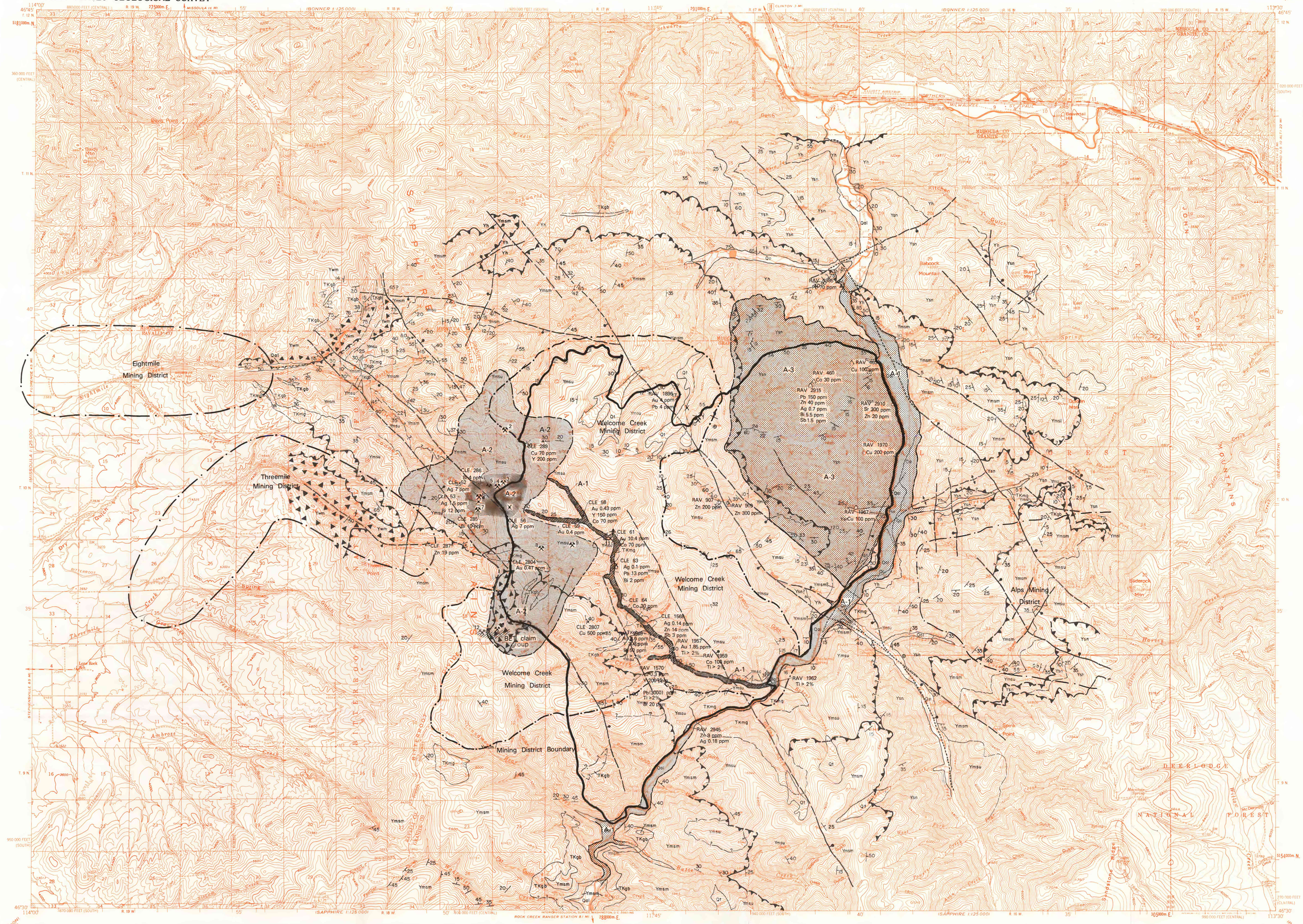
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1620-A
PAMPHLET ACCOMPANIES MAP



