GL01933

Cascades Study

June 7, '85 Newberry Crater
- Sample ~~CN~~ OR-EL-85-1 from Big Obsidian Flow, collected next to parking area.
- Sample ~~CN~~ OR-EL-85-2 from East Lake Obsidian at Hot Spring campground
- Sample ~~CN-85-3~~ OR-CH-85-1 China Hat, from So. side about half way up.
- Sample ~~CN-85-4~~ OR-EL-85-3 obsidian ~~flow~~, ~~So. E~~ from Central cone, at pumice mine.

South Sister's area
- Sample ~~CS~~ OR-TS-85-1 from fissure domes at highway, east of Devil's L.

June 8th. Blue Lake.
Sample ~~CN~~ OE-JEF-85-1 from SW rim.

Note: Highway 20 cut above Blue Lake, Lava flow is fracture permeab but flow breccia below is clay alt. and has low permeab. as water is forced out at flow base.

Hogg Rock - Appears to be an extrusive dome. A basal breccia, chilled & oxidized to rust red is ~horizontal in so part of gravel quarry. Above base is 20-60' of radom jointing & shear. Next zone up has inward dipping (15-20°) platty jointing ~50-100' thick. Top is random jointing to loose fract.

(over)

Hayrick Butte

Has same general appearence as Hogg Rock, including near vertical platy flow jointing.
Base of the butte is not exposed.

Cascades Vent Study

June 8, 85.
Detroit Dam intrusion.
~~SE~~ NE contact along Highway-
About 100m of partical to complete argillic alt. extends in Andesite flows. Some argillic alt. and ~~ch~~ chilled contact zone ~ 50m into intrusive.
- Sample OR-5-85-1 ~~CV-85-2~~ of clay alt. in a fault within the intrusive. along highway.
- Sample OR-5-85-2 ~~CV-85-3~~ of clay alt. in Fault zone in So. E part of intrusive. Intrusive med ~~v. fine~~ grain. 200' N. a 2 ft dike, unalt porphy. K-feld. X'ls. in fault with 1 ft wide fault breccia pyrite on fract. in country rock, intrusive pervasively Fe stain. Fine grained dike(?) next to fault brecc. sampled. (near So. contact)

open fract remain, see sample

- Intrusive intrudes pyroclastic-Tuff on So side.

Sample OR-5-85-3 ~~CV-85-4~~ Tuff south of Detroit Dam intrusion.

Cascades ~~Vents~~.
North Santiam District

Sample ~~CV-85-5~~ OR-5-85-4 propylitized rhy? tuff for regional meta. study. Collected on SE side of Henline Mtn. The tuff in this area is competent, holds fract.- Water flowing thru. fract. & joints.

OR-5-85-5
~~CV-85-6~~ - qtz vein with sphalerite and pyrite. Sample not found in place, but on the trail at Gold Cr, ~1/4 mi from Bimetallic & Gold bug

General Comments:
Rocks are competant, Basalts and basaltic-andesite flows are fresh, Chlorite gives a grn. cast to the matrix, but pyroxene & plag. pheno. are unaltered.
Clay and some hem/pyrite along narrow faults. Minor chlorite alt. ~1 cm out from some joints with pyrite and epidote on joint surfac

Cascade Vents - Quartzville

June 10-85

Sample ~~CV-85-7~~ OR-5-85-6 qtz crystals from vein, road cut below adit on NW trending vein, N side trib. to Dry G. Vein has open xl. lined cavities in a breccia, also clay seams - but minor.

~~CV-85-8~~ OR-5-85-7 - Tuff country rock 15 cm and ~2m from contact with andesite dike, moderate hem. stain on joints.

~~CV-85-9~~ OR-5-85-8 - Porphyritic andesite dike. Dike has few epidote veinlets and a few chlorite? veinlets epidote spread thru rock but plag. appear fresh.

- Intrusive contact is tight, irregular sharpe but chilled for ~30 ~~-~~ 60 cm. Hem. veinlets + qtz within ~15 cm of contact, in Tuff.

Dike has few irregular joints, Minor hem. on a few joints.

Tuff is closely jointed and fractured. Tuff changes across dike, poss. fault

~~CV-85-10~~ OR-5-85-9 carbonized wood from ash-flow tuff at ridge crest to N.

~~CV-85-11~~ OR-5-85-10 hem &/or Jasperoid along minor breccia in porphy. andesite intrusion? on Quartzville Cr. Intrusion is only slightly alt. - propylitized or deuteric. Hem. wide spread on joints. (2nd page)

Cascades - Quartzville Dist.

OR-5-85-11
~~CV-85-12~~ qtz vein from andesite intrusion (or poss. Lava flow) on Quartzville Cr.

OR-5-85-12
~~CV-85-13~~ - Carbon from tuff at same Location on Quartzville Cr. There is also a log impress on andesite Lava flow boulder.

Cascades - Mckenzie River

June 11, 85

Nimrod Tg intrusion

OR-S-85-13 ~~CV-85-14~~ Sample of granite-microdiorite contact. Large highway outcrop is all diorite breccia blocks intruded by granite, or qtz-monz. Contact sharp with no contact reaction affects. Always breaks accross contact (diorite-Monz) Joints are 1 m to ~5cm space-irregul. ground water flowing thru some joints. This granite-diorite breccia zone is 1/2 to 1 mi. wide

OR-S-85-14 ~~CV-85-15~~ - Country rock to west of Nimrod intrusion, appears to be ch-ep-alt. dacite lava flow & breccia Contact not exposed.

OR-S-85-15 ~~CV-85-16~~ - Sulfides and silicification 1 mi. west of Nimrod, fractured rock.

Access road to north and around Jumbo Mtn. is all hem stain and alt. to clay and gruss. Rock is uniform ~~med.~~ grain monz. or synite - no qtz. Alt. is probab. due to oxidation of pervase pyrite. Therefore alt. is probably surface weathering, good rock below along river. Intrusion extends thru Jumbo Mtn and poss. much father west, Red road cut on next ridge W. Rock was jointed with money low angle joints - A breccia zone, no dikes - except 2 mafic dikes 1-2' thick, alle also -

(page 2)

(Cascades)

Nimrod Intrusion

On ridge crest ~mi. s.w. of Hagan Mtn. several mafic dikes and a rhyolite dike intrude on same trend. — Both mafic & rhy. are vesicular, indicating shallow (younger) emplacement. Rock is less alt. near dikes but still hem-clay leach alt. including dikes.

OR-S-85-16 ~~CV-85-17~~ Calcite from lava flow breccia, on Hagan Mtn.

⇒ Note that this flow breccia contains blocks of unalt. Monz+diorite from Nimrod intrusion, and therefore post dates intrusion. Flow breccia is open, calcite on joints in shallow dikes.

~~CV-85-18~~

Cascades - Cougar Intrusion

June '' OR-C-85-1
~~CV-85-18~~ sample of glassy part of intrusion from E side.

OR-C-85-2
~~CV-85-19~~ Quartz nodules from vesicles in Cougar dacite

OR-C-85-3
~~CV-85-20~~ - Calcite filling in breccia of tuff country rock 10 m from SW Faulted contact - dacite chilled near fault.

Sample locations on geologic map, Plate 2 (Priest & Vogt 1983)

Dextra Intrusion - Cascades
or Lowell -
Rock is very fresh, aphanitic,
Fine pheno.
Joints are mostly vertical,
A close set 5-15 cm set is mostly
healed and tight, no alt. along these.
Major joints, open and spaced 2-10 m
No hem. stain, zeolite? on one fracture.
Contact with volcanic country rock
(tuff?) is sharp, not any noticeable
contact affect. Country rock is
chlor-alt, crumbly.

Bohemia District - Cascades

OR-R-85-1

~~CV-85-21~~ - Sample of country rock ash-flow tuff for regional alt-meta. Joints along bedding plains are open and transmit groundwater.

OR-R-85-2

~~CV-85-22~~ vein sample from Bohemia mine dump on west side of district. Considerable water flowing out of caved adit. Some vein material is open breccia, qtz cemented, but still very open.

Ridge crest East of Mercury District

~~Huckleberry Mtn~~ - Black Butte Hg

Large dacite(?) dike, olive green with 1-2 mm pheno. of plag, & hornb. plag. & mafics fresh.

- Picture of quarry wall with hat on log. Open joints are ~20 cm spacing. Water flow thru joints. Minor hem. stain on joint surface. Clay alt. in fault, ep. and qtz along one joint.

Cascades - Scott's Mtn.

Intrusive is a ~~a~~ medium grain, xenomorphic, monz. or syenite - unalt.
Jointing high angle, ~1m spacing forms a crude columnar jointing.
Intrudes basalt flows, partly alt. to clay. Some flank areas deeply weathered to orange grus.
The central part is a black spotted monz. which composes ~90% of the intrusion. The intrusion is several times larger than mapped, probably 2-3 mi diameter plus large dikes extending into basalt flow country rock, and the dikes form the ridges radiating from Scott Mtn.
Near some contacts more maphic phases are present, a porphyritic diorite with very fine matrix, deutricly altered. Another minor phase is a med. grain, xenomorphic diorite or gabbro ~50% pyroxenes.
- There is no indication of a significant thermal system. Some of the basalts are little alt.

OR-R-85-3 Cascades - June 13-85

~~CV-85-23~~ Glassy-black, dacite porphyry. plug? - Along North Umpqua River, near Steamboat - exact location uncertain. Dacite is columnar jointed - vertically near river but massive to horizontal columns above. Horizontal columns form between major vertical cooling joints which have qtz veins.

OR-R-85-4
~~CV-85-24~~ quartz vein from Dacite plug. Picture taken of horizontal columns and cooling fissures.

P. →

[redacted] ~~CV-85-25~~ Sample of spongy min. filling breccia in cooling joint.
OR-R-85-5

Columnar joints ~ 1/3 m spacing -
Cooling fissures ~ 5-10 m spacing.
Water flowing thru joints.
Rock very similar to Cougar Res Dacite, probably shallow intr. or dome. Contacts not exposed.

Cascades - June 13

Calf Cr. on North Umpqua R.

~~CV-85-26~~ OR-R-85-6 - andesite? flow breccia or pyroclastics - Country rock W. of intrusive. Sample of qtz vein and sulfides, those not pervasive.

OR-R-85-7 ~~CV-85-27~~ Silicified & pyrite rock exposed to the east near Dry Cr.

It is uncertain that there is an intrusion in this area. The alt. rock, CV-85-27, may be ~~an~~ a silicious lava flow. One 3 m wide basalt dike is present. Sulfide oxidation leaching is wide spread, extending up Calf Creek and E. to Dry Cr. and maybe beyond.

Possible intrusion is a aphanitic andesite porphyry just east of Dry Creek. Where exposed it is unaltered, massive, joints ~2m space. Contains fine grain xenoliths - grn

May be a thick lava flow

Cascades, Oreg, Three Fingers Jack.

Aug-3, 1985

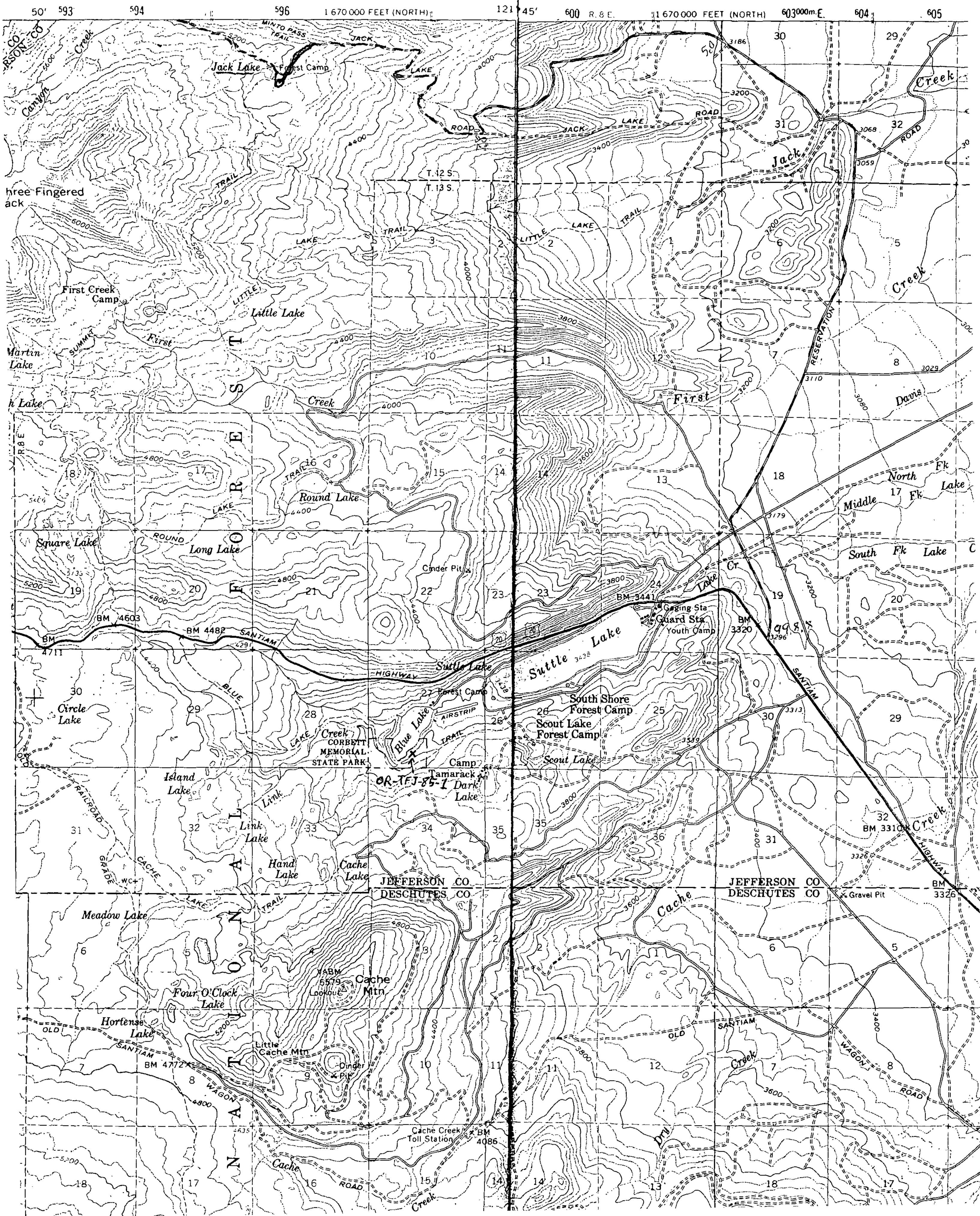
TFJ-1 - no sample-
Dike on N. side of East ridge,
Elev. ~6480, N. of Hill 6855'
~10 m thick dike dips ~80° N, E-W
Porphyritic dacite?
Joints - 1 cm platy cooling/flow shear
Picture joints, Picture with hammer horizontal
showing horizontal joints -
Horiz. joints in center of dike,
vertical joints near contacts.
Contacts - tight, poor exposure
Alteration fresh, no alt
country rock - bedded tuffs
and pyroclastic lapilli,
also unalt.
Pictures of 3 or 4 dikes cutting Tan
tuff on small ridge,
Picture 3 Finger-Jack,
Picture Mt. Jefferson.
Joints appear tight, no alt. on these

