UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Mineral Resource Potential of the Hells Canyon Wilderness and Contiguous Roadless Areas, Wallowa County, Oregon, and Idaho, Nez Perce and Adams Counties, Idaho

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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ILLUSTRATIONS

STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. 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 presently 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. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the Hells Canyon Wilderness and contiguous roadless areas, Wallowa County, Oregon, and Idaho, Nez Perce, and Adams Counties, Idaho. The Hells Canyon National Recreation Area, which includes Hells Canyon Wilderness and Snake and Rapid Wild and Scenic Rivers, was established by Public Law 94-199, December 31, 1975. The contiguous roadless areas (06298, 06300, 06299, 06297, 06295, 06296, 06602, 06294, 06293, 06292, 06291, 01853, 01854, 01922, and 04922) were classified as further planning areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

MINERAL RESOURCE POTENTIAL

SUMMARY STATEMENT

Field studies to evaluate the mineral resource potential of the Hells Canyon Wilderness and contiguous roadless areas (hereafter referred to as "study area") were carried out by the U.S. Geological Survey and U.S. Bureau of Mines in 1974-76, 1979, and 1982. The 950-mi^2 study area lies along and near the Snake River in northeast Oregon and west-central Idaho (see fig. 1 and fig. 2) at the junction of the Northern Rocky Mountains and the Columbia Plateau.

The study area is underlain by foliated metamorphic rocks, older volcanic and volcaniclastic rocks, limestone, argillic mudstone, plutonic rocks, and younger basalt flows. Metallic deposits in the rocks are of four main types. In decreasing order of potential they are: (1) copper-, silver-, zinc-, gold-, and lead-bearing deposits of volcanogenic (kuroko type) origin; (2) contact replacement zones (tactites) of copper and silver in limestone; (3) gold-, silver-, and copper-bearing, siliceous fissure veins and shear zones associated with plutonic rocks; and (4) copper-bearing magnetite veins and lenses in plutonic rocks.

On the basis of geological, geochemical, and geophysical data, 21 separate areas, totaling 42 mi^2 and concentrated in the southern part of the study area, are identified as having medium or high potential for silver, copper, lead, zinc, gold, molybdenum, or tungsten deposits. Although significant deposits are widely scattered, most deposits having known mineral resources are in five distinct regions: Windy Ridge, Kirkwood Creek, Rapid River, Imnaha-Salmon Rivers, and Jackley Mountain (see fig. 3). Fifteen of the 21 identified areas having mineral resource potential (see fig. 4) are within these five regions, whereas six areas are in regions having no apparent history of prospecting.

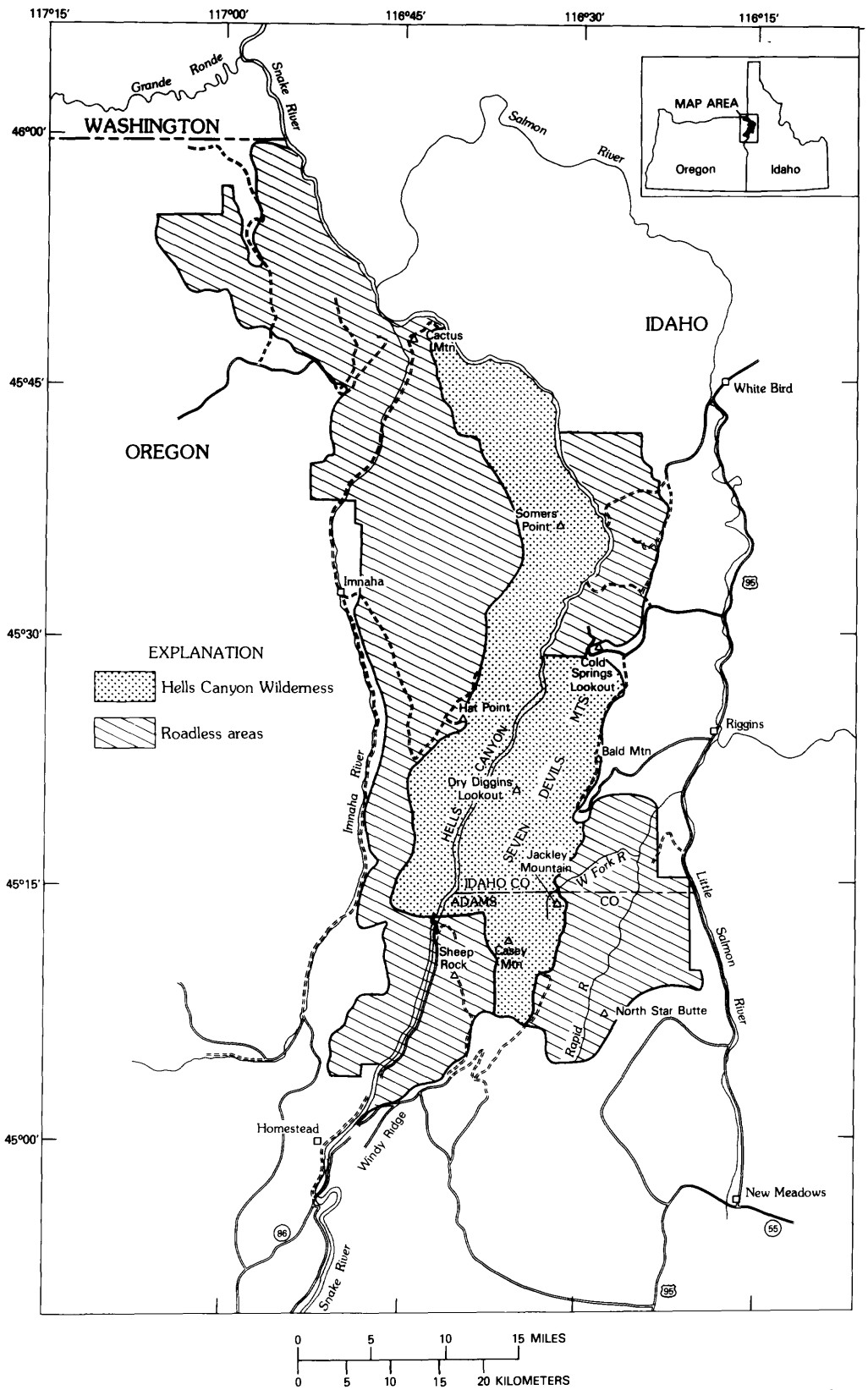

Figure 1.--Index map showing location of Hells Canyon Wilderness and contiguous roadless areas(see also figure 2).

