STUDIES RELATED TO WILDERNESS

# COUGAR LAKES–MOUNT AIX AREA, WASHINGTON

GEOLOGICAL SURVEY BULLETIN 1504

# Mineral Resources of the Cougar Lakes-Mount Aix Study Area, Yakima and Lewis Counties, Washington

*By* GEORGE C. SIMMONS, U.S. GEOLOGICAL SURVEY,
*and by* RONALD M. VAN NOY *and* NICHOLAS T. ZILKA,
U.S. BUREAU OF MINES,
*With a Section on*
INTERPRETATION OF AEROMAGNETIC DATA
*By* WILLARD E. DAVIS, U.S. GEOLOGICAL SURVEY

STUDIES RELATED TO WILDERNESS—WILDERNESS AREAS

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GEOLOGICAL SURVEY BULLETIN 1504

*An evaluation of the mineral potential of the area*

*Summary and Chapters A and B*

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UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1983

UNITED STATES DEPARTMENT OF THE INTERIOR

WILLIAM P. CLARK, *Secretary*

GEOLOGICAL SURVEY

Dallas L. Peck, *Director*

Library of Congress Cataloging in Publication Data
United States. Geological Survey.
Mineral resources of the Cougar Lakes–Mount Aix study area, Yakima and Lewis Counties, Washington.

(Studies related to wilderness— wilderness areas)
(Geological Survey Bulletin 1504)
Includes bibliographical references.
Supt. of Docs. no.: I 19.3:
CONTENTS: A. Simmons, G. C., and Davis, W. E.
Geology and interpretation of aeromagnetic data of the Cougar Lakes–Mount Aix study area, Yakima and Lewis Counties, Washington.—B. Van Noy, R. M., Zilka, N. T., and Simmons, G. C. Mines, prospects, and mineralized areas, and geochemistry of the Cougar Lakes–Mount Aix study area, Yakima and Lewis Counties, Washington.
1. Mines and mineral resources—Washington (State)—Yakima Co. 2. Mines and mineral resources—Washington (State)—Lewis Co. I. United States Bureau of Mines. II. Title. III. Series. IV. Series: United States Geological Survey Bulletin 1504.
QE75.B9 no. 1504 [TN24.W2] 557.3s [553'.09797'55] 80-607129

For sale by the Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

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STUDIES RELATED TO WILDERNESS—WILDERNESS AREAS

# MINERAL RESOURCES OF THE COUGAR LAKES-MOUNT AIX STUDY AREA, YAKIMA AND LEWIS COUNTIES, WASHINGTON

By GEORGE C. SIMMONS, U.S. GEOLOGICAL SURVEY, and
RONALD M. VAN NOY and NICHOLAS T. ZILKA,
U.S. BUREAU OF MINES

## SUMMARY

The Cougar Lakes-Mount Aix study area covers approximately 260 square miles (670 square kilometers), chiefly along and east of the crest of the Cascade Range, adjacent to the east side of Mount Rainier National Park in the State of Washington. The area is south of the Summit mining district and includes part of the Bumping Lake (Miners Ridge) mining district. Most of the terrain consists of steep, densely wooded mountains and valleys, but it also includes alpine lakes, peaks and ridges above timberline, and a large plateau on the crest of the Cascade Range. A mineral survey was made by the U.S. Geological Survey and the U.S. Bureau of Mines to assist in determining the suitability of this area for inclusion in the Wilderness System.

The mineral survey included reconnaissance geologic mapping and geochemical sampling, detailed studies of mining claims, an aeromagnetic survey, and a brief study of the geothermal potential. The geochemical sampling program consisted of the collection and analysis of 2,365 samples. Stream-sediment samples were collected from all major and most minor streams; some streams were panned to check their heavy mineral content, particularly for gold. Rock samples were collected along all major ridges and many minor ridges, slopes, and valley bottoms. Waters from several springs were tested for indications of geothermal activity. Detailed mapping and extensive sampling were carried out near mines and areas of potential mineral deposits.

Most of the study area is underlain by rocks of volcanic and intrusive origins, but perhaps 10 percent of the area is underlain by older sedimentary rocks. The sedimentary rocks and older volcanic rocks were intruded by granitic rocks and then by rhyodacite. Most of the mineralization in the area is associated with these intrusive rocks. Following intrusion and mineralization, the area was alternately eroded and partly covered during three periods of volcanism.

The Cougar Lakes-Mount Aix study area may contain deposits of copper, mercury, manganese, and zinc; but the best potential for a large ore body is near Mesatchee Creek in an area that is presently (1973) being explored for copper.

A small amount of mercury was produced from the Red Spur mine and small shipments of manganese ore reportedly have been made from the Fig property, both located in the southeast part of the study area. The mercury occurrences now exposed are submarginal, but the vicinity has the potential for the discovery of other small deposits. Manganese ore is found in several pits in an area 1,000×6,000 ft (300×1,830 m), but the continuity of the ore is unknown.

A potential zinc resource exists on the Blackjack group of claims near little Twin Sister Lake. Surface sampling indicates 4.0 percent zinc over a 4.0-ft (1.2-m) wide zone exposed for a strike length of 160 ft (50 m). Flooded workings prevented the determination of mineralization at depth.

The principal workings in the Bumping Lake district are just outside of the study area, but that part within the study area could conceivably contain small economic mineral deposits. Copper, silver, and tungsten were mined from the northwest-striking shear zones that extend toward the crest of Miners Ridge and could possibly continue into the study area.

The area may have a geothermal reservoir as it contains basaltic lava flows and a cinder cone of late Tertiary and Quaternary ages, and analyses of cold spring waters at the surface suggest that hot water at about 160°C may be at fairly shallow depth.

## INTRODUCTION

The Cougar Lakes-Mount Aix study area, a proposed wilderness, covers approximately 260 mi² (670 km²) near the crest of the central Cascade Range, and includes parts of the Snoqualmie and Gifford Pinchot National Forests in Yakima and Lewis Counties, Wash., respectively (fig. 1). The area is south and west of the Chinook Pass highway (Washington 410), north of the White Pass highway (U.S. 12), and is bounded on the west by Mount Rainier National Park. A recreation area around and south of Bumping Lake is surrounded by the study area and is reached by road along an access corridor from the northeast along the Bumping River. The settlement of Goose Prairie is located in the access corridor about 2 mi (3 km) from the lake.

The study area has been eroded by alpine glaciers (fig. 2) and is rugged, but it is not as precipitous as the northern Cascade Range. The highest peak is Mount Aix, 7,766 ft (2,367 m) (fig. 3), and the altitude at Goose Prairie on the Bumping River is 3,266 ft (995 m); thus, the region has a total relief of about 4,500 ft (1,400 m).

The entire area is in the drainage basin of the Columbia River. The larger part of the area, east of the crest of the Cascade Range, is drained by the American, Bumping, and Tieton Rivers, tributaries of the Naches River. The Naches flows into the Yakima River, which joins the Columbia near Richland, Wash. The smaller part of the area, west of the crest of the Cascades, is drained by tributaries of the Cowlitz River, which enters the Columbia near Longview, Wash.

Autumn, winter, and spring are usually cool and wet; summers are commonly temperate and dry. At Bumping Lake the annual precipitation averages 44 in. (112 cm), two-thirds of which falls as 300 in.

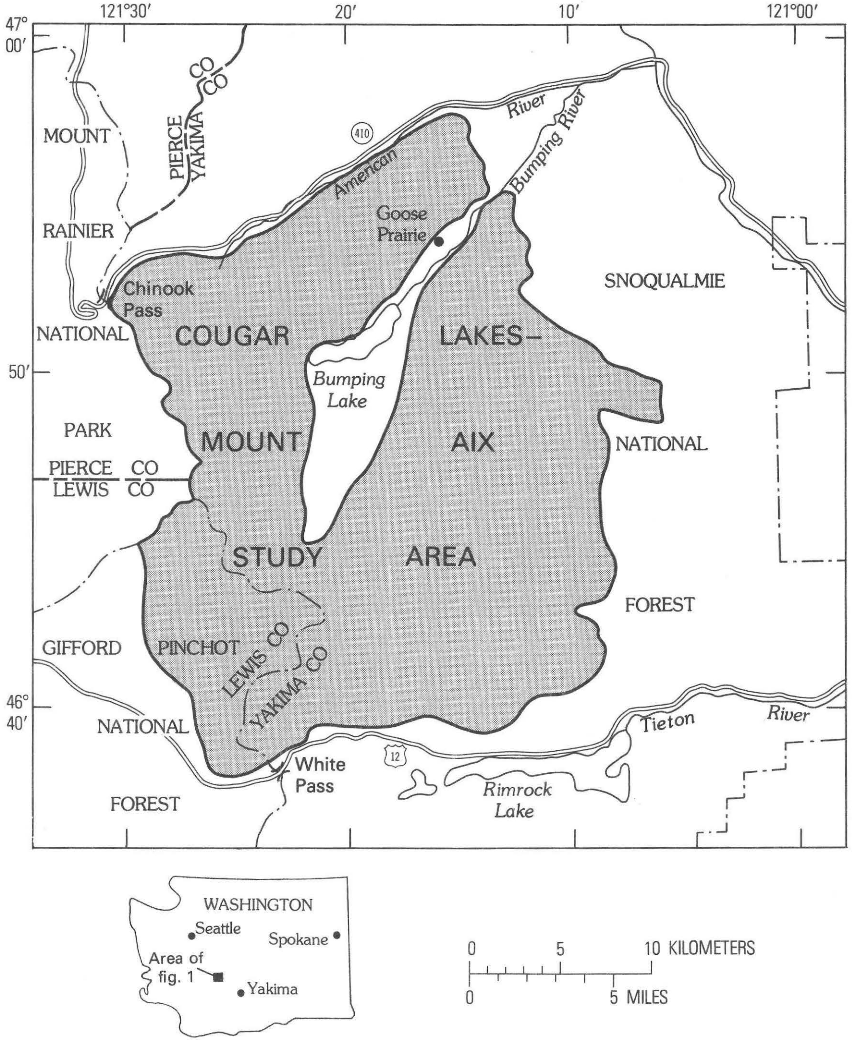


FIGURE 1.—Index map of the Cougar Lakes-Mount Aix study area.

(762 cm) of snow; precipitation is greater at the higher elevations that prevail over most of the area. The mean annual temperature at Bumping Lake is 41 °F.

## PREVIOUS INVESTIGATIONS

No comprehensive studies of the Cougar Lakes-Mount Aix region have been published, but some reports concerning areas to the north (Smith and Calkins, 1906), northeast (Smith, 1904), and east (Smith,

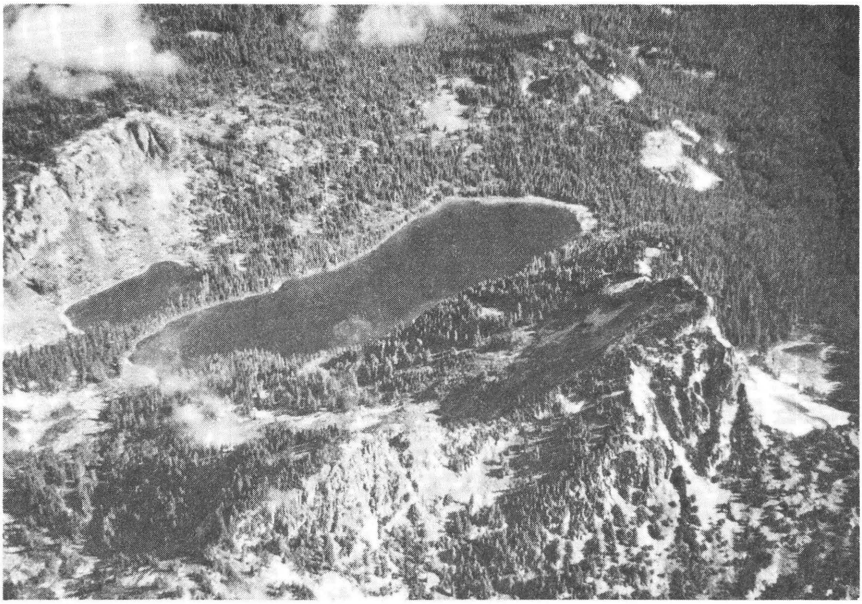

FIGURE 2.—Cougar Lake and Little Cougar Lake, tarns eroded by Pleistocene glaciers. Aerial view to northeast.

1903) were useful in obtaining an understanding of the local geology, as were the studies by Coombs (1936) and Fiske, Hopson, and Waters (1964) on Mount Rainier National Park. Some of the stratigraphic work of Warren (1936, 1941) dealt with rocks in the eastern part of the study area. Other published works, mostly concerning mineral prospects, are cited in the present study.

Prior investigations were made by the U.S. Bureau of Mines of several mineral properties. The U.S. Department of the Interior (1966) investigated the effects that raising the level of Bumping Lake would have on existing mine workings. The U.S. Bureau of Mines and the U.S. Geological Survey investigated properties for the Defense Minerals Exploration Administration (DMEA) during the 1950's. Moen (1969) took spot geochemical samples at major stream intersections in the Cascade Range and reported some anomalous metal values in the study area.

A comprehensive thesis by Abbott (1953), which contains a geologic map of much of the study area, and a report by Moen (1962) were very helpful in planning the field work. Abbott's map was used as the basis for interpreting the geology shown on plate 1 in the vicinity of Old Scab Mountain east of Goose Prairie.

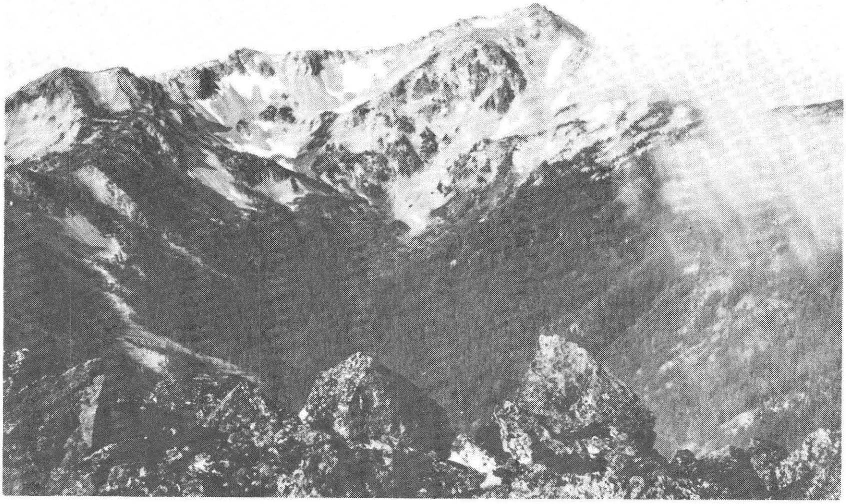

FIGURE 3.—Mount Aix, 7,766 ft (2,367 m), highest peak in the Cougar Lakes-Mount Aix study area. View southwest from the summit of Nelson Butte.

## PRESENT STUDY AND ACKNOWLEDGMENTS

The purpose of this study is to evaluate the mineral potential of the proposed wilderness area. Field studies by the U.S. Geological Survey consisted of reconnaissance geochemical sampling and geologic mapping carried out during July and August 1973 by George C. Simmons, assisted by Richard D. Andrews, James D. O'Brient, and Arthur P. Pierce, and by Simmons for 1 week during December 1973. Rock, stream-sediment, and panned-concentrate samples were systematically collected on foot and ski traverses, principally along ridges and valley bottoms, and a few water samples were taken to test the geothermal potential. Geologic data collected on the traverses were compiled to make the geologic map (pl. 1). Transportation by helicopter enabled us to cover most of the area during the summer, and a snowmobile was used during the winter. A total of 2,365 samples was collected, of which 1,541 are rock samples, 779 are stream-sediment samples, 37 are panned-concentrate samples, and 8 are water samples.

The samples of rock material were analyzed in a mobile laboratory. They were analyzed for 30 elements—iron, magnesium, calcium, titanium, manganese, silver, arsenic, gold, boron, barium, beryllium, bismuth, cadmium, cobalt, chromium, copper, lithium, molybdenum, niobium, nickel, lead, antimony, scandium, tin, strontium, vanadium, tungsten, yttrium, zinc, and zirconium—by a semiquantitative spectrographic method by K. J. Curry and E. F. Cooley; for gold by atomic absorption by A. J. Toevs; and for mercury using a mercury detector by A. L. Meier, J. D. Hoffman, and C. A. Curtis. Ten samples showing high mercury contents were reanalyzed by atomic absorption by J. G. Frisken. Seventy-six rock samples were tested for zinc by atomic absorption by A. J. Toevs, and for antimony by colorimetric methods by R. L. Turner. All samples were scanned for radioactivity by K. J. Curry and E. F. Cooley, and 25 rock samples were checked for equivalent uranium by instrument by J. C. Negri. The water samples were analyzed at the Menlo Park, Calif., laboratory of the U.S. Geological Survey by J. M. Thompson. The sample data were edited by C. M. McDougal for computer storage; L. O. Wilch, G. H. Alcott, R. J. Smith, and S. K. McDanal assisted in planning computer retrievals.

Studies by the U.S. Bureau of Mines was made during 1973 by Ronald Van Noy and Nicholas Zilka, assisted by Paul Pierce and Andrew Leszcykowski, Jr. A total of 8½ man-months was spent in the field. The Bureau's analytical work was directed by H. H. Heady, U.S. Bureau of Mines, Reno, Nev. Individual mines and prospects were investigated in the field. Records of mining claims and their locations were obtained from the Yakima and Lewis County courthouses, Yakima and Chehalis, Wash. Production records are mostly from Bureau of Mines statistical files, compiled from 1902 to the present; other sources are acknowledged in the text.

A total of 284 lode samples averaging 5–10 pounds (2.3–4.5 kg) each was collected. The samples were checked for the presence of radioactive and fluorescent minerals in the laboratory. All samples were fire-assayed for gold and silver. Other metallic elements were determined by atomic absorption, colorimetric, or X-ray fluorescent methods. At least one sample from each property or mineralized zone was analyzed by a semiquantitative spectrographic method. If an anomalous amount of a valuable element was indicated by spectrographic analysis, the sample was further analyzed by a more precise method.

A geochemical survey was made at the Red Spur mine. A total of 359 half-pound (0.2-kg) soil samples was taken. Each was screened to minus-80 mesh and then analyzed by a combustion absorption method that has a detection limit of less than 0.1 ppm mercury.

Samples from a group of placer claims were screened and then concentrated using a Wilfley table. The placer concentrates were fire-assayed for gold and silver.

We appreciate the cooperation of various claimholders, local residents, and U.S. Forest Service personnel. We especially appreciate the help given us by Ira Ford of Goose Prairie, Wash., and by personnel of Burlington Northern, Inc., and Duval International Corp.

## BASE MAP AND SAMPLE LOCALITIES

The study area is covered by parts of five topographic maps: Mount Rainier National Park, special map, 1:62,500, 1910; Bumping Lake 15′ quadrangle, 1:62,500, 1962; Mount Aix 30′ quandrangle, 1:125,000, 1910; White Pass 15′ quadrangle, 1:62,500, 1962; and Rimrock Lake 7½′ quadrangle, 1:24,000, 1967. The base map (scale 1:62,500) for plates 1, 2, and 3 consists of parts of these maps. Preliminary copies of new 7½′ quadrangle maps of the Mount Aix quadrangle were used in the field, but were not available for compilation of the base map.

Localities for all samples collected by the U.S. Geological Survey are shown on plate 2. Localities for rock and stream-sediment samples containing anomalous amounts of certain elements are shown on plate 3, and the analytical data for these samples are listed in tables 2 and 3. Localities for water samples, panned concentrates, and samples from mines, dumps, and prospects are also shown on plate 3, and analytical data for these samples are listed in tables 1, 4, and 5, respectively.

The samples listed in the tables and shown on plates 2 and 3 are located on a 10,000-foot grid that constitutes a coordinate system. The intersection of X17 and Y18 coincides with the intersection of lat 46°50′ N. and long 121°20′ W. Where a group of samples is discussed in the text, it is referred to the block in which it occurs by abbreviated coordinates of the southwest corner of the block; thus, block X15–Y16 is the 10,000-foot square whose southwest corner has the coordinates X15 and Y16.

# Geology of the Cougar Lakes–Mount Aix Study Area, Yakima and Lewis Counties, Washington

*By* GEORGE C. SIMMONS, U.S. GEOLOGICAL SURVEY,
*With a Section on*
INTERPRETATION OF AEROMAGNETIC DATA
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MINERAL RESOURCES OF THE COUGAR LAKES-MOUNT AIX STUDY AREA, YAKIMA AND LEWIS COUNTIES, WASHINGTON

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MINERAL RESOURCES OF THE
COUGAR LAKES-MOUNT AIX STUDY AREA
YAKIMA AND LEWIS COUNTIES, WASHINGTON

# GEOLOGY OF THE COUGAR LAKES-MOUNT AIX STUDY AREA, YAKIMA AND LEWIS COUNTIES, WASHINGTON

By GEORGE C. SIMMONS, U.S. Geological Survey
With a Section on
Interpretation of Aeromagnetic Data
By WILLARD E. DAVIS, U.S. Geological Survey

## GEOLOGIC HISTORY

The rocks of the Cougar Lakes-Mount Aix study area consist of sedimentary, volcanic, and intrusive rocks; most are of Cenozoic age but a few are of Mesozoic(?) age. The oldest rocks are argillite, graywacke, basalt flows, sandstone, arkose, conglomerate, and shale of Mesozoic(?) age that were folded into a series of north-trending folds, slightly metamorphosed, and eroded prior to the deposition of the Puget Group of Eocene age. The Puget Group is made up of shale, arkose, sandstone, and carbonaceous shale. It is conformably overlain by, and the upper part is locally intercalated with, the Ohanapecosh Formation of Eocene age. The Ohanapecosh is composed mostly of tuff, breccia, and flows, chiefly of andesitic composition.

Near the end of the Eocene, the pre-Puget rocks, Puget Group, and Ohanapecosh Formation were uplifted and gently folded in a broad anticlinorium, the axis of which is approximately parallel to and a few miles east of the present crest of the Cascade Range. A brief interval of erosion followed, and then, during late Eocene and Oligocene time, the older rocks were partly covered by the Fifes Peak Formation and intruded by plugs, dikes, and sills of andesite porphyry.

Uplift of the anticlinorium was rejuvenated during the Miocene, this time accompanied by the emplacement of a batholith of granite and granodiorite and the intrusion of plugs of diorite, and then by the intrusion of stocks, dikes, and sills of rhyodacite. The pre-Puget rocks, Puget Group, and Ohanapecosh Formation were fractured and sheared along zones trending northwest to west northwest. The present extent of the Fifes Peak Formation is east of the intrusive rocks where it was neither intruded nor sheared, although several large normal faults that offset the Fifes Peak Formation and the older rocks may have been active at this time.

Most of the mineralization in the area is associated with or resulted from the intrusion of the granitic rocks and rhyodacite. Concentrations of metallic elements occur as disseminated bodies in and adjacent to the intrusive rocks and as vein filling in some of the northwest- to west-northwest-trending shear zones. Small amounts of copper, mercury, and tungsten have been mined from these deposits. A small amount of manganese of uncertain origin has also been produced in the area.

During the Miocene, while the Yakima Basalt Subgroup was being extruded onto the Fifes Peak Formation to the east, and during part of the Pliocene, the study area was uplifted and eroded. Probably during the Pliocene, when the present drainage pattern was partly developed, andesite flows were extruded from several centers and flowed into the drainage system. Later, probably during the Pleistocene, when the valleys had developed a configuration much like that of the present day, basalt flows accumulated to form a plateau on the crest of part of the Cascade Range and flowed into adjacent valleys. The glaciated basalt plateau is capped by a postglacial basalt cinder cone.

## MESOZOIC(?), TERTIARY, AND QUATERNARY SEDIMENTARY AND EXTRUSIVE IGNEOUS ROCKS

### MESOZOIC(?) ROCKS

The oldest rocks in the study area are argillite, graywacke, and greenstone, basalt flows, and some sandstone, arkose, conglomerate, and shale, all of Mesozoic(?) age. The rocks crop out in the southeastern part of the area on Russell Ridge and in the drainages of Rattlesnake, Hindoo, and Wildcat Creeks (pl. 1). The best exposures are at the base of Russell Ridge in roadcuts along the north side of Rimrock Lake, just south of the study area boundary. There, a measured partial section is 9,500 ft (2,900 m) thick (Simmons, 1950), but only a small fraction of that thickness is present within the study area.

The sedimentary rocks occur in intercalated lenses ranging in thickness from less than an inch to several tens of feet (1 cm–10 m) and in lateral dimensions from less than an inch to more than a thousand feet (1 cm–300 m). The graywacke is greenish gray to gray and fine to very fine grained; it contains abundant angular and subangular quartz clasts and accessory feldspar and rock fragments in a chloritic matrix. The graywacke is cut by numerous closely spaced joints, many of which are coated by calcite. The argillite contains the same constituents as the graywacke with which it intergrades; the most common variety is a greenish-gray rock, composed chiefly of chlorite and containing about 20 percent of silt-sized clasts of quartz.

