #3728; Kuehn, 1995 #3478); such offsets yield low rates of long-term slip. Geomatrix Consultants, Inc. (1995 #3593) use estimated slip rates of 0.005-0.05 mm/yr in their analysis of earthquake hazards associated with faults in the Hite section.

| | | |
|---|---|---|
| **Length** | End to end (km): | 87.0 |
| | Cumulative trace (km): | 90.0 |

Comments:

**Average strike** (azimuth) N 27° E

***845b, Kooskooskie section***

**Section number** 845b

**Section name** Kooskooskie section

Comments: This section consists of the westernmost of three fault strands referred to as the Kooskooskie faults, which were included in the Hite fault system by Kienle and others (1979 #3728). Herein referred to as the Kooskooskie fault, this strand is one of several north-trending faults that lie to the west of the Hite fault. The fault was named after the village of Kooskooskie, Washington, which is located east of the fault near its southern end.

**Quality of location** Good

Comments: Fault traces are from 1:125,000-scale mapping of Kienle and others (1979 #3728), approximately 1:210,000-scale figure of Piety and others (1990 #3733), and 1:100,000-scale mapping of Weldon and others (2002 #5648).

**Sense of movement** SN

Comments: Sense of slip on the Kooskooskie fault has been described as normal, right lateral, or left-lateral strike slip (Newcomb, 1970 #3761; Glass, 1977 #3792; Kienle and others, 1979 #3728; Swanson and others, 1980 #3574; 1981 #3496; Tolan and Reidel, 1989 #3765). However, more recent work on faults in and near the Kooskooskie section indicate left-lateral oblique (down-to-the-northwest) slip (Piety and others, 1990 #3733; Kuehn, 1995 #3478); this sense of slip probably characterizes the entire Hite fault system (Reidel and others, 1994 #3539).

**Dip** 85°-90°

Comments: Near vertical dip measurements of 85°-90° indicate vertical to steeply northwest-dipping fault attitudes (Kienle and others, 1979 #3728).

**Main dip direction** NW

**Geomorphic expression** The Kooskooskie fault forms a straight, north-trending depression expressed as vegetation and drainage alignments and breaks in slope in rocks of the Columbia River Basalt Group, from Mud Creek in the north to Henry Canyon on the south (Glass, 1977 #3792; Kienle and others, 1979 #3728; Piety and others, 1990 #3733). Possible offset drainages suggest left-lateral displacement (Glass, 1977 #3792; Piety and others, 1990 #3733).

**Age of faulted deposits at the surface** The Kooskooskie fault offsets Miocene Columbia River basalts, but no clear evidence of faulting in Quaternary deposits has been described (Glass, 1977 #3792; Kienle and others, 1979 #3728; Swanson and others, 1980 #3574; 1981 #3496; Piety and others, 1990 #3733). A 6-m-high, late Holocene(?) fluvial terrace lies unfaulted across the trace of the fault at Mill Creek (Piety and others, 1990 #3733).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle or late Quaternary (<750 ka)

Comments: No detailed information on age of most recent faulting has been described. Glass (1977 #3792) conducted airphoto and limited field reconnaissance along the Kooskooskie fault; he concluded that the geomorphic expression suggested that the fault was active, but gave no age constraints. Kienle and others (1979 #3728) briefly described the geomorphic expression of the Kooskooskie fault, but made no mention of the age of most recent faulting. Piety and others (1990 #3733) described a 6-m-high, late Holocene(?) fluvial terrace that lies unfaulted across the trace of the fault at Mill Creek, but concluded that the presence of this terrace did not rule out the possibility of late (<125 ka) or latest (<15 ka) Quaternary displacement. Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer that the Kooskooskie fault has been active in the middle or late Quaternary (<700-780 ka).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but vertical displacement across the Kooskooskie fault in Miocene Columbia River basalts is about 100 m (Kienle and others, 1979 #3728; Swanson and others, 1980 #3574; Piety and others, 1990 #3733); such offset yields low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 18.9 |
| | Cumulative trace (km): | 18.9 |

Comments:

**Average strike** (azimuth) N 00°

***845c, Thorn Hollow section***

**Section number** 845c

**Section name** Thorn Hollow section

Comments: This section consists of the Thorn Hollow fault zone, one of several northeast-striking fault strands that extend southwest of the Hite fault. The fault was named after a linear stream valley, Thorn Hollow, by Kienle and others (1979 #3728).

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (Weldon and others, 2002 #5648), based on 1:125,000-scale mapping of Kienle and others (1979 #3728), 1:250,000-scale mapping of Swanson and others (1981 #3496), and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** SN

Comments: Sense of slip on faults in the Thorn Hollow section have been described as normal, left-lateral, and right-lateral strike slip (Kienle and others, 1979 #3728; Swanson and others, 1981 #3496; Tolan and Reidel, 1989 #3765). However, recent detailed work on faults in the Hite section indicate left-lateral oblique (down-to-the-northwest) slip (Kuehn, 1995 #3478); this sense of slip probably characterizes the entire Hite fault system (Reidel and others, 1994 #3539).

**Dip** 80°-90°

Comments: Limited dip measurements of 80°-90° indicate steeply northwest-dipping fault attitudes (Kienle and others, 1979 #3728).

**Main dip direction** NW

**Geomorphic expression** The Thorn Hollow section forms a complex zone of faulting in rocks of the Columbia River Basalt Group; it is expressed as an alignment of linear streams, saddles, and notches in ridges north of the Umatilla River, and as a shallow linear depression filled with hydrophilic vegetation south of the river (Kienle and others, 1979 #3728).

**Age of faulted deposits at the surface** Structures in the Thorn Hollow section offset Miocene Columbia River basalts, and in one place appear to offset Quaternary surficial deposits (Kienle and others, 1979 #3728). At a site along Highway 11, about 0.3 km south of Dry Creek, caliche-filled fractures associated with a 20-m-wide fault zone in basalt extend through fluvial silt, sand and gravel into overlying loess to near the ground surface (Kienle and others, 1979 #3728). Kienle and others (1979 #3728) do not discuss the age of these deposits, other than to correlate the loess to the Palouse Formation, which they apparently describe as pre-last glacial. Piety and others (1990 #3733) inferred a late Pleistocene (approximately 100 ka) age for the offset loess deposits.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: No detailed information on age of most recent faulting has been published. However, Kienle and others (1979 #3728) use apparent offset of Palouse Formation loess to infer "post late Pleistocene" displacement on the Thorn Hollow fault near Dry Creek. However, elsewhere they caution that given the uncertain age of loess deposits in the region, offset of loess is not prima facie evidence of very young faulting. More recent work on the chronology of loess deposits in this region indicates these sediments may have begun to form as much as 1-2 Ma (Busacca, 1991 #3598). Given these uncertainties, Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) show the southern part of the Thorn Hollow section as active in the Quaternary (<1.6-1.8 Ma), and the northern part of the fault as active in the middle and late (<700-780 ka) Quaternary. Piety and others (1990 #3733) also infer late Quaternary (<125 ka) displacement on the northern part of the Thorn Hollow fault.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but displacement across the Thorn Hollow fault zone in Miocene Columbia River basalts may be 80-450 meters near Interstate 84 (Kienle and others, 1979 #3728); such offset yields low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 44.0 |
| | Cumulative trace (km): | 45.5 |

Comments:

**Average strike** (azimuth) N 10° E

***845d, Agency section***

**Section number** 845d

**Section name** Agency section

Comments: This section consists of a northeast-striking fault zone that parallels the Agency syncline south of Pendleton. The fault zone was mapped by Swanson and others (1981 #3496).

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Swanson and others (1981 #3496), and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** SN

Comments: Sense of slip on faults in the Agency section have been mapped as normal, left-lateral, and right-lateral strike slip (Swanson and others, 1981 #3496; Tolan and Reidel, 1989 #3765; Walker and MacLeod, 1991 #3646). However, recent detailed work on faults in the Hite section indicate left-lateral oblique (down-to-the-northwest) slip (Kuehn, 1995 #3478); this sense of slip probably characterizes the entire Hite fault system (Reidel and others, 1994 #3539).

**Dip** Not Reported

Comments:

**Main dip direction** NW

**Geomorphic expression** Not Reported

**Age of faulted deposits at the surface** Faults in the Agency section offset Miocene Columbia River Basalt Group rocks (Swanson and others, 1981 #3496; Walker and MacLeod, 1991 #3646), but no offsets in Quaternary surficial deposits have been described.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: No detailed information on age of most recent faulting has been published. Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer Quaternary (<1.6-1.8 Ma) displacement on this part of the Hite fault system.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed fault slip data on the Agency section have been documented, but based on data from other sections of the Hite fault system, low rates of slip are probable.

**Length** End to end (km): 27.9
Cumulative trace (km): 29.4

Comments:

**Average strike** (azimuth) N 26° E

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#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3733 Piety, L.A., LaForge, R.C., and Foley, L.L., 1990, Seismic sources and maximum credible earthquakes for Cold Springs and McKay Dams, Umatilla Project, north-central Oregon: U.S. Bureau of Reclamation Seismotectonic Report 90-1, 62 p., 1 pl.

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#3738 Rigby, J.G., and Othberg, K., 1979, Reconnaissance surficial geologic mapping of the Late Cenozoic sediments of the Columbia Basin, Washington: State of Washington Department of Natural Resources Division of Geology and Earth Resources Open-File Report 79-3, 88 p., 10 pls.

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#3760 Schuster, E.J., Gulick, C.W., Reidel, S.P., Fecht, K.R., and Zurenko, S., 1997, Geologic map of Washington-southeast quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-45, 20 p. pamphlet, 2 sheets, scale 1:250,000.

#4656 Schuster, J.E., 1993, Geologic map of the Clarkston 1:100,000 Quadrangle, Washington-Idaho, and the Washington portion of the Orofino 1:100,000 Quadrangle: Washington Division of Geology and Earth Resources Open-File Report 93-4, 43 p., scale 1:100,000.

#4655 Schuster, J.E., 1994, Geologic map of the Walla Walla 1:100,000 Quadrangle, Washington: Washington Division of Geology and Earth Resources Open-File Report 94-3, 18 p., scale 1:100,000.

#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

#3574 Swanson, D.A., Wright, T.L., Camp, V.E., Gardner, J.N., Helz, R.T., Price, S.M., Reidel, S.P., and Ross, M.E., 1980, Reconnaissance geologic map of the Columbia River Basalt Group, Pullman and Walla Walla quadrangles, southeast Washington and adjacent Idaho: U.S. Geological Survey Miscellaneous Investigations Map I-1139, 2 sheets, scale 1:250,000.

#3765 Tolan, T.L., and Reidel, S.P., 1989, Structure map of a portion of the Columbia River flood-basalt Province, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, 1 sheet, scale 1:500,000.

#3756 Walker, G.W., 1973, Reconnaissance geologic map of the Pendleton quadrangle, Oregon and Washington: U.S. Geological Survey Miscellaneous Geologic Investigations I-727, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**846, Wallula fault system**

**Structure Number** 846

Comments: These structures are included in fault number 11 of Pezzopane (1993 #3544) and fault number 77 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Wallula fault system

Comments: The Wallula fault system is a prominent northwest-striking fault zone that extends from near Milton-Freewater, OR to near Kennewick, WA. This fault zone is included in several regional-scale lineaments, including the Cle Elum-Wallula deformed zone (CLEW), the Rattlesnake-Wallula trend, alignment, or lineament (RAW), and the Olympic-Wallowa lineament (OWL) (Reidel and others, 1994 #3539). Named faults in this zone in Oregon include the Bade, Barrett, Dry Creek, Forks, Little Dry Creek, Milton-Freewater, Pine Creek, Promontory Point, Umapine, Wallula, and Wallula Gap faults (Kienle and others, 1979 #3728; Mann and Meyer, 1993 #3535; McQuarrie, 1993 #4337; Reidel and others, 1994 #3539).

**Synopsis** The Wallula fault system is a prominent northwest-striking fault zone that extends from near Milton-Freewater, OR to near Kennewick, WA. This fault zone is included in several regional-scale lineaments, including the Cle Elum-Wallula deformed zone (CLEW), the Rattlesnake-Wallula trend, alignment, or lineament (RAW), and the Olympic-Wallowa lineament (OWL). The northwestern parts of these lineaments consist of anticlinal folds and thrust faults in rocks of the Miocene Columbia River Basalt Group, but the Wallula fault system is mostly mapped as linear, steeply dipping strike-slip, normal, or reverse faults in Quaternary surficial deposits and rocks of the Miocene Columbia River Basalt Group. The mapped fault pattern, local observations of subhorizontal slickensides, and north-south compressive stress regime support a right-lateral strike slip sense of slip on the Wallula fault, but other data have been used to infer that post-Miocene lateral displacement, if any, must be low. The age of most-recent faulting in the Wallula fault system is poorly known, but several studies indicate latest Quaternary displacement on at least one structure in the system.

**Date of compilation** March 10, 2003

**Compiler and affiliation** Stephen F. Personius and David J. Lidke, U.S. Geological Survey

**State** Oregon and Washington

**County** Umatilla (OR); Benton, Walla Walla (WA)

**1° x 2° sheet** Pendleton, Walla Walla

**Province** Columbia Plateaus (Walla Walla Plateau)

**Quality of location** Good

Comments: Fault traces in Oregon are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:125,000-scale mapping of Kienle and others (1979 #3728), 1:250,000-scale mapping of Swanson and others (1981 #3496), and 1:500,000-scale mapping of Pezzopane (1993 #3544). Fault traces in Washington are from 1:250,000-scale mapping of Schuster and others (1997 #3760).

**Geologic setting** The Wallula fault system is a prominent northwest-striking fault zone that extends from near Milton-Freewater, OR to near Kennewick, WA. The Wallula fault system lies in the southeastern part of the Yakima fold belt and appears to link with northwest-striking folds and thrust faults in the Rattlesnake Hills directly to the north. The Wallula fault system is included in several regional-scale lineaments, including the Cle Elum-Wallula deformed zone (CLEW), the Rattlesnake-Wallula trend, alignment, or lineament (RAW), and the Olympic-Wallowa lineament (OWL) (Reidel and others, 1994 #3539). The northwestern parts of these lineaments consist of anticlinal folds and thrust faults (Yakima fold belt structures) in rocks of the Miocene Columbia River Basalt Group. The Wallula fault system, however, is mostly mapped as linear, steeply dipping strike-slip, normal, or reverse faults in Quaternary surficial deposits and rocks of the Miocene Columbia River Basalt Group (Kienle and others, 1979 #3728; Swanson and others, 1981 #3496; Tolan and Reidel, 1989 #3765; Walker and MacLeod, 1991 #3646; Hutter, 1997 #5650).

**Sense of movement** D?, R?, N?

Comments: The northwestern continuation of the Wallula fault system in Washington consists of anticlinal folds and thrust faults, but the fault system is mostly mapped as linear, steeply dipping strike-slip, normal, or reverse faults in Oregon (Kienle and others, 1979 #3728; Swanson and others, 1981 #3496; Tolan and Reidel, 1989 #3765; Walker and MacLeod, 1991 #3646; Hutter, 1997 #5650). The mapped fault pattern, local observations of subhorizontal slickensides, and north-south compressive stress regime support a right-lateral strike slip sense of slip on the Wallula fault system (Kienle and others, 1979 #3728; U.S. Army Corps of Engineers, 1983 #3480; Mann and Meyer, 1993 #3535; McQuarrie, 1993 #4337; Kuehn, 1995 #3478; 1996 #3530). However, Reidel and Tolan (1994 #3536) and Hutter and others (1994 #3525) interpret other data to infer that post-Miocene lateral displacement, if any, must be low, and that faulting may be related to an ancient suture system and/or to extension of the La Grande graben normal fault system. Geomatrix Consultants Inc. (1995 #3593) give greater weight to a reverse faulting scenario in their modeling of earthquake hazards along the Wallula fault system. Hutter (1997 #5650) interprets exposures of steep reverse faults along the Wall Walla River as evidence of both dextral strike-slip and reverse faulting parallel to and concurrent with uplift of the Horse Heaven Hills anticline.

**Dip** 70°-90°

Comments: Vertical to steeply northeast-and southwest-dipping fault planes have been observed along several faults in the Wallula fault system; a few gently-dipping fault planes have also been observed, but these are attributed to flower or “palm tree” fault patterns (Kienle and others, 1979 #3728; Mann and Meyer, 1993 #3535; McQuarrie, 1993 #4337; Kuehn, 1995 #3478; Hutter, 1997 #5650).

**Main dip direction** None, vertical

**Geomorphic expression** Most faults in the Wallula fault system have youthful geomorphic expressions; they form topographic and vegetation lineaments, scarp-like lineations, and grabens appear to offset the youngest geologic units (upper Pleistocene to Holocene?) in the area (Kienle and others, 1979 #3728). Mann and Meyer (1993 #3535) describe numerous youthful fault scarps, lineaments, and laterally offset drainages along the fault zone. McQuarrie (1993 #4337) describes clastic dikes of Pleistocene Missoula Flood sediments (Touchet beds) cutting basalt bedrock and fault breccia and appear to be genetically related to faulting along the Wallula Gap fault. Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Several faults in the Wallula fault system offset upper Pleistocene to Holocene(?) surficial deposits (Kienle and others, 1979 #3728; Rigby and Othberg, 1979 #3738; Piety and others, 1990 #3733). One exposure of the Umapine fault offsets loess and colluvium containing the Mount Saint Helens “J” ash system (Mann and Meyer, 1993 #3535) which is thought to have been deposited about 10.7 ka (Mullineaux, 1986 #3773). McQuarrie (1993 #4337) describes clastic dikes of Pleistocene Missoula Flood sediments (Touchet beds) that may be related to faulting. Farooqui and Thoms (1980 #5824) describe evidence for late Pleistocene offset of colluvial deposits along an east-striking fault at Finley Quarry, near the apparent northwest end of the Wallula fault system.

**Paleoseismology studies** No trench investigations have been conducted along the Wallula fault system in Oregon, but the east wall of a gully exposure of the Umapine fault west of Milton-Freewater (location 846-1) was examined and logged by Mann and Meyer (their site A, 1993 #3535). The following description is from Mann and Meyer (1993 #3535).

Site 846-1. The gully exposed a several meter wide fault zone consisting of several fault strands dipping 55-

63° to the north. Brecciated basalt of the Miocene Columbia River Basalt Group was exposed in the footwall. The hanging wall consisted of a 5-m-thick section of ash-bearing gravelly colluvial horizons, interbedded with poorly consolidated loess. Numerous samples of volcanic ash were taken from the hanging wall section; most have geochemical fingerprints that are correlative with the Mount St Helens “J” ash, and some have fingerprints correlative with Mount St Helens “M”, or are intermediate between these tephra. The Mount St Helens “J” and “M” ashes are thought to have been deposited 10.7 ka and 20.35 ka (Mullineaux, 1986 #3773). The footwall section consists of four possibly discrete fault-derived colluvial layers, separated by zones of purer loess at intervals of 1-2 m. Mann and Meyer (1993 #3535) interpret these relations as evidence of four separate Holocene surface-rupturing events.

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: The age of most-recent faulting on most structures in the Wallula fault system is poorly known. Meyer and Mann (1993 #3535) discuss evidence for four surface-faulting events that post-date the 10.7 ka age of the Mount Saint Helens “J” ash on the Umapine fault west of Milton-Freewater. Kienle and others (1979 #3728) describe young faulting along the Little Dry Creek fault, where young (<13 ka) and older (Palouse Formation) loess deposits are apparently offset. Kienle and others (1979 #3728), Rigby and Othberg (1979 #3738), Piety and others (1990 #3733), and McQuarrie (1993 #4337) describe several locations along splays of the Wallula fault system where Touchet beds (10-13 ka) are either offset or involved in faulting-related dike injection. Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) show most faults in the Wallula fault system as active in the middle and late Quaternary (<700-780 ka) or Quaternary (<1.6-1.8 Ma).

**Recurrence interval** Unknown

Comments: Not reported

**Slip-rate category** <0.2 mm/yr

Comments: Very little well documented slip data are available for structures in the Wallula fault system. Hutter (1997 #5650) measured 310 m of vertical offset and a maximum of 1 km of strike-slip displacement in Miocene rocks across the longest fault in the Wallula fault system. Meyer and Mann (1993 #3535) calculate a maximum slip rate of 0.47 mm/yr on the Umapine fault, based on vertical offset of about 5 m since deposition of the 10.7 ka Mount Saint Helens ash. However, Geomatrix Consultants, Inc. (1995) used estimated slip rates of 0.04-0.07 mm/yr for a reverse faulting scenario and rates of 0.08-0.2 mm/yr for a strike-slip faulting scenario in their modeling of earthquake hazards along the entire Wallula fault system Given the poor geomorphic expression of most faults in this zone, lower slip rates seem more probable.

| | | |
|---|---|---|
| **Length** | End to end (km): | 62.9 |
| | Cumulative trace (km): | 160.2 |

Comments:

**Average strike** (azimuth) N 53° W

**References**

#5824 Farooqui, S.M., and Thoms, R.E., 1980, Geologic evaluation of selected faults and lineaments, Pasco and Walla Walla basins, Washington: Technical report to Washington Public Power Supply System under the direction of United Engineers and Constructors, Inc., under Contract 44013, C.O. 43 Task-3, May 1980, 25 p.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#5650 Hutter, I.L., 1997, The Wallula fault zone—A study of the structure and tectonic history of a portion of the Olympic-Wallowa lineament: Bellingham, Western Washington University, unpublished M.S. thesis, 194 p.

#3525 Hutter, I.L., Reidel, S.P., and Schermer, E.R., 1994, The Wallula fault zone and constraints on the timing and nature of deformation along the Olympic-Wallowa lineament: Geological Society of America Abstracts with Programs, v. 26, no. 7, p. 187.

#3728 Kienle, C.F., Jr., Hamill, M.L., and Clayton, D.N., 1979, Geological reconnaissance of the Wallula Gap, Washington - Blue Mountains - LaGrande, Oregon region: Technical report to Shannon & Wilson, Inc., Portland, Oregon, under Contract 44013, December 1979, 58 p., 1 pl., scale 1:125,000.

#3478 Kuehn, S.C., 1995, The Olympic-Wallowa Lineament, Hite fault system, and Columbia River Basalt Group stratigraphy in Northeast Umatilla County, Oregon: Pullman, Washington, Washington State University, unpublished Master's thesis, unpublished, 170 p., 4 pls.

#3530 Kuehn, S.C., Hooper, P.R., Thiessen, R.L., and Watkinson, J.A., 1996, Structures in the Columbia River basalts associated with the Olympic-Wallowa lineament and Hite fault: Geological Society of America Abstracts with Programs, v. 28, no. 5, p. 83.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3535 Mann, G.M., and Meyer, C.E., 1993, Late Cenozoic structure and correlations to seismicity along the Olympic-Wallowa Lineament, northwest United States: Geological Society of America Bulletin, v. 105, p. 853-871.

#4337 McQuarrie, N., 1993, Structural analysis of the Wallula Gap fault, southeastern Washington: Geological Society of America Abstracts with Programs, v. 25, p. 119.

#3773 Mullineaux, D.R., 1986, Summary of pre-1980 tephra-fall deposits erupted from Mount St. Helens, Washington State, USA: Bulletin of Volcanology, v. 48, p. 17-26.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3733 Piety, L.A., LaForge, R.C., and Foley, L.L., 1990, Seismic sources and maximum credible earthquakes for Cold Springs and McKay Dams, Umatilla Project, north-central Oregon: U.S. Bureau of Reclamation Seismotectonic Report 90-1, 62 p., 1 pl.

#3539 Reidel, S.P., Campbell, N.P., Fecht, K.R., and Lindsey, K.A., 1994, Late Cenozoic structure and stratigraphy of south-central Washington, *in* Lasmanis, R., and Cheney, E.S., eds., Regional geology of Washington State: Washington Division of Geology and Earth Resources, p. 159-180.

#3536 Reidel, S.P., and Tolan, T.L., 1994, Late Cenozoic structure and correlation to seismicity along the Olympic-Wallowa Lineament, northwestern United States—Discussion and reply: Geological Society of America Bulletin, v. 106, p. 1634-1638.

#3738 Rigby, J.G., and Othberg, K., 1979, Reconnaissance surficial geologic mapping of the Late Cenozoic sediments of the Columbia Basin, Washington: State of Washington Department of Natural Resources Division of Geology and Earth Resources Open-File Report 79-3, 88 p., 10 pls.

#3760 Schuster, E.J., Gulick, C.W., Reidel, S.P., Fecht, K.R., and Zurenko, S., 1997, Geologic map of Washington-southeast quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-45, 20 p. pamphlet, 2 sheets, scale 1:250,000.

#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

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#3480 U.S. Army Corps of Engineers, 1983, The Dalles and John Day Lakes earthquake and fault study—Design memorandum 26: U.S. Army Corps of Engineers, Portland District, 66 p., 19 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 847, Arlington-Shutler Butte fault

**Structure Number** 847

Comments: This structure is part of fault number 10 of Pezzopane (1993 #3544) and fault number 81 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Arlington-Shutler Butte fault

Comments: Lineaments and fault and fold traces of various orientations have been mapped as the Arlington-Shutler Butte (or Buttes) fault, Arlington-Shutler Butte lineament, and Shutler lineament (Bela, 1982 #3584; U.S. Army Corps of Engineers, 1983 #3480; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). Herein we retain the name Arlington-Shutler Butte fault.

**Synopsis** The Arlington-Shutler Butte fault is a northwest-striking fault zone marked by right-lateral strike slip and normal faults, and is coincident with anticlines of similar trend. The fault zone offsets Miocene and Pliocene volcanic and sedimentary rocks. No scarps on Quaternary deposits have been described, but geomorphic evidence suggests that the fault has undergone middle and late Quaternary displacement.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon and Washington

**County** Gilliam (OR); Klickitat (WA)

**1° x 2° sheet** The Dalles

**Province** Columbia Plateaus (Walla Walla Plateau)

**Quality of location** Good

Comments: Fault trace is from 1:100,000-scale compilations of Walsh (1986 #5189), Philips (1987 #4660), and Schuster (1994 #4654) in Washington, and from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale compilations of Swanson and others (1981 #3496) and Bela (1982 #3584), and 1:500,000-scale mapping of Pezzopane (1993 #3544) in Oregon.

**Geologic setting** The Arlington-Shutler Butte fault is a northwest-striking structure formed in Miocene Columbia River basalts and Miocene and Pliocene sedimentary rocks (Swanson and others, 1981 #3496; Bela, 1982 #3584; Walsh and others, 1987 #3579; Walker and MacLeod, 1991 #3646; Schuster and others, 1997 #3760).

**Sense of movement** D?, N?

Comments: The Arlington-Shutler Butte fault is almost everywhere coincident with and parallel to a northwest-striking anticline; in places it is mapped as a down-to-the-northeast normal fault, and in other places is mapped as a right-lateral strike-slip fault (Swanson and others, 1981 #3496; Bela, 1982 #3584; Walsh and others, 1987 #3579; Tolan and Reidel, 1989 #3765; Pezzopane, 1993 #3544; Schuster and others, 1997 #3760; Weldon and others, 2002 #5648). About 8 km of right-lateral displacement of east-northeast trending thrust faults parallel to the Columbia Hills anticline is apparent just north of the Columbia River, but other fold axes in the area are mapped across the fault without apparent displacement.

**Dip** 90°

Comments: No actual dip measurements are available, but Geomatrix Consultants, Inc. (1995 #3593) modeled the Arlington-Shutler Butte fault as a vertical strike-slip fault in their analysis of paleo-earthquake magnitudes.

**Main dip direction** None, vertical to NE

**Geomorphic expression** The Arlington-Shutler Butte fault is coincident with lineaments and short uplifts (anticlines) along most of its length (Swanson and others, 1981 #3496; Bela, 1982 #3584; U.S. Army Corps of Engineers, 1983 #3480; Tolan and Reidel, 1989 #3765). S.K. Pezzopane (pers. commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) used airphoto analysis to observe "good geomorphic expression" of faulting along the Arlington-Shutler Butte fault.

**Age of faulted deposits at the surface** The Arlington-Shutler Butte fault offsets Miocene and Pliocene volcanic and sedimentary rocks (Swanson and others, 1981 #3496; Bela, 1982 #3584; Walsh and others, 1987 #3579; Schuster and others, 1997 #3760); no evidence of faults in Quaternary deposits have been documented, but such deposits are rare in this part of the Columbia Plateau.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: No evidence of Quaternary displacement has been documented along the Arlington-Shutler Butte fault. U.S. Army Corps of Engineers (1983 #3480) used regional structural relationships to suggest that youngest movement on the fault occurred more than 1 Ma, but airphoto analysis by S.K. Pezzopane (1993 #3544) and (pers. commun., 1993, in Geomatrix Consultants Inc., 1995 #3593), and Geomatrix Consultants, Inc. (1995 #3593) suggest that the Arlington-Shutler Butte fault has "good geomorphic expression" of faulting and may have been active in the middle or late Quaternary (<700-780 ka). The fault also is mapped as active in the middle or late Quaternary (<780 ka) by Weldon and others (2002 #5648).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip data are available for the Arlington-Shutler Butte fault, but the lack of scarps on Quaternary deposits suggests low rates of Quaternary slip. Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.01-0.1 mm/yr in their analysis of earthquake hazards associated with the Arlington-Shutler Butte fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 52.2 |
| | Cumulative trace (km): | 53.4 |

Comments:

**Average strike** (azimuth) N 43° W

**References**


#3584 Bela, J.L., 1982, Geologic and neotectonic evaluation of north-central Oregon—The Dallas 1 x 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geologic Map Series GMS-27, 2 sheets, scale 1:250,000.

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#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4660 Phillips, W.M., 1987, Geologic map of the northwest part of the Goldendale Quadrangle, Washington: Washington Division of Geology and Earth Resources Open-File Report 87-13, 9 p., scale 1:100,000.

#3760 Schuster, E.J., Gulick, C.W., Reidel, S.P., Fecht, K.R., and Zurenko, S., 1997, Geologic map of Washington-southeast quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-45, 20 p. pamphlet, 2 sheets, scale 1:250,000.

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#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

#3765 Tolan, T.L., and Reidel, S.P., 1989, Structure map of a portion of the Columbia River flood-basalt Province, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, 1 sheet, scale 1:500,000.

#3480 U.S. Army Corps of Engineers, 1983, The Dalles and John Day Lakes earthquake and fault study—Design memorandum 26: U.S. Army Corps of Engineers, Portland District, 66 p., 19 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5189 Walsh, T.J., compiler, 1986, Geologic map of the west half of the Toppenish quadrangle, Washington: Washington Division of Geology and Earth Resources Open File Report 86-3, 8 p., 1 pl., scale 1:100,000.

#3579 Walsh, T.J., Korosec, M.A., Phillips, W.M., Logan, R.L., and Schasse, H.W., 1987, Geologic map of Washington-southwest quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-34, 28 p. pamphlet, 2 sheets, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**850, Unnamed faults on Tygh Ridge (Class B)**

**Structure Number** 850

Comments:

**Structure Name** Unnamed faults on Tygh Ridge (Class B)

Comments: Faults associated with the Tygh Ridge anticline have been mapped by numerous authors (Waters, 1968 #3755; Newcomb, 1970 #3761; Swanson and others, 1981 #3496; Bela, 1982 #3584; Geomatrix Consultants Inc., 1990 #3550; Pezzopane, 1993 #3544; Sherrod and Scott, 1995 #3495; Sherrod and Smith, 2000 #5165).

**Synopsis** The faults on Tygh Ridge are east-west-striking reverse or thrust faults that parallel the trend of Tygh Ridge and the Tygh Ridge anticline; these structures deform Miocene rocks of the Columbia River Basalt Group and younger Miocene volcaniclastic sedimentary rocks near the southern margin of the Yakima fold belt. The faults on Tygh Ridge were originally mapped as a down-to-the-north normal faults, but later maps show these faults as south- and/or north-dipping reverse or thrust faults; the sharp north-trending jog near the village of Tygh Valley may be related to right-lateral strike-slip faulting between north and south dipping reverse or thrust faults. No evidence of fault scarps on Quaternary deposits has been described along these faults. Herein we classify these faults as Class B structures until further studies are conducted.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Wasco

**1° x 2° sheet** The Dalles

**Province** Columbia Plateaus (Walla Walla Plateau)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:100,000-scale mapping of Sherrod and Scott (1995 #3495) and 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** The faults near Tygh Ridge are east-west-striking reverse or thrust faults that parallel the trend of Tygh Ridge and the Tygh Ridge anticline; these structures deform Miocene rocks of the Columbia River Basalt Group and younger Miocene volcaniclastic sedimentary rocks near the southern margin of the Yakima fold belt (Waters, 1968 #3755; Newcomb, 1970 #3761; Swanson and others, 1981 #3496; Bela, 1982 #3584; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Sherrod and Scott, 1995 #3495; Sherrod and Smith, 2000 #5165).

**Sense of movement** R, T, D

Comments: The faults near Tygh Ridge were originally mapped as down-to-the-north normal faults (Waters, 1968 #3755; Newcomb, 1970 #3761), but later maps show these faults as south- and/or north-dipping reverse or thrust faults (Swanson and others, 1981 #3496; Bela, 1982 #3584; Pezzopane, 1993 #3544; Sherrod and Scott, 1995 #3495); the sharp north-trending jog near the village of Tygh Valley may be related to right-lateral strike-slip faults (Swanson and others, 1981 #3496; Bela, 1982 #3584) that may be tear faults between a south-dipping reverse or thrust fault to the west and a north-dipping reverse or thrust fault to the east (Pezzopane, 1993 #3544; Weldon and others, 2002 #5648).

**Dip** Not Reported

Comments:

**Main dip direction** S, N

**Geomorphic expression** Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area, but no other evidence of Quaternary faulting has been described.

**Age of faulted deposits at the surface** The faults near Tygh Ridge offsets Miocene rocks of the Columbia River Basalt Group and younger Miocene volcaniclastic sedimentary rocks (Waters, 1968 #3755; Swanson and others, 1981 #3496; Bela, 1982 #3584; Walker and MacLeod, 1991 #3646; Sherrod and Scott, 1995 #3495; Sherrod and Smith, 2000 #5165). No evidence of faulting in Quaternary deposits has been described along these structures.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: No evidence of Quaternary displacement has been documented along the faults near Tygh Ridge. D.R. Sherrod (pers. commun., 1989, in Geomatrix Consultants Inc., 1990 #3550) indicated that latest movement on the Tygh Valley faults predates the Pliocene, but Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) classify these faults as active in the Quaternary (<1.6-1.8 Ma). Herein we classify these faults as Class B structures until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip data are available for the faults near Tygh Ridge, but the lack of significant evidence of Quaternary displacement suggests low rates of Quaternary slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 26.3 |
| | Cumulative trace (km): | 31.7 |

Comments:

**Average strike** (azimuth) N 83° E

**References**


#3584 Bela, J.L., 1982, Geologic and neotectonic evaluation of north-central Oregon—The Dallas 1 x 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geologic Map Series GMS-27, 2 sheets, scale 1:250,000.

#3550 Geomatrix Consultants Inc., 1990, Seismotectonic evaluation of Wasco Dam site: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, under Contract 6-CS-81-07310, 115 p., 2 pls., scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3495 Sherrod, D.R., and Scott, W.E., 1995, Preliminary geologic map of the Mount Hood 30 by 60 minute quadrangle, northern Cascade Range, Oregon: U.S. Geological Survey Open-File Report 95-219, 28 p., 1 pl., scale 1:100,000.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3755 Waters, A.C., 1968, Reconnaissance geologic map of the Dufur quadrangle, Hood River, Sherman, and Wasco Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-556, 1 sheet, scale 1:125,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**851, Warm Springs fault zone**

**Structure Number** 851

Comments: This fault zone is number 19 of Pezzopane (1993 #3544) and number 43 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Warm Springs fault zone

Comments: Faults in the central part of the Warm Springs Indian Reservation, including those mapped as the Shitike Creek faults by the U.S. Army Corps of Engineers (1983 #3485) were included in the Warm Springs zone or fault zone of Pezzopane (1993 #3544). Herein we follow Geomatrix Consultants, Inc. (1995 #3593) in including all these faults in the Warm Springs fault zone.

**Synopsis** The Warm Springs fault zone is a 30-km-wide zone of mostly west-dipping, north-striking normal faults that offset early Pleistocene, Pliocene, and Miocene volcanic rocks and sediments along the eastern margin of the Cascade Range in north-central Oregon. Fault scarps with heights of 3-12 m have been identified along some strands of the Warm Springs fault zone; the geomorphic expression of the youngest scarps in the zone suggest latest movement in the middle and late Quaternary.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Wasco and Jefferson

**1° x 2° sheet** Bend

**Province** Columbia Plateaus (Walla Walla Plateau); Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale compilation of Weldon and others (2002 #5648).

**Geologic setting** The Warm Springs fault zone is comprised of numerous, mostly west-dipping, north-striking normal faults (U.S. Army Corps of Engineers, 1983 #3485; Pezzopane, 1993 #3544) that offset volcanic rocks and sediments along the eastern margin of the Cascade Range in north-central Oregon. Only some of the faults in this 30-km-wide zone are shown on geologic or lineament maps of the region (Waters, 1968 #3755; Newcomb, 1970 #3761; Venkatakrishnan and others, 1980 #3748; Smith, 1987 #3758; Walker and MacLeod, 1991 #3646; Sherrod and Smith, 2000 #5165).

**Sense of movement** N

Comments: The numerous fault strands in the Warm Springs fault zone are mapped as high angle or normal faults by U.S. Army Corps of Engineers (1983 #3485), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Sherrod and Smith (2000 #5165),

**Dip** 70°-90°

Comments: U.S. Army Corps of Engineers, (1983 #3485) measured dips of 80° and "nearly vertical" on two strands of the Warm Springs fault zone. Geomatrix Consultants, Inc. (1995 #3593) use an estimated dip of 70° in their modeling of earthquake hazards associated with the Warm Springs fault zone.

**Main dip direction** W, E

**Geomorphic expression** The U.S. Army Corps of Engineers (1983 #3485) described colluvium covered, 3- to 12-m-high scarplike slopes on flat lying surfaces along several strands of the Warm Springs fault zone. S.K. Pezzopane (pers. commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) used airphoto reconnaissance to describe fault scarps up to 5 m high in Pleistocene alluvium along some fault strands in the zone. Both the U.S. Army Corps of Engineers (1983 #3485) and S.K. Pezzopane (pers. commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) noted that faults in the Warm Springs fault zone have geomorphic expressions similar to faults in the Sisters fault zone [852] to the south. However, the U.S. Army Corps of Engineers (1983 #3485) stated that the entire zone appears to be about the same age, whereas S.K. Pezzopane (pers. commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) noted that some scarps appear younger than others. Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** The faults mapped by the U.S. Army Corps of Engineers (1983 #3485), Pezzopane (1993 #3544), and Weldon and others (2002 #5648) mostly offset volcanic and sedimentary rocks of early Pleistocene, Pliocene, and Miocene age (Walker and MacLeod, 1991 #3646; Sherrod and Smith, 2000 #5165).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: No evidence of Quaternary displacement has been documented along the Warm Springs fault zone, but Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) classified these faults as active in the middle and late Quaternary (<700-780 ka). S.K. Pezzopane, (pers. commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) described degradation of fault scarps in the Warm Springs fault zone as consistent with latest displacement in the middle to late Pleistocene.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip data are available for the Warm Springs fault zone, but Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.005-0.01 mm/yr in their analysis of earthquake hazards associated with the fault zone.

| | | |
|---|---|---|
| **Length** | End to end (km): | 31.7 |
| | Cumulative trace (km): | 115.3 |

Comments:

**Average strike** (azimuth) N 03° E

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3758 Smith, G.A., 1987, Geologic map of the Seekseequa Junction and a portion of the Metolius Bench quadrangles, Jefferson County, Oregon: State of Oregon, Department of Geology and Mineral Industries GMS-44, 1 sheet, scale 1:24,000.

#3485 U.S. Army Corps of Engineers, 1983, Detroit and Big Cliff Lakes earthquake and fault study—Design memorandum 4: U.S. Army Corps of Engineers, Portland District, 93 p., 13 pls.

#3748 Venkatakrishnan, R., Bond, J.G., and Kauffman, J.D., 1980, Geological linears of the northern part of the Cascade Range, Oregon: Technical report to Geoscience Research Consultants, Moscow, Idaho, under Contract DE FC 07-79-ID-12044, 25 p., 5 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3755 Waters, A.C., 1968, Reconnaissance geologic map of the Dufur quadrangle, Hood River, Sherman, and Wasco Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-556, 1 sheet, scale 1:125,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 852, Sisters fault zone

**Structure Number** 852

Comments: This zone is fault number 23 of Pezzopane (1993 #3544) and fault number 45 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Sisters fault zone

Comments: Numerous northwest-striking fault strands are included in the Sisters fault zone, a broad zone of apparent normal faults that extend from southeast of Bend to northeast of Sisters in central Oregon (Lawrence, 1976 #3506; Peterson and others, 1976 #3735; U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; Geomatrix Consultants Inc., 1990 #3550; 1995 #3593; Ake and others, 2001 #5035; Sherrod and others, in press #5172). The fault zone was included in the Oregon-Nevada lineament of Stewart and others (1975 #3769). Herein we follow Hawkins and others (1988 #2946) and Ake and others (2001 #5035) by including the nearby Green Ridge, Black Butte, Rimrock, and Tumalo faults and the Northwest Rift Zone in a separate structure, the Metolius fault zone [853]. The only informally or formally named fault in our restricted Sisters fault zone is the Skeleton Cave fault of Hawkins and others (1988 #2946).

**Synopsis** The Sisters fault zone is comprised of numerous, northeast- and southwest-dipping, northwest-striking normal faults that offset Miocene to upper Pleistocene volcanic rocks and sediments along the eastern margin of the Cascade Range in central Oregon. The structural setting of the Sisters fault zone is open to interpretation, but it probably is a structural transition zone between the northwest-striking right-lateral(?) Brothers fault zone [819] and the more northerly striking parts of the Metolius normal fault zone [853]. Most of the fault strands that comprise the Sisters fault zone have latest displacements in the middle and late Quaternary, but two fault strands north of Tumalo may offset glacial outwash deposits and thus may have been active in the late Quaternary.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Deschutes and Jefferson

**1° x 2° sheet** Bend

**Province** Columbia Plateaus (Walla Walla Plateau and Harney sections)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale compilation of Weldon and others (2002 #5648), based on 1:500,000-scale compilation of Pezzopane (1993 #3544).

**Geologic setting** The Sisters fault zone is comprised of numerous northeast- and southwest-dipping, northwest-striking normal faults (Lawrence, 1976 #3506; Peterson and others, 1976 #3735; Walker and Nolf, 1981 #4310; 1981 #4311; U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; Geomatrix Consultants Inc., 1990 #3550; Walker and MacLeod, 1991 #3646; 1995 #3593; Ake and others, 2001 #5035; Sherrod and others, in press #5172) that offset volcanic and sedimentary rocks along the eastern margin of the Cascade Range in central Oregon. The structural setting of the Sisters fault zone is open to interpretation (Sherrod and others, in press #5172): the fault zone may form part of the eastern boundary of the Cascades graben (Taylor, 1981 #4306; 1981 #4307; Sherrod and Smith, 2000 #5165), it may be the surface expression of a right-lateral strike-slip fault system (Walker, 1969 #4296; Stewart and others, 1975 #3769; Lawrence, 1976 #3506; Walker and Nolf, 1981 #4310; 1981 #4311; U.S. Army Corps of Engineers, 1983 #3484), or it may be the northwestern apex of Basin and Range faulting in Oregon (Lawrence, 1976

#3506). Perhaps most likely, the Sisters fault zone may be a structural transition zone between the northwest-striking Brothers fault zone [819] and the more northerly striking parts of the Metolius normal fault zone [853] (Lawrence, 1976 #3506; Hawkins and others, 1988 #2946). The width and distributed nature of the fault zone also suggests that it may in part be of volcanic origin (Ake and others, 2001 #5035).

**Sense of movement** N, ND?

Comments: The numerous fault strands in the Sisters fault zone are mapped as high angle or normal faults by most workers (Peterson and others, 1976 #3735; Walker and Nolf, 1981 #4310; 1981 #4311; U.S. Army Corps of Engineers, 1983 #3484; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Sherrod and Smith, 2000 #5165; Sherrod and others, in press #5172), but if these faults are part of a regional-scale strike-slip fault system (Walker, 1969 #4296; Stewart and others, 1975 #3769; Lawrence, 1976 #3506; Peterson and others, 1976 #3735; Walker and Nolf, 1981 #4310; 1981 #4311; U.S. Army Corps of Engineers, 1983 #3485), then some oblique slip may also be present (Geomatrix Consultants Inc., 1995 #3593). Horizontal slickensides apparent in an exposure of one strand of the Sisters fault zone north of Tumalo State Park (stop one of Taylor, 1981 #4307) indicate that some fault strands in the Sisters fault zone have undergone strike-slip displacement in the Quaternary (U.S. Army Corps of Engineers, 1983 #3484). Hemphill-Haley (2001 #5036) used fault patterns to infer a left-lateral component of slip on one fault trace north of Tumalo.

**Dip** 90°?

Comments: No detailed information on fault dip is available, but several workers refer to vertical or steeply dipping fault exposures and scarps along the Sisters fault (U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; Geomatrix Consultants Inc., 1995 #3593; Ake and others, 2001 #5035; Hemphill-Haley, 2001 #5036; Sherrod and others, 2002 #5169). Such dips are consistent with a strike-slip or significant oblique sense of slip.

**Main dip direction** NE, SW

**Geomorphic expression** The Sisters fault zone consists of numerous northeast- and southwest-dipping, northwest-striking fault strands in relatively flat-lying late Tertiary and Quaternary volcanic rocks; these short (commonly 5- to 8-km-long) faults are marked by 2- to 30-m-high colluvium-mantled scarps (U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; Geomatrix Consultants Inc., 1995 #3593; Ake and others, 2001 #5035; Sherrod and others, 2002 #5169; Sherrod and others, in press #5172). Some near-vertical scarps probably owe their fresh appearance to vertical jointing in and resistance to erosion of the underlying basalt bedrock (Hawkins and others, 1988 #2946). Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** The numerous fault strands that comprise the Sisters fault zone primarily offset Miocene to upper Pleistocene basalts and tuffs (Walker and MacLeod, 1991 #3646; MacLeod and others, 1995 #3557; Sherrod and Smith, 2000 #5165; Sherrod and others, in press #5172). Offsets of Quaternary surficial deposits have been described on two strands near Tumalo that offset outwash deposits of middle(?) or late Quaternary age (Ake and others, 2001 #5035; Hemphill-Haley, 2001 #5036). Sherrod and others (2002 #5169) describe a quarry exposure of one strand of the Sisters fault zone southwest of Tumalo that showed <4 of down-to-the-northeast displacement of the Bend Pumice, 0.4 Ma Tumalo Tuff, and an overlying undated gravel deposit.

**Paleoseismology studies** Two subsurface investigations have been published on fault strands of the Sisters fault zone. Hawkins and others (locality 852-1, Hawkins and others, 1988 #2946) investigated the Sisters fault zone as part of a seismotectonic investigation for nearby Arthur R. Bowman and Ochoco dams operated by the U.S. Bureau of Reclamation. Mark Hemphill-Haley (locality 852-2, Hemphill-Haley, 2001 #5036) investigated a second location on the Sisters fault zone near Tumalo. The following discussions are from Hawkins and others (1988 #2946) and Hemphill-Haley (2001 #5036).

locality 852-1: Hawkins and others (1988 #2946) excavated a 20-m-long, 2.9-m-deep trench about 15 km southeast of Bend across a 6-km-long fault strand they informally named the Skeleton Cave fault. This strand is the southeasternrnost fault in the Sisters fault zone. The Skeleton Cave fault scarp is 5 to 30 m high, and is developed in basalt mapped as middle to late Pleistocene in age (MacLeod and others, 1995 #3557). However, Hawkins and others (1988 #2946) obtained a K-Ar age of 2.7 ± 0.3 Ma at a nearby site on basalt from the youngest flow offset by the Skeleton Cave fault, so the age of offset deposits is open to question. The trench was sited in a location where Quaternary surficial deposits are ponded against the basalt-armored fault scarp; preliminary drilling had shown that these sediments were well stratified and contained pumicious tephra layers. Unfortunately, buried basalt boulders at the base of the scarp prevented excavation closer than 8 m to the edge of the fault scarp, so the fault zone could not be exposed in the trench. Hawkins and others (1988 #2946) concluded that significant scarp retreat had occurred along the Skeleton Cave fault strand, but could make no other inferences about fault history.

locality 852-2: Hemphill-Haley (2001 #5036) excavated a 3.5-m-deep trench about 2 km north of Tumalo, across a <3.5-km-long fault strand of the Sisters fault zone. The fault strand forms scarps >10 m high in late Miocene basalt, and smaller scarps in Pleistocene outwash deposits. The scarp is characterized by anastomosing and en echelon traces suggestive of left-lateral as well as vertical displacement, but the ratio of lateral to vertical slip could not be determined. The trench was located across a relatively simple, 2-m-high east-facing scarp formed in Pleistocene outwash sands and gravels. The trench exposed several units of unconsolidated sand and gravel displaced by a broad zone of near-vertical faults with down-east displacement directions. Hemphill-Haley (2001 #5036) interpreted at least two surface-rupturing events, each with about 1 m of vertical and an unknown amount of horizontal displacement. Both events are undated because no organic materials were found. However, the youngest faulted deposit has a well developed Bt horizon developed in it that may have developed as much as 100 ka.

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: Most of the fault strands in the Sisters fault zone offset middle to upper Pleistocene (10-760 ka) basalts related to Newberry volcano (MacLeod and others, 1995 #3557; Sherrod and Smith, 2000 #5165; Sherrod and others, 2002 #5169; Sherrod and others, in press #5172), and thus have been mapped with middle or late Quaternary (700-780 ka) displacements by Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648). Two fault strands north of Tumalo offset glacial outwash deposits and thus have been interpreted as active in the latest Quaternary (Nakata and others, 1992 #3524; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). However, a trench excavated across one of these scarps (Ake and others, 2001 #5035; Hemphill-Haley, 2001 #5036) suggested the youngest faulted deposits may be as old as 100 ka, so a middle(?) or late Quaternary age may be more likely. Geomatrix Consultants, Inc. (1995 #3593) assume little significant faulting since inception of the present cycle of canyon cutting in the Late Pleistocene to Holocene.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: Data from Hawkins and others (1988 #2946) indicate a vertical displacement of 40 m of 2.7 ± 0.3 Ma basalts across an individual fault strand in the Sisters fault zone; these data yield a vertical slip rate of about 0.01 mm/yr, which Geomatrix Consultants, Inc. (1995 #3593) applied to the Sisters fault zone. Geomatrix Consultants, Inc. (1995) also used data from MacLeod and others (1982 #3722) near the southern end of the Sisters fault zone (12-15 m of vertical slip of 120-730 ka basalts) to calculate somewhat higher vertical slip rates of 0.02-0.1 mm/yr. Hemphill-Haley (2001 #5036) measured 2 m of vertical displacement in deposits that may be as old as 100 ka on one strand of the fault near Tumalo. No estimates of lateral slip rates have been determined.

**Length** End to end (km): 52.9
Cumulative trace (km): 31.5

Comments:

**Average strike** (azimuth) N 26° W

**References**


#5035 Ake, J., LaForge, R., and Hawkins, F., 2001, Probabilistic seismic hazard analysis for Wickiup Dam—Deschutes project, central Oregon: U.S. Bureau of Reclamation Seismotectonic Report 2000-04, 71 p.

#3550 Geomatrix Consultants Inc., 1990, Seismotectonic evaluation of Wasco Dam site: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, under Contract 6-CS-81-07310, 115 p., 2 pls., scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#2946 Hawkins, F.F., LaForge, R.C., Templeton, M., and Gilbert, J.D., 1988, Seismotectonic study for Arthur R. Bowman and Ochoco Dams, Crooked River Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 88-10, 57 p., 2 pls.

#5036 Hemphill-Haley, M., 2001, Appendix A - Summary of studies on the Sisters fault zone, *in* Ake, J., LaForge, R., and Hawkins, F., eds., Probabilistic seismic hazard analysis for Wickiup Dam—Deschutes project, central Oregon: Seismotectonic Report 2000-04, p. A1-B16.

#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3722 MacLeod, N.S., Sherrod, D.R., and Chitwood, L.A., 1982, Geologic map of the Newberry Volcano, Deschutes, Klamath, and Lake Counties, Oregon: U.S. Geological Survey Open-File Report 82-847, 27 p., 1 pl., scale 1:62,500.

#3557 MacLeod, N.S., Sherrod, D.R., Chitwood, L.A., and Jensen, R.A., 1995, Geologic map of Newberry Volcano, Deschutes, Klamath, and Lake Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2455, 2 sheets, scale 1:24,000 and 1:62,500.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3524 Nakata, T., Weldon, R.J.I., Pezzopane, S., Rosenfeld, C., and Yeats, R.S., 1992, Preliminary aerial photo-interpretation of active faults in Oregon: Geological Society of America Abstracts with Programs, v. 24, no. 5, p. 72.

#3735 Peterson, N.V., Groh, E.A., Taylor, E.M., and Stensland, D.E., 1976, Geology and mineral resources of Deschutes County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 89, 66 p., 4 pls.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

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## 853, Metolius fault zone

**Structure Number** 853

Comments: This fault zone is comprised of fault numbers 24, 25, and 26 of Pezzopane (1993 #3544) and fault numbers 44, 46, and 47 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Metolius fault zone

Comments: The Metolius fault zone of Hawkins and others (1988 #2946) is a zone of primarily down-to-the-west and southwest normal faults that extend from Green Ridge on the north to Newberry Volcano on the south. Named faults in this fault zone are, from north to south, the Green Ridge, Rimrock, and Tumalo faults and the Northwest Rift zone near Newberry volcano (Peterson and others, 1976 #3735; U.S. Army Corps of Engineers, 1983 #3484; 1983 #3485; Hawkins and others, 1988 #2946; Goles and Lambert, 1990 #3763; Mimura, 1992 #3590; Taylor and Ferns, 1994 #3759; MacLeod and others, 1995 #3557; Sherrod and others, in press #5172). This fault zone should not be confused with the Metolius fault located along the Metolius River northeast of Green Ridge (U.S. Army Corps of Engineers, 1983 #3485), which has not been included in recent Quaternary fault compilations (Hawkins and others, 1988 #2946; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). Fault strands in the Metolius fault zone are parallel to and have been included by various authors in the nearby Sisters and Brothers fault zones [#852 and #819, respectively], but we include these faults in the Metolius fault zone of Hawkins and others (1988 #2946) because of their consistent slip direction.

**Synopsis** The Metolius fault zone is comprised of several mostly southwest-dipping, northwest-striking normal faults that offset volcanic rocks and sediments along the eastern margin of the Cascade Range in central Oregon. The structural setting of the Metolius fault zone is open to interpretation, but the fault zone probably forms part of the eastern boundary of the Cascades graben in a structural transition zone at the northern end of the right-lateral(?) Brothers fault zone. The Metolius fault zone herein is divided into three sections, from northwest to southeast, the Green Ridge, Rimrock-Tumalo, and the Northwest Rift zone sections. The youngest movements appear to be confined to the Northwest Rift zone section of the fault zone, but these features may be surface expressions of dikes at depth, formed in response to the regional stress field.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Deschutes and Jefferson

**1° x 2° sheet** Bend, Crescent

**Province** Columbia Plateaus (Walla Walla Plateau and Harney sections), Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Geologic setting** The Metolius fault zone of Hawkins and others (1988 #2946) is comprised of several mostly southwest-dipping, northwest-striking normal faults (Peterson and others, 1976 #3735; U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; Geomatrix Consultants Inc., 1990 #3550; Walker and MacLeod, 1991 #3646; 1995 #3593; Sherrod and others, in press #5172) that offset volcanic rocks and sediments along the eastern margin of the Cascade Range in central Oregon. The structural setting of the Metolius fault zone is open to interpretation, but the fault zone probably forms part of the eastern boundary of the Cascades graben (Taylor, 1981 #4306; 1981 #4307; Sherrod and Smith, 2000 #5165), in a structural transition zone at the northern end of the right lateral(?) Brothers fault zone (Lawrence, 1976 #3506; Hawkins and others, 1988 #2946).

**Number of sections** 3

Comments: Following Hawkins and others (1988 #2946), the Metolius fault zone is divided into three sections herein; from northwest to southeast, these are the Green Ridge section, the Rimrock-Tumalo section, and the Northwest Rift zone section.

**Length** End to end (km): 93.6
Cumulative trace (km): 155.9

Comments:

**Average strike** (azimuth) N 22° W

***853a, Green Ridge section***

**Section number** 853a

**Section name** Green Ridge section

Comments: This section consists of the Green Ridge fault and several other small faults near Green Ridge and Black Butte.

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale compilation of Weldon and others (2002 #5648), based on 1:500,000-scale compilation of Pezzopane (1993 #3544).

**Sense of movement** ND?

Comments: Faults in the Green Ridge section are mapped as high angle or normal faults by most workers (Williams, 1957 #3740; Peterson and others, 1976 #3735; Taylor, 1981 #4306; 1981 #4307; U.S. Army Corps of Engineers, 1983 #3485; Walker and MacLeod, 1991 #3646; Hill, 1992 #3736; Pezzopane, 1993 #3544; Sherrod and Smith, 2000 #5165; Sherrod and others, in press #5172), but if these faults are part of the Sisters fault zone [#852], then some oblique slip may also be present (Geomatrix Consultants Inc., 1995 #3593; Sherrod and others, in press #5172).

**Dip** Not Reported

Comments:

**Main dip direction** W, SW

**Geomorphic expression** The most prominent fault in this section, the Green Ridge fault, parallels a 750-m-high, linear escarpment on Miocene volcanic rocks on the western margin of Green Ridge. Despite its height and linearity, little geomorphic evidence of Quaternary faulting has been found along this escarpment (Hawkins and others, 1988 #2946; Geomatrix Consultants Inc., 1995 #3593). Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary activity on several faults in the Green Ridge section, and Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** The Green Ridge fault offsets upper Miocene (5.27 ± 0.04 Ma) volcanic rocks of the Deschutes Formation (Smith and others, 1987 #3780) >1000 m (Taylor, 1981; Sherrod, in press #5172). Some faults in the Green Ridge section may be buried by early or middle Pleistocene basalts of Black Butte near the southern end of the section (Taylor, 1981 #4306; 1981 #4307; Hill, 1992 #3736), but U.S. Army Corps of Engineers (1983 #3484), Pezzopane (1993 #3544), Sherrod and Smith (2000 #5165), Sherrod and others (in press #5172), and Weldon and others (2002 #5648) show Quaternary faults in this area.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary displacement on the Green Ridge fault, despite the conclusions of other studies that this structure has not been active in the Quaternary (Hawkins and others, 1988 #2946). Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) inferred middle and late Quaternary (<700-780 ka) displacement on the rest of the faults in the Green Ridge section.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but the lack of significant geomorphic evidence of Quaternary displacement on most faults in the Green Ridge section suggest low rates of slip.

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|---|---|---|
| **Length** | End to end (km): | 29.4 |
| | Cumulative trace (km): | 50.2 |

Comments:

**Average strike** (azimuth) N 11° W

### *853b, Rimrock-Tumalo section*

**Section number** 853b

**Section name** Rimrock-Tumalo section

Comments: This section consists of the down-to-the-southwest, northwest-striking Rimrock and Tumalo faults and antithetic faults of similar trend (Peterson and others, 1976 #3735; Taylor, 1981 #4306; 1981 #4307; U.S. Army Corps of Engineers, 1983 #3485; Hawkins and others, 1988 #2946; Pezzopane, 1993 #3544; Taylor and Ferns, 1994 #3759; Sherrod and Smith, 2000 #5165; Sherrod and others, in press #5172).

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale compilation of Pezzopane (1993 #3544).

