UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Mineral Resources of the Humbug Spires Instant Study Area (Primitive Area and Adjacent Roadless Areas), Silver Bow County, Montana

By

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Mineral Surveys

Related to Bureau of Land Management

Instant Study Areas

In accordance with the provisions of the Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976), the Geological Survey and the Bureau of Mines have conducted mineral surveys on certain areas, which formally had been identified as "natural" and "primitive" areas prior to November 1, 1975. This report discusses the results of a mineral survey of the Humbug Spires Instant Study Area, Silver Bow County, Montana.

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GEOLOGY AND GEOCHEMICAL EVALUATION OF THE

HUMBUG SPIRES INSTANT STUDY AREA

By

Harry W. Smedes

INTRODUCTION

The Humbug Spires Instant Study Area, comprised of the Humbug Spires Primitive Area and adjacent roadless areas, takes in 11,302 acres or about 18 mi^2 (47 km^2) of the Highland Mountains, 15-20 miles (25-30 km) south-southwest of Butte, Montana (fig. 1). A mineral resource survey was made of the primitive area in 1978 by the U.S. Geological Survey; the U.S. Bureau of Mines surveyed the primitive area and adjacent roadless areas. These studies indicate that the mineral potential is low for the Humbug Spires Primitive Area, but high for part of the adjacent roadless study area to the south. This appraisal is based on geologic and geochemical investigations and on examination of prospects. Chemical and spectrographic analyses were made of stream-sediment and rock samples. No mining districts are located within the Instant Study Area.

The name "Humbug Spires" is derived from Mount Humbug (just north of the primitive area) and from the jagged peaks and "spires" of light-colored granitic rocks that make up most of the study area. These spires, whose shapes are controlled by joints, have produced a scenic terrain of extremely rugged and jagged ridges. Generally, valley bottoms are marshes, resulting from innumerable beaver ponds, and meadows. Although these terrain features combine to make the region difficult to traverse, access to the area is easy by way of gravel roads, shown on plate 1.

