STUDIES RELATED TO WILDERNESS
PRIMITIVE AREAS

HIGH SIERRA, CALIFORNIA

GEOLOGICAL SURVEY BULLETIN 1371-A

Mineral Resources of the High Sierra Primitive Area, California

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With a section on AEROMAGNETIC INTERPRETATION
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An evaluation of the mineral potential of the area

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STUDIES RELATED TO WILDERNESS

PRIMITIVE AREAS

In accordance with the provisions of the Wilderness Act (Public Law 88–577, September 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," or "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 provides that each primitive area 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 High Sierra Primitive Area and vicinity, California. The area discussed in the report includes the primitive area, as defined, and a contiguous tract that may come under discussion when the area is considered for wilderness status.

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MINERAL RESOURCES OF THE HIGH SIERRA PRIMITIVE AREA, CALIFORNIA

By JAMES G. MOORE, U.S. Geological Survey, and
LAWRENCE Y. MARKS, U.S. Bureau of Mines

SUMMARY

The High Sierra Primitive Area includes about 40 square miles in Sierra and Sequoia National Forests in the central Sierra Nevada; it is adjacent to the west boundary of Kings Canyon National Park. Cretaceous granitic rock, which occurs in many of the plutons that make up the Sierra Nevada batholith, is the dominant bedrock of the area. The granitic plutons are separated by screens and masses of Mesozoic metamorphic rocks, including rocks that were originally sedimentary and volcanic. Limy rocks are interbedded with both the metavolcanic and metasedimentary rocks, and small areas of contact metamorphic mineralization are associated with the limy rocks, particularly near contacts with the granitic rocks.

Analysis of more than 150 stream sediments and selected bedrock samples collected in and near the area did not indicate the presence of any previously unknown deposits of possible commercial value. Magnetic anomalies detected by an aeromagnetic survey can be explained as topographic effects of normally magnetized rocks.

There are two prospects: one in the Middle Fork Canyon at river level and the other near the Obelisk in the northwest corner of the study area. The Middle Fork prospect contains small, noneconomic quantities of metals in sheared quartzite. The Obelisk prospect contains about 8,000 tons of tactite averaging 1 percent WO_3, as determined by diamond drilling. Limited additional reserves may be present; thus, a small economic deposit may be developed.

An aeromagnetic survey flown at 14,000 feet elevation and 1-mile spacing indicates that total magnetic relief is about 500 gammas and that magnetic highs occur over the more mafic plutons and hypersthene-bearing metavolcanic rocks. The anomalies are caused by rock types commonly exposed at the surface. There is no magnetic evidence for buried iron deposits, serpentinite, or magnetic placers of economic importance.

INTRODUCTION

LOCATION AND GENERAL FEATURES

The area described in this report is in the Kings River drainage on the west slope of the Sierra Nevada, Fresno County, Calif. (fig. 1). It includes the High Sierra Primitive Area and a contiguous tract to the west, the study of which was requested by the U.S. Forest Service. Together, the two tracts cover an irregularly shaped area about 9½ miles long and 4 miles wide, which contains about 25,700 acres and which is here referred to as the High Sierra Primitive Area. The area is adjacent to and west of the central part of Kings Canyon National Park and lies within the east-central part of the Tehipite Dome 15-minute quadrangle and the west-central part of the Marion Peak quadrangle. The northern part of the area is within the Sierra National Forest, and the southern part within the Sequoia National Forest.

The area is dominated by the deep canyons of the Middle and South Forks of the Kings River (fig. 2) and by the high ridge between called Monarch Divide and Junction Ridge. This ridge crest is the boundary between Sierra and Sequoia National Forest. The two forks of the Kings River meet at the extreme southwest corner of the primitive area. About 5 miles of the Middle Fork is within the area, but the South Fork is not within the area since the south boundary of the area is the 6,000-foot contour on the north wall of the South Fork canyon. Geologic mapping has been completed, however, south of the primitive area across the South Fork of the Kings River to State Route 180, the main access road to the entire area.

The primitive area is characterized by extreme relief; in fact, the canyons of the Kings River are among the deepest in the United States (Matthes, 1950, p. 57). The lowest point within the area, at the junction of the two forks of the Kings River, is at an altitude of 2,200 feet, and the Obelisk, 4 miles to the north on the north boundary of the area, is at 9,700 feet. The high point of the area, 11,081 feet, is on the crest of Monarch Divide in the northeast corner of the area, between Hogback Peak and Mount Harrington.

Most of the area is trailless. The Deer Cove trail, in the southeast corner, provides access to the eastern part of the area and to the crest of Monarch Divide at Happy Gap. The northern part of the area is accessible from Tehipite Valley, the northwest corner from the trail originating at Wishon Reservoir, and the southern part from State Route 180.

PREVIOUS GEOLOGIC STUDIES

Prior to this investigation very little geologic work had been done within the High Sierra Primitive Area. In fact, one of the few "unmapped" areas depicted on the Fresno sheet of the

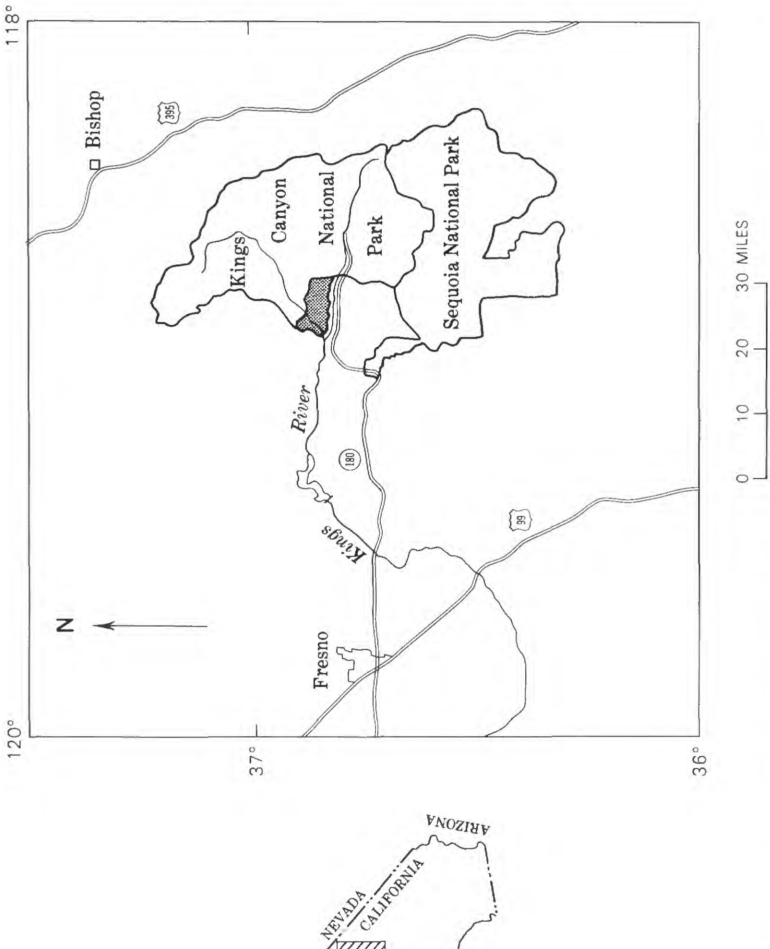


FIGURE 1. — Location of High Sierra Primitive Area (stippled) with respect to Kings Canyon and Sequoia National Parks. Diagonal pattern on map of California shows area covered by index map.

FIGURE 2.—View northeast up the canyon of the Middle Fork of the Kings River with Monarch Divide on the right. Tombstone Ridge is in the left background and Silver Spur in the right background.

Geologic Map of California (Matthews and Burnett, 1965) falls within the primitive area.

Mapping by Krauskopf (1953) as part of a regional study of tungsten deposits of the west-central Sierra Nevada was to the west of the study area and included some of the extreme western part of the area. Moore and Dodge (1962) mapped land adjacent to the south boundary of the area and made brief reconnaissance trips into the area in connection with their discovery of Mesozoic fossils in metamorphic rocks south of the South Fork of the Kings River. Moore, assisted by Phillip Fenn in 1968 and by Samuel Swanson in 1967, mapped that part of the primitive area in the Marion Peak quadrangle.

Extensive use was made of an unpublished report on the Obelisk claims by H. W. Jones (U.S. Bureau of Mines) and H. K. Stager (U.S. Geological Survey), written in connection with Defense Minerals Exploration Administration contract drilling on Obelisk 1 claim.

PRESENT INVESTIGATION

Field investigation in the area of this study was accomplished during the summer of 1970. The Geological Survey team, J. G.

Moore and Richard Farrington, made a geologic reconnaissance of the area and collected samples for geochemical studies during the period July 29–September 12. The Bureau of Mines team, Lawrence Y. Marks and Steven McElfresh, investigated mines and prospects during the period August 6–16, conducted a search of mineral production and mining claim records, and reviewed mineral resource publications concerning the area.

The High Sierra Primitive Area is rugged and remote. It has been proposed as a wilderness partly to preserve a segment of one of the deepest canyons in the United States. Because of the extreme relief, limited trail access, and difficulty in crossing the two rivers (Middle and South Forks of the Kings River), much of the work was conducted from camps established by helicopter. These camps were near the Obelisk, in Little Tehipite Valley, at the junction of the two forks of the Kings River, on the crest of Monarch Divide 1 mile west of Wren Peak, in a cirque half a mile north of Wren Peak, and at an elevation of 6,000 feet in upper Silver Creek. Twenty-two river crossings were made, but in no place within the mapped area could either fork of the Kings River be crossed safely without a fixed rope. In many places, especially before September, river crossings are hazardous under any conditions.

The aeromagnetic survey of the area was flown and data compiled in 1970 by the Geological Survey. Arthur Conradi made the magnetic measurements of selected rock samples (table 3), and H. W. Oliver was assisted by R. C. Farewell in the computer modeling along line A–A′ (pl. 1).

GEOLOGY

The primitive area is underlain by many granitic plutons, elongate northwesterly, which are a part of the Sierra Nevada composite batholith (pl. 1). The granitic rocks are apparently of Cretaceous age in this region, judging from radiometric age determinations in adjacent areas. They are separated from one another by screens and septa of metamorphic rocks that are older than the plutons. In the eastern part of the area are three masses of metavolcanic rocks presumably of Triassic or Jurassic age or both. In the western part of the area is a discontinuous mass of metasedimentary rock in which fossils of Triassic or Jurassic age have been found.

After emplacement of the granitic rocks and metamorphism of the older volcanic and sedimentary rocks, the area was uplifted, and the batholith deroofed by erosion. In late Cenozoic time, outpourings of basaltic lava covered parts of the area. Later, the main canyons were deepened and then glaciated along with the high ridges.

METASEDIMENTARY ROCKS

In the western part of the area, metasedimentary rocks form a large discontinuous screen which separates the Brush Canyon and Tombstone Creek plutons. A wide variety of rocks are represented in this screen. For mapping purposes they have been divided into four units: metaquartzite, marble, andalusite hornfels, and metasiltstone.

METAQUARTZITE

The western part of the main metasedimentary mass is largely white or gray thick-bedded metamorphosed sandstone. The sandstone is very commonly crossbedded; individual crossbeds average about half an inch thick, and the main beds are about half a foot to several feet thick. Characteristically the crossbedding is of the diagonal type, in which the crossbeds meet the main bedding planes, both above and below, at about the same angle. This feature, coupled with extensive bedding-plane shearing along mica-rich argillaceous layers, makes determination of original top directions difficult and commonly impossible. Statistical field measurements along State Route 180 and in the canyon of the Middle Fork of the Kings River, however, have established that the dominant top direction of the sandstone unit is toward the west. In a few places top direction could also be confidently determined by beds graded from a mica-rich argillaceous top to coarser grained sandstone below. In these places the top direction is also toward the west.

Generally the sandstone beds are about vertical. They have undergone very little folding compared with the other units, especially the thin-bedded metasiltstone unit to the east; however, some small folds were observed in the sandstone (fig. 3).

Although not common, coarser beds with pebbles as much as 1 centimeter in size are present in some places. Most of the pebbles are quartz, some are K-feldspar, and a few are hornfelsic-textured aggregates of quartz, K-feldspar, and muscovite.

Mineralogically the rock is predominantly quartz. The quartz occurs as ragged interlocking grains. Those smaller than a few millimeters are not rounded. K-feldspar is locally rather common and may make up 10–15 percent, but none was visible in thin sections from several places. A small amount of muscovite is present in nearly all speciemens. Biotite, chlorite, and epidote are rare constituents.

