UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PHASE II

GEOCHEMICAL MINERAL RESOURCE SURVEY OF THE WALES CREEK WILDERNESS STUDY AREA (074-150), POWELL COUNTY, MONTANA

By

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EXECUTIVE SUMMARY

The Wales Creek Wilderness Study Area (074-150) lies in the Garnet Geology, Energy and Mineral Resource Area nine miles north of Drummond, Montana. The Garnet Resource Area is part of the larger Missoula Resource Area in the Butte BLM district.

The Wales Creek WSA is in the Montana Overthrust Belt. The oldest rocks in the area are Precambrian sediments of the Mount Shields Formation. Other Precambrian sedimentary rocks include the Bonner and Garnet Range Formations. Younger Paleozoic clastic and carbonate sedimentary rocks outcrop in the southern one-third of the area. Both the Precambrian and Paleozoic sediments are intruded by granitic plutons of probable Cretaceous or Tertiary age. Younger volcanic rocks, also of probable Tertiary age, and consisting mainly of lava flows, cover significant parts of the area. The rocks in the area are faulted by a series of northwest-trending normal faults. The geology (after reconnaissance geology of Wallace and others, 1977-78) of the WSA is included as part of plate 1.

Principal mining activity, past and present, in the Wales Creek WSA is located near its southwestern corner. The Top O'Deep District located here was exploited chiefly for gold occurring in copper-bearing skarns. Extensive placer mining of drainage basins east of the district sought gold which may have been derived from quartz veins in granitic rocks to the west. There are 23 patented and 44 unpatented lode and placer mining claims in the Wales Creek WSA (Phase I Report, WGM, Inc., 1983). Most of Your Name Creek (plates 1 and 2) and the Top O'Deep District are covered by claims.

Based on recently concluded detailed geochemical work, previous larger-scale geochemical and geologic studies, and an impressive record of regional mining activity, the Wales Creek WSA is classified as having high potential (4D classification) for gold and base metals in its southwestern part and a moderate to low potential (3C-2C) for these commodities elsewhere (plate 2). The potential for other resources is considered low (plate 2). The classification scheme is summarized in table 1.

INTRODUCTION

The Wales Creek WSA, an irregularly shaped area of approximately 18 square miles (11,600 acres), is located in Powell County, west-central Montana, nine miles north of Drummond (figure 1). The area is dominated by heavily timbered mountain terrain of the Garnet Range. The highest topographic point in the study area is Chamberlain Mountain, elevation 6,860 ft. Topographic relief is 2000 ft. Principal streams draining the area are Pearson Creek to the north, Wales Creek and Your Name Creek to the east, and Murray and Douglas Creeks to the southeast. Climate in the region is typically semi-arid alpine to subalpine.

Access to the vicinity of the WSA is provided by Rattler Gulch road on the south and Deep Creek road on the west. A road originating near State Highway 200, 37 miles north of Drummond, parallels most of the western boundary of the area and connects with the Deep Creek road near Top O'Deep.

