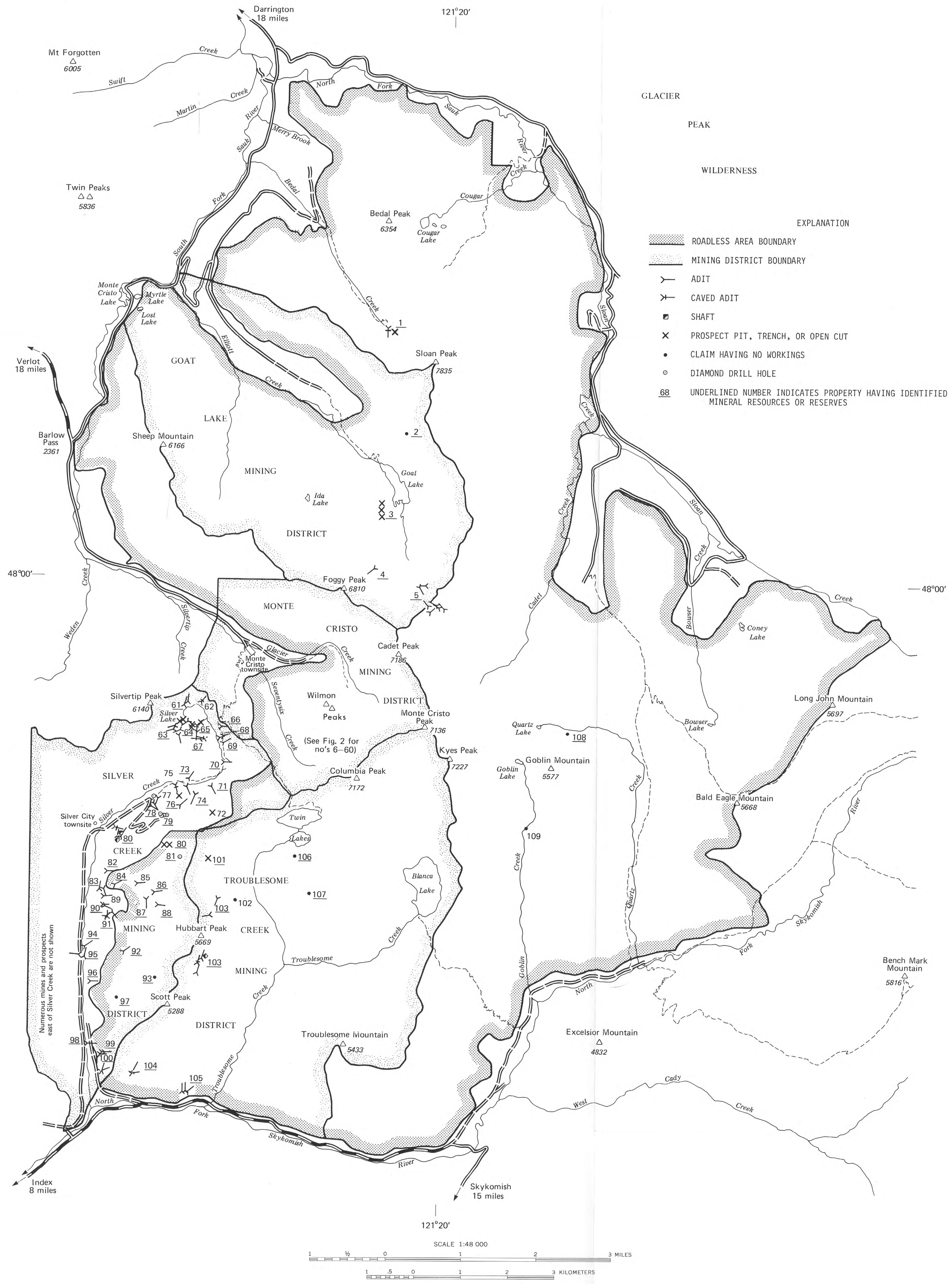
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1380-E
SHEET 1 OF 2



EXPLANATION

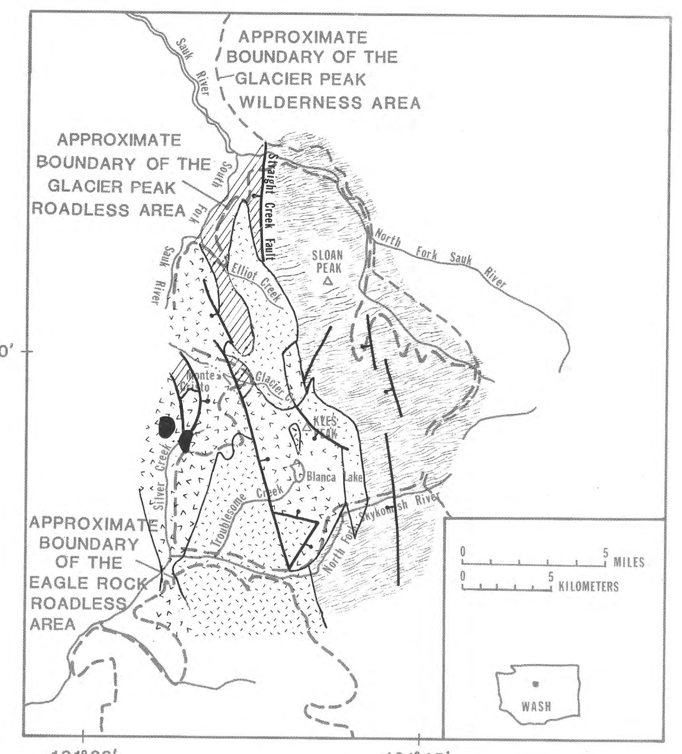
- ROADLESS AREA BOUNDARY
- MINING DISTRICT BOUNDARY
- ADIT
- CAVED ADIT
- SHAFT
- PROSPECT PIT, TRENCH, OR OPEN CUT
- CLAIM HAVING NO WORKINGS
- DIAMOND DRILL HOLE
- 68 UNDERLINED NUMBER INDICATES PROPERTY HAVING IDENTIFIED MINERAL RESOURCES OR RESERVES

