STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

Geology and Mineral Resources Map of the Limber Jim Creek Quadrangle, Union County, Oregon

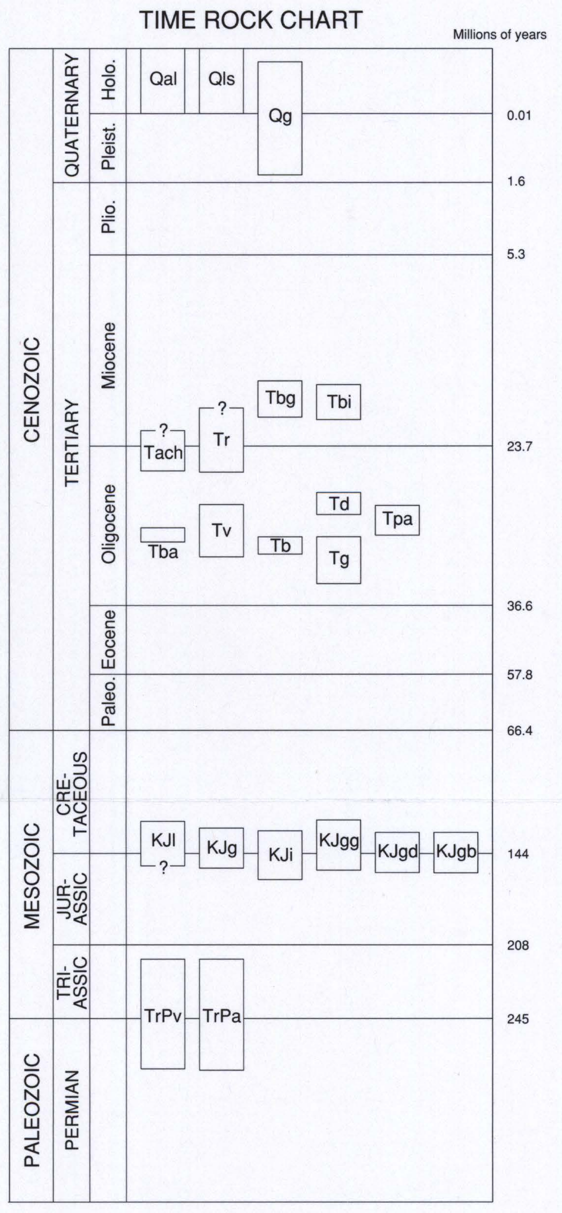
1994

GMS-82

Geology and Mineral Resources Map of the
Limber Jim Creek Quadrangle, Union County, Oregon
By M.L. Ferns and W.H. Taubeneck

Plate 1

TIME ROCK CHART



EXPLANATION

Qal	Alluvium (Holocene)
Qls	Landslides (Holocene)
Qg	Glacial deposits (Pleistocene and Holocene)
Tbg	Grande Ronde Basalt (middle Miocene)
Tbi	Basalt dikes (middle Miocene)
Tr	Rhyolite (Oligocene and Miocene)
Tach	Andesite of Chicken Hill (Oligocene? and Miocene?)
Td	Rhyodacite (Oligocene)
Tpa	Andesite porphyry (Oligocene)
Tba	Basalt, basaltic andesite, and andesite (Oligocene)
Tv	Volcaniclastic conglomerates, breccias, and tuffs (Oligocene)
Tb	Olivine basalt (Oligocene)
Tg	Conglomerate, sandstone, and siltstone (Oligocene)
KJl	Lamprophyre (Upper Jurassic? and Lower Cretaceous)
KJg	Granite of Clear Creek (Upper Jurassic and Lower Cretaceous)
KJi	Bald Mountain Batholith (Upper Jurassic and Lower Cretaceous)
KJgg	Biotite granodiorite and tonalite (Upper Jurassic and Lower Cretaceous)
KJgd	Quartz diorite (Upper Jurassic and Lower Cretaceous)
KJgb	Quartz gabbro (Upper Jurassic and Lower Cretaceous)
TrPv	Amphibolite (Permian and Triassic)
TrPa	Elkhorn Ridge Argillite (Permian and Triassic)

MAP SYMBOLS

Contact

Fault–Dashed where inferred; dotted where concealed; ball and bar on downthrown side

Strike and dip of beds

Strike and dip of joint

Strike of vertical joint

H Location of sample in Table 1

a Location of sample in Table 2

35 Location of mine/prospect in Table 3

Base map by U.S. Geological Survey

Control by USGS and NOS/NOAA

Topography by photogrammetric methods from aerial photographs taken 1960. Field checked 1965

Polyconic projection. 1927 North American datum
10,000-foot grid based on Oregon coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks, zone 11,
To place on the predicted North American Datum 1983 move the projection lines 18 meters north and 82 meters east as shown by dashed corner ticks

UTM GRID AND 1984 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology by M.L. Ferns, Oregon Department of Geology and Mineral Industries, and W.H. Taubeneck, Oregon State University