The greenstones interbedded with the sedimentary rocks are metamorphosed spilite flows. These metabasalts appear dense in hand samples, but microscopic examination reveals an original porphyritic texture of sodic plagioclase phenocrysts in a groundmass of fine-grained ferromagnesian minerals that are completely altered to chlorite.

The pre-Puget rocks were folded into north-trending anticlines and synclines, were slightly metamorphosed, and then were eroded prior to the deposition of the Puget Group. However, owing to similarities in lithology and poor exposures, the unconformable contact between the pre-Puget rocks and the Puget Group was not mapped, and the two rock units are combined into a single one on the geologic map (pl. 1).

## PUGET GROUP

The Puget Group of Eocene age consists of arkosic sandstone and conglomerate, siltstone, and shale. In addition to its occurrence in the areas mentioned for the pre-Puget rocks, the Puget Group crops out in two other principal areas, near the head of the Bumping River and north of Twin Sisters Lakes. The group also crops out in three small areas on the north side of Bumping Lake, near the north end of Nelson Ridge, and on the west side of White Pass (pl. 1). Because of the scattered distribution of the Puget Group and the difficulty of correlating the rocks from place to place, the thickness of the group is indeterminable. The thickest individual section, near Carlton Pass at the head of the Bumping River, has a calculated thickness of 900 ft (274 m).

The arenaceous rocks in the Puget Group range in grain size from siltstone to pebble conglomerate. Fresh and slightly weathered rocks are shades of brown, whereas weathered and more friable rocks are medium to light gray. Most of the rocks are poorly sorted and massively bedded, but thin-bedded and crossbedded units are also present. The principal constituents are angular to subrounded clasts of quartz and feldspar. Muscovite is abundant at many places, and black opaque heavy minerals make up about 2 percent of the rocks. Carbonaceous material is present in some sandstone.

The argillaceous rocks consist of dark-grayish-green and medium- to dark-gray shales, the colors depending upon the amount of carbonaceous material. Some shales contain clasts of quartz, either concentrated in thin laminae or disseminated; the shales grade into siltstone and sandstone.

The Puget Group is conformably overlain by the Ohanapecosh Formation, and the two units intertongue with each other locally.

### OHANAPECOSH FORMATION

The Ohanapecosh Formation of Eocene age is widely distributed and underlies about one-third of the study area (pl. 1). Most of the formation is interlayered andesitic tuffs, breccias, and flows, but a large variety of pyroclastic and flow rocks of other compositions as well as a few sedimentary rocks are also present. The maximum thickness of the formation is estimated to be more than 3,000 ft (900 m).

Most of the tuff and breccia are pale green, light green, or brilliant green, but shades of red and brown are also common. The principal constituent of the tuff is plagioclase in crystals about 1 mm long. Fine-grained potassium feldspar, quartz, and chloritized pyroxene are present in many samples. As the proportion of rock fragments increases, the tuff grades into breccia. The breccia fragments consist of a variety of volcanic rocks: (1) fine-grained and porphyritic andesite and basalt that resemble flow rocks in the formation; (2) tuff, pumice, and scoria; and (3) volcanic glass. The fragments are angular and range from microscopic- to fist-sized or large pieces. Some tuff and breccia are in beds 1–3 ft (0.3–0.9 m) thick, but other beds are more massive. Thin-bedded rocks are usually crossbedded, indicative of reworking by water.

Andesite-porphyry flows occur throughout the Ohanapecosh but are most numerous in the vicinity of Mount Aix. The rock is gray or greenish gray on fresh surfaces and weathers to shades of brown. Plagioclase phenocrysts, mostly about 5 mm long but ranging in length from 1 mm to 1 cm, occur in a fine-grained groundmass of plagioclase and pyroxene. Some flows contain small phenocrysts of pyroxene and biotite, and others, more properly designated as dacite, contain quartz. Weathering of some flows produces a distinctive rock in which the chalky-white phenocrysts of plagioclase contrast with the darker matrix.

Another type of andesite flow, common in the northwest part of the study area, is light to dark gray, weathers to shades of brown, and is fine to very fine grained. A few small crystals of plagioclase and pyroxene can be observed with the aid of a hand lens.

The Ohanapecosh also contains other flow and pyroclastic rocks, chiefly andesites, dacites, basalts, and rhyolites, and thin beds of sandstone, siltstone, and shale, some of which contain fossilized logs and fragments of plants.

The Ohanapecosh Formation was flexed into gentle, open folds and eroded prior to the extrusion of the Fifes Peak Formation, from which it is separated by an angular unconformity. Where the formations are juxtaposed near fold axes, their discordance is not apparent, but elsewhere the relation is clear.

### FIFES PEAK FORMATION

The Fifes Peak Formation of Eocene age crops out in the north and along the east edge of the study area. The formation is chiefly composed of andesite flows but locally contains thick beds of tuff and breccia. It is well exposed on Goat Peak in the north part of the study area, and on the north side of the North Fork of Rattlesnake Creek (pl. 1). At Goat Peak an incomplete section is estimated to be more than 2,500 ft (750 m) thick.

The flows that make up most of the Fifes Peak are vesicular, basaltic andesite. Slight weathering of this rock produces dark-brown shades; the medium- to dark-gray colors of fresh rock are seen only in the centers of large newly fractured blocks. Although some flows are fine grained, most are porphyritic and contain glassy phenocrysts of plagioclase that weather to chalky-appearing clay; pyroxene phenocrysts occur in some flows. The flows range in thickness from a few feet to several tens of feet (3–20 m), and columnar jointing is common in the thicker flows.

The breccias in the Fifes Peak are varicolored, mostly shades of gray, purple, and red, and consist of angular to subrounded rock fragments cemented by ash. The rock fragments are commonly a few inches in maximum dimension, rarely as much as a foot long, and are mostly andesite porphyry, pumice, and glass. With a decrease in rock fragments, the breccias grade into buff and tan tuffs that are made up mostly of subrounded plagioclase crystals, less than 1 mm long, as well as a few pebble-sized fragments. Pieces of petrified wood and carbonized vegetal matter are locally present. Most of the tuff is weakly indurated, and some is very friable. Bedding is conspicuous at some places, but at others the tuff is massive.

The Fifes Peak Formation had been eroded but apparently not deformed by the time the Yakima Basalt Subgroup was extruded. The

Yakima, of Miocene age, disconformably overlies the Fifes Peak a few miles east of the study area, and it is possible that it once existed within the study area; if so, it was completely eroded. The Yakima Basalt Subgroup is mentioned here because it is overlain by andesite flows that are similar to flows within the study area, and therefore provides a clue to the age of these flows.

## ANDESITE FLOWS

Andesite flows and a few basalt flows of Pliocene(?) or Pleistocene(?) age were extruded from several centers: (1) Spiral Butte and possibly Cramer Mountain in the southwest part of the study area; (2) an area west of Carlton Pass on the southwest side of the headwaters of the Bumping River; (3) an area on the west side of Deep Creek; and (4) an undetermined source near Swamp Lake (pl. 1). Flows from the last two places probably joined and extended down the Bumping River to Goose Prairie.

The andesites are mostly light to medium gray and dense to very fine grained. The chief minerals are too fine grained to be observed with a hand lens, but were identified in thin sections as plagioclase, which makes up more than three-quarters of the rock, hornblende, and magnetite. A few phenocrysts of forsterite were recognized in hand specimens. Some of the andesite, particularly that near Spiral Butte, is light pink, a color imparted by abundant disseminated hematite.

## BASALT FLOWS

Basalt flows, probably of Pleistocene age, form a plateau on the crest of the Cascade Range near Tumac Mountain in the southwest part of the study area. The flows extend from the plateau in three directions: (1) northeast, down the valley of the upper Bumping River; (2) west, down the valley of Summit Creek; and (3) southeast, into the drainage of the Tieton River (pl. 1). The rocks are extensively exposed on the plateau, but are mostly covered in the valleys.

Many flows are vesicular and faintly flow layered; others are nonvesicular and well banded. The latter rocks fracture into plates along the flow layers. The fresh basalts are medium to dark gray and dense to very fine grained. Weathering produces a light- to medium-gray rock or one with salt-and-pepper appearance.

The principal minerals in the basalts are plagioclase, pyroxene, olivine, and magnetite. Olivine forms small crystals in some of the dense basalts and is the only mineral that can be identified with a hand lens; it is also the coarsest constituent in the fine-grained flows, occurring in small, pale-olive-green crystals or crystal clusters as much as several millimeters in diameter. Individual crystals of plagioclase, pyroxene, and magnetite can be observed with a hand lens in some of the fine-grained basalts. Some rocks contain enough magnetite to deflect a compass needle.

### BASALT CINDER CONE

A basalt cinder cone, Tumac Mountain, of Holocene age overlies the basalt plateau. The cone, first described by Abbott (1951), is elliptical in plan, has diameters of about 4,000 and 3,000 ft (1,200 and 900 m) at its base, and is 700 ft (200 m) high. The cone has a partly breached double crater about 500 ft (150 m) deep.

Tumac Mountain is composed of brick-red and dark-gray cinders, a few thin, dark-gray basalt flows, and small volcanic bombs. All of the rocks are basaltic and dense or glassy; a few small plagioclase phenocrysts are present in some samples, but no other minerals are visible.

## TERTIARY INTRUSIVE ROCKS

### ANDESITE PORPHYRY

Andesite plugs, dikes, and sills of Eocene age, probably the same age as the Fifes Peak Formation, are chiefly basaltic andesite porphyry, but also include basalt, basalt porphyry, diorite, and gabbro. They are most abundant in the eastern part of the area where they intrude the Mesozoic(?) pre-Puget rocks, Puget Group, and Ohanapecosh Formation. Because of their intrusive relations with these older rocks and their similarity in composition and appearance to the flows in the Fifes Peak Formation, the andesite-porphyry intrusives are considered to be the hypabyssal equivalents of the Fifes Peak Formation. A few dikes of andesite porphyry occur in the Fifes Peak Formation; these are thought to be feeders for extrusive rocks higher in the formation.

Fresh andesite porphyry is medium gray in color and the rock weathers to a medium to dark brown. The rock contains glassy, gray phenocrysts of plagioclase that weather medium to very light gray and contrast with the darker groundmass. The phenocrysts are commonly 5 mm long, but may be as much as 1 cm in length. The groundmass appears to be made up of plagioclase and pyroxene, but most grains are too small to be identified with a hand lens. Rock of this type crops out in most of the dikes and sills and in the plug on Russell Ridge near the southeast corner of the area.

Coarser grained intrusives such as the one at the junction of Hindoo and Rattlesnake Creeks are even grained and dark greenish gray; they contain plagioclase, pyroxene, and chlorite. They are similar in composition to the diorite plugs and may be temporally related to those rocks.

Fine-grained basalt and andesite occur in many dikes and sills and in one plug of basalt at Ironstone Mountain near the south boundary of the area.

### GRANITIC ROCKS

Granitic rocks that are possibly part of the Snoqualmie Granodiorite of Miocene age occur in a batholith and several plugs. At depth, the batholith probably forms a continuous body that underlies a zone extending from the Rainier Fork of the American River south-southeast to Indian Creek at the south boundary of the study area (pl. 1).

The batholith ranges in composition from granite to granodiorite. The granite is light gray, weathers buff, and is coarse to medium grained. The principal minerals in order of abundance are quartz, plagioclase, orthoclase, and biotite; in some samples the amounts of plagioclase and orthoclase are approximately equal. The granodiorite is similar in color and texture to the granite; its minerals in order of abundance are plagioclase, orthoclase, quartz, hornblende, and biotite. Both hornblende and biotite commonly are present but either may occur alone. Along the margins of the batholith, the granite and granodiorite are finer grained and contain breccia fragments and inclusions, some of which can be recognized as being derived from the Ohanapecosh Formation.

### DIORITE

Plugs of diorite are (1) at Crag Mountain, (2) at the head of Rattlesnake Creek, (3) on Rattlesnake Creek west of Timberwolf Mountain, (4) on Dog Creek south of Nelson Butte, (5) at the head of Thunder Creek, and (6) on the north side of Bumping Lake. The diorite is of approximately the same age (Miocene) as the granite and granodiorite, but the mutual relation of the rocks is unknown; on the north side of Bumping Lake, the only place where the two units are adjacent to each other, the contact is covered.

The diorite is medium gray, greenish gray, and olive gray; it is commonly coarse to medium grained but also may be fine grained. Plagioclase and pyroxene, the latter partly altered to chlorite, are the principal minerals; magnetite is a common accessory mineral. Quartz was observed in a few samples, but it is a minor constituent.

### RHYODACITE PORPHYRY

Perhaps the most distinctive rock in the study area is rhyodacite porphyry, which occurs in stocks, plugs, dikes, and sills. It is commonly characterized by well-crystallized books of biotite set in a light-gray fine-grained matrix. Locally it has well-developed columnar jointing (fig. 4). This rock, like the batholith and diorite plugs, is probably Miocene in age; it is younger than the granite and granodiorite that it intrudes, but its relation to the diorite plugs is uncertain.

The rock is composed of plagioclase, quartz, orthoclase, biotite, and hornblende. The most typical variety contains books of biotite about 5 mm in diameter and 1 cm long, abundant phenocrysts of quartz as

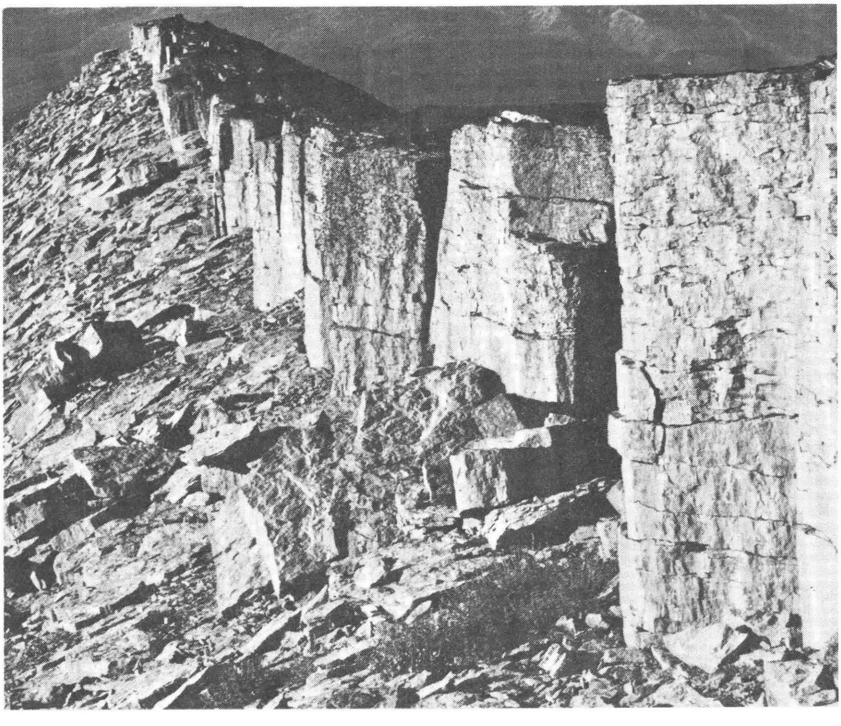

FIGURE 4.—Columnar jointing and platy fracture in a plug of rhyodacite porphyry. Columns are 7 ft (2.1 m) tall. Summit ridge of Shellrock Peak.

much as 5 mm in diameter but mostly smaller, a few crystals of hornblende, and a few phenocrysts of plagioclase and orthoclase about 2 mm in diameter. These minerals also occur in a fine-grained groundmass made up mostly of plagioclase, quartz, and orthoclase. Biotite is more abundant than hornblende in most samples, but either can be the dominant or only mafic mineral. Quartz phenocrysts are absent in some samples, but quartz is present in the matrix everywhere.

Hand samples and most outcrops resemble massive, weakly to moderately indurated crystal tuff in texture, density, and porosity. However, the relation of the rhyodacite to other rocks leaves no doubt regarding its intrusive character.

## QUATERNARY DEPOSITS

### TALUS

Talus has accumulated at the base of many cliffs and on many steep slopes. The larger accumulations are shown on plate 1, but many small deposits were not mapped.

### ALLUVIUM

Alluvium, consisting of deposits of boulders, cobbles, pebbles, sand, silt, and clay, is present along all major and most minor drainages; only the larger deposits are shown on plate 1. The unit shown on plate 1 also includes a small amount of Pleistocene glacially deposited material.

## STRUCTURAL GEOLOGY

Geologic structures in the study area include folds and faults that can be grouped according to their time of development. Few structural features encountered during the reconnaissance geologic mapping were traced in the field, and thus many fold axes and faults noted at individual outcrops are not shown on the geologic map. However, enough data were collected that some generalizations car be made.

The oldest structural features consist of a series of folds in the pre-Puget rocks. The approximate strike of the axes of the folds is a few degrees west of north, and the dip of the limbs is generally between 20° and 70°; most of the folds are open but a few are overturned. As the folds are more compressed than those in younger strata, and as the rocks involved are metamorphosed (to the chlorite grade), the deformation appears to have been more intense than that caused by later orogenic activity. The age of the deformation, like that of the rocks, is unknown other than its being pre-Eocene.

Most of the faults and folds in the area are associated with the uplift of the Cascade Range near the end of the Eocene. The axis of the uplift has a north-northwest trend, is east of the topographic crest of the Cascades near the west side of the study area, and coincides with the zone in which a granitic batholith is exposed.

The uplift of the Cascades formed a broad anticlinorium whose basic structure is recorded by the general westward dip of the Puget Group and of the Ohanapecosh Formation west of the granitic batholith and by the eastward dip on the opposite side of the batholith. The limbs of the anticlinorium are flexed into open folds whose axes trend between north and west and whose flanks dip commonly between 15° and 40°. Steep dips locally found in the Ohanapecosh result from high initial dips around small volcanic vents rather than from structural disturbances.

Probably during and shortly after the emplacement of the batholith, the granitic rocks and the Puget Group and Ohanapecosh Formation were fractured and sheared along zones trending northwest to west-northwest and dipping moderately northeast to steeply southwest. Some of these zones were passageways and sites of deposition for mineralizing solutions emanating from the batholith.

During the Oligocene and shortly after the emplacement of the batholith, the area was intruded by rhyodacite stocks, plugs, and dikes. Mineralizing solutions associated with these bodies also entered some northwest- to west-northwest-trending shear zones, but it is unknown whether the fractures were caused by the intrusion of the bodies of rhyodacite or by the older granitic rocks.

Renewed or continuing uplift of the Cascade Range during the Miocene or Pliocene is evident from the gentle, commonly 15° or less, eastward dip of the Fifes Peak Formation in the east part of the study area, and by the gentle dip of the younger Yakima Basalt Subgroup farther east.

The latest tectonic activity recorded in the rocks within the study area is two large normal faults (pl. 1) of Miocene or younger age. One of these, southwest of Goat Peak, strikes northwest and offsets the Fifes Peak Formation on the northeast against the Ohanapecosh Formation and rhyodacite on the southwest. The other, along the course of North Fork of Rattlesnake Creek, strikes west-northwest and offsets the Fifes Peak Formation on the north against the Ohanapecosh Formation on the south.

A third normal fault of possibly the same age occurs in Carlton Pass and the headwaters of Carlton Creek and of the Bumping River. The fault has a sinuous northeasterly strike and is partly covered by a concealed Quaternary basalt flow in the valley of the Bumping River; it offsets the Ohanapecosh Formation to the south against the Puget Group to the north. On the geologic map (pl. 1) it appears that the fault may offset andesite flows of Pliocene(?) or Pleistocene(?) age, the original limit of which extended to approximately the same position as the trace of the fault, but this was not determined by field studies.

## ALTERATION

Two types of alteration are common in older rocks of the area: (1) pervasive argillic alteration of uncertain origin in the Ohanapecosh Formation, and (2) hydrothermal alteration near the margins of granitic rocks and to a less extent near the margins of some rhyodacite stocks.

Most of the breccia and tuff and some of the flows in the Ohanapecosh Formation, particularly the pale-green rocks that have a dusty, bleached appearance, consist of feldspars and iron-rich minerals that are partly altered to clay and chlorite. This widespread alteration has no apparent relation to intrusive bodies and may have resulted from the rocks being erupted in water.

Alteration in and near bodies of granitic rock and rhyodacite can readily be explained by hydrothermal solutions emanating from the intrusive bodies themselves. Some of the alteration resembles the previously noted argillic alteration, but, in addition, the hydrothermal solutions locally deposited silica, and at many places, pyrite. Joints and surfaces of rocks are coated by limonite formed by oxidation of pyrite. The limonite is a conspicuous color guide for the prospector, but at only a few places in the study area is it accompanied by sulfides other than pyrite.

# INTERPRETATION OF AEROMAGNETIC DATA

By WILLARD E. DAVIS, U.S. Geological Survey

An aeromagnetic survey of the region was made by Scintrex Mineral Surveys, Inc., under contract to the U.S. Geological Survey, to assist in studying the distribution of igneous rocks and in evaluating the mineral potential of the study area. Total-intensity magnetic data were obtained along north-south lines flown about 1 mi (1.6 km) apart at an average barometric elevation of 8,000 ft (2,450 m) above sea level. The data were contoured at intervals of 20 and 100 gammas relative to an arbitrary datum, and are uncorrected for terrane. Sources of the magnetic features, interpreted from results of geologic mapping and general knowledge of the magnetic properties of rocks involved, are discussed briefly herein.

The magnetic map (pl. 1) shows prominent magnetic highs in the southwestern and northeastern parts of the area, and a group of discontinuous high-gradient anomalies over the eastern mountains. Most of the magnetic maxima occur over intrusive bodies and volcanic rocks on the mountain crests and upper slopes. Areas of low magnetic intensity are underlain mainly by sedimentary rocks and unconsolidated sediments, but some are over volcanic terrane. Local steep magnetic gradients indicate that sources of the anomalies lie near the ground surface. Topographic effects probably account for some of the variations in magnetic intensity across the mountains.

The major magnetic high in the southwest part of the area lies over the basalt plateau near Tumac Mountain. The anomaly outlines the Quaternary basalt flows on the eastern part of the plateau and their extension into the Tieton River drainage basin. Contour undulations on the flank of the feature mark short thick extensions to the north and northwest. The anomaly has an amplitude of about 700 gammas, and its intensity of 3,500 gammas represents the highest intensity observed in the area. Shape and magnitude of the magnetic maximum strongly suggest that a feeder for the basalt flows lies in the mountain. The small positive anomaly in the western part of the plateau probably represents thick basalt flows along the ridge south of Summit Creek.

To the north, a negative anomaly lies over the bordering sedimentary rocks and andesite flows. This feature may be a counterpart of the magnetic high over the Tumac Mountain plateau, though it is probably caused primarily by a reversal in the remnant magnetization of a flow member or near-surface rock of unknown origin.

Considerable magnetic relief occurs over the andesite flows south of the basalt plateau. A broad magnetic low with a minimum of 200 gammas near a mountain crest occupies the west part of the outcrop area and is attributed to abnormally directed remnant magnetization in the flows. A high of 100 gammas to the east near Spiral Butte is probably caused by the light-pink andesite, which occurs near the butte and apparently has slightly different magnetic properties.

The prominent magnetic high in the northern part of the area lies over the range crest and upper slopes near Goat Peak. This anomaly has an amplitude of almost 500 gammas and is associated with the Fifes Peak Formation, which is more than 2,000 ft (600 m) thick near the peak. Basaltic andesite flows that make up most of the formation probably are the main source of the anomaly. A small negative anomaly southeast of the Goat Peak anomaly is located on the northeast flank of Old Scab Mountain and may represent either inversely polarized andesite flows, tuff or breccia of the Fifes Peak Formation, or a buried intrusive body.

Magnetic anomalies overlying rocks of the Ohanapecosh Formation, west of Goat Peak, show a polarity transition from positive in the eastern part of the exposure to negative in the west. As discussed in the preceding section, the surface rocks have undergone widespread alteration, and subtle differences in the degree of alteration may be responsible for the observed magnetic variations. The low gradients of the anomalies, however, suggest that the source rock is deeply buried; therefore, the anomalies may be caused by an irregularly shaped upper surface of an intrusive which is possibly related to the adjoining granitic batholith.

The northeast-trending magnetic low south of the Ohanapecosh Formation exposure can be identified with the alluvial deposits of the Bumping River valley, and similarly, the northwest low results from a deep alluvial basin formed at the confluence of the Rainier Fork and American River.

