Mineral Resources of the Mission Mountains Primitive Area, Missoula and Lake Counties, Montana

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STUDIES RELATED TO WILDERNESS—PRIMITIVE AREAS

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An evaluation of the mineral potential of the area

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STUDIES RELATED TO WILDERNESS

PRIMITIVE AREAS

Pursuant to the Wilderness Act (Public Law 88-577, Sept. 3, 1964) and the Conference Report on Senate Bill 4, 88th Congress, the U.S. Geological Survey and the U.S. Bureau of Mines are making mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," and "canoe" when the act was passed were incorporated into the National Wilderness Preservation System. Areas classed as "primitive" were not included in the Wilderness System, but the act provided that each primitive area should be studied for its suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. This bulletin reports the results of a mineral survey in the Mission Mountains Primitive Area, Montana. The area discussed in the report corresponds to the area under consideration for wilderness status.

This bulletin is one of a series of similar reports on primitive areas.

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By Jack E. Harrison, Mitchell W. Reynolds, and M. Dean Kleinkopf, U.S. Geological Survey, and Eldon C. Pattee, U.S. Bureau of Mines

SUMMARY

A mineral survey of the Mission Mountains Primitive Area was made by the U.S. Geological Survey and the U.S. Bureau of Mines during the summer of 1967, and an aeromagnetic survey of the area was made by the Geological Survey during the fall of the same year. The primitive area encompasses about 118 square miles of the rugged Mission Range, which is about 40 miles north from Missoula, Mont. The mountains are formed principally from slightly metamorphosed sedimentary rocks of Precambrian age (the Belt Supergroup) that have been intruded sparsely by quartz diorite of probable Tertiary age. The Precambrian rocks have been broken by a few faults and are gently folded in places, but these structural features do not significantly interrupt the uniform northward strike and gentle eastward dip of the rock layers.

Geologic examination along several hundred miles of foot traverses, plus semiquantitative spectrographic and chemical analyses of about 500 samples of bedrock and stream sediments, did not reveal any mineral deposits of economic significance. An aeromagnetic survey did not indicate evidence of potential mineral deposits. The general lack of hydrothermal alteration in rock layers or along faults indicates that mineralizing solutions have not affected the area significantly. Field examination and chemical analyses of samples revealed a widespread irregular distribution of minor amounts of copper and lead as primary constituents of certain kinds of sedimentary rocks. The copper and lead minerals are insufficient in amount to form large low-grade ore deposits, and they were insufficiently concentrated by the original sedimentary processes to form local high-grade ore deposits. Subsequently geologic processes have not significantly increased the original concentrations.

No mineral deposits were known in the area before the present investigation, and none were discovered. In the surrounding region, vein deposits of barite, gold, silver, copper, lead, and zinc are known, but most of these are associated with types of intrusive rocks not present in the primitive area. In similar geologic settings in nearby areas are strata-bound deposits (ore deposits in certain rock layers) of copper and noncommercial occurrences of phosphorite. No phosphorite was found in the area, and an intensive search for strata-bound copper deposits revealed only scattered mineral occurrences of no economic importance.

GEOLOGY AND MINERAL RESOURCES

By Jack E. Harrison, Mitchell W. Reynolds, and M. Dean Kleinkopf
U.S. Geological Survey

INTRODUCTION

LOCATION AND GEOGRAPHY

The Mission Mountains Primitive Area in Flathead National Forest covers about 118 square miles of the Mission Range, Missoula and Lake Counties, Mont. (fig. 1). The area is entirely on the eastern slope of the mountain range. It is about 30 miles long and 1 to 7 miles wide and extends from the range crest eastward toward Swan River valley. The crest of the range is not only the western boundary of the primitive area but also part of the eastern boundary of the Flathead Indian Reservation. Altitudes generally range from 9,000 feet on the range crest to 5,600 feet on the slopes along the eastern edge of the primitive area. The Swan River valley is 2,000 feet lower, at an altitude of about 3,600 feet.

The range crest is rugged and accessible only by helicopter or arduous mountain climbing. Lower slopes and valley are more gentle, but even there the streams contain numerous falls and rapids. The high country contains only sparse vegetation; the lower slopes, however, are covered by timber and thick brush, and the lower valleys are choked by dense brush, thick timber, and jackstraw piles of windfall. The timberline is at an elevation of about 7,700 feet. Chief scenic features are snowcapped pinnacles, glacial cirques (some of which contain small glaciers), knifesharp aretes, white-water streams, waterfalls, many crystal-clear alpine lakes, and spectacular cliffs exposing layer after layer of the bedrock (fig. 2). The many streams that flow east from the crest of the range (fig. 3) join the north-flowing Swan River, whose headwaters are in the rugged cirques of the southwestern part of the area.

Access to the primitive area is fairly easy from the east side, where paved roads from Kalispell and Missoula give ready access to the Swan River valley; a few good gravel roads extend westward to the primitive-area boundary. Access from the west side and travel within the area is by horseback or on foot along a few trails. Snow-filled passes, snow-covered trails, and high water levels in streams can make travel within the area difficult and hazardous from about October 1 to July 1.

PREVIOUS WORK

Previous geologic studies in the Mission Mountains Primitive Area have been few and limited in scope. Among such studies are the ob-

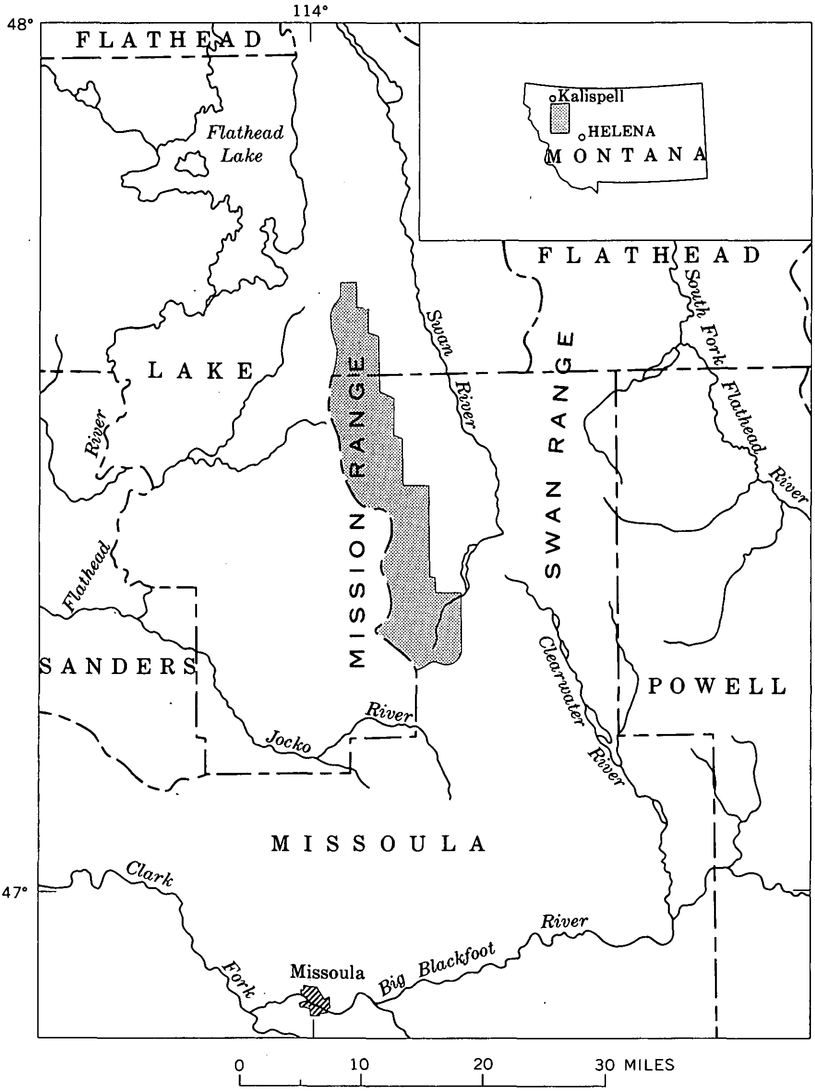

FIGURE 1.—Location of Mission Mountains Primitive Area (patterned).

servations on physiography by Davis (1916) and by Wilson.[1] Wilson also prepared a geologic map of the area based on "rough preliminary reconnaissance" that has been the principal source of geologic knowledge concerning bedrock in the high country. Pardee (1950) discussed the origin of the Mission Range and its gross landforms in conjunction with studies of similar geologic features of western

[1] Wilson, Roy A., 1929, Geology and physiography of the Mission Range region, Montana: Draft manuscript and maps submitted as dissertation to the Chicago Univ.

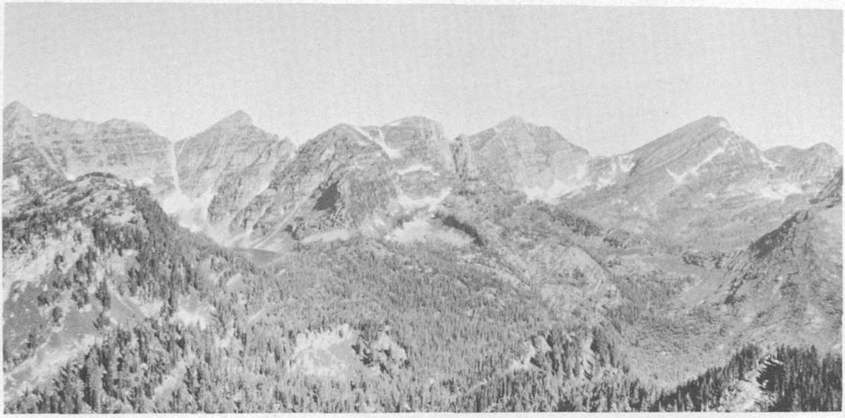

FIGURE 2.—Crestline of the Mission Range near Elk Lake. View northwestward toward crest which forms the western boundary of the primitive area. Low-dipping beds result from flexure excellently exposed in cirque containing Elk Lake (left center).

Montana. A stratigraphic study by O'Connor (1967) of rocks in a selected 1,000-foot interval is the only recent study known to us that concerns the bedrock in the area. Johns (1964) mapped the northern end of the Mission Range, and the southern boundary of his study area comes within 11 miles of the northern boundary of the primitive area.

PRESENT WORK AND ACKNOWLEDGMENTS

Geologic fieldwork was done in the primitive area between mid-June and late August 1967, by Harrison and Reynolds, who were assisted by John Lobdell and Donald Wilson, and for 1 day by A. L. Brokaw. Foot traverses were made through much of the area. Usually a helicopter carried the geologic parties into the high part of the area; from there they walked across the primitive area to a vehicle pickup point. In more inaccessible parts of the area, the helicopter was used for drops and pickups as well as for pinnacle-to-pinnacle transportation. The rocks were examined for evidence of mineralization, and both rocks and stream sediments were sampled systematically.

Spectrographic analyses for 31 elements were made on all samples in a mobile laboratory by David J. Grimes. The other analyses were made in Geological Survey laboratories in Denver, Colo.

An airborne magnetometer survey at 1-mile flight-line spacing was made in November 1967. Analysis and interpretation of the aeromagnetic data were done by Kleinkopf.

FIGURE 3.—Glacially scoured valleys separated by rugged east-trending ridges characterize the Mission Mountains Primitive Area. View to south from near Cedar Peak across most of the primitive area. Mountain peaks in the distance are higher, more rugged, and less timbered than those in the foreground. McDonald Peak, highest peak in the range and southwest of the primitive area, is in upper right center.

We are indebted to many people for aid during this study. Barney Sedlacek, district ranger, U.S. Forest Service, and members of his staff provided valuable advice on travel within the area and loaned radio equipment tuned to the Forest Service network that provided both a safety factor and a means of communicating with the helicopter at the base station. Willis M. Johns, chief geologist, Montana Bureau of Mines and Geology, kindly wrote to citizens in the Mission Mountains area who had submitted samples for mineral assay or identification to request that information regarding any mineralized areas known to them in the Mission Mountains be sent to us to aid in our mineral appraisal. We are particularly grateful to our helicopter pilots, Earl Palmer and Wil Talbot, who capably handled the aircraft in the difficult terrain, and to the mechanic, Ed Day, who ably maintained the helicopter. Richard Hickey, owner of the Diamond L Bar Ranch, provided information on little-known pack trails in the primitive area.

GEOLOGY

GEOLOGIC SETTING

The Mission Range is composed of north-trending fault-block mountains bounded on the east and west by major faults in the Swan River and Flathead River valleys and on the south by a fault in the Jocko River valley. The mountain range is about 55 miles long; it is about 18 miles wide at the south end and narrows to about 2 miles at the north end, where the north-trending bounding faults and the valleys occupied by the faults converge. Precambrian layered rocks have been pushed up and tilted eastward between the faults bounding the range, so that the west face of the mountains rises abruptly from the Flathead Valley whereas the east side slopes more gently along the dip of the rock layers into the Swan River valley.

Metasedimentary rocks of the Belt Supergroup of Precambrian age form most of the range. Similar rocks crop out over thousands of square miles of western Montana, northern Idaho, and southern British Columbia. A few quartz-diorite dikes and sills of probable Tertiary age compose a small percentage of the exposed bedrock in the Mission Range. Surficial deposits, consisting principally of glacial debris, cover the bedrock in increasing thickness from about halfway down the mountain slopes to the main north-trending valley floors.

Block faulting and tilting that raised the range to its present position were suggested by Pardee (1950, p. 395) as being late Tertiary or early Quaternary in age (a few million years ago). Although about 20,000 feet of slightly metamorphosed sedimentary rocks are now exposed in the primitive area, the upper part of the Belt Supergroup has been removed by erosion and the bottom is not exposed. The original thickness of the Belt Supergroup was probably at least twice that now exposed in the primitive area.

METASEDIMENTARY ROCKS

All metasedimentary rocks exposed in the Mission Mountains Primitive Area belong to the Belt Supergroup of Precambrian age. The rocks are assigned to five formations, which are, from oldest to youngest, the Spokane, Helena, Snowslip, Shepard, and Shields Formations. Their aggregate thickness in the primitive area is 19,800 feet. Most of the rocks are fine grained, and only a few beds have a grain size as coarse as medium sand. The only megascopic fossils in the rock are stromatolites, which are cabbage-shaped structures formed through the collection of sediment in and around certain low forms of algae.

SPOKANE FORMATION

Rocks of the Spokane Formation crop out along the northwest edge of the primitive area in a narrow belt from near Fatty Lake on the north to Piper Creek Pass on the south (pl. 1*A*). Only the upper part of the formation is present and, as mapped, may include part of the Empire Formation. The maximum exposed thickness of 2,300 feet is south of Cedar Lake.

The Spokane Formation is composed primarily of pale-purple, pale-red, and greenish-gray argillite and some siltite; purple hues are dominant. Argillite and siltite beds are laminated and very thinly bedded, but in some areas pronounced cleavage almost obliterates bedding. Ripple marks, desiccation cracks, and lenses of mud-chip conglomerate as much as 15 inches thick are common in the beds. Scattered throughout the formation are lenticular beds, one-half to 6 inches thick, of fine- to coarse-grained quartzite. Commonly the quartzite beds are micaceous and weather to very light gray or white. Rocks of the formation are soft, and they split into thin plates or block fragments. Ridges and ledges cut in the Spokane are generally more rounded than those cut in the overlying, relatively more resistant rocks of the Helena Formation.

The contact between the Spokane Formation and overlying Helena Formation is gradational through about 200 feet. Greenish-gray siltite beds, some of which are dolomitic or calcareous, increase in number in the upper part of the Spokane. We have placed the contact at the base of a waxy-green argillite and siltite bed that contains light-brown-weathering calcareous siltite and quartzite laminae.

HELENA FORMATION

The Helena Formation is the most widely exposed formation, extending virtually the entire length of the primitive area. From the north boundary of the area to Piper Creek Pass, the formation forms the eastern slopes of the Mission Range; and from Piper Creek Pass to Gray Wolf Peak, it forms the crest of the range. For a distance of about 9 miles it crops out over the entire width of the area. The formation crops out as sharp peaks, cliffs, and irregular ledges, shaped by glacial erosion and frost action on the strongly jointed and fractured rock. A calculated total thickness of about 9,800 feet is present in the Mission Range.

Lithologically the formation is divisible into three units. The basal unit, about 800 feet thick, is characterized by interbedded carbonatic siltite, dolomite, and quartzite. These rocks are laminated or very thinly bedded and generally are greenish gray to grayish orange. White quartzite occurs as lenticular beds 3 to 12 inches thick, enclosed in siltite. A few purple siltite and argillite beds are present near the base.

The middle unit, about 8,000 feet thick, composes most of the Helena Formation. Limestone, dolomite, and calcareous dolomite are dominant, but siltite and carbonatic siltite are common. Near the middle of the unit are thin beds of dark-gray argillite. Beds of stromatolites as much as 14 inches thick are present in the lowest 1,500 feet of the unit. Carbonate beds are generally medium gray and light gray, but weather to grayish orange. Siltite beds are usually greenish gray. All rocks are laminated or thinly bedded. Carbonate beds commonly show structures described by O'Connor (1967) on the basis of their geometric shape and size as horizontal and vertical pods and blobs and as horizontal and vertical ribbons. Differential weathering of the carbonate minerals in crenulated patterns of ribbon structure forms what has been called molar-tooth structure because of its resemblance to patterns on elephants' molar teeth. An interval about 1,400 feet thick lying 1,800 feet above the base of the formation contains abundant pyrite. The pyrite is conspicuous as euhedral crystals, some as large as 1½ inches across, or as filling in hairline fractures. Pyrite is widely scattered higher in the formation also. Where pyrite is abundant and surface water drips or washes across outcrops, conspicuous black streaks are formed.

The uppermost unit is 1,000 feet thick and is chiefly limestone with some dolomite, siltite, and argillite. Some limestone beds are oolitic, others are formed by stromatolites; yet others contain limestone pebbles or accumulations of fragments that may at one time have been fossils. Argillite beds generally are dark gray with some white laminae; grayish-green and tan siltite and carbonatic siltite beds are present at the top.

The contact between the Helena Formation and overlying Snowslip Formation is sharp, characterized by an abrupt change from carbonate rocks with some interbedded clastic rocks to dominantly maroon clastic rocks—siltite, argillite, and quartzite—that have streaks and thin sheets of chlorite on bedding surfaces.

SNOWSLIP FORMATION OF CHILDERS (1963)

The Snowslip Formation of Childers (1963) crops out in the south-central part of the primitive area along a belt extending from northeast of Hemlock Point south to Gray Wolf and Blacktail Peaks (pl. 1*A*). The formation is about 3,800 feet thick.

Siltite is the principal rock type in the Snowslip. Beds are typically maroon or pale red, although grayish-green intervals, several inches to 60 feet thick, are distributed irregularly through the formation. Argillite laminae locally separate coarser siltite beds. Lenticular beds of very light gray quartzite are scattered throughout. Generally the rocks are laminated, and structures such as ripple marks and desiccation cracks are common on parting surfaces; less common are mud-chip conglomerates and raindrop impressions. Quartzites are very thinly bedded, with internal cross-laminae, and are very fine to fine grained. At the base some tan quartzite beds, which produce local color banding, are calcareous and sparsely oolitic. Chlorite on bedding surfaces and on fracture faces is characteristic of the formation.

Rocks of the Snowslip lie conformably beneath the Shepard Formation. We have placed the Shepard-Snowslip contact at the base of green carbonatic-siltite beds that contain thin brown-weathering silty limestone beds.

