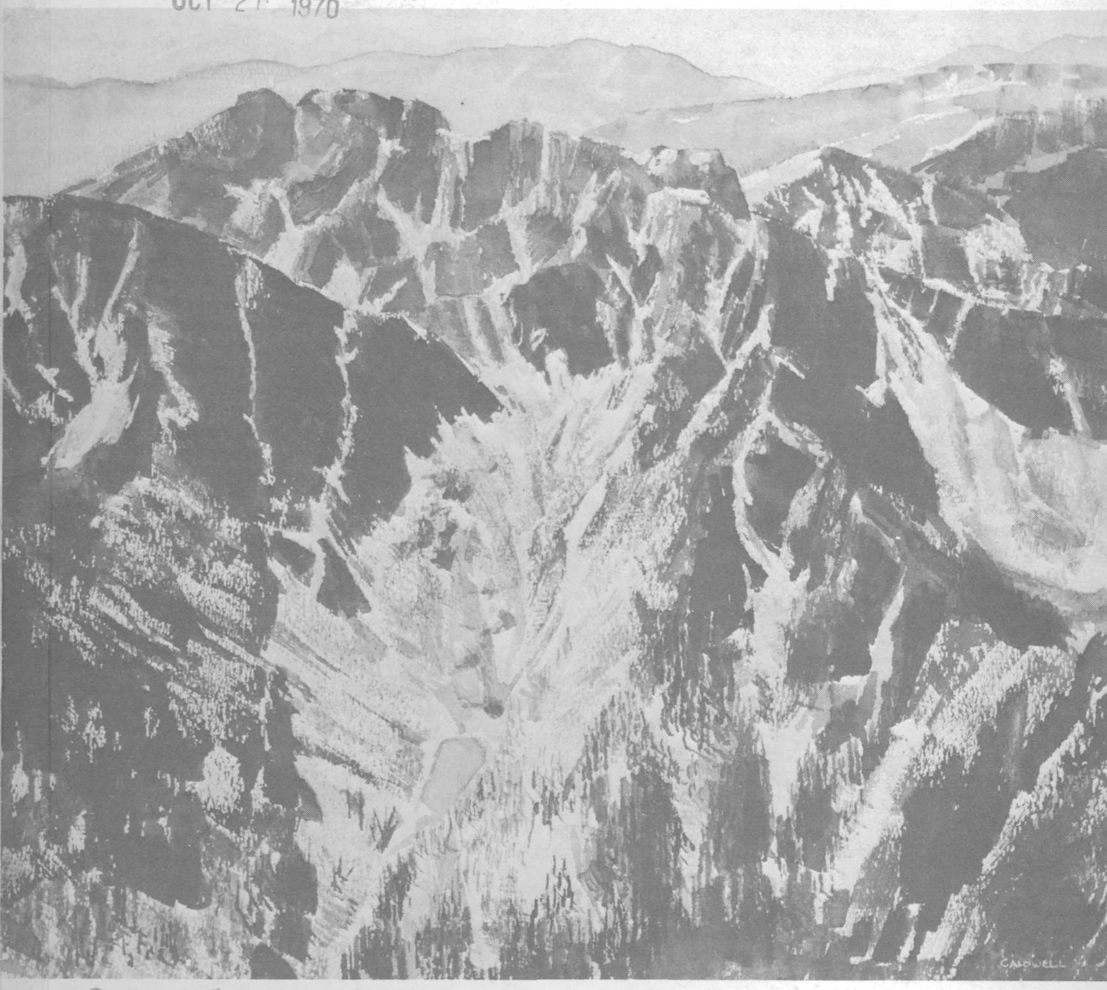
STUDIES RELATED TO WILDERNESS
PRIMITIVE AREAS

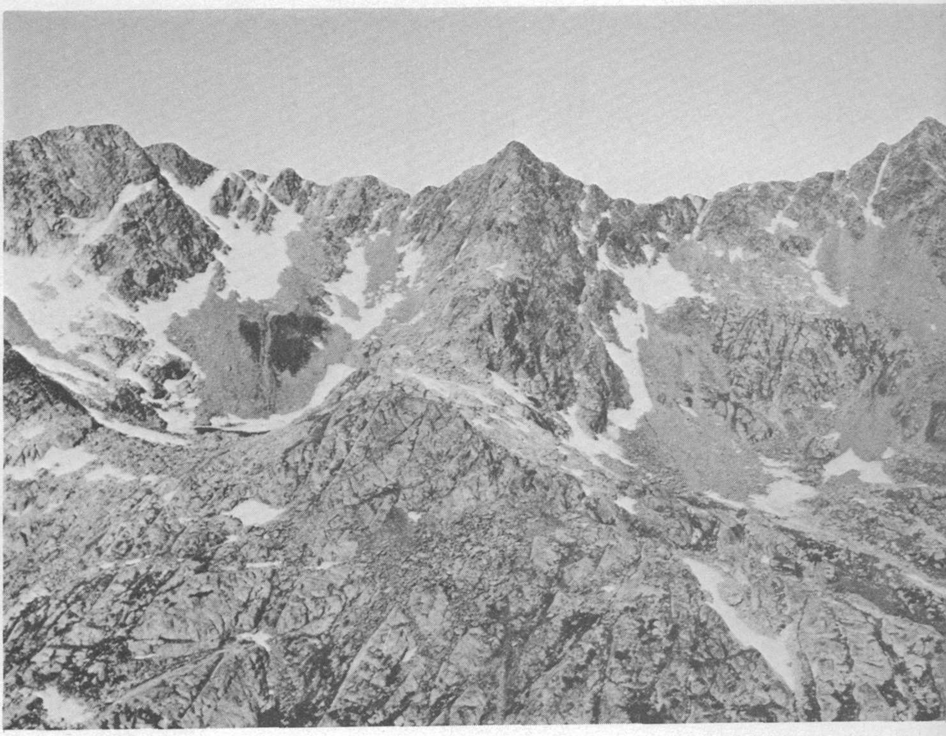


GORE RANGE-EAGLES NEST AND VICINITY, COLORADO

GEOLOGICAL SURVEY BULLETIN 1319-C

Tweto, Bryant, and Williams—GORE RANGE-EAGLES NEST PRIMITIVE AREA AND VICINITY, COLORADO—Geological Survey Bulletin 1319-C

MINERAL RESOURCES of the GORE RANGE-EAGLES NEST PRIMITIVE AREA and VICINITY, COLORADO



Crest of Gore Range and head of middle fork of Black Creek. View is westward. Mount Powell (alt 13,534 ft) is massive peak at right of center. Eagles Nest Mountain is at far right. Duck Lake is in right foreground. Trough

above right end of lake marks fault zone of north-northwest trend. Dark area on steep front of rock glacier at left in photograph is typical "wet front" suggesting ice core in rock glacier.

Mineral Resources of the Gore Range-Eagles Nest Primitive Area and Vicinity, Summit and Eagle Counties, Colorado

By OGDEN TWETO *and* BRUCE BRYANT, U.S. GEOLOGICAL SURVEY,
and by FRANK E. WILLIAMS, U.S. BUREAU OF MINES

STUDIES RELATED TO WILDERNESS—PRIMITIVE AREAS

GEOLOGICAL SURVEY BULLETIN 1319-C

An evaluation of the mineral potential of the area

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1970

UNITED STATES DEPARTMENT OF THE INTERIOR

WALTER J. HICKEL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

Library of Congress catalog-card No. 78-607129

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

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 Gore Range-Eagles Nest Primitive Area, Colo. The area discussed in the report includes the Primitive Area as defined and bordering areas that may come under discussion when the area is considered for wilderness status or that provide geologic perspective of the area. The Primitive Area is referred to as the Gore Range Primitive Area in this report, and the total area that was studied is referred to as the Gore Range.

CONTENTS

ILLUSTRATIONS

[Plates are in pocket]

TABLES

MINERAL RESOURCES OF THE GORE RANGE-EAGLES NEST PRIMITIVE AREA AND VICINITY, SUMMIT AND EAGLE COUNTIES, COLORADO

By OGDEN TWETO and BRUCE BRYANT, U.S. Geological Survey, and FRANK E. WILLIAMS, U.S. Bureau of Mines

SUMMARY

A mineral survey of the Gore Range-Eagles Nest Primitive Area and vicinity in central Colorado was made by the U.S. Geological Survey in 1969 and by the U.S. Bureau of Mines in 1968–69. An aeromagnetic survey was made earlier by the Geological Survey, in 1967. The Primitive Area as defined occupies about 96 square miles in the highest and roughest part of the spectacularly rugged Gore Range. Bordering areas on the flanks of the range were included in the study to obtain necessary perspective of the range as a geologic unit, and also to obtain information on areas that may come under discussion when the Primitive Area is considered for inclusion in the National Wilderness Preservation System. The total area considered herein is 215 square miles.

Geologically, the Gore Range is a fault block of Precambrian rocks between the Gore fault on the west and the Frontal fault on the east. Sedimentary rocks west of the Gore fault are Paleozoic and younger, and those east of the Frontal fault are Mesozoic and younger. At the south, the range extends into the border zone of the Colorado mineral belt, which in this region includes the highly productive mining districts of Climax, Leadville, and Gilman, as well as many lesser districts. The Mosquito fault, one of the controlling features of the ore deposits at Climax and Leadville, extends into the southern part of the Gore Range and connects with both the Gore and Frontal faults.

The block of Precambrian rocks that makes up the main body of the Gore Range is broken by many faults. The Gore and Frontal faults and many of the interior faults as well are old faults that were later reactivated when the range was elevated to its present height. This uplift began very late in geologic time and it continues to the present. The Frontal fault in particular shows evidence of very recent movement. The recent uplift, which began in late Tertiary time, produced a high scarp that forms the abrupt eastern front of the range, along the Frontal fault. Near Cataract Creek,

the line of recent uplift turns westward, along the north base of Eagles Nest Mountain, and connects with young faults parallel to the Gore fault on the west side of Mount Powell and in the upper Piney River drainage.

The mineral potential of the area was studied by examining the record of mining activity and mineral production, by studying the geology in relation to that of nearby productive mining districts, by examining the area for any signs of mineral deposits, and by a program of sampling and detailed analysis both of rocks showing any indication of mineralization and of sediment in the streams draining the area.

No mineral production is recorded from the Primitive Area, although small exploratory workings are present at several places. In the bordering areas, the chief production has come from the Boss mine, on North Rock Creek about half a mile east of the Primitive Area. This mine produced about $238,000 worth of silver-lead ore; most of it was produced prior to 1900. Production is not recorded for several small mines in the Chief Mountain area near Frisco, nor for a gold placer southwest of Silverthorne. The Primitive Area contains 24 patented mining claims totaling 190 acres. Adjoining parts of the study area contain an additional 24 patented claims totaling 126 acres.

Geologic studies and the search for evidence of mineralization entailed many hundreds of miles of foot traverses over the range and the collection and analysis of a total of 1,212 rock and stream-sediment samples. Visible evidence of mineral deposits in the range is sparse, although many of the faults or fracture zones contain quartz or carbonate veins or veinlets. A few fractures or veins contain visible ore minerals in small amounts, but the great bulk of them do not, and many are nothing more than slightly iron-stained fractured granite or migmatite. Nevertheless, a great many of the fractures are highly anomalous geochemically. Collectively, the anomalies include a remarkably large suite of metals: copper, lead, zinc, gold, silver, molybdenum, bismuth, arsenic, antimony, cadmium, mercury, and tin. The content of such metals in the major anomalous fracture zones is orders of magnitude greater than in the granite and migmatite country rock between the fracture zones.

The geochemical anomalies record the passage of metal-bearing solutions through the fracture system of the range. This occurred during or after the latest major uplift in late Tertiary time. Thus the anomalies are not related to mineralization episodes that created the ore deposits in the nearby mining districts of Climax, Leadville, and Gilman, but they are younger. No localized source for them, such as an intrusive body, is evident in either the geology or the magnetic features of the range. No areas of altered rocks exist to suggest that the anomalies might signify the presence of ore deposits at shallow depth within the range, nor do any other features of the geology suggest the presence of such deposits. The anomalies are concluded to have been formed by metal-bearing solutions that diffused into the fault system in small quantity from great depth, probably at the time of scattered igneous activity in west-central Colorado 10 to 12 million years ago. The Frontal fault was the master conduit, and any ore deposits that might have been formed at this time are likely to be on or near it, and east of the Primitive Area, as at the Boss mine. Evidence of mineralization along this fault is greatest in the area between Boulder and South Willow Creeks and is weak from Slate Creek northward.

In summary, the Gore Range-Eagles Nest Primitive Area contains no known ore deposits, and no geologic evidence exists to indicate a likelihood of hidden deposits beneath it, even though many fractures are geochmically anomalous. Chances for the existence of deposits increase eastward from the Primitive Area toward the Frontal fault in the southern half of the area.

The Primitive Area has no potential whatever for coal, oil, or gas, and no —or very low—potential for nonmetallic minerals. East of the Primitive Area, a potential for fluorspar exists in the sedimentary rocks beyond the Frontal fault, although only two deposits, of marginal quality, are known there now. On the west side of the range, structures favorable for oil and gas exist but are untested. Test holes in similar rocks 20 miles or more away were nonproductive.

INTRODUCTION

The Gore Range in central Colorado is in its middle part a spectacularly rugged mountain range towering to a crestline at altitudes of 12,500 to 13,500 feet. Imposing views of the range are seen by the traveler as he approaches the town of Dillon from the east via U.S. Highway 6 or Interstate 70, or as he follows Colorado Highway 9 along the Blue River between Dillon and Kremmling (fig. 1). U.S. Highway 6 crosses the range at Vail Pass, which affords an impressive view along the length of the western side of the range.

The high and rugged segment of the range, through a straight-line distance of 18 miles in a northwest-southeast direction, constitutes the Gore Range-Eagles Nest Primitive Area. To the northwest, the range extends as a lower and smoother crest to the Colorado River, and to the southeast or south also the range is smoother, though only slightly lower.

The area described in this report comprises the Gore Range-Eagles Nest Primitive Area as defined and bordering areas on all sides. Parts of the bordering areas are included because they may come under consideration in the fixing of boundaries of the area to be proposed for inclusion in the National Wilderness Preservation System, and parts are included to provide necessary geologic perspective of the range. The Primitive Area as defined occupies an area of about 61,000 acres, or 96 square miles, centered over the high part of the Gore Range. The bordering areas considered in this study include the eastern and western flanks of the high part of the range as well as crestal segments immediately north and south of the Primitive Area. The total area discussed in the report is about 215 square miles.

In this report, the term Gore Range applies only to that part of the range within the area of study, which in general extends from the latitude of Green Mountain Reservoir on the Blue River to U.S.

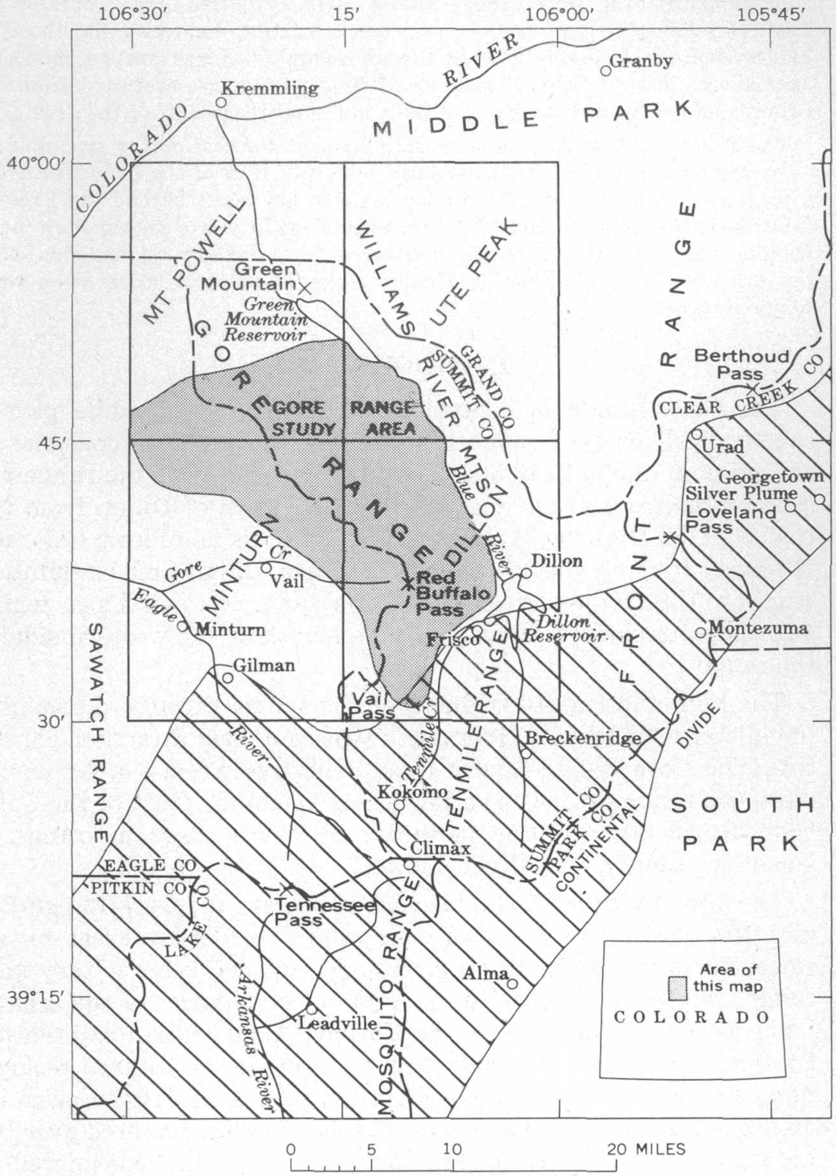


FIGURE 1.—Index map showing geographic setting of Gore Range study area (stippled) and location with respect to Colorado mineral belt (line pattern) and topographic quadrangles.

Highway 6 on Vail Pass. For brevity, the primitive area will be referred to as the Gore Range Primitive Area or just the Primitive Area.

GENERAL CHARACTER AND ACCESS

The high part of the Gore Range, embracing most of the area between the borders of the Primitive Area, consists of a sinuous knife-edge crestal spine and a series of attached high spur ridges separated by deep glaciated canyons (fig. 2). Many of the spur ridges are equally as high and jagged as the main crest, and in most views from the highways they form the skyline, hiding the main crest. All of the high slopes and ridges are bare rock (frontispiece), either in cliffs and outcroppings or in fields of frost-riven boulders. The bottoms of the canyons between the ridges are glacially smoothed bedrock which in many places is covered by a dense spruce forest up to a timberline altitude of about 11,000 feet. The canyon walls are a succession of forbidding cliffs extending to the upper limit of glacial cutting, which in most places was near the ridge tops. At the base of the cliffs, and covering the lower sides of the valleys, are almost continuous blankets of debris consisting of talus, avalanche, rock-slide, and alluvial-cone deposits.

Below the high rocky slopes, along a line on each side of the range where the bedrock changes from hard granites and gneisses to softer sedimentary rocks, the topography changes abruptly to

FIGURE 2.—Glacial topography at head of canyon of south fork of Black Creek. View westward toward crest of Gore Range. Rock glaciers in cirque at left descend into lake.

one of smooth slopes and much shallower canyons (fig. 10). These were areas of glacial deposition—where the debris from cubic miles of rock excavated by the glaciers in each of the main canyons was dumped. As a consequence, extensive aprons of glacial drift in the form of moraines mantle the lower slopes of the range, effectively concealing the bedrock. All these slopes are heavily timbered, generally by spruce and alpine fir in the canyons and by lodgepole pine on the morainal ridges and benches.

Because of its bare and forbidding character, the Gore Range has not directly supported any industry except along its lower flanks. The high part of the range is too rough and barren to support grazing except in a few canyons on the western side and south of the Gore and South Willow Creek drainages. Similarly, logging has not been feasible except on the lower flanks. No mining industry has developed in the range because, as discussed on following pages, little evidence of mineralization has been found. The only exception is the Boss mine, a moderately productive silver-lead mine a short distance east of the Primitive Area on North Rock Creek. Recreational uses such as hiking, horseback riding, fishing, and hunting constitute perhaps the only significant industry based upon the high and rocky part of the range. Lower down, as in the Blue River valley, a prosperous ranching industry is based on the grazing, hayland, and timber resources of the lower slopes, and particularly on the water draining from the range. This water, the product of heavy snowfalls in the season from October through May, and of frequent summer showers, thus far has been the single most valuable resource in the range.

Access to the Primitive Area and the high part of the range by public roads and trails is limited. On the eastern side of the range, an automobile road reaches the northern end of the Primitive Area at Lower Cataract Lake, from which two trails extend into the area. About 12 miles to the south, at North Rock Creek, an automobile road extends to within a mile of the Primitive Area. This road intersects the Gore Range Trail, which extends over the timbered and moraine-covered middle slopes of the range from the Elliott Creek area at the north to South Willow Creek at the south. From this trail, dead-end trails extend a short distance into the Primitive Area at Upper Cataract Lake, south fork of Black Creek, Upper Slate Lake, and Willow Lakes.

On the western side of the range, an automobile road via Red Sandstone Creek reaches within 2 miles of the Primitive Area near

Piney Lake, and dead-end trails extend into the area along Deluge, Bighorn, Pitkin, and Booth Creeks. The only trail across the range follows South Willow and Gore Creeks, crossing the range crest at Red Buffalo Pass (also known as Wilkerson Pass). This route has received wide attention because of proposals to construct Interstate Highway 70 along it and through a tunnel beneath the pass.

The edge of the Primitive Area may also be reached by truck or jeep from the north on Elliott Ridge, where trails to Cataract and Piney Lakes may be taken.

Except on these limited trails, travel by any means other than by foot is impossible in most of the Primitive Area. Consequently, large parts of the area are visited only by infrequent hikers or venturesome fishermen and hunters, and they thus remain in a pristine condition. In many areas, the only signs of human activity are campfire sites beside some of the small lakes, the cairns of mountain climbers and surveyors, and vague signs of prospecting along fractures and faults. These signs of prospecting are widespread, and it is clear that the range was examined closely by the early-day prospectors, but in most places the incentive for digging was slight, and evidence of prospecting is almost imperceptible except to the trained and searching eye.

PREVIOUS INVESTIGATIONS

The Gore Range has long been only poorly known geologically, and parts of it had never been mapped until the present investigation. The earliest study in the high part of the range was by Lovering and Tweto (1944) in mapping the Minturn quadrangle in 1940–42 (fig. 1). Results of study by Tweto in 1944 in the Green Mountain area, at the north end of the area here considered, are included in a brief general report on Middle Park (Tweto, 1957). The Mt. Powell quadrangle, which includes the northern part of the Primitive Area, was mapped for a thesis by Taggart (1962) in 1954–59. The Blue River valley, including the lower eastern slopes of the Gore Range, was mapped for a thesis by Holt (1962) in 1956–58. The southern part of the Primitive Area, south of Gore and South Willow Creeks, was mapped for the U.S. Geological Survey by Bergendahl (1969). An area immediately northwest of the Primitive Area, including the northwestern part of the present study area, was mapped for a thesis by Brennan (1969).

PRESENT INVESTIGATION

The geologic map (pl. 1) included in this report is based in part on the maps cited above, particularly in the Minturn quadrangle and in places along the Blue River and in the Tenmile Creek drainage, but it is primarily the product of reconnaissance mapping done by the Geological Survey party in conjunction with the examination and sampling of the area for any evidence of mineral deposits. In these field studies the Survey authors were ably assisted by Thomas L. Blanton III and Gregory K. Lee. Analyses of samples were made in mobile laboratories in the field by James G. Friskin of the U.S. Geological Survey, assisted by Scott Smith. An aeromagnetic survey, results of which are included on plate 1, was made by the Geological Survey in 1967, in advance of the field studies.

The topographic base for the geologic and sample maps (pls. 1, 2) was prepared from the 1: 62,500 maps of the Mt. Powell, Minturn, Dillon, and Ute Peak 15-minute quadrangles, enlarged to a scale of 1: 48,000. All four of these maps date from the 1930's, and they lack the accuracy of the modern topographic maps. Highways and reservoirs were added to them to make the present base, but contours and the topographic forms they depict are unchanged. As the topographic forms are generalized in many places, the plotted locations of many geologic features and of mining claims (pl. 2) are subject to considerable uncertainty. Likewise, the boundary of the Primitive Area is in most places unidentifiable on the ground as it is tied to theoretical or projected land lines in an area that is largely unsurveyed.

Field study of the area in the summer of 1969 occupied 52 man-weeks on the part of the Geological Survey party. Through more than half of this time, helicopter service was used for ferrying to and from work areas. This service greatly facilitated work in this difficultly accessible area, even though large parts of the area are too jagged or too heavily forested to permit helicopter landings. With a few minor exceptions, all the data on plate 1 are the product of foot traverses rather than of observation from helicopter. In general, traverses were made on almost all of the traversable ridges—where facture zones are best exposed—and along the bottoms or lower sides of the canyons. Canyon sides were traversed to a far lesser degree because they are a combination of cliffs and rubble that would require a very great investment of time and they present a very considerable hazard (fig. 2). However, with the extensive rock exposures afforded by the cliffy slopes and close study from the ridges and the canyon bottoms, we believe that few if any significant features were missed on the canyon walls.

In the geological study, special emphasis was placed on the faults because any ore deposits that might exist in the area are likely to be related to them.

The U.S. Bureau of Mines was concerned primarily with mineral resource economics and the record of mineral development in and adjacent to the Primitive Area. F. E. Williams examined U.S. Bureau of Land Management and U.S. Forest Service files in Denver, Colo., to determine the locations of patented claims. County records in Breckenridge (Summit County) and Eagle (Eagle County) were reviewed for information on unpatented claims. Mineral production data were obtained from U.S. Bureau of Mines files; Director of the Mint reports dating to the 1880's were examined. Data relative to the Mineral Leasing Act of 1920 were obtained from the Conservation Division of the U.S. Geological Survey, Denver, Colo.

Fieldwork and county courthouse investigations by U.S. Bureau of Mines personnel occupied 16 man-weeks in the summers of 1968 and 1969. Fieldwork, in which Williams was assisted by G. R. Leland and B. C. Pollard, Jr., consisted of physically locating all patented claims and examining them, as well as examining the areas in which unpatented claims were recorded. However, many unpatented claim locations are only vaguely described in county records and their physical locations are uncertain.

ACKNOWLEDGMENTS

Grateful acknowledgment is extended to several ranchers along the Blue River, particularly Mr. George A. Knorr, Messrs. Walter and Charles Lund, Mrs. Esther Forsrud, Mr. Carl Lindstrom, Mr. Robert Young, and Mr. Edward B. Hammer, for information or assistance. Special thanks are given Mr. Ralph G. Johnson, Kremmling District Ranger, Arapaho National Forest, and staff for many acts of assistance and particularly for making available the Slate Creek Guard Station as a field headquarters for the U.S. Geological Survey party.

In addition to thanking many of these same individuals, the Bureau of Mines party acknowledges the information on mines and prospects received from Mr. W. M. Ross and Mr. S. M. Evans and the cooperation of Mr. Don Price, Eagle District Ranger, and Mr. Don Campbell, Minturn District Ranger, White River National Forest, on questions of claim locations and status.

Finally, all the participants in fieldwork express grateful appreciation for the skill and judgment of Mr. Elwood (Swede) Nelson in piloting a helicopter among the crags at altitudes near the ceiling for the craft.

GEOLOGIC APPRAISAL

By Ogden Tweto and Bruce Bryant, U.S. Geological Survey

Geologically, the Gore Range is an elongate block of old and resistant basement rocks that has been uplifted along major bordering faults to a position high above areas of younger sedimentary rocks on each side. The western border fault—actually, a broad fault zone—is known as the Gore fault; the eastern border fault or fault zone is here called the Frontal fault. The rocks in the block between these faults are of Precambrian age and are broken by many fractures or faults (fig. 3). The bordering sedimentary rocks, which are much less fractured, differ in extent on the two sides of the range. On the eastern side, only the Jurassic Morrison and younger formations are present above the Precambrian rocks (table 1). On the western side, in contrast, thousands of feet of sedimentary rocks intervene between the Morrison and the Precambrian. The contrast in stratigraphic sequence on the two sides

Figure 3.—Fractured rocks and notches marking faults of north-northwest trend on west side of crest of Gore Range south of Mount Powell. A strong joint system with dip to south (right) characterizes much of the range.

of the range and the contrast in fracture patterns between the Precambrian and sedimentary terranes imply that the Gore and related faults were active long before the present range was formed, and that the present range is but the latest in a series of uplifts in this locality. Evidence is abundant that the latest uplift, accounting for the present altitude of the range, is geologically very recent and, indeed, continues to the present.

PRECAMBRIAN ROCKS

Precambrian rocks constitute the entire mountain block between the Gore and Frontal faults, except for a few patches of sedimentary rocks resting on the Precambrian rocks at the north end of the area. The Precambrian rocks are a complex mixture of granitic rocks with older biotitic gneisses that exhibit various stages of transformation into granitic rocks. Rocks in which a gneiss fraction is clearly evident are classed as migmatite on the geologic map (pl. 1). Most of these rocks are part biotite gneiss and part granitic material, but at Buffalo Peak and a few other localities in the southern part of the area they are almost entirely biotite gneiss or biotitic quartzite. Most of the rocks mapped as granitic rocks contain streaks or lenses of migmatitic rock, although bodies of relatively pure granitic rock occur in places. Inasmuch as the migmatite and granitic rocks intergrade, the contacts between them are vague, and most of those shown on the geologic map therefore are only approximate.

The Precambrian rocks of the northern and southern ends of the range are mainly migmatite (pl. 1). A large area in the central segment of the range, from Mount Powell to South Rock Creek, consists of intermingled migmatite and granitic rocks. In a south-central segment, in the vicinity of Gore, Bighorn, South Rock, and South Willow Creeks, the rocks are almost entirely granitic; this is the largest body of relatively uncontaminated granitic rock in the range. Smaller bodies form the high ridge between Upper Slate Lake and Black Lake, and the north-trending ridge between the upper Piney River and the headwaters of Red Sandstone Creek.