A prominent Y-shaped positive anomaly associated with older rocks in the east part of the area lies over the spur ridge east of Mount Aix, Nelson Butte, and a peak west of Nelson Butte. A maximum magnetic intensity of 200 gammas occurs over a rhyodacite exposure on the butte and over some of the bordering Ohanapecosh rocks. Amplitude of the anomaly diminishes over the Ohanapecosh Formation on peaks to the south and west. The feature is characteristic of the expression of a narrow, steep-walled intrusive body and suggests that possibly rhyodacite porphyry lies at shallow depths near the mountain peaks. Perhaps part of the anomaly represents a narrow concealed rhyodacite mass or dike swarms connecting the butte and the larger intrusive body exposed on Nelson Ridge to the west. Andesite-porphyry flows of the Ohanapecosh Formation on the mountain crests could account for part of the anomaly.

A magnetic low that is related to the Nelson Butte anomaly lies over Ohanapecosh rocks to the north. The low includes lower mountain slopes and is intensified by topographic effects.

To the northeast of the low just mentioned, on the margin of the area, a small circular positive anomaly is centered over the Fifes Peak Formation near Clover Spring. This anomaly may represent a local thick pile of andesite flows or a small rhyodacite intrusive body.

Southwest of Mount Aix, a small arcuate magnetic high of more than 200 gammas lies over a body of rhyodacite. The anomaly extends southeastward over the small rhyodacite exposure on Bismarck Peak,

TABLE 1.—*Analyses of water samples from the Cougar Lakes-Mount Aix study area*
[PPM, parts per million; EPM, equivalent parts per million; ND, not detected: < , less than; blank, not calculated]

| | CS 574-575[1/] | | CS 576-577[2/] | | CS 617-618[3/] | | CS 621-622[4/] | |
|---|---|---|---|---|---|---|---|---|
| | PPM | EPM | PPM | EPM | PPM | EPM | PPM | EPM |
| $SiO_2$---- | 286 | | 9.6 | | 239 | | 0.03 | |
| Ca------ | 370 | 18.46 | 59 | 2.94 | 230 | 11.48 | .3 | 0.015 |
| Mg------ | 50 | 4.11 | 15.1 | 1.24 | 100 | 8.23 | .88 | .0724 |
| Na------ | 300 | 13.05 | 510 | 22.18 | 1,820 | 79.13 | 1.6 | .0696 |
| K------- | 5.5 | .141 | 17.5 | .448 | 77 | 1.97 | .1 | .0026 |
| Li------ | .6 | .086 | .9 | .130 | 5.1 | .735 | <.1 | .014 |
| $HCO_3$---- | 1,820 | 29.83 | 442 | 7.24 | 3,610 | 59.17 | 19 | .311 |
| $SO_4$---- | 1.0 | .021 | 324 | 6.75 | 9.6 | .20 | ND | |
| Cl---- | 187 | 5.27 | 434 | 12.24 | 1,400 | 39.49 | ND | |
| F----- | .97 | .051 | .45 | .024 | .22 | .0116 | <.1 | |
| B----- | 2.7 | | 3.8 | | | | ND | |
| pH---- | 8.65 | | 8.71 | | 7.14 | | 5.2 | |
| Cation totals | 35.85 | | 26.94 | | 101.54 | | 0.17 | |
| Anion totals | 35.17 | | 26.25 | | 98.87 | | .31 | |

[1/] CS 574-575, Soda spring, near Soda Springs Campground on Bumping River; X200,500-Y213,200.

[2/] CS 576-577, Indian spring or Uranium spring, near the head of Pear Butte Trail on Deep Creek; X176,900-Y172,200.

[3/] CS 617-618, Soda spring, near Soda Springs Campground on Summit Creek; X132,500-Y133,200. Applying the ratios of calcium, sodium, and potassium to the geothermometry curve of Fournier and Truesdall (1973), the admixed thermal water had a temperature of about 160°C.

[4/] CS 621-622, pool in upper crater of Tumac Mountain cinder cone; X164,600-Y136,000.

and the magnetic pattern indicates that the extension is part of a narrow southeast-trending, low-amplitude magnetic high that lies over rocks of the Puget Group and over rhyodacite-porphyry outcrops on Shellrock Peak, Rattlesnake Peaks, and near the junction of Rattlesnake and Little Wildcat Creeks. The narrow magnetic high suggests that these outcrops connect at depth and may join the larger mass west of Mount Aix. A small magnetic high located over Arnesons Peak may also be attributed to rhyodacite-porphyry. Zones of low magnetic intensity associated with sedimentary rocks of the Puget Group and the Ohanapecosh Formation border this southeast-trending magnetic maximum.

In the northwestern part of the area, a broad zone of moderately high magnetic intensity extends southeastward from Rainier Fork of the American River to the head of Copper Creek and Rattlesnake Creek. Within the zone, magnetic maxima of more than 100 gammas seem to be associated mainly with peaks underlain by intrusive rocks and flows. Very likely the zone represents most of the higher part of the batholith that underlies the area. Magnetic expression of the concealed part of the batholith is probably masked by the stronger magnetic effects of overlying basalt and andesite flows and of outcrops of intrusive rock.

The variations in total magnetic intensity shown in the magnetic pattern of the area are related mostly to contrasts in magnetic properties between igneous rocks and to a lesser extent between igneous and sedimentary rocks. An extensive magnetic low that might represent a broad zone of alteration in which metallic mineral deposits could occur may exist on American Ridge near the east contact of the granitic batholith and the Ohanapecosh Formation. None of the positive anomalies is considered to be indicative of a large deposit of magnetite lying at shallow depth.

## GEOTHERMAL ENERGY

The criteria for determining the potential of an area as a source of geothermal energy include (1) late Tertiary or Quaternary volcanism, (2) thermal springs, and (3) high geothermal gradient. The Cougar Lakes-Mount Aix study area contains basaltic lava flows and a cinder cone of late Tertiary and Quaternary ages. No hot springs are known in the area. However, chemical analyses of cold spring water suggest that hot water at about 160°C may be at a depth to dilute cold meteoric waters (table 1). These data indicate that the area may have a geothermal potential that warrants further investigations.

# Mines, Prospects, and Mineralized Areas, and Geochemistry of the Cougar Lakes–Mount Aix Study Area, Yakima and Lewis Counties, Washington

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MINERAL RESOURCES OF THE COUGAR LAKES-MOUNT AIX STUDY AREA, YAKIMA AND LEWIS COUNTIES, WASHINGTON

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GEOLOGICAL SURVEY BULLETIN 1504-B

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MINERAL RESOURCES OF THE
COUGAR LAKES-MOUNT AIX STUDY AREA,
YAKIMA AND LEWIS COUNTIES, WASHINGTON

# MINES, PROSPECTS, AND MINERALIZED AREAS, AND GEOCHEMISTRY OF THE COUGAR LAKES-MOUNT AIX STUDY AREA, YAKIMA AND LEWIS COUNTIES, WASHINGTON

By RONALD M. VAN NOY and NICHOLAS T. ZILKA,
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## INTRODUCTION

Most if not all of the mineralization in the Cougar Lakes-Mount Aix study area is associated with or resulted from the emplacement of a granitic batholith and the intrusion of stocks, dikes, and sills of rhyodacite porphyry. These rocks and the rocks they intrude are fractured and sheared along northwest-striking shear zones, some of which are hydrothermally altered and mineralized. Hydrothermal alteration and mineralization also occurs locally near the margins of these intrusive rocks. No signs of alteration or mineralization were detected in younger rocks. Thus, on the basis of geologic history, it is theoretically possible for the older rocks—pre-Puget rocks, Puget Group, Ohanapecosh Formation, granitic rocks, diorite, and rhyodacite porphyry—to contain undiscovered metallic concentrations; and it is unlikely that significant metallic concentrations occur in younger rocks—andesite porphyry intrusive bodies, Fifes Peak Formation, andesite and basalt flows, and the basalt cinder cone of Quaternary age.

The results from geochemical sampling support the geologic observations. Analyses of nearly 2,400 samples indicated that nearly 260 samples contained anomalous amounts of one or more of the following elements: manganese, silver, gold, beryllium, bismuth, copper, mercury, molybdenum, lead, antimony, tin, tungsten, yttrium, and zinc. Most of the 260 samples were either of the older rocks or of stream sediments eroded from those rocks, and all clusters of anomalous samples were from older rocks or sediments derived from them. Most of the samples having the highest metallic contents were from areas presently being explored or which were previously prospected; no significant new areas were discovered.

The study area includes the south part of the Summit mining district and most of the Bumping Lake (Miners Ridge) mining district. The boundary between the two is the drainage divide separating the American and Bumping Rivers, which at most places coincides with the crest of American Ridge. The Summit district has been the site of sporadic prospecting and limited mining since the early 1880's, but few properties have been located since the turn of the century. Ores contained gold, silver, and copper (Gerry, 1897). Gold placers on Morse Creek (just north of the study area) were also worked. U.S. Bureau of Mines records show that a total of 403 tons (366 t (metric ton)) of ore averaging 0.72 oz gold/ton (25 g/t (grams per metric ton)) was produced from lode deposits between 1930 and 1950. The district continues to be the site of exploration activities.

The Bumping Lake (Miners Ridge) mining district was organized in 1913 and includes the area generally south of the Summit district through the central part of the study area to Tumac Mountain. The core of the district is on Miners Ridge, south of Bumping Lake, where copper-tungsten properties worked by Copper Mining Co. are located (Hobbs, 1942; Culver and Broughton, 1945). Northwest-trending shear zones as much as 16 ft (5 m) thick contain narrow veins of chalcopyrite, arsenopyrite, pyrite, scheelite, and molybdenite. U.S. Bureau of Mines records show that, in 1938, 150 tons (136 t) of concentrates containing 1 oz gold/ton (34.3 g/t), 99 oz silver/ton (3,394 g/t), and 4,347 lb (pounds) (1,972 kg (kilogram)) of copper were shipped. The last recorded production was in 1942 when 5 tons (4.5 t) of concentrates containing 48 oz silver/ton (1,645 g/t) and 2,000 lb (907 kg) of copper were shipped. All of the major workings on Miners Ridge are in a corridor excluded from the study area. Mineralized structures that may trend into the study area are described later in the report.

## MINERAL COMMODITIES AND ECONOMIC CONSIDERATION

Mineral commodities found in or adjacent to the Cougar Lakes-Mount Aix study area are copper, manganese, mercury, tungsten, zinc, lead, antimony, gold, silver, molybdenum, building and construction stone, coal, and mineral water. Radioactive minerals have been reported (Weis and others, 1958), but none were found during this investigation. Some of the copper, manganese, mercury, and zinc occurrences are potential resources.

The Mesatchee Creek area at the north edge of the study area may be underlain by a porphyry-type disseminated copper deposit. Whether such a deposit actually exists must await further subsurface exploration. Most domestic production of copper is from this type of deposit and dependence on domestic resources will likely increase as foreign sources become less available. The July 1979 price of copper was $0.86/lb (Engineering and Mining Journal, August 1979); an increase of about $0.22/lb from July 1978. The higher price for copper is making the lower grade deposits more economically attractive.

A small amount of hand-sorted manganese ore has been produced from the Fig mine (pl. 3, No. 53) at the south end of the study area. Several small shipments were reportedly made to the Phillipsburg smelter in Montana. Production was from high-grade lenses containing as much as 41.2 percent manganese. Extent of the manganese ore is unknown because of poor exposures and lack of systematic exploration. In July 1979, the price of manganese ore (minimum 48 percent manganese) averaged $1.40/long ton unit (Engineering and Mining Journal, August 1979). The United States has no reserve of direct shipping manganese ore (U.S. Bureau of Mines, Mineral Facts, and Problems, 1970). The United States is totally dependent upon foreign sources for its steadily increasing manganese requirements. It produced no manganese ore in recent years and has no reserves at current or substantially higher manganese prices (U.S. Bureau of Mines, Mineral Facts and Problems, 1975 and Commodity Data Summaries, 1979).

About 50-60 lb (23-27 kg) of mercury was distilled from about 1,600 lb (730 kg) of ore at the Red Spur mine (pl. 3, No. 57). This and other mercury prospects are found in an area about 5 mi (8 km) long by 2 mi (3. km) wide. The known occurrences are too small and too low grade to be minable under present economic conditions, but detailed sampling indicates a small area near the mine that warrants further investigation. The flask (76-lb, 34.5-kg) price as of July 1979 was $295 to $310 (Engineering and Mining Journal, August 1979); in 1968, it was $535/flask (U.S. Bureau of Mines, Data Summary, January 1973. In 1978, about 57 percent of domestic consumption was imported.

The main shear zone on the Blackjack group of claims (pl. 3, No. 42) contains a small potential zinc resource. Surface samples across the 4-ft (1.2-m) wide zone averaged 4.0 percent zinc. The inclined shaft was filled with water and inaccessible so that continuity of mineralization at the depth could not be established. The price of zinc was $0.39/lb in July 1979 (Engineering and Mining Journal, August 1979), up $0.09/lb from the July 1978 price. The zinc potential of this deposit is therefore enhanced as a future resource.

Other metallic commodities occurring in the study area are too low grade to have economic potential now or in the foreseeable future. Gold and silver prices (Engineering and Mining Journal, August 1979, p. 21) even at record levels (gold at $295.33/oz, silver at $9.13/oz—averages for July 1979) should have no impact on mining in the study area.

Building stone and construction materials are in the study area, but they are too far from major markets to compete with more accessible sources.

Coal has been reported in the area, but none was found during the present survey and the presence of economic deposits seems unlikely.

Mineral waters occur in two springs, one of which was formerly used by a commercial bottling works.

## INTERPRETATION OF GEOCHEMICAL DATA

### METHODS OF EVALUATION

The evaluation of mineral resources presented in this report is based on a geochemical reconnaissance consisting principally of the collection and analysis of rock, stream-sediment, panned-concentrate, and water samples, detailed study of mineral occurrences, geologic mapping, and an aeromagnetic survey.

Rock sampling was carried out by foot traverses along all major and many secondary ridges, and additional sampling was done using a helicopter on the more rugged peaks and ridges. Representative samples of all rock types were collected. Outcrops were carefully inspected for disseminated metallic minerals, limonite stains, and indications of alteration.

Traverses were also made along all major and many minor streams to obtain stream-sediment samples. A large proportion of clay- and silt-sized sediments was collected wherever possible, as they have a greater ability to concentrate metallic ions from solution. However, close attention was also given to coarser sediments for indications of mineralized rocks and changes in the country rock drained by the streams. Panned-concentrate samples were collected from streams in areas where it was suspected that gold, mercury, or tungsten might be present.

The localities and field numbers of all geochemical samples taken by the U.S. Geological Survey are shown on the sample map (pl. 2). The analytical data for all samples except the water samples are stored on a computer tape (Simmons and others, 1974). Localities for rock and stream-sediment samples containing anomalous amounts of one or more of the following elements—silver, copper, molybdenum, lead, tin, zinc, and mercury—are shown on plate 3, and the analytical values are listed in tables 2 and 3. Anomalous values of other elements of particular interest are cited at appropriate places in the text. The localities for water samples and panned-concentrate and rock samples from mines and prospects and from their dumps are shown on plate 3, and analyses for these samples are listed in tables 1, 4, and 5, respectively. The few samples collected from mines, dumps, and prospects by the U.S. Geological Survey are listed for purposes of comparison with rock samples containing anomalous amounts of metallic elements but are not taken into consideration in the discussion of geochemical anomalies; these localities were sampled in detail by the U.S. Bureau of Mines and are described in the section on mining claims.

The determinations of what constitutes an anomalous value are based upon statistical comparisons of the variations of metal content in geologic units within the study area and with similar rocks elsewhere. The evaluation of mathematical judgments, however, is thoroughly tempered by geologic and economic factors.

Slightly more than 1 percent of the rock and stream-sediment samples are anomalous in the seven elements of principal interest; the anomalous values are given in tables 2 and 3. Most are near the threshold values, the lower limits at which each element is considered anomalous. The seven elements and six others, of more limited interest because of their sparsity, are listed in table 6 with their lower limits of detection and threshold values.

## COMMODITIES

### COPPER

Anomalous amounts of copper are in 27 rock samples and 12 stream-sediment samples. In rock samples, the copper content ranged from 100 to 1,500 ppm and in stream-sediment samples, from 100 to 500 ppm. Only one panned-concentrate sample contained more than 100 ppm. The copper occurs either alone or in various combinations with anomalous amounts of silver, molybdenum, lead, tin, or zinc. Most of the samples are scattered and their copper content is low; however, in three areas they are clustered, and at one of these, Mesatchee Creek, it is possible that copper might exist in economic quantities.

The Mesatchee Creek area contains a 2-mi (3-km) -long contact zone between andesitic rocks of the Ohanapecosh Formation and a granitic pluton; the zone extends from above the east side of the creek northward to the area boundary near coordinates X15–Y20. During

TABLE 2.—*Analyses of rock samples from the Cougar Lakes-Mount Aix study area*

[Values shown are in parts per million. G, greater than the sensitivity limit; N, not detected at lower limit of detection; and L, an undetermined amount present below the lower limit of detection. Mercury analyses were made by atomic-absorption spectrometry; other elements were analyzed by 6-step semiquantitative spectrographic analysis. These elements are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, which represent approximate midpoints of group data on a geometric scale]

| SAMPLE | X-COORD. | Y-COORD. | S-AG | S-CU | S-MO | S-PB | S-SN | S-ZN | INST-HG |
|---|---|---|---|---|---|---|---|---|---|
| CA004 | 193900 | 213800 | 0.5 N | 7 | 5 N | 10 N | 10 N | 200 N | 1.10 |
| CA005 | 194300 | 211200 | 0.5 | 15 | 5 L | 10 L | 10 N | 200 N | 0.06 |
| CA069 | 201000 | 159300 | 0.5 N | 30 | 5 N | 10 N | 10 | 200 N | 0.02 N |
| CA073 | 205100 | 160500 | 0.5 N | 70 | 10 | 10 N | 10 N | 200 N | 0.02 N |
| CA090 | 178200 | 152400 | 0.5 N | 10 | 10 | 10 L | 10 N | 200 N | 0.02 L |
| CA117 | 196800 | 164200 | 0.7 | 50 | 5 N | 15 | 10 N | 200 N | 0.02 N |
| CA123 | 206100 | 163700 | 0.5 | 30 | 5 L | 300 | 10 N | 200 N | 0.02 N |
| CA153 | 139900 | 153500 | 0.5 N | 70 | 5 L | 10 L | 10 N | 200 | 0.08 |
| CA165 | 137500 | 135500 | 0.5 N | 100 | 5 N | 10 N | 10 N | 200 N | 0.02 N |
| CA228 | 147600 | 164800 | 0.5 N | 7 | 5 N | 30 | 10 N | 200 N | 0.02 N |
| CA247 | 159200 | 203300 | 0.5 N | 20 | 5 N | 150 | 10 N | 500 | 0.02 N |
| CA252 | 177900 | 154000 | 0.5 L | 150 | 5 N | 10 | 10 N | 200 N | 0.02 N |
| CA258 | 176600 | 159700 | 0.5 N | 10 | 5 N | 10 N | 15 | 200 N | 0.02 N |
| CA311 | 181600 | 208100 | 0.5 N | 5 | 5 N | 10 | 10 N | 200 N | 1.10 |
| CA337 | 162500 | 195500 | 0.5 N | 15 | 5 L | 100 | 10 N | 300 | 0.04 |
| CA341 | 162500 | 195500 | 0.5 N | 70 | 5 L | 200 | 10 N | 200 L | 0.02 N |
| CA342 | 158200 | 195300 | 0.5 N | 15 | 5 N | 15 | 10 N | 200 N | 10.00 G |
| CA362 | 170900 | 190000 | 0.5 N | 70 | 5 L | 50 | 10 N | 200 N | 0.02 N |
| CA396 | 179400 | 170400 | 0.5 N | 100 | 5 N | 10 L | 10 N | 200 N | 0.02 |
| CA413 | 202500 | 194300 | 0.5 N | 15 | 5 N | 10 N | 10 N | 200 N | 0.70 |
| CA414 | 202900 | 195000 | 0.5 N | 7 | 5 N | 10 N | 10 N | 200 N | 1.30 |
| CA440 | 198200 | 178700 | 0.5 L | 15 | 5 N | 70 | 10 N | 500 | 0.20 |
| CA452 | 191800 | 157300 | 0.5 N | 7 | 5 N | 30 | 10 N | 200 N | 0.02 N |
| CA455 | 193900 | 150700 | 0.5 N | 15 | 5 L | 10 N | 10 N | 200 | 0.10 |
| CA479 | 166300 | 147600 | 0.7 | 30 | 5 N | 20 | 10 N | 200 N | 0.02 |
| CA488 | 193500 | 160500 | 0.5 N | 5 | 5 N | 15 | 10 N | 500 | 0.02 |
| CA489 | 194000 | 159700 | 0.5 L | 5 | 5 N | 20 | 10 N | 500 | 0.02 |
| CA521 | 131300 | 149100 | 0.5 N | 20 | 5 N | 10 N | 10 N | 200 L | 10.00 G |
| CA522 | 130900 | 148200 | 0.5 N | 70 | 5 N | 10 N | 10 N | 200 N | 8.00 |
| CA544 | 135600 | 190200 | 0.5 N | 10 | 5 | 10 L | 15 | 200 N | 0.04 |
| CA558 | 139300 | 172600 | 0.5 L | 15 | 5 N | 150 | 10 N | 200 N | 0.02 |
| CA559 | 140400 | 173600 | 0.5 N | 70 | 5 | 10 | 10 N | 200 N | 0.02 N |
| CO047 | 157200 | 193400 | 0.5 N | 5 | 5 N | 10 L | 15 | 200 N | 0.02 |
| CO124 | 197700 | 165700 | 0.5 N | 5 | 5 N | 20 | 10 | 200 N | 0.02 N |
| CO148 | 207600 | 137700 | 0.5 N | 20 | 5 N | 10 | 10 N | 200 N | 0.70 |
| CO202 | 177800 | 128600 | 0.5 N | 150 | 5 N | 10 N | 10 N | 200 N | 0.18 |
| CO213 | 180900 | 129000 | 0.5 N | 200 | 5 N | 10 N | 10 N | 200 N | 0.35 |
| CO259 | 173800 | 156700 | 0.7 | 15 | 15 | 30 | 70 | 200 N | 0.02 N |
| CO269 | 157300 | 151300 | 0.5 N | 1500 | 5 N | 30 | 10 N | 700 | 0.02 N |
| CO274 | 157300 | 162100 | 0.5 N | 700 | 5 L | 15 | 10 N | 500 | 0.02 N |
| CO283 | 139400 | 179500 | 0.5 N | 100 | 5 N | 10 N | 10 | 200 N | 0.02 N |

| SAMPLE | X-COORD. | Y-COORD. | S-AG | S-CU | S-MO | S-PB | S-SN | S-ZN | INST-HG |
|---|---|---|---|---|---|---|---|---|---|
| CO285 | 139000 | 181650 | 0.5 N | 300 | 5 L | 10 L | 10 N | 200 | 0.02 |
| CO344 | 161850 | 160100 | 0.5 N | 150 | 5 N | 10 N | 10 N | 200 N | 0.02 |
| CO361 | 178700 | 162250 | 0.5 N | 5 L | 5 N | 10 N | 15 | 200 N | 0.02 |
| CO362 | 184100 | 177850 | 0.5 N | 7 | 5 N | 10 | 15 | 200 N | 0.04 |
| CO364 | 183550 | 179900 | 0.5 N | 15 | 5 N | 15 | 70 | 200 N | 0.04 |
| CO387 | 200500 | 162100 | 0.5 N | 15 | 5 N | 10 | 10 N | 200 | 0.02 N |
| CO409 | 199400 | 157500 | 0.5 N | 20 | 5 N | 10 N | 10 | 200 N | 0.02 L |
| CO495 | 137950 | 138900 | 0.5 N | 100 | 5 N | 10 N | 10 N | 200 N | 0.12 |
| CO496 | 137100 | 138000 | 0.5 N | 100 | 5 L | 10 N | 10 N | 200 N | 0.08 |
| CO499 | 137000 | 135700 | 0.5 N | 150 | 5 L | 10 N | 10 N | 200 N | 0.04 |
| CO502 | 135600 | 190900 | 0.5 N | 30 | 10 | 10 L | 10 N | 200 N | 0.06 |
| CO508 | 138200 | 191550 | 0.5 N | 70 | 7 | 10 L | 10 L | 200 N | 0.02 L |
| CO510 | 138800 | 193800 | 0.5 N | 10 | 5 | 10 | 10 N | 200 N | 0.06 |
| CO511 | 139100 | 194950 | 0.5 N | 50 | 5 L | 10 L | 15 | 200 N | 0.02 |
| CO558 | 173600 | 133650 | 0.5 N | 50 | 7 | 10 N | 10 N | 200 N | 0.02 N |
| CP099 | 187500 | 170200 | 0.5 N | 70 | 5 L | 10 L | 50 | 200 N | 0.02 N |
| CP119 | 151900 | 195200 | 1.5 | 10 | 5 N | 100 | 10 N | 200 N | 0.04 |
| CP121 | 152000 | 196600 | 2.0 | 1000 | 10 | 10 | 10 N | 200 | 0.02 |
| CP123 | 152000 | 197600 | 0.5 N | 50 | 5 N | 10 L | 10 N | 300 | 0.02 N |
| CP127 | 200600 | 176400 | 0.5 N | 15 | 5 L | 10 L | 10 N | 200 N | 0.70 |
| CP161 | 203500 | 161000 | 0.7 | 20 | 5 L | 50 | 10 N | 300 | 0.02 |
| CP191 | 201600 | 146800 | 0.5 N | 10 | 5 L | 100 | 10 N | 300 | 0.02 N |
| CP204 | 211300 | 157100 | 1.0 | 30 | 5 L | 70 | 10 N | 200 N | 0.02 N |
| CP207 | 212400 | 160000 | 0.5 N | 5 L | 5 | 15 | 10 N | 200 N | 0.02 N |
| CP236 | 171200 | 162500 | 0.5 L | 150 | 5 N | 15 | 10 N | 200 N | 0.08 |
| CP252 | 208100 | 136500 | 0.5 N | 5 | 5 N | 10 N | 10 N | 200 N | 0.80 |
| CP262 | 187800 | 123400 | 0.5 N | 7 | 7 | 10 L | 10 N | 200 N | 0.04 |
| CP274 | 183400 | 136500 | 0.5 N | 20 | 7 | 10 N | 10 N | 200 N | 0.02 N |
| CP321 | 179000 | 124500 | 0.5 N | 50 | 5 N | 10 N | 10 N | 200 N | 10.00 G |
| CP353 | 165900 | 197000 | 0.5 N | 70 | 5 N | 15 | 10 N | 200 | 0.02 |
| CP354 | 167000 | 197800 | 0.5 N | 7 | 5 | 10 | 10 N | 200 N | 0.02 L |
| CP371 | 167600 | 209800 | 0.5 N | 7 | 5 | 10 L | 10 N | 200 N | 0.02 L |
| CP401 | 186200 | 214600 | 0.5 N | 7 | 5 N | 10 N | 10 N | 200 N | 1.50 |
| CP413A | 195700 | 215300 | 0.5 N | 5 | 5 N | 10 N | 10 N | 200 N | 0.75 |
| CP431 | 197600 | 149800 | 0.5 L | 10 | 30 | 10 L | 10 N | 200 N | 0.04 |
| CP437 | 158500 | 147700 | 2.0 | 5 L | 5 N | 10 | 10 N | 200 N | 0.02 |
| CP438 | 157400 | 147800 | 0.5 N | 15 | 5 N | 10 L | 10 N | 200 | 0.02 |
| CP465 | 196800 | 186700 | 0.5 | 100 | 5 N | 10 L | 10 N | 200 L | 0.02 |
| CP486 | 173400 | 149600 | 0.7 | 10 | 7 | 10 L | 10 N | 200 N | 0.02 N |
| CP539 | 126800 | 192800 | 0.5 N | 15 | 7 | 10 N | 10 N | 200 N | 0.02 |
| CP564 | 136200 | 176000 | 0.7 | 100 | 5 L | 30 | 10 N | 200 L | 0.02 |