TFJ-2 North plug of Three Finger Jack
south contact - Tight - jointed -
Picture - vertical format - hammer horizontal
with head (left) on pyroclastics - welded
Tan is chilled margin of plug -
$\frac{1}{2}$ m. wide - Some minor auto-brec.
of intrusion near contact
Joints - ~$\frac{1}{2}$ m ave. well defined
TFJ-3 ~~no alt~~. slight alt. fine xl. - Plag.
Picture - looking E. to colorful ridge with
many dikes cutting tuff.

Three Fingered Jack   Sisters

OREGON   DEPARTMENT OF THE INTERIOR

15 MINUTE SERIES (TOPOGRAPHIC)   GEOLOGICAL SURVEY



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STATE OF OREGON

DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
1069 State Office Building
Portland 1, Oregon

Bulletin No. 55

--- 223p.

QUICKSILVER IN OREGON

By

HOWARD C. BROOKS
Geologist

1963

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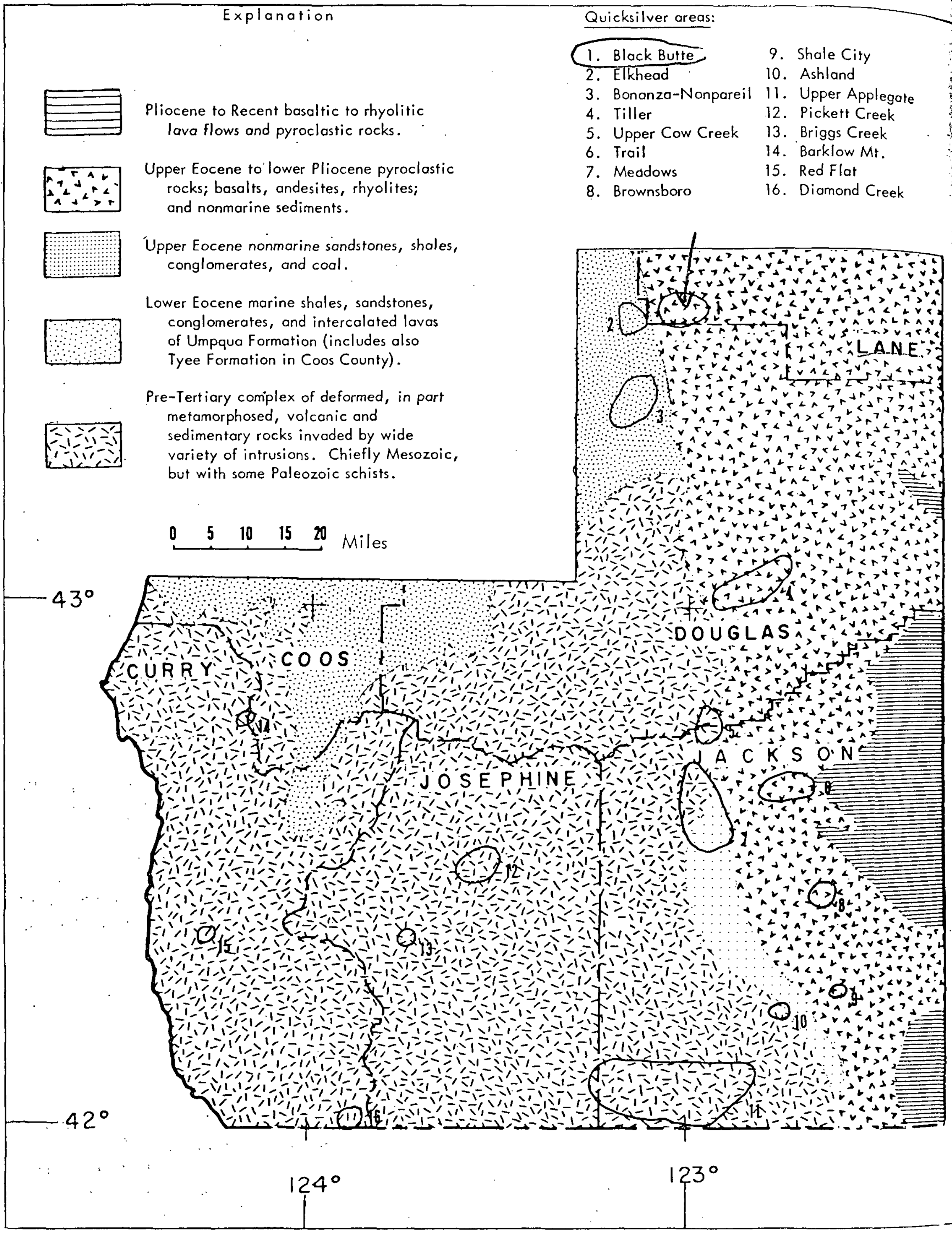


Figure 9. Geologic sketch map of southwestern Oregon showing location of quicksilver-bearing areas.

from deposits in the Meadows area west of Trail, where the deposits indiscriminately cross the boundary between the older and younger rocks.

Within the Klamath Mountains most of the known deposits in the quicksilver belt occur in rocks of the Triassic Applegate Group. Exceptions are one deposit in granite, one in sheared serpentine, and various minor occurrences in Paleozoic schists of the Siskiyou Mountains.

West of the quicksilver belt, in Josephine and Curry Counties, quicksilver deposits are widely scattered and of minor importance. They occur chiefly in Jurassic or Cretaceous volcanic and sedimentary rocks. In the Red Flat area of Curry County, cinnabar is associated with peridotite and serpentine.

Description of the Quicksilver Deposits

BLACK BUTTE AREA

The Black Butte area is in southern Lane County in Tps. 22 and 23 S., R. 3 W., near the head of the Coast Fork of the Willamette River (figure 10), about 17 miles by road south of Cottage Grove on the north slope of the Calapooya Mountains. The area is covered by the topographic map of the Anlauf quadrangle. Located therein are the Black Butte mine, the Woodard prospects, and the Hobart Butte deposit.

Rocks underlying the area are predominantly hypersthene-augite andesites of the upper or dominantly lava facies of the Calapooya Formation (Wells and Waters, 1934, p. 11), which has been shown to be the equivalent of the Fisher Formation (Hoover, 1959). The quicksilver deposits follow normal faults along which andesites have been extensively altered over broad areas by hydrothermal solutions. Rugged crags, sustained by thickly massed veinlets of silica-carbonate and deposits of silicified rock commonly mark the fault zones. On the surface, brown iron ribs produced by weathering of silica-carbonate veinlets are almost omnipresent, increasing in number near the faults. Recorded production from the area has been 16,094 flasks, all from the Black Butte mine.

BLACK BUTTE MINE

Location: The property consists of about 1,000 acres in secs. 8, 9, 16, and 17, T. 23 S., R. 3 W. The workings are in the NW$\frac{1}{4}$ sec. 16 and enter the northwest slope of Black Butte, which is a sharp-crested hill of 2,800 feet elevation.

Owner: Quicksilver Syndicate, Daniel I. Mills, Pres., Black Butte, Oregon.

Production: U. S. Bureau of Mines production figures are shown in table 3.

History: The Black Butte mine, Oregon's fourth largest quicksilver producer, was discovered in 1890 by S. P. Garoutte. Although a 40-ton-per-day Scott-Hutner furnace was installed, little development work was done until 1897, when the Black Butte Quicksilver Mining Co. was organized and took over the property. By 1908, under the direction of W. B. Dennis, some 15,000 feet of development work was done on 100, 200, 300, and 400 foot levels. Dennis also increased the capacity of the Scott-Hutner furnace with an artificial downdraft system.

From 1909 until 1916 the mine was closed, owing to the depressed price of quicksilver.

World War I saw rising prices and the mine was reopened by a New York company under the management of Earl B. Crane. A flotation unit and a redesigned Scott furnace were used from 1916 to 1919. After the war, declining prices forced a shutdown.

In 1927 the property was purchased by the Quicksilver Syndicate controlled by Robert M. Betts. By 1929 two 4-by-60-foot rotary furnaces had been installed, giving the mill a capacity of 150 tons per day. The Black Butte was operated more or less continuously from 1927 to 1942 by the Quicksilver Syndicate. During this time levels were established at 500, 600, 900, 1100, 1300, and 1600 feet. After retreating old furnace tailings, the mine was closed in March 1943 and remained idle until 1956.

In 1956 and 1957 the mine was under lease to the Mercury & Chemicals Corp. of New York. With the assistance of a DMEA loan they explored, developed, and furnaced ore from the 900 and 1,100 foot levels.

Development: The Black Butte mine has been developed by 8 adit levels distributed over a vertical distance of about 1,300 feet (see plate 3 in pocket). The principal ore shoot of the mine has been worked from surface

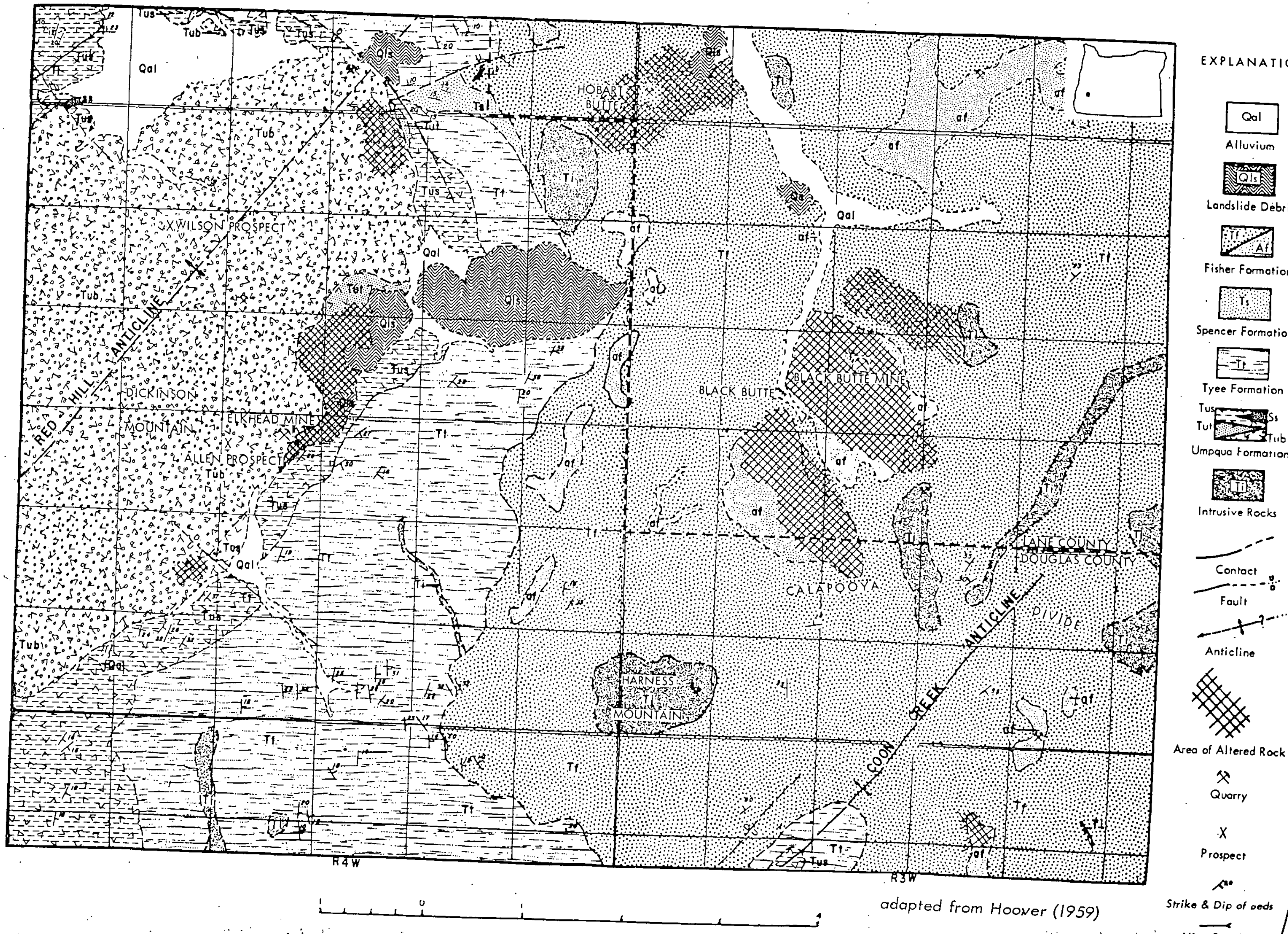


Figure 10. Geologic map of the Black Butte and Elkhead areas.

outcrops to the 1,100-foot level, a vertical distance of about 850 feet. The apex of the ore zone is 1,500 feet in elevation above the furnace level.

