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GEOLOGICAL SURVEY

Mineral Resources of Additions to the Alpine Lakes Study Area, Chelan, King, and Kittitas Counties, Washington

By

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MINERAL RESOURCES OF ADDITIONS TO THE ALPINE LAKES STUDY AREA, CHELAN, KING, AND KITTITAS COUNTIES, WASHINGTON

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SUMMARY

The Alpine Lakes area is rugged terrain on the crest of the central Cascade Range of Washington State. The original area of 324 square miles (839 km^2) was studied in the field seasons of 1971 and 1972, and the report was made available for public inspection on October 10, 1973. Eighteen additions, which range from 0.3 square mile (0.8 km^2) to 62.9 square miles (162.9 km^2) and which total 275 square miles (712 km^2), were mostly studied in the field season of 1973. The total Alpine Lakes area studied is 599 square miles (1,551 km^2).

These studies included reconnaissance geologic mapping, geochemical sampling, and examination of mines, prospects, and claims. One mineral body in the original study area was examined further.

County records show that about 1,500 unpatented lode and placer claims have been located within and adjacent to the additions since the 1870's. Approximately 77 patented claims are within or adjacent to the study areas. Nearly all were patented between 1902 and 1912. The claims lie mainly in groups in established mining districts. The study of mines and prospects was divided into nine areas that contain most of the claims. Most prospects are near the edges of granitic masses or the edges of the plutons that compose the granitic masses in the additions along the west and south sides of the original study area.

A recorded total of about 500 tons of gold-silver-copper ore has been produced in the study area. A larger but unrecorded tonnage of ore was probably produced by exploratory work.

U.S. Geological Survey personnel collected a total of 1,716 samples for analysis: 804 stream-sediment samples, 19 soil samples, two panned-concentrate samples, and 891 rock samples. Some samples, however, are from parts of the original study area. The additions were systematically sampled; areas in which anomalously high amounts of metal were detected were examined in more detail to determine the source of the metals.

U.S. Bureau of Mines personnel collected about 982 samples from prospected veins, shear zones, and mineralized areas. The samples were analyzed by fire assay and chemical methods. Thirty-five samples from placer claims and gravel deposits were concentrated and analyzed for gold and heavy mineral content.

The Deception Creek fault zone divides the Alpine Lakes area into an eastern block characterized by dominantly pre-Cretaceous metamorphic, granitic, mafic, and ultramafic rocks, and a western block characterized by Mesozoic and Tertiary sedimentary, volcanic, and granitic rocks and minor amounts of pre-Cretaceous rocks. The Deception Creek fault zone is a group of anastomosing northwest-trending vertical faults, one of which forms a shear zone in peridotite. Rocks in the western block are cut by thrust faults and by major north- to northwest-trending high angle faults.

In general, disseminated copper deposits and other mineral deposits associated with shear zones are more widespread in the additions than in the original study area. A poorly defined zone of disseminated copper deposits appears to extend from the area of the Middle Fork of the Snoqualmie River southward through the Gold Creek area to the Mineral Creek area. The belt is characterized by intensely to moderately altered and mineralized rock containing anomalously high amounts of copper and, commonly, lesser amounts of molybdenum.

Anomalous amounts of copper and molybdenum occur in granitic rock along transverse shear zones in the area of the Middle Fork of the Snoqualmie River. There, deposits in the Porter and Crawford Creek zones may potentially contain a large, low-grade copper resource; the Porter-Hemlock-Condor mineralized zones are currently being explored and possibly contain a total of 200 million tons of mineralized rock having a 0.7 percent copper content. The Three Brothers zone of mineralized granodiorite and quartz monzonite may contain as much as 2 million tons of mineralized rock averaging 0.8 percent copper. The Red Face mineralized zone in the same area contains low-grade disseminated copper and may also be a potential resource.

The Mineral Creek area contains anomalous amounts of copper and molybdenum which occur mostly in volcanic rock and to a lesser extent in adjacent granitic rock and schist near a high angle fault. Copper occurs on the west side of Red Mountain near Snoqualmie Pass near the contact of a granitic stock with sedimentary and volcanic rock.

The Dutch Miller mine in the Chain Lakes basin near La Bohn Gap is in the original study area but because thick snowpacks prevented a thorough examination during the 1971 and 1972 field seasons it was reexamined during the 1973 field season when the snow cover was relatively thin. An extension of the vein was mapped and a previously reported ore shoot was sampled. The mine contains an estimated 3,700 tons (3,600 t) of copper ore averaging more than 11 percent copper and has the potential for additional discoveries of ore.

Anomalous stream sediment and rock samples collected in the areas of lower Big Creek, Cougar Creek, Lennox Creek, the West Fork of the Miller River, and Gouging Lake may indicate the presence of undiscovered vein deposits of precious and base metals that are similar in size and tenor to worked deposits in the same general area. The deposits are characteristically arsenical and contain silver, copper, and molybdenum. Silver was detected in samples from the main mineralized areas and, in some localities, constitutes the major value of the resource. Samples indicate that the most consistent silver values are near a shear zone that extends from the upper West Fork of the Miller River to Paradise Lakes. The Cleopatra mine is estimated to have over 100,000 tons (127,000 t) of mineralized rock containing between 6.0 and 17 ounces silver per ton (332.9-514.3 g/t). Other prospects contain lesser tonnages and lower grade rock.

A shear zone with abundant limonite on the rock surfaces extends southeastward from Green Ridge Lake for about a third of a mile. Samples from the zone, however, contain only minor amounts of silver and copper.

Detectable amounts of gold were found in many places in the study area, but only the Lennox mine in the Lennox Creek drainage has produced gold ore. Two other mines adjacent to the north boundary contain concentrations of gold, one representing a minable resource. The mineralized structures may extend into the study area.

The study area has no potential for combustible fuels and probably only little potential for fissionable fuels. Small noneconomical iron deposits are present in two, and possibly three places. Small lenticular bodies of marbelized limestone are found near Snoqualmie Pass. Granitic rock and sandstone, possibly suitable for construction and decorative stone, and sand and gravel are present in the study area but are more readily available at other localities outside the area.

The Snoqualmie batholith is of late Miocene age and may retain sufficient heat to be considered a source of geothermal energy. The only known hot spring occurs near the boundary of the study area but may be generated by the oxidation of an adjacent sulfide body.

INTRODUCTION

By J. L. Gualtieri
U.S. Geological Survey

This report concerning the additions to the Alpine Lakes study area is the second of a two-part survey appraising the mineral resources of the original Alpine Lakes study area and its additions. The original area was studied in the field seasons of 1971 and 1972. A few small additional areas were also studied in 1972 in anticipation of an expansion of the study area. The areas to be added to the Alpine Lakes were finally delineated in the spring of 1973 and were studied in the summer and autumn of that year. The additions identified by letter symbol, are shown on plate 2 and are listed below. They are referred to in the report either by titles, as additions, or as the Alpine Lakes area.

Inasmuch as this report deals with an area having similar topography, geology, and geophysics to that reported on previously (Gualtieri and others, 1973), the reader will be referred repeatedly to the earlier open-file report rather than unnecessarily duplicating material here.

	Addition	Area		
		Square miles	Acres	Km^2
A.	Chiwaukum Mountains	54.5	34,880	141
B.	Icicle Creek	0.6	384	1.6
C.	Blackjack Ridge	1.0	640	2.6
D.	Cashmere Mountain	3.0	1,920	7.8
E.	Wedge Mountain	0.5	320	1.3
F.	Ingalls Creek	4.9	2,956	12.7
G.	South Fork of Fortune Creek	5.0	3,200	13.0
H.	Goat Mountain-Polallie Ridge	22.8	14,592	69.0
I.	Mineral Creek	7.8	4,942	20.2
J.	Lake Lillian	4.0	2,560	10.4
K.	Kendall Peak	0.5	320	1.3
L.	South and Middle Forks of the Snoqualmie River	49.7	31,808	128.7
M.	Middle Fork of the Snoqualmie River-Taylor River	38.0	21,920	98.4
N.	Lennox Creek-Miller River	62.9	41,256	162.9
O.	Foss River	3.7	2,368	95.8
P.	Burn Creek	2.0	1,280	5.2
Q.	Deception Creek-Tunnel Creek	13.6	8,704	35.2
R.	Cle Elum River	0.3	192	0.8

The additions total 275 square miles (712 km^2). They, with the original Alpine Lakes area, of 324 square miles (839 km^2) total 599 square miles (1,551 km^2). The report on the original Alpine Lakes area has been released as an open-file report (Gualtieri, Simmons, Thurber, and Miller, 1973).

Location and geography

The Alpine Lakes area is on the crest of the central part of the Cascade Range of Washington (fig. 1) and is roughly bounded by Interstate Highway 90 on the southwest, U.S. Highway 2 on the northwest, and U.S. Highway 97 on the southeast. The western boundary lies along the South, Middle, and North Forks of the Snoqualmie River. On the west, south, and east the boundary lies well back from the main highways and follows either section lines or such natural features as ridge crests and valley floors. The boundary of the southeastern part of the area is about 3 miles (5 km) southwest of Leavenworth, Washington. The southwestern boundary is about one-half mile (0.8 km) from the Snoqualmie Pass recreation area, and the northwestern boundary is about 2 miles (3.2 km) from the Stevens Pass recreation area.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for a description of the geography.

Previous studies

The report on the original Alpine Lakes study area was released in the open files in October 1973 (Gualtieri and others, 1973). It is available for public inspection at the offices of the U.S. Geological Survey in Denver, Colo., Salt Lake City, Utah, Menlo Park, Calif., Washington, D. C., and offices of the U.S. Bureau of Mines in Spokane, Wash., and Olympia, Wash.

Present studies and acknowledgments

The study and sampling of the additions to the Alpine Lakes area were carried out in the summer and fall of 1973 by J. L. Gualtieri with the assistance of Harvard C. Perron. George C. Simmons and Fred W. Cater helped with the work; Simmons for one week and Cater for two weeks. Approximately 6 1/2 man-months were spent by U.S. Geological Survey personnel in field investigations.

Samples of stream sediments were taken along all the large- and medium-sized stream drainages. Samples of rock were taken along the crests and flanks of most ridges, especially in areas of mineral deposits and hydrothermally altered rock, to check for metal content.

The analytical work was performed in the field by U.S. Geological Survey personnel, under the immediate supervision of C. L. Whittington. Semiquantitative spectrographic analyses of all samples were made by E. F. Cooley and K. J. Curry.

U.S. Bureau of Mines personnel did field work in the mining districts and mineralized zones in and near the additions during the summer of 1973. They also investigated a deposit in the original study area, which because

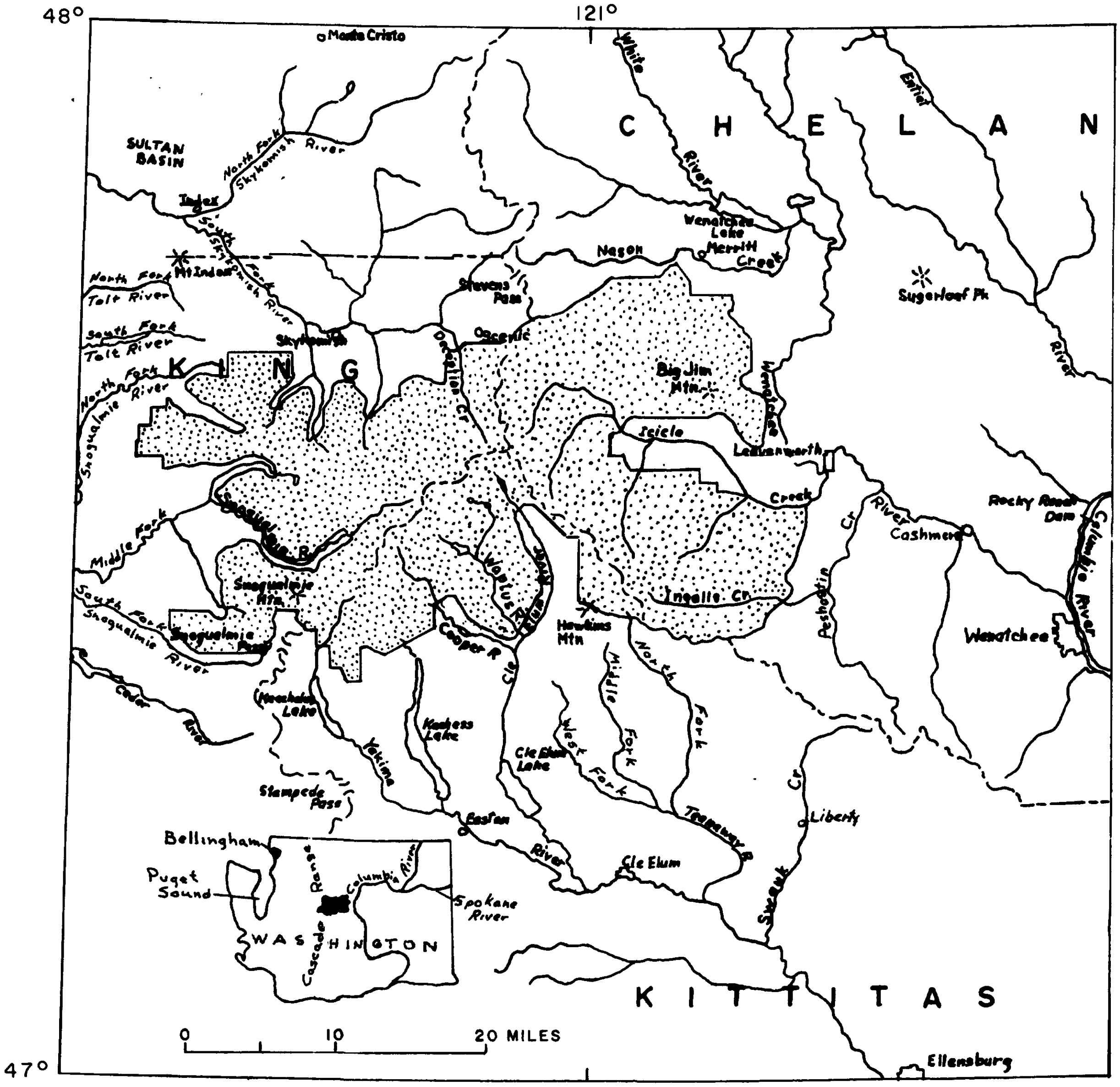

Figure 1.--Location of the area considered in this report (stippled).

of heavy snow cover, had not been completely exposed during the previous two field seasons. Investigations were made by H. K. Thurber, Michael S. Miller, and Areal B. McMahan, and Frank E. Federspiel, who were assisted by Michael B. Whaler, Ronnie B. Ream, Fred L. Johnson, and Alan L. Hart. Approximately 25 man-months were spent by Bureau of Mines personnel in field investigations.

The investigations made by the U.S. Bureau of Mines were concerned mainly with the economic aspect of the mineral resources in and adjacent to the study area. Information on mining properties was obtained from the records of the U.S. Forest Service. The records of King and Kittitas Counties were examined at their respective county seats for the location of patented and unpatented mining claims. Data on production and history of former operations were compiled from U.S. Bureau of Mines records and from various reports of the Washington Division of Mines and Geology.

The computer storage- and retrieval-program work was completed under the direction of Lamont O. Wilch with the assistance of Steven K. McDanal, both of the U.S. Geological Survey.

An airborne magnetometer survey was flown in the summer of 1972 by Scintrex Mineral Surveys, Inc. The data were interpreted by W. E. Davis of the U.S. Geological Survey.

Because of the rugged, precipitous character of the area geologic studies were carried out by helicopters; foot traverses were run between dropoff and pickup points. In low-lying areas where there are roads work was carried out by truck and foot traverses. Reconnaissance of mines and mine properties was carried out with fixed-wing aircraft. Access to mine properties was by helicopter and by foot.

The mineral appraisal of the study area was aided by the helpful cooperation of U.S. Forest Service officials in the Supervisors' offices in the Wenatchee and Snoqualmie National Forests and the personnel in the various District Ranger offices. Special acknowledgment is made to John Sargentson, Lands and Recreation Officer and Charles R. Garrett, Mining Engineer, both of Snoqualmie National Forest and to Pat Int-hout, Fire Control Officer, Wenatchee National Forest. James M. Dolan, District Ranger, North Bend, materially aided field parties in work in his district. Thanks are due the personnel of the Leavenworth National Fish Hatchery, notably Henry S. Hosking, Manager, who made available a hatchery building for use of field laboratory personnel and areas of the hatchery grounds for use as a heliport and a storage place for trailers during the winter months.

Alan Robert Grant, consulting geologist, supplied detailed information regarding exploration in the mineralized area along the Middle Fork of the Snoqualmie River; permission to use much of this data was kindly given by Grant and Gregg C. MacDonald, President, Natural Resources Development Corp. Information on the results of recent underground core drilling in

the Porter and Hemlock zones of the area was furnished by Zoeb Mogri, District Geologist and Gary Schell, Geologist, Cities Service Minerals Corp; permission to use the data was kindly granted by Robert W. Osterstock, Chief Geologist for the Corporation.

Little mining activity is underway in the additions at present. No deposits are being mined but exploration is being carried out in the snow-free months. A program of core drilling from underground stations is being conducted by a major copper-producing company in the area of the Middle Fork of the Snoqualmie River. Prospecting and small-scale exploration are being done by individuals and partnerships in the Paradise Lakes and Prospectors Ridge areas, and in the Mineral Creek area a continued program of geologic studies of copper resource potential is being carried out by the property owner.

GEOLOGY

By J. L. Gualtieri
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Geologic setting

The Alpine Lakes area is underlain by metamorphosed rocks which have been intruded by granitic plutons and which are overlain by sedimentary and volcanic rocks. A regional northwest-trending fault divides the area into two blocks of contrasting geology. To the east are mostly metamorphic, ultramafic plutonic, and mafic volcanic and related sedimentary rocks that have been intruded by a Mesozoic batholith. To the west are mostly metamorphic, arkosic sedimentary, and intermediate volcanic rocks that have been intruded by a Tertiary batholith.

The oldest rock in the area is schist that probably was metamorphosed in Mesozoic time in response to orogenic forces. Schist crops out in the eastern and the western parts of the study area and, because of slightly different lithologic characteristics, is treated in this report as two formations (Easton Schist and Chiwaukum Schist). Similar rock is exposed at numerous places along the axis of the central and north Cascade Range in Washington.

Greenstone, argillite, metagraywacke, and tuffaceous rock of the Peshastin and Hawkins Formations crop out in a structurally complex area in the southeastern and south-central parts of the Alpine Lakes area. Other graywacke deposits and andesite flows and tuff crop out in the northwestern part of the area. These rocks are isolated from similar rocks in the Cascade Range; therefore, the stratigraphic sequences cannot be correlated with confidence.

Peridotite and associated gabbroic bodies that may be genetically related intrude metamorphic rocks in the southeastern and south-central parts of the study area, and occur as roof pendants in batholithic rock in the northeastern part. The peridotite is similar to several other ultramafic bodies in the Cascade Range in Washington and, although it cannot be confidently correlated with them, it is assumed to occupy the same position in the geologic history of the range. A period of erosion followed emplacement of the peridotite. Weathering of the eroded surface led to the formation of iron-rich deposits, which were subsequently buried beneath younger sediments.

In the eastern part of the Alpine Lakes area an Upper Cretaceous granitic pluton, the Mount Stuart batholith, intrudes the schist and peridotite. This body extends eastward and northward beyond the study area, and is the southwesternmost occurrence of a series of Mesozoic plutons in northeastern Washington and southern British Columbia.

During earliest Tertiary time, contemporaneous with and immediately following intrusion of the pluton, a thick blanket of stream-deposited, arkosic sandstone, the Swauk Formation, was deposited over all or most of the Alpine Lakes area, but today it is preserved only in the western part. At several places north of the study area and south and southeast of it, occurrences of similar sandstone are known.

Following deposition of the arkosic beds the rocks were affected by thrust faults of regional scale. Later the beds were folded and offset by a few normal faults. A period of erosion followed, locally sculpturing a topography with as much as several hundreds of feet (about 200 m) of relief. Shortly thereafter, in early Tertiary time, the first of several volcanic episodes took place that were to span most of the rest of the Tertiary period in the Central Cascade Range and adjoining areas. Rocks deposited during two or more of these episodes are believed present in the Alpine Lakes area, but, either because of structural complexities of the rocks or because they have not been mapped in adequate detail, their relative stratigraphic positions are uncertain. The volcanic rocks are present only in the western part of the study area but may once have overlapped the eastern part. Two sequences are present in the area: basalt and andesite flows interbedded with arkosic sandstone, and andesite flows interlayered with andesite pyroclastic units. They are part of an extensively exposed belt that lies to the north and south of the Alpine Lakes area, and correlative units may be present in the Puget Sound lowland.

One orogenic event, and possibly more, may have taken place during the period of volcanic activity, producing the major vertical faults that cut the area.

The orogenic events that shaped the structure of the layered rocks in the western part of the Alpine Lakes area had far less effect in the eastern part. Only along the southeastern boundary, where there is a west-trending zone of sheared and deformed serpentinized peridotite with inclusions of greenstone and gabbro, is such activity evident. The zone is known to have been active at least once during early Tertiary time and may have been active repeatedly during that period.

In middle Tertiary time granitic rock (the Snoqualmie batholith) intruded the western part of the study area. It is an eastward-projecting lobe of a batholith that is extensively exposed to the west. Some deformation and uplift accompanied and followed the emplacement of the batholith. A drainage pattern with gently rolling hills and broad valleys was established at this time, and parts of this old topography are still preserved at a few high places in the study area. Final uplift of the eastern part of the area probably occurred at the same time.

Uplift of the Cascade Range on a north-trending southward-plunging axis concluded the tectonic activity in the region. Streams became entrenched to form the deep canyons that give the Alpine Lakes area its steep rugged topography.

With the onset of the Quaternary Period, developing glaciers followed the already existing valley and canyon courses, deepening and broadening them. Two or three major advances and retreats are recorded in the deposits of glacial debris, most of which are located at canyon mouths outside the Alpine Lakes area. Very minor advances and retreats are recorded as late as the middle of the 19th century.

Rocks

Easton Schist

The Easton Schist and the Chiwaukum Schist constitute the two oldest rock formations in the Alpine Lakes area.

The Easton Schist, whose thickness in the Alpine Lakes area is not known, is exposed in a fault-bounded belt about 6 miles (10 km) long and one-half to 2 miles (0.8-3 km) wide. The character of the rock differs along the belt; in the northern part the rock is quartz-graphite phyllite, and in the southern part, according to Ellis (1959), it is amphibolite schist.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Chiwaukum Schist

The Chiwaukum Schist is most extensively exposed in the extreme northeastern part of the Alpine Lakes area. It is also extensively exposed along Icicle Creek and several places near the north boundary of the Alpine Lakes area. Schist, marble, and quartzite near the extreme northwestern boundary are mapped as Chiwaukum.

The rock is mostly quartz-biotite schist and phyllite with minor amphibolite. Garnet, which can be seen in felsic foliae in grains 1-2 mm across, gives the weathered rock a wart-studded appearance.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Older volcanic rocks

Older volcanic rocks occur in the areas of Garfield Mountain and Sunday Creek around what, according to Bethel (1951, p. 56), may have been volcanic centers. In the Garfield Mountain area the older volcanic rocks are mostly dark-greenish-gray massive andesite tuff interlayered with subordinate andesite flows and breccias. Some pyroclastic units include fragments more than 2 feet (60 cm) across (Bethel, 1951, p. 58-59). In the Sunday Creek area, the older volcanic rocks include dark-greenish-gray massive porphyritic andesite flows and light-greenish-gray water-lain tuff which, southeastward, is interlayered with increasing amounts of sedimentary rock (Bethel, 1951, p. 61, 66). Near their contact with granitic rocks, the older volcanic rocks appear to be altered to hornfels.

The petrography of the massive andesite flows and tuff units has been studied by Bethel (1951, p. 67-75). According to him the flow rock is commonly holocrystalline with a finely crystalline groundmass and phenocrysts of feldspar. The discernable minerals are andesine, hornblende, iron ore minerals, and in places, pyrite. The andesine occurs in tabular bodies or lathes and is commonly zones, but the zoning is not distinct. Hornblende occurs as equigranular or needle-like bodies about 1 mm across, and is of the green and brown varieties.

In some flow rocks the groundmass is essentially aphanitic and Bethel thinks these rocks originally may have been glass.

The tuff units are finely granular and Bethel notes that some originally had glassy basal zones that have since been devitrified, whereas the basal zones in other tuff units have remained essentially undevitrified. The minerals in the tuff units include finely crystalline feldspar with a mosaic texture. Where tuff units have been altered to hornfels, presumably by the intrusion of granitic rock, they have been recrystallized to holocrystalline rock containing feldspar, hornblende, biotite, and sparse quartz. The feldspar bodies are penetrated by needles of green hornblende.

The thickness of the older volcanic rocks is not known, but perhaps more than 1,000 feet (305 m) is preserved in each of the two areas of their occurrence.

The age of the volcanic rocks is assumed to be pre-Cretaceous on the premise that the sedimentary rocks with which they are interlayered are pre-Cretaceous.

Graywacke and hornfels

Several isolated bodies of interbedded graywacke and hornfels are exposed in areas east and west of Lennox Creek. These rocks have been previously described by Bethel (1951) who mapped them in a broad north-trending belt extending from south of the Middle Fork of the Snoqualmie River to Lennox Creek and beyond. Bethel (1951, p. 22) notes the presence of feldspathic graywacke, argillite, tuffs, and tuffaceous sedimentary rocks in the unit. In the area of this report, the unit is composed of gray, fine to very fine grained graywacke which locally displays laminations but which in most places is thick bedded or massive. Individual minerals are rarely large enough to be discernable without a hand lens. The hornfels is commonly gray or black, or, more rarely, a shade of green. It is almost everywhere a dense rock, but in places contains anhedral crystals 1-4 mm long.

The thickness of the unit is not known. Bethel (1951, p. 23) estimates it may be as much as 5,000 feet (1,525 m) or more near the Middle Fork of the Snoqualmie River. Probably much less is preserved in the study area.

The age of the unit is uncertain for it contains no diagnostic flora or fauna. However, because it is intruded by a small boss of peridotite (too small to be shown at map scale), which is assumed to be the same age as the Ingalls Peridotite, the graywacke unit is tentatively regarded as pre-Cretaceous.

Interbedded volcanic rock is apparently sparse in the area of this study; tuffaceous rock overlain by porphyritic flow rock was observed in one place just east of the lower part of Sunday Creek.

Limestone and hornfels

Several isolated bodies composed mostly of hornfels and lesser amounts of limestone are exposed on Denny Mountain, Cave Ridge, and Kaleeten Peak, which are short distances north, northwest, and west, respectively, from Snoqualmie Pass. These rocks were originally mapped as part of the Guye Formation by Smith and Calkins (1906) but they were subsequently recognized as a separate formation by Foster (1960).

The hornfels commonly ranges in color from black to dark gray but in places is light gray or olive. It is dense or finely crystalline, and locally displays relict bedding or flow banding. In places where it is in contact with granitic rock, the hornfels is intensively sheared and has developed a schistose structure.

The limestone is commonly medium gray and is obviously recrystallized; on the surface of the rock is displayed a mosaic pattern of anhedral calcite bodies. Locally the limestone contains lenses or pods of chert or silicified argillaceous matter. Where limestone is intruded by granitic rock, tactite, composed in part of epidote and garnet, has developed and in a few places pods of magnetite have formed (Shedd and others, 1922). The thickness of individual limestone units ranges from several to many tens of feet (approximately 10-30 m); it is probable the beds have thinned or thickened in the course of structural deformation and recrystallization.

The total stratigraphic thickness represented by the hornfels-limestone beds is not known; it is not possible to correlate the beds of one body with those of another. Further, the individual bodies are internally deformed so that no continuous stratigraphic sequence can be confidently measured.

The age of the hornfels-limestone is assumed to be pre-Cretaceous.

Hawkins Formation

The Hawkins Formation crops out south of Mount Stuart in the southeast part of the area. The formation is composed dominantly of altered volcanic breccias and flows containing sparse feldspar phenocrysts and some fine-grained clastic rocks. These rocks have been altered to greenstone which is commonly dark grayish green and weathers somewhat lighter.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Peshastin Formation

The Peshastin Formation crops out just outside the southeastern boundary of the Alpine Lakes area, where numerous isolated bodies of it occur in an ultramafic intrusion. The Peshastin Formation (Southwick, 1962) is mostly argillite with lesser amounts of metagraywacke, and minor amounts of metaconglomerate and metavolcanic rocks, which include flows and breccias of intermediate composition, and siliceous tuffs. The rocks are foliated and have developed imperfect slaty cleavage. They weather various shades of gray, green, brown, and black.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Mafic rock

Mafic rock of uncertain formational affiliation occurs near the head of Deception Creek and between Highchair Mountain and The Cradle (pl. 1).

Metagabbro

Metagabbro occurs as dikelike bodies which crop out as steep-sided ridges and locally form knobs and subordinate spurs along lower Ingalls Creek and ridges south of the creek. The rock is medium to coarsely crystalline, and contains relic ophitic and hypidiomorphic igneous textures which have been overprinted by metamorphic textures (Southwick, 1962, p. 162).

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Ingalls Peridotite

Ingalls Peridotite crops out along the southeastern boundary of the Alpine Lakes area, along the ridge just east of the Cle Elum River to a point about as far north as Hyas Lake. Peridotite forms a large roof pendant in the Mount Stuart batholith in the east-central part of the study area and other small roof pendants are present in the northeastern part. A small boss of peridotite in the northwestern part of the study area is tentatively equated to the Ingalls peridotite. The Ingalls intrudes the Chiwaukum Schist, Hawkins Formation, and Peshastin Formation.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Granitic rocks of the Mount Stuart batholith

A steep rugged topography is developed on Mount Stuart granitic rocks. Dogtooth peaks and serrate ridges steepled with spines characterize the Stuart Range. Other areas underlain by the batholith are less rugged. Sheeting and jointing are common.

The rock is medium crystalline and is mottled very light gray and black. Megascopic minerals are subhedral feldspar, anhedral quartz which is not everywhere discernible, black biotite in books and clots, and, more rarely, subhedral hornblende.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Metasomatic rock

Several small bodies of granitoid rock occur in a belt extending from the northern part of the Chiwaukum Mountains to the area of upper Cabin Creek. The bodies commonly occur in association with granitic rock of the Mount Stuart batholith and Chiwaukum Schist. It is banded, finely to coarsely crystalline, and although texturally different from layer to layer has overall the texture of granitic rock.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Amphibolite

Several bodies of amphibolite occur in the area of the Chiwaukum Mountains and in the area to the southeast. The bodies are composed of coarsely crystalline amphibolite and occur in close spatial association with granitic and metasomatic rock.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Intermediate porphyry

A small boss of intermediate porphyry about 1,000 feet (225 m) in diameter is exposed on the ridge near Van Epps Pass. The rock is porphyritic and contains subhedral light pink feldspar bodies 1-4 mm across and sparse mafic bodies, which are possibly an amphibole mineral, as long as 4 mm. The groundmass is a mosaic of finely crystalline light and dark minerals that give the rock an overall gray color. The body may bear a significant relation to mineralization in the Van Epps area; other felsic and intermediate bodies, exposed either at the surface or in workings, have a close spatial relationship to mineralized rock. This body and the others may be differentiates derived from the nearby Mount Stuart batholith.

Swauk Formation

The Swauk Formation is preserved in the western part of the Alpine Lakes area including the Goat Mountain-Polallie Ridge addition, where it crops out in a northwest-trending belt as much as 6-8 miles (10-13 km) wide. The formation is also present east of the Cle Elum River but its northern limit lies south of the Alpine Lakes area, roughly paralleling the boundary. The formation is folded and faulted and the structures become progressively more pronounced as they cross the belt from east to west.

The Swauk Formation is mostly fluvial arkose with minor feldspathic graywacke, conglomeratic arkose, and siltstone. It is estimated that the Swauk is about 95 percent sandstone, 3-4 percent siltstone, and 1-2 percent conglomerate (Ellis, 1959, p. 18).

In at least one place, low on the west face of Summit Chief Mountain, the Swauk has been hydrothermally altered adjacent to a thrust plane. A roughly circular area of the Swauk just west of Smmmit Chief Mountain is underlain by hydrothermally altered arkosic sandstone, in part silicified and kaolinized, that extends from the thrust plane through several hundreds of feet (about 100-150 m) of section. The alteration was probably an effect of the intrusion of the nearby Snoqualmie batholith. Neither the amount of movement nor the amount of section missing from the base is known.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Guye Formation

The Guye Formation was first described and mapped by Smith and Calkins (1906), who included in it sedimentary rocks of several types and minor amounts of volcanic rock. Foster (1960) subsequently restudied these rocks, recognizing four formations. He limited the Guye Formation by including in it only shale, sandstone, and conglomerate and excluding from it volcanic rocks, limestone, and hornfels. In the area of Snoqualmie Pass and southwestward this restricts the Guye to rocks below the rhyolite of Mount Catherine.

The Guye Formation is exposed in two places: one in the area of Snoqualmie Pass and the other in the Denny Mountain-Snoqualmie Mountain-Snow Lake area. The two exposed bodies are separated by a relatively narrow, dikelike body of granitic rock of the Snoqualmie batholith.

Rocks of the Guye Formation include dense carbonaceous siltstone and shale, commonly with poorly developed partings, and carbonaceous arkosic sandstone, some of it conglomeratic. Shale is the dominant rock type and Foster (1960, p. 113) noted that it locally contains abundant fossil flora. The sandstone ranges from medium to coarse grained and where conglomeratic it contains fragments up to 3 inches (8 cm) in diameter. Beds are commonly several feet (1 m) to more than 10 feet (3 m) thick.

Where intruded by the Snoqualmie batholith, rocks of the Guye Formation have been indurated or converted to hornfels.

The thickness of the Guye Formation is not accurately known because the base is not exposed. Foster (1960, p. 113) estimates the thickness is at least 5,000 feet (1,520 m), barring possible repetitions by faulting or other structural complications. The age of the Guye Formation is tentatively given as Paleocene or Eocene by Foster (1960, p. 113) who collected and gave identifications for fossil leaves from along Coal Creek.

Rhyolite of Mount Catherine

The rhyolite of Mount Catherine was described by Foster (1960) who mapped a horseshoe-shaped body of the rock in the area of Snoqualmie Pass. The unit crops out just inside the boundary of the South Fork and Middle Forks of the Snoqualmie River addition and is inferred to be truncated by a fault at its northern extremity. The unit unconformably overlies the Guye Formation and, apparently, conformably underlies beds of sedimentary and volcanic rock according to Foster (1960, p. 114).

The rock is greenish or bluish gray and weathers yellowish brown. Foster described the unit as composed of two types of rock. One type is bedded tuff and the other is a porphyritic fragmental rock with embayed quartz phenocrysts. Both types contain devitrified material, according to Foster. In the course of the current study, lensoidal bodies of devitrified pumice 1-6 inches (2.5-15 cm) long, and as much as 1 inch (2.5 cm) thick were observed. It is assumed that the rhyolite of Mount Catherine consists of one, and possibly more, ash flows.

The thickness of the unit varies along the belt of outcrop, but in and near the study area the mapped thickness is about 100 feet (30 m).

The rhyolite is probably Eocene age, according to Foster (1960).

Naches Formation

The Naches Formation is composed mostly of flow and flow breccia units of basalt and andesite. Flows appear to be more numerous than breccia units, and andesite more abundant than basalt. The basal part of the exposed section contains arkose, siltstone, and shale interbedded with basalt flows.

The Naches Formation is hydrothermally altered in several areas in the southwestern Alpine Lakes area. Where alteration has been mild, the constituent minerals appear less distinct and they may contain pyrite; where alteration is relatively advanced, the rock is silicified and almost invariably contains pyrite. On a freshly broken surface the altered rock is white or light gray with minute anhedral sulfide grains sparsely scattered through it. Relic feldspar and a mafic mineral can be seen in some of the altered rock. Outcrops of the altered rock are conspicuously iron stained from oxidized pyrite.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Dacite dike

A dacite dike intrudes the Swauk Formation in the area of Cone Mountain and the lower Waptus River. The dike is inferred to be emplaced along a fault which follows the Waptus River. The dike parallels the strike of the adjacent Swauk beds but is not concordant with them. Near Cone Mountain the dike widens from a few hundred feet (about 60-90 m) to about 2,000 feet (600 m), and changes from northwest- to northeast-trending. Northeast of Cone Mountain, in the floor of the canyon of the Waptus River, the dike is inferred to be truncated by a fault.

The dike rock was originally mapped as part of the Keechelus Andesite by Smith and Calkins (1906). Ellis (1959, p. 63), however, distinguised it from overlying pyroclastic rock which, prior to erosion, was once continuous with volcanic rock that occurs east of the Waptus River.

The dike rock is light gray to reddish brown and is commonly porphyritic, containing anhedral quartz phenocrysts ranging from 1 to 6 mm across. In places the rock lacks quartz but contains subhedral feldspar bodies 1-2 mm across and, more rarely, an anhedral mafic mineral. Pebbles and angular fragments of Swauk as much as 1 foot (30 cm) across are abundant to sparse in the thicker part of the dike. The dike is thought to be substantially older than volcanic rocks occurring in the general area, as inferred by Ellis.

Tertiary volcanic rocks

Volcanic rocks in the areas of Goat Mountain-Spinola Creek, Mount Daniel-Marmot Lake, and the Foss and Miller Rivers, are placed in a single catch-all unit. Also included are several small bodies of volcanic rock west and northwest of Snoqualmie Pass and near the upper part of the Middle Fork of the Snoqualmie River. Rocks in the unit have been variously mapped as Keechelus Andesite (Smith and Calkins, 1906; Ellis, 1959; Foster, 1960) and Temple Mountain Andesite (Galster, 1956). All of these rocks may be part of a single consanguineous unit, which once may have been continuous through the central Cascade area. This unit is described in more detail under the heading of Keechelus Andesite in the earlier report on the Alpine Lakes study area (Gualtieri, Simmons, Thurber, and Miller, 1973), but in view of possible miscorrelation of rocks in the type area (Foster, 1967) it is considered more prudent not to use this name.

A small intrusive body

A small irregular circular body of andesite appears to intrude volcanic rock and the Swauk Formation west of Hyas Lake and the Cle Elum River (pl. 1).

This rock does not crop out in the additions and is not discussed further.

Breccia dike

A breccia dike located on the northwest side of Marmot Lake cuts the Swauk Formation from about the level of the lake to the ridge crest (pl. 1). This rock does not occur in the additions and the reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Granitic and related rocks of the Snoqualmie batholith

The Snoqualmie batholith in the Alpine Lakes area ranges in composition from gabbro and diorite to quartz monzonite. It is exposed only in the western part of the Alpine Lakes area where it crops out in an east-west trending lobe that broadens westward.

Snoqualmie granitic rocks are mostly medium crystalline but rock textures vary from one compositional phase to another and also within the respective phases. Color and mottling are those commonly characteristic of granitic rocks and depend on how mafic or how felsic the individual intrusive phase may be. Among the felsic types, one body of quartz monzonite has a distinctive pinkish cast.

Gabbro and diorite crop out in areas east and northwest of Garfield Mountain and lower Lennox Creek. The gabbro and diorite phases were recrystallized by the subsequent emplacement of younger intrusives, which was accompanied by isochemical hydration and local potash introduction.

Pyroxene granodiorite crops out along the eastern boundary of the Snoqualmie batholith near Mount Daniel and near the northern boundary south of Money Creek.

Main-phase granodiorite is present in most areas underlain by the Snoqualmie batholith except in an area extending from near Snoqualmie Pass northwestward to Garfield Mountain, where other phases are extensively exposed.

Intrusive breccia containing fragments many tens of feet (about 10-30 m) in length are reported near the head of Burntboot Creek (Erikson, 1968, p. 28). Locally abundant inclusions are found in the interior parts of the pluton. These inclusions are commonly rounded, are 1 foot (30 cm) or less in diameter, and most appear mafic-rich and in advanced states of reconstitution. Some inclusions may be cognate, and none of them are oriented.

Quartz monzonite stocks crop out in the areas of Mount Hinman, Snoqualmie Mountain, and Preacher Mountain.

Late-phase granodiorite occurs in several parts of the Alpine Lakes area including the Mount Roosevelt area, the Garfield Mountain area, and the Bare Mountain area. The primary minerals are orthoclase, zoned plagioclase, quartz, and hornblende; minor amounts of disseminated pyrite and chalcopyrite occur locally.

In addition to the principal intrusive phases, all rocks of the batholith are transected by dikes and plugs of aplite, alaskite, and granite pegmatite (Erikson, 1968, p. 53). Aplite and alaskite commonly occur in dikes ranging in width from less than 1 foot (8 cm) to as much as 75 feet (22 m). Many of the dikes are in near-horizontal attitudes. Pegmatite dikes are commonly irregular and tend to be pod-like.

Primary minerals in the aplite dikes include oligoclase, perthitic orthoclase, quartz with accessory apatite, schorlite, sphene, pistacite, and opaque minerals. The mineralogy of the pegmatite veins is similar.

The Snoqualmie batholith is the youngest rock in the area and intrudes the Swauk Formation and Tertiary volcanic rocks. It is late Miocene in age (Baadsgaard and others, 1961; Curtis and others, 1961; and Erikson, 1969).

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on this unit.

Other rocks

Numerous scattered small dike-like bodies and bosses of silicic and intermediate granitoid rock intrude ultramafic rock along the periphery of the Mount Stuart batholith. They are probably genetically related to the batholith.

Northeast- to east-trending dikes of Teanaway Basalt occur sparsely in the southeastern and west-central parts of the Alpine Lakes area. Some are as thick as a few tens of feet (about 5-10 m) and are traceable for hundreds of feet (about 100-300 m). Andesite dikes which intrude the Snoqualmie batholith occur sparsely in the northwestern part of the area.

All of these bodies are considered too insignificant or too small to be mapped at the scale of the geologic map.

Glacial, alluvial, and other surficial deposits

Glacial, alluvial, and other unconsolidated deposits occur throughout the Alpine Lakes area.

Two and possibly three, ages of glaciation are recognized in the Alpine Lakes area (Page, 1939, p. 141-180). The only mapped glacial deposits are in the extreme northeastern part of the area where two moraines are present. Numerous other glacial deposits, mostly preserved remnants of lateral moraines, occur sporadically along the walls of some canyons. Small terminal moraines, products of the 19th century advance, lie at short distances below existing glaciers. The principal glacial deposits lie at the canyon mouths, outside the Alpine Lakes area.

Alluvial deposits occur as thin mantles of silt, sand, and gravel that locally cover the floors of valleys and canyons, usually where they have been overdeepened by glaciers.

Colluvial deposits, mostly talus but also including a few rockslides and rock glaciers, occur generally throughout the area.

Structure

The Alpine Lakes area is part of a regional structural belt that includes thrust faults and younger high-angle faults that extend southward from the northern part of the Cascade Range. The continuity of the structures has been locally broken by the intrusion of the Snoqualmie batholith.

The Deception Creek fault zone

The Deception Creek fault zone (pl. 1), first mapped and described by Pratt (1958, p. 59-61), divides the Alpine Lakes area into two blocks of diverse geology. The fault zone is exposed in only a few places; elsewhere its existence is inferred from the juxtaposition of unlike rocks and from topography. Exposed segments of the zone vary from a single fault to multiple faults that form a braided pattern. South from the Hyas Lake area, one fault segment, as described by Pratt (1958, p. 60-61), is flanked by sheared serpentinite and gouge and separates relatively unaltered peridotite from serpentinized rock.

Total displacement on the structure is unknown but may measure thousands of feet (several hundreds of metres), and part of the movement may be lateral, as Pratt (1958, p. 61) noted. The structure may have been active over a considerable span of time, but the available evidence indicates movement only in early or middle Tertiary.

The reader is referred to Gualtieri, Simmons, Thurber, and Miller (1973) for more information on the structures east and west of the fault zone.

Aeromagnetic interpretation

An aeromagnetic survey of the region between lat. 47°24' N. and 47°45' N. and long. 120°40' W. and 121°24' W., which includes the Alpine Lakes area, was made by Scintrex Mineral Surveys, Inc., under contract for the U.S. Geological Survey. Total-intensity magnetic data were obtained along east-west lines flown about 1 mile (1.6 km) apart at an average barometric altitude of 9,500 feet (2,900 m) above sea level. The data were compiled at a scale of 1:62,500 and contoured at intervals of 20 and 100 gammas. No laboratory study of the magnetic properties of the rocks was made. The magnetic features, which were interpreted from the geology of the area, are discussed in Gualtieri, Simmons, Thurber, and Miller (1973) and are shown on their plate 1.

Mineral deposits

The study of the Alpine Lakes area had as its principal object the evaluation of mineral deposits and of geologic environments that suggest the presence of mineral deposits. Thus, we looked for mining claims and evidence of propsecting and mining, and investigated the geologic, geochemical, and geophysical characteristics of the area.

Setting

The central Cascade Range is part of a metallogenic belt characterized by the presence of porphyry copper and low-grade molybdenum deposits (Little and others, 1968, p. 504). The belt extends from British Columbia southward through the central Cascade Range of Washington where it becomes obscured by an extensive cover of Tertiary volcanic rocks. The mineral deposits are associated with quartz-biotite, calcic-alkalic differentiates of upper Mesozoic and Tertiary granitic intrusive complexes (Little and others, 1968, p. 504; Grant, 1969, p. 24-27), and with transverse shear zones (Grant, 1969, p. 39-46). According to Grant (1969, p. 23, 39) at least 18 major plutonic masses and six large known or inferred shear zones are present in the Cascade Range of Washington. The shear zones are east- to northeast-trending structures and their intersections with older northwest-trending folds or other structures in the vicinity of favorable plutonic rock are the loci of many mining districts (Grant, 1969, p. 45). The copper deposit at Holden (about 30 miles (48 km) north of the study area) and the gold deposit at Monte Cristo, the newly developed copper bodies at Glacier Peak (about 25 miles (40 km) north of the study area) and Sultan Basin, and a mineralized area currently being explored along the Middle Fork of the Snoqualmie River are all examples of mineral deposits along transverse shear zones.

Several types of wallrock alteration, including propylitic, quartz-sericitic, potassium silicic, and silicic (Grant, 1969, p. 49-50), occur in mineralized areas. In places, alteration halos have developed around mineralized cores. Altered areas shown on the geologic map (pl. 1) are conspicuously sericitized or silicified and they commonly contain pyrite and possibly other sulfide minerals. Where oxidized, the sulfides have stained the rock surfaces with limonite.

The Alpine Lakes area contains numerous occurrences of copper, and other base and precious metals, and although many of the deposits have been prospected and explored, few have produced ore. The area is overlapped by five mining districts (Washington Div. Mines and Geology, 1971, fig. 2) which are of past or current importance: Blewett (southeast), Ele Elum (south-central), Leavenworth (northeast), Miller River (northwest), and Snoqualmie (southwest). (See pl. 2.)

Lode deposits

Significant amounts of gold were produced from the Blewett district, which lies adjacent to the southeastern part of the Alpine Lakes area. Most production took place around the turn of the century; the district is mostly idle now. Gold was produced from ore shoots located along discontinuous, northwest- to west-trending quartz-carbonate veins in mafic and ultramafic rock (Weaver, 1911, p. 72-73). The ore shoots, according to Weaver, are irregular lensoidal bodies ranging in width from a few feet to more than 10 feet (1 to 3 m) and in vertical extent from a few tens to hundreds of feet (approximately 9-90 m) and which are as much as several hundred feet (approximately 150 m) long. The ore is oxidized near the surface and contains free gold; at depth, the ore minerals are arsenopyrite and pyrite. In addition to gold, the ore bodies contain very minor amounts of silver, copper, and lead.

Numerous other deposits of precious and base metals occur in an arcuate belt that extends westward from the Blewett district through the Swauk district and northwestward into the Cle Elum and Leavenworth districts. The belt roughly parallels the boundary of the Mount Stuart batholith and in most places lies some distance away. Many of the gold deposits, like those of the Blewett district, occur in sulfide-bearing quartz or quartz-carbonate veins in ultramafic rock (Huntting, 1955, p. 64, 66-67). The veins are apparently located along planar structural features such as shears or faults. Other auriferous deposits are located near the contact between granitic and ultramafic rock, where locally silicified-carbonatized rock has developed as a product of contact alteration and metasomatism and the subsequent introduction of sulfide minerals (Purdy, 1951, p. 62-66).

Base metal deposits, which are mostly copper-rich and contain other base and precious metals, are most numerous in the Van Epps Pass area and they overlap the gold belt. Most deposits occur as disseminated sulfide minerals deposited along weakly developed shear planes in peridotite or serpentinized peridotite. In some prospect pits only copper carbonate stain is visible. Other copper-bearing deposits appear syngenetic and consist of sulfide minerals sparsely disseminated through dikes of intermediate composition.

Locally along the mineral belt that parallels the Mount Stuart batholith, nickeliferous veins occur in ultramafic rocks. The deposits of nickel and allied metals were apparently liberated from ultramafic rock through either weathering, serpentinization, or hydrothermal activity, and were picked up and incorporated in the vein-forming solutions (Vhay, 1966, p. 122. Deposits of this type are oriented east-west (Lupher, 1944, p. 10).

Nickeliferous iron deposits are exposed in an arcuate belt that extends from the Blewett mining district through the Swauk and into the Cle Elum mining district (Lupher, 1944; Lamey and Hotz, 1951). The deposits are thin--at most no thicker than a few tens of feet (10 m±)--discontinuous lenslike bodies developed in a zone lying between ultramafic rock and sandstone of the Swauk Formation. The deposits formed through the weathering of ultrabasic rock, apparently in a warm, wet climate, and apparently were modified by colluvial processes. The more soluble constituents of the source rock were removed during weathering, leaving a relatively insoluble iron-rich residue enhanced in nickel, aluminum, and chromium.

Other iron deposits containing magnetite occur in the area of Denny Mountain near Snoqualmie Pass, and near Goat Basin in the northwestern part of the Alpine Lakes area. The deposits near Denny Mountain formed in tactite zones along the contact of granitic rock and limestone (Smith and Calkins, 1906, p. 13) whereas those near Goat Basin formed in an agmitite zone composed of diabase fragments in a granitic matrix (Plummer, 1964, p. 25).

Gold, silver, copper, and other base metals have been produced in significant quantities from the Miller River district. The current (1974) high prices for these metals have encouraged exploration in this area. Much of this mining district, including numerous mines and workings, lies within the northwestern part of the Alpine Lakes area.

Most mineral deposits in the Miller River district are in granitic rock (Purdy, 1951, p. 78-87) and some are in andesite (Livingston, 1971, p. 144). The deposits occur as veins in faults and shear zones that strike northwest and northeast and dip steeply. In most cases, the veins have replaced wallrock. Ore minerals differ in type and proportion across the district and include pyrite, arsenopyrite, chalcopyrite, galena, tetrahedrite, sphalerite, and jamesonite (Livingston, 1971, p. 137-147). The wallrock adjoining the deposits is variably altered; in places only the mafic minerals are affected but commonly the rock is kaolinized or sericitized.