TABLE 2.—*Analyses of rock samples from the Cougar Lakes-Mount Aix study area*—Continued

| SAMPLE | X-COORD. | Y-COORD. | S-AG | S-CU | S-MO | S-PB | S-SN | S-ZN | INST-HG |
|---|---|---|---|---|---|---|---|---|---|
| CP568 | 136900 | 174600 | 0.5 N | 70 | 7 | 10 L | 10 N | 200 N | 0.02 N |
| CS023 | 150000 | 202400 | 0.5 N | 70 | 30 | 10 L | 10 N | 300 | 0.50 |
| CS120 | 191600 | 184700 | 0.7 | 20 | 5 N | 50 | 10 N | 200 L | 0.02 N |
| CS132 | 156500 | 194200 | 0.5 N | 50 | 5 N | 50 | 30 | 1000 | 0.02 |
| CS207 | 215600 | 146100 | 0.5 N | 15 | 20 | 10 L | 10 N | 200 N | 0.02 N |
| CS314 | 151500 | 155700 | 0.5 L | 300 | 5 N | 10 N | 10 N | 200 N | 0.02 N |
| CS358 | 182600 | 154000 | 0.5 N | 700 | 5 N | 30 | 10 N | 500 | 0.08 |
| CS387 | 138600 | 175500 | 0.5 N | 700 | 7 | 150 | 10 N | 300 | 0.02 N |
| CS414 | 174400 | 206700 | 0.5 N | 15 | 5 L | 30 | 10 N | 200 N | 0.10 |
| CS416 | 176300 | 207800 | 0.5 L | 700 | 5 N | 15 | 10 N | 700 | 0.16 |
| CS425 | 179900 | 207600 | 0.5 N | 20 | 5 N | 15 | 10 N | 200 N | 0.90 |
| CS426 | 180200 | 205900 | 0.5 N | 7 | 5 N | 10 L | 10 N | 200 N | 1.00 |
| CS427 | 180600 | 204400 | 0.5 N | 20 | 5 L | 10 L | 10 N | 200 N | 0.80 |
| CS432 | 176800 | 204000 | 0.5 N | 100 | 5 N | 10 L | 10 N | 200 L | 0.04 |
| CS436 | 178200 | 201300 | 0.5 N | 10 | 5 | 10 L | 10 N | 200 N | 0.06 |
| CS442 | 162800 | 199500 | 0.5 N | 10 | 5 N | 30 | 10 N | 200 N | 0.04 |
| CS460 | 157300 | 190600 | 0.5 N | 10 | 5 N | 70 | 10 N | 200 L | 0.02 N |
| CS481 | 184600 | 155900 | 0.5 N | 5 L | 5 N | 10 N | 15 | 200 N | 0.30 |
| CS499 | 184800 | 171300 | 3.0 | 7 | 5 N | 200 | 70 | 200 N | 0.02 |
| CS500 | 184400 | 171700 | 0.5 | 15 | 5 N | 30 | 15 | 200 | 0.04 |
| CS501 | 184400 | 171900 | 0.5 | 20 | 5 N | 15 | 30 | 200 N | 0.02 |
| CS502 | 184400 | 172100 | 3.0 | 7 | 5 N | 20 | 50 | 200 N | 0.02 |
| CS503 | 184200 | 172800 | 1.5 | 300 | 5 L | 70 | 30 | 200 N | 0.02 |
| CS504 | 184200 | 173000 | 7.0 | 30 | 5 L | 15 | 150 | 200 N | 0.02 |
| CS505 | 184300 | 173200 | 2.0 | 150 | 5 L | 150 | 15 | 200 N | 0.02 |
| CS506 | 183700 | 174000 | 0.5 L | 15 | 5 L | 20 | 10 | 200 N | 0.02 |
| CS510 | 183950 | 177750 | 0.5 N | 5 | 5 L | 20 | 15 | 200 N | 0.02 |
| CS513 | 186100 | 174400 | 0.5 N | 15 | 5 N | 15 | 15 | 200 N | 0.02 |
| CS514 | 187100 | 174300 | 0.5 N | 15 | 5 N | 10 | 10 | 200 N | 0.04 |
| CS519 | 187600 | 172600 | 0.7 | 50 | 5 N | 50 | 30 | 200 N | 0.04 |
| CS536 | 201700 | 153100 | 0.5 N | 7 | 5 N | 10 L | 20 | 200 N | 0.04 |
| CS539 | 205700 | 156900 | 0.5 N | 100 | 5 N | 10 N | 10 N | 200 N | 0.02 |
| CS544 | 209600 | 157100 | 1.0 | 70 | 5 L | 70 | 10 N | 200 N | 0.08 |
| CS586 | 134500 | 193800 | 0.5 N | 10 | 5 N | 10 L | 10 | 200 N | 0.02 |
| CS605 | 140000 | 168600 | 0.5 N | 15 | 7 | 10 L | 10 N | 200 N | 0.10 |
| CS625 | 128700 | 200400 | 0.5 L | 5 | 5 N | 30 | 10 N | 500 | 0.10 |
| CS626 | 129300 | 200500 | 0.5 | 20 | 5 N | 30 | 10 N | 300 | 0.14 |
| CS637 | 142700 | 204000 | 0.5 N | 5 L | 5 N | 50 | 10 N | 200 L | 0.16 |
| CS638 | 143300 | 204100 | 0.5 N | 5 L | 5 N | 70 | 10 N | 200 N | 0.12 |
| CS639 | 144000 | 204600 | 0.7 | 700 | 15 | 10 N | 10 N | 200 N | 0.18 |
| CS640 | 144500 | 204900 | 0.5 L | 200 | 5 L | 10 L | 10 N | 200 N | 0.10 |
| CS642 | 227100 | 179700 | 0.5 N | 15 | 7 | 10 L | 10 N | 200 N | 0.16 |
| CS680 | 209400 | 122900 | 0.5 N | 20 | 5 N | 30 | 10 N | 200 N | 0.10 |

the geochemical reconnaissance, anomalous amounts of copper were found only in samples collected in the Ohanapecosh Formation, but subsequent, more detailed sampling in the same area revealed the presence of copper in the granitic rocks also. The anomalous copper is accompanied by anomalous amounts of silver, lead, molybdenum, tin, and zinc. The area is now being explored by the Duval Corp., and a more detailed description is included in the section on mining claims.

Emanations from the same pluton may also be responsible for the copper anomalies in the headwaters of the American River in blocks X13–Y17 and X13–Y18. There, as at Mesatchee Creek, the copper occurs in andesitic rocks of the Ohanapecosh Formation, accompanied by anomalous amounts of silver, molybdenum, lead, and zinc.

The anomalous copper in the area on the north side of Summit Creek in X13–Y13 and X14–Y13 is difficult to explain. Two rock samples from Pliocene(?) or Pleistocene(?) andesite flows, two rock samples from a Pleistocene(?) basalt flow, and two stream-sediment samples from creeks draining rhyodacite intrusive rocks contain weakly anomalous copper; the stream-sediment samples also contain weakly anomalous silver. As the last known mineralizing solutions in the area were associated with rhyodacite intrusions, the presence of copper and silver in the stream sediments is not unexpected, but the flow rocks are all younger than the rhyodacite; presumably, they had an unusually high amount (100–150 ppm) of copper originally.

## MERCURY

Anomalous amounts of mercury range from 0.7 to more than 10 ppm in 17 rock samples and 32 stream-sediment samples. Mercury in the same amounts was also determined in 10 panned concentrates. Ten samples contain more than 10 ppm of mercury by the instrument method; these were retested by the atomic absorption technique and were found to contain 4–1,500 ppm of mercury (table 7). Mercury in the form of cinnabar is widespread and is locally concentrated in a variety of rocks. The area has a fair potential for the discovery of small mercury deposits.

Most of the anomalous mercury samples are from the drainage of Indian Creek near block X18–Y13, in altered pre-Puget rocks and to a lesser extent in granodiorite that intrudes the pre-Puget rocks. Two rock samples and one stream-sediment sample also contained anomalous amounts of copper, the only example of association of mercury with another metallic element in the study area. Specks of cinnabar were seen in several rock samples, and were detected in stream-sediment and panned-concentrate samples. Exploration for mercury

TABLE 3.—*Analyses of stream-sediment samples from the Cougar Lakes–Mount Aix study area*

[Values shown are in parts per million. G, greater than the sensitivity limit; N, not detected at lower limit of detection; and L, an undetermined amount present below the lower limit of detection. Mercury analyses were made by atomic-absorption spectrometry; other elements were analyzed by 6-step semiquantitative spectrographic analysis. These elements are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, which represent approximate midpoints of group data on a geometric scale]

| SAMPLE | X-COORD. | Y-COORD. | S-AG | S-CU | S-MO | S-PB | S-SN | S-ZN | INST-HG |
|---|---|---|---|---|---|---|---|---|---|
| CA019 | 140800 | 185500 | 0.5 N | 15 | 7 | 10 L | 10 N | 200 N | 0.08 |
| CA027 | 197100 | 181400 | 0.7 | 100 | 5 N | 50 | 10 N | 200 L | 0.30 |
| CA055 | 155700 | 185400 | 0.5 N | 200 | 5 N | 15 | 10 N | 300 | 0.08 |
| CA057 | 158700 | 184600 | 0.5 N | 70 | 5 N | 10 | 10 N | 200 | 0.12 |
| CA059 | 192000 | 166800 | 0.7 | 15 | 5 N | 30 | 10 N | 200 L | 0.02 |
| CA135 | 209300 | 141600 | 0.5 N | 7 | 5 N | 10 N | 10 N | 200 N | 2.00 |
| CA160 | 143000 | 136100 | 0.7 | 100 | 5 N | 15 | 10 N | 200 N | 0.20 |
| CA162 | 140300 | 135800 | 0.7 | 200 | 5 N | 10 N | 10 N | 200 N | 0.08 |
| CA202 | 180600 | 129200 | 0.5 N | 30 | 5 N | 10 L | 10 N | 200 N | 10.00 G |
| CA203 | 180800 | 128900 | 0.5 N | 50 | 5 N | 10 L | 10 N | 200 N | 2.00 |
| CA255 | 177700 | 157500 | 0.5 | 30 | 5 N | 10 L | 10 N | 200 N | 0.24 |
| CA275 | 158300 | 160400 | 0.5 N | 15 | 5 | 10 L | 10 N | 200 N | 0.12 |
| CA286 | 145500 | 178900 | 0.5 N | 15 | 5 L | 20 | 15 | 200 N | 0.10 |
| CA424 | 197400 | 197600 | 0.5 N | 10 | 5 N | 10 L | 10 N | 200 N | 2.50 |
| CA447 | 187400 | 157700 | 0.5 N | 70 | 5 N | 10 L | 10 N | 200 N | 0.75 |
| CA493 | 195000 | 159400 | 0.5 N | 15 | 5 N | 30 | 10 N | 200 N | 0.30 |
| CA500 | 176700 | 128900 | 0.5 N | 15 | 5 N | 15 | 10 N | 200 N | 0.70 |
| CA538 | 140300 | 131400 | 0.5 N | 20 | 5 N | 10 | 10 | 200 N | 0.18 |
| CO002 | 194800 | 212400 | 0.5 N | 10 | 5 N | 10 L | 10 N | 200 N | 0.70 |
| CO004 | 193900 | 213800 | 0.5 N | 5 | 5 N | 10 N | 10 N | 200 N | 1.00 |
| CO019 | 177800 | 198500 | 0.5 N | 15 | 15 | 10 | 10 N | 200 N | 0.06 |
| CO027 | 186200 | 169400 | 0.5 | 15 | 5 N | 30 | 10 N | 200 L | 0.20 |
| CO030 | 192500 | 176900 | 0.5 N | 70 | 5 N | 30 | 10 | 200 L | 0.04 |
| CO035 | 194300 | 184800 | 0.5 L | 20 | 5 N | 30 | 10 N | 200 N | 0.10 |
| CO046 | 156600 | 193200 | 0.5 N | 15 | 7 | 10 | 10 N | 200 N | 0.08 |
| CO065 | 194300 | 168600 | 0.5 N | 15 | 5 N | 30 | 10 N | 200 N | 0.08 |
| CO090 | 178800 | 180700 | 1.5 | 70 | 7 | 30 | 15 | 200 N | 0.04 |
| CO127 | 200600 | 164100 | 1.0 | 10 | 5 N | 15 | 10 N | 200 N | 0.02 |
| CO134 | 214800 | 137900 | 0.5 N | 15 | 7 | 10 L | 10 N | 200 N | 0.02 |
| CO201 | 177800 | 128600 | 0.5 N | 300 | 5 N | 10 L | 10 N | 200 N | 0.40 |
| CO294 | 151900 | 175600 | 0.5 N | 20 | 5 | 10 | 10 N | 200 N | 0.04 |
| CO414 | 192100 | 154050 | 0.5 N | 7 | 5 N | 10 L | 10 N | 200 N | 0.75 |
| CO415 | 192300 | 154200 | 0.5 N | 7 | 5 N | 10 | 10 N | 200 N | 0.80 |
| CP015 | 164000 | 216700 | 0.5 N | 30 | 5 N | 10 | 10 N | 200 | 0.08 |
| CP041 | 204800 | 185600 | 0.5 N | 15 | 5 N | 10 N | 10 N | 200 N | 1.00 |
| CP077 | 142000 | 186000 | 0.5 N | 15 | 7 | 10 L | 10 N | 200 N | 0.04 |
| CP100 | 188500 | 170100 | 0.5 N | 15 | 5 L | 50 | 10 | 300 | 0.02 |
| CP120 | 152000 | 196600 | 1.5 | 100 | 5 L | 50 | 10 N | 500 | 0.06 |
| CP122 | 152000 | 197600 | 0.5 N | 20 | 5 N | 15 | 10 N | 200 | 0.06 |
| CP124 | 151500 | 199500 | 0.5 N | 70 | 5 N | 15 | 10 N | 300 | 0.08 |
| CP175 | 162200 | 149700 | 0.5 N | 10 | 5 N | 10 L | 10 N | 200 N | 0.70 |

| SAMPLE | X-COORD. | Y-COORD. | S-AG | S-CU | S-MO | S-PB | S-SN | S-ZN | INST-HG |
|---|---|---|---|---|---|---|---|---|---|
| CP176 | 164000 | 148200 | 0.5 N | 15 | 5 N | 15 | 10 N | 200 | 0.80 |
| CP179 | 165400 | 149800 | 1.0 | 20 | 5 N | 50 | 10 N | 200 L | 0.45 |
| CP183 | 167800 | 151700 | 0.5 L | 50 | 5 N | 15 | 10 N | 200 | 0.45 |
| CP184 | 167100 | 153300 | 0.5 N | 70 | 5 N | 10 L | 10 N | 300 | 0.28 |
| CP229 | 173000 | 164500 | 0.7 | 15 | 5 L | 10 | 10 N | 200 L | 0.30 |
| CP237 | 170900 | 162100 | 0.5 N | 20 | 5 L | 10 L | 10 N | 200 N | 0.85 |
| CP239 | 170100 | 160200 | 0.5 N | 15 | 5 N | 10 L | 10 N | 200 N | 0.80 |
| CP314 | 178600 | 130300 | 0.5 N | 50 | 5 L | 10 L | 10 N | 200 N | 0.80 |
| CP317 | 178000 | 128500 | 0.5 N | 30 | 5 L | 10 L | 10 N | 200 N | 2.00 |
| CP319 | 178300 | 128700 | 0.5 N | 70 | 5 L | 10 N | 10 N | 200 N | 10.00 G |
| CP325 | 180200 | 120000 | 0.5 N | 70 | 5 N | 10 N | 10 N | 200 N | 3.50 |
| CP402 | 187500 | 214300 | 0.5 N | 7 | 5 N | 10 N | 10 N | 200 N | 0.75 |
| CP404 | 192600 | 213400 | 0.5 N | 15 | 5 N | 15 | 10 N | 200 | 0.85 |
| CS021 | 150100 | 202600 | 0.7 | 200 | 5 L | 15 | 10 N | 300 | 0.04 |
| CS107 | 188800 | 169900 | 0.5 L | 20 | 5 N | 100 | 10 L | 300 | 0.16 |
| CS108 | 189600 | 171300 | 0.5 N | 15 | 5 N | 30 | 10 N | 200 L | 0.28 |
| CS115 | 197800 | 181400 | 0.7 | 50 | 5 N | 30 | 10 N | 200 L | 0.40 |
| CS131 | 172200 | 215700 | 0.5 N | 15 | 5 N | 10 L | 10 N | 200 N | 0.80 |
| CS143 | 149000 | 184000 | 0.5 N | 15 | 5 | 10 | 10 N | 200 N | 0.20 |
| CS182 | 179600 | 169800 | 0.5 N | 100 | 5 N | 15 | 10 N | 200 N | 0.04 |
| CS249 | 189900 | 129300 | 0.5 N | 15 | 5 N | 10 L | 10 N | 200 N | 0.80 |
| CS317 | 156900 | 163100 | 0.5 | 10 | 5 N | 10 L | 10 N | 200 N | 0.12 |
| CS318 | 157200 | 163500 | 0.5 N | 20 | 7 | 10 | 10 N | 200 L | 0.02 |
| CS319 | 158000 | 166200 | 0.5 L | 15 | 7 | 10 L | 10 N | 200 N | 0.10 |
| CS349 | 142200 | 163500 | 0.5 N | 15 | 5 | 10 | 10 N | 200 N | 0.06 |
| CS353 | 145800 | 157900 | 0.5 N | 10 | 5 N | 15 | 20 | 200 N | 0.04 |
| CS366 | 178100 | 164200 | 0.5 N | 50 | 5 | 10 | 10 N | 200 N | 0.06 |
| CS368 | 178000 | 166200 | 0.5 N | 150 | 5 N | 15 | 10 | 200 N | 0.04 |
| CS373 | 156300 | 152700 | 0.7 | 15 | 5 N | 20 | 10 N | 200 | 0.06 |
| CS374 | 156000 | 152700 | 0.5 L | 20 | 5 N | 20 | 10 N | 200 | 0.10 |
| CS468 | 162400 | 188100 | 0.7 | 30 | 5 L | 20 | 10 N | 200 N | 0.18 |
| CS470 | 162400 | 187300 | 0.5 N | 30 | 5 L | 15 | 10 N | 300 | 0.12 |
| CS515 | 185700 | 173800 | 0.5 N | 300 | 5 N | 15 | 10 L | 200 L | 0.26 |
| CS516 | 186300 | 173100 | 5.0 | 500 | 5 L | 15 | 10 N | 200 L | 0.30 |
| CS517 | 187100 | 173200 | 0.7 | 150 | 5 L | 15 | 10 N | 200 N | 0.08 |
| CS597 | 137500 | 194300 | 0.5 N | 10 | 5 N | 10 L | 10 N | 200 | 0.08 |
| CS598 | 137500 | 193900 | 0.5 N | 15 | 7 | 10 L | 10 N | 200 N | 0.04 |
| CS664 | 193700 | 116500 | 0.5 N | 50 | 5 L | 30 | 10 N | 200 N | 0.28 |

TABLE 4.—*Analyses of panned concentrate samples from the Cougar Lakes-Mount Aix study area*

[Values shown are in parts per million. G, greater than the sensitivity limit; N, not detected at lower limit of detection; and L, an undetermined amount present below the lower limit of detection. Mercury analyses were made by atomic-absorption spectrometry; other elements were analyzed by 6-step semiquantitative spectrographic analysis. These elements are reported to the nearest number in the series 1, 0.7, 0.5 , 0.3, 0.2, 0.15, 0.1, which represent approximate midpoints of group data on a geometric scale]

| SAMPLE | X-COORD. | Y-COORD. | S-AG | S-CU | S-ZR | AA-AU-P | INST-HG |
|---|---|---|---|---|---|---|---|
| CA021 | 141300 | 185900 | 0.5 N | 20 | 150 | 0.05 N | 0.04 |
| CA023 | 142300 | 187600 | 0.5 N | 20 | 200 | 0.05 N | 0.02 |
| CO070 | 227000 | 166300 | 0.5 N | 70 | 200 | 0.25 N | 0.08 |
| CP001 | 171600 | 218400 | 0.5 N | 15 | 150 | 0.05 N | 0.04 |
| CP004 | 170000 | 219000 | 0.5 N | 15 | 100 | 0.05 N | 0.02 |
| CP007 | 167900 | 216700 | 0.5 N | 30 | 100 | 0.05 N | 0.02 |
| CP011 | 165300 | 213600 | 0.5 N | 7 | 100 | 0.05 N | 0.04 |
| CP016 | 164000 | 216700 | 0.5 N | 20 | 200 | 0.05 N | 0.18 |
| CP019 | 165300 | 212800 | 0.5 N | 30 | 100 | 0.05 N | 0.02 L |
| CP021 | 161500 | 210600 | 0.5 N | 15 | 100 | 0.05 N | 0.02 L |
| CP025 | 160400 | 210100 | 0.5 N | 15 | 100 | 0.05 N | 0.04 |
| CP027 | 160300 | 209700 | 0.5 N | 15 | 100 | 0.05 N | 0.04 |
| CP081 | 142700 | 189000 | 0.5 N | 15 | 70 | 0.05 N | 0.02 |
| CP313 | 178500 | 130300 | 0.5 N | 70 | 150 | 0.0 B | 10.00 G |
| CP316 | 177900 | 128600 | 0.5 N | 30 | 30 | 0.10 N | 10.00 G |
| CP318 | 178200 | 128800 | 0.5 N | 30 | 30 | 0.10 N | 10.00 G |
| CP324 | 180200 | 120000 | 0.5 N | 30 | 30 | 0.10 N | 2.00 |
| CS002 | 177600 | 172600 | 0.5 L | 20 | 200 | 0.05 N | 0.06 |
| CS005 | 167600 | 151800 | 0.5 L | 70 | 150 | 0.25 N | 0.16 |
| CS008 | 188900 | 227400 | 0.5 L | 20 | 150 | 0.05 N | 0.04 |
| CS010 | 173200 | 218500 | 0.5 N | 70 | 200 | 0.25 N | 10.00 G |
| CS013 | 175600 | 220400 | 0.5 N | 70 | 150 | 0.25 N | 0.42 |
| CS015 | 177900 | 221300 | 0.5 N | 70 | 150 | 0.10 N | 0.16 |
| CS018 | 179800 | 222600 | 0.5 N | 30 | 150 | 0.05 N | 0.02 |
| CS020 | 180600 | 223700 | 0.5 N | 20 | 100 | 0.10 N | 0.02 |
| CS022 | 150100 | 202600 | 0.5 N | 30 | 150 | 0.05 N | 0.02 L |
| CS025 | 149900 | 202300 | 0.7 | 200 | 200 | 2.00 | 0.02 L |
| CS028 | 151400 | 205400 | 0.5 N | 30 | 150 | 0.10 N | 0.02 L |
| CS030 | 154600 | 207700 | 0.5 N | 20 | 100 | 0.25 N | 0.04 |
| CS034 | 157700 | 208700 | 0.5 N | 30 | 200 | 0.05 N | 0.02 |
| CS037 | 127800 | 194300 | 0.5 N | 20 | 100 | 0.05 N | 0.02 |
| CS069 | 143700 | 196800 | 0.5 N | 15 | 150 | 0.05 N | 0.02 L |
| CS073 | 131100 | 195900 | 0.5 N | 20 | 150 | 0.05 N | 0.04 |
| CS085 | 137200 | 200300 | 0.5 N | 15 | 100 | 0.05 N | 0.02 |
| CS284 | 132100 | 147300 | 0.5 N | 50 | 200 | 0.05 N | 0.40 |
| CS285 | 132300 | 133100 | 0.5 N | 30 | 150 | 0.05 N | 0.04 |
| CS290 | 140700 | 122700 | 0.5 N | 15 | 100 | 0.10 N | 0.04 |