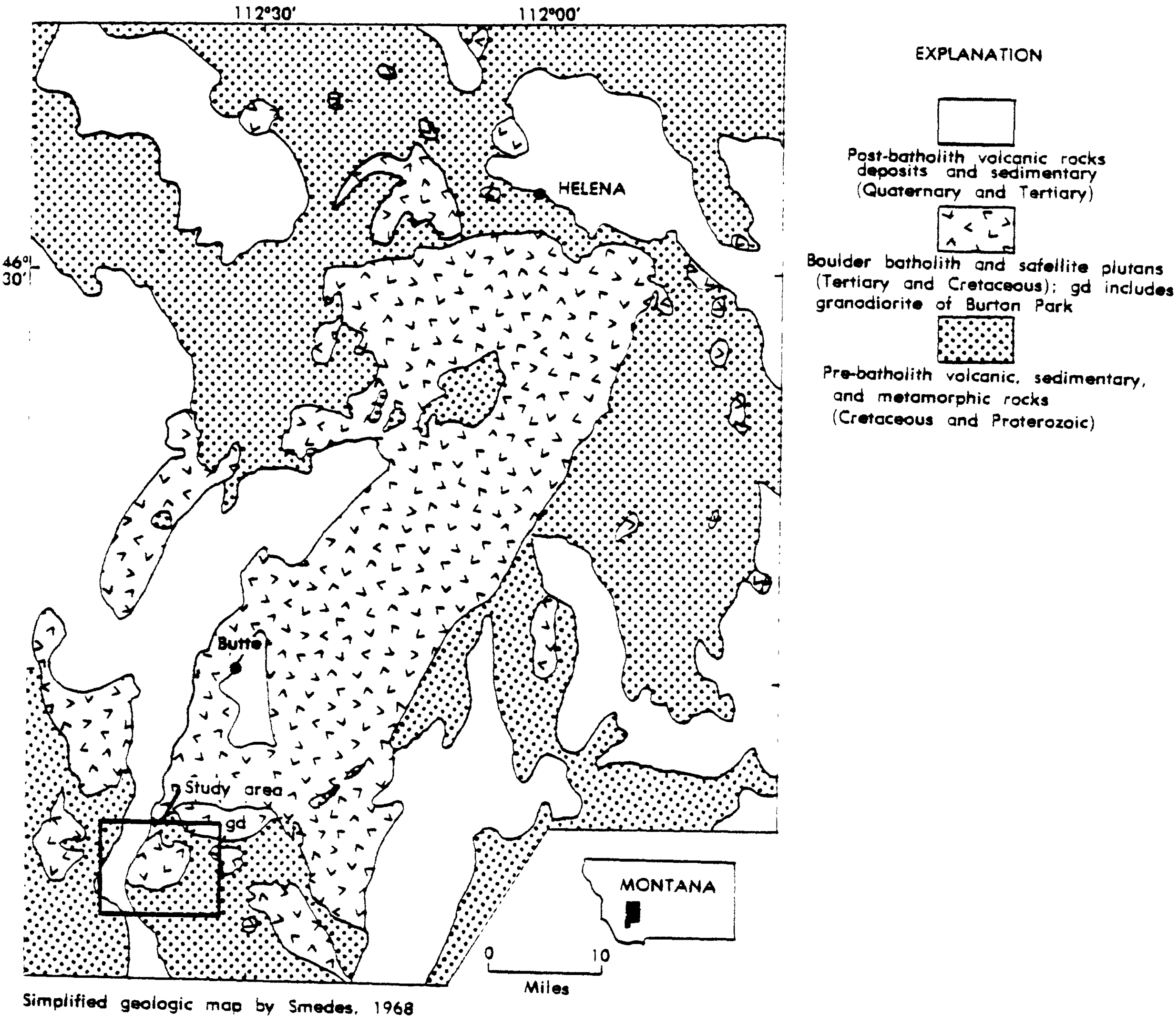

Figure 1.--Generalized regional geologic index map showing location of study area geologic map (plate 1).

PREVIOUS AND PRESENT INVESTIGATIONS

Reconnaissance studies were made in the general region of the study area by Richards and Pardee (1925), Sahinen (1939), and Theodosis (1954). A more detailed geologic study of the area was made by Andretta (1961). Garwood and Hanna (1957) described and measured sections of the sedimentary rocks, and discussed the rocks of the Moose Creek pluton.

The present study is based mainly on earlier mapping by Smedes and G. D. Fraser, only part of which has been published (Smedes, 1967). During part of that mapping, Smedes was assisted by J. P. Lockwood and R. W. Smedes. Smedes reexamined the area in August 1978, and made additional traverses, during which time he collected rock and stream sediment samples from the primitive area for spectrographic analysis.

GEOLOGIC SETTING

The primitive area and adjacent roadless areas are centered around a pluton of quartz monzonite, the Moose Creek pluton, one of several satellitic plutons south of the Boulder batholith (plate 1 and fig. 1). The Boulder batholith, which has an areal extent of about 2,300 mi^2 (6,000 km^2) (fig. 1), comprises at least 15 separate coalesced epizonal calc-alkalic plutons, which range from gabbro to granite. Rocks cut by the batholith range in age from Archean to Late Cretaceous. The batholith and its satellites were emplaced during a 10-m.y. interval (from 78 to 68 m.y. ago) at the close of the Cretaceous (Tilling and others, 1968; Smedes and others, 1968; Klepper and others, 1971; Klepper, 1973). The batholithic rocks are divided into two series, a main series and a sodic series (Tilling, 1973). Rocks of the Moose Creek pluton are of the sodic series. Klepper (1973) noted that virtually no ore deposits are associated with the sodic series; the reason for this relationship is unknown.

ROCK UNITS

Sedimentary rocks representing the Proterozoic and each period of the Paleozoic and Mesozoic, with the exception of the Ordovician and Silurian, are present in the map area. These strata are described briefly in the map explanation in their unmetamorphosed condition, as they occur in the surrounding region. In the map area, these strata have all been thermally metamorphosed to hornfels, granofels, or coarse-grained marble by the Moose Creek pluton. Except where other plutons or the Boulder batholith is nearby, the metamorphic grade decreases outward from pyroxene-hornfels facies, at the Moose Creek pluton contact, to albite-epidote facies. The disappearance of cordierite, megascopically, serves as an isograd that was mapped locally about one kilometer south of the pluton.

Nearly all the principal intrusive igneous rocks of the region are represented in the map area. They include pre-batholith andesitic dikes and sills (Ki) related to the Elkhorn Mountains Volcanics; early, main, and late-stage rock types of the Boulder batholith; and dikes correlated with the post-batholith Lowland Creek Volcanics (Ti). However, the bulk of the primitive area is underlain by quartz monzonite of the Moose Creek pluton, which probably is contemporaneous with the main stage of the batholith, the Butte Quartz Monzonite.

STRUCTURE

The Moose Creek pluton is a semiconcordant sill that intruded a north-dipping regional homocline in the Jefferson, Three Forks, and Lodgepole Formations. Except for small masses of the Three Forks and Lodgepole on the west side of the pluton, these formations were somehow removed, perhaps by stoping, assimilation, or rafting. No stoped blocks or calcium-rich contaminated pluton rocks are present. Strata along the east side of the pluton were deformed into a series of northerly trending folds, suggesting an eastward-directed pressure by the Moose Creek pluton, and perhaps a westward-directed pressure from the nearby and probably contemporaneous Moose Town pluton (plate 1). Strata to the north were also complexly folded, perhaps caught between the buttressing mass of large older masses of gabbro and granodiorite to the north, and the forcefully expanding magma of the pluton. Relations between the pluton and the anticline along its western margin suggest that at least some of the structures probably existed prior to the intrusive activity and that the structures were accentuated by the pluton. Thus, the sill-like Moose Creek pluton appears to have been intruded into an earlier folded sedimentary sequence.