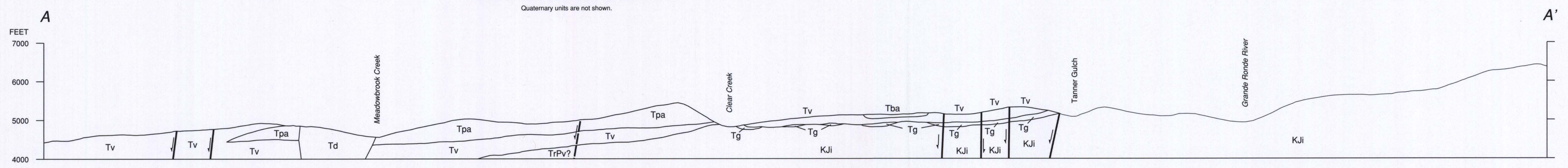
Field work completed in 1993

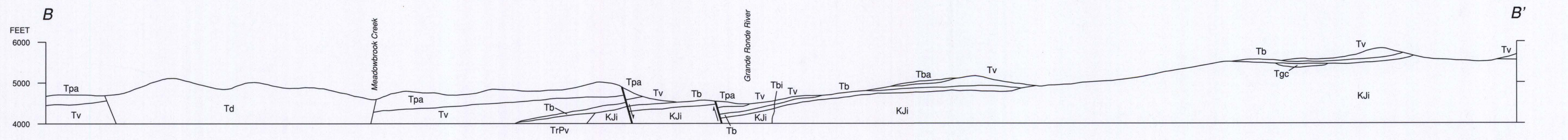
Cartography by Mark E. Neuhaus

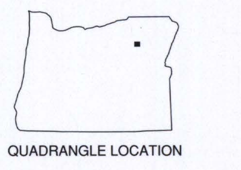
The geologic data on this map is available in digital formats.

GEOLOGIC CROSS SECTIONS

Quaternary units are not shown.







QUADRANGLE LOCATION

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

Analytical Data of the Limber Jim Creek Quadrangle, Union County, Oregon

1994

GMS-82

Geology and Mineral Resources Map of the Limber Jim Creek Quadrangle, Union County, Oregon

By M.L. Ferns and W.H. Taubeneck

Plate 2

Table 1. Major- and trace-element analyses of rock samples, Limber Jim Creek quadrangle, Union County, Oregon[1]

Map letter	Field no.	1/4	1/4	Sec.	T. (S.)	R. (E.)	Elev. (ft)	Lithology	Map unit	UTM coordinates	Major elements (wt. percent)									
											SiO_2	Al_2O_3	TiO_2	FeO	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5
A	93-BG-33	SW	NW	29	5	36	4,720	Dacite	Tpa	4995040N 394880E	69.6	15.89	0.758	3.4	0.017	3.31	0.05	2.51	4.29	0.172
B	93-BG-38	NW	NW	27	5	36	4,680	Basalt	Tb	4995680N 398020E	48.38	15.21	1.302	12.28	0.188	11.58	8.09	0.33	2.52	0.131
C	93-Bg-5	NE	NE	33	5	36	5,060	Andesite	Tba	4993860N 397800E	56.28	15.8	1.242	8.29	0.128	7.4	5.52	1.65	3.45	0.251
D	93-BG-41	NE	SE	33	5	36	4,800	Basalt	Tba	4993120N 397820E	49.48	16.92	1.434	9.6	0.151	10.63	7.64	0.77	3.12	0.246
E	93-BG-42	SW	NE	4	6	36	4,800	Basalt	Tb	4992920N 397420E	49.38	15.5	1.288	13.94	0.223	10.87	5.54	0.5	2.6	0.159
F	93-BG-12	SE	SE	12	6	35.5	5,000	Rhyodacite	Td	4989480N 392540E	72.99	15.09	0.282	1.96	0.059	2.39	0.53	2.32	4.28	0.093
G	93-BG-19	NE	SW	10	6	36	4,800	Basalt	Tbi	4989480N 398420E	53.58	13.7	2.137	12.88	0.195	8.37	4.6	1.12	3.09	0.345
H	93-BG-43	NE	SE	25	6	35.5	5,900	Dacite	Tpa	4984860N 393040E	63.52	16.39	0.709	4.49	0.072	5.59	3.44	2.44	3.17	0.168
I	93-BG-28	NE	NE	31	6	36	6,280	Andesite	Tach	4984280N 394280E	60.82	17.2	0.904	5.43	0.076	6.43	3.52	1.33	4.08	0.197
J	93-BG-11	SE	NE	29	6	36	6,080	Basalt	Tba	4985020N 396180E	48.85	16.05	1.754	11.18	0.168	9.91	9.14	0.29	2.52	0.139
*	93-BG-11	SE	NE	29	6	36	6,080	Basalt	Tba	4985020N 396180E	48.77	16.04	1.741	11.23	0.169	9.86	9.2	0.29	2.55	0.141

Map letter	Selected trace elements (ppm)																
	Ni	Cr	Sc	V	Ba	Rb	Sr	Zr	Y	Nb	Ga	Cu	Zn	Pb	La	Ce	Th
A	11	16	12	77	821	55	332	160	25	14.5	16	10	32	11	21	49	8
B	239	223	31	216	162	11	236	67	21	10.5	16	98	93	0	10	19	3
C	85	154	24	154	402	33	354	146	23	16.8	17	47	72	5	23	45	5
D	107	180	33	227	229	15	435	111	22	20.7	18	85	75	2	5	39	2
E	213	251	29	215	178	19	260	75	23	14.6	17	111	117	2	0	20	0
F	5	0	7	24	947	39	403	129	9	10.3	15	10	56	12	19	13	4
G	4	34	38	344	447	27	312	165	36	12.2	21	24	123	5	10	57	5
H	63	116	18	107	624	45	450	132	20	11.2	15	37	83	8	16	31	4
I	46	69	20	122	641	26	490	127	15	9	18	48	64	7	13	42	2
J	119	290	33	218	1445	9	295	89	20	4.5	19	69	86	0	0	0	0
*	116	286	30	227	1432	9	293	89	19	5.3	16	67	86	0	6	0	1

[1]Analyses by Washington State University GeoAnalytical Laboratory using an automatic Rigaku 3370 spectrometer.
Total Fe expressed as FeO. * denotes a duplicate bead made from the same rock powder.