TABLE 5.—*Analyses of samples from mines, dumps, and prospects from the Cougar Lakes-Mount Aix study area*

[Values shown are in parts per million. G, greater than the sensitivity limit; N, not detected at lower limit of detection; L, an undetermined amount present below the lower limit of detection; and B, no analysis. The antimony analysis was made by cold-extractable heavy-metals test by colorimetric comparison; mercury was analyzed by atomic absorption, zinc by atomic absorption (AA) and 6-step semiquantitative spectrographic analysis (S); other elements were analyzed by 6-step semiquantitative spectrographic analysis. These elements are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, which represent approximate midpoints of group data on a geometric scale]

| SAMPLE | X-COORD. | Y-COORD. | S-AG | S-CU | S-MO | S-PB | S-SN | S-ZN | INST-HG | AA-ZN-P | CM-SB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CA264 | 177400 | 169500 | 0.5 N | 300 | 5 N | 10 L | 50 | 200 N | 0.12 | 0 B | 0 B |
| CO180 | 162300 | 145400 | 50.0 | 5000 | 5 L | 70 | 10 N | 10000 G | 10.00 G | 0 B | 0 B |
| CO181 | 162300 | 145400 | 30.0 | 3000 | 5 N | 70 | 10 N | 10000 G | 5.00 | 0 B | 0 B |
| CO214 | 180700 | 129150 | 0.5 N | 100 | 5 N | 10 N | 10 N | 200 N | 5.50 | 0 B | 0 B |
| CO261 | 174200 | 156600 | 0.5 L | 7 | 5 N | 20 | 10 N | 200 N | 0.02 L | 0 B | 0 B |
| CO262 | 174200 | 156600 | 0.5 N | 70 | 5 N | 15 | 30 | 200 L | 0.02 N | 0 B | 0 B |
| CO339 | 162350 | 164900 | 1.5 | 2000 | 5 N | 10 L | 10 N | 200 | 0.12 | 200 | 4 |
| CP005 | 169000 | 218000 | 0.5 N | 20 | 5 N | 10 N | 10 N | 200 N | 0.02 | 0 B | 0 B |
| CP429 | 196300 | 149900 | 0.5 L | 7 | 5 N | 10 N | 10 N | 200 N | 0.04 | 0 B | 0 B |
| CP430 | 196300 | 149800 | 1.5 | 15 | 15 | 70 | 10 N | 200 N | 2.50 | 0 B | 0 B |
| CP522 | 168200 | 149700 | 0.5 N | 70 | 5 N | 15 | 10 N | 200 N | 0.02 N | 0 B | 0 B |

TABLE 6.—*Partial list of elements in rock and stream-sediment samples from the Cougar Lakes–Mount Aix study area showing lower limits of detection and threshold values*

[Values given are in parts per million. Limits of detection determined by sensitivity of semiquantitive spectrographic analyses, except for gold (by atomic absorption) and mercury (by mercury detector). Threshold value is that value for which the element is considered anomalous]

| Element | Limit of detection | Threshold value |
|---|---|---|
| Manganese---- | 10 | 2,000 |
| Silver------- | .5 | .5 |
| Gold--------- | .05 | -----.05 |
| Beryllium---- | 1 | 5 |
| Bismuth------ | 10 | 10 |
| Copper------- | 5 | 100 |
| Mercury------ | .02 | .8 |
| Molybdenum--- | 5 | 5 |
| Lead--------- | 10 | 30 |
| Antimony----- | 100 | 100 |
| Tin---------- | 10 | 10 |
| Tungsten----- | 50 | 50 |
| Zinc--------- | 200 | 200 |

was carried out on the Whiting and Roumm (Indian Creek) claims in this vicinity, under the auspices of the U.S. Bureau of Mines and the U.S. Geological Survey in the 1950's, but the cinnabar found was too sparsely disseminated to be mined. The properties investigated are described in the section on mining claims.

A small amount of mercury was produced from the Red Spur mine on Wildcat Creek in block X20–Y12 (pl. 3, No. 57). The ore apparently came from a northwest-trending shear zone in the Ohanapecosh Formation. A study of the accessible workings and a detailed geochemical soil sampling program, carried out by the U.S. Bureau of Mines and described in the section on mining claims, indicate a potential for an extension of the ore body and for other discoveries nearby.

Four other groups of samples contain anomalous amounts of mercury, but none of these are considered indicative of ore bodies. On a ridge north of the Red Spur mine and west of Cash Prairie in block X20–Y13, two rock samples from the Ohanapecosh Formation contained 0.7 and 0.8 ppm mercury, and a stream draining this area yielded a sediment sample containing 2 ppm. Other rock and stream-sediment samples in the vicinity did not contain anomalous amounts of mercury.

Two rock samples containing 8.0 and 1,500 ppm of mercury were collected 1,000 ft (300 m) apart in tuff of the Ohanapecosh Formation

TABLE 7.—*Analyses for mercury by atomic absorption method*

[Ten parts per million (ppm) is the upper limit at which the mercury content could be accurately determined by the instrument method. The 10 samples determined to have 10 ppm of mercury or greater by the instrument method were then tested by the atomic absorption technique]

| Sample no. | Mercury (ppm) | Type of sample |
|---|---|---|
| CA 202 | 10 | Stream sediment. |
| CA 342 | 20 | Rock. |
| CA 521 | 1,500 | Do. |
| CO 180 | 50 | Rock from prospect. |
| CP 313 | 4 | Panned concentrate. |
| CP 316 | 20 | Do. |
| CP 318 | 20 | Do. |
| CP 319 | 10 | Stream sediment. |
| CP 321 | 10 | Rock. |
| CS 10 | 100 | Panned concentrate. |

above the northwest side of Carlton Creek in block X13–Y14. Stream-sediment samples from the same area did not contain anomalous amounts of mercury.

A group of four samples containing 0.8–1.1 ppm mercury were collected from the southeast side of American Ridge, northeast of Goose Prairie in block X17–Y20 and X18–Y20. The samples are of tuff and breccia from the Ohanapecosh Formation.

Nearby, in blocks X18–Y21 and X19–Y21, a cluster of seven samples containing 0.7–1.1 ppm mercury was collected from the southeast side of Goat Creek.

MANGANESE

No manganese ore was indicated by geochemical sampling. Six rock samples from five different localities contained 2,000 ppm, the minimum amount of which manganese is considered to be anomalous. Five samples from four localities were of tuff and breccia of the Ohanapecosh Formation, and the other was of sandstone from the Puget Group.

Manganese wad is currently being mined and stockpiled at the Fig mine (pl. 3, No. 53) near Ironstone Mountain in blocks X18–Y12 and X19–Y12. The properties are described in the section on mining claims. The ore occurs as interstitial material and in pods and lenses in sedimentary rocks in the Ohanapecosh Formation and the Puget Group. The deposits are small and discontinuous, and it is unlikely that any large deposits exist. However, more detailed sampling and exploration could reveal other small deposits.

## SILVER

Anomalous amounts of silver were detected in 25 rock samples and in 18 stream-sediment samples. In the rock samples the amounts range mostly from 0.5 to 3 ppm (one sample contained 7 ppm), and in the stream-sediment samples the amounts range mainly from 0.5 to 1.5 ppm (one sample contained 5 ppm). Silver was not detected in panned concentrates. Anomalous silver is locally associated with anomalous amounts of lead, copper, tin, molybdenum, or zinc.

The anomalous samples are widely and sparsely distributed in andesite flows of Pliocene(?) or Pleistocene(?) age, the Fifes Peaks Formation of Eocene age, rhyodacite and granodiorite of Miocene age, and the Puget Group of Eocene age. The occurrence of a few weak and widespread anomalies in the andesite flows and the Fifes Peak Formation, geologic units that are younger than those accompanied by mineralizing solutions, is not economically significant, and the sparsity and generally low silver content in the other rocks are not encouraging from an economic point of new.

Besides Mesatchee Creek and the headwaters of the American River (see section, "Copper"), the only area in which samples containing anomalous silver were concentrated was along a 2,200-ft (670-m) length on the crest of Nelson Ridge and in streams draining the east side of that ridge in block X18–Y17. There, hydrothermally altered and limonite-stained rhyodacite that is locally brecciated and silicified contains from 0.5 to 7 ppm of silver, together with anomalous amounts of copper, lead, tin, and other metals. This part of Nelson Ridge has been explored by several pits, but the showings did not encourage interest beyond the prospecting stage.

Although not considered economically significant, two samples from Nelson Ridge are the most unusual ones collected in the study area from a point of view of their chemical contents. CS 503, in addition to containing anomalous amounts of of silver and copper (table 2), also contains anomalous amounts of arsenic, 10,000 ppm; boron, 1,000 ppm; bismuth, 70 ppm; antimony, 150 ppm; and tungsten, 50 ppm. CS 504, in addition to containing anomalous amounts of silver, gold, and tin (table 2), also contains anomalous amounts of arsenic, 1,000 ppm; boron, 2,000 ppm; and bismuth, 70 ppm.

## GOLD

All samples were tested for gold by both spectrographic and atomic absorption techniques, and streams in the north part of the study area were panned for gold as a consequence of gold having been reported in the Summit mining district on the north side of the study area. Gold was detected in only four samples. Three rock samples from scattered localities contained 0.05, 0.1, and 0.2 ppm of gold. The fourth sample was a panned concentrate, CS 25 from the mouth of Mesatchee Creek near the Summit district in block X14-Y20; it contained 2 ppm gold. The area is considered to have an extremely low potential for occurrence of gold deposits.

### ZINC

Anomalous amounts of zinc were detected in 25 rock samples and in 17 stream-sediment samples. In the rock samples, the amounts ranged from 200 to 1,000 ppm, and in the stream-sediment samples, from 200 to 500 ppm. Twelve panned concentrates contained zinc in the range from 200 to 300 ppm. Zinc in rock samples occurs either without anomalous amounts of other elements or with anomalous amounts of copper and (or) lead, and less commonly with one or both of these elements and silver, molybdenum, or tin. In most stream-sediment samples zinc occurs without anomalous amounts of other elements, or, in some samples, with anomalous amounts of silver, lead, copper, and tin. The potential for the discovery of zinc deposits is considered low.

Most samples containing anomalous amounts of zinc are scattered, but they do occur in groups in three areas. The largest of these is on Mesatchee Creek (see section, "Copper"). Weakly anomalous amounts of zinc were detected in a second area, 3 mi (5 km) to the south in block X15-Y18 and X16-Y18. In the latter area three sediment samples from streams that drain the same pluton west of Bumping Lake contain 200-300 ppm zinc.

Zinc (200-300 ppm) was detected in sediment samples from three streams from a third area, 7 mi (11 km) farther south, at the head of Deep Creek in blocks X16-Y14 and X16-Y15; a panned concentrate from one stream yielded 200 ppm zinc. There, granodiorite forms an intrusive wedge between rocks of the Puget Group to the west and of the Ohanapecosh Formation to the east.

Sphalerite occurs at the Blackjack claims (pl. 3, No. 42) north of the little Twin Sister Lake in block X16-Y14. In order to determine if zinc is more widespread, 76 samples from that area and from along the margin of the enclave within the study area were further tested for zinc by colorimetric methods, but little or no zinc was found.

### LEAD

Anomalous quantities of lead were found in 34 rock samples and in 15 stream-sediment samples. The amount of lead in the rock samples ranged from 30 to 300 ppm, and in the stream-sediment samples, from

30 to 50 ppm with one sample containing 100 ppm. No panned concentrates contained as much as 30 ppm of lead. Anomalous lead occurs either without anomalous amounts of other elements or with anomalous amounts of zinc, silver, copper, tin, or molybdenum. None of the data suggests the presence of a deposit of lead.

The greatest concentration of samples containing anomalous amounts of lead is on Nelson Ridge (see "Silver"); other occurrences are near Mesatchee Creek and on the ridge above American Lake at the head of the American River (see "Copper").

Elsewhere, anomalous amounts of lead are in sediments from the headwaters of Dog Creek and North Fork Rattlesnake Creek near X19-Y17; these streams drain the ridge that extends northeastward from Mount Aix to Nelson Butte (not to be confused with Nelson Ridge). This ridge is composed of andesitic tuff and breccia of the Ohanapecosh Formation, but anomalous amounts of lead were not found in samples of these rocks.

Lead contents of 30-70 ppm are in rocks and stream sediments on the northwest side of Nelson Butte and in a drainage from the opposite side of North Fork Rattlesnake Creek near the Richmon "mine" (pl. 3, No. 9) in block X19-Y18. This occurrence is similar to another along Timber Creek in the north part of the study area. At the latter locality, three rock samples from the Ohanapecosh Formation yielded anomalous amounts of lead, but many others, including all of the stream-sediment samples, contained normal amounts.

## MOLYBDENUM

Anomalous amounts of molybdenum were detected in 26 rock samples in the range from 5 to 30 ppm and in 14 stream-sediment samples in the range from 5 to 7 ppm, with 1 sample having 15 ppm. Molybdenum was not detected in panned concentrates. No strong anomalies were found, and samples with weakly anomalous quantities of molybdenum are widely scattered; only 10 rock samples and one stream-sediment sample containing anomalous amounts of molybdenum also contain anomalous amounts of other elements.

Most of the molybdenum occurrences have a spatial relationship with the granitic pluton near the northwest corner of the study area. There, molybdenum occurs in tuff, breccia, and flow rocks of the Ohanapecosh Formation and in granitic rocks near their contacts with the Ohanapecosh. The anomalous samples are from two zones, one along the southwest side of the granitic pluton between American River and Naches Peak, and another on the northeast side of the pluton in the Mesatchee Creek area. (See section, "Copper.")

## TIN

Anomalous amounts of tin were found in 29 rock samples and 7 stream-sediment samples; no tin was found in panned concentrates. In rocks samples the tin content ranged from 10 to 70 ppm with one sample containing 150 ppm; in stream-sediment samples the content ranged from 10 to 30 ppm. Most tin in the 10- to 20-ppm range is not associated with anomalous amounts of other elements. Larger amounts, 30 ppm and above, are associated with anomalous silver, lead, copper, molybdenum, or zinc. The study area is considered to have no potential for tin deposits.

Most of the samples having anomalous tin are from either intrusive bodies of rhyodacite or the Puget Group and Ohanapecosh Formation near rhyodacite, but the small amounts and sparsity of the occurrences are not promising guides for prospecting. The only area containing a concentration of anomalous samples, and which includes most of the higher amounts that were found, is on Nelson Ridge and two east-trending spur ridges from Nelson Ridge in block X18–Y17. (See section, "Silver.")

## URANIUM

Many claims, presumably for radioactive minerals, were located in the study area and vicinity during the 1950's. All of them were checked with a scintillometer by the U.S. Bureau of Mines; the highest readings were too low to suggest economic concentrations of radioactive materials and no radioactive minerals were identified. All geochemical samples collected by the U.S. Geological Survey were scanned for abnormal radioactivity with negative results. Equivalent uranium was determined on 25 samples by an instrument method with negative results. The study area is considered to have no potential for uranium deposits.

## OTHER METALS

Anomalous amounts of tungsten, antimony, beryllium, bismuth, and yttrium were found in a few samples. None of these curiosities are considered indicative of potentially economic deposits.

Only one sample in the study area contained a measurable amount (50 ppm) of tungsten; this was a sample of altered rhyodacite from Nelson Ridge. (See section, "Silver.")

Traces of tungsten are in the Clara-Red Bird vein (pl. 3, Nos. 25–26) just outside the study area, from which a small quantity of tungsten concentrates was shipped. The Clara-Red Bird vein does not crop out on the crest of Miners Ridge, the boundary of the study area, and rock samples from adjacent parts of the ridge contained no tungsten.

Antimony has been reported from two places in the study area (Purdy, 1951), but only one rock sample contained an anomalous amount. Sample CS 503, mentioned under the heading, "Silver," is of altered rhyodacite on Nelson Ridge and contains 150 ppm of antimony.

Seventy-six samples from around the margin of the enclave within the study area were tested for antimony by atomic absorption methods, but all analyses were very low, the highest being 6 ppm.

An anomalous amount of beryllium was found in one stream-sediment sample, CO 83, in block X20–Y15. The sample was taken from a small tributary to Little Hindoo Creek about 500 ft (150 m) upstream on that creek from its confluence with Hindoo Creek. The sample contained 100 ppm of beryllium and only ordinary amounts of other elements.

Traces of bismuth were found in five rock samples. Three samples contained 10 ppm and two samples, CS 503 and CS 504, contained 70 ppm; both are from altered rhyodacite in a prospected area on Nelson Ridge. (See section, "Silver.")

Concentration of a rare-earth metal was found in only one sample, CP 304, a stream-sediment sample from the mouth of a small tributary to Indian Creek in Indian Creek Meadows in block X17–Y13. At the point of sampling, the stream flows over Quaternary basalt, but most of its course is through andesitic rocks of the Ohanapecosh Formation. The sample contained 200 ppm of yttrium, but no other elements were present in anomalous amounts.

## COAL

Coal has been reported in the Puget Group along Rattlesnake Creek in the eastern part of the area, along Bumping River southwest of Bumping Lake, and along Carlton Creek near the west edge of the study area. Carbonaceous shale and carbonaceous material in sandstone of the Puget Group were found at several places, but no coal was seen during the present survey. Carbonaceous shale from the upper part of Carlton Creek contained 73.3 percent ash, 13.2 percent fixed carbon, 13.5 percent volatile matter, and a very low heating value of 2,250 BTU. A piece of carbonaceous shale from the Rattlesnake Creek area, selected because its dark color indicated that it should have a higher carbon content than any other rock seen in the area, contained 8.38 percent total carbon.

### BUILDING STONE AND CONSTRUCTION MATERIALS

The study area contains rock suitable for building stone, road building, and construction materials. The Dog Lake quarry, at the southern boundary of the study area, has produced slab andesite for specialty stone. Several acres of similar rock occur just outside the study area, along the White Pass highway. Other rock, particularly andesite, was quarried from sites along Bumping River downstream from the lake. No attempt was made to evaluate common varieties of rock in the study area, because these materials are too far from major markets to compete with more easily accessible sources of building and construction stone.

### CINDERS

Tumac Mountain, a Holocene volcanic cone, is chiefly composed of cinders with a few thin basalt flows. The materials making up the cone are suitable for road surfacing, but equally suitable materials are available much closer to market areas.

Pumice, suitable for use as an abrasive, has been reported at Tumac Mountain, but only a few pieces were seen during the present study.

### MINERAL WATER

Two mineral springs occur in and near the study area. Analyses of both springs are given in table 1. The spring on Summit Creek flows about 300 gal/min (Moen, 1962, p. 3) and was once used by a commercial bottling works. The spring on Bumping River is somewhat smaller.

## MINING CLAIMS

Records of Yakima and Lewis Counties indicate that about 450 claims have been located within or along the edge of the study area. Some claims have been filed more than once and others were relocated under different names. Only one group of placer claims is in the study area but most streams were probably prospected. There are no patented claims in the study area.

The first mining claim was staked in 1872 near Dewey Lake and the most recent claims were recorded in 1973 in the Mesatchee Creek area. Claims have been staked in four main areas: (1) American Ridge (includes Mesatchee Creek) along the north edge of the study area; (2)

Nelson Ridge, just east of Bumping Lake; (3) Miners Ridge, just south of Bumping Lake; and (4) Indian Creek-Wildcat Creek, at the southeast edge of the study area.

The properties that have mineral potential or historic significance are described in detail and are listed by map numbers shown on plate 3. Descriptions of other properties are tabulated.

## MESATCHEE CREEK AREA

The Mesatchee Creek area is at the north end of the study area (pl. 3, Nos. 3, 4). Numerous mining claims were located in the 1890's, probably as a result of activity in adjacent parts of the Summit mining district. Several claims were relocated, probably for uranium, during the middle 1950's. Recent activity has been stimulated by a geochemical survey showing copper anomalies (Moen, 1969). Burlington Northern, Inc. located 14 claims in 1970. During the 1973 field season, Duval International Corp. located claims, conducted a geochemical and magnetometer survey, and drilled one hole.

Prospect workings consist of a short adit at the falls of Mesatchee Creek (fig. 5, No. Z-137), two closely spaced pits at the crest of the ridge between the creek and American River (fig. 5, Nos. V-35 and V-36), and two caved adits and related surface cuts on the west-facing slope of the main ridge (fig. 5, Nos. V-37, V-38, V-51, V-52, and V-54).

The area is underlain by andesite and rhyolite of the Eocene Ohanapecosh Formation and by a Miocene granodiorite intrusive. The contact between formations trends northwesterly through Mesatchee Creek, with the intrusive to the west (fig. 5). Near the contact, the rocks are pyritized and stained with iron oxides. The granodiorite is also sericitized and somewhat silicified near the contact. Sulfide minerals, predominantly pyrite and minor chalcopyrite, are found disseminated or in narrow veinlets. Supergene copper minerals such as malachite and azurite are rare. According to Duval International Corp., an outcrop in the northwest part of block X15-Y19 contains chalcopyrite. The pyritized contact zone crops out along the canyon of Mesatchee Creek and along the course of an unnamed drainage near the intersection of the formation contact and Mesatchee Creek (fig. 5), and is exposed by several workings on a ridge between Mesatchee Creek and American River.

Twenty-seven samples were cut from the localities shown in figure 5. They contained as much as a trace gold, as much as 0.2 oz silver/ton (6.9 g/t), and from 0.003 to 0.072 percent copper. The highest grade copper sample, Z-136, is from an outcrop below the falls on Mesatchee

Creek. Another sample, V–34, containing 0.064 percent copper, is from rhyolite that was heavily stained with iron oxide.

Rock alteration in the area suggests the possible presence of a concealed porphyry-type copper deposit. Duval International Corp. (written commun., 1973) was encouraged by a secondary chalcocite zone intersected by diamond drilling, and plans to continue its drill program.

### RICHMOND "MINE" CLAIMS

The Richmond "mine" claims (pl. 3, No. 9) are near North Fork Rattlesnake Creek in the southeast part of block X19–Y18. Access is by 5.7 mi (9 km) of trail from Goose Prairie or 3.0 mi (5 km) of trail from Clover Spring. The Richmond group consists of 26 unpatented claims first staked in 1917. No production has been recorded. The claims are within the watershed of the city of Yakima and all mining activity has been curtailed.

Prospect workings in light-gray Pleistocene(?) or Pliocene(?) porphyritic andesite expose a shear zone trending N. 40° W. and dipping steeply to the southwest (fig. 6). The zone is poorly defined because most of the area is covered by glacial debris as much as 6 ft (2 m) deep. The zone can be intermittently traced along strike for 630 ft (190 m) and over a width of 30 ft (9 m). The zone is iron oxide stained and composed of faults separated by ½–1 ft (15–30 cm) of altered andesite. The faults are locally filled with gouge and quartz, calcite, and siderite veinlets. Sulfide minerals—pyrite, bornite, chalcopyrite, galena, arsenopyrite, and tetrahedrite—occur disseminated in the veinlets, as minute stringers, and as blebs as much as 1 in. (2.5 cm) in diameter. Copper-bearing minerals have halos of malachite and azurite. A selected sample contained 2.4 oz silver/ton (82 g/t), 1.7 percent lead, 7.6 percent zinc, and 0.5 percent copper. Three chip samples, each 3.0 ft (0.9 m) long, taken across exposed sections of the shear zone averaged 0.7 oz silver/ton (24 g/t), 0.6 percent zinc, 0.17 percent lead, and 0.17 percent copper.