Base from U. S. Geological Survey, 1:62,500
Cleveland Mtn., Ravenna, 1959

SCALE 1:50 000

CONTOUR INTERVAL 80 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MONTANA
MAP LOCATION

MINERAL RESOURCE POTENTIAL MAP OF THE WELCOME CREEK WILDERNESS, GRANITE COUNTY, MONTANA

By
D. J. Lidke, C. A. Wallace, J. C. Antweiler, W. L. Campbell, J. H. Hassemer, and W. F. Hanna, U.S. Geological Survey
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1983

EXPLANATION OF RESOURCE-RELATED MAP SYMBOLS

APPROXIMATE BOUNDARY OF THE WELCOME CREEK WILDERNESS

APPROXIMATE BOUNDARY OF MINING DISTRICT

MINE OR PROSPECT--Number shown on map and in table 2

Lode

Placer

Area that has been placer mined

A-2 AREA ASSIGNED RESOURCE POTENTIAL--See text for discussion

High

Moderate

Low

RAV 380 GEOCHEMICAL ANOMALY--Sample number and concentration of anomalous Ag 16 ppm elements in parts per million or percent shown on map.

Thresholds for selected elements listed below by sample type

Anomalous stream-sediment sample

Anomalous panned-concentrate sample

Anomalous rock sample

THRESHOLDS[1] FOR SELECTED ELEMENTS IN GEOCHEMICAL SAMPLES

[Established by the U.S. Geological Survey. Concentrations in parts per million unless specified as percent (%)]

Stream-sediment samples		Panned-concentrate samples		Rock samples	
Cobalt (Co)	[2]spec> 20	Titanium (Ti)-spec> 2%		Gold (Au)	AA> 0.05
Copper (Cu)	spec>100	Bismuth (Bi)-spec> 20		Silver (Ag)	spec> 1
Lead (Pb)	spec> 50	Cobalt (Co)	spec> 50		AA> 2.1
Zinc (Zn)	spec>200	Copper (Cu)	spec>500	Copper (Cu)	spec> 70
	AA> 6	Gold (Au)	AA> 0.1	Titanium (Ti)	spec>10%
Silver (Ag)	AA> 0.1			Lead (Pb)	AA> 3.5
Bismuth (Bi)	AA> 1			Bismuth (Bi)	AA> 1.0
Antimony (Sb)	AA> 1				
Strontium (Sr)	spec>150				

[1]Threshold, upper range of background concentrations. Concentrations of elements equal to or above threshold are anomalous.

[2]Spec, semi-quantitative emission spectrographic analysis.

[3]AA, atomic-absorption analysis.

CORRELATION OF MAP UNITS

Qal	Holocene	QUATERNARY
Qt, Qo	Pleistocene	
Unconformity		
TKgb, TKng		TERTIARY AND CRETACEOUS
Thrust faulting		
Ymsu, Ymsc	Missoula Group; Belt Supergroup	PROTEROZOIC Y
Ymsn		
Yms1		
Ysh		
Ysn		
YwH, Yk		

DESCRIPTION OF MAP UNITS

Qal ALLUVIUM (HOLOCENE)

Qo OUTWASH DEPOSITS (PLEISTOCENE)

Qt TILL AND ROCK GLACIER DEPOSITS (PLEISTOCENE)

TKng GRANITIC INTRUSIVE ROCKS (TERTIARY OR CRETACEOUS)--Granite, granite-monzonite and granodiorite plutons, stocks, and dikes. Commonly porphyritic with minor crosscutting aplite and pegmatite dikes

TKgb GABBROIC INTRUSIVE ROCKS (TERTIARY OR CRETACEOUS)--Gabbro and diabase stocks, dikes, sills, and ondis some plutons. Commonly porphyritic

MOUNT SHIELDS FORMATION (PROTEROZOIC Y)--

Ymsc Calc-silicate hornfels--May be metamorphosed carbonate-bearing beds of the upper member of the Mount Shields Formation