Typical migmatite (fig. 4) consists of layers of dark, biotitic, strongly foliated gneiss a fraction of an inch to several inches thick alternating with layers of granitic rock of about equal thickness, although the proportions of the two materials vary widely. Most of the gneiss in the migmatite is uniform in appearance and has a simple quartz-feldspar-biotite composition. Varietal minerals such as garnet or sillimanite are rare. Thus, no stratigraphic sequence is evident in the migmatite. Neither are any major struc-

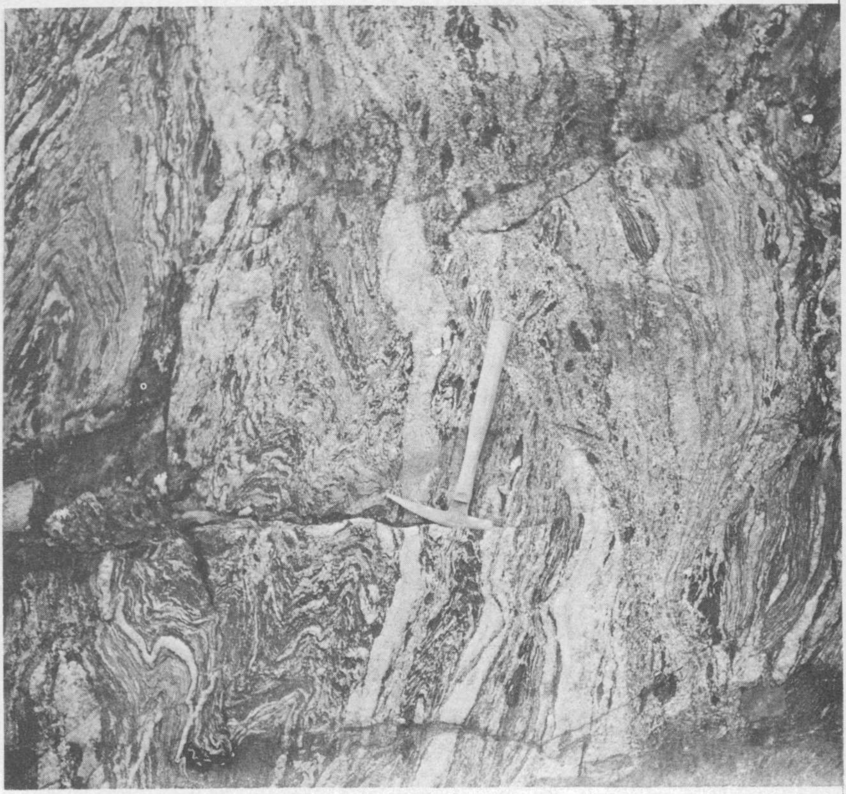


FIGURE 4.—Migmatite, showing typical mixture of biotite gneiss (dark) and granitic materials (light) and streaking and crenulation resulting from rock flowage.

tural features such as folds outlined by the migmatite. Structural continuity was destroyed by granitization, by differential crowding of blocks during pervasive granite intrusion, and by extreme plastic flow. No attempt was made to decipher structure in the migmatite beyond making general observations of strike and dip.

Rocks of the granitic unit are highly varied. Compositionally, they range from biotite-quartz diorite to granite, but the great bulk of them are granodiorite or quartz monzonite. Texturally, they range from fine grained to coarse, and from even grained to coarsely porphyritic (fig. 5). Some are gneissic in some degree, and some are massive. In general, the darker phases such as quartz diorite and granodiorite are the most gneissic and least porphyritic, and the lighter phases such as quartz monzonite and granite are the least gneissic and most porphyritic. Some granite, however,

FIGURE 5.—Porphyritic granodiorite. Large crystals of potassium feldspar (light spots) in matrix consisting of quartz, feldspars, and biotite.

is uniformly fine and even grained. The entire suite of granitic rocks is correlated with the granite of Cross Creek, near Minturn (Lovering and Tweto, 1944), and this granite is in turn correlated with the Boulder Creek Granite of the Front Range. Isotopic age determinations by Carl Hedge of the U.S. Geological Survey (written commun., 1968) indicate that the granite of Cross Creek and the granite in the Gore Range are about 1.7 billion years old.

Dikes as much as 100 feet wide of a distinctive red-brown to pink porphyry occur in places along the Gore fault zone and other faults within the range. Close examination reveals that this rock is not a true igneous porphyry, crystallized from a melt, but a recrystallized mylonite, a rock formed by fault movement under great pressure. This "porphyry" occurs as cobbles in conglomerates of Pennsylvanian age and hence is older than those rocks; it is inferred to be Precambrian in age because of its character and history.

SEDIMENTARY ROCKS

Sedimentary rocks are absent from the high crestal block of the Gore Range but they underlie both flanks of the range. In the lower parts of the range north and south of the Primitive Area, they are present on the crest also. The sequence of formations present in the near vicinity of the range is summarized in table 1. Of the formations shown, many wedge out in a zone only a few miles wide along the Gore fault on the western side of the range. This behavior has important implications on the mineral potential of the area, for some of the principal host-rock formations of ore deposits in surrounding mining districts are involved in the wedge-outs.

In the Gilman-Minturn area, 8 miles southwest of the Gore fault, the sequence of formations beneath the Minturn Formation is as shown in table 1, except that the Manitou Dolomite is absent. The same sequence occurs also in the Leadville and Kokomo mining districts to the south of the study area (fig. 7), except that the Manitou is present and the Harding Sandstone is absent and, at Kokomo, the Belden Formation is also absent. Near the Gore fault, however, the sequence and the thickness of units change markedly, not only among these formations but among overlying formations up to the Dakota Sandstone.

As shown in fault blocks of the Gore fault on the south and west slopes of Bald Mountain, the Sawatch Quartzite and red dolomitic sandstone of the Peerless Formation were beveled to a vanishing edge by erosion before the Parting Quartzite Member of the Chaffee Formation was deposited. The Manitou and Harding Formations were beveled back even more, so they are not present along the Gore fault, but their wedge edges may extend to within a mile or two from the fault beneath younger rocks in the Black Gore Creek-West Tenmile Creek area.

When the Parting Quartzite Member of the Chaffee Formation was deposited, a land area that supplied the sediment may have existed at the site of part of the present Gore Range, or immediately east of it, inasmuch as the Parting is exceptionally conglomeratic in exposures along the Gore fault. The succeeding Dyer Dolomite Member of the Chaffee and the Leadville Limestone prob-

TABLE 1.—*Sedimentary rock formations of the Gore Range and vicinity*

	System	Stratigraphic unit	General thickness (ft)	Character
Cenozoic	Tertiary	Sedimentary rocks (Troublesome Formation and equivalent(?) strata)	0–1,000	Tuffaceous claystone and siltstone, and sandstone, conglomerate, shale and tuff.
		UNCONFORMITY		
Mesozoic	Cretaceous	Pierre Shale	To 5,500	Dark shale and sandy siltstone; sandstone beds in middle part.
		Niobrara Formation	550	Limy siltstone and shale, and thin beds of limestone.
		Benton Shale	350	Black shale; sandstone at top.
		Dakota Sandstone	200–300	Gray, brown, and white sandstone, quartzite, and siltstone; locally conglomeratic at base.
		UNCONFORMITY		
	Jurassic	Morrison Formation	250–500	Varicolored siltstone, claystone, sandstone, and limestone.
		UNCONFORMITY		
		Entrada Sandstone	0–60	Light-gray and buff massive sandstone.
		UNCONFORMITY		
	Triassic	Chinle Formation	0–125	Red siltstone; Gartra Member at base, 15–25 ft of purple to white coarse sandstone.
		UNCONFORMITY		
Paleozoic	Permian and Pennsylvanian	Maroon Formation	0–4,000	Red sandstone, conglomerate, and siltsone.
	Pennsylvanian	Minturn Formation	0–6,000	Gray and red grit, conglomerate, and sandstone, and a few beds of limestone. Limestone units in upper one-third of formation constitute (descending) the Jacque Mountain, White Quail, and Robinson Limestone Members. Jacque Mountain marks top of Minturn.
		Belden Formation	0–200	Dark shale, limestone, and sandstone.
		UNCONFORMITY		
	Mississippian	Leadville Limestone or Dolomite	0–195	Massive gray limestone or dolomite; Gilman Sandstone Member at base, 10–25 ft of sandstone, sandy dolomite, and cherty dolomite.
		UNCONFORMITY		
	Devonian	Chaffee Formation	0–130	Dyer Dolomite Member at top, 0–90 ft of thin-bedded gray dolomite; Parting Quartzite Member at base, 0–40 ft of tan to white coarse-grained quartzite and conglomerate.
		UNCONFORMITY		
	Ordovician	Harding Sandstone	0–60	Green to white sandstone, quartzite, and micaceous shale.
		UNCONFORMITY		

TABLE 1.—*Sedimentary rock formations of the Gore Range and vicinity*—Continued

	System	Stratigraphic unit	General thickness (ft)	Character
Paleozoic	Ordovician	Manitou Dolomite	0–115	Light-gray cherty dolomite.
		UNCONFORMITY		
	Cambrian	Peerless Formation	0–100	Brown to red sandstone, sandy dolomite, and dolomite.
		Sawatch Quartzite	0–190	White quartzite.
		UNCONFORMITY		
	Precambrian	Crystalline Rocks		

ably were deposited over the entire area of the present range. After their deposition, but before the Belden and Minturn were deposited, uplift occurred along the Gore fault, and the Chaffee and Leadville were stripped from the site of the range. The Leadville and Dyer were stripped back far enough that their wedge edges are now buried beneath the Minturn Formation, but they probably extend to within 1 or 2 miles from the fault through the full length of the study area. The Parting Quartzite Member was not stripped back so far, and so it is exposed at places along the fault, as on the mountain between Miller and Gore Creeks and on the flanks of Bald Mountain. In these places it forms thin wedges that are—or evidently once were—overlapped by the Minturn Formation.

The uplift that caused stripping of the Chaffee and Leadville produced a highland that extended from the Gore fault eastward to the eastern slope of the present Front Range. Concurrently, a basin or trough that was invaded by marine waters developed immediately to the west. The Belden Formation was deposited in the bottom of this basin but did not extend high onto its sides, and so it probably is not present within 5 miles of the Gore fault. The Minturn Formation, consisting of as much as 6,000 feet of coarse grits, conglomerates, sandstones, and a few limestone beds, then accumulated as the basin gradually sank and the highland gradually rose. Near the Gore fault, at the border between basin and highland, the Minturn Formation thins abruptly as a result of the shingling-out of lower strata against the highland. Thus limestone beds of the Robinson Limestone Member, normally 4,200 feet above the Belden, lie within 200 feet of the Precambrian-rock basement near the mouths of Black Gore and Bighorn Creeks and on Copper Mountain, immediately south of the map area, near the mouth of West Tenmile Creek. Two other limestone members—the White Quail, about 800 feet above the base of the Robinson, and the Jacque Mountain, at the top of the Minturn Formation—originally extended as far east as the Gore fault or a little beyond and are preserved in places along the fault from Gore Creek northward. Existence and location of these three limestone members are of concern in the appraisal of the Gore Range area because the limestones—particularly the White Quail and Robinson—are the host rocks of the ore deposits in the Kokomo mining district (Koschmann and Wells, 1946) immediately south of the study area (fig. 7).

The depositional process that created the Minturn Formation continued uninterruptedly to form the overlying Maroon Formation. This formation is generally similar to the Minturn in lithology but is entirely red, contains few or no prominent limestone beds, and is finer grained. The upper part is mainly red mudstone, siltstone, and fine-grained sandstone which, in the area farther west, has been designated by some authors as the State Bridge Formation. However, marker beds that serve to separate the Maroon and State Bridge in such usage have not been identified in the study area and so the entire red-bed unit to the base of the Chinle, or in its absence, to the base of the Morrison, is here called Maroon. The Maroon is as much as 4,000 feet thick immediately west of the study area and about 1,700 feet thick just west of the Gore fault, in the valley of the North Fork of Piney River. Half a mile east of the fault, on Elliott Ridge, it is only 100 to 300 feet thick, resting on Precambrian rocks. It is represented there only by the fine-grained facies characteristic of the top of the formation, indicating that only in late Maroon time did the sediments overtop the scarp along the Gore fault. These upper strata of the Maroon Formation probably once extended at least several miles east of Elliott Ridge, but they were reduced to scattered small remnants during periods of erosion that preceded deposition of the Chinle and the Morrison Formations. Such remnants were noted beneath the Morrison Formation northwest of Boulder Lake and were noted by Taggart (1962) eastward from Elliott Ridge as far as the forks of Elliott Creek. Strata of the Maroon are also known in the valley bottom at Dillon, at the north end of a belt of such strata extending along the Blue River from the Breckenridge area (fig. 1).

After deposition of the Maroon, erosion removed an unknown but probably equal amount of Maroon strata from both sides of the Gore fault, and then the Chinle Formation was deposited over the resulting surface of unconformity. The Chinle has at its base a distinctive massive coarse-grained sandstone 15–25 feet thick that constitutes the Gartra Member. This sandstone is purple, pink, or white and is characterized by scattered quartz pebbles and, locally, abundant fragments of silicified wood. On Elliott Ridge, it contains segments of silicified logs as much as 6 inches in diameter and 3 feet in length. The Gartra shows no difference in thickness on the two sides of the Gore fault, an indication that it was deposited on a flat surface that extended uninterruptedly over the fault. The overlying red siltstone of the main body of the Chinle probably also was deposited over an area extending considerably to the east of the Gore fault, but it, along with the Gartra in places, was removed by erosion before deposition of the Morrison Formation. About 200 feet of the red siltstone of the Chinle is preserved at the western edge of the study area, north of the mouth of the North Fork of the Piney; elsewhere the red siltstone is absent, or only a few feet are preserved above the Gartra.

A short distance west of the study area, the Chinle is overlain by a cliff-forming light-colored sandstone, the Entrada Sandstone, but this apparently tapered to an edge in the eroded area of the Piney River valley and therefore does not extend into the study area.

The Morrison Formation is the oldest sedimentary rock unit present on both sides of the Gore Range. On the west side it lies on the Entrada, Chinle, or the Maroon, and on the east side, except near Dillon, it lies on Precambrian rocks. However, it is about twice as thick on the west side of the Gore fault as it is on the east side (500 feet as compared with about 250 feet), indicating some differential movement along the fault at that time. A sandstone unit at or near the base is about 35 feet thick east of the Gore fault but about 100 feet thick west of the fault. The sandstone is overlain by 15 to 20 feet of gray limestone that contains abundant tiny spherical algal structures (charophytes).

The well-known Cretaceous formations, Dakota through Pierre (table 1), are the same in character and thickness on the two sides of the Gore Range; like the Morrison, they once extended uninterruptedly across the range. The amount of the thick Pierre Shale that may be preserved on the east side of the range is uncertain because most of it is hidden beneath the extensive glacial deposits. However, thick sandstone beds which lie in the middle part of the formation (G. A. Izett, U.S. Geological Survey, written commun., 1969) were not seen, and so, presumably, most of the Pierre on the east flank of the range is in the lower 2,000 feet of the formation.

Remnants of a former cover of Tertiary sedimentary rocks are present on both sides of the range. These rocks were deposited after the first elevation and subsequent deep erosion of the modern Gore Range but before rejuvenation of the range to its present heights. On the west side, in the Piney River valley, these rocks consist of fine-grained ashy clays or siltstones of a character and age similar to the Troublesome Formation of Middle Park (Izett, 1968, p. 40–43). On the east side of the range, in a fault block at Squaw and Brush Creeks, they consist of exceedingly coarse conglomerate, tuff, clays, and minor interbedded basalt flows. Boulders in the conglomerate are as much as 8 feet in diameter. These rocks are possibly, but not certainly, a facies of the Troublesome Formation.

VOLCANIC AND DIKE ROCKS

Except for volcanic rocks in the northern part of the area, igneous rocks younger than Precambrian are sparse in the Gore Range. They are represented only by scattered small dikes of dark fine-grained rock in the northern half of the area and by a single altered porphyry dike at the head of West Tenmile Creek. This paucity of intrusive rocks is in marked contrast to the abundance of such rocks in the mineral belt, just south of the area (fig. 1).

The volcanic rocks are of two general types. The more abundant is basalt, which occurs in scattered small patches high on the side of the valley of Piney River and on Elliott Ridge. These patches are erosional remnants of a large body of basalts immediately north of the study area in the lower valley of Piney River and capping Piney Ridge. The basalts are reported to be of Miocene age and 21 to 24 million years old by Mutschler and Larson (1969). The second variety of volcanic rocks is trachytic basalt or andesite in a succession of volcanic flows in a fault block in the Otter Creek area, south of Green Mountain Reservoir. This rock seems to be of the same composition as the dark dikes in the northern part of the area. Both are characterized by conspicuous phenocrysts of sanidine in their coarser facies. This feature suggests relationship to the rocks of the Green Mountain intrusive-volcanic center (fig. 1), as the rocks of this center are trachytic and sanidine bearing (Tweto, 1957; Taggart, 1962).

UNCONSOLIDATED DEPOSITS

The flanks of the Gore Range are heavily mantled by unconsolidated deposits of various kinds. The high part of the range is largely free of such deposits except for rock glaciers near the heads of many canyons and ubiquitous but generally thin talus and alluvial-cone deposits.

The unconsolidated deposits are principally of glacial origin, but they include a thick colluvium or "slope wash" of preglacial age. This colluvium is extensively mantled and hidden by glacial deposits, but widely scattered exposures suggest that in preglacial time it formed a widespread blanket over what are now the timbered benchy slopes on the east flank of the range. The colluvium consists of coarse sand or silty sand and somewhat worn or abraded cobbles of resistant rocks such as pegmatite, vein quartz, and quartzite. Some of it is granular disintegrated granite, or grus.

The glacial deposits show by their character and distribution that they are products of at least nine episodes of glacial advance, just as elsewhere in the central Colorado mountains (Tweto, 1961). The deposits were not studied in detail but are grouped in three units on the map (pl. 1). The oldest unit consists of till in moraines eroded to a smoothly rolling or blanketlike form and related outwash gravels. These moraines were products of widespread glaciers of at least two episodes of glaciation. In both episodes, glaciers from the canyons on the eastern side of the range coalesced on the middle and lower slopes to form an almost continuous ice piedmont from Deep Creek on the north to Frisco on the south. At the time of these glaciations, the Blue River valley was not so deep as it is now, and the old moraines therefore cap benches as much as 300 feet above the present streams. The old moraines were extensively covered by younger moraines and hence are exposed at the surface only in the areas between the younger moraines. On the west side of the range, where glaciation was less extensive, the old moraines are in small patches high above the Gore and Piney valleys.

Moraines of the middle unit are the most conspicuous in the range. They form high ridges—lateral moraines—on the sides of all of the major stream valleys. On the east side of the range, these extend from the canyon mouths at the high rocky front to, or almost to, the Blue River, and on the west side they extend far down the valleys of Piney River and Gore Creek. These moraines are smooth on the valley sides, where they were graded by the moving ice, but moderately to very hummocky and bouldery on their back sides. At their lower ends, the lateral moraines of each valley coalesce into a hairpin- or horseshoe-shaped terminal moraine which typically has a subdued hummocky topography and has been more or less dissected by streams. The moraines of the middle unit are products of at least two glacial episodes. These episodes were characterized by the thickest and erosively most active of all the glaciers. Many of the glaciers were a thousand feet thick, and most of the glacial cutting in the canyons on both sides of the range was accomplished by them.

Moraines of the youngest unit or latest group of glaciers are much smaller and much more hummocky and bouldery than the earlier ones. Of the five glacial episodes recognized in this group, the first produced moraines that extend almost as far as those of the preceding group but are nested within the older moraine loops. All the succeeding glaciers were much smaller. Those of the second and third episodes typically left small moraines in the valleys near the canyon mouths. Glaciers of the last two episodes were limited to the high cirques or canyon heads, where they left only small moraines. Only a few of those are depicted on the map, except that some are included with rock glaciers.

Rock glaciers (fig. 6), or slowly moving masses of fragmental rock, are widespread in the range. They are characterized by longitudinal flow ridges, some of which join concentrically near the front, and by a cover of extremely coarse rock blocks, many of which exceed 10 feet in one dimension. Many if not all of the rock glaciers have ice cores, as indicated by very steep "raw" wet

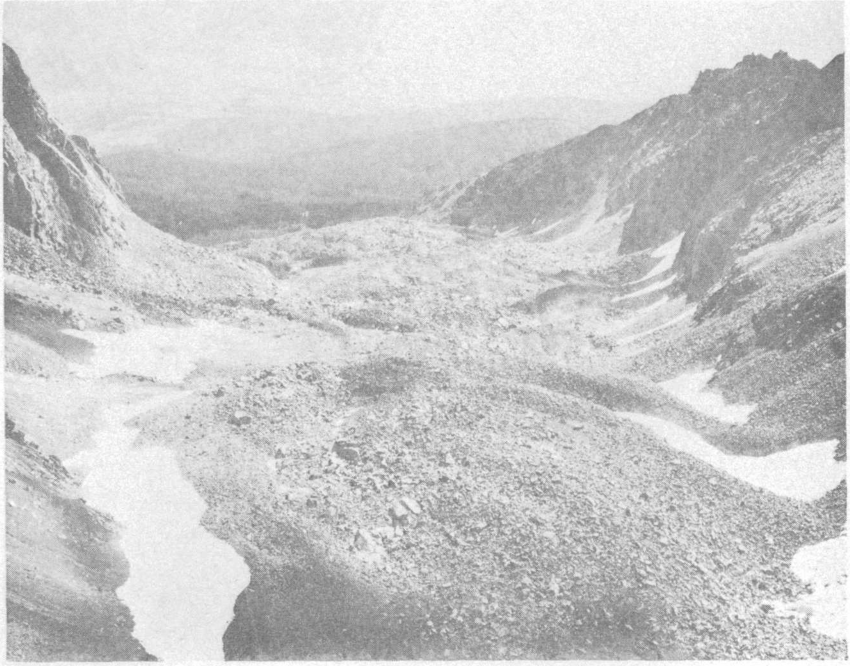


FIGURE 6—Rock glacier at the head of Brush Creek. View eastward toward precipitous dropoff at mountain front and Frontal fault.

fronts, some of which are more than 100 feet high (frontispiece). Streams emerging from these fronts are milky with glacial flour. Rock glaciers are especially prominent in the headwater canyons of South Rock Creek and in the series of cirques at the head of Brush Creek.

STRUCTURE

Structurally, the Gore Range is a fault block of Precambrian rocks 5 to 8 miles wide and more than 25 miles long between two

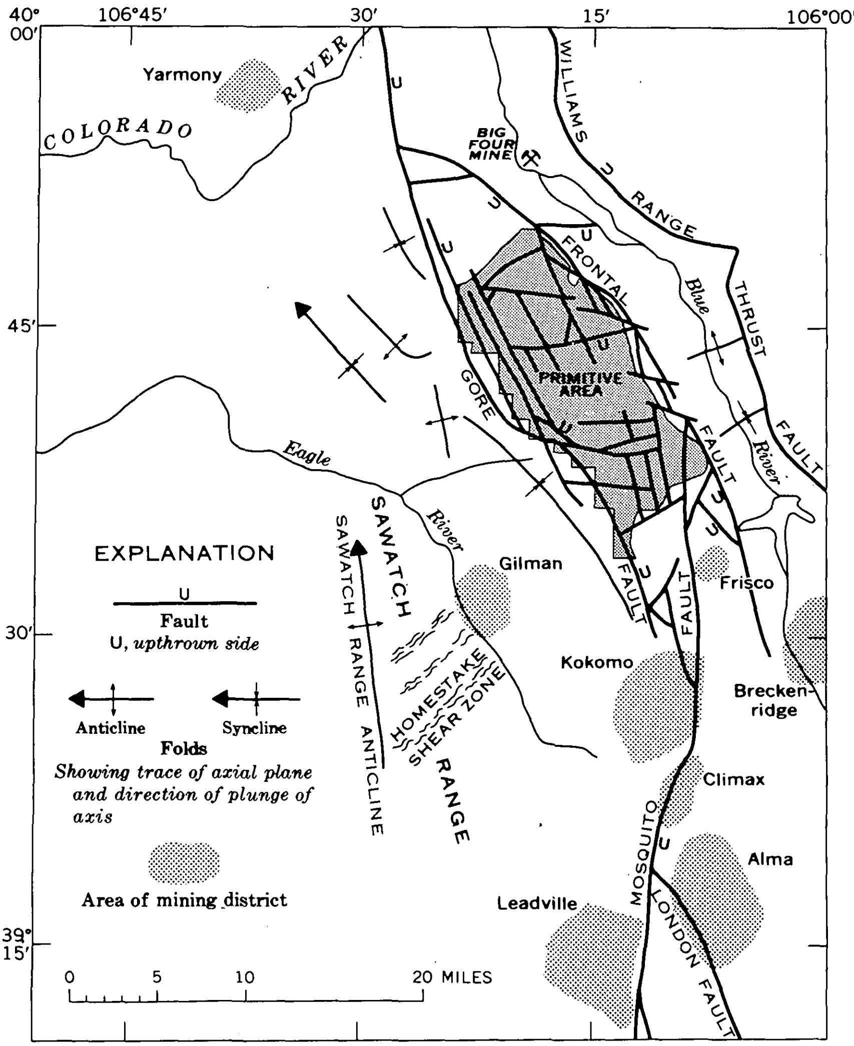


FIGURE 7.—Sketch map showing major structural features and mining districts in vicinity of Gore Range Primitive Area.

major north-northwest-trending faults, the Gore fault on the west and the Frontal fault on the east. Most of this block, through a distance of 22 miles from West Tenmile Creek to Cataract Creek, is intensely fractured and thus is subdivided into lesser blocks and slices by other faults (fig. 7). From Cataract Creek northward a few miles to its terminus, the fault block has much smaller displacement than it does to the south and is virtually free of internal faults, though it is dissected by a strong joint system.

Near its south end, the Gore Range fault block is transected obliquely by the Mosquito fault, a major north-trending fault entering the area from the south (fig. 7). The Gore fault, so far as known, ends against the Mosquito fault, which has the same sense of displacement—upthrown to the east. The area of intersection (immediately south of the area shown on pl. 1) is structurally complex and extensively intruded by porphyry. The Mosquito fault continues northward from this area to an intersection with the Frontal fault in a fault-sliced area in the vicinity of Red Buffalo Pass, Red Peak, and Willow Lakes. The upthrown block between the Mosquito and Frontal faults constitutes the northern end of the Tenmile Range (pl. 1), but the wedge end of the block extends into the Gore Range, where it includes Buffalo Mountain, a high and massive mountain that stands out in front of the main crest of the range.

The sedimentary terranes on the two sides of the Gore Range fault block are far less fractured than is that block. On the west, faults are rare within the study area (pl. 1) and only a few are present in the entire distance to the Sawatch Range (Lovering and Tweto, 1944). On the east, faults are more numerous, probably because of the location of the structurally depressed Blue River valley between the Gore Range block and the Williams Range thrust fault (fig. 7). Because of the extensive cover of glacial deposits, the fault pattern is incompletely known, but enough can be seen (pl. 1) to indicate a general parallelism in trend and pattern with the Frontal fault system. Most of the faults parallel to the range and Blue River valley have the same displacement sense as the Frontal fault, but oblique or cross faults outline blocks that are elevated or depressed relative to each other.

AGE OF FAULTS

The faults of the Gore Range are notable for their long histories of movement. Many of the faults were formed in Precambrian time, but many also show striking evidence of geologically very recent movement. The Precambrian age of some faults is shown by features such as dikes of Precambrian pegmatite or aplite along them or by the presence of certain types of fault-formed rocks on them, such as mylonites and cataclastic gneisses. These distinctive rocks are products of the depths, and only the Precambrian rocks have been eroded deeply enough to expose them. Additional evidence of Precambrian age of the Gore fault zone is furnished by dikes of fine-grained igneous rocks in fractures of the fault zone north of the study area, at the Colorado River. These dikes have been shown by isotopic dating to have a Precambrian age of slightly more than 1 billion years (Barclay, 1968).

Some of the faults in the Precambrian terrane were probably formed in the late Paleozoic, during the major uplift along the Gore fault recorded in the sedimentary rocks. Faults that cut the sedimentary rocks were formed during or after the Laramide orogeny in Late Cretaceous and early Tertiary time, when the Rocky Mountains were created, although they might follow older faults in the underlying Precambrian rocks. The swarm of faults near the intersection of the Mosquito and Frontal faults probably is Laramide or younger. The Mosquito fault shows some evidence of following a Precambrian fracture zone (Tweto and Sims, 1963) but is known to have had a moderately large Laramide displacement and a large late Tertiary displacement (Wallace and others, 1968).

As discussed later, both the Gore and Frontal faults had extensive movements in Laramide and later time, accounting for the present elevated Gore Range block between them. Along the Frontal fault, late movements of large magnitude took place both on older faults of various orientations and on younger faults connecting the older faults. Faults that displace the late Tertiary (Miocene) rocks in the Squaw Creek and Otter Creek areas and physiographic surfaces in the body of the range (fig. 8) presumably formed in conjunction with the late movements on the Frontal fault.

GORE FAULT

As a result of its long history of movement, the Gore fault is a complex fault zone that in places is as much as 3 miles wide. At the northern end of the area, the main fault lies at the base of the steep western slope of Elliott Ridge. As this slope is unstable and topographically immature, it may be in part a fault scarp produced by late movements on the fault, but it probably is mainly an exhumed scarp exposed by erosion of the adjoining sedimentary rocks. Most of the rock in the slope is shattered or crushed and stained dull maroon. In places, streaks of crushed red beds of the Maroon Formation and of crushed "red porphyry" occur among the crushed Precambrian rocks.

