MAP GQ-1694

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

GEOLOGIC MAP OF THE DOOLEY MOUNTAIN 7 1/2' QUADRANGLE, BAKER COUNTY, OREGON

By James G. Evans

GEOLOGIC QUADRANGLE MAP
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EVANS—GEOLOGY, DOOLEY MOUNTAIN QUAD., BAKER COUNTY, OREGON 1:24,000 MAP GQ-1694

GEOLOGIC MAP SYMBOLS

COMMONLY USED ON MAPS OF THE UNITED STATES GEOLOGICAL SURVEY

(Special symbols are shown in explanation)

Contact – Dashed where approximately located; short dashed where inferred; dotted where concealed

Contact – Showing dip; well exposed at triangle

Fault – Dashed where approximately located; short dashed where inferred; dotted where concealed

Fault, showing dip – Ball and bar on downthrown side

Normal fault – Hachured on downthrown side

Fault - Showing relative horizontal movement

Thrust fault – Sawteeth on upper plate

Anticline – Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric anticline – Short arrow indicates steeper limb

Overturned anticline – Showing direction of dip of limbs

Syncline – Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric syncline – Short arrow indicates steeper limb

Overturned syncline – Showing direction of dip of limbs

Monocline – Showing direction of plunge of axis

Minor anticline – Showing plunge of axis

Minor syncline – Showing plunge of axis

Strike and dip of beds – Ball indicates top of beds known from sedimentary structures

Inclined   Horizontal

Vertical   Overturned

Strike and dip of foliation

Inclined   Vertical   Horizontal

Strike and dip of cleavage

Inclined   Vertical   Horizontal

Bearing and plunge of lineation

Inclined   Vertical   Horizontal

Strike and dip of joints

Inclined   Vertical   Horizontal

Note: planar symbols (strike and dip of beds, foliation or schistosity, and cleavage) may be combined with linear symbols to record data observed at same locality by superimposed symbols at point of observation. Coexisting planar symbols are shown intersecting at point of observation.

Shafts

Vertical   Inclined

Adit, tunnel, or slope

Accessible   Inaccessible

Prospect

Quarry

Active   Abandoned

Gravel pit

Active   Abandoned

Oil well

Drilling   Shut-in   Dry hole abandoned

Gas   Show of gas

Oil   Show of oil

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DISCUSSION

INTRODUCTION

The Dooley Mountain 7 1/2' quadrangle is located 18 km south of Baker, Oregon (fig. 1). Principal access is by Oregon Highway 7 south from Baker to Oregon Highway 245, which connects the Powder River and Burnt River valleys by way of Dooley Summit. Numerous dirt roads provide access to all the major canyons in the quadrangle and to many of the ridge tops and flanks. Roadcuts provide excellent exposures of the Miocene volcanic rocks that are usually covered by thick regolith and forest.