Sampling results indicate low-grade values exist in surface exposures. It is not known what values exist at depth or along extensions of this zone presently covered by glacial debis.

### KEYSTONE CLAIMS

The Keystone property (pl. 3, No. 13) is on the west-facing slope of Nelson Ridge, 3 mi (5 km) south of Bumping Lake dam. The main workings can be reached by a steep trail from the mine campsite near the Deep Creek road. All buildings have been destroyed.

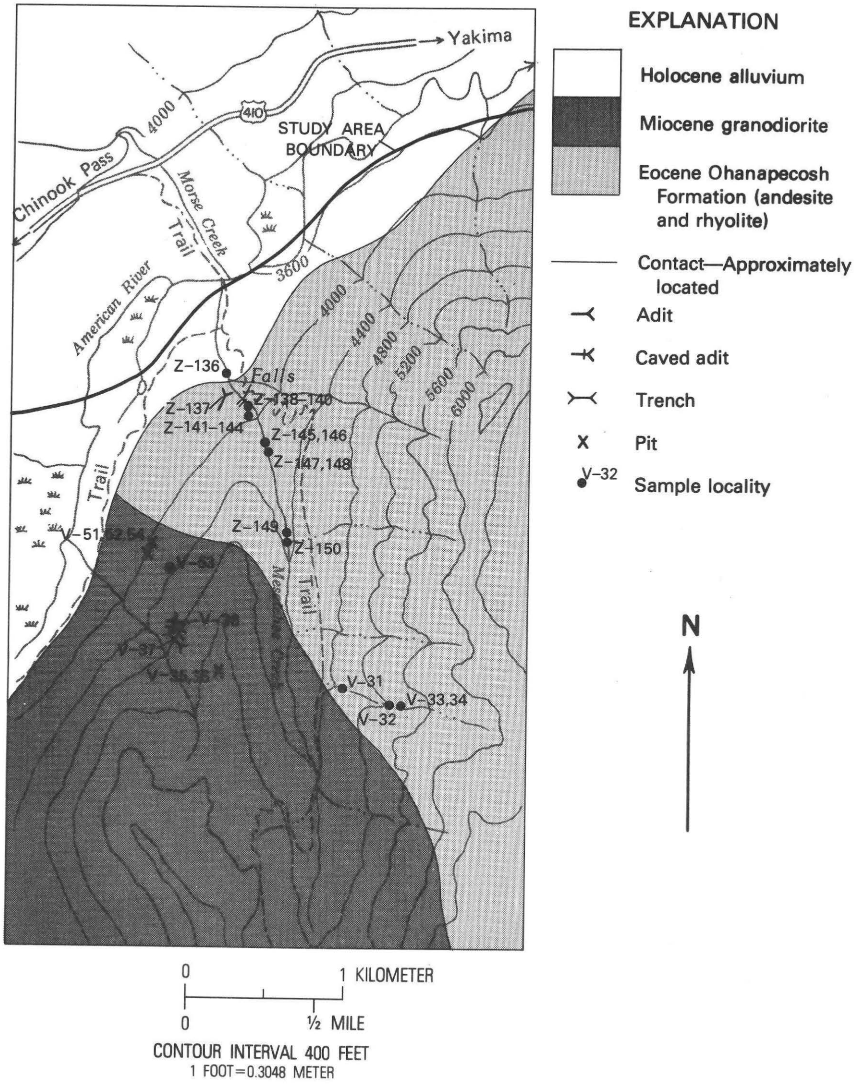



FIGURE 5.—Mesatchee Creek area.

According to county records, the first Keystone claim was located in 1913. Huntting (1956) described the property as a group of 12 unpatented claims. No production has been recorded and the property appears to have been inactive for many years.

Workings consist of two caved adits and several surface cuts (fig. 7). Huntting (1956) indicated that the main adit was 90 ft (27 m) long. The other adit appears to be much shorter. The workings are along a contact between fine- to medium-grained granodiorite and rhyodacite por-

*Data for samples shown in figure 5*

[Tr, trace; N, none detected]

| Sample | | | | | Gold (ounce per ton) | Silver (ounce per ton) | Copper (percent) |
|---|---|---|---|---|---|---|---|
| No. | Type | Length (feet) | Length (meters) | Description | | | |
| V-31 | Chip------- | 15.0 | 4.6 | Iron-oxide-stained silicified granitic rock. | N | N | 0.008 |
| V-32 | ----do----- | 5.0 | 1.5 | Limonite-filled fault in hydrothermally altered volcanic(?) rock. | N | 0.2 | .032 |
| V-33 | ----do----- | 75.0 | 22.9 | Hydrothermally altered rhyolite with iron oxides. | Tr | .1 | .003 |
| V-34 | ----do----- | 15.0 | 4.6 | Silicified rhyolite with sulfides---- | Tr | Tr | .064 |
| V-35 | ----do----- | 2.5 | .8 | Fault with gouge and iron oxides----- | Tr | .1 | .004 |
| V-36 | ----do----- | 6.0 | 1.8 | Granodiorite with iron oxides-------- | N | .1 | .005 |
| V-37 | ----do----- | 75.0 | 22.9 | Silicified granodiorite-------------- | N | N | .016 |
| V-38 | ----do----- | 8.0 | 2.4 | Iron-oxide-stained granodiorite------ | Tr | Tr | .017 |
| V-51 | ----do----- | 10.0 | 3.1 | Quartz porphyry with pyrite---------- | N | .2 | .011 |
| V-52 | Grab------- | ---- | ---- | ----do------------------------------ | N | N | .007 |
| V-53 | Chip------- | 10.0 | 3.1 | ----do------------------------------ | N | N | .006 |
| V-54 | ----do----- | 4.0 | 1.2 | Quartz porphyry with disseminated pyrite. | N | .2 | .015 |
| Z-136 | ----do----- | 15.0 | 4.6 | Iron-oxide-stained porphyritic rhyolite with pyrite. | N | N | .072 |
| Z-137 | Chip------- | 14.0 | 4.3 | Iron-oxide-stained andesite---------- | N | N | .017 |
| Z-138 | ----do----- | 35.0 | 10.1 | ----do------------------------------ | N | Tr | .024 |
| Z-139 | ----do----- | 2.0 | .6 | Granitic dikes----------------------- | N | N | .027 |
| Z-140 | ----do----- | 40.0 | 12.2 | Iron-oxide-stained andesite---------- | N | .1 | .027 |
| Z-141 | ----do----- | 22.0 | 6.7 | Iron-oxide-stained andesite with pyrite. | Tr | .1 | .025 |
| Z-142 | ----do----- | 26.0 | 8.0 | ----do------------------------------ | N | Tr | .018 |
| Z-143 | ----do----- | 31.0 | 9.5 | Iron-oxide-stained andesite with pyrite and quartz stringers. | Tr | .2 | .017 |
| Z-144 | ----do----- | 95.0 | 29.0 | Iron-oxide-stained andesite with pyrite. | N | .1 | .030 |
| Z-145 | ----do----- | 35.0 | 10.1 | Iron-oxide-stained, bleached rhyolite | Tr | .1 | .012 |
| Z-146 | ----do----- | 4.5 | 1.4 | Iron-oxide-stained porphyritic rhyolite with pyrite. | Tr | .1 | .005 |
| Z-147 | ----do----- | 41.0 | 12.5 | ----do------------------------------ | N | N | .025 |
| Z-148 | ----do----- | 41.0 | 12.5 | ----do------------------------------ | Tr | .1 | .005 |
| Z-149 | ----do----- | 27.0 | 8.2 | ----do------------------------------ | N | N | .063 |
| Z-150 | ----do----- | 20.0 | 6.1 | ----do------------------------------ | Tr | .1 | .021 |

phyry, both of Miocene age. The granodiorite contains xenoliths of a finer grained granitic rock and is locally highly iron oxide stained. The contact is mostly covered, but, where exposed, trends from north to northwest and dips towards the west (downslope). Several fault and joint sets are exposed in the granodiorite, but they do not contain significant metals. The most prominent fault zone is as much as 1.5 ft (0.5 m) wide. The only evidence of mineralized rock was found in a

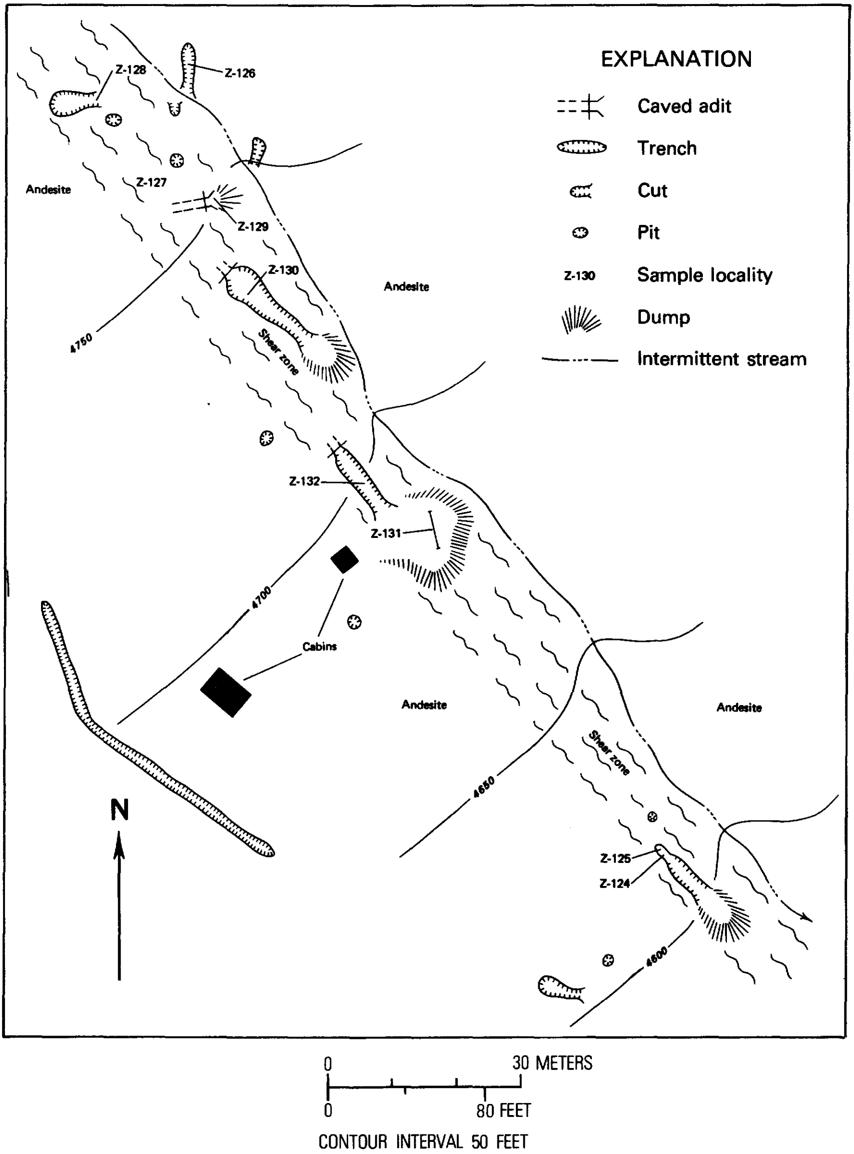



FIGURE 6.—Richmond "mine" claims. Located on plate 3, No. 9.

small stockpile and some mill concentrate in the remains of an ore bin. None of the stockpiled material is typical of rock in outcrops on the property or in the dumps; the mineralized rock either came from within the caved adits or from another property.

*Data for samples shown in figure 6*

[Tr, trace; N, none detected]

| Sample | | | | | Gold (ounce per ton) | Silver (ounce per ton) | Lead (percent) | Zinc (percent) | Copper (percent) |
|---|---|---|---|---|---|---|---|---|---|
| No. | Type | Length (feet) | Length (meters) | Description | | | | | |
| Z-124 | Chip------ | 3.0 | 0.9 | Fractured, iron-oxide-stained andesite. | N | N | Tr | Tr | Tr |
| Z-125 | Select---- | --- | --- | Gouge in 0.5-inch shear------- | N | 0.3 | 0.1 | Tr | Tr |
| Z-126 | Grab------ | --- | --- | Fractured, iron-oxide-stained andesite. | N | .2 | Tr | 0.3 | Tr |
| Z-127 | Chip------ | 3.0 | .9 | Fractured, iron-oxide-stained andesite with galena and chalcopyrite. | N | 2.1 | .4 | 1.7 | 0.4 |
| Z-128 | ----do---- | 3.0 | .9 | Fractured, iron-oxide-stained andesite. | Tr | .1 | Tr | Tr | Tr |
| Z-129 | Select---- | --- | --- | Sulfide-bearing, fractured andesite. | N | 2.4 | 1.7 | 7.6 | .5 |
| Z-130 | Grab------ | --- | --- | Fractured, iron-oxide-stained andesite. | N | N | .1 | Tr | Tr |
| Z-131 | Channel--- | 20.0 | 6.1 | ----do----------------------- | Tr | 1.0 | Tr | 1.5 | .2 |
| Z-132 | Grab------ | --- | --- | ----do----------------------- | N | 1.0 | .3 | .9 | .3 |

The material in the stockpile is a sericitized granitic rock containing arsenopyrite, chalcopyrite, and minor wolframite. A sample contained 0.2 oz silver/ton (6.9 g/t), 0.16 percent copper, 0.36 percent arsenic, and 0.01 percent $WO_3$. No gold was detected. Grab samples of mill concentrate contained 0.54 and 2.8 oz silver/ton (18.5–95.9 g/t), 3.8 and 4.43 percent $WO_3$, and a trace and 0.06 oz gold/ton (2.1 g/t), respectively.

The property is on a poorly defined mineralized zone that was traced for more than a mile. Other prospects (pl. 3, Nos. 15, 16, and 18), located from 3,600 to 6,400 ft (1,100–2,000 m) to the south, might be on the same or related structures. Most of the zone is covered by talus and other overburden.

## MINERS RIDGE AREA

Prospect workings along Miners Ridge, just south of Bumping Lake, are mostly in an area excluded from the study area. Several test pits, however, are on the ridge crest, which is the study area boundary (fig. 8; pl. 3, Nos. 25–33, 35). The main camp and mill are near Deep Creek and are accessible by a jeep road. The Copper Mining Co. group, totaling 42 claims, was located in 1906. A few intermittent shipments of copper and tungsten concentrates have been made from workings outside the study area. U.S. Bureau of Mines records indicate that 5 tons (4.5 t) containing 34 oz silver/ton (1,166 g/t) and 1,486 lb (674 kg)

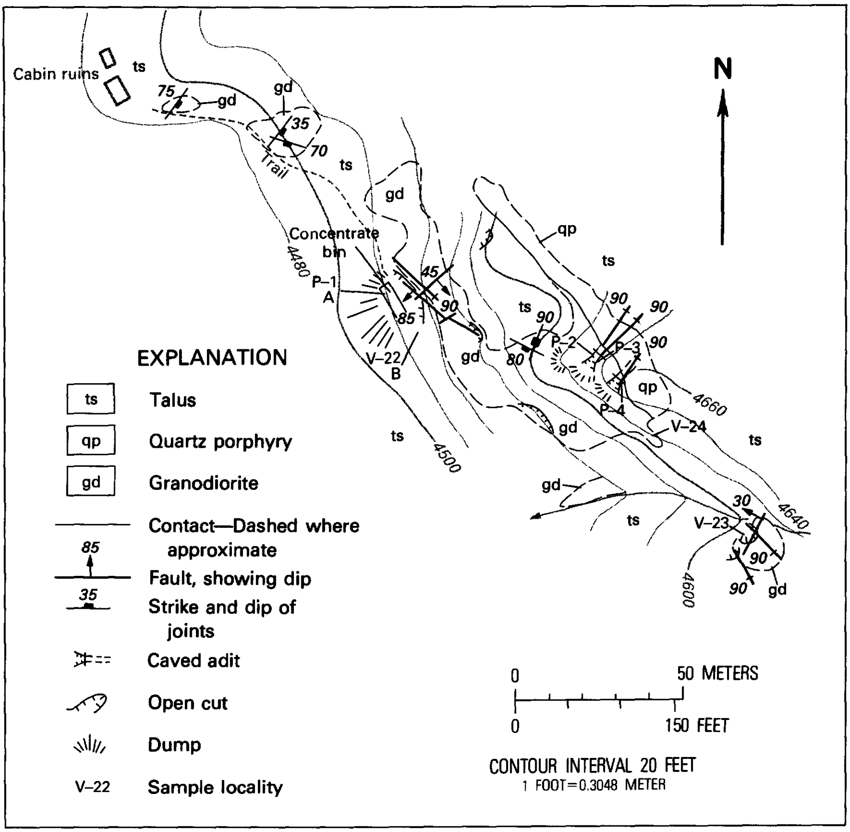



FIGURE 7.—Keystone property. Located on plate 3, No. 13.

of copper were shipped in 1917, and 150 tons (136 t) containing 1 oz gold/ton (34 g/t), 99 oz silver/ton (3,394 g/t), and 4,347 lb (1,972 kg) copper were shipped in 1938; 650 lb (295 kg) containing 62.4 percent tungsten trioxide were shipped in 1940; and 5 tons (4.5 t) containing 48 oz silver/ton (1,645 g/t) and 2,000 lb (907 kg) copper were shipped in 1942.

Miners Ridge is underlain by Miocene granodiorite cut by numerous Miocene rhyodacite dikes. Several shear zones trending about N. 65° W. were the controlling structures for the mineralization in the area, and were locally called veins. Five main shear zones have been prospected in the district. These are the Clara-Red Bird (pl. 3 and fig. 8, Nos. 25 and 26), New Find (No. 35), Pasco (No. 33), Sunset (No. 27), and 17th of Ireland (No. 24). The most significant is the Clara-Red Bird, which is exposed in three adits and several surface workings (fig. 8, Nos. 25 and 26). The Pasco shear zone is the only

*Data for samples shown in figure 7*

[Tr, trace; N, none detected; NA, not analyzed]

| Sample | | | | | Gold (ounce per ton) | Silver (ounce per ton) | Copper (percent) | $WO_3$ (percent) |
|---|---|---|---|---|---|---|---|---|
| | | Length | | | | | | |
| No. | Type | (feet) | (meters) | Description | | | | |
| P-1 | Grab------- | ---- | --- | Mill concentrate from bin-------- | Tr | 2.8 | NA | 3.80 |
| P-2 | Chip------- | 0.5 | 0.2 | Fault with gouge----------------- | N | .1 | NA | NA |
| P-3 | ----do----- | 2.0 | .6 | Iron- and manganese-oxide-stained granodiorite. | Tr | .2 | NA | NA |
| P-4 | ----do----- | 4.0 | 1.2 | ----do--------------------------- | N | N | NA | NA |
| V-22 | Grab------- | ---- | --- | Small stockpile of sulfide-rich rock. | N | .2 | 0.16 | 0.01 |
| V-23 | Chip------- | 20.0 | 6.1 | Iron-oxide-stained granodiorite with faults containing gouge. | N | .1 | .037 | .01 |
| V-24 | ----do----- | 20.0 | 6.1 | Iron-and manganese-oxide-stained granodiorite. | Tr | .1 | .022 | .02 |
| A[1/] | Grab------- | ---- | --- | Mill concentrate assumed to be similar to P-1. | 0.06 | .54 | NA | 4.43 |
| B[1/] | ----do----- | ---- | --- | Stockpile sample assumed to be similar to V-22. | .34 | 2.06 | .55 | 1.60 |

[1/]Sample taken by U.S. Bureau of Mines in 1958.

other structure with significant metal content exposed in the Miners Ridge area.

The Clara–Red Bird shear zone ranges in thickness from less than 1 in. to 16 ft (2.5 cm to 5 m) and can be intermittently traced on the surface for 1,700 ft (520 m). It strikes N. 65° W. and dips 35°–50° to the northeast. The shear zone extends into the study area, but although it is strong and well mineralized at the ridge crest, it is not exposed within the study area. The Clara–Red Bird zone is hydrothermally altered and contains chalcopyrite, arsenopyrite, pyrite, scheelite, and minor molybdenite. These minerals occur along shear planes, in clusters of crystals, and as veinlets and lenses. The ore minerals are generally confined to layers rarely exceeding 2 ft (0.6 m) in thickness.

Samples from the surface workings contained as much as 0.05 percent tungsten trioxide and 0.003 percent molybdenum, and averaged 0.6 oz silver/ton (21 g/t) and 0.21 percent copper. Samples from underground workings contained as much as 0.05 percent molybdenum and averaged 0.3 oz silver/ton (10 g/t), 0.70 percent copper, and 0.34 percent tungsten trioxide. The samples were taken across an average thickness of 2.8 ft (0.85 m).

Although the shear zone carries mineral values throughout, economic concentrations occur only in small isolated pockets. Much of it has not been explored, however, including a possible extension into the study area.

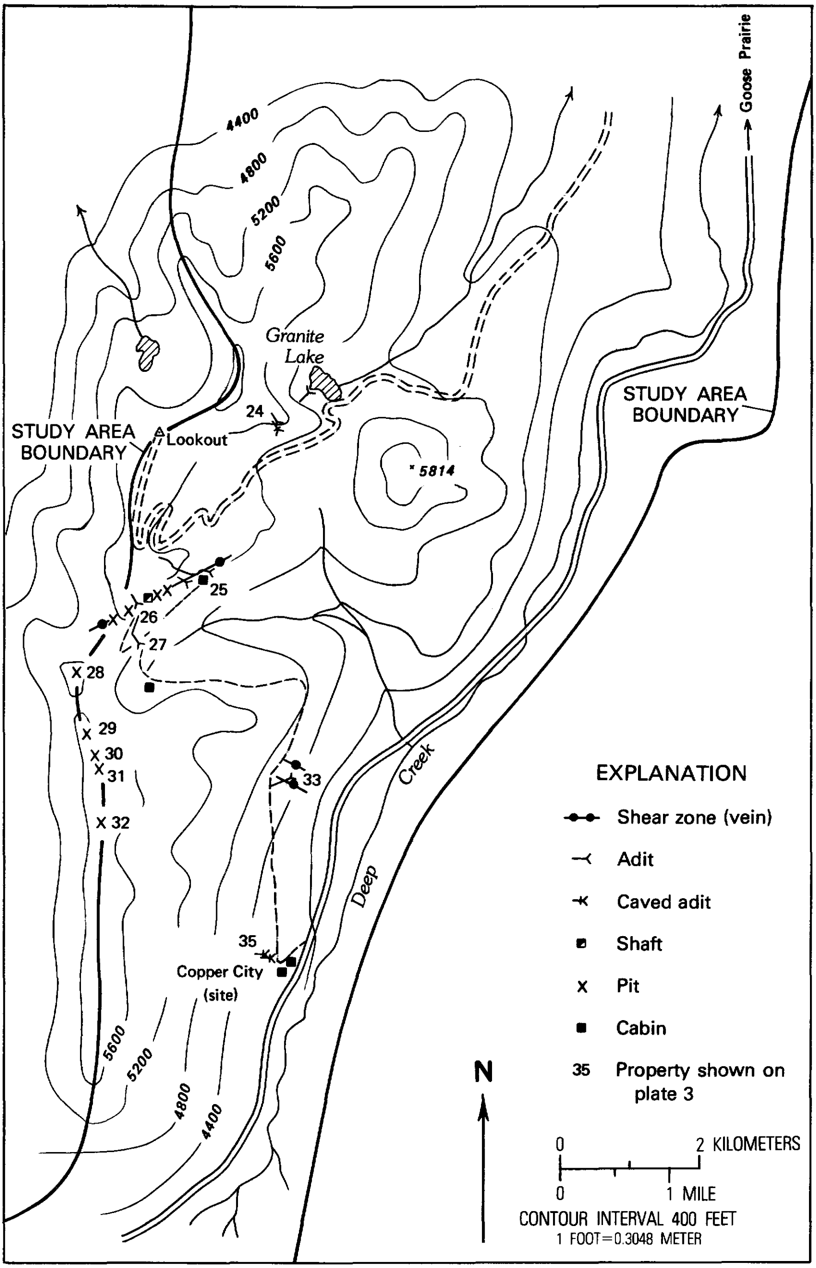



FIGURE 8.—Miners Ridge area. Location shown on plate 3, Nos. 25–33, 35.

The Pasco adit (pl. 3 and fig. 8, No. 33) is 3,500 ft (1,100 m) north of the mill and 500 ft (150 m) east of the Copper Mining Co. road. The adit is 27 ft (8 m) long and cuts a 1- to 4-in. (2.5- to 10-cm)-thick shear zone containing pyrite veins as much as 2 in. (5 cm) thick. The zone trends N. 60° W., dips 45° NE., and can be traced for 65 ft (20 m). Samples across the zone averaged 5.2 oz silver/ton (178 g/t) and 4.71 percent copper.