Other deposits, dominantly copper with little molybdenite and sparse silver and gold, occur in the Quartz Creek area of the Miller River mining district (the Snoqualmie mining district of Livingston, 1971, p. 149-152). The district is on a large east-trending transverse shear zone (Grant, 1969, p. 40) that in mineralized areas is recognizable as sets of small east-trending shears. The deposits are in elliptical, steep-sided breccia pipes in granitic rock (Grant, 1969, p. 79-81). Outcrops of the pipes are hundreds of feet (about 100-200 m) across. Angular granitic fragments within the pipes are several inches to several feet (about 10 cm-1 m) long and are cemented with quartz and sulfide minerals.

The principal sulfide minerals are pyrite, pyrrhotite, chalcopyrite, and arsenopyrite, and they occur as disseminations, veinlets, and lenticular replacement pods. The host rock in areas of mineralization is intensely altered (Grant, 1969, p. 81). Chlorite and sericite are developed at the expense of mafic minerals and feldspar in and near areas of abundant sulfide mineralization. This alteration is superposed on an earlier biotite alteration which more commonly affected the brecciated structures.

Additional copper deposits, similar in mineralogy and structure to those of the Quartz Creek area, occur in the Snoqualmie mining district (Washington Div. Mines and Geology, 1971, fig. 2), along the Middle Fork of the Snoqualmie River above Burntboot Creek. The deposits are in breccia pipes, shatter zones, and shears which transect granitic rock. They are alined along a northeast-trending zone measuring more than 6 miles (10 km) long and 400-2,500 feet (120-750 m) wide (Grant, 1969, p. 81-88). The mineralized zone may have once been continuous but subsequently was cut by a series of northwest-trending faults that subdivided it into several separate mineralized bodies (Grant, 1969, p. 85).

Sulfide minerals, principally chalcopyrite, molybdenite, pyrite, and pyrrhotite, occur in veins and fracture fillings and as disseminations in the host rock. Mineralization occurred in two or more stages: an earlier one which took place at an upper level and a later, richer one which took place at a deeper level. Biotite-potassium feldspar and quartz-sericite alteration is associated with the mineralization. Propylitic alteration also developed during the periods of mineralization, but is associated with barren pyritic rocks surrounding the areas of copper and molybdenum mineralization.

Most of the mineralized ground along the Middle Fork of the Snoqualmie River is in the Alpine Lakes area. The mineralized zone lies along a transverse shear zone (Grant, 1969, p. 40) which may extend several miles (5 km) into the study area.

Evidence of other possible mineralization occurs in the Mineral Creek area of the Snoqualmie mining district. The area is thought to have structural, alterational, and mineralogical characteristics which would make it a high-elevation equivalent of the copper deposits along the Middle Fork of the Snoqualmie River (Grant, 1969, p. 87). Mineralization and accompanying alteration in the Mineral Creek area has occurred in the upper parts of granitic intrusive rock and in adjoining volcanic rock. The mineralization there has manifested characteristics which generally correspond to the pyrite-propylite zones of the Middle Fork area. Where the Mineral Creek area has been explored by drilling, copper sulfides accompanied by alteration have been found.

The mineralized zone of Mineral Creek area is on a northeast-trending transverse shear zone.

Placer deposits

Placer deposits of gold occur in those areas where significant lode gold deposits exist, as, for example, along Peshastin Creek in the Blewett district and along Swauk Creek (fig. 1) in the Swauk district. The gold is mostly in stream-level gravels but along Swauk Creek it also occurs in older terrace gravels (Smith, 1904, p. 9). Other deposits have been worked in lower Fortune Creek, near its confluence with the Cle Elum River. The gold is assumed to have been derived from mineralized areas on the west side of Van Epps Pass.

Geochemical exploration

A geochemical survey was made concurrently with the geologic reconnaissance of the additions to the Alpine Lakes area. A total of 1,716 samples of various types were collected for analysis: 804 stream-sediment samples, 19 soil samples, two panned concentrates, and 891 rock samples. Of the total, however, 57 are from parts of the Alpine Lakes area previously studied. Another 267 samples were collected from within or near to the additions during the 1971 and 1972 field seasons. Sample localities are shown on plate 2 and analytical data on tables 8 and 9. The type of sample collected is indicated by symbol. The samples are numbered, and where two or more were taken at the same sample site, the additional samples are indicated by letter suffixes in the table. Where two workers collected from the same site, different numbers are shown. Anomalous samples are underlined, and anomalous areas are outlined on plate 2. The anomalous areas are indicated by number, with titles shown in the explanation. Number symbols and titles are also shown in the text and in table 8. Also indicated on plate 2 are stream-sediment samples that contained copper and zinc, as detected by atomic absorption, and rock samples that contain copper, zinc, and gold, as detected by atomic absorption.

Stream-sediment samples consist of the fine-grained fraction of alluvial material in active streams or dry stream beds. The samples were analyzed by several methods for various metallic and other elements. The metals are adsorbed from stream waters on clay- and silt-size particles in the stream sediments or are included in fragments of rock material in the stream. Stream sediments with anomalously high metal contents indicate mineralized rock somewhere in the drainage basin. Although magnitude of the anomaly may directly reflect the volume and concentration of metal in the source area, the magnitude may also be affected by such factors as suseptibility of the contained metals to solution, distance from the source area, and volume of the stream. For example, tributary streams at the head of Van Epps Creek drain nearby mineralized rock, some of which has been opened by prospecting and mining operations. Stream-sediment samples from the tributaries are high in metals, but about 1 mile (1.5 km) downstream near the mouth of Van Epps Creek no anomalous concentrations of metals were detected.

Stream-sediment samples were collected from most small tributary streams, usually just above their confluence with medium or large streams. The samples were taken from the finest material available, but where fine grained sediment could not be obtained, material from underwater bank sediment was taken instead. In some steep-gradient streams it was not possible to obtain sufficient fine sediment for certain types of analyses.

The samples were sieved and the minus 80-mesh fraction used for analyses. Sediment samples containing sufficient fine material were analyzed by the citrate-soluble heavy metals (cxHM) colorimetric test for combined zinc, cobalt, copper, and lead (Ward and others, 1963). Samples in which 3 ppm or more of metals were detected by the citrate-soluble method were also analyzed for copper and zinc by atomic absorption.

All stream-sediment samples, including those in which the fine fraction was insufficient for citrate-soluble analysis, were analyzed by 6-step semiquantitative spectrographic analysis for a group of 30 elements (Grimes and Marranzino, 1968). Samples containing more than normal amounts of copper, lead, or zinc were further analyzed for copper and zinc by atomic absorption (Ward and others, 1963). Such further testing was necessary because the lower limit of detection of zinc by 6-step semiquantitative spectrographic analysis is 200 ppm, which in the Alpine Lakes area is an anomalously high value.

Panned concentrates of stream sediments were taken from the West Fork of Miller River and Mineral Creek and were tested by semiquantitative spectrographic and atomic absorption analysis.

Grab samples of rock were taken throughout the study area. Where stream sediments contained anomalous amounts of metal, rock samples were taken in the drainage basin in an attempt to locate the source of the metal. Others were taken from areas of hydrothermal alteration or in the vicinity of geologic structures that might contain mineral deposits. Some were taken near mines and prospects to determine not only the amount of metal in the visible ore minerals, but also to determine other elements which occur in trace amounts and which might serve as indicators of as yet undiscovered mineral deposits. Most grab samples, however, were taken to check for possible metal anomalies or anomalous trends, and to establish the normal amounts of metal in the different rock formations. The samples were tested by 6-step semiquantitative analysis and selected samples were further checked by atomic absorption for copper, gold, and zinc.

Review of the analytical data, especially data from areas of known mineralization and hydrothermal alteration, indicates that minimum anomalous values, disregarding rock type or source of stream sediment, are as follows:

Method and element	Value (ppm)
Stream sediment samples	
cxHM	10
Atomic absorption:	
Cu	100
Zn	100
6-step semiquantitative spectrographic analysis:	
Ag	0.5
As	200
Cu	100
Mo	5
Pb	50
Sn	10
W	50
Zn	200
Rock samples	
Atomic absorption:	
Au	1
Cu	100
Zn	100
6-step semiquantitative spectrographic analysis:	
Ag	0.5
As	200
Bi	100
Cu	100
Mo	5
Pb	50
Sb	100
Sn	10
W	50

All of the data for the above elements are shown in table 10 for each sample in which one of the elements was detected at or above the minimum values considered anomalous.

The 100-ppm level for copper may be close to the background level of that metal in intermediate and mafic dikes, but not many such bodies were sampled. The relatively high chromium and nickel contents found in the few samples of ultramafic rock collected are considered to be normal background.

Only the analytical data for samples regarded as anomalous are shown in table 8. Computer tape with all U.S. Geological Survey analytical data from the Alpine Lakes study area is available (USGS-GD-75-001).

Anomalous areas

Areas designated anomalous were judged so on the abundance and areal concentration of anomalous samples occurring therein, the repetitive occurrence of anomalously high concentrations of a particular element among the respective samples, and also on the character of the geology. Included in the anomalous areas are areas known to have been prospected or mined and for which there are supporting analytical data showing anomalous concentrations. All the anomalous areas are in additions to the western part of the Alpine Lakes area. The areas are discussed in roughly clockwise order beginning with an area near Snoqualmie Pass.

The reader is reminded that many samples were analyzed by more than one method and that many samples were anomalous in more than one element; consequently, in the following discussions of the anomalous areas, the number of anomalies cited may exceed the total number of anomalous samples.

Red Mountain area (pl. 2, area 1)

Six stream-sediment samples and three rock samples anomalous in metals were collected from the west side of Red Mountain. The rock samples are from altered and iron-stained volcanic and sedimentary rocks of the Naches Formation. All the stream-sediment samples are from streams draining the west face of Red Mountain.

Three of the stream-sediment samples are anomalous in citrate-soluble heavy metals in amounts that range from 10 to 300 ppm; the heavy-metals component must be mostly copper as 220-1,700 ppm copper was determined by atomic absorption in four of the samples. These determinations check closely with the spectrographic analyses, which show 150-1,500 ppm in the same four samples. Using spectrographic analysis, other samples were determined to be anomalous in molybdenum and zinc.

Stream-sediment sample EG-2459 is notable, both for its high copper content (1,700 ppm by atomic absorption) and for the unique character of the sampled material. The material is an ocherous-colored, glutinous, clay-sized sediment uncommon to the Alpine Lakes study area. We think that it may have been flushed by circulating ground water from intensely altered subsurface areas.

Two of the rock samples are anomalous only in copper (100 and 150 ppm, respectively) and the third is anomalous in zinc and tin (200 and 50 ppm, respectively), as determined by spectrographic analysis.

The area is considered significantly anomalous. The extent of the altered area, the presence of iron-stained rock, the evidence of possible argillic alteration at depth, and the nearby existence of a granitic intrusive suggest the area may be underlain by a disseminated mineral deposit.

Tuscohatchie Lake area (pl. 2, area 2)

Ten stream-sediment samples and one rock sample that contain anomalous amounts of metals were collected in the area of Tuscohatchie Lake. The area is underlain by medium-crystalline granodiorite or quartz diorite that is not visibly altered.

Six of the anomalous stream-sediment samples are anomalous in molybdenum and four are anomalous in lead, as determined by spectrographic analysis; in only one sample is there more than one anomalous element. Molybdenum ranges in concentration from 5 tc 10 ppm and averages 7 ppm; lead concentrations range from 50 to 300 ppm and average 120 ppm. Silver and tin are also present in anomalous amounts in one sample. The sample showing highest lead was analyzed again by atomic absorption for copper and zinc and was found to contain no anomalous amounts of copper and only a slightly anomalous amount of zinc (110 ppm).

The sole anomalous rock sample is anomalous in molybdenum (50 ppm). The area is not considered significantly anomalous.

Talapus Lake area (pl. 2, area 3)

Four stream-sediment samples that contain anomalous amounts of metals were collected from the area east and north of Talapus Lake. The area is underlain by medium crystalline granodiorite.

All of the samples are anomalous in molybdenum which ranges in concentration from 5 to 15 ppm and averages 8 ppm. One sample is also anomalous in silver and copper. The determinations were made by spectrographic analysis and the presence of copper so determined was verified by atomic absorption.

The area is not considered significantly anomalous.

Lake Kulla Kulla area (pl. 2, area 4)

Five anomalous stream-sediment samples and one anomalous rock sample were collected from the Lake Kulla Kulla area. The area is underlain by medium crystalline granodiorite.

The stream-sediment samples are anomalous in molybdenum, lead, and antimony, as determined by spectrographic analysis. Lead ranges in concentration from 70 to 300 ppm lead and averages 135 ppm. The antimony anomaly, 150 ppm, occurs in the sample with the highest lead anomaly.

The area is not considered significantly anomalous.

Melakwa Pass area (pl. 2, area 5)

Ten anomalous stream-sediment samples and seven anomalous rock samples were collected from the Melakwa Pass area. The area is underlain by several rock types including quartz monzonite (Erikson, 1968) pyroclastic and flow rocks, sandstone, hornfels, and tactite.

Nine stream-sediment samples are anomalous in copper and(or) lead, as detected by spectrographic analysis. Anomalous amounts of the two metals occur together in only four samples. Copper ranges in concentration from 100 to 150 ppm and lead from 70 to 300 ppm; they average 110 and 190 ppm respectively. Anomalous amounts of silver ranging in concentration from 0.5 to 1 ppm occur in four samples, most of which are also anomalous in copper and lead. The stream-sediment samples are also anomalous in molybdenum (one sample), tin (three samples), and zinc (two samples). Two stream-sediment samples are anomalous in citrate-soluble heavy metals; the heavy-metal anomalies correspond to anomalies in copper, lead, and zinc which were detected by spectrographic analysis.

The anomalous sediment samples appear not to be derived from any one geologic environment or rock type; the samples were taken from streams draining areas underlain by hornfels, and granitic and volcanic rocks.

The rock samples were determined anomalous in copper, lead, molybdenum, and zinc by spectrographic analysis. Most of the anomalies are near minimal levels, and in most of the samples the anomalies occur in only one metal. Four samples which were checked by atomic absorption were found anomalous in zinc, having concentrations ranging from 190 to 440 ppm and averaging 315 ppm. Most of the anomalous rock samples were collected from tactite; others were collected from mylonitized hornfels, granite, sandstone, and volcanic rock.

The area is not considered significantly anomalous, although small podular mineral deposits of base metals may be present in tactite zones.

Derrick Lake area (pl. 2, area 6)

Twelve stream-sediment samples and six rock samples collected from the Derrick Lake area are anomalous. The area is underlain by granodiorite and quartz monzonite (Erikson, 1968) which in places is cut by lensoidal veins containing schorlite, pistacite, and garnet.

Ten of the sediment samples are anomalous in molybdenum, which ranges in concentration from 6 to 30 ppm and averages about 10 ppm. Four samples are anomalous in lead and one in silver. Detection was by spectrographic analysis. One sample checked by atomic absorption showed a near-minimal anomaly in copper.

The rock samples are anomalous in lead, molybdenum, tin, and zinc, as determined by spectrographic analysis. Anomalies in more than one metal occur in only two samples, ES-2058 and ES-2076. These two samples contain relatively high amounts of zinc--1,500 and 1,000 ppm, respectively. When analyzed by atomic absorption, the samples were determined to contain 430 and 1,600 ppm zinc, respectively. Sample ES-2058 is from mafic rock, probably an amphibolite inclusion in granitic rock. Sample ES-2076 is from a garnetiferous vein.

The area is not considered significantly anomalous.

Thunder Creek area (pl. 2, area 7)

Eight stream-sediment samples and one rock sample anomalous in metals were collected from the Thunder Creek area. Most of the samples are from tributary streams on the south side of the valley of the Middle Fork of the Snoqualmie River. The area is underlain by quartz monzonite (Erikson, 1968).

The stream-sediment samples are anomalous in copper, lead, molybdenum, silver, and zinc, as determined by spectrographic analysis. Only three of the eight anomalous sediment samples are anomalous in more than one metal. Silver is the most prevalent of the anomalous metals; it occurs in four samples and its concentrations range from 0.7 to 1.5 ppm and average about 1 ppm. One sample is relatively high in molybdenum at 100 ppm.

The only anomalous rock sample collected in the Thunder Creek area was a cobble of pyritized granitic rock taken from the stream gravel, and is probably extraneous to the area. It is anomalous only in tungsten (70 ppm) which was determined by atomic absorption.

This area, although adjacent to one known to be mineralized, is not considered significantly anomalous.

Middle Fork of the Snoqualmie River area (pl. 2, area 8)

Part of the anomalous area along the Middle Fork of the Snoqualmie River is currently being explored for copper. The area is about 4 miles (6.5 km) long and, in places, as much as 1 mile (1.6 km) wide. The area is underlain by main-phase granodiorite of the Snoqualmie batholith, and is located along a northeast-trending shear zone (Grant, 1969, p. 45), which in places is offset by cross faults. The shear zone is characterized by numerous breccia pipes and allied structures. Rock in the northeastern, central, and southwestern parts of the area is mineralized, principally with sulfides of copper and molybdenum accompanied by minor amounts of other metals, including silver. Plutonic rock in the mineralized parts of the area has undergone three principal types of alteration: quartz-sericitic, propylitic, and potassic, which is characterized by the formation of secondary biotite and potassium feldspar (A. R. Grant, written commun., 1971).

Fifteen stream-sediment samples and twelve rock samples anomalous in either copper, molybdenum, or silver were collected from the area.

Spectrographic analysis showed that nine sediment samples are anomalous in copper, having concentrations ranging from 100 to 3,000 ppm, with an average of 760 ppm; 13 are anomalous in molybdenum, having concentrations ranging from 5 to 70 ppm, with an average of 20 ppm; and nine are anomalous in silver, having concentrations ranging from 0.5 to 3 ppm, with an average of about 1.3 ppm. Anomalous lead occurs in six samples but is not significantly abundant. A few samples also contain anomalous tungsten and tin.

Two stream-sediment samples, EG-2502 and EG-2511, contain significantly high concentrations of citrate-soluble heavy metals, 300 and 60 ppm, respectively. EG-2502 was collected from a stream draining the mineralized ground in the northeastern part of the area and EG-2511 was collected from a stream flowing from an exploratory adit driven into mineralized ground in the middle part of the area. The heavy-metal content determined in the two samples corresponds well with the 3,000 and 2,000 ppm copper determined by spectrographic analysis, and the 4,700 and 2,000 ppm determined by atomic absorption. Two additional samples were anomalous in copper and(or) zinc as determined by atomic absorption.

Eleven rock samples are anomalous in copper (100-1,500 ppm, with an average of 376 ppm), five are anomalous in molybdenum (10-70 ppm, with an average of 31 ppm), and nine are anomalous in silver (0.7-7 ppm, with an average of about 1.4 ppm), as determined by spectrographic analysis. A few samples are also anomalous in lead, tin, tungsten, and zinc. Sample EG-2568 is unusual in that it contains 5,000 ppm lead and has some silver and zinc but no copper or molybdenum. The sample is of limonite-stained medium-crystalline granodiorite, which appears to be slightly altered, from the ridge between Burntboot Creek and the Middle Fork of the Snoqualmie River.

Parts of the area appear to be significantly mineralized; this visual impression is supported by the analytical data. Verification of the presence of a deposit or deposits of sufficient size and tenor to constitute ore at current metal prices and current state of mining technology awaits the outcome of exploration now being conducted in the area.

Burntboot Creek area (pl. 2, area 9)

The Burntboot Creek area lies approximately along the contact of the Snoqualmie batholith with volcanic rocks of the Naches Formation. Six anomalous stream-sediment samples and one anomalous rock sample were collected from the area.

Most of the stream-sediment samples are anomalous in either copper or lead at near-minimal levels, as determined by spectrographic analysis. Anomalous molybdenum and silver are also present in two of the samples. The lead anomalies occur in streams draining the area south of Burntboot Creek, which is underlain by volcanic rock; whereas the copper anomalies, with one exception, occur in streams draining the area north of the creek, which is underlain by granitic rock.

The samples found anomalous in copper by spectrographic analysis were analyzed again by atomic absorption; the determinations agree fairly well. Two of the samples so analyzed were also found anomalous in zinc but only at minimal levels.

The rock sample is anomalous only in lead, as determined by spectrographic analysis, and is from granitic rock.

On the basis of the analytical data, the Burntboot Creek area does not appear to be significantly anomalous.

Hester Lake area (pl. 2, area 10)

Five stream-sediment samples that contain anomalous amounts of metals were collected from the Hester Lake area. The area is underlain by medium-crystalline granodiorite.

Two samples are anomalous in lead and three are anomalous in molybdenum, as determined by spectrographic analysis. All anomalies are at or near minimal levels; no sample is anomalous in more than one metal.

The area is not considered significantly anomalous.

Dingford Creek area (pl. 2, area 11)

Four stream-sediment samples and one rock sample collected from the Dingford Creek area are anomalous. The area is underlain by granodiorite.

The sediment samples are anomalous in copper, lead, molybdenum, and silver, as determined by spectrographic analysis; the anomalies are not significantly high. In sample EG-2646 anomalies occur in all four metals.

The sole anomalous rock sample is anomalous in copper and tungsten.

The area is not considered significantly anomalous.

Green Ridge Lake area (pl. 2, area 12)

The Green Ridge Lake area appears to be underlain by a limonite-stained northwest-trending shear zone cutting granodiorite. The shear planes strike roughly N. 20°-30° W. and dip about 65° NE. Quartz-lined vugs are common and contain crystals as much as 1 1/2 inches (4 cm) long and three-fourths of an inch (2 cm) across. One stream-sediment sample and one rock sample are anomalous, as determined by spectrographic analysis. The sediment sample is anomalous only in silver at a near-minimal level. The rock sample is anomalous in copper (100 ppm); lead (70 ppm); molybdenum (30 ppm); silver (2 ppm); and zinc (300 ppm).

The quartz-lined vugs and limonite-stained rock may be indicative of hydrothermal activity although the paucity of anomalous samples does not indicate the presence of large amounts of metals.

Garfield Mountain Lakes area (pl. 2, area 13)

Two anomalous stream-sediment samples and four anomalous rock samples were collected from the Garfield Mountain Lakes area. The area is underlain by andesite flows, quartz monzonite, and diorite (Erikson, 1968).

The sediment samples are anomalous only in lead at minimal or near-minimal levels, as determined by spectrographic analysis. The samples were collected from the outlet and inlet of Lower Garfield Mountain Lake in an area surrounded by volcanic rock.

The rock samples are anomalous in copper, molybdenum, and silver at minimal or near-minimal levels, as determined by spectrographic analysis. Samples anomalous in copper and silver are from volcanic rock.

The area is not considered significantly anomalous.

Snoqualmie Lake Potholes area (pl. 2, area 14)

Seven stream-sediment samples and four rock samples collected from the Snoqualmie Lake Potholes area are anomalous. The area is underlain by medium to coarsely crystalline granodiorite.

The stream-sediment samples are anomalous in copper, lead, molybdenum, and silver, as determined by spectrographic analysis. Molybdenum is present in six samples and ranges in concentration from 5 to 20 ppm with an average of 12 ppm; copper is present in three samples, lead in four samples, and silver in three samples. Four of the samples are anomalous in two or more metals; two of them are anomalous in all four metals. Two samples, EC-2030 and EG-2671, are from the same site.

Three of the rock samples are anomalous only in copper and the fourth is anomalous only in silver, as determined by semiquantitative spectrographic analysis. The analysis for sample EG-2666 shows 1,000 ppm copper.

The area is not considered to be significantly anomalous.

Lake Dorothy South area (pl. 2, area 15)

Four stream-sediment samples and one rock sample that contain anomalous amounts of metals were collected in the area east and southeast of Lake Dorothy. The area is underlain by granodiorite. It adjoins a previously reported anomalous area lying to the east which includes the drainages of Camp Robber Creek and the upper West Fork of the Foss River (Gualtieri, and others, 1973).

The sediment samples are anomalous in copper, lead, molybdenum, and silver, as determined by spectrographic analysis. Only molybdenum is common to all the samples but it is present only in minimal or near-minimal amounts.

The rock sample, EG-2711, was found anomalous in copper (500 ppm), silver (2 ppm), and tungsten (100 ppm), as determined by spectrographic analysis. It was collected from an outcrop of apparently unaltered medium-crystalline granodiorite on the ridge between Lake Dorothy and Camp Robber Creek.

The area is not considered significantly anomalous.

Taylor River area (pl. 2, area 16)

Four anomalous stream-sediment samples and one anomalous rock sample were collected from the Taylor River area. Most of the area is underlain by granodiorite and a small part is underlain by andesite.

The stream-sediment samples are anomalous in lead, molybdenum, and silver, as detected by spectrographic analysis. The anomalies are at or near minimal levels and probably reflect low concentrations of these metals in granitic rock.

The anomalous rock sample, EG-2694, is andesite that does not appear mineralized or altered. It contains 700 ppm arsenic and 15 ppm tin, as determined by spectrographic analysis. Arsenic is characteristic of sulfide-bearing veins in the Lennox Creek and Miller River areas.

The area is not considered significantly anomalous.

Big Creek area (pl. 2, area 17)

Three stream-sediment samples anomalous in arsenic, copper, molybdenum, tungsten, and silver were collected from the area. The area is underlain by medium crystalline granodiorite.

Molybdenum and tungsten are common to all three samples; molybdenum is present in amounts ranging from 5 to 7 ppm, whereas tungsten is 70 ppm in each of the samples. Arsenic is present in two samples in concentrations of 200 and 300 ppm. Determination was by spectrographic analysis.

The arsenic and tungsten in the samples may have been derived from a vein deposit of sulfide minerals similar to those occurring in the Lennox Creek and Miller River areas.

The area is not considered significantly anomalous.

Marten Lake area (pl. 2, area 18)

Two stream-sediment samples and two rock samples that contain anomalous amounts of metals were collected from the Marten Lake area. The area is underlain by biotite- and pyroxene-bearing granodiorite (Erikson, 1968).

One stream-sediment sample contains 10 ppm citrate-soluble heavy metals. The other contains 5 ppm molybdenum, as determined by spectrographic analysis. The rock samples are both anomalous in copper, in 100- and 300-ppm amounts, as determined by spectrographic analysis.

The area is not considered signficantly anomalous.

Lake Isabella area (pl. 2, area 19)

Four anomalous stream-sediment samples and one anomalous rock sample were collected from an elongate area extending from Lake Isabella on the west to Mowitch Lake on the east and stradling upper Sunday Creek. The area is almost entirely underlain by granodiorite.

The stream-sediment samples are minimally or near minimally anomalous in lead, molybdenum, and silver, as determined by spectrographic analysis. The sole anomalous rock sample contains 200 ppm zinc, also determined by spectrographic analysis.

The area is not considered significantly anomalous.

Sunday Creek area (pl. 2, area 20)

Four stream-sediment samples and three rock samples anomalous in several metals were collected from the Sunday Creek area. The area, which lies along lower Sunday Creek, is underlain with granodiorite, andesite, graywacke, and hornfels.

Most of the sediment samples are commonly anomalous in lead and zinc and two samples also contain molybdenum and silver, as determined by spectrographic analysis. Anomalous zinc in two samples was determined by atomic absorption. One sample contains 16 ppm citrate-soluble heavy metals, most of which apparently are lead and zinc. Sample EG-2538, collected from the outlet of Sunday Lake, is notable in that it is anomalous in seven metals including arsenic and tungsten.

The rock samples are anomalous in copper and also contain anomalous lead and silver, as determined by spectrographic analysis. The most notable anomalous rock sample is EG-2535, collected from an outcrop of altered porphyritic andesite. In addition to anomalous copper and lead, it contains 300 ppm arsenic, 10 ppm silver, and 300 ppm zinc. The sample was analyzed again by atomic absorption for zinc and showed only 190 ppm.

The area is considered significantly anomalous; apparently metals have been introduced into volcanic rock in places where it was intruded by granitic rock.

Lennox Creek area (pl. 2, area 21)

The Lennox Creek area covers more than 10 square miles (26 km^2) and includes the drainages of Cougar Creek, Bear Creek, and northward-flowing streams tributary to the upper part of the North Fork of the Snoqualmie River. The area is underlain by diorite and granodiorite and contains numerous vein deposits of base and precious metals.

Forty-five stream-sediment samples collected from the area were found anomalous in one or more metals. Nine samples contain anomalous arsenic in concentrations which range from 200 to 1,500 ppm and which average about 480 ppm; seven samples contain anomalous copper which ranges in concentration from 100 to 500 ppm and averages about 260 ppm; six samples contain anomalous lead concentrations which range from 50 to 150 ppm and average about 75 ppm; 30 samples contain anomalous molybdenum in concentrations which range from 5 to 30 ppm and average about 11 ppm; and 13 samples contain anomalous silver in concentrations which range from 0.7 to 3 ppm and average about 1.1 ppm. All determinations were by spectrographic analysis. Other anomalous elements include tungsten and zinc. Four samples contain anomalous citrate-soluble heavy metals. Five samples analyzed by atomic absorption were determined to contain either anomalous copper or zinc in amounts usually higher than those determined by spectrographic analysis. Due to the 200-ppm zinc detection limit for spectrographic analysis, anomalous zinc was detected by atomic absorption in some samples where none was detected originally.

Two samples contain predictably high amounts of several metals: EG-2534 was collected from a stream draining a steep cliff face just below a known mine and EP-2368 was collected from water draining a prospect drift.

Nineteen rock samples collected from the Lennox Creek area are anomalous in one or more elements. The majority of the samples are, however, from mine or prospect dumps and the high metal contents are therefore to be expected.

Spectrographic analysis showed that six samples are anomalous in arsenic (300-10,000 ppm, with an average of about 7,300 ppm), eight samples are anomalous in copper (150-15,000 ppm, with an average of about 5,700 ppm), nine samples are anomalous in molybdenum (5-1,000 ppm, with an average of about 300 ppm), 10 samples are anomalous in silver (1.5-300 ppm, with an average of about 41 ppm), and seven samples are anomalous in zinc (300-7,000 ppm, with an average of about 1,750 ppm). Other anomalous metals in these samples include antimony, lead, tin, and tungsten. Atomic absorption revealed anomalous amounts of zinc in two additional samples.

Samples from workings or dumps--EG-2524-A and -B, EG-2761-A and -B, and EG-2762-B--reflect in their high arsenic anomalies the arsenical character of the mineralized rock in the Lennox Creek area, although samples EP-2368-A, -F, -G, and -H from a working in the lower part of the Lennox Creek drainage apparently contain no detectable amounts of the element.

Samples EG-2518-A and 2514-A are molybdenite-bearing quartz fragments collected along lower Cougar Creek. The samples do not appear to contain any ore mineral except molybdenite and this is verified by the analyses.

The many anomalous stream-sediment samples collected along Cougar Creek, Lennox Creek, and streams tributary to the North Fork of the Snoqualmie River may reflect the existence of numerous undiscovered vein deposits, probably similar in mineralogy, size, and tenor to those already discovered and worked. Further diligent searching in the area may lead to the discovery of new deposits.

West Fork of the Miller River area (pl. 2, area 22).

The West Fork of the Miller River area includes not only ground along the West Fork but also ground west of the main stream of the river below the confluence of the West and East Forks. The area along the West Fork is underlain by granodiorite and that below the confluence of the two forks is underlain by andesite flows (Galster, 1956). Numerous vein-type deposits of base and precious metals are contained in the area along the West Fork.

Fifteen stream-sediment samples anomalous in one or more metals were collected from the area. Spectrographic analysis showed that four samples are anomalous in arsenic (200-1,000 ppm, with an average of 450 ppm), eight samples are minimally or near minimally anomalous in lead (50-70 ppm, with an average of 65 ppm), and six samples are anomalous in silver (0.5-7 ppm, with an average of about 2 ppm). Other metals in anomalous amounts in these samples are copper, molybdenum, and tin. Only seven of the samples are anomalous in more than one element. Two additional samples were found anomalous in copper by atomic absorption; one of these also contains 18 ppm citrate-soluble heavy metals.

Six rock samples, most of which were collected from mine dumps and workings, are anomalous. All are arsenical; arsenic ranges in concentration from 1,000 to 10,000 ppm and averages about 4,300 ppm. Four samples contain anomalous tin, in amounts ranging from 10 to 30 ppm and averaging about 19 ppm. Determination was by semiquantitative spectrographic analysis. Other anomalous elements include lead, antimony, and silver, but, in general, the analytical data show the samples collected from most of the worked deposits to be barren of valuable metals. The area is nevertheless considered significantly anomalous. The presence of copper, lead, molybdenum, and silver in the stream-sediment samples may reflect the presence of undiscovered veins in the area.

Gouging Lake area (pl. 2, area 23)

Three stream-sediment samples and three rock samples collected in the Gouging Lake area are anomalous. The area is underlain by granodiorite which is locally mineralized along joint planes.

The stream-sediment samples are anomalous only in lead, which ranges from near-minimal levels to 150 ppm, as determined by spectrographic analysis.

Two samples of apparently unmineralized or unaltered rock were determined by spectrographic analysis to be anomalous in copper and zinc. The other sample, EG-2097-A, appears mineralized and is anomalous in arsenic (10,000 ppm), bismuth (700 ppm), and copper (1,000 ppm), as well as in lead, molybdenum, tin, tungsten, and silver. Because these elements generally characterize vein deposits in the near-adjacent Lennox Creek and Miller River areas, the Gouging Lake area is considered significantly anomalous.

East Fork of the Miller River area (pl. 2, area 24)

Ten stream-sediment samples and one rock sample collected from the East Fork of the Miller River area are anomalous. The area is underlain by granodiorite and andesite.

The stream-sediment samples are anomalous in copper, lead, and molybdenum at minimal or near-minimal levels, as determined by spectrographic analysis. Only two samples are anomalous in more than one metal.

The sole anomalous rock sample is from a mafic dike cutting granodiorite. The sample is anomalous only in antimony, 100 ppm, and also contains 200 ppm boron.

The area is not considered significantly anomalous.

Lake Dorothy North area (pl. 2, area 25)

Seven anomalous stream-sediment samples and one anomalous rock sample were collected from the outlet of Lake Dorothy and the upper part of the East Fork of the Miller River. The area is underlain by granodiorite.

The sediment samples, like those along the lower part of the East Fork of the Miller River, are anomalous in copper, lead, and molybdenum at minimal levels. Three of the samples are anomalous in more than one metal. Detection was by spectrographic analysis.

The sole anomalous rock sample was from apparently unaltered granodiorite and was found anomalous in gold in the amount of 3.5 ppm as determined by atomic absorption.

The area is not considered significantly anomalous.

Mineral Creek area (pl. 2, area 26)

The Mineral Creek area is one of relatively complex geology; the area is underlain by fault-bounded blocks of andesite flows, schist, and arkosic sandstone that are intruded by a granitic stock. The volcanic rock appears to have undergone intense quartz-sericite and propylitic alteration, whereas the schist and granodiorite are only mildly altered. The canyon wall on the northeast side of the lower part of Mineral Creek is stained with minonite but sulfide minerals are only sparsely distributed. Sulfide minerals are, however, abundant in the more intensely mineralized areas near the level of Mineral Creek.

Seven anomalous stream-sediment samples, one anomalous panned-concentrate sample, and twelve anomalous rock samples were collected from the area.

The stream-sediment samples are anomalous in copper (100-700 ppm, with an average of 240 ppm) and five different samples are anomalous in molybdenum (5-30 ppm, with an average of 16 ppm). Lead, silver, and zinc are also present in anomalous amounts. The determinations were by spectrographic analysis. Atomic absorption analysis of the copper content of some of the samples gave comparable concentrations. Three samples contain anomalous citrate-soluble heavy metals which are believed to be copper, lead, and zinc.

The panned-concentrate sample was collected near the mouth of Mineral Creek. It is anomalous only in copper, at 700 ppm, as determined by spectrographic analysis. It is assumed the copper was contained in minute grains of one or more sulfide minerals that were observed concentrated with other heavy minerals.

Eight samples collected from volcanic and granitic rock are anomalous in copper in concentrations ranging from 150 to 2,000 ppm and averaging about 655 ppm. Four of the samples, however, were taken from an area of relatively high concentrations of disseminated sulfide minerals near a mine on Mineral Creek. Five other samples collected from schist, volcanic, and granitic rock are anomalous in molybdenum, but in only one is it above minimal levels. That one is from near the mine on Mineral Creek and contains 300 ppm molybdenum. Two samples collected from schist near a major fault are anomalous in zinc. All determinations were by spectrographic analysis. The zinc anomalies were checked by atomic absorption and found comparable.

Part of the area is altered and mineralized and although no deposits have been discovered that are economic under current conditions, the potential remains for the future discovery of a low-grade copper deposit.

Other anomalous samples

Scattered, isolated anomalous samples that occur outside the indicated anomalous areas are shown separately in table 9, grouped according to the addition in which they occur. Some of them are discussed briefly below. Determinations were by spectrographic analysis unless otherwise stated.

Numerous rock and stream-sediment samples collected from the Chiwaukum Mountains addition were found minimally anomalous in copper and molybdenum.

Three rock samples collected from unaltered granitic rock along the ridge of Cashmere Mountain are anomalous in copper at near-minimal levels. A fourth sample, of a pegmatite vein, contains 300 ppm copper.

Rock samples collected from mine workings near the southeastern tip of the South Fork of Fortune Creek addition are anomalous in copper and zinc. The mineralized rock is confined to east-west-trending structures which may extend into the addition. Other samples anomalously high in arsenic and copper came from a working west of the addition. There the mineralized rock appears confined to a north-south-trending structure.

A few arkosic sandstone and volcanic rock samples that contain barely anomalous amounts of molybdenum were collected from the Goat Mountain area. Of some interest are anomalies in samples from iron-formation underlying the Swauk Formation that were collected along the Cle Elum River, east of the Goat Mountain-Polallie Ridge addition. The samples are minimally or near minimally anomalous in copper, tin, and zinc. The iron content exceeds 20 percent, the upper limit for determination by spectrographic analysis.

Fifteen scattered anomalous stream-sediment and rock samples were collected from outside of indicated anomalous areas in the South and Middle Forks of the Snoqualmie River addition. Most anomalies are at or near minimal levels for copper and molybdenum and five samples are anomalous in lead, silver, tin, and tungsten. Sample EG-2486 from the outlet of Edds Lake, south of Burntboot Creek, is notable; it is anomalous in copper, lead, and molybdenum, and contains 30 ppm citrate-soluble heavy metals.

Several scattered stream-sediment and rock samples collected from the Lennox Creek-Miller River addition are anomalous in arsenic, copper, molybdenum and lead, elements which are more or less characteristic of the vein deposits occurring there. Samples EG-2738-A and -B were taken from a limonite-stained narrow shear zone in granitic rock near the summit of Goat Mountain.

Other commodities investigated

Potential resources of some mineral, fuel, or rock products which are or might be present in the Alpine Lakes area were also investigated.

The Swauk Formation was examined for uranium deposits. Arkosic sandstone elsewhere in the United States contains roll-type uranium deposits which are commonly oxidized and contain a conspicuous suite of yellow minerals. However, nothing observed in the Swauk Formation indicated the presence or likely presence of uranium deposits. As a further check, selected samples from the formation were tested radiometrically for equivalent U_3O_8. In addition, several samples from the Mount Stuart and Snoqualmie batholiths were similarly tested; no anomalous uranium was detected in these, either.

Nickeliferous iron deposits occur outside the south-central part of the Alpine Lakes study area and are present in the valley of the Cle Elum River as far north as a point near the Fish Lake Guard Station. Some of these deposits have been described by Lamey and Hotz (1951). The deposits are lenticular, are rarely more than 1,000 feet (305 m) long, and commonly no thicker than a few tens of feet (10 m±). They occur in a weathered zone on serpentinized Ingalls Peridotite where it is unconformably overlain by Swauk Formation. A major high-angle fault, roughly parallel to the Cle Elum River, extends through part of the area and places Swauk and volcanic rock on the west against peridotite on the east. The weathered zone and iron deposits are assumed to be present beneath the Swauk on the west side of the fault and probably extend into the Alpine Lakes area. However, the subsurface occurrence of such iron deposits would preclude them from being economic now or in the foreseeable future.

Pegmatite dikes occur in parts of the Snoqualmie batholith but they do not contain workable quantities of muscovite, valuable feldspar, or other minerals.

Although coal occurs in the Bellingham area of the State in a formation equivalent to the Swauk, no coal is known to occur in the Alpine Lakes area. The Swauk has a very high sandstone-to-shale ratio and was deposited under conditions unfavorable for the formation of coal. Only sparse carbonized fragments and imprints of fossil flora were observed in the Swauk.

Granitic rocks, like those in both the eastern and western parts of the study area, may be crushed and used as road metal and railroad ballast or cut in large blocks and used as riprap; however, neither of the granitic bodies within the study area can be considered an economic resource because they are not accessible to the main routes of transportation.

The arkosic sandstone of the Swauk possibly may be suitable as building stone to veneer small buildings, domestic dwellings, and fireplaces. However, the esthetic attractiveness of the rock as a building stone is questionable, and because the sandstone is in thick to massive beds, it probably cannot be easily cleaved into blocks of specified sizes. Furthermore, other, more accessible, deposits of the sandstone occur outside the study area.

Sand and gravel suitable as aggregate for concrete occur in numerous deposits along stream valleys of the Alpine Lakes area. However, deposits of such material ample for foreseeable needs are available in the Puget Sound lowlands and in the Columbia River and Spokane River basins, near the urban and industrial areas where these materials are most used.

Lenticular bodies of marbleized limestone interlayered with other metamorphic rock occur in several units of pre-Cretaceous rock that crop out north and northwest of Snoqualmie Pass. However, the limestone layers are regarded as too small or are located on slopes too precipitous to be amenable to open-pit or quarry-type mining operations and most are too inaccessible for economic exploitation. Further, the chemical composition of the rock varies so much that additional blending would be required to yield a chemically consistent product.

A possible source of geothermal energy in the Alpine Lakes area could be the Snoqualmie batholith. It was emplaced in late Miocene time and may retain enough of its heat to have a geothermal gradient greater than is normal for crustal rocks. A hot spring associated with the batholith occurs just outside of the study area, but may be generated by the oxidation of a nearby sulfide deposit. Other batholithic rock assumed to be as young as that of the Snoqualmie is extensively exposed outside the Alpine Lakes area and potential geothermal development would probably occur outside the area.

Geologic appraisal of mineral resources

Most of the known mineral deposits in the Alpine Lakes area appear to be genetically related to granitic plutons that constitute parts of the Mount Stuart and Snoqualmie batholiths. The areas with the greatest potential for mineral resources, therefore, lie along or near borders of these plutons. The Snoqualmie batholith, however, has been conducive to the formation of far more mineral deposits than has the Mount Stuart.

Additions in the northern, northeastern, and east-central parts of the Alpine Lakes area are essentially devoid of mineral resources, probably because they overlie the plutons constituting the Mount Stuart batholith, which in these areas is barren. Additions near the southeastern and south-central parts of the batholith likewise appear devoid of mineral resources; however, these additions are located along a discontinuously mineralized belt that roughly parallels the periphery of the Mount Stuart batholith. The belt is delineated by gold vein deposits in the Paddy-Go-Easy Pass and Peshastin Creek areas and by a copper vein deposit near Van Epps Pass, along the ridge south and southwest of Ingalls Creek, and near Hawkins and Huckleberry Mountains. The Van Epps Pass area also contains a disseminated copper deposit. The deposits occur along the border of the batholith; however, some are as much as 4 miles (6.5 km) from it.

Disseminated copper deposits occur near the periphery of the Snoqualmie batholith and outlying stocks. The deposits appear to be associated with main-phase granodiorite. The most extensively explored disseminated copper deposit lies on the nose of a ridge between the Middle Fork of the Snoqualmie River and Burntboot Creek, in the South and Middle Forks of the Snoqualmie River addition. Another disseminated copper deposit lies on the northeastern side of lower Mineral Creek, in the Mineral Creek addition. The deposit, which is mostly in volcanic rock, lies at the southern boundary of the Three Queens stock. Similar potential deposits may be present in extensive areas of hydrothermally altered rock, such as Red Mountain.

Many vein deposits of base and precious metals are emplaced on shear zones within the Snoqualmie batholith. The deposits are concentrated between Lennox Creek and the Miller River, in the Lennox Creek-Miller River addition. They are in or near diorite and pyroxene granodiorite stocks that were intruded by main-phase granodiorite. The deposits are assumed to be derived from main-phase magma. Vein deposits occurring in the original study area and containing mostly copper, appear related to a quartz monzonite stock. Other quartz monzonite stocks that occur in the South and Middle Forks of the Snoqualmie River addition and the Middle Fork of the Snoqualmie River-Taylor River addition may contain similar deposits.

ECONOMIC APPRAISAL

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U.S. Bureau of Mines

History and production

Mining activity near the Alpine Lakes study area began with the discovery of placer gold along Peshastin Creek in 1860. Similar deposits were discovered in 1868 along Swauk Creek. The first claims on the lode sources of the Peshastin placers were located in 1873 and vein deposits of gold in the Swauk district were discovered in 1881 (Patty, 1921, p. 267-268). The combined value of production from the Peshastin and Swauk districts before 1901 exceeded $2 million (Smith, 1904, p. 8).

The discovery in 1874 of lode deposits in the index district near the northwest part of the study area stimulated prospecting in the northwest part of the study area. Claims were staked along Money Creek in 1889 (Hodges, 1897, p. 39) and in the Miller River drainage in 1892 (Hodges, 1897, p. 36). The most significant development in these areas was during the period from 1893 into the 1920's but sporadic small production from the Miller River drainage has continued to the present.

Exploration activity in the Buena Vista district, in the Lennox Creek-North Fork Snoqualmie area, began about 1896 (Hodges, 1897, p. 43) mainly on shear zones traced from the Miller River drainage. Only minor production has come from the district, mostly from the Lennox and Bear Creek prospects.

A section of the Cle Elum River drainage (the Camp Creek and Big Boulder Creek drainages) in the south-central part of the study area was first prospected in 1881, mainly for iron ore deposits (Hodges, 1897, p. 61). Prospecting continued eastward along an iron-enriched zone extending roughly through Iron Peak, Earl Peak, Navaho Peak, and Iron Mountain to the Blewett district. Some of the properties on the west end of the zone were explored between 1889 and 1892 (Shedd, 1902, p. 7). The iron deposits were first studied systematically in 1892 (Bethune, 1892). The U.S. Bureau of Mines conducted a drilling program in 1942 on deposits near the Cle Elum River. Sulfide deposits in the Gallager Head Lake area (fig. 2) were discovered in 1881. Although many claims have been located, no production, except small tonnages for smelter tests, has been reported.

Iron deposits of the Snoqualmie Pass area were discovered in 1869 on Denny Mountain. No significant work was done until 1883 when development adits were driven (Hodges, 1897, p. 40-41). The Guye iron deposits, approximately 2 miles (3.2 km) northeast of Denny Mountain, were discovered in 1881 (Shedd, 1902, p. 7). The only production from the iron deposits in the Snoqualmie Pass area has been small tonnages for metallurgical testing. The limestone deposits in the same area were first noted during the late 1880's (Hodges, 1897, p. 40).

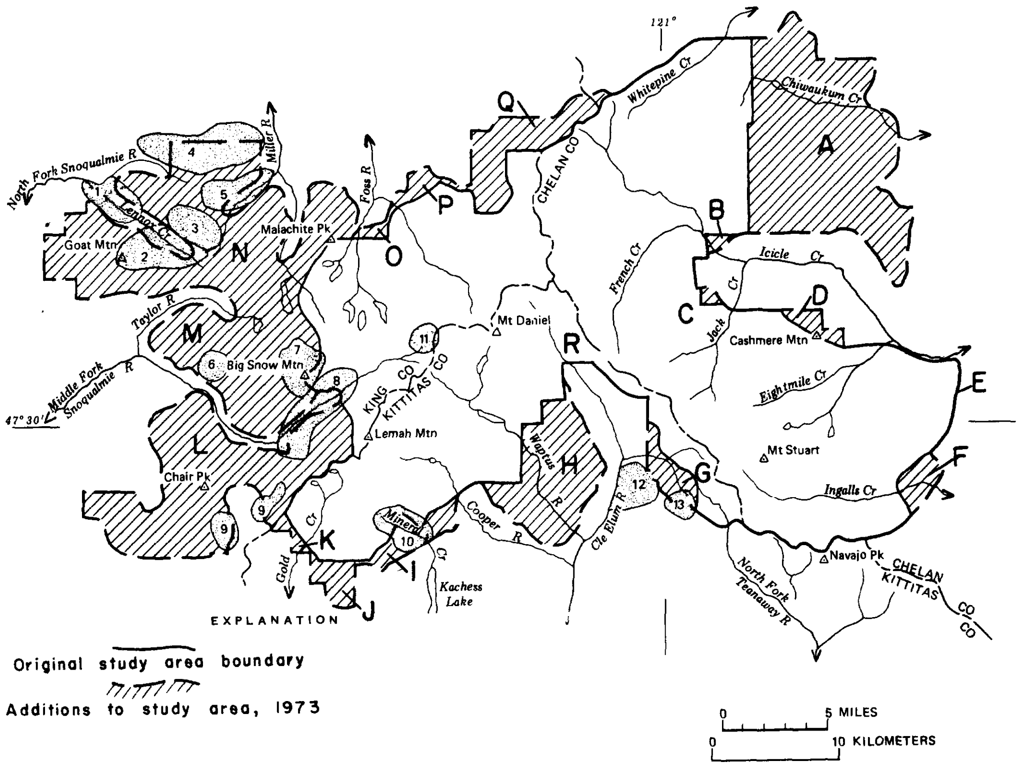


Figure 2.--Areas containing numerous prospects (stipple pattern), Alpine Lakes study area additions.

ADDITIONS TO STUDY AREA

A Chiwaukum Mountains
B Icicle Creek
C Blackjack Ridge
D Cashmere Mountain
E Wedge Mountain
F Ingalls Creek
G South Fork of Fortune Creek
H Goat Mountain-Polallie Ridge
I Mineral Creek
J Lake Lillian
K Kendall Peak
L South and Middle Forks of the Snoqualmie River
M Middle Fork of the Snoqualmie River-Taylor River
N Lennox Creek-Miller River
O Foss River
P Burn Creek
Q Deception Creek-Tunnel Creek
R Cle Elum River

AREAS STUDIED BY BUREAU OF MINES

1 Prospectors Ridge
2 Cougar Creek
3 Upper West Fork Miller River-Bear Creek
4 Money Creek
5 West Fork Miller River
6 Green Ridge Lake
7 Big Snow Mountain
8 Middle Fork Snoqualmie River
9 Snoqualmie Pass
10 Mineral Creek
11 Dutch Miller-La Bohn Gaps
12 Huckleberry Mountain
13 Gallager Head Lake

The copper deposits in the Mineral Creek area (fig. 2) were prospected in the late 1800's. Several workings were noted in 1899 when the area was mapped by the U.S. Geological Survey (Smith and Calkins, 1906). Development work continued and a mill of 25 tons per day capacity was built in 1920. However, production from the district has been minor (Patty, 1921, p. 267-268).