The workings required no timbering except in manways and chutes and when visited by the writer in the summer of 1959 most of the mine workings were still open, even though little maintenance work has been done since 1943. Ore was mined from large shrinkage stopes from adit levels, making mining costs much less than at most other quicksilver mines (see figure 11).

Table 3. Recorded Production of the Black Butte Quicksilver Mine*

Year	Treated Furnace (Short Tons)	Flasks
1900	-	200
1901	-	75
1905	-	42
1908	4,100	323
1909	231	486
1916	5,746	282
1917	12,726	380
1918	-	382
1919	-	210
1927	8,841	150
1928	26,248	999
1929	39,901	1,312
1930	49,419	1,549
1931	45,439	1,618
1932	28,667	912
1933	20,455	607
1934	23,086	1,273
1935	22,345	919
1936	21,075	788
1937	19,637	895
1938	19,701	803
1939	17,456	540
1940	18,767	439
1941	19,733	292
1942	2,678	208
1943	2,282	38
1951)	-	26
1951)	-	4
1956	2,284	45
1957	7,752	297
	418,569	16,094

*Source: U. S. Bureau of Mines

Before 1927, ore was carried to the mill by an aerial tramway from the 400-foot level. In 1927 the tramway head house was moved to the 900-foot level and a raise was driven to the 500-foot level. This tramway had 110 buckets and each bucket carried 90 pounds of crushed ore. The aerial tramway was abandoned in 1939 and ore was brought down inside the mine to the Dennis Creek (1,600) level, crushed, and trammed in mine cars to the furnace plant.

Geology: The following descriptions of the geology and the ore shoots and the suggestions for future exploration are quoted from Waters (1945).

Geology at the Black Butte Mine

"Black Butte is composed of andesitic lavas, tuffs, and breccias of the Calapooya Formation (Tertiary). At a few places in the mine these volcanic rocks have been injected by dikes and irregular intrusive masses of basalt and andesite. A single felsite dike is exposed in the lowest adit.

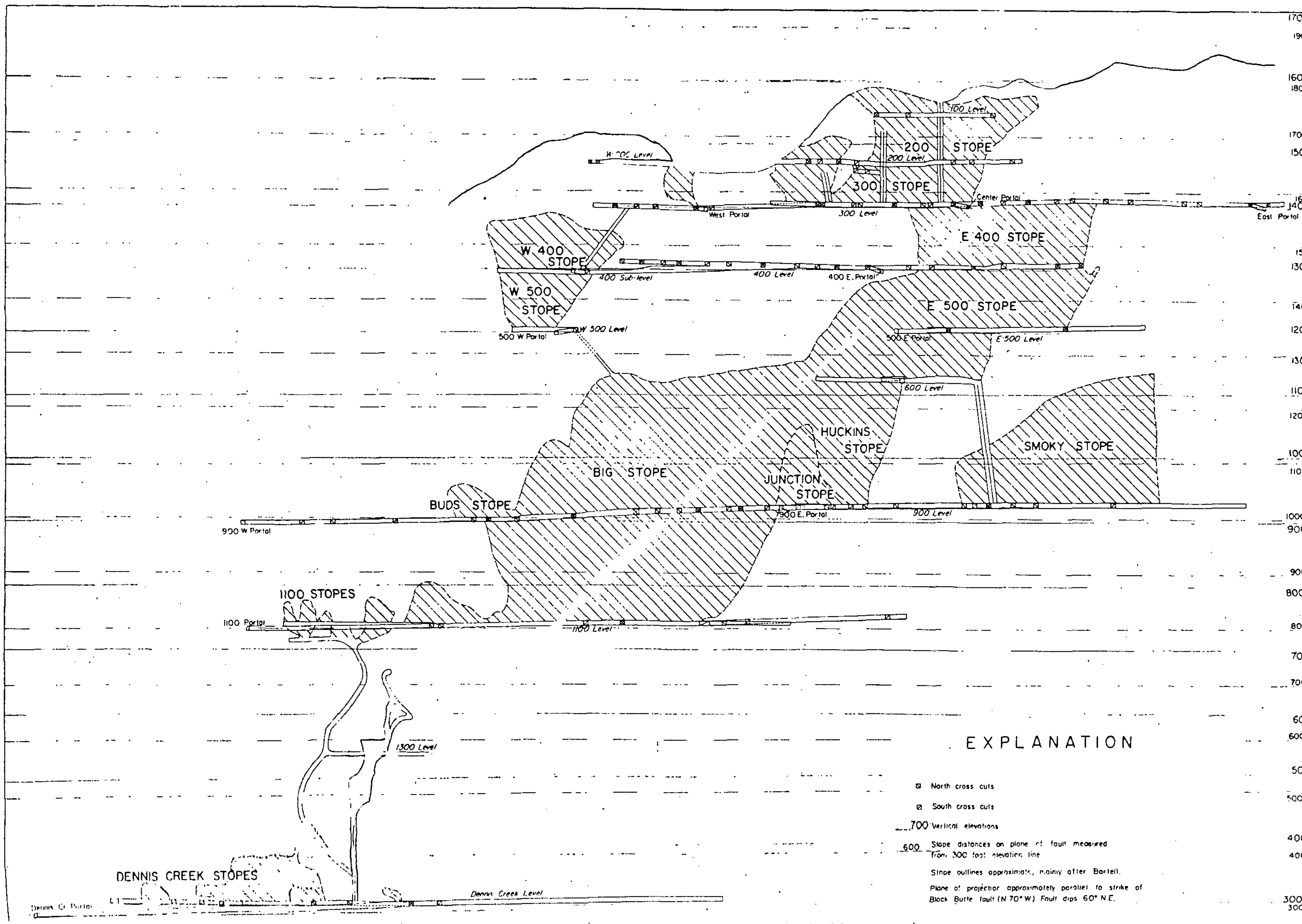
"The top of Black Butte coincides roughly with the trace of a normal fault which, though containing warps and irregularities, strikes approximately N. 70° W. and dips about 58° NE. Roughly parallel with this fault are numerous smaller faults, distributed through a considerable zone both on the hanging wall and footwall sides of the main fault.

"Hydrothermal solutions, rising along these faults and along bedding planes, joints, and other permeable zones in the volcanic rocks, have profoundly altered the andesitic lavas and pyroclastics. Much of the rock of the mountain has been so bleached and softened that its original character is almost unrecognizable. In most areas the altered rock is composed largely of carbonates and clay minerals, with variable amounts of chalcedony and quartz, and minor amounts of opal, chlorite, sericite, pyrite, and marcasite. Irregular veinlets composed of chalcedony and carbonates cut the altered rock, and are particularly numerous near the faults. The veinlets contain abundant siderite and some iron sulfides. Since the cinnabar was introduced during the last stages of silicification, the iron-stained rubble derived from the oxidation of the veinlets is a guide in prospecting.

"Locally the rock has been completely silicified. Fault breccia and gouge along the main fault have in many places been replaced by solid masses of chalcedony. These silicified rocks occur not only along the main fault but large bodies of silicified, bedded tuffs also occur in the Smoky Stope area more than 100 feet north of the main fault. The silicified rock is ore-bearing in many parts of the mine.

"During the last stages of mineralization, much calcite was introduced as veinlets and impregnations. A large body of vein calcite was deposited along the main fault between the western part of the 900 level and the 1,550 or Dennis Creek level, this body of coarsely crystalline vein calcite is over 30 feet thick and has been mined and marketed for chicken grits.

"Though the main epoch of faulting preceeded the hydrothermal alteration and ore deposition, there has also been some post-mineral movement, particularly along the main fault. The post-mineral movement has in many places polished fault surfaces that are well exposed as "walls" in the drifts and stopes.


200 STOPE
100 Level
200 Level
300 STOPE
Center Portal
West Portal
300 Level
East Portal
E 400 STOPE
W 400 STOPE
400 Sub-level
400 Level
400 E. Portal
W 500 STOPE
E 500 STOPE
500 W Portal
W 500 Level
500 E Portal
E 500 Level
600 Level
HUCKINS STOPE
SMOKY STOPE
BIG STOPE
JUNCTION STOPE
BUDS STOPE
900 W Portal
900 E. Portal
900 Level
1100 STOPES
1100 Portal
1100 Level
1300 Level
DENNIS CREEK STOPES
Dennis Creek Level
EXPLANATION
North cross cuts
South cross cuts
700 Vertical elevations
600 Slope distances on plane of fault measured from 300 foot elevation line
Stope outlines approximate, mainly after Bartell.
Plane of projection approximately parallel to strike of Black Butte fault (N 70° W) Fault dips 60° N.E.

Ore Shoots of the Black Butte Mine

"Ore shoots along the Black Butte fault: Most of the production of the Black Butte mine has come from a single continuous ore shoot along the Black Butte fault. This ore shoot has been exploited by the Big stope, and by stopes in the eastern part of the mine above the 600 level. Ore was mined from the top of the mountain to the 1,100 level, a vertical distance of 850 feet. The ore shoot, which has indefinite walls, rakes to the northwest. The greatest dimension of the stopes, measured on the fault surface in the direction of rake, is about 1,200 feet. The width of the mined area, taken at right angles to the rake, varies greatly but averages about 300 feet. The ore shoot is from 3 to 40 feet thick.

"Within this ore shoot, cinnabar and small amounts of metacinnabar and native quicksilver occur as specks, blebs, and short discontinuous veinlets in and adjacent to the brecciated and altered rock along the Black Butte fault. The tenor of the ore varies erratically; in general it is richest in the more thoroughly silicified rocks of the fault zone, where it occurs chiefly as discontinuous veinlets and blebs. Some silicified rock, however, is almost barren. After silicification, renewed movement shattered the silicified rock locally and left other parts relatively unfractured. Cinnabar and accompanying minerals were then deposited in the openings of the shattered rock. Minable ore also occurs locally in the clayey and carbonatized but unsilicified rocks in and adjacent to the fault. Here the cinnabar is chiefly disseminated in minute specks through the altered rock, though some is in short veinlets associated with siderite and chalcedony.

"Although some very rich ore has been mined, especially from the highly veined parts of the silicified rock, most ore was of very low grade. The average grade of rock mined from this ore shoot appears to be not more than 4 pounds per ton. Permeable zones, due to shattering of the silicified rock, were obviously the favored sites for ore deposition.

"The stope that extends above and below the west end of the 400 level is on the Black Butte fault, in ore of the same nature as that in the ore shoot just described. Unmined low-grade ore of the same general character lies between the two stopes on the 400 level. This ore was not extracted because the raise connecting the 400 level with lower levels was plugged.

"Ore shoots in bedded tuffs: The Smoky stope, at the east end of the 900 level, and the stopes at the west end of the 1,100 level have been opened in ore shoots that lie in bedded tuffs more than 100 feet northeast of the Black Butte fault.

"The Smoky stope ore shoot lies at the contact between two tuff beds. The upper one is a coarse, purple to red-brown, andesite tuff containing fragments up to 1 inch in diameter. The fragments are pumiceous andesite set in a lighter-colored matrix of fine andesite fragments and pumice dust. Associated with this tuff in the west end of the Smoky stope, about 40 feet above the 900 level, is a lava flow which has been converted into a beautiful replacement breccia by hydrothermal solutions. Similar altered lava at the east end of the 900 level drift may also be a part of this unit, but its exact relationship is obscured because it is separated from the rest of the main Smoky stope area by a northeast-trending cross fault, which forms the east end of the Smoky stope.