At several places observations were made on the relation of the attitude of the crossbeds to that of the main bedding in the

FIGURE 3. — Folding of metaquartzite near Horseshoe Bend on the south side of the South Fork of the Kings River. Hammer at lower left gives scale.

quartzitic sandstone. In the main eastern area of quartzite exposures in both the Middle Fork and South Fork canyons, the strike of the crossbeds is consistently more northward or northeastward than the strike of the main bedding planes. If the predominantly west-facing beds were rotated to their present near-vertical position around near-horizontal axes, then the source of the streams depositing the quartzite was to the south.

MARBLE

The most resistant unit in the main metasedimentary screen is a layer of massive marble about 1,000 feet thick which forms a high ridge on both walls of the South Fork canyon (fig. 4).

FIGURE 4.—View of Monarch Divide from the southwest. The prominent white ridge in the center is the main vertically bedded marble unit about 1,000 feet thick, flanked on the left by andalusite hornfels and another thinner marble layer. Tombstone Ridge and Tehipite Dome are visible in the left background below the horizon.

Bedding in the massive marble is poorly defined by darker more resistant layers a quarter of an inch to a foot thick. The strike of these bedding layers wraps partly around the blunt northern termination of the main marble unit on the crest of Monarch Divide. The significance of this folding is difficult to interpret. Perhaps it indicates drag on a major fault on the west side of the marble unit.

Mineralogically, the marble is largely calcite and dolomite. The grain size is as much as several millimeters. In some places calc-silicate minerals have formed, and near Boyden cave, rosettes of tremolite occur in certain zones in calcite.

The presence of both marble and quartzitic sandstone in the northern continuation of the large metasedimentary screen indicates that these rocks on the northwest boundary of the primitive area are part of the same sequence, although shaly impurities are more common in the much smaller northern marble mass.

ANDALUSITE HORNFELS

Andalusite hornfels crops out continuously in an area west of the main marble unit. Even though the andalusite rock forms topographically low areas between marble and quartzitic sandstone, the rock is very dense and tough under the hammer. It weathers to a brownish color but has a faint bluish cast on fresh surfaces.

The rock is generally mica rich and commonly schistose. In addition to quartz and spongy andalusite as much as several millimeters in size, biotite, muscovite, and chlorite are commonly present, and magnetite is locally abundant.

METASILTSTONE

Thin-bedded metamorphic rocks of diverse composition occur in a belt 2,000–4,000 feet wide on the east side of the main metasedimentary mass. Included in this unit are siliceous metasiltstones that have been only slightly recrystallized and contain preserved crinoid columnals and pelecypods with delicate ornamentation. These fossils are referred to either the Triassic or Jurassic Period (Moore and Dodge, 1962). Also present are fine-bedded calc-hornfels and very fine grained black carbonaceous hornfels.

Sedimentary breccia is common in western exposures of the unit. Fragments of beds of siltstone and fine-grained sandstone are included in a dark to black shaly to silty matrix. The fragments range from less than 1 millimeter to several tens of centimeters in length. The breccia probably originated in submarine slumps or turbidity flows.

In its eastern exposures, the unit consists of thin-bedded shale and siltstone interbedded with limy layers several millimeters to 20–40 centimeters thick. Small-scale intricate folds are common in this sequence.

METAVOLCANIC ROCKS

Two major masses of metavolcanic rocks separated by the Grand Dike pluton occur near the center of the primitive area. In addition, a third mass of mixed metavolcanic and metasedimentary rocks occurs as a thin screen in the northeastern part of the area.

The dominant rock type in all the areas of metavolcanic rocks is andesite to rhyolite tuff and breccia. Other rock types, primarily sediments derived from volcanic materials, are interbedded with the volcanic rocks. Locally the volcanic rocks are impregnated with pyrite and show characteristic yellow and reddish alteration.

The western mass of metavolcanic rocks is almost entirely restricted to Monarch Divide. On its east side this mass is composed of a separately mapped, uniform, nearly structureless volcanic tuff containing phenoclasts of quartz, oscillatorily zoned plagioclase, biotite, hornblende, and hypersthene. Apparently it represents a separate dacitic ash-flow unit.

The western part of this mass includes several types of silicic volcanic tuffs and breccias. On its west side, on the crest of Monarch Divide, the unit is a volcanic tuff-breccia with large marble clasts as much as several feet in size. On its east side, near the contact with the uniform hypersthene-bearing tuff, the unit contains several thin beds of fine-grained airfall ash having abundant accretionary lapilli.

The central mass of metavolcanic rock, which extends through Little Tehipite Valley, contains lenses of marble and calcareous sediments, particularly near its east side on the north in the canyon of the Middle Fork of the Kings River and toward the center on the south near Happy Gap. Black Hornfels is commonly associated with these sediments and is most abundant near the center of the mass in upper Silver Creek. These fine tuffs are also studded with 1- to 12-inch-diameter concretions containing pink garnet. They apparently formed by contact metamorphism of calcareous concretions within the tuffs. In several places garnetized accretionary lapilli were found within these concretions.

The eastern mass, well exposed in the Gorge of Despair and on Mount Harrington, includes a variety of rock types, and a traverse from west to east across this screen near the north boundary of the primitive area includes the following rock types: (1) quartzose hornfels containing larger grains of quartz in a hornfelsic matrix of plagioclase, quartz, hornblende, biotite, muscovite, chlorite, and some pink andalusite (this rock may have originally been a weathered siliceous tuff or a metasiltstone); (2) calc-hornfels composed predominantly of garnet and epidote; (3) calc-silicate hornfels containing quartz, epidote-zoisite, hornblende, diopside, monazite, sphene, and pyrite; (4) metarhyolite tuff containing quartz, alkali feldspar, muscovite, biotite, apatite, magnetite, and pyrite. On its southwestern side, this metamorphic screen is split and intruded by large pods and dikes of a dense quartz porphyry.

PLUTONIC ROCKS

About three-quarters of the primitive area is underlain by granitic rocks belonging to eight discrete granitic plutons intruded as separate masses. The plutons are generally small and elongate, and their long axes trend about 30° NW. They range in composition from alaskitic quartz monzonite to quartz diorite.

No radiometric age determinations have been made in the primitive area, but dating in nearby areas suggests that the granitic intrusives were emplaced primarily in the Cretaceous Period. Bateman, Clark, Huber, Moore, and Rinehart (1963) designated rocks in and near the area as Cretaceous. Evernden and Kistler (1970) delimited several general age groups of intrusive rocks on the basis of potassium-argon dating of biotite and hornblende. On their small-scale compilation map, the rocks in the western part of the primitive area are shown as Huntington Lake intrusive rocks (Lower Cretaceous) and in the eastern part as Cathedral Range intrusive rocks (Upper Cretaceous). Fossils of Jurassic or Triassic age have been found in the siltstone unit of the large metasedimentary pendant a short distance south of the mapped area (Moore and Dodge, 1962). Where they are in contact, the granitic rocks intrude the metamorphic rocks and are therefore younger.

Mafic plutonic rock occurs in three small areas in the mapped area (pl. 1). These rocks are locally variable in composition; they range from mafic granodiorite to gabbro. The mafic masses occur as small bodies along contacts between granitic plutons or between granitic and metamorphic rocks.

Quartz diorite of Yucca Point.—A rather uniform dark-colored pluton crops out in the extreme southwest corner of the primitive area and extends west at least as far as Bartons Resort on State Route 180. It is composed of dark calcic granodiorite or quartz diorite with prominent hornblende crystals and abundant mafic inclusions. The average mineralogic composition, from six samples, is 22.6 percent quartz, 6.5 percent K-feldspar, 50.3 percent plagioclase, 20.6 percent mafic minerals; the average specific gravity is 2.75.

Granodiorite of Lookout Peak.—The granodiorite of Lookout Peak occurs in a pluton in the Marion Peak quadrangle which crops out in the extreme southeast corner of the primitive area. This pluton is 8 miles long and about 5 miles in greatest width and is elongate northwesterly. It is older than the granodiorite of North Dome and is somewhat gradational into the Lightning Creek pluton on the west; however, its age relative to the latter body is uncertain. The average composition, from six samples, is 21.5 percent quartz, 9.7 percent K-feldspar, 49.6 percent plagioclase, and 19.2 percent mafic minerals; the average specific gravity is 2.74.

Granodiorite of Lightning Creek.—The granodiorite of Lightning Creek is almost entirely south of the primitive area, but in a few places it extends above and north of the 6,000-foot-elevation contour, which marks the south border of the area. This mass intrudes and truncates the large western mass of metavolcanic rocks. The average composition, from two samples, is

22.5 percent quartz, 15.5 percent K-feldspar, 46.3 percent plagioclase, and 15.7 percent mafic minerals; the average specific gravity is 2.73.

Granodiorite of North Dome.—The granodiorite of North Dome occurs in an elliptical pluton 10 miles long and 4 miles wide which is elongate northwesterly. Only a small part of the pluton occurs in the northeast corner of the primitive area. The pluton intrudes, and is therefore younger than, the quartz monzonite of Kennedy Lake and the granodiorite of Lookout Peak. The rock is a relatively uniform fine-grained granodiorite, but near the margins it is distinctly darker than elsewhere; toward the center, K-feldspar occurs in irregular large clots, and in some places the rock contains K-feldspar phenocrysts as much as 2.5 centimeters long. The average composition, from eight samples collected within the primitive area, is 22.2 percent quartz, 17.6 percent K-feldspar, 48.4 percent plagioclase, and 11.8 percent mafic minerals; the average specific gravity is 2.71.

Granodiorite of Tombstone Creek.—The granodiorite of Tombstone Creek occupies the largest area of any granitic mass in the primitive area and separates the metasedimentary screen of the west from the western metavolcanic mass on the east. The pluton is in contact with, and intrudes, the quartz monzonite of Grand Dike on the east. It is composed of a rather dark and plagioclase-rich granodiorite. The average composition, from 13 samples, is 21.6 percent quartz, 11.4 percent K-feldspar, 48.4 percent plagioclase, and 18.6 percent mafic minerals; the average specific gravity is 2.74.

Quartz monzonite of Brush Canyon.—The quartz monzonite of Brush Canyon occupies the western part of the study area and extends north and west an unknown distance. A large number of dikes related to this pluton extend south from it and are spectacularly exposed on the south side of the west end of Monarch Divide, as well as in roadcuts on State Route 180 where they cut metamorphic rocks. Some of these dikes extend 2–3 miles southeast of State Route 180, far beyond the general southern limit of the pluton.

The pluton is composed of a light-colored quart monzonite with phenocrysts of K-feldspar 1–2 centimeters in size in a matrix of plagioclase and quartz with a little K-feldspar and small grains of mafic minerals. In dikes the groundmass is distinctly finer grained than elsewhere. Dikes of the quartz monzonite of Brush Canyon clearly cut the quartz diorite of Yucca Point. The average composition, from 11 samples, is 32.2 percent quartz, 25.3 percent K-feldspar, 36.3 percent plagioclase, and 6.2 percent mafic minerals; the average specific gravity is 2.64.

Quartz monzonite of Grand Dike. — The quartz monzonite of Grand Dike occurs in an elongate pluton that extends northwestward across the central part of the area, is 9½ miles long, and averages slightly more than half a mile wide. The rock is a light-colored (commonly pinkish) alaskitic quartz monzonite with an average mafic mineral content of 3.8 percent. It is somewhat gneissose, and mafic minerals occur in elongate aggregates; the felsic minerals are relatively coarse grained (about 5 mm). Because it is resistant to jointing and weathering, the rock forms the high bold ridges of Tombstone Ridge, Eagle Spur, and Grand Dike. The average composition, from eight samples, is 33.5 percent quartz, 32.4 percent K-feldspar, 30.3 percent plagioclase, and 3.8 percent mafic minerals; the average specific gravity is 2.63.

Quartz monzonite of Kennedy Lake. — The quartz monzonite of Kennedy Lake occurs in a pluton which encloses, and is older than, the northwest end of the granodiorite of North Dome. Only a small part of the western side of the pluton occurs in the primitive area. The rock is sheared and heterogeneous and commonly contains irregular masses of dark plutonic rock. Much of it, however, is a uniform light-colored alaskitic rock which is coarse grained and resistant. The high blocky spires on Silver Spur and on the east side of the Gorge of Despair are quarried from this rock. The average composition, from seven samples, is 27.6 percent quartz, 24.1 percent K-feldspar, 39.3 percent plagioclase, and 9.0 percent mafic minerals; the average specific gravity is 2.67.

VOLCANIC ROCKS

Small masses of olivine basalt are present on ridge crests on both sides of the South Fork of the Kings River. Remnants of at least three petrographically different lava flows are present in and near the southeast corner of the primitive area.