The mineral deposits in the Middle Fork Snoqualmie River area were discovered by prospectors in the late 1890's. The copper deposit on the Dutch Miller group of claims was located in 1896, and by 1901 several small shipments of ore had been made (Landes and others, 1902, p. 86). Exploration activity by a succession of owners and lessees has continued to the present time, but little additional production has resulted. Copper-molybdenum deposits on the Clipper group of claims and in the Pedro zone were discovered around the turn of the century and claims were located in 1902. A number of claims on the Clipper and Pedro mineralized zones were surveyed for patent in 1908 and some patents were subsequently granted. Although minor copper ore production probably resulted from the major workings, none is recorded. Exploration by major mining companies in a southwestward extension of the mineralized zone has disclosed potentially large tonnages of mineralized rock which may constitute a large copper resource and exploration is continuing.

Claims have also been located outside of the main mineralized areas throughout the study area. Most are on altered iron-oxide-stained zones but some were located on quartz-rich zones. Dates of location range from the beginning of the century to recent years. Only a few have even minor development and no production has been recorded.

Mineral commodities

The search for gold and silver first brought prospectors to the study area and some small deposits were found. Discovery of iron deposits inside the south boundary stimulated prospecting for iron in other parts of the study area but no other deposits were found. Prospecting for copper, the most significant mineral commodity within the study area, continues to the present time. National and world data for the following section on economic consideratons are from the U.S. Bureau of Mines "Commodity Data Summaries" (U.S. Bureau of Mines, 1974) and Engineering and Mining Journal (1974).

Copper

In 1973 domestic copper consumption, which was estimated at a little more than 2 million tons (1.8 million t), exceeded domestic production from mines and secondary sources by about 37 percent. Copper in various forms, therefore, must be imported to meet consumer needs. With congressional approval the national copper stockpile objective was reduced to zero in March 1973, thus making available 252,000 tons (228,614 t) of stockpiled surplus copper. The largest percentage of copper is used as refined copper metal for electrical applications; some is used in alloys. Barring technological changes, demand is expected to increase at an annual rate of about 4 percent through 1980. The price of copper was 68.58 cents per pound in March 1974. Large disseminated deposits are now being surface-mined at grades as low as 0.4 percent copper.

The Middle Fork Snoqualmie River area in the Alpine Lakes additions and the Dutch Miller mine in the original study area both contain copper resources along the west side of the study area, within and near the east edge of the granitic rocks of the Snoqualmie batholith. The Mineral Creek area to the south also has a potential for discovery of copper deposits.

Estimates based upon incomplete data (B. Thomas, written commun., 1907) indicate that over 800,000 pounds (363,000 kg) of copper is contained in approximately 3,700 tons (3,357 t) of high-grade copper ore on the dumps and in limited underground workings at the Dutch Miller mine. Only small shipments were made during early exploration and development work.

Mineralized ground of the Middle Fork Snoqualmie River area lies within one of the additions. Copper-rich rock occurs as small bodies in a series of brecciated or shattered zones, 400-500 feet (120-760 m) wide, some of which have been explored by core drilling and adits. One of these zones--the Clipper zone--is estimated to contain 250,000 tons (226,800 t) of mineralized rock containing 0.9 percent copper and significant percentages of molybdenum (A. R. Grant, written commun., 1971). Geologic conditions suggest that an additional large tonnage of copper-bearing rock of the same grade may be present in the zone. Another of the zones--the Three Brothers zone--is estimated to contain an additional large tonnage of copper-bearing rock. The intensity of the brecciation and mineralization in the Three Brothers zone (somewhat more intense than that observed in the Clipper zone) suggests that the copper content may be of similar grade to that in the Clipper zone. Exploration by major companies in the Porter, Hemlock, and Condor breccia zones has indicated large copper resources favorably situated for low-cost mining. Additional exploration will probably define additional resources.

The main mineralized zone of the Mineral Creek area is inside the additions. The zone has been explored for copper since the late 1800's and small production has come from mines there. Geologic investigations are continuing in the Mineral Creek area by Cities Service Minerals Corp.

Small paramarginal and submarginal copper resources exist in other prospects in the study area.

Silver

In 1973 domestic silver consumption, which was estimated at about 187 million troy ounces (5.8 billion g), was about five times the domestic mine production. About two-thirds of the domestic production is a byproduct of base-metal mining. Most imported silver is from Canada. Silver is primarily used for electroplated ware, photographic materials, and electrical and electronic equipment. Silver sufficient to supply three-fourths of a year's demand is stockpiled by the General Services Administration. The price of silver averaged $5.32 per ounce during March 1974.

Significant amounts of silver were detected in samples from the main mineralized areas in the study area but only one deposit can feasibly be mined solely for its silver content. In some localities, however, the silver would contribute to the total value of the ore. The most consistent silver values are found in the Cleopatra mine and in the prospects on or near the Cleopatra-Bear Lakes shear zone; samples from the Dutch Miller mine contain up to 10.0 ounces of silver per ton (343 g/t). Copper would be the primary metal produced in these areas but silver would be a significant additional value.

Gold

Domestic gold mine production in 1973 was about one-sixth of consumption, which was estimated at 7.65 million troy ounces (238 million g); most United States gold imports come from Canada. Jewelry manufacturing accounts for most of the domestic consumption of gold. Gold prices averaged $168.92 per ounce during March 1974. In the Alpine Lakes region, gold will most often be produced as a byproduct or coproduct from lode deposits of other metals.

Gold occurs in minor amounts in most of the mineralized areas within the additions but the most important occurrences are in the Money Creek area. The Apex mine in the Money Creek area is adjacent to an addition and contains indicated gold resources. The gold-containing structure explored in the Apex mine might extend into the addition.

Sampling and analytical techniques

Three types of lode samples were taken: chip, a series of rock chips across or along an exposure; grab, an unselected assortment of rock pieces from an exposure or rockpile; and select, handpicked material of the highest grade rock available. In general, at least one sample from a prospect or structure was analyzed by semiquantitative spectrographic methods. Those samples showing unusual amounts of an element or known to contain mineral values were analyzed by chemical, fire assay, or atomic absorption methods. All samples were checked for radioactivity and fluorescence.

Resource classification

Resource classifications developed by joint agreement of the Geological Survey and the Bureau of Mines are used in this report. A mineral resource is a concentration of naturally occurring materials in such form that economic extraction of a commodity is currently or potentially feasible. A reserve is that part of the identified resource from which a usable mineral commodity can be economically and legally extracted. The term "ore" is used for reserves of some minerals. Identified-subeconomic resources are known resources that may become reserves as a result of changes in economic and legal conditions. A paramarginal resource is that part of a subeconomic resource that (a) borders on being economically producible or (b) is not commercially available solely because of legal or political circumstances. Submarginal resources are those parts of subeconomic resources which would require a substantially higher price or a major cost-reducing advance in technology to become economically producible (adapted from Geotimes, 1974, p. 18-19).

Mining claims

The location of patented and unpatented mining claims in and adjacent to the additions to the study area was determined by a search of the records of King and Kittitas Counties, and records of the U.S. Forest Service. Many recorded claims could not be found in the field because their locations are poorly described. Over 1,500 unpatented lode and placer claims within and adjacent to the study area were found recorded in county records but only a small percentage of these are currently held. The majority of unpatented claims are in the mineralized areas outlined on figure 2; the remainder are scattered throughout the study area. Some claimed areas exhibited no evidence of mineral deposits.

Approximately 77 patented claims are within or immediately adjacent to the additions to the study area. Nearly all were patented in the period 1902 through 1912. The largest group of patented claims is the Kimball Creek group (29 claims) which extends across the north boundary of the Money Creek addition. The six patented claims in the Beaverdale group are in the Prospectors Ridge area, within one of the additions. The remaining patented claims are in the Dutch Miller-LaBohn Gaps area, the Middle Fork Snoqualmie River area, and Snoqualmie Pass area.

Potential dam sites for the production of electricity exist within the study area but their utilization would not appear to adversely affect mineral resources and would provide a nearby source of power.

Middle Fork Snoqualmie River area

The most important mineralized zones in the study area additions are the disseminated copper-molybdenum deposits along the Middle Fork of the Snoqualmie River, mainly above the confluence of Burntboot Creek (fig. 3).

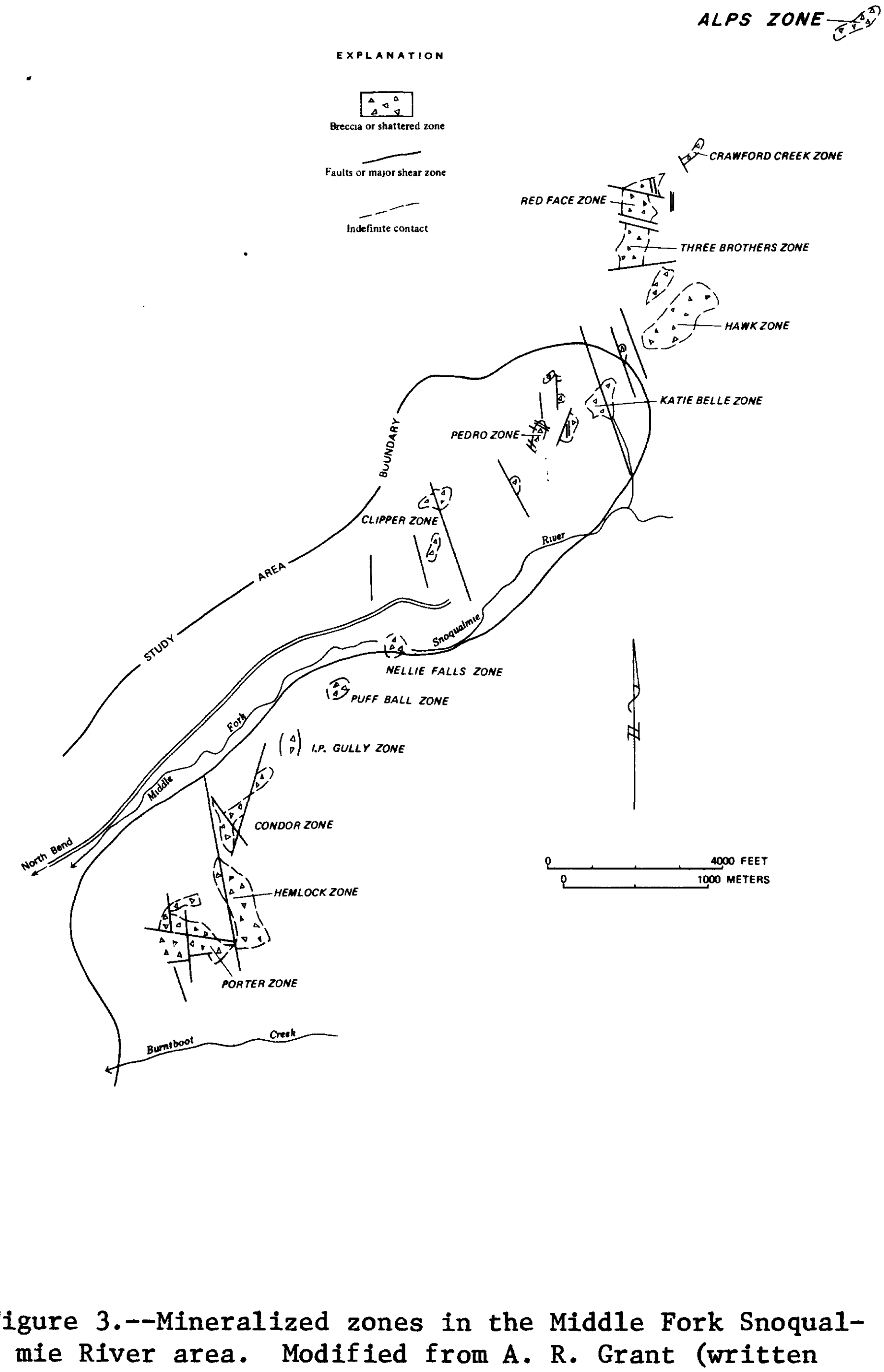


Figure 3.--Mineralized zones in the Middle Fork Snoqualmie River area. Modified from A. R. Grant (written commun., 1971).

Cities Services Minerals Corp. is presently exploring 15 patented claims, 225 unpatented claims, and 19 fractions of claims which cover the area. Fourteen mineralized zones are known. Five of these (The Three Brothers, Red Face, Hawk, Alps, and Crawford Creek) were described previously (Gualtieri and others, 1973) but are included in the present report because of additional information which has become available.

Most of the following geologic descriptions are based on work done during 1971 and 1972 by A. R. Grant and T. C. Patton for the Natural Resources Development Corp. The material is used with the kind permission of Grant and Gregg C. MacDonald, President of the corporation, and Robert W. Osterstock, Chief Geologist, and other officials of the Cities Service Minerals Corp.

Most mineralized rocks are quartz diorite but range in composition from syenite to diorite, and locally include aphanitic to porphyritic equivalents of these rocks. Aplite and porphyritic andesite intrude the granitic rocks in areas of intense structural deformation. The mineralized zones are characterized by echelon faults, breccia pipes, and large shatter zones (fig. 3). The mineralized zones trend northeast through an area 5 miles (8 km) long. Widths of the individual zones range from 400 to more than 2,500 feet (122-762 m).

A. R. Grant (oral commun., 1973) suggested that the mineralized zones were once a continuous or near-continuous linear structural body, but a complex series of north- to northwest-trending cross faults has separated it into a group of blocks (fig. 3) with a maximum measurable vertical displacement of 700 feet (213 m). There is evidence that greater displacement might have occurred. Movement along these faults probably occurred before, during, and after mineralization.

A. R. Grant (written commun., 1971) observed that the total sulfide content is generally directly proportional to the intensity of fracturing and brecciation. He believes that "multi-cyclic deformation appears to be the key to significant sulfide deposition." This is evident in some zones where early intense alteration has healed the original brecciated rock. Significant sulfide deposition has only occurred where host rocks suffered subsequent additional brecciation.

The degree and type of alteration in the breccia zones are reliable guides to copper content in this area. A detailed sampling and petrographic study by A. R. Grant (written commun., 1971) of rocks from an underground working showed that "without exception the more advanced the wallrock alteration, the more advanced the copper mineralization."

The alteration associated with the introduction of copper (as chalcopyrite) is the depletion of silica and the replacement of the plagioclase by orthoclase in the host rocks, and the consequent silicification of the rocks above the copper-deposition zones.

The vertical alteration pattern and increase of copper content at depths has been well substantiated by surface and underground drilling and geologic mapping.

Porter, Hemlock, and Condor zones

The southwest part of the Middle Fork Snoqualmie River area, which includes the Porter, Hemlock, and Condor zones, is considered to have the greatest resource potential (fig. 4). The three zones are along or near the Copper Queen fault and the less well developed fault structures which intersect it. The Hemlock and Porter zones are believed to be contiguous and are discussed together. The 2380 adit is the main working level for the Hemlock zone.

Sampling and shallow core holes in the Porter and Hemlock zones indicated areas of copper-rich rock as much as 85 feet (26 m) wide, mainly in northeast-trending structures. Drilling results in these zones indicate that there is little disseminated copper above the 3,200-foot (975.4-m) elevation.

Two core drill holes, one from the surface outside the boundary of the Hemlock zone and one from underground in the 2795 adit (fig. 4), penetrated to 2,277-foot and 2,155-foot (594.0- and 656.3-m) elevations, respectively, in the downward projection of the Hemlock zone. Silification and the disseminated sulfide minerals indicate that a deeper zone of copper-rich rock may exist at depth below the bottoms of the holes.

Sampling and petrographic studies of rock from the 1,990-foot (606-m)-long 2380 adit confirm the existence of copper there. The periphery of the Hemlock breccia zone was penetrated from the portal of the adit to the 1,365-foot (416-m) point. From that point to the working face, another 625 feet (190.5 m), the rock becomes increasingly brecciated, altered, and mineralized. The ratio of chalcopyrite to other sulfides becomes greater in this inner section of the adit. Copper content of the wallrock averages approximately 0.44 percent from the 1,400-foot (427-m) point to the face and increases to 0.61 percent in the innermost 90 feet (16.8 m). Also, in the innermost 100 feet (30.5 m) of the adit, some 5-foot (1.5-m)-long samples contain as much as 1.14 percent copper.

Samples from a 393-foot (119.3-m)-long crosscut driven (fig. 4) from the 2380 level toward the center of the Hemlock zone show an overall increase in copper values near the face. Samples taken over a 30-foot (9.1-m)-long interval between 338 and 368 feet (103 and 113 m) have a weighted average of 0.78 percent copper. The copper minerals and the rock alteration in the crosscut are similar to those in the 2380 adit.

A comparison of the rocks observed on the surface of the Hemlock breccia zone with those found approximately 1,650 feet (503.0 m) vertically below in the workings shows a pronounced increase in intensity of alteration and in the amount of copper with depth. On the surface, intense alteration

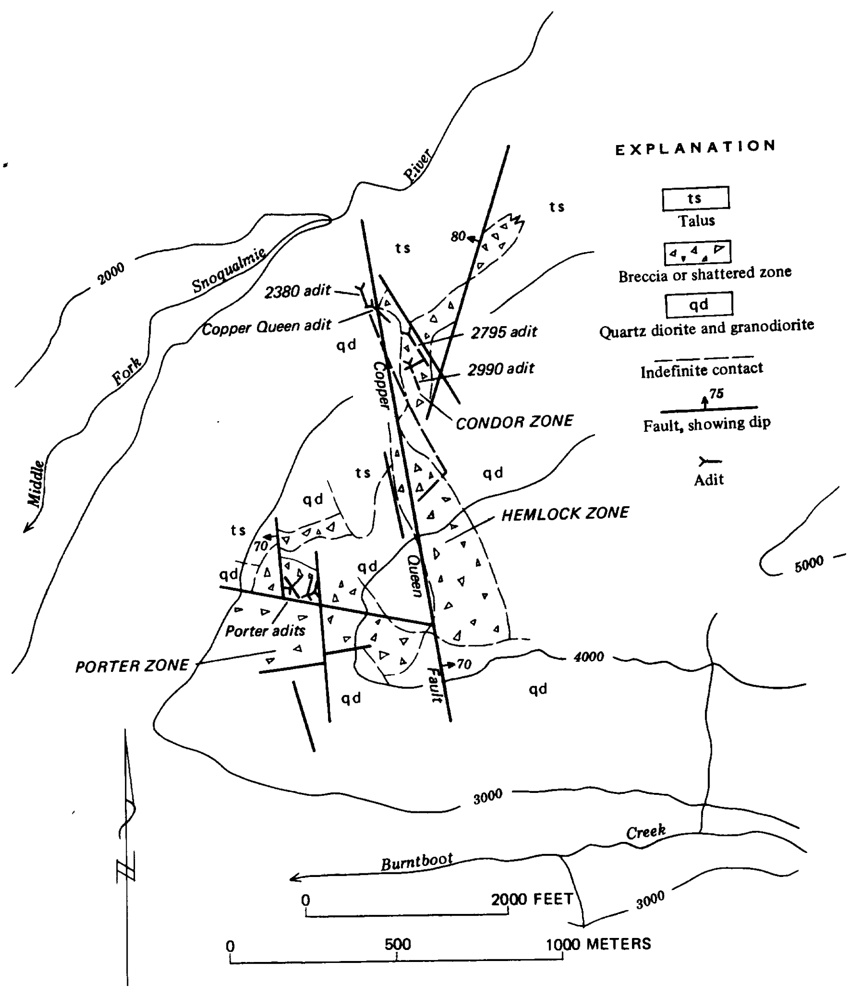


Figure 4.--Porter, Hemlock, and Condor zones. Modified from A. R. Grant (written commun., 1971).

and copper sulfide minerals commonly occur only within or adjacent to fractures, whereas at the 2380 level alteration and copper mineralization have been pervasive through large volumes of the brecciated rock. Grant observed that some large blocks of massive unaltered rock at the surface have graded vertically into mineralized and altered rock at the 2380 level. Further, because the eastern wall of the breccia zone dips steeply eastward, the area of the mineralized zone on the 2380 level is larger than on the surface. The partially completed core drilling program by the present lessee confirms that alteration and copper mineralized rock continues to lower elevations in the Hemlock breccia zone. When completed, the program will explore the Hemlock zone to the 1,000-foot (305-m) elevation.

Outcrops within the Porter zone show more intense alteration, greater chalcopyrite content, and greater silicification than outcrops within the Hemlock zone. The alteration and copper content probably increase at depth as they do in the Hemlock zone; however the Porter is believed to have a greater area and copper content at depth than the Hemlock zone.

The expenditure of exploration money by the present lessee is made in anticipation of potential production of about 100 million tons (91 million t) of rock containing 0.6-0.8 percent copper and 0.02-0.05 percent molybdenite from the Porter and Hemlock zones. The brecciated character of the mineralized zones and their relatively large extent make them amenable to block-caving mining methods, which yield a large volume at a low cost per unit. The probable grade of the ore, the topography, and environmental considerations also favor block caving.

The Condor zone (fig. 4) is considered by Grant to be a wedge-shaped horst displaced from a larger brecciated zone occurring at depth and continuing to the south. The copper content of the zone, determined from holes drilled from the surface and samples from the underground workings is higher than in the Porter and Hemlock zones but is confined to bodies less than 200 feet (70.0 m) wide. Mineralized zones sampled in eight core drill holes range in thickness from 41 to 192 feet (12.5-58.5 m) and in grade from 0.52 to 0.81 percent copper. A sample from a 50-foot (15.2-m)-long section of the 2795 adit (fig. 4) contains 0.65 percent copper. Molybdenum values are erratic.

Lessee drilling and sample data indicate as much as 2.5 million tons (2.3 million t) of rock containing 0.65 percent copper and minor silver may exist from the surface down to the 2,270 foot elevation in the Condor area. Future drilling will further refine this figure.

Poorly exposed mineralized outcrops occur northeast of the Condor zone mostly along the River and follow the trend of the general mineralized area; they are named, from south to north, the I. P. Gully zone, Puff Ball zone, and Nellie Falls zone (fig. 3). Further exploration will indicate the spatial relationship of these outcrops to the Condor or Clipper zones (fig. 3).

Maximum gold, silver, and copper contents of samples of the quartz and mineralized material are 0.04 ounce per ton (1.4 g/t), 1.5 ounces per ton (51.4 g/t), and 0.35 percent, respectively (fig. 8). Sulfide minerals in the shear zones decrease from the alaskite into the granodiorite.

Other short adits driven on shear zones expose very low grade deposits of sulfide minerals. Except for one 1.5-foot (0.5-m)-long sample (No. 55, fig. 6) which contains 2.9 ounces silver per ton (99.4 g/t), samples from the shear zones (Nos. 18, 19, 47-53, 54-56, fig. 6) contain a maximum of 0.01 ounce gold per ton (0.4 g/t), 0.9 ounce silver per ton (30.8 g/t), and 0.05 percent copper. Two grab samples from the ore bin (Nos. 20 and 21, fig. 6) average 0.04 ounce gold per ton (1.4 g/t), 12.6 ounces silver per ton (432.0 g/t) and 0.05 percent copper.

The silver resources exposed by the workings and the number of persistent intersecting shear zones indicate places in upper Bear Creek that are favorable for exploration.

<u>Cleopatra mine</u>

The Cleopatra mine workings (fig. 9) are in Cleopatra basin in the West Fork Miller River drainage. The workings are along a section of the major shear zone that trends northwest into the Bear Lakes-Paradise Lakes area (fig. 6).

The mine produced approximately $250,000 worth of silver-lead-copper ore intermittently between 1897 and 1941 (Livingston, 1971, p. 163); in 1941, the operation was terminated by War Production Board Order L208.

The workings total about 2,100 feet (640 m) and consist of drifts, crosscuts, winzes, raises, and a shaft (Livingston, 1971, p. 140); only 530 feet (162 m) of drifts and crosscuts were accessible in 1973 (fig. 9). Information on the mine, including maps and assay results from inaccessible parts of the workings, is from Purdy (1951), Livingston (1971), and J. Cashman (written commun., 1973).

Three mineralized shear zones in granodiorite were developed through underground workings. The zones are nearly parallel, strike N. 45° to 70° W., and dip 65° SW. to vertical. All are intensely kaolinized and sericitized. They contain sparse sulfide minerals including pyrite, chalcopyrite, jamesonite, galena, sphalerite, and tetrahedrite.

The main zone is exposed along a 490-foot (149-m)-long drift and two short drifts now in the inaccessible section of the adit (fig. 9). Two winzes were sunk from the long drift. This zone is 0.5-37 feet (0.2-9.8 m) wide and averages 2.5 feet (0.8 m) wide (Purdy, 1951, p. 82). A southeastern extension of the main zone is exposed in the two short drifts off the southeast branch of the lower adit, making a total known length of 910 feet (277 m) (fig. 9). A 210-foot (64-m)-high raise extends in the zone to an

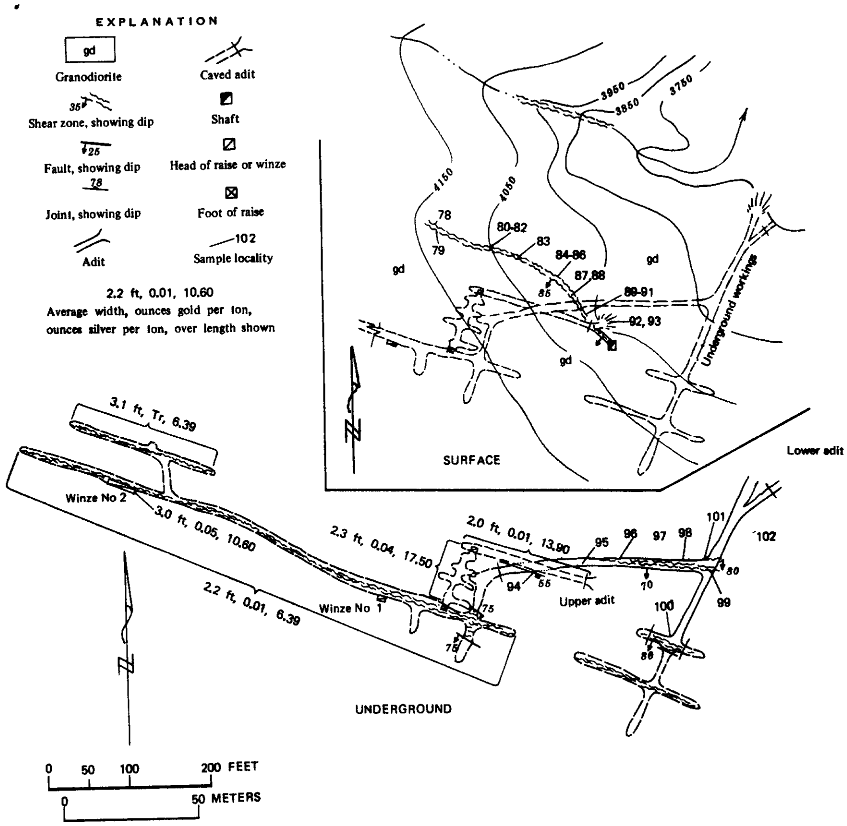


Figure 9.--Cleopatra mine.

Data for samples shown on figure 5.

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

Sample No.	Type	Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
1	Chip--	8.0	Tr	0.1	0.24
2	do----	54.0	Tr	.2	.37
3	Grab--	--	Tr	.2	.19
4	Chip--	4.5	Tr	.1	.05
5	do----	.8	Tr	Tr	.04
6	do----	8.0	Tr	.1	.36
7	Grab--	--	Tr	.6	.44
8	do----	--	Tr	.5	.50
9	Chip--	8.0	Tr	--	.02
10	do----	60.0	Tr	--	.01
11	do----	20.0	Tr	2.2	.86
12	do----	550.0	0.01	.2	.06
13	do----	17.0	Tr	.1	.39
14	do----	9.8	Tr	.3	.08
15	do----	35.0	.01	.5	.27
16	do----	7.4	.01	.5	.16
17	do----	70.0	Tr	.3	.10
18	do----	50.0	.01	.3	.21
19	do----	2.0	.01	Tr	.29
20	do----	4.0	Tr	.4	.20
21	do----	4.6	Tr	N	.048
22	do----	1.0	.01	.2	.01
23	Grab--	--	Tr	N	.02
24	Chip--	5.5	Tr	N	.02
25	do----	70.0	N	.2	.04
26	do----	80.0	N	.1	.022
27	do----	130.0	N	.1	.018
28	do----	62.0	N	.2	.015
29	do----	39.0	Tr	.3	.01
30	do----	77.0	N	Tr	.021
31	do----	56.0	N	.1	.01
32	do----	68.0	N	.2	.039
33	do----	31.0	N	.1	.012
34	do----	23.0	N	.1	.012
35	do----	32.0	N	.2	.009
36	do----	71.0	N	.1	.018
37	Grab--	--	--	--	.07
38	Chip--	8.2	Tr	.5	.50
39	Grab--	--	Tr	.2	.40
40	Chip--	4.0	Tr	N	.03
41	Grab--	--	Tr	.1	.03
42	Chip--	10.0	N	N	.039
43	do----	1.4	N	N	.035
44	do----	7.8	N	N	.035
45	do----	10.0	N	Tr	.026
46	do----	70.0	N	N	.067
47	do----	10.0	Tr	.1	.055
48	Chip--	5.0	N	N	.027
49	Grab--	112.0	N	0.1	.047
50	Chip--	78.0	N	N	.01
51	do----	90.0	N	N	.012
52	do----	121.0	N	Tr	.017
53	do----	94.0	N	.1	.011
54	do----	23.0	N	.1	.012
55	do----	50.0	N	.1	.016
56	do----	44.0	N	.1	.012
57	do----	94.0	N	Tr	.02
58	do----	17.0	N	.1	.009
59	do----	42.0	Tr	.2	.020
60	do----	35.0	N	.1	.025
61	do----	28.0	N	N	.022
62	do----	55.0	N	.1	.014
63	do----	100.0	N	.1	.017
64	do----	100.0	N	.1	.012
65	do----	100.0	Tr	.2	.009

Another shear zone cutting altered granodiorite is exposed in Katie Belle gulch and is oriented transverse to the gulch. It has been explored through an adit about 6 feet (1.8 m) long. The altered zone strikes about N. 50° to 75° E., is nearly vertical, and is 60 feet (18 m) or more wide. Quartz lenses as much as 3 feet (0.9 m) wide constitute 10-25 percent of the altered zone. The zone contains pyrite, arsenopyrite, chalcopyrite, and molybdenite.

Samples (Nos. 12-20, fig. 5) contained a maximum of 0.39 percent copper, 0.5 ounce silver per ton (17.1 g/t), and 0.01 ounce gold per ton (0.3 g/t) but the intense alteration and the existence of sulfide minerals suggest that the Katie Belle zone has a potential for discovery of mineral resources of higher tenor.

<u>Hawk zone</u>

The Hawk zone is within an addition to the study area (fig. 3), and crops out on subparallel hummocky ridges along a system of north-trending shears. The outcrops of the Hawk zone are altered brecciated granodiorite(?) and contain less than 10 percent disseminated pyrite, pyrrhotite, and other sulfide minerals. Most of the sulfide blebs are less than 1 mm across.

Surface samples contained a maximum of 0.04 percent copper, 0.3 ounce silver per ton (10.3 g/t), and a trace of gold. However, because of the brecciation, alteration, and nearness to other zones in which the copper content increases at depth, the zone may contain potential resources.

<u>Three Brothers zone</u>

The Three Brothers zone is mineralized granodiorite and quartz monzonite lying between two steeply dipping faults striking N. 75° W., and N. 80° E., in contrast to the major faults striking N. 15-20° W. (fig. 5) mapped in the Pedro and Katie Belle zones. The zone is bounded on the east by quartz diorite porphyry and is covered by talus to the west. It has been explored by means of a drill hole (drilled in 1963), a short adit, and three shallow pits.

The brecciated and altered quartz monzonite in a sample from a shallow surface cut, made near the probable south edge of the Three Brothers zone, (No. 27, fig. 5) contains stringers of vuggy quartz. Chalcopyrite, magnetite, hematite, and quartz crystals fill some of the vugs. Chalcopyrite also is disseminated near fractures and quartz veinlets.

The adit (Nos. 38 and 39, fig. 5) crosscuts three parallel steeply dipping shear zones striking N. 5° W. The adit was driven for about 30 feet (9 m) on a bearing of N. 38° W. through altered granodiorite containing disseminated pyrite. The adit ends at the footwall of a 5-foot (1.5-m)-wide shear zone where a 6-foot (1.8 m)-deep winze was put down. The zone is highly brecciated, with irregular walls and "horses"--masses--of altered granodiorite. Gouge is common. Pyrite occurs as blebs and fine disseminations throughout the brecciated rock and the horses occur across the full width of the shear. Narrower shear zones, 2-3 feet (0.6-0.9 m) wide and resembling the major zone, can be traced on the surface for about 250 feet (76 m).

Data from surface sampling and drilling suggest the possible existence of up to 2 million tons (1.8 million t) of ore containing between 0.7 and 0.9 percent copper.

Red Face zone

The Red Face zone is composed of pyrite-rich closely jointed or brecciated granodiorite. A flat-lying shear zone near the portal of an adit penetrating the zone (No. 40, fig. 5) contains many blebs of pyrite, arsenopyrite, and marcasite. A sample cut over a length of 4 feet (1.2 m) along the flat-lying fracture contains a trace of gold, no silver, and 0.03 percent copper.

North of the Red Face zone, a large area, 500 by 1,000 feet (152.4 by 304.8 m) of leached rock with minor secondary chalcocite yielded a significant induced polarization anomaly. In addition, soil samples taken downslope from the leached area contain more than 1,000 ppm copper. No drilling has been done here.

Crawford Creek and Alps zones

The Crawford Creek and Alps zones are breccia or shatter zones, apparently too low in grade to be a resource. Samples from the Crawford Creek zone contain a maximum of 0.067 percent copper, 0.1 ounce silver per ton (3.4 g/t) and a trace of gold. Those from the Alps zone contain a maximum of 0.025 percent copper, 0.2 ounce silver per ton (5.9 g/t), and a trace of gold. These zones lack the intensity of alteration and brecciation characteristic of zones believed to have potential for the discovery of copper deposits.

Upper West Fork Miller River-Bear Creek area

Claims were first staked in the Miller River drainage in 1892 (Hodges, 1897, p. 36). Exploration began in the Buena Vista mining district on the headwaters of the North Fork Snoqualmie River about 1896 (Hodges, 1897, p. 43). As access to the district improved, lode and placer claims were staked along Lennox Creek, Illinois Creek, Sunday Creek, and Bear Creek. There has been little recent activity.

The deposits in upper West Fork Miller River and Bear Creek are mostly confined to major persistent steeply dipping silicified shear zones or to similar, but lesser, structures. A few disseminated deposits exist. The shear zones are mineralized to various degrees by sulfide minerals. Silver is the most common valuable metal in these deposits.

The mineralized structures are mostly in granitic rocks but some are in roof pendants composed of metamorphosed pre-Cretaceous sedimentary and igneous rocks that overlie the granitic rocks and are commonly exposed on ridges.

The most persistent shear zone in the area is the Cleopatra-Bear Lakes zone, a well-defined structure that can be traced at the surface from the Aces Up prospect to Paradise Lakes, a distance of approximately 3 miles (4.8 km) (fig. 6). Other shear zones with various strikes occur in the Paradise Lakes, Bear Creek, and Cleopatra mine areas and some contain metallic sulfides.

Napco prospect

The Napco prospect is near Paradise Lakes (fig. 6) and the apparent northwest termination of the Cleopatra-Bear Lakes shear zone. Granitic rocks of the Snoqualmie batholith intrude metamorphosed sedimentary and igneous rocks near Paradise Lakes. The intruded rocks are partly altered, contain small amounts of sulfide minerals, and are cut by subparallel shear zones.

A 14-foot (4.3-m)-wide mineralized shear zone in granodiorite is exposed in a trench below the outlet of Paradise Lakes. The strike is N. 70° to 90° W., and the dip 55° SW. to vertical. The zone is similar to those at the Bear Basin prospects, Cleopatra mine, and other prospects in the area. It is composed of four subparallel veins which average about 0.5 feet (0.15 m) wide and between which are lenses of unaltered granodiorite. Sulfide minerals constitute approximately 70 percent of the veins and include pyrite, arsenopyrite, galena, sphalerite, chalcopyrite, and tetrahedrite. Quartz and mica are also present. The altered granodiorite matrix of the veins contains about 10 percent gray metallic grains 0.1-2.0 mm in diameter. The contact of the zone with the surrounding granodiorite is sharp; wallrock is nearly fresh. A sample of 13.5 feet (4.1 m) taken in the trench and across the shear zone contains a trace of gold, 28.3 ounces silver per ton (970.2 g/t) and 0.084 percent copper. Six other samples, however, (Nos. 8-13, fig. 6) ranging in length from 0.5 to 2.5 feet (0.1-0.8 m), taken across the vein material averaged only 0.03 ounce gold per ton (1.0 g/t), 2.66 ounces silver per ton (91.2 g/t), and 0.006 percent copper.

A 15-foot (4.6-m)-wide shear zone, possibly an extension of the zone in the trench, crops out in a cliff 400 feet (122 m) to the northeast (No. 14, fig. 6). A 1.5-foot (0.5-m)-long chip sample (No. 14, fig. 6) across a vein in the zone contains a trace of gold, 0.1 ounce silver per ton (3.4 g/t), and 0.029 percent copper. Outcrops of hornfels containing less than 5 percent sulfide minerals and weathered shear zones occur in the area of the claims. Samples (Nos. 1-6 and 15-17, fig. 6) from these outcrops and zones contained a maximum of 0.02 ounce gold per ton (0.7 g/t), 0.3 ounce silver per ton (10.3 g/t), and 0.028 percent copper.

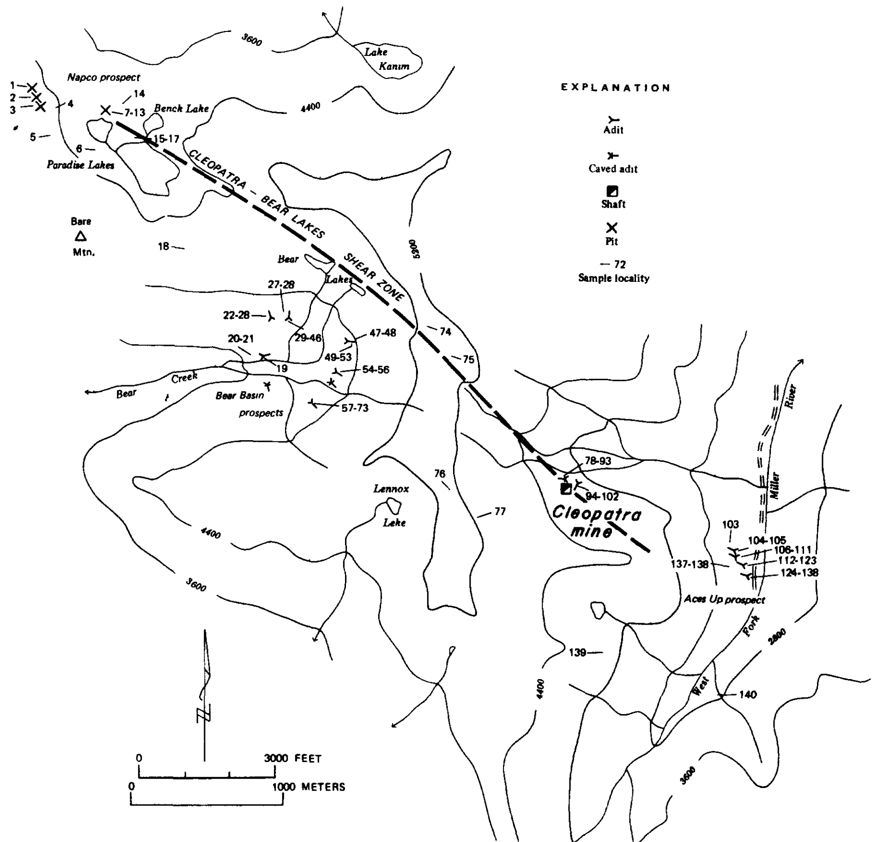


Figure 6.--Mines and prospects in the upper West Fork Miller River-Bear Creek area. Assay data for samples are given in detailed descriptions of prospects.

Deep overburden obscures most of the mineralized zone on the prospect. However, submarginal resources of silver amounting to a few tens of tons probably exist in the area of the Napco trench. Further exploratory work may disclose additional resources of silver.

Bear Creek prospects

In the early 1900's eight adits were driven along steeply dipping shear zones that cut granodiorite and alaskite in the cirque at the head of Bear Creek (fig. 6). In 1922, 360 ounces (11.2 kg) of silver was smelted from concentrates produced in a small flotation mill on the property, but little work has been done since 1934 when the mill burned (Livingston, 1971, p. 127).

Two sets of mineralized shear zones occur in the basin. One set trends about N. 50° W., parallel to the Cleopatra-Bear Lakes shear zone; the other trends about N. 80° W. Intersections of the two sets of shear zones have not been explored.

Adit 3 (Nos. 57-73, fig. 6) follows a vein of irregular width in a shear zone striking approximately N. 80° W. and dipping 85° SW to vertical (fig. 7). Country rock observed in the adit is granodiorite, fresh on the footwall but altered on the hanging wall. The shear zone can be traced on the surface for over 3,500 feet (1,067 m) but brush and talus cover prevent sampling over most of the length. Quartz stringers in the shear zone range in width from 0.6 to 5.9 feet (0.2-1.8 m).

Samples of quartz and mineralized material from adit 3 and the exposures on the surface (Nos. 58-73, fig. 7) show erratic silver values ranging in concentration from 0.1 to 33.7 ounces per ton (3.4-1,155.4 g/t) and averaging 5.6 ounces per ton (192 g/t). Maximum gold and copper contents of the samples were only 0.05 ounce per ton (1.7 g/t) and 0.16 percent, respectively (fig. 7). Indicated reserves near the portal of the adit are estimated to be small.

A parallel but wider shear zone extending eastward into Cleopatra lies approximately 400 feet (122 m) south of the structure in adit 3. This large structure contains only a few quartz stringers and apparently is not mineralized at the surface. Smaller intervening shears are not mineralized.

Adits 6 and 7 (Nos. 22-26, 29-46, fig. 6) are along two minor shear zones paralleling the Cleopatra-Bear Lakes structure. The shear zone at the portal of adit 6 is in a slightly altered and slightly mineralized alaskite, but along the drift the rock grades into relatively fresh granodiorite (fig. 8). Adit 7, driven as a crosscut at an elevation approximately 50 feet (15 m) lower than adit 6, is in alaskite (fig. 8). Pods and irregular stringers of sulfide minerals as much as 2 feet (0.6 m) wide occur in quartz veins within the persistent shear zones. The shear zones strike about N. 50° E. and dip 71° to 88° SW. Pyrite is the most abundant sulfide mineral and minor chalcopyrite is present. Locally the wallrock contains as much as 2 percent disseminated sulfide minerals.

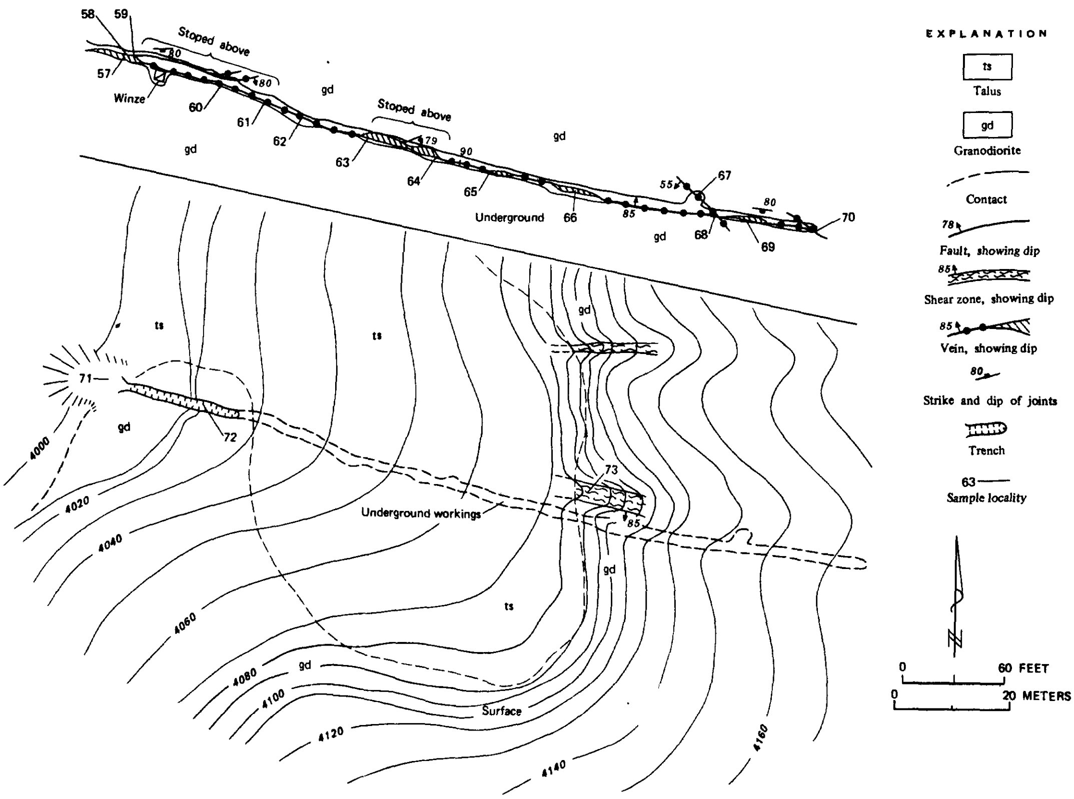


Figure 7.--Adit 3, Bear Creek prospects.

Data for samples shown on figure 7.

[Tr, trace; N, none detected; --, not analyzed; <, less than shown]

Sample No.	Sample Type	Sample Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
57	Chip--	1.6	0.05	33.7	0.16
58	do----	.6	.05	22.2	.03
59	do----	2.1	.02	.4	<.01
60	do----	.9	.02	.3	<.01
61	do----	2.2	.02	1.5	<.01
62	do----	3.8	Tr	1.1	<.01
63	do----	2.1	Tr	.6	.02
64	do----	4.2	Tr	.2	<.01
65	do----	1.9	.01	.1	<.01
66	do----	1.4	.01	.2	<.01
67	do----	1.1	.01	.4	<.01
68	do----	1.7	.01	.1	<.01
69	do----	2.1	Tr	.3	<.01
70	do----	1.1	.01	.3	<.01
71	Grab--	--	Tr	7.9	.04
72	Chip--	3.6	Tr	33.4	.08
73	do----	5.9	Tr	.7	<.01

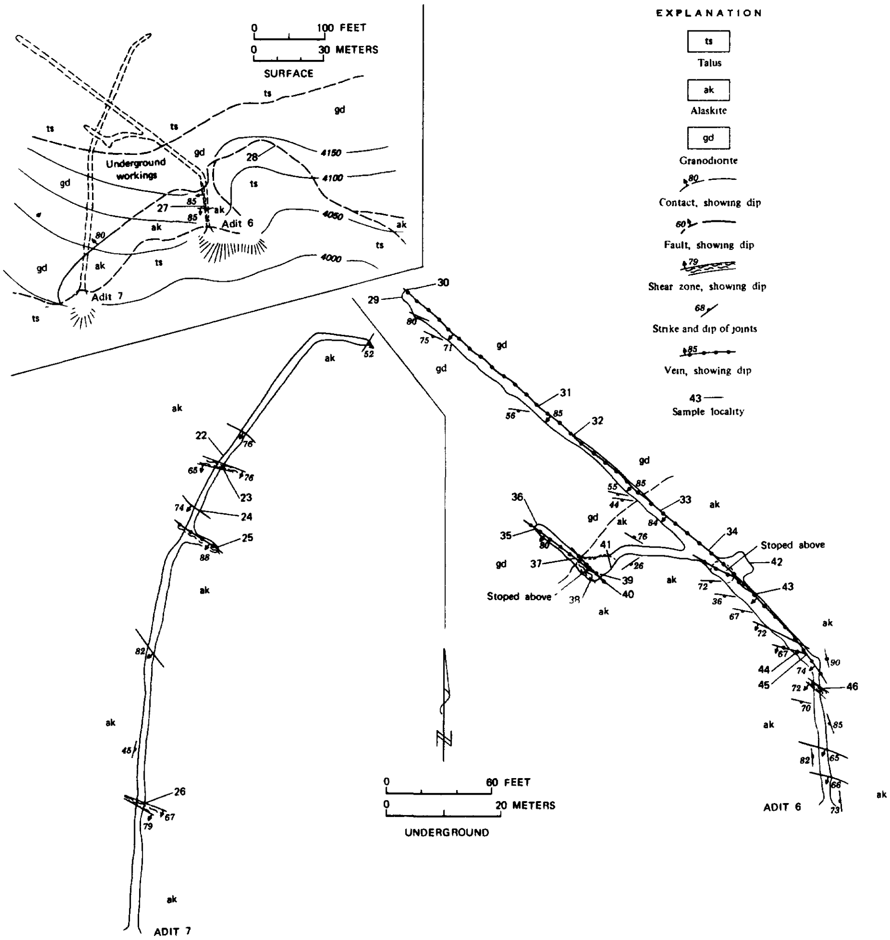


Figure 8.--Adits 6 and 7, Bear Creek prospects.

Data for samples shown in figure 8.

[Tr, trace; N, none detected; --, not analyzed; <, less than shown]

Sample No.	Sample Type	Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
22	Chip--	6.9	N	N	0.01
23	do----	4.4	Tr	0.2	.02
24	do----	1.9	Tr	.1	.04
25	do----	3.6	0.02	.4	.05
26	do----	3.3	Tr	.2	< .01
27	do----	1.8	.03	.02	.06
28	do----	52.0	Tr	.2	.01
29	do----	3.4	Tr	.1	< .01
30	do----	.4	.03	.5	.05
31	do----	.9	.04	1.5	.27
32	do----	2.1	.02	.6	.17
33	do----	1.5	.02	.2	.07
34	do----.	2.9	Tr	.2	.01

Sample No.	Sample Type	Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
35	do----	.9	.03	.2	.09
36	do----	1.5	.04	.3	.10
37	Grab--	--	.02	1.2	.26
38	Chip--	5.5	N	N	.03
39	Grab--	--	Tr	1.4	.25
40	Chip--	1.6	.04	.9	.35
41	do----	15.0	N	N	.13
42	Grab--	--	N	N	<.01
43	Chip--	3.8	.01	.9	.03
44	do----	2.0	Tr	.3	.02
45	do----	2.1	.01	.3	.07
46	do----	2.7	N	N	.01

Maximum gold, silver, and copper contents of samples of the quartz and mineralized material are 0.04 ounce per ton (1.4 g/t), 1.5 ounces per ton (51.4 g/t), and 0.35 percent, respectively (fig. 8). Sulfide minerals in the shear zones decrease from the alaskite into the granodiorite.