LIST OF MINES AND PROSPECTS

[Symbol indicates resources or reserves for that commodity.

Au-gold, Ag-silver, Cu-copper, Pb-lead, Zn-zinc, Asb-asbestos]

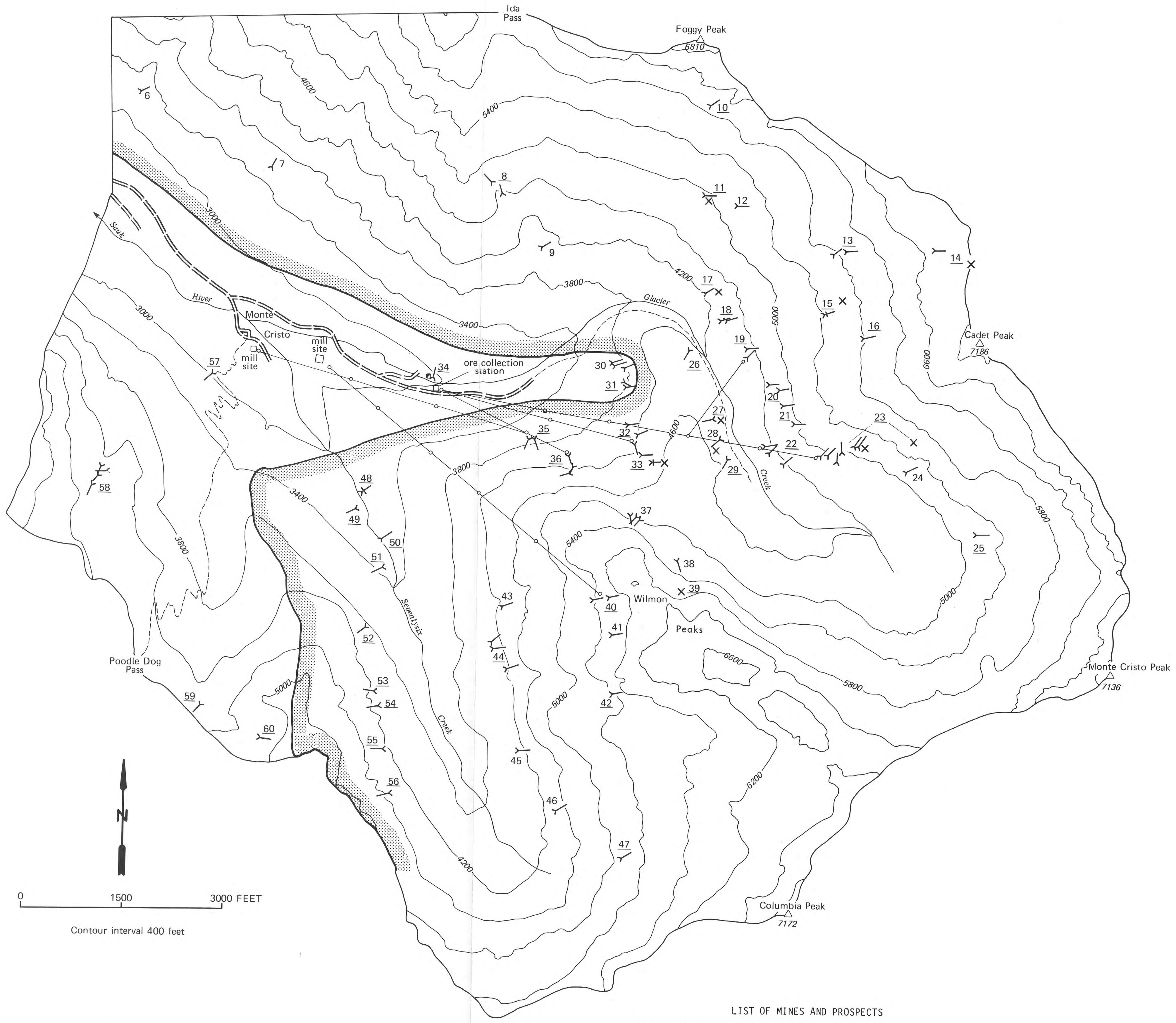
1. Phoenix Asbestos prospect Asb
2. Washington claim Au,Ag,Cu,Pb,Zn
3. East Standard prospect Au,Ag,Cu
4. Ida prospect Au,Ag,Zn
5. Foggy mine Au,Ag
6. Snowbird prospect
7. Tobique prospect
8. Marmot No. 1 prospect Au,Ag,Cu,Zn
9. Marmot No. 2 prospect
10. Montrose prospect Au
11. Shakespeare prospect Au,Ag,Cu,Pb,Zn
12. Pion prospect
13. Whistler prospect Au,Ag,Cu,Pb,Zn
14. Hilda prospect Au,Ag,Cu,Pb,Zn
15. Eureka prospect Au,Ag,Cu,Zn
16. Pica prospect Au,Ag,Cu,Pb,Zn
17. Hydra No. 2 prospect Ag,Cu,Pb,Zn
18. Tuscola prospect Au,Ag,Cu,Pb,Zn
19. Philo prospect Au,Ag,Cu,Pb,Zn
20. Portland No. 2 prospect Au,Ag,Cu,Pb,Zn
21. Washington prospect Au,Ag,Cu,Pb,Zn
22. New Discovery mine Au,Ag,Cu,Pb,Zn
23. Pride of the Mountains mine Au,Ag,Cu,Pb,Zn
24. Side Line prospect
25. Ptarmigan prospect Au,Ag,Cu,Pb,Zn
26. Meridian prospect Au,Ag,Cu,Pb,Zn
27. Potomac prospect Au,Ag,Cu,Pb,Zn
28. Pride of the Woods mine
29. IXL prospect Au,Ag
30. Pusher prospect
31. Portland No. 1 prospect Au,Ag,Cu,Pb,Zn
32. Clara prospect Au,Ag,Pb
33. Mystery mine Au,Ag,Cu,Pb,Zn
34. Rainy mine Au,Ag,Cu,Pb,Zn
35. Justice mine Au,Ag,Cu,Pb,Zn
36. Golden Cord mine Au,Ag,Cu,Pb,Zn
37. American prospect
38. Monte Cristo prospect
39. Ouida prospect Au,Ag,Cu,Pb,Zn
40. Comet mine Au,Ag,Pb,Zn
41. Nelsor prospect
42. Ranger prospect Au,Ag,Cu,Pb,Zn
43. Glacier prospect
44. Seventy-Six mine Au,Ag,Cu,Zn
45. Ibex No. 1 prospect
46. Iron Dale prospect
47. Iron Mask prospect Au,Pb,Zn
48. Lincoln mine Au,Ag,Cu,Pb
49. Liberty prospect Au,Ag
50. Sidney mine Au,Ag
51. Sheridan mine Au