Foliation in the pluton is weak and sparse and lineation was not observed. Inclusions of fine-grained dioritic rocks are sparse, except in scattered zones, and are as much as 1 m in size. Steep joints, very well developed in the pluton, controlled the erosion that produced the rugged pinnacles and spires typical of this area. Close-spaced, low-dipping joints form an arcuate belt in the southern part of the pluton. These joints are coated and filled by a late mineral assemblage, including potassium feldspar, quartz, magnetite, and sparse pyrite, which is more readily eroded than the intrusive rock. This arcuate belt is conspicuous from a distance. The veinlets are generally less than 5 mm thick and are spaced about 0.5 m apart. Analyses of the late mineral assemblage did not reveal anomalous metallic values.

Some faults in the area are older than the pluton, and others may have been formed in response to the inflating action of the intrusion, for they cut the metasedimentary host rocks but terminate abruptly at the contact of the pluton, without offsetting it. Other faults cut the Moose Creek pluton and clearly are younger than the intrusion. The principal young faults are the ones that bound the stock and older rocks on the west. These form the east edge of a fault-bounded trough that was filled in Miocene and Pliocene time, with coarse debris in coalescing fans, landslides, and debris flows from the scarps along the east side.

Glacial outwash from glaciers east of the area was carried down Moose and Maclean Creeks. Sparse scattered remnants of these deposits are preserved along Moose Creek, where they locally form small bouldery terraces.

MINERAL DEPOSITS

Mineral deposits are sparse in the study area and mining activity has been intermittent and slight, in contrast to regions just to the east and south, which were sites of active metal mining (Sahinen, 1950).

Within the Moose Creek pluton, only a few workings were found, mostly prospect pits or shallow shafts. Quartz and oxidized pyrite or chalcopyrite were the only minerals observed. Scattered small placer workings occur along Moose Creek. The only other deposits known, all of which are small, occur along the contact of the pluton. Most of these small deposits are in tactite where the only observed metallic minerals were iron sulfides and, in one small body, a few flakes of molybdenite.

Nonmetallic minerals mined in the past include limestone and fluorite. The limestone, which was quarried for smelter flux, came from the Mission Canyon Limestone (Mmc) along the west edge of the Moose Creek pluton. The fluorite occurs in a hydrothermally altered fault zone along the contact of the pluton with the sugary dolomitic marble of the Pilgrim Dolomite (Cpi) in Selway Gulch.

SAMPLING AND ANALYTICAL TECHNIQUES

Seventy-one stream-sediment and rock samples from the primitive area were collected and analyzed (fig. 2). Sediment was collected from each principal drainage and from as many minor and tributary valleys as possible. From each sediment sample location, approximately 22 lbs (10 kg) were collected. Granules, pebbles, and larger clasts, as well as twigs and other organic material, were removed by use of a 1/8-inch sieve during sampling. In the laboratory, the samples were dried, screened, and the -80 fraction analyzed. A pilot study by B. R. Berger and colleagues indicated that anomalies could be recognized without further treatment, such as separation. We thank them for these tests, and for the 10 samples they collected in the eastern part of the study area, which were the basis for the pilot study.

All stream-sediment samples consisted of quartz monzonite grus. Narrow valleys, filled with sand-flow deposits flushed out of upper reaches of the valleys during flash floods, have flat floors that were sampled by compositing at intervals across the valley floor.

Rock samples were collected at scattered localities within and adjacent to the pluton. These samples were crushed, sieved, and the -80 fraction analyzed, using the same techniques as for the stream-sediment samples. These rocks were collected in order to assist in interpreting analyses of the stream sediments. Older rocks at the pluton contact were sampled and analyzed to determine the metasomatic effects of the pluton.