Other short adits driven on shear zones expose very low grade deposits of sulfide minerals. Except for one 1.5-foot (0.5-m)-long sample (No. 55, fig. 6) which contains 2.9 ounces silver per ton (99.4 g/t), samples from the shear zones (Nos. 18, 19, 47-53, 54-56, fig. 6) contain a maximum of 0.01 ounce gold per ton (0.4 g/t), 0.9 ounce silver per ton (30.8 g/t), and 0.05 percent copper. Two grab samples from the ore bin (Nos. 20 and 21, fig. 6) average 0.04 ounce gold per ton (1.4 g/t), 12.6 ounces silver per ton (432.0 g/t) and 0.05 percent copper.

The silver resources exposed by the workings and the number of persistent intersecting shear zones indicate places in upper Bear Creek that are favorable for exploration.

Cleopatra mine

The Cleopatra mine workings (fig. 9) are in Cleopatra basin in the West Fork Miller River drainage. The workings are along a section of the major shear zone that trends northwest into the Bear Lakes-Paradise Lakes area (fig. 6).

The mine produced approximately $250,000 worth of silver-lead-copper ore intermittently between 1897 and 1941 (Livingston, 1971, p. 163); in 1941, the operation was terminated by War Production Board Order L208.

The workings total about 2,100 feet (640 m) and consist of drifts, crosscuts, winzes, raises, and a shaft (Livingston, 1971, p. 140); only 530 feet (162 m) of drifts and crosscuts were accessible in 1973 (fig. 9). Information on the mine, including maps and assay results from inaccessible parts of the workings, is from Purdy (1951), Livingston (1971), and J. Cashman (written commun., 1973).

Three mineralized shear zones in granodiorite were developed through underground workings. The zones are nearly parallel, strike N. 45° to 70° W., and dip 65° SW. to vertical. All are intensely kaolinized and sericitized. They contain sparse sulfide minerals including pyrite, chalcopyrite, jamesonite, galena, sphalerite, and tetrahedrite.

The main zone is exposed along a 490-foot (149-m)-long drift and two short drifts now in the inaccessible section of the adit (fig. 9). Two winzes were sunk from the long drift. This zone is 0.5-37 feet (0.2-9.8 m) wide and averages 2.5 feet (0.8 m) wide (Purdy, 1951, p. 82). A southeastern extension of the main zone is exposed in the two short drifts off the southeast branch of the lower adit, making a total known length of 910 feet (277 m) (fig. 9). A 210-foot (64-m)-high raise extends in the zone to an

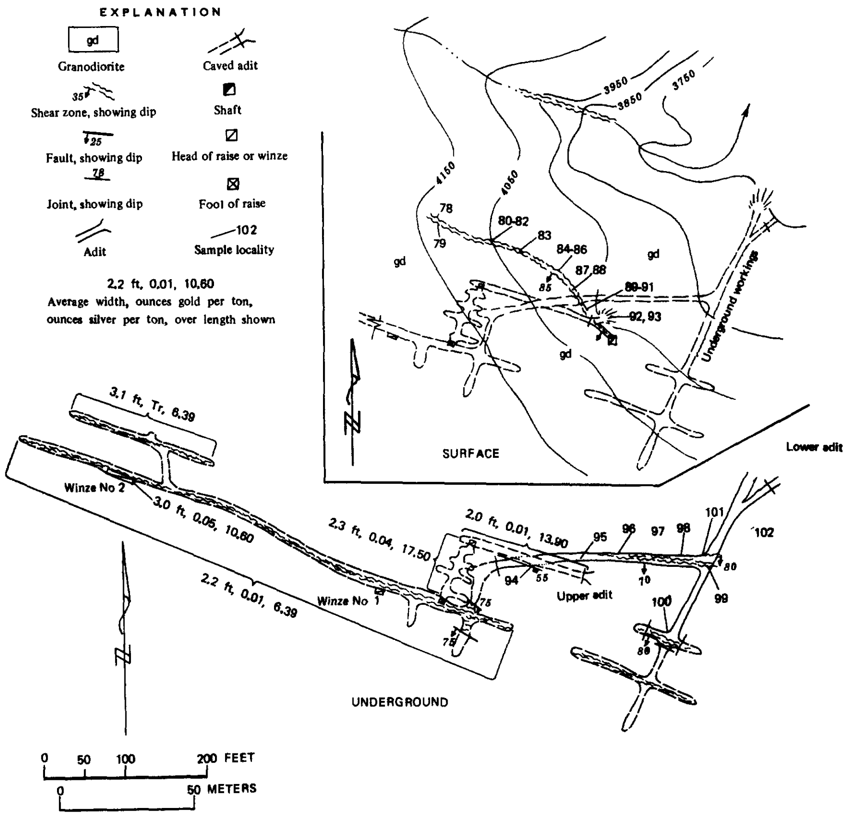


Figure 9.--Cleopatra mine.

Data for samples shown on figure 9.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)
No.	Type	Length (feet)					
78	Chip--	1.0	Tr	Tr	--	--	--
79	do----	2.5	N	0.1	--	--	--
80	do----	1.0	Tr	1.3	0.48	0.03	0.21
81	do----	3.0	N	.1	--	--	--
82	do----	3.7	Tr	.1	--	--	--
83	do----	2.0	Tr	.1	--	--	--
84	Select	.1	0.01	97.8	.62	.03	.58
85	Chip--	2.5	.02	11.0	.29	.11	.19
86	do----	2.5	N	.1	--	--	--
87	do----	2.0	.02	3.5	.51	.04	.25
88	do----	2.0	.02	1.0	.37	.02	.17
89	do----	2.0	.05	.2	--	--	--
90	do----	2.0	.04	Tr	--	--	--
91	do----	2.0	N	N	--	--	--
92	do----	3.5	Tr	.1	--	--	--
93	Chip--	2.5	N	Tr	--	--	--
94	do----	1.2	N	N	--	--	--
95	do----	6.0	N	.2	--	--	--
96	do----	6.0	N	.1	--	--	--
97	do----	4.5	N	.1	--	--	--
98	do----	1.0	N	Tr	--	--	--
99	do----	2.2	N	N	--	--	--
100	do----	5.0	N	.5	--	--	--
101	do----	2.3	N	.1	--	--	--
102	do----	31.0	N	.1	--	--	--

upper adit which was driven 160 feet (49 m) along the zone. On the surface, the zone can be traced approximately 230 feet (70 m) northwest from the portal of the upper adit (fig. 9). It is intensely weathered at the surface and only isolated lenses of sulfides remain. Samples from the long drift (Livingston, 1971, pl. 4) have a weighted average of 0.01 ounce gold per ton (0.3 g/t) and 6.39 ounces silver per ton (219 g/t) across an average width of 2.2 feet (0.7 m); samples taken from the raise across a width of 2.3 feet (0.7 m) (fig. 9) contained 0.04 ounce gold per ton (1.2 g/t) and 17.5 ounces silver per ton (600 g/t).

A second parallel shear zone was intersected by a crosscut extending northward from the long drift. A 190-foot (58-m)-long drift was driven along the zone. The probable extension of this zone is exposed in the southeast branch of the lower adit, bringing the total known length of the zone to 850 feet (259 m). Samples from the second zone (Livingston, 1971, pl. 4) averaged a trace of gold and 6.4 ounces silver per ton (219.4 g/t) across an average width of 3.1 feet (0.9 m).

Total inferred reserves for the two parallel mineralized zones above the lower adit level are about 100,000 tons (91,000 t) containing a trace to as much as 0.05 ounce gold per ton (0.1-1.7 g/t) and 6 to 17 ounces silver per ton (206-583 g/t).

Winzes were sunk in the main zone to as much as 75 feet (22.9 m) below the lower adit level and reportedly (Livingston, 1971, p. 140) encountered highly mineralized rock. The potential mineral resources may be as great below the lower adit level as they are above it.

A third zone is exposed for 150 feet (46 m) along a drift. Samples (Nos. 96-98 and 101, fig. 9) contained no gold and a maximum of 0.5 ounce silver per ton (17.1 g/t).

Aces Up mine

The Aces Up adits (fig. 10) are on the apparent southeast end of the Cleopatra-Bear Lakes structure and near the West Fork of Miller River (fig. 6). In 1948 the property produced 400 pounds (181.4 kmg) of ore containing a total of 27 ounces (839.8 g) of silver.

The adits are along three subparallel mineralized shear zones in granodiorite. The zones, which are highly weathered, strike N. 45° to 55° W., and dip 60° SW. to vertical (fig. 10). Galena, sphalerite, jamesonite, arsenopyrite, and scheelite occur in lenticular masses in the zones. Gangue minerals include pyrite, quartz, and calcite.

Adit 1, caved 220 feet (67 m) from the portal, was reportedly driven 300 feet (91 m) along the southernmost shear zone (Purdy, 1951, p. 80), which ranges in width from 0.8 to 5.0 feet (0.24-1.5 m) and has an average width of 2.4 feet (0.7 m). Pyrite, sphalerite, and galena are finely disseminated in the zone. An outcrop about 425 feet (130 m) northwest of the portal of adit 1 (Nos. 137-138, fig. 10) appears to be part of the zone.

A middle shear zone is exposed for the entire length of adit 2 (fig. 10) and in a short drift from adit 1. The zone splits from the main zone close to the portal of adit 1 and apparently was intersected by a short inaccessible drift near the end of adit 1. It ranges in width from 0.5 to 4.0 feet (15.2 cm-1.2 m) and averages 1.5 feet (0.5 m). Minor amounts of galena, and scheelite occur in lenses and pods in the zone.

The northernmost shear zone is exposed for 175 feet (53 m) in adit 3. It ranges in thickness from 0.5 to 5.3 feet (0.2-1.6 m) and averages 2.1 feet (0.7 m). Pyrite accompanied by minor amounts of sphalerite, galena, and chalcopyrite occurs in lenses as much as 2 inches (0.06 m) thick and 1 foot (0.3 m) long. A winze extends downdip from near the portal. Adit 4 was driven in mineralized rock believed to be an updip continuation of the northernmost shear zone. The rock there contains galena pods as much as 0.5 foot (0.2 m) in diameter.

Miscellaneous prospects

Other minor prospects and mineralized zones were sampled in the area. These are listed in table 1.

Prospectors Ridge area

Numerous prospects and mineralized zones are located on the north end of Prospectors Ridge and the adjacent areas of the Illinois and lower Lennox Creeks drainages (fig. 11).

Granodiorite crops out along lower Illinois Creek, on the north end of Prospectors Ridge, and at low elevations along lower Lennox Creek. Metamorphosed volcanic, sedimentary, and ultramafic rocks crop out along upper Illinois Creek and on the south end of Prospectors Ridge. Most mineral deposits occur in altered sheared granodiorite. The deposits contain abundant quartz, mica, and pyrite or arsenopyrite. Traces of sulfide minerals also occur in unaltered granodiorite. Sulfide minerals also commonly occur in iron-oxide-stained hornfels, and, in places, make up as much as 5 percent of the rock.

Beaverdale claims

The main workings on the Beaverdale patented claims consist of three adits. The workings are along an altered shear zone which strikes approximately west and dips nearly vertically (fig. 12). The shear zone

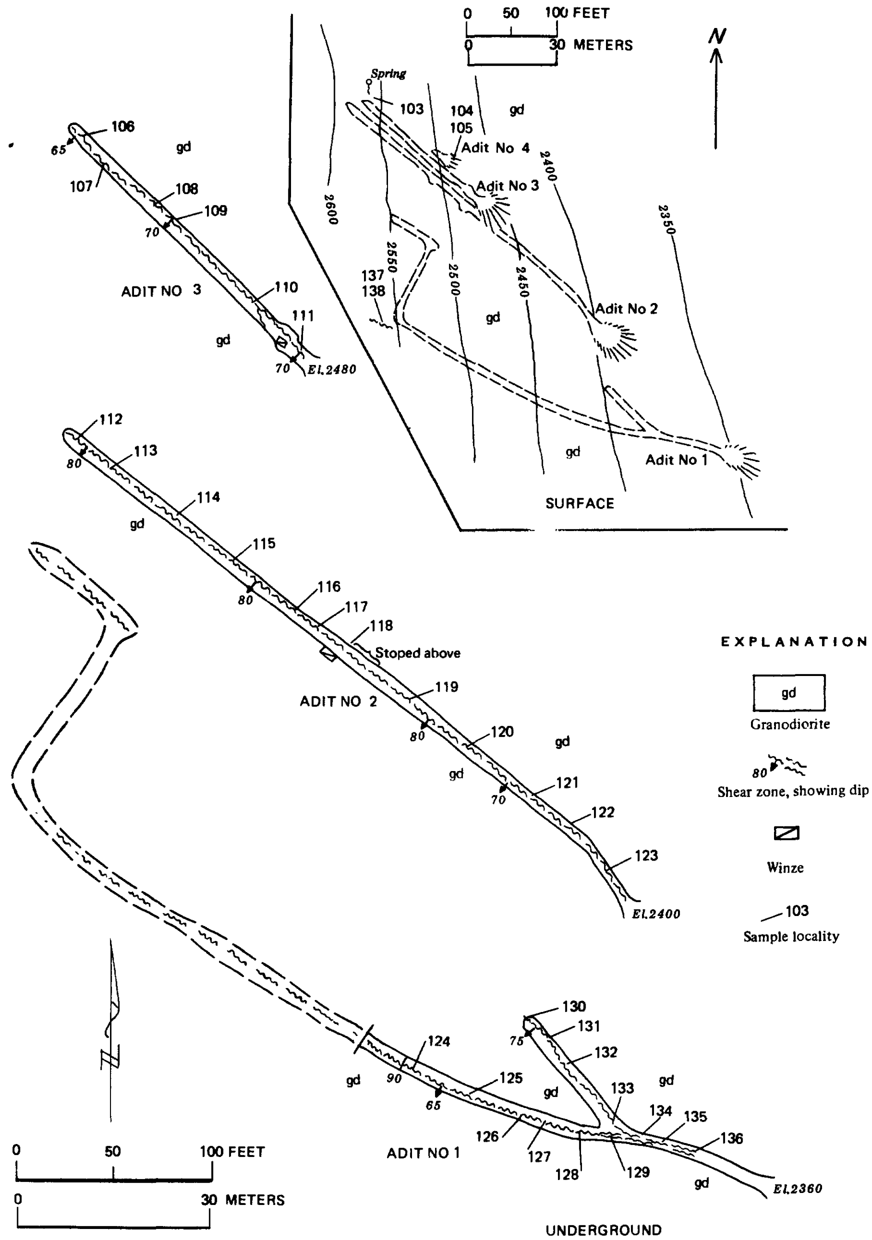


Figure 10.--Aces Up mine.

Data for samples shown on figure 10.

[Tr, trace; N, none detected; --, not analyzed; <, less than shown]

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)	Antimony (percent)	Arsenic (percent)
No.	Type	Length (feet)							
103	Grab--	--	Tr	0.07	--	--	--	--	--
104	Chip--	2.5	Tr	4.5	0.04	0.66	0.37	0.3	0.55
105	do----	1.5	Tr	.9	--	--	--	--	--
106	do----	2.5	0.03	.1	.02	<.01	--	--	--
107	do----	2.8	N	6.5	--	--	--	--	--
108	do----	3.5	.06	.4	.02	.06	.82	<.01	.86
109	do----	3.5	Tr	.3	--	--	--	--	--
110	do----	1.5	Tr	1.2	.03	.21	--	--	--
111	do----	5.3	N	Tr	--	--	--	--	--
112	do----	3.5	Tr	.1	--	--	--	--	--
113	do----	.5	N	3.2	--	-	--	--	--
114	do----	.5	N	N	--	--	--	--	--
115	do----	.5	.05	Tr	--	--	--	--	--
116	do----	2.5	.11	.2	--	--	--	--	--
117	do----	2.5	Tr	.5	.02	.04	--	--	--
118	Chip--	0.5	.07	9.4	--	--	--	--	--
119	do----	2.5	Tr	.2	--	--	--	--	--
120	do----	.5	N	N	--	--	--	--	--
121	do----	1.5	N	N	--	--	--	--	--
122	do----	1.1	N	.2	--	--	--	--	--
123	do----	5.0	N	Tr	.03	--	--	--	--
124	do----	4.0	N	.2	--	--	--	--	--
125	do----	3.5	N	.2	--	--	--	--	--
126	do----	3.5	.05	9.7	--	--	--	--	--
127	do----	1.0	.03	6.6	<.01	<.01	.012	<.01	
128	do----	.8	1.27	.2	--	--	--	--	--
129	do----	3.0	.05	11.8	--	--	--	--	--
130	do----	1.0	N	N	--	--	--	--	--
131	do----	1.0	N	N	<.01	<.01	.008	.015	.6
132	do----	3.0	N	N	--	.6	--	1.0	7.0
133	do----	1.0	.05	.3	--	.3	--	--	7.0
134	do----	3.5	N	N	--	--	--	--	--
135	Chip--	4.0	N	N	--	--	--	--	--
136	do----	2.5	N	Tr	--	--	--	--	--
137	do----	.3	Tr	.3	--	--	--	--	--
138	do----	.8	N	.2	--	--	--	--	--

Table 1.--Miscellaneous prospects and mineralized zones in the upper West Fork Miller River-Bear Creek area

Map No. (fig. 6)	Prospect name	Summary	Sample data
18	Bear Mountain Ridge No. 1	Limonite-stained, fine-grained hornfels contains less than 5 percent disseminated fine-grained sulfide minerals; mostly pyrite and arsenopyrite.	Chip sample 8 feet long (2.4 m) from area of disseminated sulfide area; no gold, trace silver, and 0.2 percent copper.
74	Cleopatra-Bear Lakes shear zone	Outcrop shear zone on divide 5,000 feet (1,500 m) northwest of Cleopatra mine. The zone is mostly altered to clay except for remnants along the hanging wall.	Chip sample 1.3 feet long (0.4 m); 0.03 ounce gold per ton (1.0 g/t), and trace silver.
75	Shear zone	A 2.5-foot-wide (0.8 m) shear zone in granodiorite, 4,300 feet (1,310 m) northwest of Cleopatra mine. The zone is south of the main Cleopatra-Bear Lakes shear zone.	Chip sample across shear zone; no gold, trace silver.
76	Dawson	A 10-foot-wide (3 m) shear zone strikes N. 65° W. and dips vertical. Shear zone in granodiorite, highly altered and iron-oxide stained.	Chip sample 10 feet long (3 m); no gold and no silver.
77	Unnamed	Brecciated rock and granodiorite contain pods of pyritic material and breccia as much as 1.5 feet (0.5 m) in diameter. Pyrite content of pods and breccia is greater than 10 percent.	A 1.5-foot-long (0.46 m) chip sample; no gold or silver.
139	Unnamed	Shear zone in granodiorite strikes N. 50° W., dips 60° SW., is 0.8 foot (1.24 m) wide, contains 1 percent pyrite, and is highly altered.	A chip sample across zone contained no gold and 0.1 ounce silver per ton (3.4 g/t).
0	Unnamed	A 10-foot-thick (3.0 m) shear zone in granodiorite. Zone strikes N. 50° W., dips 70° SW. and contains 20 percent quartz and finely disseminated pyrite.	One chip sample; trace gold and 0.3 ounce silver per ton (10.3 g/t).

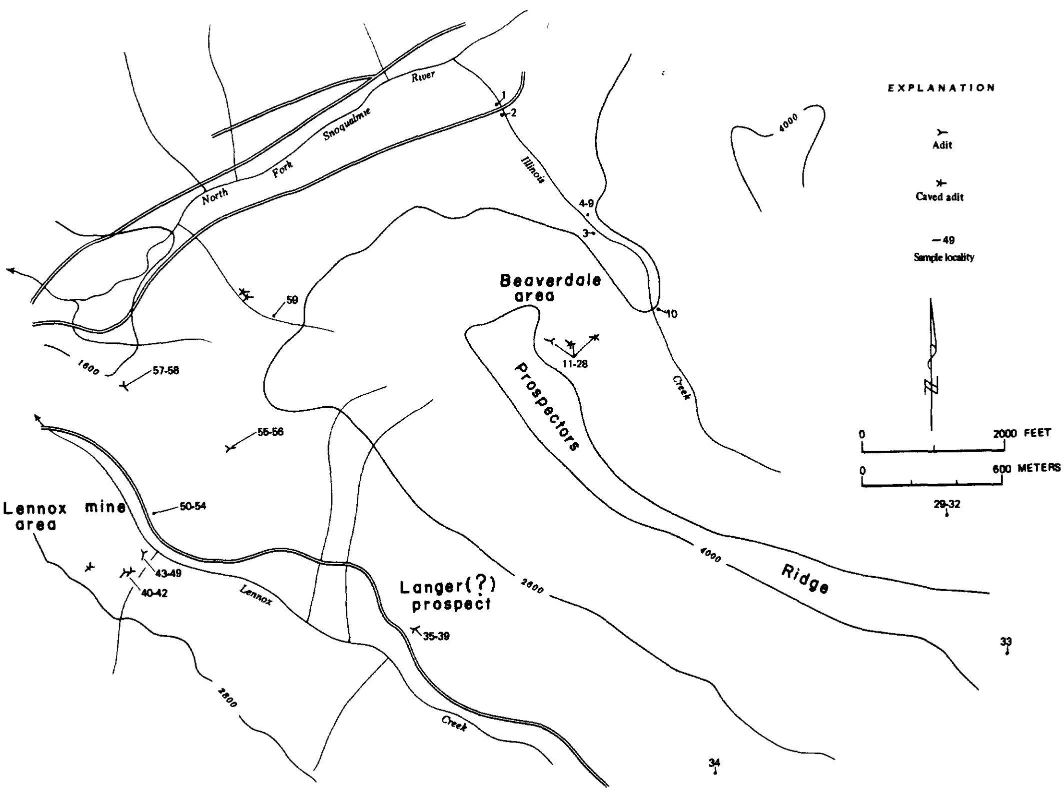


Figure 11.--Mines and prospects in the Prospectors Ridge area. Assay data for samples are given in detailed descriptions of prospects.

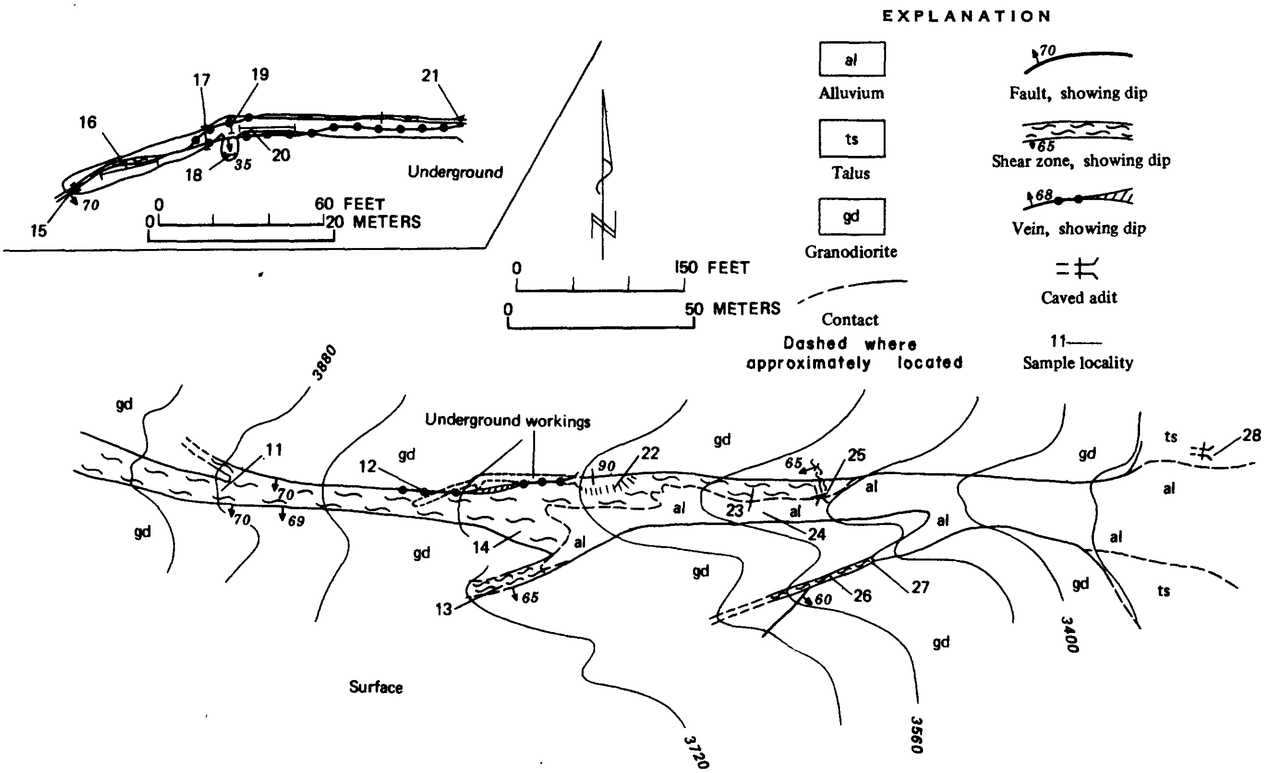


Figure 12.--Beaverdale claims.

Data for samples shown on figure 12.

[Tr, trace; N, none detected; --, not analyzed; <, less than shown]

Sample No.	Sample Type	Sample Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)
11	Chip--	2.3	N	2.4	0.01	< 0.01	0.007
12	do----	1.1	0.25	2.0	.067	.36	2.04
13	do----	12.0	Tr	.1	.009	.03	.041
14	do----	4.0	.01	.2	.008	<.01	.024
15	do----	1.0	.25	.2	.01	.06	.34
16	do----	20.0	Tr	.1	.009	.03	.048
17	do----	5.5	.01	.2	.016	.12	.43
18	do----	1.9	Tr	.1	.021	.02	.085
19	do----	3.4	.01	.2	.01	.02	.098
20	do----	20.0	.01	.2	.026	.11	.21
21	do----	2.0	.15	.4	.02	.05	.05
22	Grab--	--	Tr	.1	.02	--	--
23	Chip--	10.0	.01	.2	.015	<.01	.042
24	do----	8.0	Tr	.1	.013	<.01	.32
25	do----	4.5	.01	.2	.009	<.01	.039
26	do----	1.0	.01	.4	.033	.11	.28
27	do----	2.9	N	Tr	.004	<.01	.006
28	Grab--	--	.34	2.3	.092	.34	.36

ranges in width from 10 feet to more than 100 feet (3.0-30 m) and is intermittently exposed for more than 1,000 feet (305 m) on the steep west slope of Illinois Creek. The shear zone might extend to the North Fork Snoqualmie River in the area of two caved adits (near No. 59, fig. 11) for a total of about 6,500 feet (1,980 m).

Near the upper adit the north contact of the shear zone with the granodiorite is sharp and the country rock is unaltered. Large altered lenses of granodiorite occur in the zone near the south contact. Irregular stringers and lenses of sulfide minerals also occur in the zone.

The upper adit was driven along a continuous sulfide-rich vein that averages 1 foot (0.3 m) wide for more than 150 feet (46 m). Pyrite and arsenopyrite in nearly equal amounts compose about 75 percent of the vein. The remainder is quartz, mica, and altered granodiorite. Altered rock south of the vein contains as much as 10 percent sulfide minerals. The highest precious and base-metal contents in the upper adit are associated with the sulfide zones. Three samples (fig. 12) from the sulfide-enriched sections of the vein contain an average of 0.20 ounce gold per ton (6.86 g/t) and 0.78 ounce silver per ton (26.7 g/t) over a width of 1-2 feet (0.3-0.6 m). Samples from other parts of the vein average less than 0.01 ounce gold and less than 0.1 ounce silver per ton (0.34 g/t and 3.4 g/t, respectively) and contain minor amounts of copper, lead, zinc, and molybdenum.

The caved middle adit (No. 25, fig. 12) was driven 55 feet (17 m) along a vein striking N. 80° W. and dipping 78° W. (Bethel, 1951, p. 212). The vein is composed of 1.3 feet (0.4 m) of quartz and sulfide minerals next to the hanging wall, 1.3 feet (0.4 m) of altered brecciated granodiorite in the center, and 1.0 foot (0.3 m) of gouge next to the footwall. Pyrite is the most abundant sulfide mineral with lesser amounts of arsenopyrite.

The lower adit is caved.

A grab sample (No. 28, fig. 12) from the dump contained 0.34 ounce gold per ton (11.6 g/t) and 2.3 ounces silver per ton (18.8 g/t).

Lennox mine

The most extensive workings along lower Lennox Creek are the four adits and numerous trenches and pits at the Lennox mine (fig. 11). Upper adits (Nos. 40-42. fig. 13) were driven in the early 1900's shortly after the deposit was discovered. The main lower adit (Nos. 43-49, fig. 13) was completed in 1950 (E. A. Magill, written commun., 1951). The only recorded production from the mine was approximately 2,400 pounds (1,090 kg) of sorted ore from the two upper adits. The material contained 1.14 ounces gold per ton (39.1 g/t), 10.42 ounces silver per ton (357.2 g/t) and 1.58 percent copper.

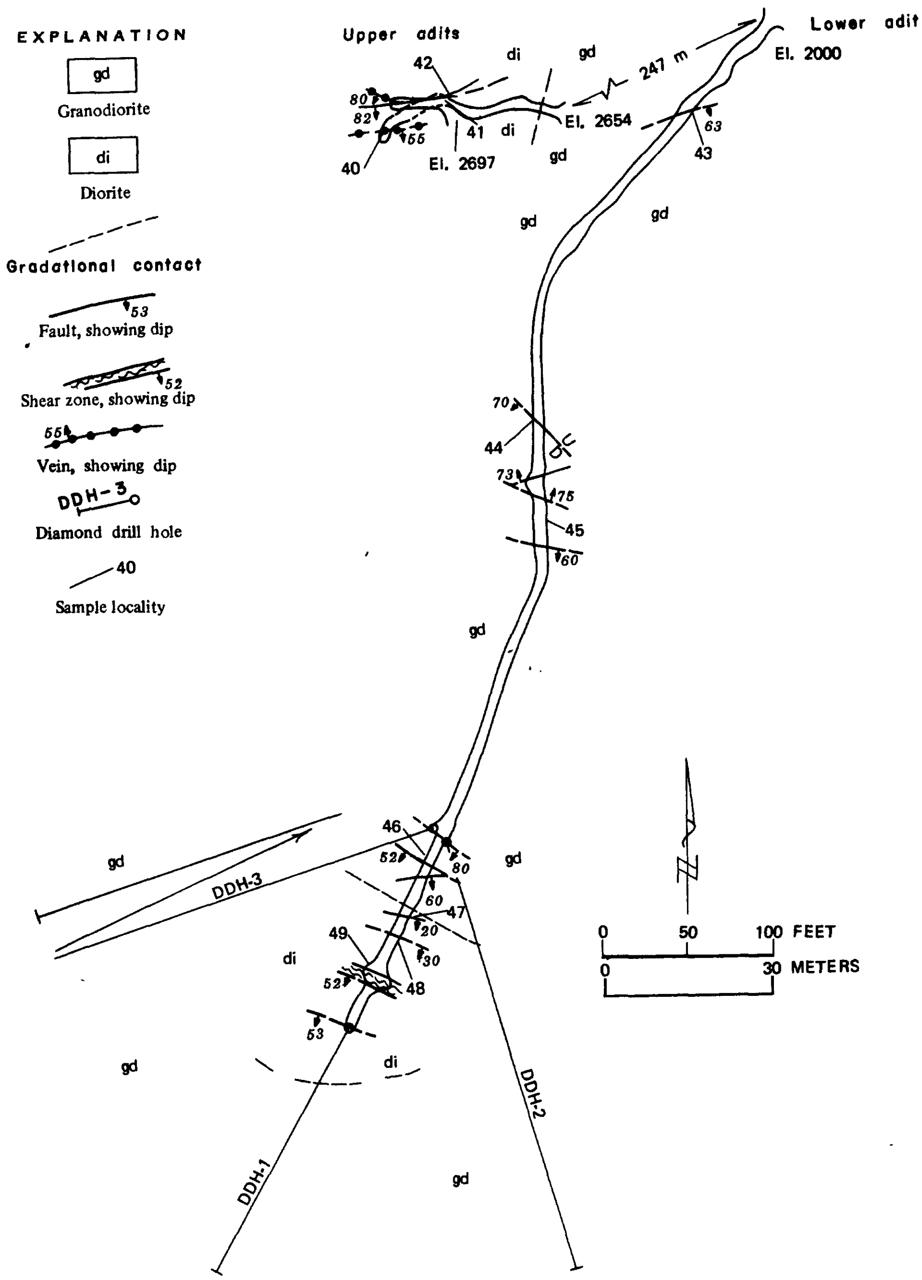


Figure 13.--Lennox mine.

Data for samples shown on figure 13.

[Tr, trace; N, none detected; --, not analyzed; <, less than shown]

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
No.	Type	Length (feet)			
40	Chip--	2.0	0.07	0.4	0.02
41	do----	1.0	.39	43.8	2.20
42	Grab--	--	.88	2.0	.46
43	Chip--	1.2	N	.1	.01
44	do----	1.0	N	.1	.02
45	do----	40.0	N	N	N
46	do----	.9	N	.1	< .01
47	Grab--	--	N	.2	.02
48	Chip--	2.1	N	.2	< .01
49	Grab--	--	Tr	Tr	< .01

All the adits were started in granodiorite which grades into diorite in the upper adits and near the face of the lower adit (fig. 13). Irregular shear zones containing lenses and stringers of quartz accompanied by pyrite, sphalerite, arsenopyrite, chalcopyrite, and galena trend northwest in the granitic rocks. The shear zones extend for several hundred feet (about 90-150 m).

The upper adits were driven along west-trending shear zones containing irregular lenses of pyrite, locally surrounded by altered rock. The middle adit (not shown on fig. 13) was driven along an apparent downward extension of the shear zones found in the upper adits. The lower adit intersected numerous small faults and shears as well as a sericitic zone with disseminated sulfide minerals. Holes drilled horizontally from the lower adit intersected mineralized structures, possibly downward extensions of the mineralized structures found in the upper adits, but no ore-grade material was encountered (fig. 13).

Samples from the upper adits across widths averaging 1.5 feet (0.5 m) (Nos. 40-41, fig. 13) contain gold values ranging in weight from 0.07 to 0.39 ounces per ton (2.4-13.4 g/t), silver values from 0.4 to 43.8 ounces per ton (14-1,467 g/t), and copper values ranging in concentration from 0.02 to 2.20 percent across an average width of 1.5 feet (0.5 m) (Nos. 40-41, fig. 13). The shear zone in the middle adit was sampled by Magill (1951). The sample across a 1.3-foot (0.4-m)-wide section of the vein contains 0.12 ounce gold per ton (4.1 g/t), 4.28 ounces silver per ton (146.7 g/t), and 0.35 percent copper. The metal content of samples from the lower adit is very low (Nos. 43-49, fig. 13).

A small gold-silver resource exists in the area between the upper and middle adits. The prospect has a potential for discovery of additional resources.

Miscellaneous prospects

Other prospects and mineralized areas in the Prospectors Ridge area either have no resource potential or are not well enough exposed to determine the potential. These are summarized in table 2.

Lower Mineral Creek area

More than 25 underground workings totaling about 1,000 feet (305 m) were mostly completed before 1930 along lower Mineral Creek (fig. 14). A 25-ton (23-t)-per-day mill, now in ruins, was built about 1920. Production from the lower Mineral Creek area includes 2,443 pounds (1,108.1 kg) of copper produced in 1917 and 3,582 pounds (1,624.8 kg) of copper and 25 ounces (777.6 g) of silver produced in 1922 (U.S. Bureau of Mines, written commun., undated). Mineral exploration will probably continue in the Mineral Creek area.

Table 2.--Miscellaneous prospects and mineralized zones in the Prospectors Ridge area.

Map No. (fig. 11)	Prospect name	Summary	Sample data
1-3	Illinois Creek placers	Samples 1 and 2 from limonite-stained gravel downstream from bedrock outcrops near Illinois Creek. Sample 3 from sandy alluvium above lower Illinois Creek falls.	Three pan samples; few very small colors of gold. No resource of gold, silver, or platinum.
4-9	Beaverdale Falls	Altered sheared zone in granodiorite. Average strike about N. 10° E., dips vertical. At least 50 feet (15 m) wide. Estimated 10 percent of rock is sheared with veins one-fourth inch (0.006 m) to 1.5-foot (0.46 m) wide. Maximum of 10 percent sulfide minerals in shears and veins, mostly pyrite, chalcopyrite, and molybdenite. Pegmatite pods 10 feet (3 m) long and 3 feet (0.9 m) wide.	Five chip samples from shears and veins; trace gold, less than 0.2 ounce silver per ton (6.8 g/t), less than 0.025 percent copper, lead, zinc, and molybdenum. One sample from a pegmatite; 0.2 ounce silver per ton (6.8 g/t), 0.17 percent copper, and 0.46 percent molybdenum.
29-33	Illinois Creek peridotite	Hornfels and sheared peridotite. Some orbicular hornblende-talc masses. Maximum of 5 percent black metallic minerals, disseminated and concentrated along joints and veins. Concentrations are 0.2-foot (0.06 m) wide and 1.5-foot (0.5 m) long.	Four chip samples; trace gold, maximum of 0.1 ounce silver per ton (3.0 g/t), no detectable platinum. One select sample of chromite-bearing rock; 12 percent chromium.
34	Unnamed	Small pit in diorite-hornfels complex is limonite stained and contains 1 to 5 percent very fine-grained disseminated sulfide minerals and some segregations as much as 0.1-foot (0.03 m) in diameter, mostly pyrite and arsenopyrite.	One chip sample; 0.021 percent copper.
35-39	Langer (?)	Limonite-stained weathered dioritic and metamorphic rock. Irregular lenticular shears and calcite-filled breccia zones 0.5- to 2.0-foot-wide (0.15-0.6 m). Maximum of 5 percent disseminated sulfide minerals throughout the rock; some concentrated along shears. Sulfide minerals are mostly pyrite, arsenopyrite, sphalerite, chalcopyrite. 402-foot-long (122.5 m) adit.	Five chip samples; maximum 0.04 ounce gold per ton (1.4 g/t), 0.1 ounce silver per ton (3.0 g/t), and 0.012 percent copper.
50-54	Sagmo and Stuber	Diorite and granodiorite containing shear zones, one zone averages 1.5-foot-wide (0.46 m). Contains 25 percent sulfide minerals, mostly pyrite, sphalerite, arsenopyrite, chalcopyrite, and galena. Strikes N. 80° W. and dips 60° SW.	Five chip samples from shear zones and silicified rock; as much as 0.2 ounce silver per ton (3.0 g/t), 0.5 percent lead in sample from silicified rock adjacent to shear.
55-56	Jack	Thirty-five-foot-long (10.7 m) adit along 0.5-foot-wide (0.15 m) shear trending N. 50° to 80° E. and dipping 72° to 85° SE., in granodiorite and schist. Sulfide minerals, mostly arsenopyrite and pyrite in shear.	Two chip samples, maximum 0.11 ounce gold per ton (3.8 g/t), 0.2 ounce silver per ton (6.8 g/t), and 0.26 percent zinc.
57-58	Nellis	Twenty-foot-long (6.1 m) adit along 1- to 2-foot-wide (0.3-0.61 m) shear in granodiorite. Shear strikes N. 70° W. and dips 60° SW. Maximum of 5 percent sulfide minerals, mostly pyrite.	Two chip samples; negligible values.

Volcanic, sedimentary, metamorphic, and granodioritic rocks underlie the lower Mineral Creek drainage. The mineralized zone extends at least 3,000 feet (900 m) vertically. Sulfide minerals, mostly pyrite, pyrrhotite, and arsenopyrite, constitute 5-10 percent of the rocks; chalcopyrite and molybdenite commonly compose less than 25 percent of the sulfide minerals. The sulfide minerals are scattered throughout the rock as small irregular blebs and as concentrations in breccias and fracture fillings.

A relatively unexplored potentially mineralized area near Mineral Creek appears to coincide with a magnetic high shown on the aeromagnetic map centered over the Park Lakes area (Gualtieri, and others, 1973, pl. 1). This high, which is part of a larger triangle-shaped anomaly that extends from Alaska Mountain through Chikamin Peak to the Three Queens may be affected by mineralized rock near the margin of the Three Queens stock.

Durrwachter prospect

The Durrwachter prospect is located along and to the north of Mineral Creek. Workings and mineralized outcrops are scattered through an area extending a few thousand feet north of the creek and a few thousand feet along the creek (fig. 15). Sulfide minerals are concentrated in granodiorite breccia, especially near northeast-trending shears, near Mineral Creek. A water-filled winze and short drift in the westernmost Durrwachter adit (Nos. 36-39, fig. 15) were driven along a shear zone about 0.5 foot (0.2 m) wide, striking about N. 60° E. and dipping about 30° SE. Pyrite and chalcopyrite are concentrated near the shear zone but the zone is composed mostly of weathered gouge and granodiorite fragments. Most or all of the production from Mineral Creek probably came from the 50-foot (15-m)-deep winze (E. A. Magill, written commun., 1955). The longest Durrwachter adit (Nos. 41-46, fig. 15) was driven into weathered granodiorite containing a maximum of 5 percent disseminated sulfide minerals.

A sulfide zone trending N. 50° W. is at least 200 feet (60 m) long and 80 feet (24 m) wide (Nos. 47-54, fig. 15) on the surface. Samples from the zone average 0.33 percent copper, no gold, 0.06 ounce silver per ton (2.06 g/t) and less than 0.01 percent molybdenum. Samples from a 1,098-foot (335-m)-deep vertical exploratory core hole drilled in the zone by Phelps Dodge Corp. (W. K. Brown, written commun., 1972) (fig. 15) show a 0.2 percent copper content in a 200-foot (61-m) section of the hole. Surface and near-surface mineralized rock in the vicinity of the major Durrwachter workings along Mineral Creek contains more than 0.2 percent copper and is estimated to total 100,000 tons (90,000 t).

Most samples from workings and mineralized outcrops away from the mineralized breccia near the stream contained less than 0.05 percent copper. Samples (Nos. 6-8, 61, 101, fig. 14) from other breccia zones containing sulfide minerals assayed as much as 0.02 percent copper, no gold, and 0.1 ounce silver per ton (3.4 g/t). One sample (No. 72, fig. 14) from a quartz vein contains 0.25 percent copper, and no gold or silver. Samples (Nos. 17, 22, 24-26, fig. 14) from shear zones containing sulfide minerals assayed as much as 0.068 percent copper, no gold, and 0.2 ounce silver per ton (6.8 g/t). Samples (Nos. 3 and 4) indicate that hornfels

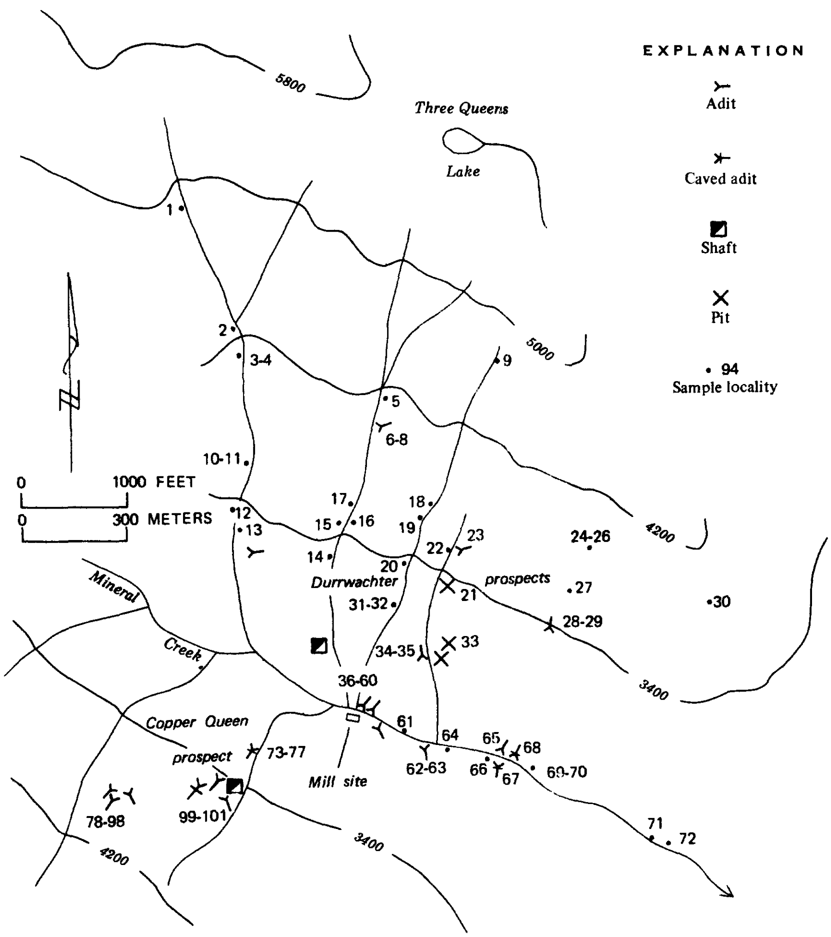


Figure 14.--Mines and prospects in the lower Mineral Creek area.

Data for samples shown on figure 14.

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

Sample No.	Sample Type	Sample Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
1	Chip--	200.0	Tr	0.2	0.014
2	do----	50.0	Tr	.2	.042
3	do----	10.0	N	Tr	.034
4	do----	50.0	N	.2	.049
5	do----	100.0	N	.1	.021
6	do----	3.0	N	N	.007
7	do----	75.0	N	.1	.011
8	do----	25.0	N	Tr	.009
9	do----	29.0	N	.1	.07
10	do----	92.0	N	.2	.014
11	do----	20.0	Tr	N	.009
12	do----	5.0	--	.2	.009
13	do----	4.8	Tr	--	.009
14	do----	100.0	N	.1	.029
15	do----	10.0	Tr	.1	.028
16	do----	5.0	Tr	Tr	.038
17	do----	2.5	N	N	.019
18	do----	1.8	N	.1	.01
19	do----	100.0	N	.2	.021
20	do----	100.0	N	Tr	.038
21	do----	4.4	Tr	.1	.046
22	do----	1.7	Tr	--	.035
23	Chip--	2.4	Tr	Tr	.01
24	do----	25.0	N	N	.042
25	do----	10.0	N	.1	.018
26	do----	2.0	N	.2	.068
27	do----	79.0	N	.1	.052
28	do----	30.0	N	.1	.033
29	do----	34.0	N	.1	.06
30	do----	2.9	Tr	.1	.07
31	do----	36.0	N	.1	.074
32	do----	30.0	N	.1	.057
33	do----	16.0	Tr	.3	.14
34	do----	5.0	Tr	Tr	.099
35	do----	6.5	Tr	Tr	.049
36	do----	3.7	N	N	.085
37	do----	1.8	N	Tr	.086
38	do----	32.0	N	.12	.19
39	Select grab--	--	.02	1.34	8.15
40	do----	--	.02	1.16	4.68
41	Chip--	11.0	N	N	.08
42	do----	17.0	N	.1	.014
43	do----	53.0	N	N	.065
44	do----	14.0	N	.1	.034
45	do----	29.0	N	.1	.019
46	do----	15.0	N	Tr	.034
47	do----	25.0	Tr	.2	.72
48	Chip--	25.0	N	.1	.43
49	Grab--	--	N	.20	.77
50	Chip--	25.0	N	.1	.49
51	do----	25.0	N	N	.16
52	do----	25.0	N	.1	.15
53	do----	25.0	N	N	.23
54	do----	25.0	N	.1	.12
55	do----	5.0	N	Tr	.008
56	do----	7.0	N	Tr	.013
57	Crushed ore grab	--	N	N	.65
58	do----	--	Tr	.5	1.71
59	Rod mill grab--	--	Tr	.2	.27
60	Blanket table-	--	N	--	--
61	Chip--	3.0	N	N	.058
62	do----	5.0	N	Tr	.017
63	do----	1.0	Tr	Tr	.005
64	do----	45.0	Tr	.1	.031
65	do----	1.0	N	N	.008
66	do----	30.0	N	N	.034
67	do----	4.0	N	.1	.055
68	do----	15.0	N	N	.20
69	do----	10.5	N	Tr	.036
70	do----	42.0	N	.1	.072
71	do----	11.0	N	N	.013
72	Chip--	1.0	N	N	0.25
73	do----	3.6	N	N	.16
74	do----	10.0	N	0.76	.23
75	do----	27.0	0.04	.28	.08
76	do----	25.0	N	.12	.02
77	do----	20.0	N	.22	.02
78	do----	1.4	N	.2	.37
79	do----	25.0	N	.07	.04
80	do----	25.0	N	.06	.06
81	do----	25.0	N	N	.04
82	do----	3.6	Tr	Tr	.23
83	do----	10.0	.08	.72	.82
84	do----	4.4	N	.2	.25
85	do----	42.0	Tr	.48	.41
86	do----	25.0	.04	.58	.89
87	do----	4.9	N	.3	.21
88	do----	13.5	.01	.58	.97
89	do----	4.0	.04	.94	.19
90	do----	8.0	N	.1	.058
91	do----	3.0	N	.5	.045
92	do----	9.0	Tr	.7	.85
93	do----	2.6	N	1.4	1.12
94	do----	5.5	N	.1	.025
95	do----	22.0	N	.2	.021
96	Muck pile grab--	--	N	N	0.087
97	Chip--	4.0	N	0.1	.054
98	do----	10.0	N	.1	.02
99	do----	5.0	N	.3	.015
100	do----	7.0	N	.2	.014
101	do----	25.0	N	.1	.02

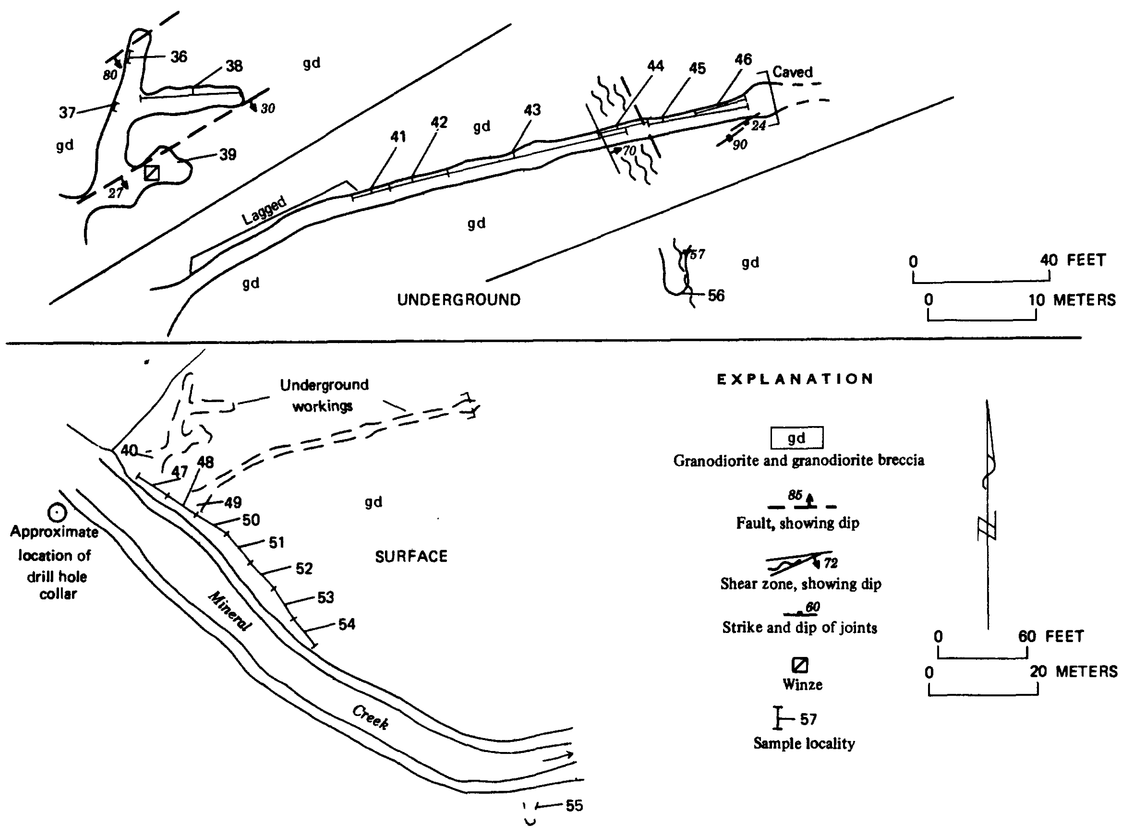


Figure 15.--Workings near Mineral Creek, Durrwachter prospect.

