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

Digital representation of the Washington state geologic map: a contribution to the Interior Columbia River Basin Ecosystem Management Project

by

Gary L. Raines and Bruce R. Johnson

Open File Report 95-684

Prepared in cooperation with the U.S. Forest Service and Bureau of Land Management.

1996

CONTENTS

Acknowledgments

Digital products such as this map would not exist without the geologic mapping of generations of geologists whose work contributed to the small-scale state geologic maps that have been published by most states. We gratefully acknowledge the work of the geologists and agencies that supported compilation of this map. Those agencies include the U.S. Geological Survey and the Washington State Department of Natural Resources.

USGS geologists, Thor Kiilsgaard and Fred Miller, provided useful advice about regional geology and the identification of unlabeled features on the published state geologic maps.

We particularly wish to acknowledge Patrick Geehan, the Bureau of Land Management Project coordinator for the Interior Columbia River Basin Ecosystem Management Project, for recognizing the importance of geology to ecosystem management and for supplying funds to digitize the Washington map.

Introduction

This report describes the digital representation of the Washington state geologic map (Hunting and others, 1961). This report contains an explantion of why the data were prepared, a description of the digital data, and information on obtaining the digital files. This report is one in a series of digital maps, data files, and reports generated by the U.S. Geological Survey to provide geologic process and mineral resource information to the Interior Columbia Basin Ecosystem Management Project (ICBEMP). The various digital maps and data files are being used in a geographic information system (GIS)-based ecosystem assessment including an analysis of diverse questions relating to past, present, and future conditions within the general area of the Columbia River Basin east of the Cascade Mountains.

The Interior Columbia Basin Ecosystem Management Project

In July of 1993, President Clinton directed the Forest Service (USFS) to “develop a scientifically sound and ecosystem-based strategy for management of eastside forests.” (SIT, 1994) What was first called the Eastside Ecosystem Management Project was chartered in January, 1994, by the Chief of the Forest Service and Director of the Bureau of Land Management (BLM) in response to the President's directive and charged to “develop an ecosystem management framework and assessment for land administered by the Forest Service and the Bureau of Land Management on those lands east of the Cascade crest in Washington and Oregon and within the interior Columbia River Basin.” (SIT, 1994) The driving force behind the project was the need to develop a strategy for dealing with anadromous fish habitat and watershed conservation and to develop overall land management policy in eastern Oregon and Washington. When it subsequently became clear that similar strategies were needed for anadromous fish in the remainder of the Columbia River Basin (particularly in Idaho and Montana), the project was extended to include all of the Columbia River drainage basin in the United States, east of the Cascade Mountain divide plus the remainder of southeastern Oregon, which is not within the drainage basin (fig. 1). At that time, the project was renamed the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