52. Mountain Maid prospect Au,Ag,Cu,Pb,Zn
53. Hannah prospect Au,Ag,Pb,Zn
54. Emma Moore prospect Au,Ag,Cu,Pb,Zn
55. Seventy-Four prospect Au,Ag,Cu,Pb,Zn
56. Congress prospect Au,Ag,Cu,Pb,Zn
57. Boston-American mine Au,Ag
58. Oliver and Birney mine Au,Ag,Cu
59. Zeta mine Au,Ag,Cu
60. Jenny D. prospect Au,Ag
61. W. Danseau prospect Au,Ag
62. Sue Kay prospect
63. Bonita prospect Au,Ag
64. Cheryl Lee prospect Au,Ag
65. F.E. Davis prospect Au,Ag,Cu,Zn
66. Seattle-Aurora prospect Au,Ag
67. Stockton prospect Au,Ag,Cu
68. Orphan Boy mine Au,Ag,Zn
69. Q.T. prospect Au,Ag,Cu,Zn
70. Minehaha prospect Au,Ag,Cu
71. Smuggler mine Au,Ag,Cu
72. Ajax prospect
73. Evening Star mine Au,Ag,Cu
74. Good Hope mine Au,Ag,Cu
75. Lucky Boy mine
76. Starlight prospect Au,Ag,Cu,Pb,Zn
77. Moly Gulch prospect
78. Mountain Queen prospect Au,Ag,Cu
79. Seacrest prospect Cu,Mo
80. New York-Seattle mine Au,Ag,Cu
81. Matt prospect Cu,Mo
82. Donkey prospect Au
83. Crown Point prospect Cu
84. Blue Canyon prospect Au,Ag,Zn
85. Oscar Todd prospect
86. Kotzebue prospect Au,Ag,Cu
87. Siberia prospect Au,Ag
88. High Level prospect Au,Ag,Cu
89. Helen No. 7 prospect
90. Helen May No. 6 prospect Au,Cu
91. Helen May No. 1 prospect Au,Ag,Cu
92. Spencer prospect Au,Ag,Cu
93. Ruby claim Au,Ag,Cu,Pb,Zn
94. Drednot prospect Au,Ag
95. Cascade prospect Au,Ag,Cu,Pb,Zn
96. Texas prospect Au
97. BG 1-8 claims Au,Ag,Cu
98. Everett prospect Au,Cu,Zn
99. Morning Glory prospect Au,Ag,Cu
100. Ione prospect Ag,Cu
101. Red Mountain prospect Au,Ag,Cu
102. Corona prospect
103. Daisy mine Au,Ag,Cu,Pb,Zn
104. Shamrock prospect Ag,Cu
105. Good Luck prospect Au,Cu
106. Great Scott claim Au,Cu
107. Remonille claim Au,Ag,Cu,Pb,Zn
108. Quartz Creek claim Au,Ag
109. Goblin Creek claim