SHEPARD FORMATION

Exposures of the Shepard Formation extend from near the North Fork of Hemlock Creek south and eastward to the primitive-area boundary (pl. 1*A*). The formation is about 2,500 feet thick, but has a greater apparent thickness northeast of Crystal Lake as a result of repetition by faulting.

Rocks of the Shepard Formation are primarily interbedded argillite and siltite, siltite, carbonatic siltite, and some silty limestone. The most abundant and characteristic rock of the Shepard Formation is laminated to very thinly laminated pale-green slightly carbonatic argillite and darker green siltite. Next most common is siltite that is very thinly laminated and grayish green; it commonly weathers brownish green or, in carbonatic beds, grayish orange. Beds of maroon siltite and argillite occur about 900 feet and 2,000 feet above the formation base. Light-gray limestone containing pod and ribbon structures similar to those in the Helena Formation is present near the base, at the middle, and in the upper part of the formation. Beds of stromatolites, 9–14 inches thick, are interbedded with siltite and molar-tooth limestone in the lowermost 150 feet and about 800 feet above the base. Commonly associated with these beds are thin lenses of quartzite and siltite containing disrupted laminae. Glauconite occurs in coarse silt laminae, and chlorite is present on a few bedding surfaces.

The contact between the Shepard and the overlying Shields Formation is sharp, marked by the maroon and brick-red argillite and siltite as well as the pink to white quartzite of the Shields.

SHIELDS FORMATION OF CHILDERS (1963)

The youngest exposed formation of the Belt Supergroup in the primitive area is the Shields Formation of Childers (1963). About 600 feet of beds is present in the vicinity of Red Butte, and a maximum thickness of 1,400 feet is present near Beaver Creek (pl. 1*A*). The formation occurs on the lower timber-covered slopes in the area and is not well exposed. The base of the formation is readily identified by the abundance of brick-red argillite, laminated red argillite and siltite, and pink to white quartzite. The remainder exposed above the base is alternating red and green layers, a few tens of feet thick, consisting principally of siltite or laminated argillite and siltite. Thin beds of fine-grained quartzite are scattered through both the red and green layers. Except for the distinctive brick-red argillite and abundant quartzites at the base, the exposed part of the formation resembles the Snowslip Formation and can easily be confused with it in a small exposure.

INTRUSIVE ROCKS

The only intrusive rock exposed in the primitive area is a mottled black and white fine- to medium-grained quartz diorite that forms two separate bodies near Elk Lake (pl. 1*A*). The larger of these is a body about 200 feet thick that follows planes of weakness in the older rocks: a joint (fig. 2), a bedding plane, and a fault can be seen as controlling structures for the dike-sill along the North Fork of Elk Creek (pl. 1). The smaller body is a sill. The intrusive bodies show thin chill margins, and the adjacent metasedimentary rocks are metamorphosed to hornfels for a few feet surrounding the body. Flow layering in the intrusive rock is weakly developed.

The rock consists principally of hornblende, plagioclase, and quartz. The main accessory minerals are sphene, magnetite, biotite, and pyrite.

We infer that the quartz diorite is Tertiary in age. This inference is based on the fresh and undeformed appearance of the rock as well as its geologic habit of filling fractures that cut across the gross structure of the range.

SURFICIAL DEPOSITS

Surficial deposits in the area are of Pleistocene and Holocene ages. Pleistocene deposits are much more abundant: till is common in thin layers in the upper parts of the valleys, forms moraines along the sides of lower valleys, and covers the tops of even lower ridges; gravelly outwash fills lower valleys. Deposits of Holocene age include thin alluvium along stream courses, small deltas built into many mountain lakes, talus along high valley walls and in cirques, and small end moraines around the glaciers.

STRUCTURE

Geologic structure in the primitive area is fairly simple. The layered rocks strike parallel to the range and dip eastward forming a homoclinal fault block (fig. 4). The rocks are folded and broken by faults, but the faults do not significantly disrupt the north-trending bedrock units, which appear on plate 1*A* as older rocks in the west ranging to younger rocks in the east.

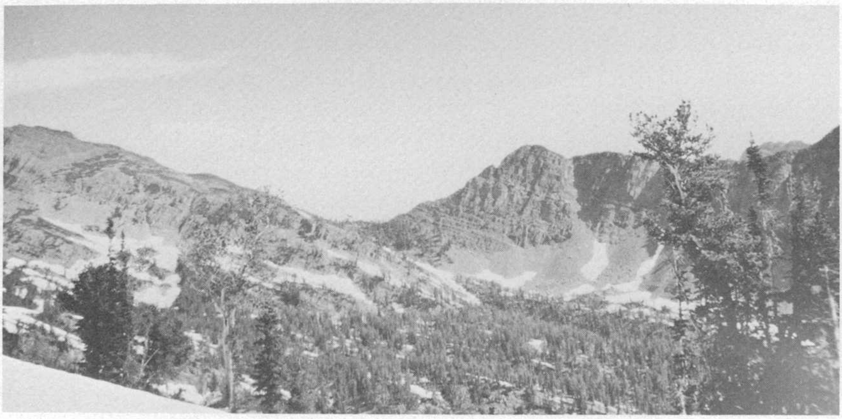

FIGURE 4.—Goat Pass as seen from near High Park Lake. View to north. Note the gentle eastward dip of the rock layers. Helena Formation on left of pass; Snowslip Formation on right.

Folds of several different sizes occur in the area. Large gentle folds are of two principal types: (1) the broad bends around east-trending axes, illustrated by the gentle arch of the Snowslip Formation across the southern part of the area (pl. 1*A*), and (2) a broad wavecrested monocline on a north-trending axis excellently exposed in the Elk Lake area (fig. 2) and shown on the map by the low dips and minor flexure axes along the broad monoclinal crest (pl. 1*A*). Other monoclinal bends, not so pronounced as that near Elk Lake, are common in the southern part of the area and generally involve a gradual change in dip of 10° or 15°. The anticlines, such as those near Grizzly Lake, commonly show fractures along the crest of the bend; the fractures are filled primarily by quartz or carbonate minerals, depending on whether the fractured rock is siliceous or carbonatic. Monoclinal folds probably are large drag folds related to movement on the major fault forming the western boundary of the Mission Range. Drag folds are common adjacent to some faults within the primitive area, but most of them are small and affect the rocks only within a few feet of the fault. The largest of these folds is shown by the steeply dipping beds that reflect drag on the downthrown (southeastern) side of the Elk Creek hinge fault (pl. 1*A*). Small folds with a wavelength of about 2 feet and an amplitude of about 4 inches occur in a few places, principally but not exclusively in argillite and siltite beds of the Helena Formation. The folds have axes that trend north and are horizontal or plunge a few degrees north or south. These small folds appear to be related to the larger monoclines of the same trend.

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Most faults within the primitive area have only a few tens to a few hundreds of feet of apparent displacement along them. Many of the faults show no drag folds along them and little breciation, alteration, or gouge in the fault zone. A few have narrow quartz veins or veinlets scattered through the fault zone. Were it not for offset of an identifiable rock layer or contact, many faults in the area would be unnoticeable even in the almost complete exposure of bedrock offered in the cirques and valley walls of the high country. The geologic map (pl. 1*A*) shows the larger or more persistent faults; several small faults were seen in single outcrops, particularly in the southern third of the area, but they could not be traced beyond that one exposure and are not shown on the map.

Of the three major faults bounding the Mission Range, only a small part of the southern one cuts through the primitive area. It is along Beaver Creek in the southeastern corner of the area.

No particular pattern exists for the various faults within the primitive area. Most appear to reflect minor adjustments to the stresses created during uplift of the mountain block. The most unusual fault is the hinge fault that parallels Elk Creek. The hinge point is near the main fork of Elk Creek, and part of the fault zone has been intruded by quartz diorite. The intrusive cuts through the main fault, where the quartz diorite changes from a dike in the fault zone to a sill on the northwestern side of the fault (pl. 1*A*).

Cleavage is found at a few places in rocks of the primitive area. Rocks adjacent to faults or near crests of folds commonly show fracture cleavage. The most extensive cleavage is in the Spokane Formation, where it almost obliterates bedding in some of the thick argillite layers.

AEROMAGNETIC SURVEY AND INTERPRETATION

In November 1967, the U.S. Geological Survey made an aeromagnetic survey of the Mission Mountains Primitive Area to help evaluate the mineral potential. The part of the survey that covers the primitive area is shown in figure 5. Magnetic traverses were flown east-west at a spacing of 1 mile and at a barometric elevation of 9,000 feet above sea level.

As shown in figure 5, the total intensity magnetic field over the primitive area has a very simple pattern; no high-amplitude anomalies are present that might indicate large concealed bodies of magnetic igneous rock and possible associated ore deposits. The faults and exposed bodies of igneous rock, despite the fact that they are unaltered quartz diorite, have no apparent anomalous magnetism. The northern part of the primitive area has a very low magnetic gradient, and the magnetic contours trend northward. The southern part has a steep mag-

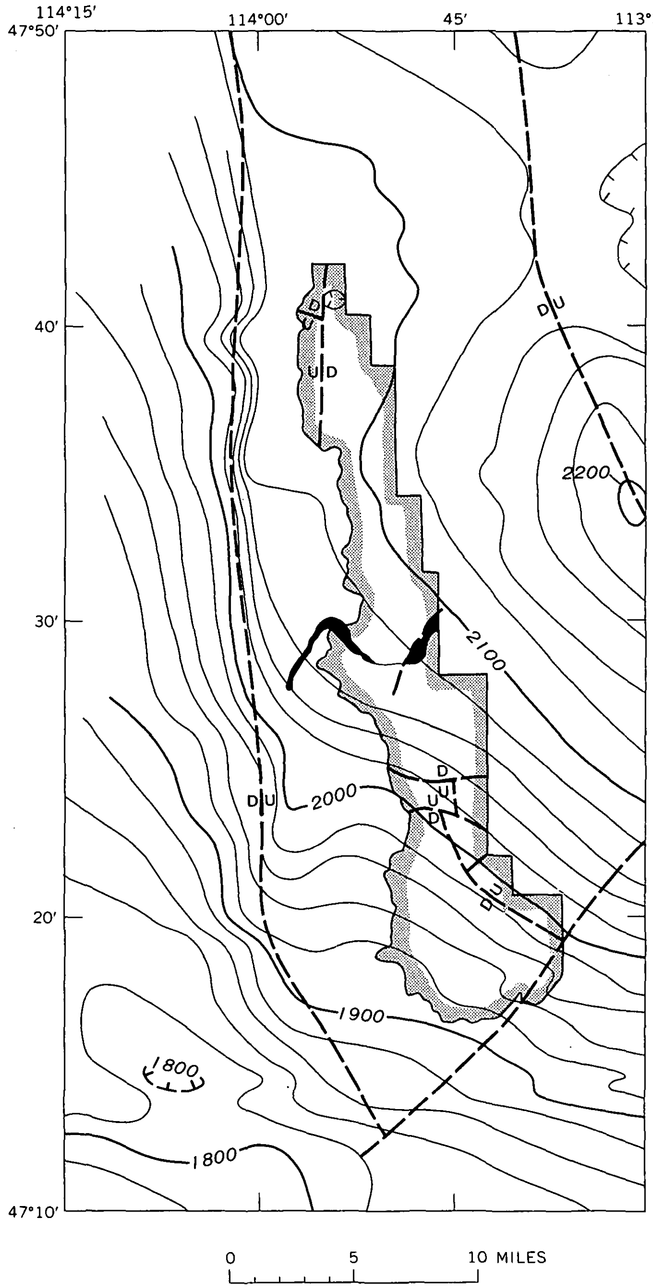

FIGURE 5.—Total magnetic intensity on arbitrary datum. Contour interval, 20 gammas. Stipple pattern indicates the primitive area. Igneous-rock outcrops shown in solid black. Dashed lines show faults; U, upthrown side; D, downthrown side.

netic gradient, as much as 18 gammas per mile, and the magnetic contours trend northwest.

The gradient change from north to south results from the influence of a large positive magnetic anomaly whose center lies about 10 miles east of the primitive area near lat 47°35′ N., long 113°40′ W. This anomaly is along a regional fault zone that bounds the west edge of the Swan Range. The source of this anomaly is interpreted to be at the surface of the crystalline basement beneath about 20,000 feet of sedimentary rocks of the Belt Supergroup.

A few miles west of the primitive area, the major north-trending fault that bounds the Mission Range and that is part of the Rocky Mountain trench rift system is the site of a steep north-trending linear magnetic anomaly. A south-southwest-trending positive anomaly or "nosing" of the contours also exists between lat 47°21′ N. and 47°30′ N. Both magnetic anomalies are believed to lie well above the crystalline basement at a depth of a mile or less. None of the Belt sedimentary rocks involved in the block faulting are magnetic enough to produce such a steep magnetic gradient. These magnetic anomalies are interpreted to be caused by buried bodies of igneous rocks that were intruded along the major fault. In fact, the largest body of quartz diorite in the primitive area continues at the surface west and southwest to within 3 miles of the magnetic "nose," suggesting that this body enlarges in that direction.

MINERAL RESOURCES

SETTING

Although Montana is a major mineral-producing State, none of the State's present mining districts are in the Mission Range. Mining claims that may lie within the Mission Mountains Primitive Area were located near the head of Red Butte Creek in 1916. (A claim near St. Mary's Peak also may be within the boundaries.) They were not found during this investigation. No mineral deposits were reported in the primitive area by residents replying to the letters of inquiry sent by Johns (p. D5), and only one shallow prospect pit, on a ridge top near Elk Lake (pl. 1*A*), was seen in the area. No evidence of potential mineral deposits was found by the aeromagnetic survey.

Some mineral resources have been exploited in areas near the Mission Range. Barite in veins in Belt rocks was discovered near Missoula within the past 20 years and has been mined in moderate quantities (Weis, 1963, p. 55). Similar deposits were reported (Johns, 1964, p. 50) in a prospect on Black Bear Creek about 30 miles east of the Mission Mountains Primitive Area. Prospects and small mines on veins containing copper, silver, gold, lead, and zinc are scattered through much of western Montana near the Mission Range (Weissenborn, 1963; Johns, 1964, p. 45–49). The nearest major mining district is the Hog Heaven district, about 30 miles west of the north end of the range. Silver has been the principal mineral produced there (Weissenborn, 1963, p. 102), but gold, copper, lead, and zinc have also been recovered from the ores (Johns and others, 1963, p. 49–58). The principal ore bodies are in veins associated with intrusive and extrusive rocks of Tertiary age (Johns and others, 1963, p. 50–52).

The geologic environment of the Mission Mountains Primitive Area suggests that other types of deposits could be present. Phosporite has been reported (Gulbrandsen, 1966) in Belt rocks about 30 miles north of Helena, Mont. Furthermore, the characteristic suite of sedimentary rocks commonly containing phosphorite (McKelvey and others, 1953) is typical of the Helena Formation. If phosphorite occurs, uranium could also be present (Davidson, 1953). Bear Creek Mining Co. has explored deposits of copper in Belt rocks in at least two areas of western Montana—one about 75 miles southeast of the Mission Range and another about 100 miles northwest.

METHODS OF EVALUATION

The Mission Mountains Primitive Area was investigated by means of visual examination of the rocks, by geochemical sampling, and by an aeromagnetic survey. Foot traverses were made through much of the area. Samples of fine-grained stream sediments were collected from along major streams and many tributaries and from deltas in mountain lakes (pl. 1*B*). In much of the high country, no stream-sediment samples could be collected because the fine sediment has all been washed down to lower levels.

All the major rock types were sampled in fresh or unaltered form, and samples were taken of all rocks that showed evidence of alteration. Representative veins and veinlets were sampled in each area where they occurred. Because of the difficulty of defining what is mineralized rock where sulfide minerals occur in strata-bound deposits in a wide range of concentration, we have not used the term "mineralized" to classify rock samples. Samples that show obvious crosscutting veins and veinlets are distinguished in the tables of analytical data, but many samples containing heavy mineral streaks, scattered pyrite or chalcopyrite, or scattered black mineral specks are listed with the fresh or unaltered rocks. We inspected the outcrops carefully, because most of the rocks containing copper minerals did not show any indications of malachite staining, alteration, or veining.

Because many of the metallic ore deposits of western Montana are associated with intrusive bodies, an aeromagnetic survey of the primitive area was made after the geologic fieldwork disclosed that previously unknown intrusive rocks crop out in the primitive area. Airborne magnetic data have proven particularly useful in detecting buried intrusive bodies in Belt Supergroup terrane (Mudge and others, 1968). Interpretation of the aeromagnetic data in conjunction with the geology indicates that buried intrusive rocks in the area are quartz diorite. Ore deposits of western Montana are commonly associated with quartz monzonite, but not with quartz diorite.

A total of 502 samples was collected for analysis. Of these, 199 were stream or lake sediments; 40 were of veins, veinlets, or altered rocks; and 263 were fresh rock samples. The heavy emphasis on fresh rock samples reflects the sparsity of altered rocks and the search for stratabound deposits of copper or phosphate. All the rock and sediment samples were analyzed chemically and spectrographically for selected elements (table 1) and 25 of the rock samples were analyzed for phosphate (table 2). The chemical and spectrographic methods used are those described by Ward, Lakin, Canney, and others (1963). Mercury and gold were determined by atomic-absorption techniques. All rock samples were scanned with a gamma-beta counter as a test for abnormal radioactivity; none was found.

EVALUATION OF METALLIC MINERALS

Visual examination of the rocks failed to reveal any metallic mineral deposits in the area. Most faults and fractures are unusually sharp and free from breccia and gouge, suggesting that they formed under low confining stress and would have been excellent passageways for mineralizing solutions had there been any in the area. Hydrothermal alteration, a common clue to mineralized areas, is almost entirely lacking along faults or fractures. The few veins that have thin alteration zones along them commonly lack visible sulfide ore minerals. The intrusive body along Elk Creek is surrounded by a thin contact-metamorphic zone, but no concentrations of ore minerals are visible there. Thin films of malachite (copper carbonate) stain a few outcrops where no indication of fracturing or alteration is visible. At other places, thin lenses or scattered specks of sulfide minerals in silty or sandy layers in the rock can be seen either with the unaided eye or, more commonly, with the aid of a hand lens. The basis for our conclusions that these are mineral occurrences rather than ore deposits is discussed in a later part of this report.

The analytical data shown in table 1 corroborate the visual examination in the field and provide further information as well. The veins and veinlets either contain insignificant amounts of metals or are barren. The fresh rocks contain a wide range of minor elements depending largely on the rock type, and the contact-metamorphosed (hornfels) rocks or those that are altered do not differ significantly in metal content from their unaltered equivalents. The widespread visual occurrence of copper minerals in the field is reflected by fairly abundant above-average copper content of samples listed in table 1. Although no lead minerals were seen in the rocks, the analytical data show a scattering of higher-than-normal lead content which, as is common, may be accompanied by small amounts of silver.

For several of the metals commonly used in geochemical prospecting, histograms were plotted to determine what was the usual range in content for samples from the primitive area and what was an unusually high content. The distribution of samples containing silver, copper, mercury, lead, zinc, and citrate-soluble heavy metals (cxHM—largely undifferentiated copper, lead, and zinc) in more than average amounts is shown on plate 1*C*.

Gold, mercury, and zinc analyses given in table 1 indicate no unusual or economically significant amounts of these elements. The few samples containing higher-than-average amounts of mercury or zinc show no unusual geographic concentration indicative of a mineral deposit (pl. 1). The gold content of the samples is so low that it was not plotted on plate 1*C*.