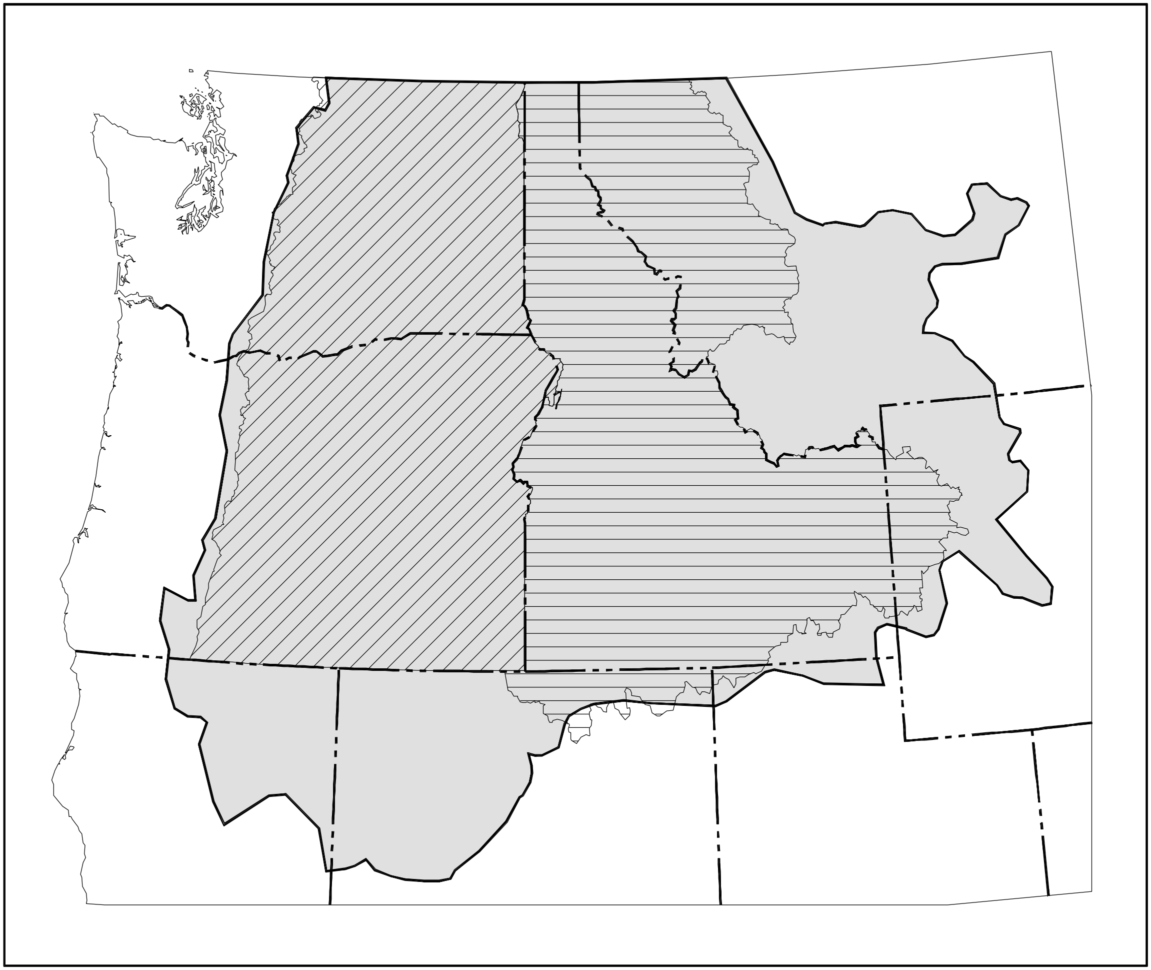

Figure 1. Index map showing the geographic extent of the Interior Columbia Basin Ecosystem Management Project. Shown on the map are the Landscape Characterization Area (grey shading) which is the study area used by most Science Integration Team staff areas, the Eastside EIS area (diagonal hatching), and the Upper Columbia EIS area (horizontal hatching).

The ICBEMP is producing scientific assessments of current and historic landscape conditions; aquatic and terrestrial habitat, species distributions, and populations; and economic and social conditions as well as the potential future conditions and possible tradeoffs likely to result from a range of possible disturbances and management practices on public lands in the basin. Although the scientific assessment is being conducted for the entire basin, the management decisions that will result from the assessments will be for public lands (USFS and BLM) only.

The goal of the ICBEMP management strategy is to provide management tools to sustain or restore ecosystem integrity and produce desired conditions, uses, products, values, and services over the long term. The intent of the project is to understand the ramifications of management practices or disturbances both in the area subject to the practice or disturbance as well as effects which may be removed, in time and space, from the area.

The project objectives are to:

- Conduct a broad integrated scientific assessment of the resources within the interior Columbia River basin to characterize and assess landscape, ecosystem, social, and economic processes and functions and describe probable outcomes of various management practices and trends.
- Develop an ecosystem management framework that includes principles and processes which may be used in a National Environmental Protection Act (NEPA) process to develop management direction for federal agencies at all levels with the basin.
- Write an Eastside Environmental Impact Statement (EIS) proposing a broad array of management alternatives for an area that encompasses ten national forests and portions of four BLM districts in eastern Washington and Oregon (fig. 1).
- Write an Upper Columbia River Basin EIS with a similar array of management alternatives for an area that encompasses lands administered by the BLM and USFS in Idaho, western Montana, Wyoming, Utah, and Nevada within the Columbia River Basin (fig. 1).
- Conduct a scientific evaluation of issues and alternatives identified through the NEPA scoping process for the Eastside EIS.