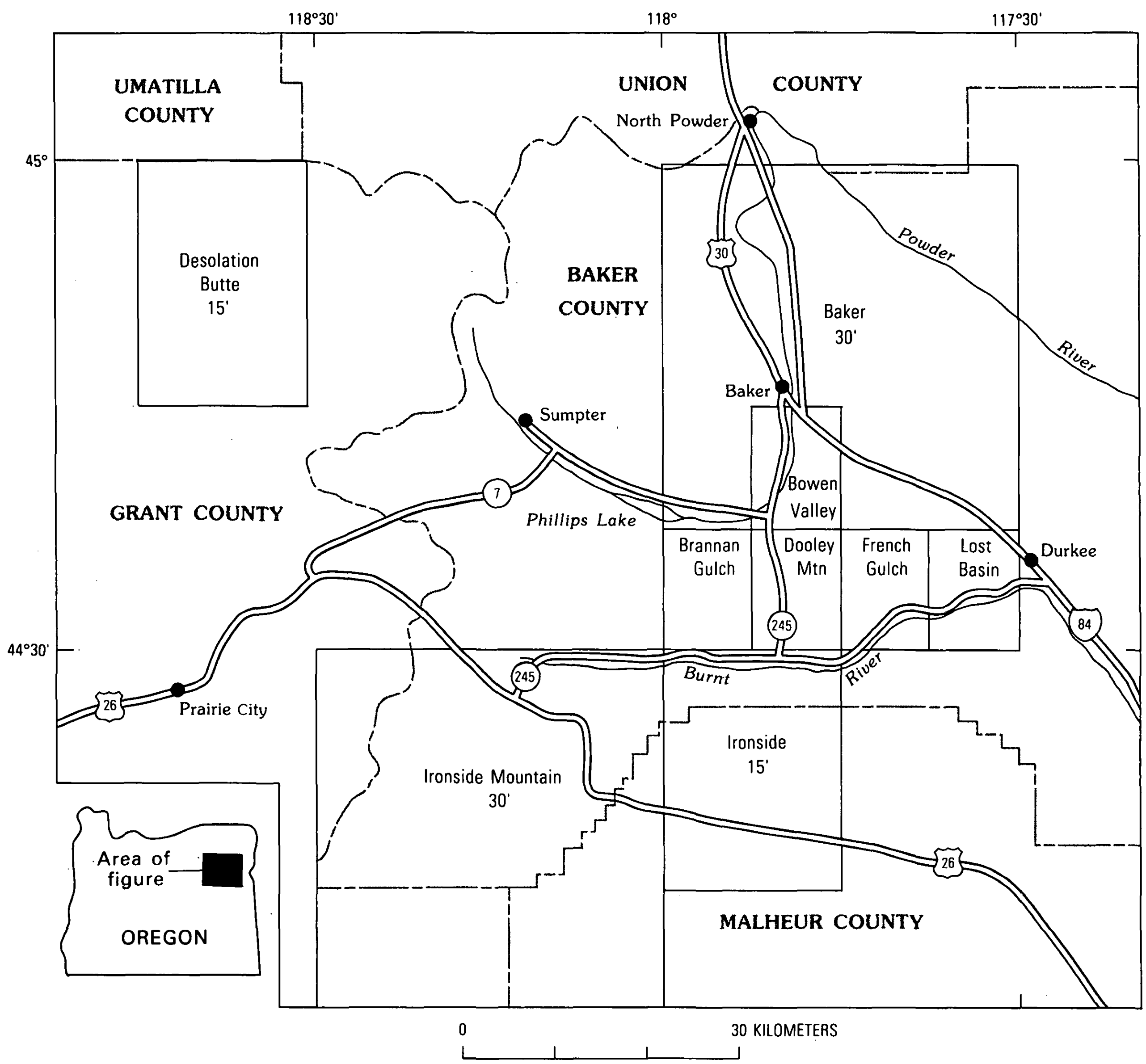

Figure 1. Index map showing locations for selected U.S. Geological Survey and Oregon quadrangles. Quadrangles are 7 1/2' quadrangles unless otherwise noted.

The quadrangle was mapped at the scale of 1:125,000 as part of the Baker 30' quadrangle (Gilluly, 1937), at the scale of 1:250,000 as part of the Baker 1° by 2° quadrangle (Brooks and others, 1976), and at the scale of 1:500,000 as part of a geologic map of eastern Oregon (Walker, 1977). The present study is a cooperative project between the U.S. Geological Survey and the Oregon Department of Geology and Mineral Industries.

The principal geologic interest in the quadrangle is a lower? and middle Miocene volcanic assemblage that consists of a thick section of rhyolitic welded tuff; a fissure-vent filled with rhyolitic pyroclastic breccia; a rectangular vent filled with basalt-rhyolite breccia, flows, and dikes; and two rhyolite domes and related flows. These rocks were named the Dooley Rhyolite Breccia by Gilluly (1937). Because that name inadequately reflects the wide range of lithology present in the unit, it is here redefined as the Dooley Volcanics.

The Dooley Volcanics was deposited on a basement of lower and middle Tertiary basalt, Triassic diorite, and Triassic sedimentary and volcanic rocks. The distribution of the Dooley Volcanics was complicated by faulting, tilting, and erosion that occurred between the volcanic eruptions. The relation, if any, between the volcanic vents within the quadrangle and the vents that supplied the thick section of pyroclastic rocks is not known.

GEOLOGY

The oldest rock unit of the quadrangle is the Burnt River Schist, which was named by Gilluly (1937). These rocks compose a part of the Baker terrane (Silberling and others, 1987). The Baker terrane consists of pieces of oceanic and island arc crust and overlying sedimentary and volcanic rock that have been greatly deformed before and during the Mesozoic when the terrane was accreted to western North America (Brooks and others, 1976; Vallier and others, 1977; Brooks and Vallier, 1978; Dickinson and Thayer, 1978; Brooks, 1979). Mullen (1985) concluded that a forearc setting is most consistent with the chemistry and petrography of the mafic metavolcanic rocks from the Baker terrane.

In the quadrangle, the rock types present in the Burnt River Schist, in order of abundance, are slate, metachert, argillite, andesitic metatuff, meta-andesite, shale-pebble conglomerate, marble, and serpentinite. The sedimentary and volcanic rocks probably represent many hundreds of meters of stratigraphic section, but they are too deformed and the outcrops too scattered to determine an approximate stratigraphic thickness. A clue to what the magnitude of the section may be is in the southeastern part of the quadrangle where the metatuff dips 60° west, and the minimum exposed thickness of unfaulted metatuff is 700 m.

A Triassic(?) age for the Burnt River Schist is based on Late Triassic pentacrinids found in a block of marble in the French Gulch quadrangle (Brooks, and others, 1976) adjacent to the Dooley Mountain quadrangle on the east; Middle to Late Triassic conodonts from the Nelson Marble of Prostka (1967) at Durkee (fig. 1; Morris and Wardlow, 1986); Early Triassic(?) conodonts from the Nelson Marble, which is enclosed by the Burnt River Schist near Durkee (Mullen and Sarewitz, 1983); and radiometrically dated Middle Triassic metamorphosed plutonic rocks intruding the Burnt River Schist, about 10 km east of the quadrangle (Walker, 1986).

