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# MINERAL RESOURCE POTENTIAL OF THE RATTLESNAKE ROADLESS AREA, MISSOULA COUNTY, MONTANA

By

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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 Rattlesnake Roadless Area, Lolo National Forest, Missoula County, Montana. The Rattlesnake Roadless Area (No. 01801) was classified as a further planning area during the Second Roadless Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

## MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

Geologic, geophysical, and geochemical investigations, and a survey of mines and prospects have been conducted to evaluate the mineral resource potential of the Rattlesnake Roadless Area, Missoula County, Mont. Surface and mineral rights are owned by the Federal Government and by private interests.

Known resources of barite, copper and silver, and limestone occur within the boundary of the Rattlesnake Roadless Area. A barite vein, located on private land, has an estimated 45 tons of high purity barite exposed at the surface; possible extensions of the barite vein are of unknown length. Copper and silver are present in a small stratabound occurrence near the northwest boundary of the study area; an estimated 38,000 tons of mineralized rock may be present and may average 0.55 percent copper and 0.2 oz of silver per ton. A limestone occurrence in the south part of the study area contains an estimated 500,000 tons of limestone that is of marginal grade for cement manufacture. About 5 mi to the southeast of this limestone occurrence two additional areas of limestone are present that are probably also of marginal grade for cement manufacture; estimates of tonnage were not made for these two exposures.

Titanium, barite, and silica, plus base metals that may be associated with sulfide-bearing veins occur in several areas of the Rattlesnake Roadless Area. A diabase body in the south part of the study area contains some titanium, chromium, manganese, zirconium, cobalt, vanadium, niobium, and zinc; concentrations of these elements appears to be normal for this rock. Covered diabase bodies may be present in two other areas. A low-grade disseminated occurrence of barite is present in the southeast part of the study area. Silica occurs as quartz veins in two fracture zones. Low-grade placers that may contain titanium in heavy minerals could be present in some drainages in the southwest part of the study area. Gold was not detected in stream deposits. Single, isolated geochemical anomalies of silver, gold, copper, zinc, and lead suggest the presence of small sulfide-bearing veins in the study area, but none were located. The study area has a low potential for the occurrence of resources of titanium, disseminated barite, silica, heavy mineral placers, and base metals. The Rattlesnake Roadless Area has a low potential for occurrence of coal, and oil and gas resources. The resource potential for geothermal energy and radioactive minerals was not investigated during this study.

Sand and gravel occur in most drainages in the study area, but these resources were not evaluated during this study.

## INTRODUCTION

The Rattlesnake Roadless Area encompasses 120 sq mi in the southern Jocko Mountains. The south boundary of the study area is about 3 mi north of Missoula, Mont. (fig. 1). The Flathead Indian Reservation borders the study area along the topographic divide on the northwest and north. The total relief in the study area is about 4,800 ft; broad, steep-sided canyons and sharp peaks were sculpted during glaciation. Paved and gravel roads provide access to the study area from the south through Butler, Grant, and Rattlesnake drainages, and gravel roads up Gold Creek drainage provide access from the east. The boundary of the roadless area is that defined by the U.S. Forest Service in 1979 as a result of the Roadless Area Review and Evaluation (RARE II).

### Previous investigations

Nelson and Dobell (1961) reported on the stratigraphy and structural geology and published a geologic map (scale 1:62,500) that encompassed the south part of the Rattlesnake Roadless Area. Some modifications were made to their map during reconnaissance mapping by C. A. Wallace in 1975 (Wallace and others, 1981). In 1975, J. E. Harrison, U.S. Geological Survey, conducted reconnaissance geologic mapping in the north part of the study area (Mudge and others, 1982). Sahinen (1957) reported on mines and mineral deposits in Missoula and Ravalli Counties, which include the Rattlesnake Roadless Area. W. M. Johns (unpub. report, 1981) completed a mineral appraisal of land controlled by Montana Power Company located in the study area.

### Present investigations

The U.S. Geological Survey conducted field investigations to evaluate the mineral resource potential of the Rattlesnake Roadless Area in 1979. Field studies included geologic mapping (Wallace and Lidke, 1980), geophysical surveys (Kulik, 1983), and geochemical sampling (Campbell and others, 1981). A field survey of known prospects was conducted by U.S. Bureau of Mines personnel during 1982 (Mayerle, 1983). Additional information on mineral potential was provided by W. M. Johns (unpub. report, 1981), with permission from Montana Power Company.

### Surface and mineral ownership

Surface and mineral rights are controlled by three main entities: Montana Power Company, the U.S. Forest Service, and the Burlington Northern Railroad. Most of the privately owned land in the south part of the Wilderness study area forms a patchwork with land controlled by the U.S. Forest Service. Nearly all of the surface and mineral rights are under the jurisdiction of the U.S. Forest Service in the north part of the area.

## GEOLOGIC SETTING

### Stratigraphy and structure

Sedimentary rocks of the Proterozoic Y Belt Supergroup underlie most of the Rattlesnake Roadless Area (Wallace and Lidke, 1980). The oldest rock unit exposed is the Helena Formation, which represents the middle part of the Belt Supergroup. Conformably overlying the Helena Formation, in ascending order, are the Snowslip, Shepard, and Mount Shields Formations, the Bonner Quartzite, the McNamara and Garnet Range Formations, and the Pilcher Quartzite. Diabase dikes and sills having compositions in the diorite and gabbro classes are of probable Proterozoic Z age and they intrude the Belt rocks in the south and west parts of the roadless area.

Phanerozoic rocks are represented by the Middle Cambrian Silver Hill Formation (Wallace and Lidke, 1980). Quaternary surficial deposits of till, outwash, and alluvium are present in glacial basins and in modern drainages.