Ymsu Upper member--Rhythmically interbedded dark-gray argillaceous limestone and argillite

Ymsm Middle member--Fine- to coarse-grained arkosic quartzite

Yms1 Lower member--Interbedded zones of argillite and fine-grained quartzite

Ysh SHEPARD FORMATION (PROTEROZOIC Y)--Tan-weathering laminated green dolomitic siltite

Ysn SNOWSLIP FORMATION (PROTEROZOIC Y)--Interbedded red and green argillite, siltite, argillaceous quartzite, and clean coarse-grained orthoquartzite

Yh HELENA FORMATION (PROTEROZOIC Y)--Interbedded dark-gray argillaceous limestone, dark-gray argillite, and tan limestone

YwH WALLACE FORMATION (PROTEROZOIC Y)
Middle member--Laminated black dolomitic argillite and tan dolomitic siltite. Includes intraformational sedimentary breccia shown a solid triangles where identified

GEOLOGY

The Welcome Creek Wilderness is on the northeast flank of the Lewis and Clark line, a complicated northeast-trending thrust zone that separates the Belt Supergroup rocks to the south from younger rocks to the north. The Lewis and Clark line is a complex zone of thrust faults that have recurrent high-angle faulting, is north of the wilderness. The Bitterroot lobe of the Idaho batholith is located to the southwest.

The Welcome Creek Wilderness is underlain mainly by sedimentary rocks of the Belt Supergroup (Proterozoic Y age). These Belt Supergroup rocks were thrust faulted during Precambrian time and later displaced along high-angle faults that also displace the thrust faults. Some high-angle faults apparently displaced Belt Supergroup rocks prior to thrust faulting as well. Small granitic and gabbroic intrusive bodies are scattered through the wilderness. Low-grade thermal metamorphism has altered the Belt Supergroup rocks exposed in the wilderness. Rocks of the Belt Supergroup are metamorphosed to hornblende-hornfels facies near contacts with larger intrusive bodies. Surficial deposits that were mapped consist of minor amounts of Quaternary till, outwash, and alluvium.

GEOCHEMISTRY

A total of 46 stream-sediment, 22 panned-concentrate, and 56 rock samples were collected and analyzed by the U.S. Geological Survey during these investigations. Stream-sediment samples were collected from most active first-order drainages as well as from selected second-order streams. At each stream-sediment sample site, a composite sample was collected of fine material from several places within the stream bed. Panned concentrates of heavy minerals in alluvial deposits were collected near most stream-sediment sample locations. Nonmineralized rock samples were collected throughout the wilderness to provide a background geochemical data. At mineralized sites, the most altered or mineralized material was collected. Samples of country rock consisted of composite chips from outcrops. Samples of mineralized as well as nonmineralized rock were collected at mines and prospects. Analytical data are available in Campbell and others (1983).

Thresholds for geochemical anomalies (see table of threshold values in map explanation) of elements of potential resource interest were determined using the following criteria: (1) for some elements threshold values were suggested by sharp breaks in the slopes of distribution curves or by discontinuities in histograms of the data; (2) based on statistical analysis; if a multiple of 2.5 times the geometric mean was chosen as the threshold for some elements; or, (3) for some elements the lower limit of analytical detection was established as the threshold. In addition, crustal abundance figures for elements were considered to establish threshold values for elements that were infrequently detected. Values chosen are listed for each selected element in the map explanation; concentrations equal to or above these values are defined as anomalous concentrations. Samples taken by the U.S. Geological Survey that contained one or more elements at anomalous concentration levels are shown on the map.

Most of the anomalous samples can be attributed to mineral occurrences or rock types in the areas assigned mineral resource potential. A few geochemical anomalies occur outside of these areas. These isolated geochemical anomalies are also shown on the map, and they are briefly described in table 1.