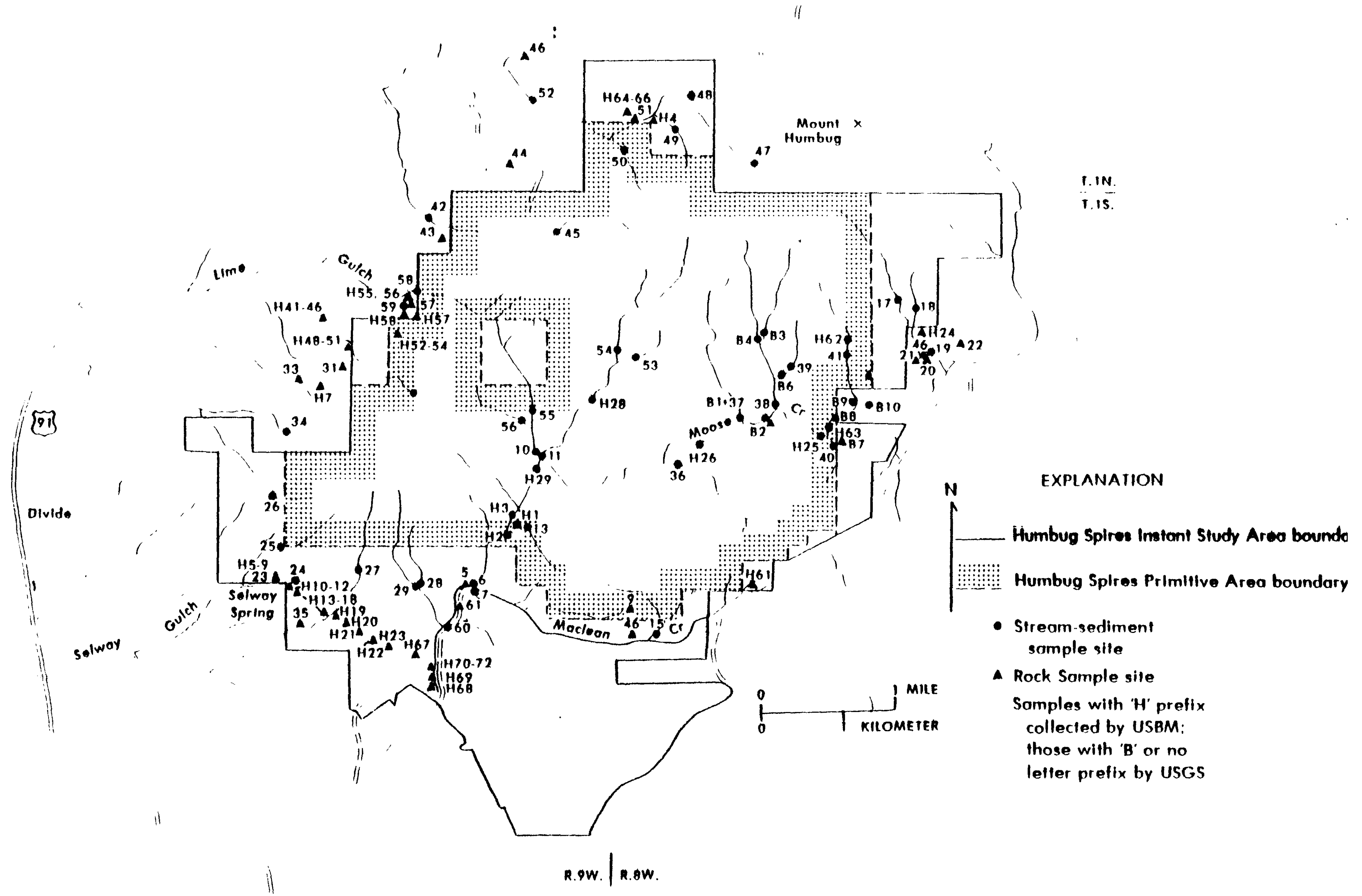

Figure 2.--Sample locality map showing rock and stream-sediment sample sites by the U.S. Geological Survey and U.S. Bureau of Mines.

EVALUATION OF ANALYTICAL DATA

Semiquantitative spectrographic analyses were made by David F. Siems using the six-step method for 30 elements. Studies of these analyses are in progress. Analyses of the pluton and stream-sediment samples are, for the most part, similar and at or below the value for "background" of quartz monzonite in general. Thus, the Moose Creek pluton is very homogeneous and evidently not mineralized. Differences in composition among other rock types are readily explained as primary differences in rock composition rather than as younger mineralization.

A few analytical values are high enough to constitute anomalies and are summarized in table 1. Nearly all anomalous values are less than an order of magnitude higher than the norm; many are only one or two analytical steps above. Many of the stream-sediment sample anomalies in table 1 are interpreted as resulting from contamination of the sediment from the Moose Creek mining district east of the primitive area. Other anomalies are due to small tactite bodies at the contact of the Moose Creek pluton. None of the anomalous values suggest the presence of unknown mineralized rocks, and thus we conclude that the mineral resource potential for the primitive area is very low.

Table 1.--Semiquantitative spectrographic analyses of mineralized rock and stream-sediment samples by David F. Siems

[Values reported in parts per million (ppm)]

Rock samples

Sample No.	Ag	As	B	Co	Cr	Mo	Ni	Pb	Sb	Sn	V	Remarks
Elements------ / Lower limit of detection--	0.5	200	10	5	10	5	5	10	100	10	10	
9								100				Zone of deuteric alteration along sheeted joints
21											700	Eastern contact of pluton near contact with calc-silicate rock and meta-andesite
23	1	2,000	100			70		70	200	30	150	Hydrothermally altered vein zone contains iron oxides and abundant powdery to sugary pale-purple fluorite
31	0.7		200	15		30	100				500	Tactite at contact of pluton; contains sparse visible molybdenite
33						7		70		30	70	Small skarn (roof pendant or xenolith?) body in pluton just south of anticline at west edge of pluton
41	0.5											Granodiorite near east edge of pluton
43						20						Quartz from quartz-rich pegmatite, near west edge of pluton
44	0.5			20							150	Granodiorite at west edge of pluton
46				15	100							Host rock (matrix) of xenolith-rich phase of pluton near north edge
51	10											Rare leucocratic phase of pluton, near tactite and Madison Group in northern part of pluton