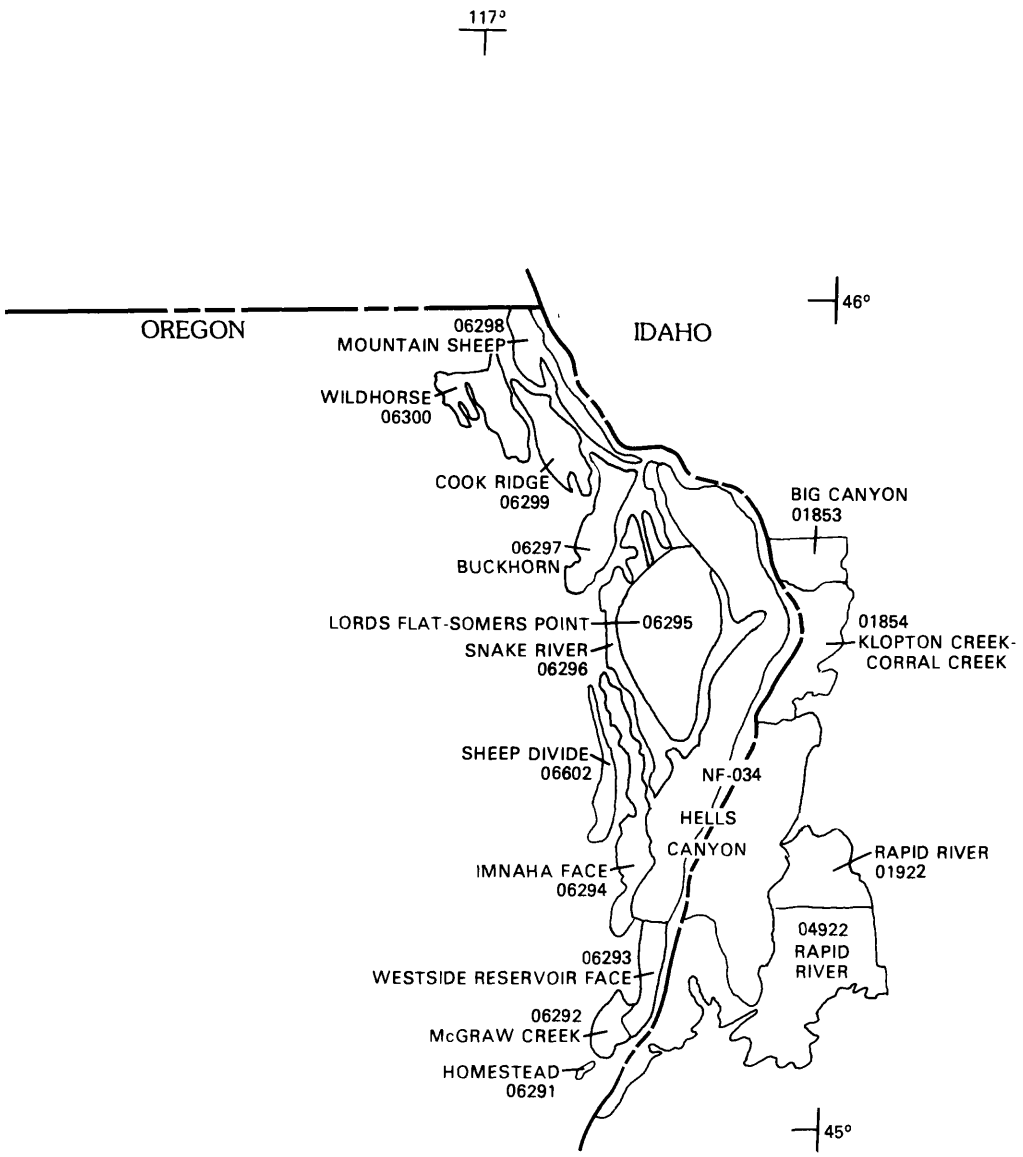

Figure 2.--Location of Hells Canyon Wilderness and contiguous roadless areas.

Seventy-six mines or prospects have resources or resource potential (see fig. 3). Thirty-four mineral deposits have resources totaling 31 million tons containing, in decreasing order of abundance, copper, silver, zinc, gold, and lead. Some are of sufficient size and grade to be minable, and subsurface exploration would probably disclose additional resources. Another 42 lodes, not sufficiently exposed to allow resource estimates, are believed to have mineral potential.

Gold placers at only one location, Dry Diggins, may be of sufficient size and grade to be minable. Placers in other parts of the study area are probably only minable using small-scale, selective methods.

Large limestone and sand and gravel deposits are present, but similar deposits are present outside the study area.

INTRODUCTION

The study area (fig. 1) covers nearly 950 mi^2 in a region of spectacular canyon and mountain scenery along the junction of the Northern Rocky Mountains and the Columbia Plateau. The study area forms an irregular, north-trending band along the Snake River within a rectangle bounded by lat 45°02' and 46°00' N., long 116°19' and 117°06' W.; it includes public lands of the Wallowa-Whitman National Forest in Oregon, and the Nezperce and Payette National Forests in Idaho.

Four principal methods of investigation were used to evaluate the mineral potential of the study area: (1) All mines and prospects that could be found were examined and mining records were studied to identify the location and types of deposits, to determine the amounts and kinds of ore that had been mined, and to identify the present resources. (2) Reconnaissance mapping was done to ascertain the petrology and distribution of rocks, their stratigraphic, structural, and metamorphic relations, and whatever controls these features might have imposed on sites of mineral deposition. (3) The area was sampled, and the resulting geochemical data were statistically analyzed in order to resolve the kinds, amounts, and significance of metals in different rocks, determine background values of metals, and identify mineralized areas. (4) Aeromagnetic and gravity surveys were made to aid in the definition of geologic features, geochemical patterns, and positions of ore bodies, and to delineate mineralized areas, which were not previously recognized.

Fieldwork by the U.S. Geological Survey was done during August and September 1974. Slightly more than 2 man-years were devoted to fieldwork. Rock, stream-sediment, and soil samples were analyzed in a mobile laboratory in the field and at laboratories in Denver, Colo., by chemists of the U.S. Geological Survey. Water samples were analyzed at the Menlo Park, Calif., laboratory of the U.S. Geological Survey. An airborne magnetometer survey was flown in 1974 by Geometrics, Inc., under contract to the U.S. Geological Survey, and a regional gravity survey was made in 1976. Don R. Mabey of the U.S. Geological Survey interpreted the geophysical data.

The U.S. Bureau of Mines examined all mines, prospects, and mineralized areas during 1974-76 (Close and others, 1982). Mining costs were estimated to determine minability and the subsequent classification of deposits. Placer deposits and 114 lode prospects were studied; most of the latter were mapped, and all were sampled. About 900 samples were collected from lode deposits, and about 270 from placer deposits. Approximately 4 man-years were spent in the field by the U.S. Bureau of Mines staff.