GEOPHYSICS

Contour maps of aeromagnetic and complete Bouguer gravity data reflect the surface and subsurface lateral contrasts of rock density and magnetization in an area. The regional aeromagnetic anomaly map (fig. 2) was derived by Douglas (1972) from data acquired along north-south flight lines spaced 1-1.5 mi apart at a barometric elevation of 7,500 ft. These data were digitized and put into a computer for recomplistance data acquired by the Department of Energy (Texas Instrument, Inc., 1979). Gravity readings were taken at 71 sites in and adjacent to the wilderness; figure 3 is a complete Bouguer gravity anomaly map for this data using a density of 2.67 g/cm³ (Hassemer, 1981). The scale of the geophysical maps lends itself to regional or broad-scale investigations of mineralization. However, the geophysical data may show possible hydrothermal alteration and partly and entirely concealed plutons.

Aeromagnetic anomalies
(See figure 2)

Shaded zone.--Divides area into a magnetically quiet zone (northeast) and a zone of more numerous magnetic highs and lows of shorter wavelength (southwest); this lineament in general coincides with a zone of northwest-trending high-angle faults.

Anomalies 1, 3, 4, and 5.--Magnetic highs associated with exposures of Belt Supergroup rocks or of plutonic rocks; 3 and 5 correlate spatially with some exposed plutonic rocks. Most of these highs coincide with areas where sedimentary rocks show an increase in degree of thermal metamorphism.

Anomalies 2, 6, and 7.--Magnetic lows. Anomaly 2 trends northeast and its part coincides with the Cleveland Mountain pluton; anomalies 6 and 7 reflect some hydrothermal alteration of sedimentary rocks associated with veins in this area. Anomaly 5 may represent sedimentary rocks that are flanked to the north and south by plutons. Anomaly 8 is an elongate northwest-trending magnetic trough that is a polarization effect; it is coupled with a high-amplitude magnetic high to the southwest of it. The trend and wavelength of these two anomalies are similar to those of the three northeast-trending highs immediately to the north. These elongate anomalies may result from equally spaced northwest-trending zones of subsurface intrusion.

Anomaly 9.--Low-amplitude magnetic high that may result from either a concealed pluton or from a slight increase in the iron-oxide content of the Snowslip and Mount Shields formations that are exposed in this region.

Gravity anomalies
(See figure 3)

Anomaly 1.--Irregular gravity low centered west of Cleveland Mountain, presumably associated with lateral density contrasts within the sedimentary rocks.

Anomaly 2.--Gravity high that may result from either higher rock densities of argillaceous rocks in this part of the Snowslip and Mount Shields formations or possibly from a concealed gabbroic pluton.

Anomaly 3.--Relatively high presumably associated with higher density rocks than the surrounding rocks, perhaps correlating with a partly exposed thrust slice of the carbonate-bearing Wallace Formation here that contrasts with rock density of quartzite and argillite to the north and a large, partly exposed granitic pluton to the south.

MINING AND MINERALIZED AREAS

The Welcome Creek wilderness encompasses most of the Welcome Creek mining district and has been the site of placer mining along Welcome Creek and lode prospecting near Cleveland Mountain. To the west of the wilderness are the Threemile and Eightmile mining districts, and to the east is the Alos mining districts.

The only documented production in the wilderness has been gold from placers along Welcome Creek. Lyden (1948) reported that $20,000 in placer gold was produced from placer deposits along Welcome Creek from 1890 to 1911. U.S. Bureau of Mines records list $500 in gold production between 1912 and the present. The Cleveland mine, located about 0.25 mi west of the wilderness, has been worked for lead. Lead was developed lode mine near the wilderness (mu, 6 on map). Sahinen (1957) briefly discussed the mine and reported that it yielded some ore during the late 1890's to early 1900's, but no offfcial records of production were kept. The other lode prospects on Cleveland Mountain and in the wilderness vicinity have remained undeveloped. The only recent mining activity has been intermittent small-scale, placer mining along upper Welcome Creek.

