STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

CABINET MOUNTAINS, MONTANA

GEOLOGICAL SURVEY BULLETIN 1501

Mineral Resources of the Cabinet Mountains Wilderness, Lincoln and Sanders Counties, Montana

By U.S. Geological Survey and U.S. Bureau of Mines

STUDIES RELATED TO WILDERNESS—WILDERNESS AREAS

GEOLOGICAL SURVEY BULLETIN 1501

An evaluation of the mineral potential of the area

Summary and Chapters A through D

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STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

Under the Wilderness Act (Public Law 88-577, Sept. 3, 1964) certain areas within the national forests previously classified as "wilderness," "wild," or "canoe" were incorporated into the National Wilderness Preservation System as wilderness areas. The act provides that the U.S. Geological Survey and the U.S. Bureau of Mines survey these wilderness areas to determine the mineral values, if any, that may be present. The act also directs that results of such surveys are to be made available to the public and submitted to the President and Congress. This report discusses the results of a mineral survey of the Cabinet Mountains Wilderness, Lincoln and Sanders Counties, Montana.

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MINERAL RESOURCES OF THE CABINET MOUNTAINS WILDERNESS, LINCOLN AND SANDERS COUNTIES, MONTANA

By U.S. Geological Survey and U.S. Bureau of Mines

SUMMARY

The results of a mineral survey of the Cabinet Mountains Wilderness, an area of about 150 mi^2 (380 km^2) in northwestern Montana, indicate areas of high potential for deposits of copper and silver. The area has moderate potential for lead, zinc, and gold, and little or no potential for other metals, fossil fuels, or geothermal resources. The mineral resource potential of the area was evaluated by detailed examination of mines and mining claims, by geologic mapping, and by geochemical, aeromagnetic, and gravity surveys.

Geologic mapping has established some important stratigraphic and structural controls on the mineral resources of the Cabinet Mountains Wilderness area. Most of the area is underlain by more than 27,000 ft (8,200 m) of metasedimentary rocks of the Belt Supergroup of Precambrian Y age. The Revett Formation, a thick quartzite-bearing unit in the middle of the Belt Supergroup, crops out extensively in the southwestern part of the area where it is an important host for copper-silver deposits. Stocks and dikes of granodiorite and quartz monzonite of Cretaceous age intrude the Belt rocks. Although similar stocks are mineralized in other areas, the igneous rocks of the Cabinet Wilderness do not appear to be associated with mineral deposits. The Precambrian rocks have been folded and offset by high-angle and thrust faults along a north-northwest trend. Some of the high-angle faults, particularly the Snowshoe and Rock Lake faults, were important in localizing mineralization. Aeromagnetic low anomalies along some faults indicate extensive zones of possible altered and mineralized rocks. Surficial glacial deposits, talus, and alluvium are present in the valleys.

County records show that about 300 mining claims or claim groups have been located within and along the boundary of the wilderness between 1882 and 1973, mostly between 1890 and 1930. No patented claims are in the wilderness. Most claims are along the Snowshoe fault near the eastern boundary and around Rock Lake. Recent exploration for copper has resulted in additional claims in the Rock Creek area.

Although no production has been recorded from the Cabinet Mountains Wilderness, mineral production since 1902 from mines within 5 mi (8 km) of the wilderness boundary has totaled 431,375 tons (391,343 t) of ore containing 12,522 oz (389,472 g) gold, 311,149 oz (9,677,677 g) silver, 8,952,999 lb (4,061,080 kg) lead, 25,459 lb (11,548 kg) copper, and 322,964 lb (146,496 kg) zinc. Output prior to 1902 is not recorded by the U.S. Bureau of Mines, but placer gold production was reportedly valued at over $100,000.

Five areas of mineral potential in and near the wilderness were identified by geologic mapping, geophysical and geochemical surveys, and detailed examination of mines and known mineral occurrences (fig. 1). These are (1) an area of copper- and silver-bearing zones in the Revett Formation, (2) an area of lead, zinc, and silver veins and geochemical anomalies along the Snowshoe fault, (3) an area of small mineral occurrences and low-level silver anomalies in soil in the northern part of the wilderness, (4) an area of gold-bearing quartz veins along the Rock Lake fault, and (5) an area of scattered gold- and sulfide-bearing quartz veins southeast of the wilderness.

Exploration by private industry in the 1960's resulted in the discovery of stratabound deposits of disseminated copper and silver in the quartzite beds of the Revett Formation at several locations in northwestern Montana. One of these is along the wilderness boundary north of Rock Creek where mineralized rock crops out within the wilderness. Exploratory drilling by industry just outside the wilderness has revealed that an area of about 0.5 mi² (1.3 km²) contains 4 million tons (3.6 million t) of indicated reserves with an average of 0.86 percent copper and 1.8 ounces of silver per ton (61.7 g/t), and indicated submarginal resources of 20.6 million tons (18.7 million t) averaging 0.29 percent copper and 0.4 ounces of silver per ton (13.7 g/t).

A geochemical survey of rock, soil, and stream sediments indicates that four copper-bearing zones are present in the Revett Formation north of Rock Creek and that some of these zones extend a distance of about 3 mi (5 km) into the wilderness (fig. 1, area 1). Analyses of chip and core samples show that a copper zone 34 ft (10.4 m) thick extends into the wilderness area and contains about 70 million tons (63.5 million t) of inferred subeconomic resources. Down-dip projection of the

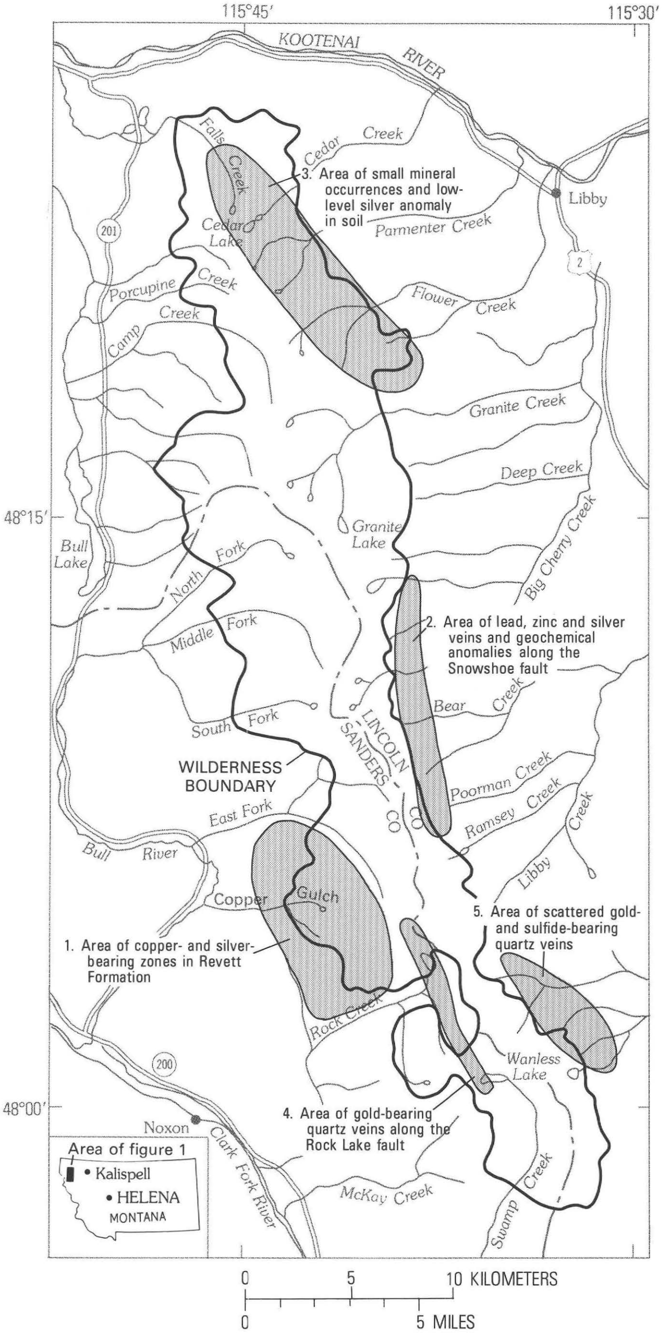

FIGURE 1.—Index map showing areas of mineral potential, Cabinet Mountains Wilderness, Mont.

copper-bearing zones to the north and west of the drilled area indicate that possibly 10 mi^2 (25 km^2), much of it in the wilderness, may contain significant resources of copper and silver. This area of potential is about 20 times as large as the area already drilled; therefore, even if only a fraction of the area is mineralized, hypothetical resources could be substantial. Drilling in the wilderness would be necessary to prove the extent of mineralized rock.

Mines along the east side of the wilderness are associated with generally narrow and discontinuous sulfide-bearing veins in and near the north-northwest-trending Snowshoe fault (fig. 1, area 2). Geochemical anomalies outline the area of mineralized rock, most of which is outside the wilderness. One area on Poorman Creek, which crosses the wilderness boundary, may have inferred subeconomic resources of 500,000 tons (453,600 t) of rock containing lead and silver.

An area of small mineral occurrences (copper, silver, and tungsten) and widespread low-level silver anomalies in soils is in the northern part of the wilderness (fig. 1, area 3). This area probably has little mineral resource potential. None of the mineral occurrences contain significant resources, and the low-level silver anomalies in soil are probably derived from small copper-silver occurrences in argillite.

The likelihood of finding economic deposits of gold in the wilderness is fair. Gold-bearing veins associated with the Rock Lake fault (fig. 1, area 4), such as those at the Heidelberg Mine, may extend into the wilderness. Gold is widespread in veins and placers southeast of the wilderness (fig. 1, area 5), but this area does not extend far into the wilderness. The volume of gold-bearing rock in most veins is probably small.

Neither petroleum nor coal nor any evidence of geothermal energy exists in or near the wilderness.

INTRODUCTION

LOCATION AND GEOGRAPHY

The Cabinet Mountains Wilderness covers 94,274 acres (38,150 hectares)[1] or about 150 mi^2 (380 km^2) in the Kootenai and Kaniksu National Forests, Lincoln and Sanders Counties, northwestern Montana (fig. 1). The wilderness extends 34 mi (55 km) along the crest of the eastern part of the Cabinet Mountains; its average width is about 4 mi (7 km). The ridges commonly have an altitude of more than 7,000 ft (2,100 m), and the highest peak has an elevation of 8,634 ft (2,633 m). The valley floors range in altitude from 2,000 ft (600 m) to 2,300 ft (700 m).

The crest of the range is extremely rugged in places and accessible only by a few trails. Timberline is at about 7,000 ft (2,100 m), and the forests are dense below that elevation. Valleys are steep and commonly choked with vegetation. Cirques with high walls at the heads of most of the valleys were formed during the last Pleistocene glaciation. Many of the cirque basins contain lakes that are fed by water from melting snow fields. Streams form spectacular waterfalls over rock ledges above and below some of the lakes.

Access to the wilderness area is by U.S. Highway 2, which passes through the town of Libby, State Highway 200 along the Clark Fork River, and State Highway 202 along the Bull River. Good gravel roads extend along some streams nearly to the wilderness boundary. A trail extends from the boundary up Cedar Creek, over William Grambauer Mountain, and down to the northwest corner of the area; and other trails extend up Parmenter Creek, Flower Creek, Granite Creek, North, Middle, and South Forks of Bull River, Copper Gulch, Swamp Creek, and McKay Creek. Many trails extend over the crest of the range where they connect with trails from the other side.

PREVIOUS STUDIES

The first reconnaissance geologic mapping of the Cabinet Mountains and northwestern Montana was by Calkins (1909) and included notes on the economic geology by MacDonald. Gibson (1948) mapped geology and investigated mineral deposits in the Libby quadrangle. Johns (1970) described the geology and mineral deposits of Lincoln and Flathead Counties, and summarized much of the data presented by earlier investigators. Crowley (1963) described mines and mineral deposits in Sanders County. The Bear Creek Mining Co. (oral com-

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[1]Measurements and values in this report were made or computed in inch-pound units; the metric units are mathematical equivalents.

mun., 1973) made geochemical surveys and drilled the strata-bound copper deposits at the west edge of the study area.

PRESENT STUDIES AND ACKNOWLEDGMENTS

Results of this study first appeared as an open-file report by Lindsey and others (1978). Geologic field work was done by the U.S. Geological Survey in July and August 1972 by John D. Wells, David A. Lindsey, and Richard E. Van Loenen, assisted by James E. Quick, Lee M. Osmonson, and Robert E. Ladd. The work was done by foot traverses from nearby roads and by helicopter. Reconnaissance geologic mapping was done, and geochemical samples of stream sediments and soils and rocks were collected. Most of the spectrographic and chemical analyses were made in mobile labs by J. A. Domenico, J. G. Frisken, and R. T. Hopkins, assisted by D. McQueen. The remainder of the analytical work was done in the U.S. Geological Survey laboratories in Denver. An airborne magnetometer survey at 1-mi (1.6-km) spacing was made in 1968 by Lockwood, Kessler, and Bartlett, Inc., under contract to the U.S. Geological Survey, and a gravity survey was completed by M. Dean Kleinkopf in 1972.

Investigations by the U.S. Bureau of Mines were made during the 1972, 1973, and 1974 field seasons. Courthouse records of Lincoln and Sanders Counties at Libby and Thompson Falls, Mont., were searched for claim locations. Production records are mostly from Bureau of Mines unpublished statistical files compiled from 1902 to the present; other sources are acknowledged. Appraisal of the mineral potential of the area was made by mapping and sampling of individual mines and prospects.

About 11 man-months were spent in the field by Bureau of Mines personnel, particularly by D'Arcy Banister, assisted by Steven Schmauch in 1972 and William Marratt in 1973. Robert Weldin, Steven Schmauch, Ronald Van Noy, and Nicholas Zilka completed the investigation in 1973 and 1974. Dean C. Holt supervised laboratory work on placer samples, and the Bureau's analytical work was directed by H. H. Heady, Bureau of Mines, Reno, Nev.

Many people aided this study. We thank George Mart, Robert Damon, and Paul Barker of the Kaniksu and Kootenai supervisors' offices and the several district rangers. We particularly thank the personnel of the Bear Creek Mining Co. and American Smelting and Refining Co. for information about the Rock Creek copper deposit, and we thank Ray Lasmanos of the Superior Mining Co. for conducting a field trip in the area to familiarize us with strata-bound copper deposits.

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Geology of the Cabinet Mountains Wilderness, Lincoln and Sanders Counties, Montana

By JOHN D. WELLS, DAVID A. LINDSEY, *and*
RICHARD E. VAN LOENEN, U.S. GEOLOGICAL SURVEY

MINERAL RESOURCES OF THE CABINET MOUNTAINS WILDERNESS, LINCOLN AND SANDERS COUNTIES, MONTANA

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GEOLOGY OF THE CABINET MOUNTAINS WILDERNESS, LINCOLN AND SANDERS COUNTIES, MONTANA

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GEOLOGIC SETTING

The Cabinet Mountains Wilderness is underlain by metasedimentary rocks of the Belt Supergroup of Precambrian Y age (pl. 1). These rocks form a north-trending range of folded metasedimentary rocks that is bounded on the east and west sides by high-angle faults. The range is tilted generally northward: younger beds crop out in the northern part of the area and older beds crop out in the southern part. All of the Belt rocks in the area have been metamorphosed to greenschist facies.

Igneous rocks of at least two ages intrude the Belt Supergroup. Mafic sills of Precambrian Y age intrude the Wallace, Burke, and Prichard Formations. A granodiorite and quartz monzonite stock of Cretaceous age crops out on Dry Creek (pl. 1) in the central part of the area; small satellitic plutons are present also. A small syenite dike occurs in the northern part of the area. Contact metamorphic rocks were formed adjacent to the plutons, particularly along the Dry Creek stock where the metamorphic halo is as much as 2 mi (3 km) wide.

An extensive period of glaciation and erosion in the Pleistocene Epoch followed uplift of the Cabinet Mountains. Glacial striations on ridges indicate that ice once covered all but the highest peaks of the range. Rock debris dislodged by the glaciers covers most of the valley bottoms. Streams have reworked much of the glacial drift to form the present alluvial valleys. Talus and rock slides cover many of the steep slopes.

PRECAMBRIAN Y ROCKS

The Belt Supergroup in the Cabinet Mountains consists of seven formations (pl. 1) whose total thickness exceeds 27,000 ft (8,200 m). From oldest to youngest, these formations are the Prichard (mainly argillite and siltite); the Burke (mainly siltite); the Revett (mainly quartzite and siltite); the St. Regis (siltite and argillite); the Wallace (argillite, siltite, and dolomite); the Striped Peak (argillite, siltite, and quartzite); and the Libby (mainly argillite). The lowermost part of the Prichard Formation and the upper part of the Libby Formation are not exposed in the wilderness.

The Belt Supergroup is metamorphosed to the greenschist facies; and the terms argillite, siltite, and quartzite are used herein to denote metasedimentary rocks consisting mainly of clay-, silt-, and sand-sized particles, respectively. The grade of metamorphism increases from north to south so that chlorite and sericite are abundant in the north and biotite and coarse-grained muscovite are abundant in the south. Biotite porphyroblasts are conspicuous in argillite in the southern part of the wilderness. In addition, rocks of the Belt Supergroup have been locally metamorphosed by intrusive activity of Cretaceous age. The most conspicuous effects of contact metamorphism are in the Wallace Formation where tremolite occurs for 2 mi (3 km) east of the Dry Creek stock.

Mafic sills of Precambrian Y age are found in the Wallace Formation along the east side of the wilderness. Thin baked zones occur in the Wallace Formation next to the sills, and the sills themselves have been altered by regional metamorphism.

PRICHARD FORMATION

The Prichard Formation crops out in the southeastern, southern, and southwestern parts of the study area, where only the upper 1,700 ft (520 m) are exposed. The exposed section consists predominantly of black and white laminated argillite that shows a characteristic rusty weathering and has interbeds of gray siltite a few centimeters thick. Massive white siltite beds occur locally. The formation is commonly phyllitic and shows cleavage near faults. Graded bedding is common and ripple marks are present locally. Pyrrhotite(?) and biotite porphyroblasts are commonly seen with the aid of a hand lens.

The Prichard Formation as mapped in the Cabinet Mountains corresponds to the middle member of Harrison and Jobin (1963, p. K8–K10). Their lower member is not exposed, and their upper member, composed of argillite and siltite, is included in the Burke Formation in this report.

BURKE FORMATION

The Burke Formation crops out in a strip along the southwest side and in the southern parts of the study area (fig. 2*A*). The formation is about 4,800 ft (1,500 m) thick; it consists predominantly of gray to light-gray siltite in tabular beds as much as 1.5–3 ft (0.45–0.90 m) thick, interbedded with dark-gray laminated argillite and silty argillite. The beds are laminated and some contain ripple marks and mud cracks. Small euhedral magnetite grains are conspicuous; micaceous and calcareous beds are present locally. In the middle part of the formation, beds 20–30 ft (6–9 m) thick of tan-weathering, gray-green argillite contain pyrite cubes.

The lower 600 ft (180 m) or more of the Burke Formation is a zone of transition between the lithologies of the Burke and those of the Prichard. Rocks equivalent to this zone were mapped as the upper member of the Prichard Formation by Harrison and Jobin (1963, p. K10). The transition zone contains gray siltite with graded bedding, unevenly bedded silty argillite, and laminated black and white argillite similar to that in the Prichard Formation. The upper contact with the Revett Formation is transitional over about 200 ft (60 m). The transition zone consists of light-gray, coarse-grained siltite and fine-grained quartzite interbedded with as much as 50 ft (15 m) of gray-green silty argillite. The quartzite contains planar lamination, crossbedding, and ripple marks.

REVETT FORMATION

The Revett Formation forms prominent ledges where it crops out in the southwestern part of the wilderness study area (fig. 2*B*), in small patches along the southern part of the Snowshoe fault, and in the east-central part of the area. Estimates of the thickness of the formation range from 1,500 ft (460 m) to as much as 2,600 ft (790 m); it consists of three quartzite members separated by two argillite and siltite members. At Rock Peak, the lower quartzite member is about 1,000 ft (300 m) thick; the middle quartzite about 150 ft (46 m) thick; and the upper quartzite about 200 ft (60 m) thick. The lower argillite is 70 ft (20 m) thick and the upper argillite is about 80 ft (25 m) thick. The top of the Revett is distinct, the contact being placed at the top of the uppermost thick quartzite beds, but the lower contact with the Burke Formation is transitional and difficult to place in the field. The definition and subdivision of the Revett used in this report do not conform to that of Harrison and Jobin (1963) and Earhart (1976), who estimated the formation to be 2,000 ft (600 m) and 2,323 ft (708 m), respectively, in the regions west of the Cabinet Mountains Wilderness. It is possible that some of the Burke Formation as defined in

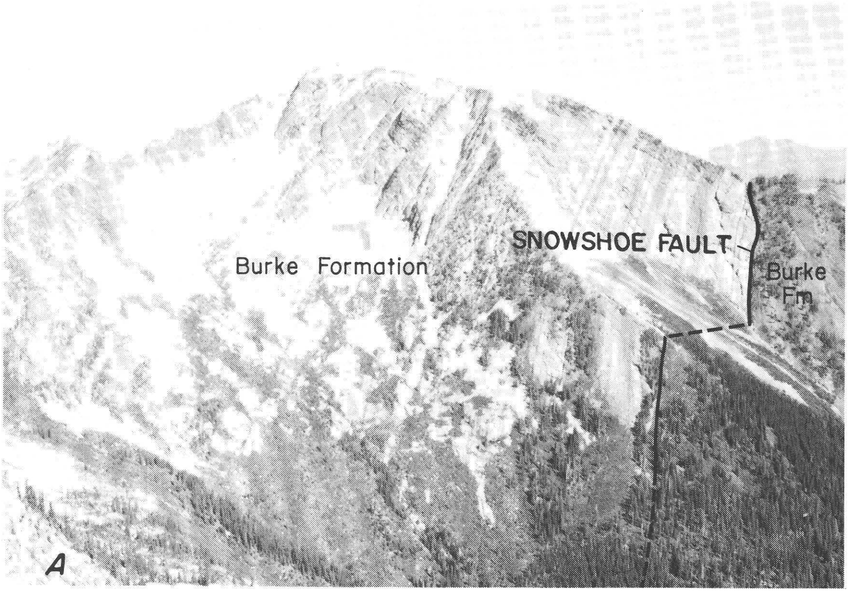


FIGURE 2.—Some geologic features of the Cabinet Mountains Wilderness area. *A*, Argillite and siltite of the Burke Formation exposed on both sides of the Snowshoe fault, a major boundary fault along the east side of the Cabinet Mountains. *B*,

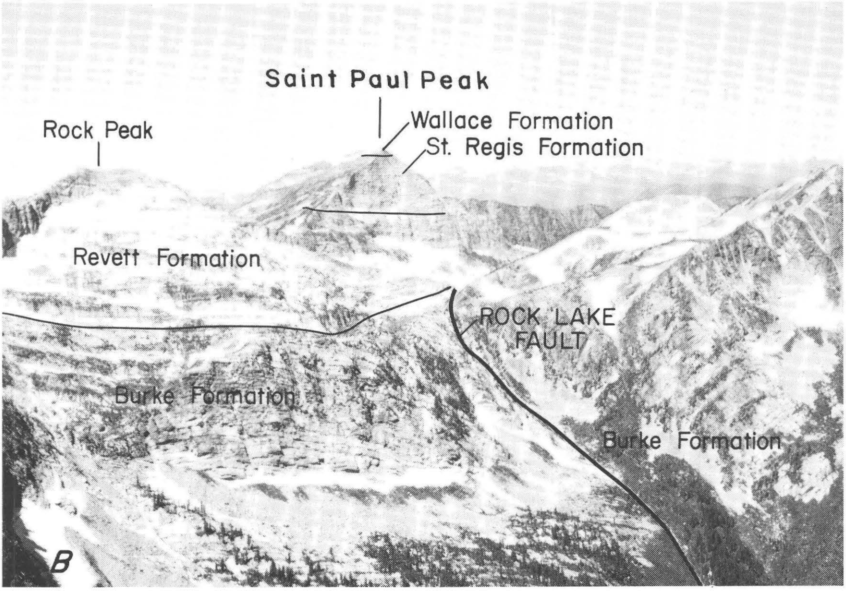
this report includes rocks that have been assigned to the Revett by others.