Table 2. Trace-element analyses of altered rocks, Limber Jim Creek quadrangle, Union County, Oregon[1]

Map letter	Field no.	1/4	1/4	Sec.	T. (S.)	R. (E.)	UTM coordinates	Rock type	Map unit	Sb (ppm)	As (ppm)	Cr (ppm)	Co (ppm)	Au (ppb)	Hg (ppb)	Pb (ppm)	Mo (ppm)	Ni (ppm)	Pd (ppm)	Pt (ppm)	Ag (ppm)	Zn (ppm)
a	93-GRR-11	NE	NW	25	6	35	4995800N 392840E	Andesite	Tpa?	<0.5	13	323	60	134	12,400	6	<4	175	<0.01	<0.05	1.4	79
b	93-BG-14	NW	SE	1	6	35.5	4991360N 393180E	Rhyolite	Tr	<0.5	1	40	5	6	194	3	<4	<2	<0.01	<0.05	0.1	31
c	93-BG-13	NE	SE	1	6	35.5	4991400N 393480E	Andesite	Tpa	<0.5	<0.5	28	5	<5	97	2	<4	<2	<0.01	<0.05	0.2	60
d	93-BG-25	SW	NE	9	6	36	4990100N 397440E	Tonalite	KJi	14	11	160	3	18	43,000	147	<4	4	<0.01	<0.05	>25	603
e	93-BG-24	SW	NE	9	6	36	4990060N 397400E	Tonalite	KJi	555	87	144	4	192	>100,000	2,310	<4	4	<0.01	<0.05	>25	3,050
f	93-BG-8	SE	NE	9	6	36	4989960N 397820E	Tonalite	KJi	1,470	191	170	5	193	>100,000	7,900	<4	4	<0.01	<0.05	>25	1,430
g	93-Bg-7	NW	SW	10	6	36	4889620N 398160E	Tonalite	KJi	2	7	160	14	1,486	1, 400	48	<4	7	<0.01	<0.05	3.3	35

[1]Analyses by SVL Analytical, Inc., using atomic absorption techniques.

Table 3. Mines and prospects, Limber Jim Creek quadrangle, Union County, Oregon[1]

Map no.	Name	T. (S).	R. (E).	Sec.	1/4	1/4	UTM coordinates	Commodity	Age	Host rock
1	Rock pit	5	36	21	SW	NE	4996640N 397100E	Stone (andesite)	Tertiary	Andesite
2	Placer	5	36	22	SW	NE	4996500N 399600E	Gold	Tertiary	Granodiorite
3	Rock pit	5	36	33	NE	NE	4995280N 397080E	Stone (andesite)	Tertiary	Andesite
4	Placer	5	36	27	SW	NE	4995060N 399000E	Gold	Tertiary	Granodiorite
5	Rock pit	5	36	29	SE	SE	4994300N 396060E	Stone (andesite)	Tertiary	Andesite
6	Rock pit	5	36	28	NW	NE	4993680N 398600E	Stone (andesite)	Tertiary	Andesite breccia
7	Placer	5	36	35	NE	NW	4993600N 400120E	Gold	Quaternary	Stream gravel
8	Placer	5	36	34	SE	NW	4993300N 398400E	Gold	Quaternary	Stream gravel
9	Rock pit	5	36	32	SW	SW	4992900N 394700E	Stone (andesite)	Tertiary	Andesite
10	Rock pit	6	36	4	NE	NE	4992480N 397700E	Stone (basalt)	Tertiary	Basalt
11	Rock pit	6	36	4	NW	NE	4992280N 398220E	Stone (basalt)	Tertiary	Basalt
12	Placer	6	36	4	NE	SW	4911400N 397000E	Gold	Quaternary	Stream gravel
13	Name unknown	6	36	6	NW	SE	4991180N 394300E	Unknown	Tertiary	Andesite
14	Placer	6	36	2	SE	SE	4990850N 400950E	Gold	Tertiary	Granodiorite
15	Hunter & Fox Placer	6	36	9	NW	NW	4990500N 396500E	Gold	Quaternary	Bench gravel
16	Indiana Mine	6	36	9	SE	NE	4990100N 397540E	Silver, gold, lead	Cretaceous	Granodiorite
17	Grande Ronde Placers	6	36	9	NE	NE	4990000N 397750E	Gold, silver	Quaternary	Stream gravel
18	Prospect	6	36	10	NW	SW	4989920N 397940E	Silver, gold	Cretaceous	Granodiorite
19	Rock Pit	6	36	7	NE	SE	4989800N 393540E	Stone (andesite)	Tertiary	Andesite
20	Murphy	6	36	9	SE	NE	4989540N 398100E	Silver, gold	Cretaceous	Granodiorite
21	Clear Creek placer	6	36	9	SW	SW	4989500N 397700E	Gold	Quaternary	Stream gravel
22	Placer	6	36	15	NE	NE	4989600N 399240E	Gold	Quaternary	Stream gravel
23	Oro Plata dredge	6	36	15	NE	NE	4988550N 399000E	Gold, silver	Quaternary	Stream gravel
24	Rock pit	6	35.5	13	SE	NE	4988520N 392840E	Stone (andesite)	Tertiary	Andesite
25	Rock pit	6	36	18	SW	NE	4988420N 395940E	Stone (andesite)	Tertiary	Andesite
26	Rock pit	6	36	17	SE	NW	4988360N 393920E	Stone (andesite)	Tertiary	Andesite
27	Carson (Reed Pit)	6	36	21	SE	SW	4987600N 398540E	Gold	Tertiary	Chert-pebble gravels
28	Carson (Big Pit)	6	36	22	NE	NW	4987300N 398500E	Gold	Tertiary	Chert-pebble gravels
29	Carson (Frenchman Pit)	6	36	21	SE	NE	4986975N 397875E	Gold	Tertiary	Chert-pebble gravels
30	Rock pit	6	35.5	24	SW	NW	4987040N 391920E	Stone (basalt)	Tertiary	Basalt
31	Rock pit	6	36	19	SE	NW	4986880N 394880E	Stone (andesite)	Tertiary	Andesite
32	Rock pit	6	36	19	SW	NW	4986720N 394360E	Stone (basalt)	Tertiary	Basalt
33	Rock pit	6	36	21	SE	NE	4986580N 397780E	Stone (basalt)	Tertiary	Basalt
34	Prospect	6	36	21	SE	SE	4985950N 397675E	Gold	Tertiary	Chert-pebble gravels
35	Grande Ronde Mines	6	36	26	SE	SE	4985000N 400200E	Silver, gold	Cretaceous	Granodiorite