GEOLOGY

The study area is along the junction of the Columbia Plateau and Northern Rocky Mountains physiographic and geologic provinces. Rocks of six principal lithologic assemblages underlie the area: (1) foliated metamorphic rocks--slate, schist, and gneiss--formed during Cretaceous time from rocks of unknown, but possibly Mesozoic and Paleozoic ages; (2) volcanic and volcaniclastic rocks of Permian and Triassic ages; (3) limestone of Triassic and possibly other ages; (4) argillic mudstone of Jurassic age; (5) plutons and related dikes and sills of Triassic through Cretaceous ages; and (6) basalt flows of Miocene age. Other units include cataclastic rocks, gravel deposits, which locally underlie the basalt flows of Miocene age, and surficial deposits (moraines, terrace gravels, colluvium, and alluvium of Quaternary age).

The following synopsis of the geologic history is based on observations of Vallier (1967, 1974), Hamilton (1963), Gualtieri and Simmons (1978), and Simmons and others (in press). The earliest established event occurred during the Permian when basalt and andesite flows and volcaniclastic rocks were deposited during concurrent uplift of the region to the west and southwest. Prior to Middle Triassic time, the Permian flows and volcaniclastic rocks were deformed and intruded by granitic and gabbroic plutons. Volcanic-flow rocks and volcaniclastic rocks were again deposited in a developing basin; locally, limestone was deposited in parts of the basin unaffected by volcanism. Additional subsidence and basin fragmentation, deposition of volcanic and volcaniclastic rocks, and the emplacement of gabbro and quartz diorite plutons took place concurrently during Late Triassic time. The Permian and Triassic flows, volcaniclastic rocks, and interbedded limestone are all assigned to the Seven Devils Group. Limestone correlative with the Martin Bridge Limestone of latest Triassic age was deposited throughout the study area.

Layered rocks of Early Jurassic age are not present in the study area, although such rocks are present a few tens of miles to the southwest near Huntington, Oreg. During this time the area was uplifted and older rocks were eroded. In Middle and Late Jurassic times, black mudstone of the Coon Hollow Formation was deposited on deformed rocks of Triassic age. The area was then folded and faulted and numerous granitic and gabbroic plutons were emplaced. At or about the same time, the volcanic and volcaniclastic rocks were metamorphosed to greenstone.

In probably very Late Jurassic time, limestone and greenstone were thrust northwestward or westward over the eastern part of the study area. Early Cretaceous granitic plutons were then emplaced at the south end of the study area and elsewhere. Later in the Early Cretaceous, the volcanic and sedimentary rocks were metamorphosed into slate, marble, schist, and gneiss. Shortly thereafter, the foliated rocks were thrust westward into the southeast part of the study area.

A hiatus marks the period from later Early Cretaceous to middle Miocene time. The region was uplifted and an erosion surface of mixed relief developed; mountains probably existed in the southeast part of the study area and a few canyons were present in the north. Then, middle Miocene basalts erupted from numerous fissures and spread over the erosion surface, inundating virtually all older rocks; these flows are part of the Columbia River Basalt Group. During late Miocene and Pliocene times the region was subjected to moderate warping and block faulting. In latest Pliocene or Pleistocene time, but prior to Wisconsin glaciation, Hells Canyon was eroded to nearly its present depth.

During the Pleistocene the mountainous, southern part of the study area was glaciated, producing morainal deposits. Some gravels were probably deposited then also. During the Holocene, alluvium was deposited along the Snake River and its tributaries, and colluvium or landslide debris was deposited at a few places.

GEOCHEMISTRY

A total of 5,268 samples was collected of which 4,757 were chemically analyzed and 135 were cut for thin sections. The analyzed samples include 3,834 rock samples, 898 stream-sediment samples, 1 panned-concentrate sample, 22 soil samples, and 2 water samples. The analytical data for all samples except the water samples are stored on a computer tape at the U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161 (Simmons and others, in press).

All of the samples except the water samples were analyzed by a six-step, semiquantitative, spectrographic method (Grimes and Marranzino, 1968). Atomic absorption analyses were made of 77 samples of limestone to determine their magnesium and calcium contents; 502 stream-sediment, rock, and panned-concentrate samples to test for gold; 52 stream-sediment samples to test for silver, cadmium, and zinc; and 54 stream-sediment samples to test for bismuth.

A total of 1,534 rock samples were analyzed for mercury by the instrument method. All soil samples and 743 stream-sediment samples were analyzed by a colorimetric method for cobalt, copper, lead, and zinc (Ward and others, 1963). All rock samples were scanned for radioactivity, and 128 rock samples were checked radiometrically for equivalent U_3O_8. The water samples were analyzed by wet methods for sodium, potassium, calcium, and silica to determine subsurface temperatures of springs.

Rock samples were collected throughout the study area to establish the normal background amounts of metals in different types of rocks, and to test for possible anomalies or anomalous trends. Samples were taken from hydrothermally altered rocks that might contain mineral deposits. Samples were collected from mines and prospect pits not only to determine the quantity of metals in the visible ore minerals, but also to discover what other elements are found in trace amounts and might serve as indicators of undiscovered mineral deposits.

Most stream-sediment samples were collected near the mouths of streams. Steep stream gradients and steep-sided canyon walls cause mixing of stream alluvium with colluvium from the streambanks. Therefore, sediments in many stream bottoms are not wholly representative of the source rocks upstream.

Slightly more than 15 percent of the geochemical samples have anomalous concentrations of silver, copper, molybdenum, lead, and zinc. These anomalous localities are shown in figure 3. Anomalous amounts of gold, silver, copper, molybdenum, lead, zinc, and tungsten may indicate ore bodies containing these metals. Other associations are erratic or are too sparse to suggest the presence of mineral deposits.

GEOPHYSICS

An aeromagnetic survey of the study area was made using a proton precession magnetometer flown along east-west flight lines, 1 mi apart and 9,000 ft above sea level. A digital computer processed the magnetic data and prepared a magnetic intensity map.

The magnetic susceptibility of rocks in the Hells Canyon region is higher than the average for rocks in the upper continental crust. Gabbro, diorite, quartz diorite, and basalt of the Columbia River Basalt Group have the highest susceptibility; sedimentary rocks and silicic volcanic rocks have the lowest. The susceptibility of greenstones varies considerably, and may be high or low.

The magnetic field is very complex, reflecting the strongly magnetized rocks and the high surface relief. The magnetic intensity is generally high west of the Snake River where the Columbia River Basalt Group is present, and is lower east of the river where that group is thinner and not so extensively distributed. Magnetic highs are over many plutons. A northeast grain to magnetic anomalies east of the Snake River in the south part of the study area appears related to tabular, northeast-trending plutons and to a northeast-trending shear zone. The lowest magnetic intensities are over altered rocks of the Seven Devils Group.