## BLACKJACK GROUP

Principal mine workings of the Blackjack group (pl. 3, No. 42) are near the Deep Creek trail, 100 yd (90 m) north of the little Twin Sister Lake. The group of 17 claims was initially located in 1906. Several claims have been relocated many times.

The main workings are a flooded 50-ft (15-m) inclined shaft, a 19-ft (6-m) adit, five trenches, and five pits. Several shear zones in fractured and silicified black argillite of Mesozoic(?) age are exposed in the workings; the most significant one was explored by the shaft. This shear zone strikes N. 45° W. and dips 40° SW. It was traced on the surface for 40 ft (12 m) northwest of the shaft and is exposed by three trenches for 120 ft (37 m) southeast of the shaft. The shear zone is about 4 ft (1.2 m) thick. It is composed of six narrower zones, the largest being 1.5 ft (0.5 m) thick. They contain gouge, sphalerite, pyrite, quartz, hematite, galena, and chalcopyrite. The gouge is locally iron oxide stained and contains some boxwork. Samples across the 4-ft (1.2-m)-thick zone averaged 4.0 percent zinc, 0.02 percent copper, and 0.07 percent lead.

A 19-ft (6-m) adit, 350 ft (110 m) N. 78° W. of the shaft, crosscuts a 3- to 10-in. (8- to 25-cm)-thick shear zone. The zone strikes N. 50° E., dips 70° NW., and is filled with iron-oxide-stained gouge and brecciated argillite. It is not exposed on the surface nor in two pits above the adit. A sample across the zone assayed 0.02 percent zinc; no other valuable metals were detected.

A trench 60 ft (18 m) N. 50° W. of the adit is on the contact between an aplite dike and argillite. A sample across the contact zone was barren of metals. Three pits and a trench to the southwest in argillite expose no mineralized rock.

Samples from the main shear zone indicate that a zinc resource may exist.

## INDIAN CREEK CINNABAR PROPERTY

The Indian Creek Cinnabar property (pl. 3, No. 50) is on an eastern tributary of Indian Creek. Access is from Rimrock Lake by U.S. Forest Service road and about 1 mi (1.5 km) of jeep road.

Originally the property consisted of two claims recorded in 1951. Later, 21 additional claims were located. Mercury was found in outcrops by the owners after tracing detrital cinnabar up Indian Creek by panning. First work on the property was an 8-ft (2.4-m)-long adit driven at the point of discovery (fig. 9).

In 1952, a DMEA (Defense Minerals Exploration Administration) contract was let to explore the property by 1,200 ft (370 m) of hand trenching and 1,400 ft (430 m) of diamond drilling (Willard Puffett, written commun., 1952, 1953). Fourteen diamond-drill holes were put down, but three were abandoned because of caving. The work explored an area along the stream for 1,500 ft (460 m). A 370-ft (110-m) adit (fig. 10) was driven to explore the zone shown by drill holes to contain the most mercury.

The three principal rock types exposed are (1) chloritic, well-foliated, metasedimentary rocks of Mesozoic(?) age; (2) light-colored, massive silica-carbonate rocks; and (3) a light-greenish-blue talcose rock, which might be either an altered metasedimentary or altered intrusive rock. Foliation strikes northwest and dips steeply to the southwest. Magnetite is disseminated in many of the rocks. Tiny grains of cinnabar occur disseminated in the silica-carbonate rocks and to a minor extent in the talcose rock.

Cinnabar was the only mercury mineral identified. A little cinnabar paint occurs in a few trenches but crystalline cinnabar was rarely seen near the surface.

The highest grade cinnabar-bearing rock intersected by drilling was in the 30- to 35-ft (9- to 11-m) interval in hole 11 (fig. 9) and from 15 to 20 ft (4.5-6 m) in hole 9. Core from these intervals contained 0.7 lb/ton (0.35 kg/t) mercury. Mercury was also detected in holes 2, 4, 5, 7, 8, and 10, but in lesser amounts. The highest grade surface sample (EAM-197) contained 12.0 lb/ton (5.5 kg/t) mercury. Samples taken in the adit contained a maximum of 3.4 lb/ton (1.7 kg/t) mercury from an 0.8-in. (20-mm)-thick gouge seam and 0.13 percent (2.6 lb/ton, 1.3 kg/t) mercury in a 2.5-ft (0.8-m) chip sample of silica-carbonate rock.

No clearly defined cinnabar-bearing structure was recognized, and the cinnabar occurrences seem to be discontinuous.

The Indian Creek Cinnabar property is at the west end of a 5-mi (8-km)-long area of known mercury occurrences that has potential for discovery of small mercury deposits.

## FIG PROPERTY

The Fig property (pl. 3, Nos. 52-55), formerly the Han-Fig property, consists of 16 manganese claims covering approximately 2 mi² (5 km² on the east side of, and including part of, Ironstone Mountain. Access is by 2 mi (3 km) of trail over Russell Ridge or 3 mi (5 km) of trail up Wildcat Creek.

Interest in the deposit began about 1928 and claims have been repeatedly relocated. Past production was small and small tonnages of manganese ore are currently being packed out and stockpiled.

Older workings, consisting of several shafts, trenches, and pits, are caved. Groups of workings are northeast of Ironstone Mountain, southeast of Ironstone Mountain (the site of present activity) (fig. 11), on Wildcat Creek, and on the crest of Russell Ridge.

The workings expose manganese-rich material in Tertiary sandstone, argillites, and dolomites of the Puget Group and Ohanapecosh Formation. Manganese concentrations occur within an area about 1,000 ft (300 m) wide and 6,000 ft (1,800 m) long, but outcrops are rare and it is not known if they are continuous between exposures. The few manganese pods and lenses that are exposed trend N. 20° W. and dip 20° NE.

The manganese occurs as wad (various manganese oxides) in irregular concentrations, interstitially, in the clastic host rocks. The manganese appears to be of sedimentary origin but has undergone some remobilization and is locally found as fracture fillings. The percentage of manganese oxides in the deposits is variable and unpredictable. Samples from the main workings ranged from 0.01 percent to 41.20 percent manganese and averaged 4.11 percent. Samples from the the workings did not exceed 0.5 percent manganese.

## RED SPUR MINE

The Red Spur mine (pl. 3, No. 57) is about 5,600 ft (1,700 m) northwest of the end of the upper Wildcat Creek road and is accessible by a jeep road. The area is moderately forested and contains few outcrops.

The Red Spur group consists of six claims located in 1941, adjoining the Fig group (pl. 3, Nos. 52-55) to the west and the Rocket group (pl. 3, No. 58) to the east.

About 50-60 lb (23-27 kg) of mercury were produced from about 1,600 lb (720 kg) of ore (Huntting, 1956). The mercury was probably distilled in a retort at the property. No other record of production is available.

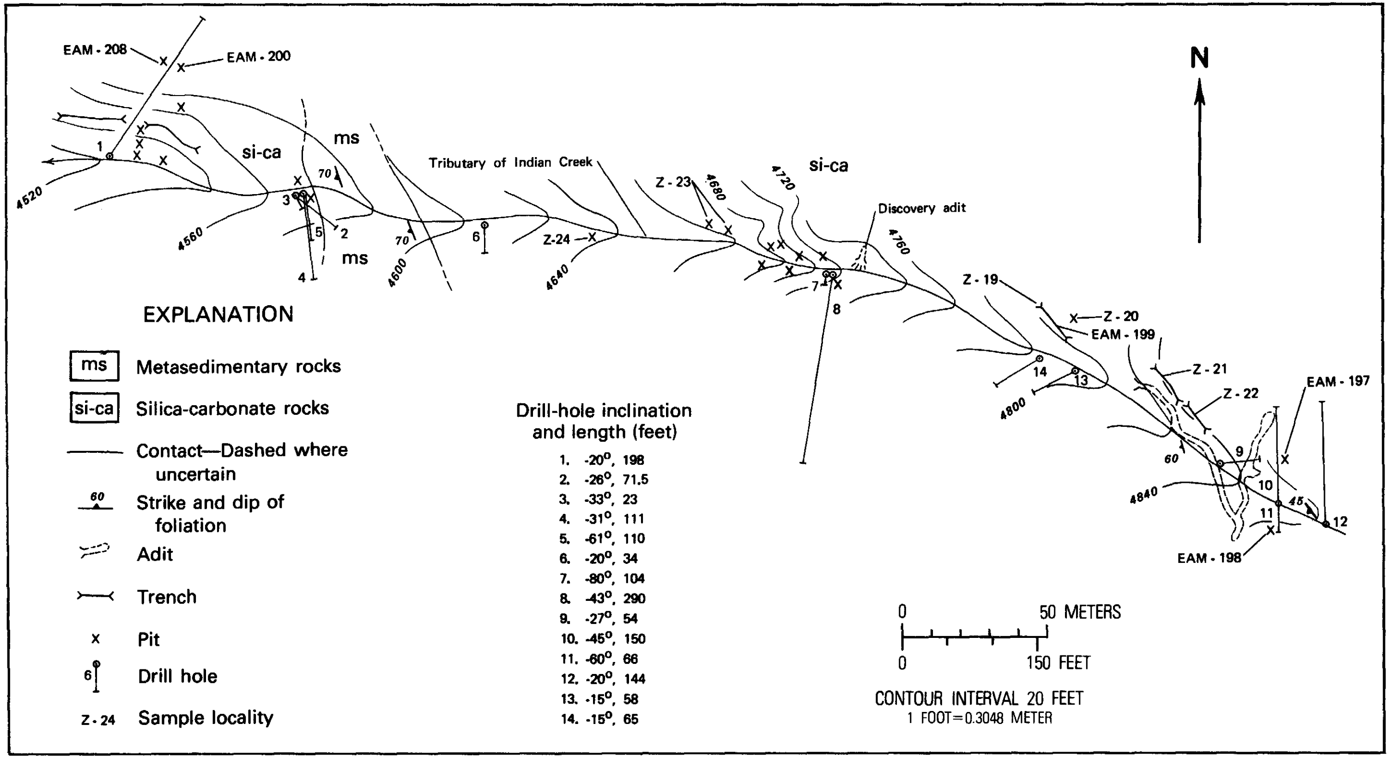



FIGURE 9.—Indian Creek Cinnabar property (pl. 3, No. 50). (Modified from Willard Puffett, written commun., 1954.)

### *Data for samples shown in figure 9*

[Tr, trace; N, none detected; NA, not analyzed]

| Sample | | | | | Gold (ounce per ton) | Silver (ounce per ton) | Mercury (pounds per ton) |
|---|---|---|---|---|---|---|---|
| | | Length | | | | | |
| No. | Type | (feet) | (meters) | Description | | | |
| Z-19 | Grab------- | ---- | --- | Silica-carbonate rock------ | Tr | 0.2 | N |
| Z-20 | ----do----- | ---- | --- | ----do------------------- | Tr | .1 | N |
| Z-21 | Chip------- | 2.0 | 0.6 | ----do------------------- | Tr | .7 | Tr |
| Z-22 | Grab------- | ---- | --- | ----do------------------- | N | .2 | N |
| Z-23 | ----do----- | ---- | --- | ----do------------------- | Tr | .1 | N |
| Z-24 | Chip------- | 3.0 | .9 | ----do------------------- | Tr | .1 | N |
| EAM-197[1/] | ----do----- | 7.0 | 2.1 | ----do------------------- | NA | NA | 12.0 |
| EAM-198[1/] | Select----- | ---- | --- | ----do------------------- | NA | NA | 7.2 |
| EAM-199[1/] | Chip------- | 10.0 | 3.1 | ----do------------------- | NA | NA | 1.2 |
| EAM-200[1/] | ----do----- | 10.0 | 3.1 | ----do------------------- | NA | NA | 2.4 |
| EAM-208[1/] | ----do----- | 10.0 | 3.1 | ----do------------------- | NA | NA | 3.6 |

[1/]Samples taken in 1952.

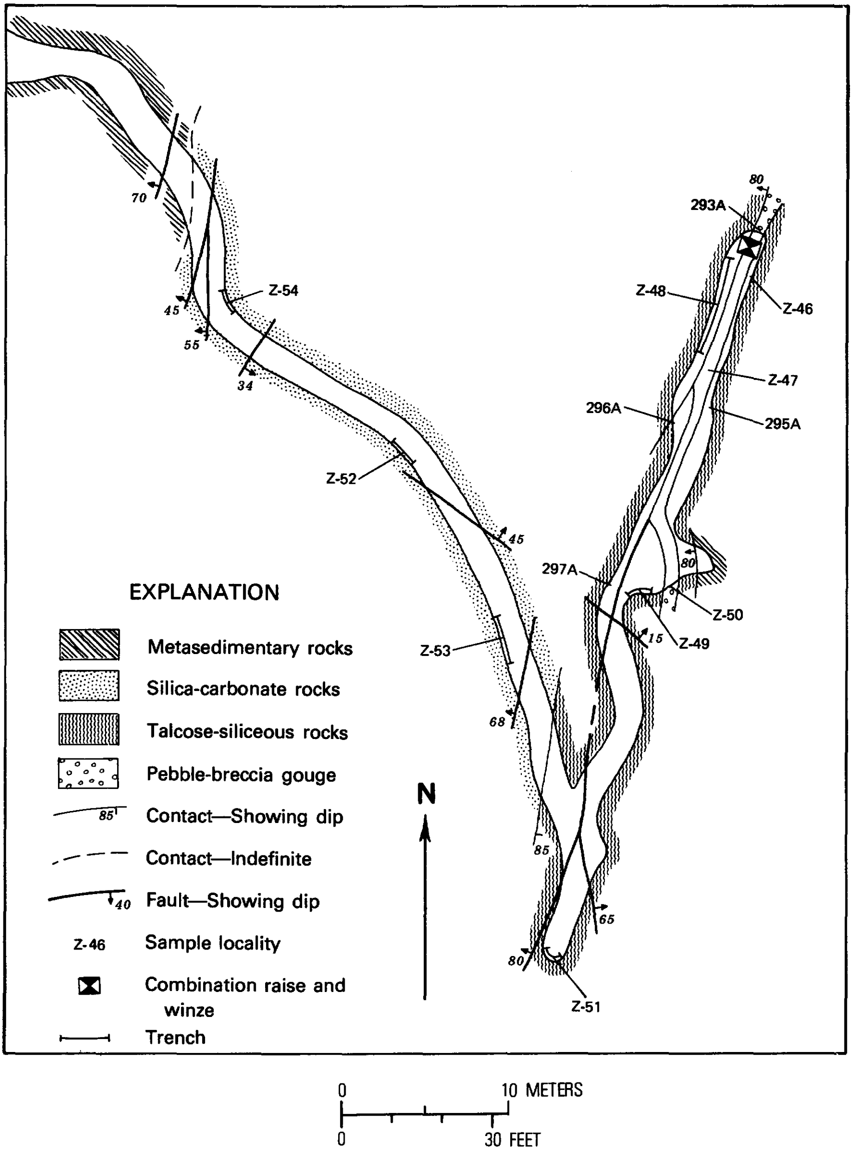



FIGURE 10.—Indian Creek Cinnabar adit. (Modified from Willard Puffett, written commun., 1954.)

Principal mine workings are a caved adit and a 250-ft (76-m)-long trench excavated above the adit (fig. 12). Several small caved prospect pits are nearby. According to Huntting (1956), the adit was at least

*Data for samples shown in figure 10*

[Tr, trace; N, none detected]

| Sample | | | | | Mercury (pounds per ton) |
|---|---|---|---|---|---|
| | | Length | | | |
| No. | Type | (feet) | (meters) | Description | |
| Z-46 | Chip------- | 4.0 | 1.2 | Silica-carbonate rock----- | Tr |
| Z-47 | ----do----- | 2.3 | .7 | Across pebble dike-------- | Tr |
| Z-48 | ----do----- | 20.0 | 6.1 | Silica-carbonate rock----- | 0.2 |
| Z-49 | ----do----- | 5.5 | 1.7 | ----do------------------- | Tr |
| Z-50 | ----do----- | 3.5 | 1.1 | Pebble dike--------------- | N |
| Z-51 | ----do----- | 4.0 | 1.2 | Silica-carbonate rock----- | .2 |
| Z-52 | ----do----- | 6.0 | 1.8 | Siliceous wallrock-------- | Tr |
| Z-53 | ----do----- | 10.0 | 3.1 | ----do------------------- | Tr |
| Z-54 | ----do----- | 3.5 | 1.1 | ----do------------------- | Tr |
| 293 A[1/] | ----do----- | .8 | .2 | Gouge-------------------- | 3.4 |
| 295 A[1/] | ----do----- | 2.4 | .7 | Silica-carbonate rock----- | N |
| 296 A[1/] | ----do----- | 2.5 | .8 | ----do------------------- | 2.6 |
| 297 A[1/] | ----do----- | 1.0 | .3 | ----do------------------- | .4 |

[1/]Samples taken in 1952.

115 ft (35 m) long. Other surface cuts, now slumped, are about 500 ft (150 m) southwest and 600 ft (180 m) southeast, respectively, of the principal workings.

The property is underlain by tuffaceous sandstone of the Ohanapecosh Formation with minor calcite and quartz veinlets. The best exposures are in the main trench. Here the rocks are faulted and sheared. The main trench follows a poorly defined, northwest-trending shear zone ranging from 2 to 4 ft (0.6–1.2 m) in thickness. It consists of brecciated sandstone, a cinnabar-bearing gouge zone as much as 4 in. (10 cm) thick, and minor calcite veins. The gouge seam strikes N. 25° W. and dips 75° west. Cinnabar and metacinnabar occur as sporadic pods and veins up to 0.25 in. (6.4 mm) thick, and as paint in the gouge.

Four chip samples averaging 3.4 ft (1 m) in length were cut across the shear zone (fig. 12). Two of the samples taken near the middle of the trench contained 2.3 and 0.2 lb/ton (1.15 and 0.1 kg/t) mercury; two samples cut across the zone at the north end of the trench contained no detectable mercury. A selected sample of the cinnabar-bearing gouge zone exposed in the floor of the trench contained 1.11 percent mercury.

Samples were also taken of the country rock in the main trench and in several pits. Sample Z-13 is from a pit about 600 ft (180 m)

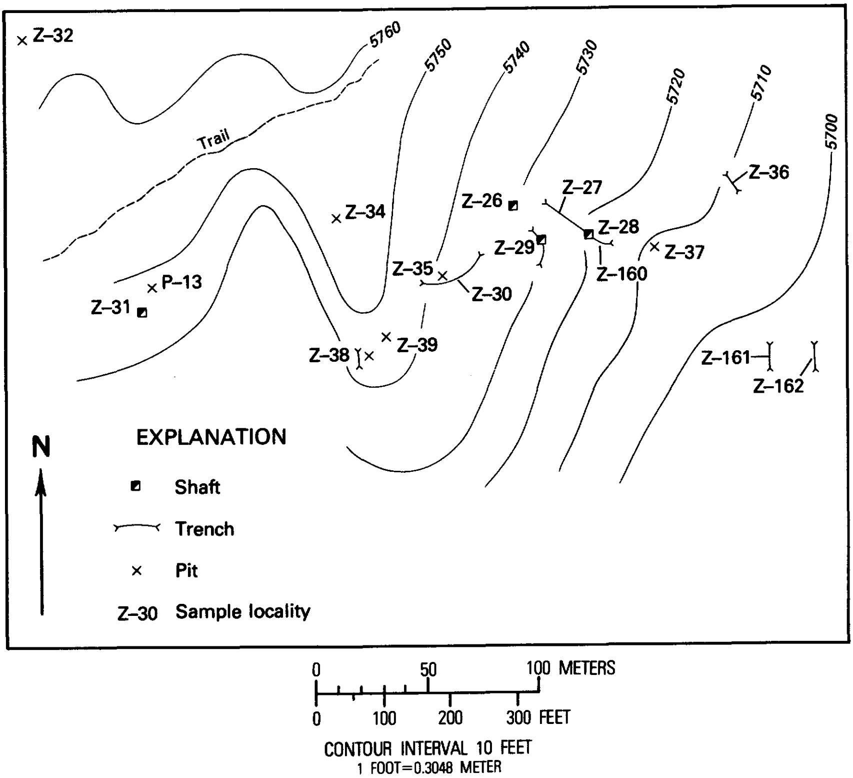



FIGURE 11.—Fig property. Location shown on plate 3, Nos. 52–55.

southeast of the main trench and contained 0.2 lb/ton (0.1 kg/t) mercury. A grab sample (Z-12) of tuffaceous sandstone containing minute cinnabar-filled fractures, found on the dump of the pit, contained 3.2 lb/ton (1.6 kg/t) mercury. Calcines at the retort contained 0.05 lb/ton (0.03 kg/t) mercury.

A geochemical survey of the soils was made over an area 450 by 500 ft (140 by 150 m) to check for possible extensions of the exposed mercury occurrence (fig. 13). A grid with 25-ft (7.6-m) intervals was established and a sample was taken at each grid intersection, except where the ground had been disturbed. A total of 359 soil samples was taken below a persistent 2- to 3-in. (5- to 8-cm)-thick layer of white volcanic ash overlain by a fairly uniform 1- to 2-in. (2.5- to 5-cm)-thick layer of mull. The mercury content of the samples ranged from 0.1 ppm to 15.0 ppm with a median value of 0.5 ppm and a mean value of 0.6 ppm. Ninety-five percent of the samples contained less than 1.0 ppm mercury.

*Data for samples shown in figure 11*

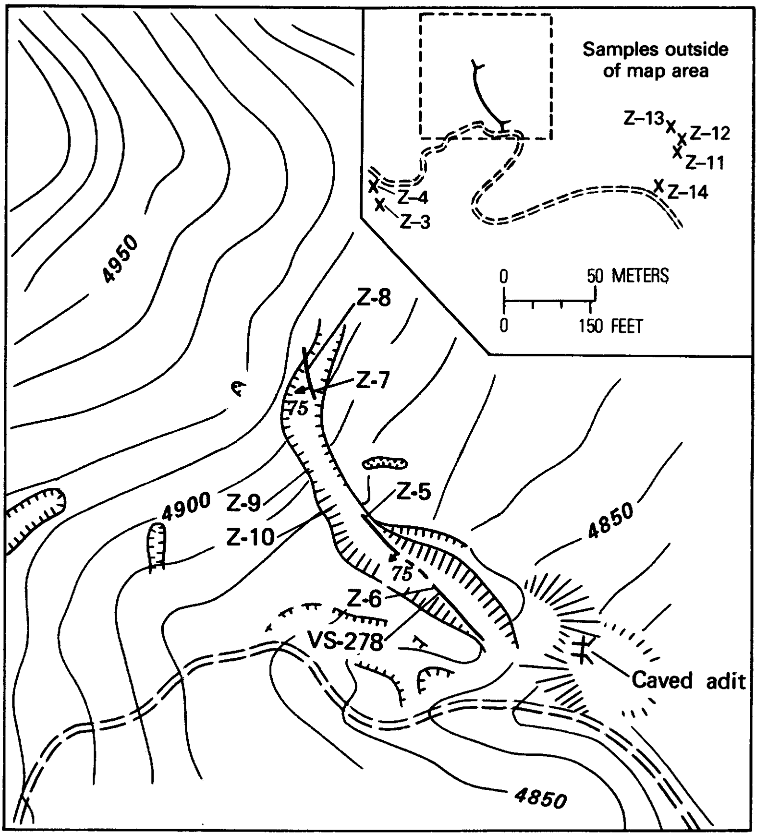
| Sample | | | | | |
|---|---|---|---|---|---|
| No. | Type | Length (feet) | Length (meters) | Description | Manganese (percent) |
| P-13 | Chip------- | 2.9 | 0.9 | Manganiferous siltstone---------- | 0.01 |
| Z-26 | ----do----- | 5.0 | 1.5 | Manganiferous sandstone---------- | .04 |
| Z-27 | ----do----- | 2.0 | .6 | ----do-------------------------- | .58 |
| Z-28 | Grab------- | ---- | --- | ----do-------------------------- | 1.28 |
| Z-29 | Chip------- | 5.0 | 1.5 | ----do-------------------------- | 20.10 |
| Z-30 | ----do----- | 30.0 | 9.2 | Sheared sedimentary rocks-------- | .19 |
| Z-31 | Grab------- | ---- | --- | Manganiferous siltstone---------- | 2.11 |
| Z-32 | ----do----- | ---- | --- | Manganiferous argillite---------- | .10 |
| Z-34 | Chip------- | 3.0 | .9 | Manganiferous sedimentary rock--- | .49 |
| Z-35 | Grab------- | ---- | --- | ----do-------------------------- | .54 |
| Z-36 | ----do----- | ---- | --- | Argillite----------------------- | .05 |
| Z-37 | ----do----- | ---- | --- | ----do-------------------------- | .05 |
| Z-38 | ----do----- | ---- | --- | Manganiferous sandstone---------- | .18 |
| Z-39 | Chip------- | 8.0 | 2.4 | ----do-------------------------- | .23 |
| Z-160 | ----do----- | 3.0 | .9 | ----do-------------------------- | 41.20 |
| Z-161 | Grab------- | ---- | --- | Argillite----------------------- | .10 |
| Z-162 | Chip------- | 2.0 | .6 | ----do-------------------------- | .06 |
| Z-163 | ----do----- | 3.0 | .9 | Manganiferous sandstone---------- | 6.63 |

Only those samples with mercury contents between 0.7 and 15.0 ppm are shown in figure 13. The distribution of the highest value soil samples (greater than 1.2 ppm) indicates that there may be parallel northwest-trending mineralized structures on either side of the trench. The results from the analyses of soil samples suggest that the property may have a higher potential for mercury than is indicated by the surface exposures, and it and the surrounding area have the potential for the discovery of small resources of mercury.