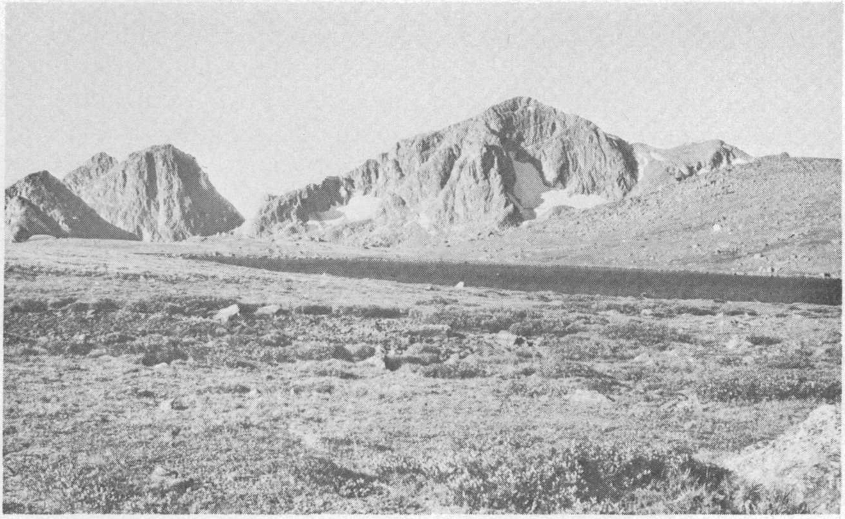


FIGURE 8.—Mount Powell from remnant of preglacial erosion surface that forms top of Dora Mountain at altitude of 12,300 feet; view westward. Mount Powell and neighboring peaks have been carved from a fault block that was uplifted higher than the Dora Mountain block. One of the intervening faults forms scarp slope at right. Dora Lake in foreground is dammed at left by low early glacial moraine of icecap type.

From the ridge north of Piney River southward to Bald Mountain, evidence of late movement on the main fault is scant, but such movement evidently occurred on several parallel faults to the east, in the upper Piney River-Mount Powell area. These faults show by their relation to faults across the end of the high part of the range at Cataract Creek that they shared in the latest uplift of the range. At Bald Mountain, the main Gore fault—as outlined by the edge of the sedimentary rocks—jogs abruptly eastward along a west-northwest-trending fracture zone that extends all the way across the range. Along the jog part of the fault, a large displacement is visible on the sides of Booth Creek canyon, where it is emphasized by abrupt bending of Minturn strata from almost horizontal to vertical along the fault, but there is little evidence of late fault movement. Instead, this movement was evidently on the faults of the upper Piney River, which are alined with the part of the Gore fault southeast of the jog (pl. 1).

At Gore Creek, a similar jog to the east on another west-northwest-trending fracture system existed in Precambrian time, but a younger fault cutting across the salient of the jog probably has been the site of most of the Laramide and younger fault movement. On the mountain south of Gore Creek, this fault is in the Precambrian rocks east of the sedimentary rocks, which are in depositional contact with the Precambrian. South of Miller Creek for about 2 miles, the main fault lies between the sedimentary and Precambrian rocks, but farther south, it is again in the Precambrian rocks. In this stretch, a lesser fault also exists at the boundary with the sedimentary rocks, but in several places this fault seems to have almost the same dip as the sedimentary rocks and is essentially a bedding-plane fault along an upturn or monoclinal bend in these rocks. Wide crushed zones and mylonitic rocks in the Precambrian rocks along this fault date from the Precambrian and are unrelated to the faulting of the sedimentary rocks.

As indicated both by scattered exposures and by its relation to topography, the Gore fault dips steeply southwest or is vertical. It is classed as a high-angle normal fault.

FRONTAL FAULT

The Frontal fault (fig. 9) is a wide and complex fault zone that can be seen only in part because of cover by glacial drift. The line of main displacement within the zone is characterized by a zigzag course and by widespread evidence of recent fault movements. Segments of the fault follow older faults of various orientations from north through northwest to nearly east-west, and these are connected by young faults that strike N. 20° to 25° W. and dip steeply northeast. The fault is of special concern because of signs of mineralization along it from Slate Creek southward. The Boss mine is located on it, as are many prospect diggings and geochemical anomalies.

The area of late fault movement on the Frontal fault extends from Surprise Lake, south of Lower Cataract Lake, southeastward to Frisco and beyond. At Surprise Lake, the main line of late displacement turns abruptly southwestward along faults near Cataract Creek that arc around the massif of Dora Mountain-Eagles Nest Mountain-Mount Powell and then connect with the faults of the Gore fault system in the upper Piney River area. This line of displacement is marked by an abrupt topographic discontinuity of 2,000–3,000 feet, making the north slopes of Dora and Eagles Nest Mountains an almost wall-like terminus of the high part of the range.

From Surprise Lake, the Frontal fault continues northwestward on a straight course and with reduced displacement. Modified scarps in glacial deposits indicate minor late movement along this segment of the fault.

From Surprise Lake southeastward, the Frontal fault zigs and zags on an irregular course at the boundary between the high and steep rocky slopes of Precambrian rocks and the lower, benchy, moraine-covered slopes (fig. 10). The moraine-covered slopes are underlain chiefly by sedimentary rocks, probably mainly Pierre Shale and Tertiary rocks, but from Slate Creek southward the exposed part of the Frontal fault zone is largely in Precambrian rocks. Fault strands that separate these rocks from the sedimentary rocks of the Blue River valley probably lie beneath the moraines.

In many places, faults displace moraines, forming scarps that show various degrees of modification, thus suggesting various ages. A striking example of a very recent scarp occurs along the north-trending segment of the fault between Slate and Boulder Creeks. There, a scarp as much as 60 feet high is so young as to be unvegetated in an area of dense forest and brushy avalanche scars. The fault at the scarp displaces young glacial deposits and even the recent avalanche deposits. In one small area the fault has a footwall of crushed, silicified, and slickensided bedrock, but elsewhere it is in glacial deposits or a fine gravelly material—either colluvium or fine breccia—that underlies the glacial deposits. Many springs emerge along the scarp, and a large stream emerges from the fault on the very crest of the ridge above Boulder Creek. A similar ridge-top spring occurs on the north side of Middle Willow Creek.

In the Rock Creek area, the Frontal fault widens into an intensely fractured zone nearly a mile wide. Within this zone are broad zones of fine-grained gougy breccia. On the slopes south of North Rock Creek, this breccia is being extruded as "boils" several hundred feet in diameter, indicating that the pressures that produce fault movement still continue. The boils are mounds of raw dirt as much as 40 feet high on an otherwise heavily timbered slope. The gougy breccia within them has shouldered aside or engulfed the morainal cover on the slope, and at the edges of the boils it is engulfing or toppling large spruce trees. In a slump-scarp at the top of the ridge nearby, glacial drift can be seen to be faulted against crushed Precambrian rocks.

Large landslides in the moraines on both sides of Slate, Black, and Cataract Creeks (pl. 1) probably were triggered by movements on the Frontal fault, which passes through or along each of the slides. All these slides contain, in addition to morainal materials, rocks of various sedimentary formations from Morrison through Pierre, indicating that the sliding was not in the moraines alone. A somewhat different slide, involving crushed rock of the

FIGURE 9.—Abrupt east front of Gore Range, representing modified scarp of Frontal fault. View southwestward at Slate Creek. Frontal fault at base of steep slope of Precambrian rocks at bottom of photograph; sedimentary rocks of Morrison and younger formations in

front of fault. Prominent peak in foreground is end of long ridge between Slate and Boulder Creeks and is at the same general altitude as the distant peaks at crest of range. (See fig. 10.)

FIGURE 10.—View northwest along scarp of Frontal fault. Canyon of South Rock Creek is in foreground; beyond it, at left, is a small remnant of preglacial topography. High ridge on skyline is ridge between Boulder and Slate Creeks. (See fig. 9.) Dump of Boss mine is light area at right center. Timbered slopes beyond it are sedimentary rocks overlain by moraines.

Frontal fault zone and the preglacial colluvium, heads between North and Middle Willow Creeks. This slide is in two parts, an early and lower one of early glacial age and a younger and upper one of postglacial age. Moraines of middle and late glacial age separate the two parts of the slide and presumably overlie material of the older slide. If they were triggered by fault movements, as seems likely, these slides indicate early glacial and postglacial movements.

With so much evidence of late movements on the Frontal fault system, it is surprising that there is no record of earthquakes in this vicinity (Hadsell, 1968). Presumably, the movement has been by creep or by small increments that produced quakes too low in magnitude to be felt. Residents of the Blue River valley report a "big earth slump" in 1920 which, among other effects, closed the openings of the Boss mine. Scarps are said to have developed south of Slate Creek at this time, and a new stream that came into being near the ridge top on the north side of Boulder Creek quickly cut a deep gully in the pulverized Precambrian rocks along the Frontal fault.

PRECAMBRIAN SHEAR ZONES

Shear zones characterized by strongly foliated cataclastic gneisses and northeast trend occur at several places in the range but are principally in the southern part. These shear zones are similar in character and direction to those of the Homestake shear zone of the Sawatch Range (Tweto and Sims, 1963). They are also approximately on the line of projection of the Homestake zone (fig. 7)), though slightly to the north. The largest and most prominent shear zone of this group extends from the Gore fault on the slope above Polk Creek to Buffalo Mountain (pl. 1). This shear zone marks the southern boundary of the main body of the granite of Cross Creek, just as in the Sawatch Range. The shear zone is 100 to 200 feet wide, but in places, such as west of Buffalo Mountain and near the Gore fault, later movements have made it a crushed or shattered zone several hundred feet wide. Northeast-trending faults in the sedimentary rocks near the intersection of the shear zone and the Gore fault may reflect the shear zone west of the Gore fault.

Another strong shear zone occurs in the Deluge Creek area, but this and other smaller ones to the north are disrupted by younger faults. No attempt was made to trace these shear zones, but detailed mapping probably would show that some of them extended across the range before disruption by younger faults. Thus, if mapped, they might serve as indicators of the directions of movements on the faults in the Precambrian rocks.

FOLDS

The sedimentary rocks of the area are gently to moderately tilted. On the west side of the range, the tilting is related to folds, but on the east side it seems to have resulted mainly from rotation of fault blocks. Along the Gore fault, the sedimentary rocks are bent up sharply and dip at various angles to the southwest except where locally overturned adjacent to the fault. A mile or two southwest of the fault, in the southern and central parts of the area, this dip reverses to 10° to 15° NE., which persists all the way to the Sawatch Range (Lovering and Tweto, 1944). Thus the axis of a broad asymmetric syncline parallels the Gore fault for many miles. Locally, as on the north side of Gore Creek, the trough, or lower southwest flank, of the syncline is interrupted by a small anticline (fig. 7). North of the Piney River, the syncline is interrupted by an anticline with a hook-shaped axis that extends from near the Gore fault westward about on the line of East Meadow Creek and then northwestward about on the line of the lower Piney. North of this anticline, along the North Fork of the Piney, the strata bend down sharply toward another synclinal axis near the Gore fault at and beyond the northern edge of the study area.

On the east side of the range, a west- to southwest-plunging anticlinal nose brings rocks of the Morrison, Dakota, and Benton Formations to the surface in the Blue River valley in the vicinity of North and South Rock Creeks and Boulder Creek. A broad complementary syncline with Pierre Shale in its center occupies the area between South Rock Creek and Silverthorne. These folds apparently are truncated by the Frontal fault. In contrast, a tight anticline outlined in the Dakota Sandstone north of Lower Cataract Lake trends parallel to the Frontal fault and may be related to it in origin.

AEROMAGNETIC RESULTS

In 1967 the U.S. Geological Survey made an aerial magnetic survey of the region between lat 39°30′ and 40°15′ N. and long 105°15′ and 106°45′ W., which includes the Gore Range (U.S. Geological Survey, 1968). The survey was flown at 14,000 feet barometric altitude and at a flightline spacing of 1 mile. The magnetic data, originally compiled at a scale of 1:125,000 and a contour interval of 20 gammas, are shown on plate 1 as enlarged to a scale of 1: 48,000 for the Gore Range area. Because of the high magnetic relief, a contour interval of 100 gammas is used on plate 1, with subsidiary 20-gamma contours indicated in places to show local details. No laboratory measurements of rock magnetic properties were made.

As is characteristic of many high mountain areas of Precambrian rocks, the Gore Range stands out as a magnetic high with local highs and lows of lower order superposed on it. The magnetic high of the range as a whole is due primarily to the altitude of the range, which brings the magnetic basement rocks close to the flight datum. In the Gore Range, this effect is increased by the presence of thick blankets of weakly magnetic sedimentary rocks on each side of the range, thus further increasing the distance from the observation level to the magnetic basement rocks. Magnetic anomalies superposed on the general magnetic high reflect both differences in the rocks to considerable depths beneath the surface, and local topographic features such as high peaks and major valleys. Among the rocks, migmatite seems to be more magnetic than most—but not all—of the granitic rocks, judged by the relation of magnetic features to geology. This is in accord with the findings by J. E. Case (U.S. Geological Survey, written commun., 1965) in the Sawatch Range, where migmatites and related biotite gneisses generally similar to those of the Gore Range show a higher magnetic susceptibility than the granitic rocks.

A major feature of the magnetic map is a somewhat sinuous line of magnetic lows extending along Gore Creek, across the crest of the range in a magnetic saddle near the heads of Deluge and North and South Rock Creeks, and into the Blue River valley near North Willow Creek. The parts of this line of lows that are in areas of exposed Precambrian rocks coincide in general with the most granitic rocks in the range, both in the sense of being close to granite in composition and in the sense of being least contaminated by migmatite. Calculations by George G. Brinkworth of the Geological Survey, using magnetic susceptibility values similar to those of the Sawatch Range, indicate that the magnetic low extending across the range could be due entirely to the presence of the granitic rocks in a belt flanked on both sides by migmatitic rocks. This interpretation is adopted there. Alternative interpretations are (1) that a body of weakly magnetic rock such as a silicic igneous body is present at depth beneath this area, and (2) that alteration along the belt has reduced the magnetic susceptibility of the rocks. These interpretations are rejected because there is no supporting evidence of an underlying silicic igneous body and no indication of a belt of rock altered to any greater degree than the rest of the rocks in the range. If an igneous body existed at depth, dikes might be expected in the overlying highly fractured rocks, but not a single dike younger than the Precambrian pegmatites is known in the area of the magnetic low. Similarly, a major alteration zone at depth should be manifested by greater alteration along the numerous faults and fractures within the magnetically low area than outside it, but no such pattern is evident.

The belt of lows along Gore Creek, west of the Gore Range, probably reflects continuation of the granite body beneath the sedimentary rocks to the northern end of the Sawatch Range, where the granite crops out again. The low on the eastern side of the range in the same belt probably also is due to this granite in an extension east of the Frontal fault.

Zones of high magnetic gradients characterize both sides of the Gore Range, reflecting the abrupt changes in surface altitude and level of the basement rocks along the Gore and Frontal faults. These zones are locally interrupted or distorted by other features, such as the magnetic lows caused by granite or topography. Along the east side of the range, the zone of high magnetic gradient continues down to a "valley" in the magnetic contours. This valley, which lies just east of the Frontal fault and extends the full length of the high part of the range, indicates that the Frontal fault persists in depth with steep dip. On the west side of the range, elements of a similar valley parallel the Gore fault on its downthrown side.

Within the general high magnetic "plateau" of the Gore Range are local magnetic features caused either by rocks or by topography, or by a combination of the two. A magnetic high centered just east of Elliott Ridge is in the largest area of "pure" migmatite in the range and is interpreted to reflect this fact. A broad magnetic shelf outlined by the 2,900-gamma contour to the southwest, across the Gore fault, suggests that the migmatite body continues in that direction beneath the sedimentary rocks. In contrast to the high associated with migmatite, a high about 6 miles to the southeast, between Slate and Black Creeks, is in an area of granitic rocks. However, these rocks are in the largest body of relatively mafic granitic rocks in the range. The principal rock is dark granodiorite that visibly contains more magnetite than the granitic rocks elsewhere, and thus it is inferred to be more magnetic. The anomaly evidently also is caused in part by the altitude of the high ridge over which it is nearly centered. Prominent highs in the southern part of the range at Buffalo Mountain and northeast of Vail Pass are over topographic highs in areas of migmatite and biotite gneiss and are reasonably attributed to this combination. In addition, however, these two highs and the magnetic ridge connecting them constitute a direct continuation of a pronounced magnetic high that characterizes the Homestake shear zone in the Sawatch Range (J. E. Case, U.S. Geological Survey, written commun., 1965). The area of the two highs contains extensions of this shear zone, as discussed in the section on structure.

Two small magnetic lows, exclusive of the magnetic saddle discussed above, lie within the range. One is centered over the large cirque area at the head of the middle fork of Black Creek, about 2 miles southeast of Mount Powell. Rocks at the surface in this area are migmatite surrounded by granitic rocks. The low probably is caused in part by the topographic low of the large cirque, but it also may indicate that the body of migmatite is underlain at shallow depth by less magnetic granitic rocks. The other low is centered over the valley of the south fork of Slate Creek, in an area of mixed granitic rocks and migmatite (pl. 1). As the south fork valley is distinctly broader than most other valleys at this position in the range, the low probably is caused in part by topography.

Just like the other low, it might be caused in part also by a change from migmatite to granite at shallow depth. In addition, however, it could conceivably reflect a small intrusive igneous body at shallow depth, as dikes, though few, are larger, longer, and more abundant in this area than anywhere else in the range. To judge by the dikes, if such an intrusive body exists it probably is of the composition of the trachytes and latites of Green Mountain. Rocks of the area of the low are fresh except for minor alteration along faults just as elsewhere in the range.

In summary, the aeromagnetic data, which provide a means of seeing beneath the surface in a limited way, are in general accord with the inferences drawn from the geology as seen from the surface. The data do not indicate any hidden features that might affect conclusions on the mineral potential of the area, except insofar as they would permit existence of a small buried intrusive body in an area of scattered dikes in the valley of the south fork of Slate Creek.

MINERAL RESOURCES

The motive for the present study was to determine the extent and nature of any mineral resources in the Gore Range Primitive Area and to appraise the potential for economic production. This was done by studying the geology in relation to that of nearby productive mining districts, by examining the area for any signs of mineral deposits, with particular attention to the fracture system, and by a program of sampling and detailed analysis of (1) rocks that showed any sign of mineralization or alteration, and (2) sediments in the streams draining the area.

MINERAL SETTING

As indicated in figure 1, the Gore Range area adjoins the Colorado mineral belt, and a line drawn between salients in the belt at Urad and Gilman would pass through the range about at Red Buffalo Pass. The segment of the mineral belt depicted in figure 1 is the most productive part of the belt. It has already furnished more than 50 percent of all the metallic mineral wealth that has been produced from Colorado, and by the time the known deposits at Climax and Urad are mined, the percentage is likely to be much greater.

The close geographic relationship of the Gore Range area to the mineral belt is, alone, adequate reason for closely examining the Gore Range for minerals, but geologic reasons exist also. Chief among these is the fact that the Mosquito fault extends into the Gore Range area, and that it connects with the Gore and Frontal faults, the bounding faults of the Gore Range. The Mosquito fault is an old and deep-going fault that served at depth as a conduit for porphyries and mineralizing solutions. The mining districts of Leadville (Tweto, 1968a), Climax (Wallace and others, 1968), and Kokomo (Koschmann and Wells, 1946) are alined along it, and the Alma district (Singewald and Butler, 1941) is on a major branch, the London fault (fig. 7). The Homestake shear zone, which extends into the Gore Range, is part of a system of shear zones that coincides approximately with the mineral belt through much of its length and evidently was a factor in the localization of the belt (Tweto and Sims, 1963). The ore deposits of Gilman (Radabaugh and others, 1968) extend down the dip of the strata at least 1½ miles toward the Gore fault, and the intervening few miles are unexplored. The Frontal fault has the Boss mine located on it (pl. 1); to the north, the Big Four mine (McCulloch and Huleatt, 1946) is not far from the fault (fig. 7); to the south, the fault projects into the Breckenridge mining area (Lovering, 1934) and has scattered mineral prospects on it near Frisco (Bergendahl, 1963). Along Black Gore Creek and also to the west of the lower Piney River, signs of uranium have induced some prospecting (Grossman, 1955; Butler and others, 1962). To the northwest of the Gore Range area, the small mining district of Yarmony (fig. 7) is possibly related to the Gore fault through a complex system of faults, although part of the ore deposits there are of a type that may have been generated entirely within the sedimentary rocks.

Despite these many features that would seem to link the Gore Range area to the mineral belt, dissimilarities are evident. Chief among these is the virtual absence of porphyries in the Gore Range. The two characterizing features of the mineral belt are porphyries and ore deposits. Although locally one may occur without the other, the virtual absence of porphyries throughout the entire area of the Gore Range suggests that the range is indeed outside the mineral belt. This is supported by the fact that except for the Boss mine, the range is not known to contain productively significant ore deposits, nor does it contain areas of altered rocks of the kind commonly associated with ore deposits in the mineral belt. The early prospectors, who clearly went over the whole range, found no such deposits, nor, as discussed below, were any found in the present study. This is not to say, however, that no traces of mineralization exist. Quartz and carbonate veins are widespread, and in many places the area contains trace metals in concentrations that constitute strong geochemical anomalies.

Substances such as coal, oil, gas, and nonmetallic minerals have not been produced in the vicinity of the Gore Range. The possibilities for their occurrence are discussed in "Coal, oil, and gas."

SAMPLING AND ANALYTICAL PROGRAM

The Precambrian rocks of the Gore Range and the Primitive Area are migmatites and granitic rocks that in themselves are barren of any mineral values. In many hundreds of miles of foot traverses over these rocks, the only signs of mineralization found were in the fracture zones. Accordingly, rock sampling was devoted almost entirely to these zones. Fractures were sampled throughout the area whether or not they showed signs of mineralization such as quartz or carbonate veins or rock alteration of kinds commonly associated with mineralization. Many of the fractures show such signs (fig. 11), but a far greater number do not. In general, the most mineralized material that could be found was sampled. For the unmineralized fractures, this was the most iron-stained rock, even though the iron evidently came from the weathering of biotite in the rock. By no means all the myriad fractures in the range were sampled, but nearly 800 samples of this type from throughout the range were deemed sufficient to appraise the

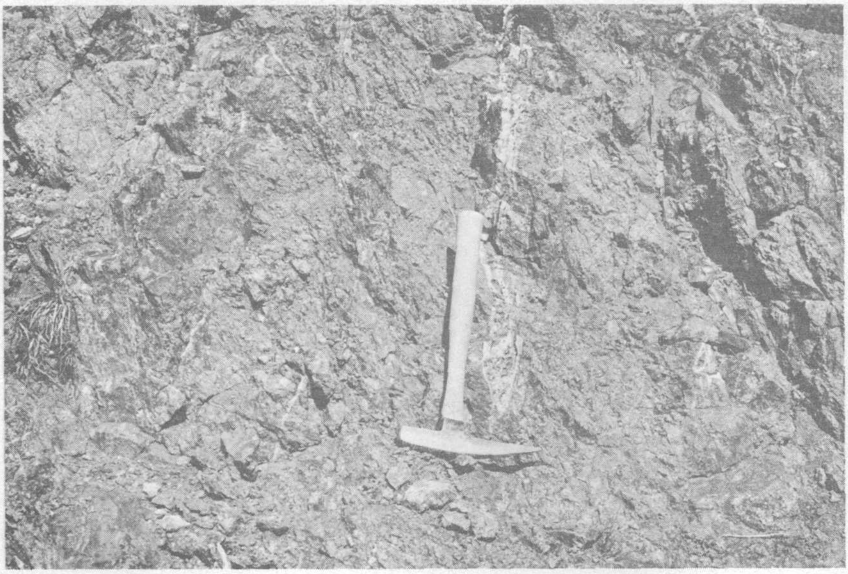


FIGURE 11.—Typical fracture zone in Precambrian rocks, on ridge west of Deluge Lake, consists of crushed granitic rock which here is stained dull red by hematite and is cut by a typical thin vein of quartz and carbonates (white).

fracture zones. Additional samples were taken from mining claims by the Bureau of Mines.

In general, the samples consisted of ½ to 2 pounds of selected chips or rock fragments showing the strongest mineralization or iron staining. They were designed as character samples to determine whether any invisible metals of value were present and not as samples for calculating grade of specific volumes of rock. Thus, with a few exceptions, no systematic channel sampling was done, although many samples were made up of a succession of chips taken across the width of wide fracture zones or features such as quartz veins, with emphasis on the parts appearing most mineralized.

As a check in case mineral deposits were not seen, or significantly mineralized fractures were not sampled, stream sediments were also sampled throughout the area. Experience has shown that the chemical compositions of fine sediments in streambeds generally will express the presence of mineral deposits upstream for some distance, even though the chemical distinctions may be subtle. In order to identify even the small deposits whose effect might not be evident in large streams, samples were taken principally from the small streams, although the larger streams were also sampled at intervals. Typical stream-sediment samples consisted of 1 to 1½ pounds of the finest sand or silt in the streambed. However, fines are scarce in many of the cascading streams, and consequently many of the samples were smaller.

Rock samples were crushed, sieved, split, and then analyzed by atomic absorption methods for gold, silver, copper, lead, zinc, and mercury in a mobile laboratory in the field. All samples were tested by scintillation counter for radioactivity, and a few were analyzed for uranium by paper chromatography (with essentially negative results). Stream-sediment samples were dried, sieved to minus 80 mesh, ignited to burn off organic matter, and analyzed for gold by atomic absorption spectrometry. Both the rock and the sediment samples were then subjected to semiquantitative spectrographic analysis for about 30 elements in the Denver laboratories of the U.S. Geological Survey. Results of the analyses of the 791 rock samples and 421 stream samples collected (pl. 2) are presented in tables 2–8. (Bureau of Mines sample data are shown in tables 9–10.) For convenience of the user, these tables are organized according to area. The rock samples (tables 2–7) are grouped according to six areas outlined on plate 2. The sediment samples (table 8) are divided according to drainage.

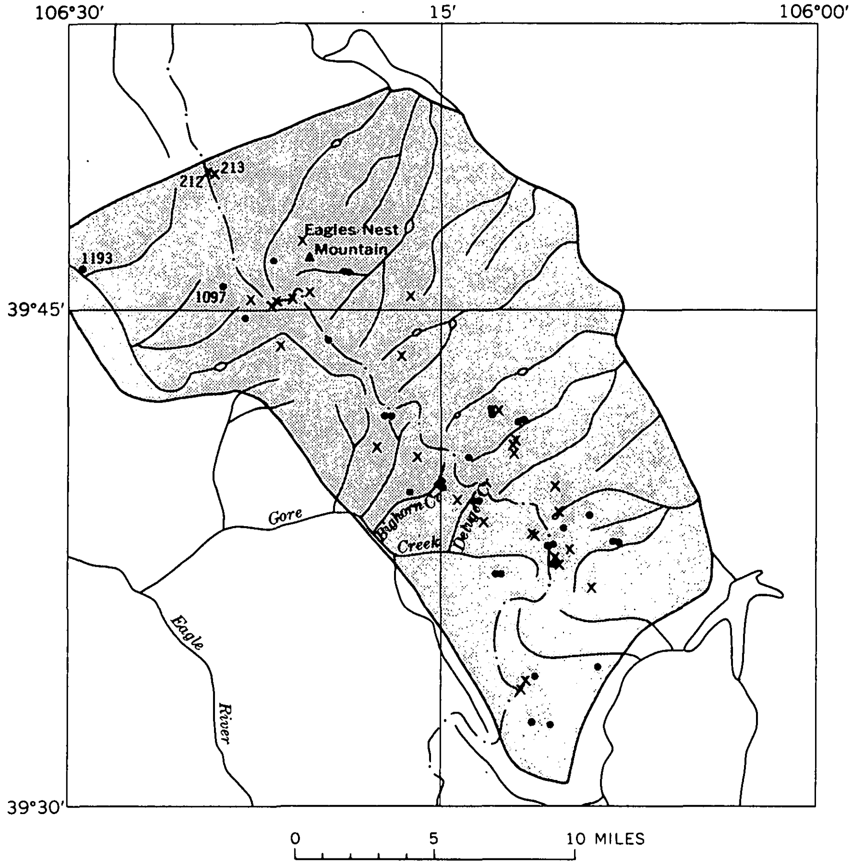


FIGURE 12.—Map of Gore Range study area (stippled) showing localities of rock samples containing 300 ppm or more copper. ×, 300–1,000 ppm Cu; •, 1,000 ppm or more Cu. Numbers are localities discussed in text.

The spectrographic analyses reported here were made in the U.S. Geological Survey laboratories in Denver by E. F. Cooley, Carl Forn, David Siems, and K. C. Watts. Chemical analyses were made by J. G. Frisken by atomic absorption techniques, mainly in a mobile laboratory in the field but also in the Denver laboratory. A few of the mercury determinations were made by instrument by L. A. Vinnola in the Denver laboratory. Paper chromatographic analyses for uranium were made in the Denver laboratory by A. W. Wells.

As the concentrations of many of the elements are very low, analytical results are expressed in parts per million (ppm), 1 ppm being 0.0001 percent. Analytical data of this kind are designed for purposes of comparison and not as tests for the presence of "ore."

By comparisons with the values for unmineralized rocks, they serve to identify localities where elements have been added by a mineralization process, even if in minute amounts. Tests for "ore" would require a different type of sample, one that is representative of a certain volume or tonnage of mineralized rock rather than being only the selected most-mineralized material. Thus, although many of the figures in the tables are of magnitudes near or at the grade levels of submarginal ores (10,000 ppm for lead and zinc, 2,500 ppm for copper, 500 ppm for molybdenum, 50 ppm for silver, and a few ppm for gold), they are not measures of grade and should not be so interpreted. For all the sample localities, grade values even for bodies as small as 100 tons would be far below the values reported for the selected samples.