MINES AND MINERALIZED AREAS

The important types of mineral deposits in the study area, from the point of view of past and potential production, include contact replacements (tactites), volcanogenic deposits, quartz veins, magnetite-hematite fissure veins, and placers. The tactite deposits are chiefly associated with the granitic pluton between Indian and Deep Creeks, where copper-silver minerals and, to a lesser extent, tungsten and other minerals replaced limestone. Volcanogenic deposits are widespread and include massive and disseminated deposits of both syngenetic and structurally controlled origin; the latter epigenetic deposits may have formed as a result of partial remobilization of syngenetic sulfides during the emplacement of plutons or during regional metamorphism. The volcanogenic deposits contain copper, silver, zinc, and lesser amounts of molybdenum, lead, and gold. Quartz veins containing gold, small amounts of silver, and, at a few places, copper are associated with the tabular granitic plutons in the southeast part of the study area. Copper is the only metal of importance that is contained in the magnetite-hematite fissure veins that are localized in the gabbro-diorite-quartz-diorite pluton near the mouth of the Imnaha River in the northern part of the area. Three types of placer gold deposits are recognized: residual deposits overlying tactite deposits, deposits on the pre-Columbia River Basalt Group erosion surface in the central part of the study area, and deposits along or in the bed of the Snake River.

The study area includes the Crooks Corral and parts of the Mountain View and Seven Devils unorganized mining districts in Idaho, and part of the Homestead district in Oregon. County records of mining claims show that approximately 4,100 claims have been located in the area since 1870. About 1,290 lode claims and 110 placer claims are in Oregon, and about 2,510 lode claims and 190 placer claims are in Idaho. U.S. Bureau of Land Management records indicate 186 patented claims; another 300 unpatented claims are currently held. Mines, prospects, and mineralized areas in the study area are shown in figure 3. Recorded production from 17 lode deposits in the study area totals 55,785 tons of ore. The ore contained 9,355 troy oz of gold, 225,530 troy oz of silver, 6,109 tons of copper, 1 ton of lead, 40 tons of zinc, and 180 lbs of tungsten trioxide. Recorded production from Snake River placers was 605 oz gold.

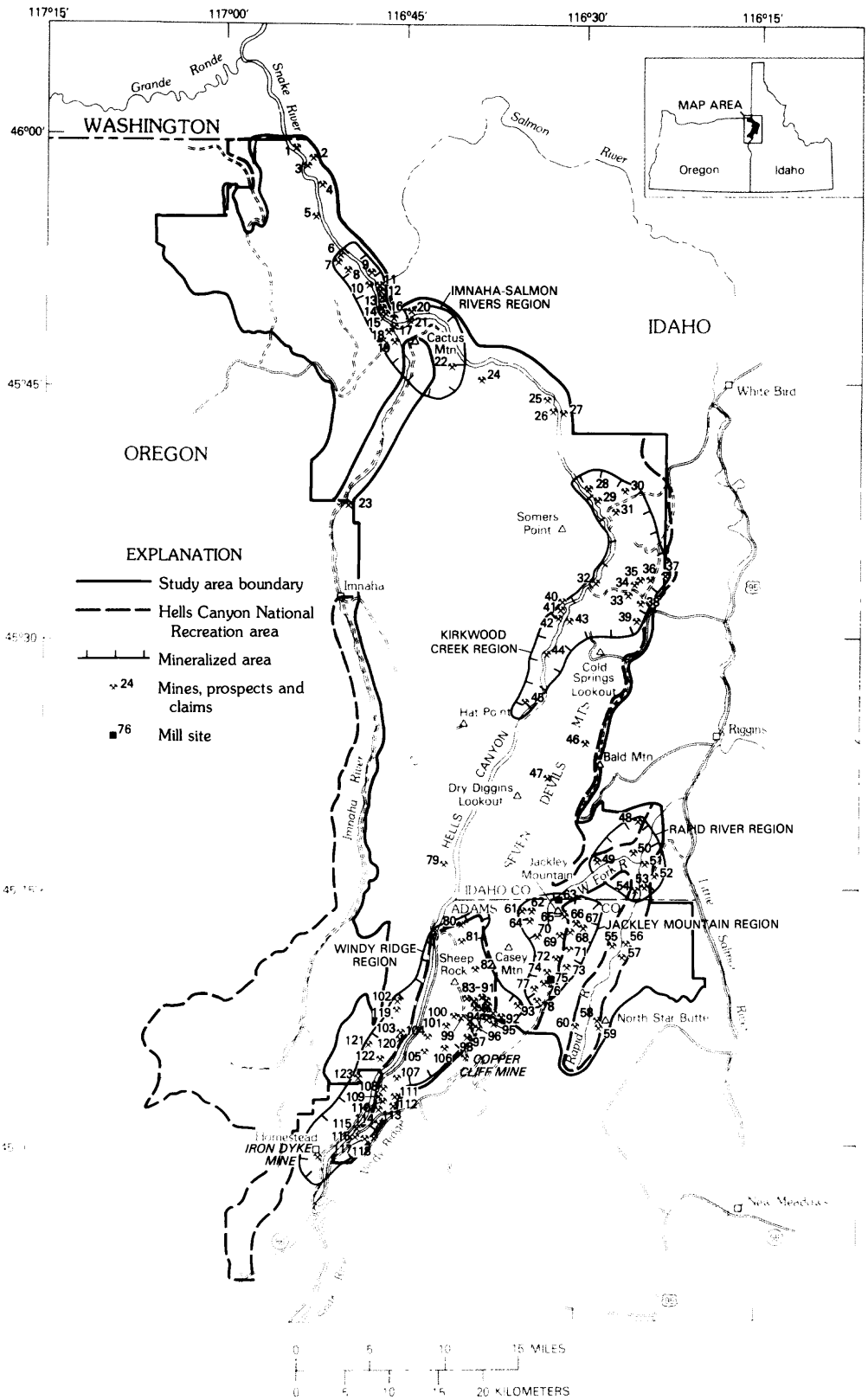

Figure 3.--Map showing mines, prospects, and mineralized regions in the Hells Canyon Wilderness and contiguous roadless areas(taken from Close and others, 1982).