**Sense of movement** ND?

Comments: Faults in the Rimrock-Tumalo section are mapped as high angle or normal faults by most workers (Peterson and others, 1976 #3735; Taylor, 1981 #4306; 1981 #4307; Walker and Nolf, 1981 #4310; 1981 #4311; U.S. Army Corps of Engineers, 1983 #3485; Walker and MacLeod, 1991 #3646; Mimura, 1992 #3590; Pezzopane, 1993 #3544; Taylor and Ferns, 1994 #3759; Sherrod and Smith, 2000 #5165; Sherrod and others, in press #5172), although some right-lateral oblique slip may also be present (Mimura, 1992 #3590; Taylor and Ferns, 1994 #3759; Geomatrix Consultants Inc., 1995 #3593).

**Dip** 70°-90°

Comments: Hawkins and others (1988 #2946) describe an exposure of the Tumalo fault about 0.5 km south of Upper Tumalo Reservoir where several fault planes in Pleistocene pumice and fluvial gravels dip southwest 70°-80°, and other workers refer to vertical or steeply dipping fault exposures and scarps along faults in the Rimrock-Tumalo section (U.S. Army Corps of Engineers, 1983 #3484; Geomatrix Consultants Inc., 1995 #3593; Sherrod and others, 2002 #5169). Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 75° in their modeling of earthquake hazards along the Tumalo fault. Such steep dips are consistent with an oblique component of slip.

**Main dip direction** SW, NE

**Geomorphic expression** The Rimrock-Tumalo section consists of several mostly southwest-dipping, northwest-striking fault strands in gently east-tilted late Tertiary and Quaternary volcanic rocks (Taylor, 1981 #4306; 1981 #4307; U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; Taylor and Ferns, 1994 #3759; Sherrod and Smith, 2000 #5165; Sherrod and others, in press #5172); these faults are marked by prominent scarps up to 70 m high on Miocene-Pliocene volcanic rocks, 2- to 10-m-high scarps on middle Pleistocene ash-flow tuffs and lavas (Hawkins and others, 1988 #2946; Hemphill-Haley, 2001 #5036; Sherrod and others, 2002 #5169), and in places have been mapped as faulting glacial outwash or alluvial surfaces (Peterson and others, 1976 #3735; Mimura, 1992 #3590; Taylor and Ferns, 1994 #3759). Fault scarps form linear escarpments and vegetation lineaments, and may form right-lateral offsets of stream channels northwest of Awbrey Butte (Mimura, 1992 #3590). Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Faults in the Rimrock-Tumalo section offset Miocene-Pliocene volcanic rocks, pyroclastic rocks of middle and late Pleistocene age, and glacial outwash and/or alluvial deposits of middle and late(?) Pleistocene age (Peterson and others, 1976 #3735; Taylor, 1981 #4306; 1981 #4307; U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; Mimura, 1992 #3590; Taylor and Ferns, 1994 #3759; Sherrod and Smith, 2000 #5165; Sherrod and others, 2002 #5169; Sherrod and others, in press #5172). A gravel pit exposure of the Tumalo fault about 0.5 km south of Upper Tumalo Reservoir shows several fault planes offsetting middle Pleistocene Tumalo Tuff(?) and Bend Pumice (0.3-0.4 Ma, Sarna-Wojcicki and others, 1987 #1707; 1989 #3725; Sherrod and others, 2002 #5169; Sherrod and others, in press #5172), and overlying fluvial deposits or glacial outwash (Taylor, 1981 #4306; 1981 #4307; U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; Hemphill-Haley, 2001 #5036). The Tumalo fault also offsets the Shevlin Park tuff, which is thought to have been deposited <170 ka, based on paleomagnetic and geochemical correlations (Gardner and others, 1992 #3786; Taylor and Ferns, 1994 #3759; D.R. Sherrod, pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593). Hawkins and others (1988 #2946) estimated an age of >125-150 ka for the gravel deposits based on soil development. Some High Cascade basalt flows that overlie these gravels are faulted, but their ages are poorly constrained.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Little detailed information on the age of most-recent faulting has been published, but mapping and reconnaissance studies indicate offsets of middle Pleistocene volcanic rocks (Peterson and others, 1976 #3735; Taylor, 1981 #4306; 1981 #4307; Walker and Nolf, 1981 #4310; 1981 #4311; U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; Mimura, 1992 #3590; Taylor and Ferns, 1994 #3759; Sherrod and Smith, 2000 #5165; Sherrod and others, 2002 #5169; Sherrod and others, in press #5172). Younger glacial outwash and/or fluvial deposits, and some High Cascades volcanic rocks are also faulted, but the ages of these deposits are poorly constrained. Hawkins and others (1988 #2946) inferred late Quaternary displacement in the gravel pit exposure of the Tumalo fault. M.L. Ferns (pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593) infers a period of significant faulting on the northern part of the Tumalo fault between 400 and 200 ka, and little or no displacement since 200 ka. Both M.L. Ferns and L.A. Chitwood (pers. communs., 1994, in Geomatrix Consultants Inc., 1995 #3593) infer that latest displacement on the Tumalo fault occurred >100 ka. D.R. Sherrod (pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593) used recently obtained age control on the Shevlin Park tuff to determine that the most recent displacement on the Tumalo fault occurred <170 ka, but probably before 10 ka (Sherrod and others, in press #5172). Taylor and Ferns (1994 #3759) found abundant evidence for repeated displacements in middle Pleistocene volcanic rocks, but no unambiguous evidence for Holocene displacement along the Tumalo fault in the Tumalo Dam quadrangle. U.S. Army Corps of Engineers (1983 #3484) infer Holocene movement on the Tumalo and Rimrock faults, but Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer middle and late Quaternary (<700-780 ka) displacement on most fault strands in the Rimrock-Tumalo section.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but Geomatrix Consultants, Inc. (1995 #3593) use slip data and age estimates from Hawkins and others (1988 #2946) to estimate slip rates of 0.01-0.1 mm/yr on the Tumalo fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 44.7 |
| | Cumulative trace (km): | 56.6 |

Comments:

**Average strike** (azimuth) N 29° W

***853c, Northwest Rift zone section***

**Section number** 853c

**Section name** Northwest Rift zone section

Comments: This section consists of the Northwest Rift zone of Peterson and Groh (1965 #3768) and MacLeod and others (1981 #4308; 1981 #4309; 1982 #3722); this structure is also known as the northwest fissure system (Goles and Lambert, 1990 #3763). This northwest-striking zone of mostly down-to-the-southwest faults and aligned volcanic vents on the northwest flank of Newberry volcano was originally mapped by Peterson and others (1976 #3735) and MacLeod and others (1982 #3722; 1995 #3557).

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale compilation of Pezzopane (1993 #3544).

**Sense of movement** ND?

Comments: Faults in the Northwest Rift zone section are mapped as high angle or normal faults by most workers (Peterson and others, 1976 #3735; MacLeod and others, 1982 #3722; U.S. Army Corps of Engineers, 1983 #3485; Walker and MacLeod, 1991 #3646; MacLeod and Sherrod, 1992 #3566; Pezzopane, 1993 #3544; MacLeod and others, 1995 #3557; Geomatrix Consultants Inc., 1995 #3593; Sherrod and Smith, 2000 #5165; Sherrod and others, in press #5172).

**Dip** 70°

Comments: No detailed dip data are available, but Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their analysis of earthquake hazards associated with faults in the Northwest Rift zone section.

**Main dip direction** SW, NE

**Geomorphic expression** The discontinuous en echelon faults in the Northwest Rift zone section are marked by 2- to 25-m-high scarps on Tertiary and Quaternary volcanic rocks (Hawkins and others, 1988 #2946). In addition to fault scarps, numerous Pleistocene and Holocene volcanic vents are aligned along the fault trends, so all these features may be surface expressions of dikes at depth, formed in response to the regional stress field (MacLeod and Sherrod, 1988 #3770; Ake and others, 2001 #5035; Hemphill-Haley, 2001 #5036).

**Age of faulted deposits at the surface** Faults in the Northwest Rift zone offset older Plio-Pleistocene through middle to late Pleistocene volcanic rocks (MacLeod and others, 1995 #3557). Offset deposits include the Tumalo Tuff and Bend Pumice, which are thought to have been deposited 0.4-0.3 Ma (Sarna-Wojcicki and others, 1987 #1707; 1989 #3725), and the Shevlin Park Tuff, recently dated at approximately 170 ka (D.R. Sherrod, pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593). Some basaltic andesites that overlie these deposits on the northwest flank of Newberry volcano are younger than the last major glaciation, and thus were deposited <15 ka (MacLeod and others, 1995 #3557). Middle Holocene (Chitwood and others, 1977 #3779; MacLeod and others, 1995 #3557) basalt flows are present along much of the section; most workers agree that these flows are not offset by faults in the Northwest Rift zone, but the source vents for these flows are aligned along the faults, so the faults probably served as magma conduits during an episode of crustal extension (Hawkins and others, 1988 #2946). The U.S. Army Corps of Engineers (1983 #3485) note lineaments on airphotos and possible fault scarps in the middle Holocene Lava Butte basalt flow near the northern end of the section; they admit the flow may be draped over an existing fault scarp, but favor a post-flow faulting interpretation.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Little detailed information on the age of most recent faulting has been published, but mapping and reconnaissance studies clearly indicate offsets of middle and probably late Pleistocene volcanic rocks, and alignment of Holocene volcanic vents and possible fault scarps in Holocene deposits suggest possible Holocene displacements (Peterson and others, 1976 #3735; U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946; MacLeod and others, 1995 #3557). Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) delineate several fault strands with geomorphic expressions suggestive of latest Quaternary or Holocene displacement.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: No detailed fault slip data have been documented, but Geomatrix Consultants, Inc. (1995 #3593) used slip data and age estimates from Hawkins and others (1988 #2946) and L.A. Chitwood (pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593) to estimate slip rates of 0.01-0.1 mm/yr on faults in the Northwest Rift zone section.

| | | |
|---|---|---|
| **Length** | End to end (km): | 42.9 |
| | Cumulative trace (km): | 49.1 |

Comments:

**Average strike** (azimuth) N 26° W

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#5169 Sherrod, D.R., Gannett, M.W., and Lite, K.E., Jr., 2002, Hydrogeology of the upper Deschutes basin, central Oregon—A young basin adjacent to the Cascade volcanic arc, *in* Moore, G.W., ed., Field guide to geologic processes in Cascadia: State of Oregon, Department of Geology and Mineral Industries Special Paper 36, p. 109-144.

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#4306 Taylor, E.M., 1981, Central High Cascade roadside geology, Bend, Sisters, McKenzie Pass, and Santiam Pass, Oregon, *in* Johnston, D.A., and Donnelly-Nolan, J., eds., Guides to some volcanic terranes in Washington, Idaho, Oregon, and northern California: U.S. Geological Survey Circular 838, p. 55-58.

#4307 Taylor, E.M., 1981, Roadlog for Central High Cascade geology, Bend, Sisters, McKenzie Pass, and Santiam Pass, Oregon, *in* Johnston, D.A., and Donnelly-Nolan, J., eds., Guides to some volcanic terranes in Washington, Idaho, Oregon, and northern California: U.S. Geological Survey Circular 838, p. 59-83.

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#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon:  U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4310 Walker, G.W., and Nolf, B., 1981, High Lava Plains, Brothers fault zone to Harney Basin, Oregon, *in* Johnston, D.A., and Donnelly-Nolan, J., eds., Guides to some volcanic terranes in Washington, Idaho, Oregon, and northern California:  U.S. Geological Survey Circular 838, p. 105-111.

#4311 Walker, G.W., and Nolf, B., 1981, Roadlog for High Lava Plains, Brothers fault zone to Harney Basin, Oregon, *in* Johnston, D.A., and Donnelly-Nolan, J., eds., Guides to some volcanic terranes in Washington, Idaho, Oregon, and northern California:  U.S. Geological Survey Circular 838, p. 113-140.

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## 854, Unnamed faults north of Diamond Lake

**Structure Number** 854

Comments:

**Structure Name** Unnamed faults north of Diamond Lake

Comments: These unnamed normal faults are located north of Diamond Lake in central Oregon (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593).

**Synopsis** These north-striking faults are located in the central Oregon Cascades, in an area underlain by lower to upper Pleistocene volcanic rocks, glacial deposits, and pumice-fall deposits from the climactic eruption of Mount Mazama. Only two of these faults are shown on published geologic maps of the region. The faults are short, parallel the trend of nearby eruptive centers, and are located in a region of lower to middle Quaternary volcanic rocks. The association with Quaternary volcanic rocks suggests that these features may be related to volcanism, rather than to tectonic processes, but the faults are included herein until additional studies are conducted.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Douglas and Klamath

**1° x 2° sheet** Roseburg and Crescent

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** These northeast- and northwest-striking faults are located in the central Oregon Cascades. The area is underlain by lower to upper Pleistocene volcanic rocks, glacial deposits, and pumice-fall deposits from the climactic eruption of Mount Mazama (Sherrod, 1991 #3568; Sherrod and Smith, 2000 #5165). Only two of these faults are shown on published geologic maps of the region (Sherrod, 1991 #3568; Walker and MacLeod, 1991 #3646; Bacon and others, 1997 #3516; Sherrod and Smith, 2000 #5165) or included in older earthquake hazards studies (U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1989 #2947).

**Sense of movement** N

Comments: Some of these faults are mapped as normal or high-angle faults by Pezzopane (1993 #3544), Sherrod (1991 #3568), and Sherrod and Smith (2000 #5165).

**Dip** Not reported

Comments:

**Main dip direction** W, E

**Geomorphic expression** No information on geomorphic expression is available. However, the faults are short, parallel the trend of nearby eruptive centers, and are located in a region of lower to middle Quaternary volcanic rocks. The association with Quaternary volcanic rocks suggests that these features may be related to volcanism, rather than to tectonic processes. Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** These faults are located in the central Oregon Cascades, in an area underlain by lower to upper Pleistocene volcanic rocks, glacial deposits, and pumice-fall deposits from the climactic eruption of Mount Mazama (Sherrod, 1991 #3568; Sherrod and Smith, 2000 #5165). The only two faults shown on a geologic map are restricted to middle Pleistocene basalt flows (Sherrod, 1991 #3568; Sherrod and Smith, 2000 #5165).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Existing geologic maps do not show most of these faults, but Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) infer middle or late Quaternary (<700-780 ka) displacement. Weldon and others (2002 #5648) inferred late Quaternary (<120 ka) displacement on one fault located near Miller Lake.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed faults north of Diamond Lake. Their apparent lack of significant geomorphic expression implies low rates of slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 44.4 |
| | Cumulative trace (km): | 39.6 |

Comments:

**Average strike** (azimuth) N 00°

**References**

#3516 Bacon, C.R., Mastin, L.G., Scott, K.M., and Nathenson, M., 1997, Volcano and earthquake hazards in the Crater Lake region, Oregon: U.S. Geological Survey Open-File Report 97-487, 30 p., 1 pl., scale 1:100,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#2947 Hawkins, F.F., LaForge, R.C., and Gilbert, J.D., 1989, Seismotectonic study for Wickiup and Crane Prairie Dams, Deschutes Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 89-2, 38 p., 1 pl.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3568 Sherrod, D.R., 1991, Geologic map of a part of the Cascade Range between latitudes 43°-44°, central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1891, 2 sheets, scale 1:125,000.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3484 U.S. Army Corps of Engineers, 1983, Cougar and Blue River Lakes earthquake and fault study—Design memorandum 19: U.S. Army Corps of Engineers, Portland District, v. 19, 90 p., 11 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**855, Unnamed fault zone near Blue Mountain**

**Structure Number** 855

Comments: This fault zone is included in fault number 50 of Pezzopane (1993 #3544) and fault number 63 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Unnamed fault zone near Blue Mountain

Comments: Parts of this fault zone were mapped by Walker and Repenning (1966 #3586), Walker (1991 #3646), Pezzopane (1993 #3544), Madin and others (1996 #3479), Narwold (2001 #3010), and Weldon and others (2002 #5648). This fault zone was included in the Owyhee River-Oregon Canyon zone or fault zone of Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149), in the Santa Rosa-Owyhee River-Oregon Canyon fault zones of Geomatrix Consultants, Inc. (1995 #3593) and in the Quinn River Valley fault zone of the Santa Rosa Range fault system of Narwold and Pezzopane (1997 #3011) and Narwold (1999 #4035, 2001 #3010).

**Synopsis** The unnamed fault zone near Blue Mountain is a north-northwest-striking, down-to-the-east normal fault zone that forms the steep eastern margin of Blue Mountain. The fault zone offsets Miocene volcanic rocks, and may be marked by intermittent, en echelon fault scarps in Quaternary deposits of unknown age. Latest movement on this fault is thought to have occurred in the early to middle Pleistocene.

**Date of compilation** November 27, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Malheur

**1° x 2° sheet** Jordan Valley

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault traces are from 1:48,000-scale mapping of Narwold (2001 #3010) and from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** This fault is a north-northwest-striking, down-to-the-east normal fault zone that forms the eastern margin of Blue Mountain, an uplifted block of Miocene volcanic rocks (Walker and Repenning, 1966 #3586; Walker and MacLeod, 1991 #3646). The fault zone is located at the intersection between the northeast-trending Owyhee River section and the north-trending Quinn River section of the Santa Rosa fault system [1508].

**Sense of movement** N

Comments: This fault zone is mapped as a zone of normal or high-angle faults by Walker and Repenning (1966 #3586), Walker (1991 #3646), Pezzopane (1993 #3544), and Narwold (2001 #3010). However, Narwold and Pezzopane (1997 #3011) report a possible component of dextral shear on faults included in their Quinn River Valley fault zone.

**Dip** Not Reported

Comments:

**Main dip direction** E

**Geomorphic expression** The fault zone is marked by intermittent, en echelon fault scarps along the steep eastern flank of Blue Mountain (Pezzopane, 1999 #4039; Narwold, 2001 #3010). Weldon and others (2002 #5648) report that the fault has obvious geomorphic expression, but does not encounter Quaternary units.

**Age of faulted deposits at the surface** The fault along Blue Mountain offsets Miocene volcanic rocks correlative with the Steens Basalt (Walker and Repenning, 1966 #3586; Walker and MacLeod, 1991 #3646). "Young" fault scarps mark the trace of the fault (Pezzopane, 1999 #4039), but no descriptions of offset Quaternary deposits have been published.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary (<1.6 Ma) displacement, and Narwold (2001 #3010) used airphoto analysis and limited field reconnaissance to infer early to middle Pleistocene (0.13-1.5 Ma) displacement. Weldon and others (2002 #5648), Geomatrix Consultants, Inc. (1995 #3593), and Madin and others (1996 #3479) show the fault as active in the Quaternary (<1.6-1.8 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed fault near Blue Mountain. However, Miocene volcanic rocks do not appear to be offset more than 300-400 m across the fault (Walker and Repenning, 1966 #3586; Walker and MacLeod, 1991 #3646); such data indicate low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 8.7 |
| | Cumulative trace (km): | 6.7 |

Comments:

**Average strike** (azimuth) N 23° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company — Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#4035 Narwold, C.F., 1999, Late Quaternary faulting along the Quinn River fault zone—A soils investigation, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 1, p. 1-18.

#3010 Narwold, C.F., 2001, Late Quaternary soils and faulting along the Quinn River fault zone, northern Nevada, southeastern Oregon: Arcata, California, Humboldt State University, unpublished M.S. thesis, 76 p., 4, scale 1:48,000.

#3011 Narwold, C.F., and Pezzopane, S.K., 1997, Preliminary analysis of late Quaternary faulting along the Quinn River fault zone, northern Nevada-southeastern Oregon: Geological Society of America Abstracts with Programs, v. 29, no. 6, p. A-323.

#4039 Pezzopane, S., 1999, Regional tectonic setting and fault studies in Quinn River Valley and surrounding regions, Oregon and Nevada, *in* Quaternary geology of the northern Quinn River and Alvord

Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 6, p. 1-11.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3586 Walker, G.W., and Repenning, C.A., 1966, Reconnaissance geologic map of the west half of the Jordan Valley quadrangle Malheur County, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-457, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 856, Steens fault zone

**Structure Number** 856

Comments: These structures are fault numbers 47, 48, and 49 of Pezzopane (1993 #3544), fault number 62 of Geomatrix Consultants, Inc. (1995 #3593), and fault number V9 of dePolo (1998 #2845).

**Structure Name** Steens fault zone

Comments: The Steens fault zone forms a steep escarpment between the uplifted Steens Mountain and Pueblo Mountains, and the western margin of Pueblo Valley and the Alvord Desert. These faults were originally mapped by Russell (1884 #5099) and later were mapped in more detail by Willden (1964 #3002), D.B. Slemmons (1966, unpublished Vya 1° X 2° quadrangle), Greene (1972 #3560) Walker and Repenning (1965 #3559), Brown and Peterson (1980 #3585), Hemphill-Haley (1987 #3960), Walker and MacLeod (1991 #3646), Dohrenwend and Moring (1991 #281), Pezzopane (1993 #3544), Madin and others (1996 #3479), and Weldon and others (2002 #5144). The fault zone was first named the Stein Mountains fault by Russell (1884 #5099) after the original spelling of Steens Mountain. The fault zone includes faults mapped as the Alvord-Steens fault zone of Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149), and the Steens fault, Alvord Desert graben, and Pueblo Mountain faults of Pezzopane (1993 #3544). Geomatrix Consultants, Inc. (1995 #3593) used the name Steens-Alvord Graben faults for all structures in the Alvord Desert area, and delineated three fault source zones: the northern segment, the Western Margin fault zone, and the East Alvord graben fault. The Steens fault zone extends into northern Nevada as the Pueblo Mountains fault zone of dePolo (1998 #2845). Hemphill-Haley (1987 #3960) named several small structures in the zone (Alvord, Dune Field, Embayment, Kueny Ditch, Serrano Point, Serrano Springs, Smyth Wells, and Wildhorse Creek faults), and included them in a larger Steens fault zone. Hemphill-Haley and others (1989 #3958; 1999 #4038) later proposed that the Steens fault zone be divided into five segments. Herein we retain the name Steens fault zone for the entire structure in Oregon and Nevada, and use the five segment names delineated by Hemphill-Haley and others (1999 #4038) as section names. A sixth, northernmost section is informally defined herein on the basis of mapping by Pezzopane (1993 #3544) and Weldon and others (2002 #5144).

**Synopsis** This very long (>100 km) fault zone is marked by nearly continuous faults that lie at the base of the steep escarpment between the eastern flanks of Steens Mountain and the Pueblo Mountains and the western margins of the Alvord Desert and Pueblo Valley in southern Oregon and northern Nevada. Steens Mountain and the Pueblo Mountains are west-tilted fault blocks comprised of Miocene volcanic rocks, whereas the adjacent Alvord Desert and Pueblo Valley are structural basins filled with thousands of meters of Tertiary-Quaternary sedimentary fill. The Steens fault zone is herein divided into six sections: from north to south they are designated the Crowley, Mann Lake, Alvord, Fields, Tum Tum, and Denio sections. This differentiation is based on fault geometry and recency of fault movement as determined at selected sites (but not on all sections). At the north end of the zone, faults in the Crowley section [856a] offset Miocene volcanic rocks a few hundred meters, and may have moved as recently as the middle and late Quaternary. Faults in the adjacent Mann Lake section [856b] offset Miocene volcanic rock a minimum of 1600 m, and also may have moved as recently as the middle and late Quaternary. The adjacent Alvord section [856c] forms the steep eastern flank of the High Steens, and has offset Miocene volcanic rock 2-4 km. Trench and fault scarp investigations indicate one or more Holocene surface-faulting events along the Alvord section, so both the long-term (Miocene) and Quaternary slip histories indicate that this section is the most active part of the Steens fault zone. Slip apparently decreases south of the Alvord section. Faults in the adjacent Fields section [856d] offset Miocene volcanic rock a minimum of 1400 m, and show their youngest movement (latest Quaternary) on short faults that lie on the playa east of the range front. Faults in the Tum Tum section [856e] appear to be slightly older than the youngest movement on the playa strands of the Fields section [856d], but are younger than the latest movement on the range front strand of the Fields [856d] and Mann Lake [856b] sections. No field work has been done on the Denio section [856d], which is the southernmost part of the Steens Mountain fault zone, but airphoto reconnaissance on the section in northern Nevada suggests youngest movement in latest Quaternary (<15 ka) time.

**Date of compilation** November 27, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey, and Thomas L. Sawyer, Piedmont Geosciences, Reno, NV

**State** Oregon; Nevada

**County** Harney (OR); Humboldt (NV)

**1° x 2° sheet** Adel, Boise, Burns, Vya

**Province** Basin and Range (Great Basin section), Columbia Plateaus (Harney and Payette sections)

**Geologic setting** This long (>100-km) fault zone is marked by nearly continuous range-bounding faults on the east side of the Pueblo Mountains and Steens Mountain. The fault zone extends from near Crowley, Oregon to the southern end of Bog Hot Valley in northern Nevada. The Pueblo Mountains and Steens Mountain are major west-tilted fault blocks (Stewart, 1978 #2866); the adjacent Alvord Desert and Pueblo Valley are structural basins (grabens) filled with 1-2.5 km of Tertiary-Quaternary sedimentary fill (Cleary and others, 1981 #3961; 1981 #5649). The region is underlain by Miocene volcanic rocks, primarily the Steens Basalt (Willden, 1964 #3002; Walker and Repenning, 1965 #3559; Greene and others, 1972 #3560; Brown and Peterson, 1980 #3585; Minor and others, 1987 #3746; Minor and others, 1987 #3747; Walker and MacLeod, 1991 #3646). The Steens fault zone is the longest, most prominent normal fault zone in the Basin and Range province of eastern Oregon, and appears to truncate the southeastern end of the northwest-striking Brothers fault zone (Lawrence, 1976 #3506).

**Number of sections** 6

Comments: Although detailed studies along the entire fault zone have not been reported, six sections are inferred based on geometry and timing of most-recent surface faulting along the zone. Hemphill-Haley and others (1999 #4038) proposed that the Steens fault zone in Oregon be divided into five segments. Herein we retain the five segment names delineated by Hemphill-Haley and others (1999 #4038) as section names, and add a sixth, northernmost section based on mapping of Pezzopane (1993 #3544). From north to south, these sections are the Crowley [856a], Mann Lake [856b], Alvord [856c], Fields [856d], Tum Tum [856e], and Denio [856f] sections.

| | | |
|---|---|---|
| **Length** | End to end (km): | 192.1 |
| | Cumulative trace (km): | 264.7 |

Comments:

**Average strike** (azimuth) N 11° E

***856a, Crowley section***

**Section number** 856a

**Section name** Crowley section

Comments: This section is herein informally named after the community of Crowley, Oregon, which lies astride the northern end of the fault zone mapped by Pezzopane (1993 #3544).

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Greene (1972 #3560), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Weldon and others (2002 #5648).

**Dip** 60°

Comments: No data on fault dip have been published, but Wong and others (1999 #5654) used an estimated dip of 60° in their analysis of paleo-earthquake magnitudes on the Crowley section.

**Main dip direction** SE

**Geomorphic expression** Faults in the Crowley section form small basins filled with Quaternary sediments, aligned along small (less than a few hundred meters high) northeast-trending, down-to-the-southeast escarpments on Miocene volcanic rocks (Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646). No fault scarps on Quaternary deposits have been reported.

**Age of faulted deposits at the surface** No fault scarps on Quaternary deposits have been reported.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer that latest movement on most faults in the Crowley section occurred in the middle to late Quaternary (<700 ka); Weldon and others (2002 #5648) also inferred youngest movement in the middle to late Quaternary (<780 ka). Wong and others (1999 #5654) considered this section to be possibly active, with assigned probabilities of 0.75 based on equivocal evidence for Quaternary displacement.

**Recurrence interval** Not reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip studies have been reported, but Wong and others (1999 #5654) estimated a vertical slip rate of 0.01 mm/yr for the Crowley section. Offsets of no more than a few hundred meters in Miocene volcanic rocks support low rates of long-term slip across faults in this section.

| | | |
|---|---|---|
| **Length** | End to end (km): | 42.6 |
| | Cumulative trace (km): | 27.5 |

Comments:

**Average strike** (azimuth) N 39° E

***856b, Mann Lake section***

**Section number** 856b

**Section name** Mann Lake section

Comments: This section was informally named the Mann Lake segment by Hemphill-Haley and others (1989 #3958; 1999 #4038) after Mann Lake, which is located near the southern end of the section. This section was informally named the northern segment of the Steens-Alvord Graben faults by Geomatrix Consultants, Inc. (1995 #3593).

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Greene (1972 #3560), Brown and Peterson (1980 #3585), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Hemphill-Haley and others (1989 #3958; 1999 #4038).

**Dip** Not reported

Comments:

**Main dip direction** SE

**Geomorphic expression** Faults in the Mann Lake section form a northeast-trending range front escarpment between the eastern margin of northern Steens Mountain, and a narrow unnamed valley (Hemphill-Haley and others, 1989 #3958; 1999 #4038). No late Quaternary fault scarps have been found along the main faults in the section, but late Quaternary scarps may be present on the east side of the valley (Hemphill-Haley and others, 1989 #3958; Pezzopane, 1993 #3544; Hemphill-Haley and others, 1999 #4038). The southern end of the section coincides with a 2-km-wide left step in the range front fault zone; at this location, Holocene faulting appears to make a right step from the north end of the Alvord section of the Steens fault zone to the west-down fault bounding the western margin of the Mickey basin (Hemphill-Haley and others, 1989 #3958; 1999 #4038).

**Age of faulted deposits at the surface** No fault scarps on late Quaternary deposits have been reported (Hemphill-Haley and others, 1989 #3958; 1999 #4038).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer that latest movement on faults in the Mann Lake section occurred in Quaternary (<1.6 Ma) or middle to late Quaternary (<700 ka) time; Weldon and others (2002 #5648) also inferred youngest movement in the Quaternary (<1.6 Ma) or the middle to late Quaternary (<780 ka). Hemphill-Haley and others (1989 #3958; 1999 #4038) did not estimate an age of most-recent faulting, but ranked their Mann Lake segment as having the oldest age of faulting of all their five segments. Madin and others (1996 #3479) mapped faults in the Mann Lake section as active in the Quaternary.

**Recurrence interval** Not reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip studies have been reported on faults in the Mann Lake section. Walker and Repenning (1965 #3559) show a minimum offset of about 1,600 m of Miocene Steens Basalt across the southern part of the section; these rocks have K-Ar ages of 15-17 Ma (Sherrod and others, 1989 #3745). Such data yield low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 42.8 |
| | Cumulative trace (km): | 42.6 |

Comments:

**Average strike** (azimuth) N 29° E

***856c, Alvord section***

**Section number** 856c

**Section name** Alvord section

Comments: This section was informally named the Alvord segment by Hemphill-Haley and others (1989 #3958; 1999 #4038) after the Alvord Desert, the large, deep basin formed in the hanging wall of the fault zone. The Alvord segment of Hemphill-Haley and others (1989 #3958; 1999 #4038) consists of the Alvord, Dune Field, Embayment, Kueny Ditch, Serrano Point, Serrano Springs, Smyth Wells, and Wildhorse Creek faults of Hemphill-Haley (1987 #3960). Geomatrix Consultants, Inc. (1995 #3593) included the Alvord segment of Hemphill-Haley and others (1989 #3958; 1999 #4038) in their West Margin fault zone.

**Quality of location** Good

Comments: Fault locations are simplified from 1:24,000-scale mapping of Hemphill-Haley (1987 #3960) (reprinted at about 1:70,000 scale in Narwold, 1999 #4045) for the southern part of the section, and are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544), for the northern part of the section.

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Brown and Peterson (1980 #3585), Greene (1972 #3560), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), Hemphill-Haley (1987 #3960), and Hemphill-Haley and others (1989 #3958; 1999 #4038). Hemphill-Haley and others (1989 #3958; 1999 #4038) could not rule out a component of lateral slip in their Dust Bowl trench exposure.

**Dip** 72°

Comments: Dip measurement is from the Bath House trench exposure of a fault plane in late Quaternary lacustrine deposits (Hemphill-Haley and others, 1989 #3958; 1999 #4038).

**Main dip direction** E

**Geomorphic expression** Faults in the Alvord section form a steep north-trending range front escarpment between the eastern margin of the "High Steens" part of Steens Mountain, and the Alvord Desert (Hemphill-Haley and others, 1989 #3958; 1999 #4038). The northern part of the section is marked by a single, nearly continuous 1.4- to 2.5-m-high fault scarp on late Quaternary surficial deposits; the southern part of the section branches into several splays of various orientations at Serrano and Alvord Points, and eventually dies out on the floor of the Alvord Desert playa (Hemphill-Haley, 1987 #3960; Hemphill-Haley and others, 1989 #3958; 1999 #4038; 2000 #3959). The Alvord section is separated from the Mann Lake section to the north by a 2-km-wide left step in the range front, and overlaps and is separated from the Fields section to the south by a 5-km-wide right step in the range front.

**Age of faulted deposits at the surface** Hemphill-Haley (1987 #3960), and Hemphill-Haley and others (1989 #3958; 1999 #4038; 2000 #3959) report offsets in Holocene surficial deposits along most of the length of the Alvord section.

**Paleoseismology studies** Hemphill-Haley and others (1989 #3958; 1999 #4038; 2000 #3959) conducted trench investigations at two sites along the Alvord section. They described evidence of Holocene displacement at both locations.

Site 856c-1. The Bath House or Hot Springs trench (named after the nearby Alvord hot springs) was excavated across a 2.5-m-high scarp developed on intermediate-aged lacustrine and alluvial deposits (Hemphill-Haley and others, 1989 #3958; 1999 #4038; 2000 #3959). A distinctive debris-flow deposit exposed in both the footwall and hanging wall indicates about 2 m of vertical displacement and additional 1.5 m of warping, for a total apparent vertical displacement of 3.5 m. A single unequivocal colluvial wedge deposit was exposed near the top of the exposure, but a folded and tilted debris-flow (Hemphill-Haley and others, 1989 #3958; 1999 #4038) or colluvial-wedge (Hemphill-Haley and others, 2000 #3959) deposit at the bottom of the hanging wall exposure may be evidence of an additional faulting event. A small piece of detrital charcoal from the base of the upper colluvial wedge yielded a conventional radiocarbon age of 8,190 ± 2240 yr B.P. (6,800 to 12,300 cal yr), and a second small piece of detrital charcoal from the upper part of the colluvial wedge yielded a conventional radiocarbon age of 470 ± 350 yr B.P. (250 to 720 cal yr). The older sample yields a maximum-limiting age and the younger sample yields a minimum-limiting age for the most-recent event exposed in the Bath House trench (Hemphill-Haley and others, 1989 #3958; 1999 #4038).

Site 856c-2. The Dust Bowl or Dune/Playa trench was excavated across a 1.1-m-high scarp developed on sand dune and lacustrine deposits (Hemphill-Haley and others, 1989 #3958; 1999 #4038; 2000 #3959). The trench exposed about 2 m of lacustrine silt, sand, and clay beds and minor dune sand; none of these deposits could be correlated across the fault. In the hanging wall, three packages of lacustrine sediment were separated by two angular unconformities. No radiocarbon ages were obtained from this trench, but the oldest lacustrine package contained the Mt St. Helens Sg ash, which has bracketing radiocarbon ages of 12-13 ka (Mullineaux, 1986 #3773), and the middle lacustrine package contained an undated mixed ash. A single, near vertical fault plane was exposed in the trench, but no fault-scarp colluvial deposits were identified. Hemphill-Haley and others (1989 #3958; 1999 #4038; 2000 #3959) interpreted two or three faulting events in the last 11-13 ka, based on the presence of the two angular unconformities; the youngest event caused the near-vertical fault zone and the 1.1-m-high fault scarp. The Dust Bowl trench apparently exposes evidence for more events and less displacement than at the Bath House trench. The reduced amounts of displacement may be attributable to the location of the Dust Bowl trench near the end of the Alvord segment; the larger number of events may reflect older sediments in the Dust Bowl trench, and this location may record a more complex fault history due to its proximity to the nearby Fields segment (Hemphill-Haley and others, 1989 #3958; 1999 #4038).

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Hemphill-Haley and others (1989 #3958; 1999 #4038; 2000 #3959) used trench data described above and fault-scarp degradation analysis to infer a Holocene (possibly middle or late Holocene) age for the most-recent event on the Alvord section. Pezzopane (1993 #3544), Madin and others (1996 #3479), and Weldon and others (2002 #5648), also infer that latest movement on faults in the Alvord section occurred in the Holocene.

**Recurrence interval** two or three events in the last 11-13 ka, or tens of thousands of years?

Comments: Recurrence data from the studies of Hemphill-Haley and others (1989 #3958; 1999 #4038; 2000 #3959) are somewhat contradictory. Evidence from the Dust Bowl trench suggests two or three events that post-date the 11-13 ka age of sediments containing the Mt St. Helens Sg ash. However, Hemphill-Haley and others (1989 #3958; 1999 #4038) also use the presence of similar-sized fault scarps on late Quaternary and older Pleistocene alluvial-fan deposits to suggest recurrence intervals of tens of thousands of years on the northern part of the section.

**Slip-rate category** 0.2-1.0 mm/yr

Comments: Hemphill-Haley (1987 #3960), and Hemphill-Haley and others (1989 #3958; 1999 #4038) report a long-term (Miocene) slip rate of 0.3-0.4 mm/yr across the Alvord section. Brown and Peterson (1980 #3585) estimated offsets of 2100-3000 m in Miocene rocks across the southern end of the section. No reports of Quaternary slip rate are available.

| | | |
|---|---|---|
| **Length** | End to end (km): | 36.1 |
| | Cumulative trace (km): | 69.3 |

Comments:

**Average strike** (azimuth) N 01° W

***856d, Fields section***

**Section number** 856d

**Section name** Fields section

Comments: This section was informally named the Fields segment by Hemphill-Haley and others (1989 #3958; 1999 #4038) after the community of Fields, which is located near the southern end of the section. This section was included in the informally named West Margin fault zone of the Steens-Alvord Graben faults by Geomatrix Consultants, Inc. (1995 #3593).

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Brown and Peterson (1980 #3585), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Hemphill-Haley and others (1989 #3958; 1999 #4038).

**Dip** Not reported

Comments:

**Main dip direction** E

**Geomorphic expression** Faults in the Fields section form a north-northeast-trending range front escarpment between the eastern margin of southern Steens Mountain and the northern end of Pueblo Valley (Hemphill-Haley and others, 1989 #3958; 1999 #4038). The section has older, partly eroded range-bounding scarps, and a younger set of scarps on alluvial and playa sediments 3-5 km east of the range front (Hemphill-Haley and others, 1989 #3958; Pezzopane, 1993 #3544; Hemphill-Haley and others, 1999 #4038). The northern end of the section overlaps with the Alvord section and coincides with a 5-km-wide right step in the range front fault zone that contains numerous short faults of various orientations; this boundary may coincide with the eastern termination of the Brothers fault zone (Hemphill-Haley and others, 1989 #3958; 1999 #4038; Narwold, 1999 #4045). The southern end of the section is marked by a 5-km-wide gap in Quaternary fault scarps south of Fields (Pezzopane, 1993 #3544; Weldon and others, 2002 #5648) and is also marked by a change from older faulting along the range front part of the Fields section to younger faulting along the Tum Tum section (Hemphill-Haley and others, 1989 #3958; 1999 #4038). The presence of younger scarps valleyward of the range front may indicate that the more recent ruptures are stepping eastward and appear to be cutting off the large embayment at the north end of the section (Hemphill-Haley and others, 1989 #3958; 1999 #4038).

**Age of faulted deposits at the surface** Older, eroded scarps are reported along the range front part of the Fields section (Hemphill-Haley and others, 1989 #3958; 1999 #4038), but Madin and others (1996 #3479) mapped Holocene displacements, and Narwold and others (1999 #4045) describe Holocene(?) offsets of latest Pleistocene pluvial shorelines on faults in the southern half of the range front part of the section. A set of younger scarps (Hemphill-Haley and others, 1989 #3958; 1999 #4038) are present on Pleistocene and Holocene deposits east of the range front (Walker and Repenning, 1965 #3559; Madin and others, 1996 #3479; Weldon and others, 2002 #5648).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: The range front part of the section has been mapped with latest movements in the middle and late Quaternary by Pezzopane (1993 #3544) an Geomatrix Consultants, Inc. (1995 #3593). Hemphill-Haley and others (1989 #3958; 1999 #4038) describe the “older” range front escarpment as similar in age to faulting along the Mann Lake section, but Madin and others (1996 #3479) and Narwold and others (1999 #4045) map or describe some faults along the southern half of the range front as active in the Holocene. Weldon and others (2002 #5648) mapped parts of the range front fault as active in the latest Quaternary (<18 ka), and other parts as active in the middle and late Quaternary (<780 ka). Faults east of the range front offset Holocene deposits (Walker and Repenning, 1965 #3559), and have been mapped with latest movements in the Holocene or latest Pleistocene by Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), Madin and others (1996 #3479), and Weldon and others (2002 #5648).

**Recurrence interval** Not reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip studies have been reported on faults in the Fields section. Walker and Repenning (1965 #3559) show a minimum offset of about 1400 m and Brown and Peterson (1980 #3585) infer about 2100 m of offset of Miocene Steens Basalt near the southern part of the section; these rocks have K-Ar ages of 15-17 Ma (Sherrod and others, 1989 #3745). Such data yield low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 15.6 |
| | Cumulative trace (km): | 23.0 |

Comments:

**Average strike** (azimuth) N 13° E

***856e, Tum Tum section***

**Section number** 856e

**Section name** Tum Tum section

Comments: This section was informally named the Tum Tum segment by Hemphill-Haley and others (1989 #3958; 1999 #4038) after Tum Tum Lake, which is located near the northern end of the section. This section was included in the informally named West Margin fault zone of the Steens-Alvord Graben faults by Geomatrix Consultants, Inc. (1995 #3593).

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Brown and Peterson (1980 #3585), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), and Hemphill-Haley and others (1989 #3958; 1999 #4038).

**Dip** Not reported

Comments:

**Main dip direction** E

**Geomorphic expression** Faults in the Tum Tum section form a north-northwest-trending range front escarpment between the eastern margin of the northern Pueblo Mountains and the western margin of Pueblo Valley (Hemphill-Haley and others, 1989 #3958; 1999 #4038). The section has an older, eroded, nearly continuous range-bounding scarp, and a younger, discontinuous set of scarps on younger alluvial and lacustrine sediments slightly east of the range (Hemphill-Haley and others, 1989 #3958; 1999 #4038). The southern end of the section is marked by a small gap in Quaternary faulting at the promontory of Red Point, where the fault strike changes from northwest on the Tum Tum section to a northeast strike on the Denio section (Hemphill-Haley and others, 1989 #3958; Pezzopane, 1993 #3544; Hemphill-Haley and others, 1999 #4038; Weldon and others, 2002 #5648).

**Age of faulted deposits at the surface** Older, eroded scarps are reported along the range front part of the Tum Tum section; these scarps do not appear to offset "recent" alluvial fans (Hemphill-Haley and others, 1989 #3958; 1999 #4038). The younger set of scarps offset "younger" alluvial fans and "intermediate" aged lacustrine beach bars (Hemphill-Haley and others, 1989 #3958; 1999 #4038).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Faults in the Tum Tum section have been mapped with latest movements in the middle and late Quaternary by Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Weldon and others (2002 #5648), although other studies suggest younger movement. Hemphill-Haley and others (1989 #3958; 1999 #4038) report that the youngest movement on the section appears to be slightly older than the youngest movement on the Fields section, but younger than latest movement on the range front strand of the Fields and Mann Lake sections. Hemphill-Haley and others (1989 #3958) concluded that with the exception of their Mann Lake segment, all of their segments are marked by Holocene fault scarps. Madin and others (1996 #3479) mapped some faults in the Tum Tum section as active in the Holocene.

**Recurrence interval** Not reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip studies have been reported on faults in the Tum Tum section. Walker and Repenning (1965 #3559) show a minimum offset of about 1,400 m of Miocene Steens Basalt across the northern part of the section; these rocks have K-Ar ages of 15-17 Ma (Sherrod and others, 1989 #3745). Such data yield low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 18.4 |
| | Cumulative trace (km): | 17.5 |

Comments:

**Average strike** (azimuth) N 24° W

***856f, Denio section***

**Section number** 856f

**Section name** Denio section

Comments: This section is informally named the Denio segment, as defined by Hemphill-Haley and others (1989 #3958; 1999 #4038), after the community of Denio, Nevada, which is located near the middle of the section. The northern part of this section was included in the informally named West Margin fault zone of the Steens-Alvord Graben faults by Geomatrix Consultants, Inc. (1995 #3593). In Nevada, faults in the section are included in the Pueblo Mountains fault zone (fault V9) of dePolo (1998 #2845).

**Quality of location** Good

Comments: Fault locations in Oregon are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544). Fault locations in Nevada are based on 1:250,000-scale mapping of Dohrenwend and Moring (1991 #281) and D.B. Slemmons (1966, unpublished Vya 1° X 2° quadrangle), and 1:24,000-scale airphoto mapping and ground reconnaissance by the compiler.

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Brown and Peterson (1980 #3585), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), Hemphill-Haley and others (1989 #3958; 1999 #4038), Dohrenwend and Moring (1991 #281) and D.B. Slemmons (1966, unpublished Vya 1° X 2° quadrangle).

**Dip** Not reported

Comments:

**Main dip direction** E

**Geomorphic expression** Faults in the Denio section form a north-northeast-trending range front escarpment between the eastern margin of the Pueblo Mountains and the western margin of Pueblo Valley; short scarps on piedmont-slope deposits and linear abrupt range fronts characterize this part of the section. The fault continues south of the southern end of the Pueblo Mountains across the floor of Bog Hot Valley as right-stepping east-facing en echelon scarps that continue along the east side of a spur ridge underlain by Tertiary volcanic and sedimentary rocks. Thousand Creek flows into Bog Hot Valley as a distributed network of parallel channels that abruptly join before crossing this transecting zone of scarps, suggesting that the fluvial system has been effected by uplift and possible westward tilt along the intrabasin fault (T.L. Sawyer, written commun., 1999). A set of older (Quaternary) intermontane faults appear to splay from the range-front fault north of Continental Lake and extend northward as aligned ridge-crest saddles along the west side of Alberson Basin (D.B. Slemmons, 1966, unpublished Vya 1° X 2° quadrangle).

**Age of faulted deposits at the surface** Late Pleistocene and latest Pleistocene and (or) Holocene alluvial deposits are locally faulted along the front of the Pueblo Mountains and basin-fill and playa deposits are faulted along the intra-basin fault on the floor of Bog Hot Valley (D.B. Slemmons, 1996, unpublished Vya 1° X 2° quadrangle, Dohrenwend and Moring, 1991 #281).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Reports on the timing of the most recent event on the Denio section are not well-constrained and somewhat contradictory. A latest Quaternary time of faulting in the Nevada part of the section is suggested by reconnaissance photogeologic mapping of Dohrenwend and Moring (1991 #281), Dohrenwend and others (1996 #2846), D.B. Slemmons (1966, unpublished Vya 1° X 2° quadrangle), and the compiler. Faults in the section in Oregon have been mapped with latest movements in the middle and late Quaternary by Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Weldon and others (2002 #5648). Hemphill-Haley and others (1989 #3958) concluded that, with the exception of their Mann Lake segment [856b], all of their segments in Oregon are marked by Holocene fault scarps.

**Recurrence interval** Not reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments: No slip studies have been reported on faults in the Denio section in Oregon. For the Nevada portion of this section, dePolo (1998 #2845) assigned a reconnaissance vertical slip rate of 0.30 mm/yr based on an empirical relationship between his preferred maximum basal facet height and vertical slip rate. The size of the facets (tens to hundreds of meters, as measured from topographic maps) indicates they are the result of many seismic cycles, and thus the derived slip rate reflects a long-term average. Unpublished data of the compiler indicate fault scarps on latest Pleistocene lake deposits on the floor of Bog Hot Valley have maximum surface offsets of about 4 m. Such offsets yield similar rates of slip.

**Length** End to end (km): 37.3
Cumulative trace (km): 84.8

Comments:

**Average strike** (azimuth) N 09° E

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#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5144 Weldon, R.J., Fletcher, D., Scharer, K.M., and Weldon, E.M., 2002, New map of active faults in central and eastern Oregon: Geological Society of America Abstracts with Programs, v. 34, no. 5, p. A-106.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#3002 Willden, R., 1964, Geology and mineral deposits of Humboldt County, Nevada: Nevada Bureau of Mines and Geology Bulletin 59, 154 p., scale 1:250,000.

#5654 Wong, I., Dober, M., Hemphill-Haley, M., Naugler, W., Silva, W.J., and Li, S., 1999, Probabilistic seismic hazard analysis and safety evaluation earthquake ground motions—Bully Creek Dam, Vale

Project, eastern Oregon:  U.S. Department of the Interior, Bureau of Reclamation Technical Memorandum D8330-99-28.

## 857, Mickey Basin faults

**Structure Number** 857

Comments: Some of these structures are included in fault number 49 of Pezzopane (1993 #3544), and fault number 62c of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Mickey Basin faults

Comments: The Mickey Basin faults are included in the Alvord Desert graben faults of Pezzopane (1993 #3544) and the East Alvord graben fault of Geomatrix Consultants, Inc. (1995 #3593). These faults consist of a prominent fault along the southeastern base of Mickey Butte, previously termed the Mickey Butte (Geomatrix Consultants Inc., 1995 #3593), Mickey (Narwold, 1999 #4045), or Mickey Springs (Lindberg, 1999 #4037) fault, unnamed faults on the southeastern margin of Mickey Basin, and an unnamed fault that lies between the basin margin faults near Mickey (hot) Springs (Lindberg, 1999 #4037; Narwold, 1999 #4045).

**Synopsis** Most faults in this area define a northeast-striking graben that forms Mickey Basin, the northeastern arm of the Alvord Desert. Fault scarps in late Pleistocene and Holocene alluvial and lacustrine deposits are present along northwest and southeast range front margins of the basin; a north-trending intra-basin fault may control the location of Mickey (hot) Springs in the southern part of the area. Scarp-profile analysis suggests latest movement on the down-to-the-southeast fault along Mickey Butte occurred about 2 ka.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Harney

**1° x 2° sheet** Adel

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544), and 1:24,000-scale mapping of Narwold and others (1999 #4045).

**Geologic setting** These faults define a graben that forms Mickey Basin, which forms the northeastern arm of the Alvord Desert. The topography of the region is dominated by extensive Basin and Range faulting along the Steens fault zone [856], which controls the western margin of the Alvord Desert. The region is underlain by Miocene volcanic rocks, primarily the Steens Basalt (Walker and Repenning, 1965 #3559; Brown and Peterson, 1980 #3585; Sherrod and others, 1989 #3745; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: Faults in this zone are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Brown and Peterson (1980 #3585), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), Narwold and others (1999 #4045), and Weldon and others (2002 #5648). Lindberg (1989 #3980) found no field evidence of oblique or strike-slip displacement on the fault near Mickey Butte.

**Dip** Not reported

Comments:

**Main dip direction** SE, NW

**Geomorphic expression** The Mickey Basin faults define a northeast-striking graben that forms the margins of Mickey Basin, the northeastern arm of the Alvord Desert. Fault scarps in Quaternary alluvial and lacustrine deposits are present along northwest and southeast range front margins of the basin; a north-striking intra-basin fault may control the location of Mickey (hot) Springs in the southern part of the area. Geomatrix Consultants, Inc. (1995 #3593) mention possible Quaternary fault scarps along small basins north of Mickey Basin, but presented no evidence to support this possibility.

**Age of faulted deposits at the surface** Faults in the Mickey Basin offset late Pleistocene and Holocene alluvium and lacustrine deposits associated with pluvial lakes in the Alvord Desert basin (Lindberg, 1989 #3980; 1999 #4037; Narwold, 1999 #4045).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Lindberg (1989 #3980; 1999 #4037) and Narwold and others, (1999 #4045) used scarp-profile modeling to determine an age of about 2 ka for the youngest event on the fault that forms the range front along Mickey Butte. Lindberg (1989 #3980; 1999 #4037) described a possible correlation between the youngest event on the fault near Mickey Butte and the youngest event on the Alvord section of the Steens fault zone [856c] to the south, and suggested that the youngest displacements in the Alvord Desert region have stepped eastward from the Steens fault zone to the Mickey Basin faults. These same authors used offsets of late Pleistocene and Holocene alluvium and lacustrine deposits to infer late Pleistocene or Holocene displacement on several other faults in the Mickey Basin. Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Weldon and others (2002 #5648) inferred Holocene or latest Pleistocene movement on faults in the Mickey Basin; Madin and others (1996 #3479) mapped some faults in the Mickey Basin as active in the Quaternary.

**Recurrence interval** Not reported

Comments:

**Slip-rate category** unknown, probably <0.2 mm/yr

Comments: No slip studies have been performed on the faults in the Mickey Basin. Offsets of about 2 m across late Pleistocene and Holocene alluvial and lacustrine deposits have been described on several faults in the basin (Lindberg, 1989 #3980; 1999 #4037; Narwold, 1999 #4045), and Brown and Peterson (1980 #3585) estimated offsets of 800-900 m in Miocene volcanic rocks across faults in the basin; such data yield relatively low rates of late Quaternary slip. Geomatrix Consultants, Inc. (1995 #3593) estimated slip rates of 0.05-0.2 mm/yr and a preferred rate of 0.1 mm/yr for faults included in their Eastern Alvord graben fault, which includes faults in the Mickey Basin.

| | | |
|---|---|---|
| **Length** | End to end (km): | 8.1 |
| | Cumulative trace (km): | 18.0 |

Comments:

**Average strike** (azimuth) N 33° E

**References**

#3585 Brown, D.E., and Peterson, N.V., 1980, Preliminary geology and geothermal resource potential of the Alvord Desert Area, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report O-80-10, 57 p., 2 pls., scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3980 Lindberg, D.N., 1989, Extending the zone of recognized Late-Holocene faulting in the basin and range of southeastern Oregon: Geological Society of America Abstracts with Programs, v. 21, no. 5, p. 106.

#4037 Lindberg, D.N., 1999, A synopsis of late Pleistocene shorelines and faulting, Tule Springs Rims to Mickey Basin, Alvord Desert, Harney County, Oregon, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 3, p. 1-13.

#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company — Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#4045 Narwold, C.F., 1999, Road log days 2 and 3, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, p. 23-55.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3745 Sherrod, D.R., Minor, S.A., and Vercoutere, T.L., 1989, Geologic map of the Sheepshead Mountains, Harney and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-2079, 1 sheet, scale 1:50,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 858, Tule Springs Rims fault

**Structure Number** 858

Comments: This fault is included in fault number 49 of Pezzopane (1993 #3544), and fault number 62c of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Tule Springs Rims fault

Comments: This fault parallels and forms the Tule Springs Rims, prominent west-facing escarpments in Miocene volcanic rocks that form the eastern margin of the Alvord Desert basin. The fault was originally mapped by Russell (1884 #5099), and is included in the Alvord Desert graben faults of Pezzopane (1993 #3544) and the East Alvord graben fault of Geomatrix Consultants, Inc. (1995 #3593).

**Synopsis** This fault parallels and forms the Tule Springs Rims, prominent west-facing escarpments on Miocene volcanic rocks that form the eastern margin of the Alvord Desert basin, a large graben in the Basin and Range of southeastern Oregon. Three-meter-high fault scarps are present in Quaternary deposits along the rim margin at the north end of the fault, but most of the fault is buried by thick eolian sediments that form sand ramps downwind of the Alvord Desert playa. Latest movement appears to have occurred in the Holocene along the northern part of the fault.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Harney

**1° x 2° sheet** Adel

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault locations are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** This fault parallels and forms the Tule Springs Rims, prominent west-facing escarpments that form the eastern margin of the Alvord Desert basin. The Alvord Desert basin is a graben controlled on the west by large-scale faulting along the Steens fault zone [856], and on the east by the fault along the Tule Spring Rims. Faulting along the Tule Springs Rims may be a southern extension of faulting along the southeastern margin of Mickey Basin [857]. The region is underlain by Miocene volcanic rocks (Walker and Repenning, 1965 #3559; Brown and Peterson, 1980 #3585; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: Faults in this zone are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Brown and Peterson (1980 #3585), Walker and MacLeod (1991 #3646), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Weldon and others (2002 #5648).

**Dip** Not reported

Comments:

**Main dip direction** W

**Geomorphic expression** This fault parallels and forms the Tule Springs Rims, prominent west-facing escarpments on Miocene volcanic rocks that form the eastern margin of the Alvord Desert. Three-meter-high fault scarps are present in Quaternary deposits along the rim margin at the north end of the fault, but most of the fault is buried by thick eolian sediments that form sand ramps downwind of the Alvord Desert playa

(Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646; Lindberg, 1999 #4037; Narwold, 1999 #4045). A series of north-south-striking fractures in playa sediments have been described by Cleary and others (1981 #5649) along the north-central part of the fault; these features may be young fault scarps (Lindberg, 1999 #4037).

**Age of faulted deposits at the surface** Alluvial fans of Quaternary age are offset along the northern part of the fault (Lindberg, 1999 #4037); if these fans post-date lacustrine deposits in the area, they must be latest Pleistocene or Holocene in age.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Lindberg (1999 #4037) used the presence of 3-m-high fault scarps in Quaternary deposits along the northern Tule Springs Rims fault to infer Holocene displacement on the fault along the east side of the Alvord Desert. Unfortunately, much of the central and southern parts of the fault is buried by young eolian sediments, so youngest movement on this part of the fault is difficult to assess. Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Weldon and others (2002 #5648) inferred middle or late Quaternary (<700-780 ka) movement on the fault along the Tule Springs Rims.

**Recurrence interval** Not reported

Comments:

**Slip-rate category** unknown, probably <0.2 mm/yr

Comments: No slip studies have been performed on the faults in the Mickey Basin. Offsets of about 3 m across Quaternary alluvial fans (Lindberg, 1999 #4037) yield relatively low rates of late Quaternary slip. Cleary and others (1981 #3961; 1981 #5649) used gravity data to infer displacements of 350 m to greater than 1300 m in Miocene volcanic rocks and Brown and Peterson (1980 #3585) inferred displacements of 600-1200 m in Miocene volcanic rocks; such data yield low rates of long term slip. Geomatrix Consultants, Inc. (1995 #3593) estimated slip rates of 0.05-0.2 mm/yr and a preferred rate of 0.1 mm/yr for faults included in their Eastern Alvord graben fault, which includes the Tule Springs Rims fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 33.4 |
| | Cumulative trace (km): | 33.5 |

Comments:

**Average strike** (azimuth) N 11° E

**References**


#3585 Brown, D.E., and Peterson, N.V., 1980, Preliminary geology and geothermal resource potential of the Alvord Desert Area, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report O-80-10, 57 p., 2 pls., scale 1:250,000.

#3961 Cleary, J., Lange, I.M., Qamar, A.I., and House, H.R., 1981, Gravity, isotope, and geochemical study of the Alvord Valley geothermal area, Oregon: Geological Society of America Bulletin, Part I, v. 92, p. 319-322.

#5649 Cleary, J., Lange, I.M., Qamar, A.I., and House, H.R., 1981, Gravity, isotope, and geochemical study of the Alvord Valley geothermal area, Oregon: Geological Society of America Bulletin, Part II, v. 92, p. 934-962.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#4037 Lindberg, D.N., 1999, A synopsis of late Pleistocene shorelines and faulting, Tule Springs Rims to Mickey Basin, Alvord Desert, Harney County, Oregon, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 3, p. 1-13.