The Rattlesnake Roadless Area crosses the boundary of two structural provinces (fig. 2): (1) the Rattlesnake thrust system dominates the structural pattern in the southwest part of the study area; and (2) a parautochthonous terrane dominates the structural pattern in the northeast part of the study area. The Rattlesnake thrust system is characterized by imbricate thrusts that disrupted formations of the middle and upper parts of the Belt Supergroup. Thrust faults of probable Mesozoic age cut diabase dikes and sills of Proterozoic Z age. Northwest-trending, steep faults appear to have had recurrent movement that may have begun before Middle Cambrian time and latest movement post-dates Mesozoic thrust faulting. The term parautochthonous terrane is used for the region northeast of the leading edge of the Rattlesnake thrust plate because this terrane presumably overlies the westward extension of sole thrusts of the Montana disturbed belt and of the Rocky Mountain fold and thrust belt (Mudge and others, 1982). The parautochthonous terrane is broken by the system of northwest-trending, steep faults described above, which generally have stratigraphic separation that is down on the southwest block. Stratigraphic separation on the steep faults ranges between 10 and 200 ft on some smaller faults and between 300 and 1,000 ft on some larger faults (Wallace and Lidke, 1980).

### Geophysical interpretation

D. M. Kulik collected and interpreted gravity data and interpreted aeromagnetic data for the Rattlesnake Roadless Area. Gravity data show that the rocks of the study area have small density contrasts and the area is characterized by a gravity plateau of little relief (Kulik, 1983). Areas of negative gravity anomalies apparently reflect gravity contrasts produced by low-density Tertiary and Quaternary valley-fill deposits. A series of northeast-trending linear high and low anomalies of small amplitude probably reflect density contrasts or structural relief in crystalline basement rocks (Kulik, 1983).

Aeromagnetic data show several positive magnetic anomalies that are associated with Proterozoic Z diabase sills and dikes that intrude essentially non-magnetic rocks of the Belt Supergroup (Kulik, 1983). This expression is typical of other dikes and sills of similar age in the region. Exposed sills and dikes and their positive magnetic anomalies trend northwest, and by association, northwest-trending positive magnetic anomalies probably represent

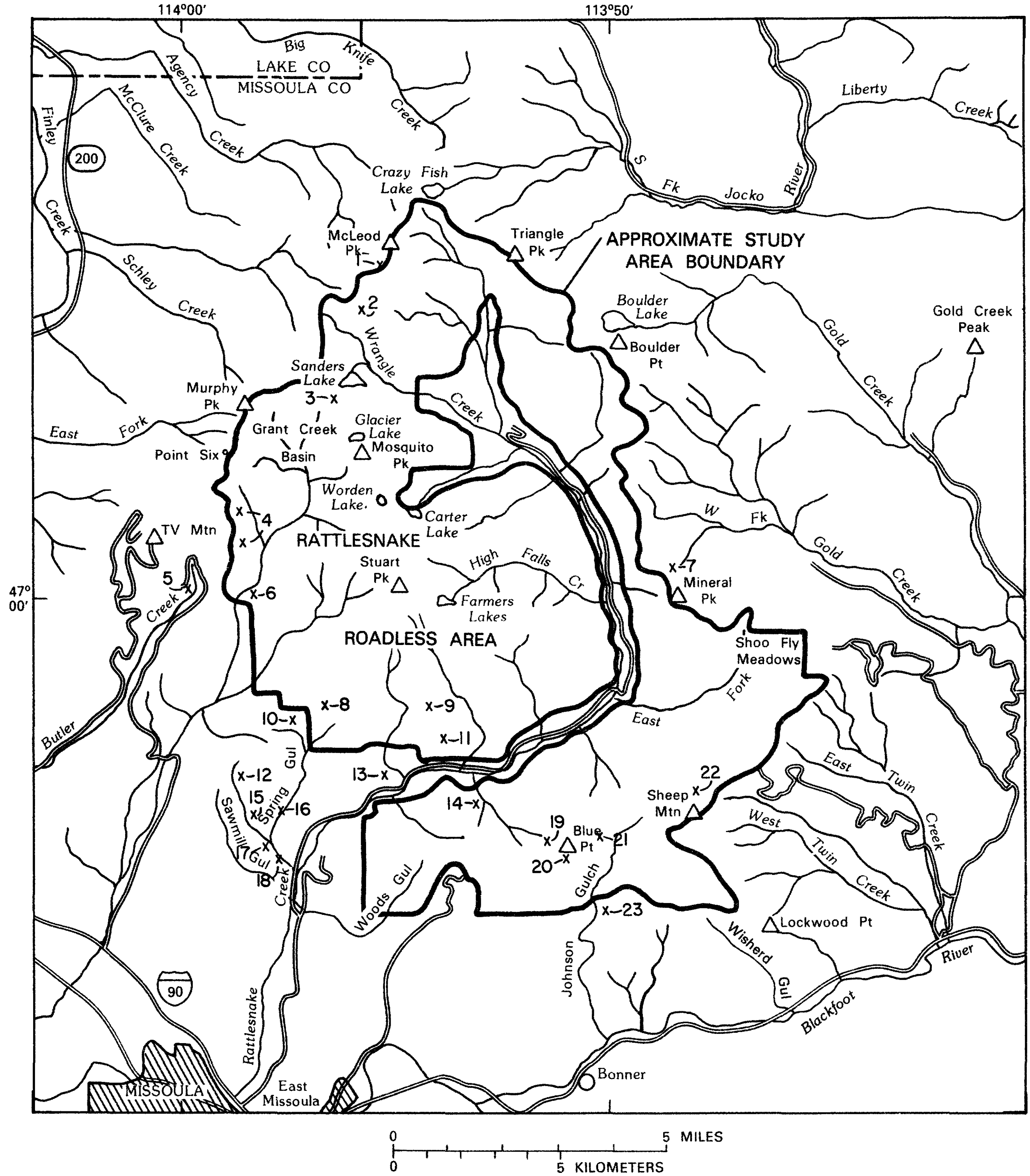


**Figure 1.--Map showing location of the Rattlesnake Roadless Area, Mont., and prospects. Numbers refer to prospects described in table 1.**