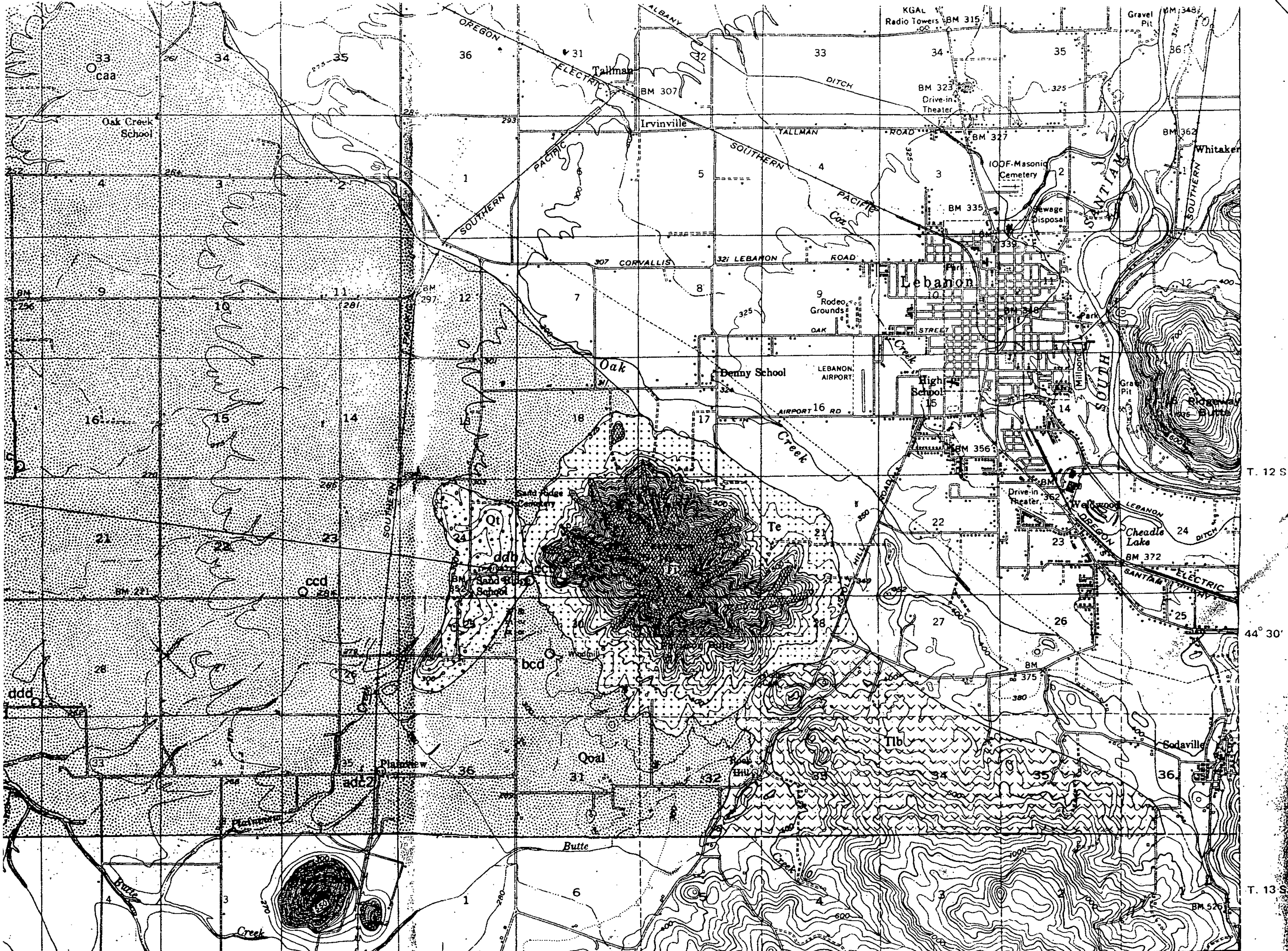
"The basal portion of the purple-brown tuff has been thoroughly silicified locally, especially along the 900 level, and the best ore occurs in and directly beneath the silicified purple-brown tuff.

"The purple-brown tuff is underlain by a highly altered white to light-buff tuff. This white tuff, which is composed largely of carbonates and clay in the Smoky stope, is more silicified toward the west and eventually passes into a hard, cream-colored, sugary-textured rock composed largely of chalcedony. The cinnabar gradually diminishes and disappears westward as the silicification increases.

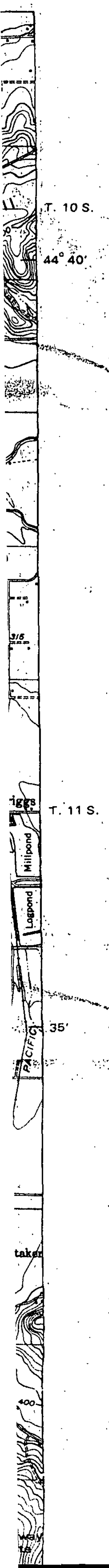
"The ore-bearing contact between the white and purple-brown tuff strikes about N. 80° W. and dips 30° to 35° NE. However, the overall inclination of the ore-bearing zone, both in the mined-out portion above the 800 level and in its downward projection as determined by drilling, is 45° to 50°. This discordance is due to the fact that the ore-bearing contact is repeatedly broken and offset by small faults with downthrow to the northeast. Some of these faults are premineral, others postmineral.

"The stopes at the west end of the 1,100 level have been opened in partially silicified, fine-grained tuffs interstratified between coarse volcanic breccias.

"Ore shoots along vertical fractures in andesite: The Dennis Creek level is mainly in a thick flow of porphyritic andesite. This andesite is cut, 250 to 300 feet north of the Black Butte fault, by a series of steeply dipping fractures that strike roughly parallel with the fault. For some distance from each fracture the lava is irregularly altered, and cinnabar has been deposited as veinlets and disseminations in the altered rock. The ore is of very low grade.



Lebanon
Tallman
Irvinville
Oak Creek School
Denny School
Sand Ridge School
Sand Ridge Cemetery
Plainview
Sodaville
Whitaker
Rock Hill
Cheadle Lake
Ridgeway Butte
Lebanon Airport
High School
Rodeo Grounds
IOOF-Masonic Cemetery
Sewage Disposal
Drive-in Theater
KGAL Radio Towers
Gravel Pit
Windmill
OREGON ELECTRIC
SOUTHERN PACIFIC
TALLMAN ROAD
CORVALLIS LEBANON ROAD
AIRPORT RD
OAK STREET
LEBANON DITCH
SOUTH SANTIAM
Oak Creek
Butte Creek
Qt
Qoal
Te
Tlb
caa
ccd
ddd
ddb
bcd
adc2
T. 12 S.
T. 13 S.
44° 30′
R. 3 W.
123° 00′
R. 2 W.
122° 55′



EXPLANATION

UNCONSOLIDATED DEPOSITS

QUATERNARY

Holocene

Qal

Younger alluvium

Assorted coarse gravel and sand. Yields moderate to large quantities of water to wells

Pleistocene and Holocene

Qoal

Older alluvium

Largely sand and gravel, with mixture of sand, silt, and clay. Is somewhat finer and less assorted than the younger alluvium. Tends to be of finer materials below depths of 50-100 feet. Yields moderate to large quantities of water to properly constructed wells. Includes some younger alluvial deposits along minor streams, and "Willamette Silt," as mapped by Allison

Qt

Terrace deposits

Poorly sorted gravel, sand, and clay, weathered in upper part. Yield small to moderate quantities of water to wells from saturated coarser grained beds

CONSOLIDATED ROCKS

TERTIARY

Oligocene and Miocene

Tlb

Little Butte Volcanic Series

Volcanic rocks, predominantly dacitic and andesitic flows and tuffs. Has limited areal extent. Where present, yields small quantities of water to wells

Oligocene

Te

Eugene Formation

Marine-deposited coarse- to fine-grained sandstone with intercalated shale. Yields water slowly to wells

Oligocene(?)

Ti

Intrusive igneous rocks

Dikes and sills of gabbro and basalt. Generally yield small quantities of water to wells

Eocene

Ts

Spencer Formation

Marine-deposited sequences of tuffaceous sandstone, shale, and mudstone. Yields water slowly to wells. Contains saline water locally

Tt

Tyee Formation

Marine-deposited tuffaceous sandstone, siltstone, and shale. Yields water slowly to wells

Tsr

Siletz River Volcanics

Zeolite pillow lava and basalt flows with interbedded tuffaceous siltstone, shale, and fine tuff. Yield small to moderate quantities of water to wells, usually adequate for domestic use

Contact

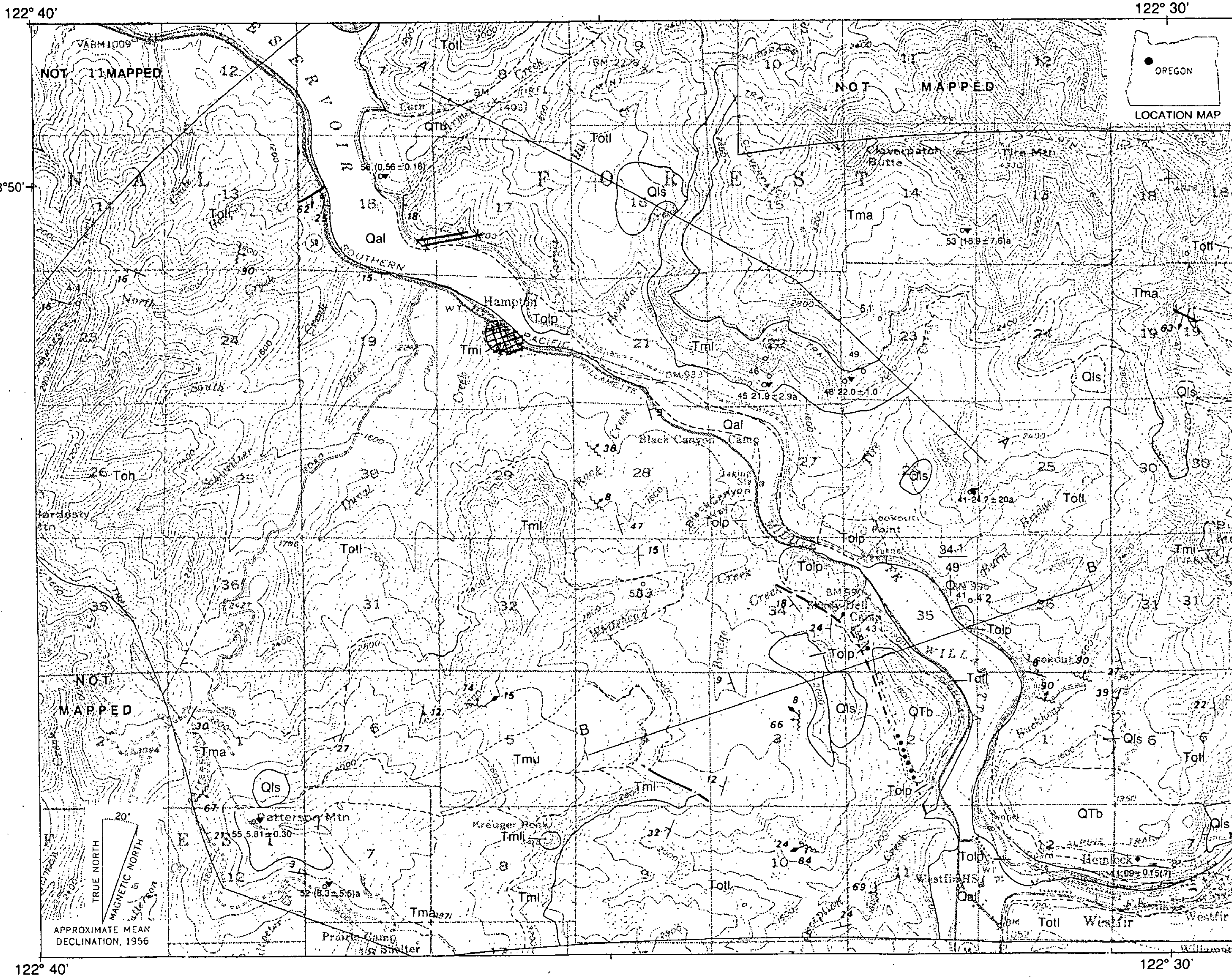
U
D

Fault

Dashed where approximately located; dotted where concealed. U, *upthrown side;* D, *downthrown side*

o dda

Well and number


122° 40'
122° 30'
43°50'
NOT MAPPED
NOT MAPPED
NOT MAPPED
LOCATION MAP
OREGON
Hampton
Black Canyon Camp
Lookout Point
Cloverpatch Butte
Tire Mtn
Patterson Mtn
Kreuger Rock
Hemlock
Westfir
Prairie Camp Shelter
Hardesty Mtn
APPROXIMATE MEAN DECLINATION, 1956
TRUE NORTH
MAGNETIC NORTH
20°
Qal
Qls
QTb
Totl
Tma
Tmi
Tml
Tmu
Tolp
Toh
56 (0.56 ± 0.18)
53 (18.9 ± 7.6)a
45 21.9 ± 2.9a
48 22.0 ± 1.0
41 24.7 ± 20a
55 5.81 ± 0.30
52 (8.3 ± 5.5)a
1.09 ± 0.15(7)
A
B