The basalt appears young and fresh and occurs as thin erosional remnants on steep slopes atop deeply eroded Cretaceous plutonic rocks. It is tentatively assigned to late Tertiary time and may belong to the general group of basalts about 3.5 million years old which have been dated by Dalrymple (1963) in the upper San Joaquin River drainage north of the primitive area and in the upper Kern River drainage south of the primitive area.

The olivine basalt south of Wildman Meadow contains abundant phenocrysts, microphenocrysts, and groundmass crystals of olivine, tiny laths of clinopyroxene, and rare elongate oxyhornblende microphenocrysts largely converted to opaque minerals. Large poikilitic crystals of alkali feldspar (probably sanidine) include opaque minerals and pyroxene. Microprobe analyses indicate that the glassy groundmass contains about 18 percent K_2O, which accounts for the high total K_2O content (5.1 percent) of the rock. Brown hornblende also occurs as small flakes in cavities, where it is a late-crystallizing mineral.

The small remnants of a basalt flow near the south end of the Grand Dike resemble the basalt south of Wildman Meadow in containing abundant phenocrysts of olivine and clinopyroxene as microphenocrysts and smaller laths. These rocks also contain small flakes of brown hornblende as a late-crystallizing mineral in cavities. It does not, however, have the large poikilitic alkalic feldspar crystals; instead, the groundmass is composed of abundant laths of plagioclase.

The basalt remnant just south of the primitive area boundary west of Deer Cove Creek is markedly different from those remnants 1 mile north on the Grand Dike ridge. This rock is dense and massive, with a platy parting, and appears to be part of a flow nearly 100 feet thick resting on a thin layer of basalt cinders. The rock contains microphenocrysts of clinopyroxene and needle-like crystals of oxyhornblende with rims of black opaque minerals; olivine is not present.

UNCONSOLIDATED DEPOSITS

Extreme relief and steep slopes have led to accelerated erosion and removal of most unconsolidated surficial debris, leaving extensive areas of bare rock. Water-worked stream deposits occur in the major canyons, and talus and scree have accumulated at the base of steep slopes. The main canyons of the two forks of the Kings River were each glaciated down to an altitude of approximately 4,000 feet. Other glaciers formed in only the highest parts of the primitive area, and these were small. Glacial moraines are present on the south slope of Monarch Divide in the eastern part of the mapped area, as well as near the headwaters of Tombstone Creek in the northwestern part of the area. A landslide has been mapped near Horseshoe bend on the steep south wall of the canyon of the South Fork of the Kings River.

GEOCHEMICAL STUDIES

Anomalously high concentrations of commercially valuable elements can commonly be detected by chemical analysis of stream sediments as well as of bedrock samples. Consequently, 47 samples of stream sediments and 109 samples of bedrock were collected and analyzed from in and near the primitive area (figs. 5, 6; tables 1, 2). An attempt has been made to sample the major streams as well as the major rock units, especially metamorphic rocks, which are commonly host to ore deposits. There are more

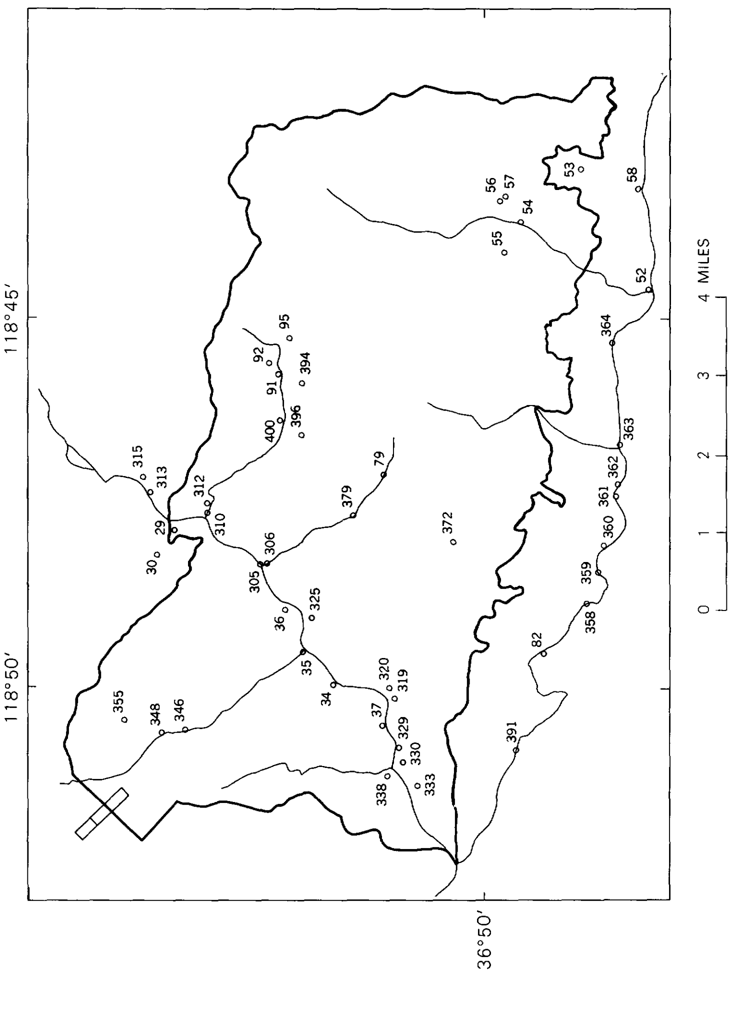


Figure 5. — Sample locations, analyzed stream-sediment samples.

TABLE 1.—*Analyses of stream sediments*

Sample	Semiquantitative spectrographic analyses (percent)				Semiquantitative spectrographic analyses (ppm) (Ag $\le$ 0.7, As<200, Au<10, Bi<10, Cd<20, Cu $\le$ 150)[1/]						
	Fe	Mg	Ca	Ti	Mn	B	Ba	Be	Co	Cr	La
29	5	1	1.5	.2	500	100	700	1	10	150	20
30	3	1.5	1.5	.2	500	70	700	<1	10	150	<20
34	2	.3	1	.15	500	<10	300	1.5	5	<10	20
35	3	.7	1	.2	500	10	300	<1	7	15	<20
36	3	1	1.5	.3	500	10	300	1	10	10	<20
37	5	.2	.3	.15	500	<10	300	1	5	10	30
52	2	.5	.7	.3	300	<10	500	1	<5	<10	50
53	2	.7	1.5	.3	700	<10	500	1	5	<10	30
54	2	.7	1	.3	700	<10	700	1.5	5	<10	20
55	3	.7	.7	.2	700	20	700	1.5	5	15	200
56	2	1	2	.7	700	<10	700	<1	7	<10	150
57	3	.7	1.5	.5	700	<10	700	<1	7	<10	70
58	5	1.5	2	.3	700	<10	500	1	10	15	20
79	1	.2	.3	.1	300	<10	300	1.5	<5	<10	<20
82	3	2	10	.2	500	20	700	<1	5	50	20
91	2	.5	.7	.2	700	<10	500	1	<5	<10	<20
92	1.5	.3	.7	.2	700	<10	300	1.5	<5	<10	<20
95	1.5	.5	.7	.2	700	10	500	1.5	<5	<10	70
305	2	.5	.5	.15	300	10	300	1	7	10	30
306	3	.7	.7	.2	300	<10	300	<1	7	10	30
310	2	.3	.5	.2	500	20	300	1.5	5	15	50
312	2	.5	.5	.15	500	20	500	1.5	5	15	30
313	5	1.5	1	.2	300	50	1000	1	10	150	30
315	3	.7	2	.2	500	20	300	1	7	10	30
319	3	2	5	.2	500	50	150	1	7	70	20
320	3	1	2	.3	700	15	300	1	7	10	20
325	3	1	2	.3	700	10	200	1	7	15	30
329	1	.15	.5	.1	50	10	150	<1	<5	15	<20
330	5	2	2	1	1000	<10	150	<1	15	50	20
333	5	1	2	1	1000	<10	200	1	10	20	20
338	2	0.2	5	.15	500	<10	300	1.5	<5	10	20
346	5	1	1.5	.2	700	<10	200	<1	10	30	20
348	3	1	1	.2	500	<10	200	<1	10	20	<20
355	5	1.5	2	.3	700	<10	300	<1	10	20	30
358	3	.7	2	.2	500	50	500	1	10	70	20
359	5	.7	1	.2	500	70	300	1	20	100	20
360	5	1.0	1.5	.3	700	<10	300	<1	10	15	30
361	3	.2	.3	.15	500	<10	700	<1	5	10	50
362	3	.7	2	.3	700	20	200	1	7	10	<20
363	7	1.5	3	.7	700	10	200	<1	10	50	20
364	3	1	2	.5	700	15	200	1	7	10	<20
372	3	.3	.3	.2	1000	20	700	2	<5	<10	100
379	2	.3	.5	.2	700	<10	300	1.5	<5	<10	<20
391	2	.7	1	.3	500	<10	300	1.5	5	<10	<20
394	2	.5	.7	.2	500	30	700	2	<5	15	30
396	1	.1	.1	.1	300	15	300	5	<5	<10	20
400	2	.7	.7	.5	700	15	700	2	<5	<10	<20

[1/] Elements looked for and found equal to, or less than, indicated amount.

from High Sierra Primitive Area

Sample and type	Semiquantitative spectrographic analyses (ppm) continued (Mo<7, Nb<30, Pb<30, Sb<100, Sn<10, Zn<300, Zr<300) 1/						Chemical analyses (ppm) (Mo<4, W<20) 1/				
	Ni	Sc	Sr	V	W	Y	Au	Cu	Pb	Zn	Sb
29	20	15	300	150	<50	20	.04	65.	10	150	4
30	20	15	200	150	<50	30	<.02	65	10	120	3
34	5	< 5	150	30	<50	10	<.02	< 5	10	40	1
35	10	15	100	100	<50	15	.02	5	10	45	1
36	5	15	200	100	50	15	.02	10	10	55	1
37	< 5	< 5	150	100	<50	15	.02	< 5	5	40	1
52	7	5	200	70	<50	20	<.02	< 5	10	30	< .5
53	7	5	500	70	<50	15	<.02	5	5	30	< .5
54	7	7	300	70	50	15	<.02	10	10	50	< .5
55	15	7	150	50	<50	20	<.02	5	10	50	< .5
56	5	10	300	70	<50	70	<.02	< 5	5	20	< .5
57	7	7	300	70	<50	70	<.02	5	10	45	< .5
58	7	10	500	150	<50	15	<.02	10	10	50	< .5
79	5	< 5	<100	10	<50	15	<.02	5	15	30	< .5
82	15	7	200	70	<50	15	<.02	15	5	90	.5
91	< 5	5	200	30	<50	15	<.02	< 5	10	30	< .5
92	< 5	5	150	20	<50	15	<.02	< 5	10	30	< .5
95	5	5	200	30	<50	15	<.02	< 5	10	30	< .5
305	< 5	10	150	70	<50	15	.04	5	10	50	1
306	5	10	150	100	<50	15	.02	10	10	60	6
310	5	7	100	70	<50	20	.04	15	10	60	2
312	5	7	150	70	<50	20	.02	15	10	60	2
313	50	10	500	200	<50	15	.02	180	15	120	5
315	5	7	300	100	<50	15	.04	10	10	45	2
319	30	10	150	100	<50	15	.04	20	20	35	2
320	5	15	200	150	<50	20	.02	5	10	40	2
325	5	15	200	200	<50	15	.02	5	10	40	1
329	< 5	< 5	<100	20	<50	<10	.04	< 5	< 5	10	1
330	5	20	100	200	<50	15	.04	5	5	20	2
333	5	20	100	200	150	20	.04	5	5	35	2
338	< 5	< 5	200	50	<50	10	.04	< 5	5	35	2
346	20	15	100	150	<50	20	.02	5	10	30	2
348	15	10	100	150	<50	10	.06	5	5	50	2
355	5	20	100	150	<50	30	.04	5	< 5	32	2
358	50	10	150	200	<50	20	.02	40	15	350	6
359	70	10	100	200	<50	30	.02	70	20	380	8
360	5	15	200	200	<50	20	.04	5	10	65	2
361	< 5	5	<100	70	200	30	.04	5	10	85	3
362	< 5	10	200	150	<50	15	.04	< 5	5	30	2
363	< 5	30	200	500	<50	50	.04	5	5	50	2
364	< 5	7	200	150	<50	<10	.02	< 5	5	40	2
372	7	10	150	15	<50	50	.02	10	30	200	4
379	< 5	7	100	30	<50	20	.15	< 5	20	50	< .5
391	5	10	150	70	<50	15	<.02	< 5	10	30	.5
394	5	5	150	20	<50	20	<.02	15	20	130	2
396	< 5	< 5	<100	<10	<50	20	<.02	5	30	70	1
400	5	7	200	50	<50	50	<.02	10	20	70	1