Known mineral occurrences in the Welcome Creek Wilderness are: (1) gold-bearing placers; and (2) silver- and gold-bearing veins. Geochemical data and favorable host rocks suggest that stratabound copper deposits occur in the northern part of the wilderness. Just to the south of the wilderness boundary, gold and tungsten were detected in samples from a probable replacement occurrence at the BET claim group. The locations of the mines and prospects examined by the U.S. Bureau of Mines are shown on the map and summary descriptions of these are presented in table 2. Table 3 summarizes U.S. Bureau of Mines investigations of the gold placers along Welcome Creek and Rock Creek.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Evaluation of the mineral resource potential of the Welcome Creek Wilderness is based on (1) investigations of mines and prospects; (2) geochemical investigations; (3) geological investigations; and (4) geophysical investigations. Three levels of potential for the occurrence of mineral resources were defined on the basis of the criteria listed in the section below. Three areas were assigned potentials for the occurrence of small deposits of metallic mineral resources; these three areas are shown on the map and summarized in table 4.

Ranking scheme for evaluation of mineral resource potential

High resource potential.--Geologic terrane ranked as having high potential for the occurrence of a mineral resource. The geologic terrane must satisfy at least criteria 1 and 2 (see below for criteria), but commonly satisfies all criteria for the type of mineral deposit.

Moderate resource potential.--Geologic terrane ranked as having moderate potential for the occurrence of a mineral resource. The geologic terrane must satisfy at least criteria 1 and 3 or 4 (see below for criteria 2, 3, and 4 for the type of mineral deposit.

Low resource potential.--Geologic terrane ranked as having low potential for the occurrence of a mineral resource. The geologic terrane must satisfy criteria 3 or 4, but commonly satisfies both criteria 3 and 4 for the type of mineral deposit.

Criteria for evaluation of mineral resources

Placers

1. Presence of placers for which gold has been produced.
2. Occurrences of gold at anomalous concentration in samples taken from alluvium.
3. Occurrences of gold at anomalous concentrations, but above detection limits in samples taken from alluvium.
4. Presence of gold in lode deposits upstream from the area.

Veins and replacement bodies

1. Presence of vein or replacement bodies from which metals have been produced.
2. Occurrences of metallic minerals in veins or replacement bodies at mines, prospects, or in undeveloped areas.
3a. Occurrences of faults, fractures, or shear zones that may contain metal-bearing veins along strike.
3b. Presence of a nearby contact zone between an intrusive body and sedimentary rocks that are favorable hosts for replacement bodies.
4. Occurrences of anomalous concentrations of most of the following elements: gold, silver, lead, zinc, copper, molybdenum, antimony, and pathfinder elements in rock samples and the samples from alluvium of streams that drain the area of possible mineralized rock.

Stratabound copper zones

1. Presence of stratabound zones from which copper has been produced.
2. Occurrences of copper in stratabound zones.
3. Presence of favorable host rocks.
4. Occurrences of anomalous concentrations of copper and, commonly, silver, mercury, molybdenum, bismuth, lead, barium, and other pathfinder elements in rock samples and in samples from alluvium of streams that drain the area of possible mineralized rock.

Energy resource potential

There were no indications of oil, gas, radioactive minerals, coal, or geothermal resources in the Welcome Creek Wilderness. No rocks with oil and gas potential are known, and the thermal history of the area suggests that pre-Cretaceous oil or gas, if any, might have been destroyed. No indications of coal or radioactive mineral resources were found, and these are not known to occur in Proterozoic Y rocks of southwestern Montana. Hot springs or volcanic rocks, which are commonly associated with geothermal areas, are not present in the wilderness.

