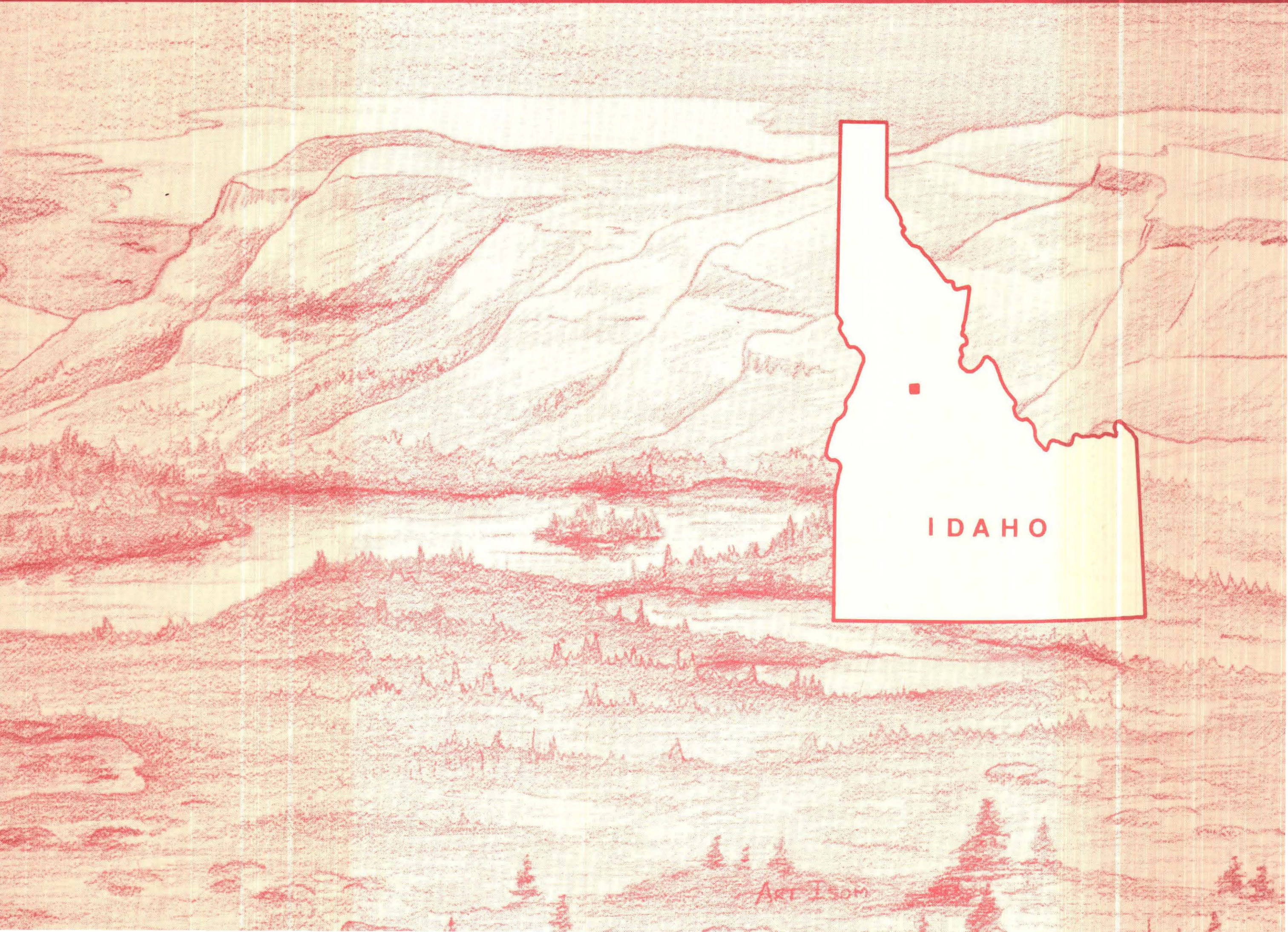
Mineral Resources of the Gospel-Hump Wilderness, Idaho County, Idaho

U.S. GEOLOGICAL SURVEY BULLETIN 1812



Mineral Resources of the Gospel-Hump Wilderness, Idaho County, Idaho

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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 Gospel-Hump Wilderness in the Nez-perce National Forest, Idaho County, Idaho. The area was established as a wilderness by Public Law 95-626, January 30, 1978.

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[Plate is in pocket]

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Mineral Resources of the Gospel-Hump Wilderness, Idaho County, Idaho

By Karen Lund, U.S. Geological Survey, *and*
Leon E. Esparza, U.S. Bureau of Mines

SUMMARY

Abstract

The Gospel-Hump Wilderness lies in central Idaho (fig. 1). A mineral survey of the 206,500 acre area in Idaho County was conducted by the U.S. Geological Survey and the U.S. Bureau of Mines during 1980 to 1983. The study consisted of new geologic mapping, geochemical sampling of the wilderness and vicinity, geophysical surveying, and investigation of claim blocks in or near the wilderness.

Fractures in the roof zone of plutons of the Idaho batholith host gold and silver deposits in mining districts that are contiguous with and included in the Gospel-Hump Wilderness. Subeconomic gold and silver resources are indicated and inferred at the War Eagle and Blue Jay mines (southeastern part of the area). Parts of the eastern half of the wilderness area, which are included in mining districts and which are along the trends of known mineralized fractures, have a high potential for gold and silver resources and moderate potential for copper, lead, zinc, and molybdenum resources in quartz fissure-veins. Other parts of the wilderness that have the same geologic setting have a moderate potential for gold and silver resources in undiscovered quartz veins that lie along the trend of or are parallel to known veins. The western third of the wilderness has a moderate potential for tungsten, silver, lead, copper, nickel, and possibly gold resources in skarn or metasomatic replacement deposits along thrust faults adjacent to carbonate units.

Manuscript approved for publication July 16, 1987.

Character and Setting

The Gospel-Hump Wilderness, in the Nezperce National Forest in Idaho County, is about 30 mi southeast of Grangeville, Idaho (fig. 1). Two unimproved roads provide access into the western and northeastern parts of the wilderness. The only other access is by pack trail or the Salmon River. The southwestern part of the Clearwater Mountains contains the highest peaks of the range. The maximum relief is 6,968 ft.

Some of the historically most important gold-producing mining districts in Idaho are near the Gospel-Hump Wilderness (Savage, 1970). Parts of the Buffalo Hump, Orogrande, Tenmile, and Florence districts are included in the wilderness, and the smaller Dixie district abuts the eastern boundary (fig. 1). Exploration and small mining operations are ongoing in and near the area.

The Gospel-Hump Wilderness is in the northern part of the Atlanta Lobe of the Idaho batholith. The country rocks consist of upper greenschist and lower amphibolite facies metasedimentary rocks that were folded and thrust faulted. These metamorphic rocks occur as roof pendants in large tonalite and granite plutons. During and after emplacement of the plutons, uplift occurred along north-northeast-trending normal faults. The precious-metals vein deposits formed in fractures at the roof of the plutons only 3 m.y. (million years) after emplacement of the granites.

Identified Resources and Resource Potential

Precious Metals

The War Eagle and Blue Jay mines in the southeastern part of the area (fig. 2) were once active