The ICBEMP is an intense, short term assessment and planning activity used to develop a set of regional implementation management alternatives. These alternatives, derived from basin-wide analyses of regional (1:500,000 and 1:1,000,000 scales) and locally more detailed (1:100,000 scale) data, will form a framework for implementation decisions at the local level. This framework will then be adapted as better data and understanding of the basin are developed. The project will provide a basin-wide, digital data framework that will evolve and improve as higher resolution data become available. All data are being collected in a GIS-compatible format for digital display, analysis, and distribution. Information on the availability of all digital data sets, paper maps, and other reports generated by the ICBEMP can be obtained from:

Interior Columbia Basin Ecosystem Management Project

ATTN: Cindy Dean

112 E. Poplar Street

Walla Walla, WA 99362

(509) 522-4030

or from:

Bureau of Land Management

ATTN: Becky Gravenmeier, OR99.2

Oregon - Washington State Office

P.O. Box 2965
Portland, OR 97208
(503) 952-6273

Project extent and scale

The scope and extent of the project area varies depending on the objective. The broad scientific assessment considers all lands, not just those that are federally managed. It is focused on the Columbia River Basin but is not strictly limited to the actual drainage basin boundaries. Some scientific assessment staff areas have extended their work beyond the formal project area because factors such as wildfires and wildlife migration are not limited to drainage divides or political boundaries. Most staff areas use the Landscape Characterization boundary developed by the Landscape Ecology group (fig. 1). The broad assessment uses information suitable for compilation at a scale of 1:1,000,000.

U.S. Geological Survey involvement

In May, 1994, the USGS approached ICBEMP staff about providing estimates of undiscovered mineral resources to the economic, landscape ecology, and aquatic-riparian assessment staff. In discussions with members of various staff areas, it became apparent that the USGS could also provide geoscientific background information relevant to the assessment of historic, current, and future ecological, economic, and social systems. Within the ICBEMP's tight schedule (7 months from the USGS start date until the information had to be available to the rest of the Science Integration Team), the USGS was able to provide basin-wide, integrated, digital information about bedrock lithology, compositional classifications of lithology, potential animal habitat, stream sediment geochemistry, volcanic and earthquake hazards, and mineral resources. The bedrock lithology information is summarized in Johnson and Raines (1995). The potential animal habitat information is summarized in Frost, Raines, Almquist, and Johnson (1996). The stream sediment geochemistry is summarized in Raines and Smith (1996). The digital hazards information was derived from Algermissen, et al (1990) and Hoblitt, Miller, and Scott (1987). The mineral resources information is summarized in Box and others (1996); Bookstrom, Zientek, and others (1996); Zientek and others (1996); and Bookstrom, Raines, and Johnson (1996). The compositionally classified lithology information is reported Raines and others (1996). The bedrock lithology, compositionally classified lithology, and potential animal habitat maps were all derived from interpretation of state geologic maps at scales of 1:500,000 to 1:750,000. Johnson and Raines (1995) summarizes the strategy that was used for the rapid analysis of geologic map data using GIS techniques. Considerably more information was identified as potentially useful to the ICBEMP, but integrated digital products could not be provided for the entire study area within the time frame of the assessment.

Data Sources, Processing, and Accuracy

The starting point for the digital geology map of Washington was a mylar copy of the published paper geologic map (Hunting and others, 1961) at a scale of 1:500,000. The map was processed digitally, as follows: the source material was scanned, the scanned image was vectorized and topologically structured, the lines and polygons were edited and proofed, attributes were added and proofed, the map was transformed from scanner units to geographic coordinates, and finally, map distortions were removed by rubber-sheeting. The initial objective was to obtain a digital representation that, when plotted, would overlay the source material within a line width; the digital version of the map meets this test. The map was processed in the ARC/INFO GIS.

A measure of the geometric accuracy of the source materials (as represented digitally) was obtained by comparing 29 points with known latitudes and longitudes from the source material with calculated locations of these points. Table 1 contains the result of this comparison as the registration root-mean-square error (RMS). Appendix B contains a detailed breakdown of registration errors for each point. The RMS error on this map (189 meters) is slightly larger than the national standard for 1:500,000-scale topographic base maps (plus or minus 140 meters horizontally), which is probably attributable to the age and condition of the mylar source materials.

State	Date	Scale	Source Material	Registration Error (RMS) input (inches), output (meters)
Washington	1961	1:500,000	Mylar	0.015, 189.092

Table 1. Source of materials and registration errors for the digital geologic map of Washington. The registration root-mean-square (RMS) errors are obtained while transforming from scanner units of inches (input in table) to real world coordinates of meters (output in table). These errors are the RMS difference between the scanned latitude-longitude location points from the source material and the calculated locations of these points.