The quartzite units are typically white to light gray but commonly show purple hues; they are medium to fine grained, and thin interbeds of siltite and silty argillite occur throughout. Individual quartzite beds commonly exceed 10 ft (3 m) thick and range from massive to laminated and crossbedded. Dark laminations formed by concentrations of heavy minerals are common. Ripple marks and mud cracks are mainly in silty and argillitic units. Euhedral magnetite and carbonate minerals that weather brown are common.

The copper deposit on Rock Creek is in the upper part of the lower quartzite unit of the Revett Formation. Here the rock weathers brown and contains small grains of iron oxide after iron-copper sulfide minerals; magnetite grains are lacking. The weathered surface of the outcrop is leached of all copper, but joint surfaces several centimeters below show malachite and azurite coatings.

ST. REGIS FORMATION

The St. Regis Formation crops out in the southwestern part of the area; a well-exposed section is on Saint Paul Peak (fig. 2*B*). The St. Regis is about 500 ft (150 m) thick and consists predominantly of



Copper-bearing quartzite of the Revett Formation east of the Rock Creek mineralized area. Section of St. Regis argillite and siltite capped by dolomite of the Wallace Formation is exposed on Saint Paul Peak.

gray to purplish-gray, thin-bedded to laminated siltite; interbedded silty argillite; and unevenly bedded, laminated, greenish-gray argillite in units a few meters to a few tens of meters thick. The lower contact is at the top of the uppermost thick quartzite beds in the Revett Formation, and the upper contact is below the first prominent dolomite beds of the Wallace Formation; both contacts can be placed within 10 ft (3 m) or less on Saint Paul Peak. Mud cracks, ripple marks, and mud-chip conglomerates are locally common. The lower part of the formation contains siltite and very light gray crossbedded quartzite in beds about 1 ft (0.3 m) thick. The upper part of the formation contains calcite- and dolomite-cemented siltite.

WALLACE FORMATION

The Wallace Formation occupies a major part of the central portion of the study area and crops out on the highest peaks. The thickness of the Wallace cannot be measured accurately owing to faulting and folding; however, the formation is estimated to be about 10,000 ft (3,000 m) thick. This compares with a thickness of about 7,000 ft (2,100 m) measured by Allen Griggs (oral commun., 1972) near Trout Creek, 9 mi (15 km) south of the study area.

The lower half of the formation is composed primarily of laminated, gray-green, silty argillite and thin-bedded argillitic siltite, with dolomite cement in most beds. Outcrops of Wallace argillite weather to red-brown shaly plates. Ripple marks and mud cracks, detrital muscovite, and euhedral pyrite crystals are common. Limestone beds are commonly interlayered in the argillite sequence. Stromatolites are locally present, and so-called "molar tooth" beds 3–5 ft (1–1.5 m) thick and intraformational conglomerates (so-called "trash beds") are common.

The upper half of the Wallace Formation is characterized by black, thinly laminated argillite and light-gray to white siltite, which are irregularly bedded and contain ripple marks, cross lamination, and mud cracks. As in the lower part of the formation, these beds are dolomitic, but calcite cement is also present. Dark-gray dolomite beds as much as 20–30 ft (6–9 m) thick are interbedded with the argillite and siltite. Stromatolites, "molar tooth" beds, and "trash beds" are present also. A 500-ft (150-m) thick bed of laminated argillite crops out near the base of the upper Wallace between Bockman and Alaska Peaks.

The upper 500 ft (150 m) of the Wallace Formation is gray-green carbonate-bearing argillite and siltite containing pyrite cubes. The carbonate is calcite and dolomite. The argillite weathers slabby to papery and is tan to red brown depending on the carbonate content. It contains mud cracks, ripple marks, and some stromatolite beds. The uppermost 100–200 ft (30–60 m) is mainly a siltite that could be included in the overlying Striped Peak Formation, but for the purpose of this reconnaissance mapping, the base of the lower Striped Peak was placed above the siltite. The uppermost part contains mud-chip conglomerates and detrital muscovite.

STRIPED PEAK FORMATION

The Striped Peak Formation crops out in the north half of the area. The best readily accessible section of the Striped Peak is in a syncline on William Grambauer Mountain, 10–12 mi (16–19 km) west of Libby, where reconstruction from several faulted blocks indicates a thickness of at least 4,100 ft (1,250 m). The basal contact is transitional with the Wallace Formation, but the upper contact with argillite of the overlying Libby Formation is sharp. The Striped Peak Formation was divided into three members: (1) a lower siltite and quartzite about 2,500 ft (760 m) thick, (2) a middle argillite about 600 ft (180 m) thick, and (3) an upper red siltite and quartzite about 1,000 ft (300 m) thick. The lower and middle members were mapped as Wallace by Gibson (1948); the upper red member corresponds to Gibson's Striped Peak Formation. We place all of these members in the Striped Peak Formation because the great thickness of silt- and sand-sized detritus and the interbedded red micaceous siltites and argillites in the lower member contrast with the fine-grained, calcareous rocks of the Wallace Formation.

Correlation of the members of the Striped Peak in the Cabinet Mountains Wilderness is problematic, but some similarities with the formation near Pend Oreille, Idaho, about 40 mi (65 km) to the west (Harrison and Jobin, 1963; Harrison and Jobin, 1965) are evident. The 2,500-ft (760-m) thick lower member occupies the same stratigraphic position as the lower argillite, siltite, and quartzite member of the Pend Oreille area where it is 600 ft (180 m) thick. The dolomite member of the Pend Oreille area is missing near Libby, but it may correspond to stromatolitic and oolitic dolomite beds found in the middle of the lower member. The 600-ft (180-m) thick middle argillite member probably corresponds to the laminated argillite and siltite member of the Pend Oreille area where its thickness is 300 ft (90 m). The upper red siltite and quartzite member corresponds to the upper quartzite member of the Pend Oreille area.

The lower member of the Striped Peak is mainly gray siltite and a few fine-grained quartzite beds ranging to 5 ft (1.5 m) thick. They contain distinctive tan streaks of dolomite which weather red brown. Many of the beds are massive, but locally they exhibit faint crossbedding and ripple marks. Tan biohermal, stromatolitic, and oolitic dolomite beds 3–40 ft (1–12 m) thick are conspicuous near the middle of the lower member. Distinctive beds of purple and gray argillite and siltite occur in the basal 100 ft (30 m) of the lower unit, and similar beds ranging to 1 ft (0.3 m) thick are interbedded with the siltite and quartzite at several higher horizons. These purple beds contain conspicuous detrital mica flakes. Ripple marks, mud cracks, and mud-chip conglomerates abound in the argillites and siltites.

The middle member of the Striped Peak consists mainly of dark- to light-gray-green argillitic siltite beds as much as 1 ft (0.3 m) thick interbedded with laminated gray-green argillite beds. Red rocks and quartzite beds are rarely present. Detrital mica and quartz sand grains are common, and the siltites contain distinctive rounded green chloritic grains.

The upper member of the Striped Peak contains interbedded grayish-red to maroon, fine-grained quartzite, siltite, and argillite. The red coloration is due to the presence of abundant hematite. Gray-green argillite and siltite are locally abundant. Crossbedding, ripple marks, mud cracks, and mud-chip conglomerates are common. The upper member is notably feldspathic and contains conspicuous large detrital mica flakes.

LIBBY FORMATION

The Libby Formation crops out in the northeast corner of the study area where less than 2,000 ft (610 m) of the lower part of the formation is exposed. About 4,500 ft (1,400 m) of the formation is exposed in roadcuts along the Kootenai River. The top of the formation is absent due to erosion. The formation is mostly unevenly laminated and thin-bedded, dark-gray-green argillite. A few silty argillite and gray-green carbonate-bearing siltite beds occur throughout the Libby Formation. Stromatolitic limestone beds as much as 10 ft (3 m) thick occur at several intervals in the formation, and a few thin beds of gray-green cherty siltite and intraformational conglomerates are present.

The lower 150 ft (46 m) of the Libby Formation consists of black argillite with laminated beds and lenses of light-gray to light-gray-green silty argillite and pyritic siltite. Mud cracks and ripple marks are common. Black and green argillite in beds as much as 20 ft (6 m) thick occurs in the lower 2,000 ft (610 m) of the formation.

MAFIC SILLS

Mafic sills as much as 100 ft (30 m) but mostly less than 50 ft (15 m) thick intrude the lower Wallace and Burke Formations. A few sills too discontinuous and too thin to be mapped occur in the Prichard Formation. The sills range from gabbro to diabase. The mineral composition of these rocks is primarily hornblende, tabular plagioclase, and biotite, according to Gibson (1948, p. 21), who provided a more detailed description of the sills than is given here. The sills were contaminated by assimilation of wall rocks and metamorphosed so that biotite and chlorite locally make up a large part of the rock. Thin "baked" zones occur in the wall rocks along the contacts.

The age of the sills in the Cabinet Mountains has not been determined, but it is probably in the same range as similar sills in nearby areas. The age of mafic sills in the Prichard Formation in Boundary County, Idaho, has been determined to be 1,320 m.y. by rubidium-strontium isochron (Bishop, 1973, p. 205), 1,330±90 m.y. by the same method (Z. E. Peterman, written commun., 1974), and 1,430 m.y. by the lead/thorium/uranium method on zircon (R. E. Zartman, written commun., 1974). Similar sills in rocks overlying the Wallace equivalent in the Glacier Park area have been dated by potassium-argon determinations at 1,073 and 1,110 m.y. (Hunt, 1962).

MESOZOIC ROCKS

GRANODIORITE-QUARTZ MONZONITE

Stocks of granodiorite and quartz monzonite intrude the Precambrian Belt rocks on Dry Creek, Granite Creek, and Hayes Ridge. The Dry Creek stock is the largest of these plutons, and the smaller stock nearby on Granite Creek may be a satellite of the Dry Creek stock. The top of the Dry Creek stock is nearly flat in the southern part and steeply dipping in the north and east; the contacts of the Dry Creek stock are parallel to near-vertical bedding on the northwest and northeast sides, and parallel to slightly dipping bedding on the south side. The stock has been extensively sheared and intertwined with metasedimentary rocks of the Belt Supergroup in the southwestern part where the Bull Lake and other faults cut the stock. The contacts of the Granite Creek stock are also parallel to steeply dipping bedding where exposed. The stock on Hayes Ridge is poorly exposed; two small outcrops of the Revett Formation within the stock appear to be roof pendants.

Detailed petrographic study of the Dry Creek stock by Gibson (1948, p. 25) showed the stock to be mostly quartz monzonite and some granodiorite. Abundant inclusions of biotite are present in the southern part. Gibson described the rock as follows:

> The stock consists mainly of a very light-gray, massive, medium-grained quartz monzonite, in which feldspar, quartz, and biotite are the dominant constituents. Near the Bull Lake fault however, the rock is foliated, the foliation becoming more and more pronounced as the fault is approached.
>
> In two-thirds of the thin sections examined andesine is more abundant than potash feldspar. Orthoclase, some of which is perthitic, is the dominant potash feldspar; in many sections, however, a little microcline is present, and in a few sections this feldspar is abundant. Hornblende is scarce, being commonly present only near the border of the stock. Accessory apatite, zircon, and magnetite are uniformly distributed; allanite is present in two-thirds of the sections studied but is nowhere abundant; sphene is even scarcer; and tourmaline and pyrite were seen in a few sections.

A dike of granodiorite intrudes the Striped Peak Formation at Indian Head Mountain; it is finer grained than most of the stocks, is locally porphyritic, and contains muscovite.

The age of the Dry Creek stock is 73±2 m.y. as determined by rubidium/strontium isochron on microcline and biotite by Z. E. Peterman of the U.S. Geological Survey (unpub. data). An unusually high initial Sr^{87}/Sr^{86} ratio (0.7130) determined from the isochron is suggestive of postcrystallization exchange. Thus, 73 m.y. is a minimum age. This age corresponds to the Cretaceous age of the Idaho and Nelson batholiths.

VEINS OF UNKNOWN AGE

Veins in the Cabinet Mountains Wilderness occur in or near fault zones and along bedding planes. Although the fault zones may be 10–15 ft (3–4 m) wide, the veins are generally a few inches to a few feet thick, are discontinuous, and form shoots and pods that have maximum lengths of a few thousand feet. The veins consist of (1) quartz with minor sulfide minerals, and (2) sulfide minerals, mainly pyrite, galena, and chalcopyrite, with quartz and carbonate minerals. The lack of persistence of the veins precludes mapping them at the reconnaissance scale of this report.

QUATERNARY DEPOSITS

PLEISTOCENE GLACIAL DEBRIS

Rock debris deposited by glaciers has accumulated along the valley walls and valley bottoms of most of the headwater areas in the Cabinet Mountains Wilderness. The debris was derived locally and consists of rounded boulders, gravel, sand, and silt. Recent talus is closely associated with the glacial deposits and was mapped with them.

HOLOCENE ALLUVIUM

Alluvium occurs in the lower reaches of the streams in the study area and consists largely of reworked glacial deposits that now form a distinct flood plain. It consists of boulders, gravel, silt, and sand, with varying amounts of organic material in the boggy areas along the streams.

STRUCTURE

The structure of the mountain range in the Cabinet Mountains Wilderness is generally anticlinal near the north and south ends (pl. 1). These north-trending anticlines have generally flat tops, broken by faults and steep flanks. They do not form a single structure but instead compose a pair of plunging folds separated by the syncline of Striped Peak and Libby Formations in the northern part of the study area. The southern anticline, termed the Snowshoe anticline by Gibson (1948), is cut by the Snowshoe fault and its branches; the crest of the anticline is truncated at an acute angle where it has been thrown up against the fault. The anticline is not cut off to the south by the Rock Lake fault, contrary to the statement of Gibson (1948, p. 40); instead, the crest of the anticline is parallel to the fault for more than 6 mi (10 km). The middle part of the range is a west-dipping homocline of Wallace Formation that has been broken by faults and intruded by the stocks on Dry Creek and Granite Creek. In general, the entire range is tilted to the north, and so the Prichard Formation is extensively exposed in the south and the Libby Formation is exposed along the Kootenai River in the north.

A discontinuous set of high-angle faults follows the margins of the range. The Snowshoe fault (fig. 2) extends along the east side of the area and is upthrown to the east. The largest offset is at the north end where the Prichard Formation is thrown up against rocks of the Wallace Formation. The Snowshoe fault passes to the south and splits into several small faults that are cut by the Rock Lake fault system. The Rock Lake fault (fig. 2) extends generally northwesterly across the range where it joins the Bull Lake fault that follows part of the west side of the range. A horst at the mouth of Rock Creek brings Prichard rocks up against the Wallace Formation. In the southern part of the area, a thrust fault puts the Prichard Formation over the Burke. The thrust fault extends about 20 mi (30 km) south of the mapped area, where the offset is much larger (Allen Griggs, oral commun., 1972). In the northern part of the area, a series of faults forms a complicated set of horsts and grabens that cut across the syncline of Striped Peak and Libby Formations and the adjacent anticline.

Fracture cleavage is common for a few tens of meters on either side of the faults, and drag folds indicate the direction of offset along most of them. Other minor folds, not directly adjacent to faults, include highly contorted folds having steep to overturned limbs and broad, open folds. Most of these minor structures are too intricate to be mapped at reconnaissance scale.

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Geophysical Surveys of the Cabinet Mountains Wilderness, Lincoln and Sanders Counties, Montana

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MINERAL RESOURCES OF THE CABINET MOUNTAINS WILDERNESS, LINCOLN AND SANDERS COUNTIES, MONTANA

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MINERAL RESOURCES OF THE
CABINET MOUNTAINS WILDERNESS,
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GEOPHYSICAL SURVEYS OF THE CABINET MOUNTAINS WILDERNESS, LINCOLN AND SANDERS COUNTIES, MONTANA

By M. DEAN KLEINKOPF, U.S. Geological Survey

DISCUSSION

Aeromagnetic and gravity studies were made to assist in the geologic assessment of the mineral resource potential of the wilderness. Previous reconnaissance aeromagnetic and gravity surveys of the region provided background information for the current evaluations (Kleinkopf and others, 1972; Harrison and others, 1972; Kleinkopf and Wilson, 1976).

The aeromagnetic data (pl. 1) are from a larger survey of northeast Idaho and western Montana that was flown by Lockwood, Kessler, and Bartlett, Inc. under contract to the U.S. Geological Survey. The survey was flown at a constant barometric elevation of 7,000 ft (2,130 m) and at a flightline spacing of 1 mi (1.6 km). Anomalies within the wilderness area were studied in detail.

The gravity survey (pl. 2) consisted of 150 stations located in and near the wilderness. Because of the rugged terrain, only 50 of the stations are within the wilderness; most of these were reached by helicopter. The gravity measurements were adjusted to the absolute datum of the Wollard airport base, station WA 100 (Woollard and Rose, 1963), located at Coeur d'Alene, Idaho. Station elevations were obtained from bench marks, spot elevations, and estimations on 7½-minute topographic maps. The station readings were reduced to the complete Bouguer gravity values using an assumed average rock density of 2.67 g/cm^3. Terrain corrections were made through the H zone of Hammer (1939) with hand templates and out to 104 mi (167 km) using a digital computer (Plouff, 1966).

The most prominent magnetic anomalies on the map are related to two types of geologic sources: (1) surface or near-surface crystalline rocks exemplified by the Dry Creek stock (Gibson, 1948) of granodiorite and quartz monzonite composition, and (2) the magnetite-rich horizons of the Belt metasedimentary rocks. The Precambrian crystalline basement does not show detectable magnetic anomalies because it is covered by a thick section of Belt rocks (Harrison and others, 1972); hence, any basement anomalies have been greatly attenuated and are beyond the resolution of the data.

The magnetic anomaly associated with the Dry Creek stock is composite. The most positive values and highest gradient zones correlate in many cases with topographic highs of the Cabinet Moutains crestline. The anomaly then diminishes in amplitude to the west in proportion to decreasing elevations and is barely detectable where the 1200-gamma contour shows a slight positive bowing over Pheasant Point (Crowell Mountain quadrangle). The extension of the expression some 2.5 mi (4 km) southwest of Gus Brink Mountain supports structural evidence that the stock extends southward beneath the Wallace Formation. Along much of its southern contact, the stock is seen to dip beneath the Wallace Formation at a low angle.

The results of laboratory determinations of magnetic susceptibilities of three samples of granodiorite show a range of 0.0015 to 0.0057 emu/cm^3 (electromagnetic units per cubic centimeter). These high susceptibilities explain the correlation between the mapped magnetic highs and the topographic highs of the stock. For example, the magnetic peaks 1238 and 1213 gammas can be related to the topographic highs, 7,350 ft (2,240 m) and 7,710 ft (2,350 m) as shown on the 7½-minute topographic maps of the U.S. Geological Survey. However, not all high elevations show corresponding magnetic highs. A narrow magnetic negative axis can be traced through Crowell Mountain, elevation 6,990 ft (2,130 m), to the peak 7,220 ft (2,200 m), located 1.2 mi (2 km) southeast of Gordan Mountain, then northward, and finally northwesterly down the drainage of Camp Creek.

Several low-amplitude anomalies over Belt metasedimentary rocks contrast with the higher amplitude and more equidimensional anomalies that are typically associated with igneous intrusives such as the Dry Creek stock. These anomalies lie along structural trends where outcrops of the Belt Supergroup are topographically high. Positive anomalies of 50–100 gammas in amplitude are associated with topographically high ridges of the Burke Formation. Both the Burke and overlying Revett Formations contain abundant magnetite. Magnetic susceptibility values for three samples of Burke Formation ranged from 0.0010 to 0.0028 emu/cm^3, which would account for these anomalies. Anomalies that are in part associated with metasedimentary rocks are evident southeast of the Dry Creek stock over outcrops of the Burke and Revett Formations. These can be identified as magnetic peaks 1119, 1102, 1195, 1204, 1070, 1043, 1096, and 1092.

In the southern part of the wilderness, a linear magnetic high that extends from Flat Top Mountain to Bald Eagle Peak (magnetic peaks 1204, 1195, and 1132) corresponds to a section of the Snowshoe and Rock Lake faults; the anomaly may indicate the extent of mineralized rock along the fault zones. There may be some contribution from the magnetic sedimentary rocks in high elevations along the ridge crest, although high magnetic values are not everywhere coincident with the mountain peaks of the ridge.

The broad highs generally defined by the 1000-gamma contour and designated by magnetic peaks 1096 and 1092 are related to high topography that consists mainly of outcropping Revett and Burke Formations. A north-northwesterly trending magnetic low that is expressed as a contour deflection is superimposed on the large magnetic high from Engle Peak to Rock Peak. The low coincides with two faults that have been mapped on Rock Peak. It may reflect a narrow zone in which magnetite has been destroyed along the faults.

The gravity map shows a series of broad highs over the Cabinet Mountains uplift with amplitudes of 7 mGal (milligals) in the northern and about 11 mGals in the southern part of the wilderness (pl. 2). These high gravity values are consistent with geologic evidence that indicates that distance to the basement is less in the south where the older Belt rocks are exposed. Separating the north and south areas is an anomalous zone about 5 mi (8 km) wide in which the gravity-contour configurations show marked cross trends that range in direction from west-southwest to west-northwest. There is no geologic evidence of cross faulting or structural breaks across the area, but the magnetic anomalies near Rock Lake are coincident with this broad break in continuity of the gravity arch over the Cabinet Mountains.

The northern gravity feature with two 130-mGal contour closures is centered over the Dry Creek stock, but it is much more extensive than the stock outcrop. Several small isolated magnetic features lie along the broad gravity high. For example, on the north side of Dome Mountain, the magnetic contours show subtle positive deflections. Other features are the magnetic highs over outcrops of the Dry Creek stock and magnetic peaks 1124, 1155, 1107, and 1073 gammas.

In the southern part of the wilderness, gravity data do not reflect the faults that coincide with magnetic anomalies. The highest gravity anomaly in the area, the -121-mGal contour closure, correlates with magnetic peaks 1092 and 1132 and may reflect mineralization. To the northwest, the magnetic high associated with magnetic peak 1096 correlates with a broad area of high gravity values that exceed -130 mGal. This gravity high terminates a south-southeasterly trending low over the valley of Bull Lake, along the west side of the wilderness. The magnetic patterns are similar except that the magnetic anomaly is of low amplitude and ill defined.

The gravity and magnetic data suggest the possibility that the uplifted range may be underlain by a batholithic granite mass, hence the gravity high. This possibility is supported by consideration of density contrasts. The density average of the granodiorite and quartz monzonites that might compose the batholith can be predicted to be only slightly higher than that of the Belt sedimentary rocks. Since the magnetic anomalies are not all or totally related to high topography, they would, by this theory, reflect apophyses of the batholith, such as the Dry Creek stock. Structural and magnetic data indicate that the stock extends southward in the subsurface. It may be that magnetic peaks 1107 and 1073 represent an even more extensive distribution of the stock in the subsurface.

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Geochemical Survey of the Cabinet Mountains Wilderness, Lincoln and Sanders Counties, Montana

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MINERAL RESOURCES OF THE CABINET MOUNTAINS WILDERNESS, LINCOLN AND SANDERS COUNTIES, MONTANA

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GEOCHEMICAL SURVEY OF THE CABINET MOUNTAINS WILDERNESS, LINCOLN AND SANDERS COUNTIES, MONTANA

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METHODS AND DATA

The geochemical survey is based on analysis of rocks, soil, and stream sediments for evidence of anomalous concentrations of metals. There were 1,268 samples collected: 473 rock samples, 590 soil samples, and 205 stream-sediment samples. Rock samples are divided into three categories: (1) unmineralized rocks, (2) rocks showing visible evidence of alteration and mineralization, and (3) veins. Unmineralized rocks of all formations were sampled to determine background concentrations of metals in these rocks. Rocks showing disseminated ore minerals, such as secondary copper minerals in the Revett Formation, are included in mineralized rocks. Soil samples 3–6 in. (7.5–15 cm) below the surface were collected to investigate mineralization in upland areas where rocks are not exposed. Sediment in all major streams and tributaries was sampled in order to develop a systematic coverage of the entire area. The stream sediment and soil samples were dried and sieved; the −80-mesh (< 0.157-mm) fraction was analyzed.