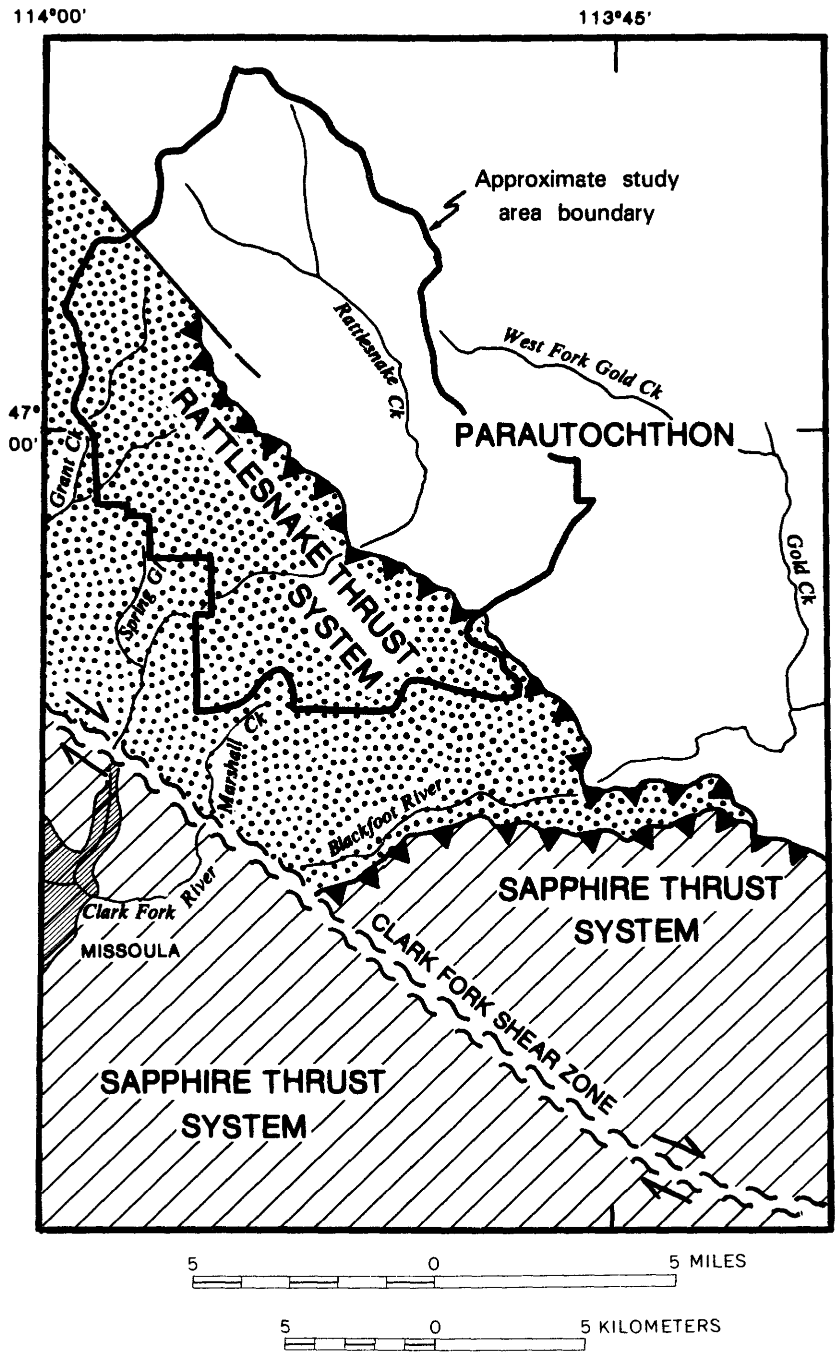


Figure 2.--Structural setting of the Rattlesnake Roadless Area, Mont.

covered diabase bodies. A magnetic gradient with an east-west trend crosses the central part of the study area, and geologic evidence and gravity data do not suggest a source for the gradient. A magnetic gradient in the northeast part of the area may result from a difference in the content of magnetic minerals in rocks of the Belt Supergroup (Kulik, 1983).

### Geochemical methods and interpretation

Geochemical interpretation is based on sampling and analysis of 130 rock samples, 135 stream-sediment and soil samples, and 110 pan-concentrate samples (Campbell and others, 1981). All samples were analyzed for 31 elements by a six-step semiquantitative emission spectrographic method (Grimes and Marranzino, 1968). All pan-concentrate samples and selected samples from mineralized rock were analyzed for gold by an atomic absorption procedure (Thompson and others, 1968). All rock and stream-sediment samples were also analyzed for silver, bismuth, cadmium, copper, lead, antimony, and zinc by a partial digestion procedure (Viets and others, 1979).

Lower threshold concentrations were established by using lower detection limits for silver, gold, bismuth, tin, and zinc. Copper and lead were considered anomalous if they were twice as great as the mean background concentration for the area.

Interpretation of geochemical data shows that the area southwest of McLeod Peak contains high anomalous amounts of silver, copper, manganese, and bismuth, which are probably related to a small area of stratabound copper in the Mount Shields Formation. Several areas of anomalous titanium, manganese, chromium, zirconium, cobalt, vanadium, niobium, and zinc in drainages of Grant and Butler Creeks coincide with outcrops of diabase dikes or probable covered diabase dikes. Isolated, high, single-element anomalies occur at scattered localities in the study area.

## MINES AND PROSPECTS

Investigations of claims records and a review of pertinent literature by the U.S. Bureau of Mines resulted in identification of 23 prospects in the study area (Mayerle, 1983). These investigations included examination of reported claims and prospects, and collection of samples from accessible prospects. Brief descriptions of prospects are given in table 1; numbers used in this table give prospect locations shown on figure 1.

No mineral production has been recorded from the study area. At least 99 claims have been located or relocated since 1866, but none of the claims in the study area are current. Prospects 1, 2, 5, and 19-23 are located on land controlled by the U.S. Forest Service. All other prospects are located on private land. Prospect 4, the location of which is uncertain, may be on Forest Service land or on private land.

About 80 samples were collected from prospect workings and dumps. Samples were analyzed by atomic absorption, chemical, fire-assay, and semiquantitative spectrographic methods. The results of field and laboratory investigations are summarized in table 1.