#4045 Narwold, C.F., 1999, Road log days 2 and 3, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, p. 23-55.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5099 Russell, I.C., 1884, A geological reconnaissance in southern Oregon: U.S. Geological Survey Fourth Annual Report, p. 431-464.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 862, unnamed faults near Sutherlin (Class B)

**Structure Number** 862

Comments: These faults are included in fault number 37 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Unnamed faults near Sutherlin (Class B)

Comments: The features near Sutherlin were mapped by Pezzopane (1993 #3544) and included in the compilation of Geomatrix Consultants, Inc. (1995 #3593). Most geologic maps in the area do not show these structures (Diller, 1898 #4075; Hoover, 1963 #4069; Niem and Niem, 1990 #4163; Walker and MacLeod, 1991 #3646), although Niem and Niem (1990 #4163) map an unnamed northeast-striking normal fault near the location of the eastern fault mapped by Pezzopane (1993 #3544) near Sutherlin and Wells and others (2000 #5122) map an unnamed thrust fault near the southern end of the northern fault mapped by Pezzopane (1993 #3544). The features mapped by Pezzopane (1993 #3544) are included in the Drain-Sutherlin faults of Geomatrix Consultants, Inc. (1995 #3593).

**Synopsis** These short northeast-striking features are located between Sutherlin and Yoncalla in the Oregon Coast Range. The area is underlain by gently folded, northeast-striking Eocene sedimentary rocks deposited in a fore-arc basin. Possible young scarps have been observed in fluvial terraces and lineaments on higher terraces along these features during airphoto reconnaissance, but these scarps may be the result of fluvial erosion rather than faulting, so we classify these features as Class B until further studies are conducted.

**Date of compilation** May 20, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Douglas

**1° x 2° sheet** Medford

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: Fault traces are from 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** These features are mapped by Pezzopane (1993 #3544) in fore-arc basin sedimentary rocks of the Eocene Roseburg and Umpqua Formations (Diller, 1898 #4075; Hoover, 1963 #4069; Niem and Niem, 1990 #4163; Walker and MacLeod, 1991 #3646). Most geologic maps in the area do not show these structures (Diller, 1898 #4075; Hoover, 1963 #4069; Niem and Niem, 1990 #4163; Walker and MacLeod, 1991 #3646), although a down-north, northeast-striking fault is mapped by Niem and Niem (1990 #4163) near the eastern of the two faults mapped by Pezzopane (1993 #3544) near Sutherlin, and Wells and others (2000 #5122) map an unnamed thrust fault near the southern end of the northern fault mapped by Pezzopane (1993 #3544). The features mapped by Pezzopane (1993 #3544) parallel the regional northeast strike of bedrock and fold trends in the area.

**Sense of movement** N?

Comments: These features are mapped as normal or high-angle faults by Pezzopane (1993 #3544); a down-north normal fault is mapped by Niem and Niem (1990 #4163) near the eastern of the two faults mapped by Pezzopane (1993 #3544) near Sutherlin, and Wells and others (2000 #5122) map an unnamed thrust fault near the southern end of the northern fault mapped by Pezzopane (1993 #3544). Geomatrix Consultants, Inc. (1995 #3593) assumed a normal sense of slip in their modeling of the earthquake hazards associated with these features.

**Dip** Not Reported

Comments:

**Main dip direction** Not Reported

**Geomorphic expression** S.K. Pezzopane (pers. commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) observed scarps and lineaments in fluvial terraces during airphoto reconnaissance, but these scarps may be the result of fluvial erosion rather than faulting. The features mapped by Pezzopane (1993 #3544) follow the northeast trends of stream valleys and linear ridges, which in turn are controlled by the northeast strikes of dipping and folded bedrock (Diller, 1898 #4075; Hoover, 1963 #4069; Niem and Niem, 1990 #4163; Walker and MacLeod, 1991 #3646; Wells and others, 2000 #5122).

**Age of faulted deposits at the surface** These features were mapped by Pezzopane (1993 #3544) from airphoto reconnaissance; the faults are mapped primarily in Eocene sedimentary rocks (Diller, 1898 #4075; Hoover, 1963 #4069; Niem and Niem, 1990 #4163; Walker and MacLeod, 1991 #3646; Wells and others, 2000 #5122). S.K. Pezzopane (pers. commun., 1993, in Geomatrix Consultants Inc., 1995 #3593) observed possible young (late Quaternary or Holocene) fault scarps in fluvial terraces and lineaments on higher terraces along these features during airphoto reconnaissance, although these scarps may be the result of fluvial erosion rather than faulting.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) show these features as active in the middle and late Quaternary (<700-780 ka), but we classify these features as Class B because evidence of Quaternary deformation is equivocal.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published, but if these features are faults, then their short length and lack of significant geomorphic expression suggests low rates of slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 27.7 |
| | Cumulative trace (km): | 34.5 |

Comments:

**Average strike** (azimuth) N 49° E

**References**

#4075 Diller, J.S., 1898, Description of the Roseburg Quadrangle, Oregon: Geological Atlas Folio Report GF-0049, 1 l., scale 1:125,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#4069 Hoover, L., 1963, Geology of the Anlauf and Drain quadrangles Douglas and Lane Counties, Oregon: U.S. Geological Survey Bulletin 1122-D, 59 p., 2 pls., scale 1:62,500.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4163 Niem, A.R., and Niem, W.A., 1990, Geology and oil, gas, and coal resources, southern Tyee Basin, southern Coast Range, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-89-3, 44 p., 3 pl.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5122 Wells, R.E., Jayko, A.S., Niem, A.R., Black, G., Wiley, T., Baldwin, E., Molenaar, K.M., Wheeler, K.L., DuRoss, C.B., and Givler, R.W., 2000, Geologic map and database of the Roseburg 30 x 60 quadrangle, Douglas and Coos counties, Oregon: U.S. Geological Survey Open-File Report 00-0376, 69 p., 1 pl., scale 1;100,000.

**863, Upper Willamette River fault zone (Class B)**

**Structure Number** 863

Comments: This fault zone is fault number 22 of Pezzopane (1993 #3544) and fault number 36 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Upper Willamette River fault zone (Class B)

Comments: The Upper Willamette River fault zone was mapped by Pezzopane (1993 #149; 1993 #3544) and named the Willamette or Upper Willamette River fault zone. Most geologic maps in the area do not show these structures (Woller and Priest, 1983 #4056; Woller and Black, 1983 #4057; Walker and MacLeod, 1991 #3646), although Sherrod (1991 #3568) maps a northwest-striking normal fault near the location of the southernmost fault mapped by Pezzopane (1993 #3544) near the Hills Creek Dam. These faults are included in the Upper Willamette River fault of Geomatrix Consultants, Inc. (1995 #3593). The three fault strands mapped by Pezzopane (1993 #3544) coincide with parts of three lineaments mapped by U.S. Army Corps of Engineers (1981 #3481), the Middle Fork Willamette River, Salt Creek, and Hills Creek lineaments. These faults and/or lineaments form the northwestern end of the Eugene-Denio zone, a northwest-striking zone of faults and lineaments that may have significant component of right-lateral strike slip (Lawrence, 1976 #3506).

**Synopsis** This northwest-striking fault zone marks the northwestern end of the Eugene-Denio zone on the western flank of the Cascade Range. The fault zone is marked by regional lineaments mostly expressed as linear stream valleys, but a few exposures of faults in bedrock have been described along these lineaments. No fault scarps on Quaternary deposits have been described, but an exposure of a fault in Pleistocene gravels and “discontinuities” in Quaternary volcanic rocks are possible evidence of Quaternary displacement. However, some investigators found no evidence of Quaternary displacement on these structures, so herein we classify these features as Class B until further studies are conducted.

**Date of compilation** May 20, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lane

**1° x 2° sheet** Roseburg

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Poor

Comments: Fault trace is from 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** These faults are mapped by Pezzopane (1993 #3544) in Tertiary and Quaternary volcanic and volcaniclastic rocks of the Cascade Range. Most geologic maps in the area do not show these structures (Woller and Priest, 1983 #4056; Woller and Black, 1983 #4057; Sherrod, 1991 #3568; Walker and MacLeod, 1991 #3646), although a down-north, northwest-striking fault mapped by Sherrod (1991 #3568) is located near the fault mapped by Pezzopane (1993 #3544) near the Hills Creek dam. U.S. Army Corps of Engineers (1981 #3481) also map faults in bedrock along their Middle Fork Willamette River, Salt Creek, and Hills Creek lineaments. All these faults or lineaments parallel the regional northwest strike of dikes in the area.

**Sense of movement** D?

Comments: Sherrod (1991 #3568) mapped a fault near the Hills Creek dam as a high-angle fault, and U.S. Army Corps of Engineers (1981 #3481) map vertical faults with near-horizontal slickensides and minor right-lateral slip indicators in bedrock along their Middle Fork Willamette River, Salt Creek, and Hills Creek lineaments. Lawrence (1976 #3506) inferred right-lateral strike slip on faults included in his Eugene-Denio zone. Pezzopane (1993 #149; 1993 #3544) showed two of these structures as down-to-the-south high-angle faults, but included these faults in the right-slip Eugene-Denio zone.

**Dip** 82°-90°

Comments: Dip measurements are from a fault mapped by Sherrod (1991 #3568) near the location of the fault at Hills Creek dam mapped by Pezzopane (1993 #3544), and from fault attitudes in bedrock from U.S. Army Corps of Engineers (1981 #3481).

**Main dip direction** none

**Geomorphic expression** Faults in this zone form regional-scale lineaments, mostly linear stream valleys along Hills Creek, Salt Creek, and the Middle Fork of the Willamette River. They were mapped on the basis of airphoto reconnaissance by Pezzopane (1993 #3544), although no geomorphic features suggestive of late Quaternary displacement were observed (S.K. Pezzopane, pers. commun., 1993, in Geomatrix Consultants Inc., 1995 #3593). No fault scarps on Quaternary deposits have been described.

**Age of faulted deposits at the surface** These faults were mapped by Pezzopane (1993 #3544) from airphoto reconnaissance; the faults are mapped primarily in Tertiary and Quaternary volcanic and volcaniclastic rocks of the Cascade Range (Sherrod, 1991 #3568; Walker and MacLeod, 1991 #3646). U.S. Army Corps of Engineers (1981 #3481) note slickensides on a fault in Pleistocene gravels along the Middle Fork Willamette River lineament in the Dexter Dam excavations, and "discontinuities" in rocks of the Pleistocene High Cascade Group or Province along the Hills Creek lineament. Woller and Black (1983 #4057) and Woller and Priest (1983 #4056) found no evidence of post-Tertiary movement on faults or lineaments associated with the Eugene-Denio zone.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) show these features as active in the Quaternary (<1.6 Ma). Geomatrix Consultants, Inc. (1995 #3593) used the poor geomorphic expression of these faults to preclude their inclusion in their analysis of active faults in the state of Oregon. We classify these features as Class B because evidence of Quaternary deformation is equivocal.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published, but the lack of significant geomorphic expression along these faults suggest low rates of slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 44.0 |
| | Cumulative trace (km): | 50.8 |

Comments:

**Average strike** (azimuth) N 52° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#3568 Sherrod, D.R., 1991, Geologic map of a part of the Cascade Range between latitudes 43°-44°, central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1891, 2 sheets, scale 1:125,000.

#3481 U.S. Army Corps of Engineers, 1981, Lookout Point, Dexter Hills Creek and Fall Creek Lakes earthquake and fault study—Design memorandum 6: U.S. Army Corps of Engineers, Portland District, 100 p., 18 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4057 Woller, N.M., and Black, G.L., 1983, Geology of the Waldo Lake-Swift Creek Area, Lane and Klamath Counties, Oregon, *in* Priest, G.R., and Vogt, B.F., eds., Geology and geothermal resources of the central Oregon Cascade Range, Chapter 6: State of Oregon, Department of Geology and Mineral Industries Special Paper 15, p. 57-87, 3 pls., scale 1:62,500.

#4056 Woller, N.M., and Priest, G.R., 1983, Geology of the Lookout Point Area, Lane County, Oregon, Chapter 5, *in* Priest, G.R., and Vogt, B.F., eds., Geology and geothermal resources of the central Oregon Cascade Range: State of Oregon, Department of Geology and Mineral Industries Special Paper 15, p. 49-56, 3 pls., scale 1:62,500.

**864, Clackamas River fault zone**

**Structure Number** 864

Comments: This fault zone is fault number 5 of Pezzopane (1993 #3544) and fault numbers 41 and 42 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Clackamas River fault zone

Comments: The fault zone includes a group of northwest-striking faults mapped as the Clackamas fault zone by U.S. Army Corps of Engineers (1983 #3485), as the Clackamas River fault zone by Priest and others (1982 #4083; 1983 #4055), Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149), and as the Clackamas River fault zone, the Oak Grove-Lake Harriet fault zone, and the Peavine Mountain fault by Geomatrix Consultants, Inc. (1990 #3550; 1995 #3593). The fault zone also includes the Canyon Creek and Lake Harriet faults of Anderson (1978 #3973). All of these faults are part of the Portland Hills-Clackamas River structural zone of Beeson and others (1985 #4022; 1989 #4023).

**Synopsis** The Clackamas River fault zone is a broad zone of mostly northwest-striking normal and right-lateral strike-slip faults that offset early Pleistocene, Pliocene, and Miocene volcanic rocks in the Cascade Range of northern Oregon. No evidence of fault scarps on Quaternary surficial deposits has been described. These faults are part of a regional structural zone that controlled the distribution of Columbia River Basalt Group lava flows in western Oregon, and may form a link between similarly striking Brothers or Sisters fault zones to the southeast and the Portland Hills fault zone to the northwest.

**Date of compilation** December 16, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Clackamas, Marion

**1° x 2° sheet** Bend, The Dalles

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Good

Comments: All published maps of the area show slightly different fault patterns, so the fault traces used herein are from the recent 1:100,000-scale compilation of Weldon and others (2002 #5648).

**Geologic setting** The Clackamas River fault zone is comprised of numerous northwest-striking normal and right-lateral strike-slip faults offsetting Miocene through early Quaternary volcanic rocks in the Cascade Range of northern Oregon (Anderson, 1978 #3973; White, 1980 #4082; Hammond and others, 1980 #4096; Hammond and others, 1982 #4124; MacLeod and Sherrod, 1988 #3770; Sherrod and Smith, 1989 #3498; Walker and Duncan, 1989 #3581; Beeson and others, 1989 #4023; Walker and MacLeod, 1991 #3646; Sherrod and Scott, 1995 #3495). These faults are part of a regional structural zone that controlled the distribution of Columbia River Basalt Group lava flows in western Oregon (Beeson and others, 1985 #4022; Beeson and others, 1989 #4023). The northwest strikes of these faults may indicate a linkage between the similarly striking Brothers or Sisters fault zones to the southeast and the Portland Hills fault zone to the northwest (Anderson, 1978 #3973; Hammond and others, 1980 #4096; Hammond and others, 1982 #4124; MacLeod and Sherrod, 1988 #3770; Sherrod and Smith, 1989 #3498; Beeson and others, 1989 #4023).

**Sense of movement** D, N

Comments: The numerous fault strands in the Clackamas River fault zone are mapped as high angle faults with normal and right-lateral senses of slip (Anderson, 1978 #3973; Hammond and others, 1982 #4124; U.S. Army Corps of Engineers, 1983 #3485; Beeson and others, 1985 #4022; Sherrod and Smith, 1989 #3498; Walker and Duncan, 1989 #3581; Beeson and others, 1989 #4023; Walker and MacLeod, 1991

#3646; Pezzopane, 1993 #3544; Sherrod and Scott, 1995 #3495). Anderson (1978 #3973) described horizontal slickensides on some faults in this zone.

**Dip** 70°-90°

Comments: The U.S. Army Corps of Engineers (1983 #3485) described an exposure of one fault in the zone that dipped 74° to the southwest. Anderson (1978 #3973) and Beeson and others (1985 #4022; 1989 #4023) describe nearly vertical to vertical dips on these faults. Geomatrix Consultants, Inc. (1995 #3593) use an estimated dip of 70° in their modeling of earthquake hazards associated with the Clackamas River and Oak Grove-Lake Harriet fault zones.

**Main dip direction** NE, SW, Vertical

**Geomorphic expression** The Clackamas River fault zone is comprised of numerous northwest-striking normal and strike-slip faults that form gentle to steep escarpments on Neogene volcanic rocks. A few of these faults are mapped in lower Pleistocene(?) volcanic rocks (Anderson, 1978 #3973; Hammond and others, 1982 #4124), but only a single fault scarp, an eroded scarp on a down-to-the-southwest normal fault located west of Rhododendron Ridge, has been described (Geomatrix Consultants Inc., 1990 #3550).
U.S. Army Corps of Engineers (1983 #3485) shows numerous northwest-trending lineaments along many traces in the fault zone. Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Faults in the Clackamas River fault zone offset Neogene volcanic rocks, some of which may be early Pleistocene in age (Anderson, 1978 #3973; Hammond and others, 1982 #4124; Sherrod and Smith, 1989 #3498; Walker and Duncan, 1989 #3581; Walker and MacLeod, 1991 #3646; Sherrod and Scott, 1995 #3495). No offsets of surficial deposits have been described.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: the U.S. Army Corps of Engineers (1983 #3485) map some faults in the Clackamas River fault zone as early Quaternary (0.5-2.0 Ma), and Pezzopane (1993 #3544) and Weldon and others (2002 #5648) mapped all faults in the zone as active in the Quaternary (<1.6 Ma). Geomatrix Consultants, Inc. (1995 #3593) classified these faults as active in the middle and late Quaternary (<780 ka), but herein we follow the most-recent compilation of Weldon and others (2002 #5648) and classify these faults as Quaternary (<1.6 Ma) until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip data are available for most faults in the Clackamas River fault zone, but Anderson (1978 #3973) and Beeson and others (1989 #4023) describe stratigraphic offsets of less than 5 m to greater than 150 m on these faults; such data yield low long-term rates of slip. Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.05-0.2 mm/yr in their analysis of earthquake hazards associated with this fault zone.

| | | |
|---|---|---|
| **Length** | End to end (km): | 28.6 |
| | Cumulative trace (km): | 92.9 |

Comments:

**Average strike** (azimuth) N 19° W

**References**

#3973 Anderson, J.L., 1978, The stratigraphy and structure of the Columbia River Basalt in the Clackamas River drainage:  Portland, Oregon, Portland State University, unpublished Master's thesis, 136 p.

#4022 Beeson, M.H., Fecht, K.R., Reidel, S.P., and Tolan, T.L., 1985, Regional correlations within the Frenchman Springs member of the Columbia River Basalt Group—New insights into the middle Miocene tectonics of northwestern Oregon:  Oregon Geology, v. 47, no. 8, p. 87-96.

#4023 Beeson, M.H., Tolan, T.L., and Anderson, J.L., 1989, The Columbia River Basalt Group in western Oregon–Geologic structures and other factors that controlled flow emplacement patterns, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 223-246.

#3550 Geomatrix Consultants Inc., 1990, Seismotectonic evaluation of Wasco Dam site:  Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, under Contract 6-CS-81-07310, 115 p., 2 pls., scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon:  Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#4096 Hammond, P.E., Anderson, J.L., and Manning, K.J., 1980, Guide to the geology of the Upper Clackamas and North Santiam Rivers Area, northern Oregon Cascade Range, *in* Oles, K.F., Johnson, G., Niem, A.R., and Niem, W.A., eds., Geologic field trips in western Oregon and southwestern Washington: State of Oregon, Department of Geology and Mineral Industries Bulletin 101, p. 133-167.

#4124 Hammond, P.E., Geyer, K.M., and Anderson, J.L., 1982, Preliminary geologic map and cross section of the Upper Clackamas and North Santiam rivers area, northern Oregon:  Portland State University, 1 sheet, scale 1:62,500.

#3770 MacLeod, N.S., and Sherrod, D.R., 1988, Geologic evidence for a magma chamber beneath Newberry Volcano, Oregon:  Journal of Geophysical Research, v. 93, no. B9, p. 10,067-10,079.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon:  Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon:  Tectonics, v. 12, p. 1140-1169.

#4083 Priest, G.R., 1982, Overview of the geology and geothermal resources of the Mount Hood area, Oregon, *in* Priest, G.R., and Vogt, B.F., eds., Geology and geothermal resources of the Mount Hood area, Oregon:  State of Oregon, Department of Geology and Mineral Industries Special Paper 14, p. 6-15.

#4055 Priest, G.R., Woller, N.M., Black, G.L., and Evans, S., 1983, Overview of the geology of the central Oregon Cascade Range, Chapter 2, *in* Priest, G.R., and Vogt, B.F., eds., Geology and geothermal resources of the central Oregon Cascade Range:  State of Oregon, Department of Geology and Mineral Industries Special Paper 15, p. 3-28, 3 pls., scale 1:62,500.

#3495 Sherrod, D.R., and Scott, W.E., 1995, Preliminary geologic map of the Mount Hood 30 by 60 minute quadrangle, northern Cascade Range, Oregon:  U.S. Geological Survey Open-File Report 95-219, 28 p., 1 pl., scale 1:100,000.

#3498 Sherrod, D.R., and Smith, J.G., 1989, Preliminary map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon:  U.S. Geological Survey Open-File Report 89-14, 20 p., 1 pl., scale 1:500,000.

#3485 U.S. Army Corps of Engineers, 1983, Detroit and Big Cliff Lakes earthquake and fault study—Design memorandum 4:  U.S. Army Corps of Engineers, Portland District, 93 p., 13 pls.

#3581 Walker, G.W., and Duncan, R.A., 1989, Geologic map of the Salem 1 by 2 quadrangle, western Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1893, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#4082 White, C., 1980, Geology of the Breitenbush Hot Springs quadrangle, Oregon: State of Oregon, Department of Geology and Mineral Industries Special Paper 9, 26 p., 1 pl., scale 1:62,500.

**866, Hood River fault zone**

**Structure Number** 866

Comments: This zone is fault number 9 of Pezzopane (1993 #3544) and fault number 38 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Hood River fault zone

Comments: The Hood River fault or fault zone is named after its location along the east side of the Hood River Valley (Timm, 1979 #3948).

**Synopsis** The Hood River fault zone defines the eastern margin of a half graben that forms the Upper Hood River Valley in the High Cascades of northern Oregon. This structure may be part of an extensive group of graben structures formed in response to subsidence related to extrusion of extensive volcanic rocks in the early Pliocene. The area is underlain by Miocene volcanic rocks of the Columbia Plateau and Pliocene through Quaternary volcanic rocks of the Cascade Range. No fault scarps on Quaternary deposits have been described, but prominent escarpments on Neogene volcanic rocks and a minimum offset of 600 m in Pliocene volcanic rocks suggest that some displacement occurred in the Quaternary.

**Date of compilation** December 13, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Hood River

**1° x 2° sheet** The Dalles

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Good

Comments: The fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale compilation of Pezzopane (1993 #3544).

**Geologic setting** The Hood River fault zone defines the eastern margin of a half graben that forms the Upper Hood River Valley in the High Cascades of northern Oregon. This structure may be part of an extensive group of graben structures formed in response to subsidence related to extrusion of extensive volcanic rocks in the early Pliocene (Timm, 1979 #3948; Williams and others, 1982 #3998; Beeson and others, 1982 #4054; Sherrod and Pickthorn, 1989 #3599; Beeson and others, 1989 #4023). The area is underlain by Miocene volcanic rocks of the Columbia Plateau and Pliocene through Quaternary volcanic rocks of the High Cascades Province (Newcomb, 1970 #3761; Timm, 1979 #3948; Swanson and others, 1981 #3496; Bela, 1982 #3584; Walker and MacLeod, 1991 #3646; Sherrod and Scott, 1995 #3495; Sherrod and Smith, 2000 #5165).

**Sense of movement** N, D?

Comments: The Hood River fault zone is shown as a normal or high-angle fault on maps of Newcomb (1970 #3761), Swanson and others (1981 #3496), Bela (1982 #3584), Walker (1991 #3646), Pezzopane (1993 #3544), Sherrod and Scott (1995 #3495), and Sherrod and Smith (2000 #5165). Timm (1979 #3948) described one exposure of the fault that shows a vertical fault dip with slickensides indicating both vertical and right-lateral strike-slip.

**Dip** 70°-90°

Comments: Timm (1979 #3948) described one exposure of the fault that shows a vertical fault dip. Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 70° in their modeling of earthquake hazards associated with the Hood River fault zone.

**Main dip direction** W

**Geomorphic expression** The Hood River fault zone forms prominent escarpments on Neogene volcanic rocks along the eastern margin of the Upper Hood River Valley and along the east side of the Hood River Gorge. Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area. Geomatrix Consultants, Inc. (1990 #3550; 1995 #3593) break the fault zone into two segments, a northern segment comprised of a complex of short faults that form the eastern margin of the Upper Hood River Valley, and a southern segment comprised of a single fault escarpment on the eastern margin of the Hood River Gorge. U.S. Army Corps of Engineers (1983 #3485) shows numerous north-trending lineaments along the trace of the fault zone. No fault scarps on Quaternary deposits have been described along either of the segments described by Geomatrix Consultants, Inc. (1990 #3550; 1995 #3593), so herein both parts of the fault zone are included in a single description.

**Age of faulted deposits at the surface** The Hood River fault zone offsets Miocene Columbia River Basalt Group and Pliocene volcanic rocks (Timm, 1979 #3948; Swanson and others, 1981 #3496; Bela, 1982 #3584; Walker and MacLeod, 1991 #3646; Sherrod and Scott, 1995 #3495; Sherrod and Smith, 2000 #5165), but no fault scarps on Quaternary surficial deposits have been described. S.K. Pezzopane (pers. commun., in Geomatrix Consultants Inc., 1995 #3593) notes that locally late Pleistocene(?) lava flows lie unfaulted across the fault zone.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: The Hood River fault zone offsets Miocene Columbia River Basalt Group and Pliocene volcanic rocks (Timm, 1979 #3948; Swanson and others, 1981 #3496; Bela, 1982 #3584; Walker and MacLeod, 1991 #3646; Sherrod and Scott, 1995 #3495; Sherrod and Smith, 2000 #5165), but no fault scarps on Quaternary surficial deposits have been described. However, Pliocene rocks are offset a minimum of 600 m (Williams and others, 1982 #3998; Sherrod and Pickthorn, 1989 #3599), so some displacement probably extended into the Quaternary. The fault zone was judged not active by Geomatrix Consultants, Inc. (1990 #3550), but was mapped as active in the middle and late Quaternary (<700-780 ka) by Pezzopane (1993 #3544) and Weldon and others (2002 #5648), and as active in the Quaternary (<1.6-1.8 Ma) by Geomatrix Consultants, Inc. (1995 #3593) and Madin and Mabey (1996 #3575). Given the lack of unequivocal evidence of Quaternary displacement, the fault zone is herein classified as Quaternary (<1.6 Ma) until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No slip data are available, but offsets of 600 m of 3 Ma volcanic rocks along the southern part of the fault zone (Sherrod and Pickthorn, 1989 #3599; Sherrod and Scott, 1995 #3495) yield low rates of slip. Geomatrix Consultants, Inc. (1995 #3593) used estimated slip rates of 0.05-0.2 mm/yr in their analysis of earthquake hazards associated with the Hood River fault zone.

| | | |
|---|---|---|
| **Length** | End to end (km): | 44.3 |
| | Cumulative trace (km): | 80.8 |

Comments:

**Average strike** (azimuth) N 11° W

**References**

#4054 Beeson, M.H., Moran, M.R., Anderson, J.L., and Vogt, B.F., 1982, The relationship of the Columbia River Basalt Group to the geothermal potential of the Mount Hood Area, Oregon, *in* Priest, G.R., and Vogt, B.F., eds., Geology and geothermal resources of the Mount Hood Area, Oregon: State of Oregon, Department of Geology and Mineral Industries Special Paper 14, p. 43-46.

#4023 Beeson, M.H., Tolan, T.L., and Anderson, J.L., 1989, The Columbia River Basalt Group in western Oregon–Geologic structures and other factors that controlled flow emplacement patterns, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 223-246.

#3584 Bela, J.L., 1982, Geologic and neotectonic evaluation of north-central Oregon—The Dallas 1 x 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geologic Map Series GMS-27, 2 sheets, scale 1:250,000.

#3550 Geomatrix Consultants Inc., 1990, Seismotectonic evaluation of Wasco Dam site: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, under Contract 6-CS-81-07310, 115 p., 2 pls., scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3599 Sherrod, D.R., and Pickthorn, L.G., 1989, Some notes on the Neogene structural evolution of the Cascade Range in Oregon, *in* Muffler, P.L.J., Weaver, C.S., and Blackwell, D.D., eds., Geological, geophysical, and tectonic setting of the Cascade Range: U.S. Geological Survey Open-File Report 89-178, p. 351-368.

#3495 Sherrod, D.R., and Scott, W.E., 1995, Preliminary geologic map of the Mount Hood 30 by 60 minute quadrangle, northern Cascade Range, Oregon: U.S. Geological Survey Open-File Report 95-219, 28 p., 1 pl., scale 1:100,000.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

#3948 Timm, S., 1979, The structure and stratigraphy of the Columbia River basalt in the Hood River Valley, Oregon: Portland State University, unpublished M.S. thesis, 58 p., 2 pls.

#3485 U.S. Army Corps of Engineers, 1983, Detroit and Big Cliff Lakes earthquake and fault study—Design memorandum 4: U.S. Army Corps of Engineers, Portland District, 93 p., 13 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#3998 Williams, D.L., Hull, D.A., Ackermann, H.D., and Beeson, M.H., 1982, The Mt. Hood region—Volcanic history, structure, and geothermal energy potential: Journal of Geophysical Research, v. 87, no. B4, p. 2767-2781.

**867, Eagle Creek thrust fault (Class B)**

**Structure Number** 867

Comments:

**Structure Name** Eagle Creek thrust fault

Comments: This fault is located northwest of Chinidere Mountain in northern Oregon (Beeson and others, 1985 #4022; Beeson and others, 1989 #4023; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593). The fault is associated with and named after the Eagle Creek Homocline (Beeson and others, 1985 #4022; Beeson and others, 1989 #4023).

**Synopsis** This northeast-striking thrust fault is located northwest of Chinidere Mountain in northern Oregon, in Miocene volcanic rocks of the Columbia River Basalt Group and Plio-Pleistocene volcanic rocks of the High Cascades Province. Thrust displacement and association with the Eagle Creek Homocline indicate that this structure is part of the Yakima fold belt of south-central Washington and northern Oregon. No detailed information on Quaternary offset is available, but limited airphoto analysis suggests possible Quaternary displacement. Given the lack of documented geomorphic expression in Quaternary deposits, herein the fault is classified as Class B until further studies are conducted.

**Date of compilation** December 13, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Hood River

**1° x 2° sheet** The Dalles

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Poor

Comments: The fault trace is from 1:500,000-scale compilation of Pezzopane (1993 #3544), after mapping of Beeson and others (1985 #4022; 1989 #4023).

**Geologic setting** This northeast-striking, southeast-dipping thrust fault is located northwest of Chinidere Mountain in northern Oregon (Beeson and others, 1985 #4022; Tolan and Reidel, 1989 #3765; Beeson and others, 1989 #4023; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593), in Miocene volcanic rocks of the Columbia River Basalt Group and Plio-Pleistocene volcanic rocks of the High Cascades Province (Newcomb, 1970 #3761; Swanson and others, 1981 #3496; Bela, 1982 #3584; Sherrod and Smith, 1989 #3498; Walker and MacLeod, 1991 #3646). Thrust displacement and association with the Eagle Creek Homocline (Beeson and others, 1985 #4022; Tolan and Reidel, 1989 #3765; Beeson and others, 1989 #4023) indicate that this structure is part of the Yakima fold belt of central Washington and northern Oregon.

**Sense of movement** T

Comments: The Eagle Creek thrust fault is mapped as a southeast-dipping thrust by Beeson and others (1985 #4022; 1989 #4023), Tolan and Reidel (1989 #3765), Pezzopane (1993 #3544), and Geomatrix Consultants, Inc. (1995 #3593). U.S. Army Corps of Engineers (1983 #3485) show a down-northwest normal fault in the approximate location of the fault.

**Dip** 29°

Comments: Dip measurement reported in Beeson and others (1989 #4023).

**Main dip direction** SE

**Geomorphic expression** Not Reported

**Age of faulted deposits at the surface** The fault is mapped by Beeson and others (1985 #4022; 1989 #4023), Tolan and Reidel (1989 #3765), Pezzopane (1993 #3544) and Geomatrix Consultants, Inc. (1995 #3593) in Miocene volcanic rocks of the Columbia River Basalt Group and Plio-Pleistocene volcanic rocks of the High Cascades Province (Newcomb, 1970 #3761; Swanson and others, 1981 #3496; Bela, 1982 #3584; Sherrod and Smith, 1989 #3498; Walker and MacLeod, 1991 #3646). No fault scarps in Quaternary surficial deposits have been described, so herein we classify the fault as Class B until further studies are conducted.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary (<1.6 Ma) displacement, and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) also show the fault as active in the Quaternary (<1.6-1.8 Ma). Weldon and others (2002 #5648) do not include this fault in their recent compilation. Wong and others (1999 #4073; 2000 #5137) do not include this fault in their recent analysis of earthquake hazards in the Portland area. Given the lack of documented geomorphic expression in Quaternary deposits, herein we classify the fault as Class B until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the Eagle Creek thrust fault, but Beeson and others (1985 #4022; 1989 #4023) measured more than 300 m of vertical offset of Miocene Columbia River Basalt Group rocks across the fault. Such data yield low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 8.1 |
| | Cumulative trace (km): | 9.0 |

Comments:

**Average strike** (azimuth) N 44° E

**References**

#4022 Beeson, M.H., Fecht, K.R., Reidel, S.P., and Tolan, T.L., 1985, Regional correlations within the Frenchman Springs member of the Columbia River Basalt Group—New insights into the middle Miocene tectonics of northwestern Oregon: Oregon Geology, v. 47, no. 8, p. 87-96.

#4023 Beeson, M.H., Tolan, T.L., and Anderson, J.L., 1989, The Columbia River Basalt Group in western Oregon–Geologic structures and other factors that controlled flow emplacement patterns, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 223-246.

#3584 Bela, J.L., 1982, Geologic and neotectonic evaluation of north-central Oregon—The Dallas 1 x 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geologic Map Series GMS-27, 2 sheets, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3498 Sherrod, D.R., and Smith, J.G., 1989, Preliminary map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Open-File Report 89-14, 20 p., 1 pl., scale 1:500,000.

#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

#3765 Tolan, T.L., and Reidel, S.P., 1989, Structure map of a portion of the Columbia River flood-basalt Province, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, 1 sheet, scale 1:500,000.

#3485 U.S. Army Corps of Engineers, 1983, Detroit and Big Cliff Lakes earthquake and fault study—Design memorandum 4: U.S. Army Corps of Engineers, Portland District, 93 p., 13 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

**868, Bull Run thrust (Class B)**

**Structure Number** 868

Comments:

**Structure Name** Bull Run thrust

Comments: The Bull Run thrust is named after its location in the Bull Run watershed of northern Oregon and its association with the Bull run anticline, which lies just southeast of the mapped fault trace (Vogt, 1981 #3949; Beeson and others, 1989 #4023).

**Synopsis** This northeast-striking thrust fault is located in the Bull Run watershed of northern Oregon in Miocene volcanic rocks of the Columbia River Basalt Group and Plio-Pleistocene volcanic rocks of the High Cascades Province. Thrust displacement and association with the Bull Run anticline indicate that this structure is part of the Yakima fold belt of south-central Washington and northern Oregon. No detailed information on Quaternary offset is available, but limited airphoto analysis suggests possible Quaternary displacement. Given the lack of documented geomorphic expression in Quaternary deposits, herein the fault is classified as Class B until further studies are conducted.

**Date of compilation** December 13, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Hood River

**1° x 2° sheet** The Dalles

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Good

Comments: The fault trace is from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale compilation of Pezzopane (1993 #3544).

**Geologic setting** This northeast-striking, southeast-dipping thrust fault is located in the Bull Run watershed in northern Oregon in Miocene volcanic rocks of the Columbia River Basalt Group and Plio-Pleistocene volcanic rocks of the High Cascades (Swanson and others, 1981 #3496; Vogt, 1981 #3949; Bela, 1982 #3584; Beeson and others, 1985 #4022; Sherrod and Smith, 1989 #3498; Tolan and Reidel, 1989 #3765; Beeson and others, 1989 #4023; Beeson and Tolan, 1990 #3999; Sherrod and Scott, 1995 #3495, Walker, 1991 #3646). Thrust displacement and association with the Bull Run anticline (Vogt, 1981 #3949; Beeson and others, 1985 #4022; Tolan and Reidel, 1989 #3765; Beeson and others, 1989 #4023; Beeson and Tolan, 1990 #3999) indicate that this structure is part of the Yakima fold belt of central Washington and northern Oregon.

**Sense of movement** T

Comments: The Bull Run thrust is mapped as a southeast-dipping thrust fault (Swanson and others, 1981 #3496; Vogt, 1981 #3949; Bela, 1982 #3584; Beeson and others, 1985 #4022; Sherrod and Smith, 1989 #3498; Tolan and Reidel, 1989 #3765; Beeson and others, 1989 #4023; Beeson and Tolan, 1990 #3999; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544; Sherrod and Scott, 1995 #3495; Geomatrix Consultants Inc., 1995 #3593).

**Dip** 12°

Comments: Dip measurement from Vogt (1981 #3949) and Beeson and others (1989 #4023).

**Main dip direction** SE

**Geomorphic expression** Not Reported

**Age of faulted deposits at the surface** The fault is mapped in Miocene volcanic rocks of the Columbia River Basalt Group and Plio-Pleistocene volcanic rocks of the High Cascades Province (Swanson and others, 1981 #3496; Vogt, 1981 #3949; Bela, 1982 #3584; Beeson and others, 1985 #4022; Sherrod and Smith, 1989 #3498; Tolan and Reidel, 1989 #3765; Beeson and others, 1989 #4023; Beeson and Tolan, 1990 #3999; Sherrod and Scott, 1995 #3495, Walker, 1991 #3646). No fault scarps on Quaternary surficial deposits have been described.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary (<1.6 Ma) displacement, and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) also show the fault as active in the Quaternary (<1.6-1.8 Ma). Weldon and others (2002 #5648) classify this fault as possibly active in the Quaternary in their recent compilation. The fault was judged not active by Geomatrix Consultants, Inc. (1990 #3550), and Wong and others (1999 #4073; 2000 #5137) do not include this fault in their recent analysis of earthquake hazards in the Portland area. Given the lack of documented geomorphic expression in Quaternary deposits, herein we classify the fault as Class B until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: Vogt (1981 #3949) measured more than 180 m of vertical offset and at least 900 m of dip slip of Miocene Columbia River Basalt Group rocks across the fault. Such data yield low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 9.4 |
| | Cumulative trace (km): | 9.5 |

Comments:

**Average strike** (azimuth) N 44° E

**References**

#4022 Beeson, M.H., Fecht, K.R., Reidel, S.P., and Tolan, T.L., 1985, Regional correlations within the Frenchman Springs member of the Columbia River Basalt Group—New insights into the middle Miocene tectonics of northwestern Oregon: Oregon Geology, v. 47, no. 8, p. 87-96.

#3999 Beeson, M.H., and Tolan, T.L., 1990, The Columbia River basalt group in the Cascade Range—A middle Miocene reference datum for structural analysis: Journal of Geophysical Research, v. 95, no. B12, p. 19,547-19,559.

#4023 Beeson, M.H., Tolan, T.L., and Anderson, J.L., 1989, The Columbia River Basalt Group in western Oregon–Geologic structures and other factors that controlled flow emplacement patterns, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 223-246.

#3584 Bela, J.L., 1982, Geologic and neotectonic evaluation of north-central Oregon—The Dallas 1 x 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geologic Map Series GMS-27, 2 sheets, scale 1:250,000.

#3550 Geomatrix Consultants Inc., 1990, Seismotectonic evaluation of Wasco Dam site: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, under Contract 6-CS-81-07310, 115 p., 2 pls., scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3495 Sherrod, D.R., and Scott, W.E., 1995, Preliminary geologic map of the Mount Hood 30 by 60 minute quadrangle, northern Cascade Range, Oregon: U.S. Geological Survey Open-File Report 95-219, 28 p., 1 pl., scale 1:100,000.

#3498 Sherrod, D.R., and Smith, J.G., 1989, Preliminary map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Open-File Report 89-14, 20 p., 1 pl., scale 1:500,000.

#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

#3765 Tolan, T.L., and Reidel, S.P., 1989, Structure map of a portion of the Columbia River flood-basalt Province, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, 1 sheet, scale 1:500,000.

#3949 Vogt, B.F., 1981, The stratigraphy and structure of the Columbia River basalt group in the Bull Run Watershed, Multnomah and Clackamas Counties, Oregon: Portland State University, unpublished M.S. thesis, 145 p., 2 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

**869, Corvallis fault zone (Class B)**

**Structure Number** 869

Comments: This fault zone is fault number 20 of Pezzopane (1993 #3544) and fault number 34 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Corvallis fault zone

Comments: The Corvallis fault zone is named after the nearby City of Corvallis; the Corvallis fault zone was first mapped and named by Vokes and others (1954 #4078), and has been subsequently mapped or described by Baldwin (1955 #4147), Lawrence and others (1977 #4027), Bela (1979 #4051), Goldfinger (1991 #3952), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Yeats and others (1996 #4291).

**Synopsis** The northeast-striking, shallowly northwest-dipping Corvallis fault zone forms the western margin of the southern Willamette Valley in the vicinity of Corvallis. The fault thrusts Eocene Siletz River Volcanics over siltstone and sandstone of the Eocene Tyee Formation The fault may have been reactivated as a steeply dipping left-lateral strike-slip fault. The fault trace is offset by two northwest-striking strike-slip faults that appear to be tear faults in the thrust sheet; however, these faults may extend eastward into the Willamette Valley and thus may not be not tear faults. No unequivocal evidence of Quaternary deformation has been described, so, herein the fault is classified as a Class B structure until further studies are conducted.

**Date of compilation** May 21, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Benton

**1° x 2° sheet** Salem

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Good

Comments: The fault trace is from 1:100,000-scale mapping of Yeats and others (1996 #4291).

**Geologic setting** The Corvallis fault zone forms the western margin of the southern Willamette Valley in the vicinity of Corvallis. This shallowly northwest-dipping fault thrusts Eocene Siletz River Volcanics over siltstone and sandstone of the Eocene Tyee Formation (Vokes and others, 1954 #4078; Bela, 1979 #4051; Walker and Duncan, 1989 #3581; Goldfinger, 1991 #3952; Yeats and others, 1996 #4291). The fault trace is offset by two northwest-striking strike-slip faults (Goldfinger, 1991 #3952; Yeats and others, 1996 #4291) that appear to be tear faults in the thrust sheet; however, these faults may extend eastward into the Willamette Valley and thus may not be not tear faults (Goldfinger, 1991 #3952). The Corvallis fault zone may have been reactivated as a steeply dipping left-lateral strike-slip fault (Goldfinger, 1991 #3952).

**Sense of movement** T,S?

Comments: The Corvallis fault zone was previously mapped as a high-angle reverse fault (Vokes and others, 1954 #4078; Bela, 1979 #4051), but recent gravity data indicate a shallow (10°-15°) northwest dip (Yeats, 1990 #4018; Goldfinger, 1991 #3952; Yeats and others, 1996 #4291). The fault zone may have been reactivated as a steeply dipping left-lateral strike-slip fault (Goldfinger, 1991 #3952). The two northwest-striking possible tear faults have left- and right-lateral strike-slip displacements.

**Dip** 10°-15° thrust, 60°-90° strike-slip

Comments: The thrust dip estimate is based on gravity data (Yeats, 1990 #4018; Goldfinger, 1991 #3952; Yeats and others, 1996 #4291); the strike-slip data are from a fault exposure described by Goldfinger (1991 #3952).

**Main dip direction** NW

**Geomorphic expression** The Corvallis fault zone parallels the western margin of the Willamette Valley in the vicinity of Corvallis; the valley margin in this location is marked by a gentle, embayed, 300-m-high escarpment in Eocene bedrock. Small (<1 m high), short scarps and lineations have been described along parts of the Corvallis fault zone and along the northwest-striking faults that offset the Corvallis fault trace, but the origin of these features is equivocal (Goldfinger, 1991 #3952; Yeats and others, 1996 #4291).

**Age of faulted deposits at the surface** The Corvallis fault zone offsets Oligocene bedrock, but no unequivocal examples of offset Quaternary deposits have been described (Yeats and others, 1996 #4291). Balster and Parsons (1968 #3989; 1969 #4003) describe evidence of uplift of their Irish Bend Member of the Willamette Formation, thought to be latest Pleistocene in age, but McDowell (1991 #4004) described nontectonic processes that were more likely responsible for the stratigraphic and geomorphic relations described by Balster and Parsons (1968 #3989; 1969 #4003). Goldfinger (1991 #3952) and Yeats and others (1996 #4291) describe stratigraphic relationships between the Willamette Formation and underlying middle to late Pleistocene Rowland Formation as equivocal evidence of Quaternary offset across the Corvallis fault zone.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) mapped this fault as Quaternary (<1.6 Ma), but later compilations (Geomatrix Consultants Inc., 1995 #3593, Madin, 1996 #3575) inferred fault movement in the middle and late Quaternary (<780 ka). Given the lack of documented geomorphic expression in Quaternary deposits (Goldfinger, 1991 #3952), herein the fault is classified as a Class B structure until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Goldfinger (1991 #3952) and Yeats and others (1996 #4291) estimate 11-13 km of horizontal shortening in Eocene bedrock, but the lack of significant geomorphic expression along these faults suggest low rates of slip. Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 0.005-0.05 mm/yr in their analyses of the earthquake hazards associated with the Corvallis fault zone.

| | | |
|---|---|---|
| **Length** | End to end (km): | 40.4 |
| | Cumulative trace (km): | 44.6 |

Comments:

**Average strike** (azimuth) N 33° E

**References**


#4147 Baldwin, E.M., 1955, Geology of the Marys Peak and Alsea quadrangles, Oregon: U.S. Geological Survey Oil and Gas Investigations Map OM-162, 1 sheet, scale 1:62,500.

#3989 Balster, C.A., and Parsons, R.B., 1968, Geomorphology and soils Willamette Valley, Oregon: United States Department of Agriculture Soil Conservation Service, 31 p., 1 pl., scale 1:200,000.

#4003 Balster, C.A., and Parsons, R.B., 1969, Late Pleistocene stratigraphy, southern Willamette Valley, Oregon: Northwest Science, v. 43, no. 3, p. 116-129.

#4051 Bela, J.L., 1979, Geologic hazards of eastern Benton County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 98, 122 p., 5 pls.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3952 Goldfinger, C., 1991, Evolution of the Corvallis fault and implications for the Oregon Coast Range: Oregon State University, unpublished M.S. thesis, 129 p., 2 pls.

#4027 Lawrence, R.D., Livingston, N.D., Vickers, S.D., and Conyers, L.B., 1977, Field guide to the geology of Corvallis and vicinity, Oregon: The ORE BIN, v. 39, no. 4, p. 53-71.

#4004 McDowell, P.F., 1991, Quaternary stratigraphy and geomorphic surfaces of the Willamette Valley, Oregon, *in* Morrison, R.B., ed., Quaternary nonglacial geology—Conterminous U.S.: Boulder, Colorado, Geological Society of America, The Geology of North America, v. K-2, p. 156-163.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4078 Vokes, H.E., Myers, D.A., and Hoover, L., 1954, Geology of the west-central border area of the Willamette Valley, Oregon: U.S. Geological Survey Oil and Gas Investigations Map OM-0150, 1 sheet, scale 1:62,500.

#3581 Walker, G.W., and Duncan, R.A., 1989, Geologic map of the Salem 1 by 2 quadrangle, western Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1893, 1 sheet, scale 1:250,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#4018 Yeats, R.S., 1990, A search for active faults in the Willamette Valley, Oregon: U.S. Geological Survey Open-File Report 90-334.

#4291 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T.A., 1996, Tectonics of the Willamette Valley, Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 183-222.

## 870, Owl Creek fault

**Structure Number** 870

Comments: This fault zone is fault number 35 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Owl Creek fault

Comments: The Owl Creek fault was mapped and named by Graven (1990 #3990) and Yeats and others (1996 #4291) after Owl Creek, a small tributary of the Willamette River that parallels part of the fault trace.

**Synopsis** The steeply east-dipping Owl Creek fault is a reverse fault associated with an anticline in the Eocene Spencer Formation mapped in the subsurface east of Corvallis on the floor of the southern Willamette Valley. The fault, which has no geomorphic expression, apparently offsets the middle to late Pleistocene Rowland Formation, but does not offset the latest Pleistocene Willamette Formation.

**Date of compilation** May 23, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Linn, Benton

**1° x 2° sheet** Salem

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:100,000-scale mapping of Yeats and others (1996 #4291).

**Geologic setting** The Owl Creek fault is located in the subsurface east of the Willamette River in the vicinity of Corvallis in the southern Willamette Valley. The steeply east-dipping reverse fault is associated with an anticline in the Eocene Spencer Formation (Graven, 1990 #3990; Yeats and others, 1996 #4291). The fault is not shown on older geologic maps of the area (Vokes and others, 1954 #4078; Bela, 1979 #4051; Walker and Duncan, 1989 #3581).

**Sense of movement** R

Comments: The Owl Creek fault is mapped as a steeply east-dipping reverse fault by Graven (1990 #3990) and Yeats and others (1996 #4291).

**Dip** 60°

Comments: No actual dip measurements have been reported, but Graven (1990 #3990) reported an estimated dip of 60° east. Geomatrix Consultants, Inc. (1995 #3593) used an estimated dip of 60° in their analysis of the Owl Creek fault.

**Main dip direction** E

**Geomorphic expression** The Owl Creek fault has only been identified in the subsurface, and apparently has no geomorphic expression (Graven, 1990 #3990; Yeats and others, 1996 #4291).

**Age of faulted deposits at the surface** The middle to late Pleistocene Rowland Formation appears to be offset across the Owl Creek fault, but no evidence of offset is apparent in the latest Pleistocene Willamette Formation (Graven, 1990 #3990; Yeats and others, 1996 #4291).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: The Owl Creek fault apparently offsets the middle to late Pleistocene Rowland Formation, but does not appear to offset the latest Pleistocene Willamette Formation (Graven, 1990 #3990; Yeats and others, 1996 #4291). Madin and others (2001 #5051) infer late Quaternary offset, and Geomatrix Consultants, Inc. (1995 #3593) and Madin and Mabey (1996 #3575) infer middle and late Quaternary (<780 ka) displacement.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Graven (1990 #3990) and Yeats and others (1996 #4291) estimate 725 m of offset of the Eocene Spencer Formation across the anticline associated with the Owl Creek fault, but the lack of geomorphic expression along this fault suggests low rates of slip. Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 0.005-0.05 mm/yr in their analyses of the earthquake hazards associated with the Owl Creek fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 14.9 |
| | Cumulative trace (km): | 14.9 |

Comments:

**Average strike** (azimuth) N 05° E

**References**


#4051 Bela, J.L., 1979, Geologic hazards of eastern Benton County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 98, 122 p., 5 pls.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3990 Graven, E.P., 1990, Structure and tectonics of the southern Willamette Valley, Oregon: Oregon State University, unpublished Master's thesis, 119 p., 10 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#5051 Madin, I.P., Wang, Z., and Graham, G.B., 2001, Finding Quaternary faults in the Willamette lowland—Are they dead or just hiding?: Seismological Research Letters, v. 72, no. 2, p. 254.

#4078 Vokes, H.E., Myers, D.A., and Hoover, L., 1954, Geology of the west-central border area of the Willamette Valley, Oregon: U.S. Geological Survey Oil and Gas Investigations Map OM-0150, 1 sheet, scale 1:62,500.

#3581 Walker, G.W., and Duncan, R.A., 1989, Geologic map of the Salem 1 by 2 quadrangle, western Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1893, 1 sheet, scale 1:250,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#4291 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T.A., 1996, Tectonics of the Willamette Valley, Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 183-222.

**871, Mill Creek fault**

**Structure Number** 871

Comments: This structure is fault number 7 of Pezzopane (1993 #3544) and fault number 33 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Mill Creek fault

Comments: Parts of this fault is included in the Salem Hills structures of Pezzopane (1993 #3544). The fault was originally mapped and named as two separate structures, the Turner and Mill Creek faults. The Turner fault is named after the town of Turner in the Salem Hills; it was mapped by Walker and Duncan (1989 #3581) and mapped and named by Graven (1990 #3990) and Yeats and others (1996 #4291). The Mill Creek fault is named after Mill Creek, which parallels part of the fault trace; the fault was mapped and named by Graven (1990 #3990) and Yeats and others (1996 #4291). Several recent studies include both faults in a single Mill Creek fault (Yeats and others, 1993 #5057; Crenna and Yeats, 1994 #4129; Geomatrix Consultants Inc., 1995 #3593), so that named is used herein. These faults are not shown on most older geologic maps of the area (Thayer, 1939 #4070; Hampton, 1972 #4065; Bela, 1981 #4033), but is included in more recent maps (Tolan and Beeson, 2000 #5069).

**Synopsis** The northeast-striking Mill Creek fault offsets Miocene rocks of the Columbia River Basalt Group in the Salem Hills and Waldo Hills of the central Willamette Valley. This fault has the same strike and displacement direction as the Corvallis fault, but there is no evidence that these structures are continuous across the Willamette River. The Mill Creek fault is coincident with a gentle, embayed range front along the southern margin of the Waldo Hills, and may deform middle Pleistocene(?) deposits near the Mill Creek water gap.

**Date of compilation** April 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Marion

**1° x 2° sheet** Salem

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:100,000-scale mapping of Yeats and others (1996 #4291).

**Geologic setting** The Mill Creek fault offsets Miocene rocks of the Columbia River Basalt Group and form aeromagnetic anomalies in the Salem Hills and Waldo Hills of the central Willamette Valley (Walker and Duncan, 1989 #3581; Yeats and others, 1996 #4291; Blakely and others, 2000 #4333; Tolan and Beeson, 2000 #5069). This fault has the same strike and displacement direction as the Corvallis fault, but there is no evidence that these structures are continuous across the Willamette River (Yeats, 1990 #4018; Yeats and others, 1993 #5057; Yeats and others, 1996 #4291).

**Sense of movement** RS?

Comments: The Mill Creek fault is mapped as a near-vertical fault by Graven (1990 #3990), Crenna and others (1994 #4129), Yeats and others (1993 #5057), and Yeats and others (1996 #4291). Yeats and Levi (1994 #4024) and Yeats and others (1993 #5057) describe basin relations that may suggest a strong component of left-lateral strike slip. The was modeled as a reverse fault in the earthquake hazards analysis of Geomatrix Consultants, Inc. (1995 #3593).

**Dip** Not Reported

Comments: The Mill Creek fault was modeled as a 70° dipping reverse fault in the earthquake hazards analysis of Geomatrix Consultants, Inc. (1995 #3593).

**Main dip direction** Not Reported

**Geomorphic expression** The Mill Creek fault has little if any geomorphic expression where it traverses the bedrock-cored Salem Hills, but the fault is coincident with a gentle, embayed range front at the southern margin of the Waldo Hills and the northern margin of the Stayton (North Santiam) basin.

**Age of faulted deposits at the surface** The Mill Creek fault may deform older Quaternary deposits along the southern margin of the Waldo Hills near the Mill Creek water gap. Yeats and others (1993 #5057) infer deformation of the middle Pleistocene(?) Lacomb gravel and Dolph geomorphic surface, but the fault does not appear to deform late Quaternary surfaces such as the Linn gravel (Rowland Formation), and the Winkle geomorphic surface (Yeats and others, 1991 #3953; Yeats and others, 1993 #5057; Yeats and Levi, 1994 #4024; Crenna and Yeats, 1994 #4129; Yeats and others, 1996 #4291).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) mapped these faults as Quaternary (<1.6 Ma), but later compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) infer middle and late Quaternary (<780 ka) displacement. Given the equivocal nature of evidence for Quaternary displacement, the Mill Creek fault is mapped herein as Quaternary (<1.6 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Graven (1990 #3990) and Yeats and others (1996 #4291) estimate 100 m and Yeats and others (1993 #5057) and Crenna and others (1994 #4129) estimated 150-210 m of offset of Miocene Columbia River Basalt Group rocks across the Mill Creek fault; these data and the lack of significant geomorphic expression along these faults suggest low rates of slip. Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 0.005-0.05 mm/yr in their analyses of the earthquake hazards associated with the Turner and Mill Creek faults.

| | | |
|---|---|---|
| **Length** | End to end (km): | 18.4 |
| | Cumulative trace (km): | 20.1 |

Comments:

**Average strike** (azimuth) N 66° E

**References**


#4033 Bela, J.L., 1981, Geology of the Rickreall, Salem West, Monmouth, and Sidney 7 1/2' quadrangles, Marion, Polk, and Linn Counties, Oregon: State of Oregon Geological Map Series GMS-18, 2 sheets, scale 1:24,000.

#4333 Blakely, R.J., Wells, R.E., Tolan, T.L., Beeson, M.H., Trehu, A.M., and Liberty, L.M., 2000, New aeromagnetic data reveal large strike-slip (?) faults in the northern Willamette Valley, Oregon: Geological Society of America Bulletin, v. 112, p. 1225-1233.

#4129 Crenna, P.A., and Yeats, R.S., 1994, Late Cenozoic tectonics and paleogeography of the Salem metropolitan area, central Willamette Valley, Oregon: Oregon Geology, v. 56, no. 6, p. 129-136.

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#3990 Graven, E.P., 1990, Structure and tectonics of the southern Willamette Valley, Oregon: Oregon State University, unpublished Master's thesis, 119 p., 10 pls.

#4065 Hampton, E.R., 1972, Geology and ground water of the Molalla-Salem Slope Area, northern Willamette Valley, Oregon: U.S. Geological Survey Water-Supply Paper 1997, 79 p., 3 pls., scale 1:48,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4070 Thayer, T.P., 1939, Geology of the Salem Hills and the North Santiam River Basin, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin No. 15, 40 p., 1 pl.

#5069 Tolan, T.L., and Beeson, M.H., 2000, Geologic map of the Turner 7.5 minute quadrangle: U.S. Geological Survey Open-File Report 00-351, 1 sheet, scale 1:24,000.

#3581 Walker, G.W., and Duncan, R.A., 1989, Geologic map of the Salem 1 by 2 quadrangle, western Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1893, 1 sheet, scale 1:250,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#4018 Yeats, R.S., 1990, A search for active faults in the Willamette Valley, Oregon: U.S. Geological Survey Open-File Report 90-334.

#3953 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T., 1991, Tectonics of the Willamette Valley, Oregon: U.S. Geological Survey Open-File Report 91-441-P, 47 p., 3 pls.

#4291 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T.A., 1996, Tectonics of the Willamette Valley, Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 183-222.

#4024 Yeats, R.S., and Levi, S., 1994, Active faults and folds in the Salem metropolitan area, Oregon: U.S. Geological Survey Open-File Report 94-176.

#5057 Yeats, R.S., Levi, S., and Crenna, P., 1993, Active faults and folds in the Salem metropolitan area, Oregon: Technical report to U.S. Geological Survey, Reston, Virginia, under Contract 14-08-0001-G2131, August 14, 1993, 22 p.

## 872, Waldo Hills fault

**Structure Number** 872

Comments: This is fault number 32 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Waldo Hills fault

Comments: The Waldo Hills or Waldo Hills Range Front fault was mapped and named by Graven (1990 #3990), Yeats and others (1993 #5057), Yeats and Levi (1994 #4024), and Yeats and others (1996 #4291). The fault is not shown on most previous geologic maps of the area (Hampton, 1972 #4065; Walker and Duncan, 1989 #3581), but is present on more recent maps (Tolan and Beeson, 2000 #5069).

**Synopsis** The northeast-striking, southeast-dipping Waldo Hills reverse fault offsets Miocene rocks of the Columbia River Basalt Group along the northwestern margin of the Waldo Hills in the central Willamette Valley. The Waldo Hills fault is coincident with a steep, linear range front that marks the northwestern margin of the Waldo Hills and the eastern margin of the central Willamette Valley, but no fault scarps on surficial Quaternary deposits have been described along its trace.

**Date of compilation** April 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Marion

**1° x 2° sheet** Salem

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault traces are from 1:100,000-scale mapping of Yeats and others (1996 #4291).