There is no evidence in the Dooley Mountain quadrangle to indicate whether or not the Burnt River Schist was intruded by diorite (T̄d), because the contact of the diorite and Burnt River Schist is covered by Tertiary rocks. However, judging from regional relations shown by Brooks and others (1976), the diorite in the Dooley Mountain quadrangle is assumed to intrude the Burnt River Schist. Later, during the Late Cretaceous or early Tertiary, the Burnt River Schist supplied sediments to conglomerate that rests on the slate and metachert in the west-central part of the quadrangle.

Olivine basalt was deposited on the Burnt River Schist in the southern part of the quadrangle. The age of the flows is not known but may be Oligocene or Early Miocene because the flows underlie the early(?) and middle Miocene Dooley Volcanics.

The Dooley Volcanics consists of about 2,400 m of rhyolitic welded tuff, tuff, vitrophyre, and coarse lithic ash-flow tuff, in addition to vent breccia and two rhyolite domes and related flows. The thickest section of the Dooley Volcanics is found in the Dooley Mountain quadrangle.

In the field, the principal characteristic used to distinguish units Td1 through Td7, Td10, Td10a, and Td12a through Td12g is whether or not the map units are densely welded and, thus, resistant to weathering. The altered glassy, or loosely consolidated tuff and breccia readily break down to form slopes of gray glassy sand devoid of outcrops. Units of similar lithology are typically indistinguishable from one another, especially the very fine grained, laminated welded tuffs and the laminated and massive vitrophyres. The chief distinguishing feature of the numbered units is their position in the stratigraphic sequence. The determination of stratigraphic position was made on a ridge-by-ridge basis from the field mapping of the unassigned lithological units. Correlation of units between the ridges was made by matching the lithologies, sequences of rock types, and relative thicknesses of the field units. Allowances were made for relatively minor stratigraphic differences. In this way, the total number of units was determined, and the units were extended across the quadrangle. The contacts between numbered units may be erosional unconformities (for example, the contact between units Td1 and Td2), or may reflect weathering characteristics related to alterations, such as perlitization, or the degree of welding. The contacts may coincide with cooling-unit boundaries (for example, the contact between units Td3 and Td4), or may mark the change from altered or unaltered vitrophyre to densely welded and recrystallized tuff (for example, the contact between units Td2 and Td3). Some of the numbered units mapped may include several cooling units, especially the thicker members like Td2 and Td3. These crudely defined units can be used to delineate the local structure and are probably much more useful in this way than for regional correlation.

The lowermost 1,555 m of welded tuff are mostly in the south half of the quadrangle. This part of the section is divided into seven numbered units, one of which, unit Td2, is divided into locally mappable units, Td2a and Td2b. Thicknesses of units Td1 through Td7 vary widely across the quadrangle, as might be expected of ash flows that sweep across a rough surface and are subject to subsequent erosion. These seven units of the Dooley Volcanics are exceptionally well preserved in the Dooley Mountain area possibly because the welded tuffs filled a small basin or a paleovalley. However, hills as high as 100 m, such as the one south of Rooster Rock Spring, were present in the basin. Erosion and, possibly, faulting between eruptions counteracted the tendency of the numerous ash flows to fill in the topographic depressions. Units Td4 and Td7 are not widely preserved due to uplift and erosion following deposition of unit Td7.

Unit Td1 on the west side of Cornet Creek is cut by glassy dikes that most likely represent remobilized material from an exceptionally hot zone lower in the member. It is not clear whether or not remelting occurred, or the hot glass flowed. This evidence suggests that much of this part of unit Td1 composes one cooling unit that is more than 120 m thick.

After deposition of unit Td7, the north half of the quadrangle was uplifted enough so that units Td1 through Td7 were largely eroded from the Burnt River Schist of the northern (footwall) block. (Was this faulting related to cauldron subsidence?) A small remnant of this part of the welded-tuff section may be preserved in the northwest corner of the quadrangle (Tdt?).

After block faulting, a north-trending fissure approximately 1 by 5 km opened in the western part of the quadrangle (fig. 2) and erupted pyroclastic breccia, some of which is preserved in unit Td8. Much of unit Td8 is interpreted as a vent breccia. Later, the fissure erupted rhyolite (Td9), which formed a dome and fed flows such as the ones along the southwest edge of the quadrangle. Thick rhyolite dikes (Tdr) in the vicinity of the rhyolite dome may be feeders of these rhyolite flows.

Following more erosion, welded tuff was again deposited across the erosionally truncated edges of units Td1 through Td9. The newly deposited unit, Td10, contains several cooling units, which could not be mapped in detail due to poor exposure. However, glassy rocks that form the lower part of the cooling units (Td10a) are locally mappable. Unit Td10 was probably widespread but has been eroded from most of the south half of the quadrangle.