## MINERAL RESOURCE POTENTIAL

### Regional setting

Interpretation of regional patterns of mineralized rock suggest that the study area does not contain intrusive rocks that have a high potential for large-scale mineral deposits, nor does the area contain stratigraphic sequences that have high potential as hosts for replacement deposits or large bodies of stratabound minerals.

In the region, diabase sills and dikes show little evidence of primary mineralization, and diabase did not serve as host rocks for later mineralization. Nelson and Dobell (1961) reported accessory pyrite, hematite, magnetite, sphene, and zircon from diabase dikes and sills. This accessory mineral suite is common elsewhere in dikes and sills of similar age.

Rocks of Proterozoic Y age of the Missoula Group contain stratabound concentrations of copper and silver in green-bed zones of the Snowslip, Mount Shields, and McNamara Formations southeast and south of the study area. Beds that contain copper and silver are lenticular and thin. Copper values as much as 700 ppm and silver values as much as 6 ppm are common in lenticular beds that range from 1 in. to 1 ft thick. Only a few beds contain copper- and silver-bearing minerals, and these mineralized beds usually cannot be traced for more than 1,000 ft.

Replacement mineral deposits have not been identified in rocks of the Helena Formation or in rocks of the Missoula Group near the study area, although the Helena contains significant copper-silver deposits near Lincoln, Mont. The geologic setting appears to be unfavorable for these types of deposits because large intrusive bodies of intermediate and silicic composition are absent, extensive hydrothermal activity is lacking, and most of the host rock available for mineralization is argillaceous and siliceous rather than carbonate bearing.

Mineralized veins have the main resource potential in this region. Barite veins have been mined in the western part of the Garnet Range (Pardee, 1917; Kauffman and Earll, 1963; Berg, 1982), about 25 mi east of the study area, and a single barite vein is present in Rattlesnake Creek within the study area. Other types of veins occur about 15 mi southeast of the study area in the Clinton district where copper-silver and lead-silver veins occur in a granodiorite stock. About 15 mi south of the study area at the Whaley mining claims, fracture-filling sulfide veins contain copper, gold, and silver.

Regional patterns of mineral occurrences suggest that rocks in most fault zones do not show anomalously higher metal values than non-sheared rocks even though fault zones have greater porosity than most rocks of the Belt Supergroup. However, the barite and sulfide-bearing quartz veins may have used zones of fracture along faults for emplacement.

### Known mineral occurrences and areas of resource potential

Known localities of mineral occurrences and areas that have geologic, geochemical, or geophysical indications of potential for occurrence of resources in

Table 1.--Summary of prospects in and adjacent to the Rattlesnake Roadless Area, Missoula County, Mont.

[Pct, percent]

| Prospect number | Name | Geologic setting | Number and types of workings | Analytical data and resource estimate |
|---|---|---|---|---|
| 1 | Unnamed prospect. | Stratabound occurrence in green-bed zone in upper member of Mount Shields Formation. | None--------- | 4 chip samples averaged 0.55 pct copper and 0.2 oz of silver per ton. One grab sample contained 0.43 pct copper and 0.3 oz of silver per ton. An inferred resource of about 38,000 tons of low-grade mineralized rock may be present. |
| 2 | ----do-------- | Quartz vein about 1,000 ft long and 10 ft wide in McNamara Formation. | ----do------- | 1 grab sample contained 89.7 pct $SiO_2$, 0.34 pct $Fe_2O_3$, and 0.27 pct $Al_2O_3$. No gold or silver detected. |
| 3 | Sanders Lake silica prospect. | Quartz veins in fault zone. | ----do------- | 3 chip samples contained 85.0-89.1 pct $SiO_2$, 0.42-0.85 pct $Fe_2O_3$, and 0.45-2.3 pct $Al_2O_3$. No gold or silver detected. |
| 4 | Index Granite prospect. | In diabase dike---------- | ----do------- | 3 chip samples averaged 1.25 pct titanium. No gold or silver detected. |
| 5 | Looks Grim prospect. | Outside of mapped area. Quartz vein along steep fault that may cut Shepard Formation. | 202-ft-long adit and 22-ft-long adit; and two trenches 40 ft and 10 ft long. | 16 chip samples; only one sample contained metal concentrations of 0.09 pct copper, 0.28 pct lead, and 0.64 pct zinc. |
| 6 | Bonanza Lime prospect. | Quartz and calcite veins in shear zone in diabase. | 212-ft adit, 35-ft caved adit, and 16-ft trench. | 7 chip samples contained 0.1 pct or less copper, lead, and zinc. 3 samples contained a trace, 0.01 oz, and 0.02 oz of gold per ton. |
| 7 | Unnamed prospect. | Limonite-stained shear zone in Bonner Quartzite. | None-------- | None. |
| 8 | ----do-------- | Epidote and quartz veins in shear zone in diabase. | A small prospect pit. | 1 sample contained 0.018 oz of gold per ton; no silver. |
| 9 | Lime Kiln prospect. | Limestone of Silver Hill Formation. | A cut 33 ft long and a lime kiln 20 ft in diameter. | 4 chip samples averaged 88.0 pct $CaCO_3$, 2.5 pct MgO, 5.0 pct $SiO_2$, 1.5 pct $Al_2O_3$, with $Fe_2O_3$ plus $Na_2O$ and $K_2O$ less than 1 pct. Estimated 500,000 tons of limestone. |
| 10 | Frenchman's prospect. | Quartz veins in lower member of Mount Shields Formation. | Caved adit 50 ft long; shaft 35 ft deep and numerous trenches and pits. | 7 samples; one contained 1.4 oz of silver per ton. |