**Geologic setting** The Waldo Hills fault offsets Miocene rocks of the Columbia River Basalt Group and forms an aeromagnetic anomaly along the steep, linear northwestern margin of the Waldo Hills in the northern Willamette Valley (Yeats and others, 1993 #5057; Crenna and Yeats, 1994 #4129; Yeats and others, 1996 #4291; Blakely and others, 2000 #4333; Tolan and Beeson, 2000 #5069).

**Sense of movement** N?, R?

Comments: The Waldo Hills fault is mapped as a steeply dipping normal(?) or reverse(?) fault by Yeats and others (1993 #5057), Yeats and Levi (1994 #4024), Crenna and others (1994 #4129), Yeats and others (1996 #4291), and Tolan and Beeson (2000 #5069).

**Dip** >60°

Comments: Dip estimate of >60° is from Yeats and others (1993 #5057) and Crenna and others (1994 #4129).

**Main dip direction** NW?

Comments: Yeats and others (1993 #5057) and Crenna and others (1994 #4129) note that the fault must dip >60° if the dip is to the northwest.

**Geomorphic expression** The Waldo Hills fault is coincident with a steep, linear range front that marks the northwestern margin of the Waldo Hills and the eastern margin of the central Willamette Valley. However, extensive degradation and the sinuosity of the Waldo Hills range front suggests low rates of fault activity (Yeats and others, 1993 #5057; Crenna and Yeats, 1994 #4129). No fault scarps on surficial Quaternary deposits have been described along the Waldo Hills fault.

**Age of faulted deposits at the surface** The steep, linear range front that marks the trace of the Waldo Hills fault suggests that the fault may deform older Quaternary deposits along the northwestern margin of the Waldo Hills, but the but the fault does not appear to deform middle or late Quaternary deposits such as the Linn gravel (Rowland Formation), and the Dolph and Winkle geomorphic surfaces (Yeats and others, 1991 #3953; Yeats and others, 1993 #5057; Yeats and Levi, 1994 #4024; Crenna and Yeats, 1994 #4129; Yeats and others, 1996 #4291).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) inferred middle and late Quaternary (<780 ka) displacement, but given the equivocal nature of evidence for Quaternary displacement, the Waldo Hills fault is mapped herein as Quaternary (<1.6 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Yeats and others (1993 #5057) and Crenna and others (1994 #4129) estimated >90 m and Yeats and others (1996 #4291) estimate a minimum of 50 m of offset of Miocene Columbia River Basalt Group rocks across the Waldo Hills fault; these data suggest low rates of slip. Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 0.005-0.05 mm/yr in their analyses of the earthquake hazards associated with the Waldo Hills fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 11.8 |
| | Cumulative trace (km): | 11.8 |

Comments:

**Average strike** (azimuth) N 45° E

**References**

#4333 Blakely, R.J., Wells, R.E., Tolan, T.L., Beeson, M.H., Trehu, A.M., and Liberty, L.M., 2000, New aeromagnetic data reveal large strike-slip (?) faults in the northern Willamette Valley, Oregon: Geological Society of America Bulletin, v. 112, p. 1225-1233.

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#4065 Hampton, E.R., 1972, Geology and ground water of the Molalla-Salem Slope Area, northern Willamette Valley, Oregon: U.S. Geological Survey Water-Supply Paper 1997, 79 p., 3 pls., scale 1:48,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#5069 Tolan, T.L., and Beeson, M.H., 2000, Geologic map of the Turner 7.5 minute quadrangle: U.S. Geological Survey Open-File Report 00-351, 1 sheet, scale 1:24,000.

#3581 Walker, G.W., and Duncan, R.A., 1989, Geologic map of the Salem 1 by 2 quadrangle, western Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1893, 1 sheet, scale 1:250,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#3953 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T., 1991, Tectonics of the Willamette Valley, Oregon: U.S. Geological Survey Open-File Report 91-441-P, 47 p., 3 pls.

#4291 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T.A., 1996, Tectonics of the Willamette Valley, Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 183-222.

#4024 Yeats, R.S., and Levi, S., 1994, Active faults and folds in the Salem metropolitan area, Oregon: U.S. Geological Survey Open-File Report 94-176.

#5057 Yeats, R.S., Levi, S., and Crenna, P., 1993, Active faults and folds in the Salem metropolitan area, Oregon: Technical report to U.S. Geological Survey, Reston, Virginia, under Contract 14-08-0001-G2131, August 14, 1993, 22 p.

## 873, Mount Angel fault

**Structure Number** 873

Comments: This is fault number 6 of Pezzopane (1993 #3544) and fault number 29 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Mount Angel fault

Comments: The Mount Angel fault was first mapped by Hampton (1972 #4065) during groundwater investigations of the central Willamette Valley. The fault is probably named after the topographic feature or town of Mount Angel, and is included in the southeastern end of the Gales Creek-Mount Angel structural zone of Beeson and others (1985 #4022; 1989 #4023).

**Synopsis** The northwest-striking Mount Angel fault offsets Miocene rocks of the Columbia River Basalt Group in the subsurface of the central Willamette Valley. The fault appears to have controlled emplacement of the Frenchman Spring Member of the Wanapum Basalt and thus must have a history that predates the Miocene age of these rocks. The Mount Angel fault appears to have been the location of earthquake swarms in 1990 near Woodburn and the $M_L$ 5.6-5.7 1993 Scotts Mills earthquake. The Mount Angel fault has only been identified in the subsurface, but historic seismicity and possible deformation of late Pleistocene(?) fluvial surfaces and changes in stream patterns across the concealed trace of the fault near Mount Angel suggests latest Quaternary displacement.

**Date of compilation** May 23, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Marion

**1° x 2° sheet** Salem, Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Poor

Comments: The fault trace is from 1:100,000-scale mapping of Yeats and others (1996 #4291).

**Geologic setting** The northwest-striking Mount Angel fault offsets Miocene rocks of the Columbia River Basalt Group and forms a linear magnetic anomaly in the central Willamette Valley (Hampton, 1972 #4065; Werner, 1990 #3946; Werner and others, 1992 #3986; Yeats and others, 1996 #4291; Burns and others, 1997 #4079; Tolan and others, 1999 #4001; Blakely and others, 2000 #4333). The fault appears to have controlled emplacement of the Frenchman Spring Member of the Wanapum Basalt (Beeson and others, 1985 #4022; Beeson and others, 1989 #4023), and thus must have a history that predates the Miocene age of these rocks. The Mount Angel fault appears to have been the location of earthquake swarms in 1990 near Woodburn (Werner, 1990 #3946; Werner and others, 1992 #3986) and the 1993 Scotts Mills earthquake (ML 5.6-5.7, Madin and others, 1993 #5120; Thomas and others, 1996 #4002).

**Sense of movement** RD

Comments: The Mount Angel fault is mapped as a high-angle reverse-oblique fault by Werner (1990 #3946), Werner and others (1992 #3986) Yeats and others (1996 #4291), and Blakely and others (2000 #4333). M.H. Beeson (pers. commun., in Yeats and others, 1996 #4291) described 1 km of right lateral offset of an intracanyon flow of the Columbia River Basalt Group in the Waldo Hills, near the southern end of the Mount Angel fault. Beeson and others (1989 #4023) describe their Gales Creek-Mount Angel structural zone as faults with dip slip and right-lateral strike slip. Earthquake focal mechanisms from the 1993 Scotts Mills earthquake indicate subequal reverse and right-lateral strike slip on the Mount Angel fault (Thomas and others, 1996 #4002).

**Dip** 60°-70°

Comments: Earthquake focal mechanisms from the 1993 Scotts Mills earthquake indicate slip on a northwest-striking, 60° northeast-dipping fault plane (Thomas and others, 1996 #4002). Seismic reflection and aeromagnetic data indicate a northeast dip of 60°-70° (Werner, 1990 #3946; Werner and others, 1992 #3986; Yeats and others, 1996 #4291; Liberty and others, 1999 #4006; Blakely and others, 2000 #4333). The Mount Angel fault was modeled as a 70° dipping reverse fault in the earthquake hazards analysis of Geomatrix Consultants, Inc. (1995 #3593).

**Main dip direction** NE

**Geomorphic expression** The Mount Angel fault has mostly been identified in the subsurface, so it has usually been described as having little geomorphic expression (Yeats and others, 1996 #4291), but exposure of Columbia River Basalt Group rocks in Mount Angel are geologic expression of faulting (Werner, 1990 #3946; Werner and others, 1992 #3986). No fault scarps on surficial Quaternary deposits have been described along the fault trace, but Unruh and others (1994 #3597) inferred possible deformation of late Pleistocene(?) fluvial surfaces and changes in stream patterns across the concealed trace of the fault near Mount Angel. Wang and Madin (2001 #5055; 2001 #5063) describe an anomalous bend and probable tectonic deformation in Quaternary sediments where the fault crosses the Pudding River, and offsets of Quaternary deposits in shallow seismic reflection profiles at several locations across the fault.

**Age of faulted deposits at the surface** The Mount Angel fault offsets Miocene Columbia River Basalt Group volcanic rocks, and Miocene and Pliocene sedimentary rocks (Hampton, 1972 #4065; Werner, 1990 #3946; Werner and others, 1992 #3986; Yeats and others, 1996 #4291; Tolan and others, 1999 #4001; Liberty and others, 1999 #4006). No fault scarps on surficial Quaternary deposits have been described along the fault trace, but Unruh and others (1994 #3597) inferred possible deformation of late Pleistocene(?) fluvial surfaces across the concealed trace of the fault near Mount Angel. If these surfaces are deformed, then offset along the Mount Angel fault occurred during the late Pleistocene or Holocene (Unruh and others, 1994 #3597). Wang and Madin (2001 #5055; 2001 #5063) describe probable tectonic deformation of late Pleistocene or Holocene alluvium near projections of the fault in cutbanks of the Pudding River, and observed 0-19 m of southeastward increasing offset of inferred late Pleistocene (~22-34 ka) Linn gravel across the fault in shallow seismic reflection profiles.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Pezzopane (1993 #3544) mapped the Mount Angel fault as active in the Quaternary (<1.6 Ma); subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) inferred latest Pleistocene or Holocene (<10-20 ka) displacement, based on historic seismicity and evidence of possible late Quaternary displacement of Unruh and others (1994 #3597). Madin and others (2001 #5051) infer late Quaternary offset. Recent results of Wang and Madin (2001 #5055; 2001 #5063) support a young age of movement.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Water well and seismic reflection data indicate 200-250 m of vertical offset of the top of Miocene Columbia River Basalt Group rocks across the Mount Angel fault (Werner and others, 1992 #3986; Yeats and others, 1996 #4291; Liberty and others, 1999 #4006), and a similar age intercanyon flow may be offset about 1 km across the fault in the Waldo Hills (M.H. Beeson, pers. commun., in Yeats and others, 1996 #4291). The horizontal component of displacement is unknown. Wang and Madin (2001 #5055; 2001 #5063) observed 0-19 m of vertical offset of inferred late

Pleistocene (~22-34 ka) Linn gravel across the fault in shallow seismic reflection profiles. Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 0.01-0.1 mm/yr in their analyses of the earthquake hazards associated with the Mount Angel fault.

**Length** End to end (km): 29.7
Cumulative trace (km): 30.4

Comments:

**Average strike** (azimuth) N 43° W

**References**

#4022 Beeson, M.H., Fecht, K.R., Reidel, S.P., and Tolan, T.L., 1985, Regional correlations within the Frenchman Springs member of the Columbia River Basalt Group—New insights into the middle Miocene tectonics of northwestern Oregon: Oregon Geology, v. 47, no. 8, p. 87-96.

#4023 Beeson, M.H., Tolan, T.L., and Anderson, J.L., 1989, The Columbia River Basalt Group in western Oregon–Geologic structures and other factors that controlled flow emplacement patterns, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 223-246.

#4333 Blakely, R.J., Wells, R.E., Tolan, T.L., Beeson, M.H., Trehu, A.M., and Liberty, L.M., 2000, New aeromagnetic data reveal large strike-slip (?) faults in the northern Willamette Valley, Oregon: Geological Society of America Bulletin, v. 112, p. 1225-1233.

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## 874, Bolton fault (Class B)

**Structure Number** 874

Comments: This structure is fault number 27 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Bolton fault

Comments: The Bolton fault was first mapped in part by Hammond and others (1974 #4050) and Schlicker and Finlayson (1979 #4166), and was mapped in detail and presumably named after the town of Bolton by Beeson and others (1989 #4047) and Madin (1990 #4067); the southern part of the fault has been mapped by Schlicker and Finlayson (1979 #4166), Burns and others (1997 #4079), and Gannett and Caldwell (1998 #4066). The fault may be part of the Portland Hills-Clackamas River structural zone of Beeson and others (1985 #4022; 1989 #4023), and is included in the Portland Hills fault zone of Blakely and others (1995 #4021).

**Synopsis** The northwest-striking Bolton fault forms a prominent (150-m-high), northeast-facing escarpment on volcanic rocks of the Miocene Columbia River Basalt Group in the northern Willamette Valley. The fault is part of the Portland Hills-Clackamas River structural zone. The fault is probably a southwest-dipping reverse fault with down-to-the-northeast separation of about 200 m in Miocene volcanic rocks. No fault scarps on surficial deposits, or other unequivocal evidence of Quaternary displacement has been described, so herein the fault is classified as Class B until further studies are conducted.

**Date of compilation** May 24, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Clackamas

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:24,000-scale mapping of Beeson and others (1989 #4047) and Madin (1990 #4067), supplemented with 1:100,000-scale mapping of Burns and others (1997 #4079), and 1:250,000-scale mapping of Gannett and Caldwell (1998 #4066).

**Geologic setting** The northwest-striking Bolton fault forms a prominent northeast-facing escarpment on volcanic rocks of the Miocene Columbia River Basalt Group in the northern Willamette Valley (Beeson and others, 1989 #4047). The fault is part of the Portland Hills-Clackamas River structural zone of Beeson and others (1989 #4023), and the Portland Hills fault zone of Blakely and others (1995 #4021).

**Sense of movement** RD

Comments: The available sense-of-movement and dip-direction data are somewhat contradictory. The Bolton fault is mapped as a high-angle, east-dipping normal fault by Schlicker and Finlayson (1979 #4166) and Beeson and others (1989 #4047), but the fault is also modeled as a 70° east-dipping reverse fault in the earthquake hazards analysis of Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137). Geologic relations are inconsistent with the latter geometry. Blakely and others (1995 #4021) describe an exposure of the Bolton fault south of Lake Oswego where slickensides and stratigraphic relations indicate west-side-up (southwest-dipping) reverse faulting with a strike-slip component. Southwest-dipping reverse displacement with a right-lateral strike-slip component is consistent with the tectonic setting, mapped geologic relations, and microseismicity in the area (Beeson and others, 1989 #4047; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021).

**Dip** Not Reported

Comments: Schlicker and Finlayson (1979 #4166) and Beeson and others (1989 #4047) show the Bolton fault dipping moderately to steeply northeast. Dip direction data from Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) are contradictory: they modeled the Bolton fault as a 70° northeast-dipping reverse fault, but a northeasterly dip direction is inconsistent with geologic mapping relations of Beeson and others (1989 #4047).

**Main dip direction** SW

Comments: Dip direction from Blakely and others (1995 #4021).

**Geomorphic expression** The Bolton fault forms a prominent, 150-m-high northeast-facing escarpment in volcanic rocks of the Miocene Columbia River Basalt Group along the western margin of the Willamette Valley (Beeson and others, 1989 #4047). Unruh and others (1994 #3597) conducted aerial and field reconnaissance and found no unequivocal evidence of fault scarps on Quaternary deposits along the Bolton and related faults. Given the lack of documented geomorphic expression in Quaternary deposits, herein we classify the fault as Class B until further studies are conducted.

**Age of faulted deposits at the surface** The Bolton fault offsets Miocene Columbia River Basalt Group volcanic rocks (Schlicker and Finlayson, 1979 #4166; Beeson and others, 1989 #4047). No fault scarps on surficial Quaternary deposits have been described along the fault trace (Unruh and others, 1994 #3597). However, the mapping and cross sections of Beeson and others (1989 #4047) are somewhat contradictory: their map shows the Bolton and related faults as either juxtaposing late Quaternary sediments against Miocene bedrock or as concealed beneath these sediments, but their cross sections show most concealed faults on the map as cutting Quaternary sediments to the surface. This discrepancy reflects drafting errors in the construction of the cross sections (I.P. Madin, pers. commun., 2000).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) mapped the Bolton fault as active in the Quaternary (<1.6 Ma). Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) mapped parts of the fault as active in the middle and late Quaternary (<780 ka) and other parts as active in the Quaternary (<1.6-1.8 Ma). Unruh and others (1994 #3597) found no unequivocal evidence of Quaternary displacement, but concluded that the fault was potentially active, based on the presence of a prominent bedrock escarpment along the trace of the fault. Wong and others (1999 #4073; 2000 #5137) considered the Bolton fault as a potentially seismogenic structure. Given the lack of documented geomorphic expression in Quaternary deposits, herein we classify the fault as Class B until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Cross sections from Beeson and others [(1989 #4047) suggest about 200 m of down-to-the-east separation of Miocene Columbia River Basalt Group volcanic rocks across the Bolton and related faults (Unruh and others, 1994 #3597); such data indicate low rates of long-term slip. Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 0.005-0.05 mm/yr in their analyses of the earthquake hazards associated with the Bolton fault.

**Length** End to end (km): 8.8
Cumulative trace (km): 9.2

Comments:

**Average strike** (azimuth) N 53° W

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#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

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**875, Oatfield fault**

**Structure Number** 875

Comments: The fault is part of fault number 3 of Pezzopane (1993 #3544).

**Structure Name** Oatfield fault

Comments: The Oatfield fault was first mapped in part by Hammond and others (1974 #4050) and Schlicker and Finlayson (1979 #4166), and was mapped in detail and presumably named after nearby Oatfield Hill by Beeson and others (1989 #4047; 1991 #4048) and Madin (1990 #4067). The fault may be part of the Portland Hills-Clackamas River structural zone of Beeson and others (1985 #4022; 1989 #4023), and is included in the Portland Hills fault zone of Blakely and others (1995 #4021).

**Synopsis** The northwest-striking Oatfield fault forms northeast-facing escarpments on volcanic rocks of the Miocene Columbia River Basalt Group in the Tualatin Mountains and northern Willamette Valley. The fault may be part of the Portland Hills-Clackamas River structural zone. The Oatfield fault is primarily mapped as a very high-angle reverse fault with apparent down-to-the-southwest displacement, but a few kilometer long reach of the fault with down-to-the-northeast displacement is mapped in the vicinity of the Willamette River. This apparent change in displacement direction along strike may reflect a discontinuity in the fault trace or could reflect the right-lateral strike-slip displacement that characterizes other parts of the Portland Hills-Clackamas River structural zone. The fault has also been modeled as a 70° east-dipping reverse fault. Reverse displacement with a right-lateral strike-slip component is consistent with the tectonic setting, mapped geologic relations, and microseismicity in the area. No fault scarps on surficial deposits have been described, but exposures in a light-rail tunnel showing offset of ~1 Ma Boring Lava across the fault indicate Quaternary displacement.

**Date of compilation** May 24, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Multnomah, Washington, Clackamas

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:62,500-scale compilation of Wong and others (1999 #4073; 2000 #5137), which is based on 1:24,000-scale mapping of Beeson and others (1989 #4047; 1991 #4048) and Madin (1990 #4067).

**Geologic setting** The northwest-striking Oatfield fault in places forms linear magnetic anomalies and southwest-facing escarpments on volcanic rocks of the Miocene Columbia River Basalt Group in the Tualatin Mountains and northern Willamette Valley (Beeson and others, 1989 #4047; Madin, 1990 #4067; Beeson and others, 1991 #4048; Blakely and others, 1995 #4021; Burns and others, 1997 #4079; Blakely and others, 2000 #4333). The fault may be part of the Portland Hills-Clackamas River structural zone of Beeson and others (1989 #4023).

**Sense of movement** RD

Comments: Schlicker and Finlayson (1979 #4166) show the Oatfield fault as a down-southwest normal fault. More recently, the fault is mapped as a high-angle reverse fault with a down-to-the-southwest displacement direction (Beeson and others, 1989 #4047; Madin, 1990 #4067; Beeson and others, 1991 #4048) but these authors also show a few kilometer long reach of the fault with down-to-the-northeast displacement in the vicinity of the Willamette River. This apparent change in displacement direction along strike may reflect a discontinuity in the fault trace, or could reflect the right-lateral strike-slip displacement that characterizes other parts of the Portland Hills-Clackamas River structural zone of Beeson and others (1989 #4023). Blakely and others (1995 #4021) used microseismicity data from Yelin (1992 #4017)] to infer reverse and strike-slip displacement on the Oatfield fault, and also use aeromagnetic data to infer a northeast-dipping thrust geometry for the fault. Exposures of several strands of the Oatfield fault in a light-rail tunnel showed faults with both vertical dextral and east-dipping thrust orientations (R.E. Wells, pers. commun., 2000, Blakely and others, 1997 #3993). The Oatfield fault is modeled as a 70° east-dipping reverse fault in the earthquake hazards analysis of Wong and others (1999 #4073; 2000 #5137). Reverse displacement with a right-lateral strike-slip component is consistent with the tectonic setting, mapped geologic relations, and microseismicity in the area (Beeson and others, 1989 #4047; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333).

**Dip** Not Reported

Comments: Blakely and others (1995 #4021) use aeromagnetic data to infer an east-dipping thrust geometry for the fault. Exposures in a light-rail tunnel showed faults with both vertical and east-dipping thrust orientations (R.E. Wells, pers. commun., 2000, Blakely and others, 1997 #3993). Wong and others (1999 #4073; 2000 #5137) modeled the Oatfield fault as a 70° east-dipping reverse fault in their earthquake hazards analysis of the Portland metropolitan area. The linear fault trace mapped by Schlicker and Finlayson (1979 #4166), Beeson and others (1989 #4047; 1991 #4048), and Madin (1990 #4067), is more consistent with a steep dip.

**Main dip direction** NE

Comments: Dip direction from Beeson and others, (1989 #4047), Wong and others (1999 #4073; 2000 #5137) and Blakely and others (1995 #4021).

**Geomorphic expression** The Oatfield fault in places forms escarpments on Miocene Columbia River Basalt Group volcanic rocks, but no other geomorphic data have been described.

**Age of faulted deposits at the surface** The Oatfield fault offsets Miocene Columbia River Basalt Group volcanic rocks, (Schlicker and Finlayson, 1979 #4166; Beeson and others, 1989 #4047; Madin, 1990 #4067; Beeson and others, 1991 #4048). No fault scarps on surficial Quaternary deposits have been described along the fault trace. However, the mapping and cross sections of Beeson and others (1989 #4047) are somewhat contradictory: their map shows the Oatfield fault as concealed beneath undifferentiated Pliocene to Holocene sediments and late Pleistocene flood deposits, but their cross sections show the concealed fault cutting these sediments to the surface. This discrepancy reflects drafting errors in the construction of the cross sections (I.P. Madin, pers. commun., 2000). Exposures in a light-rail tunnel showed offset of ~1 Ma Boring Lava (R.E. Wells, pers. commun., 2000, Blakely and others, 1997 #3993). Popowski (1996 #4677) postulated that the Oatfield fault acted as a conduit for emplacement of the Boring Lava, and that the fault offsets Miocene to Pliocene or early Pleistocene sediments.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) mapped the southern part of the Oatfield fault as active in the Quaternary (<1.6 Ma); Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) do not appear to include this fault in their compilations of Quaternary faults. Unruh and others (1994 #3597) mapped part of the fault as Tertiary. Wong and others (1999 #4073; 2000 #5137) mapped the Oatfield fault as a potentially seismogenic fault. Given the limited evidence for Quaternary displacement, the Oatfield fault is mapped as Quaternary (<1.6 Ma) herein.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Cross sections from Beeson and others (1989 #4047) suggest about 150 m of down-to-the-east separation of Miocene Columbia River Basalt Group volcanic rocks across the Oatfield fault; such data indicate low rates of long-term slip. Exposures in a light-rail tunnel showed offset of at least 100 m of 1 Ma Boring Lava, which would yield a slip rate of 0.1 mm/yr (R.E. Wells, pers. commun., 2000, Blakely and others, 1997 #3993). Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 0.05-0.4 mm/yr in their analyses of the earthquake hazards associated with the Oatfield fault, but did not document the basis for these estimates; given the limited evidence of Quaternary displacement, the lower rates are herein considered more likely.

**Length** End to end (km): 28.7
Cumulative trace (km): 27.3

Comments:

**Average strike** (azimuth) N 41° W

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#4079 Burns, S., Lawrence, G., Brett, B., Yeats, R.S., and Popowski, T.A., 1997, Map showing faults, bedrock geology, and sediment thickness of the western half of the Oregon City 1:100,000 quadrangle, Washington, Multnomah, Clackamas, and Marion Counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-4, 1 sheet, scale 1:100,000.

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#4067 Madin, I.P., 1990, Earthquake-hazard geology maps of the Portland metropolitan area, Oregon—Text and map explanation: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-90-2, 21 p., 8 pls., scale 1:24,000.

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#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

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#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

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#4020 Yelin, T.S., and Patton, H.J., 1991, Seismotectonics of the Portland, Oregon, region: Bulletin of the Seismological Society of America, v. 81, no. 1, p. 109-130.

**876, East Bank fault**

**Structure Number** 876

Comments:

**Structure Name** East Bank fault

Comments: The East Bank fault was first mapped by Madin (1990 #4067) and Beeson and others (1991 #4048) and informally named after the east bank of the Willamette River by Blakely and others (1995 #4021). The fault may be part of the Portland Hills-Clackamas River structural zone of Beeson and others (1985 #4022; 1989 #4023), and is included in the Portland Hills fault zone of Blakely and others (1995 #4021).

**Synopsis** The northwest-striking East Bank fault lies in the Portland basin, which may be a right-lateral pull-apart basin in the forearc of the Cascadia subduction zone; the fault lies a few km east of and is parallel to the Portland Hills fault [877], which forms the southwestern margin of the basin. The East Bank fault has been mapped as a high-angle normal fault with a down-to-the-southwest displacement direction, but down-to-the-northeast reverse displacement with a right-lateral strike-slip component is consistent with tectonic setting, mapped geologic relations, aeromagnetic data, and microseismicity in the area. No fault scarps on surficial Quaternary deposits have been described along the fault trace, and the fault is mapped as buried by latest Pleistocene Missoula flood deposits, but recently acquired shallow seismic-reflection suggest probable down-to-the-northeast offset of unconformities, paleochannels, and sediments associated with flood deposits at several locations across the East Bank fault.

**Date of compilation** May 28, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Multnomah, Clackamas

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:24,000-scale subsurface mapping of Madin (1990 #4067) and Beeson and others (1991 #4048), supplemented with 1:62,500-scale compilation of Wong and others (1999 #4073; 2000 #5137) and ~1:575,000-scale figure 5 of Blakely and others (1995 #4021).

**Geologic setting** The northwest-striking East Bank fault lies in the Portland basin, which may be a right-lateral pull-apart basin in the forearc of the Cascadia subduction zone (Beeson and others, 1985 #4022; Beeson and others, 1989 #4023; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333), or a piggyback synclinal basin formed between antiformal uplifts of the Portland fold belt (Unruh and others, 1994 #3597; Unruh and others, 1994 #4007). The East Bank fault lies a few km east of and is parallel to the Portland Hills fault [877], which forms the southwestern margin of the Portland basin.

**Sense of movement** RD

Comments: The East Bank fault is mapped as a high-angle normal fault with a down-to-the-southwest displacement direction (Madin, 1990 #4067; Beeson and others, 1991 #4048). Blakely and others (1995 #4021) used aeromagnetic data to infer a northeast-dipping reverse geometry for the fault. However, shallow seismic reflection data indicate down-to-the-northeast displacements that are inconsistent with a northeast-dipping reverse fault (Pratt and others, 2001 #5136). The East Bank fault is modeled as a 70° northeast-dipping reverse to vertical fault in the earthquake hazards analysis of Wong and others (1999 #4073; 2000 #5137). Reverse displacement with a right-lateral strike-slip component is consistent with the tectonic setting, mapped geologic relations, and microseismicity in the area (Beeson and others, 1989 #4023; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333).

**Dip** Not Reported

Comments: Blakely and others (1995 #4021) use aeromagnetic data to infer a northeast-dipping reverse geometry for the fault, and Wong and others (1999 #4073; 2000 #5137) modeled the East Bank fault as a 70° northeast-dipping reverse to vertical fault in their earthquake hazards analysis of the Portland metropolitan area.

**Main dip direction** NE?

Comments: Dip direction from Blakely and others (1995 #4021) and Wong and others (1999 #4073; 2000 #5137); shallow seismic reflection data indicate down-to-the-northeast displacement (Pratt and others, 2001 #5136).

**Geomorphic expression** Little geomorphic evidence of this fault exists because the Portland basin was extensively scoured and buried by debris from the latest Pleistocene Missoula floods. Shallow seismic-reflection data suggest that the East Bank fault may lie south of the trace inferred by Madin (1990 #4067) and Beeson and others (1991 #4048), and may influence the location of a paleochannel of the Columbia River near its confluence with the Willamette River (Pratt and others, 2001 #5136). No other geomorphic evidence of this fault has been described.

**Age of faulted deposits at the surface** The East Bank fault offsets Miocene Columbia River Basalt Group volcanic rocks and Miocene to Pliocene sedimentary rocks of the Troutdale Formation (Madin, 1990 #4067; Beeson and others, 1991 #4048). No fault scarps on surficial Quaternary deposits have been described along the fault trace, and the fault is shown as buried by latest Pleistocene flood deposits (Madin, 1990 #4067; Beeson and others, 1991 #4048). However, recently acquired shallow seismic-reflection data across the East Bank fault at several locations suggests probable offset of unconformities, paleochannels, and sediments associated with the 15.3-12.7 ka Missoula floods (Pratt and others, 2001 #5136).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Madin (1990 #4067) and Beeson and others (1991 #4048) show the East Bank fault as buried by Missoula flood deposits, but recently acquired shallow seismic-reflection data suggest probable offset of unconformities, and paleochannels, and sediments formed during the 15.3-12.7 ka Missoula floods (Pratt and others, 2001 #5136). Wong and others (1999 #4073; 2000 #5137) mapped the East Bank fault as a highly probable seismogenic fault.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Cross sections from Beeson and others (1991 #4048) suggest 60-120 m of down-to-the-west vertical displacement of Miocene Columbia River Basalt Group volcanic rocks, and 60-90 m of vertical displacement of Miocene-Pliocene Troutdale Formation rocks across the East Bank fault; no estimates of strike-slip displacement have been published, but such vertical displacements indicate low rates of long-term slip. Pratt and others (2001 #5136) used shallow seismic-reflection data to infer 2-5 m of vertical offset in 15.3-12.7 ka Missoula flood related sediments across several fault strands of the East Bank fault. Wong and others (1999 #4073; 2000 #5137) used estimated slip rates of 0.05-0.4 mm/yr in their analyses of the earthquake hazards associated with the East Bank fault, but did not document the basis for these estimates. Given the lack of significant geomorphic expression along the fault, the lower rates are herein considered more likely.

**Length** End to end (km): 28.9
Cumulative trace (km): 29.0

Comments:

**Average strike** (azimuth) N 46° W

**References**


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#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

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**877, Portland Hills fault**

**Structure Number** 877

Comments: This structure is included in fault number 3 of Pezzopane (1993 #3544) and is fault number 20 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Portland Hills fault

Comments: The Portland Hills fault was not shown on early geologic maps of the region (Piper, 1942 #4064; Trimble, 1963 #4062; Hart and Newcomb, 1965 #4063), despite its prominent geomorphic expression along the linear northeast margin of the Tualatin Mountains, which are locally known as the Portland Hills. The fault was first shown on maps by Schlicker and others (1964 #4019) and Schlicker and Deacon (1967 #4068), who described this fault as a major structure of regional significance. The fault is also shown on maps of Schlicker and Finlayson (1979 #4166). Balsillie and Benson (1971 #4005) apparently were the first to use the name "Portland Hills fault" in print, in their discussion of this fault. The fault is part of the Portland Hills-Clackamas River structural zone of Beeson and others (1985 #4022; 1989 #4023), and is included in the Portland Hills fault zone of Blakely and others (1995 #4021).

**Synopsis** The northwest-striking Portland Hills fault forms the prominent linear northeastern margin of the Tualatin Mountains (Portland Hills) and the southwestern margin of the Portland basin; this basin may be a right-lateral pull-apart basin in the forearc of the Cascadia subduction zone or a piggyback synclinal basin formed between antiformal uplifts of the Portland fold belt. The fault is part of the Portland Hills-Clackamas River structural zone, which controlled the deposition of Miocene Columbia River Basalt Group lavas in the region. The crest of the Portland Hills is defined by the northwest-striking Portland Hills anticline. Sense of displacement on the Portland Hills fault is poorly known and controversial. The fault was originally mapped as a down-to-the-northeast normal fault. The fault has also been mapped as part of a regional-scale zone of right-lateral oblique slip faults, and as a steep escarpment caused by asymmetrical folding above a southwest-dipping blind thrust. Reverse displacement with a right-lateral strike-slip component may be most consistent with the tectonic setting, mapped geologic relations, aeromagnetic data, and microseismicity in the area. No fault scarps on surficial Quaternary deposits have been described along the fault trace, but some geomorphic (steep, linear escarpment, triangular facets, oversteepened and knickpointed tributaries) and geophysical (aeromagnetic, seismic reflection, and ground-penetrating radar) evidence suggest Quaternary displacement.

**Date of compilation** May 28, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Multnomah, Clackamas

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:24,000-scale mapping of Beeson and others (1989 #4047; 1991 #4048) and Madin (1990 #4067), supplemented with 1:62,500-scale compilation of Wong and others (1999 #4073; 2000 #5137).

**Geologic setting** The northwest-striking Portland Hills fault forms the northeastern margin of the Tualatin Mountains and the southwestern margin of the Portland basin; this basin may be a right-lateral pull-apart basin in the forearc of the Cascadia subduction zone (Beeson and others, 1985 #4022; Beeson and others, 1989 #4023; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333), or a piggyback synclinal basin formed between antiformal uplifts of the Portland fold belt (Unruh and others, 1994 #3597; Unruh and others, 1994 #4007). The fault is part of the Portland Hills-Clackamas River structural zone of Beeson and others (1985 #4022; 1989 #4023), which controlled the deposition of Miocene Columbia River Basalt Group lavas in the region. The crest of the Portland Hills is defined by the northwest-striking Portland Hills anticline.

**Sense of movement** RD?, T?

Comments: Sense of displacement on the Portland Hills fault is poorly known and controversial. The fault was originally mapped as a down-to-the-northeast normal fault, based on offset of Columbia River Basalt Group rocks and on the location of the November 1962 Portland earthquake (Schlicker and others, 1964 #4019; Balsillie and Benson, 1971 #4005), which was located several kilometers east of the fault in the Portland basin (Yelin and Patton, 1991 #4020). The fault was mapped as a steeply southwest-dipping, right-lateral fault by Schlicker and Finlayson (1979 #4166). The fault is also mapped as part of the Portland Hills-Clackamas River structural zone of Beeson and others (1985 #4022; 1989 #4023), a regional-scale zone of right-lateral strike-slip faults, and may define the western margin of a pull-apart basin as a right-oblique-slip fault (Beeson and others, 1985 #4022; Beeson and others, 1989 #4023; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333). Unruh and others (1994 #3597) attributed the steep escarpment along the Portland Hills to asymmetrical folding above a southwest-dipping blind thrust. The Portland Hills fault is also mapped as a near-vertical dip-slip fault with a down-to-the-northeast displacement direction (Beeson and others, 1989 #4047; Madin, 1990 #4067; Beeson and others, 1991 #4048). Blakely and others (1995 #4021; 2000 #4333) used aeromagnetic data to infer a steeply southwest-dipping reverse geometry for the fault. Shallow seismic reflection data suggest northeast-side-up displacement that could reflect strike-slip or northeast-side-up dip-slip displacement (Pratt and others, 2001 #5136). The Portland Hills fault is modeled as both a 70° northeast-dipping reverse or reverse-oblique fault by Geomatrix Consultants, Inc. (1995 #3593), and as a steeply southwest-dipping to vertical fault by Wong and others (1999 #4073; 2000 #5137). Reverse displacement with a right-lateral strike-slip component is consistent with the tectonic setting, mapped geologic relations, aeromagnetic data, and microseismicity in the area (Beeson and others, 1989 #4023; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333).

**Dip** Not Reported

Comments: Schlicker and Finlayson (1979 #4166) mapped the fault as a steeply southwest-dipping, right-lateral fault. Blakely and others (1995 #4021) use aeromagnetic data to infer a southwest-dipping reverse geometry for the fault, and Wong and others (1999 #4073; 2000 #5137) modeled the Portland Hills fault as a 70° southwest-dipping reverse to vertical fault in their earthquake hazards analysis of the Portland metropolitan area.

**Main dip direction** SW?

Comments: Dip direction from Schlicker and Finlayson (1979 #4166), Wong and others (1999 #4073; 2000 #5137) and Blakely and others (1995 #4021).

**Geomorphic expression** The Portland Hills fault may be responsible for the linear, 250-m-high escarpment on Miocene rocks of the Columbia River Basalt Group along the northeastern margin of the Portland Hills. No fault scarps on Quaternary surficial deposits have been described, but Balsillie and Benson (1971 #4005) described anomalous benches, triangular facets, wineglass (oversteepened) valleys, and knickpoints on tributary streams as evidence of recent movement. Unruh and others (1994 #3597) conducted limited aerial and field reconnaissance along the northeastern margin of the Portland Hills, and found no direct evidence of faulting in Quaternary deposits.

**Age of faulted deposits at the surface** The Portland Hills fault offsets Miocene Columbia River Basalt Group volcanic rocks and Miocene to Pliocene sedimentary rocks of the Troutdale Formation (Madin, 1990 #4067; Beeson and others, 1991 #4048). No fault scarps on surficial Quaternary deposits have been described along the fault trace, and the fault is mapped as buried by latest Pleistocene Missoula flood deposits (Madin, 1990 #4067; Beeson and others, 1991 #4048). Schlicker and Finlayson (1979 #4166) and Beeson and others (1989 #4047) show the fault cutting Quaternary alluvial or flood deposits in cross section, but these relationships are due to drafting errors (I.P. Madin, pers. commun., 2000). Unruh and others (1994 #3597) cite the folding of basin-fill sediments interbedded with Boring Lava on the west flank of the Portland Hills as evidence of Quaternary movement on their hypothesized thrust fault underlying the Portland Hills anticline; Boring Lava rocks are Pliocene and Pleistocene in age (Conrey and others, 1996 #4025; Fleck and others, 2002 #5149). Recently acquired shallow seismic-reflection and ground-penetrating radar data (Hemphill-Haley and others, 2000 #5138; 2001 #5056; Pratt and others, 2001 #5136) across the mapped trace of the Portland Hills fault south of Ross Island suggest possible deformation of unconformities and sediments associated with the latest Pleistocene Missoula floods.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Madin (1990 #4067) and Beeson and others (1991 #4048) show the Portland Hills fault as buried by Missoula flood deposits, but recently acquired shallow seismic-and ground-penetrating radar data (Hemphill-Haley and others, 2000 #5138; 2001 #5056; Pratt and others, 2001 #5136) suggest possible offset of the unconformities and sediments associated with the latest Pleistocene Missoula floods. Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) mapped the Portland Hills fault as active in the Quaternary (<1.6-1.8 Ma). Unruh and others (1994 #3597) concluded that the Portland Hills fault is potentially active, and Wong and others (1999 #4073; 2000 #5137) mapped the Portland Hills fault as a highly probable seismogenic fault. Given the equivocal evidence for faulting and poor geomorphic expression in Quaternary deposits, the Portland Hills fault is mapped as Quaternary herein until more definitive studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Cross sections from Beeson and others (1991 #4048) suggest 250-350 m of down-to-the-northeast vertical displacement of Miocene Columbia River Basalt Group volcanic rocks across the Portland Hills fault; no estimates of strike-slip displacement have been published, but such vertical displacement estimates indicate low rates of long-term slip. Pratt and others (2001 #5136) used shallow seismic-reflection data to infer as much as 10 m of down-to-the-southwest vertical offset of the unconformity underlying 15 ka Missoula flood related sediments across the fault, but this sense of displacement is opposite to the long-term slip direction. Unruh and others (1994 #3597) used fault-bend fold theory to estimate approximately 1,070 m of displacement of Columbia River Basalt Group rocks across their hypothesized thrust fault beneath the Portland Hills anticline; Geomatrix Consultants, Inc. (1995 #3593) used this data to calculate slip rates of 0.07-1.0 mm/yr for one of their models of deformation across the Portland Hills. Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) calculated preferred slip rates of 0.02-0.4 mm/yr in their analyses of the earthquake hazards associated with the Portland Hills fault, but did not document the basis for these estimates. Given the lack of significant geomorphic expression in Quaternary deposits along the fault, the lower rates are herein considered more likely.

| | | |
|---|---|---|
| **Length** | End to end (km): | 49.3 |
| | Cumulative trace (km): | 50.4 |

Comments:

**Average strike** (azimuth) N 37° W

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## 878, Grant Butte fault

**Structure Number** 878

Comments: This structure is part of fault number 24 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Grant Butte fault

Comments: The Grant Butte fault was not shown on early geologic maps of the region (Piper, 1942 #4064; Trimble, 1963 #4062; Swanson and others, 1993 #4032). The fault was first shown on maps of Madin (1990 #4067; 1994 #4046), and was named after nearby Grant Butte, which lies to the north of the fault trace (Geomatrix Consultants Inc., 1995 #3593).

**Synopsis** The northeast-striking Grant Butte fault forms the southern margin of the Portland basin; this basin may be a right-lateral pull-apart basin in the forearc of the Cascadia subduction zone or a piggyback synclinal basin formed between antiformal uplifts of the Portland fold belt. The fault is mapped on the basis of subsurface data that indicates down-to-the-north displacement of Plio-Pleistocene Springwater Formation and Boring Lava, and the trace of the fault is based on the presence of an embayed, 50- to 75-m-high escarpment on these rocks. K-Ar analyses on three samples of Boring Lava in this area yield ages of about 0.5, 1.3, and 1.6 Ma, and new Ar/Ar analyses in the Portland basin have yield much younger ages of 100-125 ka, so the fault has been active in the middle and late Quaternary. No fault scarps on Quaternary surficial deposits have been described, and the fault is everywhere shown as buried by latest Pleistocene Missoula flood deposits.

**Date of compilation** May 24, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Multnomah

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:24,000-scale mapping of Madin (1990 #4067; 1994 #4046).

**Geologic setting** The northeast-striking Grant Butte fault forms the southern margin of the Portland basin; this basin may be a right-lateral pull-apart basin in the forearc of the Cascadia subduction zone (Beeson and others, 1985 #4022; Beeson and others, 1989 #4023; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333), or a piggyback synclinal basin formed between antiformal uplifts of the Portland fold belt (Unruh and others, 1994 #3597; Unruh and others, 1994 #4007). The fault is mapped on the basis of subsurface data that indicates down-to-the-north displacement of Plio-Pleistocene Springwater Formation and Boring Lava (Madin, 1990 #4067; 1994 #4046). The fault forms two splays that wrap around Powell Butte at the west end of the fault.

**Sense of movement** N

Comments: Madin (1994 #4046) shows the Grant Butte fault as a very high angle normal fault.

**Dip** Not Reported

Comments:

**Main dip direction** NW

Comments: Dip direction from Madin (1994 #4046).

**Geomorphic expression** The trace of the Grant Butte fault is based on the presence of an embayed, 50- to 75-m-high escarpment on Plio-Pleistocene rocks of the Springwater Formation and Boring Lava. No fault scarps on Quaternary surficial deposits have been described, but the trace of the fault was aggressively scoured and buried by gravel from the Missoula floods (I.P. Madin, pers. commun., 2001).

**Age of faulted deposits at the surface** The fault is mapped on the basis of subsurface data that indicates down-to-the-north displacement of Plio-Pleistocene Springwater Formation and Boring Lava (Madin, 1990 #4067; 1994 #4046). K-Ar analyses on three samples of Boring Lava in this area yield ages of about 0.5, 1.3, and 1.6 Ma (Madin, 1994 #4046; Conrey and others, 1996 #4025). However, preliminary results of Ar/Ar dating of Boring Lava in the Portland basin yield much younger ages of 100-125 ka (Fleck and others, 2002 #5149), so these rocks may be younger than previously believed. No fault scarps on Quaternary surficial deposits have been described. The fault is everywhere shown as buried by latest Pleistocene Missoula flood deposits (Madin, 1990 #4067; 1994 #4046; Burns and others, 1997 #4079).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: If the Grant Butte fault displaces 0.5-1.6 Ma rocks of the Boring Lava (Madin, 1990 #4067; 1994 #4046; Conrey and others, 1996 #4025), then the fault has been active in the middle and late Quaternary. Pezzopane (1993 #3544) does not show this fault on his map of Quaternary faults; Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) mapped the fault as active in the middle and late Quaternary (<780 ka). Unruh and others (1994 #3597) concluded that the fault is potentially active, Wong and others (1999 #4073; 2000 #5137) mapped the fault as a probable seismogenic fault, and Madin and others (2001 #5051) infer late Quaternary offset. The fault is everywhere shown as buried by Missoula flood deposits (Madin, 1990 #4067; 1994 #4046), so the youngest event must predate the latest Pleistocene age of these deposits.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Unruh and others (1994 #3597) measured about 120 m of offset of Boring Lava from the mapping of Madin (1990 #4067). The cross section across the fault in the Damascus quadrangle (Madin, 1994 #4046) appears to indicate less displacement, and this measurement is probably a maximum, because the Boring Lava was deposited on a sloping surface (Geomatrix Consultants Inc., 1995 #3593). Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) calculated preferred slip rates of 0.01-0.1 mm/yr in their analyses of the earthquake hazards associated with the combined Grant Butte-Damascus Creek-Tickle Creek faults.

| | | |
|---|---|---|
| **Length** | End to end (km): | 9.9 |
| | Cumulative trace (km): | 16.6 |

Comments:

**Average strike** (azimuth) N 77° E

**References**


#4022 Beeson, M.H., Fecht, K.R., Reidel, S.P., and Tolan, T.L., 1985, Regional correlations within the Frenchman Springs member of the Columbia River Basalt Group—New insights into the middle Miocene tectonics of northwestern Oregon: Oregon Geology, v. 47, no. 8, p. 87-96.

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#4079 Burns, S., Lawrence, G., Brett, B., Yeats, R.S., and Popowski, T.A., 1997, Map showing faults, bedrock geology, and sediment thickness of the western half of the Oregon City 1:100,000 quadrangle, Washington, Multnomah, Clackamas, and Marion Counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-4, 1 sheet, scale 1:100,000.

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#5149 Fleck, R.J., Evarts, R.C., Hagstrum, J.T., and Valentine, M.J., 2002, The Boring volcanic field of Portland, Oregon area—Geochronology and neotectonic significance: Geological Society of America Abstracts with Programs, v. 34, no. 5, p. A-33—A-34.

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#4067 Madin, I.P., 1990, Earthquake-hazard geology maps of the Portland metropolitan area, Oregon—Text and map explanation: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-90-2, 21 p., 8 pls., scale 1:24,000.

#4046 Madin, I.P., 1994, Geologic map of the Damascus quadrangle, Clackamas and Multnomah Counties, Oregon: State of Oregon Geological Map Series GMS-60, 1 sheet, scale 1:24,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#5051 Madin, I.P., Wang, Z., and Graham, G.B., 2001, Finding Quaternary faults in the Willamette lowland—Are they dead or just hiding?: Seismological Research Letters, v. 72, no. 2, p. 254.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4064 Piper, A.M., 1942, Ground-water resources of the Willamette Valley, Oregon: U.S. Geological Survey Water-Supply Paper 890, 194 p., 2 pls., scale 1:125,000.

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#4062 Trimble, D.E., 1963, Geology of Portland, Oregon and adjacent areas: U.S. Geological Survey Bulletin 1119, 119 p., 1 pl., scale 1:62,500.

#4007 Unruh, J.R., Popowski, T., Wong, I.G., and Wilson, D.C., 1994, Implications of Late Neogene to Quaternary folds and thrusts for deformation of the Cascadia Fore-arc region, NW Oregon: Geological Society of America Abstracts with Programs, v. 26, no. 7, p. A-187.

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#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

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## 879, Damascus-Tickle Creek fault zone

**Structure Number** 879

Comments: These faults are part of fault number 24 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Damascus-Tickle Creek fault zone

Comments: The Damascus-Tickle Creek fault zone is not shown on early geologic maps of the region (Piper, 1942 #4064; Trimble, 1963 #4062; Swanson and others, 1993 #4032). Schlicker and Finlayson (1979 #4166) showed some of these faults as lineaments. Most of these faults are shown on maps of Madin (1990 #4067; 1994 #4046) and Lite (1992 #3947), and are named after the town of Damascus and fault exposures near Tickle Creek (Geomatrix Consultants Inc., 1995 #3593).

**Synopsis** The Damascus-Tickle Creek fault zone consists of numerous short northeast- and northwest-striking faults that form a broad, northeast-striking fault zone; these faults fold and offset rocks of the Pliocene Troutdale Formation, Plio-Pleistocene Springwater Formation, and Pleistocene Boring Lava. The area is on the southern margin of the Portland basin, and is the location of numerous eruptive vents of the Boring Lava, some of which may have been localized along faults in the zone. Most faults in the zone are buried by latest Pleistocene Missoula flood deposits, but at least one fault strand may have deformed these deposits. Most of these faults are thought to be near-vertical reverse faults with a significant component of right-lateral strike-slip.

**Date of compilation** May 24, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Multnomah, Clackamas

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault traces are from 1:24,000-scale mapping of Madin (1990 #4067; 1994 #4046).

**Geologic setting** The Damascus-Tickle Creek fault zone consists of numerous short northeast- and northwest-striking faults that form a broad, northeast-striking fault zone; these faults fold and offset rocks of the Pliocene Troutdale Formation, Plio-Pleistocene Springwater Formation, and Pleistocene Boring Lava (Madin, 1990 #4067; Lite, 1992 #3947; 1994 #4046). The area is on the southern margin of the Portland basin, and is the location of numerous eruptive vents of the Boring Lava. Some fault strands in the Damascus-Tickle Creek fault zone may have controlled the locations of eruptive vents (Madin, 1994 #4046).

**Sense of movement** DR

Comments: In cross section, Madin (1994 #4046) shows many of these faults as very high angle reverse faults; the fault patterns, changes in dip direction along strike, and one exposure of a fault plane with horizontal slickensides suggest strike-slip displacement on many of these faults (Lite, 1992 #3947; Madin, 1994 #4046). Lite (1992 #3947) described an exposure of one left-lateral northeast-striking fault in his northwest-striking Tickle Creek fault zone, and interpreted the zone as a right-lateral wrench fault system with right-lateral slip on northwest-striking faults and left-lateral slip on northeast-striking faults.

**Dip** 60°-90°

Comments: In cross section, Madin (1994 #4046) shows some of these faults as very high angle to vertical, and describes one fault exposure with a dip of 60°. Lite (1992 #3947) described an exposure of one left-lateral northeast-striking fault with a dip of 85° southeast. Wong and others (1999 #4073; 2000 #5137) model faults in this zone as vertical faults.

**Main dip direction** E, W

**Geomorphic expression** No fault scarps on Quaternary surficial deposits have been described, but much of this area was aggressively scoured and buried by gravel from the Missoula floods (I.P. Madin, pers. commun., 2001).

**Age of faulted deposits at the surface** These faults fold and offset rocks of the Pliocene Troutdale Formation, Pliocene-Pleistocene Springwater Formation, and Pleistocene Boring Lava (Madin, 1990 #4067; Lite, 1992 #3947; 1994 #4046). K-Ar analyses on three samples of Boring Lava in this area yield ages of about 0.5, 1.3, and 1.6 Ma (Madin, 1994 #4046; Conrey and others, 1996 #4025). However, preliminary results of Ar/Ar dating of Boring Lava in the Portland basin yield much younger ages of 100-125 ka (Fleck and others, 2002 #5149), so these rocks may be younger than previously believed. No fault scarps on Quaternary surficial deposits have been described; the faults are everywhere shown as buried by latest Pleistocene Missoula flood deposits (Madin, 1990 #4067; 1994 #4046). However, a trench excavated across a northwest-striking fault strand in the SE quarter of section 12, T. 2 S., R. 2 E., exposed possible deformation in catastrophic flood deposits.

**Paleoseismology studies** A fault trench [879-1] was excavated across a northwest-trending fault strand about 3.5 km southwest of Damascus by the Oregon Department of Geology and Mineral Industries, the Oregon Department of Transportation, and the University of Oregon in 1990. No logs or detailed descriptions of this excavation were published, but Madin (1994 #4046) briefly described the results of this study.

Site 879-1. The trench was excavated in latest Pleistocene silt deposited by catastrophic outburst floods from glacial Lake Missoula across a northwest-striking fault strand in the SE quarter of section 12, T. 2 S., R. 2 E. The exposure revealed no conclusive evidence of young faulting, but the flood deposits were tilted 2° to 3° to the northeast and cut by numerous liquefaction dikes (Madin, 1994 #4046).

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Fault strands in the Damascus-Tickle Creek fault zone displace 0.5-1.6 Ma rocks of the Boring Lava (Madin, 1990 #4067; Lite, 1992 #3947; 1994 #4046; Conrey and others, 1996 #4025), so the fault has been active in the middle and late Quaternary. Most faults in the zone are buried by latest Pleistocene Missoula flood deposits, but at least one fault strand may have deformed these deposits (Madin, 1994 #4046). Pezzopane (1993 #3544) does not show these faults on his map of Quaternary faults; Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) mapped the fault zone as active in the late Quaternary (<780 ka). Unruh and others (1994 #3597)] concluded that the fault zone is potentially active, and Wong and others (1999 #4073; 2000 #5137) mapped it as a probable seismogenic fault zone.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. A cross section across several fault strands in the Damascus quadrangle (Madin, 1994 #4046) show vertical offsets of about 30 m of the early to middle Pleistocene Boring Lava. No estimates of strike-slip displacement have been described, but Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) calculated preferred slip rates of 0.01-0.1 mm/yr in their analyses of the earthquake hazards associated with the combined Grant Butte-Damascus Creek-Tickle Creek fault zones.

| | | |
|---|---|---|
| **Length** | End to end (km): | 16.7 |
| | Cumulative trace (km): | 83.8 |

Comments:

**Average strike** (azimuth) N 00°

**References**

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#3947 Lite, K.E., Jr., 1992, Stratigraphy and structure of the southeast part of the Portland Basin, Oregon: Portland State University, unpublished M.S. thesis, 82 p., 2 pls.

#4067 Madin, I.P., 1990, Earthquake-hazard geology maps of the Portland metropolitan area, Oregon—Text and map explanation: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-90-2, 21 p., 8 pls., scale 1:24,000.

#4046 Madin, I.P., 1994, Geologic map of the Damascus quadrangle, Clackamas and Multnomah Counties, Oregon: State of Oregon Geological Map Series GMS-60, 1 sheet, scale 1:24,000.

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#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4064 Piper, A.M., 1942, Ground-water resources of the Willamette Valley, Oregon: U.S. Geological Survey Water-Supply Paper 890, 194 p., 2 pls., scale 1:125,000.

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#4032 Swanson, R.D., McFarland, W.D., Gonthier, J.B., and Wilkinson, J.M., 1993, A description of hydrogeologic units in the Portland Basin, Oregon and Washington: U.S. Geological Survey Water-Resources Investigations Report 90-4196, 56 p., 10 pls.

#4062 Trimble, D.E., 1963, Geology of Portland, Oregon and adjacent areas: U.S. Geological Survey Bulletin 1119, 119 p., 1 pl., scale 1:62,500.

#3597 Unruh, J.R., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Scoggins Dam, Tualatin Project, northwestern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 206 p., 4 pls., scale 1:500,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

## 880, Lacamas Lake fault

**Structure Number** 880

Comments: This structure is part of fault number 3 of Pezzopane (1993 #3544) and fault number 22 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Lacamas Lake fault

Comments: The Lacamas Lake fault was first mapped by Mundorff (1964 #4061) during groundwater investigations in Clark County Washington. The fault was informally named (and apparently misspelled) "Lackamas Creek lineament" and "Lackamas Creek fault" by Davis (1988 #3975); this usage was continued by Unruh and others (1994 #3597) and Geomatrix Consultants, Inc. (1995 #3593). The fault was renamed the "Lacamas Lake fault" after nearby Lacamas Lake by Blakely and others (1995 #4021); this name is spelled correctly and appears to be in current usage (Wong and others, 1999 #4073; Wong and others, 2000 #5137) so is retained herein. The fault is included in the Sandy River fault zone, as part of the Portland Hills-Clackamas River structural zone of Beeson and others (1985 #4022; 1989 #4023), and is also included in the postulated Frontal fault zone of Yelin and Patton (1991 #4020) by Pratt and others (2001 #5136).

**Synopsis** The northwest-striking Lacamas Lake fault forms part of the northeastern margin of the Portland basin; this basin may be a right-lateral pull-apart basin in the forearc of the Cascadia subduction zone or a piggyback synclinal basin formed between antiformal uplifts of the Portland fold belt. The fault is mapped on the basis of exposures of slickensides and shear zones of unknown orientation along Lacamas Creek, and is also based on subsurface well, gravity, and aeromagnetic data. The fault has been mapped as a normal fault with down-to-the-southwest displacement and has also been described as a steeply northeast or southwest-dipping oblique (right-lateral) slip fault. The trace of the Lacamas Lake fault is marked by the very linear lower reach of Lacamas Creek. No fault scarps on Quaternary surficial deposits have been described, but the Columbia River jogs northwestward and parallels the strike of the fault, suggesting that the river may have been influenced by the fault. The Lacamas Lake fault may offset 0.6 Ma rocks of the Boring Lava, but seismic-reflection data suggest that the most recent event predates the latest Pleistocene age of Missoula flood deposits in the area.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Washington; Oregon

**County** Clark (WA), Multnomah (OR)

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

**Quality of location** Good

Comments: The fault trace is from 1:250,000-scale mapping of Unruh and others (1994 #3597).

**Geologic setting** The northwest-striking Lacamas Lake fault forms part of the northeastern margin of the Portland basin; this basin may be a right-lateral pull-apart basin in the forearc of the Cascadia subduction zone (Beeson and others, 1985 #4022; Davis, 1988 #3975; Beeson and others, 1989 #4023; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333), or a piggyback synclinal basin formed between antiformal uplifts of the Portland fold belt (Unruh and others, 1994 #3597; Unruh and others, 1994 #4007). The fault is mapped on the basis of exposures of slickensides and shear zones of unknown orientation along Lacamas Creek, with a down-to-the-southwest displacement direction (Mundorff, 1964 #4061). The fault trace is also based on subsurface well, gravity, and aeromagnetic data (Mundorff, 1964 #4061; Davis, 1988 #3975; Blakely and others, 1995 #4021).

**Sense of movement** DN?, R?

Comments: Mundorff (1964 #4061) mapped the Lacamas Lake fault as a down-to-the-southwest normal fault. Beeson and others (1989 #4023) followed Davis (1988 #3975) and assumed dip slip and right-lateral strike-slip on faults in their Sandy River fault zone. A focal mechanism from a 1989 $M_c$ 3.7 earthquake located a few kilometers southwest of the mapped trace of the Lacamas Lake fault suggests right-lateral-strike slip on a steeply southwest dipping fault plane (Yelin and Patton, 1991 #4020). The very linear trace of the fault suggests the fault is very high angle, which is consistent with a component of strike-slip displacement. Pratt and others (2001 #5136) postulate that the fault dips northeast, based on compatibility with the modern northeast direction of maximum principle compressive stress in the region (Yelin and Patton, 1991 #4020; Werner and others, 1991 #4127).