Table to accompany figure 3. Mines, prospects, and mineralized areas in the Hells Canyon study area

[Mines and prospects having resources or resource potential are underlined]

1. Cache Creek Rapids adit
2. Yellowboy mine
3. Little Cougar Creek adit
4. Cottonwood Creek adit
5. Treasure group
6. Cherry Creek prospect
7. Greenhorn and Verdie lodes
8. Papico lode
9. First Creek adit
10. Salmon Bar adit
11. Pullman mine
12. Pullman Gulch prospect
13. Lower Sheep Rapids shaft
14. Mountain Sheep prospect
15. Bear Rapids adit
16. Imnaha Rapids prospect
17. Fargo group
18. Banner group
19. Highland Mary and Western Union groups
20. Divide Creek prospect
21. Divide Creek Rapids prospect
22. Dug Creek prospect
23. Blue Bucket prospect
24. Deep Creek adits
25. Copper Mountain prospect
26. Electrolytic group
27. Highrange prospect
28. Davis Rapids adit
29. Copper Queen prospect
30. Short Branch claims
31. Pittsburg Landing prospect
32. Blakely prospect
33. Blue Jacket mine
34. Kirby Creek prospect
35. Sadle prospect
36. Crooks Corral elevated placer
37. Virginia group
38. Cow Camp prospect
39. Wickiup Butte prospect
40. Hominy Creek placer
41. Iron King group
42. Temperance placer
43. Duncan mine
44. High Bar adit
45. Hat Point prospect
46. Old Timer prospect
47. Dry Diggins elevated placer
48. Blue Gulch prospect
49. McCrea Creek prospect
50. Oregon group
51. Cora Gulch prospect
52. Rattlesnake Ridge prospect
53. Cougar Creek prospect
54. Wyant Creek prospect
55. Paradise Cabin prospect
56. Trail Creek prospect
57. Black Leopard prospect
58. North Star Butte prospect
59. Indian Springs prospect
60. Twin Lakes prospect
61. Anchor Creek prospect
62. Bald Eagle mine
63. Rankin mill

Table to accompany figure 3. Mines, prospects, and mineralized areas in the Hells Canyon study area--Continued

64. Stevens Saddle prospect
65. Jackley Ridge prospect
66. Mayflower group
67. White Rose prospect
68. Holbrook Saddle prospect
69. Middle Mountain prospect
70. Monument Peak prospect
71. Iron Springs prospect
72. Pactolian Gulch prospect
73. Curren Mount prospect
74. Satan Lake prospect
75. High Five placer; Maid of Erin and Summit millsites
76. Maid of Erin mine
77. Summit mine
78. Rock Lake prospect
79. Battle Creek mine
80. Cliff prospect
81. Red Ledge prospect
82. Heady prospect
83. Haily Ridge prospect
84. Peacock mine
85. South Peacock mine
86. Panama Pacific (Victoria) claims
87. Lower Devil's Hollow prospect
88. Ritchie Gulch prospect
89. Devils's Hollow prospect
90. Ritchie Gulch adit
91. Pepper box No. 2 claim
92. Virginus claim
93. Victory Tungsten mine
94. Chieftain claim
95. California group
96. Emily group
97. White Monument Copper mine
98. Lockwood mine
99. Tussel mine
100. Tussel adit
101. Tussel shaft
102. Brooklyn-Allen group
103. Dove Creek prospect
104. Dry Gulch prospect
105. Allison Creek prospect
106. East Allison Gulch prospect
107. Hibble Gulch prospect
108. North Lime Peak prospect
109. Lime Peak mine
110. Golden Star claim
111. Paducah group
112. Eureka group
113. Nix group
114. Crackerjack mine
115. River Queen mine
116. Antz Creek mine
117. Azurite mine
118. Terry group
119. Sunshine group
120. Olympia group
121. Argenta group
122. Lime Point prospect
123. Nelson Ridge prospect

Much of the mining activity in the study area transpired before thorough records were maintained; therefore, the early history of mining is not well known. The first successful mining attempts were along Windy Ridge, where residual placer claims were staked in the 1870's. When these deposits were nearly exhausted, underlying tactite deposits were discovered and mined from the 1880's until 1906. During the latter part of this period and for a few years thereafter, claims were staked in many parts of the study area: on mineralized shear zones, tactite deposits, and volcanogenic lenses in the Rapid River area until 1900; on magnetite-hematite fissure veins near the mouth of the Imnaha River until 1915; on elevated placer deposits at Dry Diggins and Crooks Corral until 1915; on quartz veins near Jackley Mountain until 1910; on volcanogenic deposits near Kirkwood Creek until 1915; and at isolated places elsewhere.

The Iron Dyke mine, 3 mi south of the study area, operated from 1914 until 1928, and as of 1982 was being redeveloped. Mining was sporadic from 1928 until the discovery in 1965 of the Copper Cliff mine, 1 mi east of the south end of the study area. This has spurred recent exploration at the nearby Red Ledge mine, and at the Nix group of claims and the Blue Jacket mine near Kirkwood Creek in the study area. The Copper Cliff mine is the only mine currently operating in the region; ore from that mine and the Iron Dyke mine was being milled at the rate of 300 tons per day. Remote locations and complex mineralogy of deposits have been the principal limiting factors to mineral development. Mineralized sites remain remote but many of the metallurgical problems have been solved.

Most mines and prospects are clustered in five regions: Windy Ridge, Kirkwood Creek, Imnaha-Salmon Rivers, Rapid River, and Jackley Mountain (fig. 3). Another 19 are scattered throughout the study area. In addition, placer gold deposits are in several areas.

Windy Ridge

Windy Ridge is in the southern part of the study area and includes known tactite and volcanogenic deposits. The tactite deposits have a northwest trend along the north side of a limestone unit. Copper and silver are the predominant metals, but tungsten and molybdenum are also present. The deposits were mined to shallow depth, but drilling indicates that they extend to greater depths as well as laterally into the surrounding granodiorite. Identified tactite resources total about 2.2 million tons. The tactite deposit at the South Peacock mine contains 1.7 million tons averaging 0.56 oz silver per ton and 1.59 percent copper.

Deposits of volcanogenic origin define a north-northeast trend associated with rhyolitic intrusions in andesitic-volcaniclastic flow rocks. Copper-lead-zinc-silver-gold ore deposits are found as large lenses in the volcanic rocks and as disseminated ore minerals in the intrusives. Resources in volcanogenic deposits total 25.5 million tons. The largest volcanogenic deposit is at the Red Ledge prospect. It contains 25.3 million tons averaging 0.02 oz gold per ton, 1.21 oz silver per ton, 0.51 percent copper, and 1.32 percent zinc. Thirty-five Windy Ridge prospects have identified resources or mineral potential.

Kirkwood Creek

The Kirkwood Creek region is in the northeast part of the study area where mines and prospects are predominantly in volcanogenic lenses and pods

and are approximately alined along a northeast trend. The deposits contain gold, silver, and copper. Resources total about 2 million tons. The Blue Jacket mine contains 1.9 million tons averaging 0.035 oz gold per ton, 3.5 oz silver per ton, and 4.0 percent copper.

Less important deposits of gold, silver, and copper consist of sulfide-bearing veins and lenses near contacts between metavolcanic and basic intrusive rocks. Resources in these deposits total 25,600 tons and average 0.12 oz gold per ton, 0.2 oz silver per ton, and 0.93 percent copper. In the vicinity of the Kirkwood Creek region are 10 lode prospects having identified resources or mineral potential.