The widespread occurrence of copper in the rocks of the area appears to be a primary original feature of the rocks. A copper content of 300 ppm (parts per million) in the quartz diorite is certainly a primary feature, is not uncommon for that intrusive rock type, and is of no economic importance. Within the Belt Supergroup rocks, contents of copper range from about 2 ppm to 1,500 ppm, and most of the rocks contain from 5 to 50 ppm. The higher contents occur in silty or sandy rocks and in clastic carbonate rocks such as stromatolites or oolites. Within these rock layers or lamellae, copper-bearing minerals occur (1) as grains in thin lenses of heavy minerals along with other heavy minerals such as magnetite and pyrite, (2) as discrete scattered grains somewhat larger than the average grain size of the layer in which they occur, and rarely (3) as irregular patches or clots in the rock. The general lack of interconnecting veinlets or fractures between the copper-bearing grains or clots plus the low permeability of Belt rocks owing to their low-grade metamorphosed and recrystallized state support a primary or early consolidation (diagenetic) origin of the copper minerals.

The distribution of the copper minerals is shown by several samples to be partly sporadic and partly stratigraphically controlled. Samples A514 and A515 were taken from the full width of a 4-inch-thick quartzite layer in the upper part of the Spokane Formation at points 10 feet apart in the layer. Only scattered dark specks were visible in most of the outcrop, and sample A515 was considered typical of the bulk of the exposure; sample A514 was collected across the part of the outcrop where sulfide minerals appeared to be most abundant. The actual difference in copper content—50 ppm for sample A515 and 300 ppm for sample A514—reflects the apparent visible difference in sulfide content seen at the outcrop and demonstrates the sporadic lateral distribution of the copper-bearing minerals seen at many other places. Two other samples, A485 and A486 were collected from a calcareous stromatolitic layer near the base of the Shepard Formation and from a dolomitic argillite bed 2 inches above the stromatolitic layer. Here the relatively higher copper, lead, and silver content of the stromatolitic layer is not reflected in the adjacent layer of different rock type. Even though stromatolitic or oolitic layers are favorable to the occurrence of copper, lead, and silver minerals, a study of table 1 in connection with plate 1 reveals that the metal content of these rock types is sporadic, particularly within the Helena Formation.

Certain layers or zones within some of the formations do show a generally higher content of copper. The most consistent is a zone of stromatolitic layers, molar-tooth carbonate layers, and calcareous or dolomitic siltite beds near the base of the Shepard Formation (pl. 1*C*). Here higher copper content is fairly consistent, particularly in the stromatolitic layers, as exemplified by samples A060, A145, A485, Z929, Z930, Z951, Z952, and probably A047. Sample A047 is from a fractured and altered zone along a fault that cuts the basal part of the Shepard Formation near Red Butte (pl. 1*C*). Each layer having a higher copper content is at most about a foot thick. The layers are scattered through several hundred feet of rock and represent only a few percent of the total volume. Another zone where copper minerals are more abundant than usual is near the middle part of the Snowslip Formation (pl. 1*C*). Here copper sulfide (chalcopyrite) and iron sulfide (pyrite) grains are concentrated in the siltier layers of green laminated argillite and siltite with no visible alteration or fracturing of the rock. A selected sample (Z016) of what appeared to be the part of the rock unit containing the most sulfides contains 500 ppm copper; sample Z017 is from a quartzite lens in the same zone of beds a few feet away and contains only 10 ppm copper. At a nearby locality a chip sample across 3.1 feet of the copper-bearing layers contains 300 ppm copper. Similar-appearing green laminated argillite and siltite with sulfide or dark mineral specks from other parts of the formation (A096, A416, and Z978, for example) do not contain unusually high amounts of copper, and some similar beds in the same stratigraphic zone in other parts of the area both do (A435) and do not (Z021) contain more-than-average amounts of copper in the strata.

We conclude from the above data as well as from our intensive search for copper minerals in outcrops that, although copper minerals can be found in many places in the Belt rocks of the primitive area, the minerals are not sufficiently abundant to form large low-grade ore deposits and are not sufficiently concentrated to form any high-grade ore deposits.

Lead in amounts above average but well below ore grade is present in several rock samples. Minor amounts of silver commonly accompany the higher lead amounts. A study of table 1 reveals that the average lead content of the carbonate-bearing rocks is greater than that of noncarbonate rocks and that most of the higher lead contents are in limestones or dolomites of the Helena Formation and in similar rocks of the Shepard Formation. As with the copper minerals, the distribution of the lead or lead-silver minerals is sporadic through the rocks. Sample Z908 (oolitic limestone) contains an exceptionally high amount of lead (7,000 ppm), but neither a similar rock (Z905) nor other kinds of limestone (Z906 and Z907) in the same area contain more-than-average amounts of lead. This same zone of oolitic beds near the top of the Helena Formation was sampled at several other localities; one sample contains slightly higher-than-average amounts of lead (A086, 300 ppm), but most contain only average or slightly above average amounts (A112, A463, Z044, Z078, and Z081). The only apparent geographic concentration of greater-than-average amounts of lead is in the Fatty Creek area at the north end of the primitive area (pl. 1*C*). Several samples from that area (A009, A010, A011, A012, and Z002) contain 100 to 500 ppm lead. Other samples of rock and several stream sediments from the area, however, contain only average amounts of lead, and it seems unlikely that the slightly higher lead content in a few samples is indicative of an economically important lead-silver deposit.

Analytical data on stream sediments are useful to identify potential placer deposits and the presence of anomalous metal concentration in the headwaters of the stream. All stream and lake sediments were analyzed by spectrographic methods for total content of 31 elements, by atomic absorption for gold and by the citrate-soluble heavy metals (cxHM) test for the easily soluble metals, largely zinc, copper, and lead.

No placer deposits of gold or tin are known in the area, and the low content of these metals in sediment samples listed in table 1 indicates that none are to be found.

The spectrographic analyses and cxHM analyses measure different chemical factors in the stream-sediment sample. This is demonstrated in table 1. Higher-than-average contents of copper, lead, or zinc, as determined by spectrographic analysis, are almost invariably accompanied by average cxHM content, and vice versa. Either set of data can be used in the search for concentrations of metals as a clue to possible ore deposits. The spectrographic method measures total chemical content of the sample, which is primarily mineral grains and rock chips that have been weathered out of the rocks in the drainage basin. By contrast, the cxHM test measures mainly metals that were dissolved by surface and ground water, were redeposited in the sediment, and now are loosely held on the surface of the mineral and rock fragments. Within the sample the metals are held on clay minerals primarily by absorption, or as chemical precipitates, primarily in hydrous iron oxide or manganese compounds. Organic debris concentrates metallic ions in a loosely bound form and, therefore, gives anomalously high cxHM content compared to nonorganic samples from the same area. In the collection of samples in the primitive area, material having a high content of organic debris (largely decayed vegetation) was avoided whenever possible.

Several widely scattered sites that have higher-than-average content of copper or lead were identified by the spectrographic analyses of stream sediments (table 1; pl. 1*C*). In view of the widely scattered minor amounts of copper and lead in the bedrock, concentrations in stream sediments of minerals containing those elements are to be expected and have no particular economic significance. The concentration of higher-than-average copper content in several samples from the North Fork of Elk Creek provides an excellent example of the manner in which stream-sediment spectrographic analyses can pinpoint areas worthy of further examination. In this area, the apparently higher-than-average copper content is merely reflecting the source rock (quartz diorite), which has a normal copper content (table 1) much higher than that of the Belt rocks (table 1) from which most stream sediments in the primitive area were derived. Thus the apparently anomalous copper content of stream sediments draining terrane containing quartz diorite in the North Fork of Elk Creek is, on review, entirely predictable and of no economic significance.

The cxHM also identified higher-than-average metal content in several widely scattered samples as well as in several samples from one general geographic area (table 1, pl. 1*C*). A few stream-sediment samples that have higher cxHM content are expectable because of the widely scattered copper and lead content of the bedrock. The two highest contents, 30 ppm in sample A454 from the drainage of Cold Creek and 25 ppm in sample A434 from the drainage of Crazy Horse Creek, come from areas where some nearby bedrock samples also contain higher-than-average amounts of copper and lead. The samples with highest cxHM content are also unusual in that one has a higher clay content than most of the samples collected and the other was unavoidably high in organic debris. None of the widely scattered samples with higher-than-normal cxHM content appear to have any economic significance. The one slight geographic concentration is in the Jim Lakes Basin along Jim Creek (table 1, pl. 1*C*). This basin drains the highly pyritic zone in the lower part of the middle unit of the Helena Formation (p. D7). The area is unique in that it is the only large, relatively low relief, almost closed basin draining the highly pyritic part of the Helena Formation. We believe that the small concentration of slightly above average cxHM content in samples taken in the basin is a result of leaching of the pyritic rocks and the resultant opportunity for iron hydroxide formation and precipitation in this physiographically unique area. No other samples of rocks or stream sediments from the Jim Lakes Basin contain exceptionally high amounts of copper or lead, and the slightly above average cxHM content probably does not indicate the presence of economically significant mineral deposits.

EVALUATION OF NONMETALLIC MINERALS

No nonmetallic mineral deposits of commerical interest were found in any of the rocks or veins in the Mission Mountains Primitive Area. Samples (table 2) indicate that P_2O_5 content is far too low for these rocks ever to be used as commercial sources of phosphate. A few layers in some of the rocks have high calcium content (table 1) and approach cement rock in quality. Most of these layers are too thin to be of commercial interest, and the few layers that possibly are thick enough are very inaccessible and hence would be costly to mine. Similar rock is abundantly exposed and much more readily accesible in nearby areas. Small deposits of sand and gravel within the primitive area are, likewise, of little commercial interest because of the abundant deposits available closer to local markets in the readily accessible valley flats of the Swan and Flathead Rivers.

ECONOMIC APPRAISAL

By Eldon C. Pattee, U.S. Bureau of Mines

INTRODUCTION

The U.S. Bureau of Mines made an appraisal of the mineral resource of the Mission Mountains Primitive Area during the summer of 1967. The appraisal consisted primarily of a search of the county records of Missoula and Flathead Counties to determine the number of mining claims and their location in the primitive area, a field search for the mining claims, and a reconnaissance of areas believed to have the best potential for metallic mineral deposits or building stone. Only four mining claims may lie within the primitive area, but location descriptions are vague; therefore, they may be outside the boundaries.

The cooperation and assistance of personnel of Region 1, U.S. Forest Service, especially Mr. Barney Sedlacek, district ranger, Condon Ranger District, is gratefully acknowledged.

INVESTIGATIONS

The field investigations included panning of gravel from several streams to test for placer values, traverses in selected areas where Geological Survey samples showed higher-than-average metal content, and a check for building stone in a few selected localities.

Only a few small gravel deposits occur in the primitive area because excessive stream fall causes most fine material to be transported to the lower valleys. In some localities it was difficult to obtain enough material for panning. Most of the pan concentrates consisted of rock fragments and sand; a few contained traces of magnetite.

The only placer sample containing minerals of interest was from the bed of the North Folk of Elk Creek in the NW¼ sec. 20, T. 20 N., R. 18 W., where the trail to Mollman Lakes crosses the creek. The sample contained 4.5 percent magnetite, a trace of chromite, and about 5 cents gold per cubic yard. The maximum amount of placer material available would be a few hundred thousand cubic yards. The source of the gold, magnetite, and chromite is believed to be a quartz diorite sill or associated rocks that crop out northeast of the creek. A 30-foot chip sample taken in the hanging wall of the quartz diorite contained 5.95 percent soluble iron, 0.02 percent chromium, and no gold or silver. Hornfels on the hanging wall of the sill contained grains of pyrite as much as ⅛ inch across. An assay of a 5.6-foot chip sample of the hornfels showed 0.01 ounce of gold per ton but no silver.

An outcrop and a boulder in two different localities contained traces of copper minerals. These were the only other metallic minerals of interest observed during traverses in areas where previous samples showed higher-than-average metal content.

The outcrop was a few hundred feet west of the junction of the Cedar Peak and Cedar Lake trails. The Geological Survey requested a search of this area after finding traces of copper minerals, but the search disclosed only one small grain of chalcopyrite. A sample of the metasedimentary rocks that surrounded the grain of chalcopyrite contained no copper, gold, or silver.

Disseminated pyrite and chalcopyrite were found in a boulder of siltite from the Snowslip Formation in the Glacier Lake area. The boulder is near the crest of the ridge between Glacier Lake and Island Lake and is near the center of the line between secs. 25 and 26, T. 19 N., R. 18 W. The disseminated sulfide grains are less than 1 millimeter across and constitute less than 0.5 percent of the rock. No copper, gold, or silver was detected in a grab sample from the boulder. A small amount of malachite is present around some of the grains. A thorough search of outcrops was made around this vicinity, but no rock containing chalcopyrite was found in place.

A small amount of flat stone from near the primitive area has been used locally for building walks and retaining walls. Outcrops of metasedimentary rocks were examined for possible sources of building stone during traverses, and a limited search for building stone was made in the southeast part of the primitive area. The metasedimentary rocks are various shades of green, gray, red, and brown and would be very attractive for building purposes, but most of the rock does not break into thin layers because cleavage is not well enough developed. No potentially economic sources of flat building stone were found.

MINING CLAIMS

The claims that may lie within the primitive area include the Saint Mary's Lode, Red Butte 1, Red Butte 2, and Red Butte 3. Descriptions of the locations are vague, and therefore the claims may lie outside the primitive area. The claims were located in 1881 and 1916, and claim markers could not be found during the present investigation.

The Saint Mary's Lode claim was located July 1, 1881, by Dudley E. Bass and William H. Ellis. The location is described in county records as "1 mile north of east from Saint Mary's Peak ½ mile north from lakes in the head of Todds creek." This location may be near Grizzly Lake within the primitive area. The surface around the lake is bare rock and talus. A thorough search of the area was made by helicopter and no prospect workings were found; however, a few narrow calcite veins were noted. One of the larger veins, 3.5 inches wide, was sampled. The vein strikes N. 10° W. and dips 60° W. in gray argillite of the Helena Formation. It was exposed for 30 feet downdip and 10 feet along the strike in the face of a cliff. The grab sample from the vein contained no gold or silver.

The Red Butte claims for platinum and iridium were located on September 15, 1916, by Albert Taylor. The location as recorded in the county records is: "Gordon Range [Ranch] lies 8 miles east and Glacier Creek lays 5 miles south and bounded on the north by Red Butte Creek." This location could be within the primitive area in the upper part of Red Butte Creek valley. The section of Red Butte Creek valley within the primitive area is densely covered with brush and forest. A search of the locality was made by helicopter and on foot, but the claims were not found. Small prospect pits, however, could be easily missed in the dense brush. Several samples from the bed of

Red Butte Creek were panned, but no platinum or other minerals of interest were identified. A few white quartz veinlets were observed on the ridge between Red Butte Creek and Crazy Horse Creek; none were noted lower in Red Butte Creek valley. The veinlets are in maroon argillite. One of the largest was sampled. It is from 0.5 to 1.5 inches wide and is exposed for 12 feet along the strike. The veinlets do not contain sulfides and an assay showed no gold or silver.

CONCLUSIONS

None of the metallic mineral occurrences found are a potential future source of the metals, and no valuable occurrences of building stone were found. On the basis of available data, there is little probability that mineral deposits of economic value exist within the primitive area.

Traces of copper minerals noted near Glacier Lake and Cedar Lake in the southern and northern parts of the primitive area, respectively, are believed to be of no significance because copper content of samples was less than assay detection limits.

The amount of gold in the placer sample from the North Fork of Elk Creek and the hornfels nearby is too small to be of economic significance.

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TABLES 1, 2

TABLE 1.—*Analyses of samples from the Mission Mountains*

[ppm, parts per million; cxHM, citrate soluble heavy metals test; number in parentheses spectrographic analyses; M. S. Rickard, R. L. Miller, W. L. Campbell,

	Semiquantitative spectrographic analyses 1/															
	(percent)				(ppm)											
Sample	Mg (.01)	Fe (.05)	Ca (.05)	Ti (.001)	Mo (5)	V (10)	Sn (10)	Ni (2)	Cr (5)	Ba (10)	Sr (50)	B (10)	Pb (10)	Mn (10)	Be (1)	Nb (10)
								Intrusive igneous rocks								
A074	3	10	3	1	N	300	N	70	70	150	300	10	10	1,500	N	N
A136	3	15	3	1	N	300	N	70	70	100	150	10	L	1,000	N	N
Z029	3	15	3	1	N	300	N	70	70	70	150	L	10	1,000	N	N
Z031	3	15	5	1	N	300	N	70	150	70	150	L	L	1,000	N	N
Z127	3	15	7	>1	N	300	N	100	150	100	150	L	N	700	N	N
Z129	3	15	3	>1	N	300	N	70	70	100	200	L	N	700	N	N
Z133	3	10	5	1	N	300	N	70	70	300	500	30	10	700	N	N
Z134	3	10	3	1	N	300	N	100	150	700	150	10	L	700	N	N
Z135	3	15	5	>1	N	300	N	100	150	100	150	10	L	700	N	N
								Metasedimentary rocks								
								Shields Formation								
A051	3	3	2	.3	N	70	N	50	30	300	N	150	N	700	2	N
A052	2	1.5	1	.3	N	50	N	50	30	500	50	70	N	300	1	N
A072	3	2	.1	.2	N	20	N	30	15	70	N	15	30	70	1	N
A073	3	5	3	.3	N	70	N	50	70	200	50	150	L	700	1	N
A076	3	3	3	.3	N	50	N	20	30	500	50	70	L	700	1	N
A489	1.5	1	1	.2	N	30	N	20	20	700	L	30	L	200	1	N
A490	3	3	2	.3	N	70	N	30	70	500	70	100	15	500	2	N
A521	2	1.5	.1	.15	N	20	N	10	15	70	N	20	N	30	L	L
A522	1.5	3	2	.3	N	50	N	30	50	200	N	100	N	300	1	10
								Shepard Formation								
A013	2	5	1	.3	N	70	N	70	70	300	L	100	L	500	2	N
A014	1.5	5	1.5	.5	N	70	N	30	70	300	50	100	L	1,000	2	10
A050	3	3	3	.3	N	70	N	50	70	200	70	150	N	500	2	N
A060	5	3	10	.1	N	70	N	20	20	700	150	50	N	700	L	N
A061	3	1.5	5	.2	N	30	N	10	15	5,000	100	10	30	300	L	N
A062	2	2	1	.2	N	50	N	30	30	1,000	70	30	N	500	1	N
A063	5	3	10	.3	N	70	N	20	70	500	100	150	10	700	1	N
A071	5	5	2	.5	N	70	N	70	50	500	100	150	L	300	2	N
A140	1	2	.15	.3	N	50	N	50	20	150	L	20	L	500	1	N
A142	2	3	2	.3	N	70	N	30	30	100	70	30	10	1,000	1	N
A145	2	3	3	.3	N	70	N	50	30	150	100	50	15	2,000	1	N
A485	3	3	10	.3	N	70	N	100	70	300	200	30	500	1,500	1	10
A486	5	3	3	.3	N	50	N	20	50	300	70	50	10	1,000	1	N
Z019	2	3	3	.3	N	50	N	30	20	700	150	30	L	1,000	1	L
Z043	3	7	.07	.3	N	70	N	50	30	150	L	70	10	300	1	10
Z916	1.5	3	20	.2	N	70	N	7	30	3,000	700	20	10	3,000	L	N
Z917	1	1.5	10	.03	N	200	N	5	7	1,500	300	L	N	1,500	L	N
Z918	1.5	2	1	.3	N	50	N	30	30	700	L	20	N	200	1	N
Z919	2	2	.7	.15	N	50	N	20	10	300	L	10	L	300	1	N
Z920	1.5	7	.1	.3	N	70	N	30	30	150	L	30	20	700	1	N
Z929	1.5	5	7	.3	N	30	N	30	30	150	100	70	L	2,000	1	10
Z930	1.5	3	7	.3	7	50	N	30	70	150	150	30	70	2,000	1	N
Z931	.5	.7	5	.1	N	30	N	3	15	150	100	10	L	2,000	N	N
Z932	5	7	2	.3	N	70	N	30	70	300	70	70	15	1,500	1	N
Z933	5	5	10	.3	N	70	N	50	70	200	150	100	10	700	1	N
Z934	2	5	.3	.3	N	70	N	50	70	200	50	70	L	150	1	L
Z949	1	3	3	.3	L	70	N	30	70	150	70	30	15	1,500	1	N
Z950	1.5	3	15	.2	7	70	N	20	30	150	300	30	70	2,000	1	N
Z951	2	3	15	.03	N	200	N	5	7	15	150	N	20	>5,000	L	N
Z952	1.5	2	15	.2	N	30	N	15	50	70	500	20	70	>5,000	L	N

1/ The symbol > indicates that an undetermined amount of the element is present above the number shown; L indicates that an undetermined amount of the element is present below the sensitivity limit; N indicates that the element was looked for but not found. Also looked for spectrographically but not found in any sample were Au (10), Sb (100), In (100), and Cd (20).