**Dip** >75°

Comments: The linear trace of the fault suggests the fault is very high angle. If the 1989 earthquake occurred on the Lacamas Lake fault, then the fault must dip to the southwest at a steep (>75°) angle (Geomatrix Consultants Inc., 1995 #3593).

**Main dip direction** SW

**Geomorphic expression** The trace of the Lacamas Lake fault is based on the very linear lower reach of Lacamas Creek. However, no fault scarps on Quaternary surficial deposits have been described (Unruh and others, 1994 #3597; Geomatrix Consultants Inc., 1995 #3593), and the fault is shown as buried by Quaternary surficial deposits on geologic maps (Mundorff, 1964 #4061; Walsh and others, 1987 #3579). The Columbia River jogs northwestward and parallels the strike of the fault, suggesting that the river has been influenced by the fault (Blakely and others, 1995 #4021). An alternative, nontectonic explanation for the jog in the Columbia River is growth of the Sandy River delta from lahar deposition from the Old Maid Flat eruption of Mount Hood (I.P. Madin, pers. commun., 2001).

**Age of faulted deposits at the surface** On the basis of subsurface data, the Lacamas Lake fault offsets Pliocene Troutdale Formation and perhaps Plio-Pleistocene Boring Lava (Mundorff, 1964 #4061). K-Ar analyses on one nearby sample of Boring Lava yielded an age of about 0.6 Ma (Conrey and others, 1996 #4025). However, preliminary results of Ar/Ar dating of Boring Lava in the Portland basin yield much younger ages of 100-125 ka (Fleck and others, 2002 #5149), so these rocks may be younger than previously believed. No fault scarps on Quaternary surficial deposits have been described, and recent seismic reflection data across the probable trace of the fault under the Columbia River yielded no unequivocal evidence of displacement of the unconformity underlying latest Pleistocene Missoula flood deposits (Pratt and others, 2001 #5136).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: If the Lacamas Lake fault displaces 0.6 Ma rocks of the Boring Lava (Mundorff, 1964 #4061; Conrey and others, 1996 #4025), then the fault has been active in the middle and late Quaternary. Seismic-reflection data (Pratt and others, 2001 #5136) suggest that the most recent event predates the latest Pleistocene age of Missoula flood deposits in the area. Pezzopane (1993 #3544) and subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575) mapped the fault as active in the middle and late Quaternary (<700-780 ka). Unruh and others (1994 #3597) concluded that the fault is potentially active, and Wong and others (1999 #4073; 2000 #5137) mapped the fault as a possible seismogenic fault.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) calculated preferred slip rates of 0.05-0.2 mm/yr in their analyses of the earthquake hazards associated with the Lacamas Lake fault.

**Length** End to end (km): 23.7
Cumulative trace (km): 23.8

Comments:

**Average strike** (azimuth) N 43° W

**References**

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#4023 Beeson, M.H., Tolan, T.L., and Anderson, J.L., 1989, The Columbia River Basalt Group in western Oregon–Geologic structures and other factors that controlled flow emplacement patterns, *in* Reidel, S.P., and Hooper, P.R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 223-246.

#4333 Blakely, R.J., Wells, R.E., Tolan, T.L., Beeson, M.H., Trehu, A.M., and Liberty, L.M., 2000, New aeromagnetic data reveal large strike-slip (?) faults in the northern Willamette Valley, Oregon: Geological Society of America Bulletin, v. 112, p. 1225-1233.

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#4025 Conrey, R.M., Uto, K., Uchiumi, S., Beeson, M.H., Madin, I.P., Tolan, T.L., and Swanson, D.A., 1996, Potassium-Argon ages of boring lava, northwest Oregon and southwest Washington: ISOCHRON/WEST, v. 63, p. 3-9.

#3975 Davis, S.A., 1988, An analysis of the eastern margin of the Portland Basin using gravity surveys: Portland State University, unpublished Master's thesis, 135 p.

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#4061 Mundorff, M.J., 1964, Geology and ground-water conditions of Clark County Washington, with a description of a major alluvial aquifer along the Columbia River: U.S. Geological Survey Water-Supply Paper 1600, 268 p., 3 pls., scale 1:48,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5136 Pratt, T.L., Odum, J., Stephenson, W., Williams, R., Dadisman, S., Holmes, M., and Haug, B., 2001, Late Pleistocene and Holocene tectonics of the Portland Basin, Oregon and Washington, from high-resolution seismic profiling: Bulletin of the Seismological Society of America, v. 91, no. 4, p. 637-650.

#4007 Unruh, J.R., Popowski, T., Wong, I.G., and Wilson, D.C., 1994, Implications of Late Neogene to Quaternary folds and thrusts for deformation of the Cascadia Fore-arc region, NW Oregon: Geological Society of America Abstracts with Programs, v. 26, no. 7, p. A-187.

#3597 Unruh, J.R., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation, Scoggins Dam, Tualatin Project, northwestern Oregon: Final Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 206 p., 4 pls., scale 1:500,000.

#3579 Walsh, T.J., Korosec, M.A., Phillips, W.M., Logan, R.L., and Schasse, H.W., 1987, Geologic map of Washington-southwest quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-34, 28 p. pamphlet, 2 sheets, scale 1:250,000.

#4127 Werner, K.S., Graven, E.P., Berkman, T.A., and Parker, M.J., 1991, Direction of maximum horizontal compression in western Oregon determined by borehole breakouts: Tectonics, v. 10, no. 5, p. 948-958.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

#4020 Yelin, T.S., and Patton, H.J., 1991, Seismotectonics of the Portland, Oregon, region: Bulletin of the Seismological Society of America, v. 81, no. 1, p. 109-130.

## 881, Tillamook Bay fault zone

**Structure Number** 881

Comments:

**Structure Name** Tillamook Bay fault zone

Comments: The Tillamook Bay fault zone was mapped by Schlicker and others (1972 #4167) and Wells and others (1983 #3583; 1994 #3988). The fault was named the Tillamook Bay fault by Goldfinger and others (1992 #446) and mapped and named the Tillamook Bay fault zone by Wells and others (1994 #3988).

**Synopsis** The Tillamook Bay fault zone is a major northwest-striking fault that offsets the Eocene Tillamook Volcanics on the west flank of the Coast Range. The fault zone has about 4 km of down-southwest vertical separation and about 20 km of left-lateral strike slip displacement in Eocene Tillamook Volcanics. No displacements in Quaternary deposits have been documented, but the fault zone parallels the mountain front that controls the northeastern margin of Tillamook Bay and thus has geomorphic expression consistent with Quaternary displacement. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Tillamook

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Good

Comments: The fault trace is from 1:62,500-scale mapping of Wells and others (1994 #3988).

**Geologic setting** The Tillamook Bay fault zone is a major northwest-striking fault that offsets the Eocene Tillamook Volcanics on the west flank of the Coast Range uplift (Schlicker and others, 1972 #4167; Wells and others, 1994 #3988). The fault zone has about 4 km of down-southwest vertical separation and about 20 kilometers of left-lateral strike slip displacement in Eocene Tillamook Volcanics (Wells and others, 1994 #3988). The fault has been reported as the projection of strike-slip faults offshore (Goldfinger and others, 1992 #446), but later mapping shows this relationship to be unlikely (Goldfinger and others, 1992 #464; McNeill and others, 1998 #4089). McNeill and others (1998 #4089) infer from structures visible on a north-south seismic reflection profile located about 10 km offshore that Tillamook Bay is underlain by an active syncline, but dip patterns in the bedrock surrounding the bay (Wells and others, 1994 #3988) do not support this inference. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** RS

Comments: Geologic mapping and local slickenside exposures indicate oblique (reverse sinistral) displacement on the Tillamook Bay fault zone (Wells and others, 1994 #3988).

**Dip** Not Reported

Comments: No fault dip data are reported (Schlicker and others, 1972 #4167; Wells and others, 1983 #3583; Wells and others, 1994 #3988), but the linear trace and presumed reverse-oblique sense of slip suggest a steep dip.

**Main dip direction** NE

Comments: Presumed dip direction, assuming oblique (reverse-sinistral), down-southwest displacement on the Tillamook Bay fault zone (Wells and others, 1994 #3988).

**Geomorphic expression** The Tillamook Bay fault zone forms and controls the northeast margin of Tillamook Bay (Wells and Snavely, 1992 #4300; Wells and others, 1994 #3988), a large lowland along the northern Oregon coast. The fault parallels the mountain front between Garibaldi and the Wilson River, suggesting structural control.

**Age of faulted deposits at the surface** The Tillamook Bay fault zone offsets Miocene and older bedrock units in the vicinity of Tillamook Bay (Schlicker and others, 1972 #4167; Wells and others, 1983 #3583; Wells and others, 1994 #3988). The fault is mapped as buried in older Pleistocene fluvial terrace deposits and Holocene alluvium (Schlicker and others, 1972 #4167; Wells and others, 1983 #3583; Wells and others, 1994 #3988), but Quaternary deposits have not been examined in detail for evidence of offset (R.E. Wells, pers. commun., 2000).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Pezzopane (1993 #3544) Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) mapped the Tillamook Bay fault zone as active in the Quaternary (<1.6-1.8 Ma). Given the equivocal evidence for Quaternary displacement, the fault is mapped as Quaternary herein.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip rate data have been published. Given the limited evidence of Quaternary displacement, low rates of slip are likely.

| | | |
|---|---|---|
| **Length** | End to end (km): | 31.8 |
| | Cumulative trace (km): | 47.6 |

Comments:

**Average strike** (azimuth) N 56° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#446 Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B., MacKay, M.E., and Moore, G.F., 1992, Transverse structural trends along the Oregon convergent margin—Implications for Cascadia earthquake potential and crustal rotations: Geology, v. 20, p. 141-144.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4167 Schlicker, H.G., Deacon, R.J., Beaulieu, J.D., and Olcott, G.W., 1972, Environmental geology of the coastal region of Tillamook and Clatsop counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 74, 164 p., 18 pls., scale 1:62,500.

#3583 Wells, R.E., Niem, A.R., MacLeod, N.S., Snavely, P.D., Jr., and Niem, W.A., 1983, Preliminary geologic map of the west half of the Vancouver (Washington-Oregon) 1 x 2 quadrangle: U.S. Geological Survey Open-File Report 83-591, 1 sheet, scale 1:250,000.

#4300 Wells, R.E., and Snavely, P.D., Jr., 1992, Quaternary thrust faulting at Netarts Bay, northern Oregon coast: Geological Society of America Abstracts with Programs, v. 24, no. 5, p. 89.

#3988 Wells, R.E., Snavely, P.D., MacLeod, N.S., Kelly, M.M., and Parker, M.J., 1994, Geologic map of the Tillamook Highlands, northwest Oregon Coast Range: U.S. Geological Survey Open-File Report 94-21, 24 p., 2 pls., scale 1:62,500.

## 882, Happy Camp fault

**Structure Number** 882

Comments: This is fault number 12 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Happy Camp fault

Comments: The Happy Camp fault was mapped by Parker (1990 #3971) and Wells and others (1994 #3988). The fault was named after the nearby community of Happy Camp by Parker (1990 #3971). Geomatrix Consultants, Inc. (1995 #3593) used the name "Netarts Bay fault", but most later references use Happy Camp fault (McNeill and others, 1998 #4089; Wong and others, 1999 #4073), so that name is retained herein. The fault may be the onshore projection of the Nehalem Bank fault [789] (McNeill and others, 1998 #4089).

**Synopsis** The Happy Camp fault is an east-striking thrust fault that offsets the Miocene sedimentary rocks of the Astoria Formation on the west flank of the Coast Range uplift. The fault may project offshore as the Nehalem Bank fault. Locally, the fault thrusts Miocene Grande Ronde Basalt over poorly dated Quaternary deposits in sea cliffs near Happy Camp at the north end of Netarts Bay. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Tillamook

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Good

Comments: The fault trace is from 1:62,500-scale mapping of Wells and others (1994 #3988).

**Geologic setting** The Happy Camp fault is an east-striking thrust fault that offsets the Miocene sedimentary rocks of the Astoria Formation on the west flank of the Coast Range uplift (Wells and others, 1994 #3988). Locally, the fault offsets Miocene Grande Ronde Basalt in sea cliffs near Happy Camp at the north end of Netarts Bay (Parker, 1990 #3971; Wells and Snavely, 1992 #4300; Wells and others, 1994 #3988). McNeill and others (1998 #4089) show a parallel anticline and north-dipping thrust fault (Nehalem Bank fault) as offshore extensions of the Happy Camp fault. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** T

Comments: Geologic mapping of a sea cliff shows low angle, north-dipping thrust faulting along this structure (Parker, 1990 #3971; Wells and Snavely, 1992 #4300).

**Dip** 10°-18°

Comments: Parker (1990 #3971) measured a dip of 10° and R.E. Wells (pers. commun., 2000) measured a dip of 18° on the Happy Camp fault; no other fault dip data are published (Wells and Snavely, 1992 #4300; Wells and others, 1994 #3988).

**Main dip direction** N

**Geomorphic expression** The Happy Camp fault is exposed in surficial deposits in a sea cliff near Happy Camp (Parker, 1990 #3971; Wells and Snavely, 1992 #4300), but no other geomorphic expression of the fault has been described.

**Age of faulted deposits at the surface** The Happy Camp fault offsets Miocene bedrock in the vicinity of Happy Camp (Parker, 1990 #3971; Wells and Snavely, 1992 #4300; Wells and others, 1994 #3988). The ages of offset surficial deposits exposed in the Happy Camp sea cliff are poorly known. Mulder (1992 #3969) observed no deformation of the 80-ka marine terrace across this fault zone. Soil development on late(?) Pleistocene (Wells and Snavely, 1992 #4300) offset channel deposits suggests an age of >125 ka (H.M. Kelsey, pers. commun., in Geomatrix Consultants Inc., 1995 #3593). More recent unpublished work yield infinite (>50 ka) radiocarbon ages from the offset deposits, and a radiocarbon age of about 3.9 ka in a probable unfaulted deposit overlying the zone (R.E. Wells, pers. commun., 2000). The Happy Camp fault may be the onshore projection of the Nehalem Bank fault [789], which has been active in the Holocene (Niem and others, 1990 #4149; Goldfinger, 1994 #3972; McNeill and others, 1998 #4089).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Geomatrix Consultants, Inc. (1995 #3593) and Madin and Mabey (1996 #3575) mapped the Happy Camp fault as active in the Quaternary (<1.8 Ma). Pezzopane (1993 #3544) mapped the fault as active in the Holocene and McNeill and others (1998 #4089) mapped the fault as late Pleistocene-Holocene, but given the poor age control at the Happy Camp exposure, the fault is mapped as Quaternary herein until further studies are conducted.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: Parker (1990 #3971) measured about 1 m of offset of Columbia River Basalt Group rocks in a sea cliff exposure; no other detailed slip rate data have been published, but low rates of slip are likely.

**Length** End to end (km): 3.3
Cumulative trace (km): 3.4

Comments:

**Average strike** (azimuth) N 73° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3969 Mulder, R.A., 1992, Regional tectonic deformation of the northern Oregon coast as recorded by Pleistocene marine terraces: Portland, Oregon, Portland State University, unpublished Master's thesis, 96 p.

#4149 Niem, A.R., Snavely, P.D., Jr., and Niem, W., A., 1990, Onshore-offshore geologic cross section from the Mist Gas Field, Northern Oregon Coast Range, to the northwest Oregon continental shelf: State of Oregon, Department of Geology and Mineral Industries Oil and Gas Investigations 17, 46 p., 1 pl.

#3971 Parker, M.J., 1990, The Oligocene and Miocene geology of the Tillamook Embayment Tillamook County, northwest Oregon: Oregon State University, unpublished Master's thesis, 515 p.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4300 Wells, R.E., and Snavely, P.D., Jr., 1992, Quaternary thrust faulting at Netarts Bay, northern Oregon coast: Geological Society of America Abstracts with Programs, v. 24, no. 5, p. 89.

#3988 Wells, R.E., Snavely, P.D., MacLeod, N.S., Kelly, M.M., and Parker, M.J., 1994, Geologic map of the Tillamook Highlands, northwest Oregon Coast Range: U.S. Geological Survey Open-File Report 94-21, 24 p., 2 pls., scale 1:62,500.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

## 883, Siletz Bay faults

**Structure Number** 883

Comments:

**Structure Name** Siletz Bay faults

Comments: Two faults in the Siletz Bay area have been named the Fishing Rock and Fogarty Creek faults, presumably after nearby geographic features of the same name (Priest, 1994 #5139; Geomatrix Consultants Inc., 1995 #3593); the other faults remain unnamed (McNeill and others, 1998 #4089). Most of these faults are projected to unnamed offshore structures (McNeill and others, 1998 #4089).

**Synopsis** The Siletz Bay faults are a group of north-northwest-striking high-angle faults that apparently offset marine-terrace platforms and overlying deposits between Government Point and the mouth of the Siletz River. These faults are not shown on geologic maps of the area, and detailed terrace mapping in the area shows two unfaulted marine terraces dipping gently to the north. Some of the Siletz Bay faults are projected to offshore structures mapped in seismic-reflection profiles. The faults apparently offset marine-terrace wavecut platforms and overlying sediment dated by correlation to approximately 80 ka marine terraces elsewhere along the Oregon Coast. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lincoln

**1° x 2° sheet** Salem

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault traces are from 1:4,800-scale mapping of Priest (1994 #5139) and approximately 1:380,000-scale figure 8 of McNeill and others (1998 #4089).

**Geologic setting** The Siletz Bay faults are a group of north-northwest-striking high-angle faults that apparently offset the approximately 80 ka marine-terrace platform and overlying deposits, from Government Point northward to the mouth of the Siletz River (Goldfinger, 1994 #3972; McNeill and others, 1998 #4089). These faults are not shown on geologic maps of the area (Snavely and others, 1976 #3985; Walker and Duncan, 1989 #3581). Most of these faults are projected to offshore structures mapped in seismic-reflection profiles (Goldfinger, 1994 #3972; McNeill and others, 1998 #4089). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** N?, R?

Comments: Mapping of beach cliff exposures shows folding and high-angle faulting across these structures, but fault attitudes are poorly known; some faults are shown with normal displacement, and some are flexural-slip faults (Goldfinger, 1994 #3972; McNeill and others, 1998 #4089).

**Dip** Not Reported

Comments:

**Main dip direction** NNE, SSW

**Geomorphic expression** The Siletz Bay faults are mapped on the basis of apparent offset marine-terrace wavecut platforms and overlying sediments (Goldfinger, 1994 #3972; Priest, 1994 #5139; McNeill and others, 1998 #4089), but no other geomorphic expression of these faults has been described. Kelsey and others (1996 #4111) mapped the marine terraces in this area in detail, and do not show faults but rather show marine terraces dipping gently to the north in the area between Government Point and the Siletz River.

**Age of faulted deposits at the surface** The Siletz Bay faults offset marine-terrace wavecut platforms and overlying sediments; these deposits are dated by correlation to the approximately 80 ka Whisky Run terrace (West and McCrumb, 1988 #4112; Kelsey, 1990 #4107) by McNeill and others (1998 #4089). Detailed mapping in the area (Kelsey and others, 1996 #4111) shows two terraces present: the approximately 80 ka Newport terrace and the approximately 125 ka Yachats terrace. Kelsey and others (1996 #4111) do not show faults in the area between Government Point and the Siletz River, but rather show marine terraces dipping gently to the north.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: If the faulted marine terrace platforms and sediments described by Goldfinger (1994 #3972) and McNeill and others (1998 #4089) are correlative with the approximately 80 ka marine highstand, then these faults have displacements in the late Quaternary. Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) do not show these structures in their Quaternary fault compilations, and Kelsey and others (1996 #4111) do not show these faults in their detailed mapping of marine terrace deposits in this area.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: McNeill and others (1998 #4089) measured a maximum offset of 30 m across their postulated fault at the mouth of the Siletz River, yielding a vertical slip rate of 0.4 mm/yr. Priest (1994 #5139) measured vertical offsets across marine-terrace deposits of 4.6 and 5.5 m, respectively, on the Fishing Rock and Fogarty Creek faults. The terrace deposits in the vicinity of these faults are correlated with the approximately 80 ka marine highstand by Kelsey and others (1996 #4111). Given the equivocal nature of the deformation at the mouth of the Siletz River, low slip rates are assumed.

| | | |
|---|---|---|
| **Length** | End to end (km): | 11.6 |
| | Cumulative trace (km): | 10.0 |

Comments:

**Average strike** (azimuth) N 73° W

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#4107 Kelsey, H.M., 1990, Late Quaternary deformation of marine terraces on the Cascadia subduction zone near Cape Blanco, Oregon: Tectonics, v. 9, no. 5, p. 983-1014.

#4111 Kelsey, H.M., Ticknor, R.L., Bockheim, J.G., and Mitchell, C.E., 1996, Quaternary upper plate deformation in coastal Oregon: Geological Society of America Bulletin, v. 108, no. 7, p. 843-860.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5139 Priest, G.R., 1994, Chronic geologic hazard map of the Fogarty Creek-Lincoln Beach area, coastal Lincoln County, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-94-18, 1 pl., scale 1:4,800.

#3985 Snavely, P.D., Jr., MacLeod, N.S., Wagner, H.C., and Rau, W.W., 1976, Geologic map of the Cape Foulweather and Euchre Mountain quadrangles, Lincoln County, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-868, 1 sheet, scale 1:62,500.

#3581 Walker, G.W., and Duncan, R.A., 1989, Geologic map of the Salem 1 by 2 quadrangle, western Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1893, 1 sheet, scale 1:250,000.

#4112 West, D.O., and McCrumb, D.R., 1988, Coastline uplift in Oregon and Washington and the nature of Cascadia subduction-zone tectonics: Geology, v. 16, p. 169-172.

## 884, Cape Foulweather fault

**Structure Number** 884

Comments:

**Structure Name** Cape Foulweather fault

Comments: The Cape Foulweather fault was originally mapped by Schlicker and others (1973 #3983) and Snavely and others (1976 #3985), and was named by Kelsey and others (1996 #4111).

**Synopsis** The Cape Foulweather fault is a down-to-the-north, northeast-striking fault that offsets marine-terrace platforms at Whale Cove, and inland, offsets Miocene through Eocene volcanic and sedimentary rocks in the Oregon Coast Range. Vertical offsets of about 20 m of the approximately 80 ka Newport marine terrace and about 80 m of the approximately 125 ka Yachats marine terrace across the projected trace of the Cape Foulweather fault indicate repeated displacements in the late Quaternary. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lincoln

**1° x 2° sheet** Salem

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Good

Comments: The fault trace is from 1:62,500-scale mapping of Snavely and others (1976 #3985).

**Geologic setting** The Cape Foulweather fault is a down-to-the-north, northeast-striking fault that offsets marine-terrace platforms at Whale Cove. Inland, the fault offsets Miocene through Eocene volcanic and sedimentary rocks in the Oregon Coast Range (Schlicker and others, 1973 #3983; Snavely and others, 1976 #3985). This fault cannot be projected to offshore structures mapped in seismic-reflection profiles (Kelsey and others, 1996 #4111; McNeill and others, 1998 #4089). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** R?, S?

Comments: The Cape Foulweather fault offsets marine-terrace platforms down to the north at Whale Cove (Kelsey and others, 1996 #4111). Kelsey and others (1996 #4111) assign this displacement to a fault mapped in bedrock in this location by Schlicker and others (1973 #3983) and Snavely and others (1976 #3985). However, the fault mapped by Schlicker and others (1973 #3983) and Snavely and others (1976 #3985) is shown with a down-south displacement direction. Faults with similar attitudes are shown as normal faults on the cross section of Schlicker and others (1973 #3983), and as reverse faults on the cross section of Snavely and others (1976 #3985). Kelsey and others (1996 #4111) concluded that most active faults along the Oregon coast are oblique-slip faults, with left lateral and either extensional or contractional dip slip. Given the north-south orientation of maximum horizontal compression in northwestern Oregon (Werner and others, 1991 #4127), a reverse sense of slip may be most reasonable for the dip-slip component.

**Dip** 60°

Comments: Schlicker and others (1973 #3983) and Snavely and others (1976 #3985) report a 60° south dip on the fault they map at Whale Cove. This dip direction is opposite the down-to-the-north direction apparent in offset marine terrace platforms (Kelsey and others, 1996 #4111).

**Main dip direction** S?, N?

**Geomorphic expression** The Cape Foulweather fault is mapped on the basis of offset marine-terrace wavecut platforms (Kelsey and others, 1996 #4111), but no other geomorphic expression of this fault has been described.

**Age of faulted deposits at the surface** The Cape Foulweather fault offsets the approximately80 ka Newport and the approximately 125 ka Yachats marine terraces at Whale Cove (Kelsey and others, 1996 #4111).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) do not show these structures in their Quaternary fault compilations. If the faulted marine terrace platforms described by Kelsey and others (1996 #4111) are correlative with approximately 80 ka and approximately 125 ka marine highstands, then this fault has displacement in the late Quaternary.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably 0.2-1.0 mm/yr

Comments: No slip rates have been determined, but Kelsey and others (1996 #4111) measured offsets of about 20 m of the approximately 80 ka Newport marine terrace and about 80 m of the approximately 125 ka Yachats marine terrace across the projected trace of the Cape Foulweather fault.

| | | |
|---|---|---|
| **Length** | End to end (km): | 10.4 |
| | Cumulative trace (km): | 10.8 |

Comments:

**Average strike** (azimuth) N 69° E

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#4111 Kelsey, H.M., Ticknor, R.L., Bockheim, J.G., and Mitchell, C.E., 1996, Quaternary upper plate deformation in coastal Oregon: Geological Society of America Bulletin, v. 108, no. 7, p. 843-860.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3983 Schlicker, H.G., Deacon, R.J., Olcott, G.W., and Beaulieu, J.D., 1973, Environmental geology of Lincoln County, Oregon: State of Oregon, Department of Geology and Mineral Industries, Bulletin 81, 171 p., 6 pls.

#3985 Snavely, P.D., Jr., MacLeod, N.S., Wagner, H.C., and Rau, W.W., 1976, Geologic map of the Cape Foulweather and Euchre Mountain quadrangles, Lincoln County, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-868, 1 sheet, scale 1:62,500.

#4127 Werner, K.S., Graven, E.P., Berkman, T.A., and Parker, M.J., 1991, Direction of maximum horizontal compression in western Oregon determined by borehole breakouts: Tectonics, v. 10, no. 5, p. 948-958.

## 885, Yaquina faults

**Structure Number** 885

Comments: Some of these faults are included in fault number 13 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Yaquina faults

Comments: Faults between Yaquina Head and Yaquina Bay were first named by Ticknor (1993 #4156); from north to south, these include the Yaquina Head, Nye Beach, and Yaquina Bay faults. These faults have subsequently been described by Kelsey and others (1996 #4111) and McNeill and others (1998 #4089). The Yaquina Head and Yaquina Bay faults, collectively called the Yaquina faults herein, were originally mapped by Schlicker and others (1973 #3983) and Snavely and others (1976 #3984).

**Synopsis** The Yaquina faults are three down-to-the-south, east-striking faults that offset marine-terrace sediments and wave-cut platforms between Yaquina Head and Yaquina Bay. Inland, the Yaquina Head and Yaquina Bay faults offset Miocene through Eocene sedimentary rocks in the Oregon Coast Range. None of these faults appear to project to offshore structures mapped in seismic-reflection profiles. Sense of slip is unknown, but these faults are probably oblique-slip faults, with left lateral and either extensional or contractional dip slip. The Nye Beach and Yaquina Head faults offset the approximately 80 ka Newport marine terrace about 1.7 and 1.5 m, respectively. The Yaquina Bay fault offsets the approximately 80 ka Newport, the approximately 105 ka Waconda, and the approximately 125 ka Yachats marine terraces. The Yachats terrace is offset about 75 m, which yields a slip rate of 0.6 mm/yr across the Yaquina Bay fault. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lincoln

**1° x 2° sheet** Salem

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Good

Comments: The fault trace is from 1:62,500-scale mapping of Snavely and others (1976 #3984), supplemented with approximately 1:190,000-scale figure 3 of Kelsey and others (1996 #4111).

**Geologic setting** The Yaquina faults are three down-to-the-south, east-striking faults that offset marine-terrace sediments and wave-cut platforms between Yaquina Head and Yaquina Bay (Ticknor, 1993 #4156; Kelsey and others, 1996 #4111). Inland, the Yaquina Head and Yaquina Bay faults offset Miocene through Eocene sedimentary rocks in the Oregon Coast Range (Schlicker and others, 1973 #3983; Snavely and others, 1976 #3984). None of these faults appear to project to offshore structures mapped in seismic-reflection profiles (Kelsey and others, 1996 #4111; McNeill and others, 1998 #4089). Goldfinger and others (1992 #464), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) also show a short east-striking fault a few kilometers south of Yaquina Bay in their compilations of active faults. No documentation of this structure has been described, and detailed mapping of marine terraces in this bay (Ticknor, 1993 #4156; Kelsey and others, 1996 #4111) apparently revealed no evidence of a fault, so this fault trace is not included herein. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** R?, S?

Comments: The Yaquina faults vertically offset marine-terrace sediments and wave-cut platforms between Yaquina Head and Yaquina Bay (Ticknor, 1993 #4156; Kelsey and others, 1996 #4111). Faults with similar attitudes are shown as reverse faults on the cross section of Schlicker and others (1973 #3983), and as normal faults on the cross section of Snavely and others (Snavely and others, 1976 #3984). Kelsey and others (1996 #4111) concluded that most active faults along the Oregon coast are oblique-slip faults, with left lateral and either extensional or contractional dip slip. Geomatrix Consultants, Inc. (1995 #3593) modeled the Yaquina Bay fault as a 60° south-dipping reverse fault, but such an attitude is inconsistent with geologic mapping relations of Ticknor (1993 #4156) and Kelsey and others (1996 #4111). Wong and others (1999 #4073; 2000 #5137) modeled the Yaquina Bay fault as a 60° north-dipping reverse fault. Given the north-south orientation of maximum horizontal compression in northwestern Oregon (Werner and others, 1991 #4127), a reverse sense of slip may be most reasonable for the dip-slip component.

**Dip** Not Reported

Comments: Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) used an estimated dip of 60° in their analyses of earthquake hazards associated with the Yaquina Bay fault.

**Main dip direction** N?

**Geomorphic expression** The Yaquina faults are mapped on the basis of offset marine-terrace sediments and wavecut platforms (Ticknor, 1993 #4156; Kelsey and others, 1996 #4111), but no other geomorphic expression of these faults has been described.

**Age of faulted deposits at the surface** The Yaquina Head and Nye Beach faults offset the approximately 80 ka Newport marine terrace; the Yaquina Bay fault offsets the approximately 80 ka Newport, the approximately 105 ka Waconda, and the approximately 125 ka Yachats marine terraces (Ticknor, 1993 #4156; Kelsey and others, 1996 #4111).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: Pezzopane (1993 #3544) and Goldfinger and others (1992 #464) show the Yaquina Bay fault as active in the Holocene or Holocene-late Pleistocene, but do not discuss the evidence for this age assignment. Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) show this structure as active in the middle and late Quaternary (<780 ka). If the faulted marine terrace platforms described by Ticknor (1993 #4156) and Kelsey and others (1996 #4111) are correlative with approximately 80 ka, approximately 105 ka, and approximately 125 ka marine highstands, then these faults have displacements in the late Quaternary.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments: Ticknor (1993 #4156) and Kelsey and others (1996 #4111) calculated a slip rate of 0.6 ± 0.06 mm/yr, based on measured offsets of about 75 m of the approximately 125 ka Yachats marine terrace across the projected trace of the Yaquina Bay fault. Measured offsets of 1.7 m and 1.5 m of the approximately 80 ka Newport marine terrace across the Nye Beach and Yaquina Head faults, respectively, yield much lower rates of slip (Ticknor, 1993 #4156; Kelsey and others, 1996 #4111). Wong and others (1999 #4073; 2000 #5137) used slip rates of 0.1-0.6 mm/yr in their analyses of the earthquake hazards associated with the Yaquina Bay fault.

**Length** End to end (km): 12.7
Cumulative trace (km): 18.5

Comments:

**Average strike** (azimuth) N 79° E

**References**


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4111 Kelsey, H.M., Ticknor, R.L., Bockheim, J.G., and Mitchell, C.E., 1996, Quaternary upper plate deformation in coastal Oregon: Geological Society of America Bulletin, v. 108, no. 7, p. 843-860.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3983 Schlicker, H.G., Deacon, R.J., Olcott, G.W., and Beaulieu, J.D., 1973, Environmental geology of Lincoln County, Oregon: State of Oregon, Department of Geology and Mineral Industries, Bulletin 81, 171 p., 6 pls.

#3984 Snavely, P.D., Jr., MacLeod, N.S., Wagner, H.C., and Rau, W.W., 1976, Geologic map of the Yaquina and Toledo quadrangles, Lincoln County, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-867, 1 sheet, scale 1:62,500.

#4156 Ticknor, R., 1993, Late Quaternary crustal deformation on the central Oregon coast as deduced from uplifted wave-cut platforms: Western Washington University, unpublished Master's thesis, 70 p.

#4127 Werner, K.S., Graven, E.P., Berkman, T.A., and Parker, M.J., 1991, Direction of maximum horizontal compression in western Oregon determined by borehole breakouts: Tectonics, v. 10, no. 5, p. 948-958.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

**886, Waldport faults**

**Structure Number** 886

Comments:

**Structure Name** Waldport faults

Comments: Faults in the vicinity of Waldport were mapped and named by Ticknor (1993 #4156); from west to east, these include the Waldport, Reynolds Creek, and Lint Slough faults. These faults have subsequently been described by Kelsey and others (1996 #4111) and McNeill and others (1998 #4089). The Waldport faults are not included on geologic maps of the area (Schlicker and others, 1973 #3983; Snavely and others, 1976 #4305; Walker and Duncan, 1989 #3581; Walker and MacLeod, 1991 #3646).

**Synopsis** The Waldport faults are three north-northeast-striking faults that offset marine-terrace sediments and wave-cut platforms in the vicinity of Alsea Bay along the central Oregon coast. The Waldport and Lint Slough faults are down-to-the-east; the very short (approximately 1-km-long) Reynolds Creek fault is down-to-the-west, but this fault may be an antithetic graben fault to the more prominent Waldport fault. None of these faults appear to project to offshore structures mapped in seismic-reflection profiles, but the greatest cumulative offset along these faults is coincident with Alsea Bay, suggesting that faulting has localized the location of the bay. Sense of slip is unknown, but these faults are probably oblique-slip faults, with left lateral and either extensional or contractional dip slip. The Waldport, Lint Slough, and Reynolds Creek faults offset the approximately 125 ka Yachats marine terrace 15-20 m, 8-15 m, and 7 m, respectively; these data yield vertical slip rates of <0.2 mm/yr in the late Quaternary. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lincoln

**1° x 2° sheet** Salem

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace is from the approximately 1:190,000-scale figure 3 of Kelsey and others (1996 #4111).

**Geologic setting** The Waldport faults are three north-northeast-striking faults that offset marine-terrace sediments and wave-cut platforms in the vicinity of Alsea Bay along the central Oregon coast (Ticknor, 1993 #4156; Kelsey and others, 1996 #4111). The Waldport and Lint Slough faults are down-to-the-east; the very short approximately 1-km-long) Reynolds Creek fault is down-to-the-west, but this fault may be an antithetic graben fault to the more prominent Waldport fault. None of these faults appear to project to offshore structures mapped in seismic-reflection profiles (Kelsey and others, 1996 #4111; McNeill and others, 1998 #4089). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** N?, R?, S?

Comments: The Waldport faults vertically offset marine-terrace sediments and wave-cut platforms in the vicinity of Alsea Bay (Ticknor, 1993 #4156; Kelsey and others, 1996 #4111). Faults with similar attitudes are shown as vertical or high-angle reverse faults on the cross sections of Schlicker and others (1973 #3983), and Snavely and others (1976 #4305). Kelsey and others (1996 #4111) concluded that most active faults along the Oregon coast are oblique-slip faults, with left lateral and either extensional or contractional dip slip. Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073; 2000 #5137) modeled the Waldport and Lint Slough faults as 60° east dipping normal faults.

**Dip** Not Reported

Comments: Geomatrix Consultants, Inc. (1995 #3593) and Wong and others (1999 #4073) used an estimated dip of 60° in their analyses of earthquake hazards associated with the Waldport faults.

**Main dip direction** E?

**Geomorphic expression** The Waldport faults are mapped on the basis of offset marine-terrace sediments and wavecut platforms (Ticknor, 1993 #4156; Kelsey and others, 1996 #4111). The greatest cumulative offset along these faults is coincident with Alsea Bay, suggesting that faulting has localized the location of the bay (Kelsey and others, 1996 #4111; McNeill and others, 1998 #4089). No other geomorphic expression of these faults has been described.

**Age of faulted deposits at the surface** The Waldport faults offset the approximately 125 ka Yachats and the >200 ka Crestview marine terraces (Ticknor, 1993 #4156; Kelsey and others, 1996 #4111).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: If the faulted marine terrace platforms described by Ticknor (1993 #4156) and Kelsey and others (1996 #4111) are correlative with the approximately 125 ka and >200 ka marine highstands, then these faults have displacements in the late Quaternary. Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) show these structures as active in the middle and late Quaternary (<780 ka). Pezzopane (1993 #3544) and Goldfinger and others (1992 #464) do not show the Waldport faults in their fault compilations.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: Kelsey and others (1996 #4111) calculated vertical slip rates of 0.1—0.15 mm/yr and 0.07-0.1 mm/yr across the Waldport and Lint Slough faults, respectively; these estimates are based on measured offsets of 15-20 m and 8-15 m of the approximately 125 ka Yachats marine terrace across these faults. Vertical offset of about 7 m of the approximately 125 ka Yachats marine terrace indicate even lower slip rates on the Reynolds Creek fault. Wong and others (1999 #4073; 2000 #5137) used slip rates of 0.05-0.1 mm/yr in their modeling of the earthquake hazards associated with the Waldport faults.

| | | |
|---|---|---|
| **Length** | End to end (km): | 14.5 |
| | Cumulative trace (km): | 18.9 |

Comments:

**Average strike** (azimuth) N 13° E

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4111 Kelsey, H.M., Ticknor, R.L., Bockheim, J.G., and Mitchell, C.E., 1996, Quaternary upper plate deformation in coastal Oregon: Geological Society of America Bulletin, v. 108, no. 7, p. 843-860.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3983 Schlicker, H.G., Deacon, R.J., Olcott, G.W., and Beaulieu, J.D., 1973, Environmental geology of Lincoln County, Oregon: State of Oregon, Department of Geology and Mineral Industries, Bulletin 81, 171 p., 6 pls.

#4305 Snavely, P.D., Jr., MacLeod, N.S., Wagner, H.C., and Rau, W.W., 1976, Geologic map of the Waldport and Tidewater quadrangles, Lincoln, Lane, and Benton counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-866, 1 sheet, scale 1:62,500.

#4156 Ticknor, R., 1993, Late Quaternary crustal deformation on the central Oregon coast as deduced from uplifted wave-cut platforms: Western Washington University, unpublished Master's thesis, 70 p.

#3581 Walker, G.W., and Duncan, R.A., 1989, Geologic map of the Salem 1 by 2 quadrangle, western Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1893, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

## 887, Unnamed Siuslaw River anticline

**Structure Number** 887

Comments:

**Structure Name** Unnamed Siuslaw River anticline

Comments: This unnamed anticline on the Siuslaw River was first mapped in Eocene bedrock by Baldwin (1956 #4164); the fold is included in some geologic compilations (Walker and Duncan, 1989 #3581; Walker and MacLeod, 1991 #3646), but not others (Schlicker and Deacon, 1974 #4155).

**Synopsis** The unnamed anticline on the Siuslaw River is a north-striking, southward plunging fold that deforms sedimentary rocks of the Eocene Tyee Formation in the forearc of the Cascadia subduction zone. The fold is parallel to numerous folds imaged in the offshore accretionary wedge, and thus may be formed by compression related to ongoing subduction of the Juan de Fuca plate. The Quaternary extent of the anticline is based on deformation of a flight of fluvial terraces that lie 70-120 m above the present channel of the Siuslaw River downstream from Mapleton. The deformed terraces are restricted to the north side of the river, which indicates southward migration of the Siuslaw River channel during the Quaternary; this relationship is consistent with the southward plunging fold geometry. No radiometric ages have been obtained on the terrace sediments, but possible correlations to marine terraces near the coast suggest that most of the deformed terraces were formed >200 ka. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fold are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lane

**1° x 2° sheet** Salem, Roseburg

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The axial trace is modified by the compiler from the approximately 1:675,000-scale figure 1 from Nelson (1992 #4277) and 1:62,500-scale mapping of Baldwin (1956 #4164) and Schlicker and Deacon (1974 #4155).

**Geologic setting** The unnamed anticline on the Siuslaw River is a north-striking, southward plunging fold that deforms sedimentary rocks of the Eocene Tyee Formation in the forearc of the Cascadia subduction zone. The fold is parallel to numerous folds imaged in the offshore accretionary wedge (Goldfinger and others, 1992 #464), and thus may be formed by compression related to ongoing subduction of the Juan de Fuca plate. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fold are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** Anticline

Comments:

**Dip** 6° to 14°

Comments: The opposing fold limbs dip 6° to 14° to the east and west (Baldwin, 1956 #4164; Schlicker and Deacon, 1974 #4155).

**Main dip direction** E and W

Comments: South plunging

**Geomorphic expression** The Quaternary extent of the unnamed Siuslaw River anticline is based on deformation of a flight of fluvial terraces mapped on the north side of the Siuslaw River downstream from Mapleton. Baldwin (1956 #4164) first mapped these terraces, but Schlicker and Deacon (p. 25, 1974 #4155) were the first to recognize that these terrace remnants have a much steeper gradient than the modern river and thus were probably folded or uplifted. Adams (1984 #4120) used the mapping of Schlicker and Deacon (1974 #4155) to profile the western limb of the fold, and attributed the anomalously steep profile to regional seaward tilting of the Coast Range. Personius (1993 #4165) mapped these terraces in more detail, recognized the existence of several sets of deformed terrace surfaces at heights of 70-120 m above the present channel, and demonstrated the eastward folding of terrace remnants on the eastern limb of the anticline. Personius (1993 #4165) also noted the restriction of older terraces to the north side of the river, which indicates southward migration of the Siuslaw River channel during the Quaternary; this relationship is consistent with the southward plunging fold geometry mapped by Baldwin (1956 #4164).

**Age of folded deposits at the surface** No radiometric ages have been obtained on the fluvial sediments underlying the deformed Siuslaw River terraces. Young terraces dated to the early Holocene are apparently undeformed, and although undated, the deformed terraces may project to marine terraces at the coast that are probably older than 200 ka (Personius, 1993 #4165). Nelson and Personius (1996 #4128) found no evidence of Holocene or latest Pleistocene deformation along the unnamed Siuslaw River anticline.

**Paleoseismology studies** None

**Time of most recent prehistoric folding** middle and late Quaternary (<750 ka)

Comments: If the deformed fluvial terraces correlate with oxygen isotope stage 7 (>200 ka) marine terrace platforms (Personius, 1993 #4165), then this fold has been active in the middle and late Quaternary. Restriction of older terraces to the north side of the river may indicate southward migration of the Siuslaw River channel throughout the Quaternary (Personius, 1993 #4165). The unnamed Siuslaw River anticline is not shown on any regional compilation of Quaternary structures (Goldfinger and others, 1992 #464; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments: No deformation rates of the unnamed Siuslaw River anticline have been published. However, Personius (1995 #4130) calculated bedrock incision rates of about 0.2 mm/yr and Kelsey and others (1996 #4111) calculated long-term coastal uplift rates of about 0.1 mm/yr in the vicinity of the Siuslaw River; The uplift rate of the unnamed Siuslaw River anticline must exceed these background or regional rates, and thus is probably >0.2 mm/yr.

| | | |
|---|---|---|
| **Length** | End to end (km): | 11.6 |
| | Cumulative trace (km): | 21.0 |

Comments:

**Average strike** (azimuth) N 10° W

**References**

#4120 Adams, J., 1984, Active deformation of the Pacific northwest continental margin: Tectonics, v. 3, no. 4, p. 449-472.

#4164 Baldwin, E.M., 1956, Geologic map of the lower Siuslaw River Area, Oregon: U.S. Geological Survey Oil and Gas Investigations Map OM-186, 1 sheet, scale 1:62,500.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4111 Kelsey, H.M., Ticknor, R.L., Bockheim, J.G., and Mitchell, C.E., 1996, Quaternary upper plate deformation in coastal Oregon: Geological Society of America Bulletin, v. 108, no. 7, p. 843-860.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4277 Nelson, A.R., 1992, Holocene tidal-marsh stratigraphy in south-central Oregon—Evidence for localized sudden submergence in the Cascadia subduction zone, *in* Fletcher, C.H., III, and Wehmiller, J.F., eds., Quaternary coasts of the United States—Marine and lacustrine systems: SEPM Special Publication No. 48, p. 287-301.

#4128 Nelson, A.R., and Personius, S.F., 1996, Great-earthquake potential in Oregon and Washington—An overview of recent coastal geologic studies and their bearing on segmentation of Holocene ruptures, central Cascadia subduction zone, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 91-114.

#4165 Personius, S.F., 1993, Age and origin of fluvial terraces in the Central Coast Range, western Oregon: U.S. Geological Survey Bulletin 2038, 56 p., 4 pls.

#4130 Personius, S.F., 1995, Late Quaternary stream incision and uplift in the forearc of the Cascadia subduction zone, western Oregon: Journal of Geophysical Research, v. 100, no. B10, p. 20,193-20,210.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4155 Schlicker, H.G., and Deacon, R.J., 1974, Environmental geology of Coastal Lane County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 85, 116 p., 3 pls.

#3581 Walker, G.W., and Duncan, R.A., 1989, Geologic map of the Salem 1 by 2 quadrangle, western Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1893, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

**888, Sunset Bay-Cape Arago folds and faults**

**Structure Number** 888

Comments:

**Structure Name** Sunset Bay-Cape Arago folds and faults

Comments: The faults and folds in the vicinity of Sunset Bay, Shore Acres, and Cape Arago were mapped by Baldwin (1966 #4122), Ehlen (1967 #4123), Newton (1980 #4144), McInelly and Kelsey (1990 #4102), and Madin and others (1995 #4158). A prominent fault (not shown on map) and an anticline at Cape Arago were named the Cape Arago fault and Cape Arago anticline by Ehlen (1967 #4123).

**Synopsis** Faults in the vicinity of Sunset Bay and Shore Acres are a group of steeply dipping, east-striking faults that offset Eocene bedrock, marine terrace sediments, and wave-cut platforms along the central Oregon coast. At least one of these faults is mapped as a right-lateral strike-slip fault. North-striking folds and associated high angle faults (not shown on map) deform Eocene bedrock and wave-cut platforms at Cape Arago. These fault and fold trends are consistent with the east-west orientation of compressive stress in this part of the forearc of the Cascadia subduction. The Sunset Bay-Cape Arago folds and faults appear to deform the approximately 80 ka Whisky Run and/or approximately 105 ka Pioneer marine terrace sediments and platforms, and thus have been active in the late Quaternary. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these structures are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Coos

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault traces are from the approximately 1:430,000-scale figure 4 of Ehlen (1967 #4123) and from the approximately 1:115,000-scale figure 2 of McInelly and Kelsey (1990 #4102). Some faults are mapped at 1:24,000-scale by Madin and others (1995 #4158).

**Geologic setting** Faults in the vicinity of Sunset Bay and Shore Acres are a group of steeply dipping, east-striking faults that offset Miocene bedrock, marine terrace sediments, and wave-cut platforms along the central Oregon coast; at least one of these faults is mapped as a right-lateral strike-slip fault (Ehlen, 1967 #4123; McInelly and Kelsey, 1990 #4102). North-striking folds and associated high angle faults (not shown on map) deform Miocene bedrock and wave-cut platforms at Cape Arago (Ehlen, 1967 #4123; McInelly and Kelsey, 1990 #4102). These fault and fold trends are consistent with the east-west orientation of compressive stress in this part of the forearc of the Cascadia subduction zone (McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these structures are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** D, N?, R?

Comments: At least one of the east-striking Sunset Bay-Shore Acres faults is mapped as a steeply dipping, oblique slip, right-lateral/normal(?) fault (Ehlen, 1967 #4123; McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158). The north-striking faults at Cape Arago are mapped as normal faults (Ehlen, 1967 #4123), but their orientation suggests that they may be bedding plane (flexural-slip) faults in the west limb of the Cape Arago anticline (Baldwin, 1966 #4122; McInelly and Kelsey, 1990 #4102).

**Dip** Not Reported

Comments:

**Main dip direction** Vertical, E, W

Comments: Vertical dip on Sunset Bay-Shore Acres faults and E and W limbs on the anticline.

**Geomorphic expression** The Sunset Bay-Cape Arago faults and folds are mapped on the basis of offset and warped marine-terrace sediments and wavecut platforms (Ehlen, 1967 #4123; McInelly and Kelsey, 1990 #4102). The location and shape of Sunset Bay and coves near Shore Acres may be related to differential erosion along these and other faults (Ehlen, 1967 #4123). The faults are not marked by definitive scarps on marine terrace sediments east of Sunset Bay (Madin and others, 1995 #4158); this relationship may be caused by rapid decrease in displacement along strike east of Sunset Bay (Madin and others, 1995 #4158), or may reflect predominantly strike-slip faulting and lack of vertical displacement. No other geomorphic expression of these faults has been described.

**Age of faulted and folded deposits at the surface** There is some conflict in the interpreted age of offset deposits: Ehlen (1967 #4123) and Newton (1980 #4144) infer offset of marine-terrace platforms along some of the Sunset Bay--Shore Acres faults, Beaulieu and Hughes (1975 #4141) and Armentrout (1980 #4098) inferred late Quaternary displacement based on changes in height of the Whisky Run marine platform along Sunset Bay, and McInelly and Kelsey (1990 #4102) map these faults as offsetting offset the approximately 80 ka Whisky Run marine terrace and in some cases the approximately 105 ka Pioneer marine terrace. However, Madin and others (1995 #4158) map faults near Sunset Bay as pre-late Quaternary, and do not show them offsetting marine-terrace sediments. The Cape Arago anticline warps the Whisky Run marine platform at Cape Arago (McInelly and Kelsey, 1990 #4102).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting and folding** late Quaternary (<130 ka)

Comments: If the faulted and warped marine terrace sediments and platforms mapped by McInelly and Kelsey (1990 #4102) are correlative with 80 ka and 105 ka marine highstands, then these faults and folds have displacements in the late Quaternary. Pezzopane (1993 #3544) and Goldfinger and others (1992 #464) show faults and folds near Sunset Bay, Shore Acres, and Cape Arago as active in the Holocene or latest Pleistocene (<20 ka); Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) do not include these faults and folds in their compilations of Quaternary faults in Oregon.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments: No slip rate data on Quaternary faults have been published, but McInelly and Kelsey (1990 #4102) calculated an uplift rate of approximately 0.6-0.8 mm/yr for the 80 ka Whisky Run marine-terrace platform along the mapped axis of the Cape Arago anticline. The short mapped length and horizontal (105 m) and vertical (few tens of meters) offsets in Eocene bedrock (Madin and others, 1995 #4158) indicate low long-term rates of slip on the east trending faults at Sunset Bay and Shore Acres.

| | | |
|---|---|---|
| **Length** | End to end (km): | 4.2 |
| | Cumulative trace (km): | 9.5 |

Comments:

**Average strike** (azimuth) N 52° W

**References**

#4098 Armentrout, J.M., 1980, Cenozoic stratigraphy of Coos Bay and Cape Blanco, southwestern Oregon, Field trip No. 9, *in* Oles, K.F., Johnson, G., Niem, A.R., and Niem, W.A., eds., Geologic field trips in western Oregon and southwestern Washington: State of Oregon, Department of Geology and Mineral Industries Bulletin101, p. 175-216.

#4122 Baldwin, E.M., 1966, Some revisions of the geology of the Coos Bay Area, Oregon: The ORE BIN, v. 28, no. 11, p. 189-203.

#4141 Beaulieu, J.D., 1975, Environmental geology of western Coos and Douglas Counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 87, 148 p., 16 pls., scale 1:62,500.

#4123 Ehlen, J., 1967, Geology of state parks near Cape Arago, Coos County, Oregon: The ORE BIN, v. 29, no. 4, p. 61-83.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4158 Madin, I.P., McInelly, G.W., and Kelsey, H.M., 1995, Geologic map of the Charleston quadrangle, Coos County, Oregon: State of Oregon Geological Map Series GMS-94, scale 1:24,000.

#4102 McInelly, G.W., and Kelsey, H.M., 1990, Late Quaternary tectonic deformation in the Cape Arago-Bandon region of coastal Oregon as deduced from wave-cut platforms: Journal of Geophysical Research, v. 95, no. B5, p. 6699-6713.

#4144 Newton, V.C., Jr., 1980, Prospects for oil and gas in the Coos Basin, western Coos, Douglas, and Lane Counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Oil and Gas Investigation 6, 74 p., 3 pls.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

**889, East South Slough faults**

**Structure Number** 889

Comments:

**Structure Name** East South Slough faults

Comments: North-northwest-striking faults on the east side of South Slough were mapped by Duncan (1953 #4121)], Madin and others (1995 #4158) and Black and Madin (1995 #4157). Madin and others (1995 #4158) named the northern fault the Joe Nye fault, apparently after nearby Joe Nye Slough.

**Synopsis** The north-northwest-striking faults on the east side of South Slough are a group of steeply dipping, north-down reverse(?) faults that offset Eocene bedrock and marine terrace sediments in the central Oregon Coast Range. Given their orientation, these may be tear faults with significant oblique (strike-slip) component; this sense of slip would be consistent with the east-west orientation of compressive stress in this part of the forearc of the Cascadia subduction zone. These faults offset the ≥200 ka Metcalf marine terrace, and thus have displacements in the middle and late Quaternary. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Coos

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Good

Comments: The fault traces are from 1:24,000-scale mapping of Madin and others (1995 #4158) and Black and Madin (1995 #4157).

**Geologic setting** The north-northwest-striking faults on the east side of South Slough are a group of steeply dipping faults that offset Eocene bedrock and marine terrace sediments. Given their orientation, these may be tear faults (Black and Madin, 1995 #4157) with significant oblique (strike-slip) component. This sense of slip would be consistent with the east-west orientation of compressive stress in this part of the forearc of the Cascadia subduction zone (McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** R?, S?

Comments: The north-northwest-striking faults on the east side of South Slough offset Eocene bedrock and marine terrace sediments. They are mapped as steeply dipping, down-to-the-north reverse(?) faults (Black and Madin, 1995 #4157; Madin and others, 1995 #4158), but the east-west orientation of compressive stress in this part of the forearc of the Cascadia subduction zone (McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158) suggests that these may be tear faults (Black and Madin, 1995 #4157) with significant oblique (strike-slip) component. Map patterns suggest some left-lateral displacement.

**Dip** Not Reported

Comments:

**Main dip direction** S

**Geomorphic expression** These faults are mapped on the basis of offset bedrock and marine-terrace sediments (Black and Madin, 1995 #4157; Madin and others, 1995 #4158). Black and Madin (1995 #4157) describe uplifted Pleistocene estuarine deposits along the north bank of Davis Slough that may be deformed along the southern unnamed fault in this group.

**Age of faulted deposits at the surface** The north-northwest-striking faults on the east side of South Slough offset Eocene bedrock and the Metcalf marine terrace (Madin and others, 1995 #4158); this marine-terrace platform is thought to correlate with a ≥200 ka sea level highstand (Kelsey and others, 1996 #4111). Black and Madin (1995 #4157) describe possibly deformed estuarine deposits along the north bank of Davis Slough that may be middle or late Pleistocene in age.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: If the faulted marine terrace sediments described by Madin and others (1995 #4158) are correlative with a ≥200 ka marine highstand, then these faults have displacements in the middle and late Quaternary. Madin and others (1995 #4158) map these faults as active in the late Quaternary, but do not define this age designation. These faults are not shown on recent compilations of Quaternary faults in Oregon (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No Quaternary slip data have been published, but vertical offsets of a few hundred meters in Eocene bedrock (Madin and others, 1995 #4158) indicate that slip rates are probably low.

**Length** End to end (km): 7.8
Cumulative trace (km): 14.1

Comments:

**Average strike** (azimuth) N 70° W

**References**

#4157 Black, G.L., and Madin, I.P., 1995, Geologic map of the Coos Bay quadrangle, Coos County, Oregon: State of Oregon Geological Map Series GMS-97, 1 sheet, scale 1:24,000.

#4121 Duncan, D.C., 1953, Geology and coal deposits in part of the Coos Bay Coal Field, Oregon: U.S. Geological Survey Bulletin 982-B, 73 p., 1 pl.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#4111 Kelsey, H.M., Ticknor, R.L., Bockheim, J.G., and Mitchell, C.E., 1996, Quaternary upper plate deformation in coastal Oregon: Geological Society of America Bulletin, v. 108, no. 7, p. 843-860.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4158 Madin, I.P., McInelly, G.W., and Kelsey, H.M., 1995, Geologic map of the Charleston quadrangle, Coos County, Oregon: State of Oregon Geological Map Series GMS-94, scale 1:24,000.

#4102 McInelly, G.W., and Kelsey, H.M., 1990, Late Quaternary tectonic deformation in the Cape Arago-Bandon region of coastal Oregon as deduced from wave-cut platforms: Journal of Geophysical Research, v. 95, no. B5, p. 6699-6713.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

## 890, South Slough thrust and reverse faults

**Structure Number** 890

Comments: Some of these faults are included in fault number 39 of Pezzopane (1993 #3544) and fault number 15 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** South Slough thrust and reverse faults

Comments: Numerous north-striking thrust and reverse faults have been mapped and named in the vicinity of the South Slough syncline [891]. Named faults include the Barview or Barview-Empire, Bastendorff, Charleston, Coos Head, Crown Point, Hayward Creek, Miner Creek, Westside, Winchester, and Yoakum Point faults (McInelly and Kelsey, 1990 #4102; Black and Madin, 1995 #4157; Madin and others, 1995 #4158).

**Synopsis** Numerous north-striking thrust and reverse faults associated with the South Slough syncline [891] were formed during ongoing east-west compression in the forearc of the Cascadia subduction zone [781]. The faults and associated folds are an onshore extension of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore [784]. Many of these faults are parallel to bedding attitudes in the west limb of the South Slough syncline and thus are bedding plane (flexural-slip) faults; these structures may not be seismogenic, but rather move in tandem with coseismic deformation related to folding. Other north-striking reverse and thrust faults have strikes and dips that are somewhat discordant with bedding attitudes in the axis and east limb of the South Slough; the structural relationship between these latter faults and folding in the syncline is unknown. Most of these faults offset middle and late Quaternary marine terrace deposits and platforms, and at least one appears to have been active in the Holocene. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these structures are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Coos

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Good

Comments: The fault traces are from 1:24,000-scale mapping of Madin and others (1995 #4158) and Black and Madin (1995 #4157).

**Geologic setting** The numerous north-striking thrust and reverse faults included in this group of faults were formed during ongoing east-west compression in the forearc of the Cascadia subduction zone in the central Oregon Coast Range (McInelly and Kelsey, 1990 #4102; Black and Madin, 1995 #4157; Madin and others, 1995 #4158). The faults and associated folds are an onshore extension of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore [784] (Goldfinger and others, 1992 #464; Nelson and Personius, 1996 #4128; McNeill and others, 1998 #4089). Many of the reverse faults, such as the Bastendorff, Coos Head, Hayward Creek, Miner Creek, and Yoakum Point faults, are parallel to bedding attitudes in the west limb of the South Slough syncline (Baldwin, 1966 #4122; Adams, 1984 #4120; McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158). These bedding plane (flexural-slip) faults may not be seismogenic, but rather move in tandem with coseismic deformation related to folding (Yeats and others, 1981 #4132; Yeats, 1986 #4159). Other north-striking reverse and thrust faults, such as the Barview, Charleston, Crown Point, Westside, and Winchester faults, have strikes and dips that are somewhat discordant with bedding attitudes in the axis and east limb of the South Slough syncline (McInelly and Kelsey, 1990 #4102; Black and Madin, 1995 #4157; Madin and others, 1995 #4158). The structural relationship between these latter faults and folding in the syncline is unknown. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these structures are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** R, T

Comments: These faults are mapped as north-striking reverse and thrust faults (McInelly and Kelsey, 1990 #4102; Black and Madin, 1995 #4157; Madin and others, 1995 #4158). Many of the reverse faults are parallel to bedding attitudes and thus are bedding plane (flexural-slip) faults. Other north-striking reverse and thrust faults have strikes and dips that are somewhat discordant with bedding attitudes of the South Slough syncline; the structural relationship between these latter faults and folding in the syncline is unknown.

