STUDIES RELATED TO WILDERNESS

PRIMITIVE AREAS

WILSON MOUNTAINS COLORADO

GEOLOGICAL SURVEY BULLETIN 1353-A

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Mineral Resources of the Wilson Mountains Primitive Area, Colorado

By CALVIN S. BROMFIELD, U.S. GEOLOGICAL SURVEY, *and* FRANK E. WILLIAMS, U.S. BUREAU OF MINES

With a section on GEOPHYSICAL INTERPRETATION

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An evaluation of the mineral potential of the area

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STUDIES RELATED TO WILDERNESS

PRIMITIVE AREAS

The Wilderness Act (Public Law 88-577, Sept. 3, 1964) and the Conference Report on Senate bill 4, 88th Congress, direct the U.S. Geological Survey and the U.S. Bureau of Mines to make 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 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 of the Wilson Mountains Primitive Area and vicinity, Colorado.

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

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MINERAL RESOURCES OF THE WILSON MOUNTAINS PRIMITIVE AREA, COLORADO

By CALVIN S. BROMFIELD, U.S. Geological Survey,
and by FRANK E. WILLIAMS, U.S. Bureau of Mines

SUMMARY

A mineral survey of the Wilson Mountains Primitive Area and adjacent study areas in southwestern Colorado was made by the U.S. Geological Survey and U.S. Bureau of Mines. The combined area encompasses about 68 square miles of rugged terrain straddling the west-trending San Miguel Mountains, on the western edge of the San Juan Mountains region. The investigations by the U.S. Geological Survey were made during 1968, and those by the U.S. Bureau of Mines were made during 1966 and 1969. The area is on the edge of the Ouray-Telluride-Silverton area, one of the great metal-mining regions of Colorado.

The principal visible structural features in the primitive area were determined by middle Tertiary intrusion of an east-west belt of composite stocks, laccoliths, sills, and dikes into nearly flat lying Mesozoic sedimentary and overlying Tertiary sedimentary and volcanic rocks. Subsequent erosion has removed much of the Tertiary sedimentary and volcanic sequence. Base- and precious-metal fissure veins cut intrusive rocks and adjacent sedimentary rocks.

Since the discovery of gold- and silver-bearing veins in 1877, mines in the Wilson Mountains Primitive Area have yielded about $1.78 million in gold, silver, copper, lead, and zinc. About 96 percent of this total is from two mines, the Silver Pick mine in the Mount Wilson district and the San Bernardo mine in the Trout Lake district. About 43 percent of the total value is from gold, 43 percent from silver, 13 percent from lead, and only 1 percent from copper and zinc. Nearby, less than 1 mile outside the eastern boundary of the primitive area, two mines—the Silver Bell and Butterfly-Terrible—yielded $3.07 million in production, mainly in silver. Production from seven smaller mines in this same area was valued at about $43,000. A few miles north of the primitive area vanadium and uranium ores have been produced from sedimentary host rocks on or near the surface. One mile south of the area coal was mined from the Dakota Sandstone.

Farther south, at Rico, limestone replacement deposits near intrusives yielded lead-zinc and precious metal ores. These same limestones probably occur near intrusive rocks beneath the surface of the Wilson Mountains area, but lie too deep to represent feasible exploration targets.

The Wilson Mountains study area contains 68 claims that have been surveyed for patent, although only 53 patents have been granted. All but three of the claims are within the primitive area. Another 29 unpatented claims, said to be located on San Bernardo Mountain, are so poorly described in the county records that they could not be accurately plotted on maps nor located on the ground. No indication of mining activity was observed in the vicinity in which the 29 claims are thought to be located. All known claims are either in the Trout Lake mining district on the east margin of the primitive area or in the Mount Wilson mining district in the center of the area. About 40 percent of the land area in five sections bordering the eastern side of the primitive area is mineral patent land (secs. 29, 32, and 33, T. 42 N., R. 9 W., and secs. 4 and 5, T. 41 N., R. 9 W.).

In evaluating the mineral resources of the primitive area, particular attention was given to veins in the Trout Lake and Mount Wilson districts and to analogous geologic environments that might contain similar deposits. Numerous areas of hydrothermal alteration were visited and sampled to check for the possible occurrence of disseminated metals. Old coal mines south of the primitive area and nearby uranium-bearing vanadium deposits were considered in terms of the potential for similar deposits in the primitive area. The possibility for oil and gas in potential reservoir rocks beneath the area is assessed. To supplement the investigation, about 350 samples of veins, altered rocks, and stream sediments were analyzed by spectrographic and chemical methods, and the results are given. An aeromagnetic survey revealed several anomalous highs over the stocks, all of which can be correlated with known features of the surface geology. No buried intrusives were detected, nor were any lows revealed which might be attributed to the destruction of magnetite that happens in some types of hydrothermal alteration.

Three parts of the area have at least some mineral resource potential:

1. The Trout Lake mining district, on the east side of the primitive area, has several generally narrow base- and precious-metal veins, one of which has had a moderate but sporadic production since 1888.
2. The Mount Wilson mining district in the center of the primitive area contains an area of disseminated copper mineralization in the quartz monzonite of the Wilson Peak stock and several narrow base- and precious-metal veins, one of which had a moderate gold production late in the last century.
3. An area near a small granodiorite plug on a fork of the West Dolores River, within the study area just southwest of the primitive area boundary, shows a mild molybdenum anomaly in stream sediments.

It is doubtful that a major mine will be developed on the generally narrow veins of the Mount Wilson and Trout Lake mining districts, but as in the past, the veins will attract occasional exploration and possible small-scale mining. Further exploration, beyond the scope of this investigation, would be needed to define the limits, grade, and volume of the disseminated copper in the Navajo Basin part of the Mount Wilson mining district.

The western group of peaks around Dolores Peak contains no known mineral deposits. Though there are prominent iron-stained areas, a reflection of the oxidation of disseminated pyrite, no geochemical anomalies were noted in rock or stream-sediment samples.

No other indications were seen of other economic or subeconomic mineral resources. Thin beds of low-rank bituminous coal in the Dakota Sandstone are probably present under the primitive area, in places at depths of considerably more than a thousand feet, but this coal is unlikely to be of any economic significance in the foreseeable future. No surface oil or gas indications are known, but lateral equivalents of reservoir rocks from which gas and oil have been produced in southwest Colorado undoubtedly occur at depth. Thus, if structural or stratigraphic traps occur, oil and gas might conceivably exist beneath the area.

INTRODUCTION

The Wilson Mountains Primitive Area is on the western edge of the spectacularly rugged San Juan Mountains region in San Miguel and Dolores Counties, southwest Colorado (fig. 1). The primitive area lies on the fringe of one of the great metal-producing regions of Colorado, and almost from the earliest days of prospecting in the San Juan region the occurrence of silver and gold and accompanying base metals in the area has supported a small sporadic mining industry. Telluride, 7 miles northeast, is the center of nearby mining activity and the nearest supply point.

The region described in this report consists of the officially designated Wilson Mountains Primitive Area of about 27,000 acres, or 43 square miles and an additional area of about 25 square miles, the study of which was requested by the U.S. Forest Service. In this report the term "primitive area" refers to the defined Wilson Mountains Primitive Area; the term "Wilson Mountains study area" or "Wilson Mountains area" refers to the larger area that was investigated.

The Wilson Mountains area includes a part of a west-trending outlier of the San Juan region known as the San Miguel Mountains. The area straddles the backbone of the range; it extends for 14 miles from the Lake Fork of the San Miguel River on the east, almost to Beaver Creek on the west, and for almost 8 miles from The Meadows on the south to Wilson Mesa on the north. The mountains rise abruptly from the mesa surface of the adjoining Colorado Plateaus province (fig. 2). Within the primitive area the San Miguel Mountains consist of two distinct clusters of peaks. The eastern cluster, informally referred to as the Wilson group, is the larger, and it contains several peaks over 14,000 feet in altitude—Mount Wilson, 14,246 feet; El Diente Peak, 14,159 feet; and Wilson Peak, 14,017 feet; and an unnamed summit on the spur south of Mount Wilson, known locally as South Wilson, 14,110 feet. Scarcely less imposing than these peaks is Gladstone Peak, 13,913 feet, which lies along the ridge between Mount Wilson and Wilson Peak. At a somewhat lower altitude, about 2 miles east of these impressive peaks, is the spectacular landmark of Lizard Head, a nearly ver-

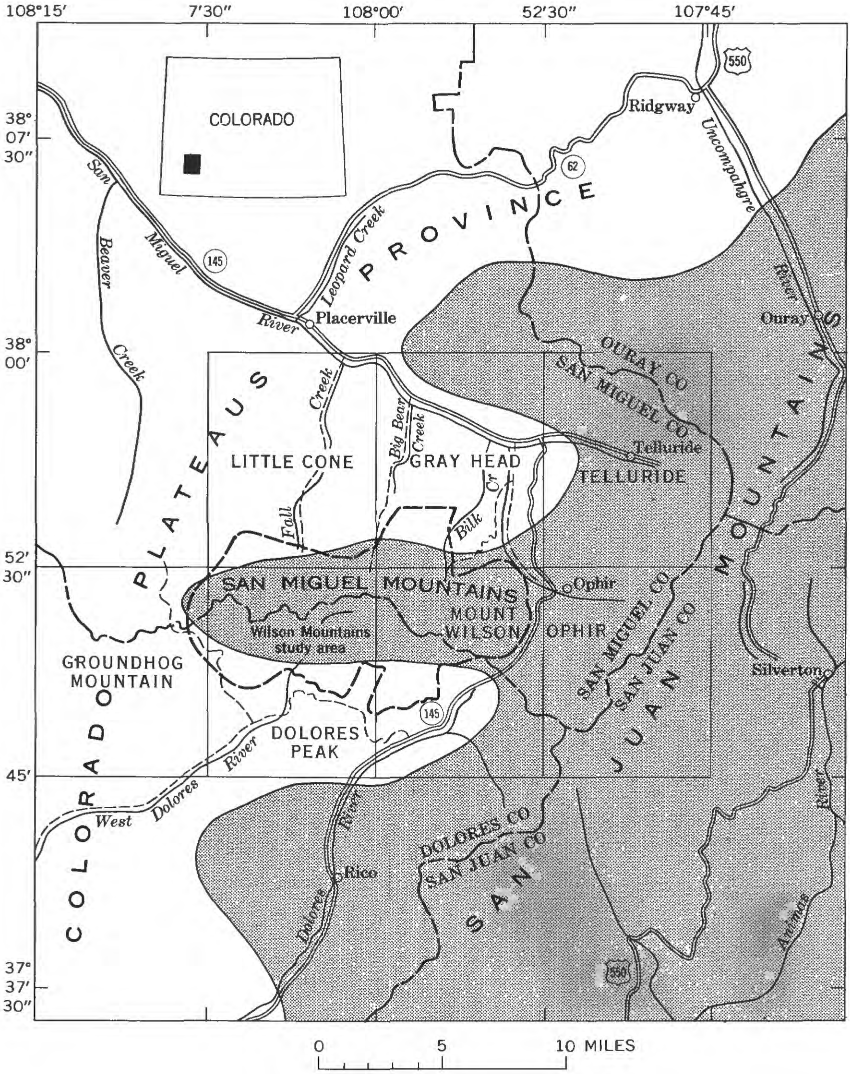

Figure 1.—Index map showing location of Wilson Mountains study area, topographic quadrangles, and physiographic provinces. Stipple, San Juan Mountains.

tical rock spire which rises 300 feet from a conical base to an altitude of 13,113 feet.

The towering peaks and serrated ridges of the Wilson group are separated from the western cluster of peaks—the Dolores Peak group—by a saddle some 2 miles in length which separates the West Dolores River drainage on the south from the Fall Creek drainage on the

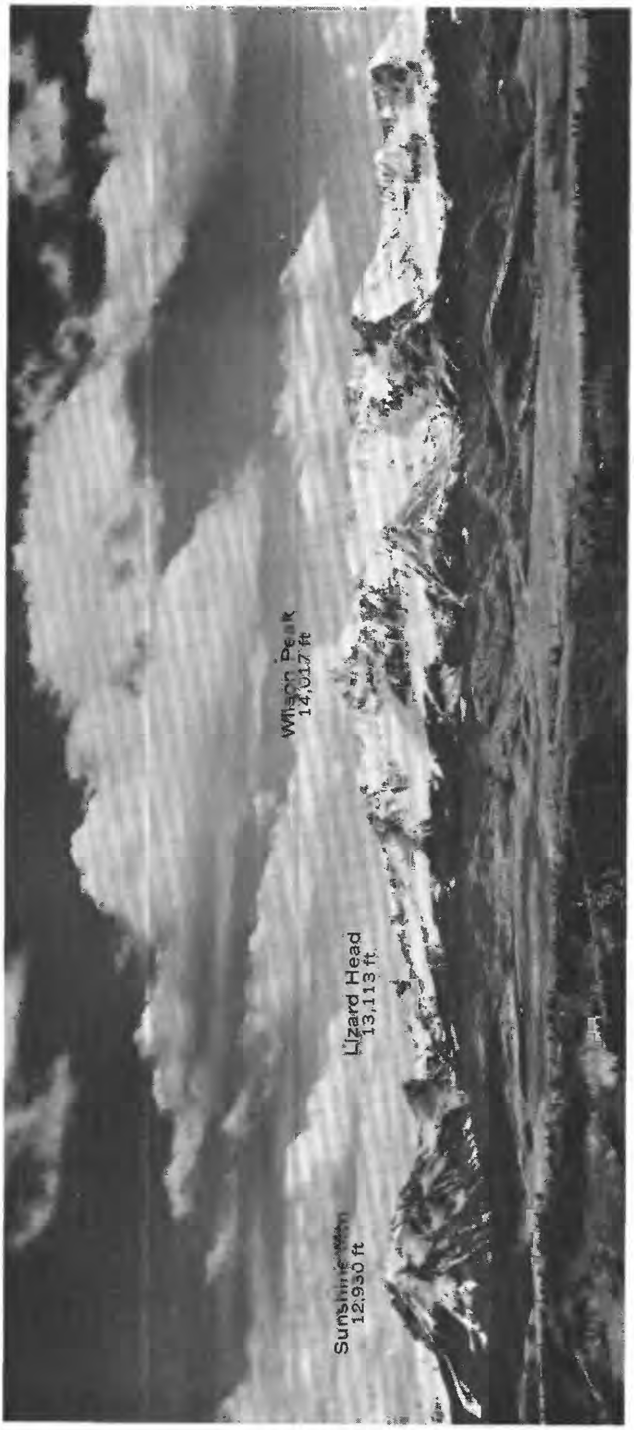

FIGURE 2.—North face of the Eastern San Miguel Mountains. Main peaks (left to right) are Sunshine Mountain (12,930 feet), the spire of Lizard Head (13,113 feet), and Wilson Peak (14,017 feet).

north. The Dolores Peak group is a smaller cluster of three peaks which reach a maximum altitude of 13,290 feet at Dolores Peak, the southeasternmost summit. The central summit of the group is Middle Peak, 13,261 feet, and the westernmost one is Dunn Peak, 12,595 feet.

Holmes (1878, p. 194, 195) said of the San Miguel Mountains that "This is one of the finest groups of summits in the Rocky Mountains, and viewed from the north presents a magnificent panorama. * * * To the eye, a more lovely region than that about these mountains cannot be found. The steeper slopes are covered by a dense growth of pine forest, and the gentler slopes below by fine aspen forest, interspersed with many park-like openings in which grass and flowers grow luxuriantly." Timberline is between 11,000 and 11,500 feet. Here trees are small, gnarled, and twisted by high winds and severe weather. Above tree line is an alpine zone which in some mountain basins is characterized by open meadows with grasses and sedges, and, during early summer, a profusion of small delicate alpine wild flowers. Still higher, conditions for life grow more severe, and finally only bare rock sparsely covered with lichen is seen.

Several roads give access to the area. State Highway 145 follows close to the east and southeast border of the area. The Dunton road, a dirt road which leaves State Highway 145 at Barlow Creek, follows the south boundary of the area. At the Dunton Guard Station an unimproved forest road leads north over the divide into the Beaver Creek drainage along the west margin of the primitive area, and in places it lies within the adjacent study area. Along the north boundary, gravel or dirt roads lead up all the principal drainages to or into the primitive area. Thus, a gravel road along Fall Creek ends at Woods Lake near the northwest boundary; a fair road in Big Bear Creek gives access to the Silver Pick Basin and Elk Creek, both within the primitive area; and the Morning Star mine in Bilk Creek is accessible by a dirt road. Trails suitable for horses reach into most of the high basins. Except for State Highway 145, all the roads are impassable during the winter.

The area has short cool summers and long severe winters. The amount of snow increases with altitude; thus, Trout Lake (alt 9,710 ft), just southeast of the area, has an average snowfall of 214 inches, whereas Savage Basin (alt 11,522 ft), about 12 miles northeast, has an average snowfall of 400 inches. Snowslides are a common hazard. Mining activity in the high basins around Mount Wilson has always been handicapped by the extreme altitudes and accompanying severe winter weather, and it has been virtually restricted to late spring, summer, and fall. Many adits and workings that long lie dormant become choked with ice. There are several permanent snowfields in the San Miguel Mountains, and snow patches remain in many sheltered areas throughout the summer.

PREVIOUS INVESTIGATIONS

The first geological observations in the region of the Wilson Mountains Primitive Area were by F. M. Endlich (1876) and W. H. Holmes (1878), geologists with the U.S. Geographical and Geological Survey of the territories under R. V. Hayden. Endlich visited the eastern part of the San Miguel Mountains in the summer of 1874, and Holmes, the famous artist-geologist, visited the western San Miguel Mountains in the summer of 1876. Stimulated by the discovery in the 1870's and 1880's of valuable deposits of precious and base metals in the western San Juans, Whitman Cross and his coworkers began extensive studies in 1894 which resulted in a series of U.S. Geological Survey geologic atlas folios: Telluride (Cross and Purington, 1899), La Plata (Cross and others, 1899), Silverton (Cross and others, 1905), Rico (Cross and Ransome, 1905), Ouray (Cross and others, 1907), and Engineer Mountain (Cross and Hole, 1910). These folios form an essential first reference to one's understanding of much of the geology of the San Juan Mountains. In these folios the broad outlines of the geologic framework of the region were firmly established, and the sedimentary, metamorphic, and volcanic units were named and defined. The subdivisions of the rock units were for the most part sound, and though in later years some units have been modified and redefined, much of Cross's terminology is still in use in the San Juan Mountains and in southwest Colorado.

The Telluride 15-minute folio (Cross and Purington, 1899), the earliest of the San Juan folios, presents the geology of the eastern part of the primitive area. In this folio Purington described some of the mineral deposits within the primitive area. Somewhat earlier, Purington (1898) gave a more detailed statement on the mineral resources. Purington's field notes were helpful in the present investigation, as they give some information on mines long inaccessible. Varnes (1947a, 1947b) briefly described some of the ore deposits within the primitive area. In 1954 a Geological Survey mapping program began in the western San Juan area, and parts of the primitive area are shown by the geologic maps of the Little Cone quadrangle (Bush and others, 1960), Gray Head quadrangle (Bush and others, 1961), Mount Wilson quadrangle (Bromfield and Conroy, 1963; Bromfield, 1967), and the Dolores Peak quadrangle (Bush and Bromfield, 1966). Bromfield (1967) discussed in detail the geology and mineral resources of the eastern half of the area.

In September 1943 the Morning Star mine (Mount Wilson district) was examined by U.S. Bureau of Mines personnel in regard to federal assistance in constructing an access road. In August 1949 the same mine was examined in connection with a Defense Minerals Exploration Administration (DMEA) loan application.

In August 1949 the Silver Pick mine was visited by a Bureau of Mines engineer, also in regard to a DMEA loan application. At that time all mine entrances were blocked by ice, but two surface samples were taken (p. A44).

The San Bernardo mine was visited by Geological Survey and Bureau of Mines personnel at the request of a lessee in 1943 and, for DMEA assistance, in 1953; on both occasions the ore zones were inaccessible to the examiners, and a thorough evaluation was impossible.

PRESENT INVESTIGATION

A mineral survey of the Wilson Mountains area was made by C. S. Bromfield, assisted by R. B. Moore, during July and August 1968. The simplified geologic map (pl. 1) in this report was compiled at a scale of 1:48,000 from published modern geologic maps cited above, with the exception of a small part at the west end of the area which was mapped by reconnaissance methods during the summer of 1968. Stream-sediment and rock samples were collected throughout the area, and selected specimens of veins were collected, chiefly from dumps, as most workings are inaccessible (pl. 2).

The U.S. Bureau of Mines focused on the economic aspects of the mineral resources in and adjacent to the Wilson Mountains Primitive Area. F. E. Williams and M. J. Sheridan examined U.S. Bureau of Land Management and U.S. Forest Service records in Denver, Colo., to determine the locations of patented claims. County records of San Miguel County (in Telluride) and Dolores County (in Dove Creek) were reviewed to determine the locations of unpatented claims. Mineral production data were compiled from numerous annual volumes of "Mineral Resources of the United States," "Minerals Yearbook," reports of the Director of the Mint dating to the 1880's, and file records of the U.S. Bureau of Mines. Data relative to the Mineral Leasing Act of 1920 were obtained from the U.S. Geological Survey files, Denver, Colo.

Fieldwork by U.S. Bureau of Mines personnel was conducted in the area late in the summers of 1966 and 1969. In 1966, M. J. Sheridan and R. G. Raabe made a field reconnaissance and collected samples from mineral deposits in the Navajo Basin, Bilk Basin, Wilson Peak, and San Bernardo Mountain areas. In 1969, F. E. Williams and B. C.

Pollard, Jr., assisted by R. L. Lowrie, evaluated and sampled additional deposits in Navajo Basin and Bilk Basin and examined the intermittently active areas near the Silver Pick, Morning Star, and San Bernardo mines.

ACKNOWLEDGMENTS

Grateful acknowledgment is extended to several local residents and individuals who have been or are engaged in mining activities within the primitive area and who gave freely of their time and information during the fieldwork: Mr. Everett Blackburn, Mr. Philip Klingenschmid, Mr. Clarence Nielsen, Mr. Jack Montgomery, Mr. Frank Montonati, Mr. John Montonati, Mr. John D. Reece, Mr. Mello Roscio, and Mr. Joseph Roscio.

Special note is made of the friendly cooperation of all residents in this region who aided in this task.

GEOLOGY

STRATIGRAPHY

The bedded rocks exposed in the Wilson Mountains area consist of nearly 3,600 feet of sedimentary rocks of Mesozoic age, almost 1,000 feet of lower Tertiary conglomerate, and about 1,300 feet of lower to middle Tertiary volcanic rocks (table 1). The Tertiary sedimentary rocks and volcanic sequence crop out only in a few places where they cap high ridges adjacent to Tertiary intrusive rocks and are only remnants of a sequence once continuous with the thick San Juan volcanic pile to the east.

No direct evidence is available on the older Mesozoic, Paleozoic, and Precambrian rocks that are inferred to underlie the study area. The total thickness of concealed strata above the Precambrian may be on the order of 7,000 or 8,000 feet. This estimate is based on indirect evidence from exposures of older Mesozoic rocks in the deep valleys of the San Miguel River to the north, and the Dolores and West Dolores Rivers to the south, and exposures near Rico of Paleozoic and Mesozoic rocks, together with cuttings from deep oil well tests to the west and north. The unexposed rocks probably include in descending order the lower part of the Jurassic Morrison Formation and the Jurassic Wanakah and Entrada Formations; Triassic Dolores Formation; Permian Cutler Formation; Permian and Pennsylvanian Rico Formation, Pennsylvanian Hermosa and Molas Formations; Mississippian Leadville Limestone; Devonian strata, possibly the Ouray and Elbert Formations; and possibly thin Cambrian units.

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TABLE 1.—*Sedimentary and volcanic rocks of the San Miguel Mountains, Colo.*

Age	Unit	Dominant lithology	Approximate maximum exposed thickness (feet)
Oligocene	Silverton Volcanic group.	Pale-red lithic-crystal tuff, greenish to dark-purple andesitic to dark quartz latitic breccia, and dark-brown pyroxene andesite flows; forms cliffs and steep slopes.	700
		UNCONFORMITY	
Oligocene and older (?).	San Juan Formation.	Grayish-green to purple andesitic to quartz-latitic tuffs, tuff breccias, and tuffaceous sandstones; in part water laid; forms cliffs and steep slopes.	600
Eocene	Telluride Conglomerate.	Pale-red arkosic conglomerate, sandstone, and siltstone; contains some thin red to gray claystones; forms cliffs.	1,000
		UNCONFORMITY	
Late Cretaceous.	Mancos Shale	Gray to black marine shale, a thin fine-grained sandstone unit in places near top, and a few thin fossiliferous limestone beds, mostly near the base; forms wooded slopes above mesa rims.	2,500
Late and Early (?) Cretaceous.	Dakota Sandstone.	Interbedded sandstone and carbonaceous shales at top; interbedded carbonaceous shales, siltstones, some thin coal beds, and a few thin sandstones in middle; light-colored sandstone and conglomeratic sandstone at base; forms alternate cliffs, slopes, and ledges.	200
		UNCONFORMITY	
Late Jurassic	Morrison Formation.	Brushy Basin Shale Member; variegated red to green mudstones and thin-bedded very fine grained sandstones; most units limy; forms covered slopes.	500
		Salt Wash Sandstone Member: light-colored thick lenticular crossbedded medium-grained sandstones and some thin interbedded red-brown to gray-green mudstones; forms cliffs, ledges, and slopes.	450

MESOZOIC ROCKS

Rocks of Mesozoic age within the area are divided into three formations—the Jurassic Morrison Formation and the Cretaceous Dakota Sandstone and Mancos Shale.

The Upper Jurassic Morrison Formation, the oldest exposed formation, crops out in only two small areas, one in the northeast corner of the area along the South Fork of the San Miguel River near Ames, and the second along the West Dolores River where it leaves the study area (pl. 1). The formation there consists of only two members, the Salt Wash Sandstone Member and the overlying Brushy Basin Shale Member; both are composed of sediments deposited in fluvial and lacustrine environments.

The Salt Wash Member is composed of 300–400 feet of massive lenticular light-colored, generally pale-yellowish-gray, fine- to medium-grained sandstone interbedded with lesser amounts of red, red-brown, and gray-green mudstone or thin-bedded sandstone. The proportion of mudstone increases near the top of the member and the Salt Wash grades into the overlying Brushy Basin Member. The Brushy Basin consists of 300–400 feet of varicolored generally dusky-red and grayish-green mudstone and thin-bedded blocky silty sandstone. Sparse red-brown limestone beds less than 1 foot thick are locally present.

Though the Salt Wash Member of the Morrison Formation has been a favorable host for uranium deposits to the west near Uravan and elsewhere on the Colorado Plateau, no deposits have been found in the area of the San Miguel Mountains.

The Lower(?) and Upper Cretaceous Dakota Sandstone typically forms the rimrock along the major drainages in the area adjacent to the San Miguel Mountains and underlies wide areas of mesa or plateau country to the west. However, within the Wilson Mountains area outcrops are restricted to a few along the west side of the South and Lake Forks of the San Miguel River along the West Dolores River, and in Cold Creek south of Dolores Peak.

The Dakota Sandstone consists of 150–200 feet of interbedded sandstone, carbonaceous siltstone and shale, and locally, thin coal beds. The formation can be divided into three units: (1) A lower cliff-forming unit of light-gray to buff, fine- to medium-grained, partly conglomeratic, sandstone, (2) a middle slope-forming unit of carbonaceous shale, siltstone, and a few thin sandstones that locally contain coal seams 16–24 inches thick, and (3) an upper ledge- and slope-forming unit of interbedded thin- and medium-bedded black sandstone and carbonaceous siltstone and shale.

The Upper Cretaceous Mancos Shale, the most widespread of the exposed formations, forms the bedrock surface over much of the area (pl. 1). The Mancos is composed of black fissile shale which weathers dark to light gray. Locally, it contains thin discontinuous limy beds and, about 1,500 feet above its base, is a notable sandstone-rich zone, 50–100 feet thick. This latter zone is particularly conspicuous between the West Dolores River and Slate Creek, at an altitude of about 11,400 feet.

The Mancos ranges in thickness from about 2,500 feet near the western end of the San Miguel Mountains to only 1,500 feet near the eastern end of the mountains. The reduced thickness results from erosion which accompanied and followed uplift in the San Juan Mountains in early Tertiary time.

CENOZOIC ROCKS

EOCENE AND OLIGOCENE ROCKS

In the western San Juan Mountains the Eocene Telluride Conglomerate was deposited on the widespread unconformity of low relief formed by early Tertiary erosion, and it rests on rocks ranging from Precambrian to Upper Cretaceous; within the smaller area of the San Miguel Mountains the Telluride lies on the Mancos Shale.