Stream-sediment samples

Sample No.	B	Cr	Mo	Pb	Sn	V	Y
Elements------------------- / Lower limit of detection---------------	10	10	5	10	10	10	10
B1				50			
B2		50	10		10	200	100
B3				50	10	70	70
B4				50			
B5				50	10		
B6						70	
B7				100	10		
B8	150	150		70	10	100	
B9				50			
B10				50		150	
7					10		
19					10		
40				50			
48		20					
49				70			
53				50			

INTERPRETATION OF AEROMAGNETIC DATA

By

William F. Hanna

INTRODUCTION

The most useful geophysical information considered in the mineral resource assessment of the Humbug Spires study area is aeromagnetic data derived from two surveys: (1) a reconnaissance of the Boulder batholith region (plate 2A) (Johnson, and others, 1965); and (2) a detailed local survey confined to the study area (plate 2B) (USGS, 1979). Regional Bouguer gravity anomaly maps (Burfeind, 1967, 1969; Biehler and Bonini, 1969), which include no stations within the study area, were inspected and judged to have no significant value to the present assessment.

SIGNIFICANCE OF RECONNAISSANCE AEROMAGNETIC DATA

The small rectangular area on the reconnaissance map (plate 2A) outlines the detailed aeromagnetic survey of the study area. The outlined area is a positive anomaly associated with the Moose Creek pluton, and steep northeast-trending gradients delineate the northwest and southeast boundaries of the plutonic rocks. Comparison of this reconnaissance map with geologic maps indicates that the Moose Creek pluton continues in the subsurface westward for 5 mi (8 km), as far as an exposed satellitic pluton, and northeastward for 1.2 mi (2 km), to an exposed leucocratic pluton. From a broader perspective, it is clear that the Moose Creek pluton forms part of an arcuate belt of diverse, relatively magnetic plutons that approximately rims the southern and southwestern margins of the Boulder batholith. The reconnaissance anomaly map is thus significant in that it identifies a subsurface continuity of the plutonic rocks not seen from surface geology.

This provides a potential exploration guide in the following way: if any mineralization can be discerned to be genetically, as well as spatially, related to any plutonic rocks in the belt, such mineralization may be repeated elsewhere in the belt. Mineralization related to the Moose Creek pluton in the study area is negligible in exposed rocks. However, extensive mineralization is spatially related to the Moose Town pluton, which lies immediately east of the study area, along the regional belt. If it can be determined that the mineralization is genetically, as well as spatially, related to that pluton, other parts of the regional belt may warrant exploration--especially the continuous unexposed subsurface parts of the belt.

SIGNIFICANCE OF DETAILED AEROMAGNETIC DATA

The detailed aeromagnetic anomaly map (plate 2B) shows an important feature not evident from the reconnaissance anomaly map, namely, that the major positive anomaly (H1) associated with the Moose Creek pluton covers only the southwestern two-thirds of the intrusive body. This fact supports the geologic interpretation that the body is floored at a shallow depth, since the positive anomaly of a typical stock having a magnetization similar to that of other plutonic rocks in this region would cover at least seven-eighths of the body, depending upon the depth of the base of the body.

A magnetically subdued zone, north and northeast of the main positive anomaly (H1), is marked in the aeromagnetic data by a saddle in the contours (in the west half of section 5), which merges counter-clockwise with the negative anomaly (L1) and a trough which leads westward out of that low. This subdued zone indicates that the plutonic rocks are thinner. The fact that this zone lies near the projected roof of the pluton--where one would expect the pluton to be thickest--suggests that the pluton has one of the following configurations: (1) there is a sharp rise in the floor beneath that zone;

(2) there are large slabs torn off the floor to form a thick zone of inclusions within the pluton; (3) there are large slabs torn off the roof and foundered into the pluton just below the presently exposed level; or (4) the concealed north edge of the pluton is a "Christmas tree" laccolith with sill wedges injected into the metasedimentary section, which is that section missing at the surface--the Jefferson Formation up through the Mission Canyon Limestone. The pendant of Madison Group, in sec. 31 and 32, may represent one of these remnants of wall rocks with plutonic rock above and below.

Positive anomaly H2 represents the faulted and buried westward subsurface expression of the belt of plutonic rocks described for the regional data above.

Positive anomalies H3, H4, and H5 all lie north of the magnetically subdued zone referred to above. They are inferred to have diverse sources. Anomaly H3 is produced by the xenolith-rich quartz monzonite body which it closely outlines. Anomaly H4 is interpreted as a local thickening of the main plutonic mass; it may mark the location of a feeder conduit. Anomaly H5 is inferred to be produced by the granodiorite that is exposed in the northeast corner of the map area, that extends beyond the map area as part of the large granodiorite of Burton Park--part of the Boulder batholith proper.