Data for samples shown on figure 15.

[Tr, trace; N, none detected; --, not analyzed; <, less than shown]

Sample No.	Sample Type	Sample Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Molybdenum (percent)
36	Chip--	3.7	N	N	0.085	--
37	do----	1.8	N	Tr	.086	--
38	do----	32.0	N	0.12	.19	--
39	Select grab--	--	0.02	1.34	8.15	--
40	do----	--	.02	1.16	4.68	--
41	Chip--	11.0	N	N	.08	--
42	do----	17.0	N	.1	.014	--
43	do----	53.0	N	N	.065	--
44	do----	14.0	N	.1	.034	--
45	do----	29.0	N	.1	.019	--
46	do----	15.0	N	Tr	.034	--
47	do----	25.0	Tr	.2	.72	0.014
48	do----	25.0	N	.1	.43	< .006
49	Grab--	--	N	.20	.77	
50	Chip--	25.0	N	.1	.49	.008
51	do----	25.0	N	N	.16	.01
52	do----	25.0	N	.1	.15	<.006
53	do----	25.0	N	N	.23	<.006
54	do----	25.0	N	.1	.12	<.006
55	Chip--	5.0	N	Tr	.008	< .006
56	do----	7.0	N	Tr	.013	<.006

carries as much as 0.049 percent copper, no gold, and 0.2 ounce silver per ton (6.8 g/t). Samples (Nos. 5, 14-16, 18, 27-30, 32-35, 64, 66, 67, fig. 14) from granodiorite with disseminated sulfide minerals contain as much as 0.099 percent copper, a trace of gold, and 0.3 ounce silver per ton (10.3 g/t). Most assays of samples of sheared or fractured granodiorite (Nos. 19, 62, 63, 65, 68, 69, 70, fig. 14) show less than 0.072 percent copper, a trace of gold, and 0.2 ounce silver per ton (6.8 g/t). One sample (No. 68), however, contains 0.20 percent copper across a width of 15 feet (4.6 m) but no gold or silver. Samples (Nos. 1, 2, 9, 10-13, 20, 21, 31, fig. 14) from metavolcanics contain as much as 0.074 percent copper, a trace of gold, and 0.2 ounce silver per ton (6.8 g/t). A sample of schist (No. 71, fig. 14) contains 0.013 percent copper and no gold or silver.

Further exploration may delineate deep copper-bearing bodies similar to those in the zone intersected by the Phelps Dodge drill hole.

Copper Queen prospect

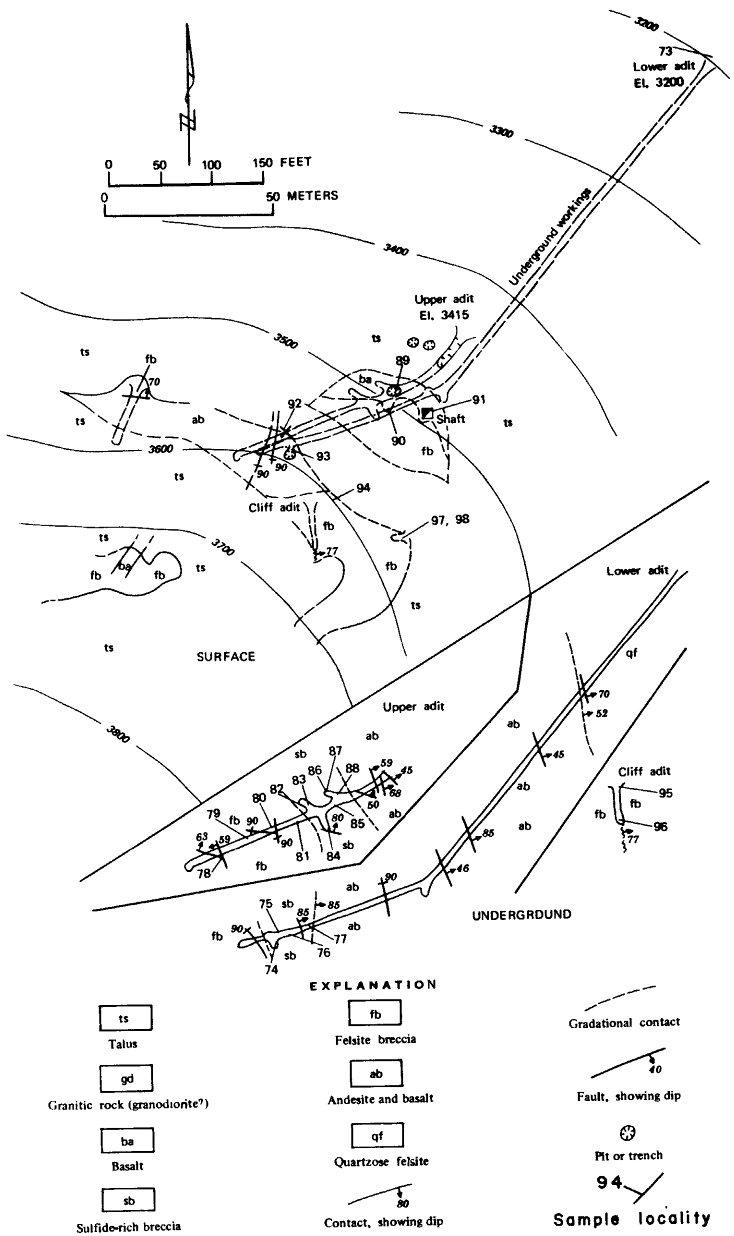
Country rocks at the Copper Queen prospect (fig. 16) are mostly andesite, basalt, felsite, and felsite breccia (fig. 16). Shear zones and dikes cut the rocks. Except for an intensely mineralized zone, where total sulfide minerals (pyrite, marcasite, arsenopyrite, and minor chalcopyrite) may exceed 30 percent, the rocks contain less than 5 percent sulfide minerals.

The intensely mineralized zone at the Copper Queen workings (Nos. 74-77, 82-88, and 89-91, fig. 16) is near the contact of the breccia and andesite. Like the major rock units in the Copper Queen area, the zone strikes about N. 30° to 45° W. and dips about 65° SW. It is irregular but probably extends from the head of the shaft through the upper adit to the lower adit, 250 feet (76 m) downdip. Drifts from the upper adit (Nos. 82-88, fig. 16) were driven about 40 feet (12 m) along the zone. The intensely mineralized zone appears to be pipe-shaped, is 45 feet (14 m) wide and at least 60 feet (18 m) long, as measured on the surface and in the upper adit, and is at least 300 feet (91 m) deep, as indicated by the depth between levels.

Indicated resources of nearly 69,000 tons (62,000 t) of rock containing about 0.63 percent copper and 0.54 ounce silver per ton (18.5 g/t) are estimated to occur in the area of the upper and lower adits. Additional mineralized rock may be found by exploration of extensions of the mineralized zones.

Lower West Fork Miller River area

The area (fig. 17) is underlain by granodiorite of the Snoqualmie batholith that is cut by strong and persistent northwest- and west-trending shear zones. Small breccia zones are randomly distributed through the area.



Data for samples shown on figure 16.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
No.	Type	Length (feet)			
73	Dump--	3.6	N	N	0.16
74	do----	10.0	N	0.76	.23
75	Chip--	27.0	0.04	.28	.08
76	do----	25.0	N	.12	.02
77	do----	20.0	N	.22	.02
78	do----	1.4	N	.2	.37
79	do----	25.0	N	.07	.04
80	do----	25.0	N	.06	.06
81	do----	25.0	N	N	.04
82	do----	3.6	Tr	Tr	.23
83	do----	10.0	.08	.72	.82
84	do----	4.4	N	.2	.25
85	do----	42.0	Tr	.48	.41
86	do----	25.0	.04	.58	.89
87	do----	4.9	N	.3	.21
88	do----	13.5	.01	.58	.97
[illegible]	do----	4.0	.04	.94	.19
90	do----	8.0	N	.1	.058
91	do----	3.0	N	.5	.045
92	do----	9.0	Tr	.7	.85
93	do----	2.6	N	1.4	1.12
94	Chip--	5.5	N	.1	.025
95	do----	22.0	N	.2	.021
96	Muck pile grab--	--	N	N	.087
97	Chip--	4.0	N	.1	.054
98	do----	10.0	N	.1	.02

Figure 16.--Copper Queen prospect.

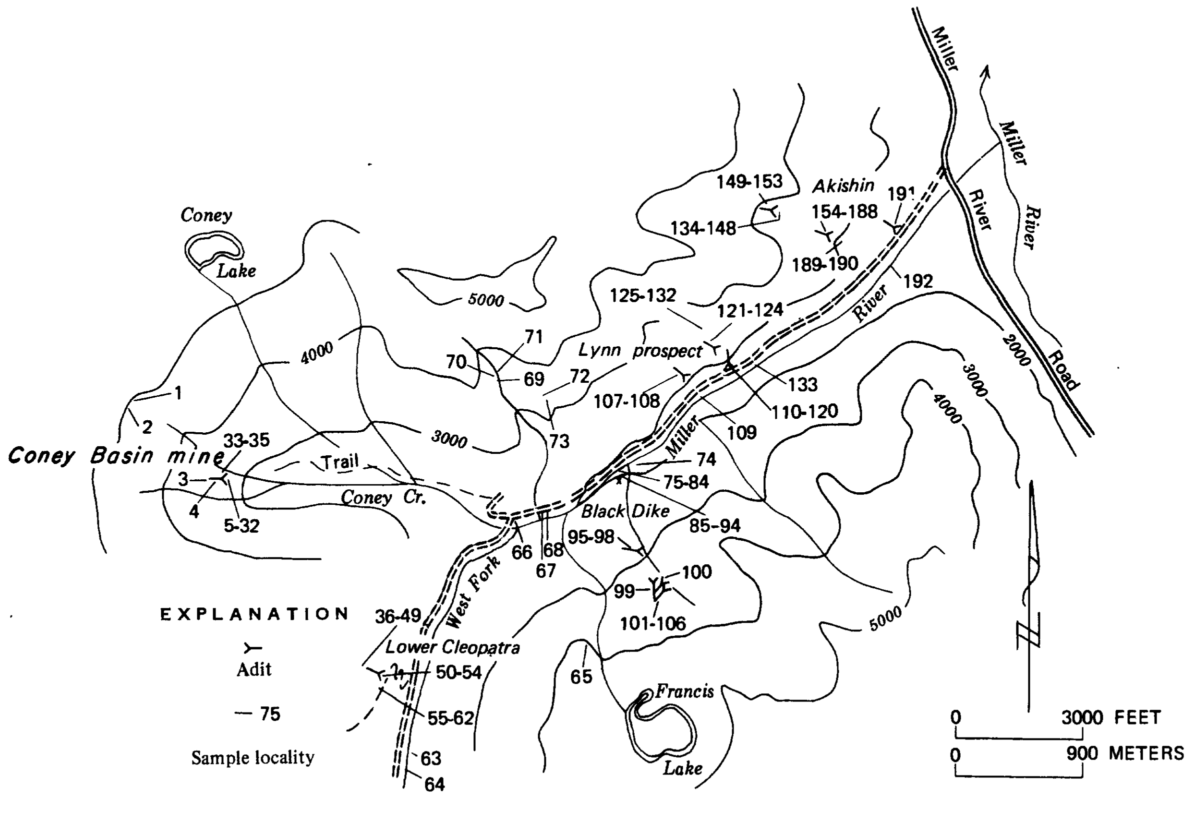


Figure 17.--Prospects in the lower West Fork Miller River area. Assay data for samples are given in detailed descriptions of prospects.

The shear zones generally contain pyrite, arsenopyrite, galena, sphalerite, jamesonite, chalcopyrite, tetrahedrite, quartz, calcite, and gouge. The highly weathered parts of the shear zones are at the surface. Magnetite occurs in veins, pods, and as fine-grained disseminations.

Many of the northwest-striking shear zones may contain small resources.

Akishin claims

A persistent sulfide-bearing shear zone is exposed in two adits on the Akishin claims (fig. 18). The zone strikes N. 70° W. to W., dips 50° to 80° SW., and cuts granodiorite. The zone ranges from 0.5 to 15 feet (0.2-4.6 m) in width and averages 2.1 feet (0.6 m). It apparently is continuous between the lower adit, upper adit, and surface west of the upper adit, a total strike length of about 2,000 feet (610 m).

Sulfide minerals in the zone include pyrite, chalcopyrite, galena, and sphalerite which occur with quartz and gouge in erratically distributed lenses and pods. The zone is highly altered and stained with copper carbonate and iron oxide minerals.

Another small shear zone about 2,000 feet (610 m) northeast of the lower adit is exposed in a 10-foot-long (3.0 m) adit (No. 191, fig. 18). It is 0.7 foot (0.2 m) wide, strikes N. 52° W., and dips 55° SW. A chip sample taken across the vein contains 0.2 ounce silver per ton (6.8 g/t) and no gold.

Small areas of the principal shear zone contain up to 0.06 ounces of gold per ton (2 g/t), 5.8 ounces of silver per ton (199 g/t), 1.37 percent copper, and minor amounts of lead and zinc. In general, however, the mineralization is very irregular and low grade.

Coney Basin mine

Two adits explore shear zones in granodiorite on the west side of Coney basin, south of Coney Lake (fig. 17). Development consists of a total of 3,000 linear feet (914 m) of underground workings (Livingston, 1971, p. 140). The lower adit is caved.

The mine produced 86 tons (78 t) of ore intermittently between 1895 and 1941 (Livingston, 1971, p. 141). Records (U.S. Bureau of Mines, written commun., undated) indicate that 46 tons (42 t) of the ore contained 26 ounces (809 g) gold, 598 ounces (18,600 g) silver, 400 pounds (181 kg) copper, and 2,461 pounds (1,116 kg) lead.

A sulfide-rich quartz vein in a west-striking shear zone, which dips 70° to 85° S., is followed for about 400 feet (122 m) by the upper adit (fig. 19). The quartz vein is 0.3-4 feet (0.1-1.2 m) wide and contains 5-15 percent sulfide minerals in lenses and pods. The sulfide minerals include pyrite, arsenopyrite, sphalerite, galena, chalcopyrite, and tetrahedrite. Assay results from the quartz-vein samples (Nos. 15-32, fig. 19) show only minor amounts of gold, silver, lead, zinc, and copper, with the exception of sample 32 from the portal at the place where the vein is intersected by the main shear zone. This sample contains 0.22 ounce of gold per ton (7.5 g/t) and 4.0 ounces of silver per ton (137 g/t) over a width of 1.2 feet (0.4 m). Samples 3 and 4 (fig. 19) in this same shear zone contain 0.09 and 0.22 ounce of gold per ton (3.0 and 7.5 g/t) and 1.5 and 8.3 ounces of silver per ton (51 and 285 g/t), respectively, over widths of 1.4 and 4 feet (0.4 to 1.2 m). Additional exploration of this shear zone may disclose a gold-silver resource.

Shear zones intersected by the adit near the face contain more than 80 percent fault gouge and 1-3 percent fine-grained sulfide minerals, mainly pyrite. Copper carbonate occurs in a shear zone intersected at 1,260 feet (384 m) from the adit portal.

Lower Cleopatra prospect

The Lower Cleopatra prospect is located above the switchbacks on the Cleopatra mine road.(fig. 17).

A segment of a northwest-trending shear zone is developed by a 90-foot (27-m)-long adit (Nos. 50-54, fig. 20). The shear zone ranges in width from 1.2 to 12.0 feet (0.4-3.7 m) and contains 3-5 percent sulfide minerals, mainly pyrite, arsenopyrite, galena, and chalcopyrite. Quartz is the principal gangue mineral.

Extensions of the shear zone are traceable in the streambed northwest of the adit (Nos. 36-49, fig. 20). These highly leached outcrops contain altered granitic rock, clay, quartz, and 1-5 percent pyrite. Six highly iron-stained shear zones, probably extensions of the main zone, crop out along the mine road southeast of the adit (Nos. 55-62, fig. 20).

Average grade of the less-altered part of the shear zone explored by the adit is 0.02 ounce of gold per ton (0.7 g/t), 5.8 ounces of silver per ton (198.8 g/t), and 0.19 percent copper. Several tens of thousands of tons of similar grade material might be developed by exploring along the strike of the shear zone.

Black Dike prospect

Medium- to coarse-grained granodiorite cut by northwest- and northeast-trending joints underlies the prospect area. Magnetite is disseminated in a 110-foot (33.5-m)-high cliff near the river (Nos. 75-94, fig. 17) and in rock surrounding adit 1 (Nos. 95-98, fig. 17). It also

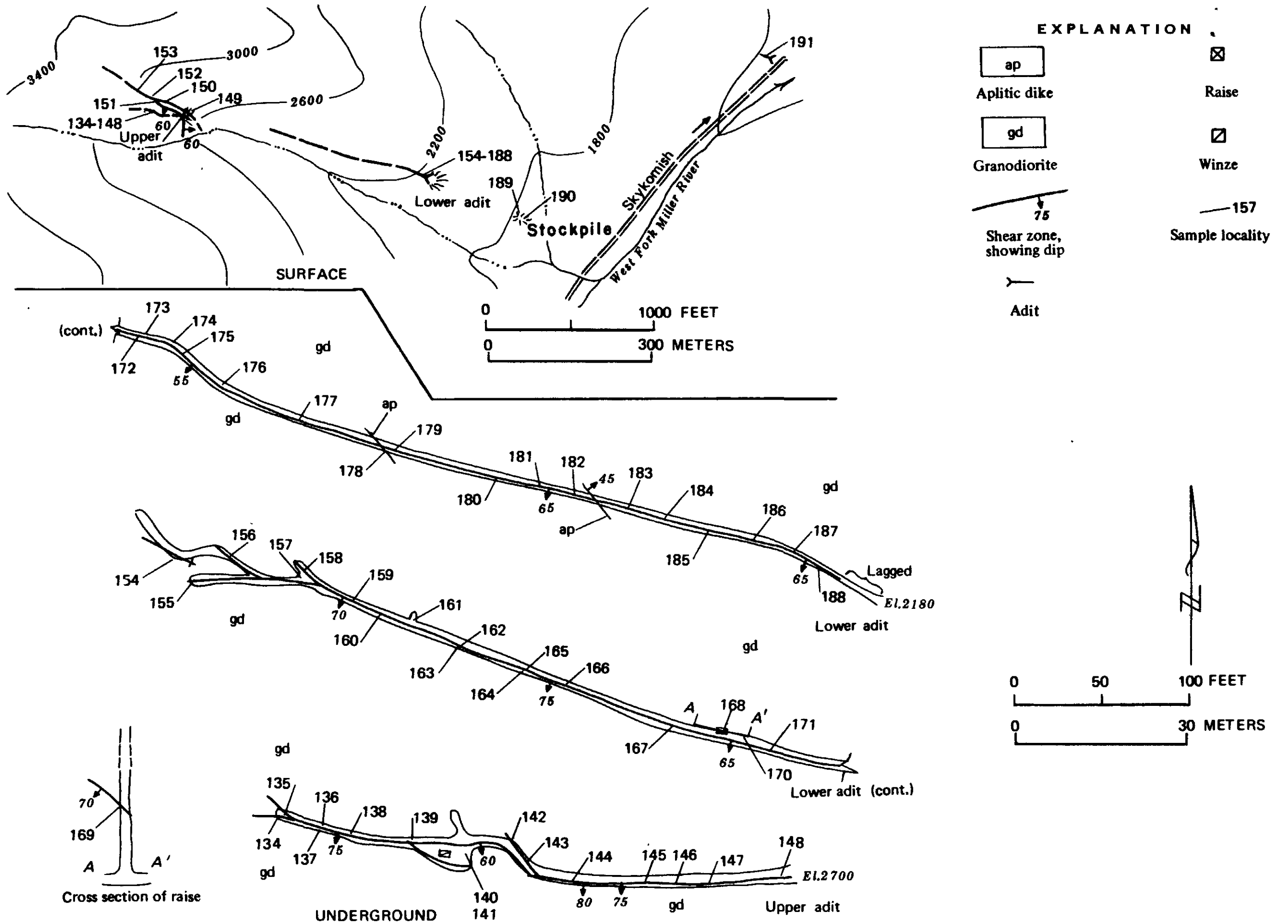


Figure 18.--Akishin claims.

Data for samples shown on figure 18.

[Tr, trace. N, none detected; --, not analyzed; <, less than shown]

Sample No.	Sample Type	Sample Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)
134	Chip--	2.5	Tr	0.7	0.045	0.25	0.35
135	do----	.8	N	N	.006	< .01	.008
136	do----	.7	N	N	--	--	--
137	do----	3.0	0.03	4.7	.14	.093	.17
138	do----	.5	.15	2.2	.01	.01	.014
139	do----	2.5	Tr	.3	.16	.074	.17
140	do----	10.0	.03	2.0	.62	1.56	1.42
141	do----	1.0	.06	5.8	1.37	.94	.44
142	do----	2.0	.01	.5	.046	.19	.22
143	do----	1.6	Tr	.2	.009	.074	.094
144	do----	.5	N	.1	.01	.05	.074
145	do----	2.4	.02	.5	.041	.55	.89
146	do----	3.0	Tr	.2	--	--	--
147	do----	.5	N	N	--	--	--
148	do----	4.0	Tr	.4	--	--	--
149	Chip--	2.0	N	.1	.053	.014	.011
150	do----	2.5	N	N	--	--	--
151	do----	2.4	N	.1	.01	.34	.38
152	do----	3.0	N	N	--	--	--
153	do----	4.0	N	Tr	--	--	--
154	do----	1.2	Tr	.1	--	--	--
155	do----	1.0	N	.2	--	--	--
156	do----	5.5	Tr	.3	--	--	--
157	do----	10.0	0.05	.5	--	--	--
158	do----	1.8	.03	3.1	.56	.16	.085
159	do----	1.5	.01	.7	.12	.097	.36
160	do----	2.5	.02	1.5	--	--	--
161	do----	7.0	.07	.9	--	--	--
162	do----	2.0	Tr	1.0	.37	.074	.42
163	do----	2.5	.03	1.9	--	--	--
164	do----	1.2	.03	2.4	--	--	--
165	do----	1.0	.01	1.3	.006	<.01	--
166	do----	4.0	.05	.4	.2	.1	.35
167	Chip--	1.5	0.01	2.0	0.13	0.28	0.39
168	Grab--	--	.01	.3	--	--	--
169	Chip--	6.0	Tr	1.1	.135	.27	1.13
170	do----	3.0	Tr	.2	.034	.14	.85
171	do----	2.0	.01	.4	--	--	--
172	do----	1.1	Tr	.5	.022	.26	.38
173	do----	.5	.02	.3	.024	.023	.38
174	do----	.7	.01	.5	--	--	--
175	do----	.7	N	.2	--	--	--
176	do----	2.0	N	N	--	--	--
177	do----	2.2	N	.2	.006	< .01	.018
178	do----	.8	N	.2	--	--	--
179	do----	1.5	.04	1.2	--	--	--
180	do----	.8	Tr	.5	.021	.33	.17
181	do----	1.0	Tr	.2	--	--	--
182	do----	1.2	N	.3	.015	.05	.045
183	do----	.8	N	N	--	--	--
184	do----	.7	N	N	--	--	--
185	Chip--	1.6	Tr	0.2	--	--	--
186	do----	.7	N	.1	--	--	--
187	do----	.7	N	.2	--	--	--
188	do----	.7	Tr	.1	--	--	--
189	Channel	--	N	1.8	--	--	--
190	do----	--	N	.7	0.05	0.18	0.28
191	Chip--	.7	N	.2	--	--	--

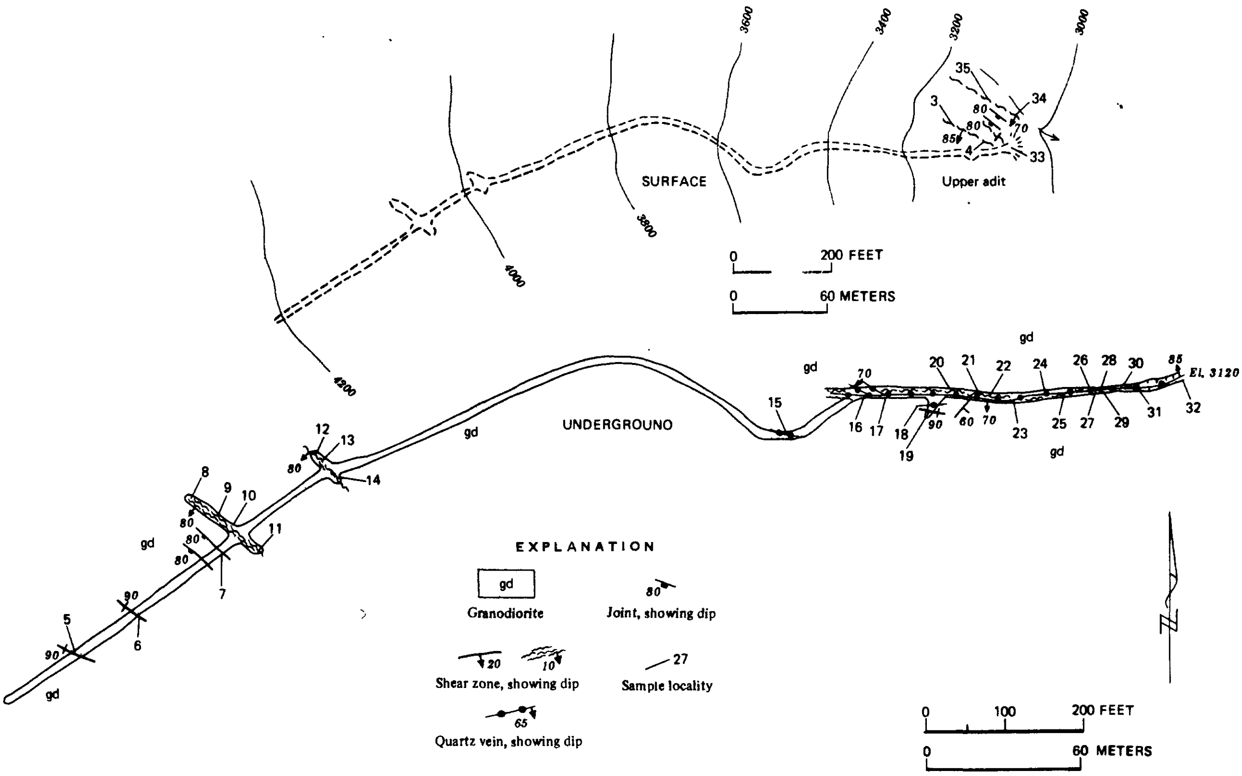


Figure 19.--Upper adit, Coney Basin mine.

Data for samples shown on figure 19.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)
No.	Type	Length (feet)					
3	Chip--	4.0	0.09	8.3	0.04	1.34	--
4	do----	1.4	.22	1.5	.025	.71	0.065
5	do----	.3	.03	N	--	--	--
6	do----	.7	.02	.1	--	--	--
7	do----	.8	.03	N	--	--	--
8	do----	.8	.04	.1	--	--	--
9	do----	.4	.03	N	.012	.01	.005
10	do----	1.2	.04	.1	.002	N	.002
11	do----	.4	.02	N	--	--	--
12	do----	3.5	.03	--	--	--	--
13	do----	3.5	Tr	.1	.006	N	.007
14	do----	1.0	Tr	.1	.008	.011	.007
15	do----	.5	Tr	.7	.029	.81	.55
16	do----	4.0	Tr	.1	.006	.012	.002
17	do----	1.5	Tr	.1	--	--	--
18	do----	.3	.01	.1	--	--	--
19	Chip--	1.8	Tr	.1	--	--	--
20	do----	1.5	N	N	--	--	--
21	do----	1.0	N	.1	--	--	--
22	do----	1.2	0.04	Tr	--	--	--
23	do----	1.5	N	N	0.007	N	0.004
24	do----	.5	N	N	.028	0.023	.014
25	do----	2.5	.01	1.4	.076	.66	1.38
26	do----	4.0	Tr	.2	.015	.092	.061
27	do----	1.5	.01	.4	.016	.20	.076
28	do----	1.8	.01	Tr	.017	.11	.072
29	do----	1.0	Tr	.1	.016	.11	.042
30	do----	2.5	.01	.1	.014	.15	.03
31	do----	.3	.01	Tr	.016	--	--
32	do----	1.2	.22	4.0	--	--	--
33	do----	2.4	.1	6.9	--	--	--
34	do----	2.5	N	Tr	--	--	--
35	do----	.5	N	N	--	--	--

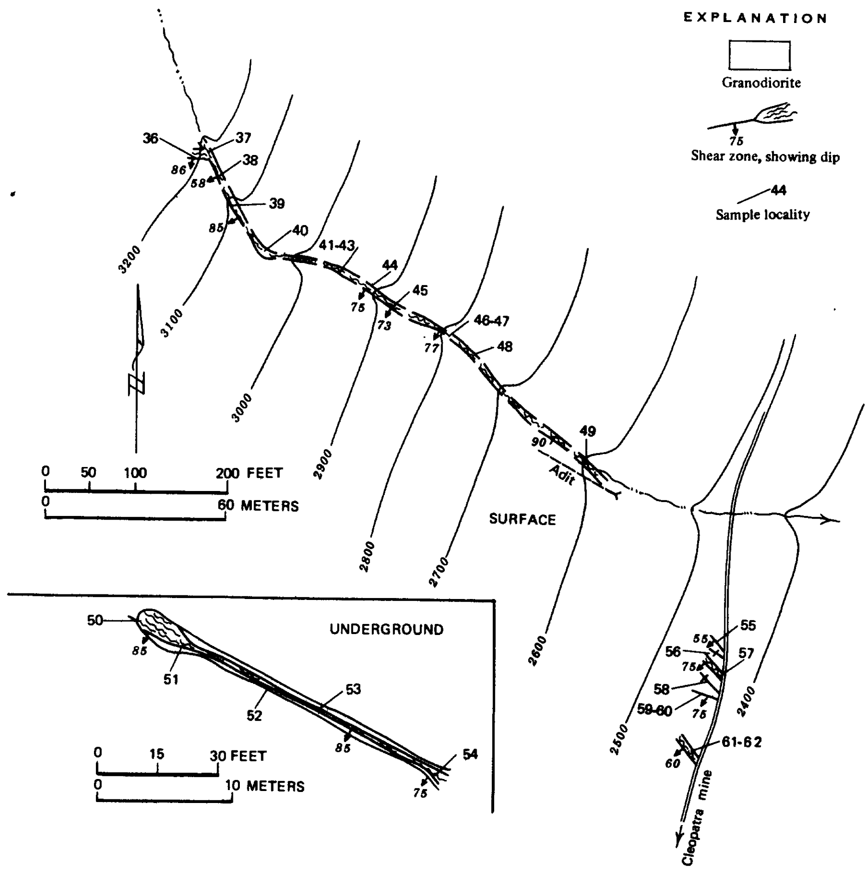


Figure 20.--Lower Cleopatra prospect.

Data for samples shown on figure 20.

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

Sample No.	Sample Type	Sample Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
36	Chip--	1.2	Tr	0.1	--
37	do----	2.0	N	.7	0.005
38	do----	2.0	N	N	.005
39	do----	2.0	0.06	8.6	--
40	do----	2.0	N	.3	.005
41	do----	2.5	N	.2	--
42	do----	7.0	Tr	.2	--
43	do----	2.5	Tr	.1	.008
44	do----	2.0	Tr	.1	.006
45	do----	1.5	N	Tr	--
46	do----	4.2	N	N	.006
47	do----	3.5	.01	.8	--
48	do----	6.0	Tr	.1	.007
49	do----	1.7	.01	1.5	--
50	do----	4.0	Tr	.2	.55
51	do----	1.5	.02	1.2	.088
52	do----	2.0	Tr	5.2	.017
53	do----	1.5	Tr	.2	.18
54	do----	4.0	.06	15.5	.006
55	do----	1.8	1.50	8.6	.005
56	do----	.4	.07	20.1	.006
57	do----	6.2	Tr	Tr	--
58	Chip--	3.7	N	N	--
59	do----	.6	N	N	.004
60	do----	2.3	Tr	.1	.004
61	do----	4.2	Tr	.2	--
62	do----	1.6	Tr	.1	--

occurs as coarse-grained blebs, as pods as much as 0.4 foot (0.12 m) in diameter, along joint surfaces, and in veins as much as 1 foot (0.3 m) wide. Samples were taken continuously up the cliff face at two localities (Nos. 75-84 and 85-94, fig. 21). At one locality (Nos. 75-84), the samples collected near the top of the cliff are higher in iron than those collected from lower on the cliff. Samples of unaltered rock from adit 1 also contain iron. Although iron-bearing float was found between the two locations, no magnetite-bearing outcrops have been discovered. A magnetometer survey (J. Cashman, written commun., 1973), which showed the anomaly above the cliff to be 180 feet (55 m) long and 120 feet (37 m) wide, failed to indicate a continuity of iron-rich rock between the cliff exposure and adit 1. A total of about 250,000 tons (181,440 t) of rock containing an average of 20.2 percent iron is estimated to exist in the exposure at the cliff (Nos. 75-95, fig. 21) and near the adit (Nos. 95-98, fig. 21).

Adits 2 and 3 penetrate a highly altered breccia pipe. Exposures indicate that the pipe is at least 25 by 60 feet (7.6 m by 18.3 m) in cross section and extends at least 40 feet (12.2 m) vertically. Randomly distributed pyrite and chalcopyrite occur in the pipe, as do clay minerals, micaceous minerals, sericite, and magnetite. About 5,000 tons of rock (4,536 t) containing 0.72 percent copper is estimated to occur above adit 2.

Lynn prospect

The workings in the Lynn prospect are along the West Fork Miller River jeep trail (fig. 22). No production has been reported from the property.

Highly weathered northwest-trending shear zones in granodiorite are intersected by the two adits (fig. 22). The lower adit intersects small fracture fillings that contain quartz, pyrite, and gouge in the initial 230 feet (70 m). The mineralized rock that formed along joints ranges in width from 0.3 to 1.5 feet (0.08-0.46 m). Beyond the jointed area, the drift follows a shear zone containing 15-30 percent quartz, 10-25 percent clay, and 3-5 percent sulfide minerals, which include pyrite, arsenopyrite, galena, sphalerite, and chalcopyrite. The sulfide minerals occur in lenticular bodies.

The upper adit was driven along two parallel shear zones. Both zones strike N. 45° W. and dip steeply southwest. These zones contain fine-grained pyrite, galena, chalcopyrite, sphalerite, and lenses of quartz.

On the surface, northwest-trending shear zones can be traced from the upper adit up the drainage for about 1,150 feet (350 m). These structures range in width from 0.7 to 8.0 feet (0.2-2.4 m) and contain highly altered granitic rock, quartz, pyrite, galena, sphalerite, and arsenopyrite. Northeast-trending crossfractures do not contain significant amounts of mineralized rock.

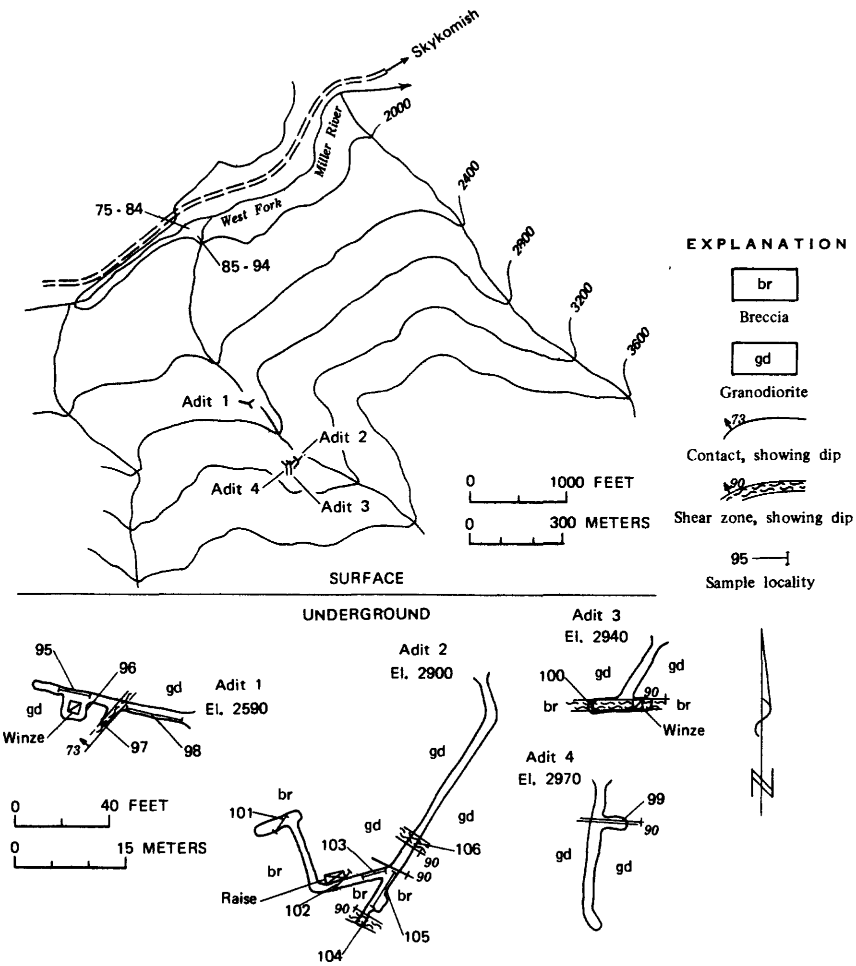


Figure 21.--Black Dike prospect.

Data for samples shown on figure 21.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Iron (percent)
No.	Type	Length (feet)				
75	Chip--	8.0	N	0.1	--	4.0
76	do----	5.0	N	.2	--	12.5
77	do----	5.0	N	.1	--	3.1
78	do----	5.0	N	Tr	--	6.1
79	do----	5.0	N	N	--	17.1
80	do----	5.0	N	.1	--	23.2
81	do----	5.0	N	N	--	21.3
82	do----	5.0	Tr	.1	--	27.7
83	do----	5.0	N	Tr	--	21.7
84	do----	7.0	Tr	.1	--	21.9
85	do----	5.5	N	.1	--	9.7
86	do----	5.0	N	N	--	12.4
87	do----	5.0	N	Tr	--	16.3
88	do----	7.0	N	.1	--	19.4
89	do----	6.0	N	.2	--	20.3
90	do----	6.0	N	Tr	--	22.2
91	do----	5.0	N	Tr	--	19.3
92	do----	5.0	N	:1	--	18.6
93	do----	5.0	Tr	Tr	--	20.8
94	do----	6.0	N	Tr	--	27.1
95	Chip--	12.0	N	Tr	--	--
96	do----	5.0	N	.3	--	58.7
97	do----	2.8	N	.1	--	24.4
98	do----	29.0	N	.2	--	30.7
99	do----	2.0	Tr	.1	0.05	--
100	do----	5.0	N	.2	--	--
101	do----	10.0	N	.3	3.32	--
102	do----	10.0	N	.5	.08	--
103	do----	4.0	N	.1	.25	--
104	do----	5.0	N	N	--	--
105	do----	20.0	N	.1	.06	--
106	do----	5.0	Tr	.2	.01	--

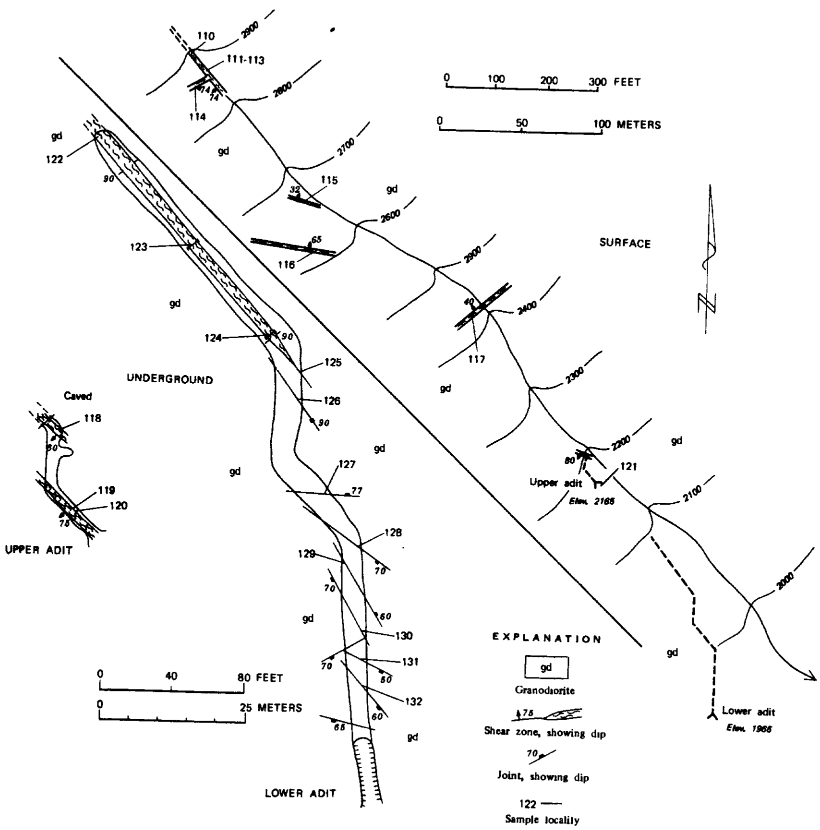


Figure 22.--Lynn prospect.

Data for samples shown on figure 22.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)
No.	Type	Length (feet)					
110	Chip--	0.8	N	0.1	--	--	--
111	do----	4.0	0.05	1.9	0.10	1.4	0.61
112	do----	4.0	N	.1	.008	.12	.21
113	do----	1.0	.01	4.6	.20	5.74	2.57
114	do----	5.0	N	.1	--	--	--
115	do----	.7	.07	2.8	.15	.47	1.79
116	do----	4.5	N	.1	--	--	--
117	do----	2.0	N	.1	--	--	--
118	do----	2.0	.01	.1	.015	.079	.022
119	do----	5.0	N	.1	--	--	--
120	do----	.3	N	.1	--	--	--
121	Dump grab--	--	Tr	2.1	.25	1.23	.44
122	Chip--	3.0	N	.2	.007	.015	--
123	do----	2.0	N	.2	.006	.001	--
124	do----	5.0	N	.3	.033	.45	--
125	Chip--	.7	.01	.3	.025	.018	--
126	do----	.01	N	.1	--	--	--
127	do----	.5	N	Tr	.023	.015	.027
128	do----	.8	Tr	.9	.16	.052	.15
129	do----	.4	N	.1	--	--	--
130	do----	1.5	N	.1	--	--	--
131	do----	.3	N	.2	--	--	--
132	do----	.3	N	.1	--	--	--

Miscellaneous prospects

Other prospects in the area have no mineral resource potential or the deposits are not sufficiently exposed to indicate a potential. Descriptions of these properties are summarized in table 3.

Money Creek area

Part of the Money Creek mining district described by Livingston (1971, p. 35) extends into the Money Creek area of the Alpine Lakes additions (fig. 2). The area has been prospected for gold, silver, copper, lead, zinc, and antimony since about 1892. Today much of the land along Money Creek and the drainages extending into the study area is held as mining claims. Patented mineral property inside the study area consists of about 40 acres (16 ha) on Kimball Creek.

Granodiorite of the Snoqualmie batholith, Tertiary volcanic rocks (mostly andesite breccia and andesite flows), and a small amount of pre-Cretaceous metamorphic rocks underlie the area.

Galena, sphalerite, chalcopyrite, stibnite, arsenopyrite, and pyrite associated with quartz, calcite and tourmaline occur in fissures and shear zones in all the rock types. Most of the major mineralized zones strike in a generally east-west direction (fig. 23). Country rock adjacent to the zones is only slightly altered and mineralized.

The Damon, Apex, and Great Republic properties adjacent to the study area have underground workings totaling 7,000 feet (2,134 m) and the mineralized structures explored by the underground workings extend into the study area. The Apex and Damon mines contain indicated paramarginal resources and submarginal resources occur at one other prospect in the study area.

Placer samples contained only trace amounts of valuable detrital minerals.

Damon mine

The Damon mine (Nos. 1-9, fig. 23) was opened in the 1890's and was worked intermittently until 1941 (Livingston, 1971, p. 147). The only production recorded is of test shipments in 1904 and 1940 which totaled 33 tons (30 t) of ore containing 21 ounces (653 g) gold, 207 ounces (6,438 g) silver, and 1,840 pounds (835 kg) lead. The principal workings are a 1,400-foot (427-m)-long crosscut adit and 730 feet (223 m) of drifts on two shear zones named the Damon and Priestly "veins".

Table 3.--Miscellaneous prospects and mineralized zones in the West Fork Miller River area

Map No. (fig. 17)	Prospect Name	Summary	Sample data
1	Unnamed	A 9.0-foot-wide (2.7 m) northwest-trending, steeply-dipping shear zone with three, 0.1-foot-wide (0.03 m) pyrite and arsenopyrite veins.	One chip sample across shear zone; 0.02 ounce gold per ton (0.7 g/t) and 0.2 ounce silver per ton (6.8 g/t).
2	do	A 1.0 foot (0.3 m) wide shear zone striking west and dipping 80° S.	One chip sample; 0.1 ounce silver per ton (3.4 g/t).
65	Francis Lake	A 2.0-foot-wide (0.6 m) iron-oxide-stained shear zone in granodiorite.	One chip sample; trace silver.
69	Magnetite prospect	A 15-foot-wide (4.6 m), northwest-trending zone with pods and lenses of magnetite.	One chip sample; 30 percent iron.
70	Unnamed	A 1.0 foot (0.3 m) wide highly altered shear zone in granodiorite.	One chip sample; no valuable metals detected.
71	do	A 7.0-foot-wide (2.1 m) northwest-trending shear zone containing quartz and less than 1 percent sulfide minerals.	One chip sample; trace gold and 0.1 ounce silver per ton (3.4 g/t).
72	do	A highly silicified shear zone with finely disseminated pyrite.	One chip sample; 0.2 ounce silver per ton (6.8 g/t).
73	do	A 5-foot-wide (1.5 m) fracture zone striking N. 35° W., dipping vertically.	One chip sample; no valuable metals detected.
107, 108	Unnamed	Two northwest-trending shear zones, 2.1 and 3.0 feet (0.6-0.9 m) wide containing less than 1 percent pyrite. One 10-foot-long (3 m) adit.	Two chip samples; as much as 0.05 ounce gold per ton (1.7 g/t), 0.2 ounce silver per ton (6.8 g/t), and 0.012 percent copper.
63, 64, 66 67, 68, 74 109, 133, 192	Placer prospects	Placer samples near bedrock exposures and favorable gravel deposits in West Fork of Miller River.	Nine pan samples; no recoverable gold. Four pan samples; 0.1 to 0.3 percent WO_3 in black sand concentrates.

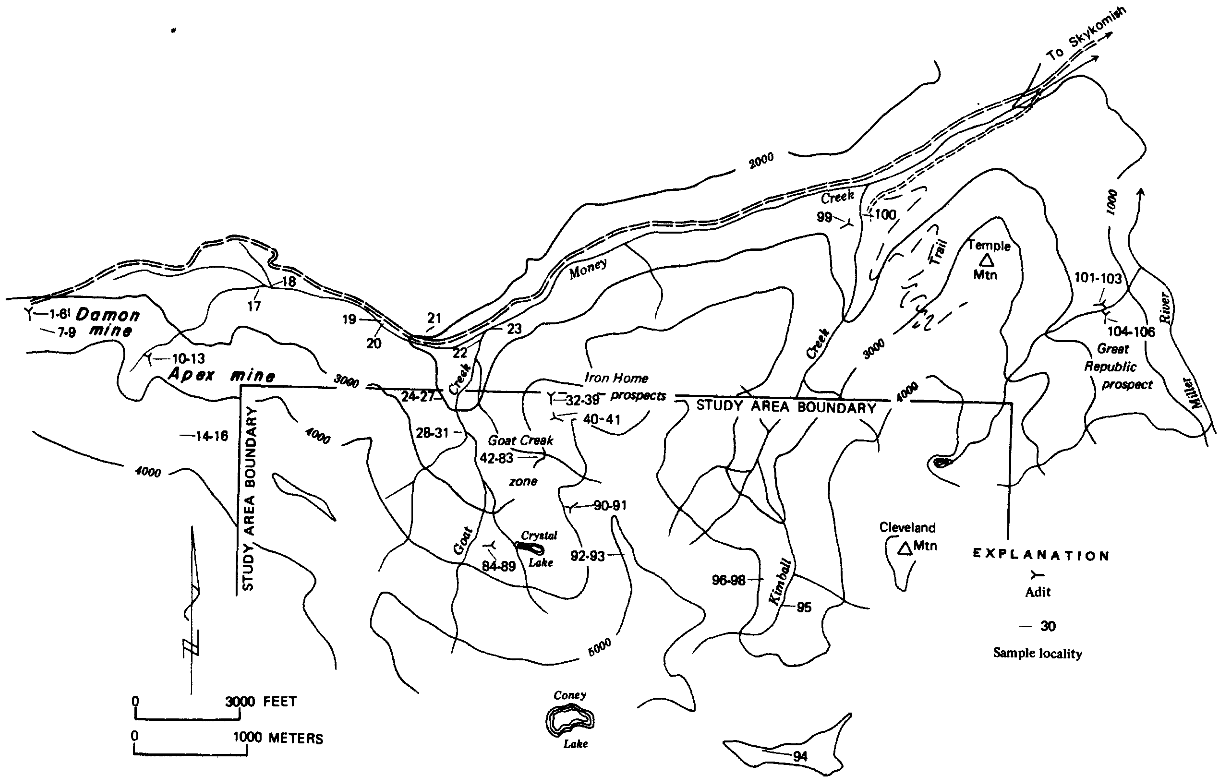


Figure 23.--Mines and prospects in the Money Creek area. Assay data for samples are given in detailed descriptions of prospects.