Imnaha-Salmon Rivers

The Imnaha-Salmon Rivers region is in the northern part of the study area. The principal deposits are copper-bearing magnetite-hematite veins and lenses along shear zones in metamorphosed gabbro and diorite; these have resources of 302,500 tons. Of this total 293,200 tons have been estimated at the Fargo group where resources average 0.48 percent copper and 34.6 percent iron. Other deposits in the area are in volcanogenic rocks or tactite; reserves of the former total 2,160 tons.

Rapid River

Mines and prospects in the Rapid River region, in the southeastern part of the study area, are in a tactite body, volcanogenic lenses, and mineralized shear zones. Resources containing gold and copper total 149,750 tons. The Oregon group has tactite resources totaling 145,000 tons averaging 0.01 oz gold per ton and 0.15 percent copper. No mineral production has been recorded. Along Rapid River there are four lode prospects having identified resources or mineral potential.

Jackley Mountain

The Jackley Mountain region is in the southeastern part of the study area. Ore deposits include gold-bearing quartz fissure veins that have a northeast trend. The veins are in shear zones in metamorphosed volcanic rocks. Native gold occurred in shallow oxidized zones, but is bound by sulfides at depth. Recorded production totaled 14,457 tons of ore with 7,196 oz gold and 1,491 oz silver. Estimated resources for the area total about 372,050 tons. The most important deposit is at the Maid of Erin mine where 245,000 tons have been estimated containing an average of 0.12 oz gold per ton. There are 11 prospects known in the area having identified resources or potential for occurrence of mineral deposits.

Miscellaneous deposits

Eighteen deposits are outside the principal mineralized areas. Two, the Battle Creek and the Yellowboy mines, have recorded production: 81 oz gold from the former and 91 oz gold and 161 oz silver from the latter. Nine prospects are in fissure veins, six are in volcanogenic rocks, and three are in tactite deposits.

Placers

Placer deposits are present in and along the Snake and Rapid Rivers and at elevated locations beneath the Columbia River Basalts and above some tactite deposits. Recorded placer production from the Snake River totaled 605 oz; that from the Crooks Corral elevated placer was 270 oz gold.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

On the basis of geological, geochemical, geophysical data, and mine and prospect site evaluation, the mineral potential of different parts of the study area is here classified as being low, medium, or high. Twenty-one separate areas, are classified in the medium and high categories. Most of the areas assigned medium and high potentials are those that have or may have volcanogenic deposits containing silver, copper, molybdenum, lead, zinc, and gold. These areas are scattered through regions of low potential and are concentrated in the southern part of the study area (fig. 4).

Most of the land assigned a low potential is overlain by hundreds to thousands of feet of basalt flows of the Columbia River Basalt Group. Although low anomalous values of metals were found in the basalt, these simply reflect normal chemical variation; the basalt shows no indications of mineralized areas nor are any metallic mineral deposits known in it. It is possible or even likely that ore deposits exist beneath the basalt, but exploration would be difficult, and for mining to be economically feasible, it would probably be necessary to discover a very large and (or) high-grade ore body. Except for one small area where an ore body may underlie a thin cover of basalt, the entire area blanketed by the Columbia River Basalt Group is classified as having low mineral potential.

Because of the common association of silver, copper, molybdenum, lead, and zinc, they will be evaluated together. Other commodities discussed include gold, tungsten, and limestone.

Silver, Copper, Molybdenum, Lead, and Zinc

Area 1 is 4 mi^2 at the southern extremity of the study area, on the east side of Hells Canyon Reservoir and the west slope of Windy Ridge. The area has a medium potential for volcanogenic deposits containing copper and silver on the basis of (1) local altered rock, silicified rock, and mineralized rock, (2) the possibly favorable effect by solutions emanated from a nearby granitic pluton whose presence is indicated by aeromagnetic data, and (3) the presence of known resources.

Area 2 is 1.5 mi^2 on the east side of Hells Canyon Reservoir between Kinney and Allison Creeks. Area 2 has a medium potential for volcanogenic deposits containing copper on the basis of local mineralized rock, the possibly favorable effect by emanated solutions from a nearby granitic pluton whose presence is suggested by aeromagnetic evidence, the presence of geochemical anomalies, and the existence of known resources.

Area 3 is 3.5 mi^2 and is an irregularly shaped area extending from the vicinity of Lockwood Saddle around the west, north, and east sides of White Monument to Pepperbox Hill. The area has a high potential for tactite deposits containing copper and silver and a medium potential for volcanogenic and porphyry deposits containing copper. The classification is based on the widespread presence of mineralized rock, geochemical anomalies in and around the granitic pluton, past production records, and known resources.