Two very low amplitude positive anomalies immediately east and southeast of the exposed pluton have unknown sources. Anomaly H6 occurs in an area devoid of exposed plutonic rocks; anomaly H7 occurs near exposed granodiorite, but is centered at a considerable distance from it. These two anomalies are inferred to be caused by local, relatively small, fingerlike bodies of plutonic rocks, perhaps offshoots from the basal part of the Moose Creek pluton, into the floor rocks.

Positive anomaly H8 is associated with, but not centered over, small plugs of intrusive andesite rocks (Ki), granodiorite (gd), and quartz monzonite (qm). It is postulated that one or more of these exposed plugs become larger at depth and are centered beneath the anomaly.

The detailed survey tends to confirm the geologic interpretation that the Moose Creek pluton is thin relative to its exposed area. This conclusion is based upon comparison of published anomalies associated with spatially finite prismatic models (see, for example, Vacquier and others, 1963; Andreasen and Zietz, 1969; Stanford Research Institute, ca 1978) and measurements of rock magnetization. The total magnetization of quartz monzonite in the main plutonic rock mass is expectedly strong; the rock's magnetic susceptibility is about 4×10^{-3} emu/cm^3, and its remanent-to-induced magnetization ratio is about 0.02. Amplitudes of anomalies associated with finite prismatic models, together with information about the height of magnetometer above ground and about the magnetization of the rock, suggest that the maximum thickness of the pluton proper is about .6 mi (1 km).

The anomaly data are entirely compatible with the interpretation derived from the geologic map relations--that the pluton is a podlike sill or laccolith dipping to the north. If the maximum thickness of the pluton is only about .6 mi (1 km), the dip of the floor of the pluton must decrease northward.

The largest exposed mass of granodiorite in the study area, situated between anomalies L1 and L2, is associated with only a very low amplitude positive anomaly forming a low saddle that connects anomalies H1 and H3. The magnetization of this rock, like that of the quartz monzonite mass, is strong; the rock's magnetic susceptibility is about 1×10^{-3} emu/cm^3 and its remanent-to-induced magnetization ratio is about 2.6. The low amplitude of the anomaly suggests that the granodiorite is thin, perhaps confined largely to the core of a syncline in Paleozoic sedimentary rocks, as suggested by the geologic field relations.

CONCLUSIONS

Regional aeromagnetic data define the position of the Moose Creek pluton in an arcuate belt of relatively magnetic plutonic rocks. The detailed aeromagnetic anomaly and magnetization data suggest that the pluton is relatively thin, becoming even thinner in much of the northeastern third of the exposed body. The detailed data also point up occurrences of local, low-amplitude positive anomalies presumably associated with relatively small subsurface masses of quartz monzonite and granodiorite. Because significant mineralization is not present in the surface exposure of the pluton, no correlation of magnetic anomalies with mineralization is possible.

MINES AND PROSPECTS OF THE HUMBUG SPIRES INSTANT STUDY AREA

By

Michael Hamilton

MINING HISTORY

Although no mining districts are located within the Humbug Spires Instant Study Area, several are located less than a mile (1.6 km) away, including the Moose Creek district to the east, Upper Camp Creek district to the southeast, and Soap Gulch district to the south. Mining activity in the region began in 1866, when rich gold placers were discovered 6 mi (10 km) east in the Highland district. Soon after, gold- and silver-bearing oxide zones, in faulted, hydrothermally altered sedimentary and metamorphic rocks, were developed in the district. By 1868, the Day and Harvey mines (plate 3) 1/2 mi (0.8 km) east of the study area, were producing gold and silver ore from quartz veins worth \$200 to \$3,500 per ton (200 to 3,860/t) (Sahinen, 1950, p. 5).

West of the study area, kilns in the vicinity of Lime Gulch were producing metallurgical grade lime at the turn of the century from nearby limestone deposits (Perry, 1949, p. 42).

Total production between 1876 and 1947, from the districts near the study area, is estimated to be as much as \$3 million worth of gold, silver, copper, and lead. Except for several small placer operations, there is no current mining activity in or near the study area.

MINES AND PROSPECTS

Most of the study area is underlain by the Moose Creek pluton, and their boundaries approximately coincide, thus restricting exploration and mining activity to contact mineralized zones in the peripheral portion of the area. Within the Proterozoic Belt, rocks in the southwestern part of the study area, stratabound base-metal deposits, and vein deposits of remobilized base metals near the intrusive border, contribute to base metal resource potential.

Mining claim records of Silver Bow County, Mont., indicate that 89 claims were located within, or adjacent to, the study area between 1887 and 1978. Eighty are lode, six are placer, and three are limestone placer claims. Thirty claims are currently held.