Table 1.--BLM Land Classification System for GEM Resources

Classification Scheme

1. The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of mineral resources.

2. The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.

3. The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.

4. The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.

Levels of Confidence

A. The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.

B. The available data provide indirect evidence to support or refute the possible existence of mineral resources.

C. The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.

D. The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

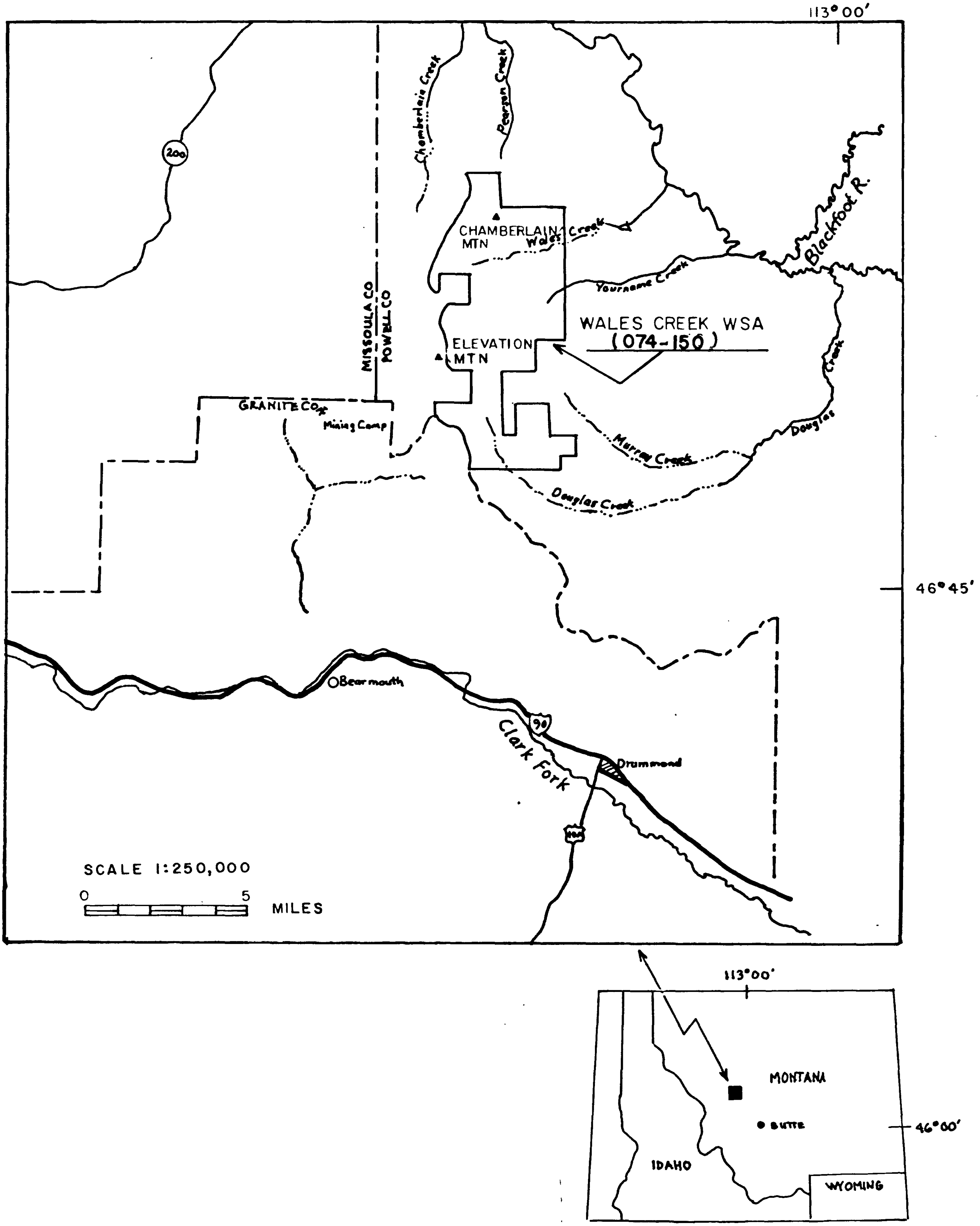

Figure 1.-- Location of the Wales Creek Wilderness Study Area (074-150), Powell County, Montana

The Wales Creek study area lies in proximity to several historically active mining districts; the most important is the Garnet District, about five miles west of the area's southern boundary, and the closest is the Top O'Deep District on the area's southwestern boundary. Geology, energy, and mineral resources (GEM) of the Wales Creek WSA were initially evaluated for the Bureau of Land Management by WGM, Inc., Mining and Geological Consultants, Anchorage, Alaska and the results are presented in the Phase I report on the GEM resources of the larger Garnet Resource Area (WGM, 1983).

Detailed geochemical work was conducted in the Wales Creek WSA by the U.S. Geological Survey in October 1983 for Phase II of the mineral assessment. This report presents the results of the geochemical study.

Sample collection and preparation

For the Phase II geochemical study, 23 stream-sediment samples were collected within and adjacent to the study area. All sediment samples were collected at the best available site in the active part of the stream with the exception of three samples (WC05SS, WC06SS, and WC08SS, plate 1) taken from, what were then, dry gulches. The sediment samples were stored in metal-free paper envelopes, air dried and sieved through 0.15 mm stainless-steel sieves. The fine fraction was saved for analysis.

Analysis of the stream-sediment samples represents the chemistry of the rock material eroded from the drainage basin upstream from each sample site. Such information is useful in identifying those basins which contain concentrations of elements that may be related to mineral deposits. Analyses of sediments may also give clues to subsurface mineralization. These analyses could reflect chemical constituents that entered the water table and were released into stream channels where they may be adsorbed on ion scavenging clays and oxide materials.

A heavy-mineral concentrate of stream sediment was collected at each sediment sample site. Approximately 10-15 pounds of sediment were panned until most of the quartz, feldspar, organic material, and clay-sized material was removed. The panned concentrate was separated into light and heavy fractions using a bromoform (heavy liquid; specific gravity 2.8) separation. The light fraction was discarded. Those minerals of specific gravity >2.8 were further separated magnetically into highly magnetic, weakly magnetic, and nonmagnetic fractions using a modified Frantz Isodynamic Separator. The nonmagnetic fraction, wherein reside any nonmagnetic ore minerals, zircon, sphene, barite, etc., was divided into two splits, one to be hand ground for analysis and the other saved for microscopic inspection.

Eight rock samples were collected at various sites. Four samples were taken from a mine dump in the Top O'Deep District. The dump was sampled in anticipation of providing trace element signatures for the auriferous copper-bearing skarn deposits occurring in the district. The other rock samples were collected because they either contained visible sulfide grains or showed signs of alteration. The rocks were crushed and then ground to minus 0.1 mm using a pulverizer equipped with ceramic plates.