[1]Information in this table is from Gray, J.J., 1993, Mineral information layer for Oregon by county, (MILOC): Oregon Department of Geology and Mineral Industries Open-File Report O-93-8, 2 diskettes.

State of Oregon
Oregon Department of Geology and Mineral Industries
Donald A. Hull, State Geologist

Geology and Mineral Resources Map of the Limber Jim Creek Quadrangle, Union County, Oregon

1994

by M.L. Ferns, Oregon Department of Geology and Mineral Industries, Baker City Field Office, and W.H. Taubeneck, Professor Emeritus, Department of Geosciences, Oregon State University, Corvallis, Oregon

EXPLANATION

Qal **Alluvium (Holocene)**—Mainly unconsolidated gravel, sand, and silt deposited in and along active stream channels. Includes flood plain deposits of sand, silt, and gravel and local accumulations of poorly sorted boulder gravels of glacial outwash on terraces above existing stream channels

Qls **Landslides (Holocene)**—Mainly slumps characterized by grassy, hummocky topography with numerous springs. Includes modern debris flows triggered by human activity on Tanner Gulch and Clear Creek. Slumps most commonly occur along contact between tuffaceous sediments of unit Tv and overlying massive porphyritic andesite flows of unit Tpa

Qg **Glacial deposits (Pleistocene and Holocene)**—Mainly unconsolidated till and morainal deposits. Well-developed terminal moraines are preserved downstream from Erickson Lakes and on the headwaters of Clear Creek

Tbg **Grande Ronde Basalt (middle Miocene)**—Brown to light-grayish-brown weathering, grayish- to bluish-black aphyric basalt flows belonging to the Grande Ronde Basalt. The Grande Ronde Basalt is the most voluminous unit of the Columbia River Basalt Group (Hooper and Swanson, 1990). Age is about 15 Ma (Fiebelkorn and others, 1982)

Tbi **Basalt dikes (middle Miocene)**—Brown-weathering, grayish- to bluish-black aphyric basalt dikes. Could be part of a minor axis of eruption for flows of the Columbia River basalt. Analyzed sample (map letter G, Table 1) is a tholeiitic basalt chemically similar to the Grande Ronde Basalt (Hooper and Swanson, 1990)

Tr **Rhyolite (Oligocene and Miocene)**—Yellowish-red to white, quartz-phyric rhyolite tuff and breccia. Lithic tuff contains about 10 percent volcanic rock fragments and 2 percent resorbed quartz phenocrysts. In the quadrangle, unit Tr is devitrified and conspicuously altered with iron-oxide staining. Considered to be distal facies of large rhyolite domes emplaced immediately to the west in the adjacent Fly Valley quadrangle. Flow domes to the west are characterized by perlitic margins with chalcedonic lithophysae. Age based on stratigraphic position between overlying Grande Ronde Basalt flows and adjoining Oligocene andesites

Tach **Andesite of Chicken Hill (Oligocene? and Miocene?)**—Platy gray andesite flows; porphyritic with plagioclase, hypersthene, and augite phenocrysts (2-5 percent) and glomerocrysts. Pilotaxitic with zoned plagioclase phenocrysts, plagioclase laths, and intergranular clinopyroxene. Generally platy jointed and highly irregular in thickness. Flow is at least 90 m (300 ft) thick near the head of Indiana Creek, where it apparently followed a topographic depression. Source vent is exposed just to the south of the quadrangle boundary on the west flank of Chicken Hill. Stratigraphic position is uncertain; unit Tach overlies Oligocene porphyritic andesites to north but is nowhere in contact with Grande Ronde Basalt flows. Chemically a high-silica andesite with >60 percent SiO_2 (map letter I, Table 1)

Td **Rhyodacite (Oligocene)**—Massive, gray to light-gray, sparsely hornblende-phyric rhyodacite, locally columnar jointed. Contains <2 percent corroded green hornblende phenocrysts and plagioclase phenocrysts in a cryptofelsite matrix. Age based on correlation with 27-28 Ma hornblende andesites and biotite rhyodacites dated by Walker (1973). Chemically a low-silica rhyolite with <73 percent SiO_2 (map letter F, Table 1)