Sample localities are shown on plate 2. Samples discussed in this report can be located by referring to their x–y coordinates and the grid on plate 2. All samples were analyzed by emission spectrography (Grimes and Marranzino, 1968) for iron, magnesium, calcium, titanium, manganese, silver, arsenic, gold, boron, barium, beryllium, bismuth, cadmium, cobalt, chromium, copper, lanthanum, molybdenum, niobium, nickel, lead, antimony, scandium, tin, strontium, vanadium, tungsten, yttrium, zinc, and zirconium. Concentrations of elements determined spectrographically are reported in the series 1, 1.5, 2, 3, 5, 7, 10, and so forth. Analysts were J. R. Domenico, J. G. Frisken, and R. T. Hopkins, U.S. Geological Survey. Gold was determined by atomic absorption because the limit of detection by the spectrographic method is not sufficiently low. Because difficulties were encountered in determining low concentrations of copper by spectrography, some samples were analyzed for copper by atomic absorption. The values determined by spectrography and by atomic absorption are comparable, however, and both were used to delineate mineralized areas. Rock samples were analyzed for mercury by instrumental methods. Soils and stream-sediment samples were analyzed for citrate-soluble heavy metal content.

A level at which each element was considered to be anomalous was determined after statistical analysis; this level was set arbitrarily and is based on experience. Frequency distributions were prepared for each element and each category of materials sampled. Samples with values in the uppermost percentiles were considered anomalous. The lowest values considered to be anomalous in the types of materials sampled are shown in table 1. Analyses of anomalous samples of stream sediments, soils, rocks exclusive of veins, and veins are listed in tables 2, 3, and 4. All analyses are stored on magnetic tape ERT-011, which is available from the National Technical Information Service, Springfield, VA. 22061.

Areas of potential mineral resources were identified from the geographic distribution of samples found to be anomalous in copper, silver, lead, zinc, molybdenum, gold, and other metals. Maps showing the location of metal anomalies were prepared by computer methods (figs. 3–13). Large metal anomalies are generally absent from formations above the Wallace, but significant areas of potential resources were outlined in the Revett Formation and in various formations along the Snowshoe fault.

DISCUSSION OF METAL ANOMALIES

COPPER

Extensive areas in the Cabinet Mountains Wilderness contain anomalous amounts of copper. Concentrations of 30 ppm or more are considered anomalous in rocks and veins, whereas values of 50 ppm are anomalous in soils and stream sediments (tables 2, 3, and 4). Anomalous values below 100 ppm are of questionable significance and must be judged in combination with the geologic environment and presence of other metals, such as silver, lead, or mercury, in anomalous amounts. Copper is commonly leached from the near-surface environment and redeposited as fracture fillings of malachite

TABLE 1.—*Levels of concentration considered to be anomalous for some elements in soil, stream sediment, rocks, and veins*

[Values shown are in parts per million. L, present in amounts less than lower limit of measurement as shown; ---, not determined. Gold and mercury analyses were made by atomic-absorption spectrometry; copper by atomic absorption and spectrographic methods; citrate-soluble heavy-metals test by colorimetric comparison; other elements by six-step semiquantitative spectrographic analysis]

Element	Soil	Stream sediment	Rocks	Veins
Cu	50	50	30	30
Ag	L(0.5)	L(0.5)	L(0.5)	L(0.5)
Pb	150	150	70	70
Zn	L(200)	L(200)	L(200)	L(200)
Mo	L(5)	L(5)	L(5)	L(5)
Au	L(0.05)	L(0.05)	L(0.05)	L(0.05)
Sb	L(100)	L(100)	L(100)	L(100)
As	L(200)	L(200)	L(200)	L(200)
Ba	2,000	2,000	3,000	1,500
Bi	L(10)	L(10)	L(10)	L(10)
Cd	L(20)	L(20)	L(20)	L(20)
Co	150	150	150	150
Cr	200	150	300	100
Hg	---	---	0.05	0.05
Ni	150	100	100	100
W	L(50)	L(50)	L(50)	L(50)
Citrate-soluble heavy metal	20	20	---	---

and azurite. Copper anomalies in soils are likely to be developed from the leaching of copper sulfide minerals in rocks. Figure 3 shows the localities of anomalous soil and stream-sediment samples, with anomalous concentrations divided into two groups: 50–100 ppm and 100 ppm or greater (fig. 3). Figure 4 shows the localities of rock and vein samples with 100 ppm or more copper.

Most of the rock, soil, and stream-sediment samples containing anomalous copper occur in a 10-mi² (25-km²) area west of the Rock Lake fault and north of Rock Creek. Low-level copper anomalies extend along the Snowshoe fault, along a zone that parallels a series of faults in the northern part of the study area, and along the Rock Lake–Bull Lake fault. Samples of Revett quartzite contain as much as 7,000 ppm copper, and samples of stream sediment and soil derived from the Revett contain as much as 1,500–2,000 ppm copper. Copper occurs locally in veins in amounts greater than 20 percent, but in most cases the values are a few hundred parts per million. Many of these veins are along the Snowshoe fault, but others occur in the St. Regis Formation near Saint Paul Peak, where the St. Regis overlies copper-bearing Revett Formation. One vein is in the Cedar

TABLE 2.—*Semiquantitative spectrographic, chemical, and instrumental analyses of selected samples of stream sediment and soil from the Cabinet Mountains Wilderness*

Sample	X coordinate	Y coordinate	Ag-ppm s	Cu-ppm s	Cu-ppm aa	Mo-ppm s	Pb-ppm s	Zn-ppm s	Au-ppm aa
				Stream Sediment					
D033	243	252	.7	150	--	N	30	N	--
D037	121	739	<.5	10	--	<5	30	N	N
D048	90	758	N	100	--	N	30	N	N
D074	313	368	N	--	50	N	70	N	N
D374	278	227	N	--	10	5	50	N	.50
D408	357	255	N	--	20	N	50	N	<.05
D452	244	171	.5	--	35	N	30	N	N
D453	213	487	N	20	--	5	30	N	N
D455	205	490	N	--	25	<5	50	N	N
M032	328	307	N	--	60	N	20	N	N
M035	267	339	N	20	--	N	70	N	.10
M037	262	338	<.5	--	85	N	100	N	N
M047	218	398	<.5	--	50	N	30	N	N
M053	244	359	1.5	100	--	N	70	N	N
M055	246	362	.7	100	--	N	50	N	N
M057	247	366	1.0	100	--	N	70	N	--
M059	246	370	.7	70	--	N	30	N	N
R026	192	778	N	--	20	5	30	N	N
R048	291	437	N	--	10	N	30	N	<.05
R079	288	587	N	--	50	N	50	N	N
R090	286	577	150.0	1,500	--	N	>20,000	>10,000	7.50
R091	296	561	70.0	700	--	N	15,000	10,000	5.00
R112	238	707	N	20	--	7	30	N	N
R129	237	299	1.0	200	--	N	100	N	N
R164	172	728	N	15	--	15	30	N	N
R165	169	728	N	20	--	10	30	N	N
R166	164	752	N	15	--	5	30	N	N
R167	149	768	N	15	--	15	30	N	N
R232	332	152	<.5	20	--	N	30	N	N
R259	262	338	N	--	60	N	50	N	N
R264	245	371	N	--	110	N	30	N	N
X094	300	403	N	--	20	N	50	N	<.05
X205	121	818	.5	15	--	N	30	N	N
X208	91	810	N	--	50	N	30	N	N
X225	280	678	N	--	50	N	70	N	N
X274	207	252	.5	--	20	N	30	N	N
X284	241	313	7.0	--	35	N	70	N	N
X328	232	320	N	--	85	N	50	N	N
X330	185	343	N	--	25	5	20	N	N
X348	160	665	N	--	25	10	30	N	<.05
X350	154	687	N	10	--	5	50	N	N
X430	391	210	<.5	--	25	N	100	N	.35
X431	403	210	<.5	5	--	N	30	N	<.25
X437	422	223	N	--	25	N	30	N	.10
X442	338	331	N	--	30	N	200	N	.10
X443	350	344	<.5	20	--	N	70	N	N
X458	420	254	N	--	20	N	30	N	.35
X459	416	252	N	--	20	N	30	N	.15
X471	327	240	N	--	20	N	30	N	<.05
X473	315	247	N	20	--	5	50	N	<.05
X498	251	256	1.0	--	50	N	30	N	N
X519	277	315	.7	300	--	N	50	N	N
X525	263	325	N	--	70	N	70	N	N
X527	257	326	N	--	35	10	100	N	N
X543	298	720	1.0	100	--	15	100	700	N
X571	190	891	<.5	--	25	N	30	N	N

TABLE 2.—*Semiquantitative spectrographic, chemical, and instrumental analyses of selected samples of stream sediment and soil from the Cabinet Mountains Wilderness*—Continued

Soil									
D015	220	286	N	100	--	N	30	N	N
D018	233	272	N	100	--	N	30	N	N
D020	234	271	N	--	25	N	500	N	N
D022	235	271	3.0	--	65	N	700	N	N
D025	236	272	5.0	2,000	--	N	30	N	N
D027	237	271	N	150	--	N	70	N	N
D029	238	271	N	150	--	N	30	N	N
D031	239	271	N	200	--	N	30	N	N
D036	122	742	N	--	10	5	30	N	N
D061	190	749	<.5	15	--	N	30	N	N
D067	179	772	<.5	15	--	N	20	N	N
D077	325	380	<.5	--	30	N	30	N	N
D078	340	393	.5	--	25	N	30	N	N
D084	160	858	N	--	60	N	50	N	N
D086	162	858	N	--	70	N	50	N	N
D098	198	874	N	--	55	N	20	N	N
D137	140	895	1.0	--	30	N	50	N	N
D145	124	873	N	20	--	N	30	N	<.05
D177	298	628	<.5	--	15	N	30	N	N
D186	278	625	N	--	25	N	30	N	.10
D201	256	558	N	--	65	N	30	N	N
D218	214	418	N	--	20	7	20	N	N
D219	220	428	N	--	25	7	30	N	N
D222	210	425	.7	--	25	N	30	N	N
D276	301	425	.5	--	25	N	100	N	N
D283	319	434	1.0	--	25	N	30	N	N
D284	326	437	1.0	--	25	N	300	300	N
D289	326	288	<.5	--	40	N	70	N	N
D298	362	301	N	--	60	N	100	N	N
D300	377	316	<.5	--	30	N	100	N	N
D328	93	656	.7	--	15	N	30	N	N
D381	275	210	N	--	70	N	30	N	N
D392	349	282	N	15	--	N	30	N	.05
D409	355	246	<.5	15	--	5	30	N	N
D411	251	304	N	--	85	N	50	N	N
D417	261	306	N	--	65	N	200	N	N
D418	266	304	N	--	60	N	50	N	N
D422	267	299	1.0	--	170	N	200	N	N
D423	265	295	N	--	90	N	50	N	N
D424	263	292	.5	--	120	N	30	N	N
D426	264	286	<.5	--	35	N	30	N	N
D427	265	284	<.5	--	150	N	30	N	N
D428	266	281	<.5	--	20	N	30	N	N
D432	275	274	N	--	50	N	30	N	N
D457	200	496	<.5	20	--	N	30	N	N
D477	235	845	<.5	--	20	<5	30	N	N
M007	256	312	N	--	60	N	20	N	N
M009	261	315	<.5	--	80	N	15	N	N
M021	335	289	<.5	15	--	N	30	N	N
M023	335	295	<.5	15	--	N	30	N	N
M029	220	375	<.5	15	--	N	10	N	N
M036	267	339	N	--	50	N	50	N	N
M038	262	338	<.5	--	90	N	70	N	N
M039	256	357	N	70	--	N	15	N	N
M041	252	366	.7	--	20	N	30	N	N
M043	247	372	<.5	20	--	N	15	N	N
M049	243	356	.7	15	--	N	20	N	N
M066	240	378	1.0	100	--	N	15	N	N
M068	241	380	N	--	80	N	15	N	N
M074	233	383	.7	--	30	N	70	200	N

TABLE 2.—*Semiquantitative spectrographic, chemical, and instrumental analyses of selected samples of stream sediment and soil from the Cabinet Mountains Wilderness*—Continued

Sample	X coor- dinate	Y coor- dinate	Ag-ppm s	Cu-ppm s	Cu-ppm aa	Mo-ppm s	Pb-ppm s	Zn-ppm s	Au-ppm aa
				Soil--Continued					
M076	230	385	<.5	10	--	N	20	N	N
M080	232	388	<.5	--	30	N	50	N	N
R009	238	276	N	300	--	N	300	N	N
R011	236	278	1.0	500	--	N	300	N	N
R012	236	278	N	100	--	N	100	N	N
R013	255	278	N	150	--	N	300	N	N
R014	255	279	N	200	--	N	300	N	N
R028	201	781	<.5	--	15	10	30	N	N
R029	209	792	<.5	--	25	N	20	N	N
R030	231	801	<.5	10	--	N	30	N	N
R031	246	800	<.5	--	10	N	30	N	N
R032	254	809	<.5	--	5	N	30	N	N
R033	264	810	<.5	--	10	N	30	N	N
R045	236	824	<.5	--	15	N	30	N	N
R047	296	440	<.5	--	15	N	50	N	<.05
R050	305	445	.5	--	35	N	150	N	N
R051	309	454	<.5	--	30	N	50	N	N
R052	326	459	1.0	--	25	N	30	N	N
R053	338	467	N	--	30	N	30	N	<.05
R059	183	817	N	--	20	N	30	N	.10
R060	193	820	<.5	--	15	N	20	N	N
R062	202	841	.7	--	15	<5	30	N	N
R064	199	855	<.5	--	15	N	20	N	N
R067	228	868	<.5	--	25	N	30	N	N
R069	246	868	N	--	5	5	20	N	N
R080	291	590	.5	--	45	N	300	N	N
R083	316	587	.5	--	25	N	70	N	N
R089	283	553	5.0	--	50	N	2,000	300	N
R092	296	559	1.5	--	15	N	70	300	N
R093	307	565	.5	20	--	N	30	N	N
R094	319	567	.5	--	35	N	50	N	N
R097	300	483	1.0	--	25	N	100	N	N
R098	301	480	3.0	15	--	N	150	N	N
R099	322	485	.5	20	--	N	30	N	N
R105	271	671	N	--	10	<5	30	N	N
R130	238	300	.7	--	30	N	30	N	N
R131	239	297	N	--	70	N	300	N	N
R133	241	293	1.5	--	180	N	70	N	N
R168	165	763	.5	--	20	10	30	N	N
R169	156	771	N	20	--	15	30	N	N
R170	144	778	N	10	--	15	30	N	N
R183	82	676	N	--	10	N	30	N	<.05
R184	84	667	N	20	--	N	30	N	<.05
R186	73	679	N	15	--	N	30	N	<.05
R190	198	601	N	20	--	N	30	N	.10
R192	177	611	N	--	50	N	30	N	N
R194	176	616	N	15	--	N	30	N	.05
R277	258	412	<.5	--	25	N	30	N	N
R283	218	415	.5	--	25	N	30	N	N
R293	148	534	N	--	70	N	50	N	N
R300	305	419	<.5	--	25	N	30	N	N
R302	307	421	3.0	--	20	N	300	N	N
R303	310	420	.5	--	20	N	30	N	N
R304	314	420	1.5	--	25	N	100	N	N
R305	317	422	1.0	--	25	N	50	N	N

TABLE 2.—*Semiquantitative spectrographic, chemical, and instrumental analyses of selected samples of stream sediment and soil from the Cabinet Mountains Wilderness*—Continued

Sample	X coor-dinate	Y coor-dinate	Ag-ppm s	Cu-ppm s	Cu-ppm aa	Mo-ppm s	Pb-ppm s	Zn-ppm s	Au-ppm aa
				Soil--Continued					
R309	306	404	1.0	--	35	N	300	N	N
R310	312	404	3.0	--	50	N	300	200	N
R320	191	325	1.0	--	25	N	30	N	N
R323	177	330	<.5	150	--	N	30	N	N
X021	238	279	N	--	80	N	30	N	N
X022	237	279	N	100	--	N	50	N	N
X024	237	280	.7	200	--	N	300	N	N
X027	236	282	N	--	30	N	300	N	N
X057	254	749	N	--	55	N	20	N	N
X062	269	749	<.5	--	15	N	30	N	N
X063	277	746	<.5	--	10	N	30	N	N
X065	254	769	.5	15	--	N	30	N	N
X067	264	778	<.5	--	25	N	20	N	N
X069	269	782	<.5	10	--	N	15	N	N
X073	283	771	.7	--	15	N	30	N	N
X074	288	772	<.5	15	--	N	30	N	N
X081	298	734	<.5	--	20	N	30	N	N
X099	308	405	10.0	--	65	N	7,000	700	.35
X101	312	406	5.0	--	80	5	1,500	500	.10
X104	317	408	2.0	--	25	N	300	N	N
X105	322	410	<.5	--	20	N	200	N	N
X108	344	420	.5	--	50	N	50	200	N
X157	181	641	N	--	120	N	20	N	N
X170	219	710	N	--	10	10	30	N	N
X198	86	844	N	15	--	N	30	N	<.05
X213	252	643	<.5	--	40	N	100	N	N
X215	252	662	N	--	50	N	30	N	N
X216	252	663	N	20	--	N	30	<200	N
X227	283	685	N	--	65	N	100	N	N
X228	281	691	<.5	--	25	N	30	N	N
X230	255	458	N	--	20	<5	30	N	N
X233	277	491	.5	--	15	N	30	N	<.05
X235	283	495	N	--	15	N	30	<200	<.05
X242	291	500	5.0	--	35	N	500	300	<.05
X243	294	501	<.5	--	15	N	50	N	N
X259	204	275	.5	--	30	N	300	300	N
X296	246	303	N	--	40	N	500	N	N
X298	244	301	N	200	--	N	2,000	N	N
X301	291	526	N	20	--	N	70	200	N
X319	335	365	N	--	55	N	50	N	N
X322	341	367	<.5	--	15	N	30	N	N
X364	104	601	N	--	15	N	30	N	.10
X391	124	570	N	--	20	N	30	N	<.05
X408	407	120	<.5	--	20	N	30	N	N
X415	421	102	<.5	--	20	N	30	N	N
X420	410	157	.5	--	20	N	30	N	N
X425	394	195	<.5	--	20	N	30	N	N
X426	393	198	N	--	70	N	50	N	N
X436	443	216	.7	300	--	N	30	N	N
X444	351	340	N	20	--	N	30	N	<.05
X451	451	196	3.0	20	--	N	100	N	N
X452	451	205	.5	--	30	N	30	N	N
X461	332	230	.5	--	20	N	30	N	N
X478	311	288	N	--	80	N	50	N	.05
X491	310	276	1.5	--	20	N	30	300	N

TABLE 2.—*Semiquantitative spectrographic, chemical, and instrumental analyses of selected samples of stream sediment and soil from the Cabinet Mountains Wilderness*—Continued

Sample	X coor-dinate	Y coor-dinate	Ag-ppm s	Cu-ppm s	Cu-ppm aa	Mo-ppm s	Pb-ppm s	Zn-ppm s	Au-ppm aa
				Soil--Continued					
X494	313	259	<.5	--	20	N	30	N	N
X497	262	256	1.5	--	55	N	30	N	N
X499	259	202	1.5	--	30	N	30	N	N
X512	290	325	N	--	55	N	30	N	.05
X514	289	320	1.0	15	--	N	30	N	N
X517	280	318	7.0	700	--	N	700	200	<.05
X540	298	723	N	20	--	5	30	N	N
X541	297	722	.7	--	25	10	50	N	N
X542	298	721	N	--	30	7	50	N	N
X567	165	890	<.5	--	10	N	50	N	N
X568	166	880	<.5	--	45	N	50	N	N
X582	201	404	<.5	--	20	N	30	N	N

TABLE 3.—*Semiquantitative spectrographic, chemical, and instrumental analyses of selected samples of rocks from the Cabinet Mountains Wilderness*

Sample	X coor-dinate	Y coor-dinate	Ag-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	Cu-ppm aa	Mo-ppm s	Pb-ppm s	Zn-ppm s	Au-ppm aa	Hg-ppm inst
						Wallace Formation						
D082	155	858	N	10	50	--	30	15	10	N	N	.02
D150	106	884	N	15	50	7	--	<5	30	N	N	N
D163	138	824	.5	5	50	--	30	N	30	N	N	.02
D168	118	835	N	10	50	--	85	N	15	N	N	<.02
D187	268	615	N	N	100	--	30	10	30	N	N	<.02
D189	259	605	N	7	70	15	--	N	N	N	<.05	N
D191	270	601	N	7	70	--	120	N	30	N	<.05	.02
D205	270	575	N	5	30	10	--	10	30	N	N	N
D207	277	570	N	30	30	15	--	N	30	N	N	N
D244	189	440	N	150	10	150	--	N	70	N	N	N
D310	60	643	N	10	70	--	35	N	20	N	N	N
D330	79	655	N	7	70	--	65	N	N	N	N	<.02
D442	241	324	.5	5	30	--	45	N	30	N	N	N
D454	207	488	N	5	50	20	--	15	30	N	N	N
D459	192	499	N	15	30	--	30	N	30	N	N	.02
R040	209	817	N	N	30	--	<5	N	10	N	.10	.04
R118	263	528	N	10	30	15	--	15	30	N	N	N
R207	201	511	N	50	50	<5	--	N	20	N	N	<.02
R209	185	512	N	5	50	20	--	N	70	N	N	N
R212	172	515	N	15	100	--	95	10	20	N	N	N
R214	168	518	N	5	100	10	--	5	30	N	N	N
R289	154	534	N	15	50	--	30	N	30	N	N	N
X054	240	749	<.5	5	150	--	95	N	N	N	N	.02
X064	275	774	N	5	50	--	<5	15	10	N	N	<.02
X068	267	779	N	N	15	20	--	N	N	N	N	.06
X113	148	806	N	50	150	--	20	N	N	N	N	<.02
X116	144	814	N	5	30	15	--	<5	N	N	N	.02
X212	248	635	N	10	30	150	--	N	70	200	N	.02
X217	254	666	N	15	30	--	30	N	10	N	N	.02
X226	282	681	N	50	30	20	--	N	10	N	N	.02
X234	277	491	<.5	5	20	15	--	N	20	N	N	N
X395	107	561	N	10	100	20	--	N	70	N	N	N
X515	288	320	1.0	15	50	15	--	N	300	N	N	<.02
X548	215	480	N	15	30	--	50	N	20	N	N	N
						Revett Formation						
D021	235	271	1.5	N	15	--	5	N	100	N	N	<.02
D024	236	272	20.0	N	30	3,000	--	N	10	N	N	.06
D026	237	271	.5	N	10	--	10	N	N	N	N	.02
M052	244	355	20.0	5	20	1,500	--	N	10	N	<.05	.04
M083	223	386	1.5	7	30	--	90	N	<10	N	N	N
M086	224	385	2.0	5	<10	20	--	N	N	N	N	.02
M088	227	388	N	15	30	--	35	N	30	N	N	<.02
R281	233	416	.5	5	30	--	30	<5	50	N	N	.02
X018	236	276	200.0	N	20	7,000	--	70	10	N	N	.28
X020	234	277	.5	N	30	--	10	N	300	N	N	.02

TABLE 3.—*Semiquantitative spectrographic, chemical, and instrumental analyses of selected samples of rocks from the Cabinet Mountains Wilderness*—Continued

Sample	X coordinate	Y coordinate	Ag-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	Cu-ppm aa	Mo-ppm s	Pb-ppm s	Zn-ppm s	Au-ppm aa	Hg-ppm inst
					Revett Formation--Continued							
X026	237	282	.7	N	30	--	5	N	50	N	N	<.02
X031	234	284	.5	5	30	20	--	N	20	N	N	.02
X248	328	504	<.5	N	20	15	--	N	N	N	N	N
X297	244	301	.5	N	10	--	20	N	500	N	N	<.02
X524	266	323	.5	N	20	30	--	N	70	N	N	.02
					Burke Formation							
D275	288	424	N	N	50	15	--	5	15	N	N	N
D281	312	432	N	7	50	15	--	N	70	N	N	N
D351	320	208	N	N	20	--	20	N	10	N	<.05	N
D352	324	203	N	N	20	--	5	N	20	N	<.05	N
R151	293	382	N	30	30	30	--	N	20	N	N	N
R253	380	228	N	15	70	15	--	7	10	N	N	N
R270	288	391	N	10	30	--	75	N	30	N	N	N
X096	297	402	N	15	70	10	--	N	10	N	N	.06
X107	336	416	N	30	70	--	100	N	50	N	N	<.02
X314	324	352	N	10	30	--	10	15	50	N	N	N
X326	363	382	<.5	N	20	15	--	<5	N	N	N	N
X429	386	204	N	70	50	--	30	N	15	N	N	N
X479	311	288	3.0	50	50	200	--	20	2,000	N	N	N
					Prichard Formation							
D387	361	279	N	15	50	--	35	5	30	N	N	N
X238	286	497	N	N	50	15	--	5	20	N	N	.04
X255	196	279	.5	5	30	20	--	N	30	N	N	N
X411	403	102	N	5	70	--	35	N	70	N	N	<.02
					Granodiorite and quartz monzonite							
D317	70	629	N	50	10	--	45	N	20	N	N	<.02
D334	62	645	N	50	20	--	30	N	20	N	N	N
X159	175	645	N	50	300	10	--	N	10	N	N	<.02
X164	171	677	.5	N	30	--	30	N	30	N	N	<.02

Creek area. Small amounts of copper occur in some of the lead-zinc veins along the Snowshoe fault and locally in the green argillite beds of the Striped Peak Formation.