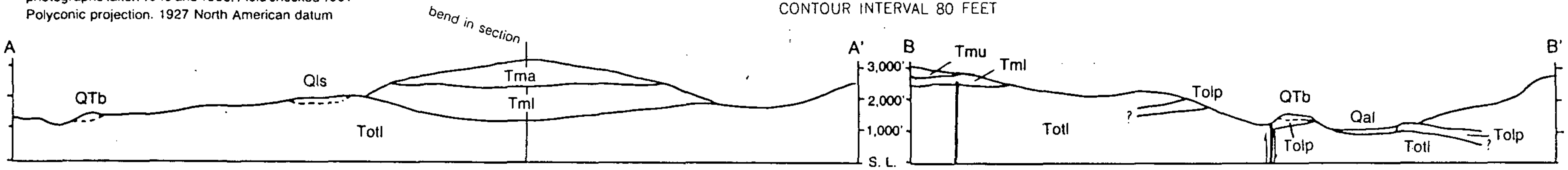
Base map by U.S. Geological Survey —
Hardesty Mountain and Sardine Butte 15' quadrangles
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial photographs taken 1949 and 1958. Field checked 1961
Polyconic projection. 1927 North American datum

SCALE 1:62500

CONTOUR INTERVAL 80 FEET

Geology by N.M. Woller and G.R. Priest

Field work dates: 1980, 1981



EXPLANATION

SURFICIAL DEPOSITS

Qal	**Recent alluvium (Quaternary):** *Recent unconsolidated sediments located in present river and creek channels*
Qls	**Landslide deposits (Quaternary):** *Unconsolidated landslide deposits, including slumps and slide blocks*

BEDROCK GEOLOGIC UNITS

Volcanic rocks of the late High Cascade episode

QTb	**Pliocene-Pleistocene basaltic lavas (Pliocene-Pleistocene):** *Olivine basalts and basaltic andesites, diktytaxitic to compact, gray, fresh. Found as intracanyon flows in canyons cut into all other rock units in drainages related to Quaternary topography. Equivalent to the basalts of High Prairie of Brown and others (1980b) and the upper part of the volcanic rocks of the High Cascades . . . [undivided] of Peck and others (1964). Armet Creek flow dated at 0.56 ± 0.16 m.y. B.P.*

Volcanic rocks of the early High Cascade episode

Tmu	**Upper Miocene lavas (upper Miocene):** *Olivine basalt, fresh, gray, compact. Caps Patterson Mountain. Equivalent to Pliocene volcanic rocks of Brown and others (1980b) and the lower part of the volcanic rocks of the High Cascades . . . [undivided] of Peck and others (1964). Dated at 5.81 ± 0.3 m.y. B.P.*

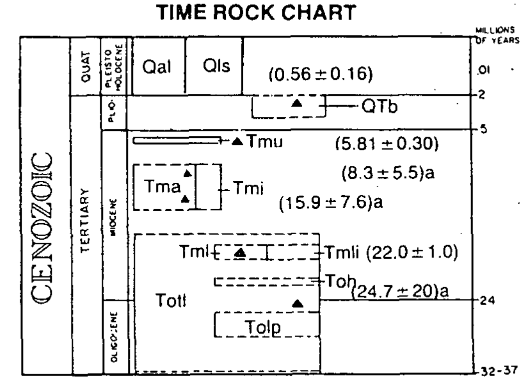
Volcanic rocks of the late Western Cascade episode

Tma / Tmi	**Miocene andesitic lavas (Miocene):** *Two-pyroxene plagioclase-rich andesites with interbeds of epiclastic volcanic rocks and minor flows of olivine basalt and dacite. Equivalent to Sardine Formation of Peck and others (1964) and Miocene volcanic rocks of Brown and others (1980b). Unit* **Tmi**: *intrusive equivalent of unit* **Tma**. *One flow low in section dated at 15.9 ± 7.6 m.y. B.P.; another flow high in the section dated at 8.3 ± 5.5 m.y. B.P.*

Volcanic rocks of the early Western Cascade episode

Totl	**Oligocene and lower Miocene tuffs and lavas, undifferentiated (Oligocene and lower Miocene):** *Lower part: lithic-fragment-rich tuff, possibly partly laharic in origin. Upper part: ash-flow tuff, air-fall tuff, silicic lavas, and sedimentary interbeds. Generally altered, stained, and deformed. Equivalent to Little Butte Volcanic Series of Peck and others (1964) and Breitenbush formation of White (1980a) and Hammond and others (1982). A lava high in section was dated at 24.7 ± 2.0 m.y. B.P. Three distinctive units within this sequence were mapped separately and are described below:*
Tml / Tmli	**Lavas of Black Canyon (lower Miocene):** *Basalt to andesite, aphyric to slightly plagioclase phyric, black, gray, or brown. Follows canyon cut into unit* **Totl**. *Contains interbeds of sediments and ash flows of unit* **Totl**. *Equivalent to Scorpion Mountain lavas of White (1980a,c). Unit* **Tmli**: *plug of these lavas. Sequence extruded in short period of time about 22 m.y. B.P.*
Toh	**Lavas of Hardesty Mountain (upper Oligocene-lower Miocene):** *Intermediate lavas, generally plagioclase phyric. Caps Hardesty Mountain*
Tolp	**Lavas of Lookout Point (upper Oligocene):** *Rhyodacitic lavas; black, gray, or pink; glassy field appearance with sparse plagioclase and rare pyroxene phenocrysts. Resistant compared to surrounding tuffs; forms knobby hills along the river*

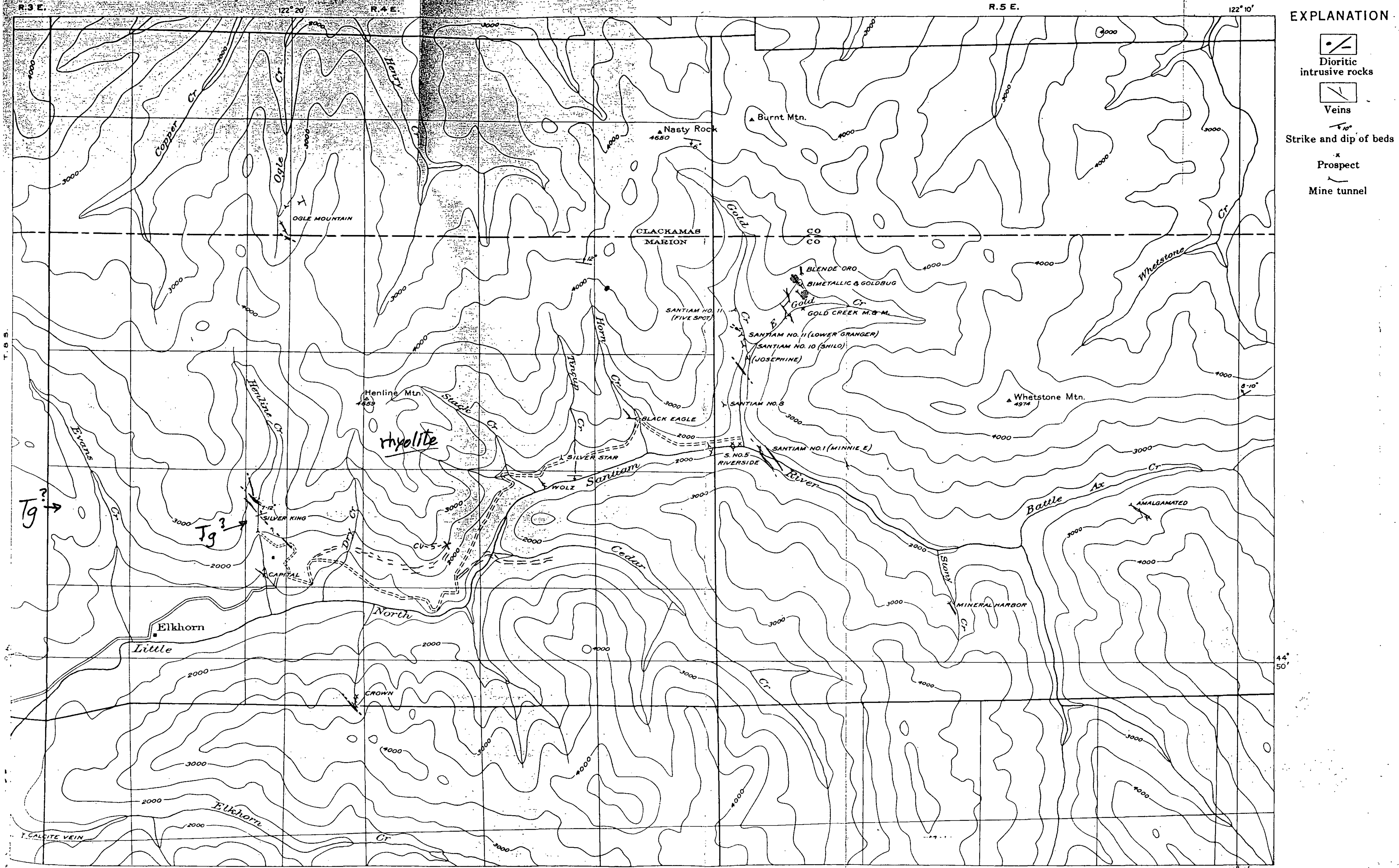
TIME ROCK CHART



GEOLOGIC SYMBOLS

	Contacts: Solid where visible; dashed where inferred below cover or from aerial photo interpretation
6	**Fault:** Solid where visible; dashed where approximately located; dotted where concealed by alluvium, landslide, or colluvium. Dip on fault plane indicated where known; bar and ball on downthrown side
	Dike: Mafic to intermediate dike, dip indicated
6	**Shear:** With dip of plane and orientation of striations within plane
4	**Shear:** With dip of plane and slickensides
5	**Strike and dip:** Of thinly bedded epiclastic units or volcanic flow tops
54o	**Geochemical sample location**
▲ 52 (8.3 ± 5.5)a	**K-Ar date:** Age in millions of years (this study). Parentheses around date indicate that sample had less than 10 percent radiogenic argon. "a" indicates date may be affected by low-grade rock alteration
♦	**K-Ar date:** Age in millions of years (Sutter, 1978)
11.09 ± 01.5(?) ɸ	**Drill hole location:** Terrain-corrected gradient in °C/km and heat-flow values in mW/m^2

Figure 5.2 (both pages). Map of the geology of the Lookout Point area.



SKETCH MAP OF NORTH SANTIAM DISTRICT, MARION AND CLACKAMAS COUNTIES, OREGON

Showing location of mines and prospects, veins, and dioritic intrusive bodies

Base from U. S. Geological Survey map of Mill City ...

CHAPTER 4. GEOLOGY OF THE COUGAR RESERVOIR AREA, LANE COUNTY, OREGON

By George R. Priest and Neil M. Woller,
Oregon Department of Geology and Mineral Industries

ABSTRACT

Volcanic rocks of the early and late Western Cascade episodes crop out at Cougar Reservoir west of the major north-south Cougar fault. Volcanic rocks of the late Western and early High Cascade episodes crop out on the east block of the Cougar fault. A drill hole on the east block revealed that at least 152 m (499 ft) of down-to-the-east movement has occurred on the fault and that the dip on the fault plane is greater than 74° to the east. The fault cuts units of late Western Cascade age (lavas of Walker Creek) that have been K-Ar dated at 13.2 m.y. B.P. Pleistocene outwash gravels that overlie the fault zone are not offset. Stratigraphic arguments suggest that 366 m (1,200 ft) to possibly more than 1,033 m (3,388 ft) of down-to-the-east movement on the fault may have occurred. Stresses similar to those producing the fault may have caused the north-south elongation of a dacite intrusion dated at 16.2 m.y. B.P., but there is only permissive evidence for this. Lavas of the early High Cascade episode which began to flow into the area between about 8.3 and 7.8 m.y. B.P. were probably prevented from flowing west by the scarp of the Cougar fault. Although most of the displacement probably occurred immediately prior to those eruptions, it is possible that displacements may have also occurred on the Cougar fault about 4 to 5 m.y. ago, when north-south faults formed east of the area. However, absence of an obvious topographic scarp today suggests that 5- to 4-m.y. B.P. displacements, if they occurred, were small.

Slight southward tilting of the area may have occurred during late Western Cascade time between about 13 and 9 m.y. B.P. Between early and late Western Cascade time, which was a period of nondeposition and erosion, a topography with at least 366 m (1,200 ft) of relief developed. A period of rapid erosion and uplift produced about 1 km (0.6 mi) of relief in the area between 5 and 4 m.y. B.P.

The gravity signature of the Cougar fault continues north and south of the study area for many kilometers and coincides with an analogous fault at McCredie Hot Springs to the south (see Chapter 6). The Cougar fault may thus be a regional structure older than and west of analogous north-south faults at the Western Cascade-High Cascade boundary at Horse Creek and Waldo Lake (see Chapter 6).

INTRODUCTION

Cougar Reservoir is located on the South Fork of the McKenzie River between the towns of Blue River and McKenzie Bridge (Figure 4.1). The area is about 80 km (50 mi) east of Eugene on State Highway 126.