Tpa **Andesite porphyry (Oligocene)**—Multiple flows of massive, gray, purplish-gray, and reddish-gray porphyritic andesite and rhyodacite as much as 90 m (300 ft) thick. Where exposed, flow bases are vitrophyres that grade upward into massive, platy-jointed lithoidal andesite. Flows typically grade upward into a brecciated flow top. Characterized by 5-10 percent phenocrysts and abundant (2 percent) holocrystalline xenoliths (hypersthene, augite, and plagioclase). Flows typically contain large (5-7 mm) zoned plagioclase phenocrysts as well as hypersthene phenocrysts in a devitrified and variably altered cryptofelsitic groundmass. Groundmass minerals include euhedral hypersthene, plagioclase, and prismatic iron oxides. Occasionally contains augite phenocrysts and partially resorbed quartz xenocrysts. Flow thickens to the northwest, where uppermost exposures on Indiana Creek contain brown biotite phenocrysts. Compositions of analyzed flows range from high-silica andesite to rhyodacite (63-69 percent SiO_2, map letters A and H, Table 1). Unit overlies and grades laterally into pyroclastic deposits of unit Tv. Age based on stratigraphic position below 27.7-Ma rhyodacite (Walker, 1973; Fiebelkorn and others, 1982) to the north

Tba **Basalt, basaltic andesite, and andesite (Oligocene)**—Platy, grayish-red to grayish-black, sparsely-phyric basalt, basaltic andesite, and andesite flows that locally fill channels within unit Tv. Includes hyalopilitic to pilotaxitic olivine-plagioclase-phyric flows with granular clinopyroxene microphenocrysts. Includes plagioclase-augite phyric andesite and orange-weathering, bluish-black olivine basalts with ophitic clinopyroxene. Platy andesites weather to shades of red and brown and are used for road metal. Compositions range from basalt with about 49 percent SiO_2 and 9.5-11 percent FeO* (map letters D and J, Table 1) to andesite with 56 percent SiO_2 (map number C, Table 1). Flows are interbedded with unit Tv pyroclastic rocks, whose age is based on stratigraphic position below 27.7-Ma rhyodacite (Walker, 1973; Fiebelkorn and others, 1982) to the north

Tv **Volcaniclastic conglomerates, breccias, and tuffs (Oligocene)**—Pyroclastic deposits include coarse, tuffaceous, matrix- and clast-supported breccias (lahars and block-on-block ash flows?) composed of large angular unit Tpa clasts. Water-lain epiclastic conglomerates are well indurated with a tuffaceous matrix and are composed of well-rounded basalt, andesite, and rhyolite clasts. Also includes tuffaceous conglomerates. Unit Tv varies in thickness and is at least 150 m (500 ft) thick on the north fork of Limber Jim Creek. The unit generally forms poor outcrops and weathers on slopes to form hillsides covered by angular to subrounded clasts. Unit Tv is interbedded with both the porphyritic flows of unit Tpa and the aphyric flow rocks of units Tb and Tba. Unit Tv unconformably overlies gravel and sand deposits of unit Tg. Age based on apparent stratigraphic position below 27.7-Ma rhyodacite (Walker, 1973; Fiebelkorn and others, 1982) to the north

Tb **Olivine basalt (Oligocene)**—Basal flow sequence that underlies unit Tv. Includes fine-grained, equigranular, brownish-gray to brownish-black vesicular flows with olivine and plagioclase phenocrysts. Petrographically, the basalts are generally hyalopilitic with subophitic clinopyroxene. Individual flows are altered, with concentric spheroidal weathering rinds and zeolite- and calcite-filled vesicles. Chemically, includes olivine tholeiites with 46-48 percent SiO_2 and 12-13 percent FeO* (map letters B and E, Table 1). Contact with upper unit Tv is marked by abundant springs. Unit Tb is 60 m (200 ft) thick north of Erickson Lake

Tg **Conglomerate, sandstone, and siltstone (Oligocene)**—Consists of interbedded conglomerate, sandstone, and siltstone beds that underlie the Tertiary volcanic units. Lowermost bed (not mapped separately) is herein referred to as the Carson Wash after Lindgren (1901). The Carson Wash is a distinctive sand-matrix-supported, coarse-grained, channel-fill quartzite- and metamorphic-clast boulder conglomerate exposed only at the Camp Carson Mine. It contains quartzite boulders as large as 0.6 m (2 ft) in diameter that are commonly dimpled with percussion marks. The sand matrix consists mainly of quartz and feldspar grains with accessory pink translucent garnet and placer gold. Exposed thickness of the Carson Wash is between 2 and 6 m (7 and 20 ft). At Camp Carson, the Carson Wash is overlain by a 0.75-m (2.5-ft)-thick coarse- to medium- and fine-grained tuffaceous sandstone bed that in turn is overlain by dark-colored, finely laminated organic and tuffaceous siltstone and mudstone. Base of the 7-m (25-ft)-thick siltstone and mudstone section is chaotically bedded and contains abundant gypsum. Fine-grained clastics are overlain by 1.5 m (5 ft) of tuffaceous sandstone that is in turn overlain by a 12-m (40-ft)-thick, matrix-supported, tuffaceous chert-bearing conglomerate. Clasts, most of which are less than 10 cm (4 in.) in diameter, include distinctive bluish-black chert and argillite clasts and weathered white tuff and rhyolite clasts. Similar chert clast conglomerates are widely exposed across much of the unit