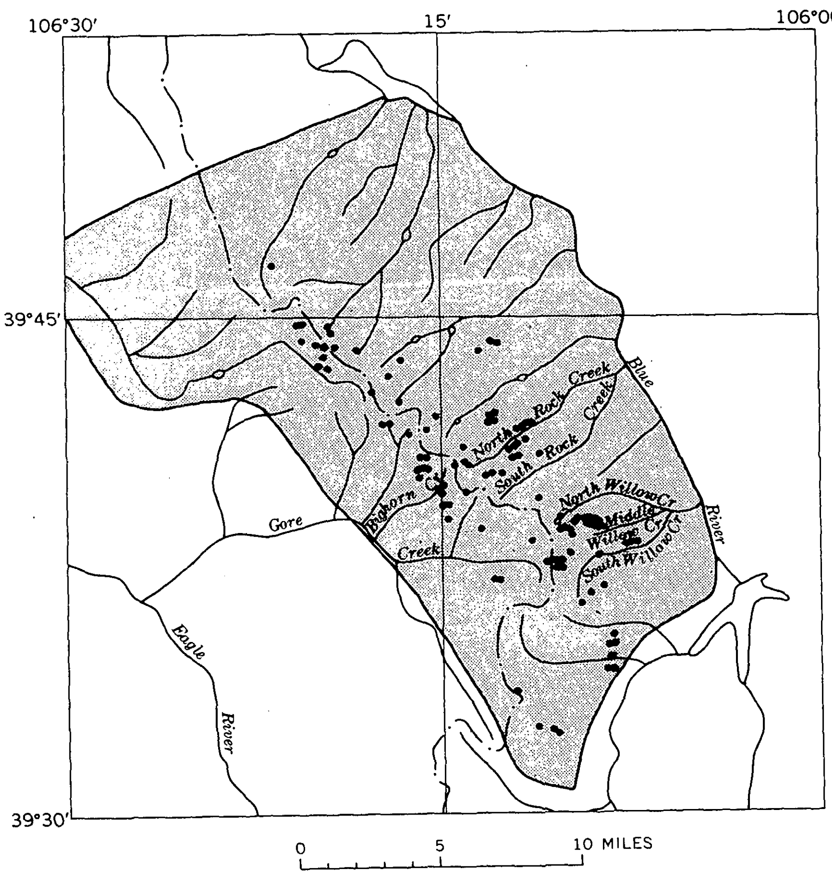


FIGURE 13.—Map of Gore Range study area (stippled) showing localities of rock samples containing 500 ppm or more lead.

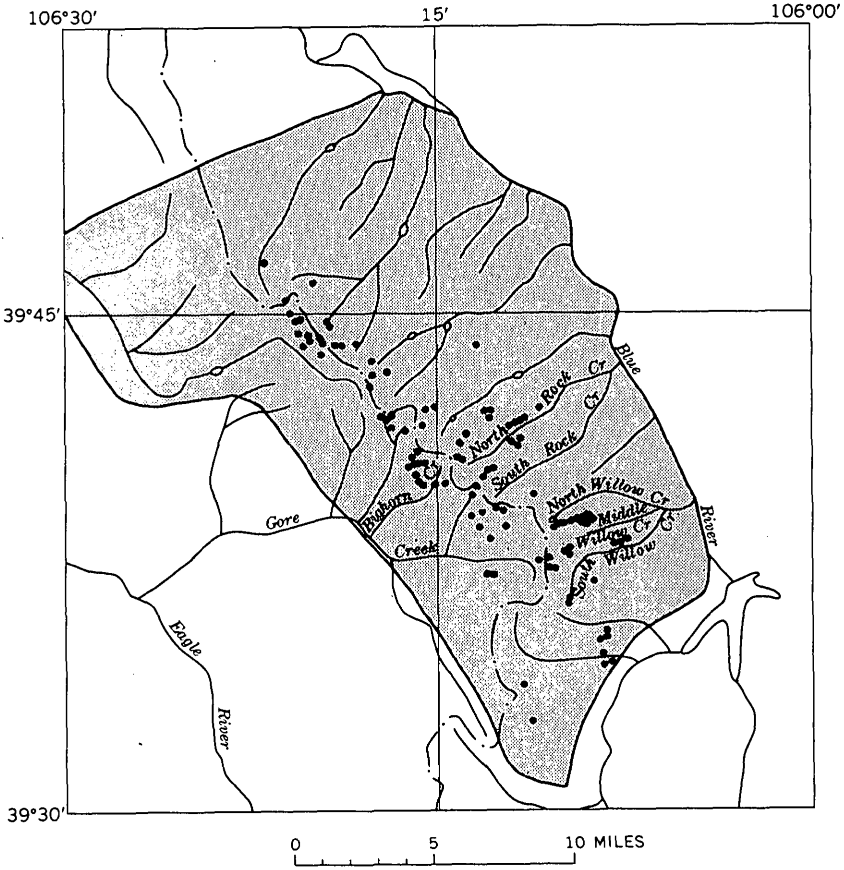


FIGURE 14.—Map of Gore Range Range study area (stippled) showing localities of rock samples containing 1,000 ppm or more zinc.

Figures in the analytical tables are not absolute values but approximations indicating the general magnitude of the concentration. The semiquantitative spectrographic method provides numerical values only in a series of steps rather than in a continuum; moreover, only 30 percent of the numerical values reported can be considered to be in the step assigned as contrasted to the next step above or below. In addition, the spectrographic method involves only a very small amount of sample, so that problems of homogeneity of the sample pulp arise, and the sensitivity of the method introduces problems of differences among spectrometers and their operators. To test for the possibility of instrumental differences and operator bias, 30 of the samples were reanalyzed for copper, lead, zinc, and silver on each of three spectrometers by three different operators. For most determinations the three values were in

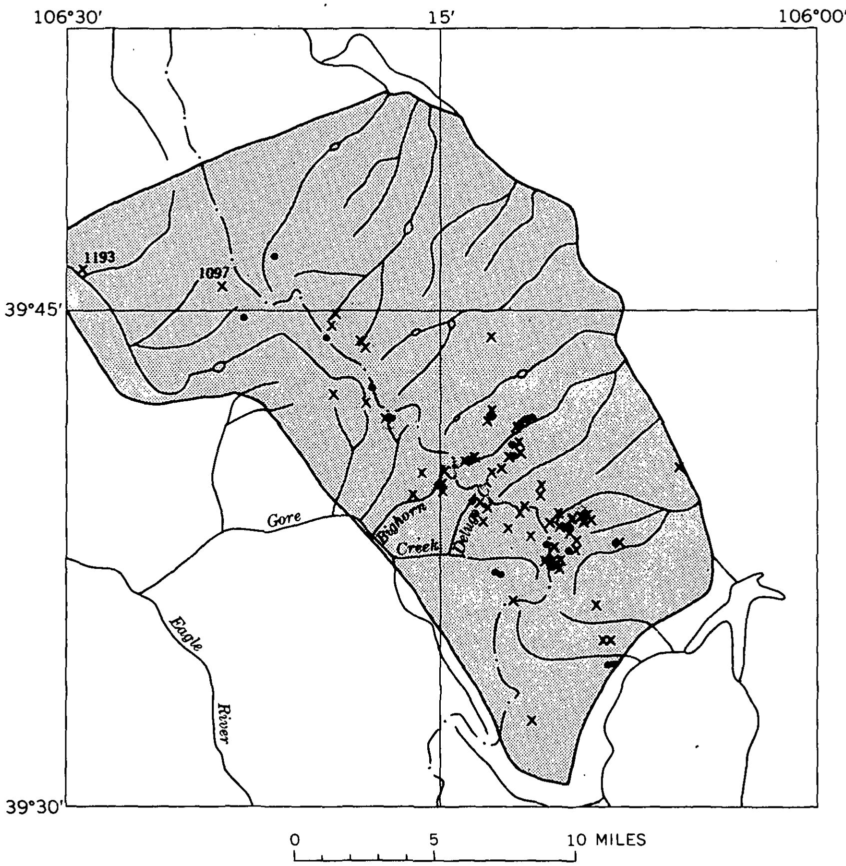


FIGURE 15.—Map of Gore Range study area (stippled) showing localities of rock samples containing 5 ppm or more silver. ×, 5–50 ppm Ag; •, 50 ppm or more Ag. Numbers are localities discussed in text.

close accord, although one instrument consistently gave somewhat higher values for copper than the other two. For a few of the determinations, one or another of the instruments gave a value far out of line with the other two, indicating a lack of homogeneity in the sample pulp.

The atomic absorption-chemical method of analysis does not have some of the weaknesses of the spectrographic method, such as the limited sample size and step results, but it has others. Chief among these are problems of complete digestion of certain types of materials and, in the case of silver, interference by calcium in such a way as to give spuriously high numerical values. Thus, for silver, the spectrographic results are regarded as more trustworthy than the chemical results. For the other elements, the two methods consistently show satisfactory accord as to magnitude, even though some of the numerical values differ appreciably.

GEOCHEMICAL PATTERNS

As tables 2–7 indicate, a great many of the fractures in the Gore Range contain various metals in concentrations far higher than those of ordinary rocks (Turekian and Wedepohl, 1961). Thus almost the entire range can be considered to be geochemically anomalous in respect to fracture zones but not in respect to the rocks between the zones. Localities of highly anomalous samples for each of 10 different metals are plotted in figures 12–19. The threshold value selected for each of these maps is very high by the standards of most geochemical surveys (compare with Ratté and others, 1969; Erickson and other, 1966; Elliott and Wells, 1968). If the

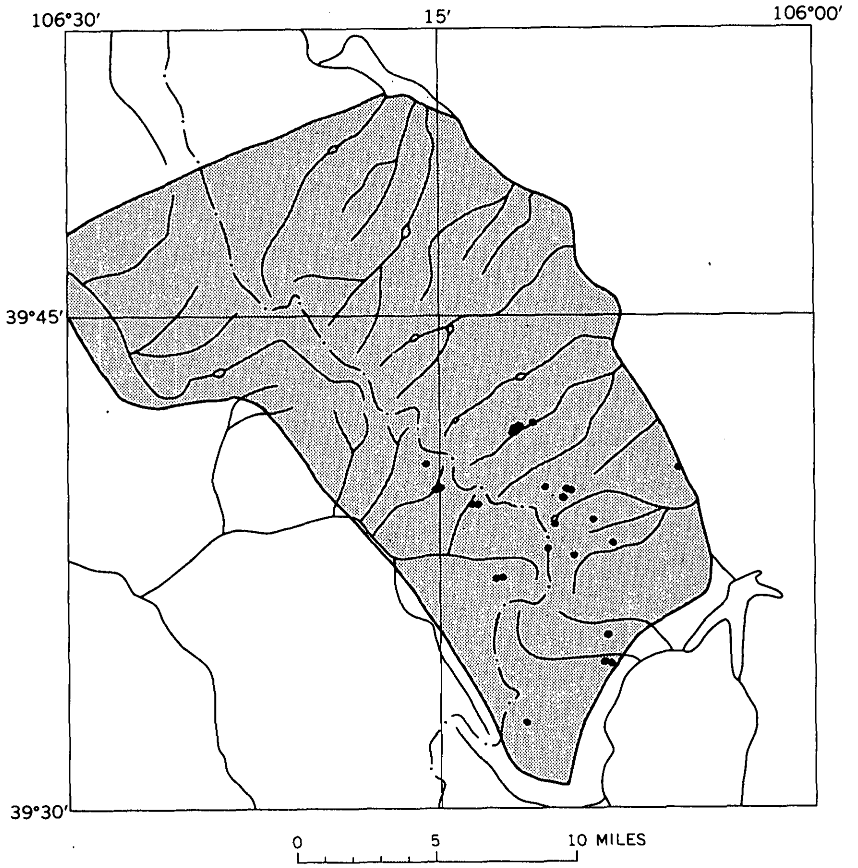


FIGURE 16.—Map of Gore Range study area (stippled) showing localities of rock samples containing 0.05 ppm or more gold.

standards of other areas were applied, the maps, except for gold, would have up to twice as many spots on them.

From preliminary geologic analysis of the Gore Range area, it was expected that the Frontal fault, because of its youth, might be characterized by geochemically anomalous amounts of metals of a group that characterizes certain ore deposits formed at shallow depths, including especially mercury, arsenic, antimony, gold, silver, and tungsten. For a different reason, namely the geologic relationships to the mineral belt, elements of a group characterizing the second of two main periods of mineralization recognized in Colorado (Tweto, 1968b), including molybdenum, bismuth, and tellurium, might also be expected. Most of these elements, except tungsten and tellurium, proved to be present in the area, along with the more common copper, lead, and zinc. However, they are not selectively concentrated along the Frontal or Gore faults but are scattered throughout the range, with many of the highest anomalies (figs. 12–19) near the crest of the range. This distribution, discussed further in a later section, is intrepreted to reflect the highly fractured character of the range together with geomorphic conditions at the time of mineralization.

Figure 12 shows that high values for copper are scattered rather evenly through the range from Eagles Nest Mountain to the southern end of the area. A cluster of samples in upper Deluge and Bighorn Creeks represents veins that contain visible copper minerals, as do two samples south of upper Gore Creek, but in many of the other localities, copper minerals either are not visible or are present only in minor quantity, as specks of malachite or azurite. Four of the localities in the northwestern part of the area (212, 213, 1097, and 1193, fig. 12 and pl. 2) are notable because they are in sedimentary rocks. Locality 1097 is at the edge of the Gore fault and the copper may be related to the fault, but the other three localities apparently are unrelated to faults. Localities 212 and 213 are of the "red-bed copper" type, representing thin black-stained layers in friable sandstone of the Gartra Member of the Chinle Formation at a point within 100 feet of the pinchout of the Gartra beneath an unconformity. Locality 1193 is from copper-stained joint surfaces in limestone in the Minturn Formation.

Figures 13 and 14, for lead and zinc, show much denser populations of points than the copper map, even though the cutoff values for plotting are higher. On both maps, dense clusters of points occur in the North, Middle, and South Willow Creeks area and in the North and South Rock Creeks-Bighorn Creek area. A few of the samples from both these areas, as well as from scattered localities elsewhere in the range, are from fractures that contain visible

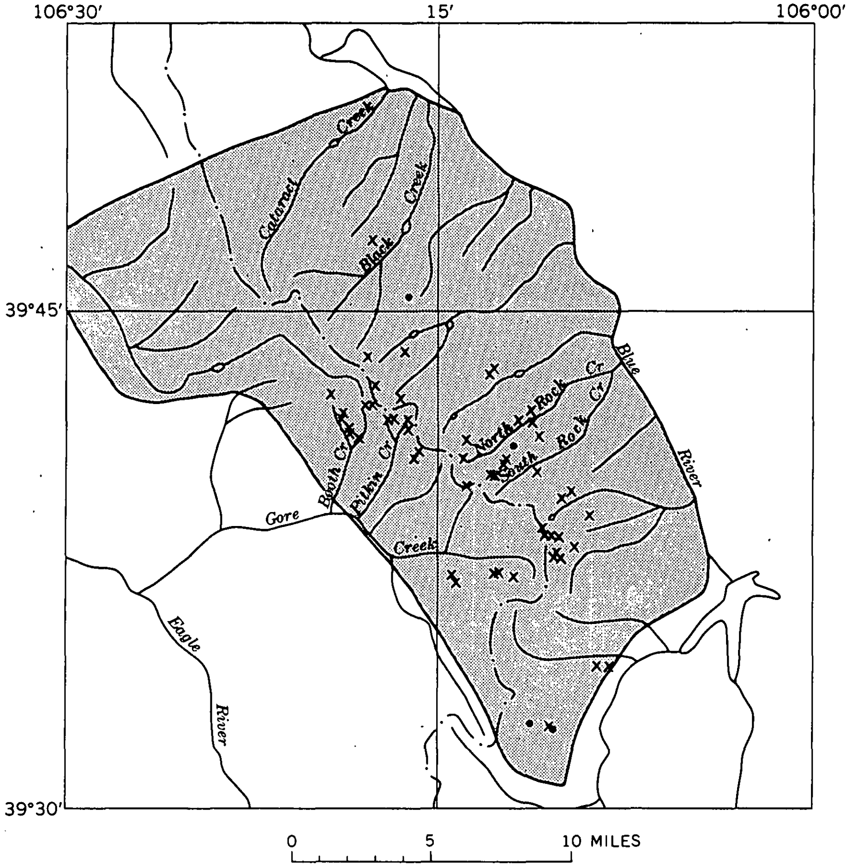


FIGURE 17.—Map of Gore Range study area (stippled) showing localities of rock samples containing 15 ppm or more molybdenum. ×, 15–100 ppm Mo; •, 100 ppm or more Mo.

galena and sphalerite, generally in thin veinlets, but many of the sample localities showed no visible lead or zinc minerals.

Figure 15 shows clearly that the samples high in silver are concentrated in the south-central part of the range, in the general area of highest lead and zinc. However, many of the high-copper localities in the Deluge-Bighorn Creek area also appear on the silver map, as do two of the high-copper localities in sedimentary rocks (1097 and 1193, pl. 2).

Figure 16, for gold, shows few localities in comparison to the maps for the other metals, and these are limited entirely to the southern half of the range. Most of the localities showing gold appear also on the copper map, and almost all of the remainder are

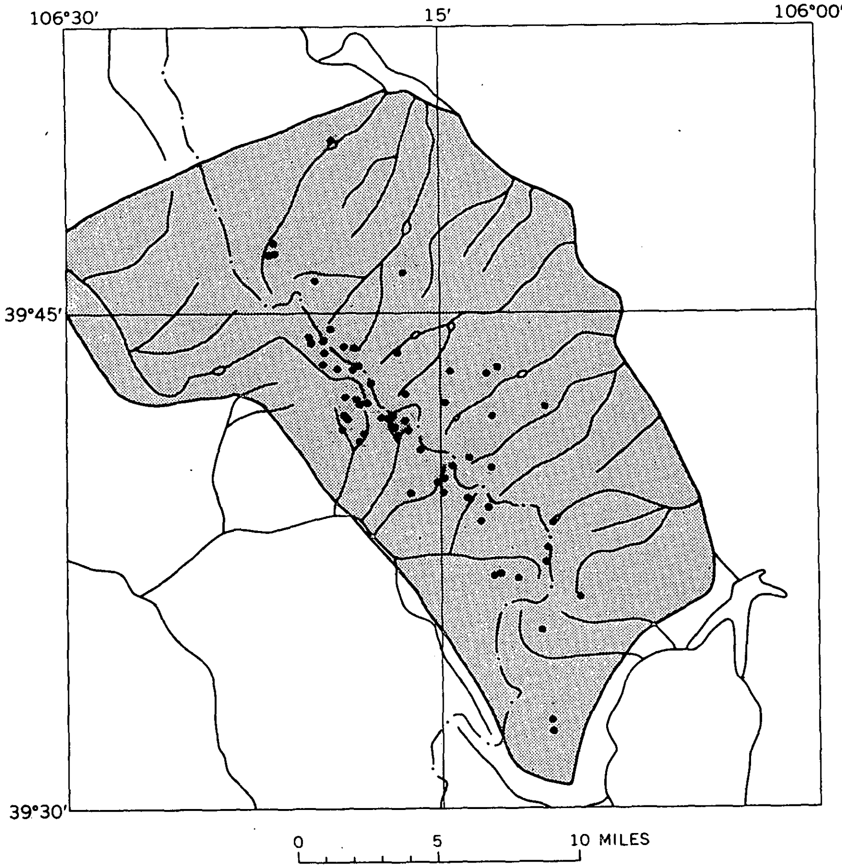


FIGURE 18.—Map of Gore Range study area (stippled) showing localities of rock samples containing 1 ppm or more mercury.

on the lead or silver maps. With the exception of one sample of high-grade ore from the dump of the Boss mine, all of the samples showing gold contained less than 1 ppm; hence, even if the samples were characteristic of large volumes of rock, the value of the gold would be only a few cents per ton.[1]

The map showing localities high in molybdenum (fig. 17) resembles the copper map more than that of any of the other base and precious metals, although it shares only a few localities in common with the copper map. Further, it contains a cluster of localities near the heads of Booth and Pitkin Creeks that does not appear on the copper map. If a lower cutoff of 10 ppm were used, the map would show a fairly dense sprinkling of localities in the Black

[1] One Troy ounce per ton is equivalent to about 34 ppm; at $35 per ounce for gold, 1 ppm thus is roughly equivalent to $1 in gold per ton.

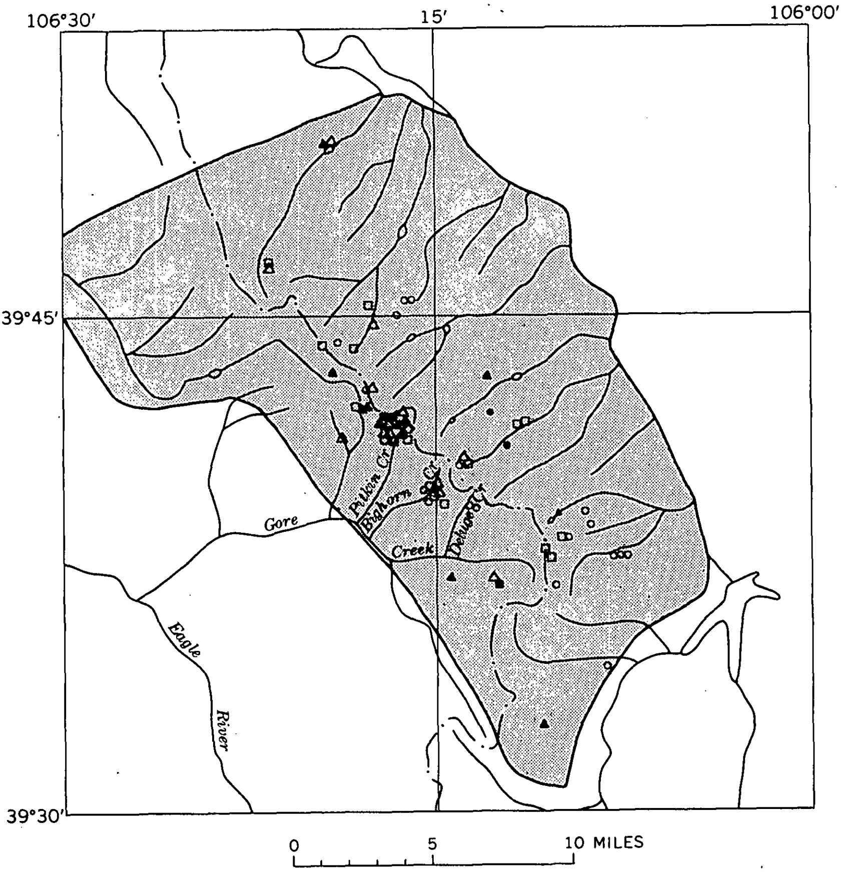


FIGURE 19.—Map of Gore Range study area (stippled) showing localities of rock samples containing 300 ppm or more arsenic, 15 ppm or more bismuth, and 200 ppm or more antimony. △, 300–1,000 ppm As; ▲, 1,000 ppm or more As; ○, 15–1,000 ppm Bi; ●, 1,000 ppm or more Bi; □, 200–1,000 ppm Sb; ■, 1,000 ppm or more Sb.

Creek-Cataract Creek area and would then closely resemble the mercury map (fig. 18). It would also show a much denser population of points in the North and South Rock Creeks area.

Mercury is present in the area only in traces, and so the map for mercury (fig. 18) is based on the low cutoff value of 1 ppm. The reason for analyzing for mercury at such low concentration levels is that, being volatile, mercury can migrate through the cracks in the rocks and may thus form a subtle but detectable "mercury halo" around a mineralized source that contains traces of mercury among the other metals. As indicated above, the mercury map resembles the molybdenum map, particularly if a lower cutoff of 10 ppm were used for molybdenum, but the two maps share relatively few localities in common. Instead, many of the mercury localities are identical with localities high in lead or copper, indicating that in a general way at least, mercury correlates with lead and copper. Mercury shows poor correlation with gold and only moderate correlation with silver.

Arsenic, antimony, and bismuth were not detected in a great preponderance of the samples, but one or more of them were present in several samples and, in a few, in remarkably high concentration. As shown in figure 19, each of these metals occurs in scattered localities through most of the range, but as a group they are concentrated particularly in the Bighorn-Deluge Creeks area and near the head of Pitkin Creek. With few exceptions they occur in localities characterized by geochemically high concentrations of one or more of the other metals, but they seem to correlate most closely with mercury, silver, and molybdenum.

ECONOMIC GEOLOGY OF AREAS

EAGLES NEST-CATARACT CREEK AREA

In the area from the north slope of Mount Powell northward (area A, pl. 2), signs of mineralization are scarce. A few of the fracture zones locally contain quartz or carbonate veinlets or silicified streaks, but most of them are simply fractured country rock more or less stained by iron oxide. The entire mountain mass of Dora Mountain-Eagles Nest Mountain-Mount Powell has the dead-gray or blue-gray color characteristic of slopes of unaltered Precambrian rocks. Table 2 and figures 12–19 show few strongly anomalous geochemical samples in the area. A notable exception is sample 289 (pl. 2), from a fault on the west slope of Eagles Nest Mountain, in the system of faults with late movement that arcs around the north end of the range. The fault is marked by iron-stained hydrothermally altered granite that is anomalous in several elements but particularly in silver, which shows the extremely high values of 300 ppm by spectrographic analysis and 180 ppm by chemical analysis. If rock of this silver content existed in minable quantity, by some standards it might be ore (5 to 9 oz. Ag per ton). However, only a small amount of the high-grade material represented by the selected sample is thought to be available, and in addition, the remoteness and extremely rugged topography of the locality probably would require ore of much higher value per ton to be economically workable.

At one locality (samples 468 and 488, pl. 2), the broad fault or shear zone along the north fork of Black Creek contains a little disseminated pyrite in bodies a few inches in diameter on its south wall, and these are anomalous in copper and molybdenum. Other samples from this shear zone are almost barren. Only one sample locality in the area appears on the molybdenum map (fig. 17), but several samples on Dora and Eagles Nest Mountains contained 10 ppm molybdenum (table 2). The two samples showing anomalous copper in black-stained sandstone of the Gartra Member (212 and 213, pl. 2) are of interest mainly in indicating that some process of metal concentration operated within the sedimentary rocks. The occurrence is similar to that of some of the copper ore in the Yarmony district to the north, and also to that of uranium-vanadium ores in sandstones, but the samples showed no uranium and only a common background value for vanadium.

Two samples (33 and 34) from highly fractured Dakota Sandstone on the north side of Lower Cataract Lake are notable for highly anomalous arsenic and for the fact that they contain almost nothing else, except that one contains 5 ppm molybdenum. This locality is near the Frontal fault, and the occurrence probably results from movement of arsenic, a migratory element, along the fault.

Stream-sediment samples (table 8A, B, C, and D) add few additional details for this area. As might be expected from the occurrence of molybdenum on some of the fracture zones, several of the samples show some molybdenum, particularly on the north fork of Black Creek (samples between 456 and 487, table 8D). Scattered samples show anomalous copper or lead; none show silver or gold. A few are anomalous in the rare earths lanthanum or yttrium, presumably reflecting contributions from pegmatites. A few, also, are mildly anomalous in chromium or vanadium.

Of 17 sediment samples from the Elliott Creek drainage (table 8A) none is anomalous in the major ore metals, except that several contain up to 10 ppm molybdenum. In the Cataract Creek drainage (table 8B), only two out of 30 samples are anomalous in ore metals other than molybdenum. One sample (35), from a minor stream in the Frontal fault zone, is anomalous in copper, and the other (303), from a small stream in the fault zone of the north front of the range near Upper Cataract Lake, is anomalous in lead. Of 13 samples from the Otter Creek drainage (table 8C) none is anomalous. Of eight samples from the north fork of Black Creek (samples between 456 and 487, table 8D), all contain molybdenum, and three are anomalous in lead. All of these are from small streams flowing along or crossing fault zones, indicating that the faults are

TABLE 2.—*Analyses of rock samples from the Gore Range*

[For sample locations see plate 2. Numbers in parentheses indicate sensitivity limit of method used. The symbol > indicates that an undetermined amount of the element is present above

	Semiquantitative spectrographic analyses[1/] (ppm)															
Sample	Ti (20)	Mn (10)	Ag (.5)	As (200)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)
33	700	20	N	1,000	10	>5,000	L	5	L	L	L	L	10	5	10	L
34	700	20	L	500	10	1,000	L	L	10	L	50	5	10	5	10	5
43	1,500	500	N	N	10	1,000	1	15	70	20	50	L	10	50	30	5
132	7,000	200	N	N	10	300	N	15	150	15	100	L	10	30	20	15
212	3,000	20	N	N	50	100	L	15	15	700	50	N	10	5	300	L
213	7,000	150	N	N	70	150	L	15	20	700	70	N	10	5	500	5
220	3,000	300	N	N	10	1,000	L	15	300	15	L	N	L	30	30	7
221	7,000	300	N	N	20	700	L	20	70	20	70	L	10	50	30	7
223	7,000	1,000	N	N	15	300	L	30	70	15	L	L	20	50	50	10
224	7,000	700	N	N	15	700	L	30	150	30	L	L	10	70	70	15
235	7,000	500	N	N	10	700	L	30	300	30	50	L	15	70	30	15
247	>10,000	300	1	N	15	3,000	L	L	10	30	300	L	15	10	100	15
248	7,000	2,000	N	N	30	700	1.5	50	70	15	100	10	20	100	70	15
249	>10,000	1,500	N	N	30	2,000	1	30	150	30	100	5	20	30	30	30
251	7,000	700	N	N	15	1,500	L	20	70	15	70	L	10	30	20	10
252	7,000	700	N	N	20	1,500	L	15	200	50	70	L	15	30	30	15
259	5,000	300	N	N	10	700	L	15	70	30	70	L	10	20	15	10
260	7,000	1,500	N	N	15	1,500	L	30	100	100	100	10	10	30	30	10
261	10,000	1,500	N	N	15	700	L	30	200	30	70	15	20	50	20	20
276	10,000	700	N	N	20	300	L	30	100	200	50	10	20	50	50	20
277	10,000	300	N	N	L	500	L	20	300	7	70	L	15	30	10	15
278	7,000	1,500	N	N	20	700	L	30	300	30	100	5	15	50	20	20
279	7,000	300	N	N	L	300	L	10	300	5	70	L	10	30	15	15
280	500	50	N	N	N	150	N	N	10	L	N	L	L	L	20	N
281	>10,000	150	N	N	20	300	L	L	300	30	150	L	30	15	70	70
282	3,000	20	N	N	10	2,000	N	N	150	5	70	L	10	7	30	10
283	>10,000	300	N	N	15	300	L	20	500	30	50	5	20	70	20	30
284	5,000	200	N	N	10	1,500	L	10	70	7	70	N	10	20	30	7
285	7,000	700	N	N	20	1,500	N	30	100	7	150	5	20	30	70	20
286	3,000	700	N	N	10	1,000	L	20	30	10	200	N	10	30	150	5
287	>10,000	200	.5	N	L	300	L	15	20	30	70	L	15	20	200	7
288	7,000	700	N	N	10	700	N	15	100	15	70	L	15	30	30	15
289[3/]	7,000	150	300	500	20	300	L	70	70	1,500	50	10	20	70	3,000	7
290	7,000	700	1	N	10	700	L	15	100	10	70	L	15	30	30	7
291	7,000	700	N	N	10	500	L	15	70	15	50	N	10	20	20	7
292	7,000	300	N	N	15	700	L	20	100	70	100	L	10	30	50	15
293	>10,000	3,000	N	N	15	700	L	30	300	70	70	5	20	50	50	30
294	7,000	2,000	N	N	15	300	L	20	200	30	150	L	15	50	30	10
295	7,000	700	N	N	15	1,500	L	30	100	300	70	L	15	70	30	10
297	7,000	700	N	N	15	700	L	20	70	70	50	L	15	30	15	15
298	10,000	700	N	N	10	700	L	20	100	50	70	L	20	30	10	20
299	10,000	300	N	N	20	1,000	L	20	150	30	70	5	15	30	30	20
300	10,000	300	N	N	15	700	L	20	300	20	N	L	15	50	15	15
302	7,000	700	N	N	15	1,000	N	30	200	70	50	L	10	50	20	15
458	5,000	1,000	N	N	20	1,500	1	20	150	15	50	L	20	30	50	20
459	10,000	1,000	N	N	20	200	2	20	200	20	100	L	20	70	20	30
460	2,000	1,500	N	N	20	200	1	20	70	100	50	L	20	50	70	20
463	10,000	100	N	N	10	200	L	L	20	20	L	L	20	5	20	L
464	1,500	1,500	N	N	20	300	3	20	20	10	L	L	20	30	150	5
465	3,000	500	N	N	10	1,000	L	10	70	15	50	L	10	20	20	10

1/ Also looked for spectrographically but not found except as noted: Au(10), Bi(10), Cd(20), Sb(100), and W(50). Sn <10 ppm.