Sample analysis--spectrographic method

The stream-sediment, heavy-mineral concentrate, and rock samples were analyzed for 31 elements using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). Spectrographic results were obtained by visual comparison of spectra derived from the sample against spectra obtained from standards made from pure oxides and carbonates. Standard concentrations are geometrically spaced over any given order of magnitude of concentration as follows: 100, 50, 20, 10, and so forth. Samples whose concentrations are estimated to fall between those values are assigned values of 70, 30, 15, etc. The precision of the analytical method is approximately plus or minus one reporting unit at the 83 percent confidence level and plus or minus two reporting units at the 96 percent confidence level (Motooka and Grimes, 1976). Values determined for the major elements (iron, magnesium, calcium, and titanium) are given in weight percent; all others are given in parts per million (micrograms/gram) (table 2).

Sample analysis--atomic absorption methods

In addition to emission spectrographic analysis, stream-sediment and rock samples were analyzed for zinc, cadmium, bismuth, antimony, and arsenic by atomic-absorption spectrometry (modification of Viets, 1978). Rock samples were also analyzed for gold by atomic absorption (Thompson and others, 1968). These elements in sediment and rock sample media have spectrographic determination limits that are often times inadequate for geochemical investigations. Limits of determination by the atomic absorption methods are: zinc, 5 parts per million (ppm); cadmium, 0.1 ppm; bismuth, 1 ppm; antimony, 2 ppm; arsenic, 5 ppm; and gold, 0.05 ppm.

GEOLOGY

Detailed discussions on the geology of the Wales Creek Wilderness Study Area, beyond the cursory description included in this investigation, are presented in the Phase I report on the Garnet Resource Area (WGM, 1983). Topics covered in that report include physiography, lithology and stratigraphy, structural geology and tectonics, paleontology, and historical geology.

ENERGY AND MINERAL RESOURCES

There are no recorded energy deposits in the Wales Creek WSA (Cole and others, 1982).

Known mineral deposits

The Top O'Deep mining district lies on the southwestern edge of the Wales Creek WSA (Plates 1 and 2). The district was exploited mainly for gold occurring in quartz veins and in copper-bearing skarns at contacts of Cretaceous-Tertiary granodiorite intrusives with Paleozoic limestones. Total production from the Top O'Deep District was estimated at $55,000 as of 1963 (Kauffman, 1963). (This dollar figure is not an accurate reflection of today's prices.) Significant amounts of gold were removed from Bilk Gulch

TABLE 2.--Limits of determination for the spectrographic analysis of rocks and stream sediments, based on a 10-mg sample

[The spectrographic limits of determination for heavy-mineral-concentrate samples are two reporting units higher than the limits given for rocks and stream sediments]

Elements	Lower determination limit	Upper determination limit
	Percent	
Iron (Fe)	0.05	20
Magnesium (Mg)	.02	10
Calcium (Ca)	.05	20
Titanium (Ti)	.002	1
	Parts per million	
Manganese (Mn)	10	5,000
Silver (Ag)	0.5	5,000
Arsenic (As)	200	10,000
Gold (Au)	10	500
Boron (B)	10	2,000
Barium (Ba)	20	5,000
Beryllium (Be)	1	1,000
Bismuth (Bi)	10	1,000
Cadmium (Cd)	20	500
Cobalt (Co)	5	2,000
Chromium (Cr)	10	5,000
Copper (Cu)	5	20,000
Lanthanum (La)	20	1,000
Molybdenum (Mo)	5	2,000
Niobium (Nb)	20	2,000
Nickel (Ni)	5	5,000
Lead (Pb)	10	20,000
Antimony (Sb)	100	10,000
Scandium (Sc)	5	100
Tin (Sn)	10	1,000
Strontium (Sr)	100	5,000
Vanadium (V)	10	10,000
Tungsten (W)	50	10,000
Yttrium (Y)	10	2,000
Zinc (Zn)	200	10,000
Zirconium (Zr)	10	1,000
Thorium (Th)	100	2,000

(plates 1 and 2) by early placer mining (Pardee, 1918). Actual figures on placer gold production in the WSA are unknown.

The record of gold and base-metal production in the Top O'Deep District and the presence of almost 70 patented or unpatented claims within the study area are testament to the geologic favorability for these deposits in parts of the WSA. The geologic environment is also locally favorable for tungsten skarns, tetrahedrite-bearing quartz veins, lead-zinc replacement deposits and breccia hosted Mississippi Valley-type lead-zinc deposits in Paleozoic carbonate rocks (WGM, 1983). The Precambrian Belt rocks in the WSA have some favorability for the occurrence of stratabound copper deposits (J. Elliott, USGS oral communication, 1984).