At least four zones of strata-bound copper minerals crop out in the Revett Formation north of Rock Creek (fig. 5). Two of these zones, one south of Chicago Peak and the other on Rock Peak, are known from surface mapping and sampling and by drilling. The most extensive zone, located south of Chicago Peak, crops out about 600 ft (190 m) below the top of the Revett Formation. Malachite coatings are present locally where these zones crop out, and soils at and below the mineralized outcrops have high concentrations (commonly 100 ppm or more) of copper. Anomalous concentrations of copper were found in soil from peak 7430 (fig. 5), south of Rock Peak, indicating that a copper-bearing zone may barely intercept the top of that peak. The altitude of the copper-bearing zone on peak 7430 is near that of the zone on Rock Peak, and so even though they are separated by a fault of small displacement, it seems likely that the two zones were once continuous.

An extensive zone of copper-bearing quartzite about 1,800 ft (550 m) below the top of the Revett Formation is inferred to extend about 2 mi (3.2 km) along the East Fork Bull River. The zone can be

TABLE 4.—*Semiquantitative spectrographic, chemical, and instrumental analyses of selected samples of veins from the Cabinet Mountains Wilderness*

Sample	X coordinate	Y coordinate	Ag-ppm s	Bi-ppm s	Cd-ppm s	Cu-ppm s	Cu-ppm aa	Mo-ppm s	Pb-ppm s	Zn-ppm s	Au-ppm aa	Hg-ppm inst
D066	181	771	N	15	N	10	--	N	N	N	N	.02
D243	189	440	N	N	N	200	--	N	10	N	N	<.02
D277	305	426	<.5	N	N	20	--	N	70	N	N	N
D299	376	309	N	N	N	7	--	N	20	N	25.00	.02
D320	72	596	N	N	N	--	70	N	20	N	N	N
D389	340	288	N	N	N	--	35	N	70	N	N	N
D396	327	264	N	50	N	--	55	N	20	N	.75	N
D429	269	279	2.0	N	N	300	--	200	N	N	<.05	.02
R042	216	818	N	N	N	--	<5	150	N	N	N	.02
R075	269	589	.7	N	N	1,500	--	N	100	N	N	<.02
R122	283	541	7.0	N	50	150	--	N	300	7,000	N	.30
R137	269	450	150.0	300	30	--	75	N	15,000	3,000	N	<.02
R138	263	449	30.0	70	N	10	--	N	3,000	700	N	N
R147	299	461	.5	N	N	--	20	N	30	200	N	N
R239	370	276	100.0	70	300	150	--	N	>20,000	>10,000	2.00	.04
R252	380	225	150.0	100	200	500	--	N	10,000	>10,000	N	.06
R287	154	528	2.0	N	N	--	70	N	100	N	N	.08
R301	305	422	50.0	N	N	3,000	--	N	7,000	700	.20	.04
R311	310	404	150.0	10	30	--	25	N	>20,000	2,000	N	.06
R313	236	320	700.0	20	N	>20,000	--	10	30	N	.05	.55
R324	177	330	5.0	<10	N	2,000	--	N	30	N	N	N
X036	133	756	N	10	N	20	--	50	10	N	N	<.02
X103	312	406	7.0	10	N	15	--	N	5,000	700	N	<.02
X240	288	498	.5	<10	N	--	20	N	20	N	N	N
X241	291	500	<.5	<10	N	5	--	<5	20	N	.20	.02
X289	246	311	N	<10	N	300	--	N	N	N	N	<.02
X311	317	343	3.0	10	N	--	150	N	300	500	N	.04
X407	409	123	.7	N	N	--	55	N	200	200	N	.04
X435	419	214	.7	N	N	--	160	N	200	N	.75	.04
X462	332	220	.7	N	N	--	10	10	30	N	.15	N
X468	330	232	N	15	N	10	--	N	N	N	9.00	N
X488	310	279	1.0	N	N	--	70	5	1,500	500	8.00	.02
X492	310	274	7.0	10	N	1,000	--	N	2,000	700	<.05	.06
X493	310	274	2.0	N	N	500	--	N	20	N	N	N
X518	280	318	2,000.0	30	150	10,000	--	70	>20,000	>10,000	.60	>10.00
X523	266	323	30.0	N	30	--	30	N	10,000	300	N	.02
X564	169	885	50.0	10	N	700	--	N	200	300	.10	1.50

projected from a locality of copper-bearing quartzite (1,500 ppm copper) by following the same stratigraphic horizon at elevations just above the location of stream-sediment and soil samples having anomalous copper.

The discovery of the copper-bearing zone along the East Fork Bull River indicates that the area of copper occurrence is more extensive than was previously realized. Copper occurs in veins in the St. Regis Formation above and west of the outcrops of copper-bearing Revett quartzite. The vein copper may be derived from subsurface extensions of the Revett copper zones. If so, the total mineralized area may be about 10 mi^2 (25 km^2). A few of the soil samples collected over the Revett Formation south of Rock Creek and along the Snowshoe fault contained anomalous copper, but most of the samples from these areas are not anomalous and the presence of extensive copper-bearing zones at these localities is unlikely.

SILVER

Samples with detectable silver (detected but less than 0.5 ppm) are considered anomalous in this study. (Silver and other metals dis-

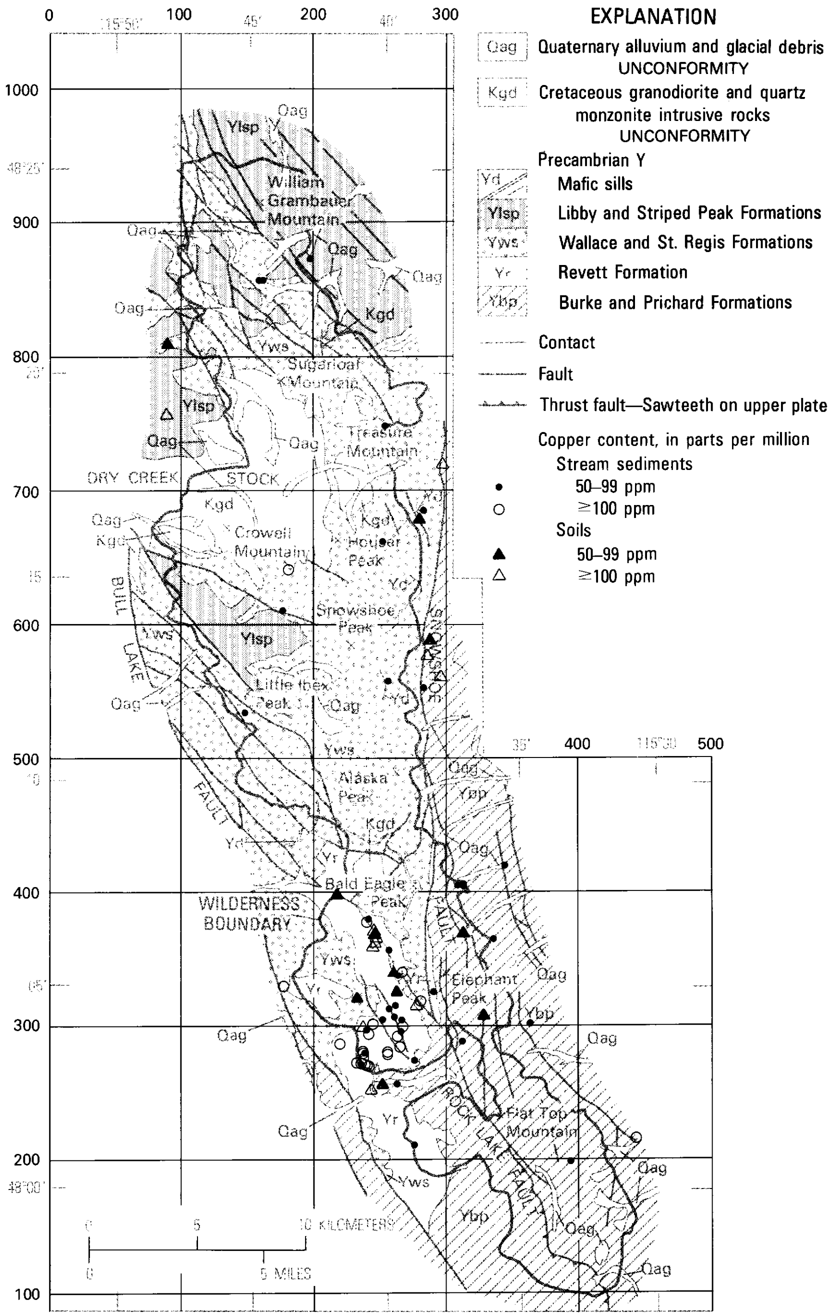


FIGURE 3.—Anomalous copper in soil and stream sediments, Cabinet Mountains Wilderness, Mont. Grid is in units of 20,000 ft (6,100 m); origin of grid at 10,000 ft (3,048 m) north of lat 47°52'30" N., long 115°52'30" W.

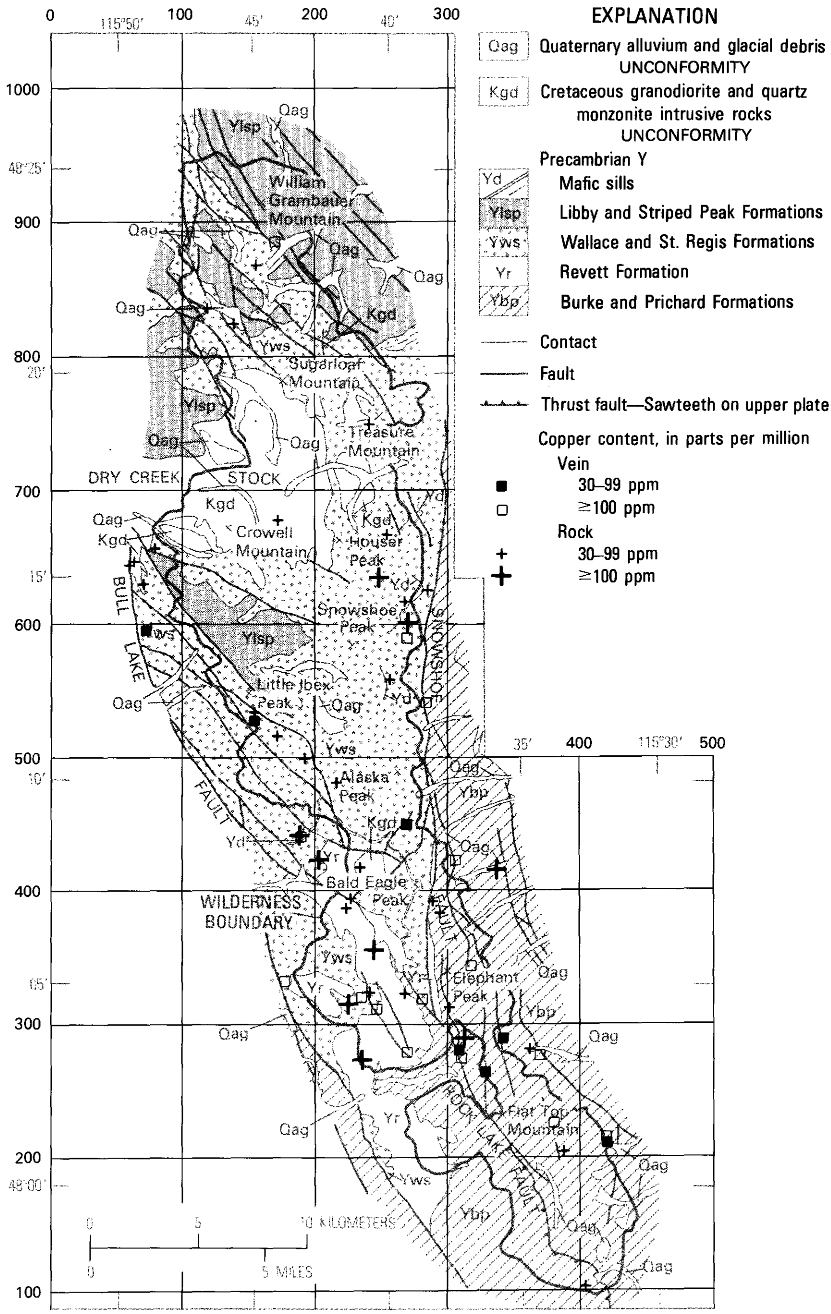


FIGURE 4.—Anomalous copper in rocks and veins, Cabinet Mountains Wilderness, Mont. Grid is in units of 20,000 ft (6,100 m); origin of grid at 10,000 ft (3,048 m) north of lat 47°52'30" N., long 115°52'30" W.

cussed in following sections were detected in amounts less than the measurable concentrations used as the limit of detection.) Concentrations are as high as 150 ppm in stream sediment, 10 ppm in soil, 20 ppm in rock, and 2,000 ppm in veins (tables 2, 3, and 4). Localities of samples having anomalous silver are shown in figures 6 and 7.

High concentrations of silver in stream sediment and soil occur in the same area where copper occurs in the Revett Formation west of the Rock Lake fault and north of Rock Creek, and along the Snowshoe fault from Poorman Creek north to the Snowshoe mine. Low-level silver anomalies extend the full length of the Snowshoe fault and along a north-northwest-trending zone of several small parallel faults that extends nearly to the north boundary of the wilderness. The widespread occurrence of low-level silver anomalies could indicate an extensive area of mineralized rock beneath the surface, but it is more likely that the silver is derived from small copper-silver occurrences in the green argillite beds of the Striped Peak Formation.

Rock samples containing anomalous silver (fig. 7) were concentrated in the same areas as the high copper in rocks north of Rock Creek. The highest silver values occur in the lead-zinc veins along the Snowshoe fault and the Rock Lake fault and in the copper-bearing veins north of Rock Creek.

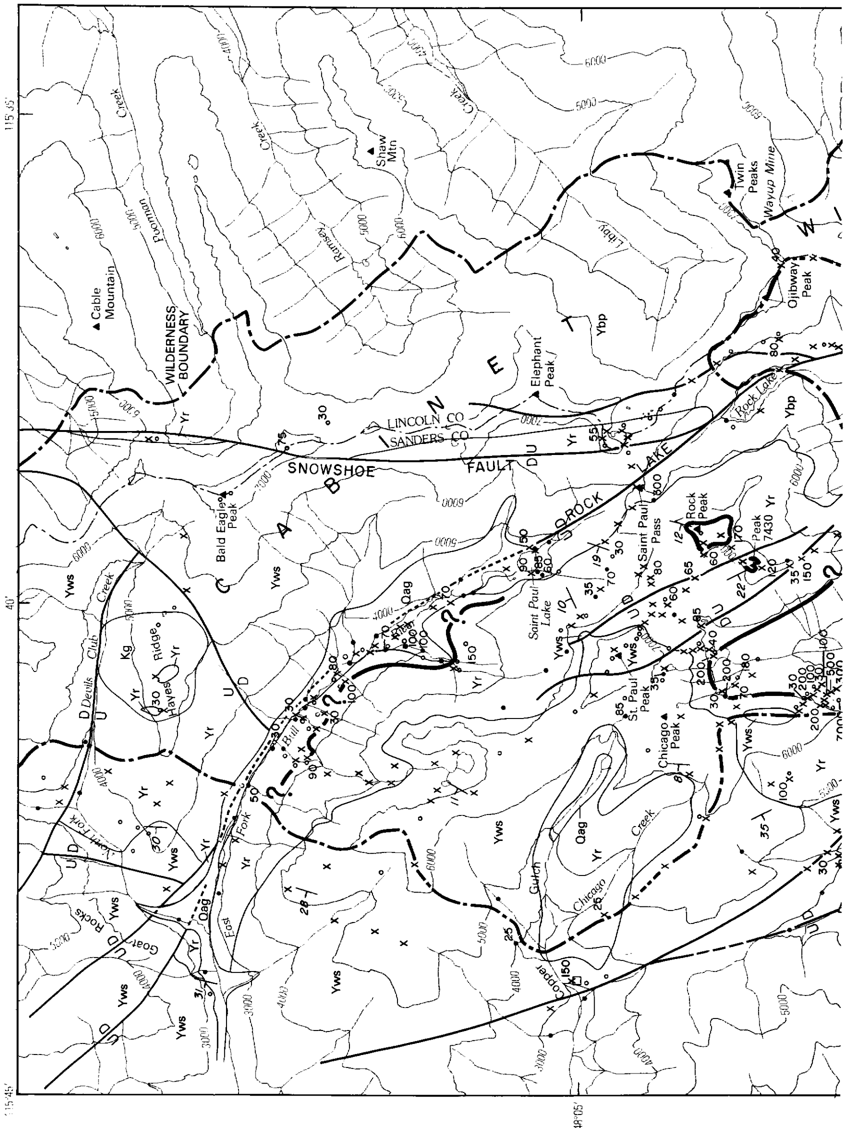
LEAD

Lead concentrations of 70 ppm or more in rock and veins are regarded as anomalous; concentrations of 150 ppm or more in stream sediment and soils are considered to be anomalous. As in the case of copper, values are somewhat higher in stream sediment and soil than in the parent rocks. Localities of samples having anomalous lead are shown in figures 8 and 9.

Anomalous concentrations of lead are most common just north of Rock Creek where they are associated with strata-bound copper in the Revett Formation, and along the Snowshoe fault from Poorman Creek to the Snowshoe mine. Samples X20, X297, X524, and D21 are rocks from the vicinity of the copper deposit in the Revett Formation. Lead occurs with zinc and silver in veins (table 4) along the southern parts of the Snowshoe and Rock Lake faults. Anomalous lead concentrations extend for about 0.7 mi (1.2 km) along Poorman Creek in and adjacent to the wilderness. Very little prospecting has occurred in this area.

ZINC

Zinc in detectable amounts (less than 200 ppm) is considered anomalous. Values range as high as 700 ppm in soil; stream sediment from below a tailings pond contains as much as 10,000 ppm; veins


WILDERNESS BOUNDARY
SNOWSHOE FAULT
ROCK LAKE
LINCOLN CO
SANDERS CO
Cable Mountain
Shaw Mtn
Twin Peaks
Wayup Mine
Ojibway Peak
Elephant Peak
Rock Peak
Rock Lake
Peak 7430
Saint Paul Pass
Saint Paul Lake
St. Paul Peak
Chicago Peak
Bald Eagle Peak
Hayes Ridge
Devils Club Creek
Goat Rocks
East Fork
Copper Gulch
Chicago Creek
115°35'
40'
115°45'
48°05'

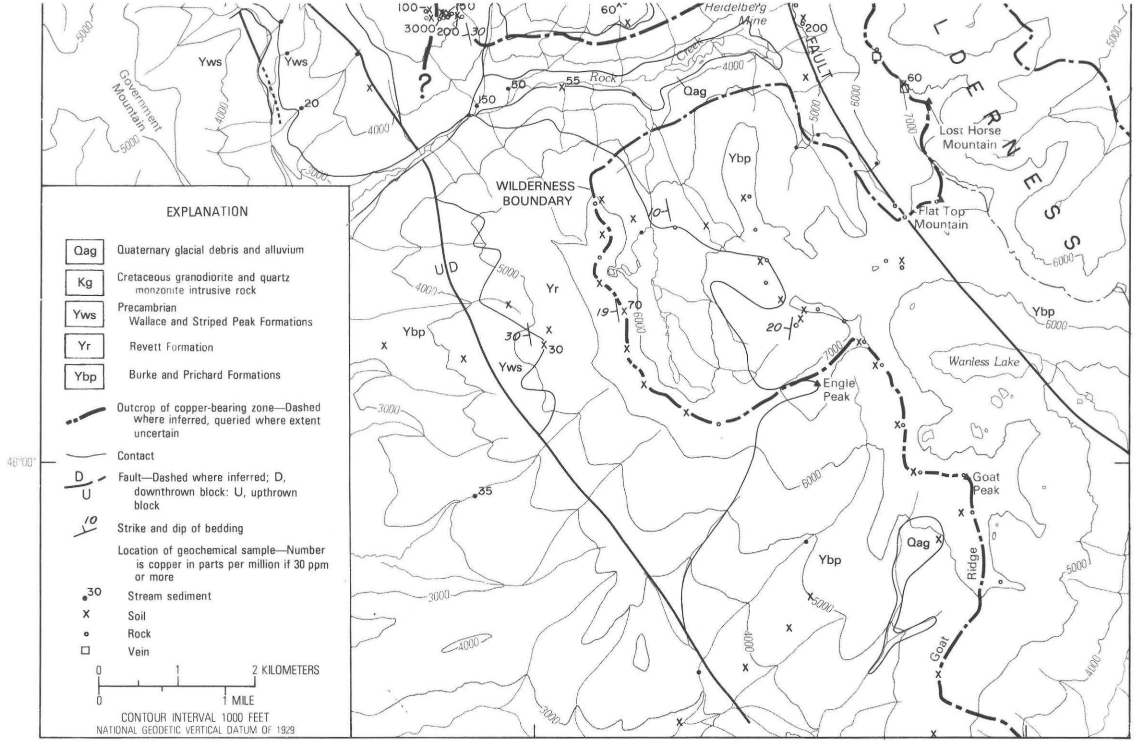


FIGURE 5.—Outcrops of copper-bearing zones in the Revett Formation, Cabinet Mountains Wilderness, Mont., as inferred from physical exploration, geochemical surveys, and geologic setting. Base from U.S. Geological Survey 1:24,000 Cable Mountain, Elephant Peak, Goat Peak, Howard Lake, Noxon Rapids Dam, Snowshoe Peak (1966).