The Telluride Conglomerate is now preserved only as remnants on the highest ridges of the San Miguel Mountains; its base is generally above 11,500 feet. The Telluride forms cliffs and ledges above the soft shale slopes of the Mancos. In the eastern cluster of peaks (the Wilson group), the formation underlies the ridges extending outward from the Wilson Peak stock, the lower slopes of Lizard Head, and the ridge leading north to Sunshine Peak; and it caps San Bernardo Mountain northwest of Trout Lake. In the western cluster of peaks (the Dolores peak group), three small remnants of Telluride Conglomerate have been preserved—one on the northeast slopes of Dolores Peak, adjacent to the stock; one on the summit ridge just southeast of Middle Peak; and one on the slopes of Dunn Peak (pl. 1). The exposures on Dunn Peak marks the westernmost occurrence of Telluride Conglomerate in the San Juan region.

Generally the formation is 900–1,000 feet thick and consists of pale-red to light-gray arkosic conglomerate, conglomeratic sandstone, sandstone, and lesser amounts of mudstone. Subrounded to subangular pebbles, cobbles, and boulders include limestone, sandstone, siltstone, quartzite, schist, and coarse-grained granites derived from a terrane to the east that supplied gravels from formations of Mesozoic, Paleozoic, and Precambrian ages.

In the western San Juan Mountain region the Telluride Conglomerate is overlain by a thick volcanic pile that covers several thousand square miles and is several thousand feet thick. In the San Miguel Mountains, however, post-volcanic erosion has removed most of this volcanic blanket, and remnants of the volcanic rocks are confined to the highest ridges. In the Wilson group of peaks in the San Miguel Mountains the oldest volcanic unit is the San Juan Formation, and this is overlain by rocks of the Silverton Volcanic Group. A small isolated remnant of volcanics occurs in the Dolores group of peaks on the ridge southwest from Dunn Peak. These volcanic rocks are tentatively correlated with the San Juan Formation. This is the westernmost occurrence of volcanic rocks in the San Juan Mountains region. The San Juan Formation, Silverton Volcanic Group, and the volcanics of Dunn Peak are combined as one map unit on plate 1. In the primitive area the San Juan Formation has a maximum thickness of somewhat over 600 feet and consists of volcanic breccias and sandstones which have been propylitized to mottled hues of green, purple, and red. The overlying rocks of the Silverton Volcanic Group, nowhere present in their original thickness, consist of a heterogeneous assemblage of as much as 700 feet of partially welded lithic-crystal tuff, volcanic breccias similar in appearance to the San Juan Formation, and flows of a dark porphyritic pyroxene andesite.

MIDDLE AND UPPER TERTIARY INTRUSIVE ROCKS

Intrusive rocks of Cenozoic age make up a large part of the San Miguel Mountains. The major intrusive bodies, from east to west, are the Ophir stock (part), the Black Face and Ames plutons, the Wilson Peak stock, and the Dolores Peak stock and associated laccoliths. Dikes, sills, and small irregular bodies are common near the major intrusive masses.

Plate 1 shows the stocks, laccoliths, and minor intrusive masses combined in one map unit of middle and late Tertiary age. Readers interested in details of distribution of rock types are referred to previously published maps by Bromfield (1967) and Bush and Bromfield (1966). Petrographic descriptions of major rock types were given by Bromfield (1967) and Bromfield and Bush (1968) and are not repeated here.

The Black Face pluton forms an elongate east-trending body southeast of the Wilson Peak stock (pl. 1). The Ames pluton, east of the stock and in contact with it, forms a narrow outcrop which crosses the northeast part of the area (pl. 1) ; the outcrop makes a spectacular cliff along the west side of the Lake Fork of the San Miguel River about 1 mile west of Ophir where it crops out as a sill as much as 800 feet thick. Both plutons are composed of granodiorite porphyry.

The highest and most impressive peaks in the San Miguel Mountains, several of which reach above 14,000 feet, are carved from the Wilson Peak stock. The stock forms Wilson Peak, Gladstone Peak, El Diente Peak, and the north slopes of Mount Wilson, and it underlies a large part of the mountain spurs and basins which surround these peaks. It is exposed through a vertical range of 4,000 feet and underlies an area of about 5 square miles. The stock is composite and is composed of microgranogabbro, granodiorite, and porphyritic quartz monzonite (adamellite), intruded in that order.

The Dolores Peak stock, like the Wilson Peak stock, is a composite mass made up of rocks that range from granogabbro to granodiorite. The central stock is of granogabbro and granodiorite; the laccolithic tongues are chiefly granogabbro. The sequence of intrusion is not clear, but in general granogabbro appears to have been emplaced first, followed by granodiorite.

The prominent laccolith that extends about 1 mile north from the stock is composed mostly of granogabbro, much of which is porphyritic.

SURFICIAL DEPOSITS

Various Pleistocene and Holocene surficial deposits in the area are combined on plate 1 into one map unit, and they include talus, rock streams, glacial drift, landslide deposits, and alluvium.

By far the greater part of the areas shown as surficial deposits on plate 1 consists of either talus or glacial drift. Talus and a few rock glaciers of Holocene age make up nearly all the surficial deposits that occupy the basins and cirque areas above timberline. Glacial deposits of pre-Wisconsin and early and late Wisconsin age cover extensive areas along and adjacent to the Lake Fork of the San Miguel River, Bilk Creek, and the West Dolores River.

STRUCTURE AND GEOLOGIC HISTORY

Geologically the San Miguel Mountains form a west-trending projection of the larger San Juan Mountains into the Colorado Plateaus on the west (fig. 1). Although the physiographic division between the two provinces is well marked by the abrupt rise from the generally flat plateau country to the rugged mountainous area, the structural boundary is less clear. The plateau is characterized by generally flat-lying sedimentary strata scored by erosion into mesa and canyon country; in contrast, to the east, the San Juan Mountains are characterized by a vast volcanic pile that has been carved into a spectacular display of precipitous peaks and ridges. Deep erosion reveals that the western part of the volcanic pile rests on the truncated surface of a broad dome which extends some 50 to 60 miles north-south. The geologic history deciphered from the exposed rocks shows that this dome formed during Laramide time (Late Cretaceous to eary Tertiary) and subsequent erosion beveled the uparched sedimentary strata to a surface of low relief upon which the piedmont alluvial gravels of the Telluride Conglomerate were deposited. Upon this gravel, beginning perhaps in early Tertiary time and extending into middle Tertiary time, several thousand feet of volcanics were deposited which eventually formed a volcanic plateau some 100 miles across and containing considerably more than 6,000 cubic miles of rocks. Well-defined subsidence structures or cauldrons mark major volcanic eruption centers. The nearest is the linked Silverton and Lake City cauldrons, about 10 miles east of the primitive area (fig. 3). During and after the eruptions the sedimentary and volcanic rocks were invaded by stocks, laccoliths, and minor intrusions in middle Tertiary time.

The chief visible structural features in the primitive area were determined by the middle Tertiary stocks and laccoliths that were intruded into the nearly flat-lying sedimentary sequence and overlying Tertiary volcanic rocks. The intrusions form an east-west belt across the primitive area and make up the backbone of the San Miguel Mountains.

In contrast with the Rico and La Plata intrusive centers to the south, the sedimentary and overlying Tertiary volcanics, though locally arched by intrusions, are not markedly domed but are nearly flat lying, and only gentle undulations are superimposed on a general southerly rise of strata toward the Rico dome.

The form of the Black Face pluton and its relations to the country rock suggest that it is an asymmetric laccolith, though no floor has been exposed by erosion. The roof rocks are still preserved near the summit of Black Face and at the east end of the intrusive mass. At both places the cap of Mancos Shale dips at relatively low angles and is in concordant relation to the underlying pluton. To the north the strata gradually arch over into steeper dips, concordantly following the intrusive roof.

In contrast, along the south side of the Black Face pluton, the Mancos Shale dips at steep angles, commonly vertical to overturned, and probably in part is faulted parallel to the contact. Locally adjacent to the pluton, overturned Mancos Shale beds dip at 30° to 70° into the contact. The Mancos Shale is crumpled into small-scale overturned folds which diminish in intensity outward and pass into normal flat-lying strata within a thousand feet of the intrusive contact. The pluton itself apparently has a somewhat irregular but steep south-dipping contact along much of its south side, but in places the contact is vertical.

As with the Black Face pluton, the Ames pluton has both concordant and discordant relations to the enclosing flat-lying sedimentary rocks and thus is not readily classified, but it has the general form of a thick irregular sill. Near the Wilson Peak stock, the Ames pluton is a discordant body adjacent to which the strata are domed and crumpled. The body grades northeastward into a sill 600–800 feet thick. The Ames and Black Face plutons probably connect in the subsurface.

The Wilson Peak stock is discordant to the enclosing sedimentary rocks, and its contacts are steep and sharp. Around somewhat more than half its periphery, the flat-lying strata of the Mancos Shale and overlying Telluride Conglomerate continue up to the stock contact with no significant deformation. This general relationship holds from near Mount Wilson on the southern boundary of the stock, west into Navajo Basin, and then east and north along the stock contact into Silver Pick Basin. On the northeast, however, along the ridge leading east from Wilson Peak, the Telluride Conglomerate and Mancos Shale dip away from the stock contact. The steep intrusive contact cuts upward across the bedding planes of the enclosing rocks, and, though it parallels the strike of the beds in some places, it cuts discordantly across the strike of the tilted beds in others. On its southeast side the stock transects a large asymmetrical overturned fold thought to be

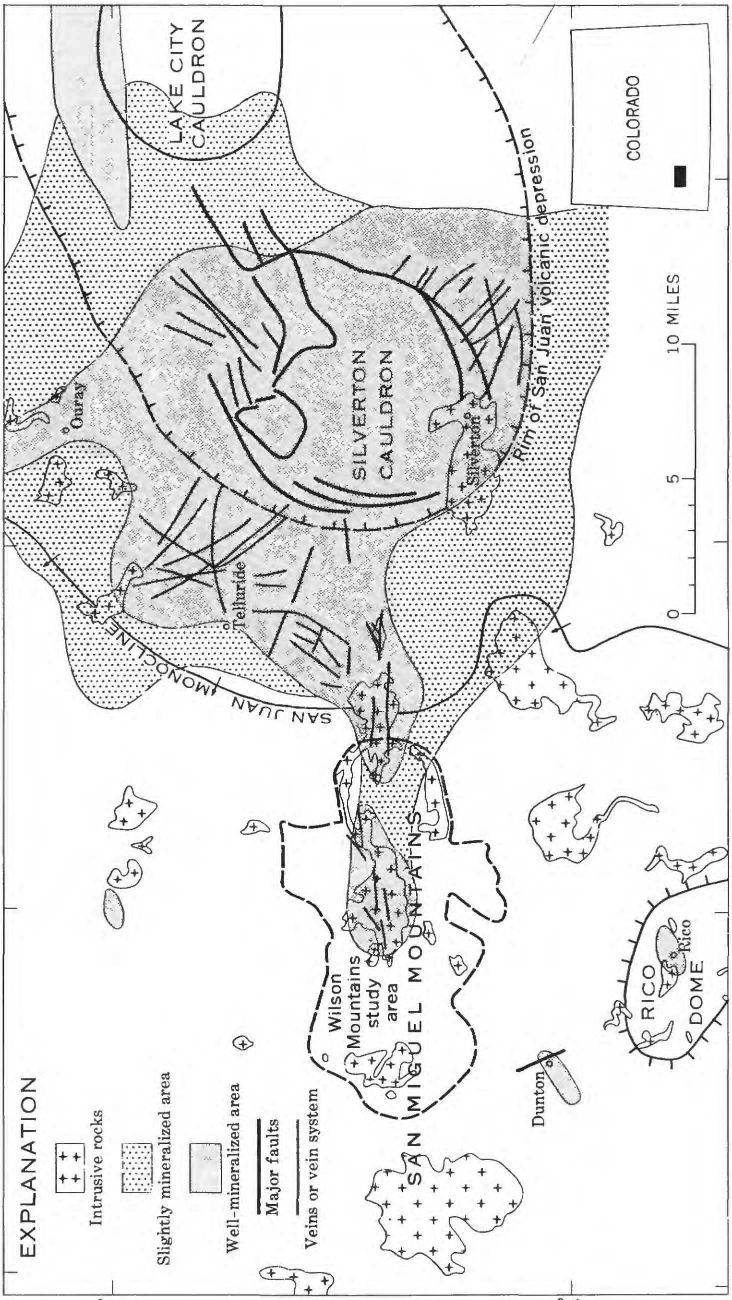

FIGURE 3.—Major structural features, intrusive igneous rocks, and distribution of mineralization in the western San Juan Mountains.

related to the intrusion of the Black Face mass. The stock cuts the fold at nearly right angles to the anticlinal axis and is interpreted to be later than the fold.

The smaller Dolores Peak group at the west end of the San Miguel Mountains is developed on the Dolores Peak stock and a pair of laccoliths that extend from it—one to the north and a smaller one to the southwest (pl. 1). The stock is a northwest-trending, broadly elliptical body about 2 miles long by 1 mile wide that underlies nearly three-fourths of the mountain mass and is exposed over a vertical range of more than 2,000 feet; it forms several peaks that reach above 13,200 feet. The intrusive rocks cut both the Mancos Shale and the westernmost exposures of the Telluride Conglomerate and have both concordant and discordant contacts with them.

At most exposures, the stock is in discordant contact with the enclosing rocks. At its southeast end the stock cuts directly across the Telluride Conglomerate, whose varied attitudes probably reflect an adjustment to the emplacement of the underlying and crosscutting igneous rock mass. To the northwest, Mancos Shale roofs the highest exposures of the stock.

The floor of the laccolith extending north from the stock is visible at a few places, and the Mancos Shale into which the laccolith is intruded is baked to a hornfels for a few feet below the contact. Near its southern junction with the stock the laccolith's roof of Mancos Shale is preserved, and locally the attitude of the Mancos mirrors the upper surface of the laccolith. Elsewhere the Mancos is preserved on the eastern flank of the laccolith, where it mantles the intrusive body through a vertical range of some 600 feet.

Faults are few and minor in the primitive area, but several generally west- to northwest- or northeast-trending fissures are parallel to the intrusive belt and localized silver, lead, zinc, and gold mineralization which followed the intrusion of the stocks.

MINERAL RESOURCE EVALUATION

HISTORY AND CLAIMS

Metal-mining activity in the western San Juan Mountains began in the early 1870's with the discovery of silver lodes in and adjacent to the Silverton volcanic center. Prospecting activities spread from the area of the initial discoveries and by 1877 claims on the San Bernardo vein had been located within the present primitive area. By 1883 the Silver Pick vein had been discovered, and probably by 1900 nearly all the claims now patented within the primitive area had been discovered and prospected. In the decade between 1890 and 1900 mining

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operations at the Silver Pick mine produced nearly all the ore with which the mine is credited; the mine has since been dormant. In the nineties, ore was produced also at the San Bernardo although a decrease in silver price after 1893 resulted in a decrease in production. During the period 1900–1928 production was sporadic at the San Bernardo but the mine has been dormant since then except for a small production in 1941–42 and 1964–66.

Patented claim locations (fig. 4) were obtained from U.S. Bureau of Land Management and U.S. Forest Service maps and files. Patented mining claims or claims surveyed for patent are generally located with reference to section corners rather than to natural features. The ravages of time have long since destroyed most section corner monuments, and because of insufficient data, few section lines are shown on recent topographic maps. Hence, although the positions of claims relative to each other are accurately shown on maps in this report, their positions with respect to natural features are generalized.

The Wilson Mountains study area contains 68 claims surveyed for patent although only 53 patents were granted. The patented claims cover 685 acres. All but three of the claims are within the primitive area. Two-thirds of the patents issued within the primitive area are dated prior to 1900. The last patent is dated 1924. Within approximately 1 mile outside the primitive area are an additional 61 patented claims, all of which are very near the east boundary, near Ophir, Colo.

Unpatented claims are plotted in figure 4 as accurately as data permit. Information about unpatented claims was obtained from records at Telluride for San Miguel County and at Dove Creek for Dolores County. The search of courthouse records was limited to claims recorded within the last 10-year period regardless of whether or not annual labor affidavits had been filed.

A group of 29 claims believed to be on San Bernardo Mountain was so poorly described that it could not be plotted in figure 4, nor could it be located on the ground.

PRODUCTION

Approximately $1.78 million in gold, silver, copper, lead, and zinc has been mined from deposits within the Wilson Mountains Primitive Area. About 96 percent of this total is from two mines, the Silver Pick mine (Mount Wilson mining district) and the San Bernardo mine (Trout Lake mining district). About 43 percent of the total is in gold values, 43 percent is in silver, 13 percent is in lead, and only 1 percent is in copper and zinc. Table 2 shows estimated production and recorded production for mines in the primitive area.

TABLE 2.—*Dollar value of precious- and base-metal production from mines in the Wilson Mountains Primitive Area*

[Data compiled from records of the U.S. Geological Survey and U.S. Bureau of Mines and from reports of the Director of the Mint]

Mine (year, or interval of record)	Gold	Silver	Copper	Lead	Zinc
Silver Pick					
1882–89	$1, 623	$821			
1890–98	668, 962	121, 905			
1905	103	404			
1908	4, 610	875	$902	$10	
1930–41	6, 823	299	41	45	
1959–61	630	6			
Total	682, 751	124, 310	943	55	
San Bernardo					
1888	9, 356	24, 177			
1890–95 [1]		141, 229		22, 400	
1902–05	620	12, 121		12, 933	
1910–20	1, 364	18, 034	2, 622	9, 834	
1920–28	29, 271	396, 776	24, 292	151, 014	
1941–42	8, 750	1, 030	55	332	
1948	70	227		269	
1964–66	13, 370	9, 731	2, 771	7, 450	$400
Total	62, 801	603, 325	29, 740	204, 232	400
Morning Star					
1904–14	9, 054	11, 835	141	18, 985	
1952		23		168	
Total	9, 054	11, 858	141	19, 153	
Clara					
1888	4, 650	12, 024			
1891 [1]		7, 200			
Total	4, 650	19, 224			
Polar					
1935–40	8, 050	467	18	85	
Special Session					
1937–40	1, 120	21	3	8	
Hattie Ross					
1931	394				
Grand total	768, 820	759, 205	30, 845	223, 533	400

[1] From C. W. Purington (unpub. data, 1896).

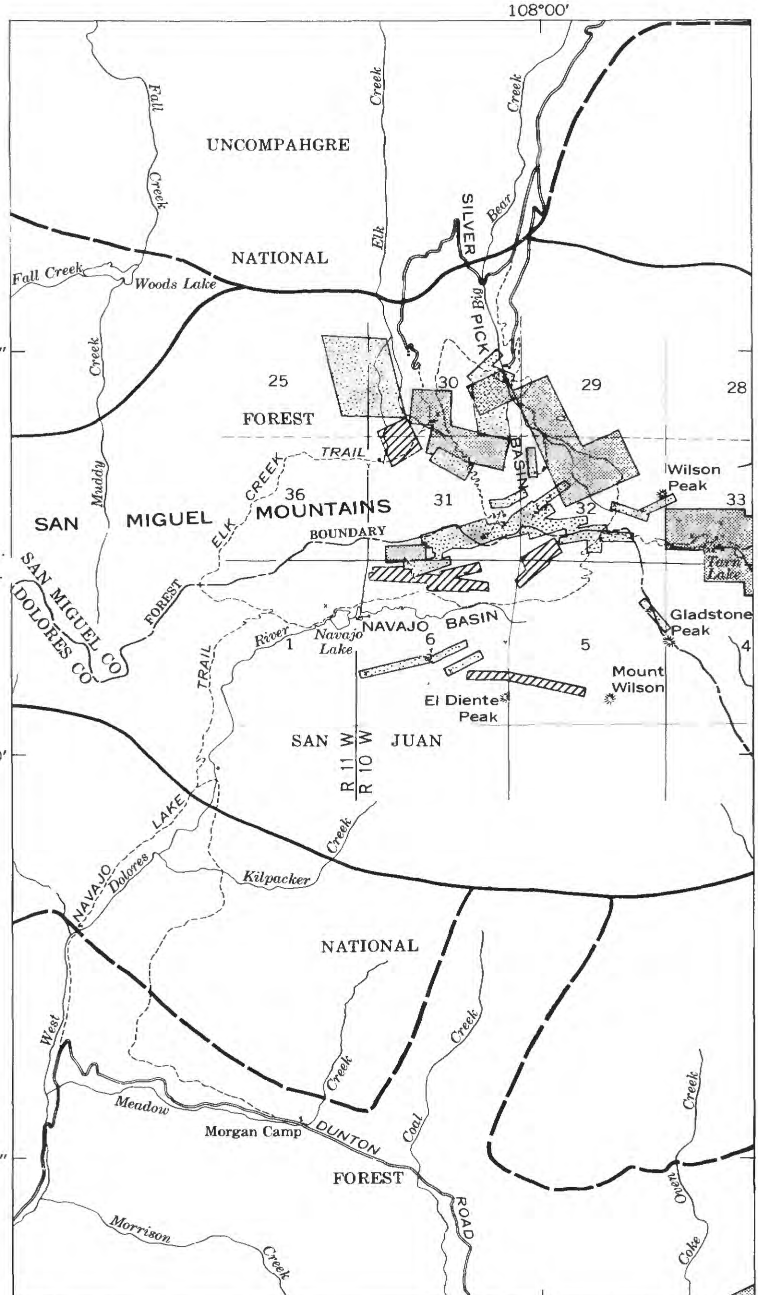
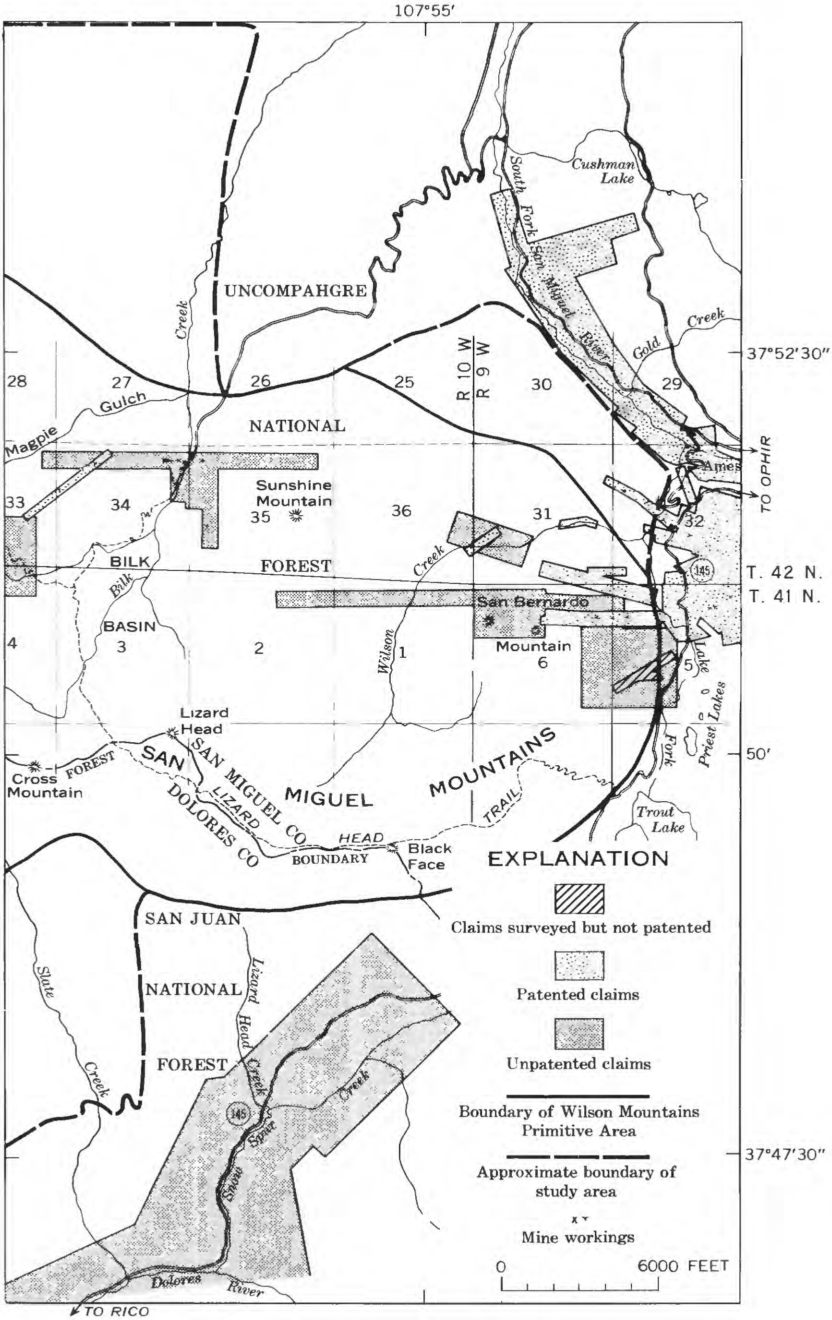


FIGURE 4.—Map showing approximate location of claims, Wilson Mountains half of the



Primitive Area. No mining claims, patented or unpatented, are in the western primitive area.

Ore valued at about $3.07 million, mainly in gold and silver, has been produced from two mines less than 1 mile beyond the eastern boundary of the primitive area; the Silver Bell mine yielded $1.65 million and the Butterfly-Terrible mine accounted for $1.42 million. About $43,000 has been recorded from seven other mines within 1 mile of the eastern boundary of the primitive area. About $600,000 in silver and gold was recovered from veins in the Cutler and Dolores Formations near Dunton, 2½ miles south of the primitive area along the West Dolores River. About 10 miles to the south, mines around the Rico intrusive center have yielded about $45 million in silver, gold, and base metals.

Uranium-bearing vanadium was mined from deposits in the Entrada Sandstone 1½ miles north of the primitive area on Big Bear Creek and several miles south of the area on Barlow Creek and North Fork Hermosa Creek. Coal was mined briefly in the late 1800's from deposits in the Dakota Sandstone immediately adjacent to the south boundary along the Dolores River near Coal Creek.

METHODS OF APPRAISAL

In assessing the mineral resource potential of the Wilson Mountains Primitive Area, particular attention was given both to known mineral deposits that occur in and near the area and to other types of deposits which the geologic environment might permit. Thus, vein deposits which occur in and near intrusives in the Mount Wilson and Trout Lake mining districts were visited and sampled, and, in addition, other intrusives in the area with no known vein deposits were visited and sampled. Areas of pyritized rock and accompanying conspicuous iron staining are common, within or adjacent to intrusive rocks of the primitive area, and their presence suggests a geologic environment that might contain disseminated metals of low grade but possibly of commercial value. The largest and most conspicuous of these were visited and sampled. Both the old coal workings south of the area and the nearby uraniferous vanadium deposits were assessed in terms of the potential for similar deposits in subsurface beneath the primitive area. Potential oil- and gas-bearing reservoir rocks probably occur in the sedimentary section beneath the primitive area, and the possibilities for oil and gas were considered in the light of oil and gas occurrences in the region.

An aeromagnetic survey of the area supplemented the ground investigations.

Reports dealing with mineral resources in and near the area were studied, and a compilation of past production was made. Records of the U.S. Bureau of Land Management, U.S. Forest Service, and San

Miguel and Dolores Counties were searched for records of patented and unpatented claims.

To supplement the geologic appraisal and the record of past and present mining activities, about 350 samples were collected and analyzed by semiquantitative spectrographic methods for about 30 elements and by atomic-absorption methods for gold; some samples were analyzed chemically for zinc, copper, lead, arsenic, and antimony. Also fire assays were made on 29 samples collected by U.S. Bureau of Mines personnel. The samples are of several types—vein and mineralized rocks (tables 3, 7), altered rocks (table 4), stream sediments (table 5), and soils and miscellaneous samples (table 6). The sample types are briefly described below, and the sample localities are shown on plate 2.

Vein and mineralized rock.—Most workings along veins in the area are caved, and surface exposures are generally concealed by sliderock or colluvium; most samples of the veins and mineralized rock reported in tables 3 and 7 are from old dumps, and only rarely are they from veins in place. The samples taken from old dumps are chiefly grab samples of the best vein material seen; accordingly, they should not be construed as representing average grade of a particular vein, nor do they necessarily represent the selected high-grade ore which was shipped in small quantities from some narrow veins in the early days of mining. The analytical data are not suitable for calculation of tonnage or grade of ore shoots or dumps. However, the range and kind of metal content shown by the analyses probably reflect the distribution of metals among the various veins and the range in tenor to be expected in the generally narrow ore shoots along the veins. Also shown in table 3 are analyses of several samples with disseminated sulfides, chiefly of copper.