A basalt-rhyolite volcanic center subsequently formed adjacent to the north end of the fissure-vent. The basalt-rhyolite vent is now mostly buried beneath younger volcanic rocks. Judging from exposed parts of the breccia in the adjacent Bowen Valley quadrangle to the north (Brooks and McIntyre, 1978), the 5 by 8 km vent was roughly rectangular and north trending. The east boundary may be just west of Beaver Creek where a fault exposes basement of metatuff below the younger overlying welded tuff. The west wall of the vent coincides with the north-striking fault along Stices Gulch, but this wall is west of Stices Gulch in the Bowen Valley quadrangle.

The vent fill (Td11) consists of mostly medium to coarse basalt and rhyolite pyroclastic breccia, air-fall tuff, and numerous dikes and flows of basalt and rhyolite. One small rhyolite dome (or laccolith?) was observed along Oregon Highway 245, 2 km north of Dooley Summit. Small deposits of welded lithic ash-flow tuff erupted from the vent are preserved on older rocks (Td9 and Td10) nearby.

Rocks adjacent to the fissure-vent and the basalt-rhyolite vent commonly have undergone argillic alteration. Plagioclase is sericitized, the rocks are silicified, and primary mafic minerals are altered to iron oxide. Some rocks contain traces of epidote and sulfide minerals. Some rocks in and near the basalt-rhyolite vent (units Td11 and Td10, respectively) contain garnet porphyroblasts. Poikiloblasts of feldspar occur in alaskite dikes and basalt in the vent fill.

The basalt-rhyolite vent could be an isolated product of crustal melting, or possibly peripherally related to the magma chamber that erupted the welded tuffs in the quadrangle (Hildreth, 1981). The proximity of the vent to the voluminous pyroclastic deposits, including coarse breccia, may not be fortuitous and is consistent with the vent developing on the outer edge of a large magma chamber. This hypothesis would link the volcanism in the quadrangle with the source of the pyroclastic rocks, but this hypothesis cannot be proven with existing data.

After another period of erosion, more welded tuff (Td12) was deposited across most of the basalt-rhyolite vent and may have formed its greatest thickness in a broad, generally north-trending paleovalley parallel to Beaver Creek, but with its depo-axis a few kilometers west of Beaver Creek. Another paleovalley, also generally north-trending, subparallel to West Fork Sutton Creek, was also filled by unit Td12. It is not clear whether or not unit Td12 was deposited across the southern part of the quadrangle, or was eroded off.

The laminated welded tuffs in units Td1 through Td7, Td10, and Td12 are very similar and are chiefly distinguished by their stratigraphic position. They contain 0 to 15 percent phenocrysts, mostly twinned and zoned euhedral to anhedral plagioclase that is usually highly fractured and less than 1 to as much as 5 mm long. A few phenocrysts of quartz and altered mafic minerals are present. The quartz is commonly rounded and deeply embayed by the matrix. The mafic minerals are usually altered to hematite, magnetite, chlorite, biotite and bowlingite. Olivine and pyroxene are present in minor amounts in all ash-flow units. Minor biotite and amphibole phenocrysts are also present in unit Td1. Total mafic mineral content is 1 to 5 percent.

Laminae are defined in hand specimens by millimeter-thick alternating light and dark layers, or layers of different colors (for example, white and pink). In thin section, these layers are sharply defined alternating phenocryst-rich and phenocryst-poor layers showing varying degrees of recrystalization to spherulites. In many rocks the recrystallization is so intense that, under a microscope, the primary textures and structures are obscured or obliterated. Where the matrix is unrecrystallized, it is commonly very fine grained quartz and feldspar and cryptocrystalline material. Irregular or millimeter-sized pore spaces are occupied by tridymite and quartz. Matrix grains surrounding filled pores and unfilled cavities are two or three times larger than the rest of the matrix. Glassy zones in the welded tuff have undergone spherulitic recrystallization and perlitization and have become birefringent. Some of the glassy zones, even partly devitrified ones, have microlites and trichites.

Reef (1983) analyzed 17 samples of welded tuff that he mapped as part of the Dooley Volcanics in the Unity Reservoir area, 20 km west of the quadrangle. He found that the SiO_2 content of the welded tuffs varied from about 70 to 83 percent. Thirteen of the welded tuffs had silica compositions more than 77 percent and are presumed to be altered. No consistent chemical trends would be expected in these rocks, and none were found. The four samples that have a silica content of less than 77 percent are peraluminous. Reef (1983) concluded that either the ash flows were not erupted from zoned magma chambers, that the magma chamber was recharged between eruptions, or that more than one chamber discharged the ash flows.