3/ 700 ppm Sb.

in the Eagles Nest-Cataract Creek area (area A, pl. 2)

the number shown; L indicates that an undetermined amount of the element is present below the sensitivity limit; N indicates the element was looked for but was not found]

	Semiquantitative spectrographic analyses--Continued (ppm)					Chemical analyses (ppm)						
Sample	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
33	200	20	10	L	100	L	0.4	L	L	L	0.50	Frd ss w FeO.
34	200	20	10	L	100	L	L	L	L	L	3.50	Do.
43	200	100	30	L	150	L	L	20	L	52	.10	Shd mig.
132	L	150	20	N	150	L	L	44	L	55	.04	FeO st sh z.
212	150	50	15	N	150	L	2.8	700	320	L	.20	8'' channel, ss.
213	150	70	15	N	150	L	4	500	340	30	.18	12'' channel, ss.
220	100	70	10	N	150	L	L	L	L	30	.03	FeO st frd mig.
221	200	70	15	N	500	L	L	17	L	200	.10	Do.
223	100	100	10	N	150	L	L	12	60	180	.05	3' FeO st fr mig.
224	200	100	15	N	200	L	L	28	L	190	.45	6' FeO st sh z.
235	100	150	15	N	300	L	L	16	L	130	.05	FeO st fr mig.
247	1,500	150	30	L	>1,000	L	2	L	L	200	.07	Sil fault z.
248	700	300	15	1,500	200	L	L	L	40	800	1.40	2' sh z w carb vnts.
249	500	700	30	N	>1,000	L	.4	17	L	160	.08	FeO st fr z.
251	100	150	20	N	200	L	L	13	L	80	.03	4' FeO st sh z.
252	100	150	15	N	150	L	L	34	L	70	.09	Hematite seams.
259	300	70	50	N	300	L	L	16	L	60	.05	FeO st mig.
260	300	150	150	N	300	L	L	200	L	160	.08	FeO-rich gneiss.
261	L	150	20	N	500	L	L	38	L	100	.10	FeO st sh z w qtz vnts.
276	700	150	200	N	200	L	L	140	L	150	.35	FeO st sil mig.
277	150	150	15	N	300	L	L	L	L	70	.08	FeO st mig.
278	300	150	30	N	150	L	L	10	L	210	.18	FeO st sh z w carb vnts.
279	150	100	15	N	150	L	L	L	L	30	.09	FeO st sh z.
280	300	15	N	N	30	L	L	L	L	L	.08	Frd pegmatite.
281	3,000	150	30	N	300	L	L	22	L	50	.16	Clayey gouge.
282	1,500	100	15	N	300	L	L	L	L	L	.15	Shd pegmatite.
283	300	150	15	N	150	L	L	20	L	80	.22	Clayey gouge.
284	200	100	15	N	150	L	L	L	L	50	.24	FeO st sh z w carb vnts.
285	3,000	150	20	N	300	L	L	L	30	160	.18	Do.
286	300	70	20	300	70	L	.6	12	60	320	.05	Do.
287	300	70	15	200	300	L	.6	20	70	230	2	Do.
288	300	150	15	N	300	L	L	L	L	70	.10	FeO st fr z.
289	200	70	20	700	150	.02	180	1,300	2,600	480	>10	Stained gr near fault.
290	100	150	15	N	200	L	L	L	L	80	N	FeO st frd gr.
291	200	70	15	N	100	L	L	20	L	60	.06	Qtz lim vein.
292	300	100	20	700	150	L	L	13	L	880	.04	Qtz lim breccia.
293	300	300	15	N	300	L	.2	44	L	120	.06	Lim sil fr z.
294	1,500	100	15	N	500	L	L	26	L	50	.13	Qtz lim vein.
295	300	150	15	N	700	L	L	230	L	110	.08	FeO st sh z.
297	300	100	20	N	700	L	L	L	L	50	.05	Do.
298	300	150	30	N	700	L	.4	30	L	90	.08	FeO st shd mig.
299	200	300	30	N	150	L	.2	11	L	70	.03	FeO st gr.
300	150	150	15	N	150	L	.2	11	L	90	.07	FeO st sh z.
302	200	200	30	N	300	L	.4	38	L	100	.03	FeO st schist.
458	200	100	200	L	200	L	.4	17	L	40	.03	FeO st sh z.
459	300	200	70	L	150	.04	.6	21	L	90	.08	Do.
460	200	200	50	1,000	150	L	1	120	40	620	1.60	FeO st sh z w qtz vnts.
463	200	100	L	L	150	L	L	15	L	L	.05	FeO st fr z.
464	500	70	20	300	20	L	.8	10	120	320	.05	Carb qtz vnt w FeO.
465	200	70	10	L	200	L	L	23	L	40	.03	FeO st sh z.

2/ Abbreviations used in table:

carb	=	carbonate	gr	=	granitic rock	qtz	=	quartz	ss	=	sandstone
FeO st	=	iron oxide stained	lim	=	limonite	sh(d)	=	shear(ed)	vnt(s)	=	veinlet(s)
fr(d)	=	fracture(d)	mig	=	migmatite	sil	=	silicified	w	=	with
									z	=	zone

TABLE 2.—*Analyses of rock samples from the Gore Range*

Sample	Semiquantitative spectrographic analyses[1/] (ppm) Ti (20)	Mn (10)	Ag (.5)	As (200)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)
467	3,000	1,000	N	N	10	1,500	L	15	30	10	100	5	20	30	100	10
468	>10,000	2,000	N	N	50	700	L	50	10	2,000	L	10	10	20	10	70
482	10,000	500	N	N	20	2,000	L	30	30	15	100	L	20	30	100	10
484	5,000	500	N	N	10	200	L	10	70	150	L	L	20	20	50	10
485	3,000	200	N	N	10	100	L	10	50	5	100	L	20	20	20	10
488	5,000	500	N	N	30	150	L	70	150	1,500	L	10	20	150	20	20
489	10,000	700	N	N	10	1,000	L	10	150	15	100	L	20	20	10	20
1189	2,000	200	N	N	10	300	1.5	10	50	10	50	N	10	20	L	10
1190	1,000	200	N	N	20	>5,000	1.5	10	30	5	L	N	10	20	10	10

geochemically anomalous, although they were not well enough exposed to be sampled directly.

BLACK CREEK-SLATE CREEK AREA

In the Black Creek-Slate Creek area (area B, pl. 2), signs of mineralization are stronger than to the north. Many of the fracture zones contain quartz or carbonate veinlets, and some of the fracture zones are distinctly anomalous geochemically. Among the more highly mineralized fracture zones are: (1) faults parallel to the Frontal fault on the ridge at the head of Brush Creek; (2) two prominent north-northwest-trending faults extending across the headwaters area of Black Creek (frontispiece); (3) a north-trending system of faults that extends from the extreme head of the south fork of Slate Creek across the head of main Slate Creek and down the valley of the south fork of Black Creek; and (4) short north-trending faults southwest of Upper Slate Lake. All these fracture zones are somewhat iron-stained, and the eastern of the two faults across the headwaters of Black Creek is a dark-reddish-brown zone more than 100 feet wide cutting through the gray rocks for miles. Sulfide or ore minerals were not seen on any of them except the short veins southwest of Upper Slate Lake. One of these (sample 478) contains marcasite coating hematite, and another (479) has disseminated pyrite in sheared gneiss. Carbonate veinlets in the faults in the Black Creek-Slate Creek area are similar to those elsewhere in the range. X-ray examination of carbonate vein matter from scattered localities throughout the range shows that it consists of a mixture of calcite with an iron-bearing dolomite approaching ankerite in composition.

Geochemically, the faults near the head of Brush Creek are characterized by anomalous copper, molybdenum, and bismuth (table 3). The faults in the head of Black Creek are anomalous at one place or another in lead, zinc, silver, molybdenum, mercury, anti-

in the Eagles Nest-Cataract Creek area—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)					Chemical analyses (ppm)						
Sample	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
467	500	70	20	300	150	L	0.4	L	50	470	0.03	Carb qtz vnts.
468	300	100	30	L	150	L	1.2	700	L	70	.01	Gneiss w pyrite.
482	700	100	30	L	300	L	L	L	25	40	L	FeO st vuggy rock.
484	100	100	L	L	200	L	L	80	L	30	L	Qtz veins.
485	200	70	20	L	300	L	L	L	L	L	L	FeO st sil mylonite.
488	100	100	20	L	200	L	1.2	1,000	L	80	L	Gneiss w pyrite.
489	100	150	50	L	200	L	L	11	L	L	L	Fault z.
1189	L	50	20	N	150	L	L	17	L	70	.10	Do.
1190	1,000	70	30	N	100	L	L	L	L	50	.02	FeO st mig w qtz carb vnt.

mony, and bismuth. The north-trending fault zone in the head of Slate Creek and along the south fork of Black Creek is characterized by anomalies in zinc and lead and, in one locality on Black Creek, in arsenic. The faults southwest of Upper Slate Lake are distinctly anomalous in copper and mildly anomalous in molybdenum.

The outstanding feature of the stream-sediment samples in this area is the occurrence of 5 ppm or more molybdenum in almost every sample from the Black Creek drainage (table 8D) and in more than half of the Slate Creek samples (table 8F). In contrast, the Brush Creek samples (table 8E) are low in molybdenum—as in everything else—even though the highest molybdenum values in this area were obtained from the faults at the head of Brush Creek. Evidently, molybdenum on fractures scattered through all of the Black and Slate Creek drainages (table 3) was widely dispersed in the stream sediments, but the molybdenum at the head of Brush Creek is localized and thus is not reflected in the stream sediments.

One sediment sample (537) from the head of the middle fork of Black Creek is remarkable for its content of zinc and antimony, substances that normally are carried away in solution and do not show up in the stream sediments. Along with these elements are appreciable molybdenum and lead. This occurrence, in a stream below a lake, illustrates the effect of the stream's crossing a geochemically anomalous fracture zone below the lake and only a few hundred feet upstream from the sample locality (for example, samples 557 and 566, table 3). At the head of Slate Creek, samples from streams below the localities of lead anomalies in fracture zones are anomalous in lead, and one contained a trace of gold (nos. 469 and 471, table 8F).

TABLE 3.—*Analyses of rock samples from the Gore*

[For sample locations see plate 2. Numbers in parentheses indicate sensitivity limit of the method used. The symbol > indicates that an undetermined amount of the element is present above

Semiquantitative spectrographic analyses[1/]

	(ppm)																
Sample	Ti (20)	Mn (10)	Ag (.5)	B (10)	Ba (20)	Be (1)	Bi (10)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sb (100)	Sc (5)
205	10,000	1,000	N	10	700	N	N	30	200	30	L	L	10	70	15	N	20
210	>10,000	1,500	N	10	1,000	N	N	30	300	70	L	5	15	100	20	N	30
211	700	2,000	N	10	300	L	N	20	10	10	30	L	150	20	20	N	5
266	7,000	700	N	L	3,000	L	N	20	20	30	70	L	10	10	50	N	15
304	7,000	300	N	L	300	L	N	10	30	L	50	N	10	20	10	N	7
308	5,000	700	N	10	1,500	L	10	5	30	10	L	5	10	10	30	N	7
309	3,000	5,000	N	20	700	L	N	30	50	20	L	5	10	30	30	N	15
310	2,000	>5,000	N	20	500	L	N	50	30	15	50	L	15	70	20	N	7
311	5,000	200	N	L	1,500	L	N	L	30	7	L	N	10	10	20	N	L
312	700	3,000	N	L	>5,000	1.5	N	30	10	30	N	N	10	30	15	N	L
313	10,000	500	N	15	700	L	N	15	70	20	100	L	20	20	30	N	10
314	5,000	1,500	N	15	700	L	N	15	30	10	50	L	15	20	20	N	7
315	5,000	5,000	N	15	1,000	L	N	30	30	10	100	L	10	30	50	N	10
316	7,000	300	N	10	150	L	N	10	70	30	150	5	15	10	20	N	7
317	700	3,000	N	15	300	7	N	50	20	15	70	N	10	50	30	N	7
318	700	500	0.5	70	300	3	30	70	300	50	50	200	20	30	30	N	N
319	300	300	L	200	50	3	150	150	700	70	L	300	15	150	70	N	N
320	700	3,000	N	10	200	150	N	70	10	300	50	5	10	50	20	N	L
470	10,000	500	N	20	200	L	N	20	50	20	100	L	20	20	30	N	15
472	1,500	700	N	20	1,000	1	N	20	50	20	100	5	20	20	70	N	15
476	10,000	5,000	N	30	>5,000	L	N	30	30	15	50	L	10	30	100	N	10
477	2,000	5,000	N	30	500	1	N	30	30	15	L	5	10	30	150	N	10
478	1,500	1,000	N	20	1,500	L	N	30	30	15	L	10	30	100	150	N	10
479	1,000	200	N	20	300	1	N	70	150	500	300	5	20	50	50	N	10
480	7,000	1,000	N	30	1,000	2	N	20	100	150	50	15	20	30	30	N	15
481	5,000	700	N	10	1,000	2	N	20	50	100	50	5	20	20	130	N	10
493	3,000	700	N	20	1,000	3	N	20	150	30	50	L	20	30	150	N	10
494	3,000	300	N	20	>5,000	2	N	20	70	20	L	L	10	30	100	N	10
495	1,500	5,000	N	50	1,500	1	N	70	50	L	L	5	10	100	100	N	5
496	500	5,000	N	20	1,000	L	N	30	L	30	50	L	10	30	100	N	L
497	1,500	5,000	N	30	2,000	L	N	70	20	10	L	5	10	100	100	N	10
498	1,000	1,500	N	20	2,000	L	N	20	15	20	50	L	10	20	50	N	7
499	1,500	1,500	N	20	1,500	1	N	20	15	7	50	L	10	20	30	N	5
529	2,000	1,000	1	10	300	.1	N	20	100	300	L	L	20	30	100	N	20
531	5,000	700	N	20	500	2	N	20	100	20	50	L	20	30	20	N	15
533	5,000	300	5	20	1,500	2	N	50	50	200	50	5	20	30	100	N	15
534	5,000	500	N	20	1,000	2	N	20	150	20	L	L	20	30	20	N	15
535	10,000	1,000	N	10	1,000	2	N	20	150	5	L	L	20	30	20	N	15
545	3,000	1,000	N	20	1,000	L	N	30	150	70	L	5	20	70	100	N	20
546	1,500	700	N	20	1,500	L	N	20	20	L	L	L	10	30	100	N	5
547	5,000	2,000	N	20	1,000	2	N	30	150	20	100	5	20	50	100	N	20
548	7,000	700	N	20	1,000	L	N	20	150	20	L	L	20	30	20	N	20
549	7,000	700	N	20	300	1	N	20	200	50	50	5	20	50	100	N	20
551	1,000	200	2	10	1,000	10	30	L	20	15	L	L	200	L	150	N	5
552	10,000	700	N	10	1,000	5	N	10	150	15	150	L	20	20	10	N	10
553	2,000	2,000	N	70	300	5	N	50	70	10	200	5	20	50	150	N	20
554	10,000	1,000	N	20	700	L	N	30	100	10	50	L	20	20	50	N	30
555	5,000	1,000	N	20	2,000	L	N	30	150	100	L	5	20	30	500	N	30
556	10,000	500	N	20	1,500	L	N	20	300	10	L	L	20	50	20	N	20
557	10,000	200	5	20	1,500	L	N	10	150	20	50	L	20	20	500	N	15

1/ Also looked for spectrographically but not found except as noted: As(200), Au(10), Cd(20), and W(50). Sn <10 ppm.

Range in the Black Creek-Slate Creek area (area B, pl. 2)

the number shown; L indicates that an undetermined amount of the element is present below the sensitivity limit; N indicates that the element was looked for but was not found.]

	Semiquantitative spectrographic analyses--Continued (ppm)					Chemical analyses (ppm)						
Sample	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
205	300	150	15	L	100	L	0.6	33	L	230	0.03	FeO st sh gr.
210	500	700	50	N	150	L	.8	34	L	140	.09	Gn w pyrite.
211	100	70	10	N	20	L	.6	10	25	110	.05	Qtz carb vein.
266	700	150	15	N	150	L	.4	21	L	70	.03	Carb FeO vnts.
304	150	70	20	N	100	L	.4	L	L	30	L	Hematitic vein.
308	300	70	15	N	300	L	L	L	L	50	.05	FeO st sh z.
309	300	150	50	N	700	L	1.6	18	L	150	.03	Carb FeO vnts.
310	200	100	70	N	50	L	2	13	L	110	.05	FeO st vnts.
311	N	50	L	N	150	L	L	L	30	L	.18	Qtz veins in fr peg.
312	300	30	15	N	70	L	.8	28	L	110	.05	Carb vnts in shd peg.
313	300	70	20	N	700	L	.4	12	L	80	.60	Qtz carb veins.
314	200	70	15.	L	150	L	L	L	L	110	.30	Sh z w carb vnts.
315	300	100	70	L	100	L	1.6	14	30	210	.03	Carb vnts.
316	700	70	30	N	700	L	L	27	L	60	1.20	Carb qtz vnts.
317	300	70	30	N	70	L	.6	L	L	40	.01	Qtz FeO veins.
318	150	150	15	N	30	L	L	24	L	L	.03	Qtz vn, FeO st rock.
319	L	300	15	N	20	L	.4	40	30	L	.03	Hem from qtz vein.
320	100	50	70	L	30	L	1.2	160	L	130	.08	Qtz FeO carb vein.
470	500	100	20	N	300	L	L	L	L	70	.21	Do.
472	1,500	150	50	200	300	L	L	10	L	270	.05	FeO st sh z.
476	1,000	100	50	500	150	L	1.4	L	40	480	.08	FeO carb vein.
477	20	100	50	1,000	100	L	1	L	80	1,300	.02	Do.
478	150	150	30	300	30	L	.4	L	70	270	4.50	Sh rk w hem; marcasite.
479	100	100	200	L	200	L	1	340	L	50	.05	quartzitic gn w pyrite.
480	100	200	50	200	300	L	1	200	L	190	.07	FeO qtz veins.
481	100	100	50	L	150	L	.6	100	30	90	.03	3' FeO st sh z w qtz vnts.
493	500	100	20	300	200	L	L	35	40	310	L	Shd altered rk.
494	700	150	10	200	200	L	L	21	110	300	.40	Sh z w qtz vnts.
495	200	150	30	300	100	L	1.4	L	60	290	L	Carb FeO vein.
496	200	50	30	300	30	L	1.8	70	60	200	.03	Do.
497	200	200	30	500	150	L	1.6	L	90	570	.05	Do.
498	500	30	30	L	50	L	1.6	26	30	150	.07	Do.
499	100	50	20	L	200	L	L	10	L	110	.03	FeO st sh z.
529	500	100	50	L	100	L	1.2	180	40	90	.15	Carb vein w pyrite.
531	500	100	50	L	200	L	L	15	L	110	.01	FeO st sh z.
533	500	100	20	L	200	L	4	190	40	40	.90	Do.
534	100	150	10	L	200	L	L	11	L	100	.05	Do.
535	100	150	20	L	300	L	L	L	L	60	.03	Do.
545	200	150	20	200	300	L	.4	43	40	150	.11	Do.
546	200	70	10	200	50	L	.8	L	50	210	.01	Carb FeO vein.
547	200	150	20	L	200	L	.3	66	50	100	.03	FeO st sh z.
548	200	150	20	L	300	L	.2	32	L	80	L	Do.
549	500	100	20	200	200	L	L	54	L	170	.10	Do.
551	1,000	50	30	L	50	L	1.2	17	70	L	L	FeO st sh z w qtz vnts.
552	300	150	20	L	500	L	L	12	L	50	.03	FeO st sh z.
553	1,000	150	50	1,000	200	L	.8	L	50	620	.03	FeO st sh z w qtz vnts.
554	200	150	50	500	500	L	L	L	L	580	.05	FeO st sh z.
555	200	150	50	2,000	100	L	1.2	100	500	2,100	1.20	Sh z w carb FeO vn.
556	200	200	30	L	500	L	L	10	L	110	L	FeO st sh z.
557	100	150	20	1,500	200	L	4.4	23	460	1,400	3	Do.

2/ Abbreviations used in table:

carb	carbonate	gr	granitic rock	sh(d)	shear(ed)
FeO st	iron oxide stained	MnO st	manganese oxide stained	sil	silicified
fr	fractured	peg	pegmatite	vnts	veinlets
gn	gneiss	qtz	quartz	z	zone
hem	hematite	rk	rock		

TABLE 3.—*Analyses of rock samples from the Gore*

Semiquantitative spectrographic analyses[1/]

Sample	Ti (20)	Mn (10)	Ag (.5)	B (10)	Ba (20)	Be (1)	Bi (10)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sb (100)	Sc (5)
	(ppm)																
558	700	700	N	20	1,000	1.0	N	10	10	100	300	L	20	20	150	N	L
565	3,000	1,500	N	50	700	2	N	30	70	50	50	L	20	100	100	N	20
566	5,000	1,500	N	50	500	L	N	50	150	5	70	5	20	150	500	N	20
567	10,000	1,500	N	20	300	1	N	30	700	70	50	5	20	50	100	N	30
568	3,000	1,500	N	20	1,000	L	N	30	150	10	L	L	20	50	70	300	30
569	10,000	300	N	L	500	1	N	20	150	50	L	N	10	50	20	N	10
580[3/]	200	5,000	N	L	200	L	N	30	10	7	N	N	L	50	1,000	N	5
581	10,000	500	N	10	500	1	N	15	100	100	50	N	15	30	50	N	10
582	50	2,000	N	L	50	L	N	20	10	7	N	N	15	30	70	N	5
583[3/]	300	3,000	N	30	700	L	N	30	20	20	20	N	10	50	300	N	10
610	5,000	1,500	N	20	1,000	2	N	15	50	10	70	N	20	20	50	N	10
611	2,000	1,000	N	L	500	L	N	20	50	7	20	N	10	30	50	N	7
612	1,000	2,000	N	L	1,000	1	N	20	20	15	20	N	15	20	70	N	5
613	3,000	3,000	1	L	700	1	N	30	50	20	L	N	10	50	70	N	7
614[4/]	700	2,000	N	15	200	1	N	20	20	5	20	N	L	30	30	N	7
616	1,000	2,000	N	L	500	1.5	N	30	20	10	20	N	10	20	70	N	10
618	7,000	300	N	10	700	L	N	20	200	7	20	N	10	50	20	N	20
626	5,000	200	1.5	50	500	1.5	N	15	70	10	20	L	20	20	70	L	10
627	1,000	300	.5	50	300	1.5	N	20	50	10	50	15	10	30	20	L	5
628	1,000	3,000	N	10	5,000	L	N	20	10	15	L	N	10	20	20	N	5
629	200	5,000	N	L	5,000	L	N	30	20	50	L	N	10	20	15	N	5
630	5,000	1,000	5	20	700	1	N	20	10	20	50	N	20	30	100	L	10
632	1,000	2,000	7	10	>5,000	L	N	10	30	200	N	N	20	20	2,000	100	7

3/ 50 ppm Cd.

BOULDER-ROCK-WILLOW CREEKS AREA

The area from Slate Creek southward to South Willow Creek (area C, pl. 2) is the most mineralized part of the Gore Range. It is characterized by the presence of the Boss mine, by a fluorspar deposit on the lower slopes south of Maryland Creek, by large quartz veins in some places, by many prospect diggings and a few small mines, by many strong geochemical anomalies, and by several patented or surveyed mining claims. Most of these features are concentrated near the Frontal fault, although many geochemical anomalies occur high in the range also.

BOSS MINE AND VICINITY

The Boss mine (see "North Rock Creek area" under "Economic appraisal") is at the end of the road up North Rock Creek. Geologically, the mine is located on the Frontal fault, and the numerous veins worked in the various tunnels that constitute the mine follow fractures within the broad zone occupied by the fault. This zone is more than 1,500 feet wide at the mine and is succeeded to the east by others through a total distance of more than 4,000 feet (pl. 1). As described in private reports by consulting mining engineers,[2]

[2] Undated report by T. F. Van Wagenen, probably 1890; undated report by Nelson Blount, probably about 1900; and report by J. H. Marks. 1928.

Range in the Black Creek-Slate Creek area—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)					Chemical analyses (ppm)						Sample description[2/]
	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	
558	100	20	30	L	300	L	L	89	110	130	0.03	Qtz FeO vein.
565	200	100	20	L	100	L	1.2	L	L	150	.20	Carb vein.
566	200	100	20	3,000	200	L	1.6	L	500	4,900	.08	Carb-FeO vnts.
567	200	200	70	300	300	L	.8	58	30	360	.09	FeO st sh z.
568	200	200	50	L	150	L	1.2	L	25	130	.05	Carb vein.
569	L	50	10	N	70	L	.4	L	L	120	.10	FeO st sh z.
580	150	15	15	3,000	20	L	1.2	14	640	5,300	.06	Qtz carb FeO veins.
581	L	70	20	300	100	L	L	15	50	350	.08	Sil FeO st sh z.
582	150	30	10	300	10	L	.8	L	50	460	.06	Carb vein.
583	L	50	20	1,000	10	L	1.8	L	120	2,700	.04	Carb-FeO vein.
610	100	70	30	L	100	L	.8	21	L	200	.08	Qtz-FeO-Carb vein.
611	100	50	10	L	100	L	.6	18	40	210	.14	Sh z w qtz carb vnts.
612	150	30	20	200	50	L	2	28	L	270	.10	Carb vein.
613	100	50	10	300	50	L	2.4	42	40	450	.30	Do.
614	100	20	20	200	30	L	1.6	L	L	220	.20	Do.
616	200	50	20	L	50	L	1.0	28	70	130	.08	Carb FeO vein.
618	100	100	50	L	100	L	L	19	L	130	.04	FeO st sh mig.
626	L	50	15	300	100	L	2.2	15	30	350	.26	FeO, MnO st sh z w qtz carb.
627	100	50	20	500	70	L	.6	20	L	580	.09	Qtz vein.
628	200	30	20	N	100	L	2.0	35	L	220	.04	Carb vein.
629	150	20	30	200	15	L	2.2	42	L	240	.07	Do.
630	300	70	10	500	70	L	3	17	90	350	.80	Sil FeO, MnO st sh z.
632	150	50	10	5,000	50	L	11	95	5,800	3,100	3.50	Qtz carb vein.

4/ 200 ppm As.

the veins dip eastward at various angles from 45° to nearly vertical and are "free of slips and faults," meaning that fault movement has not occurred on them since mineralization. However, the veins are evidently in the footwall of the main fault with late displacement. This fault apparently was reached in the easternmost workings, where it is represented by what Nelson Blount described as a "dike" more than 100 feet wide containing "rounded granite boulders of all sizes."