The area is in steep, mature topography of the Western Cascade physiographic province. The northern boundary of the area is the McKenzie River, which runs almost east-west. The central part of the area is dominated by the north-south-trending V-shaped valley of the South Fork of the McKenzie River. Cougar Dam forms a 9.2 km (5.7 mi)-long lake on the South Fork. Local relief is about 1,037 m (3,400 ft).

Geologic mapping was undertaken at a scale of 1:24,000 to define structures and rock units which control the local hydrothermal systems (see Plate 2). The area is only a few kilometers west of the Belknap-Foley Known Geothermal Resource Area (KGRA). There is one local thermal spring, Terwilliger Hot Springs, where water at about 44° C issues from fractured andesitic lavas on the west side of Cougar Reservoir at Rider Creek. Other workers, including Bowen and others (1978) and Brown and others (1980a), mentioned another thermal spring, the "Cougar Reservoir hot spring," located under what is now Cougar Reservoir. The earliest reference to this spring comes from Waring (1965), who mentioned a warm spring 12.9 km (7.7 mi) southwest of McKenzie Bridge. No spring, however, was noted by geologists of the U.S. Army Corps of Engineers at the site of "Cougar Reservoir hot spring" when constructing Cougar Dam. The mislocation of Terwilliger Hot Springs and the deletion of the correct name for the hot spring in Waring's (1965) compilation have probably created this confusion. Only one hot spring, Terwilliger Hot Springs, is known to be in the area.

PREVIOUS WORK

Many workers have mapped near the Cougar Reservoir area, but until this study, the only available maps of the area were reconaissance maps by Wells and Peck (1961) and Peck and others (1964). The authors of this present paper contributed the Cougar Reservoir portion of the larger reconnaissance map of Brown and others (1980a), but the present 1:24,000-scale map (Plate 2) represents a considerable refinement of the 1:62,500-scale map of Brown and others (1980a).

Wells and Peck (1961) mapped the entire area as middle and upper Miocene andesite roughly equivalent to the Sardine series of Thayer (1936, 1939). Peck and others (1964) mapped the entire area as Sardine Formation, except for a small area of the older tuffaceous rocks at Cougar Dam. Peck and others (1964) mapped the tuffaceous rocks as Little Butte Volcanic Series. Neither Wells and Peck (1961) nor Peck and others (1964) showed faults in the area. The correspondence of map units of this study to the rock units of earlier workers is discussed in detail on Plate 2.

PRINCIPAL CHANGES FROM PREVIOUS MAPPING

Relative to these earlier maps, the present map shows a much larger area of the older tuffaceous sequence, here informally called the tuffs of Cougar Reservoir. It also shows exten-

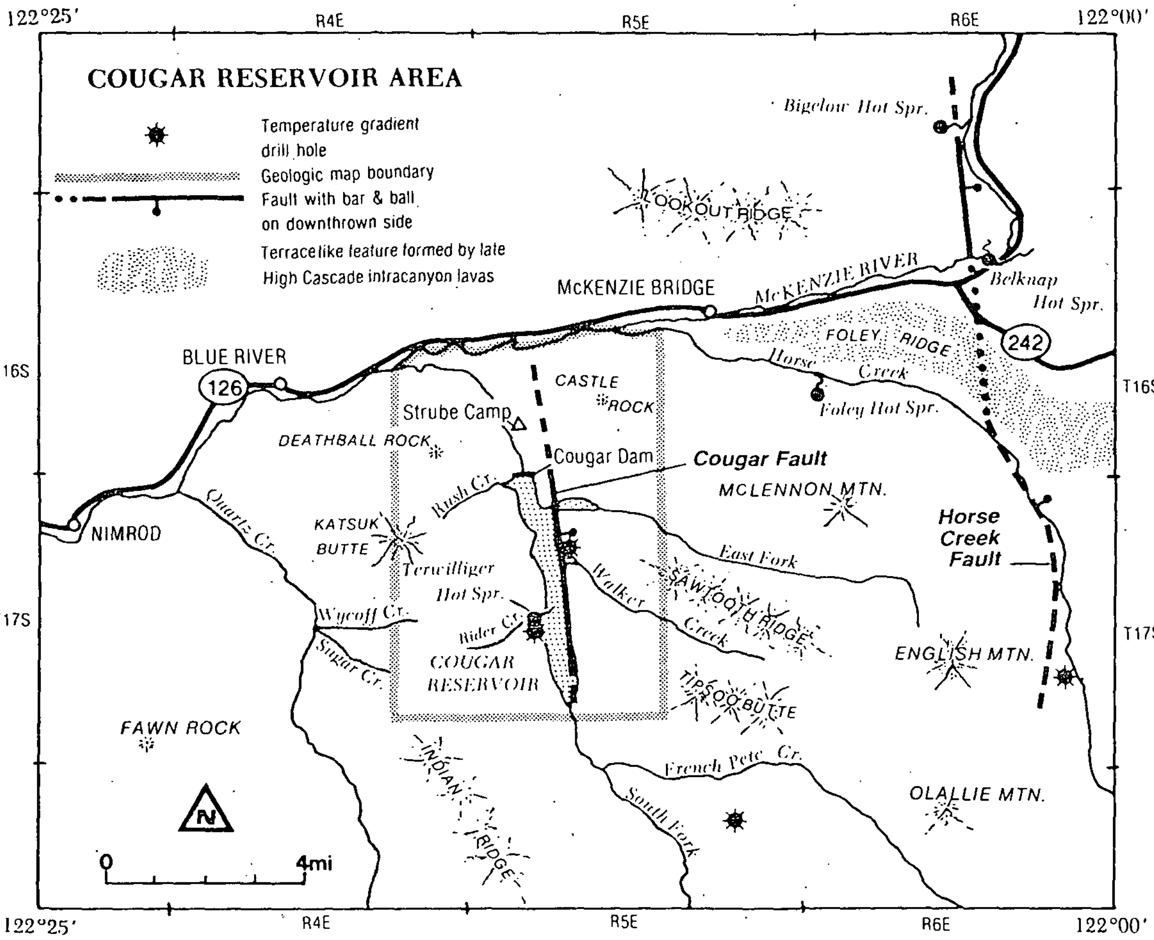


Figure 4.1. Map showing location of the Cougar Reservoir map area and other localities mentioned in the text. The Horse Creek fault is from Brown and others (1980a) and Flaherty (1981).

sive areas of basalts of the early High Cascade episode, the lavas of Tipsoo Butte, which cap the ridges east of Cougar Reservoir. The present map shows a large north-south-trending fault along the East Fork of the McKenzie River and other smaller subsidiary faults not shown on earlier maps. Earlier maps show a general easterly dip to the Western Cascade sequence, but only a very slight (7°) southerly dip was recognized in the present study. The easterly dip of the sequence in the earlier maps (Wells and Peck, 1961; Peck and others, 1964) was used as evidence of a regional anticline in the area (the Breitenbush anticline). The dominance of rocks younger than the Little Butte Volcanic Series on the limbs of the structure and the dominance of the Little Butte Volcanic Series on the axis were used as evidence for existence of an anticline. Our work suggests that younger rocks dominate east of the presumed anticlinal axis principally because of down-to-the-east step faulting along a north-south trend.

GEOLOGIC HISTORY

During early Western Cascade time (40 to 18 m.y. B.P.), the area was the site of intense silicic volcanism, principally in the form of large, tuffaceous, pumice-poor, lithic-fragment-rich lahars (tuffs of Cougar Reservoir). Although some ash-flow tuffs, rhyodacite, and moderately iron-rich andesite lavas occur in the sequence, laharic tuffs and interbedded epiclastic sandstones and mudstones dominate the volcanic pile. Between about 22 m.y. B.P.(?) and about 14 m.y. B.P., a steep topography with at least 366 m (1,200 ft) of relief developed. Andesitic lavas (andesites of Walker Creek), dacitic ash-flow tuffs and lapilli and ash-fall tuffs (tuffs of Rush Creek and tuffs of Tipsoo Butte), basaltic flows (basaltic lavas of the East Fork), and numerous andesitic to dacitic plugs (dacite intrusive of Cougar Dam and other andesitic intrusions) invaded the area during late Western Cascade time about 16.2 to 8.9 m.y. B.P. These rocks buried the earlier topography to a depth of at least 470 m (1,542 ft). The sequence of late Western Cascade age was then capped by iron-rich diktytaxitic basalts (lavas of Tipsoo Butte) during early High Cascade time (about 8.3 to 5 m.y. B.P.). These flows of the early High Cascade episode filled a topography east of Cougar Reservoir that had very little relief and flowed in from sources to the east.

Between about 5 m.y. and 4 m.y. B.P., the area was deeply dissected by the current drainage system, and numerous mudflows subsequently poured off the steep slopes. Later, in the Pleistocene, glacial outwash deposits covered the floor of the valley of the East Fork. Steep slopes in the area are very unstable and form large landslides where underlain by tuffs of the late Western Cascade episode. These landslides and glacial outwash deposits are being incised by present-day streams.

The major structure in the area is the north-south-trending Cougar fault zone, which offsets rocks dated at 13.2 m.y. B.P. by at least 152 m (499 ft) and probably by more than 366 m (1,200 ft). The relative motion on the fault is down to the east. North-south elongation of the 16.2-m.y. B.P. dacite intrusion of Cougar Dam adjacent to the Cougar fault suggests that regional stresses similar to those which caused the Cougar fault may have been active during initial volcanism of the late Western Cascade episode. Breccia dikes and magmatic dikes along small northwest-trending faults and fissures within the Cougar Dam intrusive suggest that some faulting was closely associated with the intrusion. Slight tilting of the Western Cascade sequence about 7° or less to the south probably occurred during late Western Cascade time.

STRATIGRAPHY

Introduction

Volcanic rocks of the early and late Western Cascade episodes and early High Cascade episode dominate the area (see Chapter 2 for definitions of these units). Ages have been assigned by K-Ar dating of the tops and bottoms of major sequences where possible. Stanley H. Evans of the University of Utah Research Institute determined a total of 11 K-Ar dates from rocks collected within the map area and other parts of the McKenzie Bridge quadrangle (Appendix A). All stratigraphic units used in this paper are informal and have been divided according to mappable characteristics of the rocks. The chemical classification system used to give rock names is summarized in the nomenclature section in Chapter 2. The chemical petrology and regional significance of the chemical compositions of the rocks are discussed in Chapter 2 and are not repeated here.

Detailed lithologic descriptions of volcanic bedrock units are given in Table 4.1, and correlation of all map units with units of previous workers is summarized in the geologic map legend (Plate 2). Only features useful for stratigraphic correlation and petrologic interpretation are discussed in the text.

Volcanic rocks of the early Western Cascade episode

Tuffs of Cougar Reservoir (unit Totc): Thick tuffaceous laharic and mudflow deposits, nonwelded ash-flow tuffs, epiclastic mudstone and sandstone, and minor interbedded rhyodacite to moderately iron-rich andesite flows crop out in the lowest elevations of the South Fork of the McKenzie River. These rocks are here informally called the tuffs of Cougar Reservoir. The lowest part of the sequence, which is exposed downstream from Cougar Dam, consists of abundant tuffaceous mudstone. Diamond core samples from holes drilled in the area by the U.S. Army Corps of Engineers indicate that additional lithic-fragment-rich laharic tuffs underlie the epiclastic mudstone. Most of the unit is dominated by a series of crystal-poor, pumice-poor, tuffaceous lahars with numerous mudstone and sandstone interbeds.

Laharic flows in the uppermost part of the sequence above Cougar Dam at Rush Creek are locally crystal rich and contain numerous plagioclase and hypersthene crystals. A dark, hackly, aphyric, iron-rich andesite flow (sample 20, Appendix B, Table B.2) crops out at the head of Rush Creek near the top of the sequence, and a series of rhyodacite flows occurs near the base east of Strubes Forest Camp.

All of the rocks show some alteration to fine-grained birefringent phyllosilicates. Most of these phyllosilicates are probably smectite clays which totally replace glass in most rocks and affect plagioclase and orthopyroxene in many places. In some samples, chlorite and calcite were also noted replacing mafic phases and plagioclase, respectively. Alteration of plagioclase is unknown in the overlying rock units.

Microscopic examination of the ash-flow tuffs reveals the broken nature of matrix pyroxene and plagioclase crystals and the paucity of crystals in pumice. The fine-grained vitric ash component was partially winnowed out of the matrix during transport. Pumice lapilli are not common in the ash flows and are rare in the tuffaceous mudflows and lahars. Coarse ash is common in the ash-flow tuffs. The mudflows contrast with the ash-flow tuffs by having a lithic-fragment content equal to, or in some cases exceeding, the vitric component.

The mudflows commonly contain carbonized wood fragments, as well as abundant lithic lapilli. Lithic fragments seldom exceed 1 m (3 ft) in size in the mudflows in this area, and most are less than 10 cm (4 in). The pyroclastic and epiclastic rocks generally form rounded slopes with frequent cliffs and some "hoodoos." The overall color of the tuffs is greenish gray, with abundant dark-gray to reddish-purple aphyric lithic fragments. The units are well lithified and, unlike younger tuffs, show no tendency to form major landslides.