Each polygon and line on the digital map was assigned attribute information based on the original map explanation. Details of the attributes used and the values which those attributes can contain are given in Appendix A. At least two GIS coverages are required to efficiently represent a geologic map. One coverage (lithology) contains all of the polygon data and all of the contacts between polygons. To prevent polygons from being dissected by cross-cutting lines, a second coverage (faults) is used to contain all of the linework other than contacts (faults, fold axes, etc.) Where the contact between polygons (lithologic units) is made up of a fault, the identical line (fault/contact) will exist in both coverages. Appendix B contains detailed documentation of the two coverages which were used to represent the map digitally. There were approximately 100 to 200 tiny polygons on the original map that were either ambiguously attributed or un-attributed on the original published map. These polygons were assigned map-unit attributes by consultation with regional experts and inspection of more detailed maps.

Obtaining Digital Data

To obtain copies of the digital data, do <u>one</u> of the following:

1. Download the digital files from the USGS public access World Wide Web site on the Internet.

URL = http://pubs.usgs.gov/of/1995/of95-684/

The World Wide Web site contains the geologic GIS coverages in Arc/Info Export file format as well as the associated data files and Arc/Info macro programs which are used to plot the map. Use of this data requires a GIS that is capable of reading Arc/Info Export formatted files and a computer capable of reading UNIX ASCII files. To use these files on a DOS computer, they must be put through a unix-to-dos filter. Or,

2. Obtain the digital files from the ICBEMP project office. Contact information is given in the section, **U.S. Geological Survey involvement** , above.

Digital versions of other state geologic maps in the Northwest are available as follows:

Arizona — Data files are available from **http://geology.wr.usgs.gov/docs/geologic/az/arizona.html**

California: — Contact the California Division of Mines and Geology, 1416 Ninth Street, Room 1341, Sacramento, CA 95814

Idaho: — Johnson and Raines (1996)

Montana: — Raines and Johnson (1996)

Nevada: — Turner and Bawiec (1991) — CD-ROM

Oregon: — Data files are available from

http://geology.wr.usgs.gov/docs/geologic/or/oregon.html

Utah: — Data files are available from **http://geology.wr.usgs.gov/docs/geologic/ut/utah.html**

Wyoming: — Green and Drouillard (1994) This report is a description of the digital data files only. The data files are available from **http://pubs.usgs.gov/of/1994/ofr-94-0425/**

Obtaining Paper Maps

Paper copies of the Washington state geologic map are not available from the USGS at this time. The original published geologic map is available from the Washington Department of Natural Resources. Paper copies of the map can also be created by obtaining one of the versions of the digital files as described above, and then creating a plot file in a GIS.

References Cited

Algermissen, S. T., Perkins, D. M., Thenhaus, P. C., Hanson, S. L., and Bender, B. L., 1990, Probabilistic earthquake acceleration and velocity maps for the United States and Puerto Rico: U.S. Geological Survey Miscellaneous Field Studies Map, MF-2120, scale 1:7,500,000.

Bookstrom, A. A., Raines, G. L., and Johnson, B. R., 1996, Digital mineral resource maps of phosphate and natural aggregate in the Pacific Northwest: a contribution to the Interior Columbia Basin Ecosystem Management Project: U.S. Geological Survey Open-File Report 95-681, 31 pp.

Bookstrom, A. A., Zientek, M. L., Box, S. E., Derkey, P. D., Elliott, J. E., Frishman, David, Evarts, R. C., Ashley, R. P., Moyer, L. A., Cox, D. P., and Ludington, S. D., 1996, Status and contained metal content of significant base and precious metal deposits in the Pacific Northwest: a contribution to the Interior Columbia Basin Ecosystem Management Project: U.S. Geological Survey Open-File Report 95-688, 93 pp.

Box, S. E., Bookstrom, A. A., Zientek, M. L., Derkey, P. D., Ashley, R. P., Elliott, J. E., and Peters, S. G., 1996, Assessment of undiscovered mineral resources in the Pacific Northwest: a contribution to the Interior Columbia Basin Ecosystem Management Project: U.S. Geological Survey Open-File Report 95-682, 415 pp.

Green, G.N. and Drouillard, P.H., 1994, The digital geologic map of Wyoming in ARC/INFO format: U.S. Geological Survey Open-File Report 94-0425, 10 p.