The veins of the Boss mine are described as quartz veins up to several feet wide containing streaks of sulfide ore from an inch to several inches wide. Judged by the materials on the extensive dumps of the mine and by small exposures at the edges of caved workings, the veins also include a considerable amount of silicified granite and have walls of chloritized granite extensively stained reddish by hematite. The quartz on the dumps ranges from very fine grained to coarsely crystalline comb quartz, and most of it is devoid of metallic minerals. Pieces of ore consist of galena or sphalerite, minor coarse-grained siderite, and traces of chalcopyrite in veinlets as much as 2 inches wide in the white quartz. The ore was valuable chiefly for silver, which occurred in the form of argentite, argentiferous galena, and, possibly, as the ruby silver

TABLE 4.—*Analyses of rock samples from the Gore Range*

[For sample locations see plate 2. Numbers in parentheses indicate sensitivity limit of method used. The symbol > indicates that an undertermined amount of the element is present above

Semiquantitative spectrographic analyses[1]

Sample	Ti (20)	Mn (10)	Ag (.5)	Ba (20)	Bi (10)	Cd (20)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)
	(ppm)													
1	3,000	300	0.5	700	N	N	5	70	10	70	10	20	10	70
2	1,500	500	1	3,000	N	N	15	70	15	50	10	20	20	300
3[3]	2,000	700	L	1,000	N	N	20	100	5	L	5	20	50	20
4	5,000	500	1	700	N	N	20	100	20	50	5	30	50	20
5[4]	70	200	5,000	3,000	N	200	10	L	5,000	L	L	10	10	>20,000
6	300	>5,000	300	500	N	100	50	L	700	50	15	20	70	20,000
7	700	2,000	700	5,000	N	>500	30	L	1,000	50	L	20	10	>20,000
8[3]	1,000	3,000	5	700	N	N	30	20	30	50	10	20	20	1,500
9[3]	2,000	500	L	1,500	N	N	20	20	L	50	20	20	50	100
14[5]	700	1,000	L	100	N	N	15	L	7	50	5	20	30	50
15[6]	L	50	N	L	N	N	10	L	L	50	L	10	5	L
17[6]	1,500	50	N	200	N	N	10	10	15	70	5	10	20	20
18[6]	1,000	100	N	200	N	N	10	30	20	L	30	20	20	50
19	2,000	500	N	300	N	N	20	20	5	100	L	20	20	50
20[6]	2,000	50	N	500	N	N	10	50	20	100	L	20	5	20
21[7]	1,000	30	N	2,000	N	N	5	50	10	L	30	20	10	10
22[5]	2,000	70	N	500	N	N	5	20	10	L	L	20	5	10
60	3,000	700	1	2,000	N	N	10	70	20	50	L	10	20	50
73	5,000	5,000	2	300	10	N	20	100	200	L	L	20	50	5,000
74	1,000	300	100	50	L	500	20	L	1,000	50	L	20	15	>20,000
75	700	500	20	70	L	>500	30	L	1,000	50	L	20	10	20,000
90	700	30	N	300	N	N	L	10	L	N	15	L	5	20
91	700	100	N	3,000	N	N	L	20	L	50	10	L	10	20
92	1,000	300	N	700	N	N	L	10	5	70	L	L	L	50
93	3,000	100	N	300	N	N	L	20	5	50	L	L	10	20
94	70	L	N	L	N	N	L	L	N	L	N	L	5	N
96	3,000	1,000	N	700	N	N	20	70	7	L	10	10	50	50
97	3,000	500	N	300	N	N	15	70	L	50	L	10	30	20
98	700	1,000	N	700	N	N	15	10	15	50	5	10	20	20
99	700	700	N	300	N	N	15	15	L	L	15	10	30	10
100	700	500	N	200	N	N	10	10	10	L	L	L	15	10
101	7,000	300	N	700	N	N	20	150	15	70	L	15	50	10
102	3,000	300	N	700	N	N	15	70	7	70	L	L	30	15
103	200	1,000	1.5	300	N	N	20	L	100	L	7	L	10	700
104	3,000	300	N	300	N	N	10	70	15	L	L	L	20	150
105	700	1,000	3	300	N	N	30	10	20	N	5	L	50	700
106[8]	10,000	700	5	3,000	N	N	30	700	500	70	10	L	150	700
107	700	300	70	300	>1,000	N	30	10	700	L	200	10	30	700
108	700	3,000	1	3,000	N	N	50	100	30	L	5	10	70	300
109	7,000	300	N	700	N	N	20	70	L	70	L	15	30	10
110	7,000	300	N	1,500	N	N	10	30	10	150	L	10	7	30
113	700	30	N	200	N	N	L	20	7	L	N	N	5	N
114	3,000	200	N	300	N	N	10	30	L	N	10	L	15	L
133	5,000	500	N	1,500	N	N	15	30	L	N	N	L	15	20
139	700	300	N	700	N	N	10	30	L	N	N	L	5	30

1/ Also looked for spectrographically but not found except as noted: As(200), Au(10), and W(50). Except as noted Sn <10 ppm. Values for B(<200), Be(<7), Sc(<150), Y(<200), and Zr(<1,500) not listed for brevity.

3/ 10 ppm Sn.

4/ 20 ppm Au.

5/ <200 ppm As.

6/ 200 ppm As.

7/ 5,000 ppm As.

8/ 30 ppm Sn.

in the Boulder Creek-Willow Creek area (area C, pl. 2)

the number shown; L indicates that an undetermined amount of the element is present below the sensitivity limit; N indicates the element was looked for but was not found.]

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						Sample description[2/]
	Sb (100)	Sr (100)	V (10)	Zn (200)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	
1	N	200	70	L	L	0.2	21	L	40	0.28	16' qtz vein, sil gr.
2	N	200	50	3,000	L	1.2	L	420	2,800	13.0	12" qtz vein, sil gr.
3	N	100	70	L	L	L	L	L	76	0.22	5' qtz lim vn, alt gr.
4	N	100	70	L	L	.2	L	L	110	.35	30' alt sh sil gr.
5	200	150	10	>10,000	11.0	3,000	4,100	---	---	----	Gal-qtz vn, Boss Mine.
6	300	100	20	>10,000	.08	260	600	---	---	----	Qtz w sid, Boss Mine.
7	N	150	50	>10,000	.58	580	3,100	---	---	----	Qtz w sph, Boss Mine.
8	N	150	50	10,000	L	4	---	---	---	----	Lim st qtz vn.
9	N	150	70	200	.14	.4	---	---	---	----	Do.
14	N	150	20	500	L	.8	L	44	310	.20	FeO st sh z.
15	N	150	10	L	L	L	L	L	L	.10	Qtz w FeO.
17	N	200	200	L	.02	L	11	L	96	1.30	FeMnO st fr ss br.
18	N	200	300	500	L	1.2	L	60	130	.50	Do.
19	N	200	70	500	L	.2	L	L	400	.12	FeO st fr gr and qtz vnts.
20	N	500	200	L	L	.2	22	L	40	4	Fr ss and br w FeO.
21	N	100	200	L	.02	1.6	L	L	84	.90	Brd ss w FeO.
22	N	200	150	L	L	L	L	L	L	.40	Brd ss.
60	N	200	70	L	.02	1	23	36	72	.10	Gr.
73	N	70	100	1,000	.02	1.6	120	2,400	1,800	.90	Shd gr w py.
74	N	100	30	>10,000	.08	18	1,200	11,000	---	.70	Sph qtz vn.
75	N	100	30	>10,000	.02	36	1,200	30,000	---	.75	Do.
90	N	N	L	N	L	L	L	88	130	.13	Alt gr w qtz vnts.
91	N	150	20	L	L	L	L	80	240	.60	Gr w qtz vnts.
92	N	150	15	N	L	L	L	64	35	.16	Sil gr w qtz vnts.
93	N	100	30	L	L	.2	L	64	190	.20	Qtz vn.
94	N	N	N	N	L	L	L	L	40	.08	FeO st qtz vn.
96	N	N	70	200	L	.4	L	60	330	.26	16" wide FeO st qtz vn.
97	N	N	70	L	L	.4	L	L	130	.11	24" wide FeO st qtz vn.
98	N	150	30	200	L	.4	11	L	300	.30	16' shd vn, gr.
99	N	N	30	300		.6	L	L	490	.07	9" FeO st alt gr.
100	N	N	10	L	L	.4	15	84	270	.07	2' lim cem br of alt gr.
101	N	N	300	N	L	.8	12	L	160	.03	8' FeO st sh z.
102	N	N	70	N	L	.4	11	L	60	.09	8' sh z.
103	N	N	L	1,500	L	2.4	120	1,700	2,400	.18	Qtz vn w FeO, mal.
104	N	N	70	L	L	.4	29	130	330	.08	Fr FeO st gr.
105	N	150	50	3,000	.02	4	90	1,500	5,500	.60	Qtz carb vn.
106	N	100	700	1,500	L	2	140	1,300	2,300	.13	Sh z w FeO, qtz vnts.
107	N	N	20	L	.02	88	880	3,800	370	.13	Py, gal in peg qtz.
108	N	150	70	700	.02	3.2	18	530	860	.20	Qtz carb vn.
109	N	150	150	N	L	L	L	L	110	.08	FeO st sh z.
110	N	L	70	N	L	.4	33	L	110	.10	FeO st mig.
113	N	N	10	N	L	L	28	L	30	.03	Vn.
114	N	N	30	N	L	L	52	L	75	.14	Prospect.
133	N	200	30	N	L	L	L	L	80	.05	15" sh z.
139	N	200	20	N	L	L	L	L	25	.03	Fr, FeO st gr, peg.

2/ Abbreviations used in table:

alt	altered	hem	hematite	sid	siderite
az	azurite	lim	limonite	sil	silicified
bo	bornite	mal	malachite	sph	sphalerite
br(d)	breccia(ted)	mig	migmatite	ss	sandstone
carb	carbonate	min(s)	mineral(s)	st	stained
cem	cemented	MnO	manganese oxide	sul	sulfide
chlor	chloritized	peg	pegmatite	vn(s)	vein(s)
FeO	iron oxide	py	pyrite	vnt(s)	veinlet(s)
fr	fractured	qtz	quartz	w	with
gal	galena	ser	sericitized	z	zone
gr	granitic rock	sh(d)	shear(ed)		

TABLE 4.—*Analyses of rock samples from the Gore Range*

Semiquantitative spectrographic analyses[1/]

(ppm)

Sample	Ti (20)	Mn (10)	Ag (.5)	Ba (20)	Bi (10)	Cd (20)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)
140	L	20	N	100	N	N	L	20	L	L	N	L	N	N
141	700	150	N	500	N	N	L	30	30	50	L	L	10	N
143	7,000	700	N	150	N	N	30	30	7	L	N	L	30	20
144	7,000	300	N	700	N	N	15	300	7	50	L	10	30	10
145	5,000	700	N	300	N	N	20	70	30	100	L	10	30	10
146	2,000	700	N	300	N	N	15	30	L	N	L	10	30	10
147	N	L	3	100	>1,000	N	L	N	300	N	L	L	L	200
148	700	30	3,000	>5,000	N	N	L	15	15,000	L	L	L	5	1,500
149	7,000	700	2	700	N	N	15	70	30	50	L	L	30	20
150	700	1,000	1	>5,000	N	N	30	15	7	L	L	L	70	30
151	700	150	15	3,000	N	N	L	20	70	N	L	L	10	1,500
153	700	2,000	1	3,000	N	N	20	70	5	70	L	L	30	3,000
154	5,000	300	N	50	N	N	30	50	7	70	L	L	30	20
155	700	3,000	N	>5,000	N	N	50	15	10	N	10	L	30	300
156	2,000	700	7	1,500	N	N	L	15	3,000	L	L	L	7	2,000
321	7,000	2,000	N	700	N	N	30	150	30	50	5	15	50	50
324	700	700	N	150	N	N	10	15	L	L	N	L	20	L
325	7,000	700	N	1,000	N	N	30	70	15	70	L	10	70	20
326	7,000	700	N	700	N	N	30	50	30	70	L	10	30	20
327	10,000	700	N	3,000	N	N	20	300	10	100	L	10	30	30
328	7,000	700	N	700	N	N	15	50	7	70	L	10	20	15
332	7,000	1,000	N	700	N	N	20	100	30	70	10	10	30	30
333	10,000	700	N	700	N	N	30	300	15	50	L	15	70	20
334	700	300	N	1,000	N	N	10	20	30	50	N	L	15	30
335	1,000	700	N	150	N	N	10	30	50	70	7	15	30	30
336	7,000	300	N	500	N	N	15	30	30	50	L	10	30	30
344	10,000	700	30	300	N	N	30	150	150	70	L	10	70	300
345	7,000	1,000	70	200	N	N	10	50	300	100	N	15	15	5,000
346	7,000	700	N	700	N	N	15	70	7	70	L	15	20	30
347	3,000	700	1	300	N	N	15	30	30	N	30	10	20	50
348	3,000	5,000	L	500	N	N	15	20	15	30	20	10	20	20
349	700	5,000	N	700	N	N	30	L	L	N	10	10	30	300
350	7,000	700	7	700	N	N	10	70	50	70	15	20	15	3,000
351	5,000	3,000	N	>5,000	N	N	20	20	30	N	15	10	30	700
352	3,000	1,000	1	5,000	N	N	15	10	50	N	L	10	10	300
353	3,000	700	N	3,000	N	N	10	10	5	70	N	10	7	20
354	1,000	150	N	300	N	N	L	N	L	50	N	10	L	30
355	7,000	150	7	300	N	N	L	30	20	70	L	15	10	700
363	2,000	300	1	200	N	N	L	30	7	L	N	10	10	30
364	7,000	1,500	15	700	N	N	10	70	150	70	10	20	15	3,000
365	7,000	700	.5	700	N	N	15	70	30	50	10	20	30	70
366	700	700	N	200	N	N	15	30	30	L	L	10	20	30
368	700	300	N	200	N	N	L	20	30	70	L	10	10	500
369	10,000	3,000	N	3,000	N	N	30	100	70	70	30	20	70	300
370	7,000	700	N	700	N	N	10	50	5	70	L	10	30	30
371	>10,000	1,000	N	700	N	N	20	300	10	50	5	20	70	100
372	500	2,000	N	L	N	N	20	20	10	700	10	10	200	100
373	2,000	150	N	1,000	N	N	70	10	10	70	L	20	L	100
374	2,000	2,000	1	1,000	N	N	L	100	15	50	L	20	70	1,500
375	10,000	700	N	1,000	N	N	50	500	30	100	L	20	70	70
376	3,000	200	N	1,000	N	N	20	70	10	L	L	20	30	70
377	2,000	500	3	1,000	N	N	10	20	30	50	10	20	10	5,000
378	10,000	700	N	1,000	N	N	5	100	30	100	L	20	30	50
379	3,000	2,000	N	1,000	N	N	20	500	50	L	10	20	150	150
380	5,000	700	N	300	N	N	50	150	70	L	20	20	30	70
382	3,000	700	30	700	N	N	15	70	150	L	50	20	30	5,000
383	2,000	1,500	2	700	N	N	30	200	100	L	10	20	50	300
384	7,000	1,000	N	1,000	N	N	30	70	20	100	L	20	30	70
385	>10,000	700	N	1,000	N	N	30	300	15	L	5	20	100	50
386	2,000	>5,000	N	1,000	N	N	30	70	30	100	5	10	50	70

in the Boulder Creek-Willow Creek area—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sb (100)	Sr (100)	V (10)	Zn (200)	Chemical analyses (ppm) Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
140	N	300	L	N	L	L	10	L	L	0.03	Fr peg w qtz, FeO.
141	N	N	70	N	L	L	67	L	40	.05	FeO st fr gr, peg.
143	N	N	150	N	L	L	12	L	60	.07	Do.
144	N	N	150	N	L	L	L	L	30	.03	3' FeO st sh z.
145	N	N	150	L	L	0.4	26	L	220	.05	FeO st fr gr w carb FeO vnts.
146	N	N	70	L	L	.2	L	L	300	.03	FeO st fr gr.
147	N	N	N	N	L	13	660	1,300	30	.03	Qtz vn w mal.
148	N	3,000	30	700	L	1,700	15,000	3,100	1,300	2.80	Qtz vn w br, az, mal.
149	100	300	70	200	L	1.6	15	L	590	.03	Sh alt gr peg w carb vnts.
150	N	500	50	1,500	L	2	L	40	410	.03	Carb vn.
151	N	700	30	L	L	14	80	6,800	320	.08	2" qtz carb vn.
153	N	200	100	1,500	L	2	L	4,200	7,100	.13	Alt gr w galena, calcite.
154	N	100	150	N	L	.6	L	30	150	.05	Alt gr w fluorite.
155	N	200	30	1,500	L	1	11	530	380	.22	Sh z w sul.
156	N	100	30	300	L	6.4	3,200	1,600	850	.06	Sh z from prospect dump.
321	N	N	70	L	L	L	18	L	120	.10	Qtz FeO vn.
324	N	150	30	N	L	L	L	L	80	.05	Qtz vn.
325	N	200	200	L	L	.4	11	L	130	L	Prospect on fault.
326	N	150	150	N	L	L	12	L	70	.05	Vn from fault z.
327	N	700	150	N	L	L	L	L	80	.04	Sil fr mig w FeO.
328	N	300	100	N	L	L	L	L	80	.03	Fault z.
332	N	N	100	L	L	.2	19	L	90	.04	FeO st sh z w qtz carb vnts.
333	N	N	150	N	L	.2	L	L	90	.03	FeO st sh z.
334	N	300	50	N	L	L	24	L	50	.03	Qtz FeO vnts w minor carb.
335	N	200	50	L	L	.2	65	40	260	1.80	4' qtz vn.
336	N	200	70	L	L	L	11	L	130	.13	FeO st sh z.
344	N	150	300	300	L	6	120	140	560	.13	FeO st mig.
345	100	200	150	300	L	17	240	1,200	350	.05	Qtz vn w FeO.
346	N	200	70	N	L	L	L	30	70	.03	FeO st sh, alt rock.
347	N	100	70	700	L	1.2	22	50	410	.28	Qtz vn.
348	N	100	70	N	L	.8	L	L	80	.03	Qtz vn w FeO.
349	N	200	150	1,500	L	2	10	80	1,900	.04	Carb vn.
350	N	1,500	100	3,000	L	4.8	26	1,300	2,200	2	Qtz vn w FeO.
351	N	300	70	7,000	L	1.2	18	410	7,000	.50	Qtz carb vnts.
352	N	300	70	1,500	L	1.2	26	110	1,300	.13	Do.
353	N	300	70	N	L	.4	L	L	70	.03	Do.
354	N	200	20	N	L	L	L	L	L	.03	Fr FeO st gr.
355	N	>5,000	70	500	L	2.4	14	400	260	.40	Qtz vn.
363	N	L	70	N	L	L	87	L	70	.03	Do.
364	N	100	70	500	0.04	12	130	1,400	460	.18	FeO st qtz vn.
365	N	L	150	N	L	.6	14	40	150	.03	6' sh alt mig w qtz vns.
366	N	L	70	N	L	L	17	25	80	.03	Vn.
368	N	L	70	N	L	L	20	70	L	.05	Qtz sericite vn.
369	N	500	300	700	L	.8	44	180	940	.15	FeO st vn.
370	N	200	70	L	L	L	L	L	230	.05	Qtz vn.
371	N	200	150	500	L	L	L	40	340	.07	FeO st sh z.
372	N	200	100	5,000	L	1.6	L	80	5,000	.08	Qtz carb vn.
373	N	300	20	L	L	L	L	L	30	.05	FeO st sh z.
374	N	500	150	3,000	L	1.6	L	940	3,500	.80	Carb vn.
375	N	300	200	L	L	L	42	L	250	.30	6' sh z.
376	N	300	100	L	L	L	L	L	150	.35	Sil mylonite, qtz vn.
377	N	1,500	50	300	L	2.4	52	1,400	450	5.50	Qtz vn.
378	N	200	200	L	L	L	28	L	130	.40	FeO st sh z.
379	N	1,000	150	500	L	1.6	66	210	430	.10	Carb vn.
380	N	200	150	L	L	.2	85	40	100	.07	FeO st sh z.
382	N	1,000	100	2,000	L	14	300	2,000	950	.50	Sh z w lim mal.
383	N	200	150	2,000	L	1.2	70	260	1,100	.45	FeO st sh z, FeO qtz vn.
384	N	200	100	L	L	L	14	L	100	.03	FeO st sh z.
385	N	200	200	L	L	L	13	L	110	.05	Do.
386	N	500	100	L	L	1.2	33	40	150	.05	Lim qtz vn.

TABLE 4.—*Analyses of rock samples from the Gore Range*

Semiquantitative spectrographic analyses[1]

(ppm)

Sample	Ti (20)	Mn (10)	Ag (.5)	Ba (20)	Bi (10)	Cd (20)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)
387	2,000	5,000	N	1,000	N	N	30	30	L	L	5	10	50	100
388	10,000	700	N	1,000	N	N	30	150	15	100	L	20	30	150
389	5,000	1,500	N	2,000	N	N	20	50	15	100	L	20	20	200
390	5,000	700	N	500	N	N	20	70	15	50	L	20	30	20
391	3,000	700	N	700	N	N	20	70	15	50	L	20	30	500
392	1,000	2,000	N	1,500	N	100	30	20	L	200	L	10	50	2,000
393	1,500	>5,000	N	500	N	N	30	20	10	50	5	10	50	150
409	10,000	150	2	2,000	N	L	50	150	200	50	5	10	50	70
412	1,000	2,000	N	1,000	N	N	30	20	10	50	L	10	30	70
414	1,000	1,000	30	300	N	N	L	10	10	L	10	10	5	50
415	1,000	2,000	N	500	N	N	20	10	L	L	L	10	30	100
416	1,000	200	N	200	N	N	10	20	10	50	L	10	20	15
417	1,500	200	N	1,500	N	N	L	20	5	50	L	10	15	150
418	2,000	200	20	500	N	N	10	50	15	50	150	10	20	70
419	300	200	1	500	N	N	L	15	20	50	5	10	5	20
420	>10,000	2,000	7	500	N	N	50	200	30	50	10	20	20	1,500
421	10,000	700	N	1,000	N	N	20	150	10	100	L	10	20	20
424	10,000	1,000	N	1,000	N	N	20	300	50	50	5	10	50	20
425	10,000	1,000	N	1,000	N	N	20	300	15	50	L	10	50	20
426	3,000	700	20	500	20	N	20	50	20	50	10	10	30	200
427[9]	3,000	700	100	2,000	N	N	20	200	3,000	100	5	20	50	2,000
428	5,000	2,000	3	>5,000	N	N	100	70	50	100	10	20	50	200
429	>10,000	1,000	1	200	N	N	50	1,500	100	100	10	20	500	200
432	2,000	500	N	1,000	N	N	L	30	10	200	L	10	20	20
433	5,000	2,000	70	1,000	N	N	30	300	200	L	10	20	50	>20,000
434	3,000	200	20	2,000	N	N	L	30	15	50	L	20	10	700
435	1,000	2,000	.5	500	N	N	L	10	20	L	L	20	5	2,000
436	2,000	>5,000	1	1,500	N	N	70	200	50	L	10	10	200	1,000
444	3,000	500	N	3,000	N	N	L	20	10	50	L	20	5	150
445	2,000	2,000	N	>5,000	N	N	20	70	5	150	L	20	30	150
446	1,500	>5,000	N	1,500	N	N	20	20	5	L	L	20	20	50
447	10,000	1,500	N	700	N	N	20	50	5	150	L	20	20	150
448	1,000	>5,000	30	1,000	N	N	30	20	2,000	L	20	20	30	10,000
449	1,500	>5,000	2	1,000	N	N	30	20	20	50	7	20	20	1,000
500	1,500	200	2	2,000	N	N	100	20	1,000	L	10	15	70	150
501	10,000	1,000	N	700	N	N	30	150	20	100	L	20	50	100
502	500	700	N	200	N	N	10	5	10	L	L	L	10	L
504	10,000	1,000	1	1,500	N	N	20	70	10	100	L	20	30	200
505	3,000	200	N	2,000	N	N	10	20	15	100	L	15	15	50
506	5,000	200	N	1,000	N	N	10	50	10	100	L	50	20	50
507	2,000	700	10	1,000	N	N	10	20	70	200	L	10	15	1,500
508	2,000	700	N	1,000	N	N	20	20	5	50	L	10	15	20
509	300	3,000	.5	500	N	N	L	L	10	50	L	L	10	20
510	>10,000	1,500	2	1,500	N	N	20	500	20	50	L	20	70	100
511	3,000	1,500	30	200	N	N	20	50	70	100	L	10	30	700
512	1,500	1,500	N	200	N	N	L	20	20	100	L	10	5	50
513	5,000	1,000	5	500	N	N	10	20	15	100	L	10	5	30
514	3,000	700	N	2,000	N	N	L	20	L	100	L	10	L	30
515	2,000	700	150	2,000	30	N	L	20	150	100	L	10	L	>20,000
516	1,500	200	500	700	N	N	L	20	2,000	100	L	10	5	>20,000
517	1,000	>5,000	5	500	N	N	50	20	20	L	10	10	30	150
518	1,000	500	.5	1,000	N	N	L	10	10	200	L	10	L	70
519	1,500	1,000	1	200	N	N	L	10	15	50	L	10	L	150
520	10,000	1,500	15	500	N	N	30	100	50	100	5	20	50	1,500
522	1,000	150	1	100	N	N	L	10	10	50	5	L	5	50
523	1,500	200	2	1,500	N	N	L	10	5	L	30	L	L	20
524	200	500	1	200	N	N	L	10	10	L	7	L	L	100
525	3,000	700	3	200	N	N	10	20	15	50	15	10	20	50
570[10]	300	100	2	200	N	N	L	10	10	N	N	20	L	15
571	5,000	300	N	700	N	N	10	20	70	30	N	L	20	20

9/ 500 ppm As.

in the Boulder Creek-Willow Creek area—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						
Sample	Sb (100)	Sr (100)	V (10)	Zn (200)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
387	N	300	100	300	L	0.8	L	60	290	0.03	Lim qtz vn.
388	N	300	200	500	L	L	L	100	700	.70	Do.
389	N	500	100	1,000	L	L	L	320	980	.03	FeO st sh z.
390	N	200	200	L	L	L	L	L	80	L	Do.
391	N	300	100	300	L	.2	11	290	220	.20	Qtz vn.
392	N	300	70	10,000	L	1.4	L	1,200	10,000	.03	Carb vn.
393	N	300	100	200	L	1.6	L	70	250	.08	Do.
409	N	500	200	200	L	1.6	130	L	190	.30	FeO st sh mig w py.
412	N	700	50	300	L	1.4	L	L	270	.01	Lim qtz vn w barite.
414	N	200	50	L	.38	19	L	L	L	L	Qtz vn.
415	N	100	70	500	L	1.6	L	40	550	.10	Carb FeO vn.
416	N	L	70	L	L	L	L	L	L	.03	Qtz vn.
417	N	100	50	200	L	L	L	70	160	.08	FeO st sh z.
418	N	100	500	L	L	9.6	L	30	30	.20	Qtz vn.
419	N	150	50	L	L	L	L	L	L	.08	Do.
420	N	100	300	2,000	L	3.2	21	550	1,700	.11	FeO st sh z.
421	N	100	200	L	L	L	L	L	120	.01	Do.
424	N	150	200	L	L	L	43	L	110	.03	Do.
425	N	100	150	200	L	L	L	L	160	.03	3' FeO st sh z.
426	N	200	100	L	L	5.6	10	190	70	.08	FeO st sh z w qtz vnts.
427	300	1,500	100	1,000	L	59	1,500	650	750	2.80	FeO st sh z w qtz,
428	N	1,000	300	1,000	L	2	25	160	950	.18	Fault material-float.
429	N	200	300	500	L	.8	33	210	410	.08	FeO st sil sh z.
432	N	200	100	L	L	L	L	L	30	.03	FeO st qtz vns.
433	N	100	200	3,000	L	48	150	9,600	2,000	.15	Sil sh z w carb vnts.
434	N	200	100	500	L	3.2	L	660	290	.08	Qtz vn.
435	N	100	10	2,000	L	.2	12	720	1,400	.05	Alt chlor gr from sh z.
436	N	300	100	3,000	L	3.6	29	940	4,000	.10	FeO st alt gr from sh z.
444	N	1,500	70	L	L	L	L	L	40	.03	Gr w sul vnt.
445	N	1,000	150	1,000	L	1.2	L	160	890	L	Carb vn, mylonite.
446	N	1,500	100	L	L	2	L	40	110	.03	Carb chlorite(?) vn.
447	N	100	150	500	L	L	L	80	360	.05	Qtz carb FeO vnts.
448	N	100	70	>10,000	.02	22	1,800	8,000	14,000	.08	Carb vn.
449	N	200	150	700	L	1	28	430	510	.09	Carb qtz FeO vnts
500	N	500	100	L	L	1.4	1,100	100	40	.03	Alt FeO st gr.
501	N	100	200	L	L	.4	27	80	220	.05	FeO st fr z.
502	N	L	50	L	L	L	L	L	100	.03	FeO st qtz vn.
504	N	100	150	500	L	1.8	L	360	650	.04	1' FeO st sh z.
505	N	500	100	L	L	L	L	L	80	L	FeO st alt gr.
506	N	200	150	L	L	L	13	L	80	.03	FeO st sh gr.
507	N	200	50	700	L	3.6	99	960	660	.03	Qtz carb vn w FeO.
508	N	200	50	300	L	L	L	L	230	.01	Do.
509	N	L	10	500	L	L	L	30	200	.10	Qtz vn w FeO.
510	N	200	200	700	L	2.4	13	80	720	.03	Qtz carb vn w FeO.
511	N	100	70	1,000	L	50	150	1,100	980	.08	Qtz vn w FeO.
512	N	100	70	L	L	.2	18	30	60	.03	Do.
513	N	100	70	L	L	1.6	12	L	130	.03	Do.
514	N	200	70	L	L	.2	L	L	90	L	FeO st sh z.
515	N	200	50	>10,000	L	140	210	22,000	15,000	.18	Qtz vns w mal, az, sul.
516	500	200	50	2,000	L	430	2,300	12,000	2,100	.20	Qtz vn w sul.
517	N	100	70	3,000	L	1.2	21	250	2,200	L	Qtz carb vn.
518	N	500	50	L	L	L	L	30	50	.05	FeO st sh z w qtz vn.
519	N	100	30	500	L	1.2	13	130	450	.05	Qtz vn w carb.
520	N	100	150	700	.02	12	81	600	910	.03	Qtz carb vn.
522	N	L	70	200	.04	.4	10	40	130	.03	Qtz vn.
523	N	200	50	L	.16	3	L	L	L	.03	Do.
524	N	L	20	L	.20	1.2	10	110	60	.03	Do.
525	N	L	100	L	.06	1.6	10	30	90	.03	Do.
570	N	L	20	N	.04	6	L	L	L	.10	Do.
571	N	150	50	N	L	.8	69	L	80	.50	Do.