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Table 1.--Isolated geochemical anomalies in the Welcome Creek Wilderness

[Atomic-absorption analysis (AA) by W. L. Campbell (USGS); six-step emission spectrographic analysis (S) by R. T. Hopkins, Jr. (USGS)]

Sample no.	Sample type	Anomalous elements (ppm)	Description
RAV-1985	Stream-sediment---	Lead 70 (S)--------	Source not identified.
RAV-1096	Rock----------	Gold 4.0 (AA), lead 10 (S).	Sheared quartzite with vein mineralization.
RAV-907	Stream-sediment---	Zinc 200 (S)--------	Source not identified.
RAV-909	--do----------	Zinc 200 (S)--------	Do.
CLE-83	Rock----------	Silver 0.3 (AA), lead 13 (AA), bismuth 2 (AA).	Altered granite.
CLE-2807	--do----------	Copper 500 (S)------	Heavy mineral lamination, in quartzite.

Table 2.--Summary of investigations of mines and prospects in and adjacent to the Welcome Creek wilderness

[Sampling and analyses by the U.S. Bureau of Mines (Close, 1981). Lode samples were fire assayed for gold and silver and at least one sample from each mineralized zone was analyzed spectrographically for 31 elements. Placer samples were panned or sluiced, and gold was amalgamated and weighed. N.A.D.I., no mineralized structure exposed; n.d., not detected in analysis; N/A, not applicable]

Prospect/ mine no.	Name	Workings	Description	Number of samples analyzed	Maximum metal content of samples analyzed (oz/ton) Au	Ag
			Lode prospects			
1	B and J claim.	One adit----------	Shear zone in quartzite----------	2	0.007	0.6
2	J. Jay No. 2 claim.	Seven pits and trenches, one caved shaft.	Silicified zone, quartz and limonite in argillaceous quartzite.	6	.02	.2
3	Cleveland Summit prospect.	Forty pits and trenches.	N.W.S.E. Alinement of workings suggests northeast-trending vein in quartzite and argillite.	6	n.d.	.4
4	Ellen M. claims.	Fourteen pits and trenches.	N.W.S.E. Alinement of workings suggests northeast-trending silicified zone in quartzite and argillite.	5	n.d.	.4
5	Cleveland Spring prospect.	Two pits, one trench.	N.W.S.E. Alinement of workings suggests north-trending quartz vein in quartzite and argillite.	2	.491	.8
6	Cleveland mine.	One trench, three caved adits.	Northeast-trending fracture zone with quartz veins or dike in quartzite and argillite.	8	.193	.6
7	Lucky Star claim.	Two caved adits---	N.W.S.E. Alinement of workings suggests a northeast-trending silicified zone in quartzite and argillite.	2	.018	.4
8	Carron prospect.	One trench----------	N.W.S.E. Dump material suggests quartz vein along north-trending contact between small granitic intrusive and quartzite.	1	n.d.	n.d.
9	Lucky Hancock claim.	Two pits----------	N.W.S.E. Alinement of workings indicate northwest-trending quartz vein in gabbroic intrusive.	2	n.d.	.4
10	BET claims	None----------	Gossan-capped zone in calc-silicate rocks.	22	.4	.03[1]
			Placer prospects			
				Sample sites		
11	Hungry Horse and Big Dipper claims.	Two recent discovery pits, many older workings.	Stream alluvium----------	4	.0004[2]	N/A
12	Miss Fortune	Eight pits, steel sluice box and small dam.	Imaature angular gravel-bearing sediments.	13	.0003[2]	N/A
13	Midnight placer claims.	Small hydraulic working, water ditch,ceed shaft, and numerous small pits.	Terrace and stream alluvium--------	22	.011[2]	N/A

[1]Value shows percent Ni.
[2]Values given in oz/yd³.

Table 3.--Estimates of gold in alluvium of Welcome Creek and Rock Creek

[by U.S. Bureau of Mines (Close, 1981)]

Drainage	Workings	Volume of alluvium (yd³)	Sample sites	Gold (oz/yd³) Average	Maximum
Welcome Creek placers.	Placer workings scattered along most of stream.	500,000	42	0.0003	0.0038
Rock Creek placers:	Small workings at mouth of Welcome Creek.		76		
1. Stream alluvium.		13,000,000		.0006	.009
2. Terrace alluvium.		17,000,000		.0002	.011