The crosscut adit was driven S. 15° E. in granodiorite and intersects three shear zones, all of which contain brecciated and leached diorite, white quartz, and metallic sulfide minerals (fig. 24). A minor poorly mineralized shear zone, 3.2 feet (0.98 m) wide, was crosscut 590 feet (180 m) from the portal but was not developed. The Damon "vein" (shear zone) strikes N. 80° to 85° W., dips 60° to 87° SW., and was crosscut at 920 feet (280 m). The zone ranges in wdith from 1 foot to 7 feet (0.3-2.1 m). The Priestly "vein" (shear zone) strikes N. 80° to 85° E., dips 55° to 75° SE., and was intersected at a point 1,400 feet (427 m) from the portal. The zone ranges in width from 1 foot to 4.4 feet (0.3-1.3 m).

Metallic sulfide minerals are disseminated in the quartz veins and diorite stringers within the shear zones. The minerals, in decreasing order of abundance, are arsenopyrite, pyrite, galena, sphalerite, chalcopyrite, and stibnite. The shear zones are highly altered in the underground workings and on the surface. Many of the original sulfide minerals have been oxidized or completely removed and some of the gangue minerals were altered to clay by ground-water leaching.

A summary of results that includes data from the current study, a previous Bureau of Mines investigation, a study by the State of Washington, (Livingston, 1971, p. 147). and an evaluation by a consulting engineer (J. Cashman, written commun., 1973), indicates paramarginal resources for the Damon and Priestly veins of about 340,000 tons (308,448 t) of rock with an estimated average grade of 0.16 ounce of gold per ton (4.98 g/t), 0.71 ounce of silver per ton (22.1 g/t), 0.11 percent copper, 0.93 percent lead, 0.35 percent zinc, 1.35 percent antimony, and 4.59 percent arsenic. The estimate is based on an average width of the shear zones of slightly more than 2 feet (0.62 m).

Exploration of the shear zones along the strike and at additional depths might substantially increase the potential resource.

<u>Apex mine</u>

The Apex mine was opened in 1892 by John Maloney (Livingston, 1971, p. 145). Development consists of more than 2,240 feet (683 m) of underground workings on four levels and stopes between the adit levels (fig. 25). Level 2 (fig. 25) is the only working presently open.

Total mine production is estimated to be approximately $300,000, mainly in gold values. The mine was closed by War Production Board Order L-208 in 1943 and operation was never resumed.

The adit levels drift on or intersect a persistent shear zone which strikes N. 70° to 80° E. and dips generally 60° SE. The zone includes quartz veins ranging in width from a few inches to over 6 feet (1.8 m) and averaging 1.2 feet (0.4 m). Arsenopyrite, pyrite, chalcopyrite, galena, and sphalerite occur in the shear zone, associated with quartz, tourmaline, and calcite. Fault gouge commonly occurs near the footwall in the shear zone.

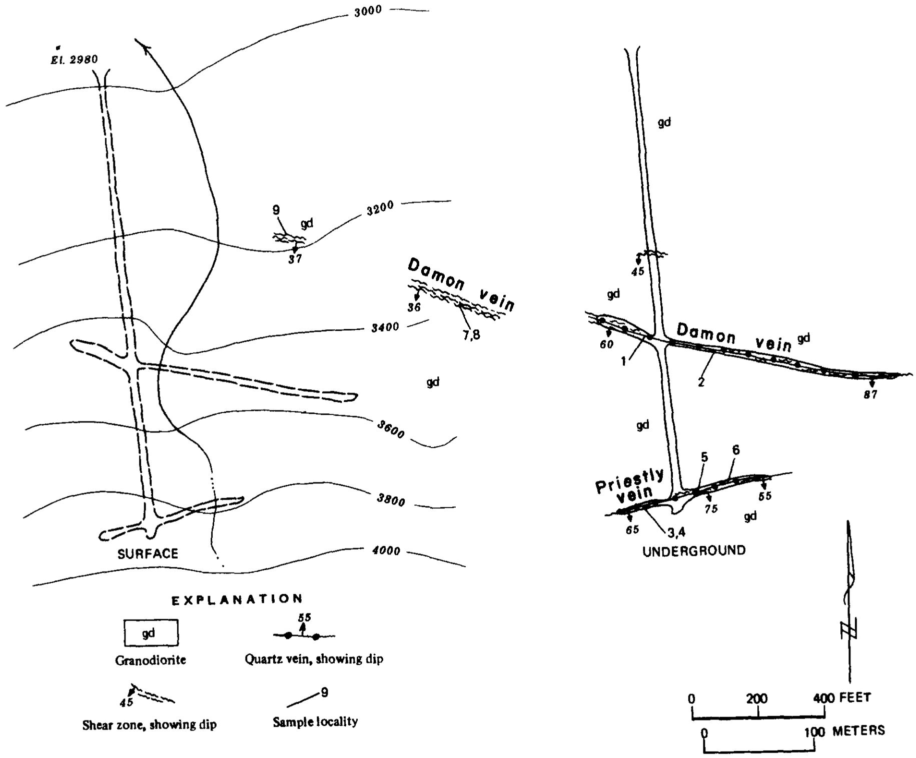


Figure 24.--Damon mine.

Data for samples shown on figure 24.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)
No.	Type	Length (feet)					
1	Chip--	1.8	0.55	0.8	0.08	0.62	0.33
2	do----	.8	.96	5.2	.077	.51	.53
3	do----	.4	N	.1	.036	.012	.009
4	do----	2.5	N	.2	--	.15	.1
5	do----	4.4	.02	.3	.057	.055	.068
6	do----	1.8	.08	.3	.03	.07	.55
7	do----	7.0	.95	11.9	.13	1.0	.2
8	do----	1.2	.19	1.6	.46	2.42	1.48
9	do----	3.0	Tr	.2	--	--	--

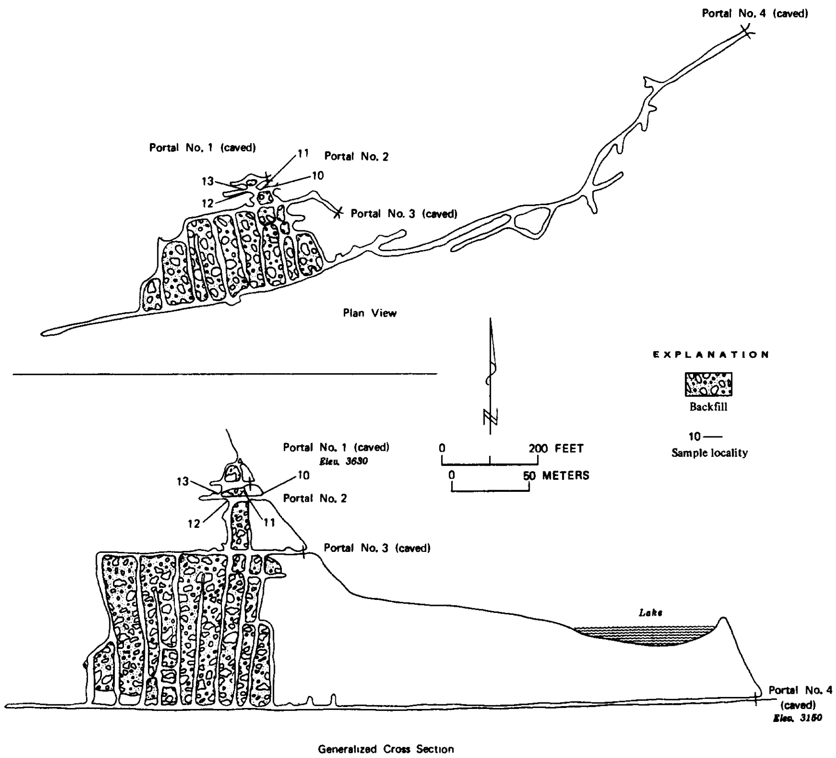


Figure 25.--Apex mine.

Data for samples shown on figure 25.

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

Sample No.	Sample Tyre	Sample Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)	Antimony (percent)	Arsenic (percent)
10	Chip--	1.2	0.19	2.8	--	--	--	--	--
11	do----	1.0	.23	.3	--	--	--	--	--
12	do----	3.1	.38	1.3	Tr	0.28	0.18	0.18	2.6
13	do----	1.4	.57	.5	--	--	--	--	--

The stoped areas extend approximately 400 feet (122 m) along the strike of the zone and over 500 feet (152 m) updip from level 4 (fig. 24), and reportedly are backfilled with low-grade ore (Livingston, 1971, p. 147 and Patty, 1921, p. 305). An estimated 20,000 tons (18,144 t) of rock containing between 0.14 and 0.50 ounce gold per ton (4.8-17.1 g/t), 0.27 ounces silver per ton (9.3 g/t), and 0.11 percent lead was used as backfill in these stopes.

Indicated resources of the Apex shear zone, based on results of the present investigation and previous studies by Livingston (1971) and W. K. Beach (written commun., 1972), are 133,000 tons averaging 1.0 ounce of gold per ton (34.3 g/t), 7.16 ounces of silver per ton (245.5 g/t), 0.16 percent copper, 0.25 percent lead, and 0.18 percent zinc. Samples from the shear zone and backfill contain up to 0.18 percent antimony and 2.6 percent arsenic.

Potential for finding additional resources along projections of the Apex shear zone is good.

Great Republic prospect

The Great Republic prospect is on the east slope of Temple Mountain. The country rock is andesite and argillite overlying granodiorite. Underground development totals 780 feet (238 m) of workings on two levels and in small stopes. The two adits are connected by a 65-foot (20-m)-long inclined raise (fig. 26).

The workings explore a 1.5- to 3.0-foot (0.5- to 0.9-m)-wide east-west-striking mineralized fault zone which dips 20° to 30° S. The zone is composed of iron-oxide- and antimony-oxide-stained fault gouge. The gouge contains lenses and fine-grained disseminations of stibnite and pyrite.

The most highly mineralized rock is found in the upper adit, where a pod of nearly solid stibnite 2.5 feet (0.8 m) thick and 4.0 feet (1.2 m) long occurs on the left wall near the portal. Thin lenses of stibnite remain on the walls of the four stopes. Beyond the stopes, the main vein ends at a narrow fault which strikes N. 70° W. and dips 45° SW. The narrow fault contains disseminated pyrite, stibnite, and thin lenses of arsenopyrite.

The mineralized fault zone in the lower adit contains scattered stibnite and pyrite. The wallrock is highly kaolinized and sericitized.

Minor antimony resources may exist along this fault zone.

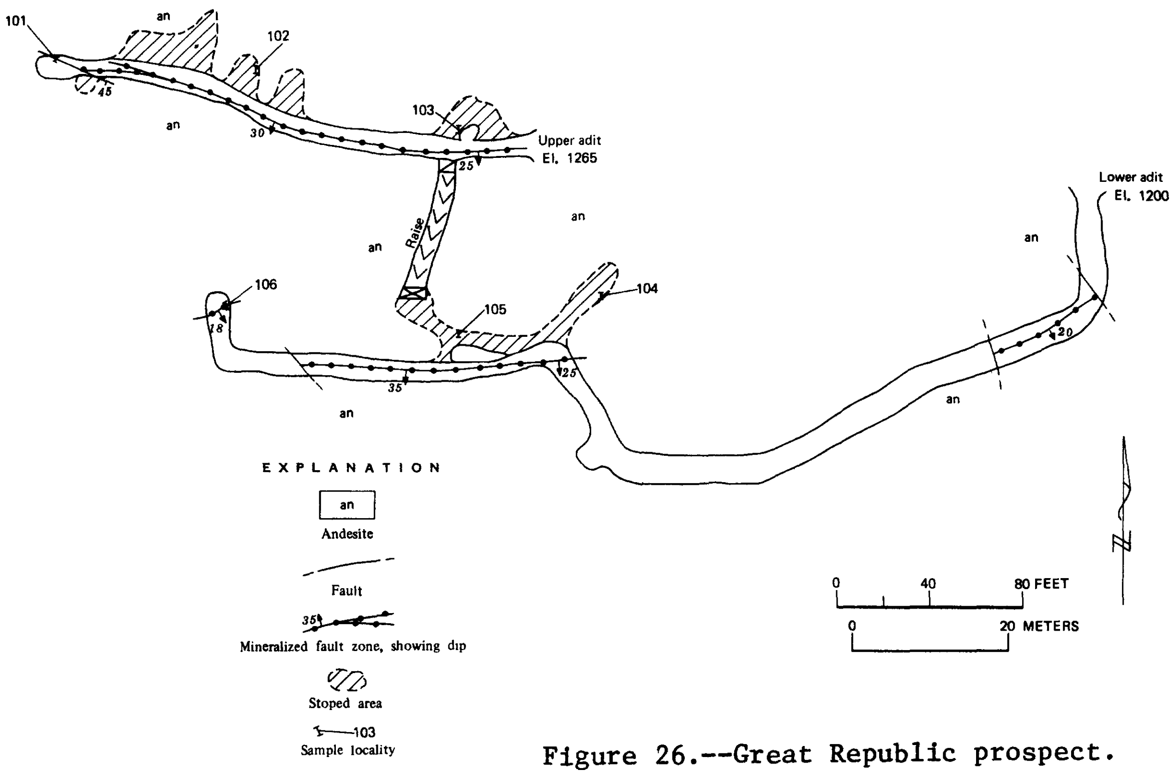


Figure 26.--Great Republic prospect.

Data for samples shown on figure 26.

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

Sample No.	Sample Type	Sample Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Antimony (percent)
101	Chip--	1.5	Tr	0.2	0.009	--
102	do----	2.0	N	Tr	.019	3.90
103	do----	2.5	0.04	.2	--	.04
104	do----	3.0	Tr	.1	.006	.04
105	do----	2.5	Tr	.1	.011	1.30
106	do----	1.5	N	N	.011	.03

Goat Creek shear zone

A sinuous 12- to 50-foot (3.7- to 15.2-m)-wide shear zone cuts granodiorite on the steep east side of Goat Creek (Nos. 42-83, fig. 27); it strikes generally N. 70° W. and dips 55° to 65° SW. The well-defined hanging wall is exposed for 1,100 linear feet (335 m). Overburden and talus cover obscure the footwall.

Most of the shear zone is composed of altered silicified granodiorite and quartz veins. Metallic sulfide minerals are disseminated in both the altered granodiorite and quartz; in descending order of abundance they are pyrite, arsenopyrite, galena, chalcopyrite, and sphalerite.

Samples of altered surface rocks from the fault zone contain low-grade gold, silver, copper, lead, and zinc values (fig. 27). Higher grade material may exist below the leached outcrops.

Miscellaneous prospects

Other prospects and mineralized zones existing in the Money Creek area have no potential or are not sufficiently exposed to determine their potential. Descriptions of these prospects are summarized in table 4.

Gallager Head Lake area

The Gallager Head Lake area is near the divide between De Roux Creek and the South Fork of Fortune Creek (fig. 28). The country rock is composed of peridotite and greenstone that are partially altered to serpentinite; remnants of felsite cap some of the ridge crests. Copper, and minor amounts of silver and nickel occur in shear zones in the rock. Prospect workings include six adits (five caved), four pits, nine trenches, and two shafts (fig. 28).

The shear zones in the area range in width from 3.0 to 13.0 feet (0.9-4.0 m) and are composed of compact schistose iron-oxide-stained material. Malachite and azurite occur on weathered surfaces of the peridotite and felsite. Chalcocite occurs in serpentinized rock in the unweathered parts of the shear zones. Quartz veinlets 0.25-0.50 inch (0.006-5 cm) wide occur in the serpentinized greenstone and felsite wallrock and as fracture fillings in the shear zones. No copper minerals were observed in the quartz veinlets.

An indicated paramarginal resource occurs in a shear zone at the west end of the mapped area (Nos. 1-4, fig. 28). This shear zone is explored by two prospect pits and a caved adit and is intermittently exposed for 925 feet (282 m). The zone averages 6.4 feet (1.95 m) wide and contains an estimated 227,000 tons (205,900 t) averaging 0.3 ounce silver per ton (10.3 g/t) and 2.23 percent copper.

Table 4.--Miscellaneous prospects and mineralized zones in the Money Creek area

Map No. (fig. 23)	Prospect name	Summary	Sample data
14-16	High Tariff	A 30- to 87-foot-wide (9.1-26.5 m), brecciated, iron-oxide stained zone in granodiorite contains pyrite and arsenopyrite.	Three chip samples across the zone; 0.1 to 0.2 ounce silver per ton (3.4-6.8 g/t), 0.01 percent copper, and trace amounts of lead, zinc, and molybdenum.
17 and 18	Money Creek placer	Stream gradient is 18 percent. Ninety percent of the deposit is composed of cobbles and boulders 6 inches (0.15 m) to 10 feet (3.1 m) in diameter.	Two pan samples; trace black sands.
19	Unnamed	A 10-foot-wide (3.0 m) shear zone occurs in iron-oxide stained quartzite. The shear strikes N. 80° E. and dips 65° SE. The zone contains disseminated pyrite and gangue minerals partially altered to clay.	One chip sample; 0.19 ounce gold (6.5 g/t) and 0.2 ounce silver per ton (6.8 g/t) across a width of 10 feet (3 m).
20	Money Creek placer	Pan sample from drainage into Money Creek. Stream gradient is 30 percent. The deposit is composed of angular rock fragments.	One pan sample; trace black sands.
21	Money Creek Road mine	A 2-foot-wide (0.6 m) iron-oxide stained, highly altered shear zone in argillite and quartzite. The zone strikes east-west, dips 45° S., and contains 10 to 20 percent disseminated pyrite and arsenopyrite.	One chip sample; 0.2 ounce silver per ton (6.8 g/t), 0.1 percent lead and 0.1 percent zinc.
22	Goat Creek placer	Stream gradient is 2 to 5 percent. More than 50 percent of the deposit is composed of boulders greater than 6 inches (0.15 m) in diameter.	One pan sample; trace black sands.
23	Money Creek placer	Stream gradient is less than 2 percent. The estimated thickness of gravel is 150 feet (45.7 m). Ninety percent of the gravel is greater than 6 inches (0.15 m) in diameter.	One pan sample; trace of black sand.
24-27	Unnamed	A shear zone 1 to 2 feet (0.3-0.6 m) wide is in granodiorite. It strikes east-west, dips south and is exposed for 200 feet (61 m). The zone is composed of highly altered granodiorite with 25-50 percent quartz and 5 percent pyrite.	Four chip samples and one grab sample; trace to 0.07 ounce gold per ton (2.4 g/t), 0.1 to 0.3 ounce silver per ton (3.4 to 10.3 g/t), and 0.02 to 0.12 percent copper.
28-31	Unnamed	A shear zone, 0.7 to 1.8 feet (0.2-0.6 m) wide occurs in granodiorite. The zone contains quartz stringers 1 to 2 inches (0.02-0.03 m) wide, about 1 percent disseminated pyrite. The zone is exposed for 300 feet (91m).	Four chip samples; two samples contained 0.1 ounce silver per ton (3.4 g/t); two samples contained no detectable valuable metals.
32-39	Iron Home No. 1	Mineralized fracture zones occur in argillite, quartzite, and shale. The zones are explored by 180 feet (55 m) of underground workings. The fracture zones range from 0.3 to 5.0 feet (0.1-1.5 m) wide. They are iron-oxide stained and contain as much as 50 percent quartz and 1 to 5 percent pryite, chalcopyrite, bornite, and galena.	Seven chip samples; trace to 0.2 ounce silver per ton (6.8 g/t), trace to 0.53 percent copper, trace lead, zinc, and antimony, and as much as 0.4 percent arsenic.
40 and 41	Iron Home No. 2	A 1.3-foot-wide (0.4 m) shear zone strikes N. 65° W., dips 60° NE., and occurs in granodiorite. It is explored by a 42-foot-long (12.8 m) adit. The zone contains quartz stringers 1 inch (0.02 m) wide and disseminated arsenopyrite, pyrite, and galena.	Two chip samples; 0.2 ounce silver per ton (6.8 g/t), 0.09 percent copper, and trace lead, zinc, and antimony.
84-89	Unnamed	A 0.3- to 0.5-foot-wide (0.08-0.15 m) shear zone occurs in granodiorite. It trends N. 80° E. and dips 55° SE. The zone is exposed for 35 feet (10.7 m) by an adit that is partially flooded.	Six chip samples; as much as 0.18 ounce gold per ton (6.2 g/t), trace to 1.6 ounce silver per ton (54.8 g/t), 0.01 to 0.14 percent copper, 0.01 to 1.41 percent lead, and 0.01 to 2.24 percent zinc.
90 and 91	Unnamed	A 10-foot-long (3.0 m) adit explores two parallel shear zones in granodiorite. The two zones are 0.3-foot (10.2 cm) and 1.5 to 5.0 feet (0.5-1.5 m) wide, trend N. 60° W., and dip 60° to 80° SW. The zones are composed of altered iron-oxide-stained granodiorite, minor arsenopyrite, and azurite, and about 5 percent pyrite.	Two chip samples; 0.1 ounce silver per ton (3.4 g/t), 0.11 percent copper, and less than 0.01 percent lead and antimony, and 0.01 percent zinc.
92 and 93	Unnamed	A shear zone in granodiorite trends east-west and dips 75° S. The zone is exposed for 100 feet (30.5 m). A 4-foot-wide (1.2 m) iron-oxide-stained, altered zone parallels the shear zone on the footwall side.	Two chip samples; as much as 0.02 ounce gold per ton (0.7 g/t), and 1.6 ounce silver per ton (54.9 g/t).
94	Unnamed	An iron-oxide stained fracture zone in granodiorite is 30 feet (9.1 m) wide, trends N. 70° W., and contains minor pyrite.	One chip sample; trace silver.
95	Unnamed	A 5.6-foot-wide (1.7 m) shear zone trends N. 10° W. and dips 75° NE. Pyrite occurs in 1 inch to 1 foot (2.5-30.5 cm) wide bands.	One chip sample; no valuable metals detected.
96-98	Unnamed	A 4.2-foot-wide (1.3 m) shear zone in granodiorite trends N. 75° W. and dips 75° SW. It contains disseminated pyrite and pyrite pods as much as 0.5-foot (0.2 m) in diameter.	Three chip samples; as much as 0.02 ounce gold per ton (0.7 g/t), 0.2 ounce silver per ton (6.8 g/t), and 0.02 percent lead.
99	Unnamed	A caved adit explored a highly altered zone in fractured granodiorite that contains about 5 percent disseminated pyrite.	One sample; no valuable metals detected.
100	Kimball Creek placer	Stream gradient is greater than 20 percent. Small gravel bars occur on the lee side of large boulders.	One pan sample; a trace of black sands.

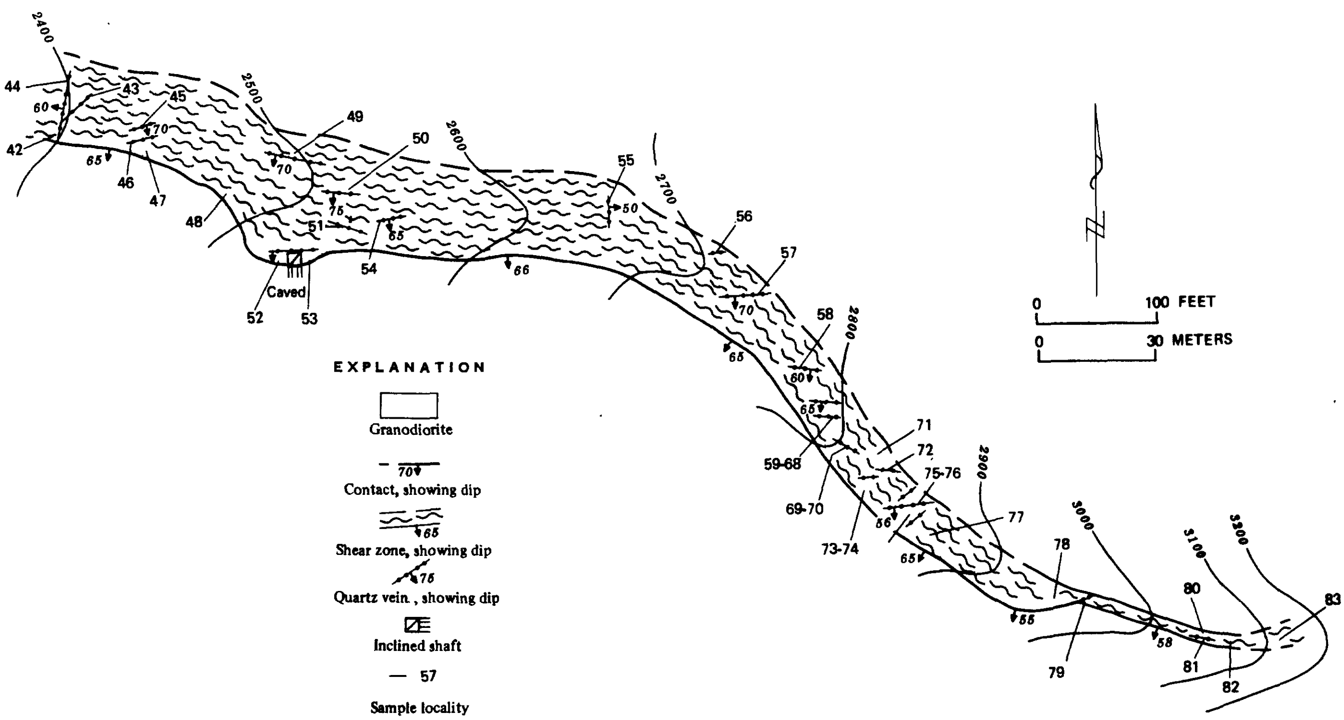


Figure 27.--Goat Creek shear zone.

Data for samples shown on figure 27.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)	Arsenic (percent)
No.	Type	Length (feet)						
42	Chip--	1.0	0.03	0.1	0.1	0.02	0.11	--
43	do----	.4	.05	.6	.02	.17	.05	--
44	do----	.8	N	.1	.01	Tr	Tr	--
45	do----	.5	N	.5	.03	.30	Tr	--
46	do----	1.8	.02	.5	.02	.13	.17	--
47	do----	11.7	.03	.2	--	--	--	0.2
48	do----	6.0	.03	.2	.01	.03	Tr	1.0
49	do----	1.0	.03	.4	--	--	--	1.0
50	do----	2.5	Tr	.2	.01	.02	.02	--
51	do----	1.0	Tr	.1	--	--	--	--
52	do----	2.8	.03	.3	.03	.03	.06	--
53	do----	2.5	N	N	.01	.06	.02	4.0
54	do----	1.7	.02	.4	--	.20	--	1.0
55	do----	9.0	Tr	.1	--	--	--	.2
56	do----	2.4	.02	.3	--	--	--	--
57	Chip--	0.5	.04	.3	--	--	--	.4
58	do----	3.0	.05	1.2	--	0.2	--	2.0
59	do----	3.8	.04	.2	0.02	.03	0.06	--
60	do----	2.4	.01	.2	Tr	Tr	.04	--
61	do----	.8	.06	.2	.02	.02	.05	--
62	do----	3.5	Tr	.1	--	--	--	.2
63	do----	14.0	Tr	.2	--	--	--	.4
64	do----	5.0	.02	.1	.02	.01	.04	--
65	do----	3.5	Tr	Tr	--	--	--	1.0
66	do----	.3	N	N	--	.3	--	2.0
67	do----	.3	Tr	.1	--	.2	--	.2
68	do----	.3	N	Tr	.01	Tr	.01	--
69	do----	2.5	Tr	.1	.02	.05	.06	--
70	do----	2.5	.01	.2	.02	.08	.16	.11
71	do----	3.0	N	N	.029	.022	.023	2.4
72	do----	2.0	Tr	.2	.01	<.01	.009	.11
73	do----	.3	N	.2	.041	.79	.035	--
74	do----	1.0	N	.1	.021	.018	.051	--
75	Chip--	23.0	N	.1	.018	.015	.024	.62
76	do----	.3	Tr	.2	.07	1.41	2.24	2.5
77	do----	18.0	Tr	.3	--	--	--	--
78	do----	5.5	N	Tr	--	--	--	--
79	do----	.5	0.18	.7	.059	.12	.014	--
80	do----	4.0	Tr	.8	.14	.025	.038	2.1
81	do----	.5	.07	.1	.055	.022	.003	--
82	do----	12.2	Tr	.2	.024	.038	.094	--
83	do----	6.0	.08	1.6	--	1.0	1.0	4.0

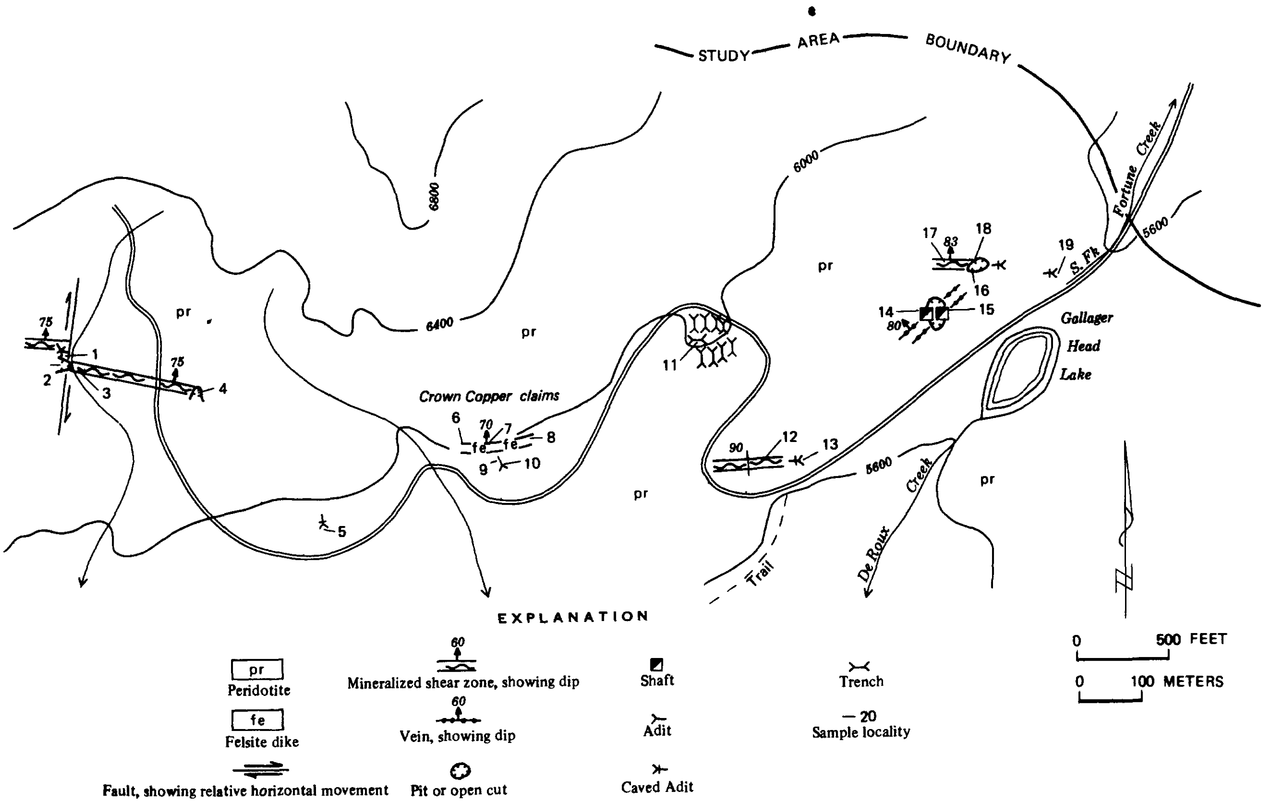


Figure 28.--Prospects in the Gallager Head Lake area.

Data for samples shown on figure 28.

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

Sample No.	Type	Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Nickel (percent)
1	Chip--	10.0	N	0.3	0.63	--
2	do----	10.0	Tr	.4	1.84	--
3	do----	2.5	Tr	.1	7.94	--
4	do----	3.0	Tr	.1	4.08	--
5	Grab--	--	Tr	.4	Tr	--
6	Chip--	13.0	N	.2	Tr	--
7	do----	13.0	N	Tr	Tr	--
8	do----	10.0	Tr	.3	.003	0.19
9	do----	34.0	N	.2	.001	.20
10	do----	64.0	Tr	.3	.003	.14
11	do----	15.0	N	.1	.002	.20
12	do----	12.0	N	N	.002	.21
13	Grab--	--	N	.1	1.39	.18
14	Chip--	3.0	--	--	.003	.13
15	do----	5.0	N	.1	.13	.19
16	do----	8.0	N	.1	.63	.49
17	do----	6.0	N	.1	.012	.12
18	do----	1.0	N	Tr	.14	.14
19	Grab--	--	N	.2	1.01	.074

Samples from two other shear zones (Nos. 12, 13, and 16-19, fig. 28) indicate additional submarginal resources. The zones are exposed for 550 and 500 feet (168 and 152 m) and average 12 and 5 feet (3.7 and 1.5 m) wide, respectively. Weathered and leached outcrops contain only minor copper values; however, unweathered material from prospect dumps contains 1 percent or more copper. The inferred combined submarginal resource of the two zones is about 200,000 tons (181,440 t). Samples taken from the leached outcrops of these two zones average 0.24 percent nickel, 0.1 percent copper, and 0.02 ounce of silver per ton (0.7 g/t).

Exploration of the shear zones in the Gallager Head Lake area and their extensions along the southern belt of peridotite might substantially increase the resource potential.

Huckleberry Mountain area

The area is on the west slope of Huckleberry Mountain, between Fortune Creek and Boulder Creek (fig. 29). Greenstone and peridotite intruded by granodiorite underlie most of the area. A roof pendant of bedded silicified volcanic breccia underlies the White Cat prospect (Nos. 19-27, fig. 29).

Prospect workings are concentrated along or near the contact between granodiorite and peridotite and along shear zones in the peridotite and volcanic breccia. Gold, silver, and copper occur in the area but surface exposures in most areas are too sparse to accurately determine the extent of resources.

White Cat prospect

The White Cat prospect is north of Camp Creek near the Cle Elum River road (fig. 29). A total of about 15.5 tons (14 t) of silver-gold ore was shipped from the property in 1929 and in 1956 (U.S. Bureau of Mines, written commun., undated).

Three adits were driven along northwest- to northeast-trending steeply dipping shear zones that cut silicified extrusive rocks containing calcite stringers (Nos. 11-27, fig. 30). Pyrite, arsenopyrite, galena, sphalerite, and chalcopyrite occur in the shear zones as lenses and pods, and in fine-grained disseminations. Quartz and calcite are common gangue minerals.

Adit 1 intersects 1- to 1.5-foot (0.3- to 0.5-m)-wide shear zones that contain randomly distributed lenses of sulfide minerals. Adit 2 intersects a 4.5- to 6.0-foot (1.4- to 1.8-m)-wide sulfide-bearing shear zone that strikes N. 55° W. and dips 35° to 45° SW. A 20-foot (6.1-m)-high stope 95 feet (29 m) from the portal of adit 2 was driven updip. Adit 3 follows a 3.0- to 3.5-foot (0.9- to 1.1-m)-wide shear zone that strikes N. 30° to 45° W. and dips 50° to 67° SW. The zone contains from 5 to 20 percent sulfide minerals in lenses and pods.

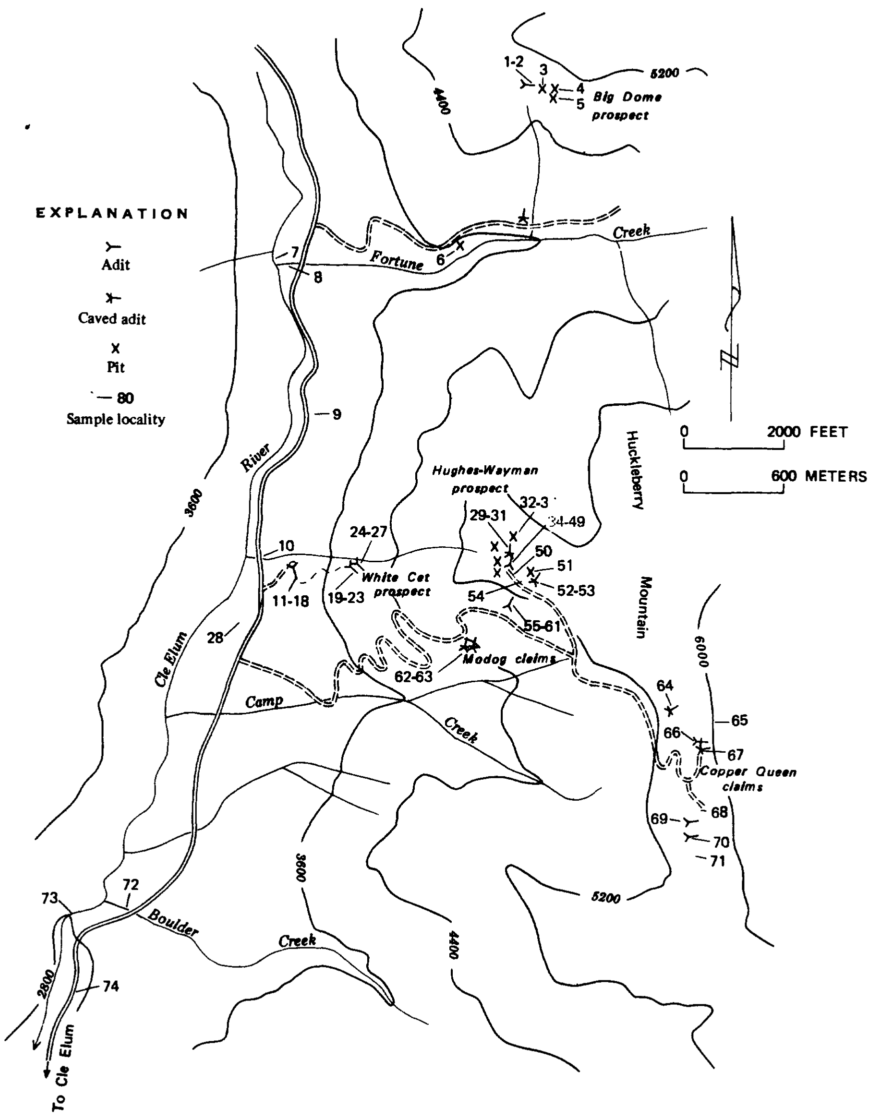


Figure 29.--Prospects in the Huckleberry Mountain area. Assay data for samples are given in detailed descriptions of the prospects.

The mineralized shear zone explored by adits 2 and 3 has an indicated submarginal resource of about 15,000 tons (13,600 t) averaging about 2.63 ounces of silver per ton (90.1 g/t), 0.07 percent copper, 0.34 percent lead, and 0.30 percent zinc.

Hughes-Wayman prospect

The Hughes-Wayman prospect (Nos. 29-61, fig. 29) is underlain by peridotite which is intruded by granitic rock. The country rock is cut by northwest- to west-trending steeply dipping shear zones that range in width from 1 to 12 feet (0.3-3.7 m) and by less well developed vertically dipping northeast-trending shear zones and quartz-filled fractures. The shear zones contain pyrite and chalcopyrite in association with quartz and gouge.

Development consists of two open adits, two caved adits, and five prospect pits (fig. 31). Adit 1 cuts 64 feet (19.5 m) of intensely silicified granitic rock containing disseminated sulfide minerals; a 3.5- to 4.0-foot (1.1- to 1.2-m)-wide highly altered shear zone and intersects three 3- to 7-feet (0.9- to 2.1-m)-wide shear zones.

Adit 2 follows a 0.5- to 1.5-foot (0.15- to 0.46-m)-wide quartz vein containing scattered pyrite crystals. The adit crosscuts four north- to northwest-trending steeply dipping fault zones that are 1.0-3.5 feet (0.3-1.1 m) wide and contain disseminated pyrite, arsenopyrite, chalcopyrite, quartz, and gouge.

North and west of adit 1, northwest-trending steeply dipping highly altered shear zones are exposed in prospect pits and on the surface. They contain pyrite, arsenopyrite, chalcopyrite, quartz, and clay. Malachite coats some rocks in the zones.

The principal shear zone averages 5.8 feet (1.8 m) wide and is traceable for a total of more than 350 feet (107 m) on the surface, in adit 1, and in prospect pits (Nos. 32, 33, 40, 41, 42, 51, and 53, fig. 31). This zone is estimated to have a resource of more than 30,000 tons (27,216 t) averaging 0.12 ounce of gold per ton (4.1 g/t), 0.27 ounce of silver per ton (9.3 g/t), and 0.34 percent copper. The deposit has potential for the discovery of additional resources.

Copper Queen claims

The Copper Queen claims are on the west slope of Huckleberry Mountain near the head of Camp Creek (Nos. 64-71, fig. 29). Country rock in the area of the claims is sheared peridotite that has been intruded by an elongate granitic body (fig. 32).

The granitic intrusion trends north, is 20 to 80 feet (6-24 m) wide, and is exposed for 600 feet (183 m). It is traceable for another 800 feet (244 m) by following float. The intrusive rock is intensely silicified, stained by iron oxide, and contains narrow veins and pods of quartz and disseminated pyrite and chalcopyrite.

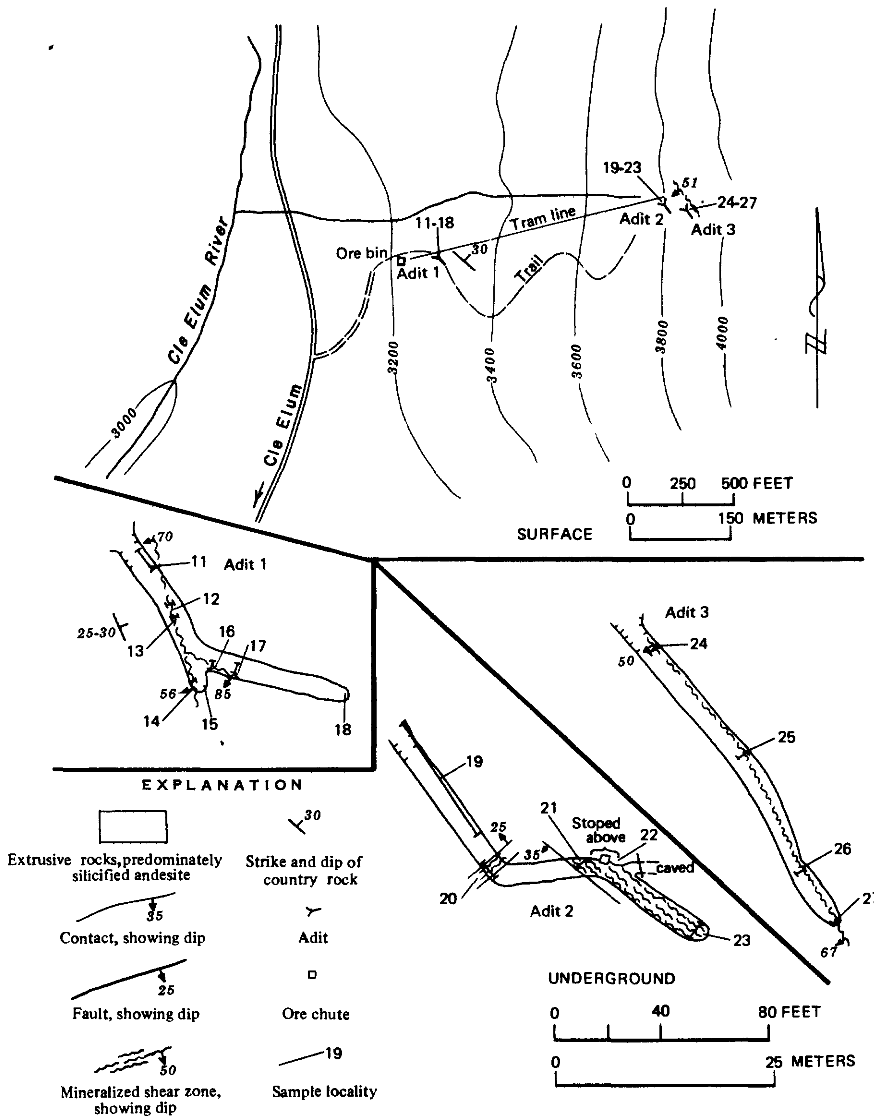


Figure 30.--White Cat prospect.

Data for samples shown on figure 30.

[Tr, trace: N, none detected; --, not analyzed; < , less than shown]

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)
No.	Type	Length (feet)					
11	Chip--	13.0	N	0.3	0.014	<0.01	--
12	do----	.5	0.01	2.2	.12	.22	--
13	do----	1.4	.01	.5	.057	.10	0.12
14	do----	1.1	Tr	.3	.06	--	--
15	do----	3.0	N	.3	.028	.032	--
16	do----	1.5	N	.1	--	--	--
17	do----	5.0	N	.2	--	--	--
18	do----	5.0	Tr	N	--	--	--
19	do----	52.0	N	N	.009	< .01	.008
20	do----	5.0	N	Tr	--	--	--
21	do----	4.5	Tr	9.6	.13	1.	.5
22	do----	4.5	.01	1.5	.037	.052	.15
23	do----	6.0	N	Tr	.004	< .01	.009
24	do----	3.0	.01	.3	.13	.15	.18
25	do----	3.5	Tr	1.5	.05	.87	.27
26	do----	3.0	Tr	2.7	.068	.032	.93
27	do----	3.5	.01	2.7	.14	.33	.35

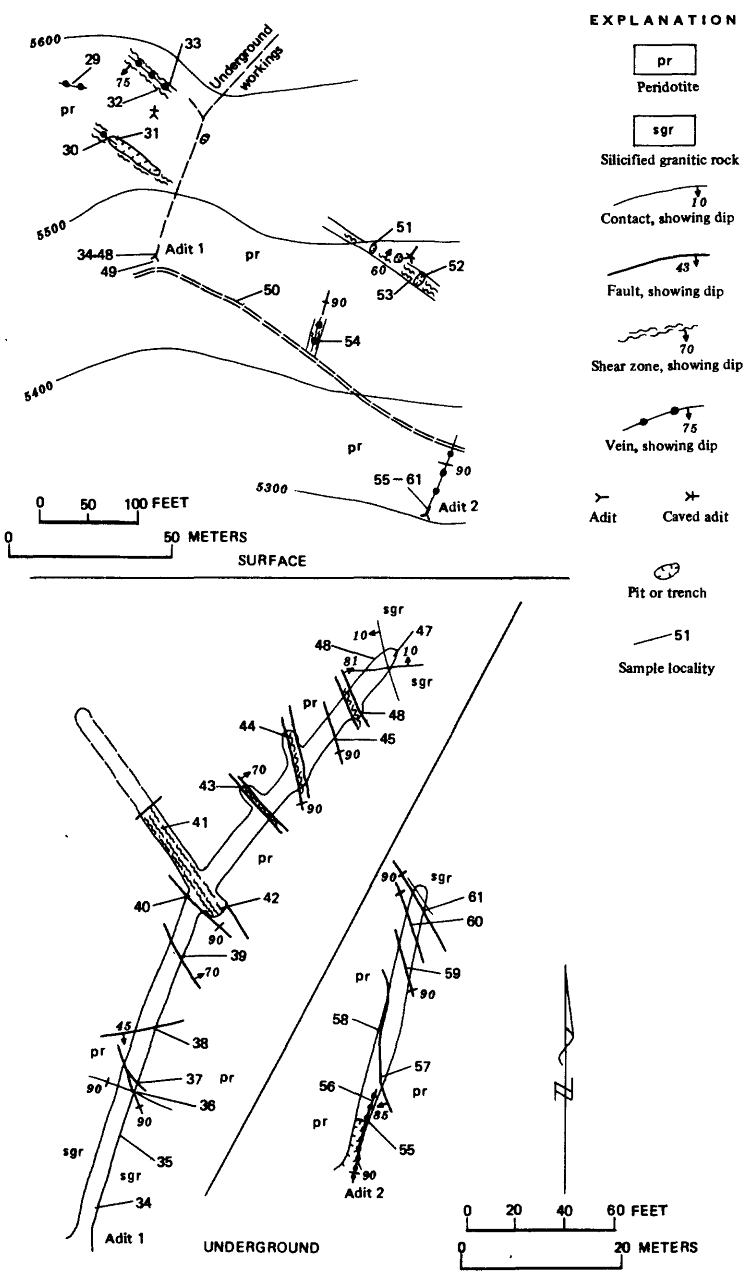


Figure 31.--Hughes-Wayman prospect.

Data for samples shown on figure 31.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
No.	Type	Length (feet)			
29	Chip--	4.0	N	0.1	--
30	do----	6.0	Tr	.2	0.047
31	do----	6.0	0.01	.2	.15
32	do----	6.5	Tr	.4	.16
33	do----	6.0	Tr	.1	.22
34	do----	32.0	N	.2	.016
35	do----	32.0	N	.1	.012
36	do----	1.0	N	.1	.13
37	do----	3.5	.13	.1	.11
38	do----	2.5	Tr	[illegible]	.064
39	do----	1.0	Tr	.2	.052
40	do----	1.0	.47	.3	.019
41	do----	3.5	N	N	.08
42	do----	4.0	N	.1	.13
43	do----	3.0	Tr	.2	.21
44	do----	4.0	.01	.2	.068
45	do----	3.0	N	N	.044
46	do----	7.0	Tr	.5	.13
47	do----	3.0	N	Tr	.028
48	do----	1.0	N	Tr	--
49	Grab--	--	.87	1.4	1.31
50	Chip--	6.0	N	0.1	--
51	do----	7.0	0.01	.8	0.31
52	do----	12.0	N	N	.068
53	do----	6.0	Tr	.5	.38
54	do----	1.0	N	.1	--
55	do----	1.5	N	N	.013
56	do----	1.4	Tr	.1	.01
57	do----	3.5	Tr	.1	.018
58	do----	3.0	Tr	.1	.085
59	do----	1.5	N	.1	.015
60	do----	1.0	Tr	.3	.24
61	do----	2.0	.01	.4	.44

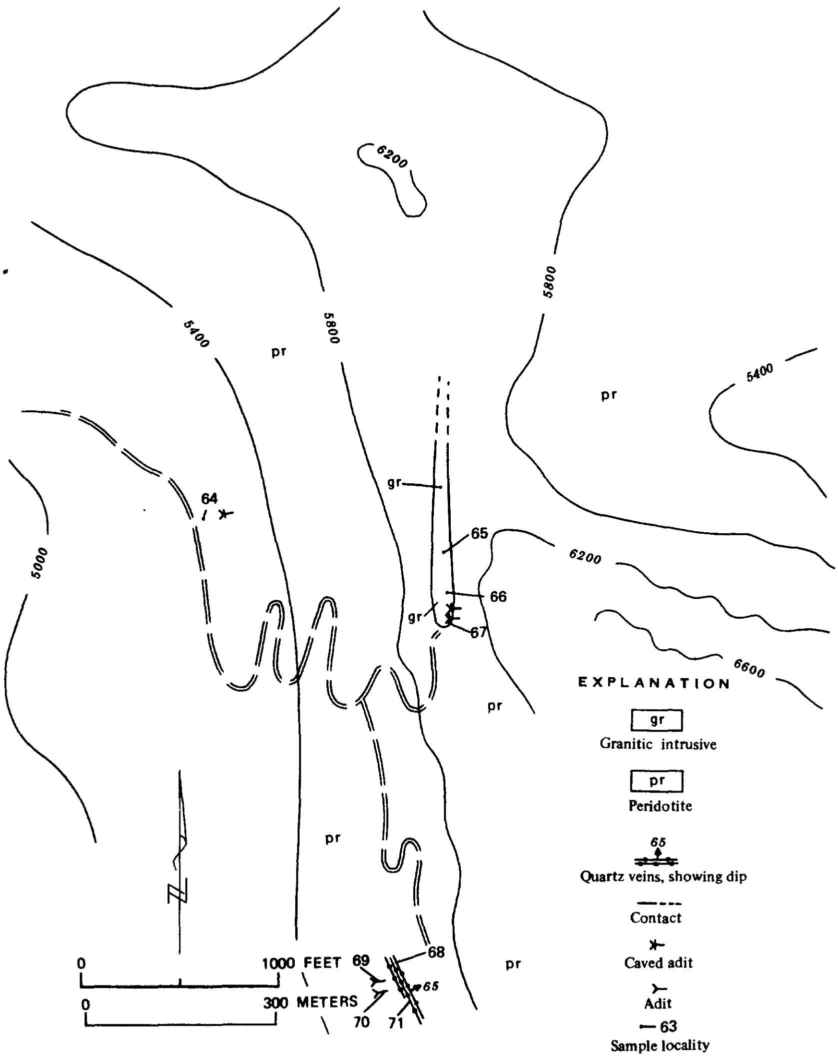


Figure 32.--Copper Queen claims.