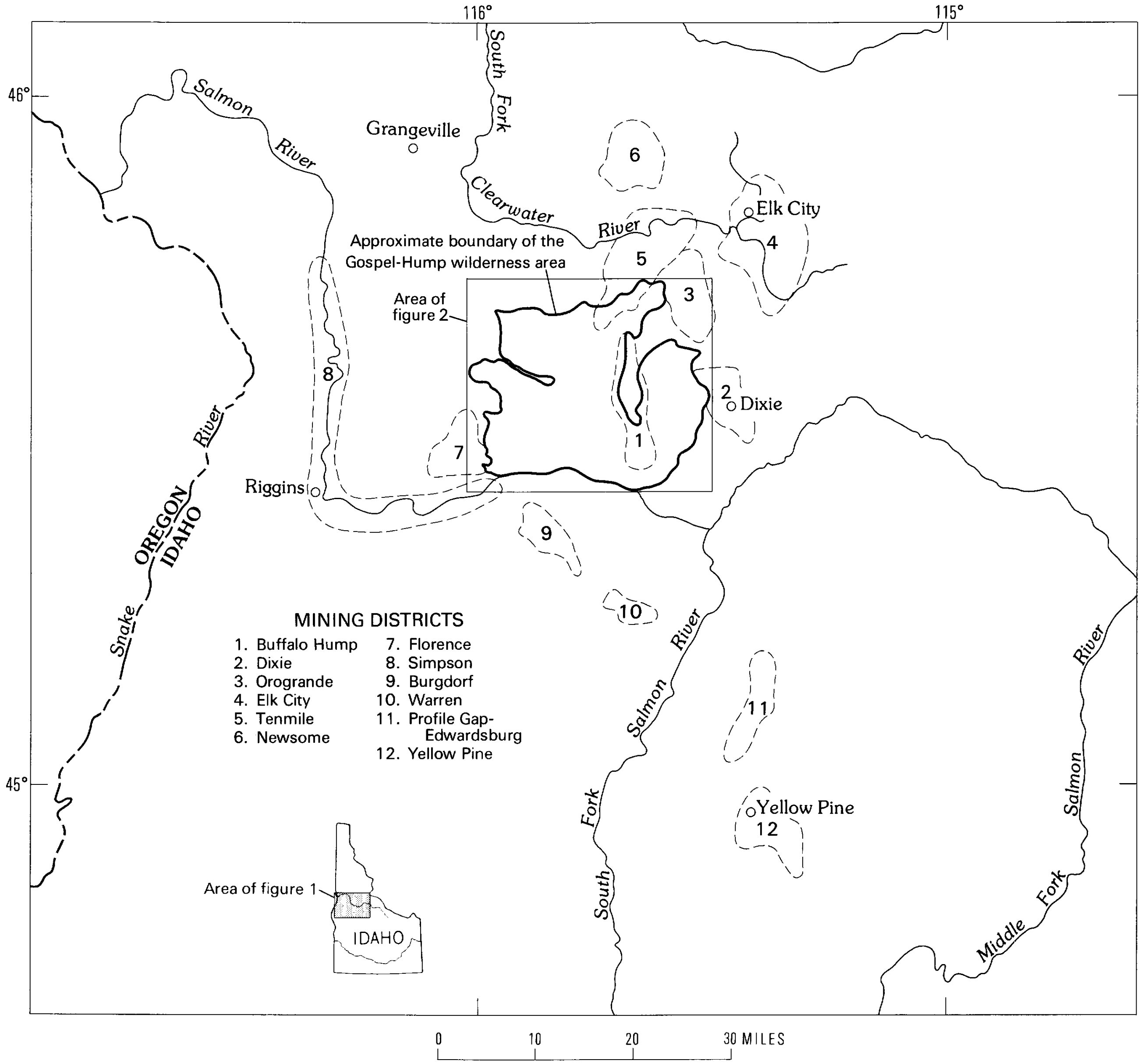

Figure 1. Index map showing location of the Gospel-Hump Wilderness, Idaho County, Idaho and nearby mining districts.

mines. Past production records and the present investigations suggest that these deposits contain sub-economic indicated and inferred gold-silver resources (table 1). Other historic mines are near Ruby and Bear Lakes on the eastern side of the wilderness area. All areas that are in the roof zone of plutons and along the extended traces of mineralized veins have high potential for the presence of undiscovered gold resources.

Geochemical anomalies and the geologic setting indicate that much of the remainder of the eastern half of the area has a moderate potential for gold resources similar to those previously recovered in the Buffalo Hump and nearby districts.

A low potential for gold resources exists throughout the rest of the wilderness area, but no mines or prospects for these resources are present in these areas. Likewise, the favorable geologic and geochemical indicators that are associated with exploited veins are not common in these areas.

Although placer gold deposits are historically more important in the region than lode deposits, this study did not identify any significant gold-bearing alluvial deposits.

A moderate potential for silver and possibly gold resources exists in small skarn or metasomatic replacement deposits in the western part of the wilderness.

Table 1. Mineral production from mining districts in the Gospel-Hump Wilderness and vicinity, Idaho

[Lode production data obtained from U.S. Bureau of Mines records. Placer gold production from Koschmann and Bergendahl (1968) and Thomson and Ballard (1924). Leaders (--) indicate no data; tr oz, troy ounce; lb, pound; ~, approximately]

District name	Placer gold production (tr oz)	Lode production				
		Gold (tr oz)	Silver (tr oz)	Copper (lb)	Lead (lb)	Zinc (lb)
Buffalo Hump	--	33,534	33,579	11,118	49,253	--
Dixie	40,000 to ~75,000	2,408	1,534	927	2,483	--
Elk City	550,000 to ~800,000	27,646	11,315	750	847	400
Florence[1]	~1,000,000	738	615	--	--	--
Newsome[2]	97,000	1,236	298	--	--	--
Orogrande	~32,000	20,827	11,698	2,871	20,941	--
Simpson	9,578	305	55	--	--	--
Tenmile[3] (Golden)	128,600	18,866	12,906	4,235	10,302	707
Warren-Burgdorf[4]	906,000	58,234	123,337	12,497	26,585	294
Total	2,763,000 to 3,048,000	163,794	195,337	32,398	110,411	1,401

[1]Reed (1939, fig. 1) shows the Bungalow district to be adjacent to and northwest of the Florence district. Lorain and Metzger (1938, p. 49 and figs. 2 and 8) imply that the Bungalow area is part of the Florence district. Production reported here is assumed to include that from Florence, Bungalow, and French Creek. Specific references to production, district boundaries, or mining history could not be found for the French Creek district, although Koschmann and Bergendahl (1968, p. 132) make reference to the "French Creek and Florence districts."

[2]Thomson and Ballard (1924, p. 13) estimate production from the Newsome district to have been worth $2,000,000. The gold price from 1850 to 1932 was $20.67 per troy ounce. Production reported herein was derived by dividing the total estimated value of the gold by the unit price.

[3]Koschmann and Bergendahl (1968, p. 133) report a total gold production of 147,000 ounces of which they state an estimated minimum of 18,400 ounces of lode production.

[4]Lorain (1938) and Lorain and Metzger (1938) refer to the composite Marshall Lake and Resort districts (Ross, 1941) as the Burgdorf district.

Base Metals

Minor amounts of copper, lead, and zinc were recovered previously from the gold-bearing quartz fissure-vein deposits in the region of the Gospel-Hump Wilderness. Molybdenum minerals are also found in the veins. Because of the limited nature of the occurrences, the areas designated as having high potential for gold resources also have moderate potential for copper, lead, zinc, and molybdenum resources.

Moderate potential for tungsten, silver, lead, copper, and nickel resources in skarn or metasomatic replacement deposits exists in the roof pendants of the western third of the wilderness. These occurrences are


116° 00′
115° 30′
45° 40′
45° 30′
Sourdough Peak
Sawyer Ridge Peak
Gospel Peak
Square Mtn
Hanover Mtn
Black Butte
North Pole Peak
Buffalo Hump Peak
Shining Butte
Quartzite Butte
Oregon Butte
Approximate boundary of the Gospel-Hump wilderness area
Creek
John
Gospel
Wind
River
Sheep
Creek
Tenmile
Creek
Lake
Creek
Salmon
River
Crooked
River
Kg
PzZu
Ys
Yq
H/C M/C L/C U/A
M/B1 L/C U/A
M/B2 L/C
L/B L/C
M/C L/C
0
5 MILES

EXPLANATION

H/C M/C	Geologic terrane having high mineral resource potential for gold and silver in veins and moderate mineral resource potential for copper, lead, zinc, and molybdenum in veins, with certainty level C
M/B_1	Geologic terrane having moderate mineral resource potential for gold and silver in veins, with certainty level B
M/B_2	Geologic terrane having moderate mineral resource potential for tungsten, silver, lead, copper, and nickel in skarn or metasomatic replacement deposits, with certainty level B
L/B	Geologic terrane having low mineral resource potential for gold and silver in veins, with certainty level B
L/C	Geologic terrane having low mineral resource potential for gold in placers, with certainty level C—Applies to entire wilderness
U/A	Geologic terrane having unknown mineral resource potential for copper-silver, lead-zinc, and cobalt-copper in sediment-hosted deposits, with certainty level A

LIST OF MAP UNITS

Kg	**Plutons (Cretaceous)**—Phases of the Idaho batholith. Medium-grained, unfoliated muscovite-biotite granite; medium-grained, unfoliated hornblende-biotite tonalite
PzZu	**Metasedimentary rocks (Late Proterozoic to Paleozoic)**—Gospel Peak roof pendant; includes quartzite, calc-silicate gneiss, marble, apatite-pyrite quartzite, and quartzite-pebble conglomerate
Yg	**Metaquartzite (Middle Proterozoic)**—Part of Buffalo Hump roof pendant. White to tan clean quartzite or quartzitic gneiss. Correlated with Belt Supergroup or with equivalent-age rocks of east-central Idaho
Ys	**Calc-silicate gneiss and schist (Middle Proterozoic)**—Part of Buffalo Hump roof pendant. Gray to tan. Correlated with Belt Supergroup or equivalent-age rocks of east-central Idaho
	Contact
	Thrust fault—Sawteeth on upper plate

Figure 2 (above and facing page). Summary map showing mineral resource potential of the Gospel-Hump Wilderness, Idaho.

localized in carbonate rocks along thrust faults. The hosting rock units are thought to be correlative with Late Proterozoic to Paleozoic metasedimentary rocks that host similar deposits in central Idaho, south of the Gospel-Hump Wilderness.