**Dip** 20°-75°

Comments: Dip measurements from McInelly and Kelsey (1990 #4102) and Madin and others (1995 #4158).

**Main dip direction** E, W

**Geomorphic expression** The numerous north-striking thrust and reverse faults included in this group of faults warp, offset, and form fault scarps on marine terraces, wave-cut platforms, and estuarine deposits in the vicinity of South Slough (Baldwin, 1966 #4122; McInelly and Kelsey, 1990 #4102; Black and Madin, 1995 #4157; Madin and others, 1995 #4158).

**Age of faulted deposits at the surface** Most of these faults offset the Whisky Run, Pioneer, Seven Devils, and/or Metcalf marine terraces; these terraces have assigned ages of about 80, 105, 125, and ≥200 ka, respectively (McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158; Kelsey and others, 1996 #4111).

**Paleoseismology studies** Madin and others (1995 #4158) excavated trenches across the southern end of the Winchester fault near Cox Canyon. The trench logs have not been published, so the following description is from Madin and others (1995 #4158) and I.P. Madin (pers. commun., 2000).

Cox Canyon site [890-1]. Three trenches were excavated across an 8-m-high scarp on a marine-terrace platform south of Cox Canyon in 1993. The trenches exposed at least two major thrust faults dipping 17°-20° west that thrust Eocene bedrock over folded, faulted, and overturned marine sediments of the >200 ka Metcalf marine terrace. At least two colluvial deposits were offset, indicating three or more surface-faulting events since deposition of the marine-terrace sediments. Carbon from both colluvial deposits yielded infinite radiocarbon ages (>47,800 yr B.P. and >52,800 yr B.P.). Carbon from a 1-m-thick post-faulting colluvial and soil deposit overlying the fault yielded a radiocarbon age of about 9,590 yr B.P., indicating the latest event is pre-Holocene in age.

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: If the faulted marine terrace sediments and platforms mapped by McInelly and Kelsey (McInelly and Kelsey, 1990 #4102) and Madin and others (1995 #4158) are correlative with 80, 105, 125, and ≥200 ka marine highstands, then most of these faults have displacements in the late Quaternary. Drowned tree stumps in the footwall of the Barview fault yielded late Holocene radiocarbon ages (McInelly and Kelsey, 1990 #4102), so at least one of these faults may have been active in the Holocene. Pezzopane (1993 #3544), Goldfinger and others (1992 #464), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) show faults in the vicinity of South Slough as active in the Holocene or latest Pleistocene (<20 ka).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: A few reverse and thrust faults in the vicinity of South Slough have published slip data in marine-terrace deposits. Bedding-plane faults such as the Yoakum Point, Miner Creek, and Bastendorff Beach faults offset the 80 ka Whisky Run terrace 4-5 m, the 125 ka Seven Devils terrace as much as 12 m, and the ≥200 ka Metcalf terrace 6-25 m (Baldwin, 1966 #4122; McInelly and Kelsey, 1990 #4102). The Charleston fault offsets the 105 ka Pioneer terrace 19 m, and may offset the 80 ka Whisky Run terrace a similar amount (McInelly and Kelsey, 1990 #4102). Madin and others (1995 #4158) measured a vertical offset of 50 m of the ≥200 ka Metcalf terrace across the Winchester fault, and calculated an actual offset of 146 m, based on projection of the fault in the subsurface; these data yield a maximum slip rate of 0.73 mm/yr (Madin and others, 1995 #4158), for perhaps the highest-slip fault in this group.

**Length** End to end (km): 13.3
Cumulative trace (km): 62.0

Comments:

**Average strike** (azimuth) N 08° E

**References**


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#4157 Black, G.L., and Madin, I.P., 1995, Geologic map of the Coos Bay quadrangle, Coos County, Oregon: State of Oregon Geological Map Series GMS-97, 1 sheet, scale 1:24,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

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#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4158 Madin, I.P., McInelly, G.W., and Kelsey, H.M., 1995, Geologic map of the Charleston quadrangle, Coos County, Oregon: State of Oregon Geological Map Series GMS-94, scale 1:24,000.

#4102 McInelly, G.W., and Kelsey, H.M., 1990, Late Quaternary tectonic deformation in the Cape Arago-Bandon region of coastal Oregon as deduced from wave-cut platforms: Journal of Geophysical Research, v. 95, no. B5, p. 6699-6713.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#4128 Nelson, A.R., and Personius, S.F., 1996, Great-earthquake potential in Oregon and Washington—An overview of recent coastal geologic studies and their bearing on segmentation of Holocene ruptures, central Cascadia subduction zone, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 91-114.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4159 Yeats, R.S., 1986, Active faults related to folding, *in* Studies in geophysics–Active tectonics: Washington, D. C., National Academy Press, p. 63-79.

#4132 Yeats, R.S., Clark, M.N., Keller, E.A., and Rockwell, T.K., 1981, Active fault hazard in southern California—Ground rupture versus seismic shaking: Geological Society of America Bulletin, v. 92, p. 189-196.

**891, South Slough syncline**

**Structure Number** 891

Comments:

**Structure Name** South Slough syncline

Comments: The South Slough syncline was named after South Slough, which occupies the axial position of the northern part of the fold. The fold was first mapped by Diller (1901 #4117), and later mapped and named by Allan and Baldwin (1944 #4162). The fold has been mapped or described in numerous subsequent publications (Baldwin, 1966 #4122; Baldwin and Beaulieu, 1973 #4145; Newton, 1980 #4144; Madin and others, 1995 #4158).

**Synopsis** The north-striking, northward plunging South Slough syncline was formed during ongoing east-west compression in the forearc of the Cascadia subduction zone [781]; the fold and associated faults are an onshore extension of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore [784]. Associated faults include tear faults, flexural-slip faults that parallel bedding in the syncline, and other reverse or thrust faults whose relationship to folding in the syncline is unknown. Folding and flexural slip faulting in the South Slough area may be caused by thrust or reverse faulting on deeper structures. The syncline and most of the active faults warp and offset an extensive flight of 80 ka to ≥200 ka marine terrace platforms and sediments that ring the margins of South Slough. The syncline is the location of numerous studies of subsidence-related deformation associated with the Cascadia subduction zone. Some of this deformation could be caused by localized folding and faulting during shallow upper-plate earthquakes, but most subsidence is probably caused by regional or local deformation during very large subduction zone earthquakes.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Coos

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Good

Comments: The axial trace is from 1:24,000-scale mapping of Madin and others (1995 #4158) and the approximately 1:190,000-scale figure 4 of McInelly and Kelsey (1990 #4102).

**Geologic setting** The north-striking, northward plunging South Slough syncline was formed during ongoing east-west compression in the forearc of the Cascadia subduction zone along the central Oregon coast (McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158). The fold and associated faults [888, 889, and 890] are an onshore extension of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore [784] (Goldfinger and others, 1992 #464; Nelson and Personius, 1996 #4128; McNeill and others, 1998 #4089). Some faults appear to be tear faults [888 and 889], and others are flexural-slip faults that parallel bedding in the syncline. The precise structural relationship between other reverse or thrust faults and folding in the syncline is unknown, but movement on these or other deeper structures may cause the folding and flexural slip faulting in the South Slough area (McInelly and Kelsey, 1990 #4102). The syncline is the location of numerous studies of subsidence-related deformation associated with the Cascadia subduction zone. Some of this deformation could be caused by localized folding and faulting during shallow upper-plate earthquakes (McNeill and others, 1998 #4089), but most of the subsidence is probably caused by regional or local deformation during very large subduction-zone earthquakes (McInelly and Kelsey, 1990 #4102; Nelson, 1992 #4277; Nelson and Personius, 1996 #4128; Nelson and others, 1998 #4197).

**Sense of movement** Syncline

Comments:

**Dip** 35° to 75°

Comments: The opposing fold limbs dip 35° to 75° into the axis of the syncline (Madin and others, 1995 #4158).

**Main dip direction** E and W; north plunging

**Geomorphic expression** The axis of the South Slough syncline lies parallel to and controls the location of South Slough, an extensive north-trending wetland in the Coos Bay area of the central Oregon coast. The geologic and geomorphic expression of the syncline is asymmetric: the west limb consists of uniformly dipping Eocene bedrock which strongly controls topography and is broken by minor cross- and bedding-parallel faults, and the east limb, which has numerous minor folds in bedrock and extensive cross- and north-trending faults (Madin and others, 1995 #4158). The syncline and most of the active faults warp and offset an extensive flight of marine terrace platforms and sediments that ring the margins of South Slough (Griggs, 1945 #4153; Baldwin, 1966 #4122; McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158).

**Age of folded deposits at the surface** The syncline and most of the active faults warp and offset an extensive flight of marine terrace platforms and sediments that ring the margins of South Slough (Griggs, 1945 #4153; Baldwin, 1966 #4122; McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158). These features include the Whisky Run, Pioneer, Seven Devils, and/or Metcalf marine terraces, which have assigned ages of about 80, 105, 125, and ≥200 ka, respectively (McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158; Kelsey and others, 1996 #4111). Extensive coring studies of tidal marsh sediments in the slough have been used to document late Holocene regional subsidence. Several of the more prominent Holocene subsidence events recorded in South Slough tidal marsh sediments are likely related to regional subsidence related to very large earthquakes on the Cascadia subduction zone, but others may be related to local earthquakes associated with tightening of the South Slough syncline or movement on nearby faults (McInelly and Kelsey, 1990 #4102; Nelson, 1992 #4277; Nelson and Personius, 1996 #4128; McNeill and others, 1998 #4089; Nelson and others, 1998 #4197).

**Paleoseismology studies** Detailed coring studies of tidal marsh sediments have been used to document late Holocene subsidence in South Slough (summarized in Nelson and others, 1998 #4197), but no detailed studies have definitively demonstrated subsidence on the South Slough syncline independent of displacement during very large earthquakes associated with the Cascadia subduction zone ([781], see discussion therein).

**Time of most recent prehistoric folding** latest Quaternary (<15 ka)

Comments: The South Slough syncline and most of the active faults warp and offset an extensive flight of marine terrace platforms and sediments that include the 80 ka Whiskey Run terrace, so these structures have been active in the late Quaternary (McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158; Kelsey and others, 1996 #4111). One associated structure, the Barview fault, appears to have offset in the late Holocene (McInelly and Kelsey, 1990 #4102). Coring studies show evidence of repeated late Holocene subsidence (Nelson and others, 1998 #4197), but this deformation is probably caused by subduction zone deformation, as well as localized movement on the syncline and associated faults.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments:  McInelly and Kelsey (1990 #4102) used deformed marine-terrace platforms to calculate horizontal strain rates of 0.044-0.13 mm/yr and uplift rates of 0.5-0.8 mm/yr across folds in the Cape Arago/South Slough area.  Slip rates as high as 0.73 mm/yr have been documented on some of the faults associated with the South Slough syncline (McInelly and Kelsey, 1990 #4102; Madin and others, 1995 #4158).

| | | |
|---|---|---|
| **Length** | End to end (km): | 17.2 |
| | Cumulative trace (km): | 17.3 |

Comments:

**Average strike** (azimuth) N 07° W

**References**

#4162 Allen, J.E., and Baldwin, E.M., 1944, Geology and coal resources of the Coos Bay quadrangle, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 27, 157 p., 3 pls.

#4122 Baldwin, E.M., 1966, Some revisions of the geology of the Coos Bay Area, Oregon:  The ORE BIN, v. 28, no. 11, p. 189-203.

#4145 Baldwin, E.M., and Beaulieu, J.D., 1973, Geology & mineral resources of Coos County, Oregon:  State of Oregon, Department of Geology and Mineral Industries Bulletin 80, 82 p., 4 pls.

#4117 Diller, J.S., 1901, Coos Bay, Oregon:  Folios of the Geologic Atlas of the United States, 5 p., 4 ls., scale 1:125,000.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain:  State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4153 Griggs, A.B., 1945, Chromite-bearing sands of the southern part of the coast of Oregon:  U.S. Geological Survey Bulletin 945-E, 113-150 p., 10 pls.

#4111 Kelsey, H.M., Ticknor, R.L., Bockheim, J.G., and Mitchell, C.E., 1996, Quaternary upper plate deformation in coastal Oregon:  Geological Society of America Bulletin, v. 108, no. 7, p. 843-860.

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#4102 McInelly, G.W., and Kelsey, H.M., 1990, Late Quaternary tectonic deformation in the Cape Arago-Bandon region of coastal Oregon as deduced from wave-cut platforms:  Journal of Geophysical Research, v. 95, no. B5, p. 6699-6713.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics:  Geological Society Special Publication No. 146, p. 321-342.

#4277 Nelson, A.R., 1992, Holocene tidal-marsh stratigraphy in south-central Oregon—Evidence for localized sudden submergence in the Cascadia subduction zone, *in* Fletcher, C.H., III, and Wehmiller, J.F., eds., Quaternary coasts of the United States—Marine and lacustrine systems:  SEPM Special Publication No. 48, p. 287-301.

#4197 Nelson, A.R., Ota, Y., Umitsu, M., Kashima, K., and Matsushima, Y., 1998, Seismic or hydrodynamic control of rapid late-Holocene sea-level rises in southern coastal Oregon, USA?:  The Holocene, v. 8, no. 3, p. 287-299.

#4128 Nelson, A.R., and Personius, S.F., 1996, Great-earthquake potential in Oregon and Washington—An overview of recent coastal geologic studies and their bearing on segmentation of Holocene ruptures, central Cascadia subduction zone, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 91-114.

#4144 Newton, V.C., Jr., 1980, Prospects for oil and gas in the Coos Basin, western Coos, Douglas, and Lane Counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Oil and Gas Investigation 6, 74 p., 3 pls.

**892, Pioneer anticline**

**Structure Number** 892

Comments:

**Structure Name** Pioneer anticline

Comments: The Pioneer anticline is a north-northwest-striking anticline originally mapped by Newton (1980 #4144) and named by McInelly and Kelsey (1990 #4102) after the Pioneer marine-terrace platform that is well preserved in the area. The Seven Devils fault zone is included in the description herein, because these faults are likely bedding-plane (flexural-slip) faults in the eastern and western (?) limbs of the Pioneer anticline (McInelly and Kelsey, 1990 #4102).

**Synopsis** The north-northwest striking, north- and southward-plunging Pioneer anticline was formed during ongoing east-west compression in the forearc of the Cascadia subduction zone [781]; the fold and associated faults are an onshore extension of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore [784]. This deformation could be caused by localized folding and faulting during shallow upper-plate earthquakes or by local deformation during very large subduction zone earthquakes. The anticline does not appear to significantly affect underlying bedrock units, and thus is thought to be a very young structure. The anticline warps the 105 ka Pioneer marine terrace platform; the associated bedding plane faults in the Seven Devils fault zone offset 105 ka Pioneer and/or 125 ka Seven Devils marine terrace sediments. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fold are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Coos

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The axial trace of the fold and fault traces are from the approximately 1:190,000-scale figure 4 of McInelly and Kelsey (1990 #4102).

**Geologic setting** The north-northwest striking, north- and southward-plunging Pioneer anticline was formed during ongoing east-west compression in the forearc of the Cascadia subduction zone [781] along the central Oregon coast (McInelly and Kelsey, 1990 #4102). The fold and associated faults are an onshore extension of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore [784] (Goldfinger and others, 1992 #464; McNeill and others, 1998 #4089). This deformation could be caused by localized folding and faulting during shallow upper plate earthquakes or by local deformation during very large subduction zone earthquakes (McInelly and Kelsey, 1990 #4102). Unlike the nearby South Slough syncline, the Pioneer anticline does not appear to significantly affect underlying bedrock units and thus is thought to be a very young structure (McInelly and Kelsey, 1990 #4102). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fold are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** Anticline

Comments:

**Dip** Not Reported

Comments:

**Main dip direction** E and W (limbs)

Comments: Anticline is north and south plunging.

**Geomorphic expression** The Pioneer anticline is a north-northwest-striking anticline that warps the Pioneer marine terrace platform; the associated bedding-plane faults in the Seven Devils fault zone offset Seven Devils marine terrace sediments (Griggs, 1945 #4153; McInelly and Kelsey, 1990 #4102).

**Age of folded deposits at the surface** The Pioneer anticline warps the Pioneer marine terrace platform, and faults in the Seven Devils fault zone offset the Seven Devils marine terrace sediments but are truncated by the Pioneer marine platform (Griggs, 1945 #4153; McInelly and Kelsey, 1990 #4102). The Pioneer and Seven Devils platforms are thought to correlate with the 105 ka and 125 ka marine highstands, respectively (McInelly and Kelsey, 1990 #4102; Kelsey and others, 1996 #4111).

**Paleoseismology studies** None

**Time of most recent prehistoric folding** late Quaternary (<130 ka)

Comments: The Pioneer anticline warps the 105 ka Pioneer terrace, so this structure has been active in the late Quaternary (McInelly and Kelsey, 1990 #4102). The fold and associated Seven Devils fault zone are shown as active in the late Pleistocene or Holocene by Goldfinger and others (1992 #464) and active in the Quaternary by Pezzopane (1993 #3544), but are not included on other recent compilations of Quaternary faults in Oregon (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments: McInelly and Kelsey, (1990 #4102) do not report uplift rates for the 105 ka Pioneer terrace, but the terrace platform lies at an elevation of about 40 m at the anticlinal axis, so uplift rates are relatively high.

| | | |
|---|---|---|
| **Length** | End to end (km): | 13.8 |
| | Cumulative trace (km): | 24.8 |

Comments:

**Average strike** (azimuth) N 33° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4153 Griggs, A.B., 1945, Chromite-bearing sands of the southern part of the coast of Oregon: U.S. Geological Survey Bulletin 945-E, 113-150 p., 10 pls.

#4111 Kelsey, H.M., Ticknor, R.L., Bockheim, J.G., and Mitchell, C.E., 1996, Quaternary upper plate deformation in coastal Oregon: Geological Society of America Bulletin, v. 108, no. 7, p. 843-860.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4102 McInelly, G.W., and Kelsey, H.M., 1990, Late Quaternary tectonic deformation in the Cape Arago-Bandon region of coastal Oregon as deduced from wave-cut platforms: Journal of Geophysical Research, v. 95, no. B5, p. 6699-6713.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#4144 Newton, V.C., Jr., 1980, Prospects for oil and gas in the Coos Basin, western Coos, Douglas, and Lane Counties, Oregon: State of Oregon, Department of Geology and Mineral Industries Oil and Gas Investigation 6, 74 p., 3 pls.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

## 893, Coquille fault

**Structure Number** 893

Comments: This structure is included in fault number 39 of Pezzopane (1993 #3544), and fault number 16 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Coquille fault

Comments: The Coquille fault was originally mapped offshore by Clark and others (1985 #4192), informally named the Coquille fault by McInelly and Kelsey (1990 #4102), and later mapped in more detail by McNeill and others (1998 #4089). Witter and others (1997 #4193) and Witter (1999 #4194) interpreted onshore deformation data to infer that the structure is an anticline (Coquille anticline) that overlies a blind reverse fault (Coquille fault). The latter name is in general usage and is retained herein.

**Synopsis** The northwest-striking Coquille fault was formed during ongoing east-west compression in the forearc of the Cascadia subduction zone [781], and is part of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore. Some parts of the structure have been variously mapped as an anticline, thrust fault, left- or right-stepping right-lateral strike slip fault, and a down-northeast normal or reverse fault, but onshore, the structure is inferred as either a fault or a fault-propagation fold that overlies a blind, southwest-dipping reverse fault. Offshore, the fault offsets the sea floor and shows evidence of active folding or slumping of Miocene bedrock that post-date erosion associated with the latest Pleistocene sea level lowstand. Onshore, the fault deforms the 80 ka Whisky Run and perhaps older marine terraces near Coquille Point. Evidence for Holocene displacement is equivocal, but the latest interpretations cite differences in local stream aggradation across the structure as evidence for coseismic slip on the fault since about 6 ka. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this structure are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** February 5, 2003

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Coos

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Oregon Coast Range section)

**Quality of location** Poor

Comments: The fault trace onshore is from the approximately 1:50,000-scale figure 2 (Chapter IV) of Witter (1999 #4194); the offshore trace is from the approximately 1:670,000-scale figure 12 of McNeill and others (1998 #4089).

**Geologic setting** The northwest-striking Coquille fault was formed during ongoing east-west compression in the forearc of the Cascadia subduction zone, and is part of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore (Clarke and others, 1985 #4192; McInelly and Kelsey, 1990 #4102; Goldfinger and others, 1992 #464; McNeill and others, 1998 #4089). Some parts of the structure have been variously mapped as an anticline, thrust fault, left- or right-stepping right-lateral strike slip fault, and a down-to–the-northeast normal or reverse fault (Clarke and others, 1985 #4192; McInelly and Kelsey, 1990 #4102; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; Witter and others, 1997 #4193; McNeill and others, 1998 #4089; Witter, 1999 #4194). Witter and others (1997 #4193) and Witter (1999 #4194) interpreted onshore deformation data to infer that at the surface, the structure may be a fault-propagation fold that overlies a blind, southwest-dipping reverse fault. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this structure are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** R?

Comments: Some parts of the fault has been variously mapped as an anticline, thrust fault, right stepping right-lateral strike slip fault, and a down-to-the-northeast normal or reverse fault (Clarke and others, 1985 #4192; McInelly and Kelsey, 1990 #4102; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972; McNeill and others, 1998 #4089). Witter and others (1997 #4193) and Witter (1999 #4194) infer that onshore, the structure may be a fault-propagation fold that overlies a blind, southwest-dipping reverse fault.

**Dip** Not Reported

Comments:

**Main dip direction** SW?

**Geomorphic expression** Offshore, the Coquille fault appears to offset the sea floor (Clarke and others, 1985 #4192), and has been imaged in several seismic reflection lines (Clarke and others, 1985 #4192; Goldfinger and others, 1992 #464; Goldfinger, 1994 #3972). No evidence of folding and faulting in Quaternary deposits was observed during submersible dives to the structure, but evidence of active folding or slumping of Miocene bedrock in folds on the sea floor that post-date erosion associated with the latest Pleistocene sea level lowstand suggest young movement (Goldfinger, 1994 #3972). Onshore, the fold causes changes in the height of the 80 ka Whisky Run and perhaps older marine terraces near Coquille Point (McInelly and Kelsey, 1990 #4102; Witter and others, 1997 #4193; Witter, 1999 #4194).

**Age of faulted deposits at the surface** No evidence of folding and faulting in Quaternary deposits was observed during submersible dives to the fault, but Goldfinger (1994 #3972) noted the presence of active folding or slumping of Miocene bedrock in folds on the sea floor that post-date erosion associated with the latest Pleistocene sea level lowstand. Onshore, the fault deforms the 80 ka Whisky Run and perhaps older marine terraces near Coquille Point (McInelly and Kelsey, 1990 #4102; Witter and others, 1997 #4193; Witter, 1999 #4194). Witter and others (1997 #4193) and Witter (1999 #4194) found no conclusive evidence of Holocene deformation in relative sea level curves constructed at sites across the Coquille fault, but Witter (pers. commun., 2003) now describes differences in local stream aggradation as evidence for coseismic slip since about 6 ka.

**Paleoseismology studies** No trenching studies have been described, but studies of subsided marsh and forest soils related to deformation on the Cascadia subduction zone [781] have been conducted in the area; these studies are described elsewhere as paleoseismology site [781-16].

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Evidence from submersible dives on the offshore projection of the fault indicates post latest Pleistocene movement (Goldfinger, 1994 #3972). Onshore, the fault appears to offset the 80 ka Whisky Run marine terrace (McInelly and Kelsey, 1990 #4102). Witter and others (1997 #4193) and Witter (1999 #4194) found no conclusive evidence of Holocene deformation in relative sea level curves constructed at sites across the projected axis of the fault, but Witter (pers. commun., 2003) now describes differences in local stream aggradation as evidence for coseismic slip on the fault since about 6 ka. Pezzopane (1993 #3544), Goldfinger and others (1992 #464), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) inferred Holocene or latest Pleistocene (<20 ka) displacement on the Coquille fault.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments: No detailed data on slip rates in Quaternary deposits have been published. McInelly and Kelsey (1990 #4102) measured >18 m of vertical offset, and Witter and others (1997 #4193) and Witter (1999 #4194/ pers. commun., 2003) inferred 20-50 m of vertical offset of the 80 ka Whisky Run marine terrace platform at Coquille Point. Geomatrix Consultants, Inc. (1995 #3593) used some of this data to estimate slip rates of 0.2-3.0 mm/yr, and used a preferred rate of 1.0 mm/yr for their analysis of earthquake hazards associated with the Coquille fault. Based on Holocene relative sea-level data and differences in local stream aggradation across the fault, the vertical component of slip does not exceed 0.2 to 0.4 mm/yr (Witter and others, pers. comm., 2003).

**Length** End to end (km): 27.1

Cumulative trace (km): 28.3

Comments:

**Average strike** (azimuth) N 30° W

**References**

#4192 Clarke, S.H., Jr., Field, M., E., and Hirozawa, C.A., 1985, Reconnaissance geology and geologic hazards of the offshore Coos Bay Basin, Oregon: U.S. Geological Survey Bulletin 1645, 41 p.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4102 McInelly, G.W., and Kelsey, H.M., 1990, Late Quaternary tectonic deformation in the Cape Arago-Bandon region of coastal Oregon as deduced from wave-cut platforms: Journal of Geophysical Research, v. 95, no. B5, p. 6699-6713.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4194 Witter, R.C., 1999, Late Holocene paleoseismicity, tsunamis and relative sea-level changes along the south-central Cascadia subduction zone, southern Oregon: University of Oregon, unpublished Ph.D dissertation, 178 p.

#4193 Witter, R.C., Kelsey, H.M., and Hemphill-Haley, E., 1997, A paleoseismic history of the south-central Cascadia subduction zone—Assessing earthquake recurrence intervals and upper-plate deformation over the past 6600 years at the Coquille River Estuary, southern Oregon: Technical report to U.S. Geological Survey, under Contract 1434-HQ-97-GR-03036, 54 p.

**894, Cape Blanco anticline**

**Structure Number** 894

Comments: This fold is included in structure number 39 of Pezzopane (1993 #3544) and structure number 17 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Cape Blanco anticline

Comments: The Cape Blanco anticline is an east-striking anticline originally recognized and named after Cape Blanco by R.J. Janda (unpub. data in Janda, 1970 #4116; Kelsey, 1990 #4107). The fold has been mapped and described in detail onshore by Kelsey (1990 #4107), and mapped offshore by Goldfinger and others (1992 #464).

**Synopsis** The east-striking Cape Blanco anticline was formed during ongoing compression in the forearc of the Cascadia subduction zone [781] along the central Oregon coast, and is an onshore extension of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore. This deformation could be caused by localized folding and faulting during shallow upper-plate earthquakes or by local deformation during large subduction zone earthquakes. The Cape Blanco anticline is not mapped on bedrock maps of the area, but the fold is expressed in the underlying Cenozoic bedrock and warps the 80 ka Cape Blanco, 105 ka Pioneer, and 125 ka Silver Butte marine terrace platforms at Cape Blanco. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fold are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Curry

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Klamath Mountains section)

**Quality of location** Poor

Comments: The axial trace is from the approximately 1:135,000-scale figure 9 of Kelsey (1990 #4107).

**Geologic setting** The east-striking Cape Blanco anticline was formed during ongoing compression in the forearc of the Cascadia subduction zone [781] along the central Oregon coast (Kelsey, 1990 #4107). The fold is an onshore extension of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore [784] (Goldfinger and others, 1992 #464; McNeill and others, 1998 #4089). This deformation could be caused by localized folding and faulting during shallow upper plate earthquakes (Goldfinger, 1994 #3972; McNeill and others, 1998 #4089) or by local deformation during large subduction zone earthquakes (McInelly and Kelsey, 1990 #4102; Kelsey, 1990 #4107). A recent study of an extensive sequence of buried lowland soils in the nearby Sixes River Valley suggests that both may be occurring (Kelsey and others, 2002 #5043). The Cape Blanco anticline is not mapped on bedrock maps of the area (Dott, 1962 #4115; 1971 #4160; Beaulieu and Hughes, 1976 #4161; Ramp and others, 1977 #4146; Walker and MacLeod, 1991 #3646), but the fold is expressed in the underlying Cenozoic bedrock (Kelsey, 1990 #4107). Geomatrix Consultants, Inc. (1995 #3593) postulate the presence of a 30° dipping blind thrust beneath the anticline. Witter and others (1997 #4193) and Witter (1999 #4194) infer that the surface structure is a fault-propagation fold that overlies a blind reverse fault. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fold are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** Anticline; blind R? or T?

Comments: The axis of the anticline is tilted east (Kelsey, 1990 #4107), consistent with eastward plunge (Janda, 1970 #4116). Geomatrix Consultants, Inc. (1995 #3593) postulate the presence of a 30° dipping blind thrust beneath the anticline, and Witter and others (1997 #4193) and Witter (1999 #4194) infer that the structure is a fault-propagation fold that overlies a blind reverse fault.

**Dip** Not Reported

Comments:

**Main dip direction** N and S

Comments: East plunging

**Geomorphic expression** The Cape Blanco anticline is an east-striking anticline that warps the Cape Blanco, Pioneer, and Silver Butte marine terrace platforms at Cape Blanco. These platforms have been dated or correlated to sea-level highstands at 80 ka, 105 ka, and 125 ka, respectively (Kelsey, 1990 #4107; Muhs and others, 1990 #4113). The fold also appears to tilt young fluvial terraces (Janda, 1970 #4116), and causes changes in relative sea-level curves (Witter and others, 1997 #4193; Witter, 1999 #4194).

**Age of folded deposits at the surface** The Cape Blanco anticline warps the Cape Blanco, Pioneer, and Silver Butte marine terrace platforms at Cape Blanco. These platforms have been dated or correlated to sea-level highstands at 80 ka, 105 ka, and 125 ka, respectively (Kelsey, 1990 #4107; Muhs and others, 1990 #4113). Witter and others (1997 #4193) and Witter (1999 #4194) used changes in Holocene relative sea-level curves at sites across the anticline to infer Holocene movement.

**Paleoseismology studies** None

**Time of most recent prehistoric folding** latest Quaternary (<15 ka)

Comments: The Cape Blanco anticline warps the 80 ka Cape Blanco terrace, so this structure has been active in the late Quaternary (Kelsey, 1990 #4107). The fold also has caused changes in Holocene relative sea-level curves at sites across the anticline (Witter and others, 1997 #4193; Witter, 1999 #4194), so the fold has also undergone Holocene deformation. The fold is shown as active in the Pliocene or Pleistocene by Goldfinger and others (1992 #464) and as active in the middle and late Quaternary (<700-780 ka) by Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593) and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments: Kelsey (1990 #4107) reported late Holocene uplift rates of 6-10 mm/yr derived from a feature identified as a late Holocene storm beach berm, but later work revealed that this feature is a spoil pile from a late 19$^{th}$ or early 20$^{th}$ century mining operation and thus has no tectonic significance (H.M. Klesey, pers. commun., 2001). Kelsey (1990 #4107) calculated average maximum late Quaternary (<125 ka) uplift rates of 0.5-1.4 mm/yr along the axis of the Cape Blanco anticline.

| | | |
|---|---|---|
| **Length** | End to end (km): | 8.1 |
| | Cumulative trace (km): | 8.1 |

Comments:

**Average strike** (azimuth) N 74° W

**References**

#4161 Beaulieu, J.D., and Hughes, P.W., 1976, Land use geology of western Curry County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 90, 148 p., 12 pls., scale 1:62,500.

#4115 Dott, R.H., Jr., 1962, Geology of the Cape Blanco Area, southwest Oregon: The ORE-BIN, v. 24, no. 8, p. 121-133.

#4160 Dott, R.H., Jr., 1971, Geology of the southwestern Oregon Coast west of the 124th meridian: State of Oregon, Department of Geology and Mineral Industries Bulletin 69, 63 p., 2 pls.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4116 Janda, R.J., 1970, Pleistocene tectonism and sedimentation near Cape Blanco, Oregon: American Quaternary Association, 1st meeting, 74 p.

#4107 Kelsey, H.M., 1990, Late Quaternary deformation of marine terraces on the Cascadia subduction zone near Cape Blanco, Oregon: Tectonics, v. 9, no. 5, p. 983-1014.

#5043 Kelsey, H.M., Witter, R.C., and Hemphill-Haley, E., 2002, Plate-boundary earthquakes and tsunamis of the past 5500 yr, Sixes River estuary, southern Oregon: Geological Society of America Bulletin, v. 114, no. 3, p. 298-314.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4102 McInelly, G.W., and Kelsey, H.M., 1990, Late Quaternary tectonic deformation in the Cape Arago-Bandon region of coastal Oregon as deduced from wave-cut platforms: Journal of Geophysical Research, v. 95, no. B5, p. 6699-6713.

#4089 McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I.S., and Vita-Finzi, C., eds., Coastal tectonics: Geological Society Special Publication No. 146, p. 321-342.

#4113 Muhs, D.R., Kelsey, H.M., Miller, G.H., Kennedy, G.L., Whelan, J.F., and McInelly, G.W., 1990, Age estimates and uplift rates for Late Pleistocene marine terraces—Southern Oregon portion of the Cascadia Forearc: Journal of Geophysical Research, v. 95, no. B5, p. 6685-6698.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4146 Ramp, L., Schlicker, H.G., and Gray, J.J., 1977, Geology, mineral resources, and rock material of Curry County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 93, 79 p., 2 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4194 Witter, R.C., 1999, Late Holocene paleoseismicity, tsunamis and relative sea-level changes along the south-central Cascadia subduction zone, southern Oregon: University of Oregon, unpublished Ph.D dissertation, 178 p.

#4193 Witter, R.C., Kelsey, H.M., and Hemphill-Haley, E., 1997, A paleoseismic history of the south-central Cascadia subduction zone—Assessing earthquake recurrence intervals and upper-plate deformation over the past 6600 years at the Coquille River Estuary, southern Oregon:  Technical report to U.S. Geological Survey, under Contract 1434-HQ-97-GR-03036, 54 p.

## 895, Beaver Creek fault zone

**Structure Number** 895

Comments: This fault is included in fault number 39 of Pezzopane (1993 #3544), and fault number 18 of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Beaver Creek fault zone

Comments: The Beaver Creek fault zone was mapped by Lent (1969 #3974), Beaulieu and Hughes (1976 #4161), and Ramp and others (1977 #4146), and informally named the Beaver Creek fault by Janda (1970 #4116) after nearby Beaver Creek. Kelsey (1990 #4107) described several strands of the fault and used the name Beaver Creek fault zone, which is retained herein.

**Synopsis** The northeast-striking Beaver Creek fault zone is mapped primarily in Jurassic and Cretaceous bedrock, and appears to be a reactivated fault with a long history of displacement. The fault is coincident with boundaries between Jurassic through Cretaceous terranes, and predates the Eocene assemblage of southern coastal Oregon. The fault is unusual in showing an extensional sense of displacement in the forearc of the Cascadia subduction zone [781]. The fault zone consists of at least six closely spaced, southwest-dipping normal faults, and offsets the ≥200 ka Indian Creek marine terrace surface a maximum of approximately 40 m. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Curry

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Klamath Mountains section)

**Quality of location** Good

Comments: The fault trace is from 1:62,500-scale mapping of Beaulieu and Hughes (1976 #4161) and the approximately 1:135,000-scale figure 9 of Kelsey (1990 #4107).

**Geologic setting** The northeast-striking Beaver Creek fault is mapped primarily in Jurassic and Cretaceous bedrock in the northern Klamath Mountains (Lent, 1969 #3974; Beaulieu and Hughes, 1976 #4161; Ramp and others, 1977 #4146; Walker and MacLeod, 1991 #3646), and appears to be a reactivated fault with a long history of displacement. The fault is coincident with boundaries between Jurassic through Cretaceous terranes, and predates the Eocene assemblage of southern coastal Oregon (Blake and others, 1985 #4103). The fault is unusual in showing an extensional sense of displacement in the forearc of the Cascadia subduction zone (Kelsey, 1990 #4107). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** N

Comments: The fault zone consists of at least six closely spaced, southwest-dipping normal faults (Kelsey, 1990 #4107).

**Dip** 60°-75°

Comments: Dip data from Kelsey (1990 #4107).

**Main dip direction** SE

**Geomorphic expression** The Beaver Creek fault zone offsets the Indian Creek marine terrace surface a maximum of approximately 40 m (Kelsey, 1990 #4107).

**Age of faulted deposits at the surface** The Beaver Creek fault zone offsets the Indian Creek marine terrace surface; this terrace has been correlated with a ≥200 ka sea-level highstand (Kelsey, 1990 #4107).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: The Beaver Creek fault zone offsets the ≥200 ka Indian Creek marine terrace surface approximately 40 m (Kelsey, 1990 #4107); such offset suggests some slip occurred in the late Quaternary. The fault is inferred as active in the late Pleistocene by Kelsey (1990 #4107), in the Pliocene or Pleistocene by Goldfinger and others (Goldfinger and others, 1992 #464) and as active in the middle and late Quaternary (<700-780 ka) by Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593) and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments: No detailed data on slip rates in Quaternary deposits has been published. Kelsey (1990 #4107) measured a maximum of approximately 40 m of offset across the ≥200 Indian Creek marine terrace surface; such data yield a long-term slip rate of 0.2 mm/yr (Geomatrix Consultants Inc., 1995 #3593).

| | | |
|---|---|---|
| **Length** | End to end (km): | 17.0 |
| | Cumulative trace (km): | 33.2 |

Comments:

**Average strike** (azimuth) N 65° E

**References**

#4161 Beaulieu, J.D., and Hughes, P.W., 1976, Land use geology of western Curry County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 90, 148 p., 12 pls., scale 1:62,500.

#4103 Blake, M.C., Jr., Engebretson, D.C., Jayko, A.S., and Jones, D.L., 1985, Tectonostratigraphic terranes in southwest Oregon, *in* Howell, D.G., ed., Tectonostratigraphic terranes of the Circum-Pacific Region: Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, Number 1, p. 147-157.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4116 Janda, R.J., 1970, Pleistocene tectonism and sedimentation near Cape Blanco, Oregon: American Quaternary Association, 1st meeting, 74 p.

#4107 Kelsey, H.M., 1990, Late Quaternary deformation of marine terraces on the Cascadia subduction zone near Cape Blanco, Oregon: Tectonics, v. 9, no. 5, p. 983-1014.

#3974 Lent, R.L., 1969, Geology of the southern half of the Langlois quadrangle, Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D thesis, 189 p.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4146 Ramp, L., Schlicker, H.G., and Gray, J.J., 1977, Geology, mineral resources, and rock material of Curry County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 93, 79 p., 2 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

## 896, Battle Rock fault zone

**Structure Number** 896

Comments: This fault is included in fault number 39 of Pezzopane (1993 #3544), and is fault number 19a of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Battle Rock fault zone

Comments: The Battle Rock fault zone apparently was informally named by Kelsey (1990 #4107) after nearby Battle Rock; faulting in this area is included in the Port Orford shear zone (Koch and others, 1961 #4105; Koch, 1966 #4114; Dott, 1971 #4160). Blake and others (1985 #4103), Kelsey (1990 #4107) and Geomatrix Consultants, Inc. (1995 #3593) correlate this fault with the Whaleshead fault zone [897] to the south. Herein we retain the Battle Rock fault zone as a separate structure because most maps show no physical connection between the Battle Rock and Whaleshead fault zones (Dott, 1971 #4160; Beaulieu and Hughes, 1976 #4161; Ramp and others, 1977 #4146), and because of differences in sense of slip.

**Synopsis** The north-northwest-striking Battle Rock fault zone is part of a major right-lateral shear zone mapped in Mesozoic bedrock in the northern Klamath Mountains part of the Cascadia subduction zone. The fault zone is coincident with boundaries between Jurassic through Cretaceous accreted terranes and predates the Eocene assemblage of southern coastal Oregon. The fault zone is mapped as a high angle fault with down-to-the-east sense of displacement in Quaternary deposits. The fault may represent Quaternary reactivation of a dextral-slip fault zone, but no evidence of strike-slip faulting in Quaternary deposits has been described. The fault zone offsets the ≥200 ka Indian Creek marine terrace surface approximately 20 m but does not laterally offset the backedge of the 105 ka Pioneer marine terrace and does not appear to vertically offset the Pioneer wave-cut platform. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Curry

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Klamath Mountains section)

**Quality of location** Poor

Comments: The northern part of the fault trace is from the approximately 1:135,000-scale figure 10 of Kelsey (1990 #4107) and 1:250,000-scale mapping of Dott (1971 #4160); the southern part of the fault trace is from 1:62,500-scale mapping of Beaulieu and Hughes (1976 #4161).

**Geologic setting** The north-northwest-striking Battle Rock fault zone is part of a major right-lateral shear zone mapped in Mesozoic bedrock in the northern Klamath Mountains part of the Cascadia subduction zone. The shear zone is coincident with boundaries between Jurassic through Cretaceous accreted terranes, and predates the Eocene assemblage of southern coastal Oregon (Blake and others, 1985 #4103; Bourgeois and Dott, 1985 #4106). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** ND?

Comments: The fault zone is mapped as a high-angle fault with down-to-the-east sense of displacement; the fault may represent Quaternary reactivation of a dextral-slip fault zone, but no evidence of strike-slip faulting in Quaternary deposits has been described (Kelsey, 1990 #4107).

**Dip** Not Reported

Comments:

**Main dip direction** Not Reported

**Geomorphic expression** The Battle Rock fault zone offsets the Indian Creek marine terrace surface approximately 20 m near Port Orford (Kelsey, 1990 #4107). The fault does not laterally offset the backedge of the Pioneer marine terrace, and within the resolution of available well data, does not vertically offset the Pioneer wave-cut platform (Kelsey, 1990 #4107). Quaternary displacement has only been described along a short section of the fault near Port Orford, but the fault trace has been extended 6 km north to bedrock faults at Blacklock Point (Dott, 1971 #4160; Kelsey, 1990 #4107) and >15 km south to bedrock faults near Sisters Rocks (Beaulieu and Hughes, 1976 #4161).

**Age of faulted deposits at the surface** The Battle Rock fault zone offsets the Indian Creek marine terrace surface; this terrace has been correlated with a ≥200 ka sea-level highstand (Kelsey, 1990 #4107).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: The Battle Rock fault zone vertically offsets the ≥200 ka Indian Creek marine terrace surface approximately 20 m, but does not appear to offset the 105 ka Pioneer marine terrace (Kelsey, 1990 #4107). The fault is inferred as active in the Pliocene or Pleistocene by Goldfinger and others (1992 #464) and as active in the middle and late Quaternary (<700-780 ka) by Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593) and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: No detailed data on slip rates in Quaternary deposits has been published. Kelsey (1990 #4107) measured 20 m of offset across the ≥200 Indian Creek marine terrace surface; such data yield a long-term maximum slip rate of 0.1 mm/yr (Geomatrix Consultants Inc., 1995 #3593).

| | | |
|---|---|---|
| **Length** | End to end (km): | 48.0 |
| | Cumulative trace (km): | 48.7 |

Comments:

**Average strike** (azimuth) N 16° W

**References**


#4161 Beaulieu, J.D., and Hughes, P.W., 1976, Land use geology of western Curry County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 90, 148 p., 12 pls., scale 1:62,500.

#4103 Blake, M.C., Jr., Engebretson, D.C., Jayko, A.S., and Jones, D.L., 1985, Tectonostratigraphic terranes in southwest Oregon, *in* Howell, D.G., ed., Tectonostratigraphic terranes of the Circum-Pacific Region: Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, Number 1, p. 147-157.

#4106 Bourgeois, J., and Dott, R.H., Jr., 1985, Stratigraphy and sedimentology of Upper Cretaceous rocks in coastal southwest Oregon—Evidence for wrench-fault tectonics in a postulated accretionary terrane: Geological Society of America Bulletin, v. 96, p. 1007-1019.

#4160 Dott, R.H., Jr., 1971, Geology of the southwestern Oregon Coast west of the 124th meridian: State of Oregon, Department of Geology and Mineral Industries Bulletin 69, 63 p., 2 pls.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4107 Kelsey, H.M., 1990, Late Quaternary deformation of marine terraces on the Cascadia subduction zone near Cape Blanco, Oregon: Tectonics, v. 9, no. 5, p. 983-1014.

#4114 Koch, J.G., 1966, Late Mesozoic stratigraphy and tectonic history, Port Orford-Gold Beach Area, southwestern Oregon Coast: Bulletin of the American Association of Petroleum Geologists, v. 50, no. 1, p. 25-71.

#4105 Koch, J.G., Kaiser, W.R., and Dott, R.H., Jr., 1961, Geology of the Humbug Mountain State Park Area: The ORE-BIN, v. 23, no. 3, p. 23-30.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4146 Ramp, L., Schlicker, H.G., and Gray, J.J., 1977, Geology, mineral resources, and rock material of Curry County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 93, 79 p., 2 pls.

## 897, Whaleshead fault zone

**Structure Number** 897

Comments: This fault is included in fault number 39 of Pezzopane (1993 #3544), and is fault number 19b of Geomatrix Consultants, Inc. (1995 #3593).

**Structure Name** Whaleshead fault zone

Comments: The Whaleshead fault zone is a complex of high-angle faults mapped by various authors (Howard and Dott, 1961 #4104; Koch, 1966 #4114; Dott, 1971 #4160; Beaulieu and Hughes, 1976 #4161; Ramp and others, 1977 #4146; Walker and MacLeod, 1991 #3646) in southwestern Oregon. Parts of the fault zone have been named the Pistol River, East Boundary, and Crook Point faults (Howard and Dott, 1961 #4104), the Gold Beach shear zone (Koch, 1966 #4114), and the Carpenterville shear zone (Beaulieu and Hughes, 1976 #4161). The entire terrane-bounding fault system was named the Whalehead fault zone by Blake and others (1985 #4103), apparently after either Whalehead Island or Whalehead Creek near the southern end of the fault system. The spelling of the fault was changed to “Whaleshead” by Kelsey and Bockheim (1994 #4108), probably because the spellings of these features were changed on later U.S. Geological Survey topographic maps. The latter spelling is consistent with modern maps and appears to be in common usage (Geomatrix Consultants Inc., 1995 #3593), so the name is retained herein. Blake and others (1985 #4103) included the Battle Rock fault zone [896] in their terrane-bounding Whalehead fault zone in a small-scale figure, but detailed mapping in the region (Howard and Dott, 1961 #4104; Koch, 1966 #4114; Dott, 1971 #4160; Beaulieu and Hughes, 1976 #4161; Ramp and others, 1977 #4146) does not show continuous faulting between the Battle Rock fault zone and faults to the southwest. Geomatrix Consultants, Inc. (1995 #3593) included all of these faults in their Whaleshead-Battle Rock fault zone, which included the Battle Rock fault zone and the Whaleshead or Whaleshead Cove fault as separate structures. Herein we restrict the Whaleshead fault zone to the zone of faults between Gold Beach and Brookings, and discuss the Battle Rock fault zone separately.

**Synopsis** The north-northwest-striking Whaleshead fault zone is part of a major right-lateral shear zone mapped in Mesozoic bedrock in the northern Klamath Mountains part of the Cascadia subduction zone [781]. The shear zone is a major boundary between Jurassic through Cretaceous rocks of the Gold Beach and Yolly Bolly accreted terranes; the timing of emplacement of the Gold Beach terrane is poorly known, but probably occurred in post-mid Eocene time. Most structures in the fault zone are mapped as high-angle faults; recent tectonic analyses indicate overall right-lateral strike slip on this fault system, although detailed mapping of Quaternary marine terrace platforms near the southern end of the zone indicate a significant component of left-lateral strike slip on some strands. Geomorphic expression of the fault zone has only been described at its southern end near Whaleshead Creek and its intersection with the coast; here the fault splits into two strands that vertically and left-laterally offset an extensive flight of marine terrace platforms and warps these terraces into an anticline south of the fault trace. The fault zone and associated fold deform the 80 ka and older marine terraces and thus has been active in the late Quaternary. Average late Quaternary vertical slip rates of 0.5 mm/yr and post-200-ka left-lateral slip rates of 2.5 mm/yr indicate high rates of activity on at least one strand of the Whaleshead fault zone. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Curry

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Klamath Mountains section)

**Quality of location** Good

Comments: Most of the fault trace is from 1:250,000-scale mapping of Dott (1971 #4160); the southernmost part of the fault trace is from the approximately 1:45,000-scale figure 3 of Kelsey and Bockheim (1994 #4108).

**Geologic setting** The north-northwest-striking Whaleshead fault zone is part of a major right-lateral shear zone mapped in Mesozoic bedrock in the northern Klamath Mountains part of the Cascadia subduction zone [781]. The shear zone is a major boundary between Jurassic through Cretaceous rocks of the Gold Beach and Yolly Bolly accreted terranes; the timing of emplacement of the Gold Beach terrane is poorly known, but probably occurred in post-mid Eocene time (Blake and others, 1985 #4103; Bourgeois and Dott, 1985 #4106). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these faults are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** D, S

Comments: Most structures in the fault zone are mapped as high-angle faults; recent tectonic analyses indicate overall right-lateral strike slip on this fault system (Blake and others, 1985 #4103; Bourgeois and Dott, 1985 #4106) but detailed mapping of Quaternary marine terrace platforms near the southern end of the zone indicate a significant component of left-lateral strike slip (Kelsey and Bockheim, 1994 #4108).

**Dip** Not Reported

Comments:

**Main dip direction** None; vertical

**Geomorphic expression** Geomorphic expression of the fault zone has only been described at its southern end near Whaleshead Creek and its intersection with the coast (Kelsey and Bockheim, 1994 #4108). Here the fault splits into two strands that vertically and left-laterally offset an extensive flight of marine-terrace platforms, and also warps these terraces into an anticline 2-4 km south of the fault trace (Kelsey and Bockheim, 1994 #4108).

**Age of faulted deposits at the surface** The Whaleshead fault zone offsets an extensive flight of marine terraces near Whaleshead Creek and its intersection with the coast; these terraces have been correlated with the 80 ka and older sea-level highstands (Kelsey and Bockheim, 1994 #4108).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: The Whaleshead fault zone offsets 80 ka and older marine terraces, and thus has been active in the late Quaternary (Kelsey and Bockheim, 1994 #4108). The fault was mapped as active in the Quaternary (<1.6 Ma) by Pezzopane (1993 #3544); Geomatrix Consultants, Inc. (1995 #3593) and Madin and Mabey (1996 #3575) infer Quaternary (<1.8 Ma) or middle and late Quaternary (<780 ka) movement on faults in the Whaleshead fault zone.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments: Kelsey and Bockheim (1994 #4108) calculated an average late Quaternary vertical slip rate of 0.5 mm/yr and a post-200-ka left-lateral slip rate of 2.5 mm/yr on the southern Whaleshead fault zone.

Geomatrix Consultants, Inc. (1995 #3593) used these data and unpublished data from H.M. Kelsey (pers. commun., 1994, in Geomatrix Consultants Inc., 1995 #3593) to estimate a range of slip rates of 0.5-2.5 mm/yr, and estimated a horizontal slip rate error of ±1.2 mm/yr. Quaternary displacement has not been documented on any other strands in the fault zone, so these high slip rates probably do not characterize the entire Whaleshead fault zone.

**Length** End to end (km): 43.0
Cumulative trace (km): 139.0

Comments:

**Average strike** (azimuth) N 12° W

**References**


#4161 Beaulieu, J.D., and Hughes, P.W., 1976, Land use geology of western Curry County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 90, 148 p., 12 pls., scale 1:62,500.

#4103 Blake, M.C., Jr., Engebretson, D.C., Jayko, A.S., and Jones, D.L., 1985, Tectonostratigraphic terranes in southwest Oregon, *in* Howell, D.G., ed., Tectonostratigraphic terranes of the Circum-Pacific Region: Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, Number 1, p. 147-157.

#4106 Bourgeois, J., and Dott, R.H., Jr., 1985, Stratigraphy and sedimentology of Upper Cretaceous rocks in coastal southwest Oregon—Evidence for wrench-fault tectonics in a postulated accretionary terrane: Geological Society of America Bulletin, v. 96, p. 1007-1019.

#4160 Dott, R.H., Jr., 1971, Geology of the southwestern Oregon Coast west of the 124th meridian: State of Oregon, Department of Geology and Mineral Industries Bulletin 69, 63 p., 2 pls.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#4104 Howard, J.K., and Dott, R.H., Jr., 1961, Geology of Cape Sebastian State Park and its regional relationships: The ORE-BIN, v. 23, no. 8, p. 75-81.

#4108 Kelsey, H.M., and Bockheim, J.G., 1994, Coastal landscape evolution as a function of eustasy and surface uplift rate, Cascadia margin, southern Oregon: Geological Society of America Bulletin, v. 106, p. 840-854.

#4114 Koch, J.G., 1966, Late Mesozoic stratigraphy and tectonic history, Port Orford-Gold Beach Area, southwestern Oregon Coast: Bulletin of the American Association of Petroleum Geologists, v. 50, no. 1, p. 25-71.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4146 Ramp, L., Schlicker, H.G., and Gray, J.J., 1977, Geology, mineral resources, and rock material of Curry County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 93, 79 p., 2 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

**898, Chetco River fault**

**Structure Number** 898

Comments:

**Structure Name** Chetco River fault

Comments: The Chetco River fault was informally named and described by Kelsey and Bockheim (1994 #4108). The fault is not shown on geologic maps of the region (Dott, 1971 #4160; Beaulieu and Hughes, 1976 #4161; Ramp and others, 1977 #4146; Walker and MacLeod, 1991 #3646).

**Synopsis** The northeast-striking Chetco River fault is mapped in Mesozoic bedrock in the northern Klamath Mountains part of the Cascadia subduction zone [781]. This area is characterized by accreted terranes of Jurassic through Cretaceous rock. The fault is mapped as a high-angle reverse(?) fault with a down-to-the-southeast sense of displacement. Other faults with similar trends in the region, such as the Whaleshead fault zone [897], are part of regional dextral shear zones, but no evidence of lateral displacement has been described along the Chetco River fault. The fault apparently vertically offsets a 125-ka marine-terrace surface approximately 30 m across the Chetco River near Brookings. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Date of compilation** May 31, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Curry

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Klamath Mountains section)

**Quality of location** Poor

Comments: The fault trace is from the approximately 1:135,000-scale figure 6 of Kelsey and Bockheim (1994 #4108).

**Geologic setting** The northeast-striking Chetco River fault is mapped in Mesozoic bedrock in the northern Klamath Mountains part of the Cascadia subduction zone [781]. This area is characterized by accreted terranes of Jurassic through Cretaceous rock (Blake and others, 1985 #4103). As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

**Sense of movement** R?, D?

Comments: The fault is mapped as a high-angle reverse(?) fault with a down-to-the-southeast sense of displacement (Kelsey and Bockheim, 1994 #4108). Other faults with similar trends in the region, such as the Whaleshead fault zone [897], are part of regional dextral shear zones, but no evidence of lateral displacement has been described along the Chetco River fault (Kelsey and Bockheim, 1994 #4108).

**Dip** Not Reported

Comments:

**Main dip direction** E?

**Geomorphic expression** The Chetco River fault apparently offsets a 125-ka marine-terrace surface approximately 30 m across the Chetco River near Brookings, but has no other geomorphic expression (Kelsey and Bockheim, 1994 #4108).

**Age of faulted deposits at the surface** The Chetco River fault apparently offsets marine terrace surface number 3; this terrace has been correlated with the 125-ka sea-level highstand by Kelsey and Bockheim (1994 #4108).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (<130 ka)

Comments: The Chetco River fault apparently offsets a 125-ka marine-terrace surface approximately 30 m, and thus has been active in the late Quaternary (Kelsey and Bockheim, 1994 #4108). The fault is not shown on active fault maps of Goldfinger and others (1992 #464), Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** 0.2-1.0 mm/yr

Comments: No detailed data on slip rates in Quaternary deposits has been published. Kelsey and Bockheim (1994 #4108) measured about 30 m of vertical offset across a 125-ka marine-terrace surface near Brookings, but did not discuss possible lateral displacement. The vertical slip data suggest a moderate long-term slip rate.

| | | |
|---|---|---|
| **Length** | End to end (km): | 5.6 |
| | Cumulative trace (km): | 7.8 |

Comments:

**Average strike** (azimuth) N 05° W

**References**

#4161 Beaulieu, J.D., and Hughes, P.W., 1976, Land use geology of western Curry County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 90, 148 p., 12 pls., scale 1:62,500.

#4103 Blake, M.C., Jr., Engebretson, D.C., Jayko, A.S., and Jones, D.L., 1985, Tectonostratigraphic terranes in southwest Oregon, *in* Howell, D.G., ed., Tectonostratigraphic terranes of the Circum-Pacific Region: Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, Number 1, p. 147-157.

#4160 Dott, R.H., Jr., 1971, Geology of the southwestern Oregon Coast west of the 124th meridian: State of Oregon, Department of Geology and Mineral Industries Bulletin 69, 63 p., 2 pls.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#464 Goldfinger, C., Kulm, L.D., Yeats, R.S., Mitchell, C., Weldon, R., II, Peterson, C., Darienzo, M., Grant, W., and Priest, G.R., 1992, Neotectonic map of the Oregon continental margin and adjacent abyssal plain: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-92-4, 17 p., 2 pls.

#4108 Kelsey, H.M., and Bockheim, J.G., 1994, Coastal landscape evolution as a function of eustasy and surface uplift rate, Cascadia margin, southern Oregon: Geological Society of America Bulletin, v. 106, p. 840-854.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4146 Ramp, L., Schlicker, H.G., and Gray, J.J., 1977, Geology, mineral resources, and rock material of Curry County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 93, 79 p., 2 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

**1490, East Pueblo Valley fault zone**

**Structure Number** 1490

Comments: Parts of this fault zone are included in fault number 48 of Pezzopane (1993 #3544), fault number 62 of Geomatrix Consultants, Inc. (1995 #3593), and fault number V10 of dePolo (1998 #2845).

**Structure Name** East Pueblo Valley fault zone

Comments: The fault zone includes faults mapped by D.B. Slemmons (1966, unpublished Vya 1° X 2° quadrangle), Dohrenwend and Moring (1991 #281) and Walker (1991 #3646), and includes faults in the East Pueblo Valley fault swarm of dePolo (1998 #2845) and the Pueblo Mountain faults of Pezzopane (1993 #3544). The fault zone is located in the southern Pueblo Valley flanking Black Mountain, the west slope of Lone Mountain, and along the western piedmont slope of the Trout Creek Mountains in northern Nevada and southern Oregon.

**Synopsis** This complex zone of faulting is marked by discontinuous fault scarps on piedmont deposits along the eastern margin of the southern Pueblo Valley and the west flank of the Trout Creek Mountains, from south of Trout Creek in southern Oregon to the southern end of Antelope Valley in northern Nevada. Fault scarps on late Pleistocene and Holocene(?) alluvial deposits indicate that most of the fault trace has been active in the late Quaternary. Trench investigations and detailed studies of scarp morphology have not been conducted, so reconnaissance photogeologic mapping of the fault zone is the primary source of data.