LAND CLASSIFICATION FOR GEM RESOURCES POTENTIAL

Plate 1 outlines the favorability for the occurrence of energy and mineral resources in the Wales Creek WSA according to the classification scheme summarized in table 1.

The intent of the Phase II geochemical investigation in the Wales Creek WSA was to provide data for the support or revision of the mineral resource evaluation made in the Phase I report. Analytical data for all the samples collected for the Phase II study are presented in tables 3, 4, and 5 which list stream sediment data, nonmagnetic heavy-mineral-concentrate data, and rock data, respectively. Sites where samples were collected, along with anomalous concentrations of trace metals in the samples where they occur are plotted on plate 1. Anomalous values were chosen by inspection of the overall data set.

Locatable resources

Locatable minerals are those defined as locatable under the General Mining Law of 1872, as amended, and the Placer Act of 1870, as amended. Minerals which are locatable under these acts include metals, ores of metals, nonmetallic minerals such as asbestos, barite, zeolite, graphite, uncommon varieties of sand, gravel, building stone, limestone, dolomite, pumice, pumicite, clay, magnesite, silica sand, etc. (Maley, 1983).

Metallic minerals

The southwest corner of the Wales Creek WSA, particularly the area adjacent to the Top O'Deep Mining District, is classified as 4D for metallic mineral occurrences (plate 1). Possible deposit types include: base- and precious-metal bearing skarns; tungsten-bearing skarns; base- and precious-metal-bearing quartz veins in intrusive and sedimentary rocks; carbonate hosted lead-zinc; and perhaps most importantly, placer gold. The favorable geologic environment and the presence of historically productive mines lend evidence to this classification. The classification is supported by the detailed, Phase II geochemical study (plate 2).

A rock sample, WC5RA, collected from a mine dump at Top O'Deep contains 1.5% copper, 1.5 ppm silver, 0.8 ppm gold, 150 ppm bismuth, 100 ppm zinc and 0.5 ppm cadmium. Sample WC5RD from the same dump contains greater than 2%

copper, 150 ppm silver, 500 ppm zinc, 1.1 ppm gold, 2.4 ppm cadmium and 100 ppm tungsten. These samples are representative of the gold-copper-bearing skarns.

Rock sample WC4R from a prospect sorting pile near the mouth of Weasel Gulch contains 15 ppm silver, 700 ppm zinc, 500 ppm copper, 50 ppm tungsten and 10 ppm arsenic. This rock is a magnetite cobble which probably originated in the skarn zones upstream.

Heavy-mineral-concentrate sample WC6C collected from a placer test pit at the mouth of Bilk Gulch contains 30 ppm Au (approximately one ounce/ton) with 10 ppm silver, 300 ppm lead, and 500 ppm tungsten. The stream sediment collected at the same site contains 150 ppm copper, 120 ppm zinc, 0.5 ppm cadmium, and 10 ppm arsenic. Pardee (1918) reports that early placering of upper Bilk Gulch yielded a 32-ounce gold nugget worth approximately $600 at the time but $12,800 at $400/oz. Stream sediment WC5SS from upper Weasel Gulch has 100 ppm copper, 70 ppm lead, 15 ppm arsenic and 0.5 ppm cadmium. The concentrate from this site contains 2 ppm silver. A concentrate sample from the mouth of Weasel Gulch contains 1.5 ppm silver, 1500 ppm lead and 200 ppm tungsten. The corresponding sediment measured 70 ppm lead, 10 ppm arsenic, and 0.5 ppm cadmium. Trace elements in these sediment and concentrate samples undoubtedly reflect the mineralized rocks in the Top O'Deep district.

Concentrate sample WC4C contains 1 ppm silver; no other trace metals commonly associated with ore deposits are present in significant amounts. Samples with a metal content that may reflect Pb-Zn occurrences in Paleozoic carbonate rocks are WC3SS (110 ppm zinc, 0.6 ppm cadmium), WC8SS (170 ppm zinc, 0.5 ppm cadmium) and WC2C (3000 ppm lead).

Your Name Creek basin is classified as 3C for metallic minerals (plate 2) based on less favorable geology than the southwestern corner of the WSA and minimal mining activity. Although production records are not available, numerous claims have been staked along the extent of the creek (WGM, 1983). Sediment and concentrate samples collected in this basin contain fewer elements of high concentration than those collected in the southwest of the WSA. Concentrate WC20C from upper Your Name Creek has 100 ppm molybdenum, 500 ppm boron, and 700 ppm lead. Concentrate WC21C from the south fork of upper Your Name Creek contains 700 ppm bismuth. The trace elements in these samples may be reflections of local mineralized veins or stratabound copper occurrences in the Precambrian sedimentary rocks. Sediment sample WC22SS, from a tributary flowing into the creek from the north, contains 100 ppm copper and the concentrate contains 1 ppm silver and 50 ppm molybdenum. The sources of these metals are probably minor stratabound or vein occurrences in the sedimentary or granitic rocks upstream. No gold was detected in the three concentrate samples collected in the basin.