Hoblitt, R. P., Miller, C. D., and Scott, W. E., 1987, Volcanic hazards with regard to siting nuclear power plants in the Pacific Northwest: U.S. Geological Survey Open-File Report 87-297, 196 pp.

Hunting, M. T., Bennett, W. A., Livingston, V. E., Jr., and Moen, W. S., 1961, Geologic map of Washington: Washington Dept. of Conservation, Division of Mines and Geology, 1 plate, scale 1:500,000.

Johnson, B.R. and Raines, G.L., 1995, Digital map of major lithologic bedrock units for the Pacific Northwest: a contribution to the Interior Columbia Bain Ecosystem Management Project: U.S. Geological Survey Open-File Report-680, 36 p. plus 2 plates.

Johnson, B. R. and Raines, G. L., 1996 , Digital representation of the Idaho state geologic map: a contribution to the Interior Columbia Bain Ecosystem Management Project: a contribution to the Interior Columbia Bain Ecosystem Management Project: U.S. Geological Survey Open-File Report 95-690, 22 pp.

Raines, G. L., Johnson, B. R., Frost, T. P., and Zientek, M. L., 1996, Digital maps of compositionally classified lithologies derived from 1:500,000 scale geologic mapping for the Pacific Northwest: a contribution to the Interior Columbia Basin Ecosystem Management Project: U.S. Geological Survey Open-File Report 95-685, 28 pp.

Raines, G. L. and Smith, C. L., 1996, Digital maps of National Uranium Resource Evaluation (NURE) geochemistry for the Pacific Northwest: a contribution to the Interior Columbia Basin Ecosystem Management Project: U.S. Geological Survey Open-File Report 95-686, 22 pp.

SIT (Science Integration Team), 1994, Framework for ecosystem management in the Interior Columbia River Basin - version 1: eastside Ecosystem Management Project, USFS, Walla Walla, Washington, 48 p.

Turner, R.M., and Bawiec, W.J., 1991, Geology of Nevada - a digital representation of the 1978 geologic map of Nevada: U.S. Geological Survey Digital Data Series, DDS-2, 1 CD-ROM.

Zientek, M. L., Bookstrom, A. A., Box, S. E., and Johnson, B. R., 1996, Future minerals related activity, Interior Columbia Basin Ecosystem Management Project area: an overview: U.S. Geological Survey Open-File Report 95-687, xx pp.

Appendix A: Geologic Map Attributes.

Attributes Compiled for Classification

The table below is a list of the ARC/INFO attributes that were compiled for each geologic map unit.

Attribute	Description
FORMATION	The map unit symbol used on the published map. This is the item that is related to the map coverage. This is not necessary a formation in the normal usage. It is a map unit.
UNIT_NAME	The map unit name from the map explanation.
ROCK_TYPE	The general rock category from the map explanation. Generally this is something like sedimentary, igneous, or metamorphic.
ERA, SYSTEM, SERIES	Age information from the map explanation.
LITH1, LITH2, etc.	Lithology from the map explanation. LITH1 is the first described lithology, LITH2 is the next, etc.
LOCATION1, LOCATION2	Notes on location of this particular map unit within the state. Some state maps have differing lithologic descriptions for a single geologic unit in different geographic portions of the state.
COMMENTS	Other comments from map explanation that do not fit in previous attributes

Example of Complete Data for One Stratigraphic Unit

Description from map explanation:

Sedimentary and Metasedimentary Rocks

Ordovician rocks — Mainly black to gray slate or slatey argillite, argillite, black to dark-gray limestone, and some black to gray quartzite. Includes dark gray siltstone in north-central Stevens County and grayish olive-green silty argillite in west-central Stevens County. Many occurrences of Early and Middle Ordovician graptolites; also rare conodonts.

GIS attributes derived from map explanation:

Attribute Name	Contents
FORMATION	O
UNIT_NAME	Ordovician rocks
ROCK_TYPE	Marine sedimentary and metasedimentary rocks
ERA	Paleozoic
SYSTEM	Ordovician
SERIES	
LITH1	slate
LITH2	argillite
LITH3	limestone
LITH4	quartzite
LITH5	siltstone
LITH6	
LITH7	
LITH8	
LOCATION1	
LOCATION2	
COMMENTS	Many occurrences of Early and Middle Ordovician graptolites; also rare conodonts.