Fluorspar on the Brown claim group (plate 3, no. 23) occurs along the contact between the Moose Creek pluton and dolomitic limestone. The deposit is estimated to contain a submarginal resource of 800 to 1,000 tons (700 to 900 t) of 20 to 23 percent CaF_2.

An estimated 22,000 tons (20,000 t) of limestone was quarried from the Lime Rock claim group (plate 3, no. 1) in the 1960's and shipped to the smelter at Anaconda, Mont., for use as flux. The Lime Rock claim group, part of which extends into the study area, is estimated to have resources of 10 to 20 million tons (9 to 18 million t) of limestone.

A high potential for stratabound base-metal deposits exists in Proterozoic argillites and quartzites near the border of the Moose Creek pluton within, east, and west of the roadless area, south of the primitive area.

The Maverick, Lime Kilns, North Lode, Tucker Creek, Last Chance, and two unnamed prospects (plate 3) within, and adjacent to, the Humbug Spires Instant Study Area either appear to have low potential, or the mineral occurrences are not well enough exposed to determine their potential.

Detailed descriptions of mines and prospects are in progress at the Bureau of Mines.

MINERAL RESOURCES OF THE HUMBUG SPIRES

INSTANT STUDY AREA

By

Michael Hamilton

Although no mining districts are located in the study area, and there has been no recorded mineral production, the possibiity of stratabound base-metal deposits within the southern part of the study area is being investigated.

The primitive area is underlain mostly by the unmineralized quartz monzonite of the Moose Creek pluton. Mining development is limited to a few prospect pits, most of which are placer gold exploration pits along Moose Creek. Stream-sediment and rock analyses confirm the unmineralized nature of the pluton. The small amount of mineralization observed consisted of quartz with pyrite or chalcopyrite.

Bordering the pluton, within roadless areas adjacent to the primitive area, is a variety of metallic and nonmetallic resources. These are along the pluton-sedimentary or metamorphic rock contact, within metasomatic and hydrothermally altered shear zones. Metallic deposits along alteration zones include a garnet tactite above Tucker Creek (plate 3, no. 9), with minor amounts of altered shale in Lime Gulch (plate 3, no. 3), small amounts of uranium and metasomatically altered dolomitic limestone near Selway Springs, magnesium (plate 3, no. 23) and minor silver (plate 3, no. 24). A small fluorspar deposit on the Brown claim group (plate 3, no. 23), occurring along the pluton-dolomitic limestone contact within hydrothermally altered fracture zones, is estimated to contain a submarginal resource of 800 to 1,000 tons (700 to 900 t) with 20 to 23 percent CaF_2.

The Mission Canyon limestone, on the Lime Rock claim group (plate 3, no. 1), was mined in the 1960's (for smelter flux), and an estimated 22,000 tons (20,000 t) was quarried from open pits. The Lime Rock claims are now estimated to have a resource of 10 to 20 million tons (9 to 18 million t) of which one-third is within the study area.

There is a high potential for stratabound base metals in the studied roadless areas south of the primitive area. These occur in Proterozoic Belt argillites and quartzites and are predominantly copper and silver. The area has been claimed and was drilled by Exxon Minerals, Cominco American, and the Anaconda Company in the last few years. Most of the base-metal occurrences are east of the study area.

SUMMARY OF MINERAL RESOURCE APPRAISAL OF THE HUMBUG SPIRES INSTANT STUDY AREA

By

Michael Hamilton and Harry W. Smedes

The Humbug Spires Instant Study Area comprises about 20 mi^2 (52 km^2) of the Highland Mountains and is 15-20 mi (24-32 km) south-southwest of Butte, Montana. A mineral resource survey was made of the area in 1978 and 1979 by the U.S. Geological Survey and the U.S. Bureau of Mines. These studies indicate that the mineral potential for the Humbug Spires Primitive Area is low. Several roadless areas south of the primitive area have a high potential for stratabound base-metal deposits, and minor resources of limestone and fluorspar occur in adjacent roadless areas (fig. 3). This appraisal is based on geologic and geochemical investigations and on field examination of prospects. Spectrographic analyses were made of stream-sediment and rock samples. No mining districts are located within the study area.

The Humbug Spires Primitive Area is underlain almost entirely by the Upper Cretaceous and(or) Paleocene Moose Creek pluton, a quartz monzonite body that is one of several satellites of the Boulder batholith. The pluton intruded and thermally metamorphosed Proterozoic Y through Upper Cretaceous sedimentary rocks typical of the region. Past and present exploration and mining activity is primarily adjacent to the primitive area because mineralization was almost entirely restricted to fractures, shear zones, and strata near the margins of the pluton where metasomatism and hydrothermal alteration of both the pluton and sedimentary rocks occurred. Some of this mineralization is found in the adjacent roadless areas. Analyses of stream-sediment and rock samples collected within the primitive area do not indicate the presence of mineralization. However, stratabound base metal