The remaining parts of the WSA are classified as 3B (plate 2). The geologic environment is somewhat favorable but the geochemical data do not suggest the presence of metallic mineral deposits.

The occurrence of tin at concentrations up to 150 ppm in concentrate samples throughout the area (table 4) may be a reflection of tin substitution for titanium, calcium, or other elements of similar ionic radii, in heavy minerals such as sphene. It is not considered to be of significance. The 1500 ppm chromium and 200 ppm nickel in concentrate WC01C (table 4) probably reflect rocks of basaltic composition which are naturally enriched in these elements.

Uranium and thorium

The entire WSA is classified 2C for uranium and thorium (plate 1). The lack of geochemical and radiometric anomalies in the available (National Uranium Resource Evaluation) NURE data and relatively unfavorable geologic environment provide basis for this classification (Phase I, WGM, 1983).

Seven heavy-mineral concentrates collected in the northern half of the area contain thorium in concentrations of 200 to 1000 ppm (Table 4). Six of these samples are from the Wales Creek drainage basin, WC9C-WC14C, the other is from Your Name Creek basin (WC22C). The thorium is not considered significant as it is probably a reflection of background levels in zircons from the granitic rocks which the streams drain.

Nonmetallic minerals

The Wales Creek WSA is classified as 3B for barite (plate 2). The geologic environment, especially the Precambrian Garnet Range formation (Berg, 1982), favors the presence of barite veins but only two heavy-mineral-concentrate samples, WC16C and WC18C, contain as much as 3000 ppm barium--not a particularly high concentration.

The southern half of the WSA, that portion underlain by Paleozoic rocks, is classified 3C for uncommon varieties of limestone (WGM, Phase I). For all other locatable nonmetallic minerals, the entire WSA is classified as 2C (plate 2).

Leasable and saleable resources

Leasable and saleable resources are defined in the Phase I report. Classification for leasable resources in the WSA are 2C for oil and gas, 1B for geothermal, 2C for sodium and potassium, and 2C for others, including asphalt, bitumen and phosphate (plate 2). Classifications for saleable resources is 2C for the entire WSA except for the southern portion; the Paleozoic carbonate rocks there have some potential for common varieties of limestone and it is therefore classified 3C (plate 1). The Phase II geochemical study does not provide data to substantiate or revise these classifications.

RECOMMENDATIONS FOR ADDITIONAL WORK

Follow-up geochemical sampling may accurately determine the sources of anomalous metal concentrations in stream-sediment and heavy-mineral concentrate samples collected in the Phase II study. Follow-up sampling would include the collection of additional sediment and concentrate samples and perhaps soil samples from both sides of metal-anomalous drainages at regular intervals upstream. Phase specific (e.g. oxides, sulfides, clays) chemical analyses of samples and a more thorough mineralogical scrutiny of concentrates may help determine which trace metals are attributable to surface or buried sources. This may reveal additional mineral occurrences.

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Table 3 - Spectrographic and chemical Analysis of stream sediment samples from the Wales Creek WSA (074-150), Powell County, Montana

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown.]

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s
WC01SS	46 48 14	113 12 6	3.0	1.5	2.0	.5	500	N	N	N	20	1,500	1.5
WC02SS	46 48 31	113 13 15	3.0	1.0	2.0	.5	1,000	N	N	N	10	2,000	1.5
WC03SS	46 49 12	113 13 23	3.0	1.5	1.5	.3	700	N	N	N	50	1,500	2.0
WC04SS	46 49 54	113 13 25	5.0	1.5	3.0	.5	1,000	N	N	N	15	2,000	1.0
WC05SS	46 49 46	113 14 52	7.0	3.0	3.0	.5	1,500	N	N	N	100	700	1.5
WC06SS	46 49 40	113 14 51	5.0	2.0	2.0	.5	700	N	N	N	100	700	1.0
WC07SS	46 49 51	113 13 33	3.0	5.0	10.0	.3	1,000	N	N	N	50	500	<1.0
WC08SS	46 49 10	113 13 36	3.0	1.0	1.5	.5	1,500	N	N	N	70	1,000	1.0
WC09SS	46 53 48	113 14 37	2.0	.7	1.0	.3	500	N	N	N	20	700	1.0
WC10SS	46 53 38	113 14 38	7.0	1.5	3.0	.5	2,000	N	N	N	20	300	1.5
WC11SS	46 53 34	113 13 52	10.0	1.5	2.0	.5	2,000	N	N	N	30	300	2.0
WC12SS	46 53 51	113 13 6	3.0	1.0	2.0	.5	1,000	N	N	N	15	500	1.5
WC13SS	46 53 55	113 11 44	3.0	1.0	1.5	.3	1,000	N	N	N	15	500	1.5
WC14SS	46 54 4	113 11 31	3.0	1.5	3.0	.5	1,500	N	N	N	20	500	1.5
WC15SS	46 54 3	113 10 33	3.0	1.0	2.0	.5	1,500	N	N	N	30	500	2.0
WC16SS	46 49 58	113 10 25	3.0	2.0	3.0	.5	1,000	N	N	N	<10	3,000	1.0
WC17SS	46 49 51	113 10 36	3.0	2.0	2.0	.5	500	N	N	N	50	2,000	1.5
WC18SS	46 49 16	113 10 6	5.0	2.0	2.0	.5	1,000	N	N	N	15	3,000	1.5
WC19SS	46 56 55	113 13 7	1.0	.7	.3	.2	200	N	N	N	150	500	3.0
WC20SS	46 52 18	113 13 0	3.0	1.5	1.0	.3	700	N	N	N	100	500	2.0
WC21SS	46 52 4	113 12 47	3.0	2.0	3.0	.5	1,000	N	N	N	50	1,500	2.0
WC22SS	46 52 40	113 11 26	2.0	1.0	2.0	.3	1,000	N	N	N	20	700	1.5
WC23SS	46 52 0	113 10 36	1.5	.5	1.0	.2	700	N	N	N	30	1,000	2.0