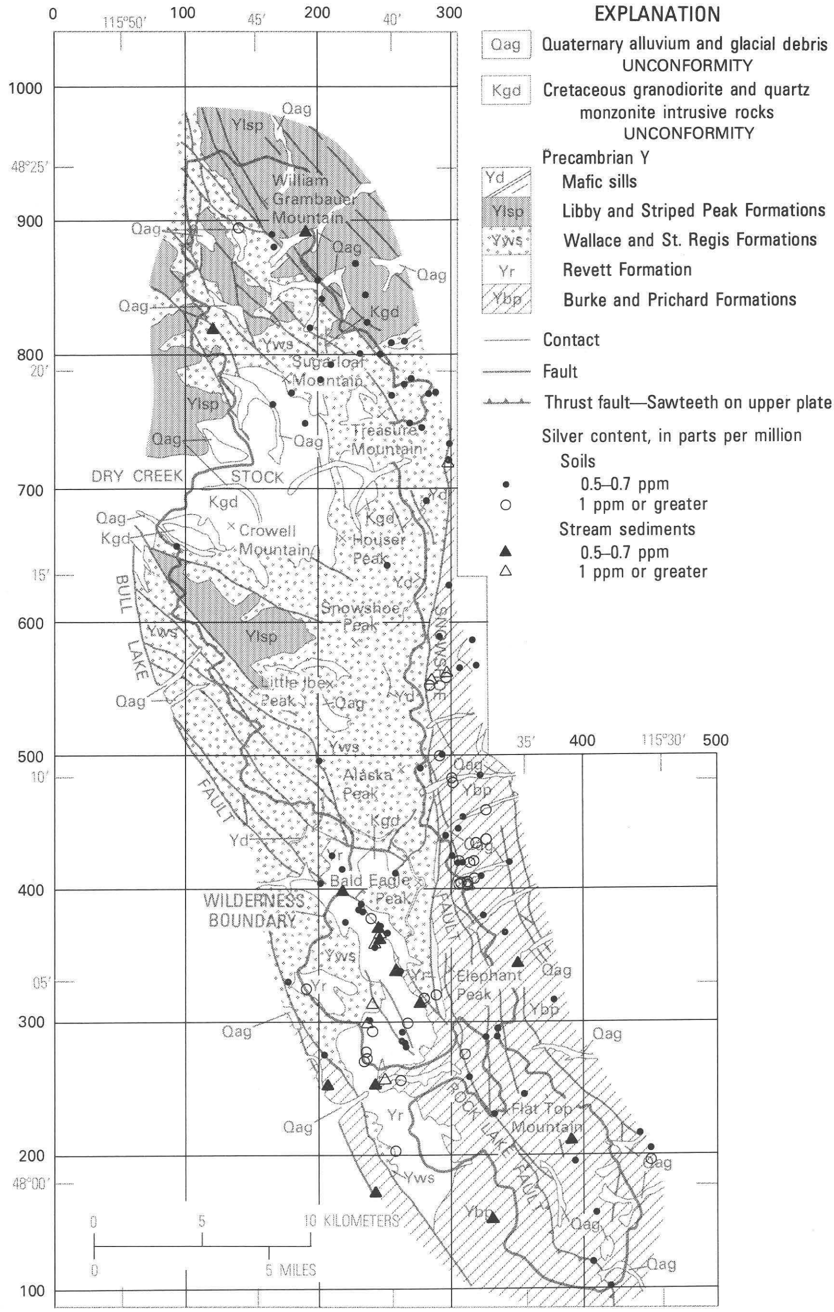


FIGURE 6.—Anomalous silver in soil and stream sediments, Cabinet Mountains Wilderness, Mont. Grid is in units of 20,000 ft (6,100 m); origin of grid at 10,000 ft (3,048 m) north of lat 47°52′30″ N., long 115°52′30″ W.

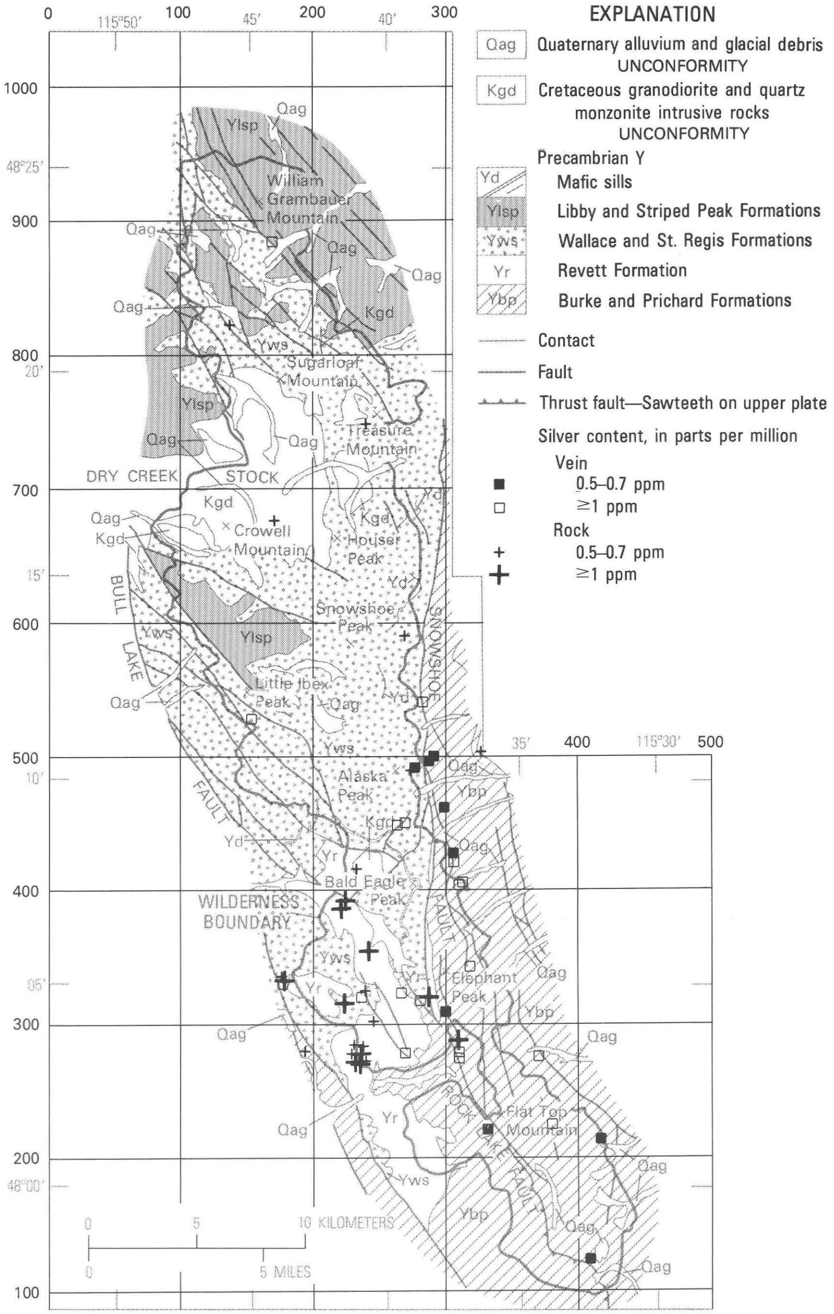


FIGURE 7.—Anomalous silver in rocks and veins, Cabinet Mountains Wilderness, Mont. Grid is in units of 20,000 ft (6,100 m); origin of grid at 10,000 ft (3,048 m) north of lat. 47°52′30″ N., long. 115°52′30″ W.

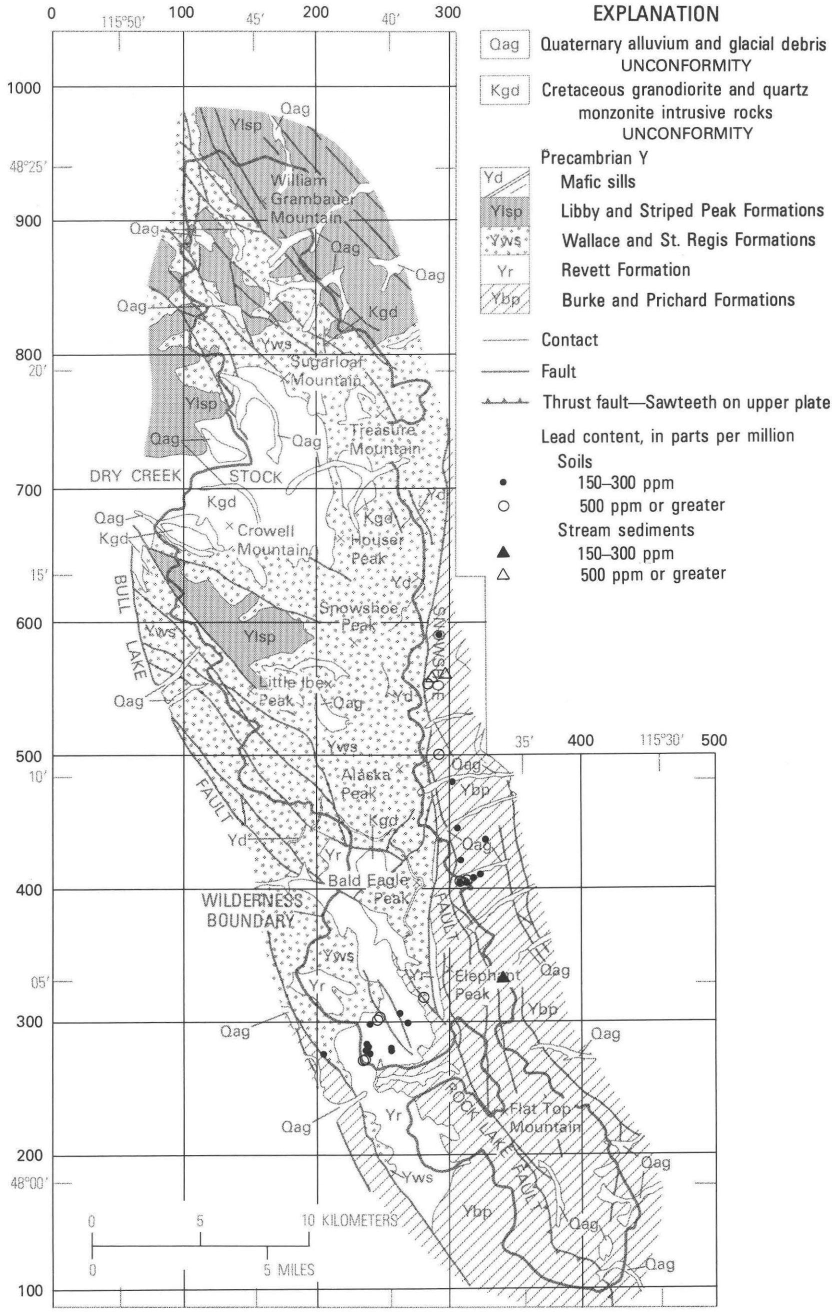


FIGURE 8.—Anomalous lead in soil and stream sediments, Cabinet Mountains Wilderness, Mont. Grid is in units of 20,000 ft (6,100 m); origin 10,000 ft (3,048 m) north of lat 47°52′30″ N., long 115°52′30″ W.

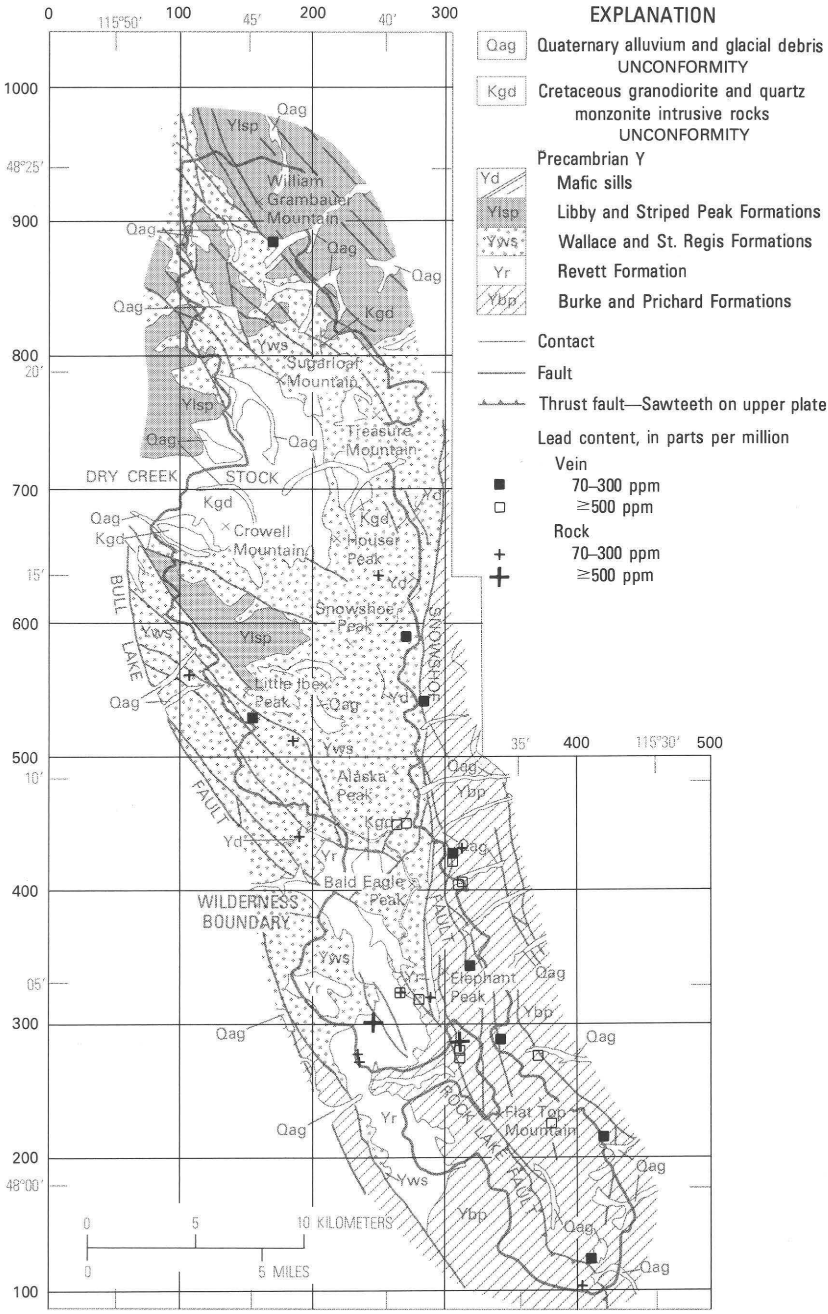


FIGURE 9.—Anomalous lead in rock and veins, Cabinet Mountains Wilderness, Mont. Grid is in units of 20,000 ft (6,100 m); origin 10,000 ft (3,048 m) north of lat 47°52′30″ N., long 115°52′30″ W.

contain as much as 500 ppm; and other rocks, 700 ppm (tables 2, 3, and 4). The localities of anomalous samples of stream sediment, soil, rock, and veins are shown in figure 10.

Anomalous concentrations of zinc occur mainly in veins along the Snowshoe fault; anomalous lead was found in stream sediment and soil samples nearby. Some lead was found in rock, but zinc was generally undetected in the area where strata-bound copper occurs in the Revett Formation north of Rock Creek.

MOLYBDENUM

Molybdenum in detectable amounts (less than 5 ppm) is considered anomalous. As much as 15 ppm molybdenum was found in soil and stream sediment, 70 ppm in rock, and 200 ppm in veins. Figure 11 shows the localities of samples with anomalous amounts of molybdenum.

Samples containing anomalous amounts of molybdenum were collected throughout the area. Most of the anomalous samples, having as much as 200 ppm, are from veins along the Rock Creek and Snowshoe faults (table 4; fig. 11). Rock, soil, and stream sediment that contain as much as 15 ppm molybdenum were found in and near the Dry Creek stock. No altered rock was observed in the stock and no other metal anomalies are present; therefore, the anomalous amounts of molybdenum may indicate only a high background level of that metal in the stock rather than a buried ore deposit.

GOLD

Gold in detectable amounts (less than 0.05 ppm) is considered anomalous. Values in this study are as much as 0.35 ppm in soil, 7.5 ppm in stream sediment below a tailings pile, 2 ppm in rock, and 25 ppm in veins. Figure 12 shows the location of samples with anomalous amounts of gold.

Anomalous amounts of gold were found in stream sediment, soil, and rock in the Wallace Formation, in mafic igneous rocks, and in veins (tables 2, 3, and 4). No anomalous gold values were found in the upper part of the Belt Supergroup. The highest gold values are in and near sulfide veins along the Snowshoe fault. Gold-bearing quartz veins occur along the Rock Lake fault from Saint Paul Pass to Wanless Lake and include those at the Heidelberg mine. Gold-bearing quartz veins are also scattered in an area southeast of the wilderness. Although some of the quartz veins are within or near the wilderness boundary, they are of limited extent and probably do not contain large resources. Most of the values shown as less than 0.05 ppm scattered throughout the area probably do not indicate significant mineral potential.

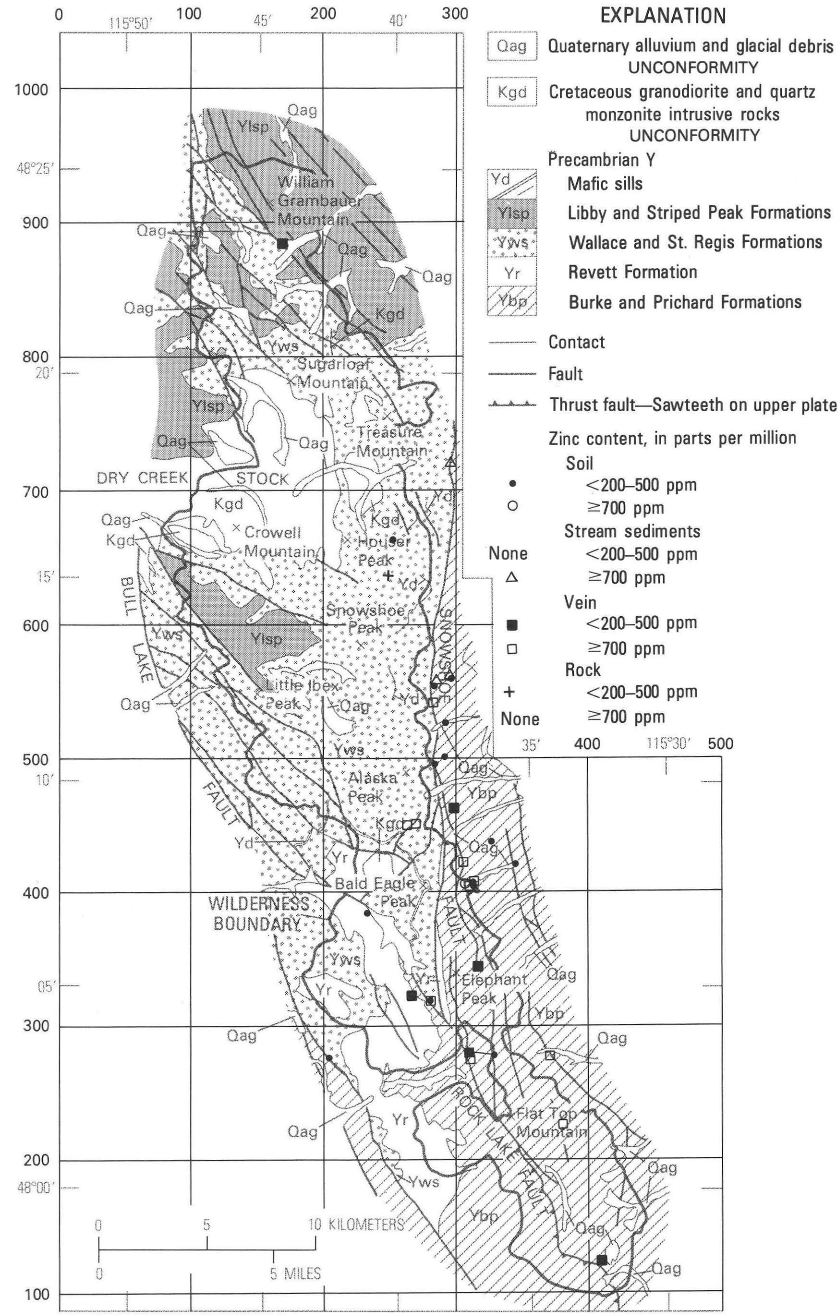


FIGURE 10.—Anomalous zinc in soil, stream sediment, rock, and veins, Cabinet Mountains Wilderness, Mont. Grid is in units of 20,000 ft (6,100 m); origin 10,000 ft (3,048 m) north of lat 47°52′30″ N., long 115°52′30″ W.

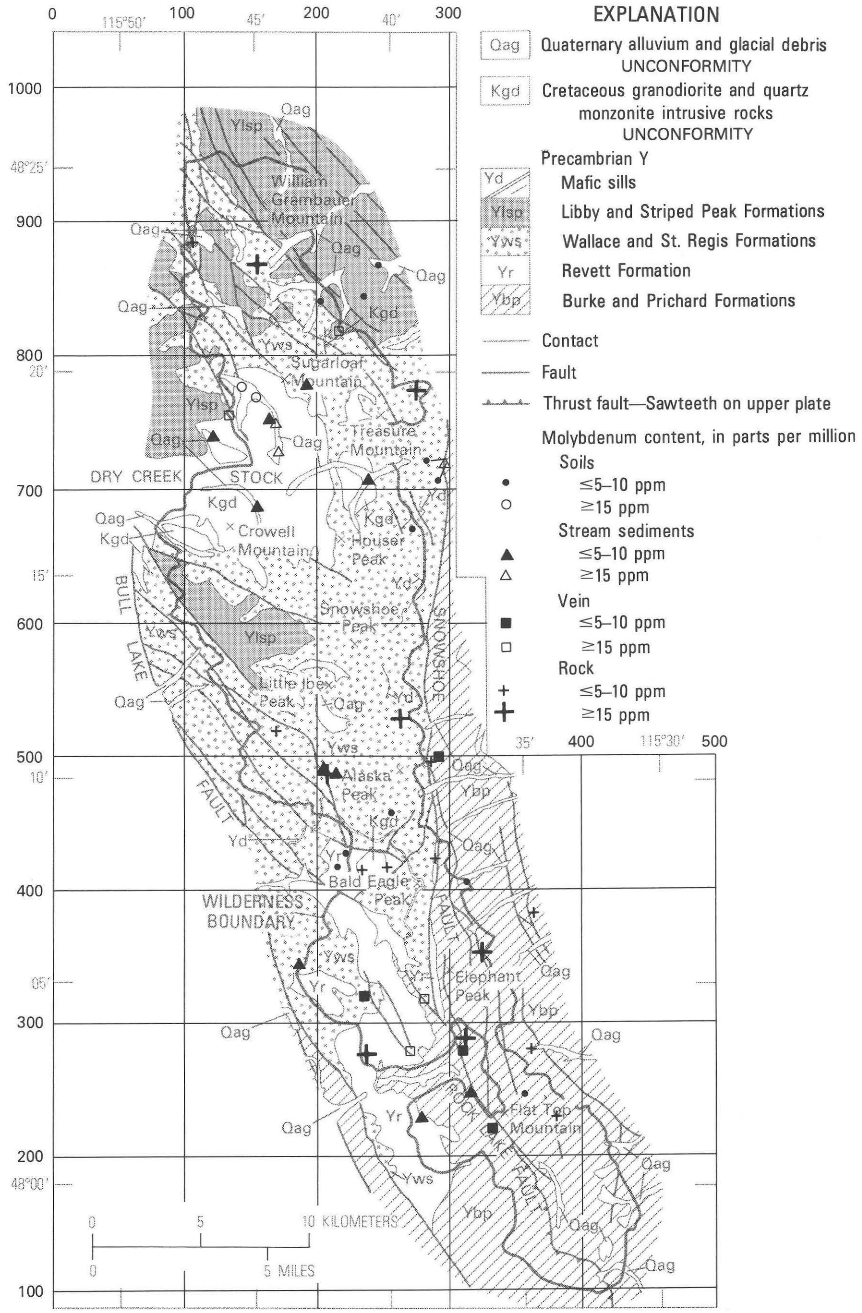


FIGURE 11.—Anomalous molybdenum in soil, stream sediment, rock, and veins, Cabinet Mountains Wilderness, Mont. Grid in units of 20,000 ft (6,100 m); origin 10,000 ft (3,048 m) north of lat 47°52′30″ N., long 115°52′30″ W.