Table 1.--Summary of prospects in and adjacent to the Rattlesnake Roadless Area, Missoula County, Mont., continued

| | | | | |
|---|---|---|---|---|
| 11 | Montana Power Company barite prospect. | A 6.5-ft thick massive barite vein exposed for 11 ft along strike and for 4.5 ft along dip. Vein probably continues along strike and dip beneath cover. Occurs along fault in Garnet Range Formation. | A 220-ft-long bulldozer trench and a 20-ft-long cut. | 3 samples contained 98.9, 95.6, and 94.6 pct barite. About 45 tons of barite exposed in cut. |
| 12 | Holliday prospect. | Limonite-stained quartz vein in Helena Formation. | 2 pits------- | 1 chip sample contained no gold or silver. |
| 13 | Swede prospect. | Pyrite-bearing quartz veins in diabase in upper member of Mount Shields Formation. | 70-ft adit in diabase, caved adit in Mount Shields Formation. | 4 chip samples of quartz veins and diabase contained no gold or silver; 2 samples averaged 0.83 pct titanium. |
| 14 | Unnamed prospect. | Quartz veins and stringers. | None--------- | 1 chip sample contained no gold or silver. |
| 15 | ----do-------- | Quartz veins as much as 5 ft thick in Helena Formation. | 55-ft-long trench. | 1 chip sample contained no gold or silver, but contained 85.9 pct $SiO_2$, 0.76 pct $Fe_2O_3$, 1.2 pct $Al_2O_3$, 2.5 pct CaO, 0.36 pct $K_2O$, and 0.18 pct MgO. |
| 16 | ----do-------- | Quartz vein 2-6 ft wide and about 700 ft long in Helena Formation. | 20-ft by 18-ft pit, 7-ft-long trench and a small pit. | 2 chip samples contained a trace of gold and 0.1 and 0.2 oz silver per ton. |
| 17 | ----do-------- | In Helena Formation------ | 10-ft-long trench and small pits. | 2 samples contained no gold or silver. |
| 18 | ----do-------- | ----do------------------ | 60-ft-long trench. | 1 sample contained no gold or silver. |
| 19 | ----do-------- | Quartz veins in McNamara Formation. | 2 shallow trenches. | 1 sample contained no gold and 0.2 oz of silver per ton. |
| 20 | ----do-------- | Limestone of Silver Hill Formation. | None--------- | 1 chip sample contained 84.4 pct $CaCO_3$, 2.8 pct MgO, 1.0 pct $Fe_2O_3$, 2.6 pct $Al_2O_3$, 5.8 pct $SiO_2$, 0.16 pct $Na_2O$, 0.97 pct $K_2O$, 0.54 pct $SO_4$, and 10.2 pct insoluble residue. |
| 21 | ----do-------- | ----do------------------ | 81- and 38-ft cuts. | 1 chip sample contained 90.6 pct $CaCO_3$, 1.5 pct MgO, 0.71 pct $Fe_2O_3$, 2.0 pct $Al_2O_3$, 4.5 pct $SiO_2$, 0.12 pct $Na_2O$, 1.0 pct $K_2O$, 0.65 pct $SO_4$, and 7.77 pct insoluble residue. |
| 22 | Sheep Mountain prospect. | Replacement barite in Pilcher Quartzite (Nelson and Dobell 1961, p. 209). | None--------- | 2 samples contained 0.03 and 0.24 pct barite. |
| 23 | Juniper prospect. | Malachite and azurite stains in quartz veins in Pilcher Quartzite. | 18-ft-long adit. | 1 sample contained 0.001 pct copper and no gold or silver. |

the Rattlesnake Roadless Area are shown on figure 3. Anomalous concentrations of elements that were located by the geochemical survey are identified with lower case letters that correspond to descriptive data given in table 2. Remaining parts of the Rattlesnake Roadless Area do not have geologic, geochemical, or geophysical characteristics that are indicative of resource potential.

Barite

Barite ($BaSO_4$) is present at two localities in the study area. At the first locality, the Montana Power Company prospect (fig. 1, prospect 11; fig. 3, locality 1), massive barite occurs in a single vein between Pilcher Creek and Fraser Creek (sec. 17, T. 14 N., R. 18 W.). The vein, of unknown length and depth, follows a fracture in the Garnet Range Formation, which is a common host for barite deposits in the region (Berg, 1982). Investigations by the U.S. Bureau of Mines show that the vein is probably bounded by faults on the northwest and southwest sides. The vein is 6.5-ft wide and is exposed for 11 ft along strike and for 4.5 ft down dip. Three samples of vein material have a $BaSO_4$ content of 98.9, 95.6, and 94.6 percent. Johns (unpub. report, 1981) collected 2 samples of barite that have $BaSO_4$ content of 97.9 and 98.4 percent. An estimated 45 tons of barite are exposed at the surface. Because the barite vein is too small, it was not detected by the gravity survey (Kulik, 1983). Heavy-mineral concentrates of stream sediment in Rattlesnake Creek show no prominent anomalies of barium downstream from the vein (Campbell and others, 1981).

A barite occurrence was investigated by the U.S. Bureau of Mines at a second locality, the Sheep Mountain prospect (fig. 1, prospect 22; fig. 3, locality 5), where barite is present in red quartzite of the Pilcher Quartzite. According to Nelson and Dobell (1961, p. 209) barite replaces clastic grains and matrix in small patches as much as 0.2 mm across. Two samples collected by the U.S. Bureau of Mines contained 0.03 and 0.24 percent barite.

Stratabound copper and silver

Copper and silver occurs in slightly metamorphosed green beds of the lower member of the Mount Shields Formation about 0.5 mi southwest of McLeod Peak in the northwest part of the study area (fig. 1, prospect 1; fig. 3, area 2). No excavations or adits are present in the area. Metal-bearing minerals are disseminated in discrete beds of siltite and very fine grained quartzite that range in thickness from 0.1 to 1 in. These siltite and quartzite beds are interlayered with thinly laminated greenish-gray argillite and greenish-tan siltite. Dolomite cement occurs in the rusty-weathering siltite and fine-grained quartzite beds. Very fine grained pyrite and bornite are disseminated through dolomite-cemented clastic rocks, which commonly have crusts of secondary copper-carbonate minerals, such as malachite, on bedding or joint surfaces. Individual beds containing sulfide minerals are lenticular and generally can be traced laterally for only a few tens of yards. The mineralized zone within the green-bed sequence persists along strike for about 600 ft, is a maximum of about 4.0 ft thick, and averages about 2.5 ft thick. The U.S. Bureau of Mines estimates that about 38,000 tons of mineralized rock are present, and this zone contains about 0.55 percent copper and 0.2 oz of silver per ton.