TABLE 2.—*Analyses of rock samples*

Sample	Type 1/	Semiquantitative spectrographic analyses (percent)				Semiquantitative spectrographic analyses (ppm) (Au<10, Be<2, Cd<70, Cu<100)2/								
		Fe	Mg	Ca	Ti	Mn	Ag	As	B	Ba	Bi	Co	Cr	La
2	V	3	1.5	1	.3	1000	<.5	<200	20	700	<10	10	<10	20
3	V	3	1.5	1	.3	1000	<.5	<200	20	700	<10	10	<10	20
4	V	1	.5	.05	.2	100	.5	<200	<10	700	<10	< 5	<10	20
5	V	2	.5	.5	.2	700	<.5	<200	<10	2000	<10	< 5	<10	30
6	G	3	1	1	.3	700	<.5	<200	<10	1500	<10	10	<10	20
9A	S	3	1	10	.5	500	<.5	<200	20	1000	<10	10	70	20
9B	S	2	1	5	.2	300	<.5	<200	20	1000	<10	7	50	<20
10	S	3	1.5	5	.3	500	<.5	<200	70	700	<10	7	100	20
11	S	3	1.5	5	.5	1000	<.5	<200	10	700	<10	10	70	20
12	S	2	1	1	.3	500	<.5	<200	<10	1000	<10	7	50	30
13	H	.5	.5	.7	.07	200	.5	700	100	500	<10	< 5	100	20
14	M	.2	10	15	.005	300	<.5	<200	<10	30	<10	< 5	<10	<20
17	Q	5	.2	.7	.1	150	<.5	<200	10	1000	700	7	<10	<20
18	M	2	1	20	.2	700	<.5	<200	<10	70	<10	10	70	20
19	T	2	1.5	15	.2	1000	<.5	<200	10	< 20	<10	5	70	20
21	Q	.2	.2	.2	.02	150	<.5	<200	<10	100	<10	< 5	<10	<20
22	G	2	.7	.7	.3	1000	<.5	<200	10	500	<10	5	70	20
25	T	5	1	10	.2	1500	<.5	<200	<10	< 20	<10	7	<10	<20
31	Q	3	.7	.05	.5	150	.7	<200	70	300	<10	10	200	150
32	S	5	1.5	.2	.5	1000	<.5	<200	<10	500	<10	10	150	50
39A	P	5	1	.5	.5	700	<.5	<200	20	500	<10	10	150	70
39B	P	.5	.1	.05	.1	50	3	<200	10	>5000	<10	< 5	50	<20
40	T	3	1.5	20	.1	1500	<.5	<200	<10	70	<10	5	70	<20
44	M	.2	10	20	.05	300	<.5	<200	<10	50	<10	< 5	<10	<20
45	Q	.1	.05	.07	.07	20	<.5	<200	<10	200	<10	< 5	<10	<20
46	S	5	1	.1	.7	1000	<.5	<200	10	1500	<10	20	100	70
48	G	3	2	3	.5	1000	<.5	<200	10	700	<10	10	<10	<20
49	G	5	2	2	.5	1000	<.5	<200	10	700	<10	20	<10	<20
50	G	2	1	1	.3	700	<.5	<200	<10	700	<10	10	<10	20
51	G	1.5	.2	.5	.1	300	<.5	<200	<10	700	<10	< 5	<10	20
60	S	5.0	2	5	.5	1000	<.5	<200	10	2000	<10	20	70	20
61	M	.05	2	20	.007	50	<.5	<200	<10	20	<10	< 5	<10	<20
62	M	.1	10	20	.1	300	<.5	<200	<10	30	<10	< 5	<10	<20
63	V	1	.2	1	.2	500	<.5	<200	<10	2000	<10	< 5	<10	20
64	V	3	.5	1	.3	1000	<.5	<200	10	1500	<10	< 5	<10	20
65	V	3	.5	.5	.3	1000	<.5	<200	10	1500	<10	< 5	<10	20
66	V	2	.5	.5	.3	1000	<.5	<200	<10	1500	<10	< 5	<10	70
67	V	2	.2	.3	.2	500	<.5	<200	<10	2000	<10	< 5	<10	20
68	V	1.5	.7	.7	.2	500	<.5	<200	<10	1000	<10	< 5	<10	30
69	V	2	.5	7	.3	700	<.5	<200	10	1000	<10	5	30	20
70	V	2	1.5	5	.3	1000	<.5	<200	10	1000	<10	10	30	20
71	G	2	1	2	.3	700	<.5	<200	<10	700	<10	20	<10	20
72	G	2	1	1	.2	500	<.5	1500	<10	300	20	5	<10	20
73	G	2	1	1	.3	500	<.5	<200	10	500	<10	10	<10	20
74	V	1	.1	.1	.1	200	<.5	<200	<10	1000	<10	< 5	<10	20
76	V	2	1	.7	.2	500	<.5	<200	15	500	<10	10	<10	20
77	V	2	1	1	.2	700	<.5	<200	30	700	<10	10	<10	<20
80	V	2	1	1	.3	500	<.5	<200	<10	700	<10	10	20	20
81	V	2	.5	.1	.3	700	<.5	<200	<10	1500	<10	< 5	<10	30
83	M	.2	5	20	.005	200	<.5	<200	<10	20	<10	< 5	<10	<20

1/B, Tertiary basalt; G, granitic rocks; H, hornfels and schist; M, marble; P, prospect or mineralized zone; Q, metaquartzite; S, metasiltstone; T, tactite; V, metavolcanic rocks.

2/Elements looked for and found equal to, or less than, indicated amount.

from High Sierra Primitive Area

Sample	Semiquantitative spectrographic analyses (ppm) (Mo<70, Nb<30, Pb<2000, Sb<300, W<50, Zn<3000)[2/]							Chemical analyses (ppm) (Sb<.2)[2/]						
	Ni	Sc	Sn	Sr	V	Y	Zr	Au	Cu	Pb	Zn	Cu	Mo	W
2	5	15	<10	300	150	20	200	<.02	<5	15	40	<.5	<4	<20
3	5	15	<10	300	100	20	100	<.02	10	10	40	<.5	<4	<20
4	5	7	<10	<100	20	30	200	<.02	<5	10	5	<.5	<4	<20
5	5	10	<10	100	20	30	200	<.02	10	10	45	<.5	<4	<20
6	5	10	<10	300	100	15	150	<.02	<5	25	65	<.5	<4	<20
9A	50	15	<10	700	200	20	150	<.02	35	25	140	<.5	8	<20
9B	30	15	<10	700	150	15	150	<.02	45	20	400	<.5	4	<20
10	50	15	<10	300	150	30	200	<.02	30	30	80	<.5	<4	<20
11	50	15	<10	200	100	30	200	<.02	20	25	25	<.5	<4	<20
12	30	15	<10	150	100	30	150	<.02	30	30	70	<.5	<4	<20
13	200	5	<10	100	5000	50	100	<.02	40	10	5000	<.5	400	<20
14	< 5	< 5	<10	<100	10	<10	< 10	<.02	5	40	10	<.5	<4	<20
17	10	< 5	<10	200	10	<10	150	<.02	20	40	15	<.5	<4	<20
18	30	10	<10	2000	30	15	70	<.02	20	35	5	<.5	<4	<20
19	30	7	<10	1500	30	15	50	<.02	10	20	15	4	<4	<20
21	5	< 5	<10	100	<10	<10	100	<.02	<5	<5	5	<.5	<4	<20
22	15	10	<10	300	70	20	500	<.02	<5	5	20	<.5	<4	<20
25	5	10	<10	300	150	15	70	<.02	5	10	10	<.5	<4	<20
31	5	20	<10	<100	150	70	100	<.02	15	15	10	<.5	30	<20
32	50	20	<10	100	100	50	150	<.02	15	20	70	<.5	<4	<20
39A	50	20	<10	200	100	20	150	<.02	30	30	65	<.5	<4	<20
39B	5	< 5	<10	>5000	10	<10	300	<.02	350	10000	15	>100	<4	<20
40	10	10	<10	500	50	30	50	<.02	5	35	10	<.5	<4	<20
44	<5	< 5	<10	300	10	<10	< 10	<.02	5	30	10	<.5	<4	<20
49	<5	< 5	<10	< 100	10	<10	100	<.02	5	< 5	< 5	<.5	<4	<20
46	70	30	<10	100	150	50	200	<.02	5	15	35	<.5	<4	<20
48	7	15	<10	700	150	20	70	<.02	<5	10	50	<.5	4	<20
49	5	30	<10	500	200	30	200	<.02	5	10	45	<.5	<4	<20
50	5	15	<10	500	150	20	150	<.02	<5	15	35	<.5	<4	<20
51	<5	5	<10	200	10	20	150	<.02	<5	15	25	<.5	<4	<20
60	70	15	<10	300	200	30	200	<.02	35	30	100	<.5	<4	<20
61	<5	< 5	<10	300	10	<10	< 10	<.02	5	40	5	<.5	<4	<20
62	<5	< 5	<10	300	10	<10	< 10	<.02	5	45	10	<.5	<4	<20
63	5	10	<10	300	10	30	150	<.02	<5	15	10	<.5	<4	<20
64	<5	15	<10	300	30	50	150	<.02	<5	20	70	<.5	<4	<20
65	<5	15	<10	300	20	50	150	<.02	<5	20	70	<.5	<4	<20
66	<5	15	<10	200	30	30	150	<.02	<5	25	60	<.5	<4	<20
67	<5	15	<10	300	10	30	150	<.02	<5	15	50	<.5	<4	<20
68	<5	15	<10	300	20	30	150	<.02	<5	20	50	<.5	<4	<20
69	10	15	<10	700	100	30	150	<.02	15	15	10	<.5	<4	<20
70	20	15	<10	700	100	30	150	<.02	<5	10	100	<.5	<4	<20
71	7	15	<10	300	100	15	100	<.02	15	15	40	<.5	<4	20
72	5	7	<10	200	70	10	150	.1	10	15	40	<.5	<4	80
73	5	10	<10	200	70	10	100	<.02	<5	15	40	<.5	<4	<20
74	5	7	<10	100	10	20	200	<.02	<5	15	55	<.5	<4	<20
76	5	10	<10	200	100	15	100	<.02	5	10	30	<.5	<4	<20
77	5	10	<10	200	100	15	100	<.02	5	15	45	<.5	<4	<20
80	7	15	<10	200	100	15	100	<.02	<5	10	30	<.5	<4	<20
81	5	15	<10	100	15	50	300	<.02	<5	20	30	<.5	<4	<20
83	<5	< 5	<10	100	<10	<10	<10	<.02	5	50	10	<.5	<4	<20