INTRODUCTION

The Gospel-Hump Wilderness covers 206,500 acres (about 322 sq mi) in the Nezperce National Forest, Idaho County, west-central Idaho (fig. 1). The name for the wilderness was created by combining the name of a feature in the western part of the area (Gospel Peak) with the name of a feature from the eastern part of the area (Buffalo Hump). The wilderness is about 30 mi southeast of Grangeville, Idaho, and is reached by a gravel road from the Riggins and Grangeville areas to the west and by a rough four-wheel-drive road from the Elk City area to the northeast. Both roads provide access well into the interior of the wilderness area but are passable only in the late summer months. Access to the southern part may be attained by boat along the Salmon River.

The wilderness area includes the southwestern corner of the Clearwater Mountains and contains the highest peaks of the range. Elevations range from 8,938 ft at Buffalo Hump to 1,970 ft on the Salmon River at the southwestern corner of the wilderness area. The northern part of the area is drained by the South Fork of the Clearwater River, and the southern part is drained by the Salmon River.

Some of the historically most important gold-producing mining districts in Idaho are near the Gospel-Hump Wilderness (fig. 1; Savage, 1970). Parts of the Buffalo Hump mining district lie in the eastern half of the wilderness area. The zone that contains most of the major mines in this district has been excluded from, but is virtually surrounded by, wilderness. The southern part of the Tenmile district is included in the northeastern part of the wilderness. The large gold placer and lode deposits of the Florence district border the area on the west, and a small part of the district is included in the southwestern corner of the wilderness. A few lode mines of the Orogrande district are included on the northeastern side. Lode and placer deposits of the Dixie district abut the eastern side.

Previous Work

Parts of the Gospel-Hump Wilderness were previously mapped at reconnaissance scales for studies of the gold vein or placer mining districts (Livingston and Stewart, 1914; Thompson and Ballard, 1924; Beckwith, 1928; Shenon and Reed, 1934; Capps, 1939; Reed, 1939) and for a reconnaissance geochemical study before the area was incorporated into the wilderness system (Knowles and Bennett, 1978). The Gospel-Hump Wilderness was included in studies by the U.S. Department of Energy in the Elk City 1° × 2° quadrangle during the National Uranium Resource Evaluation Program. These studies involved airborne radiometric and magnetic surveys (E.G. and G. Geometrics, 1980) and hydrogeochemical and stream-sediment sampling (Broxton and Beyth, 1980).

Although the Gospel-Hump Wilderness is a geologically critical area, the only early geologic mapping study that included the wilderness and that was not limited to study of the mineral deposits was Lindgren's study of the Bitterroot and Clearwater Ranges (Lindgren, 1904). Nearby areas were studied by Reid (1959), Hamilton (1963), Cater and others (1973), Greenwood and Morrison (1973), and Myers (1982). The geology of the region has been included in tectonic reconstructions for Proterozoic metamorphism, uplift, and sedimentation (Harrison and others, 1974; Armstrong, 1975; Ruppel, 1978) and in Phanerozoic plate reconstruction models (Burchfiel and Davis, 1975; Hamilton, 1978; Hyndman, 1979; Dickinson, 1981; Lund, 1984).

Investigations by the U.S. Geological Survey

Field work of the U.S. Geological Survey (USGS) was done during 1980–1983 by Karen Lund, 1981–1983 by K.V. Evans, 1981 by K.A. Geer, and 1980 by B.A. Bye, B.W. Coxe, R.O. Yeoman, and R.D. Zimmermann. A microcomputer system to store and evaluate field and geochemical data was designed for this project by J.T. Hanley (Hanley and Schruben, 1982). Assistance was provided in the field work by C. Allen, B. Biberon, H. Brandenberger, G. Cotton, J. Eisert, M. Elrick, F. Henderson, D. Hendzel, C. Manfrino, G. Meyers, J. Schuyler, E. Secor, G. Sims, and N. Winslow.

New geologic mapping was undertaken and was compiled at 1:50,000 (pl. 1) to define the geologic and mineral deposit settings. An aeromagnetic survey of the wilderness and vicinity was directed by M.D. Kleinkopf (U.S. Geological Survey, 1983).

Geochemical sampling of rocks was done concurrently with geologic mapping. Stream-sediment geochemical sampling was carried out by K.A. Geer, B.W. Coxe, and R.O. Yeoman. Geochemical samples were collected from 512 localities and analyzed by semiquantitative emission spectroscopy for 31 elements (Geer, 1983; unpub. data). These data were interpreted statistically by Geer (1983). In addition, 8 samples were collected for $^{40}Ar/^{39}Ar$ dating (Snee and others, 1985; Lund and others, 1986).

Investigations by the U.S. Bureau of Mines

Work by the U.S. Bureau of Mines (USBM) entailed several phases that spanned from 1981 to 1983 (Esparza and others, 1984). Pre-field studies included library research and collection and perusal of Idaho County and U.S. Bureau of Land Management mining and mineral lease records. USBM production records were searched and pertinent data compiled. Claim owners and leasees were contacted for permission to examine properties and publish results. Field studies undertaken during the summers of 1981 and 1982 by L.E. Esparza, J.E. Olson, and S.L. Willett involved searches for all mines, prospects, and claims indicated by the pre-field studies; those found were mapped and sampled. Mineral deposits in parts of the Florence, Buffalo Hump, and Dixie mining districts were studied for information on characteristics and genesis of known deposits. In addition, ground and air reconnaissance was done along all known trails and in areas of altered rock.

Samples collected included 309 lode samples and 90 panned-concentrate stream-sediment samples. Lode samples were analyzed by fire-assay, atomic-absorption, colorimetric, or X-ray fluorescent methods. At least one sample from each locality was analyzed by semiquantitative spectrographic methods for 41 elements (Esparza and others, 1984). Reconnaissance stream-sediment samples were concentrated to heavy-mineral fractions, examined for fluorescence and radioactivity, and visually scanned. Petrographic examinations were performed to determine selected rock types, alteration suites, and mineral assemblages. Site-specific geophysical surveys were conducted using VLF (very low frequency) electromagnetic receiver, proton magnetometer, signal enhancement seismograph, four-channel gamma-ray spectrometer, and scintillometer (Esparza and others, 1984; L.E. Esparza, unpub. data). Detailed analytical information is available for public inspection at the Bureau of Mines, Western Field Office Center, Spokane, Washington.

Acknowledgments

We thank the U.S. Forest Service District Rangers of the Slate Creek, Red River, Clearwater, and Elk City districts (Bob Abbot, Rich Inman, Joe Bednorz, and Vern Fleisher, respectively) for their help throughout this study. We are indebted to Bill Hay and Jo Molson of the Red River District and Betty Diviny of the Slate Creek District for hospitality. The biggest debt is to the Nezperce National Forest geologists Carl Harmon (1980) and John Nichols (1980-1984) for providing help with regional geology, maps, airphotos, mine and claim information, and countless small but urgent problems.

APPRAISAL OF IDENTIFIED RESOURCES

By L. E. Esparza, U.S. Bureau of Mines

Mining and Exploration History

The Gospel-Hump Wilderness is surrounded by nine mining districts (fig. 1). The wilderness area includes parts of the Tenmile, Orogrande, Buffalo Hump, and Florence districts; the Dixie district is adjacent to the eastern side of the wilderness. The initial discoveries of placer gold in districts near the area were made in 1861 (Thompson and Ballard, 1924). Lode gold and silver deposits near Elk City were first discovered in 1870, but those in the wilderness (the Buffalo Hump district and at the War Eagle mine) were not discovered until 1898 (Shenon and Reed, 1934). Mining activity throughout the region subsided by about 1910 and has been intermittent since then.