10/ <50 ppm W.

TABLE 4.—*Analyses of rock samples from the Gore Range*

Semiquantitative spectrographic analyses[1/]

(ppm)

Sample	Ti (20)	Mn (10)	Ag (.5)	Ba (20)	Bi (10)	Cd (20)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)
572[11/]	500	150	7	1,000	N	N	50	50	70	20	N	10	50	70
573	2,000	200	N	100	N	N	10	10	20	20	N	10	20	10
574	5,000	1,000	5	500	N	N	15	50	500	20	N	15	30	1,500
575	500	100	.5	50	N	N	L	20	10	N	N	10	10	10
576	500	300	1	150	N	N	7	20	50	N	10	10	10	15
577	2,000	200	L	200	N	N	7	20	20	50	N	10	15	20
578	500	2,000	N	1,000	N	N	20	20	10	50	N	10	20	70
579	2,000	300	1	500	15	N	10	30	100	50	N	20	20	50
590	1,000	1,500	N	100	N	N	20	50	10	20	N	10	50	300
591	5,000	300	N	1,500	N	N	30	30	100	100	N	20	20	20
592	2,000	500	N	300	N	N	10	10	L	20	N	20	20	200
593	300	700	N	100	N	N	L	N	7	20	N	15	10	50
594	1,000	300	1.5	300	N	N	20	20	200	L	20	10	15	1,000
595	3,000	500	N	500	N	N	30	100	300	20	N	10	30	20
596	5,000	200	N	200	N	N	20	50	L	30	N	20	30	20
597	5,000	1,500	.5	500	N	N	30	50	10	50	N	15	50	50
602	3,000	200	N	300	N	N	20	100	50	50	10	20	30	20
604	5,000	500	N	500	N	N	20	70	5	20	N	10	30	30
605	2,000	150	.5	200	N	N	7	50	10	20	N	20	20	50
606	1,500	500	.5	100	N	N	20	20	15	N	N	15	30	70
633	500	1,500	N	>5,000	N	N	15	10	5	N	N	L	20	70
634	3,000	700	N	1,000	N	N	20	100	10	30	N	20	50	70
635	700	2,000	N	>5,000	N	N	30	30	L	20	5	L	50	200
636	2,000	500	N	1,000	N	N	15	100	10	50	N	10	50	50
637	700	500	7	500	20	N	10	20	10	20	N	10	10	15,000
638	1,000	2,000	10	700	N	N	20	20	7	70	N	15	20	500
639	1,000	3,000	1	700	N	N	30	30	30	20	N	10	30	150
640	2,000	500	L	1,000	N	N	15	100	7	50	N	20	30	100
641	5,000	1,500	N	1,000	N	150	30	300	N	50	N	30	70	70
642	5,000	700	N	1,000	N	N	20	200	N	150	N	20	50	20
643	1,500	500	N	150	N	N	5	20	7	100	N	10	20	10
644	1,000	300	.5	500	N	N	5	L	5	100	N	10	15	150
645	5,000	1,000	N	700	N	N	30	200	L	30	N	20	70	50
646	300	1,000	1	500	N	N	L	10	7	N	20	10	7	15
647	1,000	200	.5	300	N	N	5	15	5	30	N	15	10	15
648	500	1,500	N	200	N	N	10	10	5	50	N	L	10	70
649	500	100	N	1,000	N	N	N	10	10	30	N	L	10	10
650	1,500	150	.7	200	N	N	7	10	5	20	N	10	20	10
651	700	150	.7	150	N	N	5	10	7	30	10	L	15	10
652	300	2,000	N	500	N	N	30	10	10	50	N	L	30	20
653	500	200	.5	1,000	N	N	L	10	L	30	N	10	7	15
654	700	700	.7	2,000	N	N	20	30	5	20	N	10	30	100
655	500	1,000	1	500	N	N	20	20	5	20	N	L	15	100
656	1,000	300	L	500	N	N	5	20	7	70	15	30	15	30
657	700	500	N	200	N	N	7	15	15	20	L	20	15	50
658	100	2,000	N	150	N	N	50	10	L	N	15	L	50	50
659	700	200	N	500	N	N	7	10	15	70	N	10	10	30
660	300	500	L	150	N	N	10	10	5	30	L	L	20	15
661	500	700	.5	150	N	N	L	15	7	50	L	10	15	L
662[10/]	500	50	.7	700	N	N	L	10	5	50	10	10	7	50
663	1,000	1,000	1	700	N	N	20	10	5	20	7	10	20	100
664	50	50	2	500	N	N	N	10	L	N	30	L	L	15
665	300	3,000	N	1,000	N	N	50	15	5	N	N	15	50	70
666	300	2,000	N	>5,000	N	N	20	10	7	30	N	10	15	30
667	200	3,000	N	500	N	N	15	10	20	N	N	10	15	50
668	700	1,000	.5	500	N	N	20	20	50	50	N	10	30	20
669	2,000	1,500	.7	1,000	N	N	20	30	70	20	N	20	30	50
670	1,000	1,000	20	300	N	N	5	20	3,000	20	10	10	15	150
671	1,000	500	200	2,000	10	N	L	20	>20,000	50	N	10	10	100
696	3,000	300	N	1,500	N	N	10	20	70	100	N	10	10	100

11/ 1,500 ppm As.

in the Boulder Creek-Willow Creek area—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						
Sample	Sb (100)	Sr (100)	V (10)	Zn (200)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
572	N	500	50	N	0.50	25.0	21	80	30	1.50	Barite lim vn.
573	N	L	70	N	L	.8	14	L	60	.08	Qtz vn.
574	N	L	30	700	L	17	300	1,300	1,800	.10	Qtz vn, sil gr.
575	N	L	70	N	L	.4	L	L	50	.11	Qtz vn.
576	N	L	30	N	.04	1.2	L	L	80	.10	Do.
577	N	100	50	N	L	.8	L	L	10	.07	Do.
578	N	300	20	300	L	.8	L	60	380	.04	Do.
579	N	100	50	N	.04	1.4	35	50	60	.10	Do.
590	N	200	30	500	L	1.8	L	160	380	.15	Carb vn.
591	N	100	100	N	L	.8	25	L	120	.10	Alt gr peg.
592	N	L	50	500	L	L	L	180	570	.08	FeO st sh z.
593	N	L	10	N	L	1.2	20	60	100	.06	Carb FeO vn w silica.
594	N	100	50	500	L	1.2	200	440	490	.02	FeO st fr mig.
595	L	100	70	200	L	.8	210	L	270	1.80	Carb lim vn.
596	N	150	70	N	L	L	L	L	80	.03	FeO st sh z.
597	N	150	100	500	L	1.6	L	L	590	.20	Carb vn.
602	N	L	70	N	L	L	38	L	100	.35	Qtz FeO vn.
604	N	L	70	N	L	.6	L	L	110	.08	Do.
605	N	100	50	200	L	L	13	L	140	.08	Fr z.
606	N	300	70	300	L	1.2	16	30	240	.13	Carb vn.
633	N	200	20	200	L	1.2	L	50	270	.16	Qtz carb vn w FeO.
634	N	L	70	N	L	1.0	27	40	120	.06	Do.
635	N	500	20	300	L	2	L	120	300	.06	Do.
636	N	300	70	N	L	.8	22	L	100	.10	Alt gr .
637	N	L	50	300	.52	4.4	32	36,000	550	.08	Qtz vn.
638	N	L	50	1,000	L	7.8	21	550	900	.06	Lim qtz vn.
639	N	L	70	200	L	2.4	68	140	270	.16	Chloritic rock.
640	N	300	50	L	L	.4	18	40	130	.16	Alt shd gr.
641	N	100	50	1,000	L	.8	L	L	1,300	.08	Limonitic rock.
642	N	200	70	N	L	.4	L	L	L	.10	Fault gouge.
643	N	L	20	N	L	L	L	L	L	.20	Qtz specularite vn.
644	N	100	15	300	L	L	L	170	230	.24	FeO st sh z w qtz vn.
645	N	L	100	500	L	L	L	L	500	.12	FeO st sh z.
646	N	100	15	N	L	.4	L	L	140	.15	Qtz carb vns.
647	N	100	30	200	L	L	L	L	220	.24	Qtz vn w FeO.
648	N	300	20	N	L	2.4	L	50	40	.04	Qtz vnts.
649	N	150	15	N	L	L	L	L	L	.02	15" qtz vn.
650	L	L	20	N	L	L	L	L	50	.10	Gray rock from dump.
651	L	L	15	N	L	L	L	L	50	.06	Qtz vn w FeO.
652	N	150	20	200	L	1	L	L	240	.09	Qtz carb vn.
653	N	150	15	N	L	L	L	L	40	.20	Qtz vn w FeO, sil sh peg.
654	N	200	30	300	L	.8	L	70	320	.05	Carb vn.
655	N	200	20	300	L	1.4	L	60	320	.04	Qtz carb vn.
656	N	100	10	N	L	L	L	L	L	.04	8' fr gr w sul.
657	N	L	20	200	L	.4	22	30	140	.05	Qtz carb vn.
658	N	500	20	200	L	2	L	30	320	.03	Carb vn.
659	N	100	10	L	L	L	54	L	150	.04	FeO st vn.
660	N	100	20	L	L	L	L	L	240	.15	Qtz vn.
661	N	L	50	L	L	L	14	L	230	.35	FeO st vn.
662	N	150	15	N	L	L	L	30	30	.06	Qtz vn.
663	N	100	30	500	L	.4	L	80	550	.45	FeO st alt gr.
664	N	100	10	N	L	.6	L	L	L	.08	Qtz carb vn.
665	N	200	15	500	L	2	32	40	530	.04	Carb lim vn.
666	N	300	20	L	L	1.2	L	25	190	.02	Carb qtz vn, FeO st alt gr.
667	N	L L	15	L	L	1.8	20	30	160	.05	Carb lim vn.
668	N	100	20	200	L	1.2	120	30	210	.12	Qtz carb vn w lim.
669	N	L	50	1,000	L	.6	110	40	750	1.40	Do.
670	100	L	30	200	L	61	4,000	90	230	.30	Qtz carb vn w lim, az, mal.
671	200	200	20	L	.08	200	32,000	100	110	.02	Do.
696	N	300	100	N	L	L	10	L	30	.09	Qtz vn w FeO.

TABLE 4.—*Analyses of rock samples from the Gore Range*

Sample	Semiquantitative spectrographic analyses[1] (ppm) Ti (20)	Mn (10)	Ag (.5)	Ba (20)	Bi (10)	Cd (20)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)
697	2,000	500	N	1,000	N	N	10	30	70	50	N	10	15	50
698[3]	3,000	700	N	1,500	N	N	15	50	70	150	N	15	20	50
699	2,000	1,500	N	1,500	N	N	15	20	30	100	N	L	20	70
700	700	1,000	0.5	200	N	N	N	7	200	100	N	L	10	70
709	1,000	5,000	20	1,500	N	200	15	5	300	50	N	L	10	2,000
710	700	1,500	1	1,000	N	N	15	5	20	70	N	10	20	100
711	700	300	N	300	N	N	10	10	10	20	N	L	15	10
738	700	300	15	50	N	N	10	5	100	100	15	L	10	10,000
739	700	500	20	500	N	N	20	5	700	50	15	L	30	1,500
740	1,500	2,000	.7	1,000	N	N	30	30	100	150	N	10	30	200
741	1,000	2,000	.5	200	N	N	20	20	30	150	N	L	30	1,500
742	700	1,500	70	200	N	N	20	30	500	20	N	L	30	1,000
743	700	2,000	30	300	N	N	30	20	150	50	L	L	30	300
744	1,500	500	N	70	N	N	15	30	30	20	N	L	20	50
745	700	300	15	30	N	N	30	15	150	20	20	L	15	300
755	700	200	N	100	N	N	10	20	20	20	N	L	20	10
756	1,000	300	.5	500	N	N	15	15	50	50	N	10	10	100
757	1,000	300	1.5	300	N	N	10	20	150	100	70	10	15	100
758	700	1,000	L	200	N	N	10	5	20	100	N	L	10	10
759	1,000	1,500	2	300	N	N	5	5	30	30	10	10	10	100
760	500	150	.5	700	N	N	5	L	20	70	N	10	7	15
761	2,000	1,500	.5	500	N	N	30	70	30	50	N	10	50	500
844	700	1,000	N	500	N	N	20	15	30	70	N	L	20	70
1181	5,000	300	N	700	N	N	10	70	20	30	N	10	30	15
1182	5,000	300	N	700	N	N	15	70	15	30	N	10	30	20
1183	500	5,000	N	300	N	N	50	20	N	N	5	N	50	500
1184	1,500	500	N	300	N	N	15	70	20	20	N	10	50	N
1185	2,000	300	N	300	N	N	10	70	70	20	N	10	20	50
1186	2,000	1,000	1.5	700	N	N	15	20	100	70	N	10	20	5,000
1187	700	1,000	15	5,000	N	N	15	10	200	30	N	L	15	>20,000
1188	1,500	1,000	N	300	N	N	15	30	20	50	N	10	30	50
1210	700	150	N	200	N	N	5	15	10	50	N	L	10	20
1211	10,000	100	5	200	N	N	5	15	10	L	N	L	10	10
1212	L	5,000	N	50	N	20	5	L	5	L	N	L	7	15

minerals proustite and pyrargyrite. The ruby silver minerals were reported to be so abundant in parts of the mine as to color the rocks and waters red, but this coloration probably was due mainly to hematite, as it was also in some other reported ruby silver occurrences along the mountain front. Selected samples of high-grade ore from the dumps of the Boss mine (samples 5–7, table 4) show a high content of silver, and one shows a high gold content of 11 ppm.

Other samples from the broad fault zone in the vicinity of the Boss mine (pl. 2) consistently show molybdenum, and three are notable for a content of 10 ppm tin. Samples from the same broad zone on the south side of North Rock Creek (samples 90–100, table 4) show only minor anomalies in molybdenum and zinc. In contrast, samples from a group of subsidiary fractures of the Frontal fault zone to the west are, variously, anomalous in silver, molybdenum, copper, lead, and zinc, and one is highly anomalous in bismuth (samples 101–107, table 4).

in the Boulder Creek-Willow Creek area—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						
Sample	Sb (100)	Sr (100)	V (10)	Zn (200)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
697	N	100	70	N	L	L	16	L	30	0.07	Qtz vn w FeO.
698	N	300	150	N	L	L	14	L	60	.04	Qtz vn.
699	N	500	70	N	L	0.2	14	30	110	.26	Qtz carb vn.
700	N	L	20	N	L	L	180	30	60	.08	Qtz vn w FeO.
709	N	200	50	>10,000	L	12	150	1,700	1,800	2	Sh alt gr w qtz lim vns.
710	N	100	50	500	L	.4	L	L	140	.40	Sh gr w qtz carb FeO vnts.
711	N	L	50	N	L	L	L	L	L	.06	FeO st sh alt gr.
738	N	300	20	500	L	11	64	3,600	350	.80	Qtz-FeO vn w gal.
739	500	100	30	2,000	L	39	880	3,300	1,300	.55	Qtz vn w mal, lim, hem.
740	N	200	100	200	L	.8	17	50	200	.04	Qtz carb vn.
741	N	200	70	500	L	1.2	L	40	330	.04	Do.
742	N	200	70	2,000	L	33	360	1,200	1,300	.09	Do.
743	N	300	70	2,000	L	35	98	190	960	.08	Do.
744	N	N	100	200	L	L	L	40	250	.08	Qtz carb vn w FeO.
745	N	N	50	300	0.06	12	120	420	250	.11	Do.
755	N	100	30	N	L	L	L	L	30	.04	Alt gr w qtz lim vnts.
756	N	100	50	500	L	L	L	30	320	.05	FeO st qtz vn.
757	N	100	70	700	L	1.4	74	170	470	.14	Qtz vn.
758	N	150	30	N	L	L	N	L	80	.05	Lim qtz vn.
759	N	100	50	300	L	3	L	290	250	.13	4' alt gr w qtz carb vnts.
760	N	100	20	2,000	L	.6	19	40	500	.10	Qtz vn.
761	N	100	100	700	L	.6	34	550	480	.11	Ser gr w py, sid vnts.
844	N	500	70	L	L	.8	L	40	120	.07	FeO-rich rock.
1181	N	100	100	L	L	L	58	L	200	.01	Lim qtz vn.
1182	N	N	100	N	L	L	22	30	90	.03	Lim on fr sh rock.
1183	N	150	100	1,500	L	2.4	L	210	2,000	.04	Carb lim vn.
1184	N	N	100	N	L	.4	14	L	110	.02	Sh mig w qtz carb lim.
1185	N	L	70	L	L	.4	40	50	100	.02	Lim, qtz on fracture.
1186	N	150	100	300	L	2	69	1,300	270	.09	Lim carb qtz vn.
1187	N	200	70	500	L	16	200	20,000	460	.26	Qtz vn (dump).
1188	N	200	100	L	L	.4	20	660	130	.03	Lim sh rock w carb.
1210	N	L	50	N	L	L	L	L	30	.03	Qtz vn.
1211	N	L	70	N	.42	.8	10	L	L	.02	Qtz vn w fluorite.
1212	N	N	N	N	L	L	L	L	30	.02	Qtz vn.

AREA NORTH OF BOSS MINE

Prospect diggings along the main Frontal fault on the ridge above the Boss mine and down the north slope toward Boulder Creek show little evidence of mineralization either physically or geochemically (samples 139–146, table 4). However, fractures to the west, in the footwall of the main fault, are mineralized and have been prospected or even worked in small mines. These fracture zones or veins consist of a few feet of sheared and altered granite containing carbonate veinlets and small pods of galena or bornite. They are thus anomalous in lead, copper, and silver (samples 147–156, table 4). In addition, one or another is anomalous in bismuth, antimony, or mercury, but they are low in molybdenum.

On the north side of Boulder Creek, the Frontal fault is marked by a broad soft zone of granulated and altered rock bordered by harder but intensely fractured rocks. The bordering fractured rocks, particularly sandstones of the Morrison Formation on the east side, are markedly anomalous in arsenic and mildly anomalous in molybdenum, copper, and zinc (samples 17–22, table 4). The soft zone (samples 324–326) is essentially barren. Farther north, a tunnel reported to have been worked for silver in the early 1920's is located on a fracture of the Frontal fault system, and several prospect pits nearby are on other fractures of the system. Samples from the dump of the tunnel (1186 and 1187, table 4) show lead, silver, and a little zinc in the carbonate and quartz vein matter.

WILLOW CREEKS-RED PEAK AREA

At Willow Lakes and at Salmon Lake half a mile to the north, quartz veins as much as 5 feet wide occupy faults parallel to the Frontal fault. These have been prospected in several places. The quartz closely resembles that of the Boss mine. It is devoid of visible metallic minerals but contains traces of silver and gold, and some of it is anomalous in molybdenum (samples 522–525 and 570–579, table 4).

A high scarp on the end of the ridge north of Middle Willow Creek is in shattered and strongly altered rocks in the footwall of the Frontal fault. The shattered rocks are chloritized and locally sericitized or argillized. Among several caved tunnels located in these altered rocks are some that had several hundred feet of workings as indicated by the size of the dumps. No well-defined continuous veins are evident at the surface, and the tunnels are judged to have explored short quartz veins in a network of discontinuous veins in the shattered rocks. Samples from the area (432–436 and 636–642, table 4) showed anomalies in silver, lead, and zinc, and one contained a little gold.

Southwest of the scarp area, on Red Peak and along the north side of South Willow Creek, are many veins or geochemically anomalous fracture zones. A few of these are on patented claims (pl. 2), and many of them have been explored by tunnels or prospect pits. (See "Red Peak area" in "Economic appraisal.") The most mineralized veins contain quartz or carbonate, although several geochemically anomalous "veins" are simply sheared rock. In veins that have been worked in small mines along South Willow Creek, the carbonate mineral is siderite, as at the Boss mine, rather than dolomite-ankerite. Fractures or veins on the ridge east and northeast of Red Peak are anomalous in silver, lead, and zinc, and a few are high also in bismuth, antimony, or copper (samples 507–520, table 4). On Red Peak and the ridge to the west and south (samples 644–671, table 4), the fractures contain only small amounts of silver and are anomalous principally in zinc. A few fractures contain molybdenum, and in one locality (samples 670 and 671) there is a copper-stained vein high in silver and anomalous also in antimony, bismuth, and gold. Some fractures or veins along the north side of South Willow Creek are anomalous in silver, copper, and molybdenum, and others, in silver, lead, and zinc; a few contain bismuth, antimony, or gold also (samples 73, 75, 738–745, and 755–761, table 4). In all of the South Willow Creek-Red Peak area, the veins or fracture zones that are anomalous are small; few exceed 5 feet in width, and many are less than 2 feet.

Hammer Fluorspar Deposits

The Hammer fluorspar deposits are far outside the Primitive Area but have some bearing on mineralization history of the Frontal fault system. The main, lower deposit is beside the highway between Maryland and North Willow Creeks (pl. 1), and the upper deposit is about 1 mile upslope to the southwest. The deposits consist largely of fragmental fluorspar dispersed in the preglacial colluvium, which here is involved in a landslide that formed before glaciers of the middle group advanced over it. The colluvium contains abundant chloritized rock and vein quartz derived from the area along the Frontal fault between North and South Willow Creeks, as well as various unaltered Precambrian rocks. A large pit at the lower deposit and trenches at the upper deposit show that some fluorspar encrusts the boulders of these varied rocks, and hence that it was introduced after they had been incorporated in the colluvium, and not before. As fluorspar is a fragile substance that would break off the boulders if they moved far, and as it is localized mainly in two distinct areas, the mineralization is inferred to have occurred approximately at the sites of the two deposits. Renewed movements of the landslide, which continue to the present at the toe of the slide, then diffused some of the fluorspar through the colluvial material in localized areas downslope from these sites. As the colluvium, which has been shown by drilling to be about 100 feet thick, was at the surface at the time of mineralization, the fluorspar can be classed as a hot-spring deposit. The hot springs probably rose along some of the faults in the sedimentary rocks subsidiary to the Frontal fault. One such fault, near the upper end of the upper deposit, evidently contains a large vein of quartz which was leached to a vuggy, porous state by the corrosive fluorine-bearing solutions. This quartz is geochemically barren (sample 1212, table 4), but quartz from a similar source incorpo-

TABLE 5.—*Analyses of rock samples from the*

[For sample locations see plate 2. Numbers in parentheses indicate sensitivity limit of method used. The symbol > indicates that an undetermined amount of the element is present above

Semiquantitative spectrographic analyses[1]

(ppm)

Sample	Ti (20)	Mn (10)	Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)	Sn (10)
67	300	200	N	L	200	1.0	5	L	L	L	L	L	10	10	L	L
68[3]	50	150	N	L	100	2	5	L	15	L	L	10	5	50	L	L
69	500	300	N	10	50	1	5	20	L	L	L	10	15	10	L	N
70[4]	10,000	500	N	L	300	L	20	100	L	L	L	20	50	10	20	N
71[5]	2,000	300	N	L	700	1	10	70	L	L	L	20	20	10	10	N
72[4]	5,000	200	N	L	1,000	L	10	100	15	L	L	20	20	15	5	N
116	3,000	70	N	L	500	N	L	30	5	50	L	L	10	L	7	N
117	L	100	N	10	150	7	L	10	L	N	N	20	L	L	L	N
118	1,500	5,000	3.0	15	300	1	15	70	150	L	5	15	20	1,500	7	N
173	2,000	700	N	10	300	N	15	30	30	50	L	L	20	20	15	N
274	5,000	300	N	100	1,500	L	L	30	7	70	N	15	10	15	10	N
275	300	70	N	30	N	L	L	5	10	N	N	5	10	150	N	N
398	3,000	150	N	10	1,500	L	L	20	10	150	L	10	L	30	5	N
403	10,000	700	N	20	1,000	L	30	150	10	100	L	10	50	20	20	N
405	7,000	1,000	N	20	500	1	20	70	50	100	L	10	30	20	20	N
406	10,000	150	N	10	1,000	L	30	100	2,000	50	20	10	100	20	20	N
438	700	5,000	50	50	200	1	10	20	150	L	10	10	10	1,500	5	N
439[6]	>10,000	2,000	100	20	150	1	30	30	200	L	10	20	10	>20,000	70	L
440	2,000	>5,000	1	20	150	1	30	50	200	L	20	20	70	200	20	L
441	500	2,000	N	10	L	L	L	50	L	L	L	L	10	15	L	L
442	2,000	>5,000	N	50	100	L	30	70	150	L	10	20	100	15	15	L
443	7,000	5,000	2	50	300	1	30	70	20	L	L	20	20	10,000	50	L
725	1,500	1,000	N	L	2,000	1.5	15	30	30	50	N	L	20	50	7	L
727	1,000	1,500	5	20	300	2	20	30	100	50	N	10	50	1,000	10	N
728	1,000	1,500	10	20	2,000	2	20	30	300	70	N	L	30	1,000	10	N
729	700	700	150	20	3,000	2	20	20	2,000	50	N	L	30	1,000	7	N
746	700	2,000	N	N	200	L	30	50	20	20	N	L	70	500	5	N
747	1,500	700	N	10	300	3	20	150	150	70	N	10	70	20	10	N
748[7]	700	2,000	.5	10	300	3	20	10	50	50	N	10	30	1,000	7	L
749	700	300	1	10	300	2	20	20	100	20	N	L	20	300	7	L
750	5,000	700	L	L	300	2	30	150	150	50	N	20	150	200	20	10
751	1,000	300	L	L	300	3	10	50	30	L	N	L	30	100	7	N
752	2,000	500	N	10	700	2	15	70	50	50	N	L	30	15	10	N
753	3,000	700	L	L	300	2	20	150	70	30	N	15	30	20	30	N
754	5,000	1,500	2	10	1,000	2	70	200	150	70	N	10	100	150	30	N
813	2,000	1,500	2	20	200	3	15	20	200	150	N	10	20	30	10	L
814	700	500	1.5	20	1,500	1.5	10	10	100	50	N	L	15	500	5	N
815	700	1,500	N	20	700	1.5	20	30	30	100	N	L	30	100	20	N
816	3,000	500	N	20	50	3	15	30	20	200	N	10	20	50	7	N
817	3,000	1,500	N	20	300	2	30	50	30	200	N	10	30	150	10	N
818	2,000	1,500	N	L	500	2	20	30	30	150	N	10	30	L	10	N
819	700	2,000	N	N	500	L	20	30	15	50	N	L	20	10	7	N
820	2,000	300	N	15	200	5	15	30	15	70	N	10	20	10	7	N
821	1,000	700	N	10	1,500	1.5	7	15	20	70	N	L	10	50	5	N
822	1,000	1,000	N	15	700	2	7	15	15	100	N	L	15	50	5	N

1/ Also looked for spectrograpnically but not found except as noted: As(200), Au(10), Bi(10), Cd(20), Sb(100) and W(50).

3/ 200 ppm As.

4/ 10 ppm Bi

5/ <10 ppm Bi.

6/ 50 ppm Bi.

7/ 70 ppm Cd.

Gore Range in the southern area (area D, pl. 2)

the number shown; L indicates that an undetermined amount of the element is present below the sensitivity limit; N indicates the element was looked for but was not found.]

Sample	Semiquantitative spectrographic analyses-Continued (ppm) Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Chemical analyses (ppm) Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2]
67	50	15	L	L	50	L	L	L	L	L	0.10	Qtz vn w FeO, MnO.
68	50	15	L	L	L	L	L	11	L	L	.14	Qtz vn w hem.
69	200	20	L	L	L	L	L	L	L	L	.07	Sil z.
70	100	100	10	L	100	L	0.60	L	L	84	.08	FeO st qtz vn.
71	100	100	L	L	150	0.02	.40	L	L	48	.05	Sil gr.
72	100	100	10	L	200	.02	.80	15	L	40	.18	Shd alt, FeO st gr.
116	N	30	15	N	150	L	L	75	L	65	.10	FeO st gr.
117	N	L	N	N	N	L	L	45	L	30	.05	Qtz vn.
118	N	70	10	2,000	100	.22	4.4	250	3,000	3,400	.22	Do.
173	L	70	15	N	150	L	L	47	40	160	.15	FeO st gr.
274	200	70	15	N	150	L	L	L	L	30	.16	FeO st fr gr.
275	300	N	L	N	70	L	L	L	480	L	.11	Sandstone.
398	300	50	20	N	500	L	L	L	L	30	.01	FeO st aplite.
403	L	200	50	L	700	L	L	L	L	90	L	FeO st sh z.
405	L	70	70	L	700	L	L	32	L	70	.01	Do.
406	50	500	30	L	300	L	.4	630	30	120	.04	Do.
438	100	100	L	>10,000	L	.30	17	150	1,800	11,000	.30	FeO st qtz vn.
439	100	300	30	2,000	200	.14	42	200	44,000	4,900	.14	10' sh z.
440	L	300	20	500	150	L	.8	180	80	310	.03	FeO st qtz vn.
441	300	20	20	L	L	L	2.6	L	30	30	L	Calcite vn w FeO, sul.
442	100	200	30	500	200.	L	.8	230	L	250	.05	FeO st qtz vn.
443	150	200	50	1,000	200	L	1.2	16	1,000	1,400	.03	Do.
725	100	200	15	N	100	L	L	L	L	80	.04	Fr FeO st gr.
727	300	100	20	1,000	100	L	2.4	53	1,100	880	.05	Qtz vn w FeO, carb.
728	300	100	20	1,000	70	L	22	320	2,000	600	.08	Carb qtz vn w copper.
729	200	50	10	1,500	70	L	760	3,000	2,400	1,300	.55	Do.
746	1,000	150	15	500	30	L	2	L	240	310	.04	Carb vn.
747	N	150	15	300	100	L	.4	16	L	300	.35	Qtz vnts, FeO st gn.
748	N	50	20	2,000	70	L	.8	L	920	1,600	.04	Carb vn.
749	N	50	15	500	70	L	.8	37	590	460	.45	FeO st gn.
750	N	150	50	700	700	L	.8	12	220	700	.40	Qtz vnlt, FeO st gn.
751	N	70	L	300	70	.04	.4	18	180	320	.55	Qtz carb vnts.
752	100	70	15	N	70	L	L	20	L	70	.11	Do.
753	L	100	15	N	100	L	L	L	25	80	.05	Carb vnts.
754	L	300	50	L	100	L	.4	19	60	170	.06	FeO st sh z.
813	150	70	50	N	70	L	1.2	110	40	110	.06	FeO, siderite in fr.
814	150	30	30	500	70	L	.8	100	660	480	1	Qtz carb vn.
815	500	70	70	700	70	L	1.2	21	70	600	.08	Alt gr w qtz, FeO.
816	1,000	70	50	N	100	L	L	L	L	100	.08	Qtz vnts.
817	300	100	50	1,000	150	L	.6	19	160	910	.13	Carb qtz FeO vn.
818	L	70	15	L	100	L	.4	L	L	170	.13	FeO st fr my gn.
819	200	100	30	N	20	L	1.6	L	25	90	.04	Carb vnts.
820	300	70	15	N	100	L	L	L	L	40	.13	FeO-rich gouge.
821	300	70	10	N	70	L	L	31	L	30	.05	Carb vnts.
822	300	70	15	N	70	L	L	L	L	50	.18	Qtz, carb, in fault.