Time Stratigraphic Symbols used for Formation Names

Because the database tables that are used with the GIS are confined to ASCII characters, the following ASCII character substitutions were used for representing geologic time designators in formation names:

Geologic Time	Map Symbols	ASCII Equivalent
Quaternary	Q	Q
Tertiary	T	T
Pliocene	P	PL
Miocene	M	MI
Oligocene	Ol	OL
Eocene	E	E
Paleocene	pE	EP
Mesozoic	Mz	MZ
Cretaceous	K	K
Jurassic	J	J
Triassic	TR	TR
Permian	PM	P
Carboniferous	C	PNM
Devonian	D	D
Silurian	S	S
Ordovician	O	O
Cambrian	Ꞓ	C
Precambrian	p Ꞓ	pC

Appendix B: GIS Coverage Documentation

Registration Tics and Registration Errors

Latitude and longitude tics that could be identified on the original map were used to rubber sheet the coverage to calculated latitude-longitude points to reduce the distortion of the paper. The latitude and longitude and the adjustment report for the points are listed below.

Results of coordinate transformation of Washington registration points:

Scale (X, Y) = (12884.954, 12861.151)

RMS Error (input, output) = (0.015, 189.092)

The RMS error measures the errors between the the output coverages tics and the transformed location of the input coverages tics. It indicates how good the derived tranformation is and is foremost a measure of the quality of the original materials used for scanning. The first number is the error in digitizer units and the second is the error in transformed map units, meters. Scale, translation, and rotation have to do with the scanning parameters, i.e. how the original map was placed on the scanner.

The following table lists the tics and their associated longitude, latitude, input and output locations, and location errors.

Id	Long.	Lat.	Input X (inches)	Input Y (inches)	Output X (meters)	Output Y (meters)	X Error (meters)	Y Error (meters)
1	124E	47E	6.022	14.160	-229151.563	5513916.000	48.258	-124.400
2	123E	46E	11.661	5.271	-155237.313	5400322.000	1.105	-65.424
3	122E	46E	17.678	5.117	-77623.352	5399041.000	-62.707	77.681
4	121E	46E	23.711	5.012	0.000	5398614.000	56.397	-6.371
5	123E	47E	11.938	13.931	-152783.125	5511814.500	-55.178	-145.901
6	122E	47E	17.859	13.770	-76396.188	5510553.500	-135.607	-129.108
7	121E	47E	23.789	13.674	0.000	5510133.500	-120.364	-117.710
8	124E	48E	6.402	22.833	-225460.531	5625682.000	70.544	-292.830
9	122E	48E	18.058	22.478	-75165.648	5622373.500	6.940	60.481
10	121E	48E	23.898	22.387	0.000	5621960.000	94.377	119.220
11	123E	49E	12.503	31.380	-147853.594	5735762.000	-88.187	387.071
12	122E	49E	18.245	31.208	-73931.273	5734541.500	-12.297	202.353
13	121E	49E	23.990	31.100	0.000	5734135.000	100.076	8.605
14	120E	46E	29.730	4.989	77623.352	5399041.000	-9.964	103.662
15	119E	46E	35.757	5.031	155237.313	5400322.000	23.503	211.064
16	120E	47E	29.726	13.648	76396.188	5510553.500	-23.504	-39.571
17	119E	47E	35.657	13.687	152783.125	5511814.500	4.604	26.706
18	118E	46E	41.791	5.137	232832.469	5402457.500	154.081	272.617
19	117E	46E	47.812	5.268	310399.438	5405446.500	150.981	-190.314
20	118E	47E	41.592	13.786	229151.563	5513916.000	93.201	20.914
21	117E	47E	47.489	13.957	305492.250	5516858.000	-286.961	101.242

22	120E	48E	29.724	22.342	75165.648	5622373.500	4.962	-61.102
23	119E	48E	35.552	22.376	150322.188	5623614.500	-66.931	-51.955
24	120E	49E	29.730	31.067	73931.273	5734541.500	120.088	-15.453
25	119E	49E	35.463	31.107	147853.594	5735762.000	55.806	75.908
26	118E	48E	41.389	22.470	225460.531	5625682.000	-18.670	-91.619
27	117E	48E	47.215	22.632	300571.563	5628576.500	-83.737	-95.366
28	118E	49E	41.196	31.211	221758.016	5737795.500	4.322	180.725
29	117E	49E	46.929	31.324	295635.594	5740642.500	-25.138	-421.125

Details of Lithology Coverage

Coverage Name: WAGEOL

Descriptive Location: Washington

Brief Description: Contacts and lithologic units for the geologic map of Washington.