Altered rocks.—Altered rock samples that were analyzed (table 4) are mostly iron-stained igneous and sedimentary rocks that generally contain disseminated pyrite. Such pyritized rocks form large, conspicuous red-brown areas in the San Miguel Mountains. These areas were sampled either by chip samples of rock in place, or by random samples of several pounds of small chips from talus cones derived from such areas. The samples were taken to check the possibility of disseminated deposits.

Stream sediment.—Stream-sediment samples shown in table 5 were collected along the major streams and, where feasible, along secondary streams. Grab samples of the finest sediment were taken at the sample locality, generally of sand and mud; each sample weighed about 1 pound. Because of the steep gradients and torrential nature of some streams, fine material had been removed and an ideal sample was not always obtainable.

Miscellaneous samples.—Table 6 includes analyses of various samples that could not be classified with the samples described above, and these are described by footnotes to that table.

Subsequent sections of this report discuss areas and mines in more detail and present relevant or significant analytical results from vein and altered rock samples. A discussion of the results of routine stream-sediment sampling follows.

RÉSUMÉ OF STREAM-SEDIMENT SAMPLING

The stream-sediment anomalies of copper, lead, and zinc reflect areas of known metalization in the Mount Wilson mining district and, to a lesser extent, the Trout Lake mining district. Consequently the stream-sediment samples from Big Bear, Elk, and Bilk Creek, and the headwaters of the West Dolores River in Navajo Basin, all of which drain the Mount Wilson district, show anomalous values in lead, zinc, and copper. Figure 5 depicts by suitable symbols the concentration of copper in the Wilson Mountain study area; patterns shown by the distribution of lead and zinc are similar to that shown by copper and are not given. No significant anomalies of lead, zinc, or copper were disclosed beyond the broad area of known mineralization.

Particularly interesting is the consistent high copper content in the stream-sediment samples from Navajo Basin (fig. 5) at the head of the West Dolores River. These evidently reflect disseminated copper minerals in this area. Stream-sediment samples from the Dolores Peak group on the west, an area not having any known vein deposits, are barren. The analytical results suggest that the westernmost limit of the west-trending zone of base- and precious-metal veins found in the Trout Lake and Mount Wilson districts apparently is in Navajo Basin.

Molybdenum is the only element to produce a consistent stream-sediment anomaly outside the Mount Wilson and Trout Lake districts; a mild molybdenum anomaly occurs along several minor tributaries of the West Dolores River just north of the south boundary of the study area (fig. 6). The distribution of the anomalous molybdenum values on tributaries which drain an area around a prominent plug of granodriorite porphyry (pl. 1) suggests that this intrusive may be the source of the anomaly. This plug is in part pyritized and has a conspicuous red-brown staining. A selection of red-stained chips from one area (sample 315, table 4) at the foot of the plug, however, did not contain an anomalous amount of molybdenum or other metals.

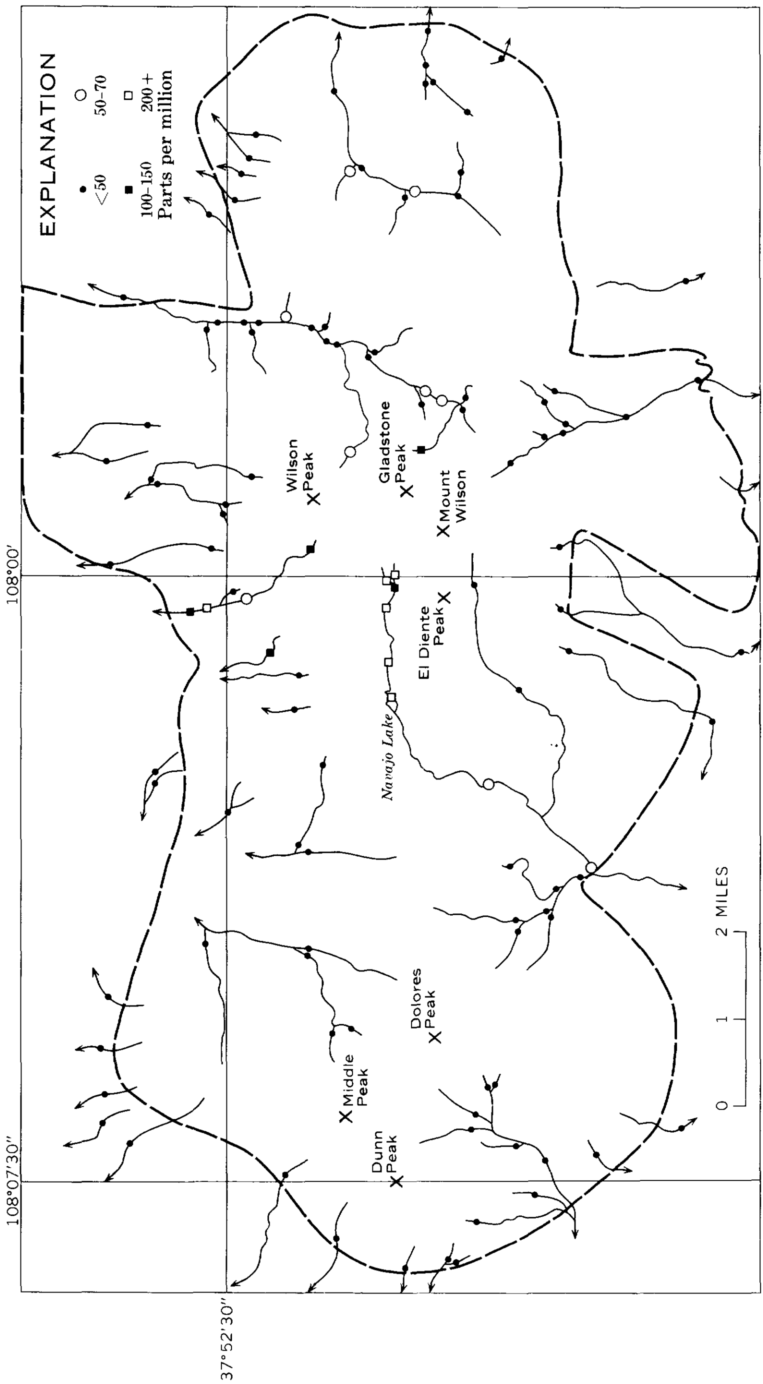


FIGURE 5.—Concentration of copper in stream sediments, Wilson Mountain study area.

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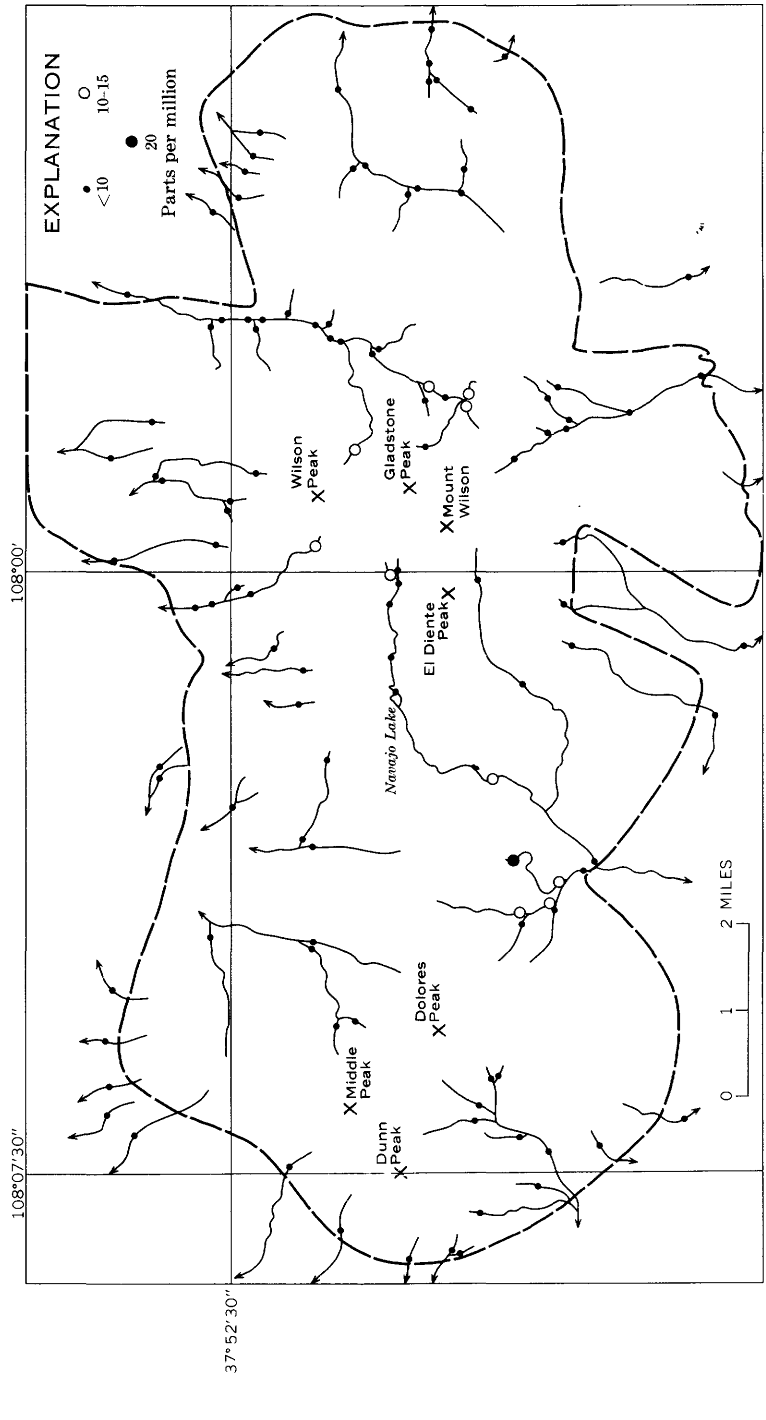

FIGURE 6.—Concentration of molybdenum in stream sediments, Wilson Mountains study area.

GEOPHYSICAL INTERPRETATION

By PETER POPENOE, U.S. Geological Survey

An aeromagnetic survey was made of the Wilson Mountains area by the U.S. Geological Survey in 1968 as part of a survey of the western San Juan Mountains. Traverses were flown in an east-west direction at 14,500 feet above sea level and the total intensity magnetic field was recorded with an ASQ–10 fluxgate magnetometer.

The major magnetic anomalies shown in figure 7 coincide with the Dolores Peak stock, the Wilson Peak stock, and the Ophir stock. These aeromagnetic highs are caused by the contrast between the moderately magnetic igneous rocks and weakly magnetic sedimentary rocks. Magnetic susceptibilities for three samples representing the three major rock types of the Wilson Peak stock ranged from 4.5 to 6×10^{-4} cgs (centimeter-gram-second) units, which are typical susceptibilities for igneous rocks of intermediate to mafic composition and they correspond to about 0.5 percent magnetite content (Lindsley and others, 1966). The high amplitudes of the anomalies developed over the stocks result mainly from the relatively infinite depth of magnetic material in the stocks and, to a lesser degree, from the topography of the area.

Smaller anomalies are evident over the Ames and Black Face plutons and along the laccolithic part of the Dolores Peak stock, where the bodies of magnetic rock are thin. The laccolithic part of the Dolores Peak stock has only a subdued magnetic effect because the laccolith coincides with the normal dipolar low on the north side of the main stock.

In this type of geologic environment an aeromagnetic map may be useful in pointing to mineralized areas that might be associated with (1) buried bodies of igneous rock, which would show up as magnetic highs, or (2) areas of hydrothermal alteration, which would show up as magnetic lows. Neither of these have been recognized in the primitive area, and all the magnetic anomalies can be correlated with the surface geology. Dipolar lows, whose positions suggest that the magnetization of the plutons is approximately alined with the earth's present field (Zietz and Andreasen, 1967), are developed on the north side of the Wilson Peak and Dolores Peak stocks. Variations in the magnetic pattern suggesting residual lows are developed on the north side of the Wilson Peak stock; however, these variations appear to be correlative with the mapped configuration of the northern margin of the stock. The closed low only part of which is shown in the southwestern corner of figure 7 and the low shown along the south edge of the map are caused both by the presence of thick sedimentary rock in this area and by a dipolar low associated with aeromagnetic highs

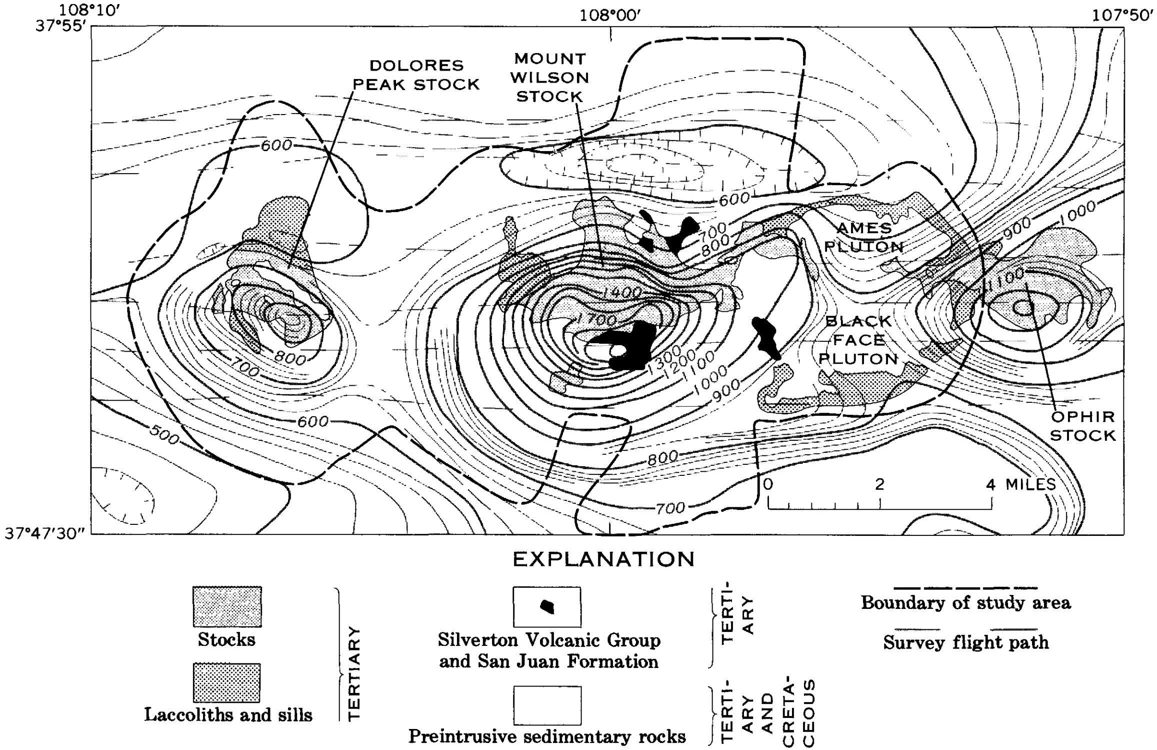

FIGURE 7.—Total intensity aeromagnetic map and generalized geology of the Wilson Mountains Primitive Area. Contour intervals 20 and 100 gammas on arbitrary datum.

caused by the Telescope Mountain and Grizzly Peak stocks to the south of the mapped area.

The U.S. Geological Survey and the U.S. Air Force Aeronautical Chart and Information Center have made gravity measurements in the San Juan Mountains region (U.S. Geol. Survey, 1968; Donald Plouff, written commun., 1969). These measurements show that the primitive area lies on the western gradient of a large regional gravity low which extends over 100 miles to the east and underlies a broad area roughly coincident with the high mountains. This regional low could represent an effect of isostatic compensation of the mountains, but gradients suggest that it could also be caused by the presence of low-density rocks underlying the mountains. A similar gravity pattern is known to exist coincident with the Colorado mineral belt in central Colorado and has been discussed by Case (1967) and Behrendt, Brinkworth, and Popenoe (1968).

On the regional Bouguer gravity map (U.S. Geological Survey, 1968) the Dolores Peak, Wilson Peak, and Ophir stocks cannot be distinguished by their gravity expression. This results partly from the insufficient number of gravity stations in this area and probably partly from the very small contrast in density between the Tertiary igneous rocks and the surrounding Mesozoic and older rocks. Behrendt, Brinkworth, and Popenoe (1968) found the average density of 159 samples of Tertiary intrusive rocks in central Colorado to be 2.65 g per cm^3 (grams per cubic centimeter). Measured densities of three samples of Tertiary intrusive rocks from the Wilson Peak stock ranged from 2.55 to 2.75 g per cm^3. Woollard (1962) showed the Mancos Shale to range in density from 2.57 to 2.68 g per cm^3 whereas Dakota Sandstone averages 2.56 g per cm^3. Seemingly only a very small density contrast is to be expected.

GEOLOGIC RELATIONS OF THE MINERAL DEPOSITS

The Wilson Mountains Primitive Area lies on the western fringe of the Telluride-Silverton-Ouray region, one of the great base- and precious-metal mining regions in Colorado and the nation (fig. 3). Mines in this region, which include such famous old mining camps as the Smuggler, Tomboy, and Camp Bird, have produced about $350 million in silver, gold, lead, zinc, and copper. Most of this production has come from the area 8 to 10 miles northeast of the study area and is chiefly from steep northwest-trending veins that cut Tertiary volcanic rocks and are radial to the Silverton cauldron (fig. 3).

West of the Silverton cauldron is a similar system of westward-trending veins closely associated with Tertiary intrusive rocks. This system, much weaker and containing fewer veins than the northwest-trending system, extends from the valley of the Howard Fork westward into the primitive area as far as the Wilson Peak stock (fig. 3). Mines along veins in this system have not been as productive as mines in the area to the northeast, and the total production probably does not exceed $5 million in precious and base metals.

Within the primitive area the veins of this system are restricted to an east-west zone or belt, 1–2 miles wide and 7 miles long, that extends from the east boundary westward into the Silver Pick and Navajo Basins area. This zone or mineral belt closely approximates the major axis of Tertiary intrusion of the major igneous masses, and the bulk of the ore produced from the primitive area has come from fissure veins within or adjacent to the igneous rocks and chiefly from two veins—the San Bernardo and the Silver Pick. Veins are virtually absent in the nonindurated sedimentary rocks between the intrusive bodies. This is probably because these rocks consist chiefly of the soft fissile shale of the Mancos Shale, which is too incompetent to provide open fissures except where it has been hardened by contract metamorphism adjacent to intrusive rocks.

On plate 1 only the most conspicuous or important fissure veins are indicated. These veins have a general westerly trend; they range in strike from N. 55° E. to N. 60° W. and generally dip steeply north or south. Locally, as in the Wilson Peak stock from upper Bilk Basin west into Navajo Basin, the jointing or fissuring of westerly trend is so closely spaced as to suggest an immense sheeting of the igneous rocks. Displacements along the fissure veins are generally imposible to determine in the massive intrusive rocks. Where movement can be determined, it is generally only a few feet.

The veins that were worked range in width from about 3 inches to about 5 feet. More commonly the paystreak in the veins averages less than 2 feet in width, but the presence of several stringers in a fissure zone locally increases the width of commercial ore.

Two general types of ores can be distinguished in the primitive area—gold ores and siver-lead ores. The known gold ores are restricted to the area near the head of Navajo and Silver Pick Basins and in the adjacent basin at the head of the east fork of Elk Creek. The only substantial producer of gold ore was the Silver Pick mine.

The gold ores are composed predominantly of pyrite and quartz gangue; variable amounts of chalcopyrite and arsenopyrite are subordinate, and galena and sphalerite are present locally but are inconspicuous. Though the gangue is chiefly white crystalline quartz, locally some carbonate minerals and, rarely, barite occur. Gold is very fine grained and is seldom visible to the eye. Higher gold values are generally associated with higher amounts of chalcopyrite and arsenopyrite. Rich pockets or streaks of gold ore assayed as much as 7 ounces per ton, but over the width of the narrow paystreaks gold values of 1 or 2 ounces per ton probably were representative of most ore mined.

The gold ores have been explored through a vertical distance of 800 feet, from an altitude of about 12,600 feet to about 13,400 feet. In this distance there was evidently no noteworthy change in character of the ores.

The silver-lead ore deposits are more widely distributed than the gold ore deposits, and they comprise all the known veins between the east boundary of the primitive area and Bilk Creek, as well as veins such as the Hattie Ross in Navajo Basin. Within the primitive area the principal producers of this type of ore are the San Bernardo and Morning Star mines.

In the silver-lead ores the predominant primary sulfide minerals are galena, sphalerite, and pyrite; although generally subordinate, chalcopyrite and tennanite-tetrahedrite are common and in places are abundant. The gangue is commonly quartz, calcite, and brown carbonate minerals; lesser amounts of barite and rhodochrosite also occur. The silver-lead ores generally contain less than 0.10 ounce of gold per ton. Silver may assay 40 ounces or more per ton locally, but available production figures from records of the U.S. Geological Survey and the U.S. Bureau of Mines suggest that the mine-run ore averaged less than 10 ounces of silver per ton.

The silver-lead ores of the area have been explored from an altitude of about 9,600 feet to at least 12,500 feet, a range of nearly 3,000 feet. The lower limit represents that imposed by the bottom of a major valley (with attendant drainage problems) rather than by a change in character of the veins; similarly, the upper altitude does not necessarily indicate an upper limit. Individual lodes have been explored through vertical intervals of 1,000 feet without appreciable change in their character.

Although all the veins in the primitive area are related in time and geologic setting, they tend to cluster geographically into two groups. Historically, the two groups have been separated into two mining districts—the Trout Lake district on the east, comprising those veins in and about the Ophir stock, and the Mount Wilson district on the west, comprising those veins in and about the Wilson Peak stock.

VEIN DEPOSITS

TROUT LAKE MINING DISTRICT

The Trout Lake mining district includes all the mines and prospects from the high ridge between Lizard Head and Sunshine Mountain to the ridge of Yellow Mountain east of the primitive area boundary. State Highway 145 in the valley of the Lake Fork of the San Miguel River bisects the district and provides access.[1]

That part of the Trout Lake district within the primitive area occupies the eastern end of the San Miguel Mountains where altitudes range from about 8,600 feet to 9,700 feet along the valley of the Lake Fork of the San Miguel River and rise to 11,880 feet on San Bernardo Mountain and 12,930 feet on Sunshine Mountain. Within the primitive area are 12 patented claims covering 141 acres and 29 unpatented claims totaling about 600 acres. Two of the latter group of claims were surveyed for patent but were never patented. An additional 29 unpatented claims have been recorded as being located on San Bernardo Mountain, but no field evidence was found for such claims. Three patented claim covering about 34 acres are within the study area but are just outside the primitive area.

Though prospectors were in the area by 1877 the earliest recorded mining activity in the Trout Lake district was in 1883 when 140 tons of ore was shipped from the Silver Bell mine and the "Garabaldi was shipping some ore from a 14-inch paystreak at $75 per ton net value" (Precious Metals in the U.S., Director of the Mint report, 1883). Production was first recorded from the San Bernardo mine and from the Clara mine in 1888.

The main producing mine wholly within the primitive area and in this mining district is the San Bernardo, whose total production exceeds $900,000. The main producing mines of the district, however, are outside the study area but are within 1 mile of the boundary. The Silver Bell mine yielded a total of $1.65 million and the Butterfly-Terrible mine accounted for a total of $1.42 million. A small amount of production from the mining district was reported in 1968.

Main surface assets of the Trout Lake mining district are two concentrating plants and the proximity to road transport service. One plant at the Silver Bell mine, about half a mile east of the primitive area boundary does custom milling on a contractual basis. The second mill, at the San Bernardo mine, is a few hundred feet east of the primitive area boundary (fig. 8) and is now (1970) in standby pending reactivation of the San Bernardo mine. It has a capacity of 100 tons per day but readily can be converted to 200 tons or more per day.

The fact that mines in the eastern part of the primitive area are adjacent to the road network reduces costs for transporting ores and concentrates to outlying smelters.

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[1] On some old claim plats and records this area is variously referred to as the Iron Springs district or the Ames district, but current usage prefers Trout Lake district. The term "Iron Springs district" is more properly restricted to the area adjacent to the valley of the Howard Fork, a few miles to the east.

FIGURE 8.—View looking west toward San Bernardo mill and mine. Dumps mark general course of the San Bernardo vein. The summit of San Bernardo Mountain is capped by Tertiary Telluride Conglomerate. Conspicuous outcrop on north shoulder of mountain (at right) is of hornfelsed Mancos Shale cut by an arm of the Ophir stock. Outcrop to right of the lower dump is granodiorite porphyry of Ames sill.

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In the Trout Lake mining district the principal sedimentary rocks exposed are nearly flat-lying to gently west-dipping Dakota Sandstone and Mancos Shale, and, on the summit of San Bernardo Mountain, a small remnant of Telluride Conglomerate. The sedimentary rocks were cut by the Ames granodiorite porphyry sill and the Ophir stock (fig. 9 and pl. 1). The sill which intruded near and at the Dakota-Mancos contact is as much as 800 feet thick west of Ames where the base is exposed.

The sedimentary rocks adjacent to the Ophir stock are metamorphosed to a hard hornfels to a distance of 2,000 or even 3,000 feet from the stock contact (fig. 9). Metamorphism adjacent to the thick sill affected the sedimentary rocks only a few feet or few tens of feet from the sill contact. Steep veins of generally westerly trend cut both the igneous and metamorphosed sedimentary rocks adjacent to the igneous bodies. The chief veins are described in following sections.

SAN BERNARDO MINE

The San Bernardo mine is on the east slope of San Bernardo Mountain west of the Lake Fork of the San Miguel River about 1 mile south of Ames (pl. 1), just inside the east boundary of the Wilson Mountains Primitive Area. The property consists of 13 unpatented claims and 6 patented claims within the primitive area and a placer and 3 millsite patented claims just outside the area. The patented claims within the boundary are the Honduras, Garabaldi, Thomas, Mosquito, San Piedro, and San Bernardo.

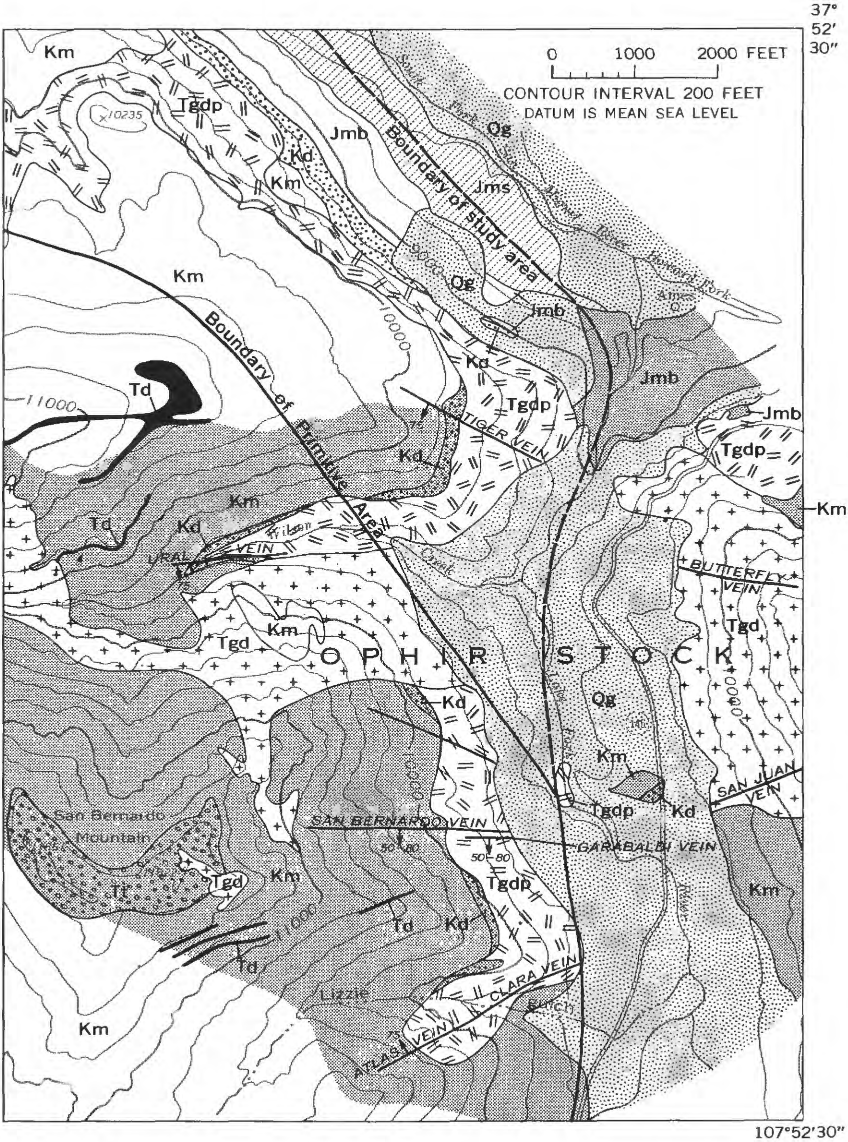
Workings consist of more than 12,000 feet of drifts on six levels with supporting crosscuts, winzes, and raises. In 1968 only level 6 and a small part of level 5 were accessible; the upper four levels were caved. The lowest, level 6, is at an altitude of about 9,500 feet, and the highest, level 1, is at an altitude of about 10,440 feet. Level 6, about 2,600 feet long, was begun in 1957 by the Silver Hat Mining Co. to explore beneath the older upper levels.