Anomalous concentrations of silver, copper, manganese, and bismuth are present in rock samples near the stratabound occurrence and in a stream-sediment sample taken in the cirque basin southeast of locality 1 (fig. 3). This suite of anomalous elements is similar to that described by Harrison and Grimes (1970) for other stratabound copper and silver occurrences.

The stratabound copper and silver occurrence has no expression on the aeromagnetic or Bouguer gravity map (Kulik, 1983); the absence of geophysical expression is typical because stratabound occurrences are not enriched with magnetite with respect to host beds, and sulfide minerals are not concentrated enough to produce a density contrast with host rocks of similar composition. A weak negative magnetic anomaly is located about 0.7 mi northwest of the stratabound occurrence, outside of the roadless area boundary, and this anomaly may be the result of a dipole effect related to positive magnetic anomalies C and D discussed by Kulik (1983).

Diabase dikes and sills

Three areas of geologic, geochemical, and geophysical anomalies (fig. 3, areas 4a, 4b, and 4c) are underlain by exposed diabase dikes and sills or by covered diabase bodies.

Diabase dikes and sills exposed in the study area exhibit little surface indication of mineralized ground. Numerous prospects are located in exposed parts of diabase bodies. Geochemical data obtained from stream-sediment sampling in Butler and Grant Creeks (area 4a) show anomalous concentrations of titanium, manganese, chromium, zirconium, cobalt, vanadium, niobium, and zinc, (Campbell and others, 1981). These anomalous concentrations are downstream from exposures of diabase dikes and sills, and the anomalies are not present upstream from these dikes and sills. The concentrations of titanium, manganese, chromium, zirconium, cobalt, vanadium, niobium, and zinc obtained from dikes and sills in the study area are typical of other diabase-diorite-gabbro dike and sill complexes in this region (J. E. Harrison, U.S. Geological Survey, oral commun., 1982). Associated with exposures of diabase dikes and sills in area 4a (fig. 3) are pronounced, elongate positive magnetic anomalies (Kulik, 1983). Gravity data, however, do not show a strong contrast between diabase intrusions and host rocks, and according to Kulik (1983) the gravity signature may be that of the underlying crystalline basement.

Heavy minerals from the diabase have been concentrated in stream deposits (fig. 3, area 7) and give slightly higher concentrations of titanium, manganese, copper, zirconium, and zinc downstream from exposures of diabase. Placers that may have concentrated titanium-bearing minerals would be very low grade. No gold was detected; consequently, stream deposits were not evaluated further.

An elongate positive magnetic anomaly (fig. 3, area 4b) is associated with three isolated anomalous concentrations of titanium, copper, and gold. This magnetic anomaly corresponds to anomalies C and D of Kulik (1983) in the Wrangle Creek drainage. In area 4b there are no surface indications of mineralized rock or intrusive bodies and no gravity anomalies. The magnetic anomaly and the anomalous concentrations of titanium and copper may be related to a covered intrusion, and, on the basis of similarity of the northwest trend and on the high concentration of titanium, a covered diabase dike or sill is the most likely type of intrusion to produce these features. The high anomalous concentration of gold associated with the positive magnetic anomaly could be fortuitous because the anomaly was obtained from a pan concentrate, and gold could have been derived from a quartz vein located upstream or from detrital gold in rocks of the Belt Supergroup.

Near Triangle Peak, along the north border of the study area another northwest-trending, elongate positive magnetic anomaly (fig. 3, area 4c) is present (anomaly E of Kulik, 1983). This magnetic anomaly has no accompanying gravity anomaly or anomalously high concentrations of elements associated with it. It is likely that a covered diabase dike or sill causes this magnetic anomaly.

### Limestone, silica, and sand and gravel

Limestone of the Silver Hill Formation is exposed at three locations (fig. 3, area 3) in the study area; the Lime Kiln prospect (fig. 1, prospect 9) is located at the northernmost limestone exposure. Analytical data obtained by the U.S. Bureau of Mines suggest that the quality of this deposit is marginal for use as cement (table 1, prospect 9). About 500,000 tons of limestone is estimated for the exposure near the Lime Kiln prospect; no estimates of tonnage are available for the other two limestone occurrences.

Silica is present as large quartz veins at two localities in the study area (fig. 1, prospects 2 and 3; fig. 3, locality 6). At prospect 2 near the northwest boundary of the study area, a quartz vein that is about 1,000 ft long and 10.0-ft wide fills an apparent fracture in the McNamara Formation. Near Sanders Lake at prospect 3 numerous quartz veins are present in a fault zone that is approximately 2 mi long. The fault zone is composed mainly of crushed quartzite; segments of the zone are filled with impure quartz veins. Individual quartz veins within the fault zone are as much as 12.2 ft wide and as much as 127 ft long. Numerous smaller, discontinuous quartz veins are scattered throughout the study area.

Sand and gravel occur in most drainages in the study area; the resource potential of surficial deposits was not evaluated.

### Isolated, single-element anomalies

Geochemical sampling located 18 sites that have high anomalous concentrations for some elements (table 2). Geologic evidence of mineralized rock is generally lacking; aeromagnetic and gravity data do not suggest the presence of buried intrusive bodies of significant size that could produce these isolated anomalous concentrations. Geologic studies did not locate vein sources for most of these anomalies, and therefore if vein sources exist, they are probably small and discontinuously exposed.

Three groups of isolated anomalies show a sequence of anomalous elements that could result from local vein sources: (1) Silver occurs in the drainage of West Twin Creek (samples d, e, and f, table 2 and fig. 3); (2) Copper and silver occur in the area of McLeod Peak (samples j and k, table 2 and fig. 3); and (3) titanium, manganese, copper, niobium, and cobalt occur northwest of Triangle Peak (samples l and n, table 2 and fig. 3). The distribution of silver suggests the occurrence of a vein source in the head of the Twin Creek drainage. However, anomalously high concentrations of other elements have not been detected from pan concentrates, and therefore, these anomalies probably do not result from a prominent vein system. Copper and silver concentrations near McLeod Peak are probably related occurrences similar to the stratabound copper occurrences of area 2 (fig. 3). The high concentration detected from the pan concentrate sample k was probably derived from the stratabound deposit of area 2, whereas the anomaly detected from the rock sample j may reflect another small, discontinuous copper concentration in the Mount Shields Formation. Titanium, manganese, copper, niobium, and cobalt anomalies probably result from the occurrence of diabase dikes or sills. No dike was mapped in the area of sample l, but sample n is located adjacent to a geophysical anomaly that suggests the presence of a covered diabase dike. The geochemical signature of the diabase intrusions is unique, and the possibility that some other type of mineralized body could produce this suite in these concentrations is remote.