**Date of compilation** May 23, 2003

**Compiler and affiliation** Thomas L. Sawyer, Piedmont Geosciences, Reno, Nevada; and Stephen F. Personius, U.S. Geological Survey

**State** Nevada; Oregon

**County** Humboldt, NV; Harney, OR

**1° x 2° sheet** Adel, Vya

**Province** Basin and Range

**Quality of location** Good

Comments: Fault locations in Nevada are chiefly based on the 1:250,000-scale map of Dohrenwend and Moring (1991 #281), which was compiled from photogeologic analysis of 1:58,000-nominal-scale color-infrared photography transferred directly to 1:100,000-scale topographic quadrangle maps enlarged to the scale of the photographs and then reduced and transferred to 1:250,000-scale topographic maps. Fault locations in southernmost Pueblo Valley are mostly from unpublished 1:250,000-scale mapping of D.B. Slemmons (1966, unpublished Vya 1° X 2° quadrangle) from analysis of 1:60,000-scale AMS photography transferred to mylar overlaid onto a 1:250,000-scale topographic map using proportional dividers. Faults in Oregon are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** This complex fault zone forms part of the eastern margin of the Pueblo Valley, a large graben associated with major normal faulting on the Steens fault zone [856] located on the west side of the valley. The region is underlain by Miocene volcanic rock, primarily the Steens Basalt and rhyolitic rock of the McDermitt Caldera complex (Willden, 1964 #3002; Walker and Repenning, 1965 #3559; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: Faults in this zone are mapped as normal or high-angle faults by D.B. Slemmons (1966, unpublished Vya 1° X 2° quadrangle), Dohrenwend and Moring (1991 #281), Pezzopane (1993 #3544), and Geomatrix Consultants, Inc. (1995 #3593).

**Dip** Not reported

Comments:

**Main dip direction** W

**Geomorphic expression** This complex zone of faulting is marked by discontinuous fault scarps on piedmont deposits along the eastern margin of the Pueblo Valley and the subdued west flank of the Trout Creek Mountains (D.B. Slemmons, 1966, unpublished Vya 1° X 2° quadrangle, Dohrenwend and Moring, 1991 #281; Walker and MacLeod, 1991 #3646). Class C faults mapped on the southeastern margin of Pueblo Valley by Dohrenwend and Moring (1991 #281) are characterized by lineations and scarps on Tertiary rock and are not shown on the map.

**Age of faulted deposits at the surface** Quaternary alluvial deposits are faulted on the piedmont slopes of Lone Mountain and the Trout Creek Mountains, and juxtaposed against pre-Tertiary and Tertiary bedrock at Lone Mountain (D.B. Slemmons, 1966, unpublished Vya 1° X 2° quadrangle, Dohrenwend and Moring, 1991 #281; Walker and MacLeod, 1991 #3646). Near the south end of Pueblo Valley, late Pleistocene piedmont-slope deposits are faulted and deposits as young as latest Pleistocene and (or) Holocene may be faulted based on reconnaissance photogeologic mapping of Dohrenwend and Moring (1991 #281).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Late Quaternary (<130 ka)

Comments: Although timing of the most recent event is not well constrained, a late Quaternary time is suggested for most of the faults by reconnaissance photogeologic mapping of Dohrenwend and Moring (1991 #281) and Dohrenwend and others (1996 #2846); latest Pleistocene and (or) Holocene faulting is suspected near Antelope Valley (Dohrenwend and Moring, 1991 #281). Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Weldon and others (2002 #5648), mapped most of the fault zone in Oregon as middle and late Quaternary (<700-780 ka), with the exception of several short, latest Quaternary scarps at the north end of the zone. These younger scarps may be related to faulting events on the more-recently active Steens fault zone [856] located on the west side of Pueblo Valley. Madin and others (1996 #3479) mapped faults in the northern part of the fault zone as active in the Quaternary.

**Recurrence interval** Not reported

Comments:

**Slip-rate category** Unknown, probably <0.2 mm/yr

Comments: No slip studies have been performed on the East Pueblo Valley fault zone. dePolo (1998 #2845) estimated a reconnaissance vertical slip rate of 0.01 mm/yr (0.003 to 0.07 mm/yr) for his East Pueblo Valley fault swarm, but this estimate is based on an empirical relationship between maximum basal facet height and vertical slip rate, rather than field data. The late Quaternary characteristics of this fault (geomorphic expression, continuity of scarps, age of faulted deposits) support a low slip rate, so the less than 0.2 mm/yr slip-rate category is assigned herein.

| | | |
|---|---|---|
| **Length** | End to end (km): | 28.1 |
| | Cumulative trace (km): | 58.3 |

Comments:

**Average strike** (azimuth) N 17° E

**References**

#2845 dePolo, C.M., 1998, A reconnaissance technique for estimating the slip rate of normal-slip faults in the Great Basin, and application to faults in Nevada, U.S.A.: Reno, University of Nevada, unpublished Ph.D. dissertation, 199 p.

#281 Dohrenwend, J.C., and Moring, B.C., 1991, Reconnaissance photogeologic map of young faults in the Vya 1° by 2° quadrangle, Nevada, Oregon, and California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2174, 1 sheet, scale 1:250,000.

#2846 Dohrenwend, J.C., Schell, B.A., Menges, C.M., Moring, B.C., and McKittrick, M.A., 1996, Reconnaissance photogeologic map of young (Quaternary and late Tertiary) faults in Nevada, *in* Singer, D.A., ed., Analysis of Nevada's metal-bearing mineral resources: Nevada Bureau of Mines and Geology Open-File Report 96-2, 1 pl., scale 1:1,000,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company — Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

#3002 Willden, R., 1964, Geology and mineral deposits of Humboldt County, Nevada: Nevada Bureau of Mines and Geology Bulletin 59, 154 p., scale 1:250,000.

## 1507, Hoppin Peaks fault zone

**Structure Number** 1507

Comments: These structures are included in fault number 50 of Pezzopane (1993 #3544), fault number 63 of Geomatrix Consultants, Inc. (1995 #3593), and fault numbers MD1A and MD1B of dePolo (1998 #2845).

**Structure Name** Hoppin Peaks fault zone

Comments: The Nevada part of this fault zone was mapped and named the Hoppin Peaks fault zone by dePolo (1998 #2845); the Oregon part was mapped and named the Hoppin Peaks fault by Narwold (2001 #3010). Herein we use the name Hoppin Peaks fault zone to encompass both parts of the fault.

**Synopsis** This down-to-the-east fault zone forms an abrupt topographic escarpment between the eastern margins of the Double H Mountains, Montana Mountains, Hoppin Peaks, and the Oregon Canyon Mountains, and the western margin of the Quinn River Valley. Quaternary fault traces have been mapped from Twelvemile Summit at the north end of the Quinn River Valley, south across the Oregon-Nevada border to about 10 km south of Moonshine Canyon. The footwall block comprised of the Montana Mountains, Double H Mountains, Hoppin Peaks, and the Oregon Canyon Mountains forms a major east-tilted fault block in the northern Basin and Range; the adjacent Quinn River Valley is a graben filled with thousands of meters of Tertiary-Quaternary fill. The Hoppin Peaks fault zone is divided into two sections herein, a northern Oregon Canyon Mountains section and a southern Hoppin Peaks section. As is common along other faults in the Quinn River Valley, both sections of the fault zone have piedmont and range-front fault scarps, but fault scarps are more continuous along the Hoppin Peaks section. No detailed fault studies have been conducted, but most of the fault zone is mapped as having youngest movement in the middle to late Quaternary. Short piedmont scarps at the northern ends of the Hoppin Peak and Oregon Canyon Mountains sections appear to have been active in the latest Pleistocene or Holocene, but the short lengths of these scarps suggest that they may be related to paleoearthquakes on the more-recently active Santa Rosa Range fault system [1508] located on the east side of the Quinn River Valley.

**Date of compilation** December 12, 2002

**Compiler and affiliation** Kenneth D. Adams, Piedmont Geosciences, Inc.; Stephen F. Personius, U.S. Geological Survey

**Geologic setting** This down-to-the-east fault zone forms abrupt eastern topographic escarpments between the Double H Mountains, Montana Mountains, Hoppin Peaks, and the Oregon Canyon Mountains, and the western margin of the northern Quinn River Valley. The footwall block forms a major east-tilted fault block in the northern Basin and Range (Stewart, 1978 #2866); the adjacent Quinn River Valley is a graben filled with 1,200 to 2,450 m of Tertiary-Quaternary fill (Erwin and others, 1985 #3009; Erwin, 1988 #3008).

**Number of sections** 2

Comments: Although detailed studies along the entire fault zone have not been completed, two sections herein are inferred based on geometry of the zone, a northern Oregon Canyon Mountains section and a southern Hoppin Peaks section. The two sections are separated by an echelon 4-km-wide left step in the range front near Washburn Creek, 7 km south of the Oregon-Nevada border. Range front and piedmont fault scarps are more consistently present along the Hoppin Peaks section.

| | | |
|---|---|---|
| **Length** | End to end (km): | 91.1 |
| | Cumulative trace (km): | 140.1 |

Comments:

**Average strike** (azimuth) N 01° E

*1507a, Oregon Canyon Mountains section*

**Section number** 1507a

**Section name** Oregon Canyon Mountains section

Comments: This section is herein informally named after the Oregon Canyon Mountains, which form the footwall of this part of the fault zone.

**State** Oregon; Nevada

**County** Malheur (OR); Humboldt (NV)

**1° x 2° sheet** Jordan Valley; McDermitt

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault locations are based on 1:48,000-scale mapping of Narwold (2001 #3010) and 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Sense of movement** N

Comments: Structures in this zone are mapped as normal or high-angle faults by Walker and Repenning (1966 #3586), Greene (1972 #3007), Walker (1991 #3646), Michetti and Wesnousky (1993 #2540), Pezzopane (1993 #3544), and Narwold (2001 #3010).

**Dip** Not reported

Comments:

**Main dip direction** E

**Geomorphic expression** Faults in this section are primarily expressed as intermittent, echelon, mostly east-facing range front and piedmont fault scarps (Narwold, 2001 #3010). Piedmont and range-front scarps in this section are less continuous that those in the Hoppin Peaks section to the south.

**Age of faulted deposits at the surface** Faults in this section offset Miocene volcanic rocks (Walker and Repenning, 1966 #3586; Walker and MacLeod, 1991 #3646); piedmont scarps at the northern end of the section offset middle to late Pleistocene alluvium (Narwold, 1999 #4035; Narwold, 2001 #3010).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (< 750 ka)

Comments: The timing of the most-recent event is not well constrained on the Oregon Canyon Mountains section. Narwold (2001 #3010) maps most fault traces in the section as early to middle Pleistocene (0.13-1.5 Ma), which is consistent with Madin and others (1996 #3479) mapping of most of the same fault strands as pre-Holocene Quaternary. Some piedmont traces at the northern end of the section are mapped as latest Quaternary by Pezzopane (1993 #3544), Narwold (2001 #3010), and Weldon and others (2002 #5648). Given the lack of a continuously mapped range-front fault along most of the eastern margin of the Oregon Canyon Mountains, the young scarps at the northern end of the section may be related to fault rupture on the more-recently active Santa Rosa Range fault system [1508] on the eastern side of the Quinn River Valley.

**Recurrence interval** Not reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip data have been obtained on faults in the Oregon Canyon Mountains section. Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) used airphoto and limited reconnaissance to infer a slip rate of 0.5-1.0 mm/yr across a broad zone of faulting from the Steens Mountain/Alvord desert area across the Santa Rosa Range fault system, but how this slip is partitioned on the numerous faults in this area is unknown. Walker and Repenning (1966 #3586) show about 1 km of throw in Miocene volcanic rocks across the Oregon Canyon Mountains section near Rock Creek. Perhaps a better estimate of fault throw can be obtained by combining the topographic relief across the fault zone (about 650 m) with estimates of the thickness of valley-fill deposits in the Quinn River Valley (1200-2450 m, Erwin and others, 1985 #3009; Erwin, 1988 #3008). These data yield a vertical separation of 1850-3100 m in Miocene bedrock that is probably correlative with the 15-17 Ma (Sherrod and Johnson, 1994 #3563) Steens Basalt (Walker and Repenning, 1966 #3586; Walker and MacLeod, 1991 #3646). Such data yield low rates of long-term slip. The Hoppin Peaks fault zone is clearly less active than the nearby Santa Rosa Range fault system [1508], which has a recently determined Quaternary slip rate of <0.1 mm/yr (Personius and others, 2002 #5651; 2002 #5652).

**Length** End to end (km): 44.0
Cumulative trace (km): 54.2

Comments:

**Average strike** (azimuth) N 16° W

***1507b, Hoppin Peaks section***

**Section number** 1507b

Comments: This section consists of fault numbers MD1A and MD1B of dePolo (1998 #2845).

**Section name** Hoppin Peaks section

Comments: This section is herein informally named after Hoppin Peaks, which form the footwall of this part of the fault zone. This section is the Hoppin Peaks fault zone of dePolo (1998 #2845).

**State** Nevada

**County** Humboldt

**1° x 2° sheet** McDermitt

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault locations are primarily based on 1:48,000-scale mapping of Narwold (2001 #3010) and unpublished 1:100,000-scale mapping of Michetti and Wesnousky (1993 #2540), both of which were compiled from the same set of 1:12,000-scale low-sun-angle aerial photographs and field checked. Additional faults were located from the 1:250,000-scale reconnaissance photogeologic mapping of Dohrenwend and Moring (1991 #284), and the 1:48,000-scale bedrock mapping of Greene (1972 #3007).

**Sense of movement** N

Comments: Structures in this zone are mapped as normal or high-angle faults by D.B. Slemmons (1966, unpublished McDermitt 1° X 2° sheet), Greene (1972 #3007), Dohrenwend and Moring (1991 #284), Michetti and Wesnousky (1993 #2540), Pezzopane (1993 #3544), dePolo (1998 #2845), and Narwold (2001 #3010).

**Dip** Not reported

Comments:

**Main dip direction** E

**Geomorphic expression** Faults in this zone are primarily expressed as east-facing scarps and faults that juxtapose Quaternary alluvium against bedrock, although a few west-facing scarps also exist (Greene, 1972 #3007; Dohrenwend and Moring, 1991 #284; Narwold, 2001 #3010). Scarps along the range front are more continuous than scarps along the Oregon Canyon Mountains section. dePolo (1998 #2845) reports a maximum preferred basal fault facet height of 195 m along the Hoppin Peaks section.

**Age of faulted deposits at the surface** Faults in this zone displace Miocene volcanic rocks (Greene, 1972 #3007) and early to middle and/or late Pleistocene (Dohrenwend and Moring, 1991 #284) or middle to late Pleistocene (Narwold, 2001 #3010) alluvial-fan deposits.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** late Quaternary (< 130 ka)

Comments: Timing of the most recent event is not well constrained on the Hoppin Peaks section. Most fault scarps in the section are on early or middle Pleistocene alluvium. At one location south of Salient Peak, a splay of the range front fault is buried by the highest (Sehoo) shoreline of Lake Lahonton (Narwold, 2001 #3010), so latest movement on this scarp must predate the 13 ka age (Adams and Wesnousky, 1999 #3982) of this feature. However, a small piedmont scarp mapped by Narwold (2001 #3010) at the northern end of the section appears to have been active in the latest Pleistocene or Holocene. The short length (7 km) of this young fault scarp and proximity to extensive latest Quaternary fault scarps on the eastern side of the Quinn River Valley suggest that the young scarp may be related to fault rupture on the more-recently active Santa Rosa Range fault system [1508].

**Recurrence interval** Not reported

Comments:

**Slip-rate category** Unknown, probably <0.2 mm/yr

Comments: dePolo (1998 #2845) assigned a reconnaissance vertical slip rate of 0.361 mm/yr to the Hoppin Peaks section, based on an empirical relationship between his preferred maximum basal facet height and vertical slip rate. The size of the facets (tens to hundreds of meters, as measured from topographic maps) indicates they are the result of many seismic cycles, and thus the derived slip rate reflects a long-term average. No detailed slip studies have been conducted on the Hoppin Peaks section, but mapping by Narwold (2001 #3010) indicates that the youngest movement on most of the section predates the latest Quaternary, and only a single small scarp offsets late Pleistocene or possibly younger surfaces. The map relations of Narwold (2001 #3010), and determination of a <0.1 mm/yr slip rate (Personius and others, 2002 #5651; 2002 #5652) on the nearby (and more-recently active) Santa Rosa Range fault system [1508] suggest lower rates of slip on the Hoppin Peaks section than those estimated by dePolo (1998 #2845).

| | | |
|---|---|---|
| **Length** | End to end (km): | 54.9 |
| | Cumulative trace (km): | 85.9 |

Comments:

**Average strike** (azimuth) N 12° E

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#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

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## 1508, Santa Rosa Range fault system

**Structure Number** 1508

Comments: These structures are included in fault numbers 50 and 51 of Pezzopane (1993 #3544), fault number 63 of Geomatrix Consultants, Inc. (1995 #3593), and fault numbers MD2A and MD2B of dePolo (1998 #2845).

**Structure Name** Santa Rosa Range fault system

Comments: This system primarily includes faults on the east side of Quinn River Valley mapped by Russell (1884 #5099), Willden (1964 #3002), Walker and Repenning (1966 #3586), D.B. Slemmons (1966, unpublished McDermitt 1° X 2° sheet), Walker (1991 #3646), Vikre (1985 #3012), Dohrenwend and Moring (1991 #284), Michetti and Wesnousky (1993 #2540), and Narwold (2001 #3010). Pezzopane (1993 #3544, 1999) and Pezzopane and Weldon (1993 #149) include all of this fault system in the informally named Owyhee River-Oregon Canyon zone or fault zone and the Santa Rosa zone or fault zone. Narwold and Pezzopane (1997 #3011) referred to the northern part of the zone that extends into Oregon as the Quinn River fault zone, which they considered part of the Santa Rosa Range fault system of Michetti and Wesnousky (1993 #2540). The name Santa Rosa Range fault system is also used by dePolo (1998 #2845) in Nevada, so that name is retained herein.

**Synopsis** This long fault zone consists of two parts, a northern, northeast-striking zone of distributed faulting, and a north-striking southern part marked by nearly continuous range-bounding and piedmont faults; the latter part forms an escarpment between the western margin of the Santa Rosa Range and the eastern margin of the Quinn River Valley in northern Nevada and southeastern Oregon. The Santa Rosa Range is a major east-tilted fault block and the adjacent Quinn River Valley is a graben filled with thousands of meters of Tertiary-Quaternary fill. The Santa Rosa Range fault system is herein divided into three sections, from north to south, the Owyhee River, Quinn River, and Santa Rosa Peak sections, based on fault geometry and recency of fault movement. At the northern end of the system, faults in the Owyhee River section form a broad zone of northeast-striking, down-to-the-northwest and down-to-the-southeast fault scarps in Miocene to Pleistocene volcanic rocks. A few faults at the western end of the section have latest Quaternary displacements, but the most-recent event on most faults in the section appears to have occurred in the middle or late Pleistocene. A 7-km-wide gap in Quaternary fault scarps divides the northeast-striking Owyhee River section from the north-striking Quinn River section at the northern end of the Quinn River Valley. The Quinn River section has three distinct parts: 1) a north-striking northern part consisting of the High Peaks fault, which forms the eastern margin of the upper Quinn River Valley, 2) a northwest-striking piedmont fault, the Hot Springs Hills fault, and 3) a southeastern part that parallels the north-trending western flank of the Santa Rosa Range. The freshest fault morphology is found along the High Peaks and Hot Springs Hills faults, so apparently the most-recent fault activity on the fault system has stepped onto the piedmont Hot Springs Hills fault and has abandoned the western margin of the Santa Rosa Range north of Canyon Creek. The most-recent event on this section appears to have occurred in the latest Quaternary. The Quinn River and Santa Rosa Peak sections are separated by an echelon right step and a nearly 90° bend in the range front near Flat Creek in northern Nevada. The Santa Rosa Peak section is primarily characterized by a prominent range front with a secondary piedmont fault zone. The piedmont faults included in the section are expressed as small, west-facing scarps on Lahontan (13 ka) lacustrine deposits and post-Lahontan alluvium on the floor of the Quinn River Valley. The range-front fault oversteepens the base of the range, juxtaposes Quaternary alluvium against older bedrock, and is also characterized by rare west-facing scarps in alluvium. The most-recent event on the Santa Rosa Peak section also appears to have occurred in the latest Quaternary, but it is unknown if the latest events on the two southern sections occurred at the same time. The location and recency of fault movement may indicate that the Santa Rosa Range fault system is the northern extension of the central Nevada seismic belt.

**Date of compilation** December 11, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey; Kenneth D. Adams, Piedmont Geosciences, Inc.; Thomas L. Sawyer, Piedmont Geosciences, Inc.

**Geologic setting** This long fault zone consists of two parts, a northern, northeast-striking zone of distributed faulting formed in Pliocene(?) and Miocene volcanic rocks of the Owyhee plateau, and a north-striking southern part marked by nearly continuous range-bounding and piedmont fault zones (Michetti and Wesnousky, 1993 #2540; Narwold and Pezzopane, 1997 #3011; Narwold, 2001 #3010) that offset Pliocene(?) and Miocene volcanic rocks of the McDermitt Caldera complex (Walker and Repenning, 1966 #3586; Walker and MacLeod, 1991 #3646). The latter part forms an escarpment between the western margin of the Santa Rosa Range, a major east-tilted fault block (Stewart, 1978 #2866), and the eastern margin of the Quinn River Valley, a graben filled with 1,200 to 2,450 m of Tertiary-Quaternary fill (Erwin and others, 1985 #3009; Erwin, 1988 #3008). The Santa Rosa Range fault system may be a northern extension of the central Nevada seismic belt, a north-trending zone of historic surface ruptures (Pezzopane and Weldon, 1993 #149; Michetti and Wesnousky, 1993 #2540; Pezzopane, 1993 #3544).

**Number of sections** 3

Comments: Although detailed studies along the entire fault zone have not been completed, three sections are inferred based on geometry of the zone, the northernmost, northeast-striking Owyhee River section, and two north-striking sections, the Quinn River and Santa Rosa Peak sections. The Owyhee River section is separated from the Quinn River section by a 7-km-wide gap in Quaternary fault scarps and a sharp change in fault strike near Blue Mountain Pass. The Quinn River and Santa Rosa Peak sections are separated by an echelon right step and a nearly 90° bend in the range front near Flat Creek in northern Nevada. The Quinn River and Santa Rosa Peak sections have range-front and piedmont fault zones, but the Santa Rosa Peak section has a much higher, more abrupt range front. The Owyhee River section is characterized by broad groups of northeast-striking scarps.

| | | |
|---|---|---|
| **Length** | End to end (km): | 127.6 |
| | Cumulative trace (km): | 374.3 |

Comments:

**Average strike** (azimuth) N 11° E

### *1508a, Owyhee River section*

**Section number** 1508a

**Section name** Owyhee River section

Comments: This section is herein informally named after the nearby Owyhee River; this section was informally called the Owyhee zone or Owyhee River fault zone by Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149). Narwold and Pezzopane (1997 #3011) and Narwold (1999 #4035; 2001 #3010) include faults in the westernmost part of this section in their Quinn River fault zone.

**State** Oregon

**County** Malheur

**1° x 2° sheet** Jordan Valley

**Province** Basin and Range (Great Basin section), Columbia Plateaus (Payette section)

**Quality of location** Good

Comments: Fault locations are based on 1:48,000-scale mapping of Narwold (2001 #3010) for the westernmost part of the section, and 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544) for the rest of the section.

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Walker and Repenning (1966 #3586), Walker (1991 #3646), Narwold (2001 #3010), and Pezzopane (1993 #3544). Narwold and Pezzopane (1997 #3011) report a possible component of dextral shear on faults in their Quinn River fault zone, but Narwold (2001 #3010) concluded that the Quinn River fault zone has undergone primarily normal displacement.

**Dip** Not reported

Comments:

**Main dip direction** NW; SE

**Geomorphic expression** Faults in the Owyhee River section form a broad zone of northeast-striking, down-to-the-northwest and down-to-the-southeast fault scarps on Miocene to Pleistocene volcanic rocks (Walker and Repenning, 1966 #3586; Walker and MacLeod, 1991 #3646). Some of these fault scarps are hundreds of feet high, have broad, gentle slopes, and form broad, flat-floored grabens and half grabens (Pezzopane, 1999 #4039). These faults form sharp, prominent scarps on airphotos (Pezzopane, 1993 #3544), but on the ground appear to be comprised of bedrock controlled platforms that have been modified by slope wash and ephemeral stream erosion (Pezzopane, 1999 #4039). Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Faults in the Owyhee River section are mapped as offsetting Miocene to Pleistocene volcanic rocks and late Pleistocene to Holocene alluvium (Walker and Repenning, 1966 #3586; Walker and MacLeod, 1991 #3646). Some faults in the western part of the section offset “older(?)” Pleistocene alluvial-fan deposits at the mouths of Rattlesnake and Battle Creeks (Pezzopane, 1999 #4039), while others offset the “youngest alluvial surfaces” (Nakata and others, 1992 #3524).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (< 15 ka)

Comments: Timing of the most-recent event on faults in the Owyhee River section is poorly constrained and spatially variable. Narwold (2001 #3010) used scarp-profile analysis to infer a latest Pleistocene or Holocene age for three short scarps at the western end of the Owyhee River section; Nakata and others (1992 #3524) also reports offsets of the “youngest alluvial surfaces” near Blue Mountain Pass at the western end of the section. Pezzopane (1993 #3544) and Weldon and others (2002 #5648) used airphoto and DEM analyses to infer latest movement on most faults in the section in the Holocene or late Pleistocene, but field reconnaissance showed no evidence of young (Holocene?) faulting on faults near Grassy Mountain at the eastern end of the section (Pezzopane, 1999 #4039). The apparent concentration of latest Pleistocene or Holocene displacement on a few faults at the western end of the section suggests that latest movements on this part of the section may be related to paleoearthquakes on the more recently active Quinn River section to the south.

**Recurrence interval** Not reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip studies have been completed on faults in the Owyhee River section. Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) used airphoto and limited field reconnaissance to infer a slip rate of 0.5-1.0 mm/yr across a broad zone of faulting from the Steens Mountain/Alvord desert area across the Santa Rosa Range fault system, but how this slip is partitioned on the numerous faults in this area is unknown. Offsets of a few hundred feet in Miocene bedrock (Pezzopane, 1999 #4039) imply very low rates of long-term slip across faults in this section.

**Length** End to end (km): 46.7
Cumulative trace (km): 112.4

Comments:

**Average strike** (azimuth) N 48° E

***1508b, Quinn River section***

**Section number** 1508b

Comments: The Nevada portion of this section is fault number MD2A of dePolo (1998 #2845).

**Section name** Quinn River section

Comments: This section is named after the Quinn River fault zone of Narwold and Pezzopane (1997 #3011). Included in this section are the High Peak and Hot Spring Hills faults of Narwold (2001 #3010).

**State** Oregon; Nevada

**County** Malheur (OR); Humboldt (NV)

**1° x 2° sheet** Jordan Valley; McDermitt

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault locations are primarily based on 1:48,000-scale mapping of Narwold (2001 #3010) and unpublished 1:100,000-scale mapping of Michetti and Wesnousky (1993 #2540). Both of these projects used the same set of 1:12,000 scale low sun-angle aerial photography that were transferred to the different-scale base maps and field checked. Fault locations were checked against 1:250,000-scale mapping of Dohrenwend and Moring (1991 #284) in Nevada and 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544), in Oregon.

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Walker and Repenning (1966 #3586), Walker (1991 #3646), Dohrenwend (1991 #284), Michetti and Wesnousky (1993 #2540), and Narwold (2001 #3010). Narwold and Pezzopane (1997 #3011) report a possible component of dextral shear on faults in their Quinn River fault zone, but Narwold (2001 #3010) concluded that the Quinn River fault zone has undergone primarily normal displacement.

**Dip** 75°

Comments: A single dip measurement of 75° was measured from a fault gouge/bedrock exposure 3.5 km northwest of Little Louse Canyon (Narwold, 2001 #3010).

**Main dip direction** W

**Geomorphic expression** The Quinn River section has three distinct parts (Dohrenwend and Moring, 1991 #284; Michetti and Wesnousky, 1993 #2540; Narwold and Pezzopane, 1997 #3011; Narwold, 2001 #3010): 1) a north-striking northern part consisting of the High Peaks fault of Narwold (2001 #3010), which forms the eastern margin of the upper Quinn River Valley, 2) a northwest-striking piedmont fault, the Hot Springs Hills fault of Narwold (2001 #3010), and 3) a southeastern part that parallels the north-trending western flank of the Santa Rosa Range. The freshest fault morphology is found along the High Peaks and Hot Springs Hills faults of Narwold (2001 #3010), so apparently the most-recent fault activity on the fault system has stepped onto the piedmont Hot Springs Hills fault and is abandoning the western margin of the Santa Rosa Range north of Canyon Creek. Narwold and Pezzopane (1997 #3011) and Narwold (2001 #3010) conducted detailed scarp-morphology studies at multiple sites along the section and reported both single-event and compound west-facing scarps with vertical offsets of 0.3 m to 3 m on Holocene or late Pleistocene piedmont-slope deposits and more than 20 m of vertical separation on much older piedmont deposits. Michetti and Wesnousky (1993 #2540) reported an early Holocene rupture that rejuvenates older fault scarps and also cuts Holocene fluvial terraces in the northern part of the section. Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs of the area. dePolo (1998 #2845) reported a preferred value of 256 m for the maximum fault facet height along this part of the fault.

**Age of faulted deposits at the surface** Dohrenwend and Moring (1991 #284) reports scarps in early to late Pleistocene alluvium, and Narwold and Pezzopane (1997 #3011) and Narwold (1999 #4035; 2001 #3010) report fault scarps in early to late Pleistocene to Holocene(?) alluvium; Michetti and Wesnousky (1993 #2540) reported offset Holocene fluvial terraces at undisclosed locations along the piedmont fault scarps in the Quinn River section. Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) reported as much as 6 m of offset of Pleistocene-Holocene(?) alluvium at undisclosed locations along the Santa Rosa Range fault system.

**Paleoseismology studies**

**Time of most recent prehistoric faulting** latest Quaternary (< 15 ka)

Comments: Although timing of the most-recent event is not well constrained, a latest Quaternary time was reported by Michetti and Wesnousky (1993 #2540) and Narwold and Pezzopane (1997 #3011). Narwold (1999 #4035; 2001 #3010) used soils and scarp-morphology data to estimate an age of 10 ka for the most-recent event on the Hot Spring Hills part of the Quinn River section. Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) reported that the youngest late(?) Holocene stream terraces are offset at undisclosed locations along the Santa Rosa Range fault system, and Madin and others (1996 #3479) map most faults in the section in Oregon as Holocene. Weldon and others (2002 #5648) mapped the High Peaks and Hot Springs Hills faults of Narwold (2001 #3010) as active in the latest Quaternary (<20 ka), and the southeastern part that parallels the western flank of the Santa Rosa Range as active in the Quaternary (<1.6 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** <0.2 mm/yr

Comments: Narwold (1999 #4035; 2001 #3010) used field measurements of surface offset and estimated ages based on calcic soil development to estimate minimum vertical slip rates of 0.01-0.15 mm/yr on several parts of the Quinn River section. Pezzopane (1993 #3544) and Pezzopane and Weldon (1993 #149) used airphoto and limited reconnaissance to infer a slip rate of 0.5-1.0 mm/yr across a broad zone of faulting from the Steens Mountain/Alvord desert area across the Santa Rosa Range fault system, but how this slip is partitioned on the numerous faults in this area is unknown. dePolo (1998 #2845) assigned a reconnaissance vertical slip rate of 0.525 mm/yr for the Nevada part of the Santa Rosa fault system based on an empirical relationship between his preferred maximum basal facet height and vertical slip rate. The size of the facets (tens to hundreds of meters, as measured from topographic maps) indicates they are the result of many seismic cycles, and thus the derived slip rate reflects a long-term average. However, the more detailed data of Narwold (1999 #4035; 2001 #3010) suggests much lower slip rates throughout the Quaternary, so these values are used herein.

| | | |
|---|---|---|
| **Length** | End to end (km): | 57.5 |
| | Cumulative trace (km): | 192.6 |

Comments:

**Average strike** (azimuth) N 07° W

***1508c, Santa Rosa Peak section***

**Section number** 1508c

Comments: The Nevada portion of this section is fault number MD2B of dePolo (1998 #2845).

**Section name** Santa Rosa Peak section

Comments: This section is herein informally named after Santa Rosa Peak, the most prominent geographic feature in this part of the Santa Rosa Range.

**State** Nevada

**County** Humboldt

**1° x 2° sheet** McDermitt

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault locations primarily are based on unpublished 1:100,000-scale mapping of Michetti and Wesnousky (1993 #2540) which was produced from analysis of 1:12,000-scale low-sun-angle aerial photography transferred to the base maps and field checked. Additional faults were located from 1:250,000-scale maps of D.B. Slemmons (1966, unpublished McDermitt 1° X 2° sheet), and all fault locations were checked against the 1:250,000-scale map of Dohrenwend and Moring (1991 #284).

**Sense of movement** N

Comments: Faults in this section are mapped as normal or high-angle faults by Dohrenwend and Moring (1991 #284) and Michetti (1993 #2540). Narwold and Pezzopane (1997 #3011) report a possible component of dextral shear on faults in their Quinn River fault zone, but Narwold (2001 #3010) concluded that the Quinn River fault zone has undergone primarily normal displacement.

**Dip** Not reported

Comments:

**Main dip direction** W

**Geomorphic expression** This section is characterized by both a steep range front fault and a recently active piedmont fault zone (D.B. Slemmons, 1966, unpublished McDermitt 1° X 2° sheet, Michetti and Wesnousky, 1993 #2540). Piedmont faults in this section are expressed as small (<1 m high) west-facing scarps on Lahontan (13 ka) lacustrine deposits and post-Lahontan alluvium on the floor of the Quinn River Valley, 3-6 km west of the Santa Rosa Range (D.B. Slemmons, 1966, unpublished McDermitt 1° X 2° sheet, Dohrenwend and Moring, 1991 #284; Michetti and Wesnousky, 1993 #2540). The range-front fault lies along the oversteepened base of the range, which slopes about 20° to 24° (Michetti and Wesnousky, 1993 #2540), and juxtaposes Quaternary alluvium against older bedrock; rare west-facing scarps are present in a few places where late Quaternary alluvium is preserved at the mouths of a few of the larger canyons (Dohrenwend and Moring, 1991 #284). dePolo (1998 #2845) reported a preferred value of 256 m for the maximum fault facet height along this part of the fault.

**Age of faulted deposits at the surface** Dohrenwend and Moring (1991 #284) reported faults that displace early to late Pleistocene alluvium, and Michetti and Wesnousky (1993 #2540) report offsets of late Pleistocene shorelines of Lake Lahontan along the piedmont scarps herein included in the Santa Rosa Peak section.

**Paleoseismology studies** Personius and others (2002 #5651; 2002 #5652) conducted trench investigations at two sites along the Santa Rosa section. A trench on a small (0.5-m-high) piedmont fault scarp 7.5 km SW of Orovada that offsets shorelines of the youngest (Sehoo) highstand of Lake Lahontan collapsed during excavation and had to be abandoned before it could be logged. However, geomorphic relations clearly indicate the youngest event on the piedmont trace post-dates the 13-ka age (Adams and Wesnousky, 1999

#3982) of the shoreline (Michetti and Wesnousky, 1993 #2540). A second trench was excavated on the range front fault southeast of Orovada. The following discussion is based on preliminary results from this trench (S.F. Personius, unpublished data, Personius and others, 2002 #5651; 2002 #5652).

Site 1508c-1. The Orovada trench was excavated across an 8.5-m-high scarp on the westernmost of two strands that form a 1.5-km-wide left step in the range front 5 km southeast of Orovada, Nevada. The scarp crosses an old alluvial-fan complex that emanates from McConnell Creek and several other canyons along this part of the Santa Rosa section. Luminescence dating indicates that the faulted fan is at least as old as the Eetza cycle (MIS 6, Adams and Wesnousky, 1999 #3982) of pluvial Lake Lahontan. The presence of multiple colluvial wedges and intervening buried soils were used to infer at least four surface-rupturing earthquakes on this strand of the Santa Rosa section since fan deposition. The trench exposed a thick sequence of silty colluvial deposits and buried soils faulted against fan alluvium. Luminescence dating of the colluvial sediments yielded the following preliminary ages for these events: most-recent event—11-15 ka; penultimate event—90-94 ka; third event—136-137 ka; fourth event—>140 ka. The trench was not deep enough to expose fan deposits in the hanging wall so the post-fan paleoseismic record may be incomplete, but nearby stream exposures indicate that nearly all of the post-fan sediment in the hanging wall was exposed in the trench. The thicknesses of colluvial wedges (1-1.5 m) were as used to estimate displacements of 1-2 m/event. Scarp profiling and luminescence dating were used to determine a long-term slip rate at the Orovada trench site. Topographic profiles indicate about 7 m of surface offset across the trenched scarp. An older untrenched scarp just uphill from the trench has about 4 m of surface offset, and the eastern range-front strand, located about 1 km east of the trench site at the mouth of McConnell Creek, offsets the same fan surface about 3 m. The age of the offset fan is poorly constrained, but several luminescence ages suggest that the alluvium is quite old. The loess deposits overlying fan alluvium exposed in a soil pit in the footwall yielded an age of about 120 ka, and a less precise age from the underlying alluvium yielded an age of 330-550 ka. The oldest age from post-fan colluvium exposed in the trench was about 137 ka, so the fan surface is likely at least 140 ka and may be much older. The combined slip data indicate a long-term average slip rate across both range-front traces at the latitude of the trench site of <0.1 mm/yr.

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: Preliminary results from the Orovada trench site (S.F. Personius, unpublished data, Personius and others, 2002 #5651; 2002 #5652) indicate latest Quaternary (11-15 ka) displacement on the Santa Rosa section. Holocene ages were also reported by D.B. Slemmons (1966, unpublished McDermitt 1° X 2° sheet) and Michetti and Wesnousky (1993 #2540).

**Recurrence interval** Not Reported

Comments: Published recurrence data have not been reported, but the preliminary data of Personius and others (S.F. Personius, unpublished data, Personius and others, 2002 #5651; 2002 #5652) indicate tens of thousands of years between the last three surface-faulting events.

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: dePolo (1998 #2845) assigned a reconnaissance vertical slip rate of 0.525 mm/yr based on an empirical relationship between his preferred maximum basal facet height and vertical slip rate. The size of the facets (tens to hundreds of meters, as measured from topographic maps) indicates they are the result of many seismic cycles, and thus the derived slip rate reflects a long-term average. Better constrained data from the Orovada trench site (S.F. Personius, unpublished data, Personius and others, 2002 #5651; 2002 #5652) indicate a long-term average slip rate of <0.1 mm/yr.

| | | |
|---|---|---|
| **Length** | End to end (km): | 27.8 |
| | Cumulative trace (km): | 69.4 |

Comments:

**Average strike** (azimuth) N 01° E

**References**


#3982 Adams, K.D., and Wesnousky, S.G., 1999, The Lake Lahontan highstand—Age, surficial characteristics, soil development, and regional shoreline correlation: Geomorphology, v. 30, p. 357-392.

#2845 dePolo, C.M., 1998, A reconnaissance technique for estimating the slip rate of normal-slip faults in the Great Basin, and application to faults in Nevada, U.S.A.: Reno, University of Nevada, unpublished Ph.D. dissertation, 199 p.

#284 Dohrenwend, J.C., and Moring, B.C., 1991, Reconnaissance photogeologic map of young faults in the McDermitt 1° by 2° quadrangle, Nevada, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Field Studies Map MF-2177, 1 sheet, scale 1:250,000.

#3008 Erwin, J.W., 1988, Discussion of the McDermitt gravity sheet, Map #86: Nevada Bureau of Mines and Geology, Open File Report 88-2, 4 p.

#3009 Erwin, J.W., Ponce, D.A., and Wagini, A., 1985, Bouguer gravity map of Nevada, McDermitt sheet: Nevada Bureau of Mines and Geology, Map 86, scale 1:250,000.

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#3479 Madin, I.P., Ferns, M.F., Langridge, R., Jellinek, A.M., and Priebe, K., 1996, Final report to Bonneville Power Administration U.S. Department of Energy Portland General Electric Company — Geothermal resources of southeast Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report OFR-0-96-4, 41 p., 6 pls.

#2540 Michetti, A.M., and Wesnousky, S.G., 1993, Holocene surface faulting along the west flank of the Santa Rosa Range (Nevada-Oregon) and the possible northern extension of the central Nevada seismic belt: Geological Society of America Abstracts with Programs, v. 25, no. 5, p. 120-121.

#3524 Nakata, T., Weldon, R.J.I., Pezzopane, S., Rosenfeld, C., and Yeats, R.S., 1992, Preliminary aerial photo-interpretation of active faults in Oregon: Geological Society of America Abstracts with Programs, v. 24, no. 5, p. 72.

#4035 Narwold, C.F., 1999, Late Quaternary faulting along the Quinn River fault zone—A soils investigation, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 1, p. 1-18.

#3010 Narwold, C.F., 2001, Late Quaternary soils and faulting along the Quinn River fault zone, northern Nevada, southeastern Oregon: Arcata, California, Humboldt State University, unpublished M.S. thesis, 76 p., 4, scale 1:48,000.

#3011 Narwold, C.F., and Pezzopane, S.K., 1997, Preliminary analysis of late Quaternary faulting along the Quinn River fault zone, northern Nevada-southeastern Oregon: Geological Society of America Abstracts with Programs, v. 29, no. 6, p. A-323.

#5651 Personius, S.F., Anderson, R.E., Okumura, K., and Hancock, D.A., 2002, Preliminary results of a trench investigation of the Santa Rosa Range fault zone, Humboldt County, Nevada: Geological Society of America Abstracts with Programs, v. 34, no. 4, p. A-11.

#5652 Personius, S.F., Anderson, R.E., Okumura, K., Mahan, S.A., and Hancock, D.A., 2002, Preliminary paleoseismology of the Santa Rosa Range fault zone, Humboldt County, Nevada: Geological Society of America Abstracts with Programs, v. 34, no. 6, p. 27.

#4039 Pezzopane, S., 1999, Regional tectonic setting and fault studies in Quinn River Valley and surrounding regions, Oregon and Nevada, *in* Quaternary geology of the northern Quinn River and Alvord Valleys, southeastern Oregon: Friends of the Pleistocene Field Trip Guide, September 24-26, 1999, Appendix 6, p. 1-11.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#149 Pezzopane, S.K., and Weldon, R.J., II, 1993, Tectonic role of active faulting in central Oregon: Tectonics, v. 12, p. 1140-1169.

#5099 Russell, I.C., 1884, A geological reconnaissance in southern Oregon: U.S. Geological Survey Fourth Annual Report, p. 431-464.

#2866 Stewart, J.H., 1978, Basin-range structure in western North America—A review, *in* Smith, R.B., and Eaton, G.P., eds., Cenozoic tectonics and regional geophysics of the western cordillera: Geological Society of America Memoir 152, p. 1-31, scale 1:2,500,000.

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#3002 Willden, R., 1964, Geology and mineral deposits of Humboldt County, Nevada: Nevada Bureau of Mines and Geology Bulletin 59, 154 p., scale 1:250,000.

**1800, Unnamed Sheepshead Mountains faults**

**Structure Number** 1800

Comments:

**Structure Name** Unnamed Sheepshead Mountains faults

Comments: These unnamed faults form several grabens in Miocene volcanic rocks in the Sheepshead Mountains of southeastern Oregon (Russell, 1884 #5099; Walker and Repenning, 1965 #3559; Sherrod and others, 1989 #3745; Walker and MacLeod, 1991 #3646).

**Synopsis** These north-striking high-angle faults form several grabens in Miocene volcanic rocks in southeastern Oregon. No detailed information on Quaternary offset is available, but limited airphoto reconnaissance suggests possible Quaternary displacement.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Harney

**1° x 2° sheet** Adel

**Province** Basin and Range (Great Basin section)

**Quality of location** Good

Comments: Fault locations are from 1:50,000-scale mapping of Sherrod and others (1989 #3745) and 1:100,000-scale mapping of Weldon and others (2002 #5648).

**Geologic setting** These north-striking faults form several grabens in Miocene volcanic rocks (Walker and Repenning, 1965 #3559; Sherrod and others, 1989 #3745; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Walker and Repenning (1965 #3559), Sherrod and others (1989 #3745), and Walker and MacLeod (1991 #3646).

**Dip** Not reported

Comments:

**Main dip direction** E, W

**Geomorphic expression** These faults form several north-trending grabens filled with Quaternary alluvial and lacustrine sediments and are marked by 100-m-high escarpments on Miocene volcanic rocks. Sherrod and others (1989 #3745) observed no deformation of Quaternary surficial and volcanic rocks on faults in the Sheepshead Mountains. Weldon and others (2002 #5648) observed lineaments across Quaternary units on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** These faults offset Miocene volcanic rocks (Walker and Repenning, 1965 #3559; Sherrod and others, 1989 #3745; Walker and MacLeod, 1991 #3646). Sherrod and others (1989 #3745) observed no deformation of Quaternary surficial and volcanic rocks on faults in the Sheepshead Mountains, but Walker and Repenning (1965 #3559) and Walker and MacLeod (1991 #3646) map Pleistocene to Holocene alluvium faulted against Miocene bedrock along some of these faults.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Sherrod and others (1989 #3745) observed no deformation of Quaternary surficial and volcanic rocks on faults in the Sheepshead Mountains, but Weldon and others (2002 #5648) used airphotos, 1:100,000 scale DEMs, and geomorphic analysis to infer fault activity in the Quaternary (<1.6 Ma).

**Recurrence interval** Not reported

Comments:

**Slip-rate category** unknown, probably <0.2 mm/yr

Comments: No published slip rate data are available for these faults. However, Sherrod and others (1989 #3745) observed as much as 325 m of offset of Miocene volcanic rocks on major faults in the Sheepshead Mountains. Such offsets imply low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 28.7 |
| | Cumulative trace (km) | 77.6 |

Comments:

**Average strike** (azimuth) N 12° E

**References**


#5099 Russell, I.C., 1884, A geological reconnaissance in southern Oregon: U.S. Geological Survey Fourth Annual Report, p. 431-464.

#3745 Sherrod, D.R., Minor, S.A., and Vercoutere, T.L., 1989, Geologic map of the Sheepshead Mountains, Harney and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-2079, 1 sheet, scale 1:50,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3559 Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-446, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**1801, Warm Springs fault**

**Structure Number** 1801

Comments:

**Structure Name** Warm Springs fault

Comments: The Warm Springs fault was informally named by Hawkins and others (1989 #3551), presumably after nearby Warm Springs Creek.

**Synopsis** These north-striking high-angle faults offset Miocene basalt, andesite, and tuffaceous sedimentary rocks in east-central Oregon. No detailed information on Quaternary offset is available, but regional geologic mapping and limited airphoto and field reconnaissance suggests possible Quaternary displacement.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Harney

**1° x 2° sheet** Burns

**Province** Columbia Plateaus (Payette section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Greene and others (1972 #3560).

**Geologic setting** These north-striking high-angle faults offset Miocene basalt, andesite, and tuffaceous sedimentary rocks (Greene and others, 1972 #3560; Walker, 1977 #3749; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: These structures as depicted as high-angle, presumably normal faults on maps of Greene and others (1972 #3560), Hawkins and others (1989 #3551), Walker (1977 #3749), and Walker and MacLeod (1991 #3646).

**Dip** Not Reported

Comments:

**Main dip direction** E

**Geomorphic expression** Hawkins and others (1989 #3551) describe the geomorphic expression of these faults as a subdued series of small escarpments and lineaments, marked in places by springs and mass movements related to spring sapping. They also describe an undated but probable late Quaternary terrace that extends unfaulted across the fault trace. Weldon and others (2002 #5648) observed lineaments across Quaternary units on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Existing geologic maps show the fault offsetting Miocene volcanic and sedimentary rocks (Greene and others, 1972 #3560; Walker, 1977 #3749; Walker and MacLeod, 1991 #3646).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Hawkins and others (1989 #3551) conducted air photo and field reconnaissance and found no evidence of late Quaternary displacement. Weldon and others (2002 #5648) used airphotos and 1:100,000 scale DEMs to infer fault activity in the Quaternary (<1.6 Ma).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the Warm Springs fault, but the poor geomorphic expression of these faults suggest low rates of slip.

**Length** End to end (km): 8.7
Cumulative trace (km): 16.3

Comments:

**Average strike** (azimuth) N 16° W

**References**

#3560 Greene, R.C., Walker, G.W., and Corcoran, R.E., 1972, Geologic map of the Burns quadrangle, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-680, 2 sheet, scale 1:250,000.

#3551 Hawkins, F.F., Gilbert, J.D., and LaForge, R.C., 1989, Seismotectonic study for Warm Springs Dam-Vale Project and Owyhee Dam-Owyhee Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 89-6, 35 p., 2 pls.

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#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**1802, Harney fault**

**Structure Number** 1802

Comments:

**Structure Name** Harney fault

Comments: The Harney fault forms the eastern margin of the Harney basin in central Oregon (Greene and others, 1972 #3560; Walker, 1977 #3749; Hawkins and others, 1989 #3551; Walker and MacLeod, 1991 #3646).

**Synopsis** This north-striking high-angle fault forms 150-m-high escarpments on Miocene volcanic rocks along the eastern margin of the Harney basin and the western margin of the Crane Creek Mountains in central Oregon. No detailed information on Quaternary offset is available, but regional geologic mapping and limited airphoto and field reconnaissance suggests possible middle or late Quaternary displacement.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Harney

**1° x 2° sheet** Burns

**Province** Columbia Plateaus (Payette section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000 mapping of Greene and others (1972 #3560).

**Geologic setting** This north-striking high-angle fault forms the eastern margin of the Harney basin and the western margin of the Crane Creek Mountains. The area is underlain by Miocene basalt and andesite in the Crane Creek Mountains and Quaternary alluvial and lacustrine deposits in the Harney basin (Greene and others, 1972 #3560; Walker, 1977 #3749; Walker and MacLeod, 1991 #3646).

**Sense of movement** N

Comments: These structures as depicted as high-angle, presumably normal faults on maps of Greene and others (1972 #3560), Hawkins and others (1989 #3551), Walker (1977 #3749), and Walker and MacLeod (1991 #3646).

**Dip** Not Reported

Comments:

**Main dip direction** W

**Geomorphic expression** The fault forms 150-m-high escarpments on Miocene volcanic rocks along the eastern margin of the Harney basin. Hawkins and others (1989 #3551) report the geomorphic expression as very subdued on aerial photographs. Weldon and others (2002 #5648) observed lineaments across Quaternary units on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** Greene and others (1972 #3560) show the fault offsetting Quaternary (Pleistocene and Holocene) alluvium and alluvial-fan deposits; Walker (1977 #3749) and Walker and MacLeod (1991 #3646) map Pleistocene and Holocene(?) alluvium faulted against Miocene bedrock.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Hawkins and others (1989 #3551) conducted air photo and field reconnaissance and found no evidence of late Quaternary displacement. Weldon and others (2002 #5648) used airphotos and 1:100,000 scale DEMs to infer fault activity in the middle to late Quaternary (<780 ka).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available, but the subtle geomorphic expression of the Harney fault suggests low rates of slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 29.5 |
| | Cumulative trace (km): | 30.6 |

Comments:

**Average strike** (azimuth) N 02° W

**References**


#3560 Greene, R.C., Walker, G.W., and Corcoran, R.E., 1972, Geologic map of the Burns quadrangle, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-680, 2 sheet, scale 1:250,000.

#3551 Hawkins, F.F., Gilbert, J.D., and LaForge, R.C., 1989, Seismotectonic study for Warm Springs Dam-Vale Project and Owyhee Dam-Owyhee Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 89-6, 35 p., 2 pls.

#3749 Walker, G.W., 1977, Geologic map of Oregon east of the 121st meridian: U.S. Geological Survey Miscellaneous Investigations Map I-902, 2 sheets, scale 1:500,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 1803, Unnamed East Christmas Lake Valley faults

**Structure Number** 1803

Comments:

**Structure Name** Unnamed East Christmas Lake Valley faults

Comments: This group of unnamed faults is located east of Christmas Lake Valley and were originally mapped by Hampton (1964 #3790) and Walker and others (1967 #3564). From north to south, these faults form the eastern margin of Christmas Lake Valley along Wildcat Butte, Stauffer Rim and the western margin of Overall Flat, the margin between Rams Butte and the eastern margin of Jew Valley, and part of the northwestern margin of Alkali Valley.

**Synopsis** These northwest-striking high-angle faults are located in the central part of the Brothers fault zone [819], a 250- to 300-km long zone of high-angle faulting that may be the surface manifestation of a regional-scale right-lateral shear zone. The faults form escarpments on Miocene and Pliocene bedrock. In some places, the faults are mapped as juxtaposing Quaternary sediments against bedrock, but no fault scarps on Quaternary deposits have been described along their traces. Analyses of airphotos and 1:100,000-scale DEMs were used to infer Quaternary displacement on these faults.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake

**1° x 2° sheet** Crescent

**Province** Columbia Plateaus (Harney section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Walker and others (1967 #3564) and 1:500,000-scale mapping of Walker and MacLeod (1991 #3646).

**Geologic setting** These northwest-striking high-angle faults are located in the central part of the Brothers fault zone [819], a 250- to 300-km-long zone of high-angle faulting that may be the surface manifestation of a regional-scale right-lateral shear zone (Walker, 1969 #4296; Stewart and others, 1975 #3769; Lawrence, 1976 #3506; Walker and Nolf, 1981 #4310; 1981 #4311). The area is underlain by Miocene and Pliocene volcanic and tuffaceous sedimentary rocks (Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646).

**Sense of movement** N, D?

Comments: These structures as depicted as normal or high-angle faults on maps of Hampton (1964 #3790), Walker and others (1967 #3564), Walker and MacLeod (1991 #3646). If they are part of the Brothers fault zone [819], then they may represent part of the surface manifestations of a regional right-lateral shear zone (Lawrence, 1976 #3506).

**Dip** Not Reported

Comments:

**Main dip direction** NE and SW

**Geomorphic expression** These northwest-striking faults form 20- to 80-m-high escarpments on Miocene and Pliocene rocks along the margins of Christmas Lake Valley, Overall Flat, Jew Valley, and Alkali Valley. No data on the geomorphic expression of these escarpments has been described, but Weldon and others (2002 #5648) observed lineaments across Quaternary deposits on 1:100,000-scale DEMs.

**Age of faulted deposits at the surface** These northwest-trending faults form escarpments on Miocene and Pliocene bedrock. In some places, the faults are mapped as juxtaposing Quaternary sediments against bedrock (Hampton, 1964 #3790; Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646), but no fault scarps in Quaternary deposits have been described along their traces.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Weldon and others (2002 #5648) used analysis of airphotos and 1:100,000-scale DEMs to infer Quaternary displacement on these faults. No other fault compilations in the region include these faults as potential seismic sources (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed faults east of Christmas Lake Valley. The largest of these faults is marked by 80-m-high escarpments on Pliocene and Miocene volcanic rocks; such slip data indicate low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 41.9 |
| | Cumulative trace (km): | 62.2 |

Comments:

**Average strike** (azimuth) N 24° W

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3790 Hampton, E.R., 1964, Geologic factors that control the occurrence and availability of ground water in the Fork Rock Basin Lake County, Oregon: U.S. Geological Survey Professional Paper 383-B, 29 p., 2 pls., scale 1:62,500.

#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3769 Stewart, J.H., Walker, G.W., and Kleinhampl, F.J., 1975, Oregon-Nevada lineament: Geology, v. 3, no. 5, p. 265-268.

#4296 Walker, G.W., 1969, Geology of the High Lava Plains Province, *in* Mineral and water resources of Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 64, p. 77-79.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4310 Walker, G.W., and Nolf, B., 1981, High Lava Plains, Brothers fault zone to Harney Basin, Oregon, *in* Johnston, D.A., and Donnelly-Nolan, J., eds., Guides to some volcanic terranes in Washington, Idaho, Oregon, and northern California: U.S. Geological Survey Circular 838, p. 105-111.

#4311 Walker, G.W., and Nolf, B., 1981, Roadlog for High Lava Plains, Brothers fault zone to Harney Basin, Oregon, *in* Johnston, D.A., and Donnelly-Nolan, J., eds., Guides to some volcanic terranes in Washington, Idaho, Oregon, and northern California: U.S. Geological Survey Circular 838, p. 113-140.

#3564 Walker, G.W., Peterson, N.V., and Greene, R.C., 1967, Reconnaissance geologic map of the east half of the Crescent quadrangle Lake, Deschutes, and Crook Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-493, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**1804, Unnamed fault east of the Dust Bowl**

**Structure Number** 1804

Comments:

**Structure Name** Unnamed fault east of the Dust Bowl

Comments: This unnamed fault is located east of the Dust Bowl in central Oregon (Pezzopane, 1993 #3544).

**Synopsis** This north-striking fault apparently forms the eastern margin of the Dust Bowl and Street Flat, which comprise a small structural basin in central Oregon. The area lies just north of the northwest-striking Brothers fault zone [819], and is underlain by Miocene and Pliocene welded tuffs and tuffaceous sedimentary rocks. The fault traces do not precisely coincide with any mapped faults on existing geologic maps, although in some places the fault traces are nearly coincident with linear mapped contacts between geologic units. This fault is not included in some compilations of active faults in the region, and no offsets of Quaternary deposits have been described. Analyses of airphotos and 1:100,000-scale DEMs were used to infer middle or late Quaternary displacement.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Crook, Deschutes

**1° x 2° sheet** Burns

**Province** Columbia Plateaus (Harney section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:500,000-scale mapping of Pezzopane (1993 #3544).

**Geologic setting** This north-striking fault apparently forms the eastern margin of the Dust Bowl and Street Flat, which comprise a small structural basin in central Oregon. The area lies just north of the northwest-striking Brothers fault zone [819] (Lawrence, 1976 #3506), and is underlain by Miocene and Pliocene welded tuffs and tuffaceous sedimentary rocks (Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646). The fault traces mapped by Pezzopane (1993 #3544) and Weldon and others (2002 #5648) do not precisely coincide with any mapped faults on existing geologic maps (Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646), although in some places the fault traces are nearly coincident with linear mapped contacts between geologic units. This fault is not included in other compilations of active faults in the region (Hawkins and others, 1988 #2946; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Ake and others, 2001 #5035).

**Sense of movement** N

Comments: These structures as depicted as high-angle, presumably normal faults by Pezzopane (1993 #3544).

**Dip** Not Reported

Comments:

**Main dip direction** W

**Geomorphic expression** Not Reported

**Age of faulted deposits at the surface** The fault is not shown on existing geologic maps, but the area is underlain by Miocene and Pliocene welded tuffs and tuffaceous sedimentary rocks (Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646). No offsets in Quaternary deposits have been described.

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Pezzopane (1993 #3544) used airphoto analysis to infer middle or late Quaternary (<700 ka) displacement on the faults east of the Dust Bowl. Weldon and others (2002 #5648) used analysis of airphotos and 1:100,000-scale DEMs to infer middle or late Quaternary (<780 ka) displacement on these faults.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for the unnamed fault east of the Dust Bowl.

| | | |
|---|---|---|
| **Length** | End to end (km): | 14.1 |
| | Cumulative trace (km): | 12.6 |

Comments:

**Average strike** (azimuth) N 14° W

**References**


#5035 Ake, J., LaForge, R., and Hawkins, F., 2001, Probabilistic seismic hazard analysis for Wickiup Dam—Deschutes project, central Oregon: U.S. Bureau of Reclamation Seismotectonic Report 2000-04, 71 p.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3560 Greene, R.C., Walker, G.W., and Corcoran, R.E., 1972, Geologic map of the Burns quadrangle, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-680, 2 sheet, scale 1:250,000.