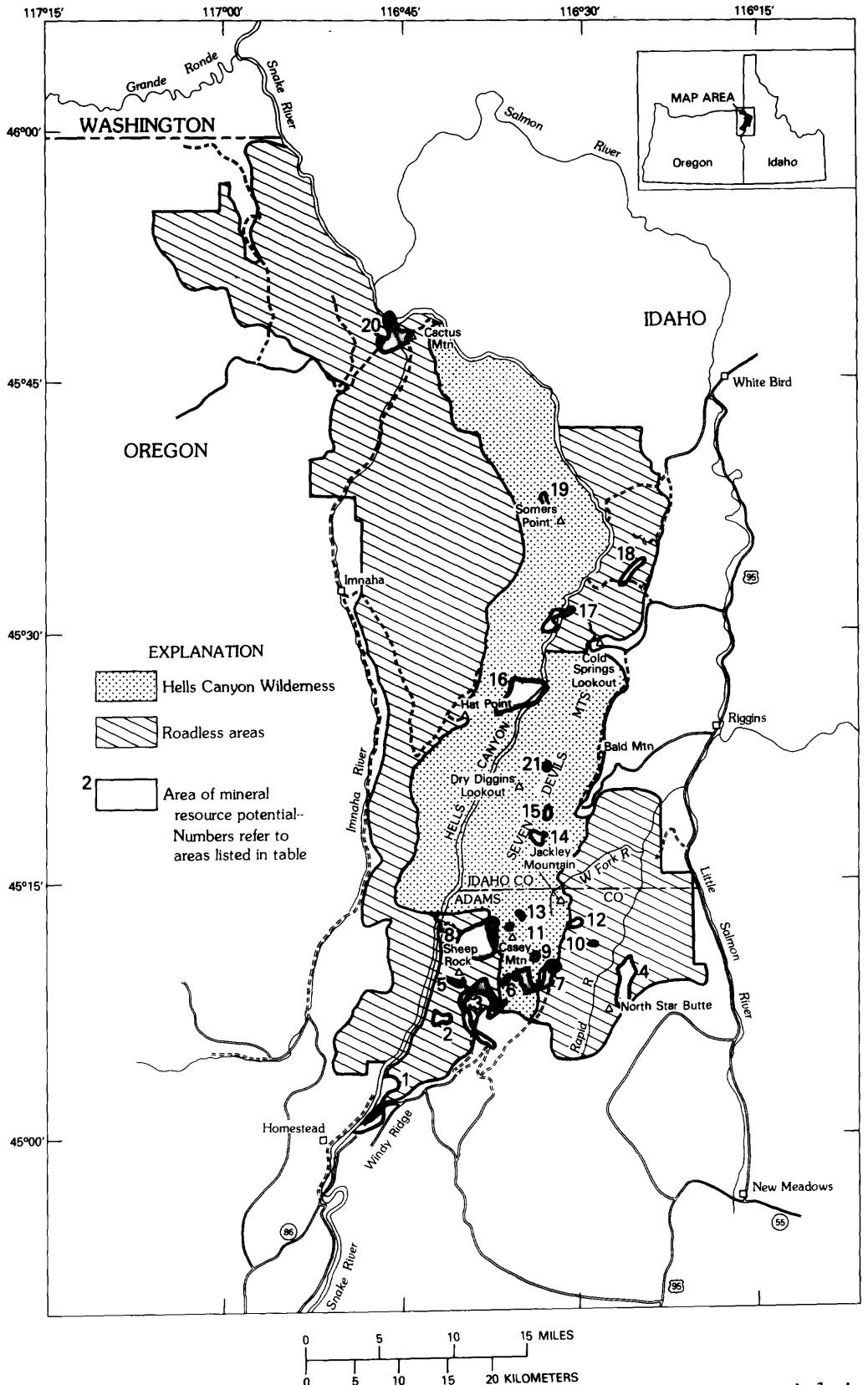

Figure 4.--Map showing areas having mineral resource potential in Hells Canyon Wilderness and contiguous roadless areas.

Table to accompany figure 4. Areas having mineral resource potential

Area	Type of Deposit	Metals	Potential
1	Volcanogenic---	Copper-silver-zinc-lead-gold--------	Medium
2	Volcanogenic---	Copper----------	Medium
3	Tactite--------	Copper-silver----------	High
	Tactite--------	Tungsten----------	Medium
	Volcanogenic---	Copper----------	Medium
	Porphyry-------	Copper----------	Medium
4	Unknown--------	Zinc----------	Medium
5	Volcanogenic---	Silver----------	Medium
6	Volcanogenic---	Lead-zinc----------	Medium
7	Vein-----------	Gold-silver----------	Medium
	Volcanogenic---	Lead-silver-copper----------	Medium
8	Volcanogenic---	Copper-silver-zinc-lead-gold--------	
9	Volcanogenic---	Molybdenum----------	Medium
10	Volcanogenic---	Silver----------	Medium
11	Volcanogenic---	Silver-lead----------	Medium
12	Vein-----------	Gold-silver----------	Medium
	Volcanogenic---	Molybdenum-silver----------	Medium
13	Vein-----------	Gold-silver----------	Medium
	Volcanogenic---	Silver-copper-zinc-molybdenum-------	Medium
14	Volcanogenic---	Lead-silver----------	Medium
15	Volcanogenic---	Lead----------	Medium
16	Volcanogenic---	Copper-silver-molybdenum-lead-zinc--	Medium
17	Volcanogenic---	Silver-zinc-molybdenum-copper-------	Medium
18	Volcanogenic---	Zinc-silver-gold----------	High
19	Volcanogenic---	Silver-lead-zinc-copper-gold--------	Medium
20	Vein-----------	Copper----------	Medium
21	Placer---------	Gold----------	Medium

Area 4 is 2.5 mi^2 east of Rapid River and chiefly in the drainage of the unnamed south fork of Fry Pan Creek. Despite the lack of highly mineralized rocks and past prospecting, the inability to relate magnetic data to geologic features, and the low values of geochemical anomalies, Area 4 has a medium potential for zinc deposits. A high percentage of the samples collected in this area contain anomalous amounts of metals, and their abundance and concentration suggest a large, concealed source of mineralized rock.

Area 5 is 1 mi^2 at Black Point and at the intersection of Grassy Ridge and Haley Ridge. Area 5 has a medium potential for volcanogenic deposits containing silver because of its possible stratigraphic and structural continuity with the volcanogenic deposit at the Red Ledge mine (Area 8), the possibility of hydrothermally altered rock as suggested by the configuration of the magnetic intensity contour lines, and because of geochemical anomalies.

Area 6 is 0.5 mi^2 on the north side of Deep Creek and on the southeast side of Emmett Mountain. The area has a medium potential for a volcanogenic deposit containing lead and zinc because of the concentration of geochemical sample localities containing anomalous amounts of those metals.

Area 7 is 3.5 mi^2 in an irregularly shaped area extending from the headwaters of Granite Creek to the headwaters of the Lake Fork Rapid River and Pactoliar Gulch. The area has medium potential for volcanogenic deposits containing lead, copper, and silver on the basis of hydrothermally altered rock and numerous geochemical anomalies having low metal concentrations.

Area 8 is 7 mi^2 and extends from the lower part of Deep Creek to the northeast across Anderson Gulch to and including much of the drainage of Oxbow Creek. The area has a high potential for volcanogenic deposits containing copper, silver, zinc, lead, and gold on the basis of extensive mineralized rock, hydrothermally altered and silicified rock, geochemical and geophysical anomalies, and known resources. The Red Ledge mine and the Cliff prospect contain 25,318,000 tons of paramarginal copper, silver, and gold resources.

Area 9 is about 0.75 mi^2 on the east side of Granite Creek, north of Emerald Lake. The area has medium potential for a volcanogenic deposit containing molybdenum on the basis of hydrothermally altered rock and geochemical anomalies. Because stream-sediment samples are more indicative of the general metallic content of an area than a like number of rock samples, the presence of anomalous amounts of molybdenum in four adjacent streamlets in the horizontal distance of 1 mi across the slope above Granite Creek may be significant.

Area 10 is about 0.33 mi^2 on the north side of Paradise Creek. The area has medium potential for a volcanogenic deposit containing silver on the basis of three adjacent samples that contain anomalous concentrations of silver and, to a small measure, because of the possibility that hydrothermally altered rocks may underlie the area. This possibility is suggested by aeromagnetic data.

Area 11 is 0.5 mi^2 near Casey Springs in the southwest side of Granite Creek. Area 11 has medium potential for a volcanogenic deposit containing silver and lead on the basis of the association of geochemical anomalies with a magnetic anomaly, which may indicate a small area of intensely altered rock.