Mesozoic intrusive rocks of the Bald Mountain Batholith. Includes in the northwest corner of the quadrangle (the Guard Station Inlier of Taubeneck, in press) three small satellite intrusions to the main mass of the Bald Mountain Batholith. The intrusives are divided into the following units:

KJl **Lamprophyre (Upper Jurassic? and Lower Cretaceous)**—Greenish-black, coarse-grained porphyritic appinite (hornblende-rich lamprophyre) stock with 2-3 cm equant hornblende crystals. Petrographically composed of intergrown poikilophitic hornblende, green clinopyroxene, and orthopyroxene crystals with occasional olivine crystals enclosed in orthopyroxene. Unit KJl is a late mafic phase of the Bald Mountain Batholith of Lindgren (1901) and unlike other lamprophyres in the Bald Mountain Batholith (Taubeneck, 1957) both in mineralogy and size

KJg **Granite of Clear Creek (Upper Jurassic and Lower Cretaceous)**—White to pale-pinkish-white, equigranular granitic stocks. Includes allotriomorphic-granular textured granodiorites with nearly equal amounts of plagioclase, orthoclase, and quartz crystals with 5 percent accessory brown biotite. Unit KJg locally includes muscovite-biotite-bearing quartz-potassium feldspar pegmatite and aplite dikes. Forms two small stocks, each less than 0.5 mi^2 in areal extent, elongated along a N. 65° E. trend. One of a number of small, late felsic phases of the Bald Mountain Batholith (Taubeneck, 1957, in press)

KJi **Bald Mountain Batholith (Upper Jurassic and Lower Cretaceous)**—Tonalite and granodiorite. White to light-gray, medium- to coarse-grained, hypidiomorphic-textured tonalite and granodiorite. Plagioclase and hornblende are mostly subhedral, as is some biotite. Quartz and potassium feldspar are anhedral. Main phase of the Bald Mountain Batholith (Lindgren, 1901; Taubeneck, 1957, in press). In the southern part of the quadrangle includes the intraplutonic contact between the granodiorite and tonalite phases of the Bald Mountain Batholith (Taubeneck, in press)

Small intrusions cut an inlier of pre-Tertiary rocks in the northwest corner of the quadrangle. Taubeneck (in press) refers to the pre-Tertiary exposures as the Guard Station Inlier, which contains the following small intrusions:

KJgg **Biotite granodiorite and tonalite (Upper Jurassic and Lower Cretaceous)**—Pinkish-white to light-gray biotite granodiorite and tonalite intruded into rocks in the northwestern corner of the quadrangle. Hypidiomorphic granular with red-brown biotite (4-9 percent). Granodiorite phase contains approximately equal amounts of quartz and plagioclase (38-44 percent), potassium feldspar (12-16 percent), biotite, and accessory muscovite (Taubeneck, in press)

KJgd **Quartz diorite (Upper Jurassic and Lower Cretaceous)**—Gray, fine-grained quartz diorite intruded into rocks in the northwest corner of the quadrangle. Characteristically contains about 30 percent hornblende and 6 percent biotite crystals with plagioclase and quartz (Taubeneck, in press)

KJgb **Quartz gabbro (Upper Jurassic and Lower Cretaceous)**—Gray, medium-grained quartz gabbro intruded into rocks in the northwest corner of the quadrangle. Characteristically hornblende-rich with >50 percent equant hornblende crystals 3-6 mm in diameter. Also contains sheared plagioclase, strained quartz, and relict augite crystals (Taubeneck, in press)

TrPv **Amphibolite (Permian and Triassic)**—Fine-grained, foliated, bluish-gray to dark-bluish-black banded amphibolite composed of alternating bands of green hornblende and plagioclase feldspar crystals. Interpreted as gabbroic rocks or volcanic and volcaniclastic rocks metamorphosed to amphibolite hornfels facies by the Bald Mountain Batholith

TrPa **Elkhorn Ridge Argillite (Permian and Triassic)**—Fine- to coarse-grained, dark-bluish-gray to black chert and siliceous argillite. Commonly metamorphosed near the margin of the Bald Mountain Batholith to coarsely crystalline, bluish-gray quartzite with micaceous partings along the margin of the Bald Mountain Batholith. Age based on radiolaria collected from localities approximately 40 km (25 mi) to the southeast, in the Elkhorn Peak quadrangle (Ferns and others, 1985)

GEOLOGIC HISTORY

The oldest rocks (unit TrPa) are contact-metamorphic Permo-Triassic chert and argillite that correlate with parts of the Elkhorn Ridge Argillite (Gilluly, 1937) exposed to the north in the adjoining Little Beaver quadrangle. Closely associated with the Elkhorn Ridge Argillite are contact metamorphic hornblende schists and gneisses (unit TrPv) that originally were either gabbroic rocks or volcanic and volcaniclastic rocks. These two map units are part of the Baker terrane (Silberling and Jones, 1984), an exotic assemblage of disrupted ocean floor and island arc volcanic and sedimentary rocks that were accreted to the much older North American cratonic margin in the late Mesozoic.

At approximately 145 Ma (Armstrong and others, 1977), the Baker Terrane was intruded by large granitic intrusions. Earliest intrusions were apparently the small mafic bodies (quartz diorite and quartz gabbro) exposed in the Guard Station Inlier (Taubeneck, in press). Four different intrusive phases of the Bald Mountain Batholith were later emplaced in the southern part of the quadrangle. Earliest of these was the large, hornblende- and biotite-rich tonalite (unit KJi) that makes up the bulk of the Bald Mountain Batholith (Taubeneck, 1957). Two much smaller masses of granite and granodiorite (unit KJg) subsequently cut the tonalite. The Bald Mountain Batholith was also intruded by a small, coarsely crystalline lamprophyre pipe (unit KJl).