The tuffs of Cougar Reservoir are too altered to provide material for accurate radiometric dates, but some constraints can be placed on the age of the sequence. The intrusion at Cougar Dam which cuts the tuffs has a K-Ar date of 16.2 m.y. B.P. Sutter (1978) listed a K-Ar date on the Nimrod stock of 15.86 ± 0.18 m.y. B.P. (which recalculates to 16.3 ± 0.2 m.y. B.P. according to Fiebelkorn and others, 1982). This quartz monzonite stock appears to intrude tuffs similar to the tuffs of Cougar Reservoir. Lavas chemically similar to the iron-rich andesite lava found near the top of the sequence occur at the top of a similar tuffaceous sequence near Lookout Point Reservoir where they have a K-Ar date of about 22 m.y. B.P. (see Chapter 5). Similar lavas in other parts of the Western Cascade Range have K-Ar dates of between 27 and 19 m.y. B.P. (White, 190a,c).

Volcanic rocks of the late Western Cascade episode

Introduction: Volcanic rocks of the late Western Cascade episode are a series of basaltic to dacitic lavas and tuffs which fill a steep topography cut into the underlying tuffs of Cougar Reservoir. The sequence thins against an east-west-trending highland formed of tuffs of Cougar Reservoir in the northwestern part of the map area. The adjacent paleovalley was at least 366 m (1,200 ft) deep, based on the rise of the lower contact of rocks of the late Western Cascade episode from the Rider Creek area to the Katsuk Butte area (Figure 4.1; Plate 2). About 470 m (1,542 ft) of rocks of the late Western Cascade episode overlie this highland at Katsuk Butte. The highland terminates abruptly at the Cougar fault. About 792 m (2,598 ft) of the sequence of late Western Cascade age is exposed on the east side of the Cougar fault, but no older rocks are exposed. The minimum offset across the fault which could displace this highland below the lowest exposure of rocks of the late Western Cascade episode on the east block of the fault is 562 m (1,843 ft). Because the lowest exposed unit on the east block of the fault (the basaltic lavas of the East Fork) is absent from the upthrown west block, it is logical to assume that these lavas may have been present on the west block but have been removed by erosion. If they were present just above the highest point on the west block (Katsuk Butte) prior to erosion, they would have been vertically displaced 1,033 m (3,388 ft) from the lowest exposure on the east block. It is possible that the displacement exceeds this amount, if the East Fork basalt were once present on the west block at an elevation higher than Katsuk Butte.

An alternative hypothesis to the above arguments is that the paleohighland in the northwest part of the area was an isolated high flanked on both the east and south by valleys when the sequence of late Western Cascade age was deposited. This would require a thicker sequence east of the fault and cause units low in the eastern section of late Western Cascade age to pinch out to the west. This highland could have been partially formed by movements on the Cougar fault prior to or during deposition of most of the sequence of late Western Cascade age. Arguments below suggest that the 16.2-m.y. B.P. dacite intrusive of Cougar Dam was roughly contemporaneous with some movement on the Cougar fault. This supports the latter hypothesis.

Additional deep drilling on the east block of the Cougar fault will be necessary to discriminate among these hypotheses. Only then will the amount of offset on the fault be known with any certainty.

Dacite intrusive of Cougar Dam (unit Tmvic): A dark, glassy, porphyritic two-pyroxene dacite forms the east and west abutments of Cougar Dam. The dacite is a cliff-forming unit which causes a narrows on the South Fork of the McKenzie River at Cougar Dam. The unit appears to have a conformable upper contact with the tuffs of Cougar Reservoir on the west abutment but obviously intrudes and alters the tuffs in the upper contact on the east abutment. Numerous dikelike protrusions are injected along the west contact in exposures just north of the dam along U.S. Forest Service Road 19. The lower contact on the west abutment also appears to be conformable with underlying, nearly horizontal tuffaceous mudstones of the tuffs of Cougar Reservoir. No lower contact is exposed on the east abutment, where the dacite appears to be a long, dikelike mass extending about 2.74 km (1.7 mi) in a north-south- to north-northwest direction. However, abutment exploration by geologists of the U.S. Army Corps of Engineers revealed pods of pyroclastic rock within and below the intrusive at the east abutment (U.S. Army Corps of Engineers, 1964). Northwest-trending shears cut through the east abutment in several places and in some cases are filled with nearly aphyric dikes. Breccia dikes filled with comminuted wall-rock and quartz-diorite fragments also fill west-northwest-trending fissures in the east abutment. One large north-trending shear at the top of the east abutment has prominent horizontal slickensides.

Lateral contacts between the intrusion and tuffs of Cougar Reservoir on the east abutment are complex. Most contacts are very sharp and steeply dipping, but others show signs of complex interactions between the intrusion and the walls. In one locality near the top of the intrusion, rounded block-size pieces of the dacite are completely surrounded by structureless, fine-grained tuff adjacent to an obscure, steeply dipping contact. Thermal metamorphic effects on wall rocks include slight bleaching and very low-grade epithermal alteration with some iron-oxide staining, possibly from minute quantities of weathered sulfides. The intrusion is slightly discolored to a darker, more stony appearance at the contact. The general appearance of the east abutment contact is indicative of interactions between moist tuffaceous wall rocks and a highly viscous, very shallow intrusion.

A plagioclase separate from the dacite yielded a K-Ar date of 16.2 ± 1.8 m.y. B.P. (0.237 percent K, 13 percent radiogenic Ar^{40}). This corresponds to the early part of the late Western Cascade episode.

Tuffs of Rush Creek (unit Tmrt): Light-colored ash-fall, ash-flow, and epiclastic tuffs interfinger with two-pyroxene andesite flows in the lower part of the sequence of late Western Cascade age at Rush Creek. Most of the ash-flow tuffs are nonwelded, but welded tuffs crop out in three localities. In the Sugar Creek drainage west of the map boundary, a densely welded, glomeroporphyritic two-pyroxene dacite ash-flow tuff crops out at about 915-m (3,000-ft) elevation (Blue River quadrangle). This tuff can be traced into the map area near the headwaters of Rider Creek. Similar partially welded to nonwelded ash-flow tuffs without the glomeroporphyritic texture are found at about the 1,006-m (3,300-ft) elevation in road cuts on the east flank of Harvey Mountain. A densely welded two-pyroxene dacite ash-flow tuff occurs in one outcrop at about the 732-m (2,400-ft) elevation (McKenzie bridge quadrangle) at the base of the section below the above-mentioned Harvey Mountain ash-flow tuffs. Although it is possible that one of the Harvey Mountain ash-flow tuffs is the distal facies of the Sugar Creek welded tuff, no certain correlation was established for any of the ash-flow tuff units over significant distances. This may be a function of the high relief which probably characterized the area. All of these welded to partially welded tuffs pinch out to the north at Rush Creek against an old highland formed by the tuffs of Cougar Reservoir. The lower contact of the tuffs of Rush Creek is exposed at the head of Rush Creek, where the peak of this old highland is covered by the tuffs. The uppermost tuffs of Cougar Reservoir at this location are a series of gray mudflows. Pieces of the white- to cream-colored Rush Creek tuff are intermixed in the gray mudflow material at the contact. This mixture is probably a mudflow formed from rocks of the underlying sequence during Rush Creek time.

Most of the tuffs of Rush Creek are composed of light-colored hypersthene-bearing dacite pumice lapilli and ash. Welded and partially welded ash-flow tuffs are dark gray to black with eutaxitic texture. Very low-grade alteration commonly has caused glass in the nonwelded and epiclastic units to alter to clay minerals. Welded ash-flow tuffs have hydrated but otherwise unaltered glass. Broken plagioclase and subordinate orthopyroxene and clinopyroxene make up most of the crystal fraction which forms up to 10 percent of the tuffs, although minor hornblende is present in some of the rocks. The tuffs generally form low-angle slopes and serve as slip planes for major landslides throughout the western half of the map.

A nonwelded ash-flow tuff at the head of Rush Creek (976-m [3,200-ft] elevation) near the top of the tuffs of Rush Creek yielded a K-Ar date of 13.8 ± 0.8 m.y. B.P. (0.349 percent K, 26 percent radiogenic Ar^{40}) on a plagioclase separate. At the 1,447-m (4,745-ft) elevation, a sample stratigraphically above the tuffs of Rush Creek yielded a K-Ar date of 11.4 ± 0.5 m.y. B.P. (0.208 percent K, 35 percent radiogenic Ar^{40}) from a plagioclase separate. A slightly altered flow of two-pyroxene andesite stratigraphically below most of the tuffs of Rush Creek yielded a K-Ar date of 12.4 ± 2.5 m.y. B.P. (0.44 percent K, 7 percent radiogenic Ar^{40}). The alteration and low radiogenic argon of the andesite flow cast doubt on the accuracy of that date.

Basaltic lavas of the East Fork (unit Tme): Fine-grained basalt to basaltic andesite lavas crop out on both sides of the East Fork of the McKenzie River. These flows dip gently toward the south and are about 91 m (300 ft) thick. They do not crop out anywhere else in the map area. They are in fault contact with the lavas of Walker Creek to the east and are cut off by the Cougar fault on the west. They are overlain by the lavas of Walker Creek to the north and south.

One sample collected at about the 537-m (1,760-ft) elevation on the south side of the East Fork yielded a K-Ar date of 8.1 ± 2.3 m.y. B.P. (0.52 percent K, 5 percent radiogenic Ar^{40}). This date is far too young, since a lava higher in the sequence of Walker Creek has a date of 13.2 ± 0.7 m.y. B.P. The lavas are chemically and mineralogically similar to the rest of the section of late Western Cascade age, and so they are probably no older than about 16.2 m.y. They are older than about 13.2 m.y.

Andesites of Walker Creek (unit Tmw): Highly phyric two-pyroxene andesite lavas and minor debris flows crop out in a 610-m (2,000-ft) section at Walker Creek, where they are capped by the lavas of Tipsoo Butte. Lavas chemically and paleocanyon incised into the Cougar fault zone. They are not cut by the fault. The deposits also occur extensively in terraces at the junction of the South Fork with the main McKenzie River. They are probably outwash gravels from melting of Pleistocene valley glaciers.

Unconsolidated Recent colluvium (Qc), alluvium (Qal), and landslide deposits (Qls)

Colluvium, as shown on the geologic map, includes all talus and thin unconsolidated residual soils which mantle bed rock. Alluvium is unconsolidated sand and gravel in overbank deposits and beds of the current streams. Landslide deposits include slump blocks and totally disaggregated landslide debris. All of these deposits are probably Holocene in age, although some of the landslides may well have begun to occur during the Pleistocene.

STRUCTURAL GEOLOGY

Introduction

The main structure in the area is the Cougar fault (Figure 4.1; Plate 2), which cuts through the middle of the map area along a N. 5° W. trend. This very steeply dipping fault offsets the east half of the area downward relative to the west half.

Generally, the tuffs of Cougar Reservoir appear to dip a few degrees to the south or southwest, although local dips to the east, west, and northeast were also measured. Fine-grained sediments near the Cougar Dam powerhouse are horizontally bedded. The sequence of late Western Cascade age also probably dips very gently toward the south. The regional tectonic significance of the Cougar fault and other deformation in the area is discussed in Chapter 2 and is not repeated here.

Cougar fault

The Cougar fault appears to be nearly vertical with chiefly dip-slip movement. Although one north-south fault in the dacite intrusion at Cougar Dam has horizontal slickensides, all documented stratigraphic offset is dip-slip. A drill hole located about 46 m (151 ft) east of where the Cougar fault zone crops out at the mouth of Walker Creek encountered 152 m (499 ft) of the lavas of Walker Creek, whereas the tuffs of Cougar Reservoir crop out on the west side of the fault. This hole demonstrates that (1) there is at least 152 m (499 ft) of apparent dip-slip offset on the fault, and (2) the minimum easterly dip is 73°. Previously discussed stratigraphic arguments presented in the section on volcanic rocks of the early High Cascade episode suggest that the offset on the fault since about 13.2 m.y. B.P. is probably at least 427 m (1,401 ft). In the previous introductory section on late Western Cascade volcanism, various hypotheses led to estimates of displacement on the Cougar fault from 562 m (1,843 ft) to more than 1,033 m (3,388 ft), although the minimum offset which can be constrained by units of the late Western Cascade episode is the 152-m (499-ft) offset estimated from the Walker Creek hole.

The age of movements on the Cougar fault is constrained by the following observations:

1. The 16.2-m.y. B.P. Cougar Dam intrusion is immediately adjacent to the Cougar fault and is elongate parallel to the trace of the fault.
2. Breccia dikes and lava-filled dikes, probably generally related to magmatic activity during the Cougar Dam intrusive event, follow small northwest-trending faults adjacent to the Cougar fault.
3. The fault definitely cuts lavas of Walker Creek dated at 13.2 m.y. B.P.
4. If the Cougar fault or related faults extend northward into the area mapped by Swanson and James (1975), then the scarp may have been responsible for creation of lakes which caused basaltic lavas of the early High Cascade episode to be pillowed in that area. These lavas began to flow into the area about 8.34 m.y. B.P., according to a date from Lookout Ridge.
5. A fault zone essentially parallel to the Cougar fault has been mapped to the east in the upper McKenzie River and Horse Creek (Figure 4.1). This fault zone formed between 5 and 4 m.y. B.P. (Taylor, 1980; Flaherty, 1981; Taylor, personal communication, 1983).
6. The Cougar fault does not cut Pleistocene gravels overlying it at the mouth of the East Fork.
7. Unlike the McKenzie River-Horse Creek fault, the Cougar fault has no well-developed topographic scarp.