## MISCELLANEOUS PROPERTIES

Mineral properties in the study area that either have no apparent economic potential or whose workings are inaccessible are briefly described in table 8.

Many of these claims are assumed to have been located for radioactive minerals during the 1950's. These were checked with a scintillometer; maximum radioactivity recorded was three times the background count for the area, too low to indicate economic concentrations of radioactive minerals; no radioactive minerals were identified.




EXPLANATION

Tuffaceous sandstone

75 Mineralized fault—Showing dip; dashed where inferred

Trench

Dump

Cut

x Pit

Z-8 Sample locality

N

0 50 METERS

0 150 FEET

CONTOUR INTERVAL 10 FEET
1 FOOT=0.3048 METER

FIGURE 12.—Red Spur mine area. Location shown on plate 3, No. 57.

*Data for samples shown in figure 12*

[N, none detected; NA, not analyzed]

| Sample | | | | | Gold (ounce per ton) | Silver (ounce per ton) | Mercury (pounds per ton) |
|---|---|---|---|---|---|---|---|
| No. | Type | Length (feet) | Length (meters) | Description | | | |
| Z-3 | Chip------- | 5.0 | 1.5 | Volcanic sandstone--------------- | N | 0.02 | N |
| Z-4 | Random chip. | --- | --- | ----do-------------------------- | N | N | N |
| Z-5 | Chip------- | 4.0 | 1.2 | Shear zone with gouge------------ | N | .2 | 2.3 |
| Z-6 | ----do----- | 2.3 | .7 | ----do-------------------------- | N | .1 | .2 |
| Z-7 | ----do----- | 3.8 | 1.2 | ----do-------------------------- | N | .1 | N |
| Z-8 | ----do----- | 3.3 | 1.0 | ----do-------------------------- | N | N | N |
| Z-9 | Random chip. | --- | --- | Volcanic sandstone--------------- | N | .1 | N |
| Z-10 | ----do----- | --- | --- | ----do-------------------------- | N | .1 | N |
| VS-258 | Select----- | .1 | .03 | Narrow gouge seam with cinnabar--- | NA | NA | 22.2 |
| Z-11 | Grab------- | --- | --- | Volcanic sandstone on dump-------- | N | N | N |
| Z-12 | ----do----- | --- | --- | Volcanic sandstone with minor cinnabar veinlets. | N | N | 3.2 |
| Z-13 | Chip------- | 2.9 | .9 | Volcanic sandstone--------------- | N | .01 | .2 |
| Z-14 | Grab------- | --- | --- | Calcines from retort------------- | N | N | .05 |

## SUMMARY OF MINERAL POTENTIAL

The Cougar Lakes-Mount Aix study area is locally mineralized and contains a few possibilities for the discovery of economic mineral deposits. The best potential for a large ore body is in and adjacent to the granitic rocks near Mesatchee Creek, in an area presently being explored for porphyry copper by a major mining company.

Small deposits of mercury and manganese may be present in the Puget Group and Ohanapecosh Formation in the south part of the study area. Past production was from small discontinuous bodies of marginal grade, and future discoveries may be of the same type.

A potential zinc resource exists in a shear zone in silicified argillite on the Blackjack group of claims near little Twin Sister Lake. Surface sampling indicates 4.0 percent zinc over a 4.0-ft (1.2-m)-wide zone exposed for a strike length of 160 ft (50 m). Flooded workings prevented the determination of mineralization at depth.

Copper, tungsten, and silver could be present in the study area on the west side of Miners Ridge. Small amounts of these metals were mined from northwest-striking shear zones in granitic rocks ouside of the study area on the east side of the ridge. If the mineralized shear zones do extend into the study area, and this seems very possible, only small amounts of metals would be expected near the suface since anomalous amounts of metals were not detected in samples collected along Miners Ridge.

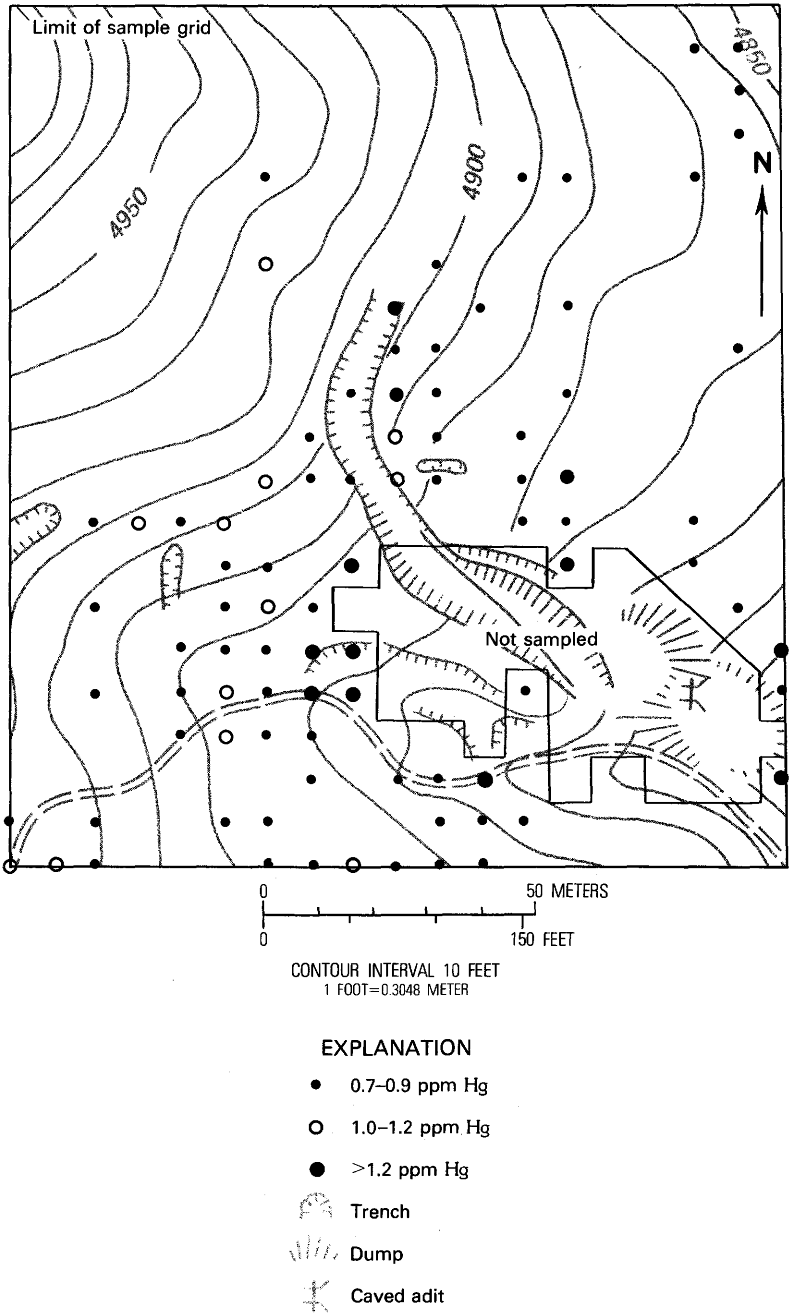



FIGURE 13.—Localities for geochemical samples, Red Spur mine area.

TABLE 8.—*Miscellaneous mining properties in the Cougar Lakes-Mount Aix study area*

| Map No. (pl. 3) | Property Name | Summary | Number and type of workings | Sample data |
|---|---|---|---|---|
| 1 | Gold lode | Iron-oxide-stained andesite. | Two pits. | One grab sample; no valuable metals detected. |
| 2 | Nettie K. | Iron-oxide-stained rhyolite. | One pit. | Three chip samples; trace gold, 0.1 ounce silver per ton. |
| 4 | K B group | Gray, porphyritic andesite is locally iron oxide stained and contains as much as 5 percent pyrite. Rock is fractured and cut by minor granitic dikes. | At least four pits, and a 22-foot (7-m) adit. | Nine chip samples; trace gold and silver, 0.03 percent copper. |
| 5 | KRD group | Andesite. | None. | None. Radioactivity, equal to background. |
| 6 | Prospect | Andesitic, granitic, and dacitic rocks in float. | Six pits. | Two grab samples; trace gold, 0.1 ounc silver per ton. |
| 7 | Prospect | Diorite. No mineralized structure found. | One pit. | One grab sample; trace gold, 0.1 ounce silver per ton. |
| 8 1/ | Prospect | Dacite porphyry. No mineralized structure found. | One pit. | One grab sample; 0.1 ounce silver per ton. Radioactivity, 3 times higher than background. |
| 10 | Rattlesnake placer | Alluvial terraces 50-300 feet (15-92 m) long, 10-100 feet (31 m) wide, and 1/2-3 feet (15 cm-0.9 m) thick are composed of andesitic cobbles and sand. | None. | Three channel samples; a few small colors. |
| 11 1/ | Hahobo | Granitic country rock. No mineralized structure found. | None. | None. Radioactivity, 1.5 times higher than background. |
| 12 1/ | Prospect | Granitic country rock. No mineralized structure found. | None. | None. Radioactivity, equal to background. |
| 14 1/ | Deep Creek group | Granitic country rock. No mineralized structure found. | None. | None. Radioactivity, equal to background. |
| 15 | Lynnwood | Poorly exposed hydrothermally altered, granitic rock containing arsenopyrite. | Two pits. | Two grab samples; trace gold, 0.2 ounce silver per ton. Radioactivity, equal to background. |

TABLE 8.—*Miscellaneous mining properties in the Cougar Lakes-Mount Aix study area*—Continued

| Map No. (pl. 3) | Property Name | Summary | Number and type of workings | Sample data |
|---|---|---|---|---|
| 16 | Frederick | Zone of hydrothermally altered granite breccia. Voids are filled with pegmatitic, granitic, and aplitic material, locally containing pyrite and arsenopyrite. Adit is on a 5-foot (1.5-m)-thick shear zone striking N. 65° W., dipping 20° NE., and containing pods and veins as much as 2 inches (5 cm) thick of arsenopyrite and pyrite. | One pit and one 15-foot (4.6-m) adit. | Two grab samples of altered material; 0.1 ounce silver per ton. Two chip samples of shear zone; 0.4 ounce silver per ton. |
| 17 1/ | JMJ | Granitic rock. | None. | None. Radioactivity, 2.0 times higher than background. |
| 18 | Suprise "mine" | Granodiorite is cut by joints trending N. 65° W. that are locally filled with veinlets of arsenopyrite and pyrite-bearing quartz. | One caved adit. | One grab sample and one chip sample; 0.1 ounce silver per ton. |
| 19 | Prospect | Altered, iron-oxide-stained granitic rock. | None. | One chip sample; 0.1 ounce silver per ton. |
| 20 | Prospect | Arsenopyrite-bearing, kaolinized rhyolite. | None. | One chip sample; trace gold, 0.2 ounce silver per ton. |
| 21 1/ | Copper Creek group | Adit crosscuts a 1-foot (.3-m)-thick shear zone. It strikes N. 30° W., dips 65° SW., and is bounded by diabase breccia and diorite. Gouge and breccia contain pyrite. Trenches expose andesite, rhyolite, and granitic country rock. Autunite reportedly found in 1956 stimulated prospecting in the district. | One 30-foot (9-m) adit and extensive dozer trenches. | Six chip samples; trace gold and silver. Radioactivity, 2.0 times higher than background. |
| 22 | Lake-Hub 1-6 | Iron-oxide-stained, gray andesite porphyry. | One pit. | One grab sample; no valuable metals detected. Radioactivity, 1.3 times higher than background. |
| 23 | MS 1-4 | A 10- to 18-inch (25- to 46-cm)-thick shear zone striking N. 20° W. and dipping 55° to 75° SW. is bounded by a rhyolite porphyry dike and granodiorite. Zone contains gouge, breccia, and 2 percent pyrite. | One 100-foot (30-m) adit, one trench, and one pit. | Seven chip samples; 0.1 ounce silver per ton, 0.4 percent copper, and 0.02 percent lead. |
| 24 1/ | 17th of Ireland | Granitic rock with shear zones as much as 5 feet (1.5 m) thick containing gouge and minor sulfide minerals. | Three adits (two caved), and one pit. | Eight chip samples across shear zone; 0.2 ounce silver per ton, 0.01 percent copper, and less than 0.002 percent molybdenum. |
| 27 1/ | Sunset | A 3- to 6-inch (8- to 15-cm)-thick shear zone in granitic country rock; no sulfide minerals found. | A 165-foot (50-m)-long adit. | Three chip samples across shear zone; no valuable metals detected. |

Table 8.--Miscellaneous mining properties in the Cougar Lakes-Mount Aix study area--Continued

| Map No. (pl. 3) | Property Name | Summary | Number and type of workings | Sample data |
|---|---|---|---|---|
| 28 | Prospect | Silicified granodiorite, locally malachite and iron oxide stained. | Two pits. | One chip sample; no valuable metals detected. Two grab samples; 0.23 percent copper. |
| 29 | Prospect | Iron-oxide- and malachite-stained granodiorite cut by a 1-inch (2.5-cm)-thick fault striking N. 35° W. and dipping 23° SW. | One pit. | One chip sample, 3.5 feet (1 m) long taken across pit; 0.64 percent copper, 0.8 ounce silver per ton. |
| 30 | Prospect | Iron-oxide- and malachite-stained, 1-foot (0.3-m)-thick shear zone striking N. 70° E. and dipping 29° NW. in granite. | One pit. | One chip sample; 0.61 percent copper. |
| 31 | Prospect | Iron-oxide- and malachite-stained granitic rock is locally cut by faults and quartz veinlets. | One pit. | One chip sample; trace gold, 0.1 ounce silver per ton and 0.33 percent copper. One grab sample; 6.06 percent copper. |
| 32 | Prospect | Dacite porphyry containing granitic xenoliths and minor malachite staining. | One pit. | One chip sample; 0.012 percent copper. |
| 34 | Stump | Six northwest-striking and eastward-dipping faults as much as 1 foot (0.3 m) thick and one 2-inch (5-cm)-thick, northeast-striking fault in dacite porphyry. Faults contain gouge and a trace of sulfides. | One adit. | Five chip samples; 0.1 ounce silver per ton. |
| 35 1/ | New Find | Granitic rock with shear zones containing quartz veins as much as 4 inches (10 cm) thick with sulfide minerals. | Two adits; one caved. | Two chip samples; 0.1 and 0.2 ounce silver per ton, 0.01 and 0.02 percent copper. One grab sample; 0.3 ounce silver per ton and 0.12 percent copper. |
| 36 | Silver Bell-Venice groups | Malachite- and iron-oxide-stained rock near an argillite and rhyolite contact. Rock contains pyrite and chalcopyrite. | None. | Three chip samples averaging 3.0 feet (1 m) long; 0.1 ounce silver per ton, 0.2 percent copper. |
| 37 | Alpine 1 and 2 | A brecciated zone in sandstone and volcanic tuff ranges from 2.5 to 4.0 feet (0.8 to 1.2 m) in thickness, trends N. 20° W., dips 25° NE., and contains clay minerals, pods of stibnite with crystals as much as 1.5 inches (4 cm) long, and quartz. | Two pits. | Two chip samples; trace silver, 0.87 percent antimony. One select grab; 5.3 percent antimony. |
| 38 | Carlton Creek "coal" | A 9-foot (3-m)-thick section of carbonaceous shale and lignite strikes N. 45° E., dips vertically, and is bounded by sandstone. | One pit. | One channel sample; 73.3 percent ash, 13.5 percent volatiles, and 0.2 percent sulfur. Heating value, 2250 BTU. |
| 39 | Jug Lake | Basalt. No mineralized structure found. | One pit. | One grab sample; 0.1 ounce silver per ton. |

TABLE 8.—*Miscellaneous mining properties in the Cougar Lakes-Mount Aix study area*—Continued

| Map No. (pl. 3) | Property Name | Summary | Number and type of workings | Sample data |
|---|---|---|---|---|
| 40 | Butler | Highly fractured, iron-oxide-stained black argillite, dolomite, and gray sandstone. Massive quartz, limonite boxwork, and pyrite occur along many of the fractures. | One pit. | One chip sample; trace silver. |
| 41 | Prospect | Aplite dike in argillite. | One pit. | One chip sample; trace gold, 0.1 ounce silver per ton. |
| 43 | B & M group | Iron-oxide-stained, black argillite is cut by a prominent joint set whose attitudes are N. 20° W.; 55° SW. and N. 45° W.; 50° NE. A 5-inch (13-cm)-thick vein fills one joint for 90 feet (27 m) and is composed of 90 percent quartz and 10 percent sphalerite. | Three pits. | Two chip samples; 0.01 ounce gold per ton, trace silver, and 1.5 percent zinc. |
| 44 | Lewis | Iron-oxide-stained black argillite, gray conglomerate, and white quartzite country rock. Rock on the dumps contains pyrite. | A caved 40-foot (12-m) adit, one water-filled inclined shaft, and one pit. | Three grab samples; 0.14 percent copper. |
| 45 | Deep Creek | Highly fractured, iron-oxide-stained, green to white quartzite is cut by 8- to 16-inch (20- to 40-cm)-thick pyrite-bearing shear zones which are as much as 60 feet (18 m) long. | One 10-foot (3-m) adit and two pits. | Five chip samples; 0.2 ounce silver per ton. |
| 46 1/ | Apex group | Dacite porphyry country rock. No mineralized structure found. | None. | None. |
| 47 | Schreiber group | Highly fractured, iron-oxide-stained, light-gray quartzite containing as much as 2 percent pyrite. | At least five pits. | Two chip samples, 2.0 feet (0.6 m) and 1.5 feet (0.5 m) long; 8.3 and and 0.1 ounces silver per ton. |
| 48 | Ivanhoe | An adit crosscuts the contact between poorly bedded, iron-oxide-stained black argillite and rock composed of 95 percent quartz and 5 percent orthoclase. The country rock is cut by several 5-inch (13-cm)-thick faults. | One 92-foot (28-m) adit and a shaft. | Five chip samples; no valuable metals detected. |
| 49 1/ | Dog Lake stone quarry | A joint set in gray andesite produces rock slabs ideal for building facings and patio stones. Similar joint sets were not found in andesite within the study area. | Open pit. | None. |
| 51 | B & B | Tertiary sandstone country rock. No mineralized structure or economic minerals found. | None. | None. Radioactivity, equal to background. |
| 52 | Fig group | Iron- and manganese-oxide-stained argillite and sandstone. | Several pits. | Two chip samples; 0.05 and 0.10 percent manganese. |

| | | | | |
|---|---|---|---|---|
| 54 | Fig group | Iron- and manganese-oxide-stained sandstone. | Several pits. | Two chip samples; 0.27 and 0.11 percent manganese. |
| 55 | Fig group | Iron-oxide-stained sandstone, argillite, and dolomite. | Several pits. | One chip sample; 0.20 percent manganese. |
| 56 | BFW | Iron- and manganese-oxide-stained gray to buff andesite porphyry country rock. No mineralized structure found. | Four pits. | Two grab samples; 0.1 ounce silver per ton. |
| 58 | Rocket group | Hydrothermally altered and mineralized volcanic breccia and Tertiary sandstone, conglomerate, and argillite. Iron-oxide, manganese-oxide, sulfide minerals, and cinnabar occur along fractures. | Five trenches. | Four chip samples; trace gold, 0.1 to 0.3 ounce silver per ton, trace mercury. |
| 59 | Witch group | Iron-oxide-stained andesite, gray graywacke, and black argillite country rock. Minor cinnabar. | Twenty-six pits and trenches in two groups. | Four grab samples; 0.2 ounce silver per ton, less than 0.02 percent mercury. |
| 60  1/ | Little Giant group | Iron-oxide-stained sandstone and argillite. No cinnabar was found. | None inside the study area. | Two grab samples; 0.01 ounce gold per ton, 0.1 ounce silver per ton, less than 0.02 percent mercury. |

1/The property is outside of the study area.

## REFERENCES CITED

Abbott, A. T., 1951, Tumac Mountain, a postglacial cinder cone in Washington State [abs]: Geological Society of American Bulletin, v. 62, no. 12, p. 1495.

______1953, The geology of the northwest portion of the Mt. Aix quadrangle, Washington: Seattle, Washington University Ph. D. thesis, 257 p.

Coombs, H. A., 1936, The geology of Mount Rainier National Park: Washington University Publications in Geology, v. 3, no. 2, p. 131-212.

Culver, H. S., and Broughton, W. A., 1945, Tungsten resources of Washington: Washington Division of Mines and Geology Bulletin 34, 89 p.

Engineering and Mining Journal, 1979, Markets: Engineering and Mining Journal, v. 180, no. 8, p. 19.

Fiske, R. S., Hopson, C. A., and Waters, A. C., 1964, Geologic map and section of Mount Rainier National Park, Wash.: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-432.

Fournier, R. O., and Truesdell, A. H., 1973, An empirical Na-K-Ca geothermometer for natural waters: Geochimica et Cosmochimica Acta, v. 37, no. 5, p. 1255-1275.

Gerry, C. N., 1897, Mining in the Pacific northwest: Seattle, The Post-Intelligencer, page unknown.

Hobbs, S. W., 1942, Report on the Copper Mining Company property, Bumping Lake mining district, Yakima County, Washington: U.S. Geological Survey Open-file report, 6 p.

Huntting, M. T. 1956, Inventory of Washington minerals, *in* Metallic minerals, Part 2, v. 1: Washington Division of Mines and Geology Bulletin 37, 428 p.

Moen, W. S., 1962, Preliminary report on mineral resources of the Cougar Lake limited area: Washington Division of Mines and Geology open-file report, 6 p.

______1969, Analyses of stream sediment samples in Washington for copper, molybdenum, lead, and zinc: Washington Division of Mines and Geology open-file report, 4 p.

Purdy, C. P., Jr., 1951, Antimony occurrences of Washington: Washington Division of Mines and Geology Bulletin 39, 186 p.

Simmons, G. C., 1950, The Russell Ranch Formation [Wash.]: Washington State College M.S. thesis, 22 p.

Simmons, G. C., and others, 1974 [1975], Magnetic tape containing spectrographic and chemical analyses of mineralized ores and floats, mines and dumps, stream sediments, and pan concentrates from the Cougar Lakes-Mount Aix study area, Yakima and Lewis Counties, Washington: U.S. Geological Survey Report USGS-GD-74-032, 4 p.; available only from U.S. Department of Commerce National Technical Information Service, Springfield, Va. 22151, as Report PB-238 413/AS.

Smith, G. O., 1903, Description of the Ellensburg quadrangle [Washington]: U.S. Geological Survey Geologic Atlas, Folio 86.

______1904, Description of the Mount Stuart quadrangle [Washington]: U.S. Geological Survey Geologic Atlas, Folio 106.

Smith, G. O., and Calkins, F. C., 1906, Description of the Snoqualmie quadrangle [Washington]: U.S. Geological Survey Geologic Atlas, Folio 139.

U.S. Bureau of Mines, 1973, Mercury section, *in* Commodity data summary: U.S. Bureau of Mines, p. 88.

______1975, Manganese section, *in* Mineral facts and problems: U.S. Bureau of Mines Bulletin 667, p. 653-668.

______1979, Manganese section, *in* Commodity data summary: U.S. Bureau of Mines, p. 94-95.

U.S. Department of the Interior, 1966, Mineral resource evaluation, Bumping Lake enlargement, Yakima project, Yakima County, Washington: U.S. Bureau of Mines Sec. Interagency Report, 6 p.

Warren, Walter, 1936, Tertiaries of the Washington Cascades: Pan-American Geologist, v. 65, no. 4, p. 241-247.

______1941, Relation of the Yakima basalt to the Keechelus andesitic series [Washington]: Journal of Geology, v. 49, no. 8, p. 795-814.

Weist, P. L., Armstrong, F. C., and Rosenblum, Samuel, 1958, Reconnaissance for radioactive minerals in Washington, Idaho, and western Montana: U.S. Geological Survey Bulletin 1074-B, 48 p.

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