TABLE 2.—*Analyses of rock samples from*

Sample	Type[1/]	Semiquantitative spectrographic analyses (percent)				Semiquantitative spectrographic analyses (ppm) (Au<10, Be<2, Cd<70, Cu<100)[2/]								
		Fe	Mg	Ca	Ti	Mn	Ag	As	B	Ba	Bi	Co	Cr	La
84	G	1	.2	.5	.1	300	<.5	<200	<10	700	<10	<5	<10	30
85	G	1	.2	.2	.1	300	<.5	<200	<10	700	<10	<5	<10	20
86	G	3	1	1	.5	700	<.5	<200	10	500	<10	10	<10	<20
87	G	1	.2	.5	.1	300	<.5	<200	<10	700	<10	<5	<10	30
88	G	10	2	5.0	.7	1000	<.5	<200	10	200	<10	30	20	<20
101	V	1.5	.2	.5	.2	500	<.5	<200	<10	1500	<10	<5	<10	20
300	G	3	2	2	.5	500	<.5	<200	10	700	<10	10	20	<20
302	G	.5	.05	.1	.02	300	<.5	<200	<10	70	<10	<5	<10	<20
303	G	1	.2	.5	.1	500	<.5	<200	<10	1000	<10	<5	<10	20
304	G	2	.2	.5	.2	500	<.5	<200	<10	1500	<10	<5	<10	20
309	G	2	.7	.7	.2	500	<.5	<200	<10	500	<10	7	<10	20
317	G	1.5	.3	.2	.2	500	<.5	<200	<10	500	<10	5	<10	20
318	Q	1	1.5	5	.02	300	<.5	<200	<10	700	<10	<5	<10	<20
322	H	3	1.5	10	.5	500	<.5	<200	10	100	<10	10	70	20
323	G	5	1.5	2	.5	700	<.5	<200	10	700	<10	20	20	20
324	G	3	1	2	.3	700	<.5	<200	10	700	<10	10	<10	20
326	G	3	1	2	.5	700	<.5	<200	10	1500	<10	10	<10	20
327	G	3	1	2	.2	1000	.7	<200	10	700	<10	20	50	20
331	G	1.5	.3	.5	.1	500	<.5	<200	<10	700	<10	5	<10	20
332	V	10	3	5	.7	1500	<.5	<200	10	70	<10	70	100	<20
334	G	1	.2	.2	.1	300	<.5	<200	<10	500	<10	<5	<10	20
335	G	3	1	2	.5	700	<.5	<200	10	500	<10	10	50	20
336	Q	1	.2	.05	.05	50	<.5	<200	<10	700	<10	<5	20	<20
337	Q	1	.1	.05	.2	50	<.5	<200	10	500	<10	<5	<10	<20
339	G	5	3	5.0	.2	1000	<.5	<200	<10	100	<10	70	150	<20
340	G	1.5	.5	.5	.2	500	<.5	<200	<10	1000	<10	5	<10	20
341	Q	.1	.05	.05	.03	100	<.5	<200	10	150	<10	<5	<10	<20
342	G	1.5	.3	.5	.2	500	<.5	<200	<10	700	<10	<5	<10	20
343	G	2	.3	.5	.2	500	<.5	<200	<10	700	<10	<5	<10	20
344	H	5	1	10	.5	1500	<.5	<200	10	20	<10	10	150	30
347	G	5	1	2	.5	700	<.5	<200	10	700	<10	10	<10	20
350	B	5	5	5	.5	1000	<.5	<200	10	1500	<10	70	1500	20
351	G	1	.05	.1	.05	300	<.5	<200	<10	70	<10	<5	<10	<20
352	G	1	.1	.1	.05	200	<.5	<200	<10	100	<10	<5	<10	<20
353	G	1	.05	.1	.03	200	<.5	<200	<10	70	<10	<5	<10	<20
354	H	5	2	10	.3	1500	.5	<200	10	700	<10	20	150	20
356	G	3	1	2	.3	700	<.5	<200	<10	500	<10	10	<10	20
357	G	3	1	2	.3	700	<.5	<200	<10	300	<10	10	<10	<20
365	G	2	.2	.5	.2	500	<.5	<200	<10	1000	<10	5	<10	20
366	G	1	.2	.2	.1	300	<.5	<200	<10	700	<10	<5	<10	<20
367	G	5	2	2	.5	700	<.5	<200	10	700	<10	10	70	20
371	V	1	.5	.1	.1	500	<.5	<200	<10	1500	<10	5	<10	20
374	V	1.5	.2	.2	.1	500	<.5	<200	<10	1500	<10	5	<10	30
375	V	2	.5	.5	.2	500	<.5	<200	<10	1500	<10	5	<10	30
376	G	1	.05	.2	.05	300	<.5	<200	<10	150	<10	<5	<10	<20
378	G	3	1.5	2	.3	700	<.5	<200	<10	700	<10	20	20	20
380	V	3	.2	.1	.2	1000	<.5	<200	10	1000	<10	5	<10	20
382	G	1	.2	.2	.1	300	<.5	<200	<10	500	<10	5	<10	20
383	Q	.3	.05	.1	.02	20	<.5	<200	<10	200	<10	<5	<10	<20
384	Q	.5	.05	.05	.15	30	<.5	<200	10	300	<10	<5	<10	<20
388	M	.3	5	10	.02	300	<.5	<200	<10	70	<10	<5	<10	<20
389	G	1	.2	.5	.1	300	<.5	<200	<10	500	<10	<5	<10	20
390	T	5	1	20	.3	1000	<.5	<200	10	500	<10	20	150	20
393	S	2	.5	2	.2	700	5	<200	50	500	<10	7	100	20
393A	S	2	.5	.5	.3	700	<.5	<200	<10	700	<10	<5	<10	20
395	S	3	2	7	.3	1000	<.5	<200	10	2000	<10	20	100	20
397	V	3	.3	1	.2	1000	<.5	<200	50	1000	<10	<5	<10	20
398	H	2	.7	.3	.1	500	<.5	<200	10	50	<10	5	<10	<20
399	P	3	.1	.05	.05	>5000	<.5	7000	>2000	70	15	5	<10	<20

1/ B, Tertiary basalt, G, granitic rocks; H, hornfels and schist; M, marble; P, prospect or mineralized zone, Q, metaquartzite, S, metasiltstone; T, tactite, V, metavolcanic rocks.

2/ Elements looked for and found equal to, or less than, indicated amount.

High Sierra Primitive Area—Continued

	Semiquantitative spectrographic analyses (ppm) (Mo<70, Nb<30, Pb<2000, Sb<300, W<50, Zn<3000) 2/							Chemical analyses (ppm) (Sb<.2) 2/						
Sample	Ni	Sc	Sn	Sr	V	Y	Zr	Au	Cu	Pb	Zn	Cu	Mo	W
84	5	5	<10	100	10	20	100	<.02	<5	10	20	<.5	<4	<20
85	5	5	<10	100	<10	30	100	<.02	<5	10	10	<.5	<4	<20
86	5	15	<10	200	100	30	70	<.02	10	20	70	<.5	<4	<20
87	5	5	<10	100	10	50	150	<.02	<5	10	20	<.5	<4	<20
88	5	30	<10	500	300	10	30	<.02	<5	10	15	<.5	<4	20
101	5	10	<10	100	20	20	150	<.02	5	15	60	<.5	<4	<20
300	7	15	<10	300	100	15	20	<.02	<5	15	50	<.5	<4	<20
302	5	<5	<10	<100	<10	20	100	<.02	<5	15	10	<.5	<4	<20
303	5	5	<10	100	<10	20	100	<.02	<5	10	35	<.5	<4	<20
304	5	5	<10	200	10	15	200	<.02	<5	10	40	<.5	<4	<20
309	7	10	<10	200	70	15	100	<.02	<5	10	35	<.5	<4	<20
317	5	5	<10	200	20	15	150	<.02	<5	10	45	<.5	<4	<20
318	5	<5	<10	150	10	<10	150	<.02	<5	95	20	<.5	<4	<20
322	50	15	<10	150	100	30	200	<.02	10	20	10	<.5	<4	<20
323	5	20	<10	300	200	30	150	<.02	5	15	45	<.5	<4	<20
324	5	15	<10	300	100	20	150	<.02	<5	15	45	<.5	<4	<20
326	5	7	<10	500	100	10	100	<.02	<5	15	45	<.5	<4	<20
327	5	15	<10	300	100	10	150	<.02	<5	15	55	<.5	<4	<20
331	5	5	<10	200	20	20	100	<.02	<5	10	35	<.5	<4	<20
332	7	30	<10	300	300	10	20	<.02	10	15	15	<.5	<4	<20
334	5	5	<10	100	10	15	70	<.02	<5	15	20	<.5	<4	<20
335	7	15	<10	500	150	20	150	<.02	10	20	60	<.5	<4	<20
336	7	<5	<10	<100	10	<10	150	<.02	<5	10	5	<.5	<4	<20
337	7	<5	<10	<100	20	<10	200	<.02	<5	5	5	<.5	<4	<20
339	10	20	<10	300	200	15	30	<.02	<5	15	10	<.5	<4	<20
340	5	5	<10	200	20	30	150	<.02	<5	10	30	<.5	<4	<20
341	5	5	<10	<100	10	10	30	<.02	<5	<5	5	<.5	<4	<20
342	5	5	<10	200	15	15	100	<.02	10	25	40	<.5	4	20
343	5	5	<10	200	15	20	150	<.02	<5	10	25	<.5	<4	<20
344	20	20	10	200	100	30	150	<.02	<5	15	15	<.5	<4	<20
347	5	15	<10	300	100	20	100	<.02	5	15	45	<.5	<4	<20
350	200	30	<10	700	100	10	150	<.02	55	25	55	20	<4	<20
351	5	7	<10	<100	<10	15	150	<.02	<5	5	20	<.5	<4	<20
352	5	5	<10	<100	<10	30	100	<.02	<5	10	15	<.5	<4	<20
353	5	5	<10	<100	<10	15	20	<.02	<5	5	10	<.5	<4	<20
354	50	20	20	500	200	20	70	<.02	15	35	210	5	<4	<20
356	5	10	<10	300	100	15	100	<.02	<5	10	35	<.5	<4	<20
357	5	10	<10	300	100	15	100	<.02	<5	10	45	<.5	<4	<20
365	5	5	<10	200	20	20	150	<.02	<5	5	35	<.5	<4	<20
366	5	5	<10	200	10	10	100	<.02	<5	10	40	<.5	<4	<20
367	15	15	<10	300	100	20	150	<.02	15	25	65	<.5	<4	<20
371	7	5	<10	200	20	15	100	<.02	<5	10	35	<.5	<4	<20
374	5	10	<10	100	20	30	150	<.02	5	10	80	<.5	<4	<20
375	5	15	<10	200	30	30	150	<.02	<5	10	55	<.5	<4	<20
376	5	5	<10	<100	<10	20	100	<.02	<5	10	15	<.5	<4	<20
378	5	15	<10	300	100	20	150	<.02	10	15	55	<.5	<4	<20
380	5	15	<10	100	15	50	200	<.02	<5	20	85	<.5	<4	<20
382	7	5	<10	100	10	15	100	<.02	<5	10	25	<.5	<4	<20
383	5	<5	<10	<100	<10	<10	50	<.02	<5	5	5	<.5	<4	<20
384	5	<5	<10	<100	<10	<10	150	<.02	<5	<5	5	<.5	<4	<20
388	<5	<5	<10	100	<10	<10	<10	<.02	5	35	30	<.5	<4	<20
389	5	<5	<10	100	<10	15	100	<.02	<5	10	25	<.5	<4	<20
390	70	15	10	2000	70	15	200	<.02	<5	15	50	<.5	<4	<20
393	70	10	<10	200	100	15	150	<.02	40	20	10	<.5	<4	<20
393A	5	10	<10	200	20	30	200	<.02	<5	25	75	<.5	<4	<20
395	15	20	<10	700	150	20	70	<.02	75	15	20	<.5	<4	<20
397	5	15	<10	200	20	30	200	<.02	<5	10	20	<.5	<4	<20
398	<5	<5	<10	<100	20	10	70	.35	<5	10	50	<.5	<4	<20
399	<5	<5	50	<100	<10	70	150	.15	<5	10	350	<.5	180	300

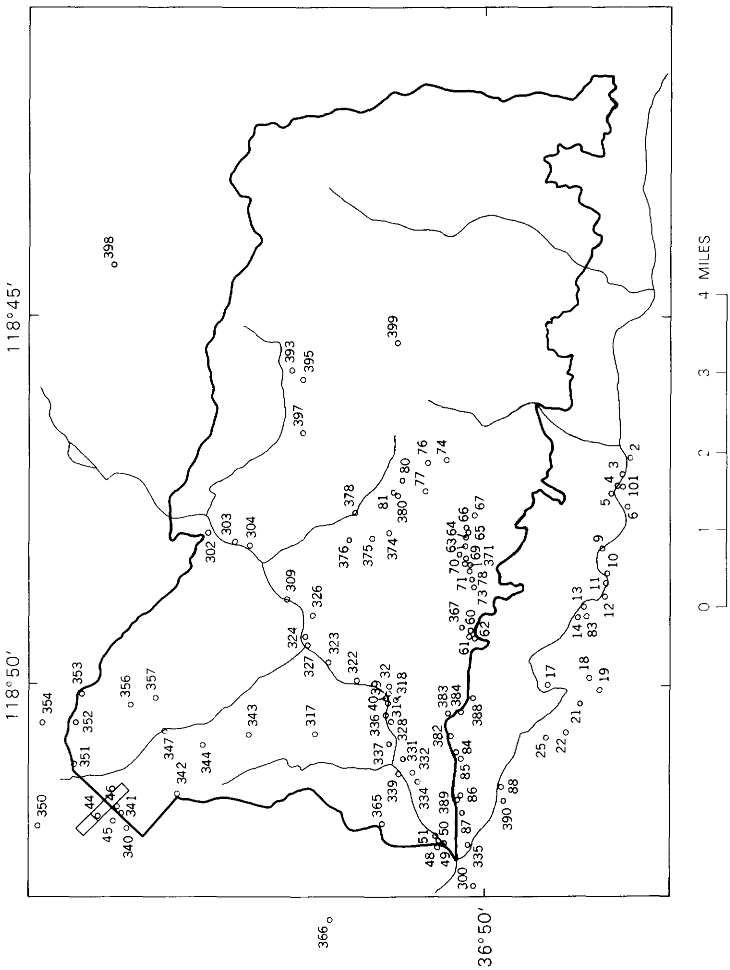


FIGURE 6.—Sample locations, analyzed rock samples.

sample localities in the western part of the study area, where most of the metamorphic rocks crop out and where known prospects occur. Also, the eastern part has been previously studied in connection with geologic mapping of the Marion Peak 15-minute quadrangle.