G. C. Giamboni, John Eder, and others located claims on the San Bernardo vein in July 1877, and the mine has been worked intermittently by various operators since then. Early production from the mine, between 1877 and 1902, is poorly known. C. W. Purington visited the property in 1896, at which time he reported (unpub. data) that it was developed by four drifts totaling several thousand feet in length and that during 1891–95 it had produced ore valued at about $130,000, mostly in silver. From 1902 to 1928 production records indicate about 91,000 tons of ore were mined containing 1,520 ounces of gold, 607,000 ounces of silver, 2,830,000 pounds of lead, and 244,000 pounds of copper. From 1928 to 1957 activity was sporadic and little ore was produced. Less than 3,000 tons of ore is reported to have been produced during 1964–66.

Igneous rocks which cut and are overlain by the Mancos Shale form the lower slope of San Bernardo Mountain in the mine area (fig. 9). The portals of the upper three levels are in nearly flat to gently west-dipping Mancos Shale, here partly metamorphosed to a hard dense hornfels. Except for a small intrusive body penetrated on level 3 these workings were reported by Purington to be entirely in Mancos Shale. The portal of level 4 is near the concordant contact between the Mancos and the intrusive (pl. 1), but the level was reported by Purington to be almost completely in the Mancos. The portal of level 5 is in the intrusive mass on the lower slopes of the montain, and the level passes into the Mancos Shale 900–1,100 feet from the portal, where the contact is concordant with the gently westward-dipping shale. Level 6 apparently is in the intrusive body from the portal to the face, a distance of about 2,600 feet. These facts suggest that the upper contact of the intrusive mass dips less than 15° westerly.

The intrusive body is principally granodiorite porphyry which is continuous with the Ames sill to the north and probably with the Black Face pluton to the southeast. The intrusive body in the vicinity of the mine is composite and is capped by porphyritic rhyodacite which is locally present along the west side of the Lake Fork. The rhyodacite is thoroughly bleached and sericitized both at the surface and underground on level 5; however, this alteration seemingly was not related to the mineralization, because its effects are widespread in this type of rock to the north and it may have been deuteric.

The San Bernardo vein trends N. 70° to 80° W. and dips on the average 50° to 80° S., but C. W. Purington (unpub. data, 1896) reported that near the breast on level 3 the vein dips steeply north for short distances. The fissure zone probably ranges in thickness from 1 foot or less to 8 feet, and it may contain several veins or stringers. The paystreak on the upper four levels was reported by Purington to be about 8 inches wide and to favor the footwall of the fissure zone. Where we saw the paystreak on level 6, it ranged in width from a few inches to nearly 2 feet and it was on the hanging wall as well. In places on levels 5 and 6, large cavernous openings are formed by the irregular walls of the fissure; in other places on level 6, the vein contains a loose uncemented breccia of the igneous wallrock and locally contains fragments of ore. This breccia has necessitated either timbering or detours into the hanging wall. The mixture of brecciated country rock and ore is locally lightly cemented or filmed by chalcedonic quartz and pyrite crystals. Whereas stoping of veins in most other mines in the primitive area has been in igneous rocks, the great bulk of the stop-



ing on the San Bernardo vein thus far has been in the metamorphosed Mancos Shale; the vein in porphyry below has been relatively unproductive. The ore shoot as defined by stoping extends upward from the porphyry contact about 800 to 900 feet, and the top of the shoot crudely parallels the porphyry contact. On level 5 the vein was stoped almost continuously along the strike for about 1,600 feet.

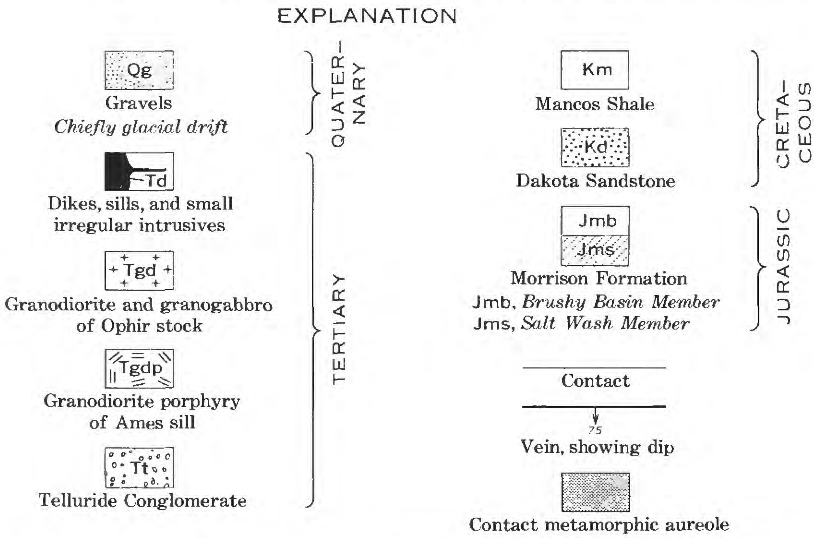


FIGURE 9 (left and above).—Geologic map of the main part of the Trout Lake mining district showing principal veins.

The principal ore minerals are galena, gray copper, and pyrite; chalcopyrite and sphalerite are present but are not abundant. The ore carries an appreciable silver content. According to Purington (unpub. data, 1896), ruby silver and native silver were found in places on level 3. The nonmetallic gangue minerals are chiefly quartz, barite, and carbonate minerals—probably calcite, siderite, and rhodochrosite. The quartz is principally white and crystalline and in places is vuggy. On level 6 the vein consists of quartz, pyrite, and lesser galena, chalcopyrite, sphalerite, and gray copper. The quartz and pyrite reportedly contain some silver.

King and Allsman (1950, p. 35) quoted Otto Beselack, who managed the mine during much of its productive period, as stating that vein matter from the last 230 feet of drifting on level 5 yielded, per ton, an average of 0.03 ounce of gold, 11.35 ounces of silver, 5.35 percent lead, and 0.42 percent copper; that from the last 50 feet, 0.03 ounce of gold, 20.75 ounces of silver, 10.82 percent lead, and 0.83 percent copper. No vein widths were given. The average tenor, however, was less than this. The 88,781 tons mined between 1902 and 1942 averaged about 0.017 ounce of gold, 6.83 ounces of silver, 1.59 percent lead, and 0.137 percent copper. Zinc was not recovered during this period, but apparently the zinc content of average ore was lass than that of lead.

The Garabaldi vein, about 200 feet south of and parallel to the San Bernardo vein, was located in 1881. The vein was explored by adits on three levels; only the lowermost was accessible in 1968. This level is identical with the San Bernardo level 6 and was rehabilitated in recent years and extended westward under the old San Bernardo workings. The Garabaldi vein strikes about N. 78° W. and generally dips steeply south, though locally dips as flat at 50° were observed. On the lower level the country rock is granodiorite porphyry. The vein is about 2–4 inches wide and not nearly so strong as the San Bernardo vein. Some old stopes were disclosed during rehabilitation of the lower level, and the vein apparently was somewhat wider where stoped. No record of production is known. Vein minerals apparently were virtually the same as in the San Bernardo vein, though Purington noted, when he visited the property in 1896, that calcite and tetrahedrite were more abundant.

ATLAS AND CLARA CLAIMS

The location of the Atlas and Clara claims is marked by old dumps and workings near the mouth of Lizzie Gulch, a steep-walled side drainage that flows east into the Lake Fork of the San Miguel River just south of the San Bernardo mine (fig. 9). The old workings are in SW¼ sec. 5, T. 41 N., R. 9 W (fig. 4), at an altitude of 9,600 to 10,000 feet. The Atlas and Clara claims were surveyed for patent but never patented and are now overlain by 12 unpatented claims.

The Atlas vein, situated on the south side of Lizzie Gulch (fig. 9), was discovered by Frank Montonati around 1900, and the claim currently is held by John Montonati of Ophir, Colo. There is no production of record, but John Montonati (oral commun., 1968) states that in 1903 his father shipped 10 sacks of silver ore that returned $1,100. The principal development is an adit about 280 feet in length, on the south side of the creek at an altitude of about 10,000 feet; it was accessible in 1968. The fissure explored by the adit cuts the granodiorite porphyry of the Black Face-Ames type that forms the lower slopes of the valley of the Lake Fork here and to the north (fig. 9). Metamorphosed Mancos Shale crops out within a few hundred feet to the south and southwest of the portal. The Atlas fissure strikes about N. 60° E. and dips 60° to 75° NW. The fissure zone is about 3 feet in maximum width and consists of decomposed altered granodiorite porphyry containing some disseminated pyrite, bordering 3–6 inches of brecciated country rock and gouge. Where observed, the mineralized part of the vein was about 2 inches wide and consisted of pyrite, galena, tetrahedrite, and probably sphalerite. A breccia dike, generally less than 1 foot wide and composed of both igneous rock and Mancos Shale fragments, follows a somewhat sinous course that in part parallels the fissure and in part coincides with the fissure. The dike is somewhat earlier than the fissure, as the dike is slightly displaced where crossed by the fissure. Sample B25 (table 7), a 1.5-foot-wide chip sample from the face of the Atlas tunnel, assayed 0.02 ounce of gold and 0.54 ounce of silver per ton, with traces of base metals.

The Clara claim is northeast of the Atlas claim on the north side of Lizzie Gulch (fig. 9). Records of the U.S. Bureau of the Mint for 1888 credit the Clara with a production of silver and gold in that year valued at $16,674 (table 2). C. W. Purington's 1896 field notes indicate that in 1891 silver ore valued at $7,200 was mined from the Clara, but his source of information was not given. The three main adits on the Clara vein have an aggregate length of about 1,400 feet and apparently explore a steeply dipping narrow fissure zone striking N. 60° to 80° E. The fissure cuts the intrusive sill and may be the northeast extension of the Atlas vein or a parallel vein. Abundant pyrite is disseminated in the country rock and in vein material on the dump that also contains minor amounts of galena and sphalerite. A selected sample from the lower adit dump (132, table 3) contained about 10 ounces

TABLE 7.—*Fire assays of grab and chip samples from mines and claims, Wilson Mountains Primitive Area*

[Analyses by Charles O. Parker and Co., commercial assayers, Denver, Colo. Sample localities are shown on plate 2. Type of sample: G, grab sample (selected vein material, chiefly from dumps); C, chip sample (chipped from vein). Tr., trace]

Sample No.	Gold	Silver	Copper	Lead	Zinc	Type of sample
	(Ounces per ton)		(Percent)			
B1	0.08	2.56	0.70	0.34	Tr.	G
2	.06	.18	.32	.12	Tr.	G
3	.05	1.33	1.78	.10	0.05	G
4	.18	11.62	.52	24.90	4.55	C
5	.46	9.28	.32	11.54	.72	C
6	.04	2.10	.01	.36	.52	C
7	.04	.54	.52	.26	.10	G
8	.03	.11	.10	1.10	6.53	G
9	.01	.13	.02	.08	.12	G
10	.02	Tr.	.02	.20	.10	C
11	.03	2.07	.08	9.76	3.30	G
12	.02	.54	.03	.52	1.40	G
13	.07	Tr.	.02	.20	.20	G
14	.07	2.03	.02	7.45	8.85	G
15	.10	3.30	.03	6.05	.18	C
16	.01	1.33	Tr.	2.45	8.85	G
17	.02	3.72	.04	12.84	21.40	G
18	.88	6.22	.75	.10	Tr.	G
19	.02	.52	.18	.12	1.55	G
20	2.28	8.52	.70	.52	Tr.	G
21	.21	2.39	.46	.15	Tr.	G
22	.03	.21	.18	.06	.06	G
23	1.76	10.54	.40	5.90	2.82	G
24	.01	.19	Tr.	Tr.	Tr.	G
25	.02	.54	Tr.	.12	Tr.	C
26	.03	5.31	.16	5.20	Tr.	G
27	.02	2.48	.04	12.95	.40	G
28	.04	1.82	.03	6.46	.95	G
29	.02	1.54	.02	5.05	2.60	G

of silver per ton, about 3 percent lead, and 10 percent zinc. Another selected sample from the lower dump (B26, table 7) assayed 0.03 ounce of gold, 5.31 ounces of silver, and 5.2 percent lead.

URAL CLAIM

The Ural claim was staked in the 1880's upon discovery of a narrow fissure vein along the south bank of Wilson Creek at an altitude of about 9,600 feet. Patented in 1892, the claim is in the SE¼ sec. 31, T. 42 N., R. 9 W., about three-quarters of a mile northwest of the San Bernardo mine. The mineralized fissure, which trends about N. 70° to 80° E. and dips 70° to 80° S., has been tested by three short adits. No production is known. The vein cuts both the igneous sill and the overlying Dakota Sandstone which here overlies the sill. The adits expose an iron-stained weakly fissured zone which contains one or two quartz veins, each ½ to 3 inches wide, that contain some pyrite and a little barite. One or two grains of galena and sphalerite(?) were noted under the hand lens. The exposed vein is too narrow and too poorly mineralized to be minable.

SUNSHINE, BEAR, AND TIGER CLAIMS

The Sunshine, Bear, and Tiger claims on the Tiger vein lie along a steep watercourse west of the Lake Fork of the San Miguel River, about 1,500 feet north of the mouth of Wilson Creek (fig. 9). The claims are in the study area northeast of the Wilson Mountains Primitive Area boundary in the NW¼ sec. 32 and NE¼ sec. 31, T. 42 N., R. 9 W. The principal development consists of three adits, three stub adits, and several shallow pits or cuts, all caved in 1968. According to original patent survey notes of 1898 these workings had an aggregate length of about 900 feet. Judged from the size of the dumps, no appreciable work had been done since the original patent survey. No production has been recorded from these three claims.

The area is covered by heavy colluvium and there are no natural outcrops, but the workings apparently explore a fissure that trends N. 60° to 80° W. In a cut near the uppermost adit the fissure dips steeply south. The geologic setting is analogous to that in the San Bernardo mine to the south. Granodiorite porphyry and overlying pyritized rhyodacite of the Ames sill form the lower slope of the mountain and are capped by flat-lying Dakota Sandstone and Mancos Shale. The Tiger vein, however, lies close to the outer margin of the contact metamorphic aureole (fig. 9), and the vein may not persist in the softer Mancos Shale to the west. No ore minerals were seen in place, but dump specimens indicate that pyrite, galena, and sphalerite were found in a quartz and barite gangue.

Two samples were handpicked from vein material on dumps. Sample B28 (table 7), from the lower dump, assayed 0.04 ounce of gold and 1.82 ounces of silver per ton, and 0.03 percent copper, 6.46 percent lead, and 0.95 percent zinc. Sample B29 (table 7), from the upper dump, assayed 0.02 ounce of gold and 1.54 ounces of silver per ton, and 0.02 percent copper, 5.05 percent lead, and 2.60 percent zinc.

Two samples of soil (095 and 096, table 6) were taken at seeps along the strike of the vein above 9,600 feet altitude and below the upper adit (pl. 2). Sample 096 was slightly anomalous in gold, silver, lead, zinc, and arsenic.

OTHER PROSPECTS

Several other claims were located and patented in this part of the primitive area. These include the Snowbank, Mountain Key, and Snowslide group, all patented in 1924 and located on the lower slopes of the east side of San Bernardo Mountain about 1,000 feet north of the San Bernardo mine; the Butterfly Pup, patented in 1907 and located about 1,500 feet north of the San Bernardo claims; and the Lizard Point, patented in 1890, and located 1½ miles upstream from the mouth of Wilson Creek. None of these claims has any record of production.

In the area described as being the location of the Snowbank, Mountain Key, and Snowslide group, two caved adits of unknown but short length were found. The lower, at an altitude of about 9,600 feet, is in the granodiorite porphyry of the Ames sill; the upper, at 9,900 feet, is in Mancos hornfels, just above the sill. The two adits explore a narrow vein about 3 inches wide that strikes about N. 60° to 70° W. and dips 85° SW. The only vein minerals seen on the dump were quartz, pyrite, and a little calcite. The Butterfly Pup claim was not surely located, but three caved adits with small dumps on the wooded slopes a few hundred feet north of the Snowbank adits probably mark its position. The lower adit, at an altitude of 9,480 feet, the middle at 9,560 feet, and the upper at 9,600 feet all apparently explored a narrow vein cutting the Ames sill. The vein strikes N. 65° to 85° W. and dips steeply south to steeply north. The vein, where observed, is no more than a few inches wide and contains quartz, pyrite, and a little calcite.

The Lizard Point claim, patented in 1890, could not be found. No evidence of any development work was observed in the area indicated by the patent plats.

MOUNT WILSON MINING DISTRICT

The Mount Wilson mining district (shown on some older claim plats and records as the Lone Cone district) centers in the high peaks, ridges, and basins surrounding Mount Wilson and Wilson Peak. Altitudes range from about 10,000 feet on Bilk Creek to over 14,000 feet on the highest peaks; most prospects are at altitudes above 12,000 feet.

For the most part the district is inaccessible to motorized vehicles mainly because old wagon roads have not been maintained and are partly covered by talus and other debris. Many of the deposits are accessible by horseback, but most can be reached only by foot.

All the claims lying in the central part of the primitive area are in the Mount Wilson mining district. A total of 38 mineral claim patents covering 510 acres were issued for the district, and 44 unpatented claims cover an additional 910 acres. Also, 13 claims were surveyed for patent but were cancelled or rejected; for 11 of these 13 surveys the surveyor's original notes stated that several feet of workings had been excavated on probable mineral veins.

Mining activity in the Mount Wilson district began at least as early as 1882 when 3.2 tons of ore was reportedly sold from the Silver Pick mine. Because of the ruggedness of terrain and fierceness of winters, mining was conducted mainly in the warmer months of summer and early fall. Only handsorted gold-silver ore could be mined and transported economically from these rugged mountains. The bulk of the ore mined in the district was produced in the years 1890–98 (table 2); lesser amounts were produced in 1904–14, 1931–40, and in a few other years.

The Silver Pick mine has been the only important producer in the district, but some ore has also come from the Morning Star mine. A small amount of ore was shipped from the Special Session, Polar, and Hattie Ross; in addition, the Rock of Ages, Wheel of Fortune, Zero, Magpie, and perhaps a few others probably made a small production.

The total recorded value of metal produced from the district is about $858,000; almost 95 percent of this value is in gold from the Silver Pick mine. The remaining 5 percent is from the Morning Star, Special Session, and Hattie Ross mines.

The dominant geologic feature in the district is the composite Wilson Peak stock, which intruded the Mancos Shale, Telluride Conglomerate, and Tertiary volcanic rocks. The stock is composed of three distinct rock types each having sharp contacts with the others: the earliest phase was fine-grained granogabbro (basic granodiorite), followed successively by granodiorite and porphyritic quartz monzonite. The stock is surrounded by a contact metamorphic envelope within which the rocks are indurated. Numerous narrow fissure veins that generally strike westerly and dip steeply cut the stock, and a few such as the Magpie cut the indurated country rocks.

Exploration activity in recent years has been limited to drilling at the Silver Pick property and drifting along a vein system at the Morning Star mine. Exploration at the Morning Star was active in the summers of 1968 and 1969.

Any future production in the district will probably require hand-sorting at the mine and truck haulage to smelters. The nearest operating smelter is in Hayden, Ariz., 430 road miles from the mining district. Other smelters accepting custom ores or concentrates are in Tooele, Utah (450 miles), and El Paso, Tex. (510 miles).

SILVER PICK BASIN

Silver Pick Mine

The Silver Pick mine is high on the rugged ridge at the head of Silver Pick Basin just west of Wilson Peak (pl. 1). It is by far the principal mine in the Mount Wilson mining district and, despite its name, the principal product has been gold. The property consists of four patented claims—Silver Pick (patented in 1886), Gold Pick, Gold Pick millsite (patented in 1893), and Silent Friend (patented in 1907)—and 13 unpatented claims called the Basin group. Altitude at the main workings exceeds 12,000 feet.

The Silver Pick mine consists of more than 8,000 feet of workings on eight levels. The highest level (No. 1) is at 13,200 feet altitude, and the lowest (No. 8) is at 12,120 feet. Little mining was done from level 8, although the crosscut reportedly reached the Silver Pick vein. The vein was worked through a vertical interval of more than 700 feet and horizontally for about 1,000 feet. All the workings were inaccessible, caved, and partly ice-filled in 1968.

The Silver Pick claim was located on July 17, 1882, by L. D. Ratliff and others. The Mount Wilson Gold and Silver Mining Co. began to work the mine in 1883; the principal output was during 1890–98, and two-thirds of the recorded production was extracted in 3 years—1894, 1895, and 1898. About 6,030 tons of ore and concentrates shipped during 1882–98 yielded about 32,000 ounces of gold, and 95,000 ounces of silver; the receipts to the mine in this period, deducting freight and smelter charges, were $601,185.30. From 1899 through about 1902 work was done by lessees, but production evidently was small. The Gold Development Co. of Utah, which controlled the mine from 1903 to 1909, drove a crosscut (level 8) approximately 1,800 feet to intersect the vein about 400 feet beneath the old workings. During the period 1899–1909 the ore produced had a value of $6,904 (table 2). Although the mine has been idle most of the time since 1909, several tons of mill cleanup and sorted high-grade ore were shipped in the 1930's.

An attempt was made to rehabilitate and open some of the old levels during 1954–58, but no production resulted. A small production recorded during 1959–61 probably resulted from treatment of old tailings.

The mine is now (1969) inactive although in recent years exploration drilling has been conducted in the late summer.

The Silver Pick vein, which is 3–6 inches wide, trends N. 40° to 60° E. and dips about 75° SE.; it cuts microgranogabbro, grandiorite, and porphyritic quartz monzonite of the Wilson Peak stock. The most productive part of the vein was in granogabbro. A conspicuous set of westward-trending fractures also cuts these rocks, and these offset the vein eastward a few inches to several feet (Purington, 1898, p. 779; Nason, 1900, p. 682). Purington was undecided whether the vein was actually faulted or whether it turned locally to follow westward-trending fractures and then resumed on a northeast-trending fissure of the same system.

The principal sulfide minerals in the vein are pyrite, chalcopyrite, and arsenopyrite. Galena and sphalerite are present, but are not conspicuous in the vein material. The gangue is chiefly white crystalline quartz, carbonate minerals, and, possibly, some barite. The gold is apparently very fine grained and, like that in many gold districts, it is closely associated with arsenopyrite and chalcopyrite. Silver exceeds gold in the ore by a ratio of 3 to 1.

No authenticated record is available on the tenor of the ore. Purington was told (unpub. field notes, 1896) that the narrow 6-inch paystreak along the fissure zone ran about $150 per ton in gold (about 7 ounces per ton based on the then-prevailing gold price of $20.67 an ounce). According to Purington, dilution by waste, occasioned by mining the narrow ore shoots, reduced the grade of ore delivered to the mill to about $30 a ton (about 1.4 ounces in gold a ton). Spaulding (1898) stated that mining was by single-jack drilling in overhand stopes. The ore was broken and handcobbed on bull hides in the stopes. The upgraded ore thus separated ran 2.5 to 3.5 ounces per ton in gold, 20 ounces per ton in silver, and 5 percent copper. The handcobbed ore was carried by aerial tramway down to a 10-stamp capacity mill at an altitude of 10,940 feet. The ore was milled and concentrated by stamps and vanners without amalgamation. The mill has recently been dismantled and removed.

Three selected samples of ore material were assayed. Sample B18 (table 7), vein matter spilled from an aerial tram, contained 0.88 ounce of gold and 6.22 ounces of silver per ton, and 0.75 percent copper, 0.10 percent lead, and a trace of zinc. Sample B19 (table 7), handpicked vein material from the dump at the fourth level, assayed

0.02 ounce of gold and 0.52 ounce of silver per ton, and 0.18 percent copper, 0.12 percent lead, and 1.55 percent zinc. Sample B20 (table 7), handpicked vein matter from the dump at the sixth level (a crosscut that reportedly reached the vein 167 feet from the portal), contained 2.28 ounces of gold and 8.52 ounces of silver per ton, and 0.70 percent copper, 0.52 percent lead, and a trace of zinc. A DMEA loan application in 1949 reported that a sample of ore from high-grade stringers in a caved surface pit above an old stope assayed 1.0 ounce of gold and 13.9 ounces of silver per ton, and 3.36 percent copper, 1.20 percent lead, and 1.75 percent zinc. A grab sample taken at the same time from the dump at the second level assayed 0.16 ounce of gold and 0.5 ounce of silver per ton, and 0.12 percent copper, 0.1 percent lead, and 0.1 percent zinc.

Other Prospects in Silver Pick Basin

The ridge above and south of the Silver Pick mine is cut by several veins that trend approximately N. 80° E. and dip nearly vertically. The frost-heaved rubble and talus which cover the steep slopes and ridge top above the Silver Pick effectively prevent tracing these narrow fissures. Some fissures have been prospected in a small way. The Tam O'Shanter (patented in 1895) and the Iron, Scranton, and Second Best claims (all patented) are at an altitude exceeding 13,000 feet. No production of ore has been recorded from the claims, but a short shaft and several short tunnels had been driven at the time of the original surveys. These workings are no longer visible.

The Tam O'Shanter vein, which crosses the ridge above 13,400 feet southeast of the Silver Pick vein, cuts granodiorite and was reported to average between 3 and 6 inches in width and to contain about 1.5 ounces of gold per ton.

The Synopsis mine, on the trail to Navajo Basin along the west slope of Wilson Peak at an altitude of 12,800 feet, consists of two claims, the Synopsis and Outlook, patented in 1914. At that time, according to the original survey notes, a 316-foot tunnel had been extended generally N. 70° E., and at a point 220 feet from the portal a 60-foot crosscut had been driven N. 18° W. According to the old patent survey notes, the workings explore a fissure zone trending N. 70° E. and dipping 70° NW. The country rock is granogabbro and granodiorite. The workings were caved and could not be examined in mid-1969. No production has been recorded from these two claims.

Sample B22 (table 7), a selected sample of vein material on the dump, assayed 0.03 ounce of gold and 0.21 ounce of silver per ton, and 0.18 percent copper, 0.06 percent lead, and 0.06 percent zinc.

Another narrow fissure zone striking about N. 80° W. and dipping 60° to 75° N. cuts granogabbro at an altitude of 12,400 feet in Silver Pick Basin. In recent years this zone has been partially exposed by bulldozer trenching for about 250 feet along the strike. The fissure zone is about 2 feet wide and consists of soft altered yellow and rusty stained granogabbro; in the zone are several narrow ⅛- to 2-inch stringers of iron oxide-stained quartz and some pyrite. No ore minerals were observed, and the better of the two samples (295 and 296, table 3) from this zone showed only 10 ppm silver and only trace values in gold, copper, lead, and zinc.

A small dump on a caved working high on the south-facing slope of a northwest-trending ridge from Wilson Peak was visited and sampled. The working is about three-fourths of a mile northeast of the Silver Pick mine at an altitude of about 12,600 feet.

An assay of a selected grab sample of ore material (B23, table 7) that once apparently had been sorted on a platform, contained 1.76 ounces of gold and 10.54 ounces of silver per ton, and 0.40 percent copper, 5.90 percent lead, and 2.82 percent zinc.

Patents were issued in 1895 for the E.C.S. and Bedrock placer claims, two claims totaling 72 acres in the SE¼ sec. 30, T. 42 N., R. 10 W. These placer claims are in Silver Pick Basin at an altitude of about 11,500 feet. Apparently they were located because of their position below and downstream from the Silver Pick mine, but no production of placer gold has been reported and no evidence of workings was observed.

LOWER BILK BASIN AREA

MORNING STAR MINE

The Morning Star mine lies on the steep slope west of Bilk Creek, almost due west of Sunshine Mountain (pl. 1) in secs. 34 and 35, T. 42 N., R. 10 W. (fig. 4). The property comprises four unpatented Morning Star lode claims, three unpatented Bilk Runner claims, and a 5-acre millsite claim. The workings consist of four adits; the lowest, or fourth level, was being driven during the summers of 1968 and 1969 at an altitude of about 10,060 feet; the third level is about 170 feet higher, the second is 125 feet higher; and the uppermost is about 110 feet above the second level. The third level is caved about 400 feet in from the portal, and the upper two levels are caved at the portal.