Whitsun (1988) studied the geochemical stratigraphy of the Dooley Volcanics in the Dooley Mountain quadrangle and concluded from analyses of nine samples that the composition of the unit was dominantly peraluminous, high-silica (76 to 78 percent) rhyolite and that the geochemical patterns are consistent with a petrogenetic model of repeated partial melting and eruption from vents within the quadrangle fed by several magma chambers in an attenuated continental crust. The conclusion that the silicic magma chambers are in an attenuated continental crust does not appear to be consistent with the location of the quadrangle in accreted terrane about 130 km west of the Sr^{87}/Sr^{86}= 0.706 line that is used to define the west edge of the Precambrian continental crust (Armstrong, 1977; Kistler and Peterman, 1978). However, the inclusion of a slab of continental crust, possibly unrelated to the North American craton, at depth within the accreted terrane of eastern Oregon cannot be ruled out.

The final volcanic event preserved in the Dooley Volcanics is extrusion of the rhyolite dome and related flows that cap part of Dooley Mountain, Beaver Mountain, and Bald Ridge. A lobe extends southward across the truncated section of early pyroclastic rocks and northward, filling part of a paleovalley on the east side of Beaver Creek. The rhyolite has a basal vitrophyre of varying thickness that is locally absent. In places the vitrophyre is brecciated. One possible vent is a rhyolite dike (Tdr) on the west side of Beaver Creek, possibly emplaced along the concealed east margin of the basalt-rhyolite vent. Another vent is postulated beneath colluvium deposits at the head of Beaver Creek (see cross section *C–C'*). Other vents may be concealed beneath the rhyolite.

The rhyolite dome (Td13) is the part of the Dooley Volcanics dated by Walker and others (1974) as 14.7±0.4 Ma (recalculated using constants of Dalrymple, 1979), or middle Miocene. The eventful volcanic history outlined above for the Dooley Volcanics, however, suggests that the earliest included tuff (Td1) may be substantially older than the rhyolite dome (Td13), possibly by as much as several million years. Other volcanic centers elsewhere in the western United States have had phases of large-volume ash-flow volcanism that lasted for 2 to 5 m.y. (Bruneau-Jarbidge eruptive center, Idaho, 2 m.y., Bonnichsen, 1982; McDermitt Caldera complex, Nevada-Oregon, 3 m.y., Rytuba and Conrad, 1981; San Juan Mountains, Colorado, 4 m.y., Lipman and others, 1970; Thunder Mountain field, Idaho, 4 m.y., Leonard and Marvin, 1982; Magic Reservoir area, Snake River Plain, Idaho, 5 m.y., Leeman, 1982). Therefore, it is possible that the oldest part of the Dooley Volcanics (Td1) could be as old as late early Miocene. In this report, the Dooley Volcanics is tentatively assigned an early(?) and middle Miocene age.

The question of how quickly the 2,400 m of welded tuff accumulated is not resolvable with existing data. Some evidence suggests that parts of the section may have accumulated quickly. The glassy dikes in Td1, described above, suggest that some cooling units may have been more than 120 m thick. Also, no paleosols were recognized. It is not clear, however, whether or not the time between eruptions was insufficient for development of paleosols, or paleosols were destroyed by scouring at the base of ash flows or from the heat of welding. Paleosols were probably developed, at least locally and sporadically, because petrified wood was found in unit Td2. If the eruptions were frequent and many of the cooling units were very thick, the welded tuffs could have accumulated in a relatively short time.

The cumulative duration of volcanic quiescence and erosion may well have constituted a significant fraction of the time between deposition of units Td1 and Td13, especially the periods between deposition of unit Td7 and emplacement of unit Td8, between emplacement of unit Td9 and deposition of unit Td10, between emplacement of unit Td11 and deposition of unit Td12, and between deposition of units Td12 and Td13.

The vent source or sources of the 2,400 m of welded tuff, tuff, and pyroclastic breccia of the Dooley Volcanics are not known. Circumstantial evidence suggests that the vent or vents are nearby and probably lie southwest or west of the quadrangle. Areas to the northwest, north, east, and south have Paleozoic and (or) Mesozoic basement rocks covered, at most, by relatively thin Tertiary formations (Brown and Thayer, 1966; Brooks and others, 1976). Areas to the southwest and west, however, are underlain by thick Tertiary volcanics that could be in part related to the Dooley Volcanics, or they could be covering Miocene vents. The coarse pyroclastic breccias, containing lithic fragments as large as 2 m across, suggest that the vent (or vents) was not far.

Other evidence suggests western or southwestern sources for the ash flows. Units Td1 through Td7 generally thin to the east. The degree of welding is more intense to the west. The stratigraphic thinning of unit Td2 northeast of the hill underlain by the Burnt River

Schist south of Rooster Rock Spring would be consistent with ash flows coming from the southwest and thinning in the lee of the hill. Shallow crenulations and grooves, possibly flow induced like the ones described by Schmincke and Swanson (1967) and Chapin and Lowell (1979), are most abundant on laminae in unit Td3. These lineations trend mostly north-northeast.

The welded tuffs are much alike physically and mineralogically, suggesting an origin from a single magma chamber that was repeatedly recharged.

Andesite dikes intrude the lower part of the Dooley Volcanics (unit Td2) and may be younger than part of the Dooley Volcanics.