Most of the gold production from the region was from placer deposits. However, in the districts included in the wilderness, production was mainly from lodes. Although production records are incomplete and estimates vary (see table 1), Thompson and Ballard (1924) estimated that more than 3 million troy ounces (oz) of gold were produced from placers and lodes in the Elk City, Newsome, Tenmile, Orogrande, Buffalo Hump, Dixie, Florence, and Burgdorf districts. Gold production of about 34,000 troy oz is reported for the Buffalo Hump district (table 1). Combined precious- and base-metals production estimates are summarized in table 1.

Precious metals exploration in mining districts near the wilderness has increased dramatically in recent years. Major recent developments include exploration drilling, pilot heap-leach studies, initiation of mining permit applications, and commencement of mining at several properties near or adjacent to the wilderness. The interest has focused on large, low-grade, heap leachable gold deposits. Information about specific operations was provided by W.L. Rice (1987, oral commun.) and Rice and others (1987).

In 1986, Coeur d' Alene Mines Corp. began open-pit mining and heap-leaching at its Thunder Mountain gold-silver property, about 20 mi southeast of the Gospel-Hump Wilderness. The mining company estimates ore reserves of 1,788 million tons, averaging 0.095 troy oz of gold and 0.077 troy oz of silver per ton. Late in 1986, Nevex Gold Company, Inc., began the permitting process for a heap-leaching facility at its Robinson Dike gold property, south of Dixie. The company reports reserves of 450,000 tons ore, grading 0.06 troy oz of gold per ton (Bill Porter, 1987, personal commun.). In the Elk City area, exploration drilling and heap-leach tests were begun at the Friday Gold property by Normine Resources Ltd. The company reports reserves of 3 to 4 million tons, grading 0.035 to 0.04 troy oz gold per ton. Also near Elk City, United Gold Corp. began drilling the Ericson Reef gold property in 1984. Drilling continued into the summer of 1986. Neither results of the drilling nor resource estimates are available. Center Star Gold Mines, Inc., reopened the Center Star gold mine in 1982, and in 1985 completed construction of a 75-ton per day mill and tailings ponds; resource information is not available.

In the Buffalo Hump mining district, which is surrounded on three sides by the Gospel-Hump Wilderness, exploration has been conducted by at least six mining companies. Activity especially worthy of note includes the continued mining by the Big Buffalo Mining Co. at its Big Buffalo mine. The company has a 50-ton per day mill installed at the site; resource information for the property is not available. In late 1986, Liberty Bell Mines, Inc., announced plans to begin mining and continue exploration at the Monte Cristo mine. The company negotiated the purchase of a 50-ton per day mill that will be installed on the property; resource information is not available. In 1984, Award Resources U.S.A., Inc., drilled six holes at the War Eagle mine. Results of the drilling are provided by Chauvot (1986).

Appraisal of Examined Sites

A total of 23 mines, claims, and prospects in the Gospel-Hump Wilderness have been identified and evaluated (table 2; Esparza and others, 1984). Three of the prospects are small gold-bearing placers in Recent alluvial deposits. Fifteen mines or prospects are located along quartz fissure veins. Four of the known prospects are within carbonate metasedimentary units in the western third of the area. One of the prospects is on an iron-stained amphibolite dike.

About 25,000 tons of indicated and inferred subeconomic gold and silver resources were estimated at the Blue Jay mine (fig. 2; pl. 1). The resources occur in quartz veins that have an average thickness of 3.0 ft. Average gold and silver grades are 0.12 oz per ton and 0.16 oz per ton, respectively. Accessory copper, lead, and zinc are also present. The resources are classed as subeconomic (U.S. Bureau of Mines and U.S. Geological

Table 2. Mines, claims, and prospects in the Gospel-Hump Wilderness, Idaho

[tr oz, troy ounces; lb, pounds]

Name	Map No.[1]	Workings	Summary
Altoona claims	7	2 shafts, each 10 ft deep; 1 90-ft-long adit and 9 prospect pits	Workings scattered along 1- to 2-ft-thick quartz vein that extends along northeast strike for about 275 ft and dips 65°-75° SE. Quartz commonly boxwork filled with limonite. At one location, vein is cut by diorite dike about 120 ft long, 4 ft thick, striking N. 75° E. and dipping 80° S. Country rock predominantly granodiorite with some muscovite schist. 2 petrographic, 7 chip, and 6 grab samples; 1 chip sample assayed 0.028 tr oz of gold per ton and 1 grab sample assayed 0.001 tr oz of gold per ton. Copper, lead, and zinc quantities were no more than 0.003, 0.03, and 0.012 percent, respectively.
Blackie No. 1	11	1 pit	Audrey Shepler located these claims in October 1935. Area around claims is glacial till, some of which is composed of massive quartz cobbles with pyrite and iron-oxide staining. 1 grab sample; no significant geochemical values.
Blue Jay mine (Sterling Silver claims)	17	2 adits, 360 and 46 ft long; several prospect pits; 1 trench	Charlie Shepp made initial discovery in 1900. He and Pete Klinkhammer periodically worked claims until at least 1905. Production records not available. Mineralized quartz veins occur along shear zones in tonalite country rock. Chalcopyrite, chrysocolla, malachite, azurite, galena, and sphalerite often associated with quartz and breccia. Gold and silver found with quartz, breccia, and gouge. Indicated subeconomic resources are 5,600 tons and inferred subeconomic resources are 19,000 tons. Weighted average gold and silver grades are 0.115 tr oz per ton and 0.610 tr oz per ton, respectively. Other commodities have weighted average grades as follows: copper, 0.05 percent; lead, 0.22 percent; zinc, 0.03 percent. Also present in trace amounts are molybdenum and tungsten. Proton magnetometer, VLF-electromagnetic receiver, and gamma-ray spectrometer data indicate presence of conductor which probably horsetails east of adits. Indications of conductive zones occur north and south of adits.

Survey, 1980) because, at current gold and silver prices, grades are insufficient to return production expenditures and a reasonable return on invested capital.

Inferred subeconomic resources totaling about 26,000 tons and averaging about 0.2 oz of gold and 0.7 oz of silver per ton are estimated at the War Eagle mine (fig.

Table 2. Mines, claims, and prospects in the Gospel-Hump Wilderness, Idaho—Continued

Name	Map No.[1]	Workings	Summary
Bull of the Woods Nos. 1-3 claims	21	None found	Located by F.M. Mitchell in October 1898 and June 1900. Quartzite and gossan occur in shear zone parallel and adjacent to Iron Claims. 1 sample assayed at 0.66 tr oz of gold and 12.0 tr oz of silver per ton, 0.15 percent copper, and 0.057 percent zinc.
Bulls Head Lode claim	14	1 pit	Sphalerite-bearing quartz occurs along joint that strikes N. 53° E. and dips 60° E. in granitic country rock. Claim was located by C.P. Carlin in June 1900. 1 grab sample had 0.01 percent zinc.
Chief Whitebird claims	4	2 adits, 57 and at least 250 ft long, and several small pits	B.B. Swarts located claims in 1903. Workings are in locally pyrite-bearing granodiorite country rock. Longer adit cross-cuts faults and shear zones that strike northerly and dip steeply eastward. Above this working, prospect pits are in granodiorite and tactite with garnet and epidote. 12 grab and 9 chip samples; 7 assayed at 0.005-0.052 tr oz of gold per ton, 6 at 0.2-0.5 tr oz of silver per ton; maximum values for copper, lead, zinc, and tungsten were no more than 0.014, 0.010, 0.018, and 0.0022 percent, respectively. Results of VLF-electromagnetic receiver, proton magnetometer, and gamma-ray spectrometer surveys do not provide clear indication of presence of conductor.
Deer Head claim	12	1 30-ft-long adit and 3 prospect pits	Located by J.J. Howry in June 1902. Iron-oxide-stained quartz vein, less than 1.0 ft thick, strikes N. 15° E. and dips vertically. 1 grab and 3 chip samples; grab sample had 0.0016 percent molybdenum.
Hidden Treasure Lode claim	3	4 trenches and 3 pits	Veinlets of pegmatite and quartz intrude iron-oxide-stained granodiorite along Tenmile Ridge. 1 grab and 4 chip samples; 1 chip sample assayed at 0.052 tr oz of gold per ton and other samples each had a trace.