The Morning Star mine was located in 1880, and unconfirmed reports suggest that most of the ore was extracted before 1903. However, the most productive period was during 1904–14, when ore that yielded 436 ounces of gold, 12,289 ounces of silver, and 466,630 pounds of lead, was mined from a stope between the second and third levels. Except for a small amount of ore mined in 1952 (table 2) the mine has since been inactive. About half the value of all the ore was from lead and one-fourth each was from gold and silver. In 1968–69 the mine was being explored by a lessee.

The Morning Star vein ranges in strike from N. 75° W. to east-west and dips about 80° N. Where observed, the vein has a maximum width of 5 inches, but where stoped (now timbered), it apparently was somewhat wider. The ore, as judged from material seen on the dumps and in place on the third level, is composed of galena, pyrite, sphalerite, and minor amounts of chalcopyrite in a gangue of quartz, calcite, and perhaps other carbonates of magnesium, iron, and manganese. The country rock of the vein is granodiorite porphyry of the Ames-Black Face type and microgranogabbro. The portal of the third level is in granodiorite porphyry, but the adit apparently crosses into microgranogabbro about 175 feet from the portal. The surface contact between microgranogabbro and granodiorite porphyry is near the portal of the second level.

About 150 feet south of the Morning Star vein is a nearly parallel vein that dips about 75° N. and is up to about 6 inches wide. The vein material is composed chiefly of fine-grained quartz and carbonates of iron, magnesium, and calcium, together with minor amounts of pyrite, arsenopyrite, and galena. The two samples from this southern vein—samples 080 and 081 (table 3)—taken in an old caved cut south of the third level portal contained, respectively, 1.0 and 0.3 ppm gold, 190 and 120 ppm silver, and minor amounts of lead, zinc, and copper. The relatively high arsenic content of both samples (table 3) reflects the presence of arsenopyrite.

In the summers of 1968 and 1969 lessees were driving an adit to intersect the Morning Star vein under the old stope between the second and third levels. The first 50 feet or so were driven on the southern vein to explore that fissure. No economic values were found there, however, and the adit was turned toward the Morning Star vein. These lower workings were about 500 feet in length. A chip sample (B6, table 7) taken across a 4-inch width of the southern vein exposed in a short branch drift about 40 feet south of the parallel Morning Star vein assayed 0.04 ounce of gold, 2.10 ounces of silver, 0.01 percent copper, 0.36 percent lead, and 0.52 percent zinc. A sample (B5, table 7) taken at the face across a 6-inch vein, probably the Morning Star vein, assayed 0.46 ounce of gold and 9.28 ounces of silver per ton, and 0.32 percent copper, 11.54 percent lead, and 0.72 percent zinc.

Magpie Mine

The Magpie mine is on the east wall of Magpie Basin about half a mile west of the Morning Star mine at an altitude of 11,400 feet (pl. 1).

Three claims—the Alameda, Magpie, and Sunlight—were located there in July 1883, and unpublished notes by C. W. Purington (1896) indicate that J. O. Campbell did the principal work on the Magpie vein in the 1880's. The claims were patented in 1904. No production is recorded, but there are unconfirmed reports that some ore was shipped. In 1968 the chief devolpment consisted of a 50-foot crosscut to the vein and about 300 feet of drifting along the vein. From the crosscut the drift extended about 175 feet southwest and was open to the face; within a short distance northeast of the crosscut, the drift was caved. The Magpie vein strikes about N. 55° E. and dips about 65° NW.; in the accessible part of the workings it cuts Mancos Shale that strikes northeast and dips about 25° NW. In this area the Mancos lies against an arm of the Wilson Peak stock and is baked to a hard hornfels. The unstoped vein, where it was observed in the accessible workings southwest of the crosscut, ranges from a tight seam to 6 inches in width. Sparse sulfide minerals in the vein consist of pyrite and some sphalerite, galena, and tetrahedrite (?) in a gangue of fine-grained white to gray quartz.

Two carefully selected samples—samples 298 and 299 (table 3)—gleaned from the most promising looking vein material on the dump contained 1,400 ppm Ag and 440 ppm Ag (chemical methods), respectively, and some anomalous but subeconomic amounts of lead and zinc. These samples reflect the type of high-grade material that attracted attention to this vein in the past. In the accessible part of the Magpie workings, however, the narrow vein width noted above has discouraged mining.

UPPER BILK BASIN

Numerous, generally very narrow veins are found in the upper part of Bilk Basin near the little lake at an altitude of 12,063 feet and west toward the divide between Bilk and Navajo Basins. These veins are in the S½ sec. 33, T. 42 N., R. 10 W., and the N½ sec. 4, T. 41 N., R. 10 W. Several of these veins have been prospected by small opencuts or short adits. Although no production is recorded from these prospects, it is probable that a few tons of handcobbed ore have been shipped in the past.

A group of 12 unpatented claims known as the Slide Rock-Silver Dollar group probably covers this area (fig. 4) but the locations of the claims cannot be entirely substantiated, owing to incomplete descriptions in the county records.

The country rock in this area is microgranogabbro, granodiorite, and quartz monzonite of the Wilson Peak stock. To the north the stock is in contact with hornfelsed Mancos Shale. The igneous rocks are cut by conspicuous, steeply dipping, west-trending joints or fissures which are in places so closely spaced as to form sheeted zones. Some of these fissures are occupied by veinlets or stringers of sulfides in a gangue of quartz and carbonate minerals.

The strongest fissure vein in upper Bilk Basin is at an altitude of about 12,400 feet, approximately 1,000 feet northwest of the lake. Mine workings comprise several surface pits, a 100-foot crosscut to the vein, perhaps 80 feet of drifting, one short spur crosscut, and a stub drift. The country rock is fine-grained dark-gray granogabbro which is close to the contact with metamorphosed Mancos Shale. The cuts and workings expose an altered and pyritized fissure zone 3–6 feet wide that trends N. 70° to 80° W. and dips about 75° N. A vein in the zone reaches a maximum observed width of about 2 feet. To the west the vein is concealed by talus, but the strike suggests it may project into a prominent couloir a short distance south of Wilson Peak. The vein consists of dark sphalerite, pyrite, and subordinate galena and chalcopyrite in a gangue of calcite and quartz. Analyses of two selected sulfide samples from a small ore pile on the dumps (244, 245) and a sample of gossan material from the uppermost cut (243) are given in table 3. The gossan sample contained about 11 ounces of silver a ton (360 ppm) and 3.6 percent lead. The higher grade (244) sample of the two from the dump contained slightly more than 2 ounces of silver per ton (70 ppm), 8 percent zinc, less than 1 percent lead, and negligible copper. Gold content of the samples did not exceed 0.03 ounce per ton.

The narrow veins between the lake and the divide to the west strike nearly east-west and dip steeply north or south; typically, they range in width from a fraction of an inch to 3 inches. Where prospected, there are commonly two or, rarely, three anastomosing veinlets in a sheeted zone 2 or 3 feet wide. Pyrite and a zone of minor argillic alteration extend a few inches on each side of the vein. The vein material is principally quartz, calcite, and pyrite, together with subordinate sphalerite and galena, and locally some arsenopyrite. No production is on record for these prospects and there is little evidence of mining except for minor "gophering" along some veins. A few tons of handcobbed ore may have been shipped. C. W. Purington (unpub. notes, 1896) wrote that handpicked ore from some of these veins had been reported to contain about 2 ounces of gold per ton. However, the highest gold content among five selected samples (analyzed by chemical methods) taken during this study was about 0.7 ounce per ton (247, table 3; pl. 2). The other four samples ran from 0.09 ounce to about 0.18 ounce gold per ton (246 and 248–250, table 3; pl. 2).

Assays of nine samples (B8–B16, table 7) collected from abandoned dumps westward from the lake showed from 0.01 to 0.10 ounce of gold per ton, a trace to 3.30 ounces of silver per ton, a trace to 9.76 percent lead, a trace to 8.85 percent zinc, and traces of copper.

NAVAJO BASIN

ROCK OF AGES MINE

The Rock of Ages mine is at an altitude of about 13,000 feet on the north side of the head of Navajo Basin in the saddle between it and Silver Pick Basin (pl. 1). The workings are caved, but at the time of patent survey in 1911 they consisted of at least 700 feet of crosscuts and drifts.

The Rock of Ages property, consisting of four claims patented in 1914 (called Rock of Ages Nos. 1 and 2, Peak View, and a millsite claim), is in the SE¼ sec. 32, T. 42 N., R. 10 W., on the San Miguel-Dolores County line. Figure 10 is a view of an abandoned cabin at the portal of the mine.

Insofar as C. W. Purington (unpub. field notes, 1896) was able to determine, the Rock of Ages mine had produced no ore up to the time of his visit; the vein was too narrow to be profitably mined. In September 1898, the Denver Mining Report stated that about 12 men were employed in driving a drift on the vein and that some ore had been shipped, though no figures were given. Other than this vague reference, no record exists of production from the Rock of Ages mine.

The country rock in the area of the workings is porphyritic quartz monzonite of the Wilson Peak stock; the granodiorite contact lies a

FIGURE 10.—Lonely vigil of abandoned mine cabin, Rock of Ages mine. Gladstone Peak (13,913 feet), in center background, and the northeast shoulder of Mount Wilson on the left are carved from the Wilson Peak stock. In right middleground are long talus slopes which descend into Navajo Basin.

short distance to the north. The stock in this area, as in upper Bilk Basin to the east, is cut by numerous fissures that strike about N. 60° to 80° E. and dip steeply north or south. Some of these fissures carry narrow veins ½–2 inches in width, chiefly of quartz and pyrite. None of the veins observed are very persistent, and individual ones can seldom be traced far. Of these, the strongest in this area is probably the Rock of Ages vein. Though weathering of the yellow altered country rock adjacent to the Rock of Ages vein makes a conspicuous notch in the sharp ridge separating Navajo Basin from Bilk Basin, the vein cannot be traced far among the jumbled frost-heaved blocks on the steep slopes of Navajo Basin (fig. 10). Judged from the few vein specimens seen on the dump, the vein consists of quartz, pyrite, and a little galena, sphalerite, and chalcopyrite.

A handpicked sample (B7, table 7) of vein material assayed 0.04 ounce of gold and 0.54 ounce of silver per ton, and 0.52 percent copper, 0.26 percent lead, and 0.10 percent zinc.

Wheel of Fortune Area

A group of two patented and six unpatented claims that partially overlap the patented claims, lie about half a mile northeast of Navajo Lake on the steep south slope of Polar Peak in the N½ sec. 6, T. 41 N., R. 10 W. (fig. 4). The Radcliff and Yellow Carbonate claims were patented in 1896; the Wheel of Fortune, Hattie Ross, Hidden Hand, Silent Friend, Illinois, and St. John were surveyed for patent in 1901, but the patent application was rejected. Principal development work on these claims was at the Wheel of Fortune adit and an adit of unknown name several hundred feet higher on the slope.

Other prospects in this area are a few test pits or short adits. In 1887 John A. Ross first located claims on narrow quartz-sulfide veins in this area, and the principal development work apparently was done in the 1890's. Since then the veins have been prospected in only a desultory way. There is no record of production during this early active period, though it is probable that a few tons of development ore were shipped. Bureau of Mines records show that, in 1937, 64 tons of ore was credited to a Hattie claim; this production may have been from the Hattie Ross claim, but this is not certain. The 64 tons averaged 1.7 ounces gold, 11 ounces silver, about 8 percent lead, 8 percent zinc, and 1 percent copper.

The Wheel of Fortune adit lies approximately half a mile northeast of Navajo Lake at an altitude of about 11,720 feet. Underground workings consist of a 310-foot crosscut and several hundred feet of drift. The crosscut intersects several narrow quartz-pyrite veinlets and the drift explores a narrow vein in dark-gray fine-grained granodiorite over an estimated strike length of about 500 feet. Several narrow veins crop out on the cliffy slopes 40–60 feet above the adit and strike N. 60° to 80° E. and generally dips steeply northwest. The strongest vein is a decomposed zone 18 inches to 2 feet wide and consists of altered, pyrite-impregnated country rock containing 6–8 inches of limonitic clay and some pyrite and quartz. According to C. T. Pierson (oral commun., 1969), who examined the underground workings in 1954, the fissure explored from the Wheel of Fortune adit ranges in width from a tight seam to about 6 inches but probably averages between 1 and 3 inches. The mineralized vein matter on the dump is chiefly of quartz and pyrite, together with scattered galena, chalcopyrite, and sphalerite. An unusual gangue mineral is black tourmaline.

Selected samples of mineralized vein matter from the dumps (182–184, table 3) and outcrop (181, table 3) contained as much as 2–3 ounces of silver per ton (70–100 ppm), about 7 percent zinc, and a little lead and copper. An assay of a handpicked specimen of vein material on the dump (sample B24, table 7) gave 0.01 ounce of gold and 0.19 ounce of silver per ton.

The narrow vein widths, low metal content, and the lack of any substantial ore shoot along the Wheel of Fortune vein discouraged further exploitation.

Another adit (perhaps the Hattie Ross) is at an altitude of 12,270 feet, about 500 feet above the Wheel of Fortune adit. The only access is by foot up the extremely steep rock and talus slopes. The adit, which trends N. 5° W., is caved at the portal and the workings were inaccessible when the area was visited, but the size of the dump indicates the workings may have been as much as several hundred feet in length. Apparently the adit was driven to test narrow mineralized veins that trend N. 75° E. and cut the igneous rocks. Nothing is known of the nature of the veins underground, but on the surface the veins range from mere seams a fraction of an inch to perhaps 6 inches wide. Sphalerite is the predominant sulfide in mineralized vein matter seen on the dump and is several times more abundant than pyrite. The gangue is quartz.

Other Prospects in Navajo Basin

In the floor of Navajo Basin and along the steep craggy south slope of the basin, under El Diente Peak, are a few scattered pits, cuts, and short adits in narrow quartz-pyrite veins cutting the Wilson Peak stock. None of these has yielded any recorded production.

The narrow veins range from seams only a fraction of an inch to 3 inches wide; in a few places they attain a width of 6 inches. Most of the veins strike from nearly east-west to N. 60° E. and dip steeply south or north.

As with other veins in Navajo Basin, the most conspicuous mineral is quartz, which usually exhibits comb structure; the most abundant sulfide mineral is pyrite. Other common minerals are galena, sphalerite, and chalcopyrite. Molybdenite was noted in a specimen of dump rock from a caved adit at 12,320 feet near the head of the basin (sample 195, table 3; pl. 2). Tourmaline was noted as a gangue mineral in one veinlet, and calcite or ankerite is also present in most veins.

Claims have been located on several of the narrow veins. The Le Conte, Tewfik, and Sherwood group of claims, patented in 1904, and the Isabella claim, patented in 1890, are at an altitude of between 11,800 and 12,400 feet, southeast of Navajo Lake in sec. 6, T. 41 N., R. 10 W. (fig. 4). In 1890, four short tunnels (40, 50, 65, and 97 feet in length) had been excavated. These tunnels are now caved and there is no recognizable evidence of any subsequent activity.

The Homerhart, Coxey, and Cleveland claims lie, end to end, in a west-northwest trend, high on the north slope of El Diente Peak in the SE¼ sec. 6, T. 41 N., R. 10 W. (fig. 4). Altitude ranges from 13,000 to 13,500 feet. The claims were surveyed for patent in 1905, but patent application was later cancelled. At the time of the original survey, a tunnel was reported to have been driven 580 feet southeastward. The tunnel is now caved and inaccessible.

The Navajo claim, patented in 1914, is located on the northwest ridge of Gladstone Peak in the NE¼ sec. 5, T. 41 N., R. 10 W. (fig. 4). At the time of the patent survey three short tunnels (29, 29, 19 feet) had been reported. No evidence of them was seen during the field investigation.

The Hidden Treasure, Zero, and Edna claims were surveyed for patent in 1903 but the patent application was rejected. These claims lie just southwest of the saddle between Navajo and Silver Pick Basins in the NW¼ sec. 5, T. 41 N., R. 10 W., and the SW¼ sec. 32, T. 42 N., R. 10 W. No production has been recorded from these claims even though a 310-foot tunnel was reported at the time of the original survey. This tunnel was partly caved at the time of the present field studies.

All these veins apparently contain some silver and gold (see sample B3, table 7, and samples 167–173, table 3) and, as with other veins in the Mount Wilson district, local high-grade pockets undoubtedly occur (sample 198, table 2; pl. 2).

Disseminated chalcopyrite is found in the area of the Hidden Treasure, Edna, and Zero claims, and this occurrence is discussed in a subsequent section (p. A55).

ELK CREEK

Special Session Mine

The Special Session mine in the S½ sec. 31, T. 42 N., R. 10 W. (fig. 4), is near the top of the divide at the head of the east fork of Elk Creek at an altitude of nearly 13,000 feet. The area lies west of the Silver Pick mine along the normal projection of the Silver Pick vein. Several claims were patented before 1900.

The Special Session, together with the Oasis, Slide Rock, and Polar Nos. 1–3, was patented in November 1899. A seventh claim, Southport (patented in 1894), is partly overlain by the Oasis claim.

The Archaen patented claim is partly overlapped by the Polar No. 2 and adjoins the Southport. Although patent was granted in 1886, no information has been found to indicate that the claim has been worked.

An unpatented claim, Gold Queen No. 1, abuts the Archaen, according to courthouse records. No workings were observed when the area was visited in 1969.

The principal development work on these claims consists of two adits on the Special Session; both adits were caved or filled with ice when the claim was visited in 1968. By 1900, workings consisted of 1,500 feet of crosscuts and drifts, and probably some work was done after that. The workings follow a narrow fissure vein that trends about N. 65° E. and dips steeply northwest. The vein cuts porphyritic quartz monzonite of the Wilson Peak stock but, because of abundant sliderock, is not well exposed at the surface. The principal sulfides seen on the dump are pyrite, arsenopyrite, chalcopyrite, galena, and some sphalerite in a quartz gangue. C. W. Purington's 1896 field notes stated that underground the vein averaged about 4 inches in width and that the average tenor was about 2 ounces of gold per ton. Unsorted mine-run ore from the width of a tunnel would be substantially less. A sample taken during the present investigation of selected rock from the dump (sample 066, table 3) ran about half an ounce in gold (18 ppm) and 2 ounces in silver per ton.

No record of production before 1900 is available from the Special Session, but by the time of Purington's visit in 1896 some stoping had been done on the vein and he estimated that about $5,000 worth of ore had been produced. The principal value of the ore was in gold, but some silver, lead, and copper were present. A small output of ore has been won from the vein at intervals since that time. Bureau of Mines records shows that during 1934–40 8 tons of ore was mined which yielded 29 ounces of gold and 30 ounces of silver. This probably represents ore upgraded by hand cobbing.

Sample B21 (table 7) was taken from the abandoned shipping bin near the ice-blocked Special Session lower portal. The handpicked specimen assayed 0.21 ounce of gold and 2.39 ounces of silver per ton, 0.46 percent copper, 0.15 percent lead, and a trace of zinc.

Production of ore worth $8,620 was reported from the Polar claims in the late 1930's.

Three other patented claims are known in Elk Creek basin—the Shenandoah, Ida G., and H.C.B. claims. The Shenandoah claim lies near the head of Elk Creek trail just north of the Special Session mine in the E½ sec. 31, T. 42 N., R. 10 W. (fig. 4). This claim evidently has never been worked other than by small discovery pits noted when the claim was patented in 1898.

The Ida G. and H.C.B. claims are at 12,000 feet altitude in the N½ sec. 31, T. 42 N., R. 10 W. (fig. 4), in Elk Creek basin north of the Shenandoah claim. No record of production nor recognizable evidence of work was disclosed during this investigation. When patents were issued for these claims in 1898, only superficial work had been done.

DISSEMINATED COPPER IN NAVAJO BASIN

Copper was found during this investigation disseminated in porphyritic quartz monzonite of the Wilson Peak stock. The area is located high on the north side of Navajo Basin, at an altitude of about 12,800 feet half a mile south of the Silver Pick mine (fig. 11).

In this area copper occurs mainly as chalcopyrite that is (1) disseminated in the quartz monzonite, (2) along minor fractures, and (3) in narrow gold-bearing quartz veins that also contain pyrite and minor galena and sphalerite. The economic potential of a mineral occurrence of this type cannot be evaluated without extensive physical exploration, but it seems to be a promising target for further work.

The narrow gold-bearing veins attracted early prospectors to this steep mountain slope and several of the veins were explored by small excavations. The principal working is the Zero adit, driven about 1900. The adit, which is caved 180 feet in from the portal and partly caved at the portal, follows a narrow fissure vein, 2–6 inches wide, in quartz monzonite which strikes N. 65° to 75° E. and dips vertically to steeply southeast. Blue-green secondary copper minerals are abundant on the walls of the adit in places. Chemical analysis of a selected sample of vein material collected on the dump (table 8, sample 180) shows 39 ppm gold (1.1 ounces per ton), 72 ppm silver (2.1 ounces per ton), 42,000 ppm copper (4.2 percent), 4,200 pm (0.42 percent) lead, and 6,800 ppm (0.68 percent) zinc.

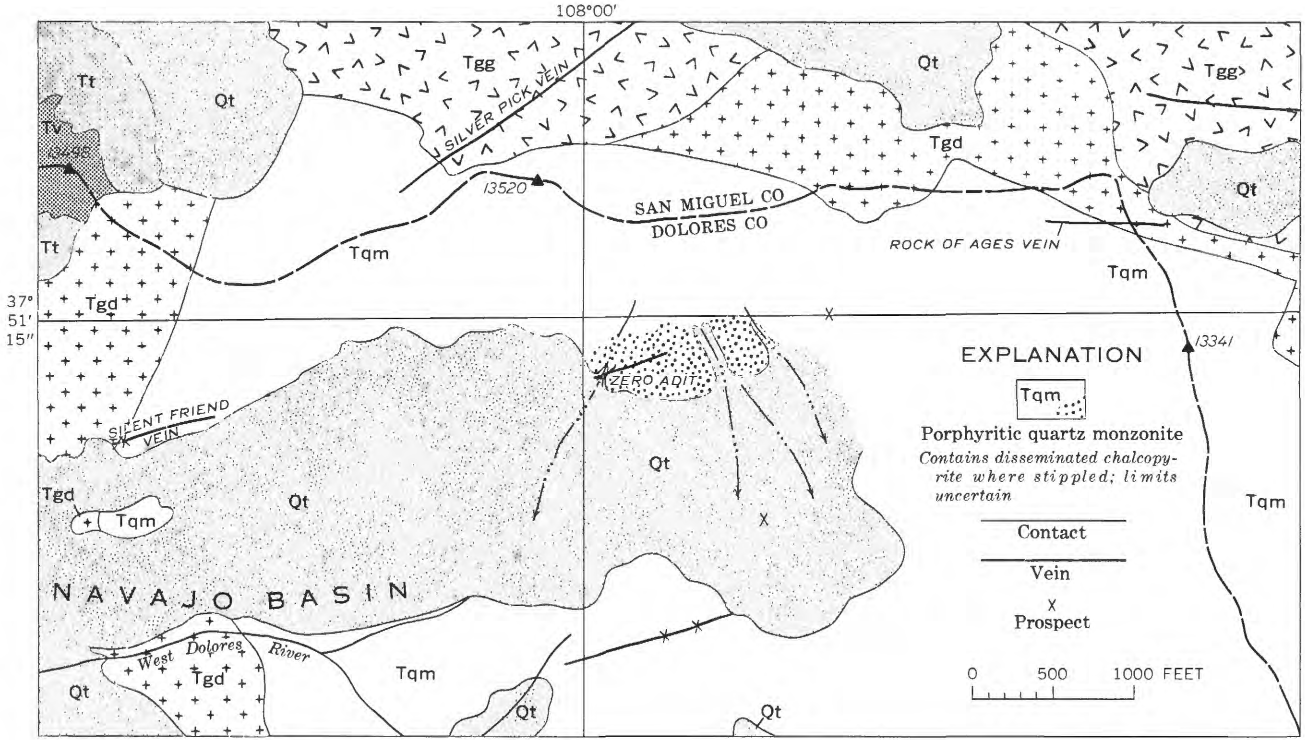


FIGURE 11.—Geologic map of the eastern part of Navajo Basin showing area with disseminated chalcopyrite. Qt, talus; Tqm, porphyritic quartz monzonite; Tgd, granodiorite; Tgg, granogabbro; Tv, Tertiary volcanics; Tt, Telluride Conglomerate.

TABLE 8.—*Partial analyses of samples from the area of disseminated copper on the north side of Navajo Basin*

[For complete analyses, see tables 3 and 6. Conversions: 34 ppm Au or Ag=1 Troy ounce per ton; 10,000 ppm=1 percent; 1,000 ppm=0.1 percent; 100 ppm=0.01 percent, and so forth]

Sample No.	Chemical analyses (ppm)					
	Au	Ag	Cu	Pb	Zn	Mo
176	3.1	2.6	9,200	38	120	5
177	.1	3.9	1,200	60	42	100
178	1.3	5.2	44,000	32	94	10
179	.4	5.7	1,000	44	38	300
180	39	72	42,000	4,200	6,800	20
190	1.8	5.5	5,800	86	150	<5
191	.4	[1] 3	[1] 5,000	100	140	15
192	.3	[1] 2	[1] 3,000	200	240	20
287	.06	2.2	1,100	40	70	<5
288	.1	1	2,000	<25	80	<5
289	.8	3.6	9,000	<25	110	5
290	.4	2.4	2,000	50	130	5
291	.08	1	950	<25	100	<5
292	.02	.8	480	25	90	<5

[1] Semiquantitative spectrographic analysis.

Description of samples

176. Malachite-stained quartz monzonite.
177. Veinlet; chiefly quartz, pyrite, minor chalcopyrite.
178. Malachite- and azurite-stained quartz monzonite with some chalcopyrite.
179. Pyrite-impregnated quartz monzonite with some chalcopyrite.
180. Selected vein material from dump of the Zero adit.
190. Selected chips from porphyritic quartz monzonite talus taken over a horizontal distance of 200 feet.

191, 192. Fines taken from between talus boulders in steep drainages east of Zero portal.

287–292. Chip samples of porphyritic quartz monzonite, selected to represent "average rock" in this area.

The area of quartz monzonite containing disseminated chalcopyrite and chalcopyrite-bearing minor fractures is poorly outlined but extends eastward along the contour from the Zero portal for nearly 1,000 feet (fig. 11). Downslope from the general altitude of the Zero portal the quartz monzonite porphyry is concealed by an unbroken apron of talus which extends to the basin floor, a vertical distance of 600–700 feet. Above the portal, forbidding bare rock cliffs and steep rock slopes cut by narrow couloirs are accessible only with considerable hazard. Malachite is particularly conspicuous and stains the cliffs 100 feet or so above the Zero portal; malachite- and azurite-coated cobbles and boulders are found in the talus from near the portal eastward for nearly 1,000 feet. Though some oxidation has taken place, as indicated by the presence of malachite and azurite, chalcopyrite is relatively common on specimens freshly broken from the outcrop.

Little is known of the extent of alteration of the quartz monzonite, but the most conspicuous effect was the introduction of silica. Quartz is common in narrow veinlets and as coatings along innumerable joint or fracture planes. Two thin sections of quartz monzonite with disseminated chalcopyrite show abundant quartz as microscopic veinlets and a recrystallized groundmass of quartz and orthoclase, with interlocking or sutured texture. In the rocks examined, plagioclase phenocrysts are sericitized, in part, and mafic minerals have been destroyed.

Seven chip samples of quartz monzonite were taken from near the Zero adit and eastward for 2,000 feet (pl. 2). The samples were chosen to represent the "average" quartz monzonite in this area; an attempt was made to reject chips which contained a malachite- or azurite-stained fracture surface or sulfide veinlets. Copper content of these samples (190, 287–292, table 8 and table 3) ranged from 480 to 9,000 ppm (0.05 to 0.9 percent). In addition, all chip samples showed low but anomalous gold content ranging from 0.02 to 1.8 ppm. Neither molybdenum, lead, nor zinc was anomalous in the chip samples, though 100 and 300 ppm molybdenum were present in two other samples (177 and 179, table 8). Visible molybdenite was observed in sample 195 (table 3) from vein material on a dump at a caved adit in talus southeast and 400 feet lower than the Zero portal.

Stream-sediment samples from Navajo Basin were consistently anomalous in copper content (fig. 5; table 5, samples 186, 187, 193, 194, 199, and 200); most contained 200 ppm copper and one contained 1,000 ppm in contrast with a content of 10–20 ppm for "average" stream sediments.