Table 4.--Summary description of areas assigned mineral resource potential

[Criterion numbers refer to criteria for evaluation of mineral resource potential discussed in text]

Commodity	Deposit type	Criteria	Mineral-resource potential
		Area A-1	
Gold-------	Placer---------	1. Much of Welcome Creek has been placer mined and has recorded production of gold. 2. Anomalous concentrations of gold were detected in mined and and unmined alluvium of Welcome Creek and in alluvium of Rock Creek between Bear Gulch and Cinnamon Bear Creek. 3. Gold was present in lower concentrations in samples from the remainder of Rock Creek. 4. Lode deposits upstream from the area is a probable source for Welcome Creek gold. In addition to A-2, other possible sources for Rock Creek gold exist.	High (Welcome Creek). Moderate-low (Rock Creek).
		Area A-2[1]	
Silver and gold.	Vein----------	1. Production of ore is indicated at the Cleveland mine and prospects in quartzite and argillite in this area. The greatest concentration is in the Cleveland Mountain part of A-2. 3a. Zones of alteration and shearing are present that may contain metal-bearing veins along trend. 4. Gold, silver, bismuth, lead, copper, antimony, zinc, and yttrium were detected in anomalous concentrations in rock samples and in samples from alluvium along Welcome Creek.	High (Cleveland Mountain area). Moderate (remainder of A-2).
Gold and tungsten.	Replacement---	2. At the BET claim group in the southern tip of A-2, gold and tungsten were detected in samples from gossan-capped calc-silicate rocks. 3b. Intrusive rocks are present near the BET claims.	Moderate (BET claims).
		Area A-3[2]	
Copper-----	Stratabound(?)	3. Presence of green argillite-siltite beds of the Missoula Group (favorable hosts for stratabound copper deposits). 4. Anomalous concentrations of copper were detected in a few samples from alluvium, but not in rock samples from A-3.	Low (A-3).

[1]A-2 coincides with geophysical anomalies that may indicate some rock alteration in this area.
[2]A-3 coincides with low amplitude positive gravity and positive magnetic anomalies.

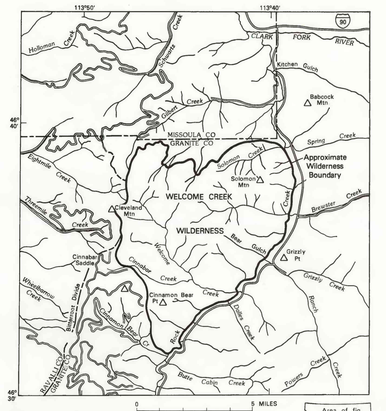


Figure 1.--Location map of the Welcome Creek Wilderness.

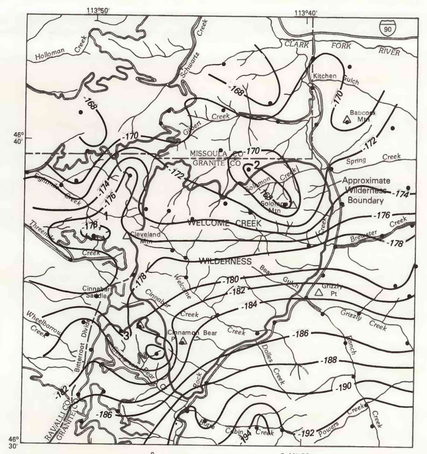
EXPLANATION

MAGNETIC CONTOUR--Contour interval 20 gammas; hachures indicate contour closure for negative magnetic anomaly

3 MAGNETIC ANOMALY--See text for discussion

MAGNETIC LINEAMENT--See text for discussion

Figure 2.--Aeromagnetic anomaly map of the Welcome Creek Wilderness, western Montana (from Douglas, 1972).



EXPLANATION

GRAVITY STATION LOCATION

-170 GRAVITY CONTOUR--Contour interval 2 milligals; hachures indicate contour closure for negative gravity anomaly

3 GRAVITY ANOMALY--See text for discussion

Figure 3.--Complete Bouguer gravity anomaly map of the Welcome Creek Wilderness, western Montana (from Hassemer, 1981).