1; pl. 1). This tonnage is based on reports by G.J. Bancroft (1925, unpub. report, USBM, Spokane) and C.F. Tolman (1918, unpub. report, USBM, Spokane); the mine workings are now mostly inaccessible. Average grade is based on production records for the mine. Assay results cited by Bancroft are as much as 10.04 oz of gold per ton and 32.44 oz of silver per ton. Accessory lead, zinc, and copper are present. Thicknesses of two mineralized veins average 3–5 ft. The resources are classed as subeconomic for the same reasons as those at the Blue Jay mine. Geophysical surveys in the area of the War Eagle mine show six previously unreported VLF-electromagnetic anomalies (L.E. Esparza, unpub. data).

Resources were identiified but not quantified at several other known mines and prospects (table 2) that are in zones of high or moderate mineral resource

Table 2. Mines, claims, and prospects in the Gospel-Hump Wilderness, Idaho—Continued

Name	Map No.[1]	Workings	Summary
Iron Nos. 1-3 claims (St. Anthony)	20	1 15-ft-long adit and numerous prospect pits	Originally located by C. Miller in August 1907 and subsequently re-located by A.A. Oliver and R.F. Groom in September 1953. Gossan zone occurs over an area about 1,500 ft long and about 40 ft wide and is part of a much larger, more subtle iron-oxide staining that encompasses the region between Slate Lake, Gospel Peak, and Moores Lake. Gossan occurs in angular to subangular, fine- to medium-grained quartzite containing minor amounts of biotite and smoky quartz, and disseminated pyrite and pyrrhotite. Minor amount of malachite staining also was observed. Tremolite-marble schist occurs in small, isolated outcrops. 17 samples; 3 assayed at 0.03-0.042 tr oz of gold per ton; 2 assayed at 0.2 tr oz of silver per ton; 4 had 0.01-0.04 percent copper; 1 had 0.06 percent lead; and 4 had 0.01-0.012 percent zinc; average assay values were 0.006 tr oz of gold per ton, and 0.018 tr oz of silver per ton.
Lenore Nos. 1-23 claims	13	1 8-ft-long adit	Located by Bill Russell in March 1975 south of Round Lake. Iron-oxide-stained quartz vein 3-21 in. thick strikes N. 10° E., dips 68° E., and fills fractures in granodiorite and pegmatite country rock. One 21-in.-long chip sample had no significant metal values.
Lucky Nos. 3 and 4 claims	15	None found	Located by Charles Paul in August 1956 near Brandon Lakes. Disseminated pyrite and chalcopyrite occur in a 30-ft-thick layer of biotite schist. 1 grab and 5 chip samples; 3 chip samples each assayed at 0.2 tr oz of silver per ton.
Mountain View	5	7 adits, all but 2 of which are caved, and numerous prospect pits and trenches. The 2 open adits are 12 and 19 ft long	W.P. Boyle filed claim in August 1907. Quartz vein and veinlets strike No. 10° W. and dip 50° NE in granodiorite country. Vein, averaging less than 10 ft thick, is locally iron-oxide stained, and contains pyrite, arsenopyrite, galena, and covellite(?). Staining predominantly limonite and subordinate amounts of hematite. Vein may be part of system

potential (pl. 1). These include gold and silver resources in lode occurrences at the Chief Whitebird, Pittsburg, Iron, and Bull of the Woods claims; gold resources in quartz veins at the Altoona claims, Hidden Treasure Lode claim, Mountain View claim, and the Spokane mine; silver resources in the Myrtle Group lode claims; and gold resources in placer claims known as The Ruins Prospect (Esparza and others, 1984).

Table 2. Mines, claims, and prospects in the Gospel-Hump Wilderness, Idaho—Continued

Name	Map No.[1]	Workings	Summary
			described as Tiger vein by Shenon and Reed (1934, p. 65). 6 chip and 8 grab samples; 6 samples assayed at 0.005-0.896 tr oz of gold per ton; 1 also assayed at 0.8 tr oz of silver per ton, 0.075 percent copper, 0.37 percent lead, and 0.42 percent zinc.
Myrtle Group claims	23	1 pit	Greg Stanley located the Myrtle, Marian, Marcie, and Madaline claims in August 1908. Country rock slightly iron-oxide-stained quartzite and granodiorite and fine- to medium-grained dolomite containing sericite and traces of chlorite, zircon, sphene, magnetite, and pyrrhotite. Shear zone strikes N. 20° E., dips 60° E., and is about 100 ft wide. 6 samples; 3 grab samples assayed at 0.7, 2.5, and 2.7 tr oz of silver per ton; 1 other grab sample had 0.012 percent copper, and 2 others had 0.024 percent and 0.012 percent zinc.
Pittsburg claim	9	1 10-ft-long adit, 2 collapsed adits, 1 trench, and numerous prospect pits	Located by H. Williams in August 1902. Iron-oxide-stained quartz vein with limonite-filled boxwork strikes N. 23° E., dips 72° SE., and averages 2.5 ft thick. 5 grab and 4 chip samples; 1 grab sample of weathered granodiorite assayed at 0.166 tr oz of gold and 2.8 tr oz of silver per ton, and another of iron-oxide-stained quartz assayed 0.058 tr oz of gold and 1.6 tr oz of silver per ton. Iron-oxide-stained quartz was found to have copper, lead, zinc, and molybdenum in quantities as high as 0.014, 0.084, 0.0033 and 0.03 percent, respectively.
The Ruins prospect	1	At least 1,000 ft of trenching with less than 30 cu yd of hydraulic workings	Alluvial placer accumulations of unknown thickness overlay granodiorite country rock. 7 placer samples assayed at 0.00007-0.009 tr oz of gold per cu yd, one had 0.08 tr oz of gold per cu yd. 1 grab sample assayed at 0.2 tr oz of silver per ton.

ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

By Karen Lund, U.S. Geological Survey

Geology

The Gospel-Hump Wilderness is in the west-central part of the Idaho batholith. The country rocks consist of an upper greenschist and lower amphibolite facies metasedimentary sequence that forms the roof of large tonalitic and granitic plutons (fig. 2).

The regional correlation of the metasedimentary rocks is an essential part of the background for formulating the mineral resource potential in a region where sediment-hosted mineral deposits are important. The early workers in the Buffalo Hump area (the eastern half of the wilderness) correlated metasedimentary rocks with parts of the Middle Proterozoic Belt Supergroup but

Table 2. Mines, claims, and prospects in the Gospel-Hump Wilderness, Idaho—Continued

Name	Map No.[1]	Workings	Summary
Spokane mine	8	1 adit at least 240 ft long, and 5 prospect pits or possible caved shafts	3.0-ft-thick quartz vein that strikes N. 10° E. and dips 62° S. is exposed in the adit. According to Shenon and Reed (1934, p. 65) mine was developed on three levels and vein with at least 30 ft maximum thickness was exposed. 2 grab and 7 chip samples; 1 grab sample assayed at 0.27 tr oz of gold per ton.
Tiger claims	6	2 collapsed adits and numerous prospect pits and trenches	Located by L.J. Anderson in January 1903. Workings are on quartz vein and veinlets that trend about N. 12° W. and dip 70° NE. Quartz is locally pyrite-bearing and frequently stained by limonite. Shenon and Reed (1934, p. 65) report vein is about 10 ft thick in Anderson Tunnel. Vein does not crop out and, because the underground workings are not accessible, confirmation could not be made. 4 samples; 1 chip sample assayed at 0.001 tr oz of gold per ton and 0.0025 percent molybdenum. 3 grab samples contained copper and molybdenum. 1 had 0.007 percent copper and 1 had 0.001 percent molybdenum.
Unknown prospect	10	1 pit	Quartz pegmatite and fine-grained schistose gneiss. 1 grab sample; no significant metal values.
Unknown prospect	19	1 pit	Pit penetrates pink feldspar-quartz-muscovite-bearing pegmatite, and quartz veinlets, which are heavily iron-oxide stained. 1 grab sample had 0.0008 percent molybdenum.
Unknown prospect	22	None found	Gossan zone occurs about 2,000 ft north of Gospel Peak in schistose gneiss, hornfels, and fine- to medium-grained granite. About 800 ft north of peak and along cirque rim is a gray, sucrosic, biotite, quartz-pebble conglomerate. 11 samples; 1 grab sample of conglomerate assayed at 0.018 tr oz of gold and 3.4 tr oz of silver per ton. Some samples of iron-oxide-stained quartzite and granodiorite had silver, copper, lead, zinc, molybdenum, and tungsten in anomalous concentrations.