The region was uplifted and deeply eroded by the middle Tertiary, when an irregular surface of pre-Tertiary granitic and metamorphic rocks was partially buried by middle Tertiary lava flows and volcaniclastic deposits. The base of the oldest Tertiary unit (unit Tg) is an undated fluviatile conglomerate that filled an eroded river channel cut into the Bald Mountain Batholith at Camp Carson. Presence of large (>0.6 m [2 ft] in diameter) quartzite boulders and small pink garnets in the channel indicate a large river with headwaters possibly in west-central Idaho. Associated overbank siltstones are interbedded with thick tuffaceous sandstones which record early volcanic activity. The proportion of volcanic material in unit Tg increased markedly when a tuffaceous, matrix-supported, chert-pebble conglomerate was deposited over a wide area. Basalt flows (unit Tb) quickly buried what remained of the old river channel.

The western part of the quadrangle was buried by a thick section of calc-alkaline andesitic lava flows (units Tba, Tpa, Tach) and volcaniclastic deposits (unit Tv) of Oligocene and early Miocene age. Lavas were erupted from vents within unit Td within the quadrangle. Unit Tach lavas were erupted from vents immediately adjacent to the quadrangle. Rhyolite flow domes (unit Tr) were later erupted from vents to the west.

In the late Miocene, tholeiitic flood lavas of the Columbia River Basalt Group (CRBG) were erupted from fissures throughout much of northeast Oregon, southeast Washington, and westernmost Idaho. Nearly all of northeast Oregon was covered by the flood basalts. North- and northwest-trending unit Tbi dikes may be part of a minor axis (CRBG) of eruption.

TERTIARY STRUCTURES

Two and possibly three sets of Tertiary faults occur in the quadrangle; the oldest set is characterized by north to northwest trends, small downthrows (<60 m [200 ft]) to the west, and local mineralization. Thickening of basal sedimentary members at Camp Carson suggest that the oldest faults controlled drainages and may be in part contemporaneous with emplacement of unit Tv sediments.

Trends of the second set of faults are subparallel to basalt dike trends and offset contacts between units Tv and Tg. A chalcedonic quartz stringer cuts a fractured boulder in the Carson Wash, indicating that the unit was cemented at the time of deformation. The fracture parallels a series of closely spaced northerly-trending faults that are exposed in the highwall between the Big and Reed Pits at Camp Carson.

Early north-trending faults are cut by later northwest- and northeast-trending faults. Dominant trends are N.30°-N.60° W., parallel to faults identified in Columbia River basalt to the north and west (Walker, 1973). Northwest-trending structures are nonmineralized. The course of the Grande Ronde River at Woodley is controlled by a northwest-trending graben similar to the structure identified by Evans (1990) on the Malheur River. South of the river, regional dips in unit Tv volcanics are to the northwest, while to the north, the regional dip shifts to the southwest.

MINERAL RESOURCES

Placer gold from deposits that have been largely exhausted has been the main mineral resource produced in the quadrangle. Largest area of workings were on the Grande Ronde River from the confluence with Clear Creek upstream to the historic Tanner Gulch, a small gulch immediately to the west of the drainage identified as Tanner Gulch on the topographic base map. Placer workings extend south up historic Tanner Gulch to Camp Carson. Main production on the Grande Ronde River came from the Oro Plata dragline dredge (23) which began operation in 1941. The Camp Carson Mine (27, 28, and 29) was one of the largest hydraulic placer mines in Union County, having a long history of successive attempts at mining since location in 1872. The mine site itself is along the contact between Tertiary and pre-Tertiary rocks east of Clear Creek, where a high, buried Tertiary channel some 60 m (200 ft) above stream level was worked by extensive hydraulic operations. Past mining has left five hydraulic pits on the property, the largest being the Big Pit (180 m by 375 m by 38 m [600 ft by 1,250 ft by 127 ft] in 1926); the French (or Frenchman's) Pit, which emptied onto Little Clear Creek; the Little French Pit; the Gorman Pit; and the Reed Pit.

The main period of mining at Camp Carson was 1893-1894, when a French company conducted extensive operations in the Big, French, and Little French Pits. Major improvements to the property were made at that time, with the construction of the main camp, a dam to raise the water level at Grande Ronde Lake, and long water ditches from Grande Ronde Lake and upper Little Clear Creek. Operations since that time have been sporadic and short lived. Total production is unknown; the 1892-1893 French operation was alleged to have produced $500,000. Grade of material mined was apparently low, averaging about 0.01 oz/yd^3, based on available assays.

Placer gold at Camp Carson is found in a 2-6 m (7-20 ft)-thick, cemented boulder-conglomerate that lies in an eroded channel directly atop weathered tonalite (Lindgren, 1901). The boulder conglomerate, locally referred to as the Carson Wash, is a distinctive matrix-supported, quartzite-boulder conglomerate that fills an eroded channel on the tonalite.

The sedimentary section that overlies the Carson Wash locally contains a clay-rich, chert-pebble conglomerate that has also been explored for gold. Similar chert-pebble conglomerates crop out at the Rainbow Mine (14) and at several prospects on Little Clear Creek and Limber Jim Creek.

Several small silver veins have been explored along the Grande Ronde River. Chief of these was the Indiana Mine (16). Mineralization typically consists of scattered quartz stringers with streaks and kidneys of massive galena and sphalerite in narrow northeast-striking zones of altered tonalite. Silver/gold ratios of high-grade ore are typically >100:1 (Wagner, 1944), with appreciable amounts of mercury (mine letters d, e, f, and g, Table 2).