Table 3 - Spectrographic and chemical Analysis of stream sediment samples from the Wales Creek WSA (074-150), Powell County, Montana

Sample	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s
WC01SS	N	N	10	150	20	70	N	N	70	20	N	10	N	700
WC02SS	N	N	15	100	20	100	N	N	100	20	N	10	N	1,000
WC03SS	N	N	10	70	20	70	N	N	100	20	N	10	N	700
WC04SS	N	N	15	200	20	70	N	N	100	30	N	15	N	1,000
WC05SS	N	N	20	100	100	70	N	N	100	70	N	15	N	500
WC06SS	N	N	10	50	150	50	N	N	70	50	N	10	N	300
WC07SS	N	N	10	50	20	30	N	N	50	70	N	7	N	200
WC08SS	N	N	10	70	30	50	N	N	50	50	N	7	N	300
WC09SS	N	N	7	20	15	20	N	N	10	15	N	7	N	200
WC10SS	N	N	10	20	20	70	N	N	10	30	N	15	N	500
WC11SS	N	N	10	50	30	50	N	N	15	30	N	15	N	500
WC12SS	N	N	10	15	20	50	N	N	15	20	N	10	N	500
WC13SS	N	N	7	20	50	20	N	N	15	30	N	7	N	700
WC14SS	N	N	15	20	20	50	N	N	15	30	N	10	N	700
WC15SS	N	N	10	30	30	50	N	N	20	30	N	10	N	500
WC16SS	N	N	20	150	20	70	N	N	100	30	N	10	N	1,500
WC17SS	N	N	10	200	20	50	N	N	100	30	N	10	N	700
WC18SS	N	N	15	150	30	70	N	N	100	30	N	10	N	1,000
WC19SS	N	N	5	20	15	30	N	N	15	20	N	5	N	<100
WC20SS	N	N	10	50	20	30	N	N	20	15	N	7	N	100
WC21SS	N	N	10	150	30	50	N	N	70	30	N	15	N	700
WC22SS	N	N	7	20	100	30	N	N	10	20	N	10	N	300
WC23SS	N	N	7	70	20	50	N	N	50	20	N	5	N	300

Table 3 - Spectrographic and chemical Analysis of stream sediment samples from the Wales Creek WSA (074-150), Powell County, Montana

Sample	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	Au-ppm aa	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa
WC01SS	50	N	20	N	200	N	--	N	75	.3	N	N
WC02SS	50	N	50	N	100	N	--	N	80	.4	N	N
WC03SS	50	N	20	N	100	N	--	5	110	.6	N	N
WC04SS	100	N	15	N	100	N	--	N	75	.2	N	N
WC05SS	200	N	30	N	100	N	--	15	65	.5	1	N
WC06SS	100	N	50	N	150	N	--	10	120	.5	N	<2
WC07SS	70	N	20	N	50	N	--	10	70	.5	N	N
WC08SS	70	N	20	N	150	N	--	5	170	.5	N	N
WC09SS	30	N	20	N	100	N	--	N	5	.1	N	N
WC10SS	200	N	70	N	200	N	--	N	15	.1	N	N
WC11SS	300	N	70	N	500	N	--	N	25	.1	N	N
WC12SS	100	N	50	N	100	N	--	N	15	.1	N	N
WC13SS	100	N	30	N	100	N	--	N	30	.1	N	N
WC14SS	150	N	70	N	100	N	--	N	15	.1	N	N
WC15SS	100	N	70	N	200	N	--	N	30	.1	N	N
WC16SS	100	N	15	N	150	N	--	N	75	.1	N	N
WC17SS	100	N	20	N	200	N	--	N	50	.2	N	N
WC18SS	70	N	20	N	200	N	--	N	60	.2	N	N
WC19SS	30	N	50	N	100	N	--	N	5	.1	N	N
WC20SS	70	N	50	N	300	N	--	N	10	.1	N	N
WC21SS	100	N	30	N	150	N	--	5	50	.2	N	N
WC22SS	100	N	30	N	70	N	--	5	20	.2	N	N
WC23SS	50	N	30	N	50	N	--	5	55	.3	N	N

Table 4 - Spectrographic analysis of nonmagnetic heavy mineral concentrates of stream sediment samples from the Wales Creek WSA (074-150), Powell County, Montana

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown.]