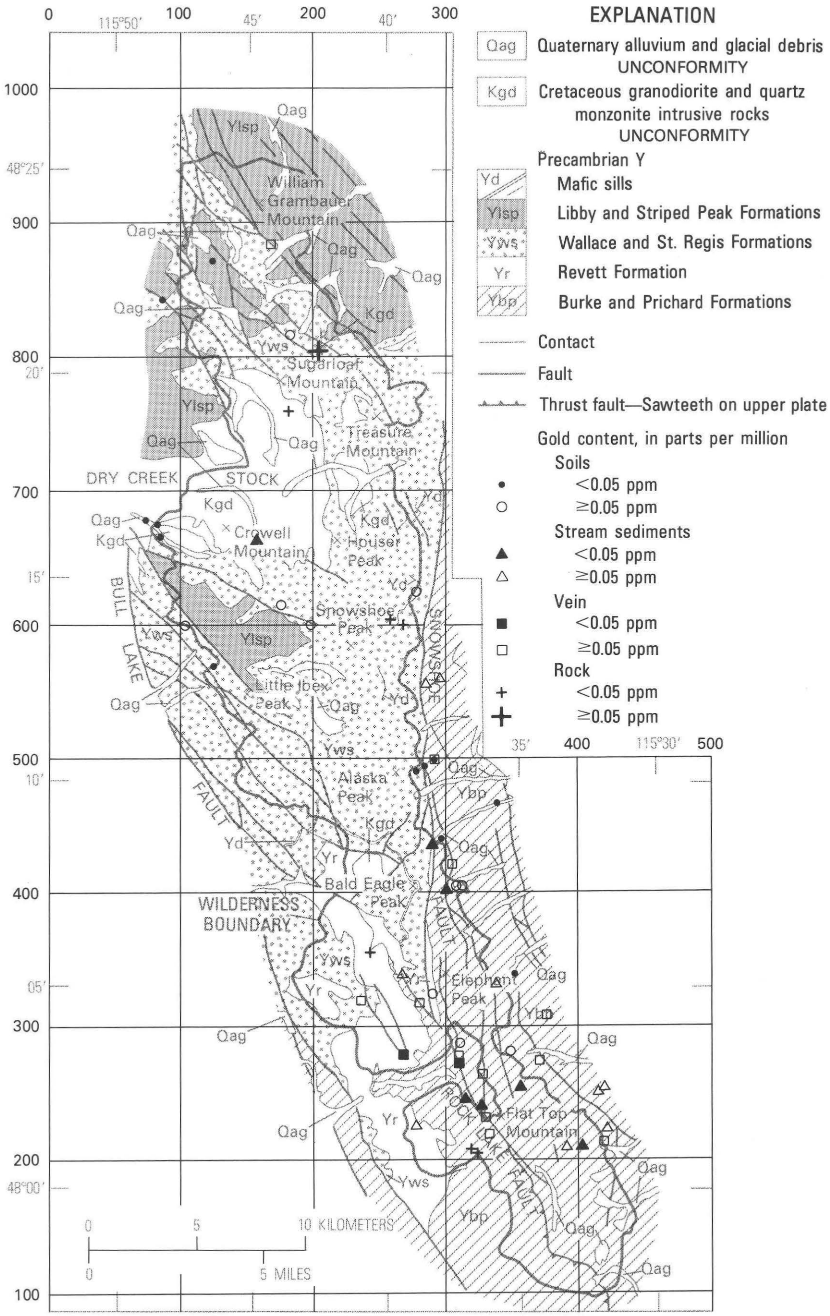


FIGURE 12.—Anomalous gold in soil, stream sediment, rock, and veins, Cabinet Mountains Wilderness, Mont. Grid in units of 20,000 ft (6,100 m); origin 10,000 ft (3,048 m) north of lat 47°52'30" N., long 115°52'30" W.

OTHER ELEMENTS

Other elements found locally in anomalous amounts include antimony, arsenic, barium, bismuth, cadmium, cobalt, chromium, mercury, nickel, and tungsten; the citrate-soluble fraction of HM (heavy metals) determined in soil and stream sediment was also locally anomalous (tables 2, 3, and 4; fig. 13). The principal areas of anomalous samples are near the copper deposit in the Revett Formation north of Rock Creek and along the Snowshoe fault where it passes the Snowshoe mine and the head of Poorman Creek.

Antimony in amounts greater than 100 ppm was detected in only a few samples in the Cabinet Mountains Wilderness. All of these are in samples from base-metal veins near the Snowshoe fault and stream-sediment samples collected below the tailings pile of the Snowshoe mine.

All detectable arsenic is considered anomalous. Arsenic ranges from less than 200 ppm to more than 10,000 ppm. All of the anomalous arsenic is from base-metal veins along the Snowshoe fault and from soils and stream sediment associated with veins. The highest concentrations were obtained from stream-sediment samples collected below the tailings of the Snowshoe mine.

Only two samples, both from the Wallace Formation in the northeastern part of the area, contain significant amounts of barium. These samples contain some molybdenum and mercury.

Small amounts of bismuth occur in samples from scattered localities throughout the area, but only those samples with 15 ppm or greater are considered anomalous. The highest concentrations are associated with the base-metal veins along the Snowshoe fault. Bismuth was not detected in the strata-bound copper deposit.

Cadmium values, generally less than 300 ppm, were found in the base-metal veins along the Snowshoe fault and in stream sediment below the tailings of the Snowshoe mine. Cadmium in the veins is probably present in sphalerite.

Cobalt concentrations in stream sediment and soils are generally less than 15 ppm but may range as high as 70 ppm. Cobalt was not considered to be present in anomalous amounts; however, the geochemical background in some of the rock formations is low, and so amounts of 30 ppm or more might be anomalous. A few samples from the Prichard, Burke, Wallace, lower part of Striped Peak, upper part of Striped Peak, and Libby Formations contain 50–70 ppm cobalt. These samples are widely scattered, and although chromium and copper occur in some of these, they probably do not indicate significant mineralized areas.

As much as 1,500 ppm chromium was found in a few samples. Most of these are associated with mafic sills that also contain anomalous

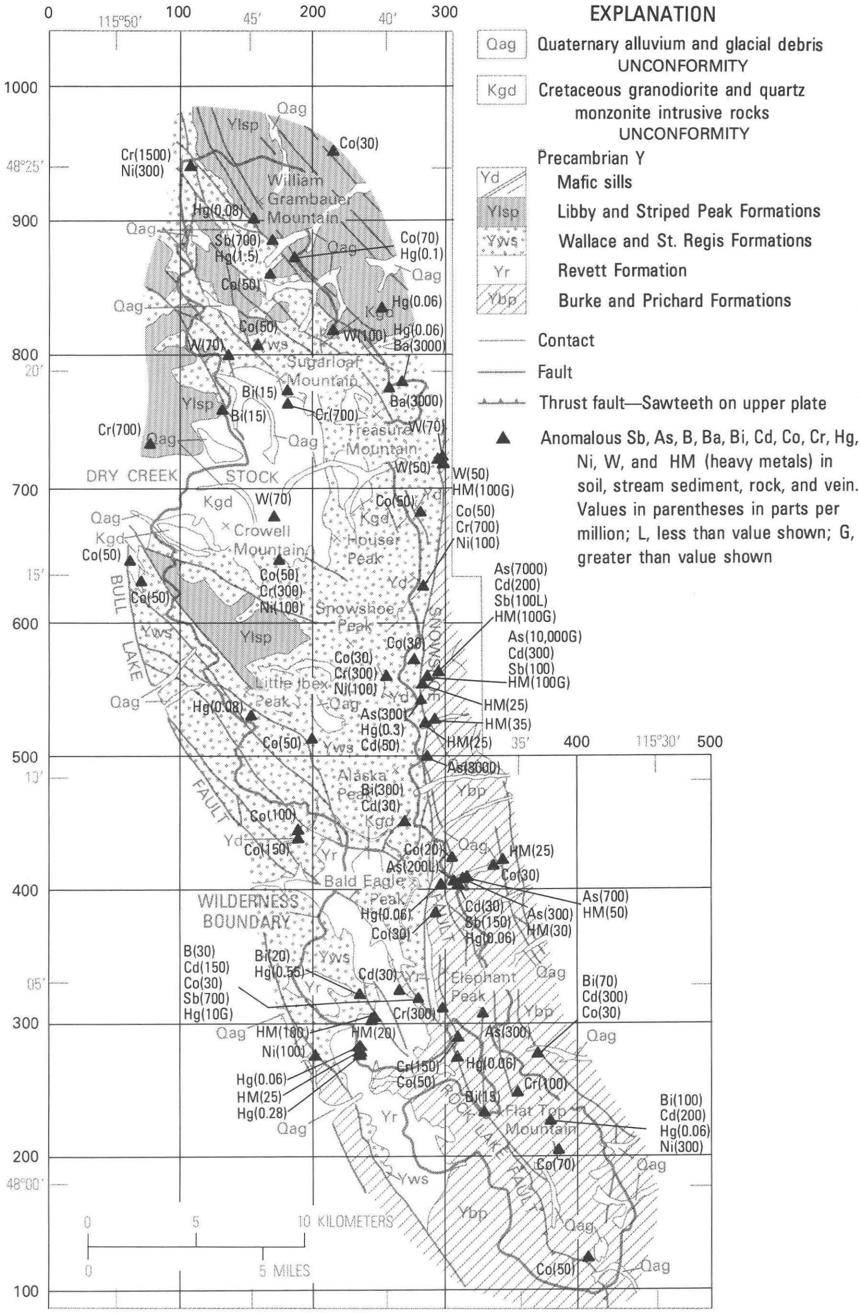


FIGURE 13.—Anomalous Sb, As, Ba, Bi, Cd, Co, Cr, Hg, Ni, W, and HM (heavy metals) in soil, stream sediment, rock, and veins, Cabinet Mountains Wilderness, Mont. Grid in units of 20,000 ft (6,100 m); origin 10,000 ft (3,048 m) north of lat 47°52′30″ N., long 115°52′30″ W.

amounts of nickel and cobalt. Although these concentrations are somewhat high, they are not unusual for mafic rocks in general and probably do not indicate mineralized areas.

Mercury is reported only for rock and vein samples. Determinations for mercury in stream sediment and soil are considered to be unreliable because of instrumental interference from organic material. The highest concentrations of mercury are in veins along the Snowshoe fault and in rock near the strata-bound copper deposit near Rock Creek. A few other rock samples from widely scattered locations contain small amounts of mercury.

A few samples having anomalous nickel occur mostly in veins along the Snowshoe fault and in mafic sills. These probably do not indicate significant mineralized areas.

Six samples containing more than 50 ppm tungsten were collected from the area. Three of these are stream-sediment and soil samples collected about 1½ mi (2.4 km) east of the wilderness boundary near Granite Creek. The other two samples were collected from thin veins in the granodiorite Dry Creek stock and just north of the stock in the wilderness. These two occurrences are too small to indicate extensive mineralized areas.

Determinations were made for citrate-soluble heavy metals (copper, silver, lead, and zinc) in the stream-sediment and soil samples. Values of 20 ppm or greater were considered to be anomalous. Anomalous concentrations of citrate-soluble heavy metals coincide generally with anomalous amounts of zinc, lead, and copper. The anomalous samples were collected from sites along the Snowshoe fault and in the area of the copper deposit north of Rock Creek.

CONCLUSIONS

Two well-defined areas, one north of Rock Creek, and the other along the Snowshoe fault, contain most of the anomalous samples. Copper, silver, and lead are most common in the mineralized Revett Formation of the Rock Creek area; lead, zinc, and silver are most common along the Snowshoe fault. The vein deposits along the Snowshoe fault and the Revett copper deposit appear to represent two different types of deposits geochemically as well as in form. Gold occurs in quartz veins in the southern part of the wilderness where the Burke and Prichard Formations are the host rocks. The Belt rocks stratigraphically above the Wallace Formation in the northern part of the area contain a weak silver anomaly, but the interpretation of this anomaly remains problematic.

Geochemical anomalies in the Revett Formation north of Rock Creek and west of the Rock Lake fault are more extensive than had been realized previous to this study. Copper and related metal anomalies extend about 3 mi (5 km) into the wilderness from Rock Creek to the East Fork Bull River and probably extend beneath the surface to the west. Copper-bearing veins cutting the St. Regis Formation in this area are evidence for buried copper deposits in the Revett. About 10 mi^2 (25 km^2) of the Revett Formation may contain copper deposits. Additional drilling would be necessary to prove the presence and extent of buried copper deposits.

The area of metal anomalies along the Snowshoe fault lies mostly outside the wilderness; it has been prospected in years past. Only thin discontinuous veins have been found, and unless new exploration at depth reveals larger, more continuous veins, the area has only a small potential for lead and silver. An area of about 0.25 mi^2 (0.65 km^2) along the wilderness boundary on Poorman Creek shows high values of lead and silver. Large amounts of arsenic and mercury, similar to those present at the Snowshoe mine, are found. These concentrations indicate a possible exploration target.

Gold values are widespread, but only the high values from veins may be of economic interest. Many of the veins are along the Snowshoe and Rock Lake faults.

REFERENCES CITED

Grimes, D. J., and Marranzino, A. P., 1968, Direct-current arc and alternating-current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: U.S. Geological Survey Circular 591, 6 p.

Economic appraisal of the Cabinet Mountains Wilderness, Lincoln and Sanders Counties, Montana

By D'ARCY P. BANISTER, ROBERT D. WELDIN, NICHOLAS T. ZILKA, *and* STEVEN W. SCHMAUCH, U.S. BUREAU OF MINES

MINERAL RESOURCES OF THE CABINET MOUNTAINS WILDERNESS, LINCOLN AND SANDERS COUNTIES, MONTANA

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ECONOMIC APPRAISAL OF THE CABINET MOUNTAINS WILDERNESS, LINCOLN AND SANDERS COUNTIES, MONTANA

By D'ARCY P. BANISTER, ROBERT D. WELDIN, NICHOLAS T. ZILKA, and STEVEN W. SCHMAUCH, U.S. Bureau of Mines

INTRODUCTION

The Cabinet Mountains Wilderness is in the midst of a region where large quantities of silver, lead, zinc, and gold have been produced and significant copper deposits have been discovered. The area lies about 60 mi (100 km) north of the Coeur d'Alene mining district and about 5 mi (8 km) east of the Spar Lake copper deposit, which is 3 mi (5 km) west of Bull Lake. Mineral production in the immediate vicinity of the wilderness area has been from silver, lead, zinc, and gold veins and from placer gold deposits. The first mining was from gold placers just east of the wilderness area in the 1880's. Veins along the Snowshoe fault have been most productive; the Snowshoe mine, opened in 1892, has produced more than $1 million in ore.

In the mid 1960's, exploration by the Bear Creek Mining Co. revealed strata-bound copper deposits in the Revett Formation. Several deposits in this formation have been found between Trout Creek, 9 mi (15 km) south of the wilderness area, and Troy, 4 mi (7 km) north-northwest of the wilderness area. The most extensively explored deposit is near Spar Lake, about 3 mi (5 km) west of Bull Lake and 5 mi (8 km) west of the Cabinet Mountains Wilderness. A similar deposit was found on Rock Creek along the western boundary of the Cabinet Mountains Wilderness. The discovery outcrop is within the wilderness, and the deposit has been explored by drilling just outside the wilderness.

METHODS

The U.S. Bureau of Mines sampled all mines and prospects where bedrock was exposed, even where mineralized rock was not apparent. A total of 164 lode samples was taken. They were checked for radioactivity and fluorescence. All were analyzed by fire assay for gold and silver; other metallic elements were determined by atomic absorption, colorimetric, or X-ray fluorescence methods. At least one sample from each property or mineralized zone was analyzed by a semiquantitative spectrographic method. When an anomalous amount of a potentially valuable element was indicated, the sample was further assayed by a quantitative method. Several reconnaissance pan samples were taken to test for placer gold and other heavy detrital minerals. The samples were screened and then concentrated by a laboratory-size Wilfley[1] table.

Categories of resources used for this study follow those outlined by the U.S. Bureau of Mines and U.S. Geological Survey (1976). *Resources* are concentrations of naturally occurring materials from which commodities may be extracted, either currently or in the future. *Reserves* are part of the total resources and refer to mineralized material (ore) that can be mined and marketed under prevailing economic conditions. *Measured reserves* are those computed from sample analyses and measurements from closely spaced sample sites. *Indicated reserves* are computed partly from sample analyses and measurements and partly from reasonable projections. *Inferred reserves* are estimates based on relatively few sample sites and measurements, and on geologic evidence and projection. *Submarginal resources* require more than 1.5 times the current price or a major cost-reducing advance in mining and extractive technology. *Paramarginal resources* (a) border on being economic grade or (b) are not exploitable because of legal or political circumstances. Undiscovered resources include *hypothetical resources* in known mining districts and *speculative resources* in undiscovered districts.

MINERAL PRODUCTION

The Libby (Snowshoe), Cabinet (Fisher River), Silver Butte (Vermillion), and Noxon mining districts are on the east and southeast sides of the Cabinet Mountains Wilderness (pl. 2). Recorded mineral production since 1902 from mines within 5 mi (8 km) of the wilderness boundary totaled 431,375 tons (391,343 t) of ore containing 12,522 oz (389,472 g) gold, 311,149 oz (9,677,677 g) silver, 8,952,999 lb (4,061,080 kg) lead, 25,459 lb (11,548 kg) copper, and 322,964 lb

[1]Any use of brand names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey or the U.S. Bureau of Mines.

(146,496 kg) zinc (table 5). No records are available describing earlier production, but Dingman (1932, p. 24) reported that placer miners probably recovered over $100,000 worth of gold from Libby Creek, Big Cherry Creek, Little Cherry Creek, Howard Creek, West Fisher Creek, and other streams in the area.

TABLE 5. —*Recorded metal production, by district, from mines adjacent to the Cabinet Mountains Wilderness*

[U.S. Bureau of Mines product records, 1902 to present. Data recorded in inch-pound system; 1 ton = 0.9073 t; 1 oz (troy) = 31.103 g; 1 lb = 0.4536 kg]

Mining district	Tons of ore	Gold (oz)	Silver (oz)	Copper (lb)	Lead (lb)	Zinc (lb)
Libby-------	386,353	5,046	305,239	21,595	8,900,620	306,094
Cabinet-----	41,561	7,334	5,448	3,730	39,215	300
Silver Butte and Noxon-	3,461	142	462	134	13,164	16,570
Totals---	431,375	12,522	311,459	25,459	8,952,999	322,964

The Libby district has had the largest recorded production. Principal lode deposits are along the Snowshoe fault or related mineralized structures; the southern part of the 20-mi (30-km) fault extends into the study area. The Snowshoe mine (pl. 2, No. 9) was the largest and had peak production around the turn of the century.

Extensive activity in the Cabinet and Silver Butte districts began in the 1880's and centered on gold- and silver-bearing veins along bedding planes. Many claims were patented, especially in the Bramlet Creek area, which yielded most of the lode production.

Several deposits were developed along the Rock Lake fault both in and outside of the wilderness. The Heidelberg mine (pl. 2, No. 22) produced minor amounts of gold-silver ore.

Increases in metal prices and the discovery of disseminated copper and silver stimulated widespread prospecting in the region in the 1960's. Most significant was Bear Creek Mining Company's discovery of the Spar Lake deposit. This deposit is 5 mi (8 km) west of the Cabinet Mountains Wilderness and is a strata-bound deposit of disseminated sulfide minerals in quartzite. Other similar deposits were subsequently discovered, notably the Rock Creek deposit, which represents a significant resource along and within the Cabinet Wilderness.

MINERAL COMMODITIES AND ECONOMIC CONSIDERATIONS

Copper and silver occur in strata-bound deposits in the Revett Formation near Rock Creek in and along the southwest edge of the study area. Some vein deposits in and adjacent to the study area may also have potential for future production of gold, silver, lead, zinc, and copper.

The long-term outlook for these metals is for higher prices and demands, especially if greater emphasis is placed on domestic self sufficiency.

MINING CLAIMS

Courthouse records indicate that about 300 mining claims or groups of claims have been located within and along the edge of the study area. Most of the early claims were located from 1890 to 1930 along the eastern boundary and around Rock Lake. Most of the recent claim locations have been concentrated in the Rock Creek area. No patented claims are in the study area. Locations of mines, prospects, and claim groups are shown on plate 2.

MINERALIZED AREAS

Mineral location and mining activity in and near the study area have centered mainly on mineralized zones within the Precambrian Revett Formation, the Snowshoe fault, and the Rock Lake fault. The mineralized areas and associated prospects within the study area are described below in order of decreasing importance.

DEPOSITS RELATED TO THE REVETT FORMATION

Strata-bound copper deposits occur locally in a belt about 120 mi (190 km) long and 40 mi (60 km) wide that extends from British Columbia to the Coeur d'Alene mining district in Idaho. Strata-bound copper sulfide deposits are widespread in the Precambrian Belt rocks, but those of significance are in quartzite in the Revett Formation.

A significant deposit was discovered in the late 1960's by Bear Creek Mining Co. on Spar Lake, 5 mi (8 km) west of the Cabinet Mountains Wilderness. American Smelting and Refining Co. may develop the property. The deposit contains 58 million tons (53 million t) of quartzite averaging 0.79 percent copper and 1.67 oz silver per ton (57.3 g/t) (American Smelting and Refining Co., oral commun., 1975).

A geologically similar deposit within Revett quartzite occurs near Rock Creek, both within and along the west edge of the wilderness. Other strata-bound deposits may occur at depth in the study area, but they are difficult to identify. Attempts to correlate stratigraphic features have proven unsuccessful, and leaching and oxidation make surface sampling somewhat unreliable. Secondary copper minerals common on the surface along fracture planes are evidence of copper mineralization in the area. However, subsurface exploration would be necessary to establish the existence of any deposit.

ROCK CREEK AREA

The Rock Creek deposit (pl. 2, No. 21) is between the West Fork and the East Fork of Rock Creek, about 6.5 mi (10 km) northeast of Noxon. Access is via the Rock Creek and the Chicago Peak roads. Most of the Rock Creek road is well graveled and passable from May until November; the upper part of the Chicago Peak road is blocked by snow until early July.

The Revett Formation in the Rock Creek area is part of Precambrian strata that are folded in a gentle north-northwest-plunging anticline. The Revett Formation crops out mainly in this part of the study area and occupies an area about 12 mi (20 km) long and as much as 4 mi (6 km) wide.

Two sulfide-bearing zones were sampled. They are sections of mineralized beds or groups of beds. The lower zone is thicker, more highly mineralized, and of present economic interest. Sulfides occur disseminated in the form of discrete blebs as fracture fillings, and concentrated along bedding planes and basal portions of individual beds. Grain size of the sulfides increases with grain size of the host rocks. Chief sulfides are bornite, chalcopyrite, chalcocite, and galena.

The lower, main zone crops out about 1–2 mi (2–3 km) west of Rock Peak (fig. 14). This zone has been drilled just outside the study area along the ridge to Chicago Peak by Bear Creek Mining Co. (table 6). Weighted on the basis of sample length, the zone intersected by the drilling averages 0.35 percent copper and 0.51 oz silver per ton (17.8 g/t) and has an average thickness of 34 ft (10 m).

Sixteen chip samples were taken across outcrops of the main zone in the valley east of the drill sites (table 7). Outcrops of the zone were found for about 2 mi (3 km) along the strike. At the surface, the zone averages 0.06 percent copper and 0.6 oz silver per ton (21 g/t). The zone probably contains higher copper values beneath the surface because the surface has been leached. The average silver content of the zone at depth and that of surface outcrops are comparable, however.

The upper zone has been little explored but is known to crop out at 7,200 ft (2,195 m) elevation on Rock Peak (fig. 14). Major north-northwest-trending faults of unknown displacement have offset the upper zone. The mineral zone is 1 ft (0.3 m) thick where sampled. The sample assayed 0.06 percent copper and 0.3 oz silver per ton (10.3 g/t). Because of the remote location and narrow thickness, it is doubtful that it will be further explored.