Data for samples shown on figure 32.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
No.	Type	Length (feet)			
64	Grab--	--	N	0.2	--
65	Chip--	35.0	Tr	Tr	0.057
66	do----	60.0	0.01	.7	.016
67	do----	20.0	.30	N	.041
68	do----	4.0	N	.3	--
69	do----	3.0	Tr	.1	2.96
70	do----	12.0	N	N	.86
71	do----	20.0	Tr	Tr	.03

Two adits, 10 and 20 feet (3 and 6 m) long, crosscut the upper part of the intrusive. A caved adit (No. 64, fig. 32), estimated to be more than 300 feet (91 m) long, probably marks an attempt to crosscut the granite at depth.

Two adits, 34 and 60 feet (10 and 18 m) long, crosscut an intensely altered shear zone in peridotite (Nos. 68-71, fig. 32). The shear zone is as much as 20 feet (6.1 m) wide and is exposed for 260 feet (79 m). Peridotite near the shear zone is partly altered to serpentinite; it is siliceous, iron-oxide-stained, and contains pods and stringers of calcite and narrow quartz veins. Finely disseiminated pyrite and chalcopyrite occur in the serpentinized peridotite and quartz. The exposed surfaces and joints contain crusts and scales of malachite and azurite.

A minor gold and copper resource is believed to occur at the Copper Queen prospect, but the mineralized areas are not sufficiently exposed to allow calculation of tonnage and grade. Exploration of the granitic intrusive (Nos. 65-67, fig. 32) and the quartz-filled shear zones (Nos. 68-71, fig. 32) may delineate other resources, especially in the area of sample 67.

Miscellaneous prospects

Other prospects and mineralized zones in the Huckleberry Mountain area are summarized in table 5.

Cougar Creek area

Several prospects are along Cougar Creek and on Dog and Goat Mountains in the Cougar Creek area (fig. 33). Granodiorite and steeply dipping mineralized shear zones crop out in the area. Quartz, mica, talc, tourmaline, pyrite, arsenopyrite, chalcopyrite, galena, sphalerite, and molybdenite are the principal minerals in the mineralized zones. Gold and scheelite are minor constituents. Most of the sulfide minerals are confined to or are near altered zones and joints.

Jack Pot prospect

The Jack Pot workings (fig. 34) are probably along sheared altered echelon zones which strike N. 60° to 70° W. and dip nearly vertical. The width of most zones is 1.5-5 feet (0.5-1.5 m). One zone, however, is at least 200 feet (61.0 m) wide. The most abundant sulfide mineral is arsenopyrite; pyrite is the next most abundant. The matrix is mostly quartz and mica.

Overburden obscures the width and length of the shear zone system but some individual zones are, however, traceable. Narrow shear zones were traced over a strike length of approximately 2,000 feet (610 m) (Nos. 58-87, fig. 33). The zones are intensely altered and sulfide rich. The two largest are lenticular and about 140 feet (43 m) apart, and crop out along the creek for at least 240 feet (73 m). These two zones average

Table 5.--Miscellaneous prospects and mineralized zones in the Huckleberry Mountain area.

Map No. (fig. 29)	Prospect name	Summary	Sample Data
1-5	Big Dome	Pits, trenches, and one 30-foot-long (9.1 m) adit explore granitic porphyry that intrudes peridotite. Chalcopyrite is disseminated in granitic rock near contact and in joints.	Five chip samples; 0.1 to 0.3 ounce silver per ton (3.4-10.3 g/t), as much as 0.64 percent copper, 0.02 to 0.04 percent tungsten, and traces of gold, lead, and zinc.
6	Unnamed	One pit explores a 0.3-foot-wide (0.09 m) quartz vein at a peridotite-granodiorite contact.	One chip sample; 0.01 percent copper, trace silver, lead, and zinc.
7-10, 28	Fortune Creek, Camp Creek and vicinity placers	Small deposits of stream gravel.	Five pan samples; minor black sand, trace scheelite and no gold.
62 and 63	Modog	Two caved adits explore on a 0.5-foot-wide (0.15 m) quartz vein in peridotite near a diorite contact. The contact zone contains chalcopyrite and malachite in quartz veinlets.	One chip sample across quartz vein; 0.98 ounce gold per ton (33.6 g/t), 0.4 ounce silver per ton (13.7 g/t), and 0.5 percent copper. One grab sample of peridotite; trace gold, 0.1 ounce silver per ton (3.4 g/t).
72-74	Boulder Creek, Little Boulder Creek and Cle Elum River placers	Small deposits of stream gravel.	Three pan samples; very little black sand, no gold.

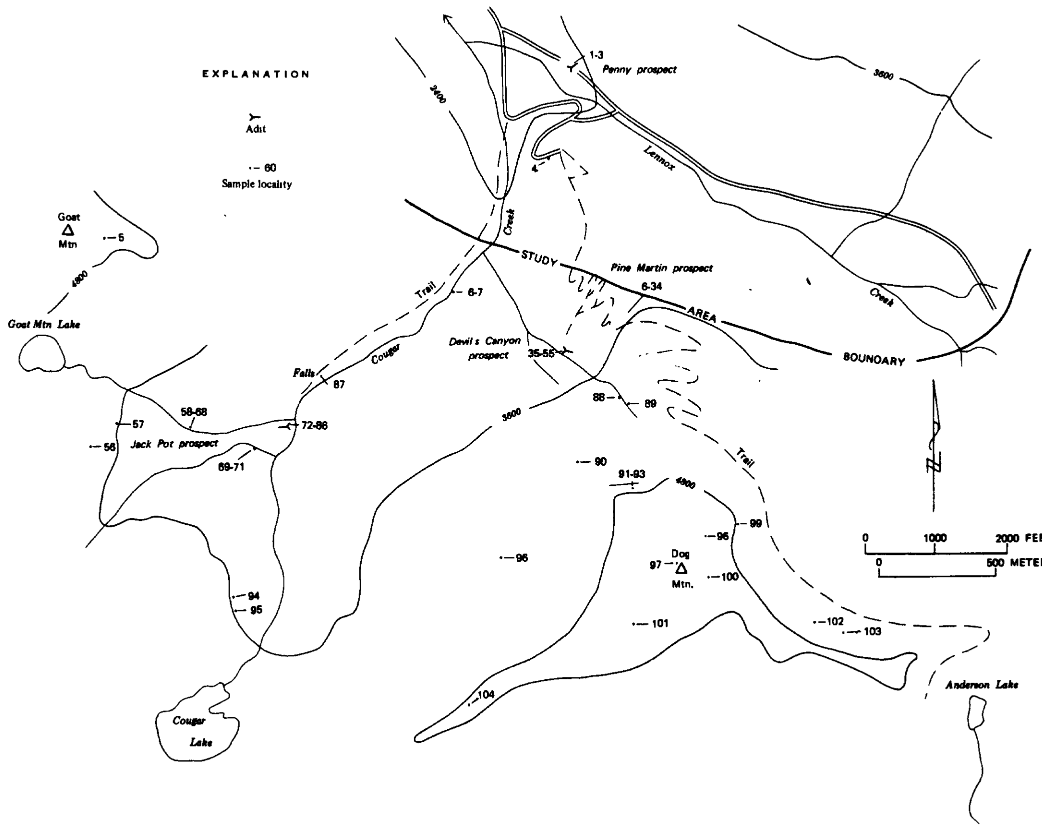


Figure 33.--Prospects in the Cougar Creek area. Assay data for samples are given in detailed descriptions of prospects.

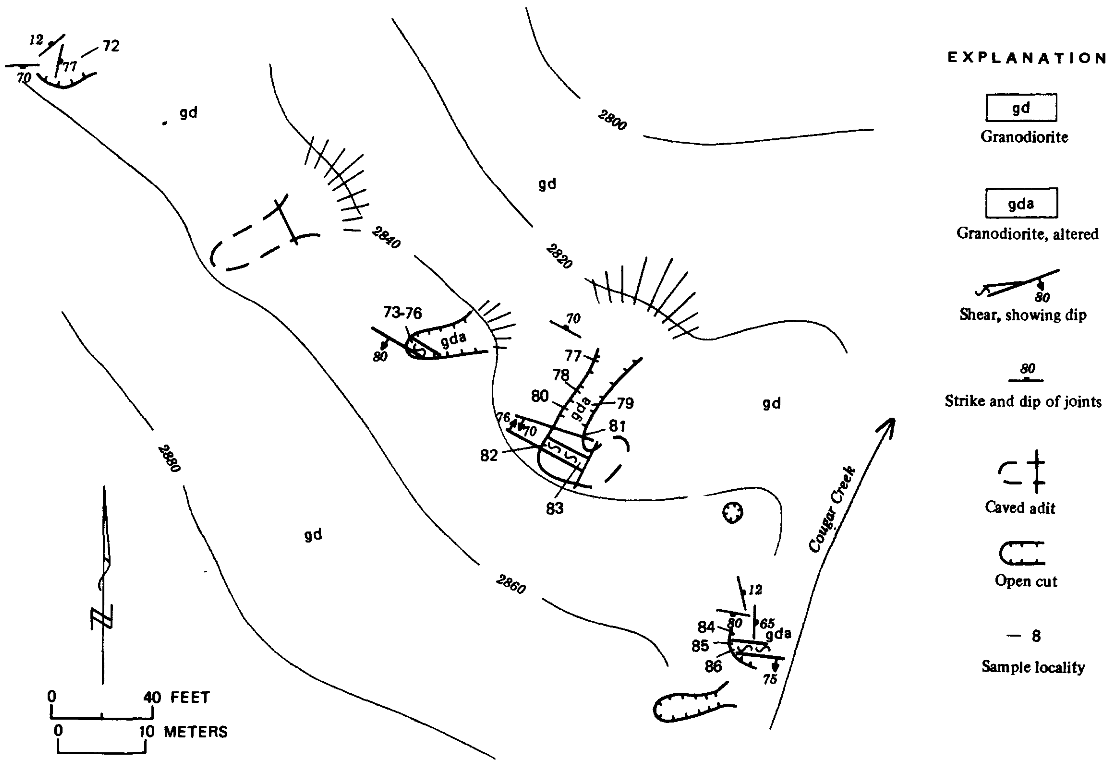


Figure 34.--Jack Pot prospect.

Data for samples shown on figure 34.

[Tr, trace; N, none detected; --, not anlayzed; <, less than shown]

Sample No.	Sample Type	Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)	Molybdenum (percent)
72	Chip--	20.0	Tr	Tr	0.01	0.01	0.005	< 0.006
73	do----	1.0	N	N	.072	< .01	.005	< .006
74	do----	4.0	Tr	0.2	.02	< .01	.015	< .006
75	do----	1.5	N	N	.006	.022	.003	< .006
76	do----	3.0	N	1.02	.95	--	--	.04
77	do----	8.0	N	N	.02	< .01	.007	< .006
78	do----	25.0	N	N	.065	< .01	.053	.071
79	do----	1.0	N	N	.005	< .01	.005	< .006
80	do----	9.0	N	N	.08	--	--	.09
81	do----	.7	Tr	.3	.41	< .01	.006	.049
82	do----	3.8	N	N	.032	< .01	.017	< .006
83	do----	2.0	N	.28	.10	--	--	.04
84	do----	8.0	Tr	Tr	.032	< .01	.013	--
85	do----	4.6	N	N	.24	< .01	.021	< .006
86	do----	4.0	N	.46	.34	--	--	.19

about 2 feet (0.6 m) wide, strike N. 65° to 70° W., and dip 40° SW. and 82° SW. Their total content of sulfide minerals may be as much as 30 percent, of which pyrite and arsenopyrite constitute more than 95 percent. Chip samples (Nos. 56, 58-86) contain as much as 1.02 ounces of silver per ton (35.0 g/t) and 0.95 percent copper. The average content of the samples, however, is no gold, 0.1 ounce of silver per ton (3.4 g/t), 0.06 percent copper, 0.01 percent lead, 0.02 percent zinc, and 0.04 percent molybdenum.

The 200-foot (61.0-m)-wide shear zone strikes N. 10° W. to N. 20° W. and dips 70° to 90° NE. Overburden obscures the lateral extent. Most of the exposed part of the zone is altered granodiorite with sulfide-rich segments averaging 0.1-1.0 feet (0.03-0.3 m) wide and about 2-20 feet (0.6-6.1 m) apart. A 100-foot (30.5-m)-long chip sample (No. 57, fig. 33) taken across the exposure contained no gold, no silver, and only 0.009 percent copper. Leaching by surface weathering may have decreased the metal content of the sample.

Devils Canyon extension prospect

A possible extension of the Devils Canyon shear zone is exposed on the bank of Cougar Creek (Nos. 6 and 7, fig. 33). The shear zone is approximately 20 feet (6.1 m) wide and is mostly composed of shattered iron-oxide-stained granodiorite with sulfide stringers. One select sample of mineralized rock contains 2.64 percent copper, 1.4 ounces of silver per ton (48.0 g/t), and a trace of gold. A chip sample (No. 6, fig. 33) across an 18-foot (5.5-m)-wide section of the shear zone contains 0.23 percent copper, 0.2 ounce of silver per ton (6.8 g/t), and a trace of gold.

Deep overburden along the projected strike of the shear zone northwest and southeast of the creek obscures possible extensions in the vicinity. The deposit, however, may have potential for discovery of resources.

Samples 88 and 89 (fig. 33) were taken near the southeast limit of the exposure of Devils Canyon shear zone. Both contained only a trace of gold and silver and a maximum of 0.02 percent copper.

Pine Marten prospect

The prospect is at the north end of Dog Mountain (fig. 35) on an outcrop of granodiorite containing disseminated sulfide minerals. Only one very short adit was driven on the prospect, but the outcrop is exposed over a distance of approximately 320 feet (98 m) in an east-west direction. The exposure ranges in width from about 15 to 160 feet (4.6-48.8 m). To the north, south, and east the granodiorite is covered by talus.

Pyrite, chalcopyrite, and molybdenite are scattered throughout the granodiorite in irregular masses as much as 5 mm across and are concentrated along or near fractures in the granodiorite. Total sulfide mineral content is probably less than 2 percent of the rock but locally may exceed 10 percent. Pyrite is commonly the most abundant sulfide mineral but, in places,

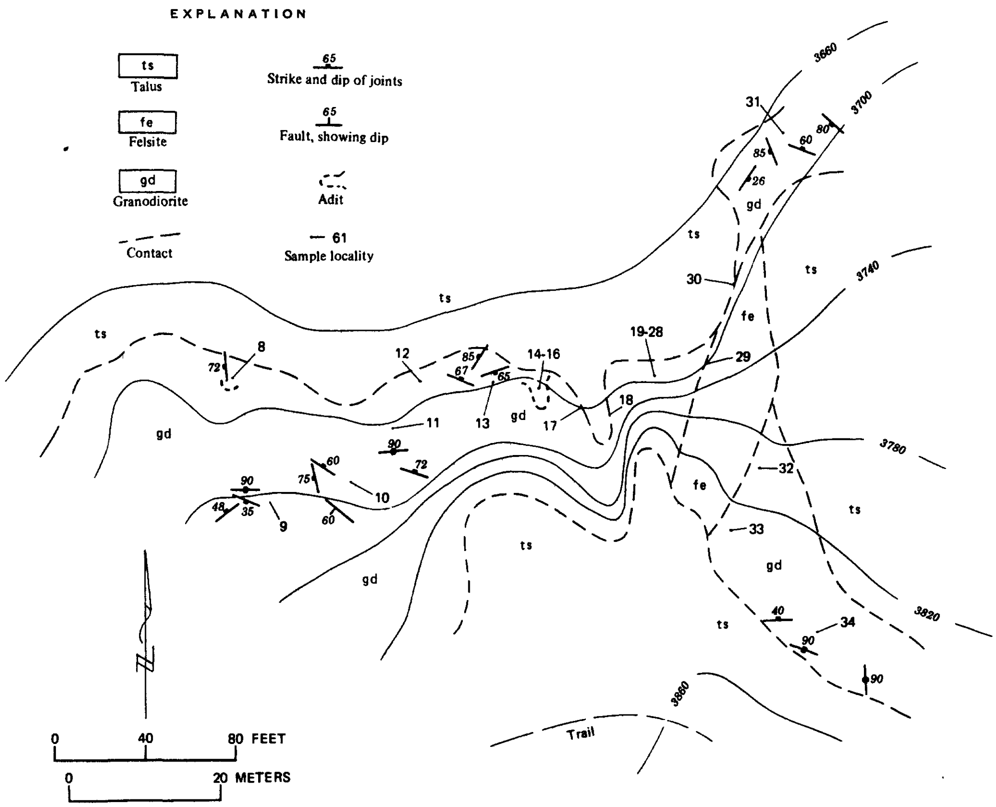


Figure 35.--Pine Marten prospect.

Data for samples shown on figure 35.

[Tr, trace; N, none detected; --, not analyzed; < , less than shown]

Sample No.	Sample Type	Sample Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Molybdenum (percent)
8	Chip--	10.0	N	N	0.08	< 0.01
9	do----	55.0	N	N	.12	< .01
10	do----	20.0	N	N	.19	.02
11	do----	32.0	N	N	.11	.02
12	do----	31.0	Tr	Tr	.1	< .01
13	do----	44.0	N	N	.20	.01
14	do----	8.0	N	N	.12	.02
15	Grab--	--	Tr	0.1	1.98	.04
16	Chip--	4.0	Tr	.1	.35	.02
17	do----	34.0	Tr	Tr	.12	.02
18	do----	23.0	Tr	Tr	.14	.02
19	do----	16.0	Tr	Tr	.24	.02
20	do----	5.0	Tr	.3	.43	< .02
21	Grab--	--	Tr	.4	.50	.30
22	Chip--	10.0	Tr	.3	.58	< .02
23	do----	10.0	Tr	.2	.72	< .02
24	do----	10.0	Tr	.1	.19	< .02
25	do----	10.0	Tr	.2	.26	< .02
26	do----	1.5	Tr	.2	.55	.04
27	do----	10.0	Tr	.2	.67	< .02
28	do----	24.0	Tr	.2	.32	< .01
29	do----	50.0	N	N	.08	< .01
30	Chip--	111.0	N	N	.09	.02
31	do----	84.0	Tr	.1	.14	< .01
32	do----	37.0	Tr	.1	.24	.01
33	do----	30.0	N	N	.09	< .01
34	do----	100.0	N	N	.05	< .01

chalcopyrite and molybdenite predominate. The granodiorite, which is locally moderately stained by iron oxide, is altered pervasively to silica, but the alteration is much less intense than in most shear zones in the area.

The potential resource in the area of the outcrops is estimated to be in excess of 400,000 tons (362,880 t). Samples (fig. 35), including those taken by earlier investigators (J. R. McWilliams, written commun., 1956) average 0.17 percent copper, 0.01 percent molybdenum, less than 0.1 ounce of silver per ton (3.4 g/t) and a trace of gold. Leaching has probably removed some copper from the outcrops. The deposit has potential for discovery of additional resources.

Miscellaneous prospects

Prospects or minereralized outcrops with no potential or that are not well enough exposed to determine their potential are summarized in table 6.

Snoqualmie Pass area

Iron and limestone deposits on Denny Mountain (fig. 36) and Guye Peak in the Snoqualmie Pass area have been investigated by government agencies and private interests since their discovery in the 1860's and the 1880's. There has been very minor production of iron and limestone from the deposits for metallurgical testing, but paramarginal and submarginal resources of both iron and limestone are known to exist in the area.

Intrusive and metamorphic rocks north and west of Chair Peak (pl. 1) were examined in the present study. Some concentrations of magnetite were found and most of the rock contained very small amounts of metallic sulfides.

Denny Mountain prospects

Diorite, granodiorite, volcanic rocks, limestone, and clastic sedimentary rocks crop out in the Denny Mountain area near Snoqualmie Pass (fig. 36). Most of the older sedimentary and volcanic rocks are metamorphosed; locally, some have been metamorphosed to tactite.

A lens of white to gray limestone crops out on the southwest face of Denny Mountain (fig. 36). Danner (1966, p. 375) estimated that the lens contains 6 million tons (5.4 million t) of crystalline medium- to coarse-grained limestone. The main outcrop of the limestone is about 2,500 feet (760 m) long and 500 feet (150 m) wide (Danner, 1966, p. 377). Tactites, developed where granitic rock intrudes limestone, contain garnet, epidote, amphiboles, coarse calcite, quartz, specularite, magnetite, and pyrite. Danner (1966, p. 380) suggested that the steep slopes would hinder open-pit quarrying of the limestone. He also recognized that the sporadic occurrence of magnesium in the limestone would prevent its being used in the manufacture of Portland cement, because its composition would be too variable.

Table 6.--Miscellaneous prospects and mineralized zones in the Cougar Creek area.

Map No. (fig. 33)	Prospect name	Summary	Sample data
1-3	Penny prospect	Adit about 160 feet (49 m) long in altered granodiorite containing sulfide minerals.	Three chip samples; maximum 0.1 ounce silver per ton (3.4 g/t).
4	Unknown	Granodiorite with less than 1 percent sulfide minerals, disseminated in rock and as fracture fillings.	One chip sample; no gold, trace silver, and 0.053 percent copper.
5	Goat Mountain east ridge	Altered zone at least 15 feet (4.6 m) wide containing sulfide minerals. Strike N. 85° W., dip near vertical.	One chip sample; 0.01 ounce gold per ton (0.3 g/t), 0.009 percent zinc, trace silver.
56, 57	Goat Mountain Lake	Shear zone 2 feet (0.6 m) wide strikes N. 60° W., dips vertical in limonite-stained granodiorite.	One sample across shear zone; 0.11 percent copper and 0.1 ounce silver per ton (3.4 g/t). One sample from granodiorite; 0.009 percent copper.
87	Cougar Creek Falls	Limonite-stained granodiorite with prominent joint set trending N. 85° W., dipping 65° SW.	One sample; 0.03 percent copper.
94, 95	Cougar Lake	Shear zone 1 foot (0.3 m) wide strikes N. 78° W., and dips vertically in granodiorite.	One sample (No. 94) across shear zone; 0.1 ounce silver per ton (3.4 g/t), 0.062 percent copper. One sample from granodiorite; 0.1 ounce silver per ton (3.4 g/t) and 0.01 percent copper.
90, 91-93, 96, 97-104	Unknown	Granodiorite with sulfide-quartz-mica filled shear zones.	Two samples across shear zones; maximum of 0.26 percent copper, less than 1.0 ounce silver per ton (34.0 g/t) and trace gold. Eleven chip samples (Nos. 92, 93, 96, 97-104) from granodiorite; 0.01 to 0.10 percent copper.
35-41	Devils Canyon prospect	A 200-foot-long (61 m) adit along a 2- to 20-foot-thick (0.6-6.1 m) shear zone trending N. 70° W. and dipping 60° NE. to vertical in granodiorite. As much as 20 percent of the zone is quartz veins. Zone extends at least 2,000 feet (610 m).	Seven chip samples; as much as 0.05 ounce gold per ton (1.7 g/t), 0.30 ounce silver per ton (10.3 g/t) and 0.006 percent copper.
88, 89	Unknown	Mineralized granodiorite in and along sheared zone. Zone appears to be the same structure as in the Devils Canyon prospect.	Two chip samples; maximum 0.02 percent copper and trace silver and gold.

Pods of magnetite and hematite in the limestone have been examined by numerous geologists to evaluate their potential as an iron resource. The small size of the deposits has probably prevented the use of the high-quality, iron-rich rock. Glover (1942, p. 8) estimated that the known tonnage of iron ore at the Denny property is more than 5,000 tons (4,500 t) and is possibly as much as 100,000 tons (91,000 t). Zapffe (1949, p. 22) estimated a smaller resource. Contorted rock, steep cliffs, and poor exposures complicate the measurement of the deposits. Two samples of magnetite (Nos. 3 and 4, fig. 36) from the northwest end of the limestone contain about 64 percent iron. Samples containing specularite (Nos. 1 and 7, fig. 36) contain as much as 47.3 percent iron. Each sample contains less than 0.1 percent of combined titanium, phosphorous, and sulfur.

Two magnetite-rich samples (Nos. 25 and 26, fig. 37) from near the southeast end of the limestone body contain 33 and 28 percent iron, respectively. If the two samples are from a continuous pod, the magnetite-rich rock at the site will total 1,300 tons (1,179.4 t).

Samples (Nos. 24 and 29, fig. 36) from two short adits in tactite bodies near the contact of the limestone with hornfels contain 0.14 and 0.17 percent copper.

Mineral collectors have worked the tactite on Denny Mountain for years. Some of the minerals, many well crystallized and of museum quality, are calcite, quartz, garnet, epidote, magnetite, pyrite, specularite, tremolite, actinolite, talc, mica, dolomite, siderite, arsenopyrite, chalcopyrite, azurite, malachite, and iron oxides. Samples of tactite (Nos. 2-6, fig. 36) contain negligible mineral values except one 23-foot (6.9-m)-long sample, (No. 5, fig. 36) taken along the base of a cliff, which contains 0.53 percent copper.

Guye Peak deposits

Metamorphosed limestone and siliceous sedimentary rocks intruded by the granodiorite that is extensive on Snoqualmie Mountain occur between Snoqualmie Mountain and Guye Peak (pl. 1). Solution caves on this saddle have prompted the name Cave Ridge. Tactites occur on Cave Ridge and contain magnetite, garnet, diopside, epidote, actinolite, tremolite, sphene, pyrite, galena, and sphalerite (Livingston, 1971, p. 171; Pariseau and Gooch, 1960, p. 5-11). Pods of magnetite in or near the limestone are believed to be metasomatic.

Glover (1942, p. 8-9) reported that the Guye Peak magnetite pods possibly are larger than those on Denny Mountain. The magnetite zone, as surveyed by magnetic dip needle, may be at least 1,000 feet (305 m) long (W. R. Green, W. J. LaMotte, and C. P. Purdy, written commun., 1974). One magnetite body, exposed over a length of 80 feet (24 m), averages 20 feet (6.1 m) in width. Glover estimated the volume of Guye Peak iron deposits to be 10,000-200,000 tons (9,000-181,000 t) of iron-rich rock containing about 60 percent iron.

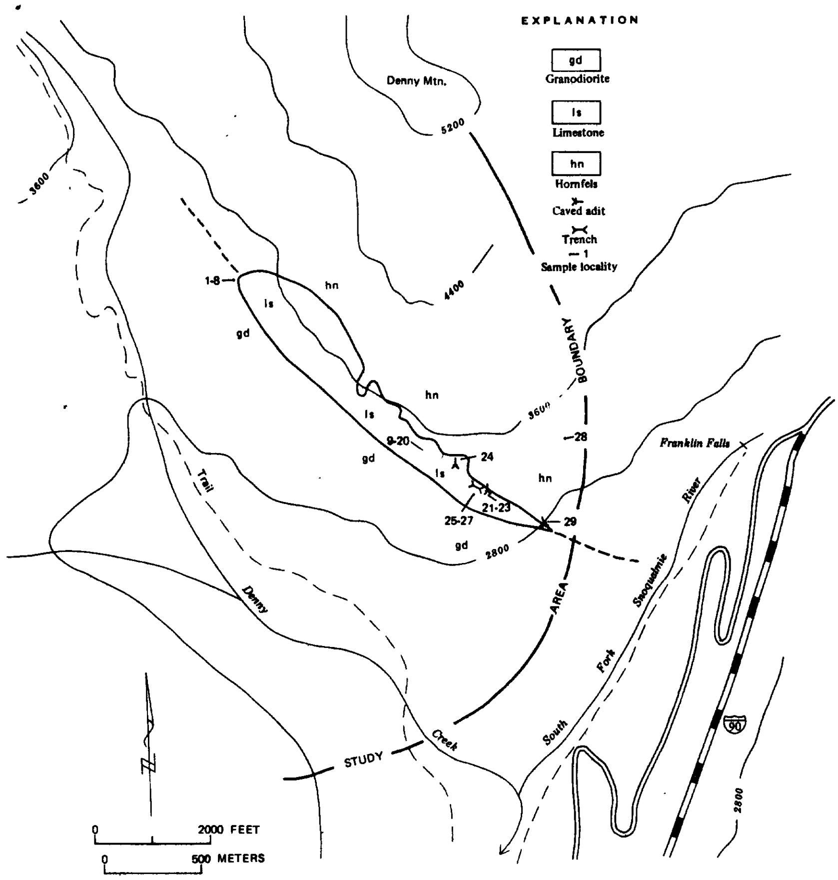


Figure 36.--Prospects in the Snoqualmie Pass area.

Data for samples shown on figure 36.

[Tr, trace; N, none detected; --, not analyzed; <, less than shown]

Sample No.	Sample Type	Sample Length (feet)	Copper (percent)	$CaCO_3$ (percent)	MgO (percent)	Fe (percent)	S (percent)	P (percent)	Ti (percent)
1	Select grab--	--	0.01	--	--	13.0	0.58	0.4	--
2	Chip--	14.0	.021	--	--	--	--	--	--
3	do----	3.0	--	--	--	63.7	.014	.007	0.008
4	do----	8.0	--	--	--	64.8	.025	<.002	.06
5	do----	23.0	.53	--	--	--	--	--	--
6	do----	39.0	.003	--	--	--	--	--	--
7	do----	10.0	--	--	--	47.3	.014	.004	< .03
8	do----	NA 1/	--	66.3	--	--	--	--	--
9	do----	do	--	95.7	1.4	--	--	--	--
10	do----	do	--	84.2	1.5	--	--	--	--
11	do----	do	--	75.5	5.3	10.5 Fe_2O_3	--	--	--
12	do----	do	--	90.0	5.0	--	--	--	--
13	do----	do	--	85.9	4.5	--	--	--	--
14	do----	do	--	77.4	8.0	--	--	--	--
15	do----	do	--	90.9	2.0	--	--	--	--
16	do----	do	--	95.7	.91	--	--	--	--
17	Chip--	NA 1/	--	84.3	4.04	--	--	--	--
18	do----	do	--	89.4	1.40	--	--	--	--
19	do----	do	--	91.9	3.12	--	--	--	--
20	do----	do	--	78.4	6.85	--	--	--	--
21	do----	do	--	81.6	3.6	--	--	--	--
22	do----	do	--	86.3	1.7	--	--	--	--
23	do----	do	--	84.3	4.06	--	--	--	--
24	Select	2.0	.14	--	--	--	--	--	--
25	Chip--	1.0	.004	--	--	--	--	--	--
26	do----	6.0	.12	--	--	33.0	.94	.06	--
27	do----	1.0	.069	--	--	28.0	.78	.03	--
28	do----	33.0	.01	--	--	--	--	--	--
29	do----	5.0	.17	--	--	--	--	--	--

1/ Assay results from Danner, 1966. No lengths given in table.

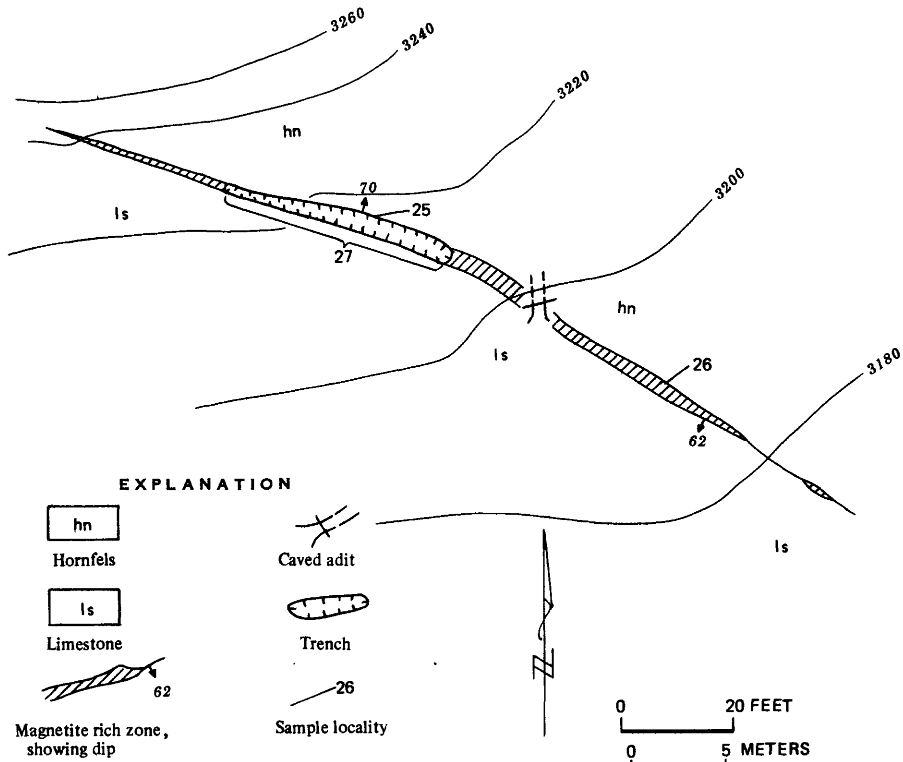


Figure 37.--Denny Mountain deposit.

Chair Peak deposits

Granodiorite and diorite have intruded and metamorphosed the volcanic and sedimentary rocks near Chair Peak (pl. 1). Faulting and intense folding have contorted and sheared some of the rocks. Most of the intruded rocks contain less than 2 percent pyrite and arsenopyrite in small blebs. Two samples from sheared limonite-stained granodiorite and diorite south of Snow Lake contain 0.2 ounce of silver per ton (6.8 g/t).

Magnetite is concentrated in breccia at Chair Peak Lake. The magnetite, associated with epidotite, constitutes less than 1 percent of the rock. Some masses of magnetite are at least 0.5 foot wide (15 cm) but they constitute less than 0.5 percent of the rock.

Green Ridge Lake area

The Green Ridge Lake area is near the drainage divide between the North Fork Snoqualmie River and the Taylor River (pl. 1). Breccia zones in quartz diorite as long as 2,500 feet (762 m) are the principal host for metallic minerals (fig. 38). Smaller masses of schistose metamorphic rock and tactite crop out near one brecciated area.

The breccia fragments of granitic rock are altered to varying degrees. The material cementing the breccia is 15-55 percent quartz, 10-20 percent sulfide minerals, and 10-25 percent mica. Much of the cementing silica is euhedral quartz crystals, most less than 0.2 foot (0.06 m) long but some 0.5 foot (0.15 m) long. Most of the crystals are colorless but a small percentage are amethystine.

Assay values are low, but as all samples were taken at the surface some of the metal may have leached during weathering. Chip samples from the major granodiorite breccia outcrop, the nearby unbrecciated granodiorite, and the smaller breccia mass at its border all contain traces of gold and less than 0.3 ounce of silver per ton (10.3 g/t); only one sample contains more than 0.02 percent each copper and molybdenum. A selected sample (No. 16, fig. 38) of the garnet schist taken over a 15-foot-square (21 m^2) area contains approximately 0.5 percent tungsten.

Further exploration in the Green Ridge Lake area may reveal a copper-silver-molybdenum resource similar to that in other breccia zones near the Middle Fork Snoqualmie River.

Big Snow Mountain area

The Big Snow Mountain area is chiefly underlain by granitic rocks containing shear zones as much as 2 miles (3.2 km) long (fig. 39). The Katie Belle shear zone extends through the area from the mineral deposits along the Middle Fork Snoqualmie River (fig. 39). It is made up of three

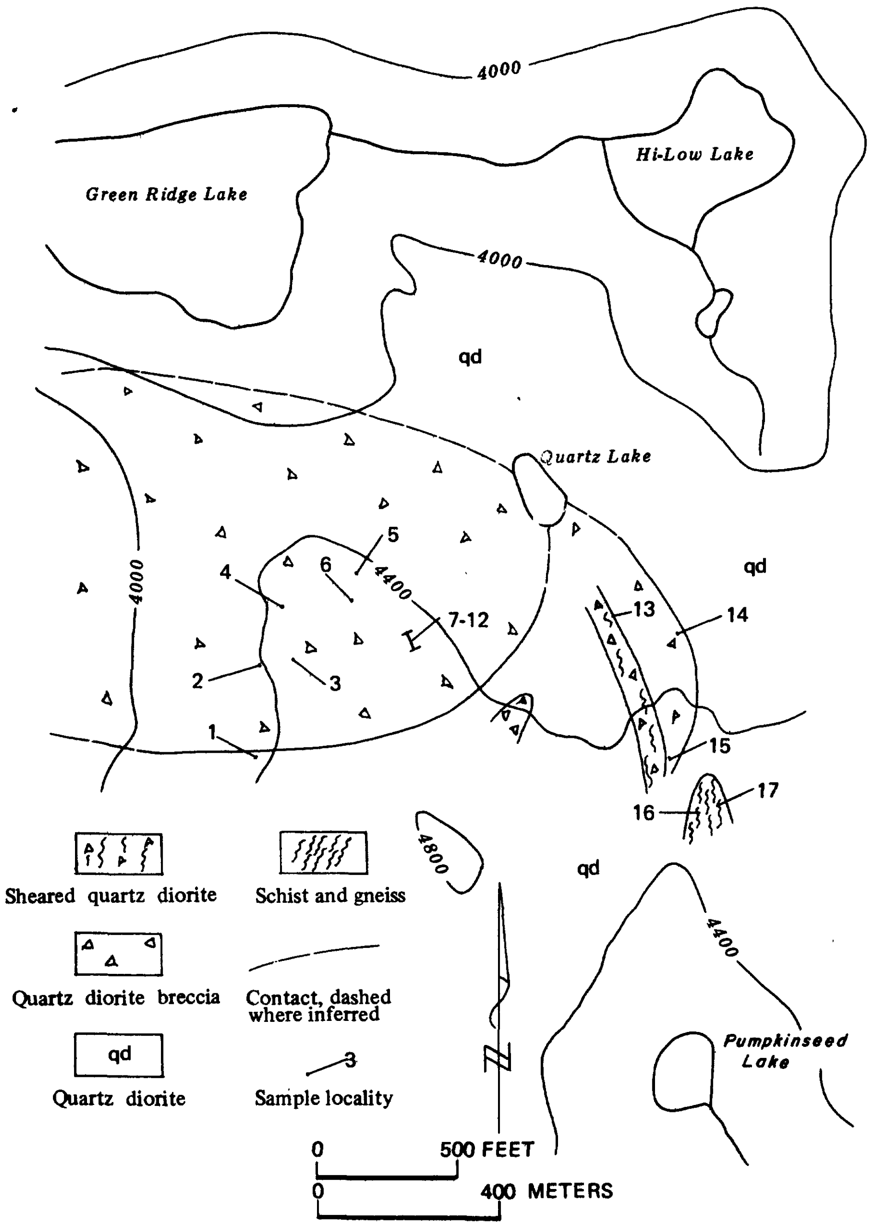


Figure 38.--Green Ridge Lake area.

Data for samples shown on figure 38.

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

Sample No.	Sample Type	Sample Length (feet)	Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Molybdenum (percent)
1	Chip--	26.0	N	0.2	0.005	0.006
2	do----	29.0	Tr	.1	.005	.006
3	do----	36.0	Tr	.1	.005	.006
4	do----	15.0	N	.2	.007	.006
5	Grab--	--	N	.1	.004	.006
6	Chip--	25.0	N	.2	.005	.006
7	do----	6.0	N	.2	.015	.006
8	do----	7.0	N	.3	.005	.006
9	do----	8.0	N	.3	.007	.006
10	do----	3.0	N	1.1	.009	.006
11	do----	1.0	N	.2	.01	.006
12	do----	7.0	N	.1	.004	.006
13	do----	24.0	N	.1	.004	.006
14	do----	37.0	N	.2	.004	.012
15	do----	23.0	N	.2	.005	.006
16 1/	Grab--	--	Tr	.2	.009	.006
17	Chip--	10.0	Tr	.3	.004	.006

1/ Sample 16 contained 0.5 percent tungsten.

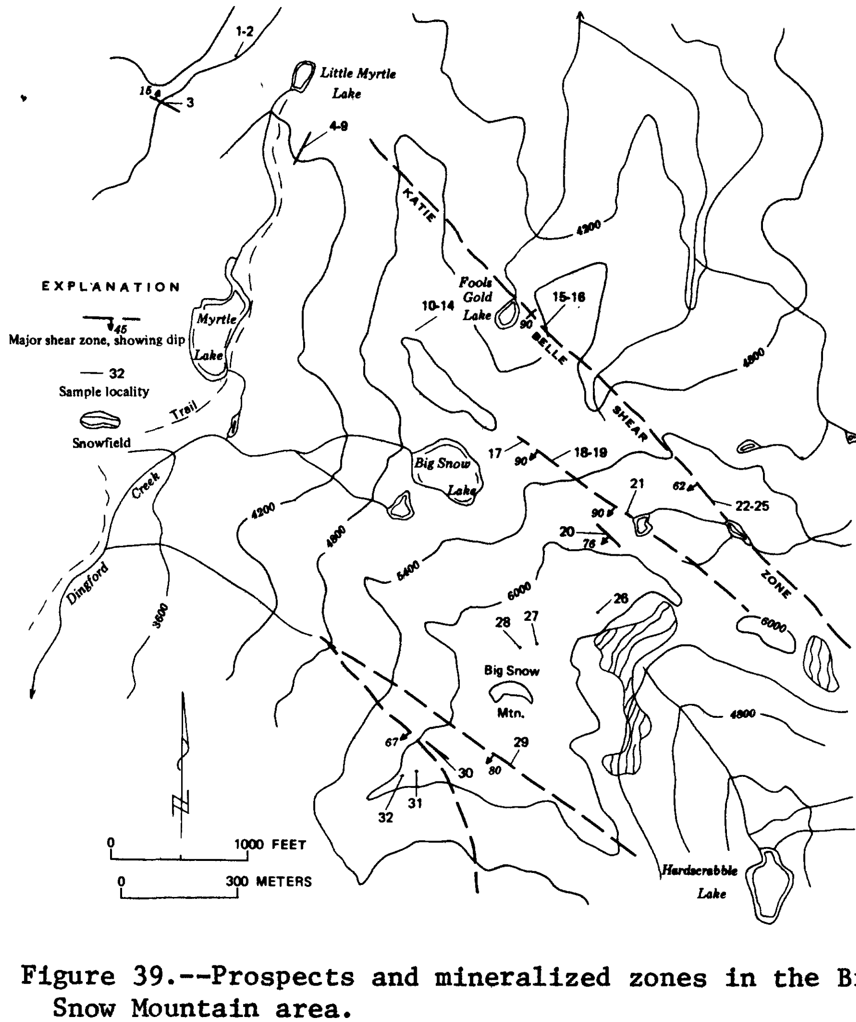


Figure 39.--Prospects and mineralized zones in the Big Snow Mountain area.

Data for samples shown on figure 39.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)
No.	Type	Length (feet)			
1	Chip--	225.0	N	N	0.015
2	Grab--	--	--	--	.015
3	Chip--	.8	N	0.2	.016
4	do----	--	--	--	.01
5	do----	.9	--	--	.011
6	Grab--	--	--	--	.025
7	do----	--	--	--	.009
8	do----	--	--	--	.007
9	Chip--	69.0	--	--	.017
10	do----	125.0	N	.1	.02
11	do----	122.0	N	Tr	.022
12	do----	80.0	N	Tr	.014
13	do----	100.0	Tr	.1	.016
14	do----	83.0	Tr	Tr	.017
15	do----	105.0	Tr	.1	.016
16	do----	1.0	N	N	.027
17	do----	5.0	N	.2	.027
18	do----	15.0	N	.2	.015
19	do----	6.0	N	.2	.019
20	do----	.5	N	.8	.043
21	do----	.8	N	.2	.007
22	Chip--	77.0	N	Tr	.006
23	do----	26.0	N	Tr	.005
24	do----	65.0	N	.1	.008
25	do----	2.7	N	.1	.008
26	do----	74.0	N	N	.006
27	do----	31.0	N	.1	.01
28	do----	6.0	N	.1	.005
29	do----	14.0	N	N	.006
30	do----	.7	N	.1	.012
31	do----	9.5	N	.1	.007
32	do----	1.0	N	.2	.012

systems of shear zones: one strong steeply dipping system that strikes about N. 40° W.; a second, intersecting, less extensive system that trends mostly N. 50° to 80° E. and dips nearly vertical; and a locally mineralized, low-angle (dipping in most places less than 30°) centroclinal system of partly sheared joints east of Snoqualmie Lake Potholes (Nos. 1, 2, and 3, fig. 39). The northwest- and northeast-trending shear zones are locally mineralized near their intersections. In several areas limonite-stained granodiorite (Nos. 10-14, 26, 27, 31, 32, fig. 39) contains joints with coatings of as much as 3 percent sulfide minerals.

The northwest-trending system is made up of numerous parallel shear zones located every few feet (about 1 m) across a belt several hundreds of feet (tens of metres) wide. The individual shear zones range in width from 0.5 to 2.0 feet (0.2-0.6 m). The medial part of the system commonly contains altered granodiorite which ranges in width from 5 to 50 feet (1.5-15 m), and is commonly obscured either due to weathering, erosion, or talus cover. Quartz, mica, and iron oxide minerals are abundant along outcrops of most of the individual shear zones. Voids, which constitute as much as 15 percent of the sheared rock, represent volumes occupied by sulfide minerals prior to leaching. Only a few exposures on Big Snow Mountain, such as the site of sample 20 (fig. 39), contain unweathered sulfide minerals at the surface. Pyrite and arsenopyrite are most abundant; chalcopyrite, sphalerite, and galena are less common. Some of the shear zones contain very small amounts of molybdenite and scheelite, notably at the site of sample 27 (fig. 39). In some areas, such as in the Mudge claims, irregular minor shear zones striking N. 20° to 30° E. contain pyrite and pyrrhotite (Nos. 4-9, fig. 39).

The Mudge claims near Little Myrtle Lake are located on altered granodiorite. The shear zones on the claims contain vuggy quartz, pyrite, and pyrrhotite. Samples from the zones contained a maximum of 0.025 percent copper.

Samples from the shear zones and anomalously mineralized areas in the granitic country rock contain a trace or less of gold, generally less than 0.2 ounce of silver per ton (6.8 g/t), and less than 0.05 percent copper. The oxidized condition of the outcrops indicates higher values may exist in the shear zones below the leached surface. The area has a potential for the discovery of resources of silver, copper, and molybdeum.

Isolated, outlying prospects

Three prospects or claimed areas are outside the areas shown on figure 2. These isolated prospects either have no potential or the deposits are not sufficiently exposed to estimate potential. The location descriptions and assay data for samples from these prospects are listed in table 7.

Table 7 [illegible]d, outlying prospec

Map No. 2 Prospect name	Location	Summary	Sample data
Garfield Mountain claims	Near the confluence of Middle Fork Snoqualmie River and Taylor River	Granitic rocks intrude volcanic and sedimentary rocks. Sulfide minerals diss-eminated in volcanic and sedimentary rocks and concentrated in fracture fillings. Sulfide minerals, mostly less than 2 percent of the rock, are mostly pyrite, arsenopyrite, and pyrrhotite.	Five samples of hornfels, less than 0.02 percent copper, less than 0.2 ounce silver per ton (6.8 g/t), and traces of molybdenum and gold.
Trail Creek prospect	Along Trail Creek about 300 feet (43.8 m) east from the junction of Trail Creek and Waptus River	A 3.5-foot-wide (1.1 m) shear zone is exposed in a 10-foot-long (3.1 m) adit driven in quartzite. A 1.3-foot-wide (0.4 m) shear zone occurs nearby. Shear zones contains 1 to 5 percent sulfide minerals with minor chalcopyrite. Shear zones trend east-west.	One 3.5-foot-long (1.1 m) chip sample; no gold, 0.1 ounce silver per ton (3.4 g/t). One 1.3-foot-long (0.4 m) chip sample; trace gold, 0.3 ounce silver per ton (10.3 g/t), and 0.5 percent copper.
Sunday Creek claims	In Sunday Creek drainage, a tributary of North Snoqualmie River	Several claims were located in the Sunday Creek drainage mostly during the early 1900's. No workings were found in the area and no significant mineralized outcrops were observed.	

Dutch Miller mine area

The Dutch Miller mine is near La Bohn Gap at the head of the Middle Fork Snoqualmie River (fig. 2). Although this mine (fig. 40) is in the area previously studied (Gualtieri and others, 1973) rather than in the additions, it is included in this report because a relatively light snowpack permitted additional data to be obtained during the study of the additions. Detailed descriptions of the deposit are contained in the previous report (Gualtieri and others, 1973).

In the area, sulfide minerals occur in several quartz-tourmaline veins in granodiorite. The main vein is now known to be 330 feet (100 m) long and as much as 30 feet (9.1 m) wide (fig. 39) rather than the lesser dimensions previously reported (Gualtieri and others, 1973, p. 78). The mine is estimated to have about 3,500 tons (3,175 t) of indicated reserves exposed in the workings (B. Thomas, written commun., 1907) and there are 200 tons of ore (181 t) in stockpiles. The reserves contain from 4 percent to more than 20 percent copper and more than 5 ounces of silver per ton (171 g/t). The 200 tons (181 t) of ore stockpiled near the southernmost shaft (Nos. 9, 10, 11, and 19, fig. 40) contain a weighted average of 12.8 percent copper and 7.7 ounces of silver per ton (264 t).

The probability of developing additional resources is good because the full extent of the ore shoots has not been delineated.