Primitive Area, Missoula and Lake Counties, Mont.

indicates sensitivity limit of method used. Analysts: D. J. Grimes—semiquantitative G. W. Dounay, and H. D. King—gold; S. L. Noble—mercury and cxHM]

Sample	Semiquantitative spectrographic analyses[1]--Continued (ppm) Y (5)	Cu (2)	Zr (10)	Ag (.5)	La (20)	Sc (5)	Co (5)	Zn (200)	Chemical analyses[2] (ppm) Au (.02)	Hg (.02)	cxHM (.5)	Sample description
							Intrusive igneous rocks					
A074	70	300	200	N	N	30	100	N	A	A	---	Quartz diorite.
A136	50	300	200	N	N	70	70	N	A	.02	---	Do.
Z029	30	300	150	N	N	50	70	N	A	.02	---	Do.
Z031	20	200	100	N	N	50	70	N	A	.02	---	Do.
Z127	50	300	200	N	N	70	100	N	A	.06	---	Do.
Z129	70	300	300	N	N	100	100	N	A	A	---	Do.
Z133	70	100	200	N	70	70	70	N	A	.03	---	Do.
Z134	50	300	150	N	N	100	150	N	A	A	---	Do.
Z135	50	200	200	N	N	70	150	N	A	A	---	Do.
							Metasedimentary rocks					
							Shields Formation					
A051	20	10	300	N	50	15	10	N	A	.03	---	Argillite.
A052	15	15	300	N	20	7	15	N	A	.02	---	Sandy siltite.
A072	15	2	300	N	L	5	10	N	A	A	---	Silty quartzite.
A073	30	2	200	N	30	15	30	N	A	A	---	Argillite and siltite.
A076	30	10	300	N	30	10	15	N	A	A	---	Siltite.
A489	10	20	200	N	L	5	7	N	A	.03	---	Quartzite.
A490	20	15	300	N	50	15	15	N	A	.03	---	Argillite and siltite.
A521	15	30	200	N	L	5	7	N	A	.09	---	Silty quartzite.
A522	15	10	300	N	30	7	10	N	A	.02	---	Argillite and siltite.
							Shepard Formation					
A013	30	10	300	N	50	15	20	N	A	.07	---	Argillite and siltite.
A014	70	5	300	N	50	15	20	N	A	A	---	Do.
A050	20	5	300	N	30	20	5	N	A	.03	---	Do.
A060	30	200	100	N	20	7	N	N	A	A	---	Stromatolite, 3 in. bed.
A061	15	15	200	N	N	5	L	N	A	A	---	Dolomitic quartzite.
A062	15	5	300	N	20	7	10	N	A	A	---	Glauconitic quartzite.
A063	20	15	200	N	30	15	10	N	A	.02	---	Silty dolomite.
A071	30	5	300	N	50	15	15	N	A	A	---	Argillite and siltite.
A140	30	15	300	N	30	10	15	N	A	A	---	Siltite.
A142	50	15	300	N	30	15	10	N	A	.02	---	Argillite and siltite.
A145	20	150	150	L	30	15	15	N	A	.02	---	Stromatolite, 4 ft. bed.
A485	50	500	300	.5	150	10	70	N	A	.02	---	Stromatolite, 2 ft. bed.
A486	15	15	150	N	20	10	15	N	A	.03	---	Dolomitic argillite.
Z019	15	7	200	N	30	10	20	N	A	.02	---	Calcareous quartzite.
Z043	20	100	200	N	20	15	15	N	A	.03	---	Argillite and siltite.
Z916	150	10	300	N	100	7	5	N	A	.03	---	Stromatolitic limestone, 9 in. bed.
Z917	100	30	150	N	100	7	L	N	A	A	---	Calcareous quartzite.
Z918	10	10	300	N	20	7	15	N	A	.02	---	Siltite.
Z919	15	15	200	N	20	5	5	N	A	.03	---	Do.
Z920	20	100	300	N	20	10	5	N	A	A	---	Do.
Z929	50	1,500	300	N	70	10	5	N	A	.05	---	Calcareous siltite.
Z930	15	100	300	.5	30	10	20	N	A	.10	---	Stromatolite, 10 in. bed.
Z931	15	15	300	N	30	5	L	N	A	.02	---	Calcareous quartzite.
Z932	30	15	300	N	50	20	15	N	A	.03	---	Siltite.
Z933	20	50	150	N	20	15	20	N	A	.03	---	Argillitic limestone.
Z934	20	10	300	N	30	15	20	N	A	A	---	Siltite.
Z949	50	30	300	N	30	20	70	N	A	.05	---	Calcareous siltite.
Z950	30	50	100	N	30	10	30	N	A	.07	---	Stromatolitic limestone, 9 in. bed.
Z951	100	200	20	N	30	7	5	200	A	A	---	Calcareous quartzite.
Z952	50	1,500	200	N	70	7	30	N	A	.02	---	Stromatolitic limestone, 1 ft. bed.

[2] The symbol A indicates that none of the element or elements was detected at the sensitivity limit of the method. Sensitivity limit for gold is 0.02 ppm but may range up to 0.1 ppm because of small sample size. Where the sensitivity limit differs from 0.02, it is shown in parentheses for the individual samples to which it applies.

TABLE 1.—*Analyses of samples from the Mission Mountains*

Semiquantitative spectrographic analyses 1/

Sample	Mg (percent) (.01)	Fe (percent) (.05)	Ca (percent) (.05)	Ti (percent) (.001)	Mo (ppm) (5)	V (ppm) (10)	Sn (ppm) (10)	Ni (ppm) (2)	Cr (ppm) (5)	Ba (ppm) (10)	Sr (ppm) (50)	B (ppm) (10)	Pb (ppm) (10)	Mn (ppm) (10)	Be (ppm) (1)	Nb (ppm) (10)
Metasedimentary rocks--Continued																
Shepard Formation--Continued																
Z953	2	3	20	.1	5	70	N	10	30	70	700	10	150	5,000	L	N
Z954	.5	7	1	.02	7	150	N	10	10	30	N	L	N	1,500	L	N
Z957	1.5	3	10	.3	L	70	N	30	50	150	150	50	70	1,500	1	N
Z958	.5	10	1.5	.02	10	150	N	3	7	70	N	L	L	700	L	N
Z980	.7	2	3	.3	N	50	N	20	15	150	50	20	N	1,500	1	10
Snowslip Formation																
A043	1.5	3	.3	.5	N	70	N	70	70	300	L	100	N	500	1	N
A045	1.5	5	7	.1	N	100	N	30	30	700	200	20	15	5,000	1	N
A046	.5	1.5	2	.15	N	20	N	7	10	200	L	15	10	700	1	N
A054	1.5	5	3	.5	N	50	N	70	50	500	70	70	N	2,000	2	10
A055	.2	7	.07	.5	7	30	N	7	30	200	50	50	70	100	2	10
A056	1	5	2	.5	N	50	N	30	30	200	70	50	N	1,500	1	10
A059	.5	1.5	.7	.3	N	50	N	15	50	300	50	30	N	700	1	N
A096	1.5	3	1	.3	N	70	N	30	70	300	50	150	15	1,500	1	N
A098	1.5	5	.7	.5	N	70	N	30	70	150	L	100	N	700	1	L
A138	.3	1.5	1	.2	N	30	N	10	7	300	L	15	N	700	L	N
A139	1.5	7	.7	.3	N	70	N	70	70	200	L	30	10	500	1	N
A416	1.5	3	.1	.5	N	100	N	50	70	500	L	100	L	300	2	N
A421	.7	1	1.5	.15	N	30	N	15	15	700	50	10	N	1,000	1	N
A433	1.5	2	1.5	.3	N	70	N	30	30	300	50	100	10	500	1	N
A435	1	2	.3	.5	70	70	N	70	50	200	L	150	150	300	1	10
A461	3	3	1.5	.3	N	70	N	30	30	500	50	100	L	500	1	N
A462	3	3	10	.3	N	30	N	30	30	1,500	150	100	N	1,000	1	N
A465	3	3	7	.2	N	50	N	20	20	500	70	50	L	500	1	N
A523	1.5	3	.3	.3	N	70	N	30	50	200	L	100	150	300	1	15
Z008	1.5	3	.3	.5	N	70	N	50	50	200	N	100	L	500	1	L
Z010	2	3	.15	.5	N	50	N	30	30	300	N	70	L	150	1	L
Z011	1.5	1.5	5	.3	L	50	N	30	20	200	100	30	150	1,000	1	N
Z013	1.5	5	.07	.5	N	70	N	30	70	200	L	50	L	300	1	L
Z014	.2	1.5	.3	.1	N	20	N	7	5	1,500	L	10	L	300	N	N
Z016	1	2	.07	.3	100	70	N	50	50	300	L	100	N	200	1	N
Z017	.7	1.5	.15	.3	N	50	N	30	20	150	L	50	N	300	1	N
Z018	.5	.7	.2	.15	N	30	N	10	15	2,000	70	L	L	300	L	N
Z020	.7	3	.3	.3	N	50	N	20	20	200	L	30	L	300	1	N
Z021	.7	3	.5	.3	N	70	N	20	20	200	L	30	L	700	1	N
Z023	.15	.7	3	.07	N	20	N	7	7	300	N	L	N	1,500	N	N
Z041	.7	2	3	.2	N	50	N	20	20	500	70	30	L	2,000	1	N
Z042	.1	.2	1	.1	N	10	N	L	10	1,000	L	10	N	700	L	N
Z047	.7	1.5	.07	.3	N	50	N	10	50	500	L	50	L	150	1	L
Z048	1	3	.07	.3	N	70	N	30	30	300	L	150	N	200	1	L
Z079	2	3	3	.3	N	70	N	30	50	700	100	150	L	700	1	N
Z096	2	3	7	.3	N	50	N	30	30	700	200	70	L	1,500	1	N
Z107	.3	2	1.5	.2	N	30	N	2	15	300	70	15	N	1,500	1	N
Z912	.5	1.5	1	.3	N	50	N	15	20	150	50	30	L	700	1	N
Z921	1.5	5	.07	.5	N	70	N	50	50	200	N	150	L	200	2	L
Z925	1.5	7	.1	.5	N	70	N	50	70	300	L	70	10	200	1	10
Z926	1	5	.2	.5	N	70	N	20	70	300	L	70	L	700	2	10
Z927	.2	1.5	.15	.1	7	30	N	15	15	150	N	L	N	700	L	N
Z948	.3	3	.3	.3	N	50	N	20	20	300	L	30	L	300	L	N
Z978	1	3	.1	.3	N	70	N	50	50	300	L	70	N	200	1	15
Helena Formation																
A001	3	2	15	.15	N	50	N	20	30	200	150	30	30	700	1	N
A002	3	2	10	.3	N	70	N	20	30	300	70	50	30	300	1	N
A004	5	3	5	.3	N	70	N	20	30	1,000	70	50	N	700	1	N
A005 3/	.2	.1	.3	.15	N	L	N	5	N	70	N	N	N	150	N	N
A007	1.5	3	.3	.3	N	70	N	20	30	700	L	30	10	300	2	N

3/ Sample A005 was reported as L(200) for As. All other samples reported as N(200) for As.

Primitive Area, Missoula and Lake Counties, Mont.—Continued

Sample	Semiquantitative spectrographic analyses[1] --Continued (ppm)								Chemical analyses[2] (ppm)			Sample description
	Y (5)	Cu (2)	Zr (10)	Ag (.5)	La (20)	Sc (5)	Co (5)	Zn (200)	Au (.02)	Hg (.02)	cxHM (.5)	
									Metasedimentary rocks--Continued			
									Shepard Formation--Continued			
Z953	30	20	70	N	30	7	L	N	A	A	---	Limestone.
Z954	10	70	100	N	20	5	L	N	A	.03	---	Quartzite.
Z957	30	20	300	N	30	15	20	N	A	.04	---	Calcareous argillite and siltite.
Z958	15	30	15	N	L	L	N	N	A	.02	---	Pyritic quartzite.
Z980	15	7	200	N	20	7	5	N	A	.05	---	Siltite.
									Snowslip Formation			
A043	20	20	300	N	20	20	30	N	A	.02	---	Argillite and siltite.
A045	100	50	50	N	50	20	30	N	A	.02	---	Calcareous glauconitic quartzite.
A046	15	10	500	N	30	L	N	N	A	.02	---	Quartzite.
A054	100	20	1,000	N	100	15	20	N	A	.03	---	Calcareous glauconitic quartzite.
A055	50	15	700	L	50	10	20	N	A	A	---	Pyritic siltite.
A056	70	20	500	N	50	15	70	N	A	.16	---	Do.
A059	15	10	300	N	L	7	7	N	A	.02	---	Siltite.
A096	30	10	300	N	50	15	20	N	A	.02	---	Argillite and siltite.
A098	50	70	500	N	70	15	30	N	A	.02	---	Do.
A138	15	15	300	N	20	7	5	N	A	A	---	Calcareous quartzite.
A139	30	10	300	N	30	20	20	N	A	.07	---	Argillite and siltite.
A416	20	10	200	N	30	30	30	N	.02	.03	---	Do.
A421	15	30	300	N	20	5	7	N	A	A	---	Silty quartzite.
A433	20	15	300	N	30	15	15	N	A	.02	---	Siltite.
A435	20	200	500	.7	20	20	50	N	A	.08	---	Argillite and siltite.
A461	15	30	300	N	30	15	15	N	A	.03	---	Argillitic siltite.
A462	15	10	150	N	20	7	15	N	A	.03	---	Calcareous glauconitic quartzite.
A465	20	30	300	N	20	10	10	N	A	.03	---	Calcareous siltite.
A523	15	300	300	.5	30	10	15	L	A	.06	---	Argillite and siltite, 3.1 ft chip.
Z008	20	7	500	N	20	15	20	N	A	A	---	Siltite.
Z010	15	50	300	N	20	10	15	N	A	.03	---	Do.
Z011	50	700	100	.5	50	10	30	N	A	.07	---	Dolomitic quartzite.
Z013	30	20	700	N	50	15	20	N	A	.03	---	Siltite.
Z014	7	20	200	N	N	L	N	N	A	.03	---	Quartzite.
Z016	15	500	300	.5	30	15	20	N	A	.04	---	Argillite and siltite.
Z017	15	10	300	N	20	7	15	N	A	.03	---	Quartzite.
Z018	15	50	300	N	L	L	7	N	A	.02	---	Do.
Z020	15	30	300	N	30	7	7	N	A	A	---	Siltite.
Z021	15	30	300	N	30	7	30	N	A	.16	---	Pyritic argillite and siltite.
Z023	15	30	100	N	N	N	N	N	A	.02	---	Quartzite.
Z041	20	20	300	N	20	7	15	N	A	.03	---	Do.
Z042	10	20	500	N	N	N	N	N	A	.03	---	Do.
Z047	15	30	500	N	20	10	7	N	A	.02	---	Siltite.
Z048	20	10	300	N	30	15	15	N	A	A	---	Do.
Z079	30	10	300	N	30	10	20	N	A	A	---	Calcareous quartzite.
Z096	30	7	300	N	30	10	15	N	A	A	---	Calcareous oolitic quartzite.
Z107	15	10	500	N	30	7	L	N	A	A	---	Quartzite.
Z912	30	7	300	N	20	7	5	N	A	A	---	Siltite.
Z921	30	50	300	N	30	15	30	N	A	.03	---	Argillite and siltite.
Z925	>200	L	300	N	70	20	30	N	A	.02	---	Argillite.
Z926	30	7	700	N	30	15	5	N	A	.02	---	Pyritic siltite.
Z927	15	10	300	N	20	L	L	N	A	.02	---	Quartzite.
Z948	30	70	300	N	20	7	7	N	A	A	---	Do.
Z978	15	L	300	N	30	15	15	N	A	.09	---	Argillite and siltite.
									Helena Formation			
A001	15	15	100	N	20	7	10	N	A	.03	---	Calcareous dolomite.
A002	15	7	200	N	20	7	15	N	A	A	---	Calcareous siltite.
A004	20	5	150	N	30	7	15	N	A	A	---	Dolomitic argillite.
A005	7	30	150	N	A	N	L	N	A	.02	---	Quartzite.
Z007	30	7	200	N	30	10	15	N	A	A	---	Dolomitic siltite.