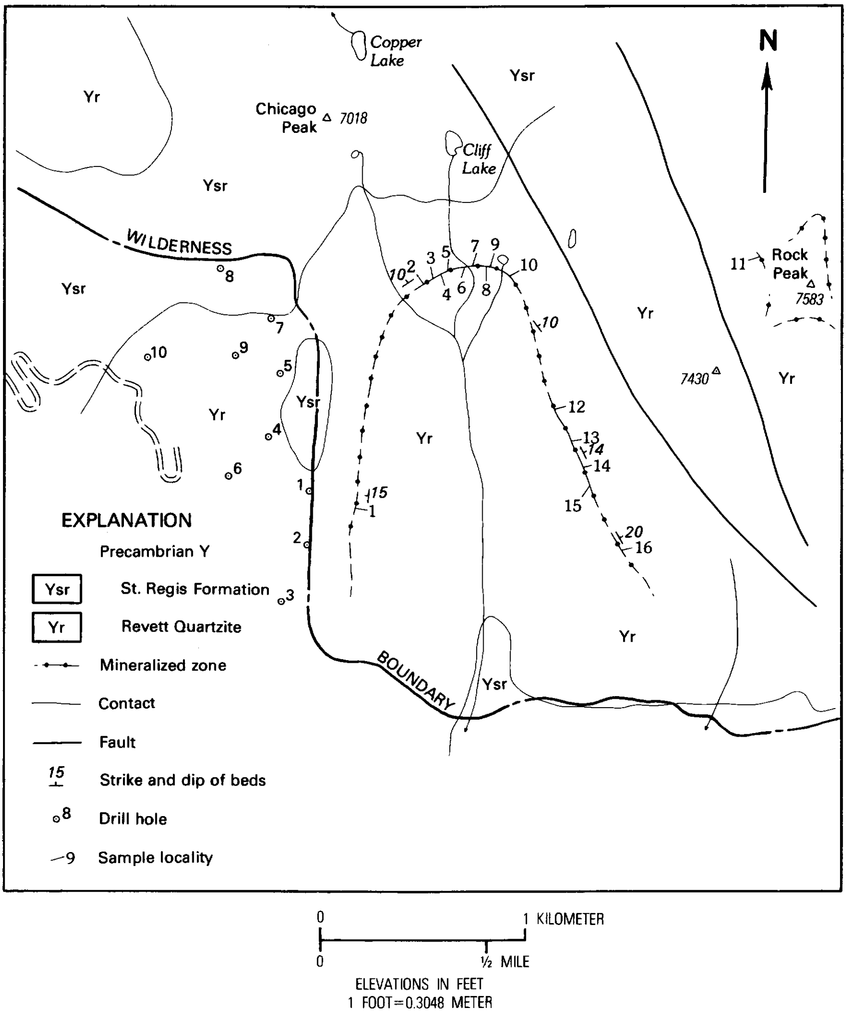

FIGURE 14.—Rock Creek area sample localities.

Indicated reserves and resources of the Rock Creek mineralized zones have been calculated using polygonal areas of influence between drill holes, a 15° average dip of the zone, and a 500-ft (150-m) maximum extension of the deposit beyond the holes.

Four million tons (3.6 million t) of indicated reserves averaging 0.86 percent copper and 1.80 oz silver per ton (61.7 g/t) are estimated near drill holes 1, 5, and 9 (fig. 14). Inclusion of the intervening block of low-grade material at hole 4 increases the estimated tonnage to 5.8 million tons (5.3 million t), but reduces the grade to 0.65 percent

TABLE 6. —*Summary of diamond drill-hole data, Rock Creek area*

[Data recorded in inch-pound system; 1 ft = 0.3048 m; 1 oz/ton = 34.285 g/t; 1 ton = 0.9073 t]

Hole No.	Thickness of mineralized zone (ft)[1]	Copper (percent)	Silver (oz/ton)	Estimated tonnage (millions of tons)
1---	18	0.99	1.5	1.4
	26	.82	.57	2.0
	46	.57	.80	3.6
2---	38	.42	.44	2.8
	62	.34	.35	4.6
3---	16	.30	.40	1.2
	50	.26	.34	3.7
4---	20	.18	.23	1.8
5---	21	.71	2.4	1.5
	36	.55	1.8	2.5
6---	22	.19	.03	1.7
7---	16.7	.56	1.34	1.3
	31.7	.47	.90	2.4
8---	8	.48	.65	.6
	34.7	.26	.42	2.8
9---	12	.87	1.4	1.1
	26	.50	8	2.3
10--	10	.10	.19	.9

[1]Numbers represent thickness of mineralized interval at different average grade. Compiled from Bear Creek Mining Co. unpublished data.

copper and 1.3 oz silver per ton (44.9 g/t). The remaining submarginal resources total 20.6 million tons (18.7 million t), averaging 0.29 percent copper and 0.4 oz silver per ton (13.7 g/t).

The mineralized zone probably extends east from the eastern outcrops to the fault north to Chicago Peak, and 500 ft (150 m) west of drill hole 10. Allowing for topographic limitations and assuming the zone to maintain the 34-foot average thickness displayed in the drill holes, about 70 million tons (63 million t) of inferred subeconomic resources are contiguous to the deposit blocked out by the drill holes. Additional drilling is needed to verify the assumptions, but because this area is almost entirely within the wilderness boundary, it has not been done.

The nature of the deposit and the occurrence of copper-bearing veins in Copper Gulch (pl. 2, Nos. 18, 19) 1 mi (1.6 km) north suggest that the zone may actually be more extensive.

TABLE 7.—*Summary of sample data from leached outcrops, Rock Creek area*

[Sample localities shown in fig. 14. Data given in inch-pound units; 1 ft = 0.3048 m; 1 oz/ton = 34.285 g/t]

Sample No.	Length (ft)	Copper (percent)	Silver (oz/ton)
1----	48.0	0.044	0.25
2----	5.0	.09	.7
3----	33.1	.003	.88
4----	18.3	.14	1.05
5----	23	.18	1.2
6----	12.0	.16	1.0
7----	2.0	.004	.1
8----	8.0	.096	1.25
9----	5.0	.008	.2
10----	37.0	.01	.1
11----	2.5	.06	.3
12----	8.5	.02	1.00
13----	10.0	.004	.5
14----	5.0	.085	.6
15----	7.0	.22	.9
16----	13.5	.02	.3

DEPOSITS RELATED TO THE SNOWSHOE FAULT

The Snowshoe fault zone consists of north- to northwest-trending near-vertical faults near the east edge of the study area. The majority of mining has been along the fault zone between Flower and Lake Creeks. The Snowshoe mine (pl. 2, No. 9) was the largest producer. Other properties with recorded production are the Silver Mountain (pl. 2, No. 5), Victor Empire (pl. 2, No. 4), Montana Silver Lead (pl. 2, No. 8), Fairbault (pl. 2, No. 11), Statesman (pl. 2, No. 15), and Silver Cable (pl. 2, No. 14). Mine and mill tailings have been reworked one or more times; several limited attempts have been made to reopen the Snowshoe and other mines, but none of the operations have persisted.

Lead, zinc, silver, and copper minerals have been discovered in numerous places along the Snowshoe fault zone, which is generally about 5 ft (1.5 m) wide and is a maximum of 15 ft (4.5 m) wide at the Snowshoe mine (Johns, 1970). Continuous, massive sulfide veins were only found at the Snowshoe mine where quartz and siderite veins in the fault zone range from less than an inch (2 cm) to a few feet (1–2 m) wide. Galena and sphalerite are the predominant sulfides, usually with pyrite, arsenopyrite, and chalcopyrite. Some of the sulfide minerals contain silver and some gold.

The Snowshoe mine and other properties on the northern portion of the fault zone are outside the study area and are not described in this report. Maps and descriptions of these mines are in Gibson (1948) and Johns (1970). Descriptions of two prospects that are on the southern part of the fault zone and within the study area are included here. The undeveloped parts of the fault zone should be considered good exploration targets.

POORMAN CREEK-STATESMAN PROSPECTS

The Poorman Creek–Statesman prospects (pl. 2, No. 15) are on the south side of Poorman Creek near its headwaters. The original Statesman is on the west side of the claim group. Access is from a logging road along the north side of the creek.

Several pits and short adits are on a series of north-trending, near-vertical faults that are part of the Snowshoe fault zone. The zone enters the study area on the Poorman Creek–Statesman prospects and continues to the south. The Silver Cable prospect, just over the ridge to the north, is on the northern extension of the fault zone.

Workings are on the three major faults (fig. 15) whose widths range from 1 to 8 ft (0.3 to 2.4 m) and contain numerous irregular quartz veins, lenses, and gouge. The country rock is quartzite and argillite that strike northwest and dip northeastward. The quartz vein contains galena, sphalerite, and pyrite, and lesser amounts of chalcopyrite, arsenopyrite, and pyrrhotite. Select samples of quartz vein material contained as much as 1.6 oz silver per ton (54.9 g/t) and 2.28 percent lead. Samples taken across the eastern fault, whose average width is 1.5 ft (0.5 m), averaged 0.02 oz gold per ton (0.69 g/t), 3.04 oz silver per ton (95 g/t), 3.02 percent lead, and minor zinc. Samples across the western fault, whose average width is 1.8 ft (0.5 m), averaged 0.02 oz gold per ton (0.69 g/t), 0.5 oz silver per ton (16 g/t), 0.6 percent lead, and a trace of zinc. Samples across the middle fault had a trace of gold, silver, lead, and zinc.

Mineralized material occurs in all three faults, but sampling indicates that the eastern fault contains enough mineralization to be of present interest. Assuming that the western fault maintains a 5-ft (1.5-m) average width over its intermittently exposed 1,600-ft (490-m) slope length, 0.5 million tons (0.45 million t) of submarginal resources can be inferred. Additional tonnages probably occur in the extensions of these faults or in similar faults in the Snowshoe fault zone to the south.

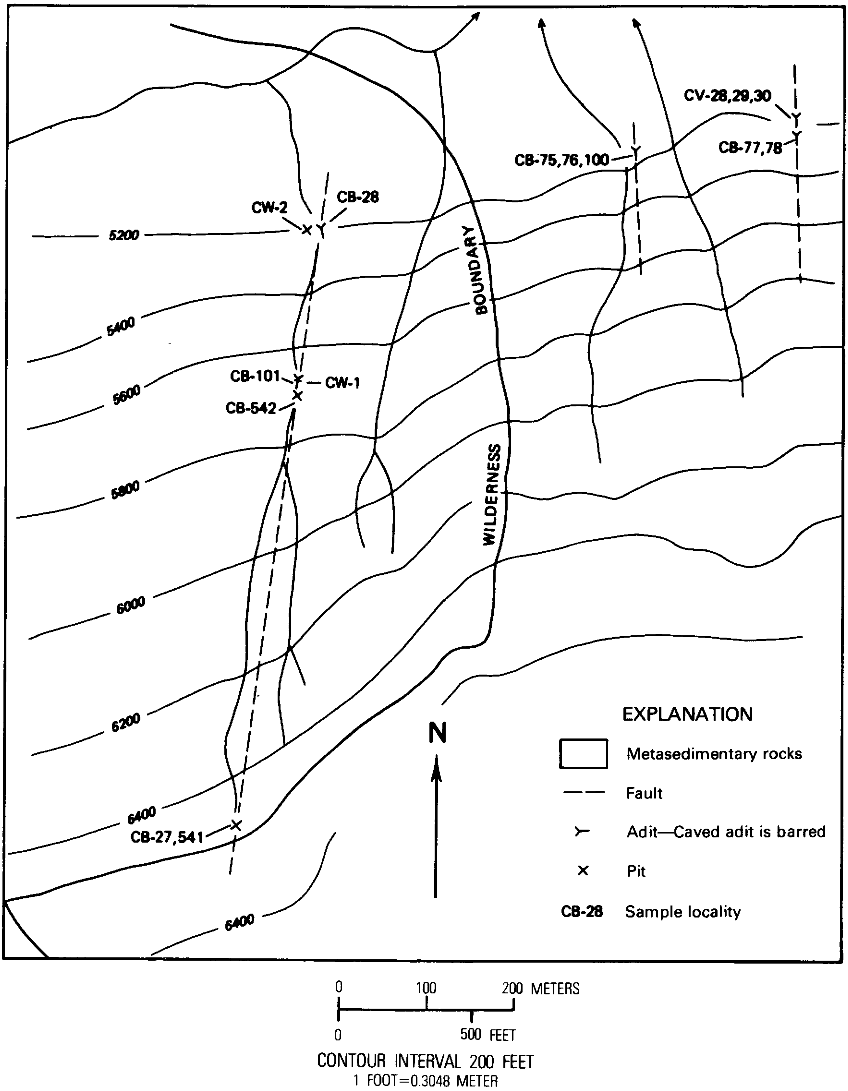

FIGURE 15.—Poorman Creek-Statesman prospects sample localities.

WAY UP MINE

The Way Up mine (pl. 2, No. 23) is on the side of the steep, south-facing mountain slope of Twin Peaks near the head of West Fisher Creek. A narrow, rough jeep road leads to the mine from West Fisher Creek road. U.S. Bureau of Mines records show 293 tons (266 t) of ore have been produced.

Analyses of samples from Poorman Creek–Statesman prospects, shown in figure 15

[Tr, trace; N, none detected; --, not applicable or not analyzed. Data shown in inch-pound units; 1 oz/ton = 34.285 g/t]

Sample No.	Type	Length (ft)	Description	Gold (oz/ton)	Silver (oz/ton)	Lead (per-cent)	Zinc (per-cent)
CB-27	Grab--	--	Dump material	Tr	1.0	1.96	0.04
CB-28	Select grab	--	-----do------	Tr	1.3	2.28	.38
CB-75	Chip--	0.8	Quartz vein--	0.01	.6	.23	.07
CB-76	--do--	3.3	Fault zone---	Tr	Tr	.05	.08
CB-77	--do--	3.2	-----do------	.02	5.5	4.02	1.22
CB-78	--do--	.5	Quartz vein--	.04	1.6	1.36	2.21
CB-100	--do--	2.5	Fault zone---	Tr	N	.07	.09
CB-101	--do--	4.5	-----do------	N	N	.04	.08
CB-541	--do--	1.6	-----do------	.05	2.1	2.10	.04
CB-542	--do--	.6	-----do------	Tr	.4	.16	.01
CV-28	--do--	1.3	-----do------	N	.3	.18	.10
CV-29	--do--	1.5	-----do------	.09	2.3	2.33	.82
CV-30	--do--	.8	-----do------	.01	Tr	.01	--
CW-1	--do--	1.3	-----do------	.11	.1	.25	.02
CW-2	--do--	1.0	-----do------	N	.4	1.60	.05

Four adits have been driven along a branch of the Snowshoe fault about ½ mi (1 km) south of Twin Peaks. All the workings were inaccessible. Johns (1970) indicated that the lower adit is 340 ft (100 m) long and that the upper adits are 180, 150, and 40 ft (55, 45, and 12 m) in length. A 110-ft (34-m) long adit on a separate minor structure is to the west. These workings are 800 ft (240 m) east of the study area boundary, but the fault extends into the area both to the north and south. The fault trends N. 10° E. and dips from 65° E. to vertical. It is bounded on the east by quartzite and on the west by argillite. The fault is about 4 ft (1.2 m) wide and filled with irregularly distributed, 2-in. (5.0-cm) wide quartz veins and gouge. Gold is associated with minor galena and pyrite in the quartz veins. Gold values as much as 0.60 oz/ton (20.6 g/t), were reported (Johns, 1970, p. 109) for material in the upper adits, but the total exposed fault averaged 0.24 oz/ton (8.29 g/t). Three samples taken across the fault by the Bureau of Mines, at the adit portals, averaged 0.46 oz gold per ton (15.8 g/t).

The significant gold values in the fault at the workings indicate that the several faults of the Snowshoe fault zone may have economic importance in this area.

DEPOSITS RELATED TO THE ROCK LAKE FAULT

The Rock Lake fault is one of the major structural features of the region. Gibson (1948, p. 46) estimated 2,500 ft (750 m) of vertical displacement for the 30-mi (48-km) long fault. Three mining properties are on the fault, two of which are in the wilderness area and one is outside. The Heidelberg (pl. 2, No. 22) has the only recorded production.

Mineralized zones consist of several small quartz veins along the fault with intervening gouge and breccia, or of single quartz veins along bedding-plane shears subsidiary to the fault. The veins pinch and swell and are both replacement and fissure fillings. Chalcopyrite, galena, and pyrite occur mainly in quartz with some calcite and sericite. Gold is associated with the sulfide minerals.

HEIDELBERG MINE

The Heidelberg mine (pl. 2, No. 22) consists of 20 claims south and southeast of Rock Lake just south of the study-area boundary. Access is by dirt road from Montana Highway 200.

The R. J. Price Mining Co. did initial exploration during the 1920's. A 45-ft (14-m) long adit between 4,000–4,500-ft (1,200–1,350-m) elevation east of Rock Creek was driven N. 10° E. to intersect the Rock Lake fault zone. The company changed its name to the Heidelberg Mining Company in 1936 and extended the crosscut to 780 ft (240 m), far short of the fault zone.

In the 1960's, a vein along a bedding-plane shear zone in a disturbed area adjacent to and just east of a branch of the Rock Lake fault zone was explored (fig. 16). A trench, a short adit, and a shaft expose this vein for 160 ft (50 m) along its strike. The vein parallels the bedding of the quartzite and argillite country rock, strikes about N. 15° E., and dips 35° to 45° SE. The vein is from 1 to 30 in. (2 to 75 cm) wide, but averages about 6 in. (15 cm). Four samples taken across the 160 ft (50 m) of the exposed vein have a weighted average of 1.58 oz gold per ton (54.2 g/t), 1.66 oz silver per ton (56.9 g/t), and minor lead, zinc, and copper. South of this area are three crosscuts driven to intersect the vein found in the shaft and associated workings.

The vein is reported to be intermittently exposed for 1,000 ft (300 m) (Crowley, 1963, p. 20). It may be exposed in the upper of two crosscuts that are located 1,300 ft (400 m) south of the shaft. A 6-in. (15-cm) wide quartz vein parallel to the bedding is crosscut by the 14-ft (4-m) upper adit. A sample (CV–22) of the vein in this crosscut contained 0.36 oz gold per ton (12.3 g/t) and 0.1 oz silver per ton (3.4 g/t). The next crosscut 300 ft (90 m) downslope is 350 ft (107 m) long. It

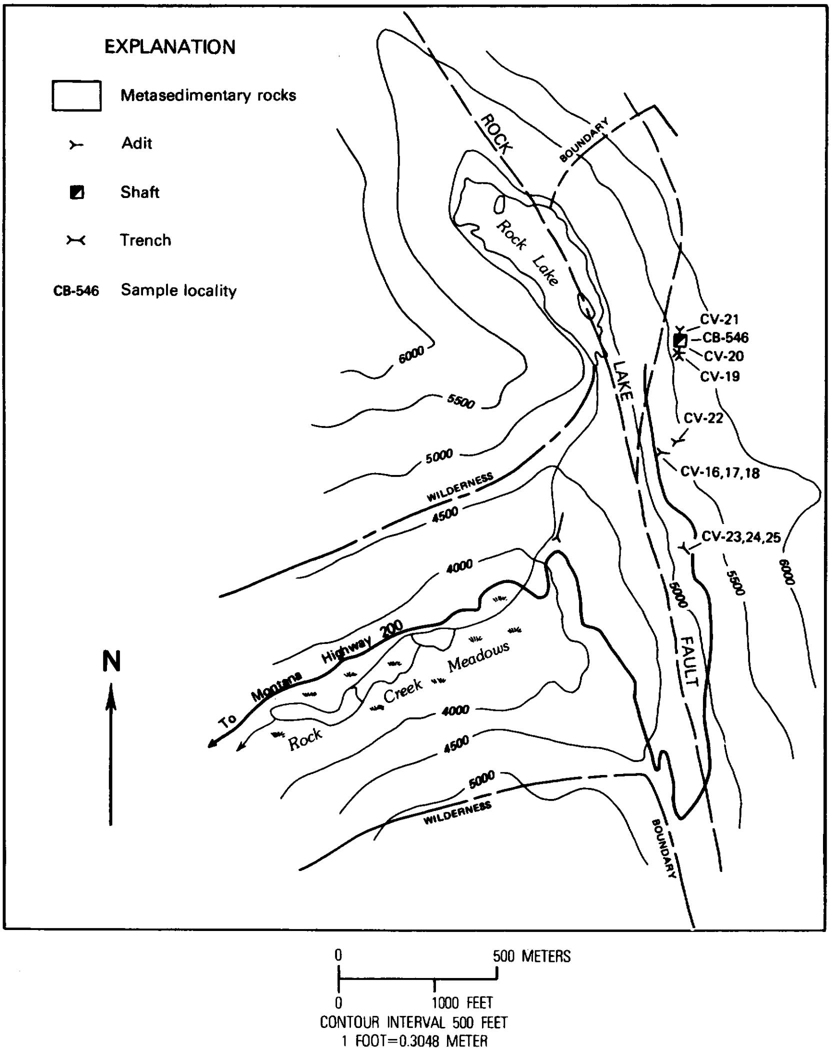

FIGURE 16.—Heidelberg mine area sample localities.

probably was not driven far enough to intersect the vein, but the crosscut does intersect quartz- and gouge-filled shear zones that contain traces of gold and silver. Fifteen hundred feet (450 m) farther south is a 105-ft (32-m) long crosscut, which trends S. 60° E. but does not intersect the vein. The crosscut does intersect a 4-ft (1.2-m) wide shear zone that strikes N. 30° W. and dips 60° to 80° NE. Samples of the zone contained as much as 0.01 oz gold per ton (0.34 g/t), 0.1 oz silver per ton (3.4 g/t), and 0.15 percent copper.

The apparent continuity of the vein suggests that it may extend

Data for samples from localities shown in figure 16

[Tr, trace; N, none detected; --, not applicable or not analyzed. Data recorded in inch-pound units; 1 ft = 0.3048 m; 1 oz/ton = 34.285 g/t]

Sample No.	Type	Length (ft)	Description	Gold (oz/ton)	Silver (oz/ton)	Lead (percent)	Zinc (percent)
CB-546	Chip--	2.0	Quartz vein	2.24	2.3	0.6	Tr
CV-16	--do--	1.5	Shear zone-	N	.1	--	--
CV-17	--do--	2.0	Quartz lens	N	.1	--	--
CV-18	--do--	1.0	Shear zone-	.02	.3	--	--
CV-19	--do--	2.0	Quartz vein	.25	.3	.1	--
CV-20	--do--	2.0	----do-----	2.90	3.0	1.0	--
CV-21	--do--	1.0	----do-----	.29	.4	.4	--
CV-22	--do--	.5	----do-----	.36	.1	.1	--
CV-23	--do--	4.0	Shear zone-	.01	Tr	Tr	--
CV-24	--do--	4.0	----do-----	N	.1	Tr	--
CV-25	Grab--	--	Shaft dump-	N	.1	Tr	--

northward into the study area. Samples from the northern workings indicate that the vein carries economically significant mineral values.

SAINT PAUL PASS PROSPECT

The prospect straddles Saint Paul Pass (pl. 2, No. 20). R. J. Price Mining Co. located the prospect in the 1920's. Access is by trail from Rock Lake.

A 20-ft (6-m) long adit and two pits expose the Rock Lake fault zone for a distance of over 200 ft (60 m). The zone trends N. 40° W. and dips steeply to the east. It is bounded on the west by the Burke Formation and on the east by the Wallace Formation. The zone is 8–10 ft (2–3 m) wide and contains several quartz veins, lenses, and pods. Veins range from 6 in. to 3 ft (15 cm to 1.0 m) wide, but are not continuous along the strike. Three selected chip samples of some of the mineralized areas averaged 0.01 oz gold per ton (0.34 g/t), 5.0 oz silver per ton (171.5 g/t), and 0.45 percent copper.

WANLESS LAKE PROSPECT

The Wanless Lake prospect (pl. 2, No. 35), also known as the Hamermill, is south of Wanless Lake on the Goat Peak Trail. A small pit is on part of the Rock Lake fault zone. Country rock is of the Prichard Formation on the west and the Burke Formation on the east side of the fault. The zone is poorly exposed but appears to be several feet wide and trends northwestward. Small quartz veins containing chalcopyrite, pyrite, and galena occur along shears within the zone. Two selected samples of some of the mineralized areas contained as much as 0.02 oz gold per ton (0.69 g/t), 0.2 oz silver per ton (6.9 g/t), and 0.5 percent lead.

OTHER DEPOSITS

Isolated mining claims and mineral occurrences not related to major geologic features occur at several localities, mainly in the southern part of the study area. Some mineralization was found in quartz veins along shears. The veins are commonly parallel to the bedding of the enclosing rocks, but some crosscut the beds at low angles. The veins pinch, swell, and often branch. Sheeting, caused by movement after formation of the veins, exists locally. Placer deposits have been claimed at the heads of several creeks on the east side of the area. Most of the sediments are essentially glacial till. The prospects and occurrences are described in order of importance. Other miscellaneous prospects are tabulated (table 8).