Basalt overlies the uppermost welded tuff unit (Td12) in the northwest corner of the quadrangle and may also be younger than the rhyolite dome (Td13). The basalt is contiguous with the more widespread basalt flows in the adjacent Bowen Valley quadrangle (fig. 1; Brooks and McIntyre, 1978), which were assigned a Miocene age on the basis of plant fossils in tuff interbeds and their lithologic similarity to basalt flows of the Columbia River Group. Basalt flows in the southwest corner of the quadrangle are similar to the basalt flows in the northwest corner and are tentatively correlated with them.

Tuff and lacustrine sedimentary rocks are found in the southwest and southeast corners, respectively. The tuff lies on Miocene basalt. The base of the sedimentary rocks is not exposed, but the underlying unit is probably the Dooley Volcanics. The tuff and sedimentary rocks are lithologically similar to rocks of the Idaho Group mapped by Lowry (1968) in the adjacent Ironside Mountain 30' quadrangle to the southwest (fig. 1). Lowry (1968) cites vertebrate and plant fossils in support of an early and middle Pliocene age for the Idaho Group. This age is tentatively accepted for the tuff and lacustrine sedimentary rocks in the Dooley Mountain quadrangle.

Fanglomerate containing clasts mostly of rhyolitic lithologies was deposited on the northern and southern flanks of Dooley Mountain in the Pliocene and Pleistocene and has been subsequently dissected. These deposits were much more extensive than they are at present.

Colluvium, landslide deposits, and alluvium were formed in the Pleistocene and Holocene.

STRUCTURE

The Burnt River Schist is exposed in two main blocks separated by the overlying Dooley Volcanics; one block is in the west-central part of the quadrangle, and the other one is in the southeastern part. The internal structure in the blocks is slightly different from one another. In the west-central block, the slate commonly has two intersecting cleavages, one of which is better developed than the other. Angles between pairs of cleavages varies from 20° to 90°. Although clusters of poles occur on an orientation diagram, the dominant and subordinate cleavages are not separable into discrete groups on the basis of orientation and degree of development. Poles of slaty cleavages lie along a great circle that is approximately perpendicular to cleavage mullions and crenulations on the cleavage. These linear structural elements plunge at low to moderate angles west-southwest. The slate is cut by irregularly spaced fracture cleavages that are oriented at large angles to the cleavage mullions and crenulations.

In the southeast block, one slaty cleavage is developed in most outcrops. These cleavages dip moderately to steeply southward and correspond with one of the groups of poles of slaty cleavage in the west-central block. West-southwest-plunging cleavage mullions and crenulations are present, but they do not form a dominant group of linear elements. Other folds plunge south, southeast, and northeast. Spaced fracture cleavages at large angles to west-southwest-plunging cleavage mullions are poorly developed.

The internal geometry of the Burnt River Schist, described above, was developed during Mesozoic subduction-related processses under conditions of the lower greenschist facies. Ashley (1966) studied the mesoscopic structure of the Burnt River Schist in detail to the east in the French Gulch and Lost Basin quadrangles (fig. 1).

Tertiary tectonics in the quadrangle mostly involved vertical movements, including opposite slip inferred at different times along some faults. Vertical separation of more than 2,000 m occurred along a northeast-striking normal fault across the middle of the quadrangle sometime in the early or middle Miocene. Part of the fault along which the separation occured may be preserved along the west edge of the quadrangle in the upper part of Cornet Creek (sec. l, T. 12 S., R. 39 E.). To the east, the fault has been displaced along younger faults and buried beneath younger pyroclastic deposits and a rhyolite dome. The upthrown northern block probably changed local drainage patterns significantly and may have established the drainage divide that now separates the Powder River and Burnt River valleys.

Later in the Miocene the predominant strain was east-west extension when the fissure occupied by units Td8 and Td9 (of the Dooley Volcanics) formed. Local extension of 1 km developed in the western part of the quadrangle.

The basalt-rhyolite breccia complex erupted at the north end of the older fissure-vent. After piercing the carapace of the Burnt River Schist, the volcanic center probably initially erupted slate and metachert along with the basalt and rhyolite debris. Much of the space for the vent, however, may have been made by shouldering aside several cubic kilometers of the Burnt River Schist. Because of the approximately rectangular shape of the vent, local strain was probably complicated, although it included a large east-west component of extension.

Since the Miocene, the Dooley Mountain block was uplifted, resulting in tilting of the fanglomerate on the south edge of the quadrangle by as much as 15° and by tilting of the basalt on the north edge by 5° to 20°. The uplift may have involved broad arching of the volcanic rocks, because the welded tuff on the north and south dip away from the crest of the range.