never agreed on which units were present (Lindgren, 1904; Beckwith, 1928; Shenon and Reed, 1934). Kopp (1973) also correlated the metasedimentary rocks in the Gospel Peak area (the western third of the wilderness) to the Belt Supergroup. However, a recent study by Knowles and Bennett (1978) equated the metasedimentary rocks throughout the wilderness area to the Middle Proterozoic Yellowjacket and Hoodoo Formations described from east-central Idaho (Ruppel, 1975). Other workers have suggested that meta-

Table 2. Mines, claims, and prospects in the Gospel-Hump Wilderness, Idaho—Continued

Name	Map No.[1]	Workings	Summary
			Visual inspection and VLF-electromagnetic receiver, proton magnetometer, and gamma-ray spectrometer surveys show oxidation occurs in granodiorite, pegmatite, and foliated schistose gneiss. Some iron-oxide staining is result of decomposition of biotite. Other oxidation features may be result of intrusion of granitic rocks along a thrust fault reported by Shenon and Reed (1934, p. 20).
War Eagle mine (Little Bear claims)	18	9 adits, only 1 of which is open; 1 shaft, numerous prospect pits, and remnants of a 25-ton per day flotation mill	William Boyce made initial discovery on Blue Bell claim in 1898. From 1934-1937, at least 11,896 tons of ore yielded 2,230 tr oz gold, 8,838 tr oz silver, 18,216 lb lead, and 5,374 lb copper. Granodiorite and quartz monzonite are cut by dacite porphyry dikes, quartz veins, War Eagle fault, and shear zones. Tolman identified propylitic and silicic alteration in rocks at and near mine, and pyrite, sphalerite, chalcopyrite, tetrahedrite, galena, argentite, gold and silver telluride(?), covellite, chalcocite, native silver, native gold(?), iron and copper oxides in quartz at mine. Inferred subeconomic resources for War Eagle mine are 26,000 tons, averaging 0.2 tr oz gold and 0.7 tr oz silver per ton. Grade is based on production records from 1934-1937. VLF-electromagnetic receiver, proton magnetometer, and gamma-ray spectrometer surveys indicate presence of conductor along War Eagle fault zone. 7 conductive zones are identified within 300 ft of adits and prospect pits.

[1]See map sheet.

sedimentary units in the area are entirely pre-Belt basement (Harrison and others, 1974; Armstrong, 1975). Each of these correlations indicates a different type of possible mineral deposit.

Metasedimentary Units

Two main tectonostratigraphic units crop out as roof pendants in the eastern part of the wilderness (Buffalo Hump area) and together represent about 3 mi of stratigraphic thickness (fig. 2; pl. 1). The lowermost unit comprises calc-silicate gneiss and schist (Ys). Although the texture of the rocks is largely metamorphic, primary sedimentary features are preserved in many localities. The upper tectonostratigraphic unit is a thick, clean quartzite or quartzitic gneiss (Yq). The composition, sedimentary structures, continuity of facies, and thickness of these tectonostratigraphic units indicate that the roof pendants in the Buffalo Hump area probably correlate either to the Middle Proterozoic Belt Supergroup or to equivalent rocks of east-central Idaho (Lund, 1984). On the basis of available regional information, a more conclusive statement on the correlation cannot be made.

Metasedimentary roof pendants (PzZu) in the western part of the area (the Gospel Peak area) represent another 4 mi of stratigraphic thickness which are markedly different from rocks in the Buffalo Hump area. The Gospel Peak roof pendants consist of a variety of laterally continuous lithologies including schist, clean quartzite, calc-silicate gneiss, marble, apatite-pyrite quartzite, and quartzite-pebble conglomerate. The diversity of metasedimentary rocks and the abruptness of vertical lithologic changes reflect a depositional environment of rapid changes in water level, type of sediment, and source of sediment. No undisputed fossils have been found in the region, and correlations are based on generalized lithologic and depositional similarities. Rapid facies changes are not characteristic of Middle Proterozoic rocks of the Belt Supergroup or equivalent east-central Idaho rocks. The metasedimentary rocks of the Gospel Peak pendant have features more similar to Late Proterozoic to Paleozoic sedimentary rocks of central Idaho than to the Middle Proterozoic sedimentary rocks.

Plutonic Units

The Cretaceous Idaho batholith in the Gospel-Hump Wilderness consists of two major phases (combined on the map as Kg). Hornblende-biotite tonalite, which commonly contains medium-grained sphene and epidote, forms the roof and western edge of the batholith. Muscovite-biotite granite makes up the core of the batholith. Granite was emplaced directly below the roof of tonalite in the Buffalo Hump area and higher than the roof zone of tonalite in the Sheep Creek and Gospel Peak areas. In the wilderness, both phases are unfoliated. The tonalite has been dated at 83.9±0.3 Ma by $^{40}Ar/^{39}Ar$ age-spectrum methods on hornblende (Snee and others, 1987) and the granite has been dated at 73.8±0.4 Ma on muscovite by the same method (Snee and others, 1986; Lund and others, 1986).

Unconsolidated Deposits

Valleys draining northward into the South Fork of the Clearwater River contain Quaternary glacial sediments deposited by valley glaciers that flowed from an ice cap in the high elevations in the Buffalo Hump to Gospel Peak areas. Minor alluvial deposits are found in the major stream valleys.

Structure

Metasedimentary rocks were metamorphosed and multiply deformed by several episodes of compressional deformation episodes prior to the intrusion of the Late Cretaceous plutons. Subparallel bedding, primary schistosity, and metamorphic compositional layering were deformed by (1) folding and concurrent thrust faulting, (2) minor folding-related to movement along thrust fault surfaces, (3) thrust stacking of previously deformed plates, and (4) gentle folds superposed across several plates. Structural transport was west-over-east during deformation.

The plutons were emplaced passively, by magmatic stoping. The plutons cut all folds and thrust faults and did not form new structures or cause large-scale contact metamorphic fabrics in the country rocks. Abundant xenoliths are found in the upper parts of the intrusions. Because little rotation occurred between xenolith blocks, both schistosity and lithology are continuous from block to block and country rock structures can be traced through mixed rock zones.

Uplift of the terrane began after emplacement of the tonalitic plutons and took place mostly before emplacement of granite plutons. Uplift continued at a slower rate, during and after emplacement of granite, until about 67 m.y. ago (Lund and others, 1986). Most of the uplift occurred along north-northeast-trending fault zones in the Florence basin and the Dixie basin that lie west and east of the wilderness, respectively. Minor movement also took place along steep normal faults in the Buffalo Hump district (pl. 1). These normal faults were the loci for precious-metal quartz fissure-vein deposits of the Florence, Dixie, Buffalo Hump, and other surrounding mining districts. The mineralizing event has been dated by $^{40}Ar/^{39}Ar$ methods at 71.0±0.4 Ma (Snee and others, 1985; Lund and others, 1986) for deposits at the Mother Lode mine in the Buffalo Hump district and 71.7±0.4 Ma for the deposit at the War Eagle mine (Chauvot, 1986). Many other deposits in the region have also been dated and ages of these deposits range from about 78 to 68 Ma.

Geology of Quartz Vein Deposits

Gold and silver deposits in the districts near the Gospel-Hump Wilderness occur in north-northeast-trending, nearly vertical quartz veins that pinch and swell along trend. Vein widths ranging from 0.3 to 30 ft have been reported (Beckwith, 1928). The vein material is mainly coarsely crystalline, milky-white quartz exhibiting uncommon banding and open-space filling. The quartz appears to have been deposited, brecciated, and re-introduced several times. Sulfide mineral assemblages within the quartz veins include common pyrite, sphalerite, chalcopyrite, and tetrahedrite, and local galena, arsenopyrite, molybdenite, and stibnite (Shenon and Reed, 1934). Gold and silver are present mainly as finely dispersed inclusions in the sulfide minerals, as tellurides, and as fine, free grains. Only minor amounts of altered rock are found associated with the veins (Muniz, 1985). Contacts between the wall rock and veins are well defined and in places contain fault gouge. Lode deposits in the wilderness area have been dated at 71.0±0.4 Ma (Lund and others, 1986) and 71.7±0.4 Ma (Chauvot, 1986) and are related to the muscovite-biotite granite plutons that are of similar age and host some of the deposits. $^{40}Ar/^{39}Ar$ cooling studies based on sericite from mineralized vein material and based on microcline from the granitic country rock show that emplacement of the quartz fissure-vein deposits occurred at a depth of about 2.5 mi (Lund and others, 1986).