REMP MINE

The Remp mine (pl. 2, No. 2) is near the head of Cedar Creek and one-half mile (0.8 km) northeast of Lower Cedar Lake. Access is by 1 mi (1.6 km) of trail from the end of a dirt road. Early operators packed out a small amount of high-grade ore. The property (now the Silver Ghost) is intermittently active, but has not recently produced.

A quartz vein parallel to bedding is exposed in two groups of workings 260 ft (80 m) apart (fig. 17). The area between is covered by overburden. The vein trends N. 35° W. Tetrahedrite, galena, chalcocite, pyrite, pyrrhotite, and copper carbonates occur disseminated or in bands in argillite.

The vein is exposed for 90 ft (27 m) in a trench 220 ft (67 m) south of the cabin. The vein dips 28° SW. and ranges from 1.0 to 1.5 ft (0.3 to 0.5 m) wide. Three samples across it averaged 1.0 oz silver per ton (34.0 g/t) and 0.1 percent lead. A 20-ft (6-m) long adit 30 ft (9 m) below and slightly southwest of the trench was driven on a branch of the main vein dipping 55° SW. The adit failed to crosscut the main vein because it was driven at an improper bearing. Two caved adits, possibly on the vein, are 300 ft (90 m) farther southeast. A select sample from one of the dumps contained 12.8 oz silver per ton (398 g/t).

Northwest of the cabin, the vein crops out or is exposed by workings over a strike length of 280 ft (85 m). A 35-ft (10-m) deep inclined shaft and several small trenches explore the vein, which dips 36° SW. and ranges from 0.8 to 3.2 ft (0.2 to 1.0 m) wide. Seventeen samples

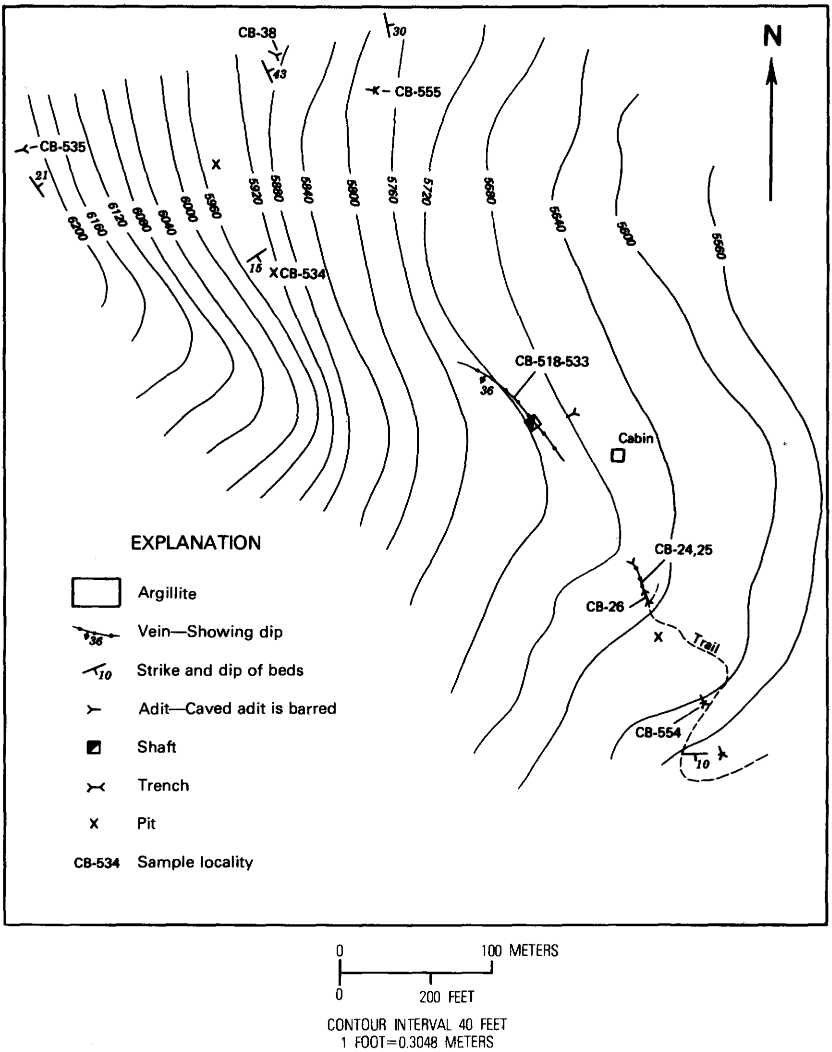

FIGURE 17.—Remp mine sample localities.

across the vein had a weighted-by-length average of 1.2 oz of silver per ton (41.2 g/t) and 0.27 percent lead. An adit is currently being driven S. 70° W. to crosscut the vein at depth. At the time of the examination, the adit was driven 35 ft (10 m), about 120 ft (36 m) short of intersecting the vein.

Assuming that the vein averages 1.6 ft (0.5 m) wide and is 630 ft (192 m) long, 25,000 tons (22,680 t) of submarginal resources are estimated.

Data for samples from localities shown in figure 17

[Tr, trace; N, none detected; --, not applicable or not analyzed. Data recorded in inch-pound units. 1 ft = 0.3048 m; 1 oz/ton = 34.285 g/t]

Sample No.	Type	Length (ft)	Description	Gold (oz/ton)	Silver (oz/ton)	Lead (percent)	Zinc (percent)
CB-24	Chip--	1.5	Quartz vein--	Tr	0.4	0.03	0.03
CB-25	--do--	1.0	-----do------	Tr	1.8	.25	.02
CB-26	--do--	1.3	-----do------	Tr	2.2	.28	.01
CB-38	--do--	.6	-----do------	Tr	.2	.09	.08
CB-518	--do--	3.1	-----do------	Tr	.4	.14	.01
CB-519	--do--	1.9	-----do------	Tr	.5	.06	.03
CB-520	--do--	1.6	-----do------	Tr	.6	.03	.03
CB-521	--do--	1.6	-----do------	Tr	.7	.21	.01
CB-522	--do--	3.0	-----do------	Tr	.5	.05	.09
CB-523	--do--	3.2	-----do------	Tr	1.0	.30	.04
CB-524	--do--	2.8	-----do------	Tr	2.8	.55	.03
CB-525	--do--	2.4	-----do------	Tr	.4	.14	.01
CB-526	--do--	2.1	-----do------	Tr	1.9	.90	.03
CB-527	--do--	1.5	-----do------	Tr	.6	.10	.01
CB-528	--do--	1.1	-----do------	Tr	.7	.05	.01
CB-529	--do--	2.2	-----do------	Tr	1.6	.13	.02
CB-530	--do--	2.4	-----do------	Tr	N	.01	.01
CB-531	--do--	1.4	-----do------	Tr	.1	.01	.01
CB-532	--do--	.9	-----do------	Tr	.3	.08	Tr
CB-533	--do--	.8	-----do------	Tr	.2	.03	Tr
CB-534	--do--	1.0	-----do------	Tr	2.1	.73	.07
CB-535	--do--	.8	-----do------	Tr	Tr	.02	Tr
CB-554	Grab--	--	Dump material	0.02	12.8	.04	.30
CB-555	Chip--	.4	Quartz vein--	Tr	3.1	1.00	--

FREEMAN PROSPECT

The Freeman prospect in the study area (pl. 2, No. 19) is at the head of Copper Gulch, 1 mi (1.6 km) from the end of the Chicago Peak road.

A copper-bearing quartz fissure vein is partially exposed on the east side of Copper Lake (fig. 18). The vein is traceable for about 1,600 ft (490 m). It strikes N. 55° W., dips 45° NE., and is in argillite. Principal workings are a 75-ft (23-m) long adit and an 80-ft (24-m) deep inclined shaft driven along the vein. The adit and shaft intersect at a depth of 20 ft (6 m). The vein averages 3 ft (0.9 m) wide, but is 7 ft (2 m) wide at the workings and narrows to 0.3 ft (0.1 m) wide to the southeast and northwest. Chalcocite, tetrahedrite, and copper

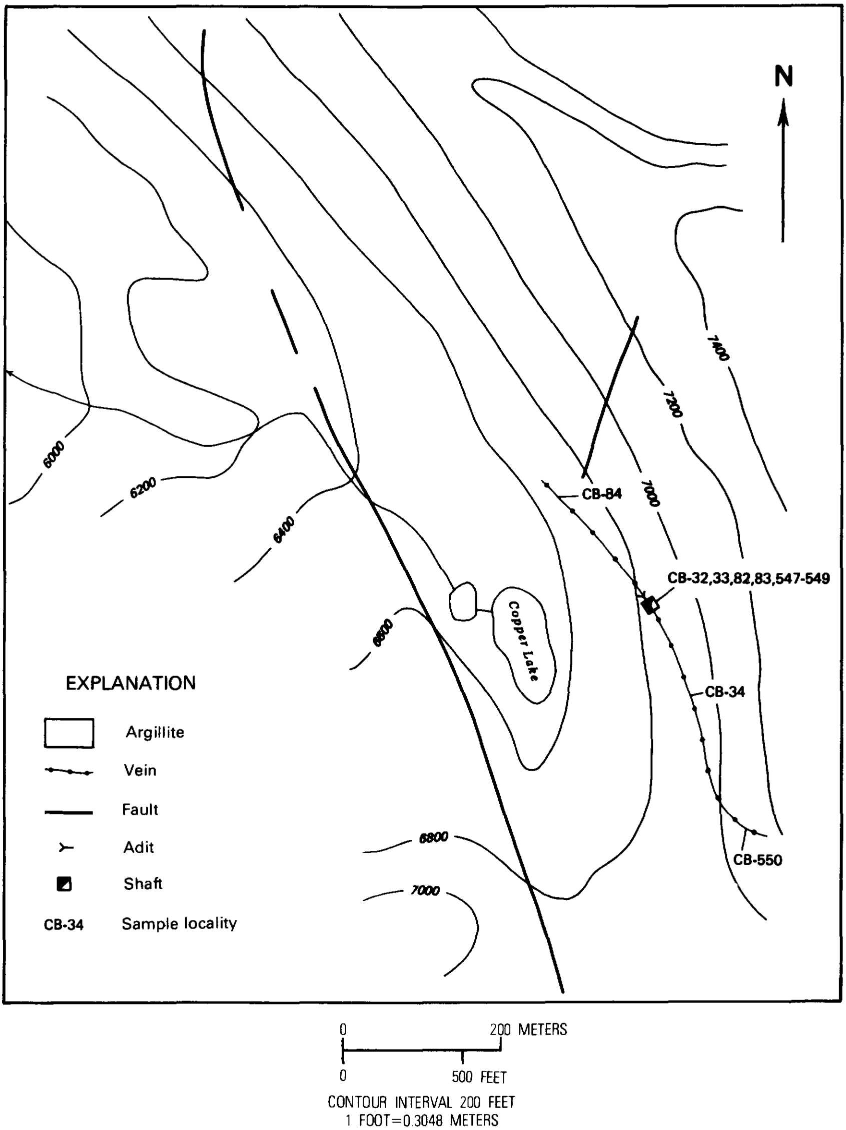

FIGURE 18.—Freeman prospect sample localities.

carbonate minerals occur both disseminated and as bands in the quartz vein. Samples of the 80x80x7-ft (24x24x2-m) block of vein material exposed in the workings averaged 1.3 oz silver per ton (44.6 g/t) and 1.8 percent copper. Samples from the northern and southern extensions contained as much as 0.8 oz silver per ton (27.4 g/t) and 0.6 percent copper.

Data for samples from localities shown in figure 18

[Tr, trace; N, none detected. All samples from quartz vein. Data recorded in inch-pound units; 1 ft = 0.3048 m; 1 oz/ton = 34.285 g/t]

Sample No.	Type	Length (ft)	Gold (oz/ton)	Silver (oz/ton)	Copper (percent)	Lead (percent)
CB-32	Chip--	4.0	Tr	0.5	0.12	0.04
CB-33	--do--	6.0	Tr	.7	1.86	N
CB-34	--do--	6.0	Tr	.2	.50	.01
CB-82	--do--	6.0	Tr	2.3	3.69	N
CB-83	--do--	6.5	Tr	1.5	2.51	N
CB-84	--do--	.3	Tr	.6	.51	N
CB-547	--do--	1.5	Tr	3.8	3.08	N
CB-548	--do--	5.3	Tr	.3	.35	N
CB-549	--do--	.9	Tr	1.1	.85	N
CB-550	--do--	1.2	Tr	.8	.55	N

FOURTH OF JULY-ILLINOIS-MONTANA GROUP

The Fourth of July–Illinois–Montana group (pl. 2, No. 36) are patented claims on the wilderness boundary and include the small ridge to the northeast of Geiger Lakes. Access is by trail from the Lake Creek road and by a primitive road up Fourth of July Creek. A production of 1,000 tons (900 t) of ore was realized from the group around 1902. A mill on Fourth of July Creek burned in 1909 (Gibson, 1948, p. 90).

The upper part of the ridge contains numerous quartz veins conformable with the bedding of the argillite country rock. The argillite strikes N. 20° W. and dips 15° NE. Argillite adjacent to the veins is limonite stained and silicified.

Exploration on the north side of the ridge consists of two 200-ft (60-m) long trenches on a 1-ft (0.3-m) wide vein (fig. 19). They are about 200 ft (60 m) apart and trend northeast along the ridge. An 80-ft (24-m) long adit was driven S. 20° E. on the vein from the east end of the western trench. Three samples taken across the vein exposed in the western trench and in the adit averaged 0.01 oz gold per ton (0.3 g/t) and 0.15 percent lead. A grab sample of the most mineralized material on the dump of the eastern trench contained 0.05 oz gold per ton (1.7 g/t), 0.03 oz silver per ton (1.0 g/t), 1.65 percent lead, and 0.15 percent zinc. Noncontinuous, 1-ft (0.3-m) wide veins are exposed by short

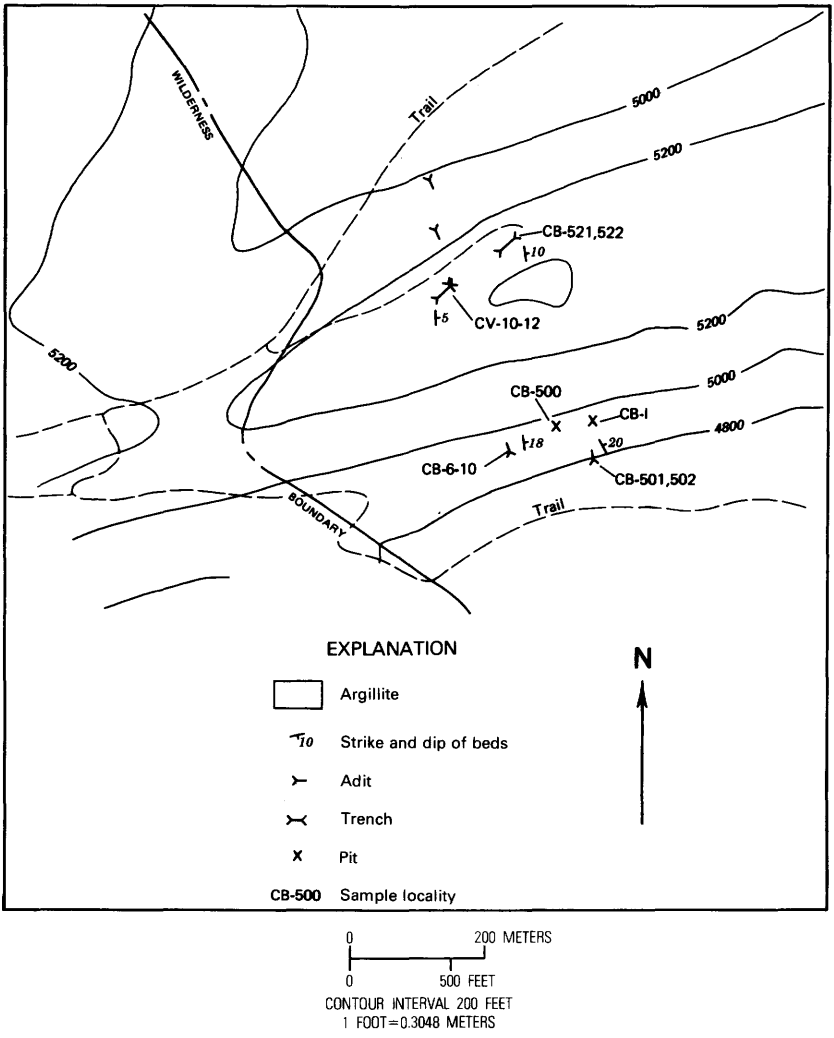

FIGURE 19.—Fourth of July–Illinois–Montana group sample localities.

adits 200 and 340 ft (60 and 100 m) below the main vein. No samples of the veins were taken.

Veins on the south side of the ridge are exposed by two adits and several pits. A 243-ft (74-m) long adit was driven N. 15° W. on a group of quartz veins parallel to bedding. Individual veins are 0.2–2.5 ft (0.1–0.8 m) wide. Vein material is similar to the main vein exposed on the north side of the ridge, but lower in section. Samples from the veins in the adit averaged a trace of gold, silver, copper, lead, and zinc. A sample of veins in a pit 200 ft (60 m) east of the adit assayed

Data for samples from localities shown in figure 19

[Tr, trace; N, none detected; --, not applicable or analyzed. Data shown in inch-pound units; 1 ft = 0.3048 m; 1 oz/ton = 34.285 g/t]

Sample No.	Type	Length (ft)	Description	Gold (oz/ ton)	Silver (oz/ ton)	Lead (per- cent)	Zinc (per- cent)
CB-1	Grab--	--	Dump-------	Tr	0.1	0.3	Tr
CB-6	Chip--	1.3	Quartz vein	Tr	.1	.3	Tr
CB-7	--do--	.4	----do-----	Tr	N	--	Tr
CB-8	--do--	1.3	----do-----	Tr	.2	Tr	--
CB-9	--do--	1.3	----do-----	Tr	N	--	--
CB-10	--do--	1.0	----do-----	Tr	.3	--	--
CB-500	--do--	7.0	----do-----	Tr	1.7	3.0	--
CB-501	--do--	1.1	----do-----	Tr	N	.1	Tr
CB-502	--do--	2.2	----do-----	Tr	N	.1	Tr
CB-521	--do--	1.0	----do-----	Tr	.3	1.9	Tr
CB-522	Grab--	--	----do-----	0.05	.3	1.7	0.3
CV-10	Chip--	1.6	----do-----	.02	N	.2	Tr
CV-11	--do--	1.5	----do-----	.01	N	.2	Tr
CV-12	--do--	1.1	----do-----	N	Tr	.2	Tr

1.7 oz silver per ton (58.3 g/t), 3.0 percent lead, and 0.9 percent copper. A 40-ft (12-m) long adit 400 ft (120 m) southeast of the main adit is on a separate, 1-ft (0.3-m) wide bedded quartz vein. Samples contained traces of gold, copper, and lead. The higher grade samples at the pit indicate that a potential for the discovery of lead and silver resources exists between the two sets of workings.

PLACER DEPOSITS

Placer deposits were located on several creeks that drain the wilderness study area. Except for claims along Granite Creek and possibly Parmenter Creek, the only sizable volume of gravels or till in the study area is that in glacial cirques. Old placer claims at the heads of Snowshoe, Bear, Cable, Ramsey, Libby, and Lake Creeks are in glacial cirques, but no evidence indicates that they were ever worked. The cirques are geologically unfavorable for economic concentration of valuable placer minerals, because the till has not been adequately reworked by stream action to concentrate any gold present.

Claims were located on more than 70 acres (28 ha) of stream gravel along Granite Creek in 1903. Most of this area is now inside the Cabinet Mountains Wilderness. Apparently the claims were soon abandoned; no records or old workings were found. A few pan samples were taken at sites most likely to contain concentrations of gold.

TABLE 8. —*Miscellaneous prospects*

Map No. (plate 2)	Prospect	Summary	Number and type of workings	Sample data
1----	Bee and Zee	Quartz veins a few inches to 2 ft (0.6 m) wide occur along shear zones conformable and unconformable with the bedding of the argillite host rock.	None--------------	Five select samples of veins; trace gold and silver.
3----	Indian Head Tungsten	Numerous quartz veinlets as much as 6 in. (15 cm) wide in quartzite and argillite.	None--------------	Two samples of veins; as much as 0.015 percent molybdenum and 0.01 percent tungsten.
7----	Leigh Creek	Discontinuous quartz veins as much as 1 ft (0.3 m) wide occur along bedding planes of northeast-striking, northwest-dipping Wallace Formation. Pyrite is the only sulfide identified.	Two adits, 50 ft (15 m) and 54 ft (16 m) long.	Four samples of quartz vein material on dumps and in place; trace copper and lead.
16----	Moran Basin	A northwest-striking and northeast-dipping, 1.6-ft (0.5-m)-thick quartz fissure vein intersects a northeast-striking, vertically dipping fault zone containing quartz veinlets.	Three trenches----	Three samples across structures; as much as 0.7 ounce silver per ton and 0.3 percent copper.

18----	Signal Point	A fault zone 8-12 in. (20-30 cm) wide cuts gently dipping, northeast-striking quartzite. Quartz veinlets occur locally in the 200-ft (60-m)-long zone.	One 170-ft (52-m)-long adit.	One sample across zone; 0.01 percent copper.
34----	Olsen-Switzer	A 2-3-ft (0.6-1-m) wide horizontal quartz vein is partially exposed along the hillside 20 ft (6 m) above Bramlet Lake.	One caved adit, four trenches, two dozer cuts.	Five dump samples; as much as 0.2 ounce silver per ton and 0.35 percent lead.
38----	Gold Standard	Several small veins and dikes occur along shears, both conformable and unconformable with the bedding of quartzite and argillite host rocks. The veins are as much as 8 in. (20 cm) wide. Minor malachite, azurite, chalcopyrite, and pyrite are found.	Two adits, eight pits.	Nine samples of vein and dike material; as much as 0.03 ounce gold per ton, 0.2 ounce silver per ton, and 0.5 percent lead.

Most of the gravel was too deep to obtain samples on bedrock except for one sample near the upper end. Gold values were less than one-half cent per cubic yard ($0.001 g/m^3), and black sands were less than 2 lb/yd^3 (0.69 kg/m^3). Traces of tungsten were present.

MISCELLANEOUS PROSPECTS

Miscellaneous prospects having no historical importance or apparent mineral potential are tabulated in table 8.

CONCLUSIONS

No production has been recorded from the Cabinet Wilderness, but three areas of mineralized zones have potential. Recently discovered, potentially minable deposits are being explored nearby. County records indicate that about 300 claims have been located within the study area from 1882 to 1973.

The highest mineral potential in the study area appears to be in the vicinity of Rock Creek on the southwest side of the area. The Rock Creek area is underlain by a strata-bound, disseminated copper-silver zone, similar to the Spar Lake (Mt. Vernon) deposit to the northwest. (The Spar Lake deposit was discovered in the 1960's by Bear Creek Mining Company and may be developed by American Smelting and Refining Company.) On the basis of company diamond drilling just west of the wilderness boundary, and Bureau of Mines sampling in the wilderness just east of the boundary, about 4 million tons (3.6 million t) of indicated reserves exist that average 0.86 percent copper and 1.80 oz silver per ton (62 g/t); and about 21 million tons (19 million t) of indicated subeconomic resources exist that average 0.29 percent copper and 0.4 oz silver per ton (13.7 g/t). An additional 70 million tons (64 million t) of copper-silver-bearing rock are inferred.

Several mines adjacent to the east side of the study area are along sulfide-bearing veins associated with the northwest-trending Snowshoe fault. Most mining has been along the northern part of the fault outside the study area. The southern portion extends into the wilderness area and two prospects may contain over 500,000 tons (454,000 t) of submarginal resources.

Veins associated with the Rock Lake fault are being explored at three localities. The Heidelberg vein near Rock Lake contains as much as 2.9 ounces of gold per ton (99 g/t). It may extend into the wilderness area.

Several isolated mining claims within the wilderness have been located on sulfide-bearing quartz fissure veins not related to the major structures. The veins presently have low economic potential. Placer claims have been located in areas covered by glacial till and have low potential.

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