#2946 Hawkins, F.F., LaForge, R.C., Templeton, M., and Gilbert, J.D., 1988, Seismotectonic study for Arthur R. Bowman and Ochoco Dams, Crooked River Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 88-10, 57 p., 2 pls.

#3506 Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, p. 846-850.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**1805, Unnamed faults near Arrowwood Point (Class B)**

**Structure Number** 1805

Comments:

**Structure Name** Unnamed faults near Arrowwood Point

Comments: These unnamed faults are located near Arrowwood Point in central Oregon (Swanson, 1969 #3592; Walker and MacLeod, 1991 #3646; Pezzopane, 1993 #3544).

**Synopsis** These east-west-striking faults form a graben in middle(?) Pliocene to lower Pleistocene basalts in an eruptive center near Arrowwood Point in central Oregon. The faults are mostly restricted to volcanic rocks and may be related to volcano-tectonic processes. No field studies have been described, but the limited available data have been used to infer middle and late Quaternary displacement. Herein the faults are classified as Class B structures because of their probable volcanic origin.

**Date of compilation** December 9, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Crook

**1° x 2° sheet** Bend

**Province** Columbia Plateaus (Walla Walla Plateau section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others (2002 #5648), based on 1:250,000-scale mapping of Swanson (1969 #3592).

**Geologic setting** These east-west-striking faults form a graben in middle(?) Pliocene to lower Pleistocene basalts in an eruptive center near Arrowwood Point in central Oregon (Swanson, 1969 #3592; Walker and MacLeod, 1991 #3646). The faults are mostly restricted to volcanic rocks and may be related to volcano-tectonic processes.

**Sense of movement** N

Comments: These structures as depicted as normal faults on the maps of Swanson (1969 #3592) Walker (1991 #3646), and Pezzopane (1993 #3544).

**Dip** Not Reported

Comments:

**Main dip direction** N, S

**Geomorphic expression** No information on geomorphic expression is available. Swanson (1969 #3592) describes the volcanic rocks in this vicinity as “prominently faulted”. Escarpments approximately 30 to 40 m high on Plio-Pleistocene volcanic rocks are coincident with the most prominent of these faults. Weldon and others (2002 #5648) observed lineaments across Quaternary units on 1:100,000-scale DEMs of the area.

**Age of faulted deposits at the surface** The faults are developed in rocks mapped as middle(?) Pliocene to lower Pleistocene (Swanson, 1969 #3592; Walker and MacLeod, 1991 #3646).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments:  Pezzopane (1993 #3544) used airphoto analysis and Weldon and others (2002 #5648) used analysis of airphotos and 1:100,000-scale DEMs to infer middle and late Quaternary (<700-780 ka) displacement.  However, these faults are mapped as Class B structures herein because of their probable volcanic origin.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments:  No published slip data are available for the unnamed faults near Arrowwood Point.  However, probable 30- to 40-m-high escarpments on middle(?) Pliocene to lower Pleistocene volcanic rocks indicate low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 13.1 |
| | Cumulative trace (km): | 15.4 |

Comments:

**Average strike** (azimuth) N 68° W

**References**

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon:  Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3592 Swanson, D.A., 1969, Reconnaissance geologic map of the east half of the Bend quadrangle, Crook, Wheeler, Jefferson, Wasco, and Deschutes Counties, Oregon:  U.S. Geological Survey Miscellaneous Geologic Investigations I-568, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon:  U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon:  U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**1806, Newberry volcano ring faults (Class B)**

**Structure Number** 1806

Comments:

**Structure Name** Newberry volcano ring faults (Class B)

Comments: This group of faults form the caldera rims of the Newberry volcano in central Oregon (MacLeod and Sherrod, 1992 #3566; MacLeod and others, 1995 #3557).

**Synopsis** These ring faults form the caldera rims of the Newberry volcano, a large shieldlike Quaternary volcano that lies near the boundary between the Cascade Range and Basin and Range physiographic provinces in central Oregon. Mapped rock units comprising the volcano are mostly rhyolitic in composition and range in age from about 600 ka to the late Holocene. Individual sections of the ring faults form escarpments more than 100 m high on late Quaternary volcanic rocks of the Newberry volcano. However, these faults are everywhere concealed, and have been mapped on the basis of the topographic expression of these escarpments. The faults form several nested caldera rims, each of which probably collapsed during individual pumicious eruptions. We classify these features as Class B because they are volcanic features associated with caldera collapse, rather than tectonic faulting, and thus do not constitute a significant seismic hazard.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Deschutes

**1° x 2° sheet** Crescent

**Province** Columbia Plateaus (Harney section)

**Quality of location** Good

Comments: Fault traces are from 1:24,000-scale mapping of MacLeod and others (1995 #3557), summarized at 1:100,000-scale by Weldon and others (2002 #5648).

**Geologic setting** These faults form the caldera rims of the Newberry volcano, a large shieldlike Quaternary volcano that lies near the boundary between the Cascade Range and Basin and Range physiographic provinces in central Oregon. Mapped rock units comprising the volcano are mostly rhyolitic in composition and range in age from about 600 ka to the late Holocene (MacLeod and others, 1995 #3557).

**Sense of movement** N

Comments: These faults are mapped as a normal (ring) faults by MacLeod and Sherrod (1992 #3566) and MacLeod and others (1995 #3557).

**Dip** Not Reported

Comments:

**Main dip direction** Not applicable

Comments: These faults rim the caldera walls in a circular pattern, and thus dip in all directions.

**Geomorphic expression** Individual sections of the ring faults form escarpments more than 100 m high on late Quaternary volcanic rocks of the Newberry volcano. However, these faults are everywhere concealed, and have been mapped on the basis of the topographic expression of these escarpments (MacLeod and others, 1995 #3557). The faults form several nested caldera rims, each of which probably collapsed during individual pumicious eruptions (MacLeod and others, 1995 #3557).

**Age of faulted deposits at the surface** The rim faults are formed in late Holocene to middle Pleistocene volcanic rocks of Newberry volcano (MacLeod and others, 1995 #3557).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: The rim faults are formed in late Holocene to middle Pleistocene volcanic rocks of Newberry volcano; the youngest extensive eruption occurred about 1,300 yr B.P. (MacLeod and others, 1995 #3557). Weldon and others (2002 #5648) mapped these faults as active in the late (<120 ka) or latest (<20 ka) Quaternary.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: Escarpments more than 100 m high on Quaternary volcanic rocks could imply high rates of slip, but these features are associated with caldera collapse, rather than tectonic faulting. Their mode of formation is poorly known: they could have formed as single events as block collapse or slumping, and likely are associated with collapse following individual voluminous pumicious eruptions (MacLeod and others, 1995 #3557).

| | | |
|---|---|---|
| **Length** | End to end (km): | 7.6 |
| | Cumulative trace (km): | 26.5 |

Comments:

**Average strike** (azimuth) N 16° W (these faults rim the caldera walls in a circular pattern and thus strike in all directions)

**References**

#3566 MacLeod, N.S., and Sherrod, D.R., 1992, Reconnaissance geologic map of the west half of the Crescent 1° by 2° quadrangle, central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2215, 1 sheet, scale 1:250,000.

#3557 MacLeod, N.S., Sherrod, D.R., Chitwood, L.A., and Jensen, R.A., 1995, Geologic map of Newberry Volcano, Deschutes, Klamath, and Lake Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2455, 2 sheets, scale 1:24,000 and 1:62,500.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**1807, Mount Mazama ring faults (Class B)**

**Structure Number** 1807

Comments:

**Structure Name** Mount Mazama ring faults (Class B)

Comments: This group of faults forms the caldera rim of Mount Mazama, the volcano in which the Crater Lake caldera is formed in south-central Oregon (Bacon and Nathenson, 1996 #3541; Bacon and others, 1997 #3516).

**Synopsis** These faults form the rim of the Crater Lake caldera, which formed about 7.7 ka in Mount Mazama, a large Quaternary stratovolcano in the Cascade Range of south-central Oregon. Mount Mazama is comprised of andesite to rhyodacite rocks which range in age from about 400 ka to the middle Holocene. The caldera may be localized at the intersection of the Klamath graben with the Cascades volcanic province. The mode of formation of these faults is poorly known, but they probably occurred as collapse in as little as a few days following the climactic eruption 7.7 ka. These faults are classified as Class B structures herein because they are volcanic features associated with caldera collapse, rather than tectonic faulting, and thus do not constitute a significant seismic hazard.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Klamath

**1° x 2° sheet** Medford

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains sections)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Weldon and others, (2002 #5648).

**Geologic setting** These faults form the rim of the Crater Lake caldera, which formed about 7.7 ka in Mount Mazama, a large Quaternary stratovolcano in the Cascade Range of south-central Oregon. Mount Mazama is comprised of andesite to rhyodacite rocks which range in age from about 400 ka to the middle Holocene. The caldera may be localized at the intersection of the Klamath graben with the Cascades volcanic province (Bacon, 1983 #3787; Bacon and Nathenson, 1996 #3541; Bacon and others, 1997 #3516).

**Sense of movement** N

Comments: These faults are mapped as normal (ring) faults by Sherrod and Smith (2000 #5165) and Weldon and others, (2002 #5648).

**Dip** Not Reported

Comments:

**Main dip direction** Not applicable

Comments: These faults rim the caldera walls in a circular pattern, and thus dip in all directions.

**Geomorphic expression** No details of the geomorphic expression of these faults has been published. The steep rim of Crater Lake is at least 370 m high, and the lake reaches depths of more than 500 m. None of the published geologic maps of the area (Smith and others, 1982 #3493; Sherrod and Smith, 1989 #3498; Walker and MacLeod, 1991 #3646; Bacon and others, 1997 #3516), with the exception of Sherrod and Smith (2000 #5165), show the ring fractures mapped by Weldon and others, (2002 #5648). Bacon (1983 #3787) postulated a collapse ring about 5 km in diameter, and a postulated ring fracture zone of similar dimension has been mapped in the subsurface of Crater Lake, based on the locations of a ring of explosion craters on the caldera floor (Nelson and others, 1988 #5039; Bacon and Nathenson, 1996 #3541). These postulated fracture zones are about 1 km inboard of the mapped trace of Weldon and others, (2002 #5648), which coincides with the steep topographic rim of the caldera.

**Age of faulted deposits at the surface** The rim faults are formed in middle Holocene to middle Pleistocene volcanic rocks of Mount Mazama (Bacon, 1983 #3787; Bacon and Nathenson, 1996 #3541; Bacon and others, 1997 #3516; Sherrod and Smith, 2000 #5165).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** latest Quaternary (<15 ka)

Comments: The rim faults are formed in middle Holocene to middle Pleistocene volcanic rocks of Mount Mazama; the youngest extensive eruption occurred about 7.7 ka (Bacon, 1983 #3787; Bacon and Nathenson, 1996 #3541; Bacon and others, 1997 #3516). Weldon and others (2002 #5648) mapped these faults as active in the latest (<20 ka) Quaternary.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: Escarpments hundreds of meters high on Quaternary volcanic rocks imply high rates of slip, but these features are associated with caldera collapse, rather than tectonic faulting. Their mode of formation is poorly known, but probably occurred as collapse in as little as a few days following the climactic eruption 7.7 ka (Bacon and Nathenson, 1996 #3541).

| | | |
|---|---|---|
| **Length** | End to end (km): | 8.0 |
| | Cumulative trace (km): | 27.1 |

Comments:

**Average strike** (azimuth) N 87° W (these faults rim the caldera walls in a circular pattern and thus strike in all directions)

**References**


#3787 Bacon, C.R., 1983, Eruptive history of Mount Mazama and Crater Lake Caldera, Cascade Range, USA: Journal of Volcanology and Geothermal Research, v. 18, p. 57-115.

#3516 Bacon, C.R., Mastin, L.G., Scott, K.M., and Nathenson, M., 1997, Volcano and earthquake hazards in the Crater Lake region, Oregon: U.S. Geological Survey Open-File Report 97-487, 30 p., 1 pl., scale 1:100,000.

#3541 Bacon, C.R., and Nathenson, M., 1996, Geothermal resources in the Crater Lake Area, Oregon: U.S. Geological Survey Open-File Report 96-663, 34 p.

#5039 Nelson, C.H., Carlson, P.R., and Bacon, C.R., 1988, The Mount Mazama climactic eruption (approximately 6900 yr B.P.) and resulting convulsive sedimentation on the Crater Lake caldera floor, continent, and ocean basin, *in* Clifton, H.E., ed., Sedimentologic consequences of convulsive geologic events: Geological Society of America Special Paper 229, p. 37-57.

#3498 Sherrod, D.R., and Smith, J.G., 1989, Preliminary map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Open-File Report 89-14, 20 p., 1 pl., scale 1:500,000.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#3493 Smith, J.G., Page, N.J., Johnson, M.G., Moring, B.C., and Gary, F., 1982, Preliminary geologic map of the Medford 1x2 quadrangle, Oregon and California: U.S. Geological Survey Open-File Report 82-955, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## 1808, Unnamed fault near Lookout Butte

**Structure Number** 1808

Comments:

**Structure Name** Unnamed fault near Lookout Butte

Comments: This unnamed fault is located near Lookout Butte, about 10 km east of Crater Lake in south-central Oregon (Bacon and others, 1997 #3516).

**Synopsis** This fault, and several others with similar trends to the south, is located on the eastern flank of Mount Mazama in south-central Oregon. This fault is thought to have been active in the past few million years, but is buried by pre-Mazama rhyodacite and dacite lava flows thought to have been emplaced about 400 ka.

**Date of compilation** December 10, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Klamath

**1° x 2° sheet** Klamath Falls

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Bacon and others (1997 #3516) and Weldon and others (2002 #5648).

**Geologic setting** This fault, and several others with similar trends to the south, is located on the eastern flank of Mount Mazama. This fault is thought to have been active in the past few million years, but is buried by pre-Mazama rhyodacite and dacite lava flows thought to have been emplaced about 400 ka (Bacon and others, 1997 #3516). The fault is not shown on less detailed geologic maps of the region (Walker and MacLeod, 1991 #3646; Sherrod and Pickthorn, 1992 #3567).

**Sense of movement** N

Comments: This fault is mapped as a normal or high-angle fault by Bacon and others (1997 #3516).

**Dip** Not Reported

Comments:

**Main dip direction** E

**Geomorphic expression** Not Reported

**Age of faulted deposits at the surface** This fault is thought to have been active in the past few million years, but is buried by pre-Mazama rhyodacite and dacite lava flows thought to have been emplaced about 400 ka (Bacon and others, 1997 #3516)

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** Quaternary (<1.6 Ma)

Comments: Bacon and others (1997 #3516) mapped this and several other faults with similar trends to the south as active in the past few million years, but buried by 400 ka lava flows. Weldon and others (2002 #5648) mapped this fault as active in the Quaternary.

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No published slip data are available for this fault, but burial by 400 ka lava flows (Bacon and others, 1997 #3516) indicates low rates of long-term slip.

**Length** End to end (km): 8.1
Cumulative trace (km): 8.2

Comments:

**Average strike** (azimuth) N 19° E

**References**

#3516 Bacon, C.R., Mastin, L.G., Scott, K.M., and Nathenson, M., 1997, Volcano and earthquake hazards in the Crater Lake region, Oregon: U.S. Geological Survey Open-File Report 97-487, 30 p., 1 pl., scale 1:100,000.

#3567 Sherrod, D.R., and Pickthorn, L.B.G., 1992, Geologic map of the west half of the Klamath Falls 1° by 2° quadrangle, south-central Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-2182, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

**1809, White Branch fault zone**

**Structure Number** 1809

Comments:

**Structure Name** White Branch fault zone

Comments: This fault zone was mapped by Sherrod and others (in press #5172) and named by Conrey and others (2002 #5168) after fault exposures along the White Branch of the McKenzie River in the central Oregon Cascades. These faults form the southern part of the Horse Creek fault zone (Sherrod and others, in press #5172).

**Synopsis** The recently discovered White Branch fault zone forms the southern part of the Horse Creek fault zone, a regional normal fault zone that forms the western margin of the High Cascades graben, a 30-km-wide structure that bounds the young volcanoes of the central Oregon High Cascades. The White Branch fault zone forms a younger graben within an older graben-margin fault that lies to the west. The fault zone consists of many en echelon strands that are mapped as juxtaposing upper Pliocene to middle Pleistocene basalt against middle Pleistocene to Holocene basalt. Individual faults have offsets of 50-100 m, and some faults are marked by lavas that thicken considerably on the downthrown side, indicating ponding against pre-existing scarps. The youngest faulted rocks are thought to be early Bruhnes age (<0.78 Ma), so the time of most-recent faulting herein is assumed to be middle and late Quaternary (<750 ka).

**Date of compilation** December 16, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lane

**1° x 2° sheet** Bend

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains section)

**Quality of location** Good

Comments: Fault traces are from 1:100,000-scale mapping of Sherrod and others (in press #5172).

**Geologic setting** The recently discovered White Branch fault zone forms the southern part of the Horse Creek fault zone, a regional normal fault zone that forms the western margin of the High Cascades graben, a 30-km-wide structure that bounds the young volcanoes of the central Oregon High Cascades (Sherrod and others, in press #5172). Conrey and others (2002 #5168) describe the White Branch fault zone as a younger graben within an older graben-margin fault that lies to the west. This fault zone is not shown on most geologic maps (Walker and MacLeod, 1991 #3646; Sherrod and Smith, 2000 #5165) or included in Quaternary fault compilations (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648) of the area.

**Sense of movement** N

Comments: These faults are mapped as normal or high-angle faults by Sherrod and others (in press #5172) and Conrey and others (2002 #5168).

**Dip** Not Reported

Comments:

**Main dip direction** E

**Geomorphic expression** Little detailed information on the geomorphic expression of these faults has been published. These faults were delineated by mapping the Matuyama-Bruhnes paleomagnetic contact with a fluxgate magnetometer (Conrey and others, 2002 #5168), rather than by mapping prominent fault scarps. The fault zone consists of many en echelon strands with individual offsets of 50-100 m. Some faults are marked by lavas that thicken considerably on the downthrown side, which probably indicates ponding against pre-existing scarps (Conrey and others, 2002 #5168).

**Age of faulted deposits at the surface** Sherrod and others (in press #5172) map the fault zone as juxtaposing undifferentiated older (upper Pliocene to middle Pleistocene) basalt (QTb) against undifferentiated younger (middle Pleistocene to Holocene) basalt (Qb). The youngest faulted rocks are thought to be early Bruhnes (<0.78 Ma) in age (Conrey and others, 2002 #5168).

**Paleoseismology studies** None

**Time of most recent prehistoric faulting** middle and late Quaternary (<750 ka)

Comments: Sherrod and others (in press #5172) map the fault zone as juxtaposing undifferentiated older (upper Pliocene to middle Pleistocene) basalt (QTb) against undifferentiated younger (middle Pleistocene to Holocene) basalt (Qb). The youngest faulted rocks are thought to be early Bruhnes age (<0.78 Ma), so the time of most-recent faulting herein is assumed to be middle and late Quaternary (<750 ka).

**Recurrence interval** Not Reported

Comments:

**Slip-rate category** unknown; probably <0.2 mm/yr

Comments: No detailed slip data on this fault zone has been described, but poor geomorphic expression and individual offsets of 50-100 m in middle Pleistocene rocks (Conrey and others, 2002 #5168) suggest low rates of long-term slip.

| | | |
|---|---|---|
| **Length** | End to end (km): | 18.3 |
| | Cumulative trace (km): | 18.6 |

Comments:

**Average strike** (azimuth) N 06° E

**References**

#5168 Conrey, R.M., Taylor, E.M., Donnelly-Nolan, J.M., and Sherrod, D.R., 2002, North-central Oregon Cascades—Exploring petrologic and tectonic intimacy in a propagating intra-arc rift, *in* Moore, G.W., ed., Field guide to geologic processes in Cascadia: State of Oregon, Department of Geology and Mineral Industries Special Paper 36, p. 47-90.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#5165 Sherrod, D.R., and Smith, J.G., 2000, Geologic map of upper Eocene to Holocene volcanic and related rocks of the Cascade Range, Oregon: U.S. Geological Survey Geologic Investigations Map I-2569, 2 sheets, scale 1:500,000.

#5172 Sherrod, D.R., Taylor, E.M., Ferns, M.L., Scott, W.E., Conrey, R.M., and Smith, G.A., in press, Geologic map of the Bend 30' x 60' quadrangle, central Oregon: U.S. Geological Survey Geologic Investigations Map I-2683, 1 sheet, scale 1:100,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## Suspect (Class C) Faults

This group of structures include faults or other geologic features that we have intentionally excluded from the national map and database.  Class “C” features are those where geologic evidence is insufficient to demonstrate (1) the existence of a tectonic fault, or (2) Quaternary slip or deformation associated with the feature.  Eighteen features in Oregon have been included in this category and are listed in Table 2.  These features are mostly faults included in previous compilations where no evidence of displacement in Quaternary deposits has been demonstrated.

## Unnamed feature near Applegate (Class C)

**Structure Name** Unnamed feature near Applegate (Class C)

Comments: The feature near Applegate was mapped by Pezzopane (1993 #3544). Geologic maps in the area do not show faults in the vicinity of this feature (Beaulieu and Hughes, 1977 #4060; Smith and others, 1982 #3493; Moring, 1983 #3554; Walker and MacLeod, 1991 #3646).

**Reason for exclusion** The feature near Applegate was mapped as a high-angle fault by Pezzopane (1993 #3544) using airphoto analysis, and was included in two subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575). The feature lies just east of and parallels the northeast-trending Thompson Creek, a tributary of the Applegate River. The area is underlain by steeply southeast-dipping Triassic to Paleozoic metamorphic rocks of the Klamath Mountains (Beaulieu and Hughes, 1977 #4060; Smith and others, 1982 #3493; Walker and MacLeod, 1991 #3646). Near the mapped location of the feature shown by Pezzopane (1993 #3544), Moring (1983 #3554) mapped alluvial-fan deposits of Pleistocene and Holocene age. However, the fault-like feature is short (<5 km long) is not shown on published geologic maps (Beaulieu and Hughes, 1977 #4060; Smith and others, 1982 #3493; Moring, 1983 #3554; Walker and MacLeod, 1991 #3646), does not form a recognizable escarpment on 1:24,000-scale topographic maps, and thus herein is classified as a Class C structure until more detailed studies are conducted.

**Date of compilation** June 26, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Jackson

**1° x 2° sheet** Medford

**Province** Pacific Border (Klamath Mountains section)

### References


#4060 Beaulieu, J.D., and Hughes, P.W., 1977, Land use geology of central Jackson County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 94, 87 p., 10 pls., scale 1:62,500.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3554 Moring, B., 1983, Reconnaissance surficial geologic map of the Medford 1 x 2 quadrangle, Oregon-California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1528, 2 sheets, scale 1:125,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3493 Smith, J.G., Page, N.J., Johnson, M.G., Moring, B.C., and Gary, F., 1982, Preliminary geologic map of the Medford 1x2 quadrangle, Oregon and California: U.S. Geological Survey Open-File Report 82-955, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

## Unnamed features in Camas Valley (Class C)

**Structure Name** Unnamed features in Camas Valley (Class C)

Comments: The two features in Camas Valley were mapped by Pezzopane (1993 #3544). Geologic maps in the area do not show these features (Niem and Niem, 1990 #4163; Walker and MacLeod, 1991 #3646; Black and Priest, 1993 #4049).

**Reason for exclusion** The two features near Camas Valley were mapped as high-angle faults by Pezzopane (1993 #3544) using airphoto analysis and were included in two subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575). These features are located in the northeastern part of the Camas Valley in the Oregon Coast Range. The area is underlain by the Fluornoy Formation, which is comprised of Eocene sandstone deposited in a forearc basin (Niem and Niem, 1990 #4163; Walker and MacLeod, 1991 #3646; Black and Priest, 1993 #4049). However, these fault-like features are short (<5 km long) are not shown on published geologic maps (Niem and Niem, 1990 #4163; Walker and MacLeod, 1991 #3646; Black and Priest, 1993 #4049), do not form recognizable escarpments on 1:24,000-scale topographic maps, and thus herein are classified as Class C structures until more detailed studies are conducted.

**Date of compilation** June 26, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Josephine

**1° x 2° sheet** Medford

**Province** Pacific Border (Oregon Coast Range section)

### References


#4049 Black, G.L., and Priest, G.R., 1993, Geologic map of the Camas Valley quadrangle, Douglas and Coos Counties, Oregon: State of Oregon Geological Map Series GMS-76, 1 sheet, scale 1:24,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#4163 Niem, A.R., and Niem, W.A., 1990, Geology and oil, gas, and coal resources, southern Tyee Basin, southern Coast Range, Oregon: State of Oregon, Department of Geology and Mineral Industries Open-File Report 0-89-3, 44 p., 3 pl.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

## Unnamed faults on Cedar Mountain (Class C)

**Structure Name** Unnamed faults on Cedar Mountain (Class C)

Comments: These unnamed normal faults are located on Cedar Mountain in southeastern Oregon. They have been mapped by Ferns and others (1993 #3561) and are included in recent Quaternary fault compilations (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Weldon and others, 2002 #5648).

**Reason for exclusion** These unnamed north-striking normal faults form a graben on Cedar Mountain, a middle to upper Miocene basaltic shield volcano in southeastern Oregon. These and other north-striking faults in the area are part of an old fault system, the Oregon-Idaho graben, that is largely filled with Miocene volcanic rocks (Walker and MacLeod, 1991 #3646; Ferns and others, 1993 #3561). These faults are shown on the Quaternary fault compilation of Pezzopane (1993 #3544) and other compilations derived from his work (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648). However, none of these compilations is based on field reconnaissance of these faults, and no evidence of Quaternary displacement has been described. The faults on Cedar Mountain are herein classified as Class C structures because recent field investigations restricted fault movement to Miocene rocks (Ferns and others, 1993 #3561), and the faults are confined to the Cedar Mountain shield volcano and thus may be volcanic in origin.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Malheur

**1° x 2° sheet** Boise

**Province** Columbia Plateaus (Payette section)

### References

#3561 Ferns, M.L., Evans, J.G., and Cummings, M.L., 1993, Geologic map of the Mahogany Mountain 30 x 60 minute quadrangle, Malheur County, Oregon, and Owyhee County, Idaho: Geologic Map Series GMS-78, 1 sheet, scale 1:100,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## Unnamed fault southeast of Condon (Class C)

**Structure Name** Unnamed fault southeast of Condon

Comments: This northeast-striking fault is mapped southeast of Condon in north-central Oregon (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Weldon and others, 2002 #5648).

**Reason for exclusion** The fault southeast of Condon is mapped as a down-to-the-southeast fault in recent Quaternary fault compilations (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648). The area is underlain by volcanic rocks of the Columbia River Basalt Group, but this fault is not shown on geologic maps of the area (Swanson and others, 1981 #3496; Bela, 1982 #3584; Walker and MacLeod, 1991 #3646). The fault in places may form northeast-trending aligned drainages, but otherwise has little geomorphic expression. No scarps in Quaternary deposits have been described along the fault. The fault is herein classified as a Class C structure until more detailed studies are conducted.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Gilliam

**1° x 2° sheet** The Dalles

**Province** Columbia Plateaus (Walla Walla Plateau)

### References


#3584 Bela, J.L., 1982, Geologic and neotectonic evaluation of north-central Oregon—The Dallas 1 x 2 quadrangle: State of Oregon, Department of Geology and Mineral Industries Geologic Map Series GMS-27, 2 sheets, scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3496 Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 35 p., 5 pls., scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

### Unnamed features near Drews Reservoir (Class C)

**Structure Name** Unnamed features near Drews Reservoir

Comments: These features are mapped near Drews Reservoir, an impoundment on Drews Creek located west of Lakeview in the Basin and Range of southern Oregon (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648).

**Reason for exclusion** These northwest-striking features were mapped as down-to-the-northeast faults by Pezzopane (1993 #3544) and included in subsequent Quaternary fault compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648). The southern fault is mapped mostly beneath the waters of Drews Reservoir, and the northern fault northwest of Drews Reservoir is mapped along a dissected hillslope of Tertiary volcanic rocks. Neither of these features is shown on published geologic maps of the area (Walker, 1963 #3565; Walker and MacLeod, 1991 #3646), no information on the geomorphic expression of these two faults has been described, and these features have no obvious expression on 1:24,000-scale topographic maps of the area. These features are herein classified as Class C structures until more detailed studies are conducted.

**Date of compilation** December 4, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Lake

**1° x 2° sheet** Klamath Falls

**Province** Basin and Range (Great Basin section)

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3565 Walker, G.W., 1963, Reconnaissance geologic map of the eastern half of the Klamath Falls (AMS) quadrangle, Lake and Klamath Counties, Oregon: U.S. Geological Survey Mineral Investigations Field Studies Map MF-260, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## Firn Hill fault zone (Class C)

**Structure Name** Firn Hill fault zone (Class C)

Comments: The Firn Hill fault zone was apparently named after its location near Firn Hill, near the southern bank of the Columbia River in northwestern Oregon by Ryan and Stevenson (1995 #4119). The fault has been mapped by Nelson (1977 #3977) and Niem and others (1985 #4170).

**Reason for exclusion** The Firn Hill fault zone is mapped onshore as a northeast-striking, down-to-the-southeast fault in Miocene sedimentary rocks (Nelson, 1977 #3977; Niem and others, 1985 #4170). Ryan and Stevenson (1995 #4119) used high-resolution geopulse data to infer recent activity across the fault in the Columbia River, although no age constraints on this deformation are available. Ryan and Stevenson (1995 #4119) observed truncated and dipping reflectors in the subsurface, and apparent offsets of the river bottom associated with the projected fault trace. However, the apparent offsets of the river bottom are down-to-the-northwest, opposite to the sense of displacement of the mapped trace of the fault onshore. This relationship suggests that the apparent displacements of the river bottom are caused by differential erosion of the channel bottom, rather than to recent fault activity. The fault is not included in any of the Quaternary fault compilations in the region (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Wong and others, 1999 #4073).

**Date of compilation** July 19, 2000

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Clatsop

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

### References


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3977 Nelson, M.P., 1977, Tertiary stratigraphy and sedimentation in the Young's River—Lewis and Clark River Area, Clatsop County, Oregon: Oregon State University, unpublished M.S. thesis, 242 p., 1 pl.

#4170 Niem, A.R., Niem, W.A., Martin, M.W., Kadri, M.M., and McKeel, D.R., 1985, Correlation of exploration wells, Astoria Basin, N.W. Oregon—Explanatory text for plate 2: State of Oregon, Department of Geology and Mineral Industries Oil and Gas Investigation 14, 8 p., 1 pl.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4119 Ryan, H.F., and Stevenson, A.J., 1995, Cruise Report for C1-94-OW—Reconnaissance high resolution geopulse data acquired for seismic hazard studies along the Columbia River from July 18-22, 1994: U.S. Geological Survey Open-File Report 95-668, 38 p.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

## Fulmar fault (Class C)

**Structure Name** Fulmar fault (Class C)

Comments: The Fulmar fault was originally designated fault “A” on cross sections (Snavely and others, 1980 #4084; 1980 #4136; 1982 #4134; 1985 #4135), and later apparently renamed by Peterson and others (1986 #4133) and Snavely (1987 #4086) after its location near the Union Oil Company Fulmar P-0130 exploratory well offshore of Florence, Oregon.

**Reason for exclusion** The Fulmar fault is mapped offshore as a large displacement north-striking right-lateral strike-slip fault that forms the seaward boundary between Eocene volcanic rocks of the Siletzia terrane and Eocene and older accretionary melange rocks (Snavely and others, 1980 #4084; 1980 #4136; 1985 #4135; Peterson and others, 1986 #4133; Snavely, 1987 #4086). Snavely and others (1980 #4084), Snavely (1987 #4086), and Snavely and Wells (1996 #4290) inferred more than 200 km of dextral separation on the fault, but concluded that most displacement occurred in the Eocene because the fault is overlapped by late Eocene strata. Fleming and Truhu (1999 #4237) suggested that deformation along the Stonewall anticline [structure #786] was related to the Fulmar fault, but McNeill and others (2000 #5060) used differences in trend to discount this idea. Some geophysical data suggest disruption of Neogene strata above the projected trace of the Fulmar fault in a few locations (Trehu and others, 1995 #4236; Fleming and Trehu, 1999 #4237), but no surface expression of the fault was apparent in sidescan sonar data or deep submersible dives to the seafloor (Goldfinger, 1994 #3972). Goldfinger (1994 #3972) found no evidence for a through-going fault in the vicinity of the Fulmar fault, and concluded that structures apparent in Neogene strata on seismic reflection profiles are related to active folding of the continental shelf, rather than to the Fulmar fault. Witter and others (1997 #4193) and Witter (1999 #4194) correlate the Coquille fault [893] with the Fulmar fault offshore, but presented no evidence to support this correlation. The Fulmar fault is not included in any of the Quaternary fault compilations in the region (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Wong and others, 1999 #4073), and is herein classified as a Class C structure until more detailed studies are conducted.

**Date of compilation** July 19, 2000

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR (offshore)

**County** Douglas (offshore), Coos (offshore), Lane (offshore)

**1° x 2° sheet** Coos Bay (offshore)

**Province** Offshore of Pacific Border (Oregon Coast Range section)

### References

#4237 Fleming, S.W., and Trehu, A.M., 1999, Crustal structure beneath the central Oregon convergent margin from potential-field modeling—Evidence for a buried basement ridge in local contact with a seaward dipping backstop: Journal of Geophysical Research, v. 104, no. B9, p. 20,431-20,447.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3972 Goldfinger, C., 1994, Active deformation of the Cascadia Forearc—Implications for great earthquake potential in Oregon and Washington: Oregon State University, unpublished Ph.D thesis, 246 p.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#5060 McNeill, L.C., Goldfinger, G., Kulm, L.D., and Yeats, R.S., 2000, Tectonics of the Neogene Cascadia forearc basin: Investigations of a deformed late Miocene unconformity: Geological Society of America Bulletin, v. 112, no. 8, p. 1209-1224.

#4133 Peterson, C.P., Kulm, L.D., and Gray, J.J., 1986, Geologic map of the ocean floor off Oregon and the adjacent continental margin: State of Oregon Geological Map Series GMS-42, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4086 Snavely, P.D., Jr., 1987, Chapter 14-Tertiary geologic framework, neotectonics, and petroleum potential of the Oregon-Washington continental margin, *in* Scholl, D.W., Grantz, A., and Vedder, J.G., eds., Geology and resource potential of the continental margin of Western North America and adjacent ocean basins—Beaufort Sea to Baja, California: Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, Volume 6, p. 305-335, 3 pls.

#4084 Snavely, P.D., Jr., Wagner, H.C., and Lander, D.L., 1980, Interpretation of the Cenozoic geology history, central Oregon continental margin—Cross-section summary: Geological Society of America Bulletin, Part I, v. 91, p. 143-146.

#4136 Snavely, P.D., Jr., Wagner, H.C., and Lander, D.L., 1980, Geologic cross section of the central Oregon continental margin: Geological Society of America Map and Chart Series MC-28J, 8 p., 1 pl.

#4135 Snavely, P.D., Jr., Wagner, H.C., and Lander, D.L., 1985, Land-sea geologic cross section of the southern Oregon continental margin: U.S. Geological Survey Miscellaneous Investigations Map I-1463, 1 sheet, scale 1:125,000.

#4134 Snavely, P.D., Jr., Wagner, H.C., and Rau, W.W., 1982, Biostratigraphy and correlation of Tertiary rocks in wells on southern Oregon continental margin: U.S. Geological Survey Miscellaneous Field Studies Map MF-1482, 1 sheet,.

#4290 Snavely, P.D., and Wells, R.E., 1996, Cenozoic evolution of the continental margin of Oregon and Washington, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 161-182.

#4236 Trehu, A.M., Lin, G., Maxwell, E., and Goldfinger, C., 1995, A seismic reflection profile across the Cascadia subduction zone offshore central Oregon–New constraints on methane distribution and crustal structure: Journal of Geophysical Research, v. 100, no. B8, p. 15,101-15,116.

#4194 Witter, R.C., 1999, Late Holocene paleoseismicity, tsunamis and relative sea-level changes along the south-central Cascadia subduction zone, southern Oregon: University of Oregon, unpublished Ph.D dissertation, 178 p.

#4193 Witter, R.C., Kelsey, H.M., and Hemphill-Haley, E., 1997, A paleoseismic history of the south-central Cascadia subduction zone—Assessing earthquake recurrence intervals and upper-plate deformation over the past 6600 years at the Coquille River Estuary, southern Oregon: Technical report to U.S. Geological Survey, under Contract 1434-HQ-97-GR-03036, 54 p.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

### Unnamed feature near Grants Pass (Class C)

**Structure Name** Unnamed feature near Grants Pass (Class C)

Comments: The feature near Grants Pass was mapped by Pezzopane (1993 #3544). Geologic maps in the area do not show faults in the vicinity of this feature (Ramp and Peterson, 1979 #4059; Smith and others, 1982 #3493; Moring, 1983 #3554; Walker and MacLeod, 1991 #3646).

**Reason for exclusion** The feature near Grants Pass was mapped with airphoto analysis as a high-angle fault by Pezzopane (1993 #3544), and included in two subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575). The fault lies along the northwest-trending southwest flank of Beacon Hill on the northeastern edge of the city of Grants Pass. The area is underlain by Triassic to Paleozoic metamorphic rocks and Cretaceous to Jurassic intrusive rocks of the Klamath Mountains (Ramp and Peterson, 1979 #4059; Smith and others, 1982 #3493; Walker and MacLeod, 1991 #3646). Near the mapped location of the feature shown by Pezzopane (1993 #3544), Moring (1983 #3554) mapped alluvial-fan deposits of Pleistocene and Holocene age. However, this feature is short (<5 km long), is not shown on published geologic maps (Ramp and Peterson, 1979 #4059; Smith and others, 1982 #3493; Moring, 1983 #3554; Walker and MacLeod, 1991 #3646), does not form a recognizable escarpment on 1:24,000-scale topographic maps, and thus herein is classified as a Class C structure until more detailed studies are conducted.

**Date of compilation** June 26, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Josephine

**1° x 2° sheet** Medford

**Province** Pacific Border (Klamath Mountains section)

**References**

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3554 Moring, B., 1983, Reconnaissance surficial geologic map of the Medford 1 x 2 quadrangle, Oregon-California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1528, 2 sheets, scale 1:125,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4059 Ramp, L., and Peterson, N.V., 1979, Geology and mineral resources of Josephine County, Oregon: State of Oregon, Department of Geology and Mineral Industries Bulletin 100, 45 p., 4 pls.

#3493 Smith, J.G., Page, N.J., Johnson, M.G., Moring, B.C., and Gary, F., 1982, Preliminary geologic map of the Medford 1x2 quadrangle, Oregon and California: U.S. Geological Survey Open-File Report 82-955, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

## Harrisburg anticline (Class C)

**Structure Name** Harrisburg anticline (Class C)

Comments: The Harrisburg anticline is named after its location near the town of Harrisburg in the southern Willamette Valley (Graven, 1990 #3990).

**Reason for exclusion** The Harrisburg anticline was first recognized in the subsurface by Graven (1990 #3990), using seismic reflection and water well data; the fold is shown on maps of Graven (1990 #3990) and Yeats and others (1996 #4291). Total relief across the structure is about 100 m of the Eugene-Spencer Formation contact. Unnamed fluvial sediments associated with the proto-Willamette River are warped about 50 m across the axis of the fold; these sediments post-date the Miocene age of the Columbia River Basalt Group, but their age is otherwise unknown (Graven, 1990 #3990; Yeats and others, 1996 #4291). This fold has no geomorphic expression and no unequivocal evidence of Quaternary deformation has been described (Graven, 1990 #3990; Yeats and others, 1996 #4291). Pezzopane (1993 #3544), Geomatrix Consultants (1995 #3593), and Madin and Mabey (1996 #3575) do not include this fold in their compilations of Quaternary structures in Oregon.

**Date of compilation** July 19, 2000

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Lane, Linn

**1° x 2° sheet** Salem

**Province** Pacific Border (Puget Trough section)

### References


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#3990 Graven, E.P., 1990, Structure and tectonics of the southern Willamette Valley, Oregon: Oregon State University, unpublished Master's thesis, 119 p., 10 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4291 Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T.A., 1996, Tectonics of the Willamette Valley, Oregon, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., eds., Assessing earthquake hazards and reducing risk in the Pacific Northwest: U.S. Geological Survey Professional Paper 1560, v. 1, p. 183-222.

## Unnamed faults near Ireland Flat (Class C)

**Structure Name** Unnamed faults near Ireland Flat (Class C)

Comments: These unnamed northwest-trending faults were mapped northeast of Brothers near Ireland Flat in central Oregon by Pezzopane (1993 #3544).

**Reason for exclusion** The Ireland Flat faults were mapped with airphoto analysis as down-to-the-southwest, high-angle faults by Pezzopane (1993 #3544), and included in three subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648). These faults are located north of and are parallel to the northwesterly strike of the Brothers fault zone in central Oregon. The area is underlain by Miocene to Pliocene tuffaceous sedimentary rocks and ash flow tuffs (Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646). These faults are not shown on any published geologic maps (Walker and others, 1967 #3564; Walker and MacLeod, 1991 #3646) or included in older earthquake hazards studies (U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946) in the region. The faults do not form recognizable escarpments on 1:24,000-scale topographic maps, and thus herein are classified as Class C structures until more detailed studies are conducted.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Crook, Deschutes

**1° x 2° sheet** Crescent

**Province** Columbia Plateaus (Harney section)

### References


#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#2946 Hawkins, F.F., LaForge, R.C., Templeton, M., and Gilbert, J.D., 1988, Seismotectonic study for Arthur R. Bowman and Ochoco Dams, Crooked River Project, Oregon: U.S. Bureau of Reclamation Seismotectonic Report 88-10, 57 p., 2 pls.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3484 U.S. Army Corps of Engineers, 1983, Cougar and Blue River Lakes earthquake and fault study—Design memorandum 19: U.S. Army Corps of Engineers, Portland District, v. 19, 90 p., 11 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#3564 Walker, G.W., Peterson, N.V., and Greene, R.C., 1967, Reconnaissance geologic map of the east half of the Crescent quadrangle Lake, Deschutes, and Crook Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations I-493, 1 sheet, scale 1:250,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## Limekiln fault (Class C)

**Structure Name** Limekiln fault (Class C)

Comments: The Limekiln fault has been mapped by Camp (1976 #4686), Reidel (1978 #4685), Myers and others (1979 #5175), Swanson and others (1980 #3574), Schuster (1993 #4656) and Reidel and others (1992 #3578) in Washington, by Newcomb (1970 #3761) and Walker (1979 #3576) in Oregon, and was mapped as the Lime Point fault in Idaho by Bond (1963 #618). The northern part of the structure in Idaho is mapped as a fold named the Craig Mountain anticline or Craigmont uplift (Bond, 1963 #618; Myers and others, 1979 #5175).

**Reason for exclusion** The Limekiln fault is a northeast-striking, down-to-the-northwest normal fault that primarily offsets Columbia River Basalt Group rocks in northeastern Oregon, southwestern Washington, and western Idaho (Bond, 1963 #618; Camp, 1976 #4686; Walker, 1979 #3576; Swanson and others, 1980 #3574; Walker and MacLeod, 1991 #3646; Schuster, 1993 #4656; Schuster and others, 1997 #3760). This part of Oregon and Washington is a deeply dissected highland in Miocene basalts with only sparse Quaternary deposits (Myers and others, 1979 #5175). Pezzopane (1993 #3544) used airphoto analysis to infer Quaternary displacement, but no scarps in Quaternary deposits have been described along the length of the fault. Other compilations describe the fault as active in the Quaternary (Madin and Mabey, 1996 #3575), as probable Quaternary (Geomatrix Consultants Inc., 1995 #3593), and as Neogene (Howard and others, 1978 #312), but none of these studies discusses evidence of Quaternary displacement.. The latest fault compilation in the region (Weldon and others, 2002 #5648) classified the Limekiln fault as a possible Quaternary fault. Given the uncertainty in age of latest movement and lack of documentation of offset of Quaternary deposits, we herein classify the fault as a Class C structure until more detailed studies are conducted.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR, WA, ID

**County** Wallowa (OR), Asotin (WA), Nez Pierce (ID)

**1° x 2° sheet** Grangeville, Pullman

**Province** Columbia Plateaus (Blue Mountain section)

### References

#618 Bond, J.G., 1963, Geology of the Clearwater Embayment: Idaho Bureau of Mines and Geology Pamphlet 128, 83 p., 2 pls.

#4686 Camp, V.E., 1976, Petrochemical stratigraphy and structure of the Columbia River Basalt, Lewiston Basin area, Idaho-Washington: Pullman, Washington State University, unpublished Ph.D. dissertation, 201 p.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#312 Howard, K.A., Aaron, J.M., Brabb, E.E., Brock, M.R., Gower, H.D., Hunt, S.J., Milton, D.J., Muehlberger, W.R., Nakata, J.K., Plafker, G., Prowell, D.C., Wallace, R.E., and Witkind, I.J., 1978, Preliminary map of young faults in the United States as a guide to possible fault activity: U.S. Geological Survey Miscellaneous Field Studies Map MF-916, 2 sheets, scale 1:5,000,000.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#5175 Myers, C.W., Price, S.M., Caggiano, J.A., Cochran, M.P., Czimer, W.J., Davidson, N.J., Edwards, R.C., Fecht, K.R., Holmes, G.E., Jones, M.G., Kunk, J.R., Landon, R.D., Ledgerwood, R.K., Lillie, J.T., Long, P.E., Mitchell, T.H., Price, E.H., Reidel, S.P., and Tallman, A.M., 1979, Geologic studies of the Columbia Plateau—A status report: Technical report to U.S. Department of Energy, under Contract DE-AC06-77RL01030, October 1979, variously paginated, 36 pls.

#3761 Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group Washington, Oregon, and Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations I-587, 1 sheet, scale 1:500,000.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#4685 Reidel, S.P., 1978, The stratigraphy and petrogenesis of the Grande Ronde Basalt in the lower Salmon and adjacent Snake River canyons: Pullman, Washington State University, unpublished Ph.D. dissertation, 415 p.

#3578 Reidel, S.P., Hooper, P.R., Webster, G.D., and Camp, V.E., 1992, Geologic map of southeastern Asotin County, Washington: Washington Division of Geology and Earth Resources Geologic Map GM-40, 2 Sheets, scale 1:48,000.

#3760 Schuster, E.J., Gulick, C.W., Reidel, S.P., Fecht, K.R., and Zurenko, S., 1997, Geologic map of Washington-southeast quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-45, 20 p. pamphlet, 2 sheets, scale 1:250,000.

#4656 Schuster, J.E., 1993, Geologic map of the Clarkston 1:100,000 Quadrangle, Washington-Idaho, and the Washington portion of the Orofino 1:100,000 Quadrangle: Washington Division of Geology and Earth Resources Open-File Report 93-4, 43 p., scale 1:100,000.

#3574 Swanson, D.A., Wright, T.L., Camp, V.E., Gardner, J.N., Helz, R.T., Price, S.M., Reidel, S.P., and Ross, M.E., 1980, Reconnaissance geologic map of the Columbia River Basalt Group, Pullman and Walla Walla quadrangles, southeast Washington and adjacent Idaho: U.S. Geological Survey Miscellaneous Investigations Map I-1139, 2 sheets, scale 1:250,000.

#3576 Walker, G.W., 1979, Reconnaissance geologic map of the Oregon part of the Grangeville quadrangle, Baker, Union, Umatilla, and Wallowa Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1116, 1 sheet, scale 1:250,000.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#5648 Weldon, R.J., Fletcher, D.K., Weldon, E.M., Scharer, K.M., and McCrory, P.A., 2002, An update of Quaternary faults of central and eastern Oregon: U.S. Geological Survey Open-File Report 02-301 (CD-ROM), 26 sheets, scale 1:100,000.

## Mount Hood fault (Class C)

**Structure Name** Mount Hood fault (Class C)

Comments: The Mount Hood fault was named by Geomatrix Consultants, Inc. (1990 #3550) after nearby Mount Hood, a Quaternary volcano of the High Cascades volcanic province.

**Reason for exclusion** The Mount Hood fault is shown on numerous Quaternary fault compilations (U.S. Army Corps of Engineers, 1983 #3485; Geomatrix Consultants Inc., 1990 #3550; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Wong and others, 1999 #4073; Wong and others, 2000 #5137); inclusion of the Mount Hood fault in these studies was based on mapping of Keith and others (1982 #4052) that shows the fault as offsetting Pleistocene to Holocene lava flows from Mount Hood. However, the mapped fault is restricted to Miocene bedrock or is not shown at all on recent geologic maps (Walker and MacLeod, 1991 #3646; Sherrod and Scott, 1995 #3495; Scott and others, 1997 #3997). Recent investigations in the area found no evidence of tectonic faulting along the trace mapped by Keith and others (1982 #4052), but rather found evidence of landslide slip features, perhaps related to deglaciation (W.E. Scott, pers. commun., 2002). Given that recent field investigations have restricted fault movement to only Miocene rocks, the Mount Hood fault is herein classified as a Class C structure.

**Date of compilation** June 6, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Clackamas

**1° x 2° sheet** The Dalles

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains section)

### References


#3550 Geomatrix Consultants Inc., 1990, Seismotectonic evaluation of Wasco Dam site: Technical report to U.S. Department of Interior, Bureau of Reclamation, Denver, under Contract 6-CS-81-07310, 115 p., 2 pls., scale 1:250,000.

#3593 Geomatrix Consultants Inc., 1995, Seismic design mapping, State of Oregon: Technical report to Oregon Department of Transportation, Salem, Oregon, under Contract 11688, January 1995, unpaginated, 5 pls., scale 1:1,250,000.

#4052 Keith, T.E.C., Beeson, M.H., and Bargar, K.E., 1982, Geologic map of the Mount Hood Wilderness, Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-1379-A, 1 sheet, scale 1:62,500.

#3575 Madin, I.P., and Mabey, M.A., 1996, Earthquake hazard maps for Oregon: State of Oregon, Department of Geology and Mineral Industries Geological Map Series GMS-100, 1 sheet,.

#3544 Pezzopane, S.K., 1993, Active faults and earthquake ground motions in Oregon: Eugene, Oregon, University of Oregon, unpublished Ph.D dissertation, 208 p.

#3997 Scott, W.E., Gardner, C.A., Sherrod, D.R., Tilling, R.I., Lanphere, M.A., and Conrey, R.M., 1997, Geologic history of Mount Hood volcano, Oregon—A field trip guidebook: U.S. Geological Survey Open-File Report 97-263, 38 p.

#3495 Sherrod, D.R., and Scott, W.E., 1995, Preliminary geologic map of the Mount Hood 30 by 60 minute quadrangle, northern Cascade Range, Oregon: U.S. Geological Survey Open-File Report 95-219, 28 p., 1 pl., scale 1:100,000.

#3485 U.S. Army Corps of Engineers, 1983, Detroit and Big Cliff Lakes earthquake and fault study—Design memorandum 4: U.S. Army Corps of Engineers, Portland District, 93 p., 13 pls.

#3646 Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, Special Geologic Map, 2 sheets, scale 1:500,000.

#4073 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 1999, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon metropolitan area: Technical report to U.S. Geological Survey, under Contract 1434-HQ-96-GR-02727, 16 p., 12 pls.

#5137 Wong, I., Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li, S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake scenario and probabilistic ground shaking maps for the Portland, Oregon, metropolitan area: State of Oregon, Department of Geology and Mineral Industries Interpretive Map Series IMS-16, 16 p. pamphlet, scale 1:62,500.

**Pony Slough faults (Class C)**

**Structure Name** Pony Slough faults (Class C)

Comments: The existence of two unnamed faults in the vicinity of Pony Slough near Coos Bay was postulated by Briggs (1994 #4189).

**Reason for exclusion** Two north-northwest-striking faults were postulated by Briggs (1994 #4189), based on differences in late Holocene tidal-marsh stratigraphy described in cores in Pony Slough. Faults were inferred on the presence of up to five episodic subsidence events with recurrence intervals of 670 years in some cores, but not others. However, Briggs (1994 #4189) did not discuss possible non-tectonic origins of these stratigraphic differences, and described no geomorphic evidence of faulting. These postulated structures are not shown on any geologic maps of the area (Baldwin and Beaulieu, 1973 #4145; Beaulieu, 1975 #4141; Newton, 1980 #4144; Walker and MacLeod, 1991 #3646), and are not included in any of the Quaternary fault compilations in the region (Goldfinger and others, 1992 #464; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Wong and others, 1999 #4073).

**Date of compilation** July 19, 2000

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Coos

**1° x 2° sheet** Coos Bay

**Province** Pacific Border (Oregon Coast Range section)

**References**

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**Salmon River fault zone (Class C)**

**Structure Name** Salmon River fault zone (Class C)

Comments: The Salmon River fault zone is named after its location in the Salmon River watershed of northern Oregon.

**Reason for exclusion** The fault zone is shown on recent Quaternary fault compilations (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575). The fault zone location is based on lineaments identified during airphoto analysis (Geomatrix Consultants Inc., 1990 #3550; Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593), but no field evidence of Quaternary displacement has been described. None of these faults is shown on recent geologic mapping in the area (Sherrod and Scott, 1995 #3495). The fault zone was judged not active by Geomatrix Consultants, Inc. (1990 #3550; 1995 #3593). Latest movement is thought to have occurred in the Pliocene (Burck, 1986 #3950; Beeson and others, 1989 #4023; Geomatrix Consultants Inc., 1990 #3550; 1995 #3593).

**Date of compilation** July 19, 2000

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Clackamas

**1° x 2° sheet** The Dalles, Vancouver

**Province** Cascade-Sierra Mountains (Middle Cascade Mountains section)

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## Sandy River fault zone (Class C)

**Structure Name** Sandy River fault zone (Class C)

Comments: The Sandy River fault zone was first identified with gravity data by Davis (1988 #3975), and later described by Beeson and others (1989 #4023) and Lite (1992 #3947); the fault was presumably named after its proximity to the Sandy River by Davis (1988 #3975). The fault is included in the Portland Hills-Clackamas River structural zone of Beeson and others (1985 #4022; 1989 #4023).

**Reason for exclusion** The Sandy River fault zone was described and mapped at small scale by Davis (1988 #3975) and Beeson and others (1989 #4023), but the fault is not shown on most geologic maps of the region (Trimble, 1963 #4062; Swanson and others, 1993 #4032; Gannett and Caldwell, 1998 #4066). The fault trace is marked by discontinuous aeromagnetic anomalies (Blakely and others, 1995 #4021; Blakely and others, 2000 #4333). Pezzopane (1993 #3544) showed this fault as Quaternary (<1.6 Ma) on his Quaternary fault compilation, but did not document evidence of Quaternary displacement. Unruh and others (1994 #3597) mapped the fault as Tertiary in their analysis of Quaternary faults in the region. Geomatrix Consultants, Inc. (1995 #3593) mapped the fault as active in the middle to late Quaternary, but based this age assignment solely on the faults proximity to the nearby Lacamas Lake fault [880]. No evidence of Quaternary displacement has been described along the Sandy River fault zone, so Geomatrix Consultants, Inc. (1995 #3593) concluded that the fault is probably not active.

**Date of compilation** July 19, 2000

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Multnomah

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

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## Sherwood/Lake Oswego fault (Class C)

**Structure Name** Sherwood/Lake Oswego fault (Class C)

Comments: The Sherwood fault is likely named after its location near the town of Sherwood in the northern Willamette Valley; it is aligned with and may connect with the Lake Oswego fault, which is mapped in the Lake Oswego area (Beeson and others, 1989 #4047; Yeats and others, 1996 #4291).

**Reason for exclusion** The fault is shown on numerous maps of the area (Warren and others, 1945 #4076; Hart and Newcomb, 1965 #4063; Beeson and others, 1989 #4023; Yeats and others, 1991 #3953; Unruh and others, 1994 #3597; 1996 #4291). The map trace is based on offset of Miocene Columbia River Basalt Group rocks (Beeson and others, 1989 #4047; Yeats and others, 1996 #4291) and is marked by aeromagnetic anomalies (Blakely and others, 1995 #4021; Blakely and others, 2000 #4333), but no fault scarps in Quaternary deposits have been described. Pezzopane (1993 #3544) did not include this fault in his compilation of Quaternary faults. Geomatrix Consultants (1995 #3593) mapped this fault as possibly active in the Quaternary, but concluded that it was not active. Madin and Mabey (1996 #3575) mapped this fault as possibly active in the Quaternary. Unruh and others (1994 #3597) used airphoto, aerial, and field reconnaissance to determine that latest movement on the Sherwood fault predates the late Pleistocene. They mapped the fault as Tertiary, and concluded that it was not active. Wong and others (1999 #4073; 2000 #5137) did not include this fault in their assessments of earthquake hazards in the Portland area.

**Date of compilation** February 6, 2003

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Yamhill, Clackamas, Washington

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

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## Swan Island fault (Class C)

**Structure Name** Swan Island fault (Class C)

Comments: The Swan Island fault was first identified by Glenn (1965 #4080) in a stream bank exposure along the Molalla River near Canby in the northern Willamette Valley; the fault is named after the nearby informally named Swan Island in the Molalla River (Glenn, 1965 #4080).

**Reason for exclusion** The Swan Island fault was identified by Glenn (1965 #4080) in a stream bank exposure along the east bank of the Molalla River near Canby. In this exposure, a steeply north dipping fault offsets mudstone beds about 1 m; the fault is overlain unfaulted to the land surface by several meters of bedded silts of the late Pleistocene Willamette Formation. The faulted mudstone has been correlated with Pleistocene sediments now known as the Diamond Hill member of the Rowland Formation (Glenn, 1965 #4080), but the faulted sediments have not been dated and the exposure lacks a characteristic paleosol at the top of this unit (Werner, 1990 #3946; Yeats and others, 1996 #4291). These sediments could be part of a Miocene or Pliocene fluvial sequence exposed east of Canby (Werner, 1990 #3946; Yeats and others, 1996 #4291). The fault may be related to intrusion of Boring Lava in the region (Werner, 1990 #3946). The fault has no geomorphic expression on topographic maps, has no expression in high resolution aeromagnetic data (Snyder and others, 1993 #4000; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333), and is not included in recent compilations of Quaternary faults in the region (Pezzopane, 1993 #3544; Unruh and others, 1994 #3597; Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Wong and others, 1999 #4073; 2000 #5137).

**Date of compilation** July 19, 2000

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** Oregon

**County** Clackamas

**1° x 2° sheet** Vancouver

**Province** Pacific Border (Puget Trough section)

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## Unnamed faults near Wagontire Mountain (Class C)

**Structure Name** Unnamed faults near Wagontire Mountain (Class C)

Comments: These unnamed high-angle faults are located east of Wagontire Mountain in central Oregon (Pezzopane, 1993 #3544; Geomatrix Consultants Inc., 1995 #3593; Weldon and others, 2002 #5648).

**Reason for exclusion** The Wagontire Mountain faults were mapped with airphoto analysis as high-angle faults by Pezzopane (1993 #3544), and included in three subsequent compilations (Geomatrix Consultants Inc., 1995 #3593; Madin and Mabey, 1996 #3575; Weldon and others, 2002 #5648). The major fault is shown as down-to-the-west, and thus faces uphill to the east-sloping eastern flank of Wagontire Mountain. The area is underlain by Pliocene tuffaceous sedimentary rocks (Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646). These faults are not shown on small-scale published geologic maps (Greene and others, 1972 #3560; Walker and MacLeod, 1991 #3646) or included in older earthquake hazards studies (U.S. Army Corps of Engineers, 1983 #3484; Hawkins and others, 1988 #2946) in the region. The faults are short, have no documentation of offset in Quaternary deposits, apparently have uphill-facing geometry, do not form recognizable escarpments on 1:24,000-scale topographic maps, and thus herein are classified as Class C structures until more detailed studies are conducted.

**Date of compilation** December 3, 2002

**Compiler and affiliation** Stephen F. Personius, U.S. Geological Survey

**State** OR

**County** Harney

**1° x 2° sheet** Burns

**Province** Columbia Plateaus (Harney section)

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