The above observations are consistent with movement on the Cougar fault shortly before 16.2 m.y. B.P. and after 13.2 m.y. B.P. If the Cougar fault or related faults caused ponding of lavas of the early High Cascade episode mapped by Swanson and James (1975), then it may have been active about 8.34 m.y. B.P. If the fault experienced additional displacement when the Horse Creek fault formed, then it may have moved between 5 and 4 m.y. B.P. Movement on the fault apparently ceased before deposition of Pleistocene outwash gravels in the area, but the exact age of the gravels is not known.

The Cougar fault also appears to have affected the pattern of gravity and aeromagnetic anomalies in the area. The west block of the fault has a complete Bouguer gravity value of about -102 mgal, whereas the east block has a value of about -110 mgal (Pitts and Couch, 1978; Pitts, 1979). The decrease in Bouguer gravity values occurs approximately along the Cougar fault. Using a reduction density of 2.43 g/cm^3, Pitts (1979) produced a residual gravity anomaly map which shows a decrease in gravity values of 6 mgal from the west block to the east block (also see Couch and others, 1982a,b). This decrease in residual gravity occurs over an east-west distance of only 3.9 km (2.3 mi), producing a very steep north-south-trending gradient. The Cougar fault follows the east side of this steep gradient. The residual and Bouguer gravity gradients continue toward the north across Lookout Ridge into the area mapped by Swanson and James (1975), suggesting that the Cougar fault also continues toward the north, which lends credence to observation number 4 above on the age of movement on the fault. The same gradients continue toward the south, where they coincide with another down-to-the-east, north-south fault in the McCredie Hot Springs area (Woller and Black, Chapter 6).

The aeromagnetic map of Couch and others (1978) also shows a steep change in the pattern of magnetism at the Cougar fault. The west block of the fault has a magnetic high of $+250$ gammas centered on Harvey Mountain, while the east block of the fault from Walker Creek to Castle Rock is characterized by a broad magnetic low of between -50 and -150 gammas. The transition between these two areas occurs at a steep north-south-trending gradient which terminates at the Cougar fault. A magnetic low along the McKenzie River to the north and an east-west-trending magnetic high at Tipsoo Butte changes the north-south pattern of contours. The north-south pattern, however, appears to reestablish itself north of Lookout Ridge in the area mapped by Swanson and James (1975).

Local tilting and folding

There is no evidence of a major fold in the area. Wells and Peck (1961) plotted the axis of the Breitenbush anticline a few kilometers west of the map area, but the general easterly dip of 10° to 20° inferred from their map could not be demonstrated in the map area. Dips measured in the section of early and late

WELCOME TO THE QUARTZVILLE RECREATION CORRIDOR

Landowners, land managers, and others are keeping the Quartzville Corridor open to recreational mining use as well as other recreational uses. The Quartzville Corridor starts at the Rocky Top Road (Road 12-3E-16, which crosses an arm of the Green Peter Reservoir) and prceeds upstream about 19.5 road miles to Freezeout Creek Road (Road 1152). The Quartzville Corridor includes Quartzville Creek, the land between the creek and the Quartzville Road, and the Boulder Creek crushed-rock stockpile site. A map showing the corridor, developed parks, and the Quartzville mining district and townsite is printed along with a brief history of the Quartzville mining district on the reverse side of this sheet.

Corridor guidelines:

1. Camping within the corridor is limited to a maximum of 16 days per 30-day period.

2. Camping is limited to the developed campground, and the area between the Quartzville Road and Quartzville Creek, and the Boulder Creek crushed-rock stockpile site.

3. Please be careful with campfires. An untended and/or unsafe fire is a violation of both Federal and State law. *Report wild fires to State Forestry, phone (503) 367-6108.*

4. Do not discharge firearms within the Quartzville Corridor.

5. Help keep the Corridor clean. If you pack it in, pack it out.

6. Dumping of recreational vehicle holding tanks at other than approved facilities is against both Federal and State law. There are facilities for emptying the tanks in Sweet Home.

7. There is no land open for staking a mining claim within the Corridor. From map point A (Rocky Top Road Bridge, Road 12-3E-16), to map point B (Galena Creek Road Bridge, Road 805), fishing, camping, picnicking, and recreational mining are allowed. From map point B to map point C (Freezeout Creek Road, Road 1152), recreational mining is *not* permitted because of existing mining claims.

8. Most forms of placering, including the use of a 5-inch suction dredge, can be used within the Corridor between map points A and B. Hydraulic mining of the stream banks is *not* permitted.

9. Watch how much muddy water is being produced. Help the person down stream. State law limits the muddy water plume. Use good mining manners.

The following organizations are co-operators in this effort, questions about the management and resources of the Corridor may be addressed to them:

1. Linn County Parks Department, 3010 Ferry S.W., Albany, Oregon 97321, phone (503) 967-3917.

2. U.S. Bureau of Land Management, P.O. Box 3227, Salem, Oregon 97302, phone (503) 399-5646.

3. Champion International Corporation, 3213 S. Santiam Highway, Lebanon, Oregon 97355, phone (503) 451-1460.

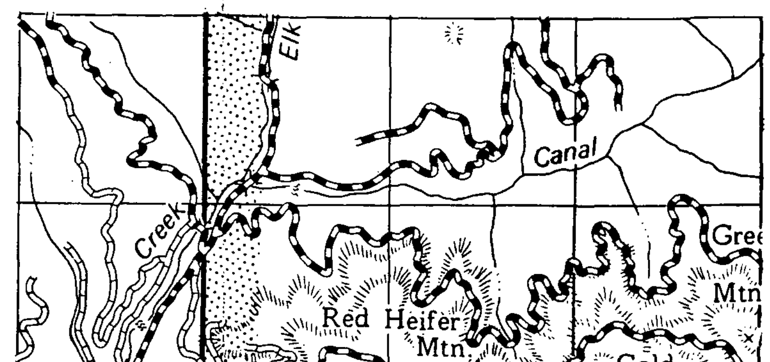
4. City of Sweet Home, 1730 N. 9th, Sweet Home, Oregon 97386, phone (503) 367-6977.

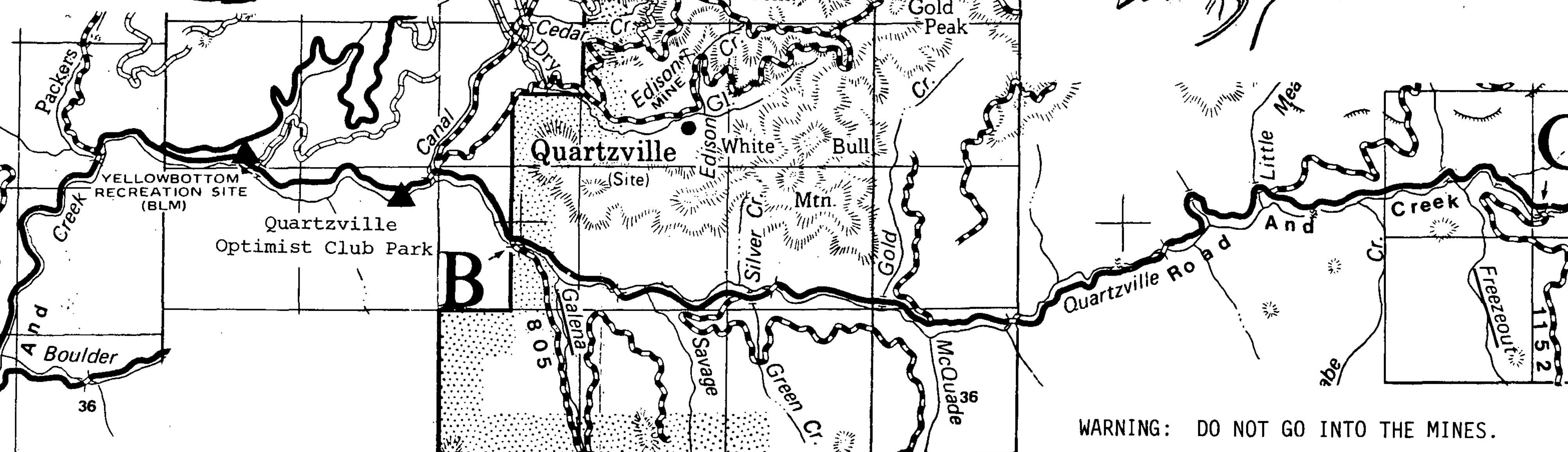
5. U.S. Forest Service, 4431 Highway 20, Sweet Home, Oregon 97386, phone (503) 367-5168.

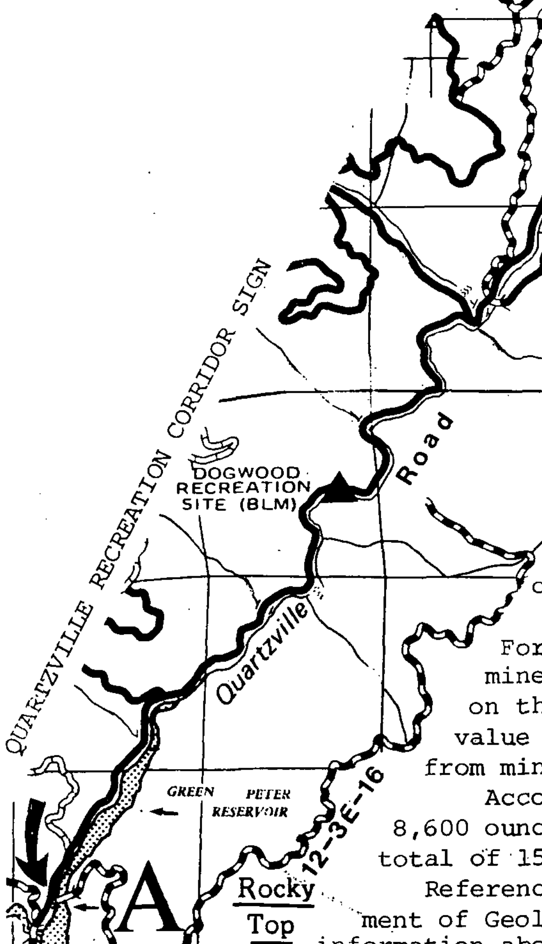
6. Oregon State Forestry Dept., 4690 Highway 20, Sweet Home, Oregon 97386. *Report fires here. Phone (503) 367-6108.*

7. Western Mining Council, Gerald Ullman, 122 Chemawa Road N., Keizer, Oregon 97303, phone (503) 390-3497. Note--the Council meets on the second Friday of the month, September through June, at 8:00 p.m. at the Senior Citizens Center, 585 Park, Lebanon, Oregon. Visitors are welcome.

QUARTZVILLE RECREATION CORRIDOR
GUIDELINES, HISTORY, AND MAP







WARNING: DO NOT GO INTO THE MINES.

QUARTZVILLE MINING HISTORY

The Quartzville mining district has been the site of both hard-rock and placer mining for gold since the mid-1800's. Dr. E.O. Smith is credited with original discovery of lode gold in the district. Jeremiah Driggs located the first claims, the White Bull and Red Bull claims, on September 5, 1863; and a mining district was organized in 1864. Several large stopes in the Lawler Mine and a small stope in the Albany Mine were worked, and mills were installed in the early 1890's. Although most hard-rock mining operations ceased by 1900, prospectors have kept the district active by continuing to recover small quantities of gold from pockets.

Gold has also been recovered from placer deposits. Gravel bars along the Quartzville Creek drainage and parts of the Middle Fork of Santiam River were placered in the middle 1800's and again the in 1930's. In the early 1930's during the depression, miners using hand-placering mining equipment were able to recover enough gold to survive. During 1935, eleven mines were worked on three creeks in Linn County. That year small-scale gold miners in Oregon sold gold with a total weight of 4,021 ounces and value of $140,730 to bullion to buyers. Average daily gross income for all miners was $1.19 per day, and the average annual income from mining was $44, since miners worked an average of 37 days per year. Small-scale placer mining has continued to the prsent.

According to U.S. Mint reports and U.S. Bureau of Mines data, from 1884 to the present, the Quartzville district has produced about 8,600 ounces of gold and 3,000 ounces of silver. Unofficial estimates add another 6,400 ounces of gold and 2,000 ounces of silver, for a total of 15,000 and 5,000 ounces respectively.

Reference-- Gray, J.J., 1977, A geological field trip guide from Sweet Home, Oregon, to the Quartzville mining district: Oregon Department of Geology and Mineral Industries, 1005 State Office Building, Portland, OR 97201, The Ore Bin, v. 39, no. 6, p. 93-108. Detailed information about the Quartaville mining district may be obtained from the Western Mining Council (see other side of this sheet).