Copper or molybdenum porphyry systems and proposed Eocene plutons have been inferred to be the source at depth of metals for the lode deposits of central Idaho (Anderson, 1951; Bennett, 1980; Criss and Taylor, 1983). No geochemical anomalies were found that could be attributed to this type of deposit. In addition, ages of mineralization and host rocks as well as information on the regional cooling history gained through this study have demonstrated that the episode of mineralization was related to the Cretaceous plutonic event, was short-lived, and was localized along the veins (Lund and others, 1986). The gold-bearing lode deposits are probably not related to either a Cretaceous or Eocene unexposed porphyry system at depth.

Geology of Skarn or Metasomatic Replacement Deposits

Small skarn or metasomatic replacement deposits are present in calcareous lithologies in roof pendants in the Gospel Peak area. The deposits are composed primarily of iron and manganese oxides and form gossans up to 0.25 sq mi in area. The mineralogy consists of disseminated pyrite, pyrrhotite, and copper carbonate. These small skarns occur as discontinuous lenses within marble at thrust contacts between the marble and overlying quartzite. Because carbonates are not everywhere mineralized near the plutons, it appears that thrust fault planes channeled fluids and allowed the formation of these deposits in favorable lithologies.

Although previously undescribed in the area of the Gospel-Hump Wilderness, skarn or metasomatic replacement deposits are known throughout a northwest-trending zone in central Idaho (Cook, 1956; Savage, 1970) and probably represent a regional distribution of favorable lithologies rather than some regional structure as was previously suggested by Cook (1956). The northwest trend of these deposits coincides with trends of known or suspected Late Proterozoic to Paleozoic miogeoclinal sedimentary and metasedimentary rocks. It is significant that the correlation of the Gospel Peak metasedimentary units with Late Proterozoic to Paleozoic sedimentary rocks is supported by both the lithologies and structural trends as well as by the similar type of associated mineral deposit.

Geochemistry

Knowles and Bennett (1978) reported that contamination by previous mining activity caused difficulty with the interpretation of stream-sediment geochemical anomalies in the eastern half of the area. Because of this, an extensive orientation survey of stream sediments near the mining districts was conducted by Geer (1983) as part of the present study. The orientation survey was designed to establish the most effective sample media to discriminate between contaminated and mineralized material (Geer and Closs, 1983). A base metal association of copper, lead, and iron in stream sediments was found to characterize mining contamination. The results of the study were used in the preparation of samples and evaluation of analyses from reconnaissance stream-sediment samples taken in the wilderness area.

The reconnaissance stream-sediment geochemical survey in the wilderness and vicinity (Geer, 1983; Karen Lund, unpub. data) was used to identify trace elements useful for the assessment of mineral resource potential. Stream sediments were sampled at 243 sites in the wilderness and vicinity. The reconnaissance survey consisted of 165 sample localities determined on the basis of one site per square kilometer. In each square kilometer, one second-order stream, or a first-order stream (unbranched) draining into a third or higher order stream, was randomly chosen for sampling. The remaining 78 localities were part of an orientation survey in the mining districts (Geer, 1983).

Two kinds of samples were collected from each locality, a panned-concentrate sample and a fine stream sediment (minus-80 mesh) sample. In the lab, panned-concentrate stream-sediment samples were further concentrated by bromoform separation. The magnetic fraction was discarded and the remaining fraction was pulverized to minus-150 mesh. All samples were analyzed for 31 elements (Ag, As, Au, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, La, Mg, Mn, Mo, Nb, Ni, Pb, Sb, Sc, Sn, Sr, Th, Ti, V, W, Y, An, Ar) using a six-step semiquantitative emission spectrographic method (Meyers and others, 1961).

Correlation analysis and R-mode factor analysis were conducted to facilitate data interpretation (Geer, 1983). Several suites of elements, discussed below, were noted for the study area; these suites correspond to major lithologic units or to restricted mineralized zones.

An association of precious and base metals occurs in panned-concentrate and fine stream-sediment fractions from tributaries of upper Tenmile, Sheep, and Lake Creeks and lower Jumbo Canyon in the northeastern part of the wilderness area. Anomalously high values for suites that include the association of gold, silver, copper, molybdenum, chromium, cobalt, tin, tungsten, and antimony are most common. A few of these tributaries have known mineralization in the drainage basin but most do not.

Anomalously high values of gold and silver occur in fine stream-sediment and panned-concentrate samples from the Fitz Creek and West Fork Creek drainages below the War Eagle and Blue Jay mines; anomalously high concentrations of tin are found associated with the precious metals in one Fitz Creek panned-concentrate sample.

Several streams draining Elk Butte in the south-central part of the area also have anomalously high values for base-metal assemblages from the panned-concentrate fraction. High values are reported for the base metals copper, lead, zinc, vanadium, molybdenum, cobalt, and boron. Anomalously high values for silver, lead, zinc, and chromium were obtained from fine stream-sediment fractions. The rocks underlying these drainages (fig. 2; pl. 1) are schistose roof pendants (Ys) and granitic intrusive rocks (Kg).

High values for tungsten are associated with moderately high values for a different assemblage of base metals (copper, molybdenum, lead, zinc) in samples of panned concentrate from the upper Gospel Creek and Wind River drainages. High values for manganese and scandium as well as copper, lead, zinc, and molybdenum also occur in panned-concentrate samples from drainages on the western side of Wind River. High values for barium occur in fine stream-sediment fractions from these same areas. The rocks underlying drainage basins in these areas are mainly Late Proterozoic to Paleozoic metasedimentary rocks (PzZu).

High values for cobalt alone or for cobalt associated with boron and other base-metal suites are found in the areas of precious- and base-metal anomalies and in areas underlain by quartz-biotite schist (Ys) in the Buffalo Hump pendant (especially in panned-concentrate samples from near Elk Butte) and east of the Gospel Peak roof pendant (near Square Mountain and Plummer Point).

Rock chip samples were collected from 269 sites in the Gospel-Hump Wilderness and vicinity. These included samples from mineralized rock, from altered country rock, from quartz veins, and from barren country rock for comparison. Samples were crushed and pulverized to less than 100 mesh. Samples were analyzed for 31 elements by six-step semiquantitative emission spectrographic techniques (Meyers and others, 1961). Threshold values correspond to natural breaks in the distribution of values and generally are well above background levels.

Anomalously high values for the association of silver, copper, cobalt, barium, and beryllium from rock chip samples characterize the gold-bearing quartz fissure-veins. In addition, anomalously high values for gold, arsenic, molybdenum, lead, chromium, and tungsten are found commonly in the quartz-vein samples but do not constitute a characteristic element assemblage.

The association of manganese, silver, barium, cobalt, copper, and nickel in anomalously high amounts is representative of the skarn or metasomatic replacement deposits found in rocks of the Gospel Peak area. Anomalously high values of arsenic and gold are found in some samples from gossans associated with these deposits.

Geophysics

An aeromagnetic survey was conducted by the USGS in 1980 (U.S. Geological Survey, 1983) as part of the present study. The strongest magnetic patterns expressed on the aeromagnetic map of the area are north trends that represent Late Cretaceous or younger features related to post-batholithic uplift of the wilderness area with respect to the basins on the east and west sides. In general, magnetic highs exist over the Middle Proterozoic metasedimentary roof pendants in the eastern half of the area and magnetic lows exist over the plutons of the Idaho batholith and the Late Proterozoic to Paleozoic roof pendants in the central and western parts of the area. Weak, northwest-trending regional high values extend into the area from the south. North-northeast-trending, paired, high and low values in the northwestern corner of the map area overlie a major fault between different basement blocks (Lund, 1984). These northwest and north-northeast patterns represent structures that pre-dated the regional uplift.

The Buffalo Hump, Florence, and Orogrande mining districts lie within north-trending areas of low magnetic values. This pattern reflects the localization of mineralization by through-going north-trending fractures related to uplift. The skarn deposits in the western part of the wilderness area all fall within minor but abrupt zones of low magnetic values that reflect thrust faults in the Late Proterozoic to Paleozoic roof pendants.

Mineral Resources

The geologic setting of the wilderness area is compatible with a variety of possible mineral deposits. Comparison of geochemical, geophysical, and geologic data for the wilderness area with that for mining districts in the region and with mineral deposit models forms the basis for assessment of the mineral resource potential. Types of deposits for which the setting is favorable are (1) precious-metal quartz fissure-vein deposits similar to those in the surrounding mining districts; (2) silver, lead, copper, nickel metasomatic replacement or skarn deposits similar to those in central Idaho south of the wilderness area; (3) porphyry-type copper and molybdenum deposits similar to others in central Idaho; (4) sediment-hosted deposits such as the cobalt and copper deposits at Blackbird, Idaho, or the stratabound copper and silver deposits at Spar Lake, Montana, or lead and zinc deposits at Sullivan, British Columbia; and (5) gold-bearing placer deposits similar to those in nearby districts. Assessment of mineral resource potential follows usage suggested by Taylor and Steven (1983) and Goudarzi (1984).