TABLE 1.—*Analyses of samples from the Mission Mountains*

Semiquantitative spectrographic analyses [1]

Sample	Mg (.01)	Fe (.05)	Ca (.05)	Ti (.001)	Mo (5)	V (10)	Sn (10)	Ni (2)	Cr (5)	Ba (10)	Sr (50)	B (10)	Pb (10)	Mn (10)	Be (1)	Nb (10)
	(percent)				(ppm)											
						Metasedimentary rocks--Continued										
						Helena Formation--Continued										
A008	1	1	1	.7	N	10	N	3	5	200	N	10	L	500	1	N
A009	3	3	2	.3	N	50	N	20	50	500	L	70	100	200	1.5	10
A010	3	3	2	.3	N	50	N	20	30	500	50	50	300	200	1.5	N
A011	3	2	10	.3	N	70	N	20	30	300	70	50	150	300	2	N
A012	5	3	10	.15	N	30	N	15	30	300	70	30	500	1,500	1	N
A017	7	3	10	.2	N	30	N	20	30	300	70	50	10	700	1	N
A018	7	3	10	.15	N	30	N	20	15	500	100	20	20	1,000	1	N
A020	3	3	2	.3	N	70	10	20	30	2,000	L	100	15	300	3	15
A021	1.5	1	15	.1	N	30	N	10	15	300	200	10	30	1,000	L	N
A023	3	1.5	2	.2	N	70	L	20	20	700	L	70	30	100	5	15
A075	5	3	7	.15	N	30	N	15	30	500	70	50	10	700	L	N
A077	5	2	5	.3	N	50	N	30	30	500	70	70	15	500	1	N
A078	5	2	3	.15	N	50	N	20	30	500	70	50	150	700	1	N
A080	3	3	2	.3	N	70	N	30	50	2,000	L	70	15	300	2	N
A081	2	1.5	.5	.2	N	70	N	20	30	700	N	50	L	300	2	N
A082	1	1.5	2	.2	N	30	N	15	15	300	50	30	L	150	1	N
A083	2	2	3	.3	N	70	N	30	50	300	L	100	10	300	2	N
A084	2	1.5	15	.2	N	50	N	20	30	150	150	100	L	500	L	N
A085	2	1	15	.07	N	20	N	10	20	100	200	20	70	1,000	L	N
A086	2	.7	20	.05	N	15	15	10	7	70	300	10	300	700	L	N
A092	3	2	3	.3	N	70	N	30	70	700	70	150	L	500	1	N
A109	2	3	.2	.3	N	70	N	20	70	300	L	100	L	70	1	N
A110	3	1.5	20	.07	N	30	N	15	30	150	150	50	30	700	L	N
A111	5	1.5	15	.1	N	50	N	20	30	300	150	50	20	700	1	N
A112	2	.7	20	.05	N	15	N	10	10	100	300	15	70	700	N	N
A113	5	2	2	.3	N	70	N	20	30	500	50	50	L	300	1	N
A115	1.5	3	1	.3	N	50	N	30	20	700	L	50	L	150	2	L
A117	2	2	.1	.3	N	70	N	20	30	500	L	30	L	70	1	N
A124	1	.7	2	.15	N	20	N	10	10	500	L	10	N	100	1	N
A125	5	2	10	.15	N	30	N	15	15	300	150	10	30	700	L	N
A126	3	1.5	10	.15	N	50	N	20	20	300	100	20	30	300	1	L
A127	2	1	7	.15	N	30	N	20	15	200	70	20	30	300	1	N
A128	5	3	5	.2	N	50	N	20	30	300	50	30	L	700	2	L
A401	2	2	3	.3	N	20	10	15	30	1,000	70	30	30	300	1	N
A424	1	.7	3	.2	N	30	N	15	15	300	70	30	N	200	1	N
A431	3	2	5	.3	N	70	N	30	20	700	70	70	10	500	1	N
A442	5	1.5	10	.1	N	30	N	7	15	300	100	30	15	700	1	N
A443	5	3	7	.2	N	70	N	15	20	300	50	30	15	300	1.5	N
A444	5	2	10	.2	N	70	N	20	30	700	100	30	10	300	1	N
A445	5	2	7	.07	N	30	N	10	7	200	70	15	10	700	1	N
A453	5	1.5	15	.1	N	30	N	10	15	200	150	15	10	700	L	N
A455	2	3	1	.3	N	30	N	30	20	2,000	70	50	N	200	2	10
A456	1.5	1	15	.15	N	10	N	7	15	3,000	500	15	200	1,000	L	N
A457	3	3	5	.3	N	30	N	15	30	300	70	30	150	700	1	N
A458	2	5	2	.3	N	30	N	50	30	1,000	L	50	N	300	1.5	N
A463	2	1	20	.07	N	15	N	7	7	100	200	15	70	1,000	L	N
A470	7	3	15	.07	N	30	N	15	15	300	200	20	50	700	1	N
A473	3	3	.5	.5	N	100	N	15	70	500	N	70	L	150	3	10
A477	5	2	15	.2	N	30	N	20	20	150	150	50	20	1,000	1	N
A478	3	1.5	15	.15	N	30	N	10	20	200	150	50	10	700	1	N
A479	5	3	15	.2	N	70	N	15	30	700	100	30	30	700	1	N
A480	5	1.5	7	.3	N	30	N	15	30	700	70	70	10	200	2	N
A482	3	3	3	.3	N	50	N	30	50	1,000	50	150	30	100	2	N
A492	10	5	15	.7	N	20	N	20	15	150	70	15	10	1,500	1	N
A497	7	3	10	.15	N	50	N	20	20	200	100	20	10	1,000	L	N
A498	5	3	7	.3	N	50	N	30	70	300	100	70	70	700	1	N
A500	5	3	20	.15	N	30	N	20	70	150	200	15	50	700	L	N
A501	2	2	.5	.3	N	50	N	20	30	300	N	15	10	700	2	10
A502	1	2	.15	.3	N	50	N	30	30	500	L	10	L	500	2	10
A503	1.5	2	.1	.3	N	50	N	30	15	300	N	15	L	70	1.5	L

Primitive Area, Missoula and Lake Counties, Mont.—Continued

Sample	Semiquantitative spectrographic analyses1/ -- Continued (ppm)								Chemical analyses2/ (ppm)			Sample description
	Y (5)	Cu (2)	Zr (10)	Ag (.5)	La (20)	Sc (5)	Co (5)	Zn (200)	Au (.02)	Hg (.02)	cxHM (.5)	
												Metasedimentary rocks--Continued
												Helena Formation--Continued
A008	20	70	150	N	30	L	5	N	A	.02	---	Quartzite.
A009	30	20	300	L	50	15	10	N	A	.03	---	Dolomitic argillite.
A010	10	20	300	1.5	20	10	10	N	A	.03	---	Pyritic dolomitic siltite.
A011	15	20	200	L	30	10	15	N	A	.02	---	Pyritic dolomite.
A012	15	10	150	2	L	7	10	N	A	.03	---	Do.
A017	20	7	200	N	20	7	5	N	A	A	---	Do.
A018	20	3	200	N	20	5	15	N	A	.02	---	Stromatolite, 3 in. bed.
A020	70	5	300	N	70	15	30	N	A	.03	---	Dolomitic argillite.
A021	70	20	200	.5	30	5	15	N	A	.02	---	Dolomitic limestone.
A023	30	3	200	L	30	10	L	N	A	A	---	Calcareous argillite.
A075	20	15	150	N	20	7	5	N	A	.03	---	Dolomitic siltite.
A077	20	10	200	N	30	7	15	N	A	.04	---	Do.
A078	20	15	150	N	20	7	20	N	A	.03	---	Pyritic dolomitic argillite.
A080	50	L	300	N	70	15	20	N	A	A	---	Dolomitic argillite.
A081	20	7	300	N	30	10	10	N	A	A	---	Pyritic dolomitic argillite.
A082	20	15	300	N	50	7	10	N	A	.02	---	Pyritic siltite.
A083	20	10	300	N	30	15	15	N	A	.03	---	Argillite.
A084	30	5	200	N	30	7	10	N	A	.02	---	Stromatolitic limestone.
A085	30	5	100	N	30	5	15	N	A	.04	---	Limestone.
A086	50	300	30	L	70	N	10	500	A	.15	---	Oolitic limestone, 8 in. bed.
A092	30	5	200	N	50	15	15	N	A	A	---	Argillite and siltite.
A109	20	7	300	N	30	10	15	N	A	.02	---	Do.
A110	15	20	150	N	20	5	7	N	A	.02	---	Argillitic dolomitic limestone.
A111	30	30	150	N	30	7	10	N	A	A	---	Sandy calcareous dolomite.
A112	30	10	50	L	50	5	20	N	A	.03	---	Pelletal limestone, 2 in. bed.
A113	15	5	200	N	20	10	15	N	A	.03	---	Stromatolite, 2 ft. bed.
A115	30	20	300	N	30	10	200	N	A	.28	---	Pyritic argillite and siltite.
A117	15	15	200	N	20	15	5	N	A	.03	---	Do.
A124	7	50	100	N	L	5	10	300	A	.04	---	Quartzite.
A125	20	20	70	N	20	7	15	N	A	.04	---	Dolomitic silty quartzite.
A126	15	5	70	N	20	10	10	N	A	.04	---	Laminated argillite and limestone.
A127	10	50	100	N	20	10	15	N	A	.05	---	Do.
A128	20	15	200	N	30	15	10	N	A	.02	---	Pyritic dolomitic siltite.
A401	20	200	500	N	30	7	20	N	A	.38	---	Dolomitic siltite.
A424	15	20	300	N	30	10	10	N	A	.02	---	Calcareous siltite.
A431	15	20	200	N	30	10	10	N	A	.03	---	Argillite and siltite.
A442	30	20	70	N	30	7	N	N	A	.02	---	Dolomite.
A443	20	7	70	N	30	15	15	N	A	.02	---	Dolomitic argillite.
A444	20	10	100	N	30	15	7	N	A	.02	---	Dolomite.
A445	15	10	30	N	20	7	7	N	A	A	---	Argillitic dolomite.
A453	20	7	70	N	20	7	N	N	A	A	---	Calcareous dolomite.
A455	20	3	200	N	50	7	10	N	A	.02	---	Dolomitic argillite.
A456	20	150	200	.5	30	5	5	N	A	A	---	Calcareous quartzite.
A457	15	15	200	L	30	7	15	N	A	.03	---	Do.
A458	30	L	200	N	50	7	100	N	A	.07	---	Pyritic argillitic siltite.
A463	20	10	30	L	30	L	15	N	A	.03	---	Oolitic limestone.
A470	20	7	70	N	20	5	5	N	A	.03	---	Dolomite.
A473	20	2	300	N	30	15	15	N	A	A	---	Silty argillite.
A477	20	3	70	N	30	7	15	N	A	A	---	Calcareous dolomite.
A478	15	2	70	N	30	7	5	N	A	.03	---	Do.
A479	30	5	150	N	30	10	10	N	A	.03	---	Do.
A480	15	30	200	N	30	7	7	N	A	.14	---	Dolomitic siltite.
A482	15	20	300	N	30	15	15	N	A	.03	---	Argillite and siltite.
A492	15	20	50	N	20	5	15	N	A	.04	---	Pyritic dolomite.
A497	15	10	70	N	L	7	10	N	A	.02	---	Do.
A498	30	15	150	N	30	10	15	N	A	.03	---	Pyritic dolomitic siltite.
A500	30	10	100	N	20	7	7	N	A	.03	---	Pyritic pelletal limestone.
A501	20	10	200	N	30	10	15	N	A	.03	---	Quartzite.
A502	20	5	300	N	30	15	15	N	A	.02	---	Do.
A503	20	7	200	N	20	10	15	N	A	A	---	Siltite.

TABLE 1.—*Analyses of samples from the Mission Mountains*

Semiquantitative spectrographic analyses 1/

Sample	Mg (percent) (.01)	Fe (percent) (.05)	Ca (percent) (.05)	Ti (percent) (.001)	Mo (ppm) (5)	V (ppm) (10)	Sn (ppm) (10)	Ni (ppm) (2)	Cr (ppm) (5)	Ba (ppm) (10)	Sr (ppm) (50)	B (ppm) (10)	Pb (ppm) (10)	Mn (ppm) (10)	Be (ppm) (1)	Nb (ppm) (10)
Metasedimentary rocks--Continued																
Helena Formation--Continued																
A504	1	1	3	.3	N	30	N	20	15	300	70	15	10	700	1	N
A511	2	2	.5	.3	N	30	N	30	30	300	50	15	L	500	1	L
Z002	1.5	1.5	20	.3	N	20	N	15	L	50	150	N	300	1,500	L	N
Z003	3	3	15	.3	N	50	N	20	50	300	70	70	15	700	1	N
Z004	.3	.3	3	.03	N	L	N	2	5	70	L	N	15	200	L	N
Z005	5	3	10	.07	N	20	N	7	10	150	100	10	30	1,000	1	N
Z006	2	2	15	.3	N	50	N	20	30	700	100	20	10	500	1	N
Z007	2	1.5	3	.2	N	20	N	7	15	500	70	20	70	500	1	N
Z040	5	3	10	.2	N	70	N	30	30	1,000	70	70	10	700	1	N
Z044	1.5	3	15	.2	N	30	N	30	20	200	300	50	10	1,500	1	N
Z046	.5	1	1	.2	N	30	N	7	30	500	50	20	100	300	L	N
Z049	2	3	10	.3	N	50	N	20	30	500	70	70	10	300	1.5	N
Z050	1.5	.5	10	.15	N	30	N	7	10	150	70	10	L	1,500	1	N
Z051	.7	.3	5	.15	N	20	N	3	10	300	50	10	15	200	1	N
Z052	3	2	2	.3	N	50	N	30	15	300	L	50	20	200	1	L
Z057	3	2	10	.3	N	50	N	15	20	700	70	30	10	200	1	N
Z058	3	1.5	20	.07	N	10	N	10	7	100	200	10	20	1,000	L	N
Z061	3	3	3	.3	N	70	N	15	50	700	50	150	L	150	3	N
Z067	3	1.5	1	.3	N	70	N	30	30	700	N	50	L	70	2	L
Z068	1.5	1	20	.07	N	15	N	10	10	100	150	10	70	700	L	N
Z071	5	3	15	.3	N	50	N	20	30	150	150	20	L	500	1	N
Z074	3	2	1.5	.3	N	70	N	20	30	700	L	30	N	150	1.5	N
Z077	7	3	10	.3	N	30	N	15	30	>5,000	300	20	L	700	1	N
Z078	1.5	2	10	.2	N	20	N	7	30	300	500	20	10	1,500	L	N
Z081	5	3	7	.3	N	50	N	20	30	2,000	150	50	N	700	1	N
Z083	.7	.5	3	.3	N	30	N	7	10	500	50	10	10	100	1	N
Z085	2	2	5	.3	N	70	N	20	30	300	50	30	10	150	1	N
Z089	5	1.5	15	.15	N	50	N	15	20	150	150	20	N	500	1	N
Z091	2	2	.15	.3	N	70	N	30	30	300	N	70	L	50	2	N
Z093	3	3	5	.3	N	50	N	50	30	300	70	20	L	200	1	N
Z095	5	3	.3	.5	N	70	N	50	50	500	L	70	N	70	1	N
Z101	3	7	.2	.5	N	100	N	70	70	300	L	150	N	70	2	N
Z102	1.5	3	.07	.2	N	30	N	30	15	150	L	30	L	150	1	N
Z116	2	3	.2	.3	N	50	N	20	20	200	L	20	L	300	1	N
Z117	.5	.3	2	.02	N	10	N	2	5	>5,000	150	N	L	300	N	N
Z905	2	2	10	.1	N	30	N	10	20	200	150	100	30	1,500	1	N
Z906	3	3	10	.2	N	50	N	15	30	300	100	100	10	1,000	1	N
Z907	3	1.5	15	.2	N	30	N	20	30	300	100	70	15	300	L	L
Z908	1.5	.7	20	.02	N	10	N	3	10	70	500	L	7,000	1,000	L	N
Z936	5	5	5	.2	N	50	N	30	15	150	50	10	50	700	1	N
Z937	3	1.5	10	.2	N	30	N	10	20	200	100	20	70	300	1	N
Z938	5	3	7	.15	N	20	N	7	15	100	70	10	50	700	L	N
Z939	3	3	3	.3	N	70	N	20	30	500	L	50	15	300	2	10
Z940	1.5	7	>20	.05	N	10	N	2	10	50	300	L	30	1,000	N	N
Z943	3	2	5	.2	N	50	N	15	50	300	50	50	L	300	1	N
Z944	7	3	10	.07	N	20	N	10	15	150	70	15	L	1,500	L	N
Z945	5	3	10	.07	N	15	15	5	7	150	150	15	30	1,000	1	N
Z946	3	2	7	.3	N	50	N	15	50	1,000	70	70	30	300	2	10
Z965	1.5	3	2	.3	N	50	N	30	30	500	70	20	50	300	1	10
Z966	.7	1	3	.1	N	30	N	15	15	300	L	N	10	200	L	N
Z970	1.5	1.5	2	.2	N	50	N	15	15	300	70	10	50	500	2	N
Z971	5	3	20	.2	N	30	N	20	30	150	700	20	70	1,500	L	N
Z976	.7	.3	1.5	.03	N	20	N	7	7	700	50	L	N	300	L	N
Z981	.7	1	7	.15	N	30	N	7	15	300	50	20	N	100	L	L
Z982	1.5	2	.3	.3	N	70	N	15	30	500	L	100	L	50	1	10
Z983	.7	.7	>20	.03	N	L	N	3	5	50	300	L	10	700	N	N
Z984	3	2	15	.15	N	30	N	20	30	300	100	50	150	500	L	N
Z985	1.5	1.5	7	.2	N	30	N	7	30	300	50	50	N	200	1	L
Z986	.7	1	3	.15	N	20	N	10	15	300	L	15	70	100	L	L
Z987	1	1.5	10	.15	N	30	N	10	30	300	70	20	L	300	L	L

Primitive Area, Missoula and Lake Counties, Mont.—Continued

Sample	Semiquantitative spectrographic analyses[1]--Continued (ppm) Y (5)	Cu (2)	Zr (10)	Ag (.5)	La (20)	Sc (5)	Co (5)	Zn (200)	Chemical analyses[2] (ppm) Au (.02)	Hg (.02)	cxHM (.5)	Sample description
												Metasedimentary rocks--Continued
												Helena Formation--Continued
A504	20	15	200	N	L	10	7	N	A	A	---	Siltite.
A511	20	7	200	N	20	10	15	N	A	.02	---	Do.
Z002	70	30	15	.7	30	N	50	N	A	.03	---	Pelletal limestone.
Z003	20	15	200	N	50	10	15	N	A	.02	---	Dolomitic limestone.
Z004	15	15	70	N	20	N	N	N	A	A	---	Quartzite.
Z005	15	10	100	N	20	5	N	N	A	A	---	Pyritic dolomite.
Z006	20	15	200	N	20	7	7	N	A	A	---	Pelletal limestone.
Z007	15	20	200	N	20	7	5	200	A	.02	---	Calcareous quartzite.
Z040	20	5	200	N	50	10	10	N	A	.02	---	Pyritic dolomite.
Z044	20	15	200	N	20	5	5	N	A	.02	---	Oolitic limestone.
Z046	15	300	300	L	20	5	5	N	A	A	---	Pyritic quartzite.
Z049	30	15	300	N	70	10	15	N	A	.02	---	Calcareous argillite.
Z050	15	10	70	N	20	5	5	N	A	.02	---	Silty dolomite.
Z051	20	30	200	N	30	5	N	N	A	.02	---	Calcareous quartzite.
Z052	15	20	200	N	30	10	20	N	A	.02	---	Calcareous argillite.
Z057	30	10	300	N	30	7	5	N	A	A	---	Dolomite.
Z058	50	10	200	N	20	L	15	N	A	A	---	Oolitic limestone.
Z061	50	2	300	N	70	15	15	N	A	A	---	Pyritic calcareous argillite.
Z067	30	10	300	N	20	10	15	N	A	A	---	Pyritic siltite.
Z068	50	20	30	N	50	L	10	N	A	A	---	Limestone.
Z071	20	30	150	N	30	7	10	N	A	A	---	Pyritic argillitic limestone.
Z074	30	7	300	N	70	7	10	N	A	A	---	Pyritic siltite.
Z077	30	15	200	N	70	7	15	N	A	.02	---	Dolomite.
Z078	30	15	300	N	30	5	5	N	A	A	---	Oolitic limestone.
Z081	30	5	200	N	30	7	15	N	A	A	---	Do.
Z083	7	30	300	N	20	5	7	N	A	A	---	Quartzite.
Z085	15	20	300	N	30	7	15	L	A	.07	---	Dolomitic siltite.
Z089	15	3	70	N	20	7	15	N	A	.03	---	Stromatolite, 6 in. bed.
Z091	30	15	300	N	50	15	15	N	A	.02	---	Pyritic siltite.
Z093	20	150	300	N	50	15	15	N	A	.05	---	Dolomitic quartzite.
Z095	20	5	300	N	50	15	30	N	A	.03	---	Argillite.
Z101	30	10	300	N	70	15	30	N	A	A	---	Do.
Z102	15	30	200	N	20	7	30	N	A	.02	---	Pyritic siltite.
Z116	15	L	300	N	20	7	10	N	A	.03	---	Siltite.
Z117	7	50	50	N	L	N	N	N	A	A	---	Quartzite.
Z905	30	7	200	N	30	5	10	N	A	A	---	Oolitic limestone.
Z906	15	2	200	N	30	7	15	N	A	A	---	Stromatolitic limestone, 6 in. bed.
Z907	15	15	100	N	30	7	10	N	A	.02	---	Limestone.
Z908	20	7	10	1.5	30	N	10	200	A	.04	---	Oolitic limestone.
Z936	20	15	150	N	L	7	15	N	A	.05	---	Pyritic dolomitic siltite.
Z937	10	5	70	N	20	7	5	300	A	.03	---	Calcareous dolomite.
Z938	20	15	50	N	L	5	L	N	A	A	---	Pyritic dolomitic siltite.
Z939	50	7	300	N	30	10	15	N	A	.03	---	Pyritic dolomitic argillite.
Z940	15	7	50	N	30	L	N	N	A	.02	---	Stromatolitic limestone, 1 ft. bed.
Z943	30	15	200	N	30	15	5	N	A	A	---	Dolomitic argillite.
Z944	15	20	70	N	20	5	L	N	A	.02	---	Dolomite.
Z945	15	150	50	N	20	5	N	N	A	.03	---	Pyritic calcareous dolomite.
Z946	20	10	200	N	50	10	15	N	A	.02	---	Calcareous argillite.
Z965	30	20	300	N	30	15	15	N	A	A	---	Siltite.
Z966	20	30	150	N	30	5	5	N	A	.02	---	Quartzite.
Z970	30	150	300	L	30	10	7	N	A	A	---	Do.
Z971	50	10	300	N	50	7	15	N	A	.02	---	Silty dolomitic limestone.
Z976	10	10	50	N	L	N	L	N	A	A	---	Quartzite.
Z981	10	30	200	N	20	5	5	N	A	.06	---	Calcareous siltite.
Z982	15	10	200	N	30	7	10	N	A	.04	---	Argillite.
Z983	15	5	20	N	N	N	15	N	A	.06	---	Limestone.
Z984	15	10	100	N	20	7	5	N	A	.13	---	Do.
Z985	10	15	200	N	20	7	5	N	A	.10	---	Dolomitic siltite.
Z986	5	50	150	N	N	5	5	N	A	.04	---	Siltite.
Z987	15	10	70	N	30	7	5	N	A	.10	---	Calcareous argillite and siltite.