This area may represent a potential copper resource. More intensive exploration beyond the scope of this investigation, including systematic and extensive sampling and drilling, would be needed to define the limits, volume, and grade of disseminated copper in the quartz monzonite.

VANADIUM

Vanadium has been mined from the upper part of the Jurassic Entrada Sandstone in the Placerville district about 1½ miles north of the primitive area in Big Bear and Fall Creeks. About 240,000 tons of ore which averaged a little more than 2 percent V_2O_5 was produced. According to Fischer (1968), this represented about 5 percent of the total domestic production of vanadium. Details on the geology of these deposits were given by Fischer, Haff, and Rominger (1947), Hess (1913), and Fischer (1968). Vanadium-bearing micaceous minerals with a composition close to roscoelite impregnate a wavy layer within the upper 25 feet of the Entrada Sandstone. The tabular vanadiferous sandstone layer is virtually continuously mineralized in two belts. The principal belt is about 1½ miles wide and has been traced in outcrop for nearly 9 miles, from Leopard Creek on the north to Big Bear Creek on the south. The north and south limits of this vanadium mineralized belt have not been determined, as the Entrada is concealed by younger formations. The southward projection of the vanadium belt passes beneath the Wilson Mountains Primitive Area. The belt seems to occur south of the primitive area along the Dolores River, above its junction with Slate Creek, where recent drilling disclosed vanadium minerals in the Entrada Sandstone. This find suggests that the vanadium belt passes beneath the primitive area, but the depth of the Entrada Sandstone along the general trace of the projected vanadium belt beneath the primitive area would range from 1,200 to at least 3,500 feet.

Though vanadium deposits similar in grade and tonnage to those mined in the Big Bear Creek-Fall Creek belt might occur under the primitive area, exploration and development of such deposits at the depths indicated above would be prohibitively expensive at the current or immediately forseeable value of vanadium.

COAL

Minable coal seams are found locally in the Cretaceous Dakota Sandstone, in the western San Juan Mountains. Before the turn of the century coal was mined from two localities just south of the primitive area—one near the abandoned saw mill (pl. 1) on the north side of the Dolores River just east of Coal Creek, and the other on the south side of the Dolores River just east of Barlow Creek. Both mines have been abandoned for many years and the workings are now largely caved and inaccessible.

The coal occurs in the middle carbonaceous shale unit of the Dakota Sandstone as local seams which, where exploited, range in thickness from 16 to 24 inches.

The coal is of bituminous rank, as are most coals from the Dakota in southwest Colorado (Landis, 1959). An analysis of coal from the middle unit of the Dakota near Naturita, 40 miles northwest, showed the coal to be high-volatile B bituminous in rank (U.S. Bureau of Mines, 1937, p. 110–111).

In the early days the coal seams along the Dolores River were exploited for use at nearby Rico in making coke for smelting operations. Remains of beehive coking ovens are still visible along the Dolores River between Coke Oven and Coal Creeks. The coal was also used locally for household heating. Hills (1893) reported that the use of this coal was abandoned when railroad connection with Durango gave access to the better coals of that area.

As the Dakota Sandstone extends beneath the Wilson Mountains area it is probable that thin low-rank bituminous coal seams are locally present, but at depths well over a thousand feet under much of the area. Even the coal seams that crop out and are readily accessible have not attracted exploration for nearly 80 years, being too thin, lenticular, and low in grade; any subsurface coal present in the primitive area is unlikely to be of any economic significance in the forseeable future.

OIL AND GAS

No surface oil or gas indications are known within the boundaries of the primitive area. Though oil and gas have been produced from several localities in southwest Colorado the nearest production comes from the recently discovered Andy's Mesa field, 30 miles northwest, on the north flank of Gypsum Valley. Four wells completed there in 1967 are producing gas from Pennsylvanian and Permian strata. Somewhat closer was the discovery of gas in several shallow wells in the Mancos Shale near Ridgway, Colo., 25 miles northeast; but no production resulted from this drilling.

Nearer to the primitive area, two occurrences of hydrocarbons are known. Ten miles north along the San Miguel River near Placerville hardened uranium-bearing petroliferous material ("hydrocarbon") occurs in and adjacent to veins along northwest-trending faults which cut the Permian Cutler Formation and Triassic Dolores Formation. The hydrocarbons are associated with copper sulfide in a barite-calcite gangue. According to V. R. Wilmarth and C. C. Hawley (in Bush and others, 1959, p. 378), the hydrocarbons probably were derived from petroleum that was migrating in fracture systems or was contained in adjacent rocks. Pierson, Weeks, and Kleinhampl (1958, p. 404) reported an interesting occurrence of viscous hydrocarbon from Tertiary volcanic rock in the Smuggler mine, 8 miles northeast of the primitive area.

In southwest Colorado production has come from zones in Devonian, Mississippian, Pennsylvanian, Permian, and Cretaceous strata. Nearly all these strata or their lateral equivalents underlie the primitive area, as shown in a test well drilled near Placerville, 8 miles north, which collared in the Permian Cutler Formation and penetrated slightly more than 6,000 feet of Paleozoic rocks before reaching the Precambrian basement.

Detailed structure of the deeper strata beneath the primitive area is not known, but in general the formations probably strike eastward and rise to the south toward the Rico dome. This general pattern is interrupted by crosscutting stocks. At the surface the intrusive rocks and sedimentary rocks affected by associated contact metamorphism occupy about 20 square miles; rocks such as these are generally considered to have poor potential for oil or gas.[2]

[2] Exceptions to this judgment are found; a nearby one is the unusual geologic trap discovered in the Carrizo Mountains of northeast Arizona where oil is being produced from fractures in a sill of Miocene "syenite."

In summary, no occurrences of oil or gas are known within the boundaries of the primitive area. A few minor indications of petroleum are known within about 8–10 miles of the area; gas occurrences are known within 25 miles; and gas production, within 30 miles. In southwest Colorado, oil and gas have come from several formations that are present under the primitive area. If stratigraphic or structural traps exist under the primitive area, then oil or gas could be present.

SAND AND GRAVEL

Deposits of sand and gravel occur within the primitive area, wherever glacial deposits are found. The deposit that is largest and closest to transportation is on the Lake Fork of the San Miguel River straddling the east boundary of the area. This deposit is part of a glacial moraine and is well exposed in the roadcuts of State Highway 145; recently it was utilized briefly while the highway was being paved. Other glacial gravels occur along the West Dolores River, along Slate Creek, and, as small patches, elsewhere. None of the gravel deposits within the primitive area has been utilized, and probably none has economic potential, as similar deposits are widespread in the western San Juan and are closer to transportation and to settled areas.

CONCLUSIONS

The Wilson Mountains Primitive Area contains several veins in its central and eastern parts which have yielded approximately $1.78 million dollars, chiefly in gold, silver, and lead but with lesser amounts of zinc and copper. About 96 percent of this total came from two mines—the Silver Pick in the Mount Wilson mining district in the center of the primitive area, and the San Bernardo in the Trout Lake mining district on the east side of the primitive area. Several other vein deposits have yielded small quantities of ore, and numerous other veins have been prospected by shallow workings. The veins are generally narrow, and ore shoots commonly are erratically distributed. Similar undiscovered vein deposits undoubtedly occur locally along veins in both the Mount Wilson and Trout Lake districts. Though it is doubtful that a major mine will be developed on a vein deposit, further exploration and possible small-scale mining is to be expected.

Of more significant mineral potential is disseminated chalcopyrite found in an area of quartz monzonite in Navajo Basin in the Mount Wilson mining district. Further exploration, beyond the scope of this investigation, would be needed to define the limits, grade, and volume of this mineralized occurrence.

A mild molybdenum anomaly is shown by stream-sediment samples in an area near a small granodiorite plug on a fork of the West Dolores River near the south boundary of the study area.

Apparently the only substantial contiguous part of the primitive area with no known metallic mineral potential is the western group of peaks around Dolores Peak.

No other indications were seen in the study area of other economic or subeconomic mineral resources. Thin low-rank bituminous coal in the Dakota Sandstone is probably present under the primitive area, in places at depths of well over a thousand feet, but this coal is unlikely to be of any economic significance in the foreseeable future. No surface oil or gas indications are known, but lateral equivalents of reservoir rocks from which gas and oil have been produced in southwest Colorado undoubtedly occur at depth. Thus if structural or stratigraphic traps occur, oil and gas might conceivably exist beneath the study area.

REFERENCES CITED

Behrendt, J. C., Brinkworth, G. L., and Popenoe, Peter, 1968, Geophysical investigations in the Colorado Mineral Belt [abs.]: Geophysics, v. 33, no. 6, p. 1030.

Bromfield, C. S., 1967, Geology of the Mount Wilson quadrangle, western San Juan Mountains, Colorado: U.S. Geol. Survey Bull. 1227, 100 p.

Bromfield, C. S., and Bush, A. L., 1968, Multiple intrusion in the San Miguel Mountains, Colorado, *in* New Mexico Geol. Soc. Guidebook 19th Field Conf., 1968: p. 94–99.

Bromfield, C. S., and Conroy, A. R., 1963, Preliminary geologic map of the Mount Wilson quadrangle, San Miguel County [and Dolores County], Colorado: U.S. Geol. Survey Mineral Inv. Field Studies Map MF–273 [1964].

Bush, A. L., and Bromfield, C. S., 1966, Geologic map of the Dolores Peak quadrangle, Dolores and San Miguel Counties, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ–536.

Bush, A. L., Bromfield, C. S., Marsh, O. T., and Taylor, R. B., 1961, Preliminary geologic map of the Gray Head quadrangle, San Miguel County, Colorado: U.S. Geol. Survey Mineral Inv. Field Studies Map MF–176.

Bush, A. L., Bromfield, C. S., and Pierson, C. T., 1959, Areal geology of the Placerville quadrangle, San Miguel County, Colorado: U.S. Geol. Survey Bull. 1072–E, p. 299–384.

Bush, A. L., Marsh, O. T., and Taylor, R. B., 1960, Areal geology of the Little Cone quadrangle, Colorado: U.S. Geol. Survey Bull. 1082–G, p. 423–492 [1961].

Case, J. E., 1967, Geophysical ore guides along the Colorado mineral belt: U.S. Geol. Survey open-file rept., 13 p., 8 figs.

Cross, Whitman, and Hole, A. D., 1910, Description of the Engineer Mountain quadrangle, Colorado: U.S. Geol. Survey Geol. Atlas, Folio 171, 14 p.

Cross, Whitman, Howe, Ernest, and Irving, J. D., 1907, Description of the Ouray quadrangle, Colorado: U.S. Geol. Survey Geol. Atlas, Folio 153, 20 p.

Cross, Whitman, Howe, Ernest, and Ransome, F. L., 1905, Description of the Silverton quadrangle, Colorado: U.S. Geol. Survey Geol. Atlas, Folio 120, 34 p.

Cross, Whitman, and Purington, C. W., 1899, Description of the Telluride quadrangle, Colorado: U.S. Geol. Survey Geol. Atlas, Folio 57, 19 p.

Cross, Whitman, and Ransome, F. L., 1905, Description of the Rico quadrangle, Colorado: U.S. Geol. Survey Geol. Atlas, Folio 130, 20 p.

Cross, Whitman, Spencer, A. C., and Purington, C. W., 1899, Description of the La Plata quadrangle Colorado: U.S. Geol. Survey Geol. Atlas, Folio 60, 14 p. [1901].

Endlich, F. M., 1876, Report [on the San Juan district, Colorado]: U.S. Geol. and Geog. Survey Terr. (Hayden) 8th Ann. Rept., 1874, p. 181–240.

Fischer, R. P., 1968, Vanadium deposits of the Placerville area, San Miguel County, Colorado, *in* New Mexico Geol. Soc. Guidebook 19th Field Conf., 1968: p. 100–103.

Fischer, R. P., Haff, J. C., and Rominger, J. F., 1947, Vanadium deposits near Placerville, San Miguel County, Colorado: Colorado Sci. Soc. Proc., v. 15, no. 3, p. 115–146.

Hess, F. L., 1913, Notes on the vanadium deposits near Placerville, Colorado: U.S. Geol. Survey Bull. 530–C, p. 142–156.

Hills, R. C., 1893, Coal fields of Colorado: U.S. Geol. Survey Mineral Resources U.S., 1892, p. 319–365.

Holmes, W. H., 1878, Report on the geology of the Sierra Abajo and west San Miguel Mountains: U.S. Geol. and Geog. Survey Terr. (Hayden) 10th Ann. Rept., 1876, p. 187–195.

King, W. H., and Allsman, P. T., 1950. Reconnaissance of metal mining in the San Juan region, Ouray, San Juan, and San Miguel Counties, Colorado: U.S. Bur. Mines Inf. Circ. 7554, 109 p.

Landis, E. R., 1959, Coal resources of Colorado: U.S. Geol. Survey Bull. 1072–C, p. 131–232.

Lindsley, D. H., Andreasen, G. E., and Balsley, J. R., 1966, Magnetic properties of rocks and minerals, Section 25 *in* Handbook of physical constants [revised ed.]: Geol. Soc. America Mem. 97, p. 543–552.

Nason, F. L., 1900, The geology and vein systems of the Mount Wilson mining district, Colorado: Eng. and Mining Jour., v. 69, p. 681–682.

Pierson, C. T., Weeks, W. F., and Kleinhampl, F. J., 1958, Reconnaissance for radioactivity in the metal-mining districts of the San Juan Mountains, Colorado: U.S. Geol. Survey Bull. 1046–O, p. 385–413 [1959].

Purington, C. W., 1898, Preliminary report on the mining industries of the Telluride quadrangle, Colorado: U.S. Geol. Survey 18th Ann. Rept., pt. 3, p. 745–850.

Spaulding, M. B., 1898, The Silver Pick, Wilson: Columbia School of Mines Quarterly, v. 20, p. 41–47.

U.S. Bureau of Mines, 1937, Analyses of Colorado coals: U.S. Bur. Mines Tech. Paper 574, 327 p.

U.S. Geological Survey, 1968, Transcontinental geophysical survey (35°–39° N.) Bouguer gravity map from 100° to 112° W. longitude: U.S. Geol. Survey Misc. Geol. Inv. Map I–533–B.

Varnes, D. J., 1947a, Iron Springs Mining district (Ophir, Ames), San Miguel County, *in* Vanderwilt, J. W., Mineral resources of Colorado: Colorado Mineral Resources Board Bull., p. 425–427.

Varnes, D. J., 1947b, Mount Wilson district, San Miguel County, *in* Vanderwilt, J. W., Mineral resources of Colorado: Denver, Colorado Mineral Resources Board, p. 428

Woollard, G. P., 1962, The relation of gravity anomalies to surface elevation, crustal structure and geology: Wisconsin Univ. Geophys. and Polar Research Center Research Rept. Ser., Rept. 62–9, 292 p.

Zietz, Isidore, and Andreasen, G. E., 1967, Remanent magnetization and aeromagnetic interpretation, *in* Mining geophysics—volume 2, Theory: Tulsa, Okla., Soc. Explor. Geophysicists, p. 569–590, illus., tables.

TABLES 3–6

TABLE 3.—*Analyses of veins and mineralized rocks*

[Semiquantitative analyses were made by C. L. Forn, E. L. Mosier, and J. M. Motooka. Gold analyses were made by atomic-absorption spectrometry by R. W. Leinz and M. S. Rickard. Copper, lead, zinc, and silver analyses were made by atomic-absorption spectrometry by Z. C. Stevenson.

Spectrographic analyses are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, and so forth, which represent approximate midpoints of group data on a geometric scale. The assigned group for semiquantitative results will include the

Semiquantitative spectrographic analyses

Sample	(Percent) Fe	Mg	Ca	Ti	(ppm) Mn	Ag	As	B	Ba	Bi	Cd	Co	Cr	Cu	Mo	Ni
014	7.0	0.05	0.3	0.07	300	150.0	10,000	15	<20	150	<20	<5	<5	3,000	10	5
066	7	.15	1	.15	700	30	3,000	10	500	30	<20	10	<5	3,000	10	<5
070	2	.7	1	.3	1,500	30	3,000	1,500	100	<10	<20	5	<5	150	<5	<5
080	10	.07	.15	.03	>5,000	150	2,000	15	150	<10	<20	10	<5	700	15	15
081	10	L	L	.015	300	300	7,000	15	20	<10	300	5	<5	1,500	15	5
119	5	1.5	5	.15	1,000	<.5	<200	10	2,000	<10	<20	7	10	20	<5	10
132	3	.7	10	.05	3,000	200	2,000	<10	300	<10	>500	5	10	500	100	15
133	5	1	2	.2	>5,000	30	<200	20	500	20	50	10	20	300	10	20
135	5	1	1.5	.3	1,000	.5	<200	10	300	15	<20	7	5	20	<5	<5
136	.3	.1	.05	.15	30	3	<200	30	200	<10	<20	<5	15	20	<5	<5
137	10	1.5	.15	.15	200	.5	<200	10	<20	<10	<20	5	20	7	<5	10
138	3	.7	.7	.2	1,500	15	300	20	300	10	<20	7	10	200	20	10
139	7	.3	.15	.15	>5,000	300	300	10	700	50	<20	15	5	1,500	<5	10
142	3	1	.7	.2	1,000	.7	<200	50	300	<10	<20	10	10	200	<5	15
167	7	1.5	10	.1	>5,000	50	2,000	15	300	30	<20	20	10	15,000	<5	5
168	15	1.5	.2	.3	2,000	100	<200	200	700	300	<20	30	20	10,000	<5	15
169	7	1.5	10	.5	3,000	.5	<200	15	500	<10	<20	20	20	50	5	10
170	3	1	20	.15	>5,000	<.5	<200	20	150	<10	<20	<5	10	15	<5	<5
171	20	.5	10	.1	5,000	30	1,500	70	150	50	<20	20	5	150	10	<5
172	15	2	.3	.5	300	.5	<200	70	700	<10	<20	<5	100	30	<5	7
173	10	2	1	.5	2,000	1	<200	70	1,000	<10	<20	15	30	10	<5	15
174	10	1	.1	.3	1,000	.5	<200	30	500	<10	<20	10	5	7	<5	5
175	7	.5	.07	.2	500	15	2,000	15	500	30	<20	10	5	1,000	10	5
176	7	1	.5	.2	1,000	1.5	<200	<10	700	<10	<20	15	5	10,000	5	7
177	7	.7	.2	.3	200	2	<200	10	700	10	<20	<5	5	1,500	100	5
178	5	.5	.15	.15	1,000	3	<200	<10	500	<10	<20	15	5	>20,000	10	5
179	7	.2	.05	.15	150	5	<200	<10	700	<10	<20	<5	5	1,000	300	5
180	7	.3	.7	.2	500	50	<200	<10	700	50	<20	10	5	>20,000	20	5
181	10	.3	.05	.5	150	1	<200	70	500	<10	<20	<5	5	20	<5	<5
182	15	.2	.05	.3	70	1	<200	500	700	<10	<20	<5	5	10	<5	<5
183	5	.5	.1	.3	150	20	<200	150	700	15	<20	<5	<5	20	<5	<5
184	7	.5	.7	.2	700	70	1,500	20	3,000	<10	500	10	5	7,000	<5	5
190	7	1	1	.3	700	5	<200	<10	700	<10	<20	10	10	5,000	<5	7
195	10	.2	5	.15	1,000	50	1,500	<10	300	500	<20	7	5	7,000	>2,000	5
197	5	1	.3	.3	200	<.5	<200	10	700	<10	<20	<5	10	2,000	7	5
198	10	.7	.2	.15	500	700	10,000	1,500	500	>1,000	50	10	5	>20,000	<5	<5
243	5	.5	.15	.2	>5,000	3	2,000	30	300	<10	<20	7	5	100	<5	5
244	20	1	2	.005	>5,000	70	1,500	<10	<20	<10	500	5	<5	150	<5	<5
245	20	2	7	.002	>5,000	150	700	<10	1,500	<10	>500	<5	<5	150	<5	<5
246	5	.1	.1	.07	150	1	200	30	150	<10	<20	<5	10	50	<5	<5
247	20	.1	.05	.1	70	3	<200	500	200	<10	<20	10	<5	20	<5	<5
248	7	.05	.15	.07	50	3	200	<10	200	15	<20	<5	10	100	<5	5
249	10	.02	.07	.03	500	70	10,000	<10	100	<10	>500	20	5	1,000	<5	<5
250	10	.3	2	.1	1,000	7	>10,000	<10	100	<10	100	15	10	150	<5	5
287	1.5	.3	.3	.3	300	.7	<200	<10	1,000	<10	<20	10	10	700	<5	5
288	2	.7	.3	.3	300	.7	<200	<10	1,500	<10	<20	10	15	1,500	<5	5
289	3	.3	.2	.2	300	1.5	<200	<10	700	<10	<20	10	10	3,000	5	5
290	3	.3	.15	.2	300	1	<200	<10	700	<10	<20	10	10	1,500	5	<5
291	1.5	.7	.7	.2	150	.5	<200	<10	700	<10	<20	10	15	700	<5	5
292	1.5	.7	.7	.15	150	.7	<200	<10	700	<10	<20	10	15	300	<5	5
295	7	1	1	.3	200	.5	<200	<10	300	<10	<20	<5	5	70	<5	<5
296	7	.5	.07	.2	300	7	<200	10	300	20	<20	5	5	500	<5	<5
298	3	.5	1.5	.3	>5,000	500	1,500	<10	50	<10	70	<5	5	500	<5	5
299	10	.5	1.5	.15	1,500	300	5,000	20	<20	<10	100	5	15	300	<5	10

1/ Abbreviations used in table:

alt = altered	az = azurite	carb = carbonate	Fe ox = iron oxide	ig = igneous
apy = arsenopyrite	bx = breccia	cp = chalcopyrite	gn = galena	lim = limonite

from the Wilson Mountains Primitive Area

quantitative value about 30 percent of the time. These data should not be quoted without stating these limitations.
---, not looked for ; <, less than the amount shown ; >, more than the amount shown. Where these symbols are used the amount shown is the lower or upper limit of semiquantitative determination. Some elements are reported at one lower or upper limit of determination for some samples and at different limits for other samples, because of different sensitivities of the different instruments used for analyses]

	Semiquantitative spectrographic analyses--Continued						Chemical analyses					
	(ppm)						(ppm)					
Sample	Pb	Sb	Sn	Sr	V	Zn	Au	Ag	Cu	Pb	Zn	Sample description[1]
014	700	7,000	15	N	30	1,500	21.0	460.0	16,000	9,400	2,400	Qz, py, apy, gn.
066	2,000	700	<10	<100	30	3,000	18	63	9,200	9,600	8,000	Qz, py, gn, cp, sp.
070	5,000	<100	<10	<100	70	3,000	.9	41	190	19,000	8,000	Qz, py, gn, sp.
080	2,000	700	<10	<100	30	1,500	1	190	950	15,000	6,000	Fe ox gossan, clay.
081	3,000	3,000	10	<100	10	>10,000	.3	120	1,400	18,000	13,000	Ox vn, qz.
119	50	<100	<10	300	70	<200	>.02	---	---	---	28	Qz, py, carb.
132	>20,000	700	<10	250	50	>10,000	.8	120	570	34,000	100,000	Vn; qz, carb, gn, sp.
133	15,000	<100	<10	<100	150	>10,000	.1	48	280	33,000	6,500	Vn bx; py, gn.
135	150	<100	<10	300	150	<200	.02	1.4	17	180	100	Ig rk; py.
136	500	<100	<10	200	30	<200	.02	7	51	2,200	40	Py, gn.
137	30	<100	20	<100	30	<200	.02	1.8	<10	64	84	Ig rk; py.
138	5,000	100	<10	200	100	200	.02	22	250	13,000	250	Vn; qz, gn.
139	20,000	1,500	<10	300	50	700	.2	130	100	19,000	75,000	Vn; ox py, sp.
142	150	<100	<10	<100	150	<200	.04	2.6	32	910	250	Ig rk; py.
167	20,000	<100	<10	500	100	7,000	.8	56	16,000	12,000	6,400	Vn; qz, gn, sp, cp.
168	1,000	<100	<10	<100	200	300	1.2	140	9,000	1,000	420	Vn; qz, py, cp.
169	100	<100	<10	500	200	<200	.02	1.1	70	54	120	Vn; qz, py.
170	150	<100	<10	200	70	<200	>.02	2.6	30	80	170	Vn; qz, carb, lim.
171	3,000	<100	<10	<100	20	500	.02	38	280	3,600	260	Vn; qz, py.
172	300	<100	<10	1,000	200	<200	>.02	1	38	92	98	Vn; qz, lim.
173	100	<100	<10	500	200	200	.04	1.2	16	44	130	Vn; qz, py.
174	50	<100	<10	<100	100	<200	8.4	1	12	30	79	Vn; py.
175	2,000	150	10	<100	70	500	1.0	39	700	2,800	460	Vn; qz, py.
176	100	<100	<10	500	100	<200	3.1	2.6	9,200	38	120	Po qz monz w cp, mal.
177	150	<100	10	200	100	<200	.1	3.9	1,200	60	42	Po qz monz w cp.
178	30	<100	<10	200	70	<200	1.3	5.2	44,000	32	94	Po qz monz w cp, mal, az.
179	70	<100	<10	100	50	<200	.4	5.7	1,000	44	38	Alt qz monz w py.
180	5,000	<150	10	100	70	10,000	39	72	42,000	4,200	6,800	Vn; qz, cp, sp, gn.
181	30	<100	<10	<100	70	<200	.4	1.5	41	40	<25	Vn; clay, lim.
182	50	<100	<10	<100	50	<200	<.02	3.9	10	52	<25	Vn; clay, py.
183	70	<100	<10	100	70	<200	.08	---	---	---	100	Vn; clay, alt rk.
184	>20,000	700	<10	500	70	>10,000	1.2	100	24,000	30	76,000	Vn; qz, py, sp.
190	150	<100	<10	700	100	<200	1.8	5.5	5,800	86	150	Po qz monz; cp, mal.
195	700	150	30	<100	50	1,000	2.2	62	8,400	720	1,000	Vn; qz, py, cp, mo.
197	100	<100	15	700	100	<200	<.02	1	98	54	26	Vn; qz, py.
198	15,000	100	<10	100	50	10,000	600	750	48,000	19,000	11,000	Vn; qz, py, cp, gn, sp.
243	300	<100	<10	<100	100	500	.3	360	1,500	36,000	800	Gossan.
244	15,000	100	<10	<100	20	>10,000	.8	70	200	8,800	80,000	Vn; qz, sp, gn.
245	>20,000	200	<10	100	10	>10,000	.2	1.6	200	160	84	Vn; qz, carb, py.
246	200	<100	<10	<100	20	<200	.3	5.6	150	640	650	Vn; qz, py.
247	150	<100	<10	<100	30	<200	25	7.4	18	160	70	Do.
248	150	<100	<10	<100	20	200	3	7	200	240	110	Do.
249	>20,000	200	<10	<100	20	>10,000	6	180	2,300	14,000	96,000	Vn; qz, py, sp, gn.
250	1,500	100	<10	<100	30	>10,000	4.5	14	150	4,400	23,000	Vn; qz, py, sp, gn, apy.
287	20	<100	<10	500	50	<200	.06	2.2	1,100	40	70	Po qz monz; cp.
288	30	<100	<10	500	50	<200	.1	1	2,000	<25	80	Do.
289	30	<100	<10	300	70	<200	.8	3.6	9,000	<25	110	Do.
290	70	<100	<10	300	50	<200	.4	2.4	2,000	50	130	Do.
291	30	<100	<10	300	70	<200	.08	1	950	<25	100	Do.
292	30	<100	<10	300	70	<200	.02	.8	480	25	90	Do.
295	100	<100	<10	300	100	200	.06	1.2	73	80	230	Vn; gossan.
296	150	<100	<10	<100	70	<200	.02	10	720	240	130	Vn; qz, py, lim.
298	2,000	2,000	<10	<100	10	>10,000	.4	1,400	520	2,800	37,000	Vn; qz, py, sp.
299	7,000	1,500	<10	<100	30	>10,000	2	440	390	16,000	28,000	Vn; qz, py, sp, gn.

mal = malachite
mo = molybdenite
monz = monzonite
ox = oxidized
po = porphyritic
py = pyrite
qz = quartz
rk = rock
sp = sphalerite
vn = vein
w = with

TABLE 4.—*Analyses of altered rocks from*

[Semiquantitative analyses were made by C. L. Forn, J. M. Motooka, and K. C. Watts. Gold analyses were made by atomic-absorption spectrometry by R. W. Leinz and M. S. Rickard. Zinc analyses were made by atomic-absorption spectrometry by Z. C. Stevenson. Arsenic and antimony analyses were made by colorimetric methods by J. G. Frisken, M. J. Horodyski, E. R. Iberall, and S. L. Noble. Mercury analyses were made by vapor detector method by S. L. Noble.