EXPLANATION

- TONALITE INTRUSIVE (UPPER MIOCENE)
- VOLCANIC AND SEDIMENTARY ROCKS (MIOCENE TO EOCENE)
- GRANODIORITE PLUTON (MIOCENE TO OLIGOCENE)
- METAMORPHIC ROCKS (CRETACEOUS)
- METAMORPHOSED MARINE SEDIMENTARY AND VOLCANIC ROCKS (CRETACEOUS-PERMIAN)
- CONTACT
- FAULT--Bar and ball on downthrown side

Figure 1.--Index map showing simplified geology of the Glacier Peak Roadless Area, L6031 (geology after Tabor and others, 1982b).



EXPLANATION

- ROADLESS AREA BOUNDARY
- ADIT
- CAVED ADIT
- SHAFT
- PROSPECT PIT, TRENCH, OR OPEN CUT
- 8 PROPERTY HAVING IDENTIFIED MINERAL RESOURCES OR RESERVES
- APPROXIMATE TRAMWAY SITE

LIST OF MINES AND PROSPECTS

[Symbol indicates resources or reserves for that commodity.

Au-gold, Ag-silver, Cu-copper, Pb-lead, Zn-zinc, Asb-asbestos]

6. Snowbird prospect
7. Tobique prospect
8. Marmot No. 1 prospect Au,Ag,Cu,Zn
9. Marmot No. 2 prospect
10. Montrose prospect Au
11. Shakespeare prospect Au,Ag,Cu,Pb,Zn
12. Pion prospect
13. Whistler prospect Au,Ag,Cu,Pb,Zn
14. Hilda prospect Au,Ag,Cu,Pb,Zn
15. Eureka prospect Au,Ag,Cu,Zn
16. Pica prospect Au,Ag,Cu,Pb,Zn
17. Hydra No. 2 prospect Ag,Cu,Pb,Zn
18. Tuscola prospect Au,Ag,Cu,Pb,Zn
19. Philo prospect Au,Ag,Cu,Pb,Zn
20. Portland No. 2 prospect Au,Ag,Cu,Pb,Zn
21. Washington prospect Au,Ag,Cu,Pb,Zn
22. New Discovery mine Au,Ag,Cu,Pb,Zn
23. Pride of the Mountains mine Au,Ag,Cu,Pb,Zn
24. Side Line prospect
25. Ptarmigan prospect Au,Ag,Cu,Pb,Zn
26. Meridian prospect Au,Ag,Cu,Pb,Zn
27. Potomac prospect Au,Ag,Cu,Pb,Zn
28. Pride of the Woods mine
29. IXL prospect Au,Ag
30. Pusher prospect
31. Portland No. 1 prospect Au,Ag,Cu,Pb,Zn
32. Clara prospect Au,Ag,Pb
33. Mystery mine Au,Ag,Cu,Pb,Zn
34. Rainy mine Au,Ag,Cu,Pb,Zn
35. Justice mine Au,Ag,Cu,Pb,Zn
36. Golden Cord mine Au,Ag,Cu,Pb,Zn
37. American prospect
38. Monte Cristo prospect
39. Ouida prospect Au,Ag,Cu,Pb,Zn
40. Comet mine Au,Ag,Pb,Zn
41. Nelsor prospect
42. Ranger prospect Au,Ag,Cu,Pb,Zn
43. Glacier prospect
44. Seventy-Six mine Au,Ag,Cu,Zn
45. Ibex No. 1 prospect
46. Iron Dale prospect
47. Iron Mask prospect Au,Pb,Zn
48. Lincoln mine Au,Ag,Cu,Pb
49. Liberty prospect Au,Ag
50. Sidney mine Au,Ag
51. Sheridan mine Au
52. Mountain Maid prospect Au,Ag,Cu,Pb,Zn
53. Hannah prospect Au,Ag,Pb,Zn
54. Emma Moore prospect Au,Ag,Cu,Pb,Zn
55. Seventy-Four prospect Au,Ag,Cu,Pb,Zn
56. Congress prospect Au,Ag,Cu,Pb,Zn
57. Boston-American mine Au,Ag
58. Oliver and Birney mine Au,Ag,Cu
59. Zeta mine Au,Ag,Cu
60. Jenny D. prospect Au,Ag

Figure 2.--Enlargement of the Monte Cristo mining district.

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal land to determine their mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mines and prospects survey of the Glacier Peak Roadless Area (L6031), Mount Baker-Snoqualmie National Forest, Snohomish County, Wash. The Glacier Peak Roadless Area was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979. The Washington Wilderness Act designates that the roadless area be incorporated with the Glacier Peak Wilderness as designated by Public Law 88-577 and Public Law 90-544.

INTRODUCTION

The Glacier Peak Roadless Area (fig. 1), covering 57,320 acres in the Cascade Range, is 50 mi northeast of Seattle, Wash. Over 4,000 claims have been located in or near the roadless area. One hundred ninety-six patented claims are in or within 1 mi of the area. Ore production from the roadless area is estimated to be about 280,000 tons, mainly gold-silver ore from seven mines in the Monte Cristo mining district. Of the 57,320 acres, about 2,100 acres are patented mining claims. The roadless area is bounded on the south and west by county roads and on the northeast by U.S. Forest Service roads. It is adjoined by the Glacier Peak Wilderness on the east.