TABLE 1.—*Analyses of samples from the Mission Mountains*

Semiquantitative spectrographic analyses 1/

Sample	(percent) Mg (.01)	Fe (.05)	Ca (.05)	Ti (.001)	(ppm) Mo (5)	V (10)	Sn (10)	Ni (2)	Cr (5)	Ba (10)	Sr (50)	B (10)	Pb (10)	Mn (10)	Be (1)	Nb (10)
							Metasedimentary rocks--Continued									
							Helena Formation--Continued									
Z988	2	1.5	10	.2	N	30	N	20	30	300	100	30	15	500	1	L
Z991	3	2	.3	.3	N	50	N	15	30	300	N	30	L	150	1	N
Z992	2	7	.2	.3	N	70	N	30	70	700	L	20	15	300	1	10
Z996	3	2	2	.3	N	50	N	10	30	700	L	50	L	500	1	10
Z997	3	3	.7	.3	N	70	N	15	70	500	L	50	L	100	2	10
							Spokane Formation									
A030	.2	.2	.15	.03	N	10	N	5	5	150	N	N	L	150	L	N
A031	1.5	5	.3	.5	N	70	N	30	50	700	50	30	15	300	2	N
A032	3	5	.15	.5	N	70	N	30	70	700	50	30	30	300	3	10
A034	1.5	1.5	.15	.2	N	70	N	20	15	150	N	15	L	150	1	N
A114	3	3	.2	.3	N	70	N	50	30	300	50	20	10	300	2	N
A505	.3	.5	.5	.07	N	15	N	5	10	150	N	L	N	300	L	N
A506	.7	1	2	.07	N	20	N	15	10	300	70	L	10	500	1	N
A507	1.5	3	.3	.3	N	30	N	30	50	300	70	20	10	300	2	10
A512	1	1	.1	.07	N	15	N	5	10	200	N	L	N	200	L	N
A513	1	1.5	.1	.3	N	15	N	10	20	300	N	10	10	70	1	L
A514 4/	1.5	1	1	.1	N	20	N	7	15	300	N	10	200	200	1	N
A515 4/	1.5	.7	.3	.05	N	15	N	10	10	700	N	L	100	150	1	N
A516	1.5	1.5	1	.3	N	50	N	20	20	700	50	10	10	700	1	10
A517	.7	.7	1	.07	N	15	N	3	10	150	50	L	15	300	L	N
A518	1.5	1.5	1	.15	N	20	N	15	15	1,500	50	L	30	300	1	N
A519	.3	.3	1	.03	N	10	N	5	10	100	L	N	N	300	L	N
A520	1.5	.7	.7	.1	N	20	N	15	10	150	L	L	L	300	L	N
Z112	1.5	1.5	2	.15	N	30	N	15	15	500	50	L	N	700	1	N
Z113	2	5	.3	.3	N	70	N	30	50	500	L	30	20	300	2	L
Z114	1	1.5	1	.15	N	30	10	15	10	300	L	L	30	700	1	N
Z123	1.5	1.5	.7	.2	N	50	N	20	15	300	50	15	L	500	1	N
Z961	1.5	2	2	.3	N	30	N	30	30	300	150	20	30	500	1	N
Z962	2	3	.5	.3	N	70	N	50	30	700	L	20	15	150	2	L
Z963	1	1	.7	.3	N	20	N	15	15	200	L	L	L	300	L	N
Z964	3	3	2	.3	N	70	N	30	30	500	70	30	15	1,000	1	L
Z967	5	3	5	.2	N	50	N	30	30	200	150	15	20	1,000	1	N
Z969	.3	.7	1	.07	N	20	N	10	7	100	N	N	N	150	L	N
Z972	2	5	.3	.3	N	70	N	20	50	700	50	30	10	200	3	10
Z973	1.5	1.5	1	.15	N	30	N	15	15	300	50	L	L	700	1	N
Z974	1	1.5	.7	.2	N	30	N	15	15	200	L	L	L	300	1	N
Z975	2	2	1	.3	N	70	15	30	20	500	70	15	10	500	1	L
Z977	5	2	3	.2	N	30	N	15	20	150	150	10	15	1,000	1	N
Z993	2	5	2	.3	N	70	N	20	50	500	70	30	15	1,000	1.5	10
Z995	2	3	.15	.3	N	50	N	20	50	700	L	20	10	700	2	10
Z998	3	2	5	.2	N	50	N	20	30	2,000	500	20	30	1,000	L	L
Z999	5	1.5	7	.2	N	50	N	20	30	5,000	700	20	30	1,500	L	N
							Veins, veinlets, and altered rocks									
A033	1.5	2	.3	.3	N	50	N	15	20	300	50	20	L	200	1	N
A038	.7	1.5	.2	.5	N	70	N	20	30	300	L	30	N	150	1	L
A039	1	2	.15	.3	N	70	N	50	30	700	70	150	N	300	1.5	L
A040	1.5	3	1	.7	N	70	N	70	30	500	50	100	15	700	1.5	10
A041	.7	3	.7	.2	N	70	N	20	20	200	L	50	70	200	1	N
A042 5/	.15	5	L	.15	N	70	N	5	5	50	N	50	N	70	N	N
A044	.7	1.5	.07	.3	N	50	N	10	20	300	N	70	N	300	1	N
A047	2	3	.3	.3	N	30	N	30	20	300	N	20	N	200	1	10
A048	2	3	.07	.3	N	50	N	30	20	150	N	30	N	150	1	N
A049	3	3	.07	.5	N	70	N	30	70	300	N	100	N	150	2	N

4/ Sample A514 contains 10 ppm Bi and sample A515 was reported as L(10) for Bi. All other samples are reported as N(10) for Bi.

Primitive Area, Missoula and Lake Counties, Mont.—Continued

Sample	Semiquantitative spectrographic analyses[1]--Continued (ppm)								Chemical analyses[2] (ppm)			Sample description
	Y (5)	Cu (2)	Zr (10)	Ag (.5)	La (20)	Sc (5)	Co (5)	Zn (200)	Au (.02)	Hg (.02)	cxHM (.5)	
												Metasedimentary rocks--Continued
												Helena Formation--Continued
Z988	10	7	70	N	30	7	7	N	A	.02	---	Calcareous silty dolomite.
Z991	15	7	300	N	L	7	10	N	A	.03	---	Argillitic siltite.
Z992	30	10	300	N	30	15	15	N	A	.02	---	Argillite and siltite.
Z996	20	15	300	N	30	10	5	N	A	.02	---	Calcareous argillitic siltite.
Z997	15	15	300	N	30	20	L	N	A	.02	---	Silty argillite.
												Spokane Formation
A030	7	15	70	N	20	N	N	N	A	A	---	Quartzite.
A031	30	50	300	N	50	10	15	N	A	.02	---	Argillite.
A032	30	20	300	N	50	15	15	N	A	.02	---	Argillite and siltite.
A034	15	5	300	N	20	5	20	N	A	A	---	Quartzite.
A114	20	L	300	N	50	15	15	N	A	A	---	Silty argillite.
A505	30	10	150	N	70	L	5	N	A	A	---	Quartzite.
A506	20	10	150	N	70	5	7	N	A	A	---	Silty quartzite.
A507	30	15	300	N	50	10	15	N	A	A	---	Do.
A512	20	10	70	N	30	L	7	N	A	.03	---	Quartzite.
A513	20	15	300	N	30	7	10	N	A	A	---	Siltite.
A514	30	300	300	1	30	7	5	N	A	.03	---	Quartzite, 4 in. bed.
A515	20	50	150	.7	30	5	5	N	A	.03	---	Quartzite (same bed as A514).
A516	20	50	200	N	30	7	10	N	A	.03	---	Quartzite.
A517	50	15	200	N	50	L	5	N	A	.03	---	Do.
A518	30	30	200	N	70	7	15	N	A	.05	---	Do.
A519	15	L	100	N	20	L	5	N	A	.02	---	Do.
A520	30	70	150	N	50	5	5	N	A	.05	---	Do.
Z112	15	3	200	N	L	7	10	N	A	.02	---	Do.
Z113	20	10	300	N	50	15	20	N	A	.02	---	Argillite.
Z114	30	15	300	N	20	5	7	500	A	A	---	Quartzite.
Z123	20	10	300	N	20	7	15	N	A	.02	---	Do.
Z961	30	50	300	N	30	7	15	N	A	A	---	Do.
Z962	30	7	300	N	70	15	30	N	A	A	---	Siltite.
Z963	15	30	300	N	20	5	7	N	A	A	---	Quartzite.
Z964	30	15	300	N	20	15	20	N	A	A	---	Siltite.
Z967	30	10	300	N	50	10	15	N	A	A	---	Calcareous siltite.
Z969	15	30	300	N	20	L	5	N	A	A	---	Quartzite.
Z972	50	5	300	N	50	20	10	N	A	A	---	Siltite.
Z973	15	50	150	N	20	7	10	N	A	.02	---	Quartzite.
Z974	20	5	200	N	30	7	10	N	A	.03	---	Do.
Z975	20	10	150	L	30	15	15	N	A	A	---	Siltite.
Z977	30	30	150	N	30	7	15	N	A	.03	---	Calcareous siltite.
Z993	20	10	300	N	20	15	15	N	A	A	---	Argillite.
Z995	30	50	300	N	30	10	15	N	A	A	---	Siltite.
Z998	30	15	300	N	30	7	20	N	A	.02	---	Calcareous siltite.
Z999	20	100	150	N	30	7	15	N	A	A	---	Dolomitic argillite.
												Veins, veinlets, and altered rocks
A033	20	2	300	N	30	7	10	N	A	.02	---	Quartz-chlorite veinlets.
A038	30	3	500	N	30	10	15	N	A	.02	---	Do.
A039	20	3	500	N	50	15	20	N	A	A	---	Bleached siltite.
A040	30	L	700	N	20	15	20	N	A	.02	---	Do.
A041	20	5	500	N	20	7	15	N	A	A	---	Black stained argillitic siltite.
A042	N	7	20	N	N	N	N	N	A	A	---	Quartz-hematite vein.
A044	10	15	200	N	N	7	5	N	A	A	---	Quartz veinlets.
A047	70	1,500	200	N	50	7	5	N	A	.03	---	Fractured siltite in fault zone.
A048	70	20	300	N	30	7	15	N	A	.03	---	Do.
A049	15	2	300	N	20	15	20	N	A	A	---	Iron-stained siltite in fault zone.

[5] Sample A042 was reported as L(50) for W. All other samples are reported as N(50) for W.

TABLE 1.—*Analyses of samples from the Mission Mountains*

Semiquantitative spectrographic analyses 1/

Sample	(percent) Mg (.01)	Fe (.05)	Ca (.05)	Ti (.001)	(ppm) Mo (5)	V (10)	Sn (10)	Ni (2)	Cr (5)	Ba (10)	Sr (50)	B (10)	Pb (10)	Mn (10)	Be (1)	Nb (10)
							Veins, veinlets, and altered rocks--Continued									
A057	5	3	.1	.5	N	50	N	30	50	150	N	70	N	300	1	10
A058	1	1	.05	.03	N	10	N	10	10	20	N	N	N	150	L	N
A070	.3	.3	.15	.03	N	10	N	3	7	30	N	10	N	70	N	N
A146	.3	.7	.15	.05	N	20	N	7	L	30	N	L	L	150	L	N
A481	5	3	10	.2	N	30	N	15	30	500	150	50	15	700	L	N
A487	3	3	3	.3	N	70	50	30	70	300	70	100	70	300	1	N
A488	3	3	7	.3	5	50	N	30	70	200	150	70	15	1,000	1	N
A499	1.5	1	20	.07	N	20	15	20	7	150	500	N	30	200	N	N
A524	.2	.15	>20	.01	N	N	N	N	N	30	300	N	L	300	N	N
A525	.2	.5	20	.015	N	L	N	N	L	50	500	N	300	300	N	N
Z009	.1	.07	.2	.015	N	L	N	2	L	20	N	N	L	70	N	N
Z015	.05	.05	.1	.01	N	L	N	N	N	150	N	N	N	200	N	N
Z022	.2	.7	.07	.07	N	10	N	7	7	50	N	L	N	300	N	N
Z026	5	3	.7	.3	N	70	N	30	50	300	70	10	10	500	1	N
Z028	3	3	5	.3	N	70	N	30	30	300	70	15	L	300	2	N
Z033	3	3	3	.3	N	70	N	30	30	300	50	15	L	700	1	L
Z045	.3	.3	.2	.03	N	20	N	7	7	50	N	10	L	200	L	N
Z082	.5	.3	20	.01	N	15	N	2	5	30	700	N	L	500	N	N
Z092	.3	.2	.1	.07	N	20	N	5	7	70	N	L	L	100	L	N
Z103	.3	.2	.07	.03	N	15	N	7	L	30	N	L	N	150	L	N
Z125	2	2	7	.3	N	70	N	30	50	700	70	30	N	300	1	N
Z126	5	3	5	.3	N	70	N	30	30	300	70	15	N	700	1	N
Z128	3	3	15	.15	N	20	N	20	20	150	150	10	20	700	L	N
Z130	3	3	10	.3	N	50	N	30	70	500	150	10	L	300	L	N
Z131	3	3	2	.3	N	100	10	20	70	700	70	50	L	70	1	15
Z132	3	2	3	.3	N	70	N	15	20	500	100	L	15	300	1	N
Z915	.03	.1	.1	.001	N	10	N	3	5	30	N	N	N	300	L	N
Z928	.1	L	.07	.003	N	10	N	5	L	15	N	L	N	70	N	N
Z956	.03	.15	.07	.005	5	20	N	7	5	20	N	N	N	200	N	N
Z979	.03	.07	.05	.01	N	N	N	N	L	50	N	N	N	150	N	N
							Stream and lake sediments									
							Fatty Creek drainage									
A003	.7	1	1	.15	N	30	N	3	30	500	70	20	10	700	1	N
A006	.5	1.5	.7	.15	N	30	15	5	30	300	70	15	15	700	1	N
A035	.5	2	.5	.3	N	70	N	7	15	300	50	20	10	2,000	1.5	N
A036	.7	1	.5	.2	N	50	N	7	15	300	L	20	10	2,000	1	N
A037	.7	1	.3	.2	N	70	N	7	15	300	50	20	10	500	1.5	N
Z001	1	1.5	1	.2	N	50	N	10	10	200	N	30	15	700	1.5	N
Z024	2	3	.3	.3	N	70	N	50	30	500	N	30	70	700	2	N
Z025	2	3	.5	.3	N	70	N	30	30	300	N	30	30	700	2	10
Z990	1.5	2	.5	.3	N	50	N	15	15	300	L	30	10	700	2	L
							Cedar Creek drainage									
A116	2	3	.2	.3	N	70	N	20	30	500	L	20	50	700	1	N
A118	2	3	.15	.3	N	70	N	20	50	500	50	20	10	200	1	N
A119	1.5	2	.1	.3	N	70	N	15	30	500	L	15	L	200	1	N
A120	1.5	2	.3	.3	N	70	N	20	30	500	50	20	30	300	1.5	L
A121	.3	.3	1	.1	N	30	N	N	10	200	L	L	15	150	L	N
A122	.7	.7	.5	.2	N	50	30	5	15	300	50	15	70	100	1	N
A123	1.5	3	.07	.3	N	70	N	30	30	500	L	20	30	100	1	L
A508	3	5	.1	.5	N	70	N	50	70	500	L	30	50	1,500	2	L
A509	.2	.7	.5	.15	N	50	N	3	7	150	N	L	70	700	1	N
A510	2	5	.15	.5	N	70	N	30	50	700	50	30	70	700	2	L
Z901	.7	.7	.5	.2	N	30	N	2	15	200	L	10	50	500	1	N
Z902	2	3	.3	.3	N	70	N	15	50	500	70	20	50	700	1	N
Z903	1	.7	.3	.3	N	50	N	3	15	200	L	15	10	300	1	N
Z994	.7	1.5	.7	.3	N	50	N	10	30	200	70	10	30	700	1	N