## ASSESSMENT OF RESOURCE POTENTIAL

### Minerals

Known resources of barite, copper and silver, and limestone are present in the study area. The barite vein at locality 1 (fig. 3) contains an estimated 45 tons of high-purity barite exposed at the surface; extensions of the vein may be concealed by colluvium and country rock. Copper and silver resources are present in a small stratabound occurrence (fig. 3, locality 2) that may contain 38,000 tons of rock that averages 0.55 percent copper and 0.2 oz of silver per ton. Limestone near the Lime Kiln prospect (fig. 1, prospect 9), contains about 500,000 tons of rock that is of marginal grade for use in cement manufacture. Limestone occurrences, which are probably of marginal grade, are known in two other areas about 5 mi southeast of the Lime Kiln prospect; no estimate of tonnage was made for these occurrences.

Sand and gravel occur in most drainages of the study area, but these resources were not evaluated during this study.

Titanium, barite, metals associated with sulfide-bearing veins, silica, heavy-mineral placers, and sand and gravel are present in the study area. Area 4a (fig. 3) has a low potential for the occurrence of a low-grade resource of titanium in exposed diabase. A low potential for the occurrence of a low-grade resource of titanium in possible covered diabase is assigned to areas 4b and 4c (fig. 3). The low potential for the occurrence of a resource of barite near Sheep Mountain (fig. 1, prospect 22; fig. 3, locality 1) is based on the low concentration of barite in the rock and on the apparent disseminated occurrence of barite. Isolated anomalies of silver, gold, copper, zinc, and lead suggest the occurrence of

## EXPLANATION OF MINERAL RESOURCE POTENTIAL

AREAS OR LOCALITIES OF KNOWN MINERAL OCCURRENCE

$\boxed{1}$ Barite vein, prospect 11

$\boxed{2}$ Stratabound copper and silver, prospect 1

$\boxed{3}$ Limestone, and prospect 9

AREAS OR LOCALITIES WITH LOW POTENTIAL FOR OCCURRENCE OF RESOURCES

4a Titanium in exposed diabase

4b Titanium in possible covered diabase

4c Titanium in possible covered diabase

5 Disseminated, low-grade barite, prospect 22

6 Silica in fracture zones, prospects 2 and 3

7 Titanium in possible placers

•a Site of single, isolated geochemical anomaly described in table 2

x-9 Prospect described in table 1

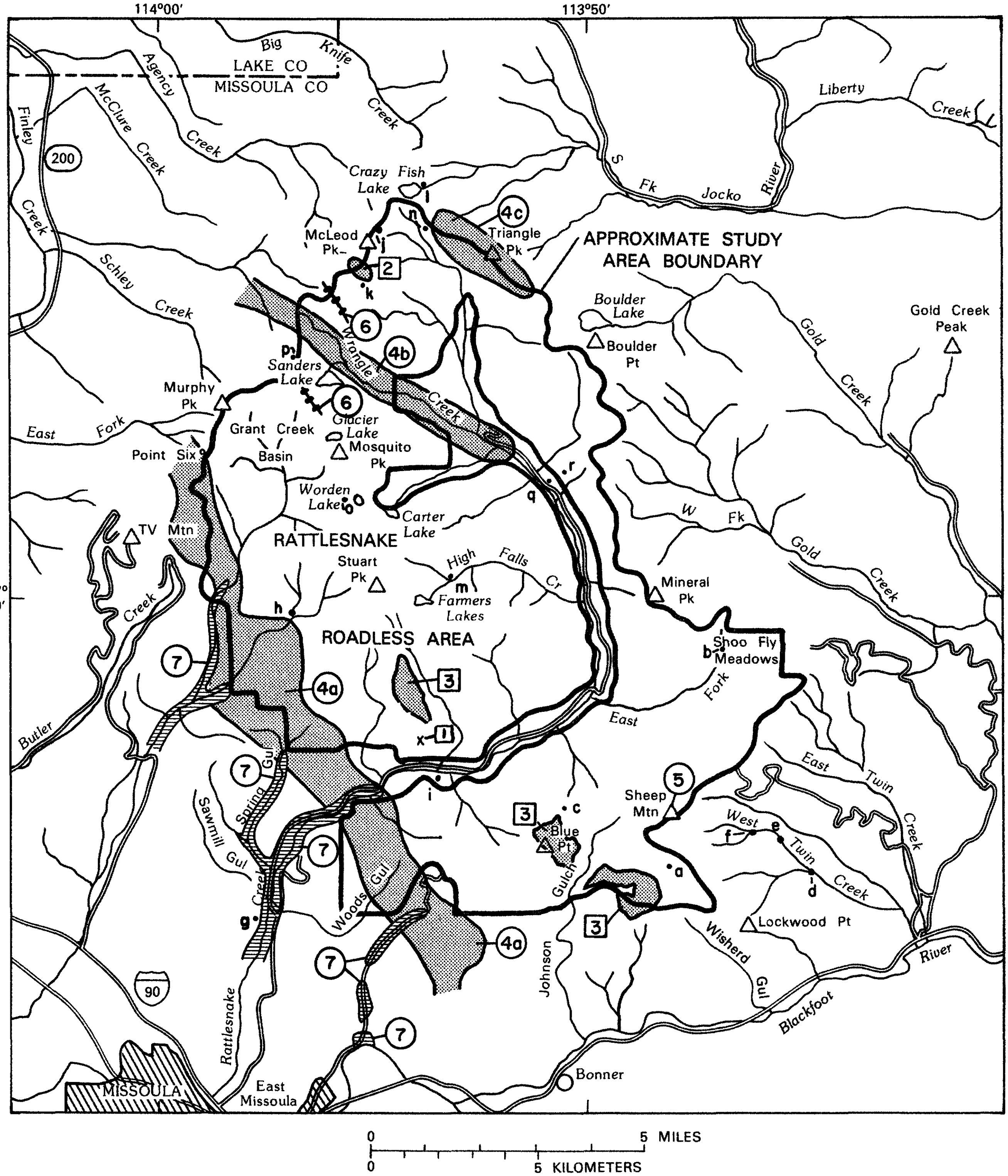


**Figure 3.—Generalized map showing mineral resource potential and sample localities in the Rattlesnake Roadless Area, Mont.**