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas of Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Welcome Creek Wilderness in the Lolo National Forest, Granite County, Montana. The Welcome Creek Wilderness was established by Public Law 95-237, January 1979.

MINERAL RESOURCE POTENTIAL
SUMMARY STATEMENT

On the basis of these mineral resource studies, three areas in and adjacent to the Welcome Creek Wilderness were assigned low-moderate-high potential for the occurrence of small deposits of metallic mineral resources.

An area of alluvium along Welcome Creek (A-1 on map) is assigned a high potential for the occurrence of a small placer gold resource. Sampling indicates that small and scattered gold placers are present. However, much of the Welcome Creek streambed has been placer mined, and the remaining gold resource in alluvium along Welcome Creek apparently is low. The potential for the occurrence of gold resources in alluvium of Rock Creek (A-1 on map), along the eastern boundary of the wilderness, is ranked as moderate between Cinnamon Bear Creek and Bear Gulch and as low north of Bear Gulch.

An area along the western boundary of the wilderness (A-2 on map) is assigned moderate to high potential for the occurrence of small silver and gold resources in veins. The veins are thin, discontinuous, and low grade. The BET claim group (mu, 10 on map), located in the southern part of area A-2 and just outside the wilderness, is assigned a moderate potential for gold and tungsten resources of probable replacement origin.

An area (A-3 on map) in the northeastern part of the wilderness is assigned a low potential for the occurrence of copper resources. Here rock types favorable for stratabound copper-bearing zones are present, and copper was detected in anomalous concentrations in some stream-sediment samples. However, no copper-bearing rocks were found.

No indications of oil, gas, geothermal, coal, radioactive minerals, and geothermal energy resources were found in the Welcome Creek Wilderness.

INTRODUCTION

Location, size, and geographic setting

The Welcome Creek Wilderness (fig. 1) encompasses an area of about 71 sq mi in the Lolo National Forest southwest of Missoula, Mont. The two most prominent topographic features, the Bitterroot Divide and Rock Creek, define respectively, the western and eastern boundaries of the wilderness. Steep-sided valleys with narrow ridgetops and moderate slopes typically dissect much of the wilderness. The wilderness is densely forested except for cliff-faces and has a total relief of about 3,000 ft; the maximum elevation is 7,733 ft along the Bitterroot Divide, and the minimum elevation is 3,880 ft along Rock Creek. The east side of the wilderness is accessible by an unpaved road that follows Rock Creek south from interstate 90, about 18 mi southeast of Missoula. The remaining sides of the wilderness are accessible by unpaved Forest Service roads from Highway 93, about 12 mi south of Missoula.

Present studies

This report on the mineral resource potential of the Welcome Creek Wilderness presents the results of a cooperative study conducted by the U.S. Geological Survey and the U.S. Bureau of Mines. Geologic mapping was done by D. J. Lidke, C. A. Wallace, and R. E. Zarske (U.S. Geological Survey). Most of the geochemical sampling was done in 1979, with additional sampling in 1982 by J. C. Antweiler, W. L. Campbell, and G. K. Lee (U.S. Geological Survey). Geophysical investigations were done by J. H. Hassemer and W. F. Hanna (U.S. Geological Survey). Mineral resource potential assessments were conducted during 1981 by T. J. Close (U.S. Bureau of Mines) and W. Zechnckke (U.S. Bureau of Mines).

Geology mapped in 1982 by D. J. Lidke, C. A. Wallace, and R. E. Zarske; compiled in 1982 by D. J. Lidke.
Geochemical sampling done in 1979 and 1982 by J. C. Antweiler, W. L. Campbell, and G. K. Lee; compiled in 1982 by W. L. Campbell.
Investigations of mines and prospects done in 1980 by T. J. Close, W. Zechnckke, and W. Zechnckke; compiled in 1981 by T. J. Close.

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1983

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