The roadless area is characterized by extremely rough topography. Elevations range from 1,100 ft along the North Fork Skykomish River to 7,835 ft at the summit of Sloan Peak. Located on the west side of the Cascade crest, the area receives much precipitation. The climate, combined with the rough topography, creates unusually severe mining problems. Very dense brush and forest covers the area from valley floors to about 4,500 ft elevation. Snow starts accumulating at higher elevations in September, with severe avalanche conditions persisting from late October through early June. During hard winters, snow depths may reach as much as 10 ft in Monte Cristo and 30 ft on the upper slopes of mountains.

During the 6 years ending in 1981, U.S. Bureau of Mines personnel attempted to find all mines, prospects, and mineral occurrences in and near the Glacier Peak Roadless Area. One hundred sixty-two underground and 43 surface workings were found, examined, and, where warranted, mapped and sampled. Heavy brush cover, inclement weather, heavy snow pack, and extremely steep topography limited those areas which could be investigated thoroughly. In spite of these conditions, about 2,060 samples were taken from outcrops, stockpiles, and dumps. These samples were analyzed by atomic absorption, chemical, and fire assay methods. At least one sample from every prospect was analyzed by semiquantitative spectrographic methods to determine the presence of unsuspected elements. Table 1 lists all properties that were examined during the investigation and summarizes data collected in the field. Complete sample analyses are on file at the U.S. Bureau of Mines, Western Field Operations Center, Spokane, Wash.

In addition to this study, the U.S. Bureau of Mines examined many of the mines and prospects in the Silver Creek mining district during the 1950's (Magill and Schlagel, 1962). Spurr (1901) examined the Monte Cristo mining district during the summer of 1900.

Many mining companies were active in the roadless area from the early 1890's through the 1930's. More recently, Texasgulf, Inc., Exxon Minerals Co., Cities Service Co., Duval Corp., Inspiration Development Co., Nord Resources Corp., Tanda Exploration, Burlington Northern, Inc., Bear Creek Mining Co., Bren Mac Mines Ltd., Bethex Corp., and others have been exploring in the area. Development work was in progress at the Shamrock prospect in the Troublesome Creek mining district during the summer of 1981.

ACKNOWLEDGMENTS

Mike King and John Robinson, U.S. Forest Service personnel, furnished information regarding claims, access routes, and names of claim owners. Phillip R. Woodhouse, author of the book "Monte Cristo," was especially helpful in providing information about the mining history of the area. Jerod Rosman, currently a resident of Monte Cristo, also provided helpful information.

Collection of samples and field data was aided by Terry Close, Fred Spicker, Rod Jeske, Dale Avery, Bill White, Mike DeVeau, Jim Werle, Jim Rigby, Doug Harby, Jeff Wilson, Randy Cross, Jim Greeves, Larry Reigel, Sue Lupinski, Rob Collins, Steve Drussel, Craig Rankin, Stuart Simpson, Corolla Hoag, Susan Douglas, Kevin Lakey, Glen Carter, Ruth Satterlund, Bill Wickstrom, Dominic Winslow, Dave Hatfield, and Rick Fredricksen. Appreciation is also extended to our helicopter pilots LeRoy Brown, Ben VanEtten, Timothy Wiltrout, and Jerry Wise.

GEOLOGY

The Glacier Peak Roadless Area (fig. 1) is roughly divided into two geologic terranes by the north-trending Straight Creek fault, a major Pacific Northwest structure which may have had considerable strike-slip movement prior to the Tertiary (Vance and Miller, 1981). Rocks west of the fault are part of a major melange belt and consist of the low-grade, metamorphic Darrington Phyllite of Misch (1966) and relatively unmetamorphosed marine sandstone, shale, basalt, chert, and ultramafic rocks. Rocks east of the fault are the higher grade metamorphic rocks of the North Cascades crystalline core, which consist mostly of the metamorphosed shale of the Chiwaukum Schist, banded gneiss derived from the schist, and gneissic Sloan Creek plutons. Through most of the roadless area, the Straight Creek fault has been intruded by tonalite and granodiorite of the Miocene Grotto batholith (25 m.y.), which now separates the contrasting rocks of the two terranes. West of the fault, the constituents of the melange range in age from Permian to Triassic and possibly Jurassic (Tabor and others, 1982a, 1982b). The melange is overlain by strongly folded, fluviatile, feldspathic sandstone of the Eocene Swauk Formation, the principal host for the sulfide vein-type mineralization in the Silver Creek mining district.

The melange rocks, the Swauk Formation, the Darrington Phyllite, and the metamorphic rocks east of the Straight Creek fault are overlain unconformably by the Barlow Pass volcanic rocks of Vance (1957). In the roadless area, the volcanic rocks are highly altered and locally recrystallized to hornfels by the Tertiary plutons. In the Monte Cristo mining district, Barlow Pass volcanic rocks are a principal host for ore.