Sediments in the streams draining the metavolcanic rocks are generally slightly enriched in boron, beryllium, and chromium. Stream sediments originating in limy rocks of the western mass of metasedimentary rocks are somewhat enriched in tungsten. One sediment sample (No. 379, table 1) collected at 6,600 feet in northern Wren Creek contained 0.15 parts per million gold.

Analyses of 109 rock specimens clearly demonstrate that the common rock types in the area are not strongly enriched in any particular element. The metavolcanic rocks are generally slightly enriched in barium, and the black metasedimentary rocks in vanadium, zinc, and molybdenum. These metasedimentary rocks are derived from carbonaceous shales, which commonly concentrate minor elements (Krauskopf, 1955).

Metals are locally concentrated in a shear zone in the Middle Fork canyon (sample 39B: copper, lead, silver, barium), in contact-metamorphosed rocks on Monarch Divide (sample 399: arsenic, boron, tin, zinc, molybdenum), and in a metavolcanic screen north of the primitive area (sample 398: gold). All these geochemical anomalies are small and do not represent economic deposits.

AEROMAGNETIC INTERPRETATION

By H. W. OLIVER

Previous work in the Sierra Nevada has shown that aeromagnetic surveys are a helpful adjunct to geologic mapping. In addition to providing information on depth and structure of certain geologic units, they have been used to locate iron deposits directly and gold, silver, and tungsten ores indirectly through their association with the magnetic minerals magnetite (Fe_3O_4) and pyrrhotite ($Fe_{1-x}S$) (Henderson and others, 1966; Peterson and others, 1968; Oliver, 1970). An aeromagnetic survey will detect through forest and soil cover, water, and nonmagnetic rocks house-size concentrations of magnetic minerals at depths of several hundred feet and will detect concentrations of less than 1 percent magnetite where the magnetite is distributed throughout large rock units, as is common in igneous terrane.

For these reasons, an aeromagnetic survey of the High Sierra Primitive Area and vicinity was flown in 1970 along a series of west-east lines spaced approximately 1 mile apart at a constant altitude of 14,000 feet above sea level. The results of the survey are presented as a total intensity magnetic map, which is overprinted on the generalized topographic and bedrock geologic map (pl. 1). The values of the 10-gamma contour lines are the total magnetic intensities in gammas minus 49,780 gammas.

Regional gravity measurements have also been made in this part of the Sierra Nevada. They show a strong eastward decrease in Bouguer values, in accordance with what would be expected on the basis of isostasy (Oliver and Mabey, 1963; Oliver, 1969). The data are too sparse, however, for use in connection with detailed geologic mapping; moreover, the contrast in densities between the different rock units is rather small, generally less than 0.2 grams per cubic centimeter (table 3).

DESCRIPTION OF MAGNETIC FIELD

After subtracting a base value of 49,780 gammas, the total magnetic intensity ranges from about 1,550 gammas in the southwest corner of the area to a maximum of 2,045 gammas near Mount Harrington in the northeastern quadrant (pl. 1). The area of the magnetic map southwest of a diagonal connecting the northwest and southeast corners is characterized by a fairly uniform regional gradient of 30–50 gammas per mile, the field increasing in a direction of about N. 30° E. This gradient is significantly higher than that of the main dipole field of the earth, which increases at the rate of about 10 gammas per mile in a direction of N. 25° E. in this area (U.S. Coast and Geodetic Survey, 1965). The magnetic contours in the southwestern part of the primitive area are generally independent of topography, so the exposed rocks are essentially nonmagnetic.

Farther north, the 1,700–1,800-gamma contours are warped into a magnetic recess located over the 3,000–4,000-foot-deep canyon of the Middle Fork of the Kings River, where the canyon cuts through the Tombstone Creek and Grand Dike plutons. Northwest of the Middle Fork, the total intensity rises at a faster rate, 100 gammas per mile. Additional data show that this gradient culminates in a closed magnetic high about 1 mile north of the northwest corner of plate 1.

Two closed anomalies occur within the study area. One is near Mount Harrington. Its maximum value is 2,045 gammas, and it is located over parts of the North Dome and Kennedy Lake plutons. The other is in the hypersthene-bearing metavolcanic rocks, and its maximum is 1,805 gammas. The total intensity profile along the flight line through the center of the Mount Harrington anomaly is illustrated as *A–A′* (pl. 1).

MAGNETIC PROPERTIES OF GEOLOGIC UNITS

To help determine which rock types cause the magnetic anomalies, the magnetic properties of several samples of each of nine rock types within the study area were measured. The samples were selected in the general vicinity of *A–A′* (pl. 1) from those that had been collected by J. G. Moore; they were not oriented, and thus, we were not able to determine the direction of remanent magnetization (J_r).

Table 3 summarizes the results of the laboratory measurements. The data for plutonic rocks are comparable with other suites of plutons studied in the Sierra Nevada by Grommé and Merrill (1965) and Oliver (1970). The Koenigsberger ratio (Q) of most of these rocks is less than half, indicating that their total magnetizations (J_T) are at least somewhat similar in direction and intensity to their induced magnetizations (J_i); thus, the aeromagnetic survey reflects primarily the distribution of magnetite within the plutonic rocks. Also, the granodiorites are generally more magnetic than the quartz monzonites. The data are too sparse to define precise averages, but the susceptibility measurements of three samples of the granodiorite of North Dome are within 20 percent of each other and are significantly higher than the susceptibilities of the other plutons, except perhaps Kennedy Lake and Lookout Peak. Certainly, the quartz monzonites of Brush Canyon and Grand Dike are essentially nonmagnetic ($J_T<3\times10^{-4}$emu/cm^3 (electromagnetic units per cubic centimeter)), the granodiorite of Tombstone Creek is weakly magnetic (J_T=3–10$\times10^{-4}$emu/cm^3), and at least parts of the North Dome, Lookout Peak, and Kennedy Lake plutons are moderately magnetic (J_T=10–20$\times10^{-4}$emu/cm^3).

The measurements of eight samples of metavolcanic rocks suggest that these rocks are nonmagnetic, except for the hypersthene-bearing metadacite tuff and the magnetite nodules within the eastern mass. No magnetic measurements of the quartz porphyry within the eastern mass were made.

INTERPRETATION OF MAGNETIC DATA

When an aeromagnetic survey is flown at a constant elevation over precipitous terrain, the degree of correlation between total intensity and topography can be used to estimate the total magnetization of the rocks in which the topographic forms are carved. Thus, the lack of correlation between the magnetic contours and the huge canyons of the Middle and South Forks where they cross the Brush Canyon pluton, andalusite hornfels, metasiltstone, marble, and metarhyolite indicates that these units are nonmagnetic, in agreement with the measurements of samples (table

TABLE 3.—*Densities, susceptibilities, Koenigsberger ratios, and rock samples. The location of samples is shown on*

Rock type	Specimen No.	Remarks	Density (ρ) in g/cm³ (core)
Plutonic rocks:			
Kqb, quartz monzonite of Brush Canyon (porphyritic)	70W-51		2.53
	70W-382	on ridge near contact with dg	2.58
	70W-84		2.54
Kqg, quartz monzonite of Grand Dike (chiefly alaskite)	70W-351		2.55
	70W-376		2.52
Kqk, quartz monzonite of Kennedy Lake	68M-113	(west flank)	2.56
	67M-45	(east flank)	2.68
Kgk, granodiorite of Lookout Peak	68M-93		2.58
	64M-1	(S. of Kings R.)	2.68
Kgn, granodiorite of North Dome	68M-29	(typical; located east of mapped area)	2.63
	67M-52	(modes available)	2.66
	67M-54	(modes available)	2.60
Kgt, granodiorite of Tombstone Creek	70W-73		2.62
Metavolcanic rocks:			
mv, Western masses			
Metadacite tuff	70W-77		2.66
Dacite crystal tuff	70W-375		2.62
Silicified metadacite tuff	70W-380		2.71
st, black siltstone	70W-393		2.70
mv, thin-bedded tuff	70W-397		2.72
mv, Eastern mass (between Kennedy Lake and North Dome plutons)			
Garnet-diopside-epidote hornfels	67M-60		2.66
Magnetiferous nodule in limy metavolcanic rock	67M-35	21% magnetite	2.82
mvh, hypersthene-bearing metadacite tuff	70W-392	(representative)	2.75

1/ According to Currie and others (1963) and Grommé and Merrill (1965), the average in Yosemite National Park is only 15°-20° different from the direction of the present be within cos 20° or 94% of the vector sum(J_T) and, of course, represent a maximum

2/ These magnetization values are based largely on the scalar sum of the induced and magnetizations of plutonic rocks for which $Q>1$ (samples 70W-382 and 64M-1) which sample localities (see pl. 1) indicates that these samples are not representative of a

3/ It is less probable that the remanent magnetization of this metavolcanic sample is in edly quite variable

induced, remanent, and total magnetizations of selected
plate 1

Magnetic susceptibility (k), in 10^{-4} emu/cm³	Induced magnetization (J_i=.52k) in 10^{-4} emu/cm³	Remanent magnetization (J_r), in 10^{-4} emu/cm³	Koenigsberger ratio ($Q=J_r/J_i$)	Total magnetization (J_T): Scalar sum J_i+J_r [1] in 10^{-4} emu/cm³	Total magnetization (J_T): Best value [2] in 10^{-4} emu/cm³
1.28	.66	.2	.30	.86	1
1.27	.66	15.8	24.	16.5	
1.93	1.0	.1	.1	1.1	
< .1	< .05	< .1	-	< .15	< .2
< .1	< .05	< .1	-	< .15	
7.78	4.0	2.7	.68	6.7	5-20?
28.0	14.0	2.4	.17	16.4	
9.69	5.0	.3	.06	5.3	5-20?
29.4	15.	68.5	4.6	83.5	
15.5	8.1	1.7	.21	9.8	~ 12
12.9	6.7	7.3	1.1	14.0	
16.6	8.6	1.7	.20	10.3	
5.13	2.7	3.1	1.1	5.8	~ 6
5.11	2.6	7.4	2.8	10.0	< 1
< .1	< .05	< .1	-	< .15	
< .1	< .05	< .1	-	< .15	
< .1	< .05	< .1	-	< .15	
.67	.35	< .1	< .3	< .45	
< .1	< .05	< .1	-	< .15	< .2
176.	92.	1920.	21.	2012.	~2000
17.4	9.0	73.0	8.1	82.0	10-70? [3]

direction of remanent magnetization for a similar suite of Cretaceous plutons located magnetic field. Thus the scalar sum of the vectors J_i =.52k and J_r should, on the average, value

remanent magnetizations of the samples, but I have discarded the two unusual remanent are probably caused by lightning strikes. The lack of magnetic anomalies near these significant portion of their respective plutons.

the same general direction as the induced magnetization, and the remanence is undoubt

3). In contrast, the good correlation between the eastern part of the large anomaly over the North Dome pluton and Monarch Divide (outlined by the 10,000-ft contour) indicates that this pluton is moderately magnetic; moreover, the location of the magnetic maximum south and slightly west of the topographic divide indicates that the total magnetization of the pluton is in the same general direction of the earth's inducing field, which has a declination of N. 16° E. and an inclination of 61° in this area.

Quantitatively, the effect of topography on total magnetic intensity was computed for trial values of total magnetization J_T of 5, 10, 15, and 25×10^{-4}emu/cm³, taking J_T to be in the same direction as the earth's inducing field. The computation was first made by assuming a two-dimensional model along *A–A′* and extending it 20 miles to the east of *A′* so as to avoid edge effects. The best fit with the eastern slope of the Mount Harrington anomaly and data farther east to which the North Dome pluton extends was for $J_T=15\times10^{-4}$emu/cm³, and the results are illustrated in *A–A′* (pl. 1). Thus, the computed effect of the west face of Mount Harrington is about 140 gammas, and the effect of the east slope is about 100 gammas.

Because two dimensions are not a good approximation for Monarch Divide, the computation was repeated in three dimensions for Mount Harrington and vicinity by digitizing the 7,000-, 8,000-, 9,000-, and 10,000-foot contours (pl. 1) and using a modification of Talwani's (1965) computer program. The results along *A–A′* (not shown on pl. 1) are similar to the two-dimensional model, but the magnetic effect is reduced 30–40 percent. This means that the average value of the total magnetization of the North Dome pluton is perhaps a third greater than the 15×10^{-4}emu/cm³ value adopted from two-dimensional modeling and supported by laboratory measurements (table 3), and this factor must be considered in a final analysis.