Area 12 is about 0.75 mi^2 on the north side of Copper Creek and the south and southeast sides of Jackley Mountain. The area has medium potential for volcanogenic deposits containing molybdenum and silver on the basis of geochemical anomalies and the possibility of metals concentrated in a thin roof above the tip of a pluton.

Area 13 is 0.5 mi^2 between Granite Creek and West Fork Rapid River and at Carbonate Hill. The area has medium potential for a volcanogenic deposit

containing silver, copper, zinc, and molybdenum on the basis of geochemical anomalies, mineralized and altered rock, and the possibility of more intensely altered rock at depth, which is suggested by the magnetic data.

Area 14 is a little more than 1 mi^2 near Baldy Lake on the west side of the highest peaks in the Seven Devils Mountains. The area has medium potential for volcanogenic deposits containing lead and silver on the basis of the large number of geochemical samples, particularly the stream-sediment samples, which contain anomalous amounts of metals.

Area 15 is about 0.5 mi^2 near Gem Lake on the north side of the He Devil in the Seven Devils Mountains. The area has medium potential for a volcanogenic deposit containing lead because of the concentration of stream-sediment samples containing anomalous amounts of that element.

Area 16 is 5 mi^2 in the canyon of the Snake River, in the drainages of Sluice Creek, Rattlesnake Creek, Ruth Creek, and Pony Creek in Oregon, and near Johnson Bar in Idaho. The area has medium potential for volcanogenic deposits containing silver, copper, molybdenum, lead, and zinc on the basis of known resources, extensive hydrothermally altered rock, mineralized rock, the highly anomalous values of metals in some geochemical samples, and known resources.

Area 17 is 2 mi^2 in the canyon of the Snake River near Quartz Creek and Dry Gulch in Oregon, and near Meyer Creek and Caribou Creek in Idaho. The area has medium potential for volcanogenic deposits containing silver, zinc, molybdenum, and copper on the basis of known mines and prospects, the association of geochemical anomalies and hydrothermally altered rock, and the possibility of more extensive altered and mineralized rock at depth as suggested by the magnetic data.

Area 18 is 2.5 mi^2 in the upper parts of the drainages of Kirkwood, Kirby, and Corral Creeks in the vicinity of the Blue Jacket mine. The area has high potential for volcanogenic deposits containing zinc and silver on the basis of anomalous geochemical values in altered rocks and soil samples in a zone of low magnetic intensity, known mineralized rock, past production, and identified resources.

Area 19 is 0.75 mi^2 in the drainage of the upper part of Somers Creek. The area has medium potential for a volcanogenic deposit containing silver, lead, zinc, copper, and gold. Despite the fact that this area is covered by the Columbia River Basalt Group, the covering may not be thick, and the high metal values in stream-sediment samples are indicative of a highly mineralized source nearby.

Area 20 is 2.5 mi^2 near the junction of the Imnaha and Snake Rivers. The area has medium potential for vein deposits of copper on the basis of the large number of known veins and geochemical samples indicating its presence. However, the deposits thus far discovered are small and low grade, and the association of copper with magnetite and hematite renders the recovery of the copper economically unfeasible at this time.

Numerous prospects and mines outside areas 1 through 20 contain copper and silver, and lesser amounts of lead, zinc, and molybdenum. Even though some of the mines contain resources of these metals, the areas in which they are found have low potential for ore bodies. These deposits are small and low grade and are not associated with significant geochemical anomalies, magnetic anomalies, or favorable geologic environments. Lacking such features, these areas are not as highly ranked as areas in which combinations of these features are found. The classification of low potential does not necessarily signify that no new deposits will be found.

Gold

The potential for the occurrence of gold is restricted to those types of deposits from which the metal was mined in the past, that is, placer deposits, quartz fissure veins, and volcanogenic deposits. The gold in volcanogenic deposits is present in only minor quantities and has been or would be only a byproduct of mining for other metals. Therefore, the potential for gold deposits of this type depends upon the potential that an area has for volcanogenic deposits containing other metals. Areas 1 and 19 have medium potential for volcanogenic deposits containing gold, and areas 8 and 18 have high potentials for volcanogenic deposits containing gold.

Quartz fissure veins were mined for their gold content, and these veins also contained minor amounts of silver. Both metals were detected in geochemical samples from a few prospects and at mines where resources exist. However, no gold was found in samples collected near veins or in areas in which veins are found.

Area 7 has medium potential for gold-silver fissure-vein deposits. The Curren Mountain prospect contains 25,300 tons of submarginal gold-silver resources averaging 0.03 oz gold per ton and 0.3 oz silver per ton and the Maid of Erin mine and the Summit mine contain 328,000 tons of paramarginal gold-silver resources averaging 0.12 oz gold per ton and 0.1 oz silver per ton.

Area 12 has medium potential for vein deposits containing gold and silver on the basis of vein deposits at the Mayflower group, White Rose prospect, and Middle Mountain prospect.

Area 13 has medium potential for gold-silver fissure-vein deposits. The Bald Eagle mine contains 18,750 tons of submarginal gold and silver resources averaging 0.03 oz gold per ton and 0.4 oz silver per ton.

Placer deposits may exist along the Snake River, in terraces above the river, and in high-level gravels on the pre-Columbia River Basalt Group erosion surface. The alluvium along the Snake River totals 370 million yd^3. Samples from 300 yd^3 of alluvium in the stream channel had as much as $30 per yd^3 in gold values but averaged $0.33 per cubic yard at a gold price of $500 per troy ounce. Samples from 70 million yd^3 of alluvium in the terraces that border the Snake River had as much as $2 gold per yd^3 but averaged $0.07 per cubic yard. Past mining operations and the present study indicate that deposits along the Snake River are small and that the small size of the particles of gold would render their recovery difficult. The potential for gold placer deposits along the Snake River is classified as low.

Gold is found in high-level gravels at Crooks Corral and Dry Diggins. The deposits at Crooks Corral are practically mined out, and past attempts to mine at Dry Diggins (Area 21) have been unsuccessful. The Dry Diggins placer has 627,000 yd^3 of alluvium averaging about $10 per yd^3. Because of its remote location and the shortage of water, the placer is classified as having medium potential.

Tungsten

Tungsten is found in parts of Area 3, where tactite deposits containing scheelite and powellite are associated with limestone inclusions in the pluton near White Monument. Tungsten has been found at a number of prospects and mines in this vicinity, and the Alaska mine, just outside the study area, produced a small amount of tungsten ore. On the basis of these deposits and

two geochemical samples, Area 3 has medium potential for tactite deposits containing tungsten.

Limestone

Principal limestone deposits are along the Snake River near Windy Ridge. They contain large resources of materials that would meet many industrial specifications. Similar deposits are being mined near Lime, about 40 mi to the south.

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