Spectrographic analyses are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, and so forth, which represent approximate midpoints of group data on

	Semiquantitative spectrographic analyses																		
	(percent)				(ppm)														
Sample	Fe	Mg	Ca	Ti	Mn	Ag	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Nb	Ni
006	1.5	0.7	2.0	0.3	300	<0.5	<200	10	500	<1	<10	<20	7	20	15	<20	<5	10	7
007	1.5	.7	1.5	.3	300	<.5	<200	10	500	<1	<10	<20	7	30	15	<20	<5	10	7
013	2	1	2	.3	700	<.5	<200	10	700	<1	<10	<20	7	<5	15	<20	<5	10	5
032	3	.7	1.5	.3	700	<.5	<200	<10	700	<1	<10	<20	7	7	7	<20	<5	10	5
047	1.5	1.5	2	.3	300	<.5	<200	15	500	1	<10	<20	7	50	7	<20	<5	10	10
048	1.5	1.5	1.5	.3	500	.5	<200	10	700	<1	<10	<20	5	70	15	<20	20	10	30
055	3	.7	1	.3	300	<.5	<200	<10	700	<1	<10	<20	7	15	15	<20	<5	10	7
056	3	1.5	1.5	.3	700	<.5	<200	<10	700	1	<10	<20	7	10	30	<20	<5	10	7
058	1.5	1	.7	.3	700	<.5	<200	10	300	<1	<10	<20	7	70	30	<20	7	10	7
059	3	1.5	1.5	.3	700	<.5	<200	<10	300	<1	<10	<20	7	7	7	<20	<5	10	7
060	5	1.5	3	.15	1,000	<.5	<200	10	10	<1	<10	<20	10	150	30	<20	50	10	70
061	3	.7	7	.2	200	1.5	<200	10	<20	<1	30	<20	7	70	150	20	70	<10	30
062	2	2	5	.3	150	1.5	<200	70	300	1.5	<10	<20	10	70	30	70	<5	15	30
063	2	1.5	3	.3	1,500	.7	<200	30	3,000	1.5	<10	<20	10	70	15	50	<5	20	20
064	2	1.5	3	.3	300	<.5	<200	<10	1,500	1	<10	<20	10	20	20	30	<5	20	7
065	3	1.5	3	.3	150	<.5	<200	10	700	1.5	<10	<20	15	70	20	50	<5	15	15
067	2	.5	.7	.3	500	1.5	<200	<10	700	1.5	10	<20	5	<5	150	50	<5	15	<5
068	2	.7	.5	.3	100	<.5	<200	<10	700	1.5	<10	<20	10	20	15	30	<5	20	5
069	2	.3	.7	.2	700	<.5	<200	15	700	1.5	<10	<20	7	20	<5	30	<5	15	5
082	3	1.5	3	.3	150	<.5	<200	<10	700	1	<10	<20	10	30	50	30	<5	15	10
126	1.5	.5	1.5	.2	500	<.5	<200	10	700	1	<10	<20	<5	15	10	50	<5	10	<5
127	.5	.1	.5	.07	150	<.5	<200	<10	300	1	<10	<20	<5	<5	7	30	5	<10	<5
128	1.5	.7	.7	.15	300	<.5	<200	15	700	1	<10	<20	<5	10	10	50	<5	10	<5
135	5	1	1.5	.3	1,000	.5	<200	10	300	<1	15	<20	7	5	20	50	<5	<10	<5
145	7	2	.7	.2	1,000	<.5	<200	<10	1,000	<1	<10	<20	10	10	15	20	<5	<10	5
154	7	.2	.3	.1	500	10	700	10	300	1	<10	70	5	15	100	20	<5	10	<5
155	3	1.5	1	.2	200	<.5	<200	10	700	1	<10	<20	15	100	50	30	<5	10	50
161	7	1.5	5	.3	700	<.5	<200	10	700	<1	<10	<20	10	15	10	50	<5	15	10
163	5	1.5	1.5	.2	500	<.5	<200	<10	700	<1	<10	<20	7	10	10	30	<5	<10	<5
164	3	2	1.5	.3	300	<.5	<200	<10	500	1	<10	<20	7	70	20	20	<5	10	30
185	5	2	5	.2	1,000	.5	<200	<10	700	<1	<10	<20	10	10	150	50	<5	<10	5
188	2	.5	.1	.15	150	2	<200	<10	700	1.5	10	<20	<5	10	150	70	<5	15	<5
189	1	.5	.07	.2	70	5	300	<10	500	1.5	15	<20	<5	10	20	100	<5	15	<5
196	.7	.1	<.05	.07	20	1.5	<200	<10	200	<1	<10	<20	<5	<5	50	30	20	10	<5
201	2	1	2	.3	500	<.5	<200	10	700	1	<10	<20	5	30	30	30	<5	<10	10
202	2	1	2	.5	500	<.5	<200	15	500	1	<10	<20	<5	70	20	50	<5	10	10
203	1.5	1.5	.7	.3	300	<.5	<200	20	200	1.5	<10	<20	5	100	7	50	5	15	50
204	1.5	.7	1	.15	500	<.5	<200	<10	700	1	<10	<20	<5	10	7	30	<5	<10	<5
205	2	1	5	.3	500	<.5	<200	70	500	1	<10	<20	15	50	10	50	<5	10	10
208	3	1.5	3	.2	500	<.5	<200	<10	700	1	<10	<20	7	50	50	30	<5	<10	5
209	2	2	2	.3	300	<.5	<200	15	700	1.5	<10	<20	7	150	30	30	<5	10	50
210	3	1.5	5	.3	500	<.5	<200	<10	700	1	<10	<20	7	20	50	30	<5	<10	5
211	2	2	2	.3	200	<.5	<200	20	700	1.5	<10	<20	7	150	50	50	10	15	50
212	3	2	5	.5	500	<.5	<200	<10	700	1	<10	<20	10	<5	50	50	<5	<10	<5
213	2	2	2	.5	200	<.5	<200	50	700	1	<10	<20	10	150	70	50	20	10	70
214	3	1.5	5	.5	700	<.5	<200	<10	1,000	1	<10	<20	7	<5	50	50	<5	<10	<5
215	3	2	1	.3	300	.5	<200	15	500	1.5	<10	<20	10	100	100	50	10	10	50
216	7	2	1.5	.3	1,000	<.5	<200	<10	1,000	<1	<10	<20	10	15	10	50	<5	10	5
217	7	2	1.5	.3	1,000	<.5	<200	<10	700	<1	<10	<20	7	15	20	50	<5	10	5
218	5	1.5	1.5	.3	700	<.5	<200	<10	1,000	<1	<10	<20	7	15	15	50	<5	10	5
219	7	1.5	1.5	.5	700	<.5	<200	<10	1,000	<1	<10	<20	10	15	30	50	<5	10	15
220	7	1	1	.2	500	<.5	<200	<10	700	<1	<10	<20	5	5	20	20	<5	<10	5
221	5	1.5	1	.3	1,000	<.5	<200	<10	700	<1	<10	<20	5	7	7	20	<5	<10	<5
222	3	1	1	.2	300	<.5	<200	30	700	<1	<10	<20	7	30	20	30	5	10	15
223	5	2	1	.3	500	<.5	<200	30	700	<1	<10	<20	10	70	30	30	10	10	30

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a geometric scale. The assigned group for semiquantitative results will include the quantitative value about 30 percent of the time. These data should not be quoted without stating these limitations.

---, not looked for; <, less than the amount shown. Where less than symbol is used the amount shown is the lower limit of semiquantitative determination. Some elements are reported at one lower limit of determination for some samples and at different limits for other samples, because of different sensitivities of the different instruments used for analyses]

	Semiquantitative spectrographic analyses--Continued									Chemical analyses					
	(ppm)									(ppm)					Sample
Sample	Pb	Sb	Sc	Sn	Sr	V	Y	Zn	Zr	Au	Zn	As	Sb	Hg	description 1/
006	15	<100	7	<10	300	70	15	<200	70	<0.02	48	<10	---	0.05	Tl, py ig.
007	10	<100	7	<10	200	70	15	<200	70	<.02	44	<10	---	.02	Do.
013	20	<100	15	<10	700	150	15	<200	70	<.02	90	<10	---	.02	Do.
032	10	<100	15	<10	700	150	15	<200	70	<.02	47	<10	---	.02	Do.
047	20	<100	7	<10	200	70	15	<200	70	<.02	31	<10	---	---	Py Km.
048	30	<100	10	<10	200	200	15	<200	70	<.02	120	<10	---	.12	Do.
055	20	<100	10	<10	300	150	15	<200	70	<.02	190	<10	---	.08	Py ig.
056	15	<100	15	10	700	150	15	<200	70	<.02	54	<10	---	.05	Do.
058	30	<100	7	<10	300	150	15	<200	70	<.02	320	<10	---	.07	Do.
059	20	<100	15	<10	500	150	15	<200	70	<.02	85	<10	---	.08	Do.
060	20	<100	7	10	300	300	15	<200	50	<.02	61	<10	---	.28	Skarn, mg.
061	30	<100	7	10	200	300	15	<200	70	<.02	280	200	---	.26	Do.
062	10	<100	10	<10	150	150	30	<200	150	<.02	90	40	10	---	Py Km.
063	200	<100	10	<10	100	100	20	700	150	<.02	680	100	6	---	Do.
064	30	<100	10	<10	700	100	20	<200	150	<.02	40	<10	2	---	Tl, py ig, Km.
065	70	<100	15	<10	300	150	30	<200	150	<.02	70	<10	1	---	Py Km, ig.
067	150	<100	7	<10	200	70	20	300	100	.9	400	40	5	---	Tl, py ig.
068	20	<100	7	<10	500	70	15	<200	300	<.02	40	<10	1	---	Tl, py Km, ig.
069	30	<100	7	<10	100	50	15	<200	300	<.02	120	30	4	---	Do.
082	15	<100	10	<10	700	100	15	<200	70	<.02	50	<10	5	---	Py ig, Km.
126	20	<100	10	<10	700	70	20	<200	100	<.02	50	<10	<1	.04	Py ig.
127	15	<100	5	<10	300	10	10	<200	70	<.02	30	<10	2	.03	Do.
128	20	<100	15	<10	700	70	20	<200	150	<.02	52	<10	2	.02	Do.
135	150	<100	10	<10	300	150	20	<200	150	.02	100	<10	3	---	Do.
145	30	<100	15	<10	500	150	15	<200	70	<.02	66	10	1	.02	Do.
154	200	<100	5	<10	<100	30	15	2,000	70	<.02	3,000	200	12	.06	Qz, py, gn vn.
155	50	<100	10	<10	200	150	20	<200	150	<.02	32	20	2	.07	Py Km.
161	50	<100	10	<10	700	150	20	<200	150	<.02	70	20	1	.02	Blch Tt.
163	30	<100	10	<10	700	150	20	<200	150	<.02	62	20	2	.01	Tl, py ig.
164	30	<100	10	<10	200	150	20	<200	150	<.02	62	10	2	.02	Tl, py Km.
185	30	<100	20	<10	1,000	100	20	<200	70	.04	66	10	1	.03	Py ig.
188	50	<100	10	<10	<100	50	20	<200	150	.14	<25	40	4	.08	Py arg ig.
189	1,000	<100	15	<10	<100	50	20	<200	200	.28	<25	200	8	.16	Do.
196	50	<100	<5	<10	<100	15	<10	<200	30	.02	<25	10	3	.06	Py ig.
201	30	<100	15	<10	700	100	20	<200	70	<.02	72	<10	<1	.04	Tl, py ig.
202	20	<100	20	<10	500	150	30	<200	100	<.02	48	40	2	.03	Tl, py Km.
203	30	<100	15	<10	100	150	50	<200	200	<.02	96	<10	2	<.01	Do.
204	10	<100	10	<10	700	50	20	<200	70	<.02	72	<10	1	.06	Tl, py ig.
205	10	<100	20	<10	700	150	30	<200	150	<.02	78	<10	<1	.06	Do.
208	10	<100	15	<10	700	150	20	<200	100	<.02	40	90	2	.04	Do.
209	20	<100	20	<10	200	200	30	<200	100	<.02	92	<10	2	.05	Tl, py Km.
210	10	<100	20	<10	1,000	100	20	<200	50	<.02	68	10	2	.03	Tl, py ig.
211	15	<100	20	<10	300	200	30	<200	150	<.02	72	<10	4	.03	Tl, py Km.
212	10	<100	20	<10	700	150	30	<200	70	<.02	120	20	2	.06	Tl, py ig.
213	10	<100	20	<10	300	300	50	<200	100	<.02	48	10	2	.04	Tl, py Km.
214	15	<100	20	<10	1,000	150	30	<200	70	<.02	156	20	3	.03	Tl, py ig.
215	30	<100	20	<10	200	300	30	<200	100	<.02	120	<10	2	.04	Tl, py Km.
216	30	<100	15	<10	700	200	30	<200	150	.02	60	10	2	<.01	Tl, py vol.
217	30	<100	15	<10	700	200	30	<200	150	<.02	62	10	1	.01	Tl, py ig.
218	30	<100	15	<10	700	150	20	<200	200	<.02	34	20	1	.02	Do.
219	30	<100	20	<10	700	200	30	<200	150	<.02	80	20	2	.02	Do.
220	20	<100	15	<10	700	100	10	<200	100	<.02	38	10	2	.02	Py ig.
221	50	<100	15	<10	700	150	10	<200	100	<.02	42	<10	1	.02	Do.
222	20	<100	10	<10	300	150	20	<200	150	<.02	26	20	2	.02	Tl, py ig.
223	30	<100	15	<10	200	200	20	<200	150	<.02	88	10	1	<.01	Tl, py Km.

TABLE 4.—*Analyses of altered rocks from the*

Semiquantitative spectrographic analyses

Sample	Fe (percent)	Mg	Ca	Ti	Mn (ppm)	Ag	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Nb	Ni
224	3.0	1.5	1.5	0.2	300	<0.5	<200	15	700	<1	<10	<20	7	20	15	20	10	10	15
225	10	2	2	.3	1,000	<.5	<200	<10	1,000	<1	<10	<20	10	15	15	70	<5	<10	10
226	10	1.5	2	.3	700	<.5	<200	15	700	<1	<10	<20	7	20	20	30	<5	<10	15
228	10	2	3	.3	1,000	<.5	<200	<10	1,000	<1	<10	<20	10	10	7	30	<5	<10	5
229	5	2	1.5	.3	300	<.5	<200	20	700	1	<10	<20	7	30	30	30	<5	10	30
230	7	2	1.5	.3	300	<.5	<200	20	700	<1	<10	<20	15	100	50	30	<5	10	30
231	10	2	2	.5	500	<.5	<200	<10	1,500	<1	<10	<20	10	50	50	20	<5	10	15
232	7	2	1.5	.5	1,000	<.5	<200	10	700	<1	<10	<20	10	30	30	20	<5	10	10
233	2	.7	1	.2	300	<.5	<200	20	700	1	<10	<20	<5	20	15	20	<5	<10	5
235	10	1.5	1.5	.3	500	<.5	<200	<10	700	<1	<10	<20	10	15	70	30	<5	10	15
236	7	2	1	.3	300	<.5	<200	15	700	1	<10	<20	10	70	50	30	<5	10	50
237	7	1.5	1.5	.3	300	<.5	<200	<10	1,000	<1	<10	<20	10	50	150	30	<5	10	15
238	5	1.5	.7	.2	200	<.5	<200	50	500	<1	<10	<20	7	70	50	30	10	10	30
239	7	3	2	.5	1,000	<.5	<200	700	300	<1	<10	<20	15	20	30	30	<5	<10	10
241	7	2	1.5	.3	1,000	<.5	<200	50	700	<1	<10	<20	15	50	70	20	20	<10	30
242	5	1	1.5	.2	700	<.5	<200	<10	700	<1	<10	<20	5	5	10	20	<5	<10	5
252	10	2	1.5	.2	500	<.5	<200	300	700	<1	<10	<20	10	50	50	30	<5	10	20
253	5	1.5	1	.2	300	<.5	<200	<10	1,000	<1	<10	<20	5	5	7	30	<5	<10	<5
254	7	1.5	1.5	.3	500	<.5	<200	<10	700	<1	<10	<20	7	5	20	30	<5	<10	<5
255	7	2	1.5	.3	200	<.5	<200	<10	700	1.5	<10	<20	7	70	30	30	<5	10	20
257	7	2	2	.3	1,000	<.5	<200	<10	700	<1	<10	<20	10	5	15	30	<5	<10	<5
258	5	2	1	.3	500	<.5	<200	10	700	1.5	<10	<20	7	70	30	30	<5	10	30
259	7	1.5	2	.3	1,000	<.5	<200	<10	700	<1	<10	<20	7	5	10	20	<5	<10	<5
260	3	1.5	1.5	.2	300	<.5	<200	20	500	1	<10	<20	10	70	30	50	<5	10	30
261	3	1	1.5	.2	500	<.5	<200	<10	700	<1	<10	<20	10	10	7	30	<5	<10	5
268	1.5	.7	3	.3	300	.5	<200	<10	700	<1	<10	<20	10	20	70	30	<5	15	7
269	3	1.5	3	.3	300	<.5	<200	<10	700	<1	<10	<20	10	10	10	30	<5	15	<5
286	2	.3	.7	.15	300	.5	<200	<10	1,000	<1	<10	<20	5	10	150	30	<5	10	<5
300	3	1	5	.5	1,000	<.5	<200	<10	1,000	<1	<10	<20	<5	<5	10	30	<5	<10	<5
301	2	1.5	1.5	.3	300	.5	<200	10	500	1	<10	<20	7	100	50	50	<5	10	50
302	2	1.5	1	.2	150	<.5	<200	10	700	1	<10	<20	5	100	30	30	<5	<10	50
303	3	1.5	5	.2	500	<.5	<200	10	700	1	<10	<20	10	10	20	30	<5	10	<5
304	2	2	3	.5	300	<.5	<200	30	700	1	<10	<20	10	150	50	50	<5	10	50
305	2	1.5	3	.3	500	<.5	<200	10	1,000	1	<10	<20	7	10	30	50	<5	10	5
306	2	2	3	.5	300	<.5	<200	50	700	1.5	<10	<20	10	100	30	50	<5	15	30
307	2	2	5	.2	700	<.5	<200	10	700	1	<10	<20	10	10	30	50	<5	10	5
308	2	1	2	.3	500	<.5	<200	15	700	1	<10	<20	7	<5	20	50	<5	<10	<5
315	7	1.5	1.5	.3	500	<.5	<200	<10	500	<1	<10	<20	10	20	15	30	<5	<10	15
324	5	1	1.5	.2	500	<.5	<200	<10	700	<1	<10	<20	7	5	5	30	<5	<10	<5
326	3	1	1	.2	300	<.5	<200	10	500	1	<10	<20	5	15	15	20	<5	<10	15
328	5	1.5	2	.3	500	<.5	<200	<10	500	<1	<10	<20	10	5	10	20	<5	<10	5

1/ Abbreviations used in table.

arg	argillized	Km	Cretaceous Mancos Shale	tl	sample of chips collected from talus
blch	bleached	mg	magnetite	Tt	Telluride conglomerate
gn	galena	py	pyrite	vn	vein
ig	igneous rock	qz	quartz	vol	volcanic rock

Wilson Mountains Primitive Area—Continued

	Semiquantitative spectrographic analyses--Continued									Chemical analyses					
	(ppm)									(ppm)					
Sample	Pb	Sb	Sc	Sn	Sr	V	Y	Zn	Zr	Au	Zn	As	Sb	Hg	Sample description [1]
224	15	<100	10	<10	500	150	15	<200	150	<0.02	<25	20	1	<0.01	Tl, py ig, Km.
225	50	<100	20	<10	700	200	20	<200	150	<.02	38	20	2	<.01	Tl, py ig.
226	30	<100	15	<10	700	200	20	<200	150	<.02	56	30	2	<.01	Tl, py Tt, ig.
228	20	<100	20	<10	700	200	30	<200	150	<.02	44	20	<1	<.01	Tl, py ig.
229	30	<100	15	<10	200	150	20	<200	150	<.02	200	10	<1	<.01	Tl, py Km.
230	30	<100	15	<10	300	200	20	<200	150	<.02	150	20	2	.02	Tl, py Km, ig.
231	30	<100	15	20	500	200	30	<200	150	<.02	140	10	1	<.01	Py ig.
232	20	<100	15	<10	500	200	30	<200	150	<.02	38	20	1	<.01	Tl, py ig, Km.
233	30	<100	10	<10	300	50	20	<200	200	<.02	42	30	1	.01	Tl, py Km.
235	15	<100	15	<10	700	150	30	<200	150	<.02	90	10	1	<.01	Tl, py ig.
236	30	<100	15	<10	200	200	30	<200	150	<.02	82	<10	1	<.01	Tl, py Km.
237	30	<100	15	<10	700	150	30	<200	150	<.02	36	20	1	<.01	Tl, py ig.
238	30	<100	10	<10	200	100	30	<200	150	.1	88	30	2	<.01	Tl, py Km.
239	50	<100	20	<10	700	200	30	500	150	<.02	850	30	1	<.01	Tl, py ig.
241	20	<100	20	<10	500	300	30	<200	150	<.02	92	30	3	<.01	Py Km, ig.
242	20	<100	7	<10	700	70	15	<200	150	<.02	36	<10	2	.03	Py ig.
252	100	<100	15	<10	300	150	30	<200	150	<.02	96	20	3	.02	Py Km.
253	20	<100	7	<10	500	100	10	<200	150	<.02	<25	20	2	.02	Py ig.
254	30	<100	10	<10	500	100	20	<200	150	<.02	42	10	1	<.01	Do.
255	20	<100	10	<10	300	150	30	<200	200	<.02	40	30	1	<.02	Py ig, Km.
257	10	<100	15	<10	700	150	30	<200	150	<.02	82	40	2	<.01	Py ig.
258	30	<100	15	<10	200	150	20	<200	150	<.02	88	10	2	<.01	Py Km.
259	20	<100	10	<10	700	150	20	<200	150	<.02	46	10	2	<.01	Tl, py ig.
260	20	<100	10	<10	200	150	20	<200	150	<.02	94	10	2	<.01	Tl, py Km.
261	10	<100	10	<10	500	100	15	<200	150	<.02	80	10	1	<.01	Tl, py ig.
268	15	<100	10	<10	300	70	15	<200	150	<.02	40	20	3	---	Do.
269	20	<100	15	<10	700	100	15	<200	150	<.02	40	10	1	---	Do.
286	30	<100	7	<10	700	50	10	<200	100	.02	110	10	3	---	Py ig.
300	20	<100	15	<10	1,000	100	20	<200	50	.06	48	<10	2	.03	Tl, py ig.
301	30	<100	15	<10	200	100	30	<200	100	.04	150	<10	3	.03	Tl, py Km.
302	20	<100	15	<10	200	100	20	<200	70	.04	110	10	3	.06	Do.
303	20	<100	20	<10	1,000	150	20	<200	70	.02	48	<10	2	.03	Tl, py ig.
304	20	<100	20	<10	500	150	50	<200	100	<.02	52	20	2	.06	Tl, py Km.
305	70	<100	15	<10	1,000	100	50	<200	70	<.02	50	<10	2	.06	Tl, py ig.
306	50	<100	20	<10	500	150	50	<200	200	.06	60	<10	2	.02	Tl, py Km.
307	70	<100	15	<10	700	70	50	<200	70	<.02	110	<10	2	.04	Tl, py ig.
308	70	<100	15	<10	700	70	30	<200	100	<.02	150	10	3	.03	Do.
315	15	<100	15	<10	500	200	20	<200	150	<.02	58	10	2	<.01	Py ig.
324	15	<100	7	<10	700	100	20	<200	100	<.02	54	10	<1	<.01	Do.
326	15	<100	7	<10	300	100	20	<200	70	<.02	62	20	1	.01	Do.
328	15	<100	10	<10	700	150	20	<200	70	<.02	90	20	<1	<.01	Do.

TABLE 5.—*Analyses of stream sediments and panned*

[Semiquantitative analyses were made by C. L. Forn, J. M. Motooka, and K. C. Watts. Gold analyses were made by atomic-absorption spectrometry by R. W. Leinz and M. S. Rickard.

Spectrographic analyses are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, and so forth, which represent approximate midpoints of group data on a geometric scale. The assigned group for semiquantitative results will include the

Semiquantitative spectrographic analyses

	(percent)				(ppm)										
Sample	Fe	Mg	Ca	Ti	Mn	Ag	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu
							Stream sediments								
001	1.5	0.7	0.3	0.3	200	<0.5	<200	30	300	<1	<10	<20	7	30	150
003	3	.7	.7	.3	300	1.5	<200	15	300	<1	<10	<20	10	7	300
009	1.5	.7	.7	.3	300	<.5	<200	15	300	1	<10	<20	7	15	30
015	1.5	.7	.3	.3	300	<.5	<200	30	300	<1	<10	<20	7	30	15
016	1.5	.7	.2	.3	200	<.5	<200	30	300	<1	<10	<20	7	30	15
017	1.5	.7	.15	.3	200	<.5	<200	30	300	<1	<10	<20	7	70	15
018	1.5	1.5	.3	.3	200	<.5	<200	50	300	<1	<10	<20	7	70	15
019	1.5	.7	.3	.3	300	<.5	<200	15	300	<1	<10	<20	7	30	15
020	1.5	.7	.2	.3	300	<.5	<200	30	300	<1	<10	<20	7	30	15
021	1.5	1.5	1.5	.3	150	<.5	<200	50	300	<1	<10	<20	7	30	15
022	1.5	1.5	1	.3	100	<.5	<200	30	300	<1	<10	<20	7	30	15
025	1.5	.7	.7	.3	300	<.5	<200	30	300	<1	<10	<20	7	30	15
027	1.5	.7	.3	.3	300	<.5	<200	30	300	<1	<10	<20	7	30	15
028	1.5	1.5	.7	.3	150	<.5	<200	30	300	<1	<10	<20	7	30	15
029	1.5	.7	.3	.3	300	<.5	<200	70	300	1	<10	<20	7	70	15
030	1.5	1.5	.7	.3	200	<.5	<200	30	300	<1	<10	<20	7	70	15
031	1.5	1.5	.7	.3	200	<.5	<200	30	300	<1	<10	<20	7	150	15
034	1.5	1.5	.7	.3	150	<.5	<200	30	300	<1	<10	<20	7	50	15
035	1.5	1.5	1.5	.3	150	<.5	<200	30	300	<1	<10	<20	7	50	15
036	1.5	1.5	2	.3	150	<.5	<200	30	300	<1	<10	<20	7	50	15
037	3	.7	.3	.3	300	<.5	<200	30	500	1	<10	<20	7	50	30
038	3	.7	.3	.3	300	<.5	<200	30	300	<1	<10	<20	7	50	20
039	1.5	.3	.7	.3	200	<.5	<200	15	300	1.5	<10	<20	5	20	15
040	3	.7	.3	.3	300	<.5	<200	70	300	<1	<10	<20	7	50	15
043	3	.7	.3	.3	700	7	<200	30	300	<1	<10	<20	7	30	150
045	3	.7	.3	.3	300	<.5	<200	30	300	<1	<10	<20	5	30	30
049	3	1.5	.3	.3	300	<.5	<200	50	300	<1	<10	<20	5	150	20
050	3	1.5	.3	.3	300	<.5	<200	30	300	<1	<10	<20	5	70	15
052	3	.7	.7	.3	300	<.5	<200	30	300	<1	<10	<20	5	30	15
053	3	1.5	.3	.3	300	<.5	<200	70	500	<1	<10	<20	5	150	15
073	3	.7	.3	.3	150	<.5	<200	30	300	<1	<10	<20	5	30	15
074	3	1.5	.3	.3	300	<.5	<200	30	300	<1	<10	<20	5	70	15
075	3	.7	.3	.3	300	<.5	<200	30	300	<1	<10	<20	5	150	15
076	3	.7	.7	.3	150	<.5	<200	30	300	<1	<10	<20	5	70	15
077	3	.7	.3	.3	150	<.5	<200	30	300	<1	<10	<20	5	70	15
078	3	.7	.7	.3	100	<.5	<200	30	300	<1	<10	<20	5	70	15
079	3	.7	.7	.3	300	<.5	<200	10	700	<1	<10	<20	5	5	70
083	1.5	.7	1	.2	200	<.5	<200	30	300	<1	<10	<20	5	70	20
084	1.5	.5	.5	.2	300	<.5	<200	30	300	1	<10	<20	5	70	20
085	1	.3	.3	.2	200	<.5	<200	30	300	1	<10	<20	5	30	15
086	1	.3	.3	.2	200	<.5	<200	30	300	1	<10	<20	5	70	20
087	1	.7	1	.2	200	<.5	<200	30	300	1	<10	<20	7	100	20
088	1	.7	1	.2	150	<.5	<200	50	300	1	<10	<20	7	100	20
089	1	.3	.3	.2	300	<.5	<200	20	300	1	<10	<20	5	30	15
090	1.5	.5	.5	.2	500	<.5	<200	30	300	1	<10	<20	5	70	20
091	1	.3	.7	.2	500	<.5	<200	10	700	<1	<10	<20	5	10	20
092	.7	.2	.5	.15	200	<.5	<200	15	300	1	<10	<20	5	20	20
093	.7	.3	.5	.15	200	<.5	<200	20	200	1	<10	<20	5	30	15
094	1.5	1	1.5	.3	300	<.5	<200	15	300	<1	<10	<20	7	70	20
097	1	.3	.7	.3	500	<.5	<200	15	300	1	<10	<20	5	15	15
098	1.5	.3	.7	.2	500	<.5	<200	20	500	<1	<10	<20	7	20	20
099	1	.3	.3	.2	700	<.5	<200	30	300	<1	<10	<20	5	20	10
100	1.5	.3	.5	.2	1,000	<.5	<200	30	300	1	<10	<20	5	30	30
101	1.5	.3	.3	.2	500	<.5	<200	30	300	<1	<10	<20	5	50	20
102	.7	.15	.5	.15	150	<.5	<200	10	200	<1	<10	<20	<5	<5	10

concentrates from the Wilson Mountains Primitive Area

quantitative value about 30 percent of the time. These data should not be quoted without stating these limitations.
<, less than the amount shown. Where less than symbol is used the amount shown is the lower limit of semiquantitative determination. Some elements are reported at one lower limit of determination for some samples and at different limits for other samples, because of different sensitivities of the different instruments used for analyses]