A comparison of the observed total intensity along *A–A′* with the computed effect of topography assuming $J_T=15\times10^{-4}$emu/cm³ indicates that all the rock units west of the Kennedy Lake pluton are relatively nonmagnetic, having a J_T of less than about 4×10^{-4}emu/cm³, and that no possibility exists for varying J_T to fit both the east and west flanks of the Mount Harrington anomaly by topography alone. Thus, a major magnetic contrast must exist at approximately the position of the western contact of the Kennedy Lake pluton. The position, depth, and attitude of the contrast have been modeled by a trial-and-error process to yield the vertical contact between the Kennedy Lake pluton and the central mass of metavolcanic rocks extending to a depth of about 1 mile below sea level (pl. 1). It was also necessary to slant the bottom of this magnetic mass upward to about sea level to obtain a reasonable fit to the observed data.

The uncertainties in the magnetic model superimposed on the geologic section (pl. 1) are large because of the two-dimensional approximation of three-dimensional topography. Also, the assumption of constant magnetization of a pluton is unrealistic, because the distribution of magnetite may increase or decrease exponentially, for example, with depth. Nevertheless, the fit between the observed and computed curves is good for this sort of anomaly, and it does demonstrate that the Mount Harrington anomaly is caused largely by a combination of the Kennedy Lake and North Dome plutons rather than some hidden source of serpentinite, concentrated magnetite, or some other material of possible economic importance.

The previously mentioned anomaly over the hypersthene-bearing metadacite tuff has a residual amplitude of only 50–70 gammas, which is consistent with the induced magnetization of 12×10^{-4}emu/cm^3 determined for the representative sample (table 3). The small size of the anomaly indicates that the measured remanent magnetization of the tuff sample (73×10^{-4} emu/cm^3) is not representative of the unit.

ECONOMIC SIGNIFICANCE OF MAGNETIC DATA

Within the framework and limitations of an aeromagnetic survey with 1-mile spacing, the following conclusions can be drawn:

1. The two closed anomalies within the study area are undoubtedly caused by igneous and metamorphic rocks commonly exposed at the surface and extending to depths of several miles.
2. All the metasedimentary rocks and about half the igneous rocks are nonmagnetic.
3. There are no economic iron (magnetite) deposits in the study area.
4. There are no sepentinite bodies or strongly magnetized placers of the type that have served as guides to deposits of metallic or sulfide minerals in other parts of the Sierra Nevada.

MINERAL RESOURCES

MINERAL DEPOSITS IN NEARBY AREAS

The High Sierra Primitive Area is at the eastern edge of a northwesterly trending group of tungsten-rich bodies on the west slope of the Sierra Nevada. Tungsten deposits which have produced ore are within 7 miles of the primitive area; one of these (Garnet Dike mine) was a major tungsten source during World

War II. Most tungsten deposits in this group contain scheelite in tactite, a lime silicate metamorphic rock, at or near the contact between calcareous metasedimentary rocks and granitic rocks (Krauskopf, 1953). Metamorphic roof pendants provide similar geological relationships in the primitive area.

The Lockwood Creek prospect, consisting of 13 claims, is about 2 miles outside the primitive area, in sec. 6, T. 13 S., R. 29 E. (fig. 7). The prospectors probably explored for tungsten ore, but no work has been done here for many years. Workings consist of two caved adits on the southwest side of Lockwood Creek and a network of bulldozed roads, presumably used for access to drill the six diamond-drill holes (totaling 941 ft) reported in the 1939 record of annual assessment work. Bedrock is Mesozoic marble and schist, part of a roof pendant in Cretaceous granitic rocks. Two calcareous rock samples, one of float from the former loading area and another from the waste dump, contained traces of gold. The dump sample contained about 0.03 percent tungsten; 0.03 percent chromium was estimated from semiquantitative spectrographic analysis. Mineralization appears to be weak, and no mineral reserves are indicated on this property.

During an earlier study, magnetite-rich concretions in limy metavolcanic rocks were noted north of the primitive area in the eastern screen of metavolcanic rocks. One sample collected more than 1 mile north of the primitive area, however, does not have a high iron content, though gold (0.35 ppm) is somewhat enriched (sample 398, fig. 6; table 2). Equivalent rocks sampled on the primitive area boundary and in sec. 20, T. 12 S., R. 30 E., contain only minor quantities of iron. The aeromagnetic anomaly near this area can be attributed to a topographic effect of normally magnetized rocks.

Another prospect, the Uncle Sam, is about 2 miles north of the study area (fig. 7), in secs. 2 and 3, T. 12 S., R. 29 E. A field examination was not made for the present investigation, but the U.S. Forest Service examined the property prior to its inclusion in Kings Canyon National Park. The information they supplied, supplemented by U.S. Bureau of Mines production records, is as follows (Wesley Moulton, written commun., 1970): A shaft was sunk to a depth of 36 feet, and 11 tons of ore containing 846 pounds of copper, 103 ounces of silver, and 0.92 ounce of gold was mined in 1915. An adit was driven southwesterly from a point about 150 feet down the hill to intersect the vein and was extended to 98 feet in 1917, but it did not penetrate any ore. Work was discontinued and never resumed. There is no evidence of ore reserves on this property.

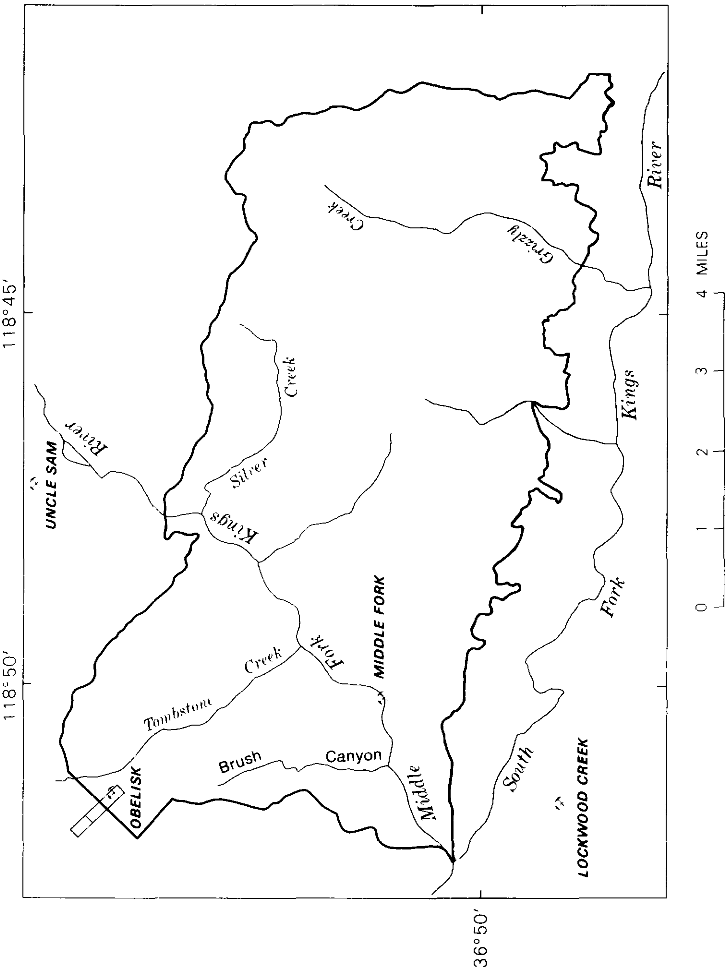


FIGURE 7. — Prospects in the High Sierra Primitive area and vicinity.

MINERAL DEPOSITS IN THE STUDY AREA

Fresno County mining records show only one mining claim, Obelisk 1, within the study area. A search of county mining records did not disclose any claims as having been located at the site of the Middle Fork prospect.

OBELISK CLAIMS

Obelisk 1–3 are unpatented mining claims near the head of Tombstone Creek in sec. 7, T. 12 S., R. 29 E., and sec. 12, T. 12 S., R. 28 E. (fig. 8). They belong to Vance H. Hongola, Rolling Hills, Calif., and James Clark, Reedley, Calif. Access is by 13 miles of jeep road from Wishon Reservoir to Spanish Lake, then by 3 miles of unmaintained foot trail southeasterly to the prospect.

Several shallow pits were excavated on the claims between 1953 and 1958. About 30 tons of ore was produced during that period. In 1955, 4 tons of ore was mined and handsorted to obtain 70 pounds of concentrate (containing 57 percent WO_3), which was shipped for milling tests. The property was explored by diamond drilling, mostly under a Defense Minerals Exploration Administration contract, between July and September 1956. Eight holes totaling 1,107 feet were drilled from six stations (fig. 8).

Cretaceous granitic rocks of the Sierra Nevada batholith underlie the northeastern part of the claim group, and quartzite and marble of a Mesozoic (?) roof pendant the remainder. The pendant is from about 800 to 2,000 feet wide and trends northwesterly through the claim group. Beds strike N. 30° W. and dip from 35° NE. to vertically. Garnet-epidote tactite containing scheelite (calcium tungstate) occurs in the roof pendant.

The deposit at the Obelisk 1 claim consists of two parallel tactite bodies, 10–20 feet apart, near the contact of marble and granitic rocks of the batholith (fig. 9). Tactite strikes N. 30° W. and dips 35°–65° NE. The thickness ranges from a few inches to 7 feet. One body is 3 feet in average thickness, and the other 2 feet. Tactite crops out over about 100 feet of strike distance. It appears to pinch out to the south and terminate against granodiorite to the north. Exposures and drilling results (fig. 10) indicate the maximum length is about 300 feet.

Scheelite is uniformly disseminated through the tactite as crystals from one-sixteenth to 1 inch in diameter. Samples from exposures contained from 0.27 to 1.32 percent WO_3 (fig. 9). Mineralized sections of the Defense Minerals Exploration Administration drill holes contained from 0.06 to 1.31 percent WO_3 (table 4). About 8,000 tons of tactite containing an average of about 1 percent WO_3 is estimated on Obelisk 1 claim.