Table 2.--Single, isolated geochemical anomalies in the Rattlesnake Roadless Area

| Sample location figure 3 | Sample number | Sample type | Anomalous value | Probable origin of anomaly |
|---|---|---|---|---|
| a | BLP 0041R | Rock------------- | Zr >1,000 ppm--- | Heavy mineral lamination in quartzite of Garnet Range Formation. |
| b | BLP 0205P | Pan concentrate-- | Au--0.08 ppm---- | Possibly related to quartz veins; no other anomalies in drainage. |
| c | BLP 0435S | Soil------------- | Ag--20 ppm------ | May be related to isolated vein occurrence; no other anomalies associated with occurrence. |
| d | BLP 1488P | Pan concentrate-- | Ag--2 ppm------- | Possible vein source in head of West Twin Creek. Concentrations low and associated suite of anomalous elements not detected, which suggests the anomaly source is isolated and not part of a larger mineralized system. |
| e | BLP 1492P | ----do----------- | Ag--1 ppm------- | |
| f | BLP 1496P | ----do----------- | Ag--1 ppm------- | |
| g | NEM 0613R | Rock------------- | Cu--160 ppm----- | Possible primary or secondary mineralization in Belt rocks. Isolated occurrence. |
| h | NEM 0811S | Stream sediment-- | Zn--200 ppm----- | Possible vein source. No other anomalous elements detected; anomaly is an isolated occurrence. |
| i | NEM 1940S | ----do----------- | Zn--500 ppm----- | Do. |
| j | STU 0016R | Rock------------- | Ag--0.91 ppm----<br>Cu--140 ppm | Probably associated with stratabound copper occurrence in Mount Shields Formation. These occurrences are low grade and small in volume. |
| k | STU 0022S | Stream sediment-- | Cu--100 ppm----- | |
| l | STU 0257P | Pan concentrate-- | Ti--2 percent---<br>Mn--3,000 ppm<br>Cu--150 ppm<br>Nb--50 ppm | Proterozoic diabase dike or sill probable source of anomaly. Concentrations of elements typical of other diabase intrusives. |
| m | STU 0267P | ----do----------- | Ag--7 ppm------- | Possible vein source. No other anomalous elements detected; anomaly is an isolated occurrence. |
| n | STU 0283R | Rock------------- | Ti >1.0 percent-<br>Cu--130 ppm<br>Co--50 ppm | Proterozoic diabase dike or sill probable source of anomaly. Concentrations of elements typical of other diabase intrusives. |
| o | STU 0643R | ----do----------- | Y--300 ppm------ | Possible vein source. No other anomalous elements detected; anomaly is an isolated occurrence. |
| p | STU 0803R | ----do----------- | Pb--100 ppm----- | Possible sulfide-bearing vein source. No other anomalous elements detected. |
| q | WLA 0634P | Pan concentrate-- | Mo--10 ppm------ | Possibly related to stratabound copper occurrence near McLoed Peak. No other anomalous elements detected; anomaly is an isolated occurrence. |
| r | WLA 1852S | Soil------------- | Pb--100 ppm----- | Possible sulfide-bearing vein source. No other anomalous elements detected; anomaly is an isolated occurrence. |

small, sulfide-bearing veins in the study area, but the low concentrations of metals, the general absence of suites of metals in samples, and the failure to find metal-bearing veins during field investigations suggest that the potential for occurrence of metallic mineral resources in sulfide-bearing veins is low. Silica is present as discontinuous quartz veins in fracture zones at two localities (fig. 1, prospects 2 and 3; fig. 3, locality 6). Tonnage and grade were not determined for the silica; a low potential for occurrence of a resource of silica in veins is assigned to these fracture zones. Concentrations of titanium, cobalt, zirconium, and other elements associated with the exposed diabase occur in stream deposits below the diabase. The study area is assigned a low potential for the occurrence of a low-grade titanium resource in stream deposits.

### Energy resources

The potential for the occurrence of coal, oil, and gas resources is low for the entire study area. The potential for occurrence of resources of geothermal energy or radioactive minerals is not known. Coal resources (lignite) occur in the Hellgate mine, which is located southwest of the southwestern boundary of the study area. The mine is currently inactive, and it is unlikely that coal beds extend into the study area because Tertiary lake and shore-line deposits that contain coal do not extend into the study area. The potential for the occurrence of oil or gas in the study area can only be tentatively assessed because seismic and drill-hole data are lacking, and because structural interpretations are based solely on surface geology. Regional geologic data (Wallace and others, 1981) and structural interpretations of the study area (Wallace and Lidke, 1980) suggest that source rocks for hydrocarbons are not present beneath the Rattlesnake thrust plate, which occurs in the southwest part of the study area. It is unlikely that Proterozoic rocks could have generated and preserved oil or gas. Moreover, much of the area is underlain by old rocks that are metamorphosed to chlorite-biotite grade, which is not a common environment for generation, preservation, or entrapment of oil and gas. The potential for resources of radioactive minerals was not evaluated during field studies, but regional interpretations suggest the rocks of the Belt Supergroup are unlikely hosts for uranium mineralization. Characteristic associations of hot springs and young igneous rocks are not known from the area, and heat-flow data were not collected during this study. The potential for occurrence of geothermal resources is not known.

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