Quartz Fissure-Vein Deposits

Several known gold and silver mines and prospects are located in the wilderness area. Directly south of the Buffalo Hump district, the War Eagle and Blue Jay mines lie at a deeper level within the granitic plutons than the deposits in the main Buffalo Hump district. One mine and several known prospects lie along vein systems in Whistling Pig Canyon and near Bear and Ruby Lakes (in the Buffalo Hump mining district east of the wilderness exclusion). The deposits are all coeval (Lund and others, 1986; L.W. Snee and Karen Lund, unpub. data) and lie along parallel vein systems. Areas in the east-central part of the wilderness that lie on mineralized quartz fissure-veins or along the extended traces of mineralized veins have high potential for gold and silver resources in both partly exploited and unexploited quartz veins. The available information gives a good indication of the level (high) of mineral resource potential, and thus a certainty level C is assigned (fig. 2, pl. 1).

Areas surrounding the known deposits have geological settings similar to the known deposits. However, given the minor amount of movement expressed along the mineralized fissures, it is difficult to trace known fractures or to identify new ones. In addition, there are many geochemical anomalies in parts of this area that cannot be attributed to known or previously exploited deposits. These factors indicate that much of the remainder of the eastern half of the area and a part of the Florence district in the southwestern corner have a moderate potential for gold and silver resources in quartz fissure-veins similar to those previously exploited in nearby districts. Because available information merely suggests the level (moderate) of mineral resource potential, a certainty level B is assigned (fig. 2, pl. 1).

Low potential for gold and silver resources in the same quartz fissure-vein deposit exists throughout the rest of the wilderness. Exploited precious-metal-bearing veins from the mining districts north and south of the wilderness trend across the center of the area. However, there are no mines or prospects in the central part of the wilderness. Because of the difficulty of tracing fractures with minor amounts of movement through plutonic rocks, it is unknown if these favorable geological indicators occur in this part of the area. Favorable geochemical indicators are also not common. Therefore, available information merely suggests the level (low) of mineral resource potential, and a certainty level B is assigned (fig. 2, pl. 1).

Base metals are associated with gold and silver in the quartz vein deposits of the region of the Gospel-Hump Wilderness. Minor copper, lead, and zinc were recovered previously from many of the mines along the quartz fissure veins (table 1). Molybdenum minerals, not recognized by previous workers, are found sparsely in many veins. Areas designated as having high potential for gold and silver resources also have moderate potential for copper, lead, zinc, and molybdenum resources. Available information gives a good indication of the level (moderate) of mineral resource potential, thus a certainty level C is assigned (fig. 1, pl. 1).

Skarn or Metasomatic Replacement Deposits

A moderate potential for tungsten, silver, lead, copper, and nickel (possibly including minor gold) resources exists in skarn or metasomatic replacement deposits located in carbonate-bearing roof pendants of the western third of the wilderness. These deposits are characterized by (1) the presence of favorable lithologies (quartzite structurally overlying marble) along thrust fault contacts; (2) anomalously high values for the suite of manganese, silver, barium, cobalt, copper, and nickel found in rock samples taken from gossan zones in the favorable areas; (3) anomalously high values for tungsten and other base metals in stream sediments draining this part of the area; and (4) the occurrence of rock units that are thought to be Late Proterozoic to Paleozoic (fig. 2; Lund, 1984) and that host similar deposits elsewhere in central Idaho (Cookro, 1983). Because available information merely suggests the level (moderate) of mineral resource potential, a certainty level B is assigned (fig. 2, pl. 1).

Sediment-Hosted Deposits

The metasedimentary schists of the eastern part of the area are probably correlative with the lower part of the Belt Supergroup or with the lower part of the equivalent rocks of east-central Idaho. Those Middle Proterozoic sedimentary sequences contain many occurrences of copper-silver (as at Troy, Montana), lead-zinc (as at Sullivan, British Columbia), or cobalt-copper (as at Blackbird, Idaho). The potential for these resources in the Gospel-Hump Wilderness is unknown because (1) although high cobalt values and, in some cases, high boron values were found in samples of stream sediment that came from stream drainages underlain by biotite schist, no appropriately anomalous rock-chip geochemical values were found, and (2) the typical lithologies related to these kinds of deposits were not identified in the amphibolite-facies metasedimentary rocks in the wilderness area. Available information is not adequate for determination of the level of mineral resource potential, and a certainty level A is assigned (fig. 2, pl. 1).

Placer Deposits

The largest historic production of gold resources in the region surrounding the Gospel-Hump Wilderness has been from large placers commonly not related to present drainage systems. In the wilderness area, no such large placers were found. Potential for placer gold resources within the confines of the wilderness area is low. Available information gives a good indication of the level (low) of mineral resource potential, thus a certainty level C is assigned (fig. 2, pl. 1).

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APPENDIX

DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

Definitions of Mineral Resource Potential

LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is unlikely. This broad category embraces areas with dispersed but insignificantly mineralized rock as well as areas with few or no indications of having been mineralized.

MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral-deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

UNKNOWN mineral resource potential is assigned to areas where information is inadequate to assign low, moderate, or high levels of resource potential.

NO mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

Levels of Certainty

LEVEL OF RESOURCE POTENTIAL →

<table>
<tr><td rowspan="4">U/A
UNKNOWN POTENTIAL</td><td>H/B
HIGH POTENTIAL</td><td>H/C
HIGH POTENTIAL</td><td>H/D
HIGH POTENTIAL</td></tr>
<tr><td>M/B
MODERATE POTENTIAL</td><td>M/C
MODERATE POTENTIAL</td><td>M/D
MODERATE POTENTIAL</td></tr>
<tr><td rowspan="2">L/B
LOW POTENTIAL</td><td rowspan="2">L/C
LOW POTENTIAL</td><td>L/D
LOW POTENTIAL</td></tr>
<tr><td>N/D
NO POTENTIAL</td></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td></tr>
</table>

LEVEL OF CERTAINTY →

A. Available information is not adequate for determination of the level of mineral resource potential.
B. Available information suggests the level of mineral resource potential.
C. Available information gives a good indication of the level of mineral resource potential.
D. Available information clearly defines the level of mineral resource potential.

Abstracted with minor modifications from:

Taylor, R. B., and Steven, T. A., 1983, Definition of mineral resource potential: Economic Geology, v. 78, no. 6, p. 1268–1270.

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RESOURCE/RESERVE CLASSIFICATION

	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range (or)	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUB-ECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		

Major elements of mineral resource classification, excluding reserve base and inferred reserve base. Modified from McKelvey, 1972, Mineral resource estimates and public policy: American Scientist, v.60, p.32-40, and U.S. Bureau of Mines and U.S. Geological Survey, 1980, Principles of a resource/reserve classification for minerals: U.S. Geological Survey Circular 831, p.5.

GEOLOGIC TIME CHART

Terms and boundary ages used in this report

EON	ERA	PERIOD		EPOCH	BOUNDARY AGE IN MILLION YEARS
Phanerozoic	Cenozoic	Quaternary		Holocene	0.010
				Pleistocene	1.7
		Tertiary	Neogene Subperiod	Pliocene	5
				Miocene	24
			Paleogene Subperiod	Oligocene	38
				Eocene	55
				Paleocene	66
	Mesozoic	Cretaceous		Late	96
				Early	138
		Jurassic		Late Middle Early	205
		Triassic		Late Middle Early	~ 240
	Paleozoic	Permian		Late Early	290
		Carboniferous Periods	Pennsylvanian	Late Middle Early	~ 330
			Mississippian	Late Early	360
		Devonian		Late Middle Early	410
		Silurian		Late Middle Early	435
		Ordovician		Late Middle Early	500
		Cambrian		Late Middle Early	~ 570[1]
Proterozoic	Late Proterozoic				900
	Middle Proterozoic				1600
	Early Proterozoic				2500
Archean	Late Archean				3000
	Middle Archean				3400
	Early Archean				3800?
pre-Archean[2]					4550

[1] Rocks older than 570 m.y. also called Precambrian, a time term without specific rank.

[2] Informal time term without specific rank.

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