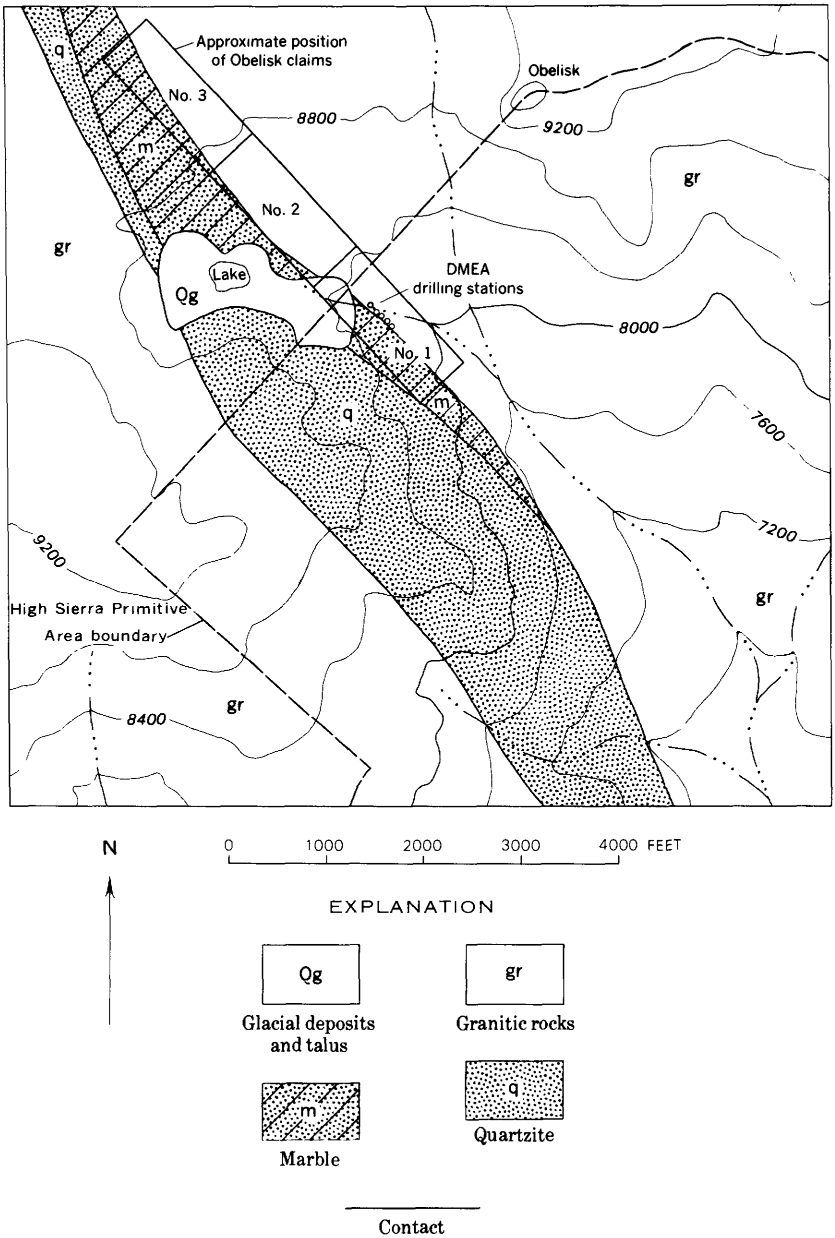
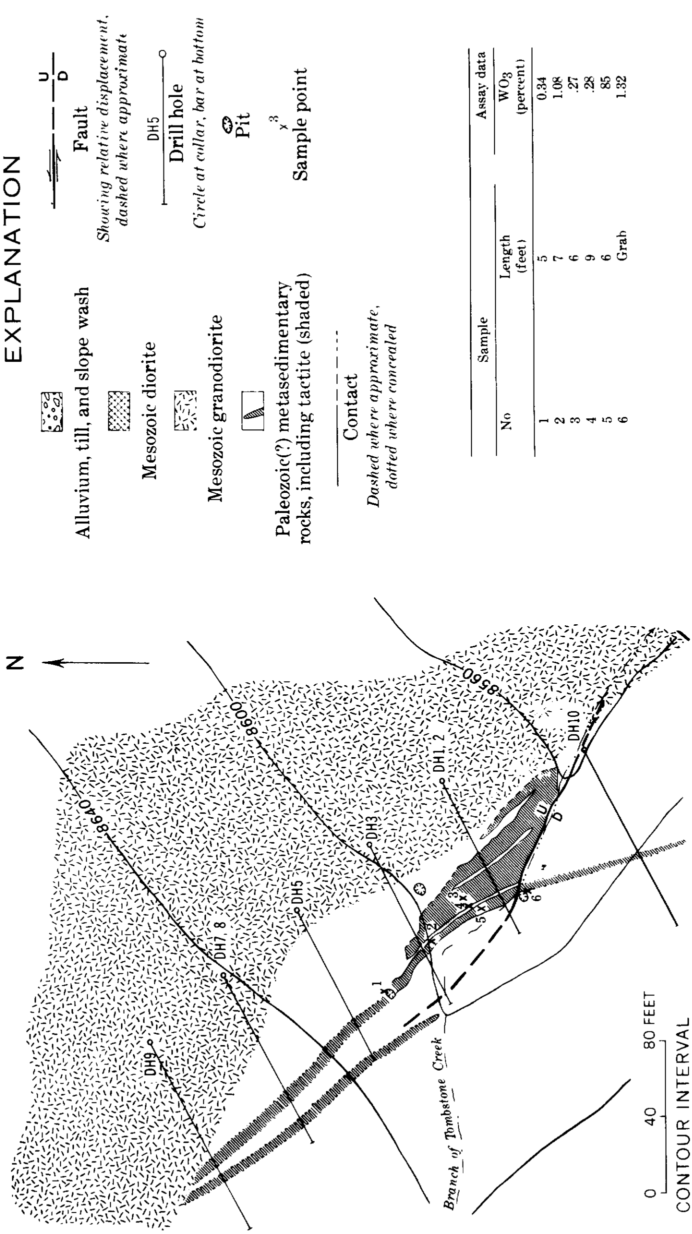


FIGURE 8. — Geology of Obelisk prospect, sec. 7, T. 12 S., R. 29 E., and sec. 12, T. 12 S., R. 28 E. (See fig. 7 for location.)

There are insufficient known resources on the Obelisk 1 claim to mine profitably under present economic conditions. Discovery of additional mineralized material might make construction of a



Sample		Assay data
No	Length (feet)	WO_3 (percent)
1	5	0.34
2	7	1.08
3	6	.27
4	9	.28
5	6	.85
6	Grab	1.32

FIGURE 9. — Geology of the Obelisk 1 claim.

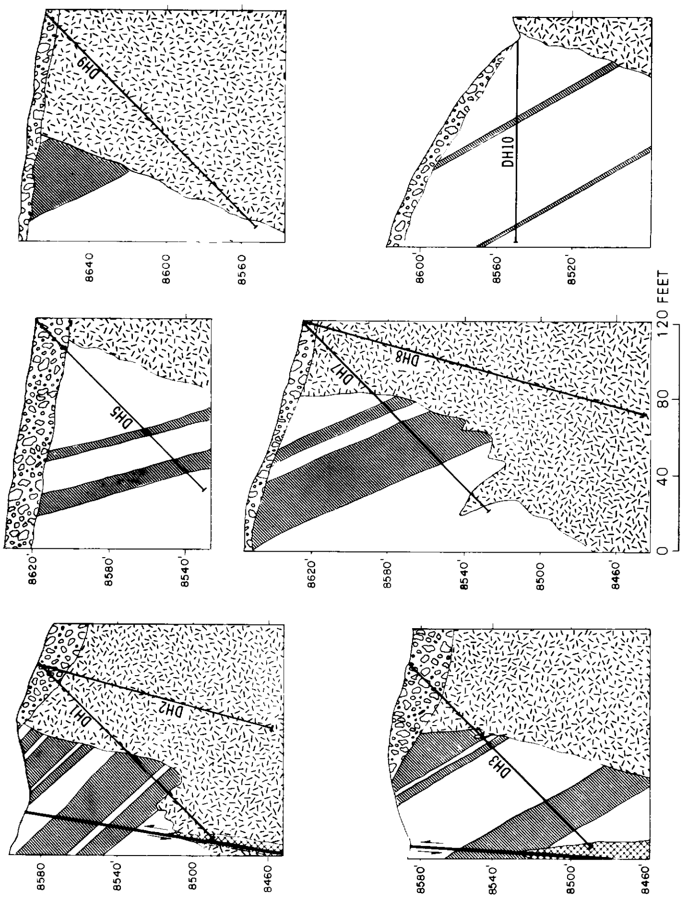


FIGURE 10. — Geologic cross sections of the Obelisk 1 claim.

TABLE 4.—*Drill hole assay data, Obelisk prospect*

Hole No.	Mineralized interval (feet)	WO_3 (percent)	Molybdenum (percent)
1	80.0- 82.0	0.06	
1	83.0- 83.5	.42	
1	87.0- 89.7	.17	
3	100.7-103.7	.51	0.01
3	105.2-112.0	1.14	.02
5	81.5- 84.6	.49	.01
5	102.5-107.8	1.31	.03
5	107.8-108.8	< .01	.01
7	63.5- 64.5	.01	.01
7	66.0- 67.0	< .01	.01
7	73.5- 75.0	.39	.01
7	78.0- 80.0	.53	.01
7	102.0-103.5	.87	.01
7	137.0-138.0	.01	.01
9	153.0-155.0	< .01	
10	41.0- 43.5	< .01	

mill on the property feasible. The mine-mill combination would minimize ore transportation and milling costs and could lead to profitable operation. Additional tungsten-rich tactite bodies may occur in the part of the roof pendant which extends northwesterly across and beyond the Obelisk 2 and 3 claims. The pendant also extends about 1½ miles southeast of the Obelisk 1 and might contain tungsten-rich tactite along this length. This part of the pendant has not been explored, but its potential is based upon geologic similarity and proximity to the Obelisk mineralized zone.

Only the southern two-thirds of Obelisk 1 claim (about 15 acres) is in the primitive area; however, this part contains the known tungsten resources. Any additional resources discovered on the property probably would be outside the primitive area. The logical place to begin mining development, however, would be inside the primitive area at the southeastern, or downhill, end of the claims.

MIDDLE FORK PROSPECT

The Middle Fork prospect is at the bottom of the canyon of Middle Fork, sec. 32, T. 12 S., R. 29 E. (fig. 11). It can be reached from State Route 180 by walking about 1 mile northward on the Yucca Point trail, crossing the South Fork of Kings River (which is hazardous), and continuing northeastward up the Middle Fork canyon about 3 miles on difficult unmaintained trails.

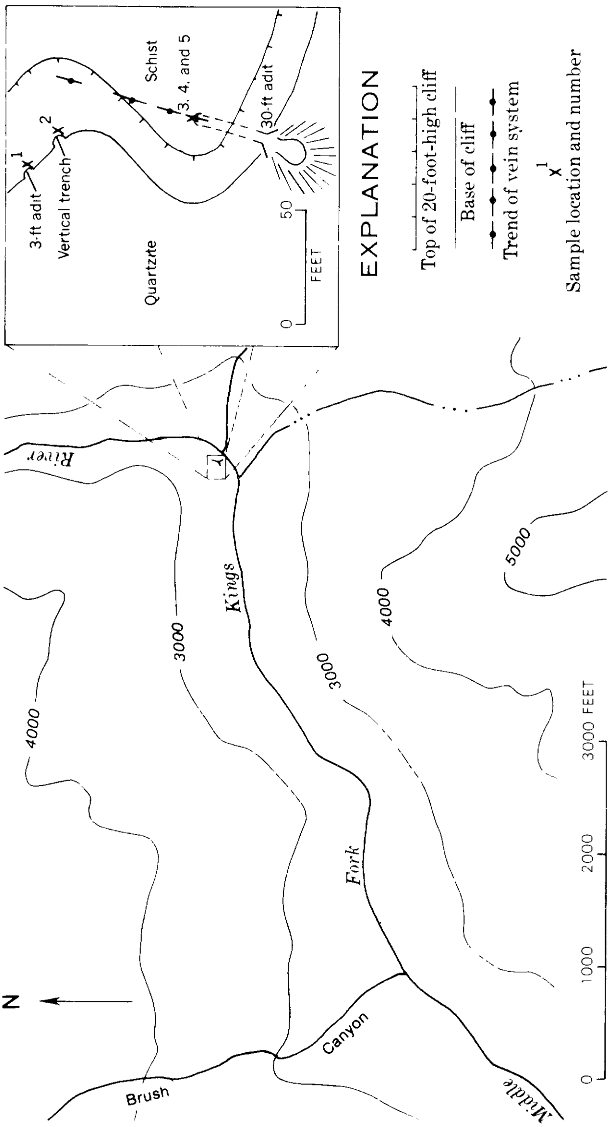


FIGURE 11. — Middle Fork prospect. (See fig. 7 for location.) Analytical data on numbered channel samples on inset map are given in table 5.

TABLE 5.—*Analytical data, Middle Fork prospect*

[*Channel sample locations shown in figure 11*]

Sample		Semiquantitative spectrographic analysis results (estimated weight percent)				
No.	Length (feet)	Lead	Barium	Copper	Chromium	Zirconium
1	4	0.2	10.0	0.015	0.015	0.04
2	6	1/ 1.3	4.0	.03	.015	.015
3	1.5	.02	-	-	.015	-
4	1.5	.05	-	.015	.03	.03
5	1.5	.02	-	.015	.03	-

1/ Actual percent by chemical analysis.

Prospect workings are a 30-foot adit, a nearly vertical trench about 3 feet deep and 10 feet high, which has been cut in a cliff at the base of the canyon wall about 100 feet north of the portal of the adit, and a 3-foot adit about 20 feet northwest of the trench. The workings are in a roof pendant composed principally of Mesozoic quartzite and marble. The main adit has been driven N. 15° E. along vertical calcite veins about 1 inch thick in dark-gray micaceous quartzite. The trench and the shorter adit also are in quartzite.

No marble or tactite was seen, and tungsten was not reported in semiquantitative spectrographic analyses of five channel samples (table 5) taken at the prospect. A 6-foot channel sample of quartzite in the face of the vertical trench shows galena and contains 1.3 percent lead (table 5). A grab sample from the face of the adit also carried 3 parts per million silver (table 2, sample 39B). The highest barium (probably in barite) content occurs in samples with highest lead content. There is no evidence of a minable deposit on this property, which has not been worked for many years.

MINERAL RESOURCE POTENTIAL

Only one mining claim with known mineral resources occurs within the primitive area — Obelisk 1. The deposit consists of scheelite-bearing tactite in a roof pendant. About 8,000 tons of tungsten resources averaging 1 percent WO_3 was calculated on the basis of diamond drilling. About 15 acres of Obelisk 1 is inside the primitive area, and the known tungsten resources are within this area. Known tungsten resources are insufficient to mine under present economic conditions; however, additional small deposits of tungsten-rich tactite might be discovered. If 25,000 tons of approximately the same grade of tungsten resources should be found at the property, a mine-mill combination might be profitable. Additional scheelite-bearing tactite might occur in the western part of the area, where Mesozoic quartzite and marble crop out in roof pendants.

Geochemical sampling of stream sediments and rock samples did not reveal any abnormal concentrations of elements that might suggest the presence of unknown economic mineral deposits. An aeromagnetic survey does not indicate the presence of buried iron deposits, serpentinite, or magnetic placers of economic importance. These data, together with the extreme relief and inaccessibility of the region, minimize the possibility of discovery of economic mineral deposits in the primitive area.

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