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
WC01C	46 48 14	113 12 6	3.0	7.00	10.0	1.5	700	N	N	N	20	700
WC02C	46 48 31	113 13 15	3.0	1.50	5.0	2.0	700	N	N	N	N	700
WC03C	46 49 12	113 13 23	1.5	5.00	10.0	>2.0	500	N	N	N	<20	300
WC04C	46 49 54	113 13 25	1.0	7.00	10.0	>2.0	500	1.0	N	N	50	150
WC05C	46 49 46	113 14 52	1.0	.50	10.0	>2.0	1,000	2.0	N	N	<20	70
WC06C	46 49 40	113 14 51	.5	5.00	10.0	>2.0	700	10.0	N	30	150	100
WC07C	46 49 51	113 13 33	.3	7.00	15.0	>2.0	500	1.5	N	N	20	100
WC08C	46 49 10	113 13 36	.7	5.00	10.0	>2.0	700	N	N	N	<20	150
WC09C	46 53 48	113 14 37	1.0	.15	10.0	>2.0	1,000	N	N	N	100	70
WC10C	46 53 38	113 14 38	1.0	.15	10.0	>2.0	1,000	N	N	N	N	150
WC11C	46 53 34	113 13 52	.5	.10	10.0	>2.0	700	N	N	N	N	150
WC12C	46 53 51	113 13 6	.5	.10	10.0	>2.0	1,000	N	N	N	<20	<50
WC13C	46 53 55	113 11 44	.5	.10	10.0	>2.0	500	N	N	N	N	100
WC14C	46 54 4	113 11 31	.7	.07	10.0	>2.0	1,000	N	N	N	N	<50
WC15C	46 54 3	113 10 33	.7	.07	10.0	>2.0	1,000	N	N	N	N	<50
WC16C	46 49 58	113 10 25	2.0	5.00	15.0	>2.0	1,000	N	N	N	N	3,000
WC17C	46 49 51	113 10 36	2.0	5.00	5.0	2.0	700	N	N	N	N	500
WC18C	46 49 16	113 10 6	1.0	7.00	15.0	1.5	500	N	N	N	<20	3,000
WC19C	46 56 55	113 13 7	.3	.50	5.0	>2.0	500	N	N	N	100	300
WC20C	46 52 18	113 13 0	.7	1.00	7.0	>2.0	700	N	N	N	500	300
WC21C	46 52 4	113 12 47	2.0	3.00	10.0	>2.0	500	N	N	N	N	500
WC22C	46 52 40	113 11 26	.5	.10	10.0	>2.0	1,000	1.0	N	N	30	150
WC23C	46 52 0	113 10 36	.3	.20	.5	2.0	50	N	N	N	N	500

Table 4 - Spectrographic analysis of nonmagnetic heavy mineral concentrates of stream sediment samples from the Wales Creek WSA (074-150), Powell County, Montana

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s
WC01C	N	N	N	20	1,500	30	100	N	N	200	30
WC02C	N	N	N	<10	700	30	300	N	N	70	3,000
WC03C	N	N	N	10	150	20	200	N	<50	70	30
WC04C	<2	N	N	10	70	10	500	N	50	15	<20
WC05C	N	N	N	15	50	20	1,000	20	100	10	20
WC06C	N	N	N	10	50	30	700	10	70	15	300
WC07C	N	N	N	<10	30	30	500	10	50	10	1,500
WC08C	N	N	N	10	50	20	700	10	70	30	50
WC09C	N	N	N	15	30	<10	1,000	15	100	<10	30
WC10C	N	N	N	15	20	10	1,000	10	150	N	150
WC11C	N	N	N	10	20	15	700	<10	70	N	70
WC12C	N	N	N	15	20	<10	1,000	20	150	N	50
WC13C	N	N	N	10	20	<10	700	N	50	<10	50
WC14C	N	N	N	15	20	<10	1,000	30	150	N	20
WC15C	N	N	N	15	20	<10	1,500	20	150	N	30
WC16C	N	N	N	<10	500	N	200	N	N	70	<20
WC17C	N	N	N	<10	500	N	150	N	<50	100	20
WC18C	N	N	N	10	300	<10	100	N	<50	70	<20
WC19C	N	N	N	<10	<20	<10	500	15	150	10	20
WC20C	N	N	N	10	150	30	150	100	150	15	700
WC21C	N	700	N	<10	300	20	200	<10	100	50	20
WC22C	N	N	N	20	30	70	1,500	50	200	N	30
WC23C	<2	N	N	<10	50	<10	<50	N	50	<10	50