Primitive Area, Missoula and Lake Counties, Mont.—Continued

Sample	Semiquantitative spectrographic analyses[1/]--Continued (ppm)								Chemical analyses[2/] (ppm)			Sample description
	Y (5)	Cu (2)	Zr (10)	Ag (.5)	La (20)	Sc (5)	Co (5)	Zn (200)	Au (.02)	Hg (.02)	cxHM (.5)	
												Veins, veinlets, and altered rocks--Continued
A057	30	10	500	N	70	10	15	N	A	A	---	Quartz-chlorite veinlets.
A058	70	10	100	N	N	N	5	N	A	A	---	Quartz vein.
A070	N	L	10	N	N	N	N	N	A	.02	---	Quartz veinlets.
A146	N	10	30	N	N	N	5	N	A	.02	---	Quartz-chlorite vein.
A481	20	20	150	N	20	7	10	N	A	.03	---	Bleached dolomite.
A487	20	10	200	N	30	15	20	N	A	.12	---	Argillite with sulfide veinlets.
A488	20	15	150	N	30	10	30	N	A	.07	---	Fractured argillite and siltite.
A499	30	200	50	L	20	L	15	N	A	.03	---	Dense carbonate on joint.
A524	15	15	N	N	20	N	N	N	A	.03	---	Quartz-carbonate vein.
A525	15	10	L	N	20	N	N	N	A	.04	---	Do.
Z009	L	30	10	N	N	N	N	N	A	.05	---	Quartz vein.
Z015	N	10	N	N	N	N	N	N	A	.04	---	Do.
Z022	N	10	70	N	N	N	N	N	A	A	---	Do.
Z026	15	20	300	N	50	15	15	N	A	A	---	Hornfelsed argillitic siltite.
Z028	30	20	200	N	50	15	15	N	A	.02	---	Hornfelsed dolomitic siltite.
Z033	15	50	200	N	30	10	20	N	A	A	---	Do.
Z045	N	15	15	N	N	L	N	N	A	.02	---	Quartz vein.
Z082	15	3	N	N	50	5	N	N	A	A	---	Calcite vein.
Z092	5	7	30	N	L	L	7	N	A	A	---	Quartz vein.
Z103	N	10	70	N	N	L	5	N	A	.03	---	Do.
Z125	30	30	300	N	50	15	15	N	A	.03	---	Hornfelsed calcareous argillite.
Z126	20	15	200	N	20	15	5	N	A	A	---	Hornfelsed dolomitic siltite.
Z128	30	20	700	N	20	5	7	N	A	A	---	Hornfelsed calcareous dolomite.
Z130	50	20	200	N	30	15	7	N	A	.02	---	Hornfelsed dolomitic siltite.
Z131	20	100	300	N	30	20	15	N	A	.03	---	Do.
Z132	10	70	200	N	20	10	7	N	A	A	---	Do.
Z915	N	15	N	N	N	N	N	N	A	.02	---	Quartz vein.
Z928	N	7	N	N	N	N	N	N	A	.03	---	Do.
Z956	N	30	L	N	N	N	N	N	A	A	---	Do.
Z979	N	7	N	N	N	N	N	N	1.0	.07	---	Do.
												Stream and lake sediments
												Fatty Creek drainage
A003	20	10	150	N	L	7	5	N	A	----	4	Stream sediment.
A006	15	20	200	N	N	7	7	N	A	----	5	Do.
A035	30	150	200	N	50	10	15	N	A	----	1	Do.
A036	20	20	200	N	N	7	5	N	A(.1)	----	14	Do.
A037	30	30	200	N	50	7	N	N	A	----	7	Do.
Z001	70	15	150	N	30	7	5	N	A	----	5	Do.
Z024	15	30	300	N	30	15	20	N	A	----	3	Do.
Z025	20	30	300	N	50	15	15	N	A	----	3	Do.
Z990	50	20	150	N	70	7	7	N	A	----	2	Do.
												Cedar Creek drainage
A116	30	50	200	N	70	15	15	N	A	----	3	Stream sediment.
A118	50	30	300	N	50	15	15	N	A	----	.5	Do.
A119	20	15	300	N	20	10	15	N	A	----	1	Do.
A120	20	20	300	N	70	15	15	N	A	----	1	Do.
A121	30	20	30	N	L	5	N	N	A(.1)	----	1	Do.
A122	70	20	150	N	150	7	5	N	A	----	2	Do.
A123	30	20	300	N	50	10	15	N	A	----	A	Do.
A508	50	15	300	N	30	20	30	N	A(.04)	----	2	Do.
A509	10	50	70	N	30	7	L	N	A	----	1	Do.
A510	30	30	300	N	70	20	30	N	A	----	5	Do.
Z901	15	20	200	N	20	5	L	N	A	----	2	Do.
Z902	50	70	300	N	70	15	15	N	A	----	3	Do.
Z903	15	20	300	N	20	7	N	N	A	----	1	Do.
Z994	50	150	150	.7	300	10	5	N	A	----	5	Do.

TABLE 1.—*Analyses of samples from the Mission Mountains*

Semiquantitative spectrographic analyses 1/

Sample	(percent) Mg (.01)	Fe (.05)	Ca (.05)	Ti (.001)	(ppm) Mo (5)	V (10)	Sn (10)	Ni (2)	Cr (5)	Ba (10)	Sr (50)	B (10)	Pb (10)	Mn (10)	Be (1)	Nb (10)
								Stream and lake sediments								
								Piper Creek drainage								
Z115	3	3	.2	.3	N	70	N	20	30	300	50	20	70	700	2	L
Z118	2	3	.15	.3	N	70	N	20	30	500	L	20	70	700	1	N
Z119	2	5	.3	.5	N	70	N	30	50	500	50	30	50	1,000	1	L
Z120	.7	3	.5	.3	N	70	N	5	20	300	L	15	70	1,000	1	N
Z121	1.5	3	.5	.3	N	70	N	15	30	500	70	30	50	700	2	L
Z122	2	3	.5	.3	N	70	N	30	30	500	50	30	70	1,000	1	10
Z124	2	3	.1	.3	N	70	N	30	30	500	L	30	L	200	1	L
Z941	1	2	.3	.3	N	70	N	15	20	300	L	30	70	1,000	1	N
Z942	.7	2	.7	.3	N	70	N	15	15	150	50	15	20	700	1	N
Z968	1	3	.3	.3	N	70	N	15	20	300	50	20	30	700	1	N
								Jim Creek drainage								
A474	1.5	1.5	.3	.3	N	70	N	7	15	300	N	30	20	300	1	L
A475	2	3	.7	.5	N	70	N	30	30	300	50	30	30	200	1	10
A476	2	3	.15	.3	N	70	N	30	30	500	N	30	50	1,000	2	L
A491	3	3	.3	.3	N	50	N	30	30	300	N	30	50	700	1	N
A493	2	3	.15	.3	N	50	N	50	30	300	N	30	70	1,500	2	N
A494	2	3	.3	.3	N	70	N	50	30	500	N	30	70	1,000	2	10
Z053	3	3	.3	.3	N	50	N	20	30	500	L	70	50	1,000	1	10
								N. Fork Cold Creek drainage								
A100	2	2	.3	.3	N	70	N	7	30	300	N	50	15	300	1	N
A101	3	3	.3	.3	N	70	N	15	50	700	N	50	15	500	1	L
A102	1.5	1	.3	.2	N	50	N	5	20	300	N	30	15	150	L	N
A103	1	1.5	.3	.3	N	70	N	5	15	300	N	20	10	700	1	N
A104	1	.7	.3	.2	N	70	N	2	15	300	N	20	15	50	2	N
A105	3	2	.15	.3	N	70	N	20	50	500	N	50	15	500	3	L
A106	2	2	.5	.3	N	70	N	20	50	300	L	70	50	700	2	L
A107	2	3	.3	.3	N	70	N	30	50	500	L	50	50	700	1.5	L
A108	2	3	.3	.5	N	70	N	30	50	700	L	70	50	1,000	1	N
								Cold Creek drainage								
A402	3	3	.3	.3	N	70	N	30	50	500	L	50	70	700	1	L
A403	1.5	1.5	.3	.3	N	70	N	7	30	300	N	30	30	500	1	N
A404	3	3	.3	.5	N	70	N	20	50	500	N	50	50	700	1	L
A405	3	3	.3	.3	N	70	N	20	70	500	N	70	50	500	1	10
A406	2	3	.5	.3	N	70	N	15	30	500	50	50	30	300	1	L
A407	2	1.5	.5	.3	N	70	N	10	30	500	L	50	30	300	1	L
A408	3	2	.3	.3	N	70	N	15	50	700	50	50	30	500	2	L
A451	1.5	2	.5	.5	N	70	N	20	20	700	50	50	50	500	1	N
A452	.5	1	.5	.3	N	50	N	7	7	200	N	15	10	500	1	N
A454	.3	1	.5	.1	N	30	N	3	15	150	L	L	30	700	1	N
A459	1	1.5	.5	.2	N	50	N	7	20	200	N	20	70	700	1	N
A460	3	2	.5	.3	N	70	N	20	30	700	50	70	30	700	2	10
Z069	2	5	.5	.3	N	50	N	15	30	300	50	70	70	1,000	1	L
Z070	1.5	2	.3	.3	N	70	N	15	20	300	N	50	70	700	1	N
Z072	3	5	.3	.3	N	70	N	20	30	500	L	100	70	1,500	2	L
Z073	1.5	3	.3	.2	N	50	N	10	20	300	L	50	50	700	1	L
Z075	3	7	.5	.3	N	70	N	20	50	700	L	70	70	700	1	L
Z076	.7	1.5	.7	.3	N	50	N	7	30	200	50	20	50	1,500	1	N
								S. Fork Cold Creek drainage								
A019	1.5	3	1.5	.3	N	70	N	30	30	300	70	50	50	700	1	N
A022	1.5	3	.5	.3	N	70	N	15	30	300	L	50	20	700	1	N
A024	2	3	.7	.3	N	70	N	30	30	300	50	30	70	1,000	1	L
A025	3	3	.7	.3	N	50	N	30	50	1,000	L	50	70	1,500	1	N
A026	1.5	2	1	.3	N	70	N	20	20	500	70	30	15	1,000	1	N

Primitive Area, Missoula and Lake Counties, Mont.—Continued

Sample	Semiquantitative spectrographic analyses[1]—Continued (ppm) Y (5)	Cu (2)	Zr (10)	Ag (.5)	La (20)	Sc (5)	Co (5)	Zn (200)	Chemical analyses[2] (ppm) Au (.02)	Hg (.02)	cxHM (.5)	Sample description
								Stream and lake sediments				
								Piper Creek drainage				
Z115	30	30	300	N	50	15	15	N	A	---	3	Stream sediment.
Z118	30	30	300	N	50	15	20	N	A	---	1	Do.
Z119	70	30	300	N	100	15	20	N	A	---	5	Do.
Z120	20	70	150	N	30	10	5	N	A	---	3	Do.
Z121	50	20	300	N	100	15	10	N	A	---	5	Do.
Z122	50	20	300	N	100	15	15	N	A	---	5	Do.
Z124	30	15	300	N	70	15	15	N	A	---	1	Do.
Z941	30	30	200	N	30	7	10	N	A	---	4	Do.
Z942	70	20	300	N	50	15	10	N	.03	---	.5	Streambank sediment.
Z968	15	20	200	N	50	15	15	N	A	---	2	Stream sediment.
								Jim Creek drainage				
A474	20	15	200	N	70	7	7	N	A	---	7	Stream sediment.
A475	20	15	300	N	50	10	15	N	A	---	4	Lake sediment.
A476	20	15	200	N	50	15	20	N	A	---	7	Stream sediment.
A491	30	20	300	N	30	10	15	N	A	---	9	Do.
A493	20	20	200	N	50	10	20	N	A	---	14	Do.
A494	50	20	300	N	70	15	20	N	A	---	17	Do.
Z053	30	15	200	N	50	15	15	N	A	---	3	Do.
								N. Fork Cold Creek drainage				
A100	50	10	200	N	30	10	10	N	A	---	2	Stream sediment.
A101	20	15	300	N	30	10	15	N	A	---	1	Do.
A102	15	15	100	N	30	7	5	N	A	---	4	Do.
A103	15	10	100	N	30	7	10	N	A	---	5	Do.
A104	20	5	200	N	50	5	L	N	A	---	1	Do.
A105	30	15	300	N	50	15	15	N	A	---	2	Do.
A106	20	20	300	N	50	15	15	N	A	---	3	Do.
A107	30	30	300	N	70	10	15	N	A	---	4	Do.
A108	30	30	300	N	50	10	15	N	A	---	3	Do.
								Cold Creek drainage				
A402	20	20	300	N	70	15	15	N	A	---	7	Stream sediment.
A403	15	20	150	N	L	7	L	N	A	---	5	Do.
A404	30	30	300	N	50	15	15	N	A	---	7	Do.
A405	50	20	300	N	50	15	15	N	A	---	5	Do.
A406	20	30	300	N	50	10	15	N	A	---	1	Do.
A407	20	15	200	N	70	7	7	N	A	---	3	Do.
A408	50	30	300	N	70	10	15	N	A	---	1	Do.
A451	20	20	300	N	30	10	15	N	A	---	5	Do.
A452	15	150	200	N	L	7	N	L	A	---	3	Do.
A454	15	20	50	N	20	5	L	N	A	---	30	Do.
A459	20	20	150	N	20	7	7	N	.03	---	9	Do.
A460	30	20	300	N	50	15	15	N	A	---	1	Do.
Z069	30	30	200	N	50	10	15	N	A	---	2	Do.
Z070	30	20	200	N	50	10	7	N	A	---	4	Do.
Z072	30	20	300	N	70	15	15	N	A	---	9	Do.
Z073	20	15	150	N	50	7	7	N	A	---	3	Do.
Z075	30	30	300	N	50	10	15	N	A	---	1	Do.
Z076	50	70	150	N	30	7	5	N	A	---	3	Do.
								S. Fork Cold Creek drainage				
A019	70	50	200	N	30	15	15	N	A	---	4	Stream sediment.
A022	30	30	200	N	30	15	10	N	A	---	3	Do.
A024	70	30	300	N	30	15	15	N	A	---	7	Do.
A025	50	30	300	N	30	15	15	N	A	---	4	Do.
A026	70	30	300	N	30	10	10	N	A	---	2	Do.

TABLE 1.—*Analyses of samples from the Mission Mountains*

Semiquantitative spectrographic analyses 1/

Sample	(percent) Mg (.01)	Fe (.05)	Ca (.05)	Ti (.001)	(ppm) Mo (5)	V (10)	Sn (10)	Ni (2)	Cr (5)	Ba (10)	Sr (50)	B (10)	Pb (10)	Mn (10)	Be (1)	Nb (10)
Stream and lake sediments																
S. Fork Cold Creek drainage--Continued																
A483	1.5	3	.7	.3	N	70	N	30	50	500	L	70	50	1,000	1	L
A484	2	5	.5	.3	N	70	N	30	70	700	70	70	30	700	1	L
Z062	3	3	.3	.5	N	70	N	20	20	700	70	50	30	500	2	L
Z063	3	3	.5	.5	N	70	10	30	30	700	150	20	50	700	1	N
Z064	5	3	.3	.5	N	70	N	20	30	1,000	70	50	50	700	2	L
Z065	3	3	.2	.3	N	70	N	20	15	700	N	70	30	500	2	L
Z066	2	3	.2	.3	N	70	N	30	30	1,000	L	70	30	700	2	N
N. Fork and main Elk Creek drainages																
A079	2	3	.3	.3	N	70	15	15	30	700	L	50	70	1,000	1	10
A129	1.5	2	.7	.3	N	70	N	10	20	300	L	20	20	300	1	N
A130	3	7	1.5	1	N	200	N	50	50	300	70	30	30	700	N	N
A131	3	7	1.5	.5	N	100	N	50	70	500	50	30	20	700	1	10
A133	3	5	1.5	.5	N	150	N	50	20	300	50	30	20	700	1	L
A134	3	5	1.5	.5	N	150	N	50	15	300	L	50	15	700	1	N
A135	3	3	1	.5	N	100	N	50	20	300	L	30	30	700	1	N
Z027	1.5	15	.7	>1	N	1,000	N	70	50	100	100	10	10	1,500	N	N
Z030	1	7	1.5	.7	N	300	N	50	50	70	70	10	15	1,500	N	N
Z032	1	5	1	.5	N	150	N	30	30	150	50	15	10	700	1	N
Z034	3	10	3	.7	N	300	N	70	100	150	150	10	20	1,500	L	N
Z035	2	3	1	.3	N	50	N	20	30	500	50	70	50	700	2	N
Z036	.5	1.5	.5	.2	N	30	N	L	15	150	L	10	20	500	1	N
Z037	1	3	.7	.3	N	70	N	15	20	500	50	20	50	1,000	1	N
Z038	2	3	.5	.3	N	70	N	30	50	300	50	30	70	700	1	N
Z039	1.5	2	.5	.3	N	70	N	20	30	300	50	20	100	1,000	1	N
Z059	1.5	2	.5	.3	N	70	N	15	15	500	L	30	30	300	1	N
Z060	3	15	2	>1	N	1,000	N	70	30	150	150	15	30	1,500	N	N
S. Fork Elk Creek drainage																
A132	3	7	1.5	.7	N	150	N	50	30	300	70	20	20	700	1	N
Z084	1.5	1.5	.7	.3	N	70	N	10	15	200	L	100	50	700	1	N
Z086	3	3	.5	.5	N	70	N	30	70	300	50	150	70	700	2	N
Z087	2	3	.5	.3	N	70	N	30	70	300	L	150	70	1,000	2	10
Z088	3	5	.3	.3	N	70	N	50	70	300	L	200	70	1,000	1	L
Z090	1.5	3	.5	.3	N	70	N	7	20	200	L	100	20	700	1	N
Hemlock, Frenchy, and Red Butte Creek drainages																
A015	.7	3	.2	.3	N	70	N	30	70	300	50	100	70	500	1	L
A016	1.5	5	.3	.5	N	70	N	50	70	300	50	100	30	700	3	10
A149	3	5	.15	.5	N	70	N	50	50	300	L	100	20	500	1	L
A150	1.5	3	.15	.5	N	70	N	50	30	300	L	70	15	500	1	L
A446	2	3	.3	.5	N	70	N	30	70	500	50	70	50	700	2	L
A447	3	3	.3	.5	N	70	N	50	70	500	50	70	70	500	1	N
A448	1.5	3	.1	.5	N	70	N	50	70	300	L	70	30	500	1	N
A449	1.5	3	.2	.5	N	70	N	30	70	300	50	70	30	500	2	L
A450	2	5	.15	.5	N	70	N	50	70	300	L	70	30	300	2	L
A464	5	3	.3	.5	N	70	N	30	50	700	N	150	20	700	1.5	15
A466	1.5	1.5	.5	.3	N	70	N	15	20	700	N	70	30	700	2	L
A467	1	1.5	.7	.15	N	50	N	7	20	500	50	50	30	300	1	N
A468	1.5	3	.5	.5	N	70	N	50	70	500	50	200	30	500	2	L
Z012	.7	3	.3	.3	N	70	N	20	50	300	50	150	50	700	1	L
Kraft Creek drainage																
A027	1.5	3	1	.3	N	70	N	15	30	300	70	70	20	700	1	N
A028	5	3	.2	.3	N	70	L	50	70	300	N	50	L	500	1	15
A029	5	3	.5	.3	N	70	N	20	30	300	50	70	30	700	1	10
A053	1.5	3	.5	.5	N	70	N	30	50	700	70	100	30	300	1	N