GEOCHEMICAL STUDIES

The following discussion of geochemical studies is a synopsis of a report published by Evans (1989). Anomalous amounts of gold [anomalous in comparison to crustal abundance of about 3 parts per billion (ppb); Simons and Prinz, 1973] were found in 10 of the 33 panned-concentrate samples and five of 37 stream-sediment samples. The gold concentrations of the analyzed samples ranged from 6.4 to 2,600 parts per million (ppm) in panned concentrates and from 0.05 to 0.4 ppm in stream sediments, a sample medium in which detectable amounts of gold are unusual at a lower limit of detection of 0.05 ppm. The drainage areas of the streams containing gold (fig. 2) underlie much of the quadrangle. It is possible that even more of the quadrangle contains anomalous concentrations of gold. Due to the low concentrations of nonmagnetic heavy minerals in the stream sediments, the presence of gold in some drainages cannot be adequately determined by panning only two pan loads of stream sediment, as was done in the geochemical study (Evans, 1989). The low sample weights of the nonmagnetic heavy-mineral fractions obtained (Evans, 1989, table 5) resulted in high and variable lower limits of detection for gold. The area of anomalous gold (fig. 2) was based on detectable concentrations of gold in stream sediments and panned concentrates and is a minimum prospective area. This area of anomalous gold may be much larger than the source areas, which may consist of a few scattered mineralized zones.

The area of anomalous gold extends into the adjacent Brannan Gulch quadrangle to the west as indicated by the high gold concentrations from panned concentrates from part of the upper part of Stices Gulch (fig. 2; 6.4, 22, and 2,600 ppm). The geology of the drainage containing the sample that has 2,600 ppm gold suggests that gold mineralization is along a fault between the early(?) and middle Miocene Dooley Volcanics and the Triassic(?) Burnt River Schist. Gold mineralization also occurs in the Burnt River Schist, but no bedrock sources were identified.

The nonmagnetic heavy-mineral fractions analyzed were highly concentrated residues of the stream sediments. Therefore, the analytical concentrations of gold do not directly reflect the amount or richness of gold-mineralized rock in the drainages. The concentrations of gold in these analyzed samples may reflect the so-called nugget effect, which occurs if relatively few grains of gold account for most of the gold in a large volume of material. If this is the case in a drainage, most samples removed from the stream bed will show no gold, but the few samples that capture the scarce gold grains will show relatively large amounts of gold. Also, some of the gold may be associated with mafic or sulfide minerals in the samples. If the gold grain size is small enough, some gold may have been lost during panning.

Thirteen of the rock samples in the gold anomaly had gold concentrations ranging from 0.05 to 1.75 ppm (Evans, 1989, 278 rock samples analyzed). Eight of these samples, containing gold concentrations covering this range of values, were located near the 1 by 5 km fissure-vent occupied by rhyolitic pyroclastic breccia and rhyolite (fig. 2). Two of these samples also contained silver concentrations of 1.5 and 2 ppm (not shown on fig. 2). One of the samples containing 1.3 ppm gold was taken near the collar of an exploration drill hole made by Freeport Corp. This sample also had 2,000 ppm arsenic, 150 ppm antimony, 200 ppm lead, and 1,000 ppm zinc. Other rock samples in and near the vent were anomalous in arsenic (1,500 ppm maximum), antimony (3,000 ppm maximum; not shown on fig. 2), and mercury (1 to greater than 10 ppm). The rocks containing anomalous amounts of mercury tended to occur farther from the fissure-vent than the other elements mentioned above; this distribution suggested element zonation around the vent.

The gold anomalies along Water Gulch, the upper part of Auburn Creek, and Sutton Creek were not associated with anomalous concentrations of other elements. The rocks in all three anomalies are intensely faulted, although the major faults themselves are poorly exposed. These faults may have served as pathways for mineralizing epithermal solutions, but it is not clear whether the faults themselves or the adjacent Dooley Volcanics are mineralized. In addition, the upper part of Auburn Creek and the Sutton Creek area are near the probable vent that fed the uppermost rhyolite flow and dome unit of the Dooley Volcanics. An epithermal system related to that vent may have resulted in localized gold mineralization.

EXPLANATION

Fissure vent

Paved roads

Dirt roads

Boundary of anomaly

Gold

Silver

Zinc

Stream-sediment and panned-concentrate samples containing anomalous concentrations of gold (Au), silver (Ag), or zinc (Zn)—In parts per million

△61Au Panned concentrate

○0.4Au Stream sediment

▲27Au 300Zn Stream sediment and panned concentrate

Rock samples containing anomalous concentrations of gold, silver, arsenic or mercury—In parts per million