	Semiquantitative spectrographic analyses--Continued (ppm)													Chemical analyses (ppm)
Sample	La	Mo	Nb	Ni	Pb	Sb	Sc	Sn	Sr	V	Y	Zn	Zr	Au
						Stream sediments								
001	30	<5	<10	15	50	<100	<5	<10	150	70	15	<200	70	0.08
003	30	7	<10	7	150	<100	<5	<10	300	70	15	200	70	.2
009	<20	<5	<10	7	70	<100	<5	<10	150	70	15	<200	150	1.3
015	<20	<5	<10	10	10	<100	<5	<10	<100	70	15	<200	150	<.02
016	<20	<5	<10	30	10	<100	<5	<10	<100	70	15	<200	70	<.02
017	<20	<5	<10	30	10	<100	<5	<10	<100	70	15	<200	70	<.02
018	<20	<5	<10	30	15	<100	<5	<10	<100	70	15	<200	70	<.02
019	30	<5	<10	15	15	<100	<5	<10	100	70	15	<200	70	<.02
020	30	<5	<10	15	15	<100	<5	<10	<100	70	15	<200	150	<.02
021	<20	<5	<10	15	10	<100	<5	<10	<100	70	15	<200	70	<.02
022	<20	<5	<10	10	10	<100	<5	<10	<100	70	15	<200	70	<.02
025	30	<5	<10	10	30	<100	<5	<10	150	70	15	<200	70	<.02
027	30	<5	<10	15	30	<100	<5	<10	150	70	15	<200	70	<.02
028	30	<5	<10	30	L	<100	<5	<10	<100	70	15	<200	100	<.02
029	30	5	<10	30	10	<100	<5	<10	<100	70	15	<200	70	<.02
030	30	<5	<10	30	10	<100	<5	<10	<100	70	15	<200	70	<.02
031	30	<5	<10	30	10	<100	<5	<10	<100	70	15	<200	70	<.02
034	30	<5	<10	20	10	<100	<5	<10	<100	70	15	<200	70	<.02
035	30	<5	<10	20	10	<100	<5	<10	<100	70	15	<200	70	<.02
036	30	5	<10	30	10	<100	<5	<10	150	70	15	<200	70	<.02
037	30	<5	<10	30	30	<100	7	<10	150	150	20	<200	300	<.02
038	<20	<5	<10	30	30	<100	7	<10	100	150	20	<200	70	<.02
039	30	<5	<10	7	30	<100	7	<10	100	70	20	<200	300	<.02
040	30	<5	<10	15	30	<100	7	<10	150	100	20	<200	300	<.02
043	30	<5	<10	7	70	<100	7	<10	150	70	20	300	70	.1
045	<20	<5	<10	7	30	<100	7	<10	<100	70	20	<200	70	<.04
049	<20	5	<10	30	30	<100	10	<10	150	150	20	<200	70	<.02
050	<20	5	<10	30	30	<100	7	<10	100	150	20	<200	70	<.02
052	<20	<5	<10	20	15	<100	7	<10	<100	70	20	<200	70	<.02
053	<20	5	<10	30	30	<100	7	<10	<100	150	20	<200	70	<.02
073	30	<5	<10	30	15	<100	7	<10	<100	70	20	<200	300	<.02
074	30	<5	<10	30	20	<100	7	<10	100	70	20	<200	200	<.02
075	30	<5	<10	7	20	<100	7	<10	150	70	20	<200	200	<.02
076	<20	<5	<10	30	20	<100	7	<10	<100	70	20	<200	200	<.02
077	<20	<5	<10	15	15	<100	7	<10	100	70	20	<200	300	<.02
078	<20	<5	<10	7	15	<100	7	<10	<100	70	20	<200	200	<.02
079	<20	<5	<10	7	20	<100	7	<10	300	70	20	<200	70	<.02
083	20	<5	<10	20	30	<100	7	<10	<100	200	20	<200	150	<.02
084	20	<5	<10	15	30	<100	7	<10	<100	150	20	<200	200	<.02
085	20	<5	10	20	15	<100	7	<10	<100	100	20	<200	300	<.02
086	20	<5	<10	20	20	<100	7	<10	<100	150	20	<200	200	<.02
087	20	10	<10	30	20	<100	7	<10	100	200	20	<200	150	<.02
088	20	7	<10	30	20	<100	7	<10	<100	200	20	<200	150	<.02
089	20	<5	<10	5	15	<100	7	<10	100	100	20	<200	300	<.02
090	20	<5	<10	15	30	<100	7	<10	100	150	20	<200	200	<.02
091	20	<5	<10	<5	20	<100	7	<10	300	70	15	<200	200	<.02
092	20	<5	<10	<5	15	<100	7	<10	100	70	15	<200	300	<.02
093	20	<5	<10	5	20	<100	7	<10	<100	70	15	<200	150	<.02
094	30	5	10	30	20	<100	7	<10	100	200	20	<200	150	<.02
097	20	<5	<10	5	15	<100	7	<10	200	100	15	<200	150	<.02
098	20	<5	<10	5	20	<100	7	<10	300	100	15	<200	150	<.02
099	20	<5	<10	5	10	<100	5	<10	100	100	15	<200	200	<.02
100	20	<5	10	10	30	<100	7	<10	100	100	20	<200	200	<.02
101	20	<5	10	15	20	<100	7	<10	<100	150	15	<200	200	<.02
102	20	<5	<10	<5	15	<100	5	<10	100	30	15	<200	100	<.04

TABLE 5.—*Analyses of stream sediments and panned concentrates*

Semiquantitative spectrographic analyses

	(percent)				(ppm)										
Sample	Fe	Mg	Ca	Ti	Mn	Ag	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu
						Stream sediments--Continued									
104	1.0	0.3	0.7	0.3	500	<.5	<200	30	300	1	<10	<20	5	20	15
105	1.5	.7	.7	.3	500	<.5	<200	30	300	<1	<10	<20	5	30	20
106	.7	.2	.5	.15	300	<.5	<200	15	200	<1	<10	<20	<5	10	10
107	.7	.2	.5	.2	150	<.5	<200	20	200	<1	<10	<20	<5	30	20
108	1	.5	.3	.2	200	<.5	<200	30	300	<1	<10	<20	5	50	30
109	1.5	.7	1	.2	150	<.5	<200	50	300	<1	<10	<20	5	70	20
110	1.5	.7	.7	.2	200	<.5	<200	50	300	<1	<10	<20	7	70	30
111	1.5	.7	.5	.3	150	<.5	<200	70	300	<1	<10	<20	7	100	30
120	.7	.3	.3	.2	200	<.5	<200	20	300	<1	<10	<20	<5	30	15
121	.7	.7	1	.2	150	<.5	<200	30	300	<1	<10	<20	5	50	20
122	.7	.7	1.5	.15	150	<.5	<200	30	300	<1	<10	<20	5	50	20
123	.7	.7	1	.2	200	<.5	<200	30	300	<1	<10	<20	5	50	20
124	1	.5	.3	.2	300	<.5	<200	20	300	<1	<10	<20	5	50	50
125	1.5	.7	1	.2	300	<.5	<200	30	300	<1	<10	<20	5	70	20
130	1	.7	.7	.3	200	<.5	<200	50	500	<1	<10	<20	7	70	30
134	1	.3	.7	.2	200	<.5	<200	30	200	<1	<10	<20	5	50	20
140	1	.5	.7	.2	300	<.5	<200	20	300	<1	<10	<20	7	50	30
143	2	1	1	.2	500	<.5	<200	20	500	1	<10	<20	7	30	20
144	2	1	.7	.2	300	<.5	<200	30	500	1	<10	<20	7	50	15
146	1	.3	.7	.15	300	<.5	<200	20	150	<1	<10	<20	<5	20	7
147	.7	.3	.5	.1	200	<.5	<200	20	200	<1	<10	<20	<5	30	5
148	1	.3	1	.2	500	<.5	<200	15	300	1	<10	<20	10	50	7
149	1	.5	.7	.15	200	<.5	<200	50	200	1	<10	<20	<5	50	10
150	1	.7	.7	.15	200	<.5	<200	70	300	1	<10	<20	<5	70	10
151	1	.5	.7	.15	200	<.5	<200	50	300	1	<10	<20	<5	70	10
152	1	.3	1	.1	300	<.5	<200	50	300	1	<10	<20	<5	50	10
153	1	.5	1.5	.15	200	<.5	<200	20	200	1	<10	<20	<5	70	10
156	2	.7	1	.3	500	<.5	<200	20	700	1	<10	<20	15	30	20
157	1.5	.7	.5	.3	150	<.5	<200	30	700	<1	<10	<20	5	70	15
158	1.5	.5	.3	.3	200	<.5	<200	20	700	1	<10	<20	5	70	10
159	1.5	.7	.7	.2	200	<.5	<200	20	500	1	<10	<20	7	50	20
162	1.5	.7	.7	.2	200	<.5	<200	15	500	1	<10	<20	5	70	15
186	2	.7	2	.2	500	.5	<200	<10	700	1	<10	<20	15	50	200
187	5	1	2	.5	700	.5	<200	20	700	1.5	<10	<20	10	20	200
193	3	1	2	.7	700	.7	<200	30	700	1.5	<10	<20	15	70	200
194	3	1	5	.7	500	.5	<200	20	700	1.5	<10	<20	10	50	150
199	1	.5	1	.15	300	<.5	<200	15	300	1.5	<10	<20	<5	20	1,000
200	2	1	3	.7	700	.5	<200	20	500	1.5	<10	<20	15	50	200
206	1	.5	.7	.1	150	<.5	<200	15	150	<1	<10	<20	<5	30	10
207	2	.7	1	.5	300	<.5	<200	20	500	1	<10	<20	5	70	10
227	3	.7	1.5	3	1,000	<.5	<200	20	1,000	2	<10	<20	15	50	20
234	2	1	.7	5	300	<.5	<200	100	500	1.5	<10	<20	7	100	20
240	3	1.5	1	7	500	.5	<200	50	700	1.5	<10	<20	15	100	100
251	2	.7	.7	5	700	1	<200	50	700	1.5	<10	<20	15	50	50
256	1	.5	1	.15	300	<.5	<200	15	500	1	<10	<20	<5	50	50
262	1	.3	.7	.15	150	<.5	<200	20	500	1.5	<10	<20	<5	50	7
263	1.5	1	.5	.5	300	<.5	<200	70	500	1.5	<10	<20	5	100	10
264	1	.3	.7	.1	200	<.5	<200	20	200	1	<10	<20	<5	50	7
265	1.5	.5	.5	.3	300	<.5	<200	50	500	2	<10	<20	5	100	10
266	2	.7	.7	.5	500	<.5	<200	50	500	1	<10	<20	10	70	10
267	1	.5	.5	.5	200	<.5	<200	50	500	1	<10	<20	7	100	10
297	5	.7	1	.5	1,000	1.5	<200	70	700	1.5	<10	<20	15	30	150
309	1.5	.7	1.5	.3	700	<.5	<200	20	500	1.5	<10	<20	5	100	15
310	1.5	1	2	.5	300	<.5	<200	30	500	1.5	<10	<20	5	100	10
311	2	.5	.7	.5	300	<.5	<200	20	500	1.5	<10	<20	<5	100	10
312	2	1	5	.3	200	<.5	<200	30	500	1	<10	<20	<5	100	10
313	2	.7	.5	.5	300	<.5	<200	20	500	1	<10	<20	5	100	20
316	1.5	1	15	.15	200	<.5	<200	20	500	1	<10	<20	<5	150	20
317	2	1	1	.3	500	<.5	<200	20	500	1.5	<10	<20	5	100	50
319	1.5	.7	1.5	.2	300	<.5	<200	20	500	1	<10	<20	5	100	20

from the Wilson Mountains Primitive Area—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)													Chemical analyses (ppm)
	La	Mo	Nb	Ni	Pb	Sb	Sc	Sn	Sr	V	Y	Zn	Zr	Au
							Stream sediments--Continued							
104	20	<5	<10	5	15	<100	7	<10	150	100	20	<200	150	<0.02
105	20	<5	<10	7	20	<100	7	<10	200	150	15	<200	150	<.02
106	<20	<5	<10	<5	10	<100	5	<10	<100	50	10	<200	70	<.04
107	<20	<5	<10	10	10	<100	<5	<10	<100	100	15	<200	150	<.02
108	20	5	10	20	20	<100	7	<10	<100	150	20	<200	200	<.02
109	30	<5	10	30	20	<100	7	<10	<100	150	20	<200	200	.02
110	30	<5	10	30	30	<100	7	<10	<100	150	20	<200	200	<.02
111	30	7	10	30	30	<100	7	<10	<100	200	30	<200	200	<.02
120	20	<5	<10	20	15	<100	5	<10	<100	150	15	<200	150	<.02
121	20	<5	<10	20	20	<100	7	<10	<100	150	15	<200	150	.02
122	20	7	<10	20	20	<100	7	<10	<100	200	15	<200	150	.02
123	30	<5	<10	15	20	<100	7	<10	<100	100	15	<200	150	<.02
124	30	<5	<10	15	20	<100	7	<10	<100	100	15	<200	150	.02
125	20	5	<10	20	20	<100	7	<10	<100	200	20	<200	150	<.02
130	20	<5	10	30	30	<100	7	<10	<100	200	20	<200	200	.02
134	<20	<5	<10	20	30	<100	7	<10	<100	150	15	<200	150	<.02
140	20	7	10	20	20	<100	7	<10	150	150	15	<200	200	<.02
143	20	<5	10	20	50	<100	10	<10	300	70	20	<200	100	<.02
144	20	<5	10	50	30	<100	10	<10	200	100	20	<200	100	<.02
146	20	<5	<10	5	20	<100	5	<10	100	70	10	<200	100	<.02
147	20	<5	<10	10	20	<100	7	<10	100	70	15	<200	70	<.02
148	20	<5	10	5	15	<100	7	<10	200	70	20	<200	100	<.02
149	20	<5	10	30	20	<100	7	<10	100	100	20	<200	200	<.02
150	20	<5	15	20	20	<100	10	<10	100	100	20	<200	150	<.02
151	30	<5	15	15	20	<100	10	<10	100	70	20	<200	150	<.02
152	30	<5	15	20	30	<100	7	<10	100	100	20	<200	100	<.02
153	20	<5	10	20	15	<100	10	<10	150	70	20	<200	100	<.02
156	50	<5	15	15	150	<100	15	<10	300	50	50	<200	200	<.02
157	50	<5	20	20	50	<100	10	<10	100	50	30	<200	200	<.02
158	50	<5	15	15	50	<100	10	<10	150	70	20	<200	150	<.02
159	50	<5	15	20	70	<100	15	<10	150	50	50	<200	150	<.02
162	50	<5	15	15	30	<100	10	<10	100	100	30	<200	200	<.02
186	20	5	10	10	100	<100	15	<10	700	70	20	<200	100	<.02
187	70	<5	15	10	150	<100	15	<10	500	100	20	200	150	<.02
193	70	5	15	20	150	<100	15	<10	500	100	50	200	100	.02
194	50	5	15	15	100	<100	15	<10	700	100	30	<200	100	.02
199	20	10	10	10	70	<100	10	<10	200	100	20	<200	50	<.04
200	70	5	20	15	150	<100	20	<10	700	100	50	<200	200	.4
206	20	<5	<10	5	20	<100	5	<10	100	70	10	<200	70	<.02
207	20	<5	10	15	30	<100	15	<10	200	100	20	<200	200	<.02
227	50	<5	20	20	50	<100	10	<10	500	100	50	<200	200	<.02
234	30	<5	20	50	50	<100	15	<10	100	150	50	<200	200	<.02
240	70	<5	20	30	100	<100	20	<10	500	100	50	<200	200	<.02
251	70	15	20	15	200	<100	15	<10	300	70	50	500	300	<.02
256	50	5	10	15	20	<100	7	<10	100	70	20	<200	200	<.02
262	50	5	10	7	15	<100	7	<10	100	50	20	<200	200	<.02
263	50	5	20	30	50	<100	10	<10	<100	100	50	<200	300	<.02
264	50	<5	<10	15	20	<100	7	<10	<100	50	20	<200	100	<.04
265	50	<5	20	30	50	<100	10	<10	150	100	30	<200	200	<.02
266	50	<5	20	30	50	<100	15	<10	200	100	30	<200	500	<.02
267	50	<5	20	50	50	<100	10	<10	150	100	30	<200	200	<.02
297	70	10	20	15	500	<100	15	<10	500	100	50	700	150	<.02
309	50	10	20	50	50	<100	10	<10	200	150	30	<200	200	<.02
310	50	7	30	50	30	<100	15	<10	150	150	50	<200	200	<.02
311	50	15	30	20	20	<100	10	<10	200	100	50	<200	300	<.02
312	50	10	20	50	30	<100	10	<10	150	100	50	<200	200	<.02
313	50	<5	10	30	20	<100	10	<10	200	100	20	<200	200	<.02
316	30	20	<10	50	30	<100	10	<10	500	200	20	<200	70	<.02
317	50	10	15	50	50	<100	15	<10	200	150	30	<200	150	<.02
319	30	<5	15	50	30	<100	10	<10	150	100	20	<200	150	<.02

TABLE 5.—*Analyses of stream sediments and panned concentrates*

Semiquantitative spectrographic analyses

Sample	(percent) Fe	Mg	Ca	Ti	(ppm) Mn	Ag	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu
							Stream sediments--Continued								
320	1.5	1.0	0.3	0.3	200	<0.5	<200	20	500	1	<10	<20	7	100	50
321	1.5	.7	1	.3	500	<.5	<200	10	300	1	<10	<20	5	100	30
322	1.5	1	.7	.3	200	<.5	<200	20	500	1.5	<10	<20	7	150	30
323	1.5	1.5	1.5	.5	500	<.5	<200	15	500	1.5	<10	<20	7	100	50
325	2	1	.5	.5	200	<.5	<200	20	500	1.5	<10	<20	10	100	50
327	3	.7	.7	.5	300	<.5	<200	10	500	1	<10	<20	5	70	20
329	2	1	.5	.5	300	<.5	<200	20	700	1	<10	<20	10	150	30
331	1.5	.7	.5	.3	300	<.5	<200	10	500	1.5	<10	<20	<5	70	7
							Panned concentrates								
002	1.5	.7	0.5	0.3	300	0.5	<200	30	500	<1	<10	<20	10	50	150
004	3	.7	.7	.3	300	1	<200	15	500	<1	10	<20	20	20	300
008	15	.3	.7	.7	700	3	<200	20	300	<1	20	<20	30	150	150
010	1.5	.7	.7	.3	300	<.5	<200	10	300	<1	<10	<20	7	10	10
026	1.5	.7	.5	.3	300	<.5	<200	50	500	1	<10	<20	10	70	5
041	1.5	.7	1	.2	150	<.5	<200	50	1,500	<1	<10	<20	7	70	5
042	1.5	.7	.5	.3	300	<.5	<200	50	300	1	<10	<20	10	70	5
044	3	.7	.3	.3	700	15	700	30	300	<1	30	<20	30	7	30
046	3	1.5	.3	.3	700	<.5	<200	30	300	<1	<10	<20	7	150	15
051	7	.7	.7	.5	700	<.5	<200	30	300	<1	<10	<20	20	70	10
054	1.5	.7	.7	.3	300	<.5	<200	50	300	<1	<10	<20	10	70	5
270	3	.7	1.5	.5	700	<.5	<200	30	500	<1	<10	<20	10	30	30
314	2	.7	1	.3	300	<.5	<200	15	1,000	1	<10	<20	7	100	30
318	3	1	.1	.3	500	<.5	<200	15	500	1	<10	<20	10	100	50
330	2	1.5	.3	.5	200	<.5	<200	20	500	1	<10	<20	5	150	30

from the Wilson Mountains Primitive Area—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) La	Mo	Nb	Ni	Pb	Sb	Sc	Sn	Sr	V	Y	Zn	Zr	Chemical analyses (ppm) Au
						Stream sediments--Continued								
320	50	5	10	30	30	<100	15	<10	200	150	50	<200	300	<0.02
321	50	10	15	20	50	<100	10	<10	150	70	20	<200	150	<.02
322	50	10	15	70	30	<100	15	<10	200	100	30	<200	200	<.02
323	50	5	15	50	30	<100	20	<10	300	100	30	<200	150	<.02
325	50	10	15	70	30	<100	20	<10	150	200	30	<200	100	<.04
327	50	5	15	15	30	<100	10	<10	200	100	20	<200	150	<.02
329	70	7	10	70	30	<100	15	<10	150	150	30	<200	100	<.04
331	50	<5	15	20	30	<100	10	<10	100	70	30	<200	150	<.04
						Panned concentrates								
002	20	5	10	7	70	<100	7	<10	200	70	15	200	70	1.3
004	20	5	10	7	150	<100	7	<10	300	70	15	300	70	46
008	<20	5	15	<5	150	<100	10	70	150	300	30	200	700	3.2
010	<20	<5	10	7	30	<100	7	15	200	70	15	<200	70	.6
026	<20	5	10	15	30	<100	10	<10	200	150	15	<200	70	<.02
041	<20	5	10	20	20	<100	7	<10	100	70	15	<200	100	<.02
042	<20	5	10	20	30	<100	10	<10	150	150	15	<200	100	<.02
044	70	5	<10	7	300	<100	7	<10	150	70	20	150	70	.4
046	<20	<5	<10	15	30	<100	7	<10	<100	70	20	<200	70	<.04
051	<20	<5	15	20	50	<100	15	15	150	300	20	<200	300	.1
054	<20	5	10	20	30	<100	10	<10	150	150	15	<200	70	<.02
270	30	<5	30	7	30	<100	10	<10	300	150	15	<200	700	.02
314	50	<5	<10	50	20	<100	10	<10	200	100	20	<200	200	<.04
318	50	10	10	50	30	<100	15	<10	200	150	20	<200	200	<.1
330	50	10	10	50	30	<100	20	<10	100	200	30	<200	100	<.02

TABLE 6.—*Analyses of soils and miscellaneous samples*

[Semiquantitative analyses were made by C. L. Forn, J. M. Motooka, and K. C. Watts. Gold analyses were made by atomic-absorption spectrometry by R. W. Leinz and M. S. Rickard. Zinc analyses were made by atomic-absorption spectrometry by Z. C. Stevenson. Arsenic analyses were made by colorimetric methods by M. J. Horodyski.

Spectrographic analyses are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, and so forth, which represent approximate midpoints of group data on a geometric scale. The assigned group for semiquantitative results will include the

Semiquantitative spectrographic analyses

	(percent)				(ppm)										
Sample	Fe	Mg	Ca	Ti	Mn	Ag	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu
005 1/	7.0	0.7	0.7	0.3	700	1.5	<200	10	500	<1	10	20	10	10	150
011	3	.7	.3	.3	300	<.5	<200	15	300	<1	<10	<20	5	20	70
012	3	.7	.3	.3	300	.7	<200	15	300	<1	<10	<20	5	7	70
023 2/	1.5	.3	.3	.3	1,500	3	<200	15	300	<1	<10	<20	7	15	15
024 2/	1.5	.7	.3	.3	700	1.5	<200	15	300	<1	<10	<20	7	15	15
033	3	.7	.3	.3	300	<.5	<200	15	300	<1	<10	<20	5	15	15
095 3/	.7	.2	7	.1	150	<.5	<200	15	200	<1	<10	<20	<5	20	10
096 3/	1.5	.15	.7	.15	300	7	300	20	500	1	<10	<20	7	5	30
112	.7	.3	.3	.2	150	<.5	<200	20	300	<1	<10	<20	5	30	20
131	1	.7	15	.15	150	<.5	<200	20	200	<1	<10	<20	5	50	15
141 4/	15	<.02	<.05	.005	150	<.5	300	<10	50	<1	<10	<20	<5	<5	20
166 5/	1.5	.3	>20	.03	>5,000	<.5	<200	<10	50	<1	<10	<20	<5	<5	<5
191	5	.7	.7	.5	700	3	<200	10	700	1.5	<10	<20	10	20	5,000
192	5	1	.7	.7	1,000	2	<200	20	700	2	<10	<20	20	30	3,000
293	2	.7	1.5	.3	150	.5	<200	70	300	<1	<10	<20	10	70	15
294	1.5	.3	.5	.2	300	<.5	<200	70	300	<1	<10	<20	5	30	<5

1/ Tails from Silver Pick millsite, Silver Pick Basin.

2/ Muck from seep in area of the Morning Star vein, lower Bilk Basin.

3/ Muck from seep along strike of Tiger vein.

from the Wilson Mountains Primitive Area

quantitative value about 30 percent of the time. These data should not be quoted without stating these limitations.

<, less than the amount shown ; >, more than the amount shown. Where these symbols are used the amount shown is the lower or upper limit of semiquantitative determination. Some elements are reported at one lower or upper limit of determination for some samples and at different limits for other samples, because of different sensitivities of the different instruments used for analyses]

	Semiquantitative spectrographic analyses--Continued (ppm)													Chemical analyses (ppm)		
Sample	La	Mo	Nb	Ni	Pb	Sb	Sc	Sn	Sr	V	Y	Zn	Zr	Au	Zn	As
005	20	<5	10	7	150	<100	10	10	300	300	15	<200	70	1.4	240	100
011	<20	<5	<10	7	30	<100	7	<10	150	50	15	<200	70	<.02	190	<10
012	<20	<5	<10	7	70	<100	7	<10	200	50	15	<200	70	<.02	200	<10
023	<20	<5	<10	7	700	<100	<5	<10	150	30	10	300	70	<.02	2,400	<10
024	30	<5	<10	7	700	<100	<5	<10	150	50	15	300	70	<.02	720	<10
033	<20	<5	<10	7	15	<100	7	<10	150	50	15	<200	70	<.02	130	<10
095	<20	5	<10	5	15	<100	5	<10	200	70	10	<200	70	<.4	120	20
096	20	<5	<10	5	500	<100	5	<10	200	70	15	500	100	.5	550	450
112	<20	5	<10	20	20	<100	5	<10	<100	150	15	<200	300	.04	500	10
131	<20	<5	<10	10	30	<100	5	<10	200	100	15	<200	100	<.02	45	<10
141	<20	<5	<10	<5	15	<100	<5	<10	<100	15	<10	<200	<10	.02	38	1,500
166	70	<5	<10	<5	10	<100	<5	<10	300	50	50	<200	<10	<.02	<25	10
191	50	15	15	<5	100	<100	10	<10	300	70	30	200	150	.4	140	20
192	70	20	20	<5	200	<100	15	<10	500	100	30	<200	200	.3	240	60
293	30	<5	15	30	20	<100	10	<10	<100	300	15	<200	150	<.02	110	<10
294	30	<5	15	10	30	<100	5	<10	<100	70	15	<200	150	<.02	100	<10

4/ Iron-rich precipitate from water draining from adit on Clara claim.

5/ Calcite specimen from talus north of Wilson Peak.

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