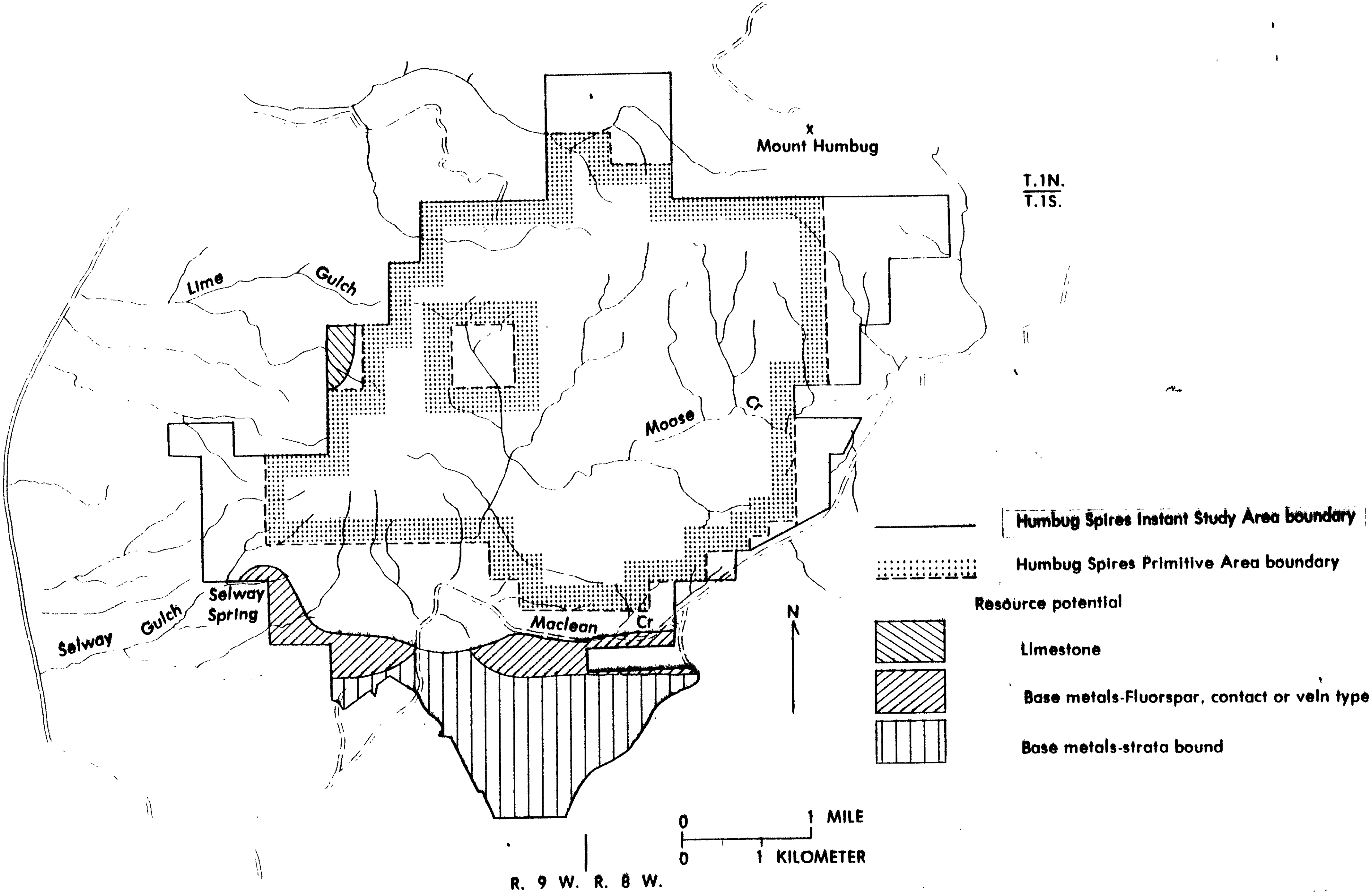

Figure 3.--Mineral resource potential of the Humbug Spires Instant Study Area.

deposits and base metal vein deposits do occur in the Proterozoic Belt rocks in a roadless area in the southwestern part of the study area.

Fluorspar on the Brown claim group (plate 3, no. 23) occurs along the contact between the Moose Creek pluton and dolomitic limestone. The deposit is estimated to contain a submarginal fluorspar resource of 800 to 1,000 tons (700 to 900 t) of 20 to 23 percent CaF_2. In the 1960's an estimated 22,000 tons (20,000 t) of limestone was quarried from the Lime Rock claim group (plate 3, no. 1) and is now estimated to have a resource potential of 10 to 20 million tons (9 to 18 million t); approximately one-third of this resource is within the study area. A high potential for stratabound base-metal deposits is inferred in argillites and quartzites south of the primitive area and partially within the adjacent roadless areas. The Maverick, Lime Kilns, North Lode, Tucker Creek, Last Chance, and two unnamed prospects (plate 3) within the Humbug Spires study area appear either to have low mineral potential, or the mineral occurrences are not sufficiently exposed to determine their potential.

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