● 0.3 Gold

⊙0.7 Silver

◈200 Arsenic

□5.5 Mercury

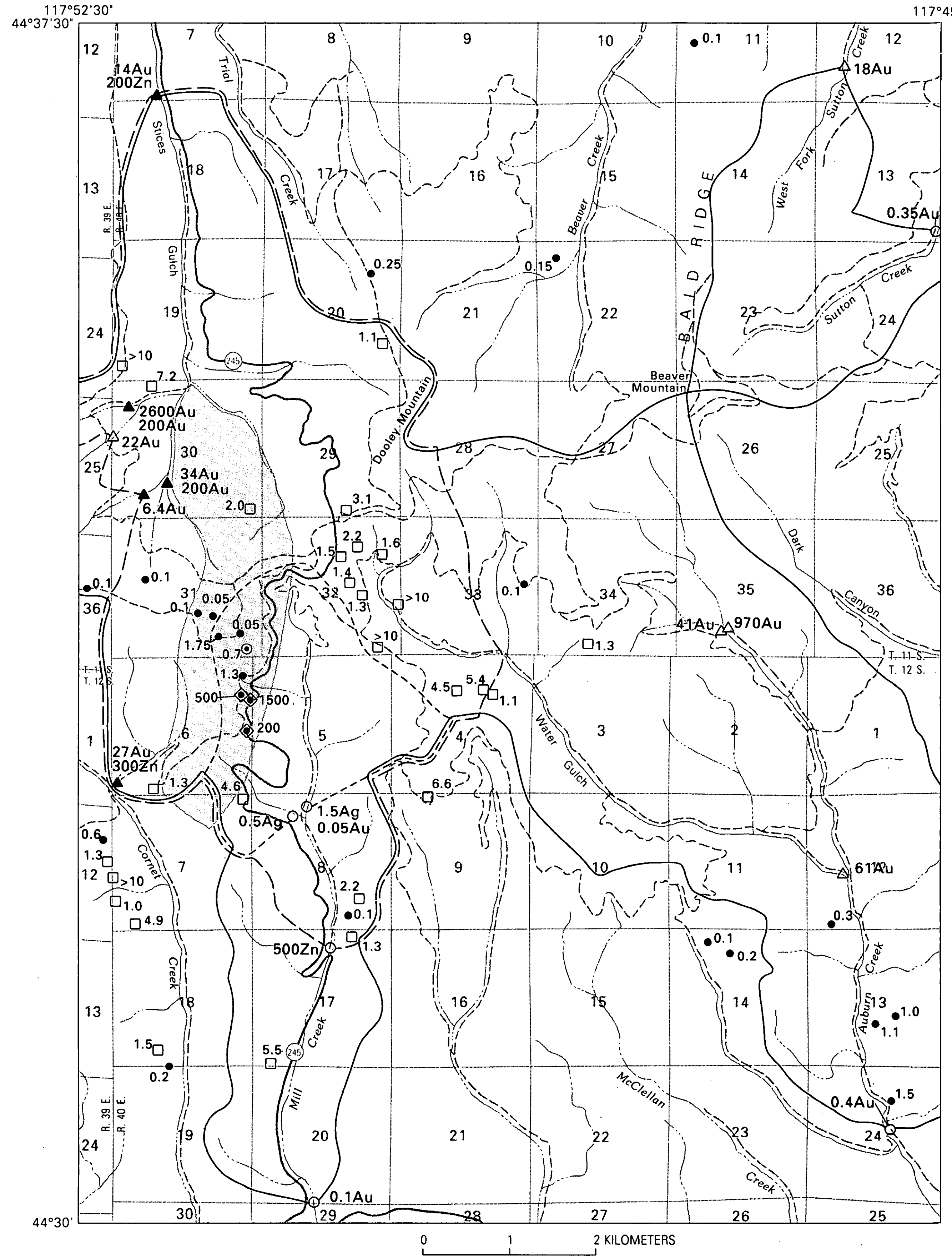

Figure 2. Dooley Mountain 7 1/2' quadrangle showing locations of fissure-vent, anomalous areas (gold, silver, and zinc), and stream-sediment, panned-concentrate, and rock samples containing anomalous concentrations of gold, silver, zinc, arsenic, and mercury (from Evans, 1989).

Four occurrences of gold (0.25 to 1.1 ppm) in quartz veins in the Burnt River Schist in the southeastern part of the quadrangle were associated with 0.4 ppm gold in stream sediments in the lower part of Auburn Creek (fig. 2). Three of these rock samples also contained silver (0.5 to 1.5 ppm). One of the samples contained 500 ppm zinc. The gold occurrences were at prospects along a part of the lower part of Auburn Creek that has been placered.

Minor amounts of gold were found in talc (0.1 ppm) and serpentinite (0.2 ppm) east of Juniper Hill Spring in the southeastern part of the quadrangle (fig. 2). Both samples were taken from shallow workings in which the ultramafic rocks are hosted by the Burnt River Schist. Sheared talc and serpentinite that is common in the area near these samples suggest the possibility of more widespread low-gold concentrations. However, these gold occurrences were not associated with anomalous concentrations of gold in stream-sediment and panned-concentrate samples collected downstream.

Much of the gold anomaly in Stices Gulch, East Fork Cornet Creek, and the upper part of Mill Creek coincided with part of a zinc anomaly defined by concentrations of zinc in stream-sediment samples greater than or equal to the 200 ppm detection limit. A part of the upper part of Mill Creek contained a silver anomaly defined by silver concentrations greater than or equal to the 0.5 ppm detection limit in stream sediments.

Commercially exploited perlite is located in the upper part of Auburn Creek (NE1/4, sec. 2, T. 12 S., R. 40 E.) on the east edge of the central part of the main gold anomaly.

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