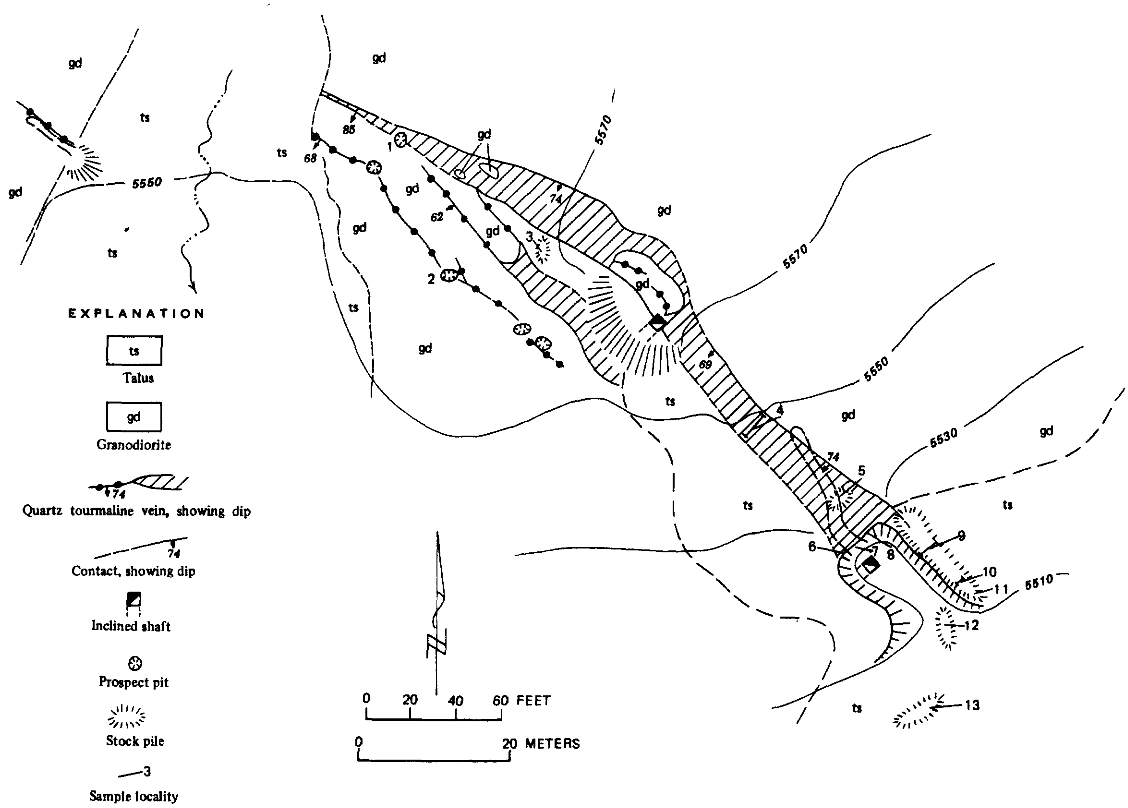


Figure 40.--Dutch Miller mine.

Data for samples shown on figure 40.

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

Sample			Gold (ounce per ton)	Silver (ounce per ton)	Copper (percent)	Lead (percent)	Zinc (percent)
No.	Type	Length (feet)					
1	Grab--	--	Tr	0.4	0.49	0.14	0.21
2	do----	--	Tr	.3	.12	.87	.21
3	do----	--	Tr	10.3	15.0	1.56	2.73
4	Chip--	12.0	N	.08	.30	N	--
5	Grab--	--	Tr	12.00	13.40	1.97	--
6	Chip--	6.7	Tr	3.7	9.83	.79	1.13
7	do----	3.7	Tr	8.1	16.9	2.45	3.17
8	do----	7.0	Tr	4.4	2.29	1.61	1.05
9	Trench	8.0	Tr	7.5	12.2	.95	.76
10	Chip--	3.3	N	9.1	16.2	1.50	2.22
11	do----	3.8	Tr	8.0	11.5	1.57	1.05
12	do----	5.5	N	N	.02	.55	.05
13	Grab--	--	Tr	6.6	12.4	.92	.98

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Table 8.--Analytical results of anomalous samples from designated anomalous areas in the Alpine Lakes additions

[The analytical data in the table are separated into three categories on the basis of the type of sample taken: stream sediment, panned concentrate, and rock. The data are further classified on the basis of 26 areas containing anomalous amounts of metal.

The letter symbols shown at the head of the columns of analytical data indicate the following: S, 6-step semiquantitative spectrographic analysis; AA, atomic absorption; Cm-CX-HM, citrate-soluble heavy metals colorimetric test; and EU, radiometric uranium. The letter symbols at the right of the analytical data indicate the following: N, looked for but not detected; L, detected but below limit of determination value shown; G, detected in quantities greater than value shown; OB, not determined.

All elements, except iron, magnesium, calcium, and titanium, which are reported as percent, are reported in parts per million. Citrate-soluble heavy metals are reported in parts per million.]

TABLE 8. ANALYTICAL RESULTS OF ANOMALOUS SAMPLES FROM ADDITIONS TO THE ALPINE LAKES AREA

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM	EU
STREAM SEDIMENT SAMPLES - RED MOUNTAIN - AREA1																
EG2459	0.5 N	200 N	10 N	10 N	1500	5 L	15	100 N	10 N	50 N	200 N	0.0 B	1700	120	300	0 B
EP2262	0.5 N	200 N	10 N	10 N	150	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	220	25	10	0 B
EP2264	0.5 N	200 N	10 N	10 N	50	5	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EP2265	0.5 N	200 N	10 N	10 N	500	7	15	100 N	10 N	50 N	200 N	0.0 B	440	25	10	0 B
EP2267	0.5 N	200 N	10 N	10 N	200	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	220	25	6	0 B
EP2269	0.5 N	200 N	10 N	10 N	70	5 N	30	100 N	10 N	50 N	200	0.0 B	50	140	4	0 B
ROCK SAMPLES - RED MOUNTAIN - AREA 1																
ES1080C	0.5 N	200 N	10 N	10	50	5 N	10 N	100 N	50	50 N	200	0.05 L	0 B	0 B	0 B	0 B
FG2458A	0.5 N	200 N	10 N	10 N	150	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EP2261	0.5 N	200 N	10 N	10 N	100	5 N	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - TUSCOHATCHIE LAKE - AREA 2																
EG2496	0.5 N	200 N	10 N	10 N	30	7	50	100 N	10 N	50 N	200 N	0.0 B	35	65	4	0 B
EG2497	0.5	200 N	10 N	10 N	20	5 L	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
EG2498	0.5 N	200 N	10 N	10 N	20	7	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
EP2384	0.5 L	200 N	10 N	10 N	30	5 L	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EP2387	0.5 N	200 N	10 N	10 N	20	7	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2388	0.5 N	200 N	10 N	10 N	30	5	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
ES2004	0.5 N	200 N	10 N	10 N	15	7	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2008	0.5 N	200 N	10 N	10 N	20	5 L	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
ES2009	0.5 N	200 N	10 N	10 N	20	10	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2011	0.5 N	200 N	10 N	10 N	50	5 L	300	100 N	150	50 N	200 N	0.0 B	35	110	8	0 B
ROCK SAMPLE - TUSCOHATCHIE LAKE - AREA 2																
ES2002	0.5 N	200 N	10 N	10 N	5	50	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - TALAPUS LAKE - AREA 3																
ES2022	0.5 N	200 N	10 N	10 N	20	5	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2023	1.5	200 N	10 N	10 N	150	7	30	100 N	10 L	50 N	200 N	0.0 B	260	40	8	0 B
ES2024	0.5 N	200 N	10 N	10 N	20	15	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2026	0.5 N	200 N	10 N	10 N	15	5	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
STREAM SEDIMENT SAMPLES - LAKE KULLA KULLA - AREA 4																
ES2015	0.5 L	200 N	10 N	10 N	50	7	100	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2396	0.5 N	200 N	10 N	10 N	20	7	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2397	0.5 L	200 N	10 N	10 N	15	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2398	0.5 N	200 N	10 N	10 N	50	5 L	100	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2400	0.5 L	200 N	10 N	10 N	7	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B

TABLE 8. ANALYTICAL RESULTS OF ANOMALOUS SAMPLES FROM ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM	EU
ROCK SAMPLE - LAKE KULLA KULLA - AREA 4																
ES2028	0.5 N	200 N	10 N	10 N	100	5 N	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - MELAKWA PASS - AREA 5																
EP2303	1.0	200 N	10 N	10 N	100	5 L	150	100 N	10 N	50 N	500	0.0 B	0 B	0 B	1	0 B
EP2304	0.5 N	200 N	10 N	10 N	150	5 N	70	100 N	10 N	50 N	200 N	0.0 B	170	55	12	0 B
EP2309	0.5 N	200 N	10 N	10 N	20	7	150	100 N	30	50 N	200 N	0.0 B	35	35	10	0 B
EP2310	0.5	200 N	10 N	10 N	50	5 L	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2311	0.5 L	200 N	10 N	10 N	30	5 N	300	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
EP2413A	0.5 N	200 N	10 N	10 N	100	5 N	30	100 N	10 N	50 N	200 N	0.05 N	130	150	4	0 B
EP2414	0.7	200 N	10 N	10 N	100	5 L	300	100 N	10	50 N	200 N	0.55	80	65	6	0 B
EP2419	0.5 L	200 N	10 N	10 N	30	5 N	150	100 N	10 N	50 N	200 N	0.20 N	0 B	0 B	1 L	0 B
EP2420	0.7	200 N	10 N	10 N	100	5 N	200	100 N	10 N	50 N	300	0.10 N	0 B	0 B	1 L	0 B
EP2483	0.5 N	200 N	10 N	10 N	100	5 N	70	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	1	0 B
ROCK SAMPLES - MELAKWA PASS - AREA 5																
EG2543	0.5 L	200 N	10 N	10 N	100	7	10 N	100 N	10 N	50 N	500	0.05 N	0 B	370	0 B	0 B
EG2545	0.5 L	200 N	10 N	10 N	30	5 N	70	100 N	10 N	50 N	200 N	0.05 N	0 B	0 B	0 B	0 B
EG2545A	0.5 N	200 N	10 N	10 N	20	5 L	50	100 N	10 N	50 N	200	0.05 L	0 B	190	0 B	0 B
EG2547	0.5 N	200 N	10 N	10 N	7	10	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2550	0.5 N	200 N	10 N	10	50	5 N	50	100 N	10 N	50 N	300	0.05 L	0 B	260	0 B	0 B
EP2417	0.5 N	200 N	10 N	10 N	100	5 L	30	100 N	10 N	50 N	200 N	0.05 N	0 B	0 B	0 B	0 B
EP2480	0.5 N	200 N	10 N	10 N	70	7	50	100 N	10 N	50 N	700	0.0 B	0 B	440	0 B	0 B
STREAM SEDIMENT SAMPLES - DERRICK LAKE - AREA 6																
EP2312	0.7	200 N	10 N	10 N	30	10	30	100 N	10 N	50 N	200 N	0.0 B	35	45	8	0 B
EP2315	0.5 N	200 N	10 N	10 N	10	30	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2588	0.5 N	200 N	10 N	10 N	70	7	100	100 N	10 N	50 N	200 N	0.0 B	130	25	6	0 B
ES2055	0.5 N	200 N	10 N	10 N	30	30	150	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	1	0 B
ES2060	0.5 N	200 N	10 N	10 N	30	5	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2061	0.5 N	200 N	10 N	10 N	15	10	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2064	0.5 N	200 N	10 N	10 N	30	7	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2066	0.5 N	200 N	10 N	10 N	7	10	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2067	0.5 N	200 N	10 N	10 N	30	5	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2070	0.5 N	200 N	10 N	10 N	10	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2071	0.5 N	200 N	10 N	10 N	20	5 L	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2072	0.5 N	200 N	10 N	10 N	7	7	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B

TABLE 8. ANALYTICAL RESULTS OF ANOMALOUS SAMPLES FROM ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM	EU
ROCK SAMPLES - DERRICK LAKE - AREA 6																
EG2562	0.5 N	200 N	10 N	10 N	50	5 N	300	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	40
EG2583	0.5 N	200 N	10 N	10 N	20	200	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2586A	0.5 N	200 N	10 N	10 N	5	15	10 N	100 N	10 N	50 N	200 N	0.05 N	0 B	0 B	0 B	0 B
ES2058	0.5 N	200 N	10 N	10 N	5	5 N	10	100 N	70	50 N	1500	0.0 B	0 B	430	0 B	0 B
ES2076	0.5 N	200 N	10 N	10 N	5	5 N	30	100 N	30	70	1000	0.0 B	0 B	1600	0 B	0 B
EG2622	0.5 N	200 N	10 N	10 N	30	5 N	20	100 N	10 N	50 N	200	0.0 B	0 B	200	0 B	0 B
STREAM SEDIMENT SAMPLES - THUNDER CREEK - AREA 7																
EG2472	0.7	200 N	10 N	10 N	100	5 L	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2473	0.5 N	200 N	10 N	10 N	100	5 L	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
EG2474	0.5 L	200 N	10 N	10 N	70	15	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2475	1.0	200 N	10 N	10 N	70	5 N	70	100 N	10 N	50 N	200 L	0.0 B	35	100	12	0 B
EP2290	1.5	200 N	10 N	10 N	70	5 L	100	100 N	10 N	50 N	200	0.0 B	40	170	16	0 B
EP2317	0.5 L	200 N	10 N	10 N	15	100	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2319	0.5 L	200 N	10 N	10 N	70	5 N	30	100 N	10 N	50 N	200	0.0 B	70	180	14	0 B
EP2320	0.7	200 N	10 N	10 N	10	5 L	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ROCK SAMPLE - THUNDER CREEK - AREA 7																
EG2574	0.5 N	200 N	10 N	10 N	30	5 N	10 N	100 N	10 N	70	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - MIDDLE FORK OF THE SNOQUALMIE RIVER - AREA 8																
EK0388	0.5	200 N	10 N	10 N	30	5	70	100 N	10 N	50 N	200 N	0.02 N	35	60	2	0 B
EK0390	1.5	200 N	10 N	10 N	150	15	100	100 N	15	50 N	200 N	0.04 N	140	35	6	0 B
ET0333	0.7	200 N	10 N	10 N	20	5 N	50	100 N	10 N	50 N	200 N	0.02 L	40	40	3	0 B
ET0334	0.7	200 N	10 N	10 N	30	10	70	100 N	10 N	50 N	200 N	0.02 L	50	70	3	0 B
EP2287	0.5 N	200 N	10 N	10 N	100	50	30	100 N	10 L	50 N	200 N	0.0 B	90	50	4	0 B
EP2289	0.7	200 N	10 N	10 N	70	7	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EG2500	0.5 N	200 N	10 N	10 N	150	5	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2502	3.0	200 N	10 N	15	3000	70	15	100 N	10 N	50	200 N	0.0 B	4700	140	300	0 B
EG2504	0.5 L	200 N	10 N	10 N	150	10	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
EG2505	3.0	200 N	10 N	10 N	700	15	30	100 N	10 N	50 N	200 N	0.0 B	530	220	8	0 B
EG2506	0.5 N	200 N	10 N	10 N	30	5	30	100 N	10 N	50 N	200 N	0.0 B	25	70	4	0 B
EG2508	0.5 N	200 N	10 N	10 N	70	15	20	100 N	10 N	50	200 N	0.0 B	0 B	0 B	1 L	0 B
EG2509	0.5 N	200 N	10 N	10 N	300	5 L	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2510	0.7	200 N	10 N	10 N	300	7	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2511	1.5	200 N	10 N	10 L	2000	50	15	100 N	10 N	50 L	200 N	0.0 B	2200	70	60	0 B
ROCK SAMPLES - MIDDLE FORK OF THE SNOQUALMIE RIVER - AREA 8																
EP2288	0.5 N	200 N	10 N	10 N	100	5 N	10 N	100 N	10 N	70	200 N	0.0 B	0 B	0 B	0 B	0 B

TABLE 8. ANALYTICAL RESULTS OF ANOMALOUS SAMPLES FROM ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM	FU
EG2500A	1.5	200 N	10 N	10 N	1500	5 N	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2500B	1.5	200 N	10 N	10 N	1500	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2568	7.0	200 N	10 N	10 N	20	5 N	5000	100 N	10 N	50 N	300	0.0 B	0 B	200	0 B	0 B
EG2569	0.7	200 N	10 N	10 N	300	10	20	100 N	10	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2569A	7.0	200 N	10 N	10 N	150	70	10 L	100 N	10	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2570	1.0	200 N	10 N	10	300	5 N	20	100 N	10 L	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2570A	3.0	200 N	10 N	10 N	700	15	10 L	100 N	10 L	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2571	1.0	200 N	10 N	10 N	300	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2571A	5.0	200 N	10 N	10 N	500	50	10 N	100 N	10	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2572	0.5 N	200 N	10 N	10 N	150	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2572A	0.5 N	200 N	10 N	10 N	150	5 N	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2573	0.5 N	200 N	10 N	10 N	200	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - BURNTBOOT CREEK - AREA 9																
EG0646	0.5 N	200 N	10 N	10 N	100	5 N	50	100 N	10 N	50 N	200 N	0.0 B	190	130	5	0 B
EG2465	0.5 N	200 N	10 N	10 N	100	5 N	30	100 N	10 N	50 N	200 N	0.0 B	180	100	4	0 B
EP2279	0.5 L	200 N	10 N	10 N	70	5 L	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2280	0.5 L	200 N	10 N	10 N	20	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EP2283	1.0	200 N	10 N	10 N	30	5 N	70	100 N	10 N	50 N	200 L	0.0 B	40	85	4	0 B
EP2286	0.5 N	200 N	10 N	10 N	150	7	20	100 N	10 N	50 N	200 N	0.0 B	180	70	6	0 B
ROCK SAMPLE - BURNTBOOT CREEK - AREA 9																
EG2467	0.5 L	200 N	10 N	10 N	15	5 N	100	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - HESTER LAKE - AREA 10																
EG2633	0.5 N	200 N	10 N	10 N	20	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2635	0.5 N	200 N	10 N	10 N	15	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2652	0.5 N	200 N	10 N	10 N	50	7	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2654	0.5 N	200 N	10 N	10 N	70	7	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2655	0.5 N	200 N	10 N	10 N	70	7	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
STREAM SEDIMENT SAMPLES - DINGFORD CREEK - AREA 11																
EG2646	1.5	200 N	10 N	10 N	100	5	150	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
EG2649	0.5 N	200 N	10 N	10 N	50	5	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EC2015	0.5 N	200 N	10 N	10 N	10	7	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2468	0.7	200 N	10 N	10 N	70	5 L	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
ROCK SAMPLE - DINGFORD CREEK - AREA 11																
EG2650	0.5 N	200 N	10 N	10 N	150	5 N	10 L	100 N	10 N	70	200 N	0.0 B	0 B	0 B	0 B	0 B

TABLE 8. ANALYTICAL RESULTS OF ANOMALOUS SAMPLES FROM ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM	EU
STREAM SEDIMENT SAMPLE - GREEN RIDGE LAKE - AREA 12																
EC2027	0.7	200 N	10 N	10 N	30	5 N	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ROCK SAMPLE - GREEN RIDGE LAKE - AREA 12																
EC2039	2.0	200 N	10 N	10 N	100	30	70	100 N	10 N	50 N	300	0.0 B	0 B	190	0 B	0 B
STREAM SEDIMENT SAMPLES - GARFIELD MTN. LAKES -AREA 13																
EG2684	0.5 N	200 N	10 N	10 N	70	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2685	0.5 N	200 N	10 N	10 N	20	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
ROCK SAMPLES - GARFIELD MTN. LAKES -AREA 13																
EG2682A	0.5 N	200 N	10 N	10 N	100	5 N	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2683	1.0	200 N	10 N	10 N	100	5 N	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2684B	1.0	200 N	10 N	10 N	200	5 N	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2691A	0.5 N	200 N	10 N	10 N	70	7	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - SNOQUALMIE LAKE POTHOLES - AREA 14																
EP2462	1.5	200 N	10 N	10 N	70	5	100	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EP2463	0.5 N	200 N	10 N	10 N	70	5	20	100 N	10 L	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2669	0.5 N	200 N	10 N	10 N	150	15	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2670	0.5 L	200 N	10 N	10 N	70	10	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EG2671	1.0	200 N	10 N	10 N	150	20	50	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1	0 B
EC2028	0.5 N	200 N	10 N	10 N	30	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EC2030	0.7	200 N	10 N	10 N	150	20	30	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1 L	0 B
ROCK SAMPLES - SNOQUALMIE LAKE POTHOLES - AREA 14																
EG2662	1.5	200 N	10 N	10 L	20	5 N	30	100 N	30	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2666	0.5 N	200 N	10 N	10 N	1000	5 N	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2667	0.5 N	200 N	10 N	10 N	100	5 N	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2668	0.5 N	200 N	10 N	10 N	150	5 N	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - LAKE DOROTHY SOUTH - AREA 15																
EG2699	0.5 N	200 N	10 N	10 N	100	5	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
EG2701	0.5 N	200 N	10 N	10 N	50	7	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2702	0.7	200 N	10 N	10 N	70	7	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2707	0.5 N	200 N	10 N	10 N	50	7	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
ROCK SAMPLE - LAKE DOROTHY SOUTH - AREA 15																
EG2711	2.0	200 N	10 N	10 N	500	5 N	10	100 N	10 N	100	200 N	0.0 B	0 B	0 B	0 B	0 B

TABLE 8. ANALYTICAL RESULTS OF ANOMALOUS SAMPLES FROM ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM	EU
STREAM SEDIMENT SAMPLES - TAYLOR RIVER - AREA 16																
EG2363	0.5 N	200 N	10 N	10 N	15	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2366	0.5	200 N	10 N	10 N	30	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2370	0.5 N	200 N	10 N	10 N	30	5	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2371	0.5	200 N	10 N	10 N	30	5 L	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
ROCK SAMPLE - TAYLOR RIVER - AREA 16																
EG2694	0.5 N	700	10 N	10 N	10	5 N	10 N	100 N	15	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - BIG CREEK - AREA 17																
EG2722	0.5 N	200	10 N	10 L	200	7	10	100 N	10 N	70	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2723	0.5	300	10 N	10 N	50	7	10 L	100 N	10 N	70	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2724	0.5 N	200 N	10 N	10 N	30	5	10 L	100 N	10 N	70	200 N	0.0 B	0 B	0 B	1 N	0 B
STREAM SEDIMENT SAMPLES - MARTEN LAKE - AREA 18																
EP2222	0.5 N	200 N	10 N	10 N	70	5 L	30	100 N	10 N	50 N	200 N	0.0 B	70	45	10	0 B
EG2728	0.5 N	200 N	10 N	10 N	70	5	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ROCK SAMPLES - MARTEN LAKE - AREA 18																
EG2726	0.5 N	200 N	10 N	10 N	100	5	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2729A	0.5 N	200 N	10 N	10 N	300	5 N	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - LAKE ISABELLA - AREA 19																
EC2107	0.5	200 N	10 N	10 N	70	5 N	70	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1 L	0 B
EC2108	0.5 N	200 N	10 N	10 N	70	7	20	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1 N	0 B
EC2112	0.5 N	200 N	10 N	10 N	30	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EC2113	0.5 N	200 N	10 N	10 N	20	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
ROCK SAMPLE - LAKE ISABELLA - AREA 19																
EC2119	0.5 N	200 N	10 N	10 N	10	5 N	10 L	100 N	10 N	50 N	200	0.0 B	0 B	50	0 B	0 B
STREAM SEDIMENT SAMPLES - SUNDAY CREEK - AREA 20																
EG2538	1.5	500	10 N	10 N	200	7	100	100 N	10 N	70	300	0.0 B	0 B	0 B	1 N	0 B
EC2115	0.7	200 N	10 N	10 N	70	7	100	100 N	10 N	50 N	200 L	0.0 B	80	140	16	0 B
EC2116	0.5 N	200 N	10 N	10 N	70	5 N	50	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	1 L	0 B
EG2766	0.5 N	200 N	10 N	10 N	30	5 L	30	100 N	10 N	50 N	200 N	0.0 B	50	140	4	0 B
ROCK SAMPLES - SUNDAY CREEK - AREA 20																
EG2535	10.0	300	10 N	15	150	5 L	200	100 N	10 N	50 N	300	0.0 B	0 B	190	0 B	0 B
EG2536	0.5 N	200 N	10 N	10 N	100	5 N	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B

TABLE 8. ANALYTICAL RESULTS OF ANOMALOUS SAMPLES FROM ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM	EU
EG2536A	0.7	200 N	10 N	10 N	150	5 N	70	100 N	15	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - LENNOX CREEK - AREA 21																
EG2518	0.5 N	200 N	10 N	10 N	70	15	20	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1	0 B
EP2332	0.5	200 N	10 N	10 N	20	15	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EP2333	3.0	200 N	10 N	10 N	10	5 L	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2336	0.5 N	200 N	10 N	10 N	500	10	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2342	0.5 N	700	10 N	10 N	30	5	20	100 N	10 N	50 N	200	0.0 B	0 B	0 B	1	0 B
EP2343	1.5	200 N	10 N	10 N	10	5 N	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EP2346	0.5 N	200 N	10 N	10 N	20	10	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2347	0.7	200 N	10 N	10 N	15	15	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2349	0.5 N	200 N	10 N	10 N	20	15	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2352	0.5 N	200 N	10 N	10 N	30	5	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2353	0.5	200	10 N	10 N	30	30	30	100 N	10 N	70	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2354	0.5 N	200 N	10 N	10 N	15	5	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2355	0.5 N	200 N	10 N	10 N	15	15	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2358	0.5 N	200 N	10 N	10 N	15	10	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2365	0.5 N	200 N	10 N	10 N	15	7	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EP2368	0.5 N	500	10 N	10 N	500	7	70	100 N	10 N	50 N	1000	0.0 B	620	1700	40	0 B
EG2519	0.5 L	200 N	10 N	10 N	150	20	20	100 N	10 L	50 L	200 N	0.0 B	220	110	6	0 B
EG2520	0.5 N	200 N	10 N	10 N	70	5	20	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1	0 B
EG2522	0.5 N	200 N	10 N	10 N	30	30	15	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1	0 B
EG2523	0.5 N	200 N	10 N	10 N	70	30	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2528	0.5 N	200 N	10 N	10 N	7	5 L	10	100 N	10 N	100	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2531	0.5 N	200 N	10 N	10 N	20	15	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2532	0.5 N	200 N	10 N	10 N	30	7	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2533	0.5 N	200 N	10 N	10 N	50	5 L	70	100 N	10 N	50 N	200 L	0.0 B	95	200	6	0 B
EG2534	1.5	1500	10 N	10 N	150	5 L	150	100 N	10 N	50 N	200	0.0 B	220	390	35	0 B
EP2377	0.5 N	300	10 N	10 N	30	5	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2378	0.5 N	200 N	10 N	10 N	10	5	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2379	0.5 N	200	10 N	10 N	50	5 L	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2381	0.5 N	200 N	10 N	10 N	30	5	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2382	0.5	300	10 N	10 N	15	5 L	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2383	0.5	200 N	10 N	10 N	70	5 N	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2731	1.5	200 N	10 N	10 N	300	5 L	300	100 N	10 N	50 N	200 N	0.0 B	400	25	12	0 B
EG2736	0.5 N	200 N	10 N	10 N	30	5	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2737	0.5 N	200 N	10 N	10 N	100	5 N	30	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	1 N	0 B
EG2746	0.7	200 N	10 N	10 N	100	10	300	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EC2124	0.5 N	300	10 N	10 N	70	5 N	30	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1 L	0 B
EG2755	3.0	200 N	10 N	10 N	15	5 N	30	100 N	10 N	50 N	200 N	0.0 B	40	55	10	0 B
EG2756	0.7	200 N	10 N	10 N	30	5	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B

TABLE 8. ANALYTICAL RESULTS OF ANOMALOUS SAMPLES FROM ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM	EU
EG2757	0.5 L	200 N	10 N	10 N	15	5	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2758	0.5 N	200 N	10 N	10 N	50	5 L	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
EG2760	1.0	200 N	10 N	10 N	30	7	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EG2769	0.5 N	300	10 N	10 N	10	5 L	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2366	0.5 N	200 N	10 N	10 N	20 N	5 L	10	100 N	10 N	100	200 N	0.0 B	0 B	0 B	2	0 B
ROCK SAMPLES - LENNOX CREEK - AREA 21																
EG2518A	0.5 N	200 N	10 N	10 N	5 L	700	10 N	100 N	10 N	50 N	200 N	0.05 L	0 B	0 B	0 B	0 B
EG2519A	0.5 N	200 N	10 N	10 N	5	1000	10 N	100 N	10 N	50 N	200 N	0.05 N	0 B	0 B	0 B	0 B
EG2519B	0.5 N	200 N	10 N	10 N	70	15	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2524	30.0	200 N	10 N	10 N	10000	5 L	30	100 N	30	50 N	1500	0.0 B	0 B	1400	0 B	0 B
EG2524A	20.0	1500	10 N	20	7000	300	100	100 N	30	50 N	300	0.0 B	0 B	400	0 B	0 B
EG2524B	0.5 N	300	10 N	10 L	150	5	10	100 N	30	70	200 N	0.0 B	0 B	0 B	0 B	0 B
EP2368A	1.0	200 N	10 N	10 N	15	5 N	10	100 N	10 N	50 N	200 N	0.05 N	0 B	0 B	0 B	0 B
EP2368F	0.5 L	200 N	10 N	10 N	500	5 L	10 L	100 N	10 N	50 N	2000	0.05 L	0 B	1800	0 B	0 B
EP2368G	7.0	200 N	10 N	10 N	3000	5 L	10 N	100 N	10 N	50 N	500	0.20	0 B	320	0 B	0 B
EP2368H	0.5 N	200 N	10 N	10 N	15	5 L	10	100 N	10 N	50 N	500	0.05 N	0 B	180	0 B	0 B
EP2373	0.5 N	200 N	10 N	10 N	150	5 N	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2761	7.0	10000	10 N	10 N	7	5 N	200	500	10 N	50 N	500	0.30	0 B	85	0 B	0 B
EG2761A	20.0	3000	10 N	10 N	30	30	20	150	15	50 N	200 N	0.50	0 B	130	0 B	0 B
EG2761B	300.0	10000	10 N	10 N	700	5 N	1500	3000	300	50 N	7000	0.80	0 B	10000	0 B	0 B
EG2762	1.5	200 N	10 N	10 N	70	7	10	100 N	70	50 N	200 N	0.05 L	0 B	0 B	0 B	0 B
EG2762A	1.5	200 N	10 N	15	150	5 N	30	100 N	50	50 N	200 N	0.05 L	0 B	0 B	0 B	0 B
EG2762B	20.0	3000	10 N	30	15000	7	70	100 L	15	50 N	200 N	0.05	0 B	160	0 B	0 B
EG2763	0.5 L	200 N	10 N	10 N	70	5 N	10 N	100 L	50	50 N	200 N	0.05	0 B	0 B	0 B	0 B
EG2763A	0.5 N	200 N	10 N	10 N	20	7	15	100 N	10 N	50 N	200 N	0.05 N	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - WEST FORK OF THE MILLER RIVER - AREA 22																
EG2616	0.5 N	200 N	10 N	10 N	70	5 N	50	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1	0 B
EG2618	0.5 N	200 N	10 N	10 N	70	5 N	50	100 N	10 N	70	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2451	0.5	200 N	10 N	10 N	50	5 N	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
EP2452	7.0	1000	10 N	10 L	100	5 N	70	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	1 N	0 B
EP2453	1.5	200 N	10 N	10 N	70	5 N	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2456	7.0	300	10 N	10 N	100	5 N	70	100 N	10 N	50 L	200 L	0.0 B	0 B	0 B	1 N	0 B
EP2457	0.5 N	200 N	10 N	10 N	70	5 N	70	100 N	10 N	50 N	200 L	0.0 B	140	270	18	0 B
EP2458	0.5 N	200 N	10 N	10 N	70	5 N	30	100 N	10	50 L	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2089	0.5 N	200 N	10 N	10 N	70	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
ES2091	1.5	300	10 N	10 N	70	5 N	20	100 N	10 N	50 N	200 N	0.0 B	100	50	4	0 B
ES2093	1.0	200	10 N	10 N	50	5 N	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EC2134	0.5 N	200 N	10 N	10 N	30	5 L	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2817	0.5 N	200 N	10 N	10 N	20	5	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2	0 B
EG2821	0.5 N	200 N	10 N	10 N	50	5	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B

TABLE 8. ANALYTICAL RESULTS OF ANOMALOUS SAMPLES FROM ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM	EU
ROCK SAMPLES - WEST FORK OF THE MILLER RIVER - AREA 22																
ES2092	0.5 N	1000	10 N	10 N	15	5 L	10 L	100	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2834	0.5 N	1500	10 N	10 N	5	5 N	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2834A	0.5 N	3000	10 N	10 N	5	5 N	10 N	100 N	10	50 N	200 N	0.10	0 B	0 B	0 B	0 B
EG2834B	0.5 N	3000	10 N	10 N	5	5 N	10 N	100 N	20	50 N	200 N	0.10	0 B	0 B	0 B	0 B
EG2834C	0.5 N	3000	10 N	10 N	10	5 N	10 L	100 L	15	50 N	200 N	0.10	0 B	0 B	0 B	0 B
EG2835	7.0	10000	10 N	10 N	50	5 N	2000	1500	30	50 N	200 N	0.25	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - GOUGING LAKE - AREA 23																
EC2078	0.5 L	200 N	10 N	10 N	15	5 L	150	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EC2080	0.5 N	200 N	10 N	10 N	30	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EC2096	0.5 N	200 N	10 N	10 N	70	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
ROCK SAMPLES - GOUGING LAKE - AREA 23																
EC2093	0.5 N	200 N	10 N	10 N	200	5 N	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EC2097A	5.0	10000 G	10 N	700	1000	70	150	100 N	15	50	200 N	0.0 B	0 B	0 B	0 B	0 B
EC2098	0.5 N	200 N	10 N	10 N	50	5 N	30	100 N	10 N	50 N	700	0.0 B	0 B	800	0 B	0 B
STREAM SEDIMENT SAMPLES - EAST FORK OF THE MILLER RIVER - AREA 24																
EG2602	0.5 N	200 N	10 N	10 N	70	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2606	0.5 N	200 N	10 N	10 N	70	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EP2426	0.5 N	200 N	10 N	10 N	100	15	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2430	0.5 N	200 N	10 N	10 N	50	7	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2433	0.5 N	200 N	10 N	10 N	70	5	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2436	0.5 N	200 N	10 N	10 N	100	5 N	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2440	0.5 N	200 N	10 N	10 N	30	5	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2443	0.5 N	200 N	10 N	10 N	30	7	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
EG2614	0.5 N	200 N	10 N	10 N	70	7	20	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1 N	0 B
EP2448	0.5 N	200 N	10 N	10 N	70	5 N	50	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	1 L	0 B
ROCK SAMPLE - EAST FORK OF THE MILLER RIVER - AREA 24																
EG2601	0.5 N	200 N	10 N	10 N	10	5 N	10 L	100	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - LAKE DOROTHY NORTH - AREA 25																
EG2595	0.5 N	200 N	10 N	10 N	70	10	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2596	0.5 N	200 N	10 N	10 N	100	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L	0 B
EG2597	0.5 N	200 N	10 N	10 N	100	15	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N	0 B
EG2610	0.5 N	200 N	10 N	10 N	20	7	20	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	1 L	0 B
EG2611	0.5 N	200 N	10 N	10 N	70	7	100	100 N	10 N	50 L	200 N	0.0 B	0 B	0 B	2	0 B
EG2612	0.5 N	200 N	10 N	10 N	70	7	10 L	100 N	10 N	50	200 N	0.0 B	0 B	0 B	1 N	0 B

TABLE 8. ANALYTICAL RESULTS OF ANOMALOUS SAMPLES FROM ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM	EU
EG2827	0.5 N	200 N	10 N	10 N	10	5 L	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1	0 B
ROCK SAMPLE - LAKE DOROTHY NORTH - AREA 25																
EG2827A	0.5 N	200 L	10 N	10 N	15	5 N	15	100 N	10 N	50 N	200 N	3.50	0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - MINERAL CREEK - AREA 26																
ES0193	0.5 N	200 N	10 N	10 N	50	15	10	100 N	10 N	50 N	200 N	0.0 B	55	30	1 L	0 B
ES0194	1.5	200 N	10 N	10 N	150	10	30	100 N	10 N	50 N	200 N	0.02 L	180	120	3	0 B
EG2032	0.5 N	200 N	10 N	10 N	100	5 N	70	100 N	10 N	50 N	500	0.0 B	100	390	35	0 B
EG2427	0.5 N	200 N	10 N	10 N	100	5	10	100 N	10 N	50 N	200 N	0.0 B	140	90	6	0 B
EG2428	0.5 L	200 N	10 N	10 N	150	30	10	100 N	10 N	50 N	200 N	0.0 B	150	45	8	0 B
EG2430	0.5	200 N	10 N	10 N	700	20	30	100 N	10 N	50 N	200 N	0.0 B	590	80	40	0 B
EG2434	0.5 N	200 N	10 N	10 N	20	5 N	300	100 N	10 N	50 N	200 N	0.0 B	40	75	20	0 B
PAN CONCENTRATE SAMPLE - MINERAL CREEK - AREA 26																
EG2783	0.7	200 N	10 N	10 N	700	5 L	10 L	100 N	10 N	50 N	200 N	0.25	0 B	0 B	0 B	0 B
ROCK SAMPLES - MINERAL CREEK - AREA 26																
EG2413	0.5 N	200 N	10 N	10 N	10	5	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2420	0.5 N	200 N	10 N	10 N	20	5 L	10 N	100 N	10 N	50 N	300	0.0 B	0 B	220	0 B	0 B
EG2420A	0.5 N	200 N	10 N	10 N	200	5 L	10 N	100 N	10 N	50 N	200	0.0 B	0 B	250	0 B	0 B
EG2421	0.5 N	200 N	10 N	10 N	50	10	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2425	0.5 N	200 N	10 N	10 N	30	5	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2426	0.5 L	200 N	10 N	10 N	700	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2430A	0.5 N	200 N	10 N	10 N	300	5 N	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2431	0.5	200 N	10 N	10 N	700	7	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2431A	2.0	200 N	10 N	10 N	2000	300	10 N	100 N	10 L	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2431B	0.7	200 N	10 N	10 N	500	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2431C	1.0	200 N	10 N	10 N	700	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B
EG2432	0.5 N	200 N	10 N	10 N	150	5 N	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B	0 B

Table 9.--Analytical results of other anomalous samples gathered from or near the Alpine Lakes additions

[The analytical data in the table are separated into two categories on the basis of the type of sample taken: stream sediment and rock. The data are further classified on the basis of 10 areas mostly within the additions, but not within the anomalous areas where samples containing anomalous amounts of metal occur.

The letter symbols shown at the head of the columns of analytical data indicate the following: S, 6-step semiquantitative spectrographic analysis; AA, atomic absorption; CM-CX-HM, citrate-soluble heavy metals colorimetric test; and EU, radiometric uranium. The letter symbols at the right of the analytical data indicate the following: N, looked for but not detected; L, detected but below limit of determination value shown; G, detected in quantities greater than value shown; OB, not determined.

All elements, except iron, magnesium, calcium, and titanium, which are reported as percent, are reported in parts per million. Citrate-soluble heavy metals are reported in parts per million.]

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM
STREAM SEDIMENTS SAMPLES - CHIWAUKUM MOUNTAINS - ADDITION A															
EP2017	0.5 N	200 N	10 N	10 N	30	10	50	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	2
EG2092	0.5 N	200 N	10 N	10 N	20	5 N	10	100 N	10 N	50 N	200	0.0 B	0 B	0 B	1 L
EG2137	0.5 N	200 N	10 N	10 N	7	5	15	100 N	10 N	50 N	200 N	0.0 B	15	30	4
EG2152	0.5 N	200 N	10 N	10 N	20	5 N	10 L	100 N	10 N	100	200 N	0.0 B	0 B	0 B	1
EG2167	0.5 N	200 N	10 N	10 N	30	5	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2
EG2212	0.5 N	200 N	10 N	10 N	50	5 L	70	100 N	10 N	50 N	200 N	0.0 B	30	55	10
EG2214	0.5 N	200 N	10 N	10 N	70	5 L	15	100 N	10 N	50 N	200 N	0.0 B	20	30	12
EG2280	1.0	200 N	10 N	10 N	10	5 L	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1
ROCK SAMPLES - CHIWAUKUM MOUNTAINS - ADDITION A															
EG2055	0.5 N	200 N	10 N	10 N	100	5 N	20	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	0 B
EG2057	0.5 N	200 N	10 N	10 N	100	5 N	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2061	0.5 N	200 N	10 N	10 N	100	5 N	20	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	0 B
EP2031	0.5 N	200 N	10 N	10 N	30	5 N	20	100 N	10 N	50 N	200 L	0.0 B	0 B	20	0 B
EP2039	0.5 N	200 N	10 N	10 N	20	5 N	10	100 N	10 N	50 N	200 N	0.0 B	0 B	15	0 B
EG2114	0.5 N	200 N	10 N	10 N	100	5 N	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EP2080	0.5 N	200 N	10 N	10 N	150	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2262A	0.5 N	200 N	10 N	30	10	7	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2268	0.5 N	200 N	10 N	10 N	20	5	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2269	0.5 N	200 N	10 N	10 N	7	50	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EP2131	0.5 N	200 N	10 N	10 N	100	5 N	10 N	100 N	15	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2279A	0.5 N	200 N	10 N	10 N	5	5	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
ROCK SAMPLES - CASHMERE MTN. - ADDITION D															
EG0787A	0.5	200 N	10 N	10 N	300	5 N	10 L	100 N	10	50 N	200 N	0.02 N	10	0 B	0 B
ES0302	0.5 N	200 N	10 N	10 N	100	5 N	30	100 N	10 N	50 N	200 N	0.02 N	230	0 B	0 B
EG0785	0.5 N	200 N	10 N	10 N	100	5 N	10	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	0 B
EG0784	0.5 N	200 N	10 N	10 N	150	5 N	10	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - SOUTH FORK OF FORTUNE CREEK - ADDITION G															
ET0304	1.0	200 N	10 N	10 N	30	5 N	20	100 N	10 N	50 N	200 N	0.02 L	25	50	2
EG1071	0.5 N	200 N	10 N	10 N	30	5 N	15	100 N	10 N	50 N	200	0.05 N	30	0 B	3
ROCK SAMPLES - SOUTH FORK OF FORTUNE CREEK - ADDITION G															
EG1070	3.0	1000	15	10 N	3000	5 N	15	100 N	10 N	50 N	300	16.00	0 B	0 B	0 B
EG1070A	0.5 N	200 L	10 N	10 N	500	5 N	10 L	100 N	10 N	50 N	3000	2.50	0 B	0 B	0 B
EG1081	0.5 N	200 N	10 N	10 N	300	5 N	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG1081A	2.0	200 N	10 N	10 N	20000 G	30	10 N	100 N	10 N	50 N	500	0.05 N	0 B	0 B	0 B
EG1081B	0.5 N	200 N	10 N	10 N	10000	5 N	10 N	100 N	10 N	50 N	200	0.05 N	0 B	0 B	0 B

TABLE 9. ANALYTICAL RESULTS OF OTHER ANOMALOUS SAMPLES FROM AND NEAR ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM
EG2809	30.0	10000 G	30	100	7000	5 L	30	500	15	50 N	300	18.00	0 B	250	0 B
EG2809A	5.0	10000 G	30	50	300	5	10 L	500	10 N	50 N	200 N	32.00	0 B	0 B	0 B
EG2810	0.5 N	1500	10 N	10 N	10	5 N	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLE - GOAT MOUNTAIN - POLALLIE - ADDITION H															
EP2341	0.5 N	200 N	10 N	10 N	15	5 L	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
ROCK SAMPLES - GOAT MOUNTAIN - POLALLIE - ADDITION H															
EG1469C	3.0	200 N	10 N	10 N	50	5 N	100	10000 G	10 N	50 N	200 N	0.05	0 B	0 B	0 B
EG2007B	0.5 N	200 N	10 N	10 N	150	5 N	10 N	100 N	10 N	50 N	500	0.0 B	0 B	110	0 B
EG1469B	0.5 N	200 N	10 N	10 N	20	5 N	20	200	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2008	0.5 N	200 N	10 N	10 N	30	5 N	10 N	100 N	10 N	50 N	300	0.0 B	0 B	110	0 B
EG2335	0.5 N	200 N	10 N	10 N	5 L	100	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2349	0.5 N	200 N	10 N	10 N	15	5	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2356	0.5 N	200 N	10 N	10 N	10	5	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EP2211	0.5 N	200 N	10 N	10 N	10	5	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EP2215	0.5 N	200 N	10 N	10 N	15	7	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2382A	0.5 N	200 N	10 N	10 N	7	15	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EP2234	0.5 N	200 N	10 N	10 N	5	7	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EP2236	0.5 N	200 N	10 N	10 N	7	7	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2807	0.5 N	200 N	10 N	10 N	100	5 L	10 L	100 N	15	50 N	200 N	0.0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - LAKE LILLIAN - ADDITION J															
EP2249	0.5 N	200 N	10 N	10 N	50	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L
EP2257	0.5 N	200 N	10 N	10 N	30	5 N	200	100 N	10 N	50 N	200 N	0.0 B	25	35	4
EG2445	0.5 N	200 N	10 N	10 N	30	5 L	30	100 N	10 N	50 N	200 N	0.0 B	10	45	10
ROCK SAMPLES - LAKE LILLIAN - ADDITION J															
EP2251	0.5 N	200 N	10 N	10 N	70	5	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2449	0.5 N	200 N	10 N	10 N	300	15	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - SOUTH AND MIDDLE FORKS OF THE SNOQUALMIE RIVER - ADDITION L															
EG2464	0.5 N	200 N	10 N	10 N	150	5 L	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1
EP2270	0.5 N	200 N	10 N	10 N	150	5 L	20	100 N	10 N	50 N	200 N	0.0 B	150	65	10
EP2274	0.5 N	200 N	10 N	10 N	70	5	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1
EG2486	0.5 N	200 N	10 N	10 N	200	10	500	100 N	10 N	50 N	200 L	0.0 B	220	90	30
EP2322	0.5	200 N	10 N	10 N	50	5 L	30	100 N	10 N	50 N	200 L	0.0 B	0 B	0 B	1
EP2325	0.5 N	200 N	10 N	10 N	30	7	10	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1
EP2394	0.7	200 N	10 N	10 N	15	5 L	100	100 N	30	50 N	200 N	0.0 B	0 B	0 B	1 L
EP2408	0.5 L	200 N	10 N	10 N	100	5	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
ES2043	0.5 N	200 N	10 N	10 N	70	7	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM
ROCK SAMPLES - SOUTH AND MIDDLE FORKS OF THE SNOQUALMIE RIVER - ADDITION L															
EG2460	0.5 N	200 N	10 N	10 N	10	15	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2464A	0.5 N	200 N	10 N	10 N	70	7	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2486A	0.5 N	200 N	10 N	10 N	70	15	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2553	0.5 N	200 N	10 N	10 N	100	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2780	0.5 N	200 N	10 N	10 N	300	5 L	10 N	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - MIDDLE FORK OF THE SNOQULLMIE RIVER - TAYLOR RIVER - ADDITION M															
EG2373	0.5 N	200 N	10 N	10 N	70	5 L	70	100 N	10 N	50 N	200	0.0 B	0 B	0 B	1
EG2499	0.5 N	200 N	10 N	10 N	50	5 L	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1
EG2644	0.5 N	200 N	10 N	10 N	70	5	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1
EC2020	0.5 N	200 N	10 N	10 N	20	5 N	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
EP2474	0.5 N	200 N	10 N	10 N	20	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
EC2023	0.5 L	200 N	10 N	10 N	30	5 L	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
EC2047	0.5	200 N	10 N	10 N	70	5	15	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
EC2051	0.5	200 N	10 N	10 N	30	5 L	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
EC2056	0.5 N	200 N	10 N	10 N	50	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
STREAM SEDIMENT SAMPLES - LENNOX CREEK - MILLER RIVER - ADDITION N															
EC2066	0.5 N	200 N	10 N	10 N	100	5 N	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
EC2083	0.5 N	200 N	10 N	10 N	70	5 N	50	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 L
EG2822	0.7	300	10 N	10 N	30	5	200	100 N	10 N	50 N	200 N	0.0 B	45	120	8
EG2823	0.5 L	700	10 N	10 N	30	5 L	100	100 N	10 N	50 N	200 N	0.0 B	50	100	6
EG2717	0.5 N	200 N	10 N	10 N	50	5 L	70	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
ROCK SAMPLES - LENNOX CREEK - MILLER RIVER - ADDITION N															
EG2738	5.0	1500	10 N	10 N	150	5 N	700	100 N	10 N	50 N	700	0.0 B	0 B	650	0 B
EG2738A	50.0	10000 G	10 N	150	1000	5	700	100 L	30	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2738B	0.5	1000	10 N	10 N	30	5 N	20	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
EG2824	1.5	10000 G	10 N	10 N	30	5 L	70	300	10 N	50 N	200 N	0.0 B	0 B	0 B	0 B
STREAM SEDIMENT SAMPLES - FOSS RIVER - ADDITION O															
ES2078	0.5 N	200 N	10 N	10 N	20	10	10 L	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1 N
EG2748	0.5 N	200 N	10 N	10 N	70	5 N	150	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	1
EG2750	0.5 N	200 N	10 N	10 N	30	5 N	50	100 N	10 N	50 N	200	0.0 B	0 B	0 B	1 L
ROCK SAMPLES - FOSS RIVER - ADDITION O															
EG2107	0.5 N	200 N	10 N	10 N	70	5 N	20	100 N	10 N	50 N	200 L	0.0 B	0 B	80	0 B
EG2108	0.5	200 N	10 N	10 N	150	5 N	50	100 N	10 N	50 N	200	0.0 B	0 B	210	0 B

TABLE 9. ANALYTICAL RESULTS OF OTHER ANOMALOUS SAMPLES FROM AND NEAR ADDITIONS TO THE ALPINE LAKES AREA--CONTINUED

SAMPLE	S-AG	S-AS	S-AU	S-BI	S-CU	S-MO	S-PB	S-SB	S-SN	S-W	S-ZN	AA-AU-P	AA-CU-P	AA-ZN-P	CM-CX-HM
STREAM SEDIMENT SAMPLES - DECEPTION CREEK - TUNNEL CREEK - ADDITION Q															
EG0064	0.5 N	200 N	10 N	10 N	20	5 N	100	100 N	10 N	50 N	200 N	0.0 B	15	60	5
EG0705	0.5 N	200 N	10 N	10 N	15	5 N	50	100 N	10 N	50 N	200 N	0.0 B	15	30	2
EG0706	0.5 N	200 N	10 N	10 N	100	5 N	30	100 N	10 N	50 N	200 N	0.0 B	0 B	0 B	2
EG0717	0.5 N	200 N	10 N	10 N	15	5 N	50	100 N	10 N	50 N	200 N	0.0 B	15	35	3
EG0718	0.5 N	200 N	10 N	10 N	15	5 N	200	100 N	10 N	50 N	200 N	0.0 B	15	100	25

STUDIES RELATED TO WILDERNESS

STUDY AREAS

In accordance with the provisions of the Wilderness Act (Public Law 88-577, Sept. 3, 1964) and the Conference Report on Senate bill 4, 88th Congress, the U.S. Geological Survey and the U.S. Bureau of Mines have been making mineral surveys of wilderness and primitive areas. Studies and reports of all primitive areas have been completed. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are currently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. This report discusses the results of a mineral survey of some national forest lands in additions to the Alpine Lakes study area, Washington, that are under consideration for wilderness designation. The areas studied are on the crest of the Cascade Range in west-central Washington.