Primitive Area, Missoula and Lake Counties, Mont.—Continued

Sample	Semiquantitative spectrographic analyses[1]--Continued (ppm)								Chemical analyses[2] (ppm)			Sample description
	Y (5)	Cu (2)	Zr (10)	Ag (.5)	La (20)	Sc (5)	Co (5)	Zn (200)	Au (.02)	Hg (.02)	cxHM (.5)	
												Stream and lake sediments
												S. Fork Cold Creek drainage--Continued
A483	70	70	300	N	50	15	15	N	A	---	7	Stream sediment.
A484	20	30	300	N	30	15	15	N	A	---	2	Do.
Z062	15	30	300	N	50	10	15	N	A	---	1	Do.
Z063	70	200	300	N	70	15	15	N	A	---	.5	Do.
Z064	30	20	300	N	70	10	15	N	A	---	1	Do.
Z065	20	15	300	N	100	10	15	N	A	---	A	Do.
Z066	30	150	300	N	70	15	15	N	A	---	2	Do.
												N. Fork and main Elk Creek drainages
A079	20	200	300	N	50	15	15	N	A	---	2	Stream sediment.
A129	30	15	200	N	50	15	5	N	A(.04)	---	9	Do.
A130	30	70	300	N	20	50	70	N	A	---	1	Do.
A131	30	50	200	N	30	30	50	N	A	---	1	Do.
A133	50	50	300	N	30	20	30	N	A	---	3	Do.
A134	30	30	200	N	30	30	30	N	A	---	1	Do.
A135	50	50	200	L	30	20	30	N	A	---	2	Dry streambed sediment.
Z027	20	300	300	N	L	70	100	N	A	---	1	Stream sediment.
Z030	30	150	100	N	20	30	50	N	A	---	1	Do.
Z032	20	100	100	N	30	15	20	N	A	---	.5	Do.
Z034	30	200	150	N	N	50	70	N	A	---	2	Do.
Z035	30	30	300	N	30	10	15	N	A	---	4	Do.
Z036	15	20	70	N	L	7	N	N	A	---	12	Do.
Z037	20	20	200	N	30	10	15	N	A	---	7	Do.
Z038	30	50	200	N	30	10	15	N	A	---	4	Do.
Z039	30	30	150	N	30	7	15	N	A	---	7	Do.
Z059	30	30	200	N	70	7	5	N	A	---	3	Do.
Z060	50	300	200	N	N	30	70	N	A	---	3	Do.
												S. Fork Elk Creek drainage
A132	50	70	200	N	30	30	50	N	A	---	1	Stream sediment.
Z084	20	10	200	N	30	10	5	N	A	---	3	Do.
Z086	30	30	200	N	50	15	15	N	A	---	1	Do.
Z087	30	30	300	N	50	15	15	N	A	---	5	Do.
Z088	30	30	300	N	50	15	20	N	A	---	5	Do.
Z090	50	20	200	N	20	10	7	N	A	---	9	Do.
												Hemlock, Frenchy, and Red Butte Creek drainages
A015	30	100	300	N	70	15	15	N	A	---	5	Stream sediment.
A016	30	20	300	N	70	15	15	N	A	---	2	Do.
A149	15	100	300	N	30	15	20	N	A	---	5	Do.
A150	20	30	300	N	50	15	20	N	A	---	5	Do.
A446	15	70	300	N	70	15	15	N	A	---	5	Do.
A447	15	30	300	N	50	15	15	N	A	---	7	Do.
A448	20	20	300	N	70	20	20	N	A	---	1	Do.
A449	30	50	300	N	30	15	15	N	A	---	3	Do.
A450	20	20	300	N	70	20	15	N	A	---	9	Do.
A464	30	30	300	N	30	15	30	N	A	---	3	Do.
A466	30	30	300	N	50	15	10	N	A	---	3	Do.
A467	15	20	150	N	20	7	7	N	A(.04)	---	4	Do.
A468	30	20	300	N	50	15	20	N	A	---	12	Do.
Z012	30	70	300	N	50	15	15	N	A	---	7	Do.
												Kraft Creek drainage
A027	30	30	300	N	50	15	10	N	A	---	2	Stream sediment.
A028	30	150	300	N	70	15	15	N	A	---	.5	Do.
A029	30	20	300	N	50	15	15	N	.03	---	1	Do.
A053	50	30	300	N	70	15	15	N	A	---	4	Do.

TABLE 1.—*Analyses of samples from the Mission Mountains*

Semiquantitative spectrographic analyses [1/]

Sample	(percent) Mg (.01)	Fe (.05)	Ca (.05)	Ti (.001)	(ppm) Mo (5)	V (10)	Sn (10)	Ni (2)	Cr (5)	Ba (10)	Sr (50)	B (10)	Pb (10)	Mn (10)	Be (1)	Nb (10)
Stream and lake sediments																
Crazy Horse Creek drainage																
A425	3	5	.2	.3	N	70	15	50	70	300	L	150	50	700	1	10
A426	3	3	.2	.3	N	70	10	30	50	200	N	150	70	1,000	1	L
A427	3	3	.3	.3	N	70	N	30	70	300	L	150	70	700	1	L
A428	3	3	.3	.5	N	70	N	30	70	300	L	150	70	700	2	L
A429	2	5	.3	.3	N	70	N	30	70	300	L	150	30	100	2	10
A430	1.5	3	.5	.3	N	70	N	20	30	300	L	100	50	700	1	N
A432	1.5	3	.5	.3	N	70	N	20	30	500	50	100	70	500	1	N
A434	.3	.7	.3	.15	N	30	N	L	20	300	50	20	50	500	1	N
A436	2	3	.1	.3	N	70	N	30	50	300	N	150	30	300	1	L
A437	2	5	.3	.3	N	70	N	30	70	300	L	150	70	700	2	10
A438	1.5	5	.1	.3	N	70	N	30	70	300	L	150	15	300	1	10
A439	.7	2	.3	.3	N	70	N	10	50	200	50	50	30	300	1	N
A440	2	5	.2	.3	N	70	N	50	70	300	L	70	30	700	1.5	L
Z094	3	3	.2	.5	N	70	N	30	70	300	L	150	70	1,000	2	L
Z097	2	5	.5	.7	N	70	N	50	70	500	70	150	1,500	1,500	1.5	L
Z098	1.5	3	.5	.5	N	70	N	15	50	300	70	100	50	700	1	L
Z099	3	5	.3	.3	N	70	N	20	50	300	L	150	50	700	1	L
Z100	3	3	.3	.3	N	70	N	30	50	300	L	150	70	700	2	L
Z104	1.5	3	.15	.5	N	70	N	30	70	300	L	200	10	200	1	L
Z105	.7	1	.5	.15	N	30	N	L	15	300	L	50	30	1,500	1	N
Z106	3	3	.3	.5	N	70	N	20	70	500	50	150	50	700	1.5	10
Z108	1.5	3	.3	.5	N	70	N	30	70	300	50	150	50	700	1	L
Z109	1	2	.3	.2	N	70	N	15	50	300	N	70	50	700	3	N
Z110	3	.5	1.5	.1	N	20	N	L	7	200	L	10	70	700	1	N
Z909	3	3	.3	.3	N	70	N	15	50	500	L	200	70	700	1	N
Z910	1	2	.3	.3	N	50	N	7	20	500	L	150	50	1,000	1	N
Z911	3	5	.3	.3	N	70	N	20	70	300	L	300	70	700	1	N
Glacier Creek drainage																
A064	1.5	5	.5	.3	N	70	N	30	30	300	L	70	30	1,500	2	L
A065	1.5	2	.3	.3	N	70	N	20	20	300	L	30	20	700	1	N
A066	1.5	3	.5	.3	N	50	N	30	50	300	L	30	30	700	2	N
A093	.3	.7	.7	.1	N	20	N	2	10	200	70	15	70	300	1	N
A094	.5	1.5	.3	.2	N	70	N	7	15	300	50	30	50	700	1	N
A095	.3	1.5	.15	.2	N	70	L	7	7	150	L	30	30	300	1	N
A097	.3	1.5	.5	.3	N	70	N	5	30	300	50	30	70	200	1	N
A099	.7	1.5	.3	.3	N	70	N	5	30	300	50	70	70	300	1	N
A471	.7	2	.3	.3	N	50	N	15	30	300	L	70	15	500	1	L
A472	2	3	.2	.5	N	70	N	50	70	500	L	150	50	300	1	L
Z111	1.5	3	.7	.5	5	70	N	20	50	300	70	100	50	700	1	L
Z913	2	5	.2	.5	N	70	N	30	70	300	L	200	L	500	1	10
Z914	.5	1	.5	.2	N	30	N	2	10	500	50	30	70	1,500	1	N
Z922	.7	1.5	.15	.3	N	70	N	15	30	300	50	70	30	300	1	N
Z923	.3	1.5	.3	.3	N	70	N	10	20	300	50	20	70	700	1.5	N
Z924	.5	1.5	.5	.3	N	70	N	10	15	500	70	15	50	700	1	N
Herrick Run drainage																
A067	3	5	.2	.3	N	70	N	50	70	300	L	70	30	700	3	N
A068	2	5	.5	.5	N	70	N	50	50	500	50	50	20	1,000	2	10
A069	2	7	.1	.5	N	70	N	30	70	300	L	150	L	700	1.5	10
Swan River drainage																
A087	3	3	.15	.3	N	70	N	30	50	300	L	100	30	500	1	N
A088	3	3	.3	.3	N	70	N	20	50	500	L	100	70	500	1	N
A089	3	3	.3	.3	N	70	N	15	30	300	L	100	70	300	1	L
A090	5	3	.07	.3	N	70	N	30	50	500	L	150	50	500	1	N
A091	3	3	.2	.3	N	70	N	30	50	300	L	100	50	500	1	N

Primitive Area, Missoula and Lake Counties, Mont.—Continued

Sample	Semiquantitative spectrographic analyses[1]--Continued (ppm) Y (5)	Cu (2)	Zr (10)	Ag (.5)	La (20)	Sc (5)	Co (5)	Zn (200)	Chemical analyses[2] (ppm) Au (.02)	Hg (.02)	cxHM (.5)	Sample description
					Stream and lake sediments							
					Crazy Horse Creek drainage							
A425	30	20	300	N	50	15	15	N	A	---	1	Stream sediment.
A426	30	30	300	N	50	15	20	N	A	---	5	Do.
A427	30	20	300	N	50	15	15	N	A	---	3	Do.
A428	30	15	300	N	70	15	15	N	.04	---	3	Do.
A429	70	30	300	N	70	15	15	N	A	---	1	Do.
A430	30	30	200	N	30	15	15	N	A	---	3	Do.
A432	30	50	200	N	30	10	15	N	A	---	5	Do.
A434	20	20	100	N	30	5	L	N	A(.1)	---	25	Do.
A436	15	30	300	N	30	15	15	N	A	---	2	Do.
A437	30	70	300	N	70	15	15	N	A	---	1	Do.
A438	30	70	300	N	30	15	15	N	A	---	.5	Do.
A439	20	50	200	N	50	7	5	N	A	---	2	Do.
A440	30	30	300	N	30	15	20	N	A	---	2	Do.
Z094	30	30	300	N	30	15	15	N	A	---	4	Do.
Z097	30	100	300	L	70	15	30	N	A	---	12	Do.
Z098	50	30	300	N	50	15	15	N	A	---	2	Do.
Z099	30	30	300	N	50	15	15	N	A	---	7	Do.
Z100	30	20	300	N	50	15	15	N	A	---	5	Do.
Z104	50	30	300	N	30	15	15	N	A	---	1	Do.
Z105	30	30	150	N	20	5	L	N	A	---	3	Do.
Z106	15	30	300	N	70	15	15	N	A	---	2	Do.
Z108	30	30	300	N	50	15	20	N	A	---	2	Do.
Z109	30	30	150	N	30	15	15	N	A	---	5	Dry streambed sediment.
Z110	20	20	70	N	L	5	N	N	A(.04)	---	14	Stream sediment.
Z909	20	30	300	N	50	10	15	N	A	---	7	Do.
Z910	20	100	300	N	30	10	5	N	A	---	9	Do.
Z911	30	50	300	N	30	15	15	N	A(.04)	---	9	Do.
					Glacier Creek drainage							
A064	20	20	300	N	70	15	15	N	A	---	3	Stream sediment.
A065	20	15	200	N	70	7	10	N	A	---	3	Do.
A066	100	50	150	N	70	15	10	N	A	---	2	Do.
A093	15	20	70	N	L	5	L	N	A(.04)	---	5	Do.
A094	15	70	100	N	30	7	7	N	A	---	7	Do.
A095	15	15	150	N	30	7	7	N	A	---	3	Do.
A097	15	30	150	N	L	7	5	N	A(.04)	---	5	Do.
A099	15	50	200	N	20	7	7	N	A(.04)	---	3	Do.
A471	15	15	300	N	50	10	5	N	A	---	7	Do.
A472	20	150	300	N	50	15	15	N	A	---	7	Do.
Z111	50	30	300	N	50	15	15	N	A	---	1	Do.
Z913	30	20	300	N	50	15	15	N	A	---	3	Do.
Z914	15	30	100	N	20	5	N	N	A	---	9	Do.
Z922	15	20	300	N	30	10	10	N	A	---	.5	Do.
Z923	15	70	100	N	50	5	10	N	A	---	7	Do.
Z924	15	20	300	N	30	10	10	N	A	---	2	Lake sediment.
					Herrick Run drainage							
A067	50	70	200	N	30	15	20	N	A	---	2	Stream sediment.
A068	30	30	300	N	50	20	15	N	A	---	2	Do.
A069	20	20	300	N	30	15	20	N	A	---	1	Do.
					Swan River drainage							
A087	15	10	300	N	50	10	15	N	A	---	1	Stream sediment.
A088	30	20	200	N	70	15	15	N	A	---	2	Lake sediment.
A089	20	20	200	N	70	15	15	N	A	---	5	Do.
A090	15	15	300	N	70	15	15	N	A	---	1	Stream sediment.
A091	20	20	200	N	50	15	20	N	A	---	7	Do.

TABLE 1.—*Analyses of samples from the Mission Mountains*

Semiquantitative spectrographic analyses [1]

Sample	(percent) Mg (.01)	Fe (.05)	Ca (.05)	Ti (.001)	(ppm) Mo (5)	V (10)	Sn (10)	Ni (2)	Cr (5)	Ba (10)	Sr (50)	B (10)	Pb (10)	Mn (10)	Be (1)	Nb (10)
								Stream and lake sediments								
								Swan River drainage--Continued								
A137	.2	.5	.3	.2	N	50	N	L	7	150	N	10	20	300	1	L
A141	1.5	7	.07	.3	N	70	N	70	70	300	L	70	50	500	1	L
A143	.7	3	.7	.3	N	50	N	15	50	200	70	15	50	700	1	N
A144	.7	2	.3	.3	N	70	100	10	50	200	L	20	70	500	1	N
A147	1.5	2	.3	.3	N	50	N	30	70	300	150	20	30	200	1	N
A148	1.5	2	.3	.3	N	70	N	20	50	300	50	30	50	700	1.5	N
A409	1.5	3	.2	.5	N	70	N	20	50	300	L	70	10	300	1	L
A410	1.5	3	.5	.5	N	70	N	30	70	700	50	30	50	700	3	L
A411	2	5	.3	.5	N	70	N	30	70	700	50	70	20	500	1	10
A412	1.5	3	.3	.3	N	70	N	20	70	300	70	15	30	300	1	L
A413	2	5	.1	.3	N	70	N	30	70	300	L	15	15	150	1	10
A414	2	5	.3	.5	N	70	N	30	70	300	50	20	30	500	2	L
A415	1.5	3	.15	.3	N	70	N	30	50	200	L	15	L	150	1	L
A417	1.5	3	.3	.5	N	70	N	50	70	300	L	70	30	500	1	L
A418	1.5	3	.3	.3	N	70	N	30	70	300	L	100	30	500	2	L
A419	1.5	5	.15	.5	N	70	N	50	70	300	L	50	15	700	1	L
A420	.5	.7	1	.15	N	30	N	2	30	300	50	20	20	200	1	N
A422	.7	2	.3	.3	N	70	N	15	50	300	L	50	70	500	1	N
A423	1.5	3	.2	.5	N	70	N	50	70	300	L	150	15	500	1	10
Z080	.7	2	.3	.3	N	70	N	7	15	300	50	50	50	200	1	N
Z935	.3	1	.7	.15	N	30	N	5	50	200	70	10	50	100	1	N
Z955	1	2	.3	.5	N	70	N	10	30	300	50	50	20	300	1	N
Z959	1.5	5	.15	.3	N	70	N	50	70	300	L	100	30	300	2	L
Z960	2	3	.1	.5	N	70	N	50	70	300	L	150	30	200	2	10
								Beaver Creek drainage								
Z054	3	7	.15	.5	N	70	N	30	70	300	L	150	L	500	2	15
Z055	3	5	.2	.3	N	70	N	30	50	500	L	100	10	700	1	10
Z056	3	3	.15	.3	N	70	N	30	30	300	L	70	L	500	1	10

Primitive Area, Missoula and Lake Counties, Mont.—Continued

	Semiquantitative spectrographic analyses1/--Continued (ppm)								Chemical analyses2/ (ppm)			
Sample	Y (5)	Cu (2)	Zr (10)	Ag (.5)	La (20)	Sc (5)	Co (5)	Zn (200)	Au (.02)	Hg (.02)	cxHM (.5)	Sample description
						Stream and lake sediments						
						Swan River drainage--Continued						
A137	15	20	100	N	30	5	N	N	A(.04)	---	4	Stream sediment.
A141	30	30	300	N	30	20	20	N	A	---	1	Do.
A143	20	30	150	N	50	10	15	N	A	---	.5	Streambank sediment.
A144	15	20	150	N	50	10	10	N	A	---	7	Stream sediment.
A147	20	30	300	N	20	15	15	N	A	---	3	Lake sediment.
A148	20	20	300	N	50	10	15	N	A	---	2	Stream sediment.
A409	50	30	300	N	50	10	15	N	A	---	3	Do.
A410	70	100	300	L	70	15	15	N	A	---	2	Do.
A411	20	30	300	N	70	15	15	N	A	---	2	Do.
A412	20	20	300	N	50	15	15	N	A	---	1	Do.
A413	20	50	300	N	50	15	15	N	A	---	.5	Do.
A414	30	20	300	N	50	15	15	N	A	---	2	Do.
A415	20	20	300	N	30	15	15	N	A	---	1	Do.
A417	30	30	300	N	50	15	15	N	A	---	1	Do.
A418	50	50	300	N	50	15	15	N	A	---	1	Do.
A419	30	30	300	N	50	15	15	N	A	---	3	Do.
A420	20	30	50	N	L	5	L	N	A(.04)	---	2	Streambank sediment.
A422	30	30	200	N	30	7	7	N	A(.1)	---	7	Stream sediment.
A423	30	20	300	N	30	15	15	N	A	---	2	Do.
Z080	20	20	200	N	20	7	L	N	A	---	1	Do.
Z935	20	30	50	N	20	7	5	N	A	---	1	Do.
Z955	15	20	300	N	30	10	5	N	.03	---	2	Streambank sediment.
Z959	30	20	500	N	50	15	20	N	A	---	7	Stream sediment.
Z960	50	20	500	N	30	20	20	N	A	---	5	Do.
						Beaver Creek drainage						
Z054	30	50	300	N	50	15	15	N	A	---	1	Stream sediment.
Z055	50	30	300	N	30	15	15	N	A	---	.5	Do.
Z056	30	50	300	N	50	15	15	N	A	---	1	Do.

TABLE 2.—*Phosphate content of selected samples*

Sample	Formation	Sample description	P_2O_5 (percent)
A007	Helena	Dolomitic siltite	0.075
A008	do	Glauconitic quartzite	.035
A045	Snowslip	Calcareous glauconitic quartzite	.070
A062	Shepard	Glauconitic quartzite	.075
A086	Helena	Oolitic limestone	.020
A112	do	Pelletal limestone	.030
A138	Snowslip	Calcareous quartzite	.050
A462	do	Calcareous glauconitic quartzite	.070
A463	Helena	Oolitic limestone	.030
A500	do	Pyritic pelletal limestone	.20
Z002	do	Pelletal limestone	.050
Z006	do	do	.060
Z007	do	Calcareous quartzite	.055
Z044	do	Oolitic limestone	.060
Z058	do	do	.050
Z061	do	Pyritic calcareous argillite	.12
Z068	do	Limestone	.020
Z071	do	Pyritic argillitic limestone	.070
Z078	do	Oolitic limestone	.030
Z079	Snowslip	Calcareous quartzite	.085
Z081	Helena	Oolitic limestone	.070
Z095	do	Black argillite	.085
Z905	do	Oolitic limestone	.060
Z907	do	Limestone	.060
Z908	do	Oolitic limestone	.020

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