The youngest tonalite intrusions crop out in the upper reaches of Silver Creek. The small tonalite intrusions are part of a linear array of small stocks and plugs extending northeastward to the 23-m.y.-old Cloudy Pass batholith in the Glacier Peak Wilderness. This linear array is also reflected in geochemical anomalies and is more or less coincident with the northeast-trending Glacier Peak transverse structural belt of Grant (1969, p. 40-41).

Mineralization occurs in northeast-trending, sulfide-bearing quartz veins and shear zones associated with the tonalite intrusions. Mineralization may have been controlled by the intersection of the northwest-trending Straight Creek fault with the Glacier Peak transverse structural belt. The structural belt is characterized by an en echelon, northeast-trending shear and fracture system traceable from the west edge of the Index mining district, located south of the roadless area, into the Glacier Peak Wilderness.

MINING DISTRICTS AND MINERAL DEPOSITS

Exploration in the Glacier Peak Roadless Area began in the 1870's in the Silver Creek mining district and spread to the Monte Cristo mining district in 1889. Although exploration activity in the Silver Creek mining district has been intense, nearly all production has been from the Monte Cristo mining district. Mining activity was greatest during the late 1800's and early 1900's. Exploration activity in the Goat Lake and Troublesome Creek mining districts has been moderate, but there is no recorded production from either district.

Over 4,000 mining claims had been located in or near the Glacier Peak Roadless area by summer 1979, and 196 patented claims are in or within 1 mi of the roadless area. A few placer claims have been located along Glacier Creek, Silver Creek, Troublesome Creek, Elliot Creek, and the South Fork Sauk River. Of the total number of claims, over 2,500 were in the Silver Creek mining district, 1,130 in the Monte Cristo mining district, 180 in the Troublesome Creek mining district, 179 in the Goat Lake mining district, and about 100 in outlying parts of the roadless area.

Mineral occurrences are of several distinct types. They include copper-molybdenum porphyries, sulfide-bearing quartz veins in fault zones, sulfide-bearing shear zones, sulfide-bearing breccia pipes, copper- and nickel-bearing ultramafic bodies, stockwork systems, and gold-bearing placers. Known mineral resources in the roadless area occur in northeast-trending, sulfide-bearing quartz veins and shear zones controlled by the intersection of the northwest-trending Straight Creek fault with the Glacier Peak transverse structural belt.

Monte Cristo mining district

The Monte Cristo mining district (fig. 2) is in the west-central part of the roadless area. It is accessible by a county gravel road from Barlow Pass. Philip Woodhouse (1979) has studied the mining history of the region, and data from his book was used freely.

Prospecting in the Monte Cristo mining district began in the spring of 1889 when Joe Pearsall found sulfide-bearing quartz veins as rich as "Monte Cristo." Pearsall, accompanied by Frank Peabody, staked the Independence of 1776 on July 4, 1889, the first mining claim in the district. Claim staking and development work gained momentum after Joe Pearsall's first visit.

Stories about the ore deposits in the district were making headlines from coast to coast and this prompted investors, including John D. Rockefeller, to buy into the mines. By spring 1891, construction of a road up the Sauk River from Sauk City had begun. Finally, on September 6, 1893, after many problems, the Everett and Monte Cristo Railroad was completed, and the first scheduled train reached Monte Cristo.

During the early 1890's, while the railroad was being constructed, development at the mines was continuing at a fast pace. In 1893, work began on a 300-ton-per-day concentrator and tramways to the Mystery and Pride of the Mountains mines. The tramways were completed in early August 1894. The concentrator began treating ore from the district on August 20, 1894, and the first concentrates were shipped to the Everett smelter shortly thereafter.

The town of Monte Cristo grew and prospered as the mines produced high-grade ore, reaching record levels each year until November 19, 1897, when massive floods destroyed much of the railroad. Investors announced that the railroad would not be rebuilt; most mining ceased in the district in December 1897.

Rockefeller gained controlling interest in the Monte Cristo mines and attendant companies by early 1899. Railroad service was restored to Monte Cristo during the summer of 1900, and mining began again. Josiah Spurr, of the U.S. Geological Survey, studied the geology and ore deposits in the district during the summer of 1900, and a report was published in 1901. Spurr concluded that the ore value decreased with depth. After Spurr's report was published, Rockefeller began selling his holdings. The Guggenheim smelter trust, later to be known as ASARCO, acquired the Monte Cristo Mines and the Everett smelter. The company was interested mainly in the smelter, so again the mines were shut down in 1903. Limited production resumed in 1906, but the mines were closed again in the fall of 1907. Several feeble attempts were made to revive mining in the district through the winter of 1920 without success. The district has been idle since 1920.

By summer 1979, over 1,130 claims had been located in the Monte Cristo mining district. Seventy-four patented claims are in or partially in the district. Several placer claims are located along the Sauk River from the confluence of Seventysix Creek with Glacier Creek.