LANDSLIDES

Nearly all of the small landslides in the quadrangle are in unit Tv, occurring mainly in areas near faults where relatively incompetent unit Tv sedimentary rocks are overlain by more competent lava flows. Two of the larger slides have been triggered or reactivated by modern road building and mining activities. The slide at the Reed Pit at Camp Carson is of recent origin, triggered by an unsuccessful mining venture in 1982. Located on the northeast rim of the Reed Pit, the slide is a disturbed mass of silt, claystone, and washed gravels that had been pushed out onto a steep hillside. Part of the instability is due to the dumping of the finer grained siltstone and claystone overburden directly onto a steep slope underlain by weathered granitics, then loading by dumping of washed gravels atop the overburden. The result is the mass wasting of the gravels down over the bank into the gulch some 60 m (200 ft) below. Tension cracks are now developing along the outer edge of the spoils, indicating that a substantial additional mass of material may be about to slide off into Tanner Gulch.

The USDA Forest Service has attempted to mitigate effects of the Camp Carson slide by building two check dams on Tanner Gulch. The check dams were designed to prevent rapid influx of silt and clay into the critical salmon spawning grounds of the upper Grande Ronde River. At the present time, the upper check dam is full of debris, with the toe of the slide extending around the upper check dam. Further stabilization and revegetation work on the Camp Carson slide has been proposed by the Oregon Department of Geology and Mineral Industries and the USDA Forest Service in connection with the Oregon Watershed Health Program.

Other landslides in the quadrangle may also pose sedimentation risks to the spawning habitat. The upper slide on Clear Creek has been recently active and is now contributing sediment to Clear Creek.

ANALYTICAL METHODS

Major- and trace-element analyses were determined by the Washington State University GeoAnalytical Laboratory, using an automatic Rigaku 3370 spectrometer. Each element analysis is fully corrected for line interference and matrix effects. Results are normalized on a volatile-free basis and printed with total iron expressed as FeO. For a more complete description of Washington State University GeoAnalytical Laboratory analytical methods, see Hooper and others (1993).

Trace elements for altered rock samples were determined by SVL Analytical Inc, Kellogg, Idaho, using Atomic Absorption techniques.

ACKNOWLEDGMENTS

The USDA Forest Service provided analyses of altered rocks in Table 2. Our thanks are extended to them and their knowledgeable geologists Mike Doran and Tracy Palmer, who provided important information on the geologic setting of the Camp Carson area. Our thanks are also extended to Peter Hooper, Washington State University, for stimulating interest in the Tertiary volcanic rocks of the area.

REFERENCES

Armstrong, R.I., Taubeneck, W.H., and Hales, P.O., 1977, Rb-Sr and K-Ar geochronometry of Mesozoic granitic rocks and their Sr isotopic composition, Oregon, Washington, and Idaho: Geological Society of America Bulletin, v. 88, p. 397-411.

Evans, J.G., 1990, Geology and mineral resources map of the Jonesboro quadrangle, Malheur County, Oregon: Oregon Department of Geology and Mineral Resources Geological Map Series GMS-67, scale 1:24,000.

Ferns, M.L., Brooks, H.C., Avery, D.G., and Blome, C.D., 1987, Geology and mineral resources map of the Elkhorn Peak quadrangle, Baker County, Oregon: Oregon Department of Geology and Mineral Industries Geological Map Series GMS-41, scale 1:24,000.

Fiebelkorn, R.B., Walker, G.W., MacLeod, N.S., McKee, E.H., and Smith, J.G., 1982, Index to K-Ar age determinations for the State of Oregon: U.S. Geological Survey Open-File Report 82-596, 40 p.

Gilluly, J., 1937, Geology and mineral resources of the Baker quadrangle, Oregon: U.S. Geological Survey Bulletin 879, 119 p.

Hooper, P.R., and Swanson, D.L., 1990, The Columbia River Basalt Group of the Blue Mountains Province, *in* Walker, G.W., ed, Geology of the Blue Mountains region of Oregon, Idaho, and Washington: U.S. Geological Survey Bulletin 1437, p. 63-99.

Hooper, P.R., Johnson, D.M., and Conrey, R.M., 1993, Major- and trace-element analyses of rocks and minerals by automated X-ray spectrometry: Washington State University Geology Department Open-File Report, 36 p.

Lindgren, W., 1901, Gold Belt of the Blue Mountains of Oregon: U.S. Geological Survey Annual Reports, no. 22, p. 551-776.

Oregon Department of Geology and Mineral Industries: Unpublished mine files, Baker City Field Office.

Silberling, N.J., and Jones, D.L., eds., 1984, Lithotectonic terrane maps of the North American Cordillera: U.S. Geological Survey Open-File Report 84-523, 106 p., 4 maps.

Taubeneck, W.H., 1957, Geology of the Elkhorn Mountains, northeastern Oregon: Bald Mountain Batholith: Geological Society of America Bulletin, v. 68, p. 181-238.

Taubeneck, W.H., in press, A closer look at the Bald Mountain Batholith, Elkhorn Mountains, and some comparisons to the Wallowa Batholith, Wallowa Mountains, northeastern Oregon, U.S. Geological Survey Bulletin 1438.

Wagner, N.S., 1945, Indiana Mine (silver-lead): Oregon Department of Geology and Mineral Industries unpublished mine-file report, Baker City Field Office, 5 p.

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