Table 4 - Spectrographic analysis of nonmagnetic heavy mineral concentrates of stream sediment samples from the Wales Creek WSA (074-150), Powell County, Montana

Sample	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
WC01C	N	30	N	500	100	N	150	N	>2,000	N
WC02C	N	30	150	<200	100	N	100	N	>2,000	N
WC03C	N	30	20	200	100	N	150	N	>2,000	N
WC04C	N	15	70	<200	100	N	200	N	1,000	N
WC05C	N	10	70	<200	300	N	700	N	700	<200
WC06C	N	15	50	200	200	500	300	N	1,000	N
WC07C	N	<10	20	200	300	200	200	N	500	N
WC08C	N	15	30	<200	200	N	300	N	>2,000	<200
WC09C	N	30	100	N	300	N	1,500	N	>2,000	700
WC10C	N	30	100	<200	200	N	1,000	N	>2,000	500
WC11C	N	70	70	<200	200	N	700	N	>2,000	700
WC12C	N	50	100	N	300	N	1,000	N	>2,000	1,000
WC13C	N	50	70	200	200	N	1,000	N	>2,000	<200
WC14C	N	15	100	<200	300	N	1,000	N	2,000	200
WC15C	N	30	100	<200	500	N	1,000	N	>2,000	700
WC16C	N	30	N	700	200	N	300	N	>2,000	N
WC17C	N	20	N	200	150	N	200	N	>2,000	N
WC18C	N	30	N	1,500	70	N	150	N	>2,000	N
WC19C	N	15	20	N	100	N	300	N	>2,000	<200
WC20C	N	100	150	<200	300	N	300	N	>2,000	N
WC21C	N	30	<20	500	300	N	300	N	>2,000	N
WC22C	N	10	150	N	300	N	700	N	2,000	500
WC23C	N	20	<20	N	70	N	100	N	>2,000	N

Table 5 - Spectrographic and chemical analysis of rock samples from the Wales Creek WSA (074-150), Powell County, Montana

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown.]

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s
WC02R	46 48 31	113 13 15	2.0	2.00	.05	.200	150	N	N	N	100	1,500	<1.0
WC04R	46 49 51	113 13 30	>20.0	.05	1.00	.005	2,000	15.0	N	N	N	70	N
WC05RA	46 49 29	113 15 29	20.0	.05	10.00	.005	3,000	1.5	N	N	N	50	N
WC05RB	46 49 29	113 15 29	10.0	.07	15.00	.005	2,000	N	N	N	N	20	N
WC05RC	46 49 29	113 15 29	2.0	1.00	2.00	.300	700	3.0	N	N	N	700	1.0
WC05RD	46 49 29	113 15 29	7.0	.05	.07	.002	15	150.0	N	N	<10	70	1.0
WC11R	46 53 34	113 13 52	.5	5.00	7.00	.150	700	N	N	N	N	500	1.5
WC16R	46 49 58	113 10 25	3.0	1.50	2.00	.300	200	N	N	N	N	3,000	1.0

Table 5- Spectrographic and chemical analysis of rock samples from the Wales Creek WSA (074-150), Powell County, Montana

Sample	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s
WC02R	N	N	5	N	20	50	5	N	5	30	N	10	N	100
WC04R	N	N	100	N	500	N	N	N	5	<10	N	N	N	N
WC05RA	150	N	30	N	15,000	N	N	N	5	30	N	N	15	N
WC05RB	N	N	<5	N	500	N	N	N	<5	N	N	N	10	N
WC05RC	N	N	7	<10	200	50	N	N	5	10	N	7	N	500
WC05RD	<10	N	10	N	>20,000	N	10	N	5	N	N	N	<10	N
WC11R	N	N	5	20	20	30	N	N	7	N	N	5	N	100
WC16R	N	N	15	70	30	70	N	N	50	30	N	7	N	1,000

Table 5 - Spectrographic and chemical analysis of rock samples from the Wales Creek WSA (074-150), Powell County, Montana

Sample	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	Au-ppm aa	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa
WC02R	20	N	15	<200	100	N	N	5	80	.5	N	N
WC04R	30	50	10	700	N	N	N	10	180	.6	N	N
WC05RA	50	<50	<10	<200	N	N	.80	<5	100	.5	65	N
WC05RB	100	N	N	N	N	N	N	N	<5	.3	2	N
WC05RC	150	N	20	N	100	N	N	N	10	.2	N	N
WC05RD	20	100	N	500	N	N	1.10	N	170	2.4	1	N
WC11R	30	N	20	N	100	N	N	N	N	.1	N	N
WC16R	70	N	10	N	100	N	N	N	45	.1	N	N