Among the important mineral deposits in the Monte Cristo district, the northeast-trending, northwest-dipping shear zone developed by the Justice, Golden Cord, Mystery, Pride of the Woods, New Discovery, and Pride of the Mountains mines (fig. 2) has produced the bulk of the ore (Church and others, 1983). The shear zone is exposed either underground or on the surface over a strike length of 5,800 ft. It ranges in width from less than 1 ft to over 20 ft and contains quartz veins and lenses that pinch and swell sporadically along both strike and dip. The veins and lenses contain various amounts of pyrite, pyrrhotite, arsenopyrite, sphalerite, galena, chalcopyrite, stibnite, and lesser amounts of azurite, malachite, boulangerite, realgar, orpiment, and numerous unidentified sulfosalts. The sheared, bleached, limonite-stained country rock bordering the quartz veins contains disseminated sulfide minerals, but metal concentrations are much lower than in the veins. Most of the other deposits in the district resemble this deposit and are different only in scale.

Silver Creek mining district

The Silver Creek mining district extends into the southwest part of the roadless area. It is accessible by a poor-quality county road from the main road along the North Fork Skykomish River.

The first mining claims in the Silver Creek district were located by George White and Hill Tyler in 1871. A rush of prospectors resulted in establishment of the town of Silver City near the head of Silver Creek in May 1873. An arrastra was built to crush and grind gold ore in 1880, but the ores of the district were not free-milling, and gravity concentration of ground ore was unsuccessful. Prospecting activity waned until the discovery of the Monte Cristo district in 1889. By 1907, the New York-Seattle mine had a mill and tramway operating and the mine was producing ore. Production was short-lived and exploration activity did not pick up again until the late 1950's when major companies began exploring for porphyry copper deposits (Majors and McCollum, 1977).

In 1967 and 1968, Seacrest Oil Co. explored a copper deposit using geophysical methods and subsequently drilled eight holes, all outside the roadless area. Cities Service Co. staked claims and drilled several holes from 1976 through 1979, two of these are in the roadless area. In 1980, Exxon Minerals Co. drilled a deep hole in a copper porphyry system that may extend into the roadless area.

Over 2,500 mining claims have been located in the district; many have been patented. Although exploration activity has been high, production from the district is sparse. The only recorded production came from the New York-Seattle mine.

Most of the deposits in the Silver Creek district lie just outside the roadless area. The Seacrest prospect is a copper-molybdenum porphyry deposit that also contains a copper-nickel-chromium-bearing ultramafic body. Tonalite has intruded volcanic breccias and flows, and both the intrusive and extrusive rocks contain disseminated pyrite, chalcopyrite, and a trace of molybdenite. Although there are no outcrops, several drill holes intersected the ultramafic body in the porphyry complex. The porphyry system appears to be low grade but very large and may extend into the roadless area. Sulfide minerals at the Red Mountain prospect in the Troublesome Creek district may be an eastern expression of the porphyry system.

The New York-Seattle mine explores part of a quartz stockwork complex in quartz diorite. The quartz diorite intruded sedimentary rocks and is exposed only near Silver Creek and in an east-trending drainage where the thermally metamorphosed sedimentary rock has been eroded. Sulfide-bearing quartz veins and veinlets that trend N. 20° E. and N. 60° W. occur in the quartz diorite. The sulfide minerals include chalcopyrite, pyrite, arsenopyrite, and lesser amounts of sphalerite. The deposit may extend into the roadless area.

One shear-zone deposit, inside the roadless area at the Blue Canyon prospect, contains over 100,000 tons of gold-bearing resources. Just outside the roadless area, the New York-Seattle mine contains 100 million tons of copper-gold-bearing resources. The resources outside the roadless area, at the Seacrest prospect, are calculated only for the areas delineated by the drill holes and probably are much larger.

Troublesome Creek mining district

The Troublesome Creek mining district is in the southwest part of the roadless area. Access is limited to a road along the North Fork Skykomish River, a trail from Monte Cristo to Twin Lakes, and a trail into Blanca Lake from the east. Prospecting began in the district as early as 1874, with the first claims being located in 1889. Exploration and development was greatest between 1890 and 1899. Over 180 claims had been located in the district by 1980, and eleven of them have been patented. No production has been recorded from the district. The Daisy mine is on the only patented claim group in the district, and it is just below the ridge between Silver and Troublesome Creeks. Four adits, totalling over 1,400 ft in length, develop shear zones exposed for a strike length of 5,300 ft in quartz diorite. The zones, which trend north and dip about 70° to the west, contain sulfide-bearing quartz veins. The major sulfide minerals are arsenopyrite, pyrite, sphalerite, galena, and chalcopyrite. The Red Mountain prospect explores the contact between the Swauk Formation and the Grotto batholith. Chalcopyrite, pyrite, and bornite are disseminated in both formations near the contact. Total inferred and indicated resources and restricted marginal reserves in the district are over 1.7 million tons; almost all of which are at the Daisy mine.

Goat Lake mining district

The Goat Lake mining district is in the northwest part of the roadless area. It is accessible by a logging road that follows Elliot Creek to within 1.5 mi of Goat Lake. Prospecting in the Goat Lake mining district began in July 1891 when Henry Cochran and Dell Bishop located the Augusta and Mayflower claims. The Goat Lake Gold Mining Company and the Mackintosh Mining Company were organized during the next several years (Majors and McCollum, 1977). Twenty-two claims held by the Mackintosh Mining Company were sold to a group of investors from Pennsylvania in 1894, and, in 1895, these investors organized the Penn Mining Company. The company began development work at the Foggy mine in 1897 and work continued through 1906 (Woodhouse, 1979). When the mine was shut down, seven levels with about 10,000 ft of drifts and crosscuts had been developed. The Foggy mine workings explore two northeast-trending, vertically dipping shear zones. The zones vary from 0.2 ft to 27 ft thick and contain kaolinite, limonite, sheared wall rock, and a variety of sulfide minerals including arsenopyrite, realgar, orpiment, pyrite, and sphalerite. The country rock is metamorphic; it grades from fine-grained, light-gray quartzite, to gneiss, phyllite, slate, and finally a series of quartz-garnet-biotite schists. Gold concentrations in the shear zones are low, but the tonnage of gold-bearing rock is large. No production has been recorded from the Foggy mine or elsewhere in the district. A total of 161 lode claims and 18 placer claims had been recorded by 1979. Eleven lode claims and two millsites have been patented.