Data Source: Hunting, M.T., Bennett, W.A., Livingston, V.E., Jr., and Moen, W.S., 1961, Geologic map of Washington: Washington Dept. of Conservation, Division of Mines and Geology, 1 Plate, Scale 1:500,000.

Source Point of Contact: Washington Dept. of Natural Resources, Division of Mines and Geology

Source Material: mylar

Source Scale: 1:500,000

Source Projection: Lambert projection, North American datum, 1927

Units	METERS	Spheroid	CLARKE1866

Parameters:

1st standard parallel	33 0 0.000
2nd standard parallel	45 0 0.000
central meridian	-121 0 0.00
latitude of projection's origin	0 0 0.000
false easting (meters)	0.00000
false northing (meters)	0.00000

Source Date (Publication date): 1961

General Comments: Digitized on contract from a mylar copy. The mylar was poorly prepared with a non-cartographic camera. The resulting mylar had some minor radial distortion, which was subsequently removed with a rubber-sheet stretch. The contractor, Optronics Specialty Co., Northridge California, used scanning technology and delivered the coverage in digitizer coordinates.

Digital Compilation Information:

Responsible Organization/Agency: Spokane and Reno Office/WMR/USGS

Project Name: Interior Columbia River Basin Project

Points of Contact: Gary L. Raines or Bruce R. Johnson

Telephone: 702/784-5591 or 509/353-3176

Creation Date: November, 1994

GIS Used: ARC/INFO

Feature Types: polygons, arcs

Topology Present: polygon, arc

Precision: Single Precision

DATAFILE NAME: WAGEOL.PAT

Starting Column	Item Name	Width	Output Width	Data Type	Decimal Places	Description
1	AREA	4	12	F	3	Internal GIS item
5	PERIMETER	4	12	F	3	Internal GIS item
9	WAGEOL#	4	5	B	-	Internal GIS item
13	WAGEOL-ID	4	5	B	-	Internal GIS item
17	FORMATION	11	11	C	-	Map unit name

DATAFILE NAME: WAGEOL.AAT

Starting Column	Item Name	Width	Output Width	Data Type	Decimal Places	Description
1	FNODE#	4	5	B	-	Internal GIS item
5	TNODE#	4	5	B	-	Internal GIS item
9	LPOLY#	4	5	B	-	Internal GIS item
13	RPOLY#	4	5	B	-	Internal GIS item
17	LENGTH	4	12	F	3	Internal GIS item
21	WAGEOL#	4	5	B	-	Internal GIS item
25	WAGEOL-ID	4	5	B	-	Internal GIS item
29	ARC_TYPE	8	8	C	-	Code for type of arc
37	LTYPE	31	31	C	-	Contact, fault, fold, or other type of line
68	MODIFIER	21	21	C	-	Type of contact: fault, fold, or other.
89	ACCURACY	16	16	C	-	Positional accuracy.
105	FAULT_CONT	3	3	C	-	Yes - fault polygon-bounding arc No - Non-fault polygon-bounding arc

For file wageol.aat, these are the unique item values. The LTYPE polybrk is used to designate a line added to break polygons that are too large. This line should not be printed as it is not geologically meaningful.

ARC_TYPE	LTYPE	MODIFIER	ACCURACY
CON	contact	normal	N/A
CONUNCR	contact	scratch	N/A
FLTAPPXC	fault	normal	approx. located
FLTC	fault	normal	certain
FLTCNCLC	fault	normal	concealed
FLTTHRAC	fault	thrust	approx. located
FLTTHRC	fault	thrust	certain
POLYBRK	polybrk	N/A	N/A

The following table is derived from the explanation that accompanies the map. All the data in the table is explicitly stated in the map explanation. The values in LITH# are ordered as they appeared in the explanation. It is assumed that the first listed lithology is the most common lithology. The first three LITH# items are generally the major lithologies associated with each map unit.

DATAFILE NAME: WAGEOL.TBL. See Appendix A for the description and examples of these items.