ASSESSMENT OF MINERAL DEPOSITS

Mineral resources identified at 16 properties in the Glacier Peak Roadless Area total almost 53 million tons. Of this total, nearly 47 million tons are classified as restricted marginal reserves (U.S. Bureau of Mines and U.S. Geological Survey, 1980). These resources are restricted because of current environmental regulations on production and disposal of arsenic-bearing materials. Another 110 million tons of subeconomic resources, mostly in low-grade copper porphyry and stockworks, occur in four deposits just outside the roadless area.

All of the resources in the roadless area occur in shear zones ranging from less than 1 ft to as much as 20 ft thick. Although the shear zones pinch and swell, they appear to be persistent along strike. One major zone is exposed for over a mile along strike. Quartz veins and lenses in the shear zones also pinch and swell sporadically along strike and dip and contain most of the metal values. Gold and silver values in the quartz veins differ greatly along strike and dip; locally high values occur in ore shoots. Most of the stopes in the mines represent those areas that formerly contained high-grade ore shoots.

The resources in the large shear zone developed by the Justice, Golden Cord, Mystery, Pride of the Woods, New Discovery, and Pride of the Mountains mines are divided into lower and upper blocks. The lower block is relatively deep and less thoroughly explored; resources in the lower block are estimated at a lower level of confidence than in the upper block.

Two mining methods could probably be used for deposits identified in the roadless area:

1) The shrinkage stoping method could be used where the shear zone is over 4 ft thick and where the back and walls will stand well. In this method, ore is mined in successive slices, working upward from each level; all material, ore and waste, in the mined thickness is broken and removed together. The shear zone developed by the Justice, Golden Cord, Mystery, Pride of the Woods, New Discovery, and Pride of the Mountains mines probably is amenable to this method. Mining this zone would cost at least $32 per ton.

2) The resuing method could be used at those deposits with thin, high-grade veins. In this method, wall rock (waste) on one side of the vein is removed before ore rock is broken; there is less dilution of the ore with this method. As in the shrinkage stope method, both the walls and back would have to stand well. Resuing works best where the ore is not "frozen" to the walls and where there is considerable difference between the hardness of the ore and the wall rock (Gardner and Jackson, 1937). Cost per ton of ore removed by this method is considerably higher than that for the shrinkage stoping method and is dependent upon the vein thickness.

Two deposits in the Silver Creek mining district, just outside the roadless area, contain very large, low-grade copper resources. The Seacrest, a porphyry-type deposit, and the New York-Seattle, a stockwork deposit, are large enough to employ lower-cost, open-pit or sublevel-caving mining methods. The mining method used would depend on the shape and orientation of the ore body.

Beneficiation of the resources in the roadless area would be unusually difficult because of the complex mineralogy of the ore. Mine-run ore would contain various amounts of pyrite, pyrrhotite, arsenopyrite, chalcopyrite, sphalerite, galena, stibnite, and lesser amounts of azurite, malachite, boulangerite, realgar, orpiment, and other sulfosalts, all in a gangue of quartz and sheared country rock.

Because of the complexity of the ore, only the gold, silver, lead, and zinc would probably be recovered. The process might include: grinding the ore and, then, by floatation, making a lead concentrate containing gold and silver. Tailings from the lead floatation circuit would go to a zinc floatation circuit; the zinc concentrate would also contain gold and silver. Lead and zinc concentrates and tailings from the zinc floatation circuit would go to separate hearth roasters to remove arsenic. Lead and zinc concentrates would then be sent to a smelter to recover lead, zinc, gold, and silver. Material from the zinc circuit tailings roaster would be treated with a cyanide leach solution to recover gold and silver. Metal recovery is estimated at 80 percent for lead and zinc and 70 percent for gold and silver. The cost for milling mine run ore, using the above process, would probably be at least $22 per ton for a 2,000 ton per day mill.

On the basis of estimates using 1983 costs, total development, mining, milling, smelting, and other production costs probably would total about $70 per ton of ore for large, thick deposits amenable to shrinkage stoping; costs would be considerably higher for smaller deposits.

It should be emphasized that the above beneficiation process is greatly simplified, and the recoveries and costs are only estimates. Exhaustive testing is required to determine the best recovery process for the smallest investment. Arsenic in ores is extremely detrimental; concentrate which goes to the smelter can contain only very small amounts of arsenic, or the smelter will not process it. Also, large amounts of arsenic oxides would be produced in the process outlined in this report. If the arsenic concentrates cannot be sold, there could be problems with their disposal.

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