Starting Column	Item Name	Width	Output Width	Data Type	Decimal Places
1	FORMATION	11	11	C	-
12	UNIT_NAME	75	76	C	-
87	ROCK_TYPE	50	51	C	-
137	ERA	24	25	C	-
161	SYSTEM	24	25	C	-
185	SERIES	24	25	C	-
209	LITH1	40	41	C	-
249	LITH2	40	41	C	-
289	LITH3	40	41	C	-
329	LITH4	40	41	C	-
369	LITH5	40	41	C	-
409	LITH6	40	41	C	-
449	LITH7	40	41	C	-
489	LITH8	40	41	C	-
529	LOCATION1	60	61	C	-
589	LOCATION2	60	61	C	-
649	COMMENTS	70	71	C	-

Details of Faults Coverage

Coverage Name: WAFAULT

Descriptive Location: Washington

Brief Description: Faults for the geologic map of Washington.

Data Source: Hunting, M.T., Bennett, W.A., Livingston, V.E., Jr., and Moen, W.S., 1961, Geologic map of Washington: Washington Dept. of Conservation, Division of Mines and Geology, 1 Plate, Scale 1:500,000.

Source Point of Contact: Washington Dept. of Natural Resources, Division of Mines and Geology

Source Material: mylar

Source Scale: 1:500,000

Source Projection: Lambert projection, North American datum 1927

Units	METERS	Spheroid	CLARKE1866

Parameters:

1st standard parallel	33 0 0.000
2nd standard parallel	45 0 0.000
central meridian	-121 0 0.00
latitude of projection's origin	0 0 0.000
false easting (meters)	0.00000
false northing (meters)	0.00000

Source Date (Publication date): 1961

General Comments: Digitized on contract from a mylar copy. The mylar was poorly prepared with a non-cartographic camera. The resulting mylar had some minor radial distortion, which was subsequently removed with a rubber-sheet stretch. The contractor, Optronics Specialty Co., Northridge California, used scanning technology and delivered the coverage in digitizer coordinates.

Digital Compilation Information:

Responsible Organization/Agency: Spokane and Reno Office/WMR/USGS

Project Name: Interior Columbia River Basin Project

Points of Contact: Gary L. Raines or Bruce R. Johnson

Telephone: 702/784-5591 or 509/353-3176

Creation Date: November, 1994

GIS Used: ARC/INFO

Feature Types: arcs

Topology Present: arc

Precision: Single Precision

DATAFILE NAME: WAFAULT.AAT

Starting Column	Item Name	Width	Output Width	Data Type	Decimal Places	Description
1	FNODE#	4	5	B	-	Internal GIS item
5	TNODE#	4	5	B	-	Internal GIS item
9	LPOLY#	4	5	B	-	Internal GIS item
13	RPOLY#	4	5	B	-	Internal GIS item
17	LENGTH	4	12	F	3	Internal GIS item
21	WAGEOL#	4	5	B	-	Internal GIS item
25	WAGEOL-ID	4	5	B	-	Internal GIS item
29	ARC_TYPE	8	8	C	-	Code for type of arc
37	LTYPE	31	31	C	-	Contact, fault, fold, or other type of line
68	MODIFIER	21	21	C	-	Type of contact, fault, fold, or other
89	ACCURACY	16	16	C	-	Positional accuracy
105	FAULT_CONT	3	3	C	-	Yes - fault polygon-bounding arc. No - Non-fault polygon-bounding arc

For file wafault.aat, these are the unique item values. The apparent duplication, such as FLTCNCL and FLTCNCLC, differentiate those lines that are contacts between polygons (FLTC) and not contacts (FLT). Another item FAULT_CONT, which is not listed in this table, uniquely differentiates such lines.

ARC_TYPE	LTYPE	MODIFIER	ACCURACY
FLT	fault	normal	certain
FLTAPPX	fault	normal	approx. located
FLTAPPXC	fault	normal	approx. located
FLTC	fault	normal	certain
FLTCNCL	fault	normal	concealed
FLTCNCLC	fault	normal	concealed
FLTTHR	fault	thrust	certain
FLTTHRA	fault	thrust	approx. located
FLTTHRAC	fault	thrust	approx. located
FLTTHRC	fault	thrust	certain
ICESHEET	other	glacier boundary	certain
MARKS	other	outer align. mark	N/A
TERDIKE	other	tertiary dikes	certain