2/ Abbreviations used in table:

alt	altered	hem	hematite	sil	silicified
carb	carbonate	lim	limonite	st	stained
FeO	iron oxide	MnO	manganese oxide	sul	sulfide
fr(d)	fracture(d)	my	mylonite	vn	vein
gal	galena	py	pyrite	vnt(s)	veinlets
gn	gneiss	qtz	quartz	w	with
gr	granitic rock	sh(d)	shear(ed)	z	zone

TABLE 5.—*Analyses of rock samples from the*

Semiquantitative spectrographic analyses[1/] (ppm)

Sample	Ti (20)	Mn (10)	Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)	Sn (10)
823	2,000	300	N	10	500	2.0	7	20	30	70	N	20	10	10	7	N
824	3,000	1,500	L	20	500	2	20	30	100	150	N	10	50	100	10	N
825	3,000	300	N	15	700	2	30	100	20	150	N	10	50	20	15	N
826	3,000	500	N	15	700	2	15	20	15	100	N	10	20	20	10	N
827	500	300	L	20	100	2	7	5	70	70	N	10	7	50	5	10
828	1,000	1,500	N	20	200	3	15	20	70	70	N	10	30	70	10	N
829	3,000	1,000	N	15	500	2	30	150	200	200	N	15	30	20	15	N
830	500	1,000	N	10	1,000	1.5	15	10	100	50	L	L	20	30	5	N
831[8/]	1,000	1,500	N	N	300	1.5	30	30	30	300	N	L	20	15	10	N
832	1,000	700	N	10	700	2	10	20	50	200	N	10	10	20	7	N
833	1,000	500	N	10	1,000	2	20	20	20	100	N	10	20	30	7	N
834	500	2,000	N	N	200	N	50	20	20	30	N	N	30	50	10	N
835	700	1,000	N	20	200	2	15	15	50	100	N	L	20	50	10	N
836	200	1,000	N	15	50	2	15	L	30	20	N	10	20	10	5	N
837	700	1,000	N	15	700	1.5	15	5	20	30	N	L	30	20	5	N
838	700	1,500	N	10	700	1	30	20	20	30	N	L	30	70	7	N
839	500	2,000	5.0	10	1,000	1	10	L	50	50	N	L	10	50	7	N
840	700	1,500	N	20	700	2	20	20	30	150	N	L	20	50	7	N
841	700	1,500	N	L	1,500	L	50	30	15	50	N	L	30	50	7	N
842	500	200	N	20	150	1.5	5	L	50	50	N	L	5	20	5	N
843	700	200	N	20	5,000	2	10	20	30	50	15	L	15	20	7	N
852	700	700	N	50	>5,000	1.5	15	10	20	70	N	10	20	20	7	N
853	2,000	300	L	50	1,000	2	20	50	50	70	N	10	20	50	15	N
854	10,000	1,000	L	30	1,000	1.5	70	700	70	70	N	10	200	30	30	N
855	2,000	500	N	15	50	2	30	100	50	50	N	L	100	10	10	N
856	1,000	700	L	50	200	2	15	30	50	50	N	L	30	15	10	N
857	1,000	500	.5	30	300	2	10	20	50	50	N	10	10	150	7	L
858	700	1,000	L	20	300	1.5	10	L	50	50	N	10	5	100	7	10
859[9/]	700	300	L	20	500	3	15	L	50	20	30	10	5	700	7	L
861	700	1,500	N	10	2,000	1	20	10	50	200	N	L	20	150	7	N
862	3,000	1,500	N	10	1,500	1	30	200	100	50	N	L	50	30	20	N
864[10/]	200	20	200	20	>5,000	2	5	L	5,000	20	70	L	5	15,000	5	N
865[11/]	100	10	150	20	>5,000	1.5	5	L	10,000	20	30	L	7	10,000	L	N
1117	500	3,000	N	L	>5,000	L	10	15	20	30	N	L	10	30	L	N
1118	10,000	700	N	20	200	1.5	15	700	7	30	N	L	100	10	15	L
1119	300	700	N	30	150	2	7	10	100	20	N	15	10	10	7	L
1120	700	700	N	30	150	3	7	10	10	30	N	15	7	20	7	10
1121	200	2,000	N	L	700	L	20	7	5	L	L	L	20	50	L	N
1122	1,500	100	N	20	150	1.5	5	20	15	20	N	L	10	N	L	N
1132	5,000	200	N	10	700	2	15	70	5	50	N	10	20	10	10	N
1138	5,000	100	1.5	15	100	2	5	50	500	50	N	10	10	300	7	N
1139	3,000	3,000	2	15	2,000	2	15	50	3,000	50	N	10	20	50	10	N
1144	3,000	3,000	N	50	700	2	30	70	10	70	N	10	30	70	15	N
1145	3,000	500	.5	20	700	2	15	70	20	70	N	10	20	1,500	10	N
1146	2,000	500	.5	50	700	5	7	15	500	30	N	L	15	200	5	10
1147	7,000	500	.5	20	300	2	10	150	20	70	N	10	20	100	10	N
1148	700	2,000	N	20	500	1.5	10	20	10	N	5	10	20	20	7	N
1149	1,500	150	L	15	700	1	5	20	200	70	N	L	10	150	5	N
1150	500	>5,000	N	10	700	1.5	50	150	5	100	5	L	50	70	10	N
1151	3,000	>5,000	2	20	150	3	70	3,000	150	20	5	L	200	70	70	N
1152[12/]	3,000	100	L	10	1,500	L	5	50	20	70	200	20	5	500	10	N
1153	200	>5,000	2	20	2,000	L	20	500	3,000	30	15	N	20	1,000	L	N
1154	1,500	500	10	20	>5,000	2	50	20	20,000	150	100	10	20	3,000	7	N
1155	5,000	500	N	15	700	2	15	100	70	50	N	20	20	20	15	L
1156	1,500	700	N	50	700	2	15	70	150	30	N	10	15	30	10	L

8/ 100 ppm Bi.

9/ 2,000 ppm As.

10/ 2,000 ppm As, 10 ppm Bi, 70 ppm Cd, 2,000 ppm Sb.

Gore Range in the southern area—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)					Chemical analyses (ppm)						
Sample	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description2/
823	150	50	10	N	70	L	L	10	L	40	0.05	Sil gr w qtz vnts.
824	200	100	15	500	300	L	L	28	70	220	.16	FeO, qtz in fault.
825	150	100	70	N	200	L	L	L	L	80	.04	FeO st sh z.
826	200	70	20	200	200	L	L	L	L	180	.08	Do.
827	100	10	L	N	10	L	L	56	30	30	.09	Do.
828	150	70	15	1,500	50	L	L	30	130	1,300	.75	FeO st w qtz vnts.
829	150	100	30	300	200	L	L	150	L	240	.26	Do.
830	200	70	L	N	50	L	L	10	40	70	.06	FeO st sh z w qtz carb.
831	200	100	50	N	70	L	1.2	L	40	120	.05	FeO st sh z w qtz FeO.
832	1,000	70	20	N	200	L	L	L	L	40	.16	Do.
833	700	70	20	N	100	L	L	L	L	90	.40	Qtz vn.
834	300	100	50	200	50	L	2	17	40	190	.11	Carb vn.
835	1,000	50	20	L	100	L	L	L	L	120	.16	FeO qtz carb vnts.
836	200	20	L	L	L	L	.8	18	L	110	.08	Sh z w carb.
837	500	70	10	300	70	L	.4	L	L	240	.04	Qtz carb vn.
838	500	200	15	500	50	L	1.2	L	30	400	.05	Qtz FeO carb vn.
839	300	50	20	N	20	L	2	39	25	100	.08	Carb vn.
840	300	70	L	500	50	L	1.2	11	L	280	.09	Do.
841	300	100	20	500	50	L	1.4	L	30	240	.07	Do.
842	200	20	L	200	50	L	L	L	L	210	.20	FeO st qtz vn.
843	300	70	L	L	70	L	L	L	L	130	3	FeO st sh z w qtz vns.
852	1,000	50	20	200	70	L	L	L	L	170	.19	Qtz, FeO, carb in fault.
853	300	150	20	N	100	L	L	40	30	90	.30	Alt sh z w FeO
854	150	300	30	200	100	L	.6	31	L	260	.11	Fault z w carb.
855	L	70	10	200	70	L	L	11	L	210	.08	Hematitic gouge w py.
856	200	50	20	500	100	L	L	21	L	480	.13	Qtz carb vnts.
857	100	50	20	L	70	L	L	35	130	150	.20	Lim coated joints in gr.
858	150	20	20	L	70	L	L	14	45	110	.16	FeO st shd gr.
859	500	20	15	300	100	L	.4	38	990	270	.70	Sericitized FeO st gr.
861	500	70	20	700	50	L	.4	14	30	490	.15	Lim carb vn.
862	200	200	20	N	70	L	1.2	42	L	150	.07	Carb vn.
864	1,500	10	10	2,000	15	0.06	300	11,000	54,000	3,000	>10	Qtz vn w copper.
865	5,000	10	L	1,500	10	.06	260	18,000	18,000	820	>10	Do.
1117	500	50	20	L	30	L	1.6	36	70	140	.06	Carb vn.
1118	100	200	50	200	200	L	L	L	L	220	.14	FeO-rich migmatite.
1119	200	20	L	200	20	L	L	83	L	140	.12	Qtz carb vn.
1120	500	20	20	L	150	L	L	L	L	120	.13	Do.
1121	300	30	10	500	N	L	1	L	50	520	.04	Carb vn.
1122	100	20	L	N	150	L	L	L	L	L	.11	Hematitic migmatite.
1132	100	100	20	L	200	L	L	L	L	100	.55	Sh z w lim, hem.
1138	100	70	15	500	150	L	2.4	350	540	550	.15	Sh z w carb FeO.
1139	200	200	20	N	150	L	2.8	2,000	30	110	.20	FeO st frd alt gr.
1144	700	100	20	300	200	L	.6	L	30	220	.13	Qtz carb vn.
1145	100	70	20	300	200	L	.4	37	520	240	.05	FeO st gr w qtz vnt.
1146	200	70	20	300	150	L	.4	380	150	230	.22	FeO st sh z.
1147	500	100	50	N	500	L	.4	29	80	130	.05	Fault w qtz, carb FeO.
1148	150	50	20	300	50	L	1.2	L	40	410	.13	Carb qtz vn.
1149	150	50	20	N	150	L	L	350	100	50	.06	FeO st sil rock.
1150	500	150	30	300	20	L	1.6	L	60	310	.55	Carb vn.
1151	300	300	30	200	30	L	2.8	150	60	230	1.50	Alt gr w carb vns.
1152	500	50	50	N	700	L	.6	L	190	L	2	Qtz vn, alt rock.
1153	100	20	70	700	20	L	4.4	2,000	370	610	.20	Carb vn.
1154	200	300	50	2,000	150	.22	30	5,200	20,000	2,700	.28	Sh z w carb, FeO.
1155	100	200	50	N	200	L	.4	100	L	60	.11	FeO st my.
1156	500	70	10	L	100	L	L	140	L	80	.11	Qtz FeO vnts.

11/ 2,000 ppm As, 10 ppm Bi, 100 ppm Cd, 7,000 ppm Sb.

12/ 1,500 ppm As.

TABLE 5.—*Analyses of rock samples from the*

Sample	Ti (20)	Mn (10)	Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)	Sn (10)
	Semiquantitative spectrographic analyses[1] (ppm)															
1167	10,000	700	N	20	1,000	N	50	3,000	N	N	N	N	200	70	70	10
1168	1,000	200	N	10	1,500	1.0	50	30	5	70	N	L	50	70	10	N
1169	5,000	700	N	10	700	2	50	500	10	50	N	10	150	50	20	N
1170	2,000	700	L	50	500	7	15	70	50	50	N	15	30	15	15	N
1171	1,000	300	N	30	500	5	10	50	7	50	N	10	30	10	5	L
1172	2,000	500	N	30	700	3	10	70	7	50	N	10	20	15	7	L
1173	1,500	1,000	N	30	300	2	20	200	15	30	N	10	30	30	10	10
1174	1,000	300	L	50	200	2	7	15	30	20	20	10	10	300	5	N
1175	1,000	150	L	50	500	2	5	15	20	50	N	15	7	300	7	10
1176	2,000	700	N	15	1,500	1	5	15	50	30	N	10	7	300	5	N
1177	5,000	1,500	L	15	1,000	1	20	20	15	50	N	10	20	20	20	L
1178	5,000	500	N	15	300	1.5	15	70	10	30	N	10	30	50	10	N
1179	7,000	500	N	20	200	2	15	100	10	70	N	10	50	L	10	N
1180	5,000	300	N	50	500	1	10	70	10	50	N	10	30	20	20	N
1201	3,000	700	N	10	700	2	15	70	10	30	N	15	50	50	20	10
1202	1,500	300	N	100	200	1.5	10	50	5	100	N	10	20	10	15	N
1203	1,500	300	N	20	100	2	10	70	5	100	N	10	15	N	10	N
1204	700	150	N	50	50	1	5	15	5	L	N	10	10	N	7	N
1205	3,000	500	N	10	500	2	15	50	5	100	N	20	15	10	20	15
1206	1,000	3,000	N	10	700	1.5	7	15	5	50	N	10	10	10	15	N
1207	1,000	150	10.0	10	200	2	7	50	150	L	N	10	10	7,000	7	N
1208	2,000	2,000	10	20	200	1.5	15	150	70	L	N	15	20	3,000	20	N

rated in the colluvium at the lower fluorspar deposit contains a little gold and silver (sample 1211). The fluorspar deposits are of marginal quality in terms of the combination of size and grade in light of ordinary market value of fluorspar.

STREAM SEDIMENTS

Stream sediments from this rather mineralized area are not strongly anomalous (table 8G, H, I). Many contain molybdenum in moderate amounts or traces of gold, and several are anomalous in lead. Two samples from upper North Rock Creek and two from upper South Willow Creek are notable for the presence of zinc. In both areas, nearby fracture zones are anomalous in zinc.

SOUTHERN AREA

The southern part of the study area, south of Gore and South Willow Creeks (area D, pl. 2), has been rather extensively prospected, especially on the east side of the range; but except in the vicinity of Chief Mountain and the lower valley of the North Fork of Tenmile Creek, it contains no mines and only a few strong geochemical anomalies. The most striking geochemical anomaly in the area is on a north-northwest-trending fracture zone on the south side of Gore Creek (localities 864 and 865, pl. 2). Two short prospect adits expose a copper-stained vein of vuggy quartz and sheared granite more than 5 feet wide. Dark copper minerals are

Gore Range in the southern area—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)					Chemical analyses (ppm)						
Sample	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2]
1167	200	1,500	L	200	50	L	0.4	L	L	170	0.04	Migmatite w serpentine(?).
1168	700	150	20	300	150	L	1.2	L	50	270	.08	Carb vn.
1169	150	200	30	L	300	L	.8	22	40	190	.03	FeO st sh z w carb vnt.
1170	200	70	15	L	150	L	L	65	L	140	.45	Qtz vnts w FeO.
1171	200	70	10	L	150	L	L	10	L	70	1.50	Do.
1172	200	70	10	L	200	L	L	10	L	90	.55	Do.
1173	700	100	15	L	100	L	L	18	L	90	.24	FeO st sh z.
1174	100	30	L	500	100	L	L	55	860	390	.09	Qtz FeO vn.
1175	200	30	20	N	150	L	L	38	250	70	.20	FeO st gr.
1176	200	30	L	N	200	L	L	48	140	50	.04	FeO in frd gr.
1177	200	150	50	200	150	L	.8	25	30	150	.03	Fr gr w carb qtz vnts.
1178	200	70	15	L	150	L	L	L	L	70	.05	FeO st shd gr.
1179	150	70	20	L	200	L	L	23	L	100	.04	FeO st gr.
1180	200	100	20	N	300	L	L	L	L	90	.05	Do.
1201	L	150	30	L	200	L	.4	13	30	190	.10	FeO st sh sil migmatite.
1202	200	70	30	N	150	L	.2	12	L	150	.26	FeO st sil my.
1203	150	70	20	N	200	L	L	10	L	90	.04	FeO st sh sil migmatite.
1204	L	30	10	N	200	L	L	L	L	L	.05	FeO st sandstone.
1205	L	150	50	N	300	L	L	L	L	70	.05	FeO st sil sh z.
1206	L	50	30	N	200	L	1	L	30	90	.11	FeO st sh sil migmatite.
1207	N	100	30	>10,000	30	0.04	14	240	9,200	15,000	.65	1' sil sh z w gal.
1208	L	100	30	2,000	200	L	9.2	43	3,200	3,400	.12	10' sh z w gal, py.

visible in some of the quartz. As indicated in table 5, this vein is remarkably anomalous geochemically. In addition to containing much copper, it is anomalous in silver, arsenic, bismuth, cadmium, molybdenum, lead, antimony, strontium, zinc, gold, and mercury. A sample (839) 1 mile to the southeast on the same fault was anomalous only in silver. To the north, across Gore Creek, fractures possibly related to this fault are anomalous only in zinc (samples 776, 785, 789, table 6).

Near the tiny lakes at the head of South Willow Creek, closely spaced fractures containing thin carbonate and quartz veinlets are geochemically anomalous in silver, copper, lead, and zinc (samples 727–729 and 832, table 5). To the southeast, several samples along the ridgetop and on top of Buffalo Mountain (pl. 2) are mildly anomalous in zinc. Fractures of east-northeast trend in a small area near the head of Officers Gulch contain carbonate and quartz veinlets and are anomalous in silver, arsenic, and molybdenum as well as in copper, lead, and zinc (samples 1152–1154, table 5).

The Gore fault shows little evidence of geochemical anomaly in this area except the strand in the saddle between peaks 12072 and 12513. Two samples from there (1145 and 1146, pl. 2 and table 5) showed anomalies in lead and copper, respectively. A fault extending northeast from near this locality also is anomalous in copper (samples 1138–1139). West-northwest-trending faults near the

TABLE 6.—*Analyses of rock samples from the Gore Range*

[For sample locations see plate 2. Numbers in parentheses indicate sensitivity limit of method used. The symbol > indicates that an amount of the element is present above the sensitivity

	Semiquantitative spectrographic analyses 1/ (ppm)															
Sample	Ti (20)	Mn (10)	Ag (.5)	As (200)	Ba (20)	Be (1)	Cd (20)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sb (100)
450	5,000	500	N	N	1,500	L	N	10	70	L	50	L	20	20	50	N
451	2,000	1,500	N	N	1,500	L	N	10	20	50	100	L	20	20	50	N
452	5,000	1,000	N	N	1,500	1.0	N	15	100	15	50	L	20	30	50	N
673	1,000	700	0.5	N	1,000	1.5	N	10	10	10	70	N	20	10	15	N
674	2,000	1,000	L	N	700	2	N	20	30	10	50	N	20	20	50	N
675	2,000	500	L	N	700	1	N	20	70	30	20	N	10	20	20	N
676	2,000	1,000	N	N	1,000	1	N	20	50	L	30	N	10	20	50	N
677	2,000	700	N	N	1,000	1.5	N	20	50	10	20	N	20	20	10	N
678	2,000	1,000	N	N	1,000	2	N	20	70	10	30	N	15	30	15	N
679	1,000	500	N	N	500	2	N	10	15	5	20	N	L	10	100	N
680 3/	700	150	1	N	100	1	N	L	15	500	L	L	L	7	10	N
681 4/	500	200	10	N	1,000	1	N	N	50	2,000	20	N	L	10	15	N
682 5/	3,000	100	50	N	500	1	N	7	50	20,000	N	N	15	15	20	N
683 6/	1,500	70	N	N	500	1	N	7	10	50	70	N	20	20	50	N
684	1,000	2,000	L	N	700	2	N	30	50	70	20	N	10	50	70	N
685	1,000	1,000	N	N	300	1.5	N	10	20	7	70	5	15	10	70	N
686	300	3,000	N	N	150	1.5	20	30	20	10	20	N	L	30	200	N
687	3,000	2,000	.7	N	700	2	N	50	150	70	50	N	20	70	150	N
688	3,000	3,000	N	N	700	1.5	N	50	150	20	200	L	L	70	70	N
689	3,000	3,000	N	N	700	1.5	N	50	150	30	100	N	L	70	70	N
690	500	3,000	N	N	1,500	1	N	50	15	10	50	N	L	50	70	N
691	1,000	1,500	L	N	>5,000	1.5	N	15	30	100	50	N	L	30	70	N
692	5,000	1,500	N	N	1,000	2	N	50	150	70	200	N	10	50	50	N
693	700	200	2	N	1,000	2	N	50	15	100	N	15	10	15	700	N
694	2,000	3,000	N	N	1,500	1.5	N	30	150	50	100	N	10	50	30	N
695	700	1,500	N	N	500	1.5	N	10	5	7	150	N	10	10	50	N
701	700	1,000	N	N	150	2	N	30	20	20	100	N	L	30	50	N
702	700	700	N	N	20	2	N	10	20	50	70	N	L	10	20	N
703	700	2,000	2	N	300	2	N	20	15	10	70	N	10	20	70	N
704	2,000	1,000	N	N	1,000	2	N	15	30	30	150	N	10	20	70	N
705	700	1,000	5	N	300	2	N	15	20	150	50	N	L	20	150	N
706	700	700	5	N	500	1.5	N	10	5	300	50	N	10	10	1,000	N
707	700	>5,000	2	N	5,000	N	N	15	5	500	70	N	L	5	150	N
717	700	2,000	20	N	5,000	1.5	20	30	5	200	50	10	L	30	200	N
762	2,000	700	N	N	700		N	20	100	30	50	N	L	30	30	N
763	500	200	.7	N	5,000	N	N	50	15	15	50	5	L	30	150	N
764	3,000	200	N	N	700	1.5	N	30	150	15	300	N	L	50	15	N
765	700	1,000	.5	N	2,000	1.5	N	7	10	15	70	N	10	10	300	N
766	700	300	N	N	300	1.5	N	10	50	30	100	N	10	10	20	N
767	700	500	5	N	300	2	N	20	30	20	50	N	10	10	200	N
768	700	150	N	N	300	1.5	N	5	L	15	70	N	10	7	20	N
769	700	1,500	N	N	300	1.5	N	30	15	30	50	N	L	30	200	N
770	700	200	.5	N	300	5	N	10	5	30	100	N	10	10	50	N
771	700	200	10	N	150	5	N	10	20	200	70	N	10	15	100	N
772	3,000	200	L	N	2,000	1.5	N	30	200	150	100	N	10	150	70	N
773	2,000	1,000	2	N	3,000	10	N	50	50	700	50	10	10	70	1,500	100
774	2,000	200	N	N	700	1.5	N	15	30	20	70	N	10	30	100	N
775	2,000	300	3	N	500	1.5	N	15	30	150	70	N	10	30	70	N
776	700	300	1	N	500	1.5	N	10	20	15	70	N	L	20	70	N
777	700	200	3	N	500	2	N	10	5	100	70	N	L	10	200	N

1/ Also looked for spectrographically but not found except as noted: Au(10), Bi(10), and W(50). Values for B(<70) and Sc(<50) not listed for brevity.

3/ <50 ppm W.

4/ 20 ppm Bi.

5/ 50 ppm Bi.

6/ <10 ppm Bi.

in the Gore Creek-Booth Creek area (area E, pl. 2)

limit; L indicates that an undetermined amount of the element is present below the sensitivity limit; N indicates the element was looked for but was not found.]

	Semiquantitative spectrographic analyses--Continued (ppm)						Chemical analyses (ppm)						
Sample	Sn (10)	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
450	N	200	70	20	L	200	L	L	L	L	60	0.03	FeO st shr z.
451	L	500	70	30	L	200	L	0.4	80	L	100	.11	Do.
452	L	200	100	20	200	200	L	L	L	L	140	.09	Qtz vn w FeO.
673	N	150	20	10	N	50	L	L	20	L	50	.06	FeO carb vnts.
674	N	300	50	10	N	150	L	L	17	L	120	.08	Hem qtz carb vns.
675	N	150	50	10	L	100	L	L	90	L	100	.08	Frd FeO st gr.
676	N	100	30	10	L	100	L	L	L	30	140	.28	FeO st qtz carb vnts.
677	N	100	50	15	N	200	L	L	24	L	40	.02	FeO st gn w carb vnts.
678	N	100	50	10	N	100	L	.2	24	L	70	.08	Sil fault rock.
679	N	150	20	L	700	50	L	L	L	130	570	3	Lim qtz vn.
680	N	100	30	20	N	50	L	1.2	1,100	L	L	.02	Sh gr w qtz vn Cu min.
681	N	100	50	10	N	70	0.72	9.2	2,800	L	50	.04	Do.
682	N	L	150	20	N	150	.36	42	16,000	L	30	.06	Do.
683	N	100	15	20	N	200	L	L	19	L	60	.12	Hem gr w qtz seams.
684	N	200	100	20	1,000	70	L	.4	12	30	390	.06	Lim qtz carb vnts.
685	15	1,000	20	50	N	70	L	L	13	L	30	.10	FeO st fr z.
686	N	300	100	50	1,500	20	L	2	L	90	1,400	.50	FeO st carb vn.
687	N	1,500	150	50	1,000	150	L	.8	23	40	740	.70	Do.
688	N	200	150	70	300	200	L	1.2	16	30	190	.06	Do.
689	N	200	150	50	500	100	L	1.2	L	30	240	.04	Do.
690	N	300	70	30	300	70	L	1.2	18	30	200	.08	Do.
691	N	1,500	70	15	N	70	L	.4	46	25	60	.20	Do.
692	N	200	200	50	200	500	L	.8	31	30	110	.08	Do.
693	N	200	70	L	N	100	L	.8	40	490	L	.11	Do.
694	N	200	200	50	200	150	L	.8	11	30	120	.30	FeO st sh z w carb vnts.
695	20	1,500	50	50	N	70	L	L	L	L	60	.05	FeO st sh z w qtz vnts.
701	N	300	50	20	L	30	L	.8	16	30	130	.11	Carb vn.
702	N	300	50	15	N	100	L	L	L	L	L	.04	FeO st sh z.
703	N	200	70	15	700	50	L	1.8	L	50	370	.07	Sh gr w qtz carb vnts.
704	N	500	70	20	N	300	L	L	L	L	130	.30	Carb qtz vnts.
705	N	300	50	15	500	70	L	2	70	90	270	.65	FeO st qtz vnts.
706	L	300	50	30	N	70	L	1.6	110	440	50	.06	FeO st rock.
707	N	1,000	50	L	300	N	L	2.4	240	50	260	.04	Carb vn.
717	N	500	50	20	2,000	70	L	3.6	110	120	1,700	.90	FeO st qtz carb vn.
762	10	200	100	15	N	70	L	L	25	L	100	.06	FeO st sh z.
763	N	300	100	50	1,500	30	L	2	15	140	880	.15	Carb vn.
764	L	150	150	30	N	100	L	.4	L	L	L	.02	Alt gr w hem, carb vnts.
765	L	300	50	30	1,500	70	L	.8	L	190	750	.22	Carb vn, breccia.
766	N	300	70	20	N	70	L	L	L	L	60	.06	Alt gr w hem.
767	N	200	50	10	500	50	L	5.6	29	290	280	3.50	Qtz vnts.
768	L	200	50	20	N	100	L	L	L	L	L	.04	Qtz vn, alt rock.
769	N	300	70	L	2,000	70	L	.4	L	150	2,500	.02	Carb vnts.
770	N	150	50	20	N	70	L	L	70	25	90	.55	Qtz vn.
771	L	150	50	20	300	70	L	2.6	130	80	260	.70	Qtz vnts w FeO.
772	N	300	100	50	300	500	L	L	130	40	240	.40	FeO st sh z.
773	N	150	70	50	1,500	70	L	3.2	330	4,100	800	2.20	Qtz carb vn.
774	L	300	70	20	200	100	L	L	11	L	160	.13	FeO st sh z.
775	N	150	70	15	300	100	L	1.2	140	40	270	.20	Qtz vnts.
776	N	300	50	15	500	50	L	.8	L	30	430	.15	Qtz carb vnt.
777	N	200	50	20	N	100	L	4.8	90	380	80	.30	FeO st my w qtz vn.

2/ Abbreviations used in table:

alt	altered	hem	hematite	sh(d)	shear(ed)
ba	barite	lim	limonite	sil	silicified
carb	carbonate	mal	malachite	st	stained
Cu	copper	min(s)	mineral(s)	sul	sulfide
FeO	iron oxide	MnO	manganese oxide	tr	trace
fr(d)	fracture(d)	my	mylonite	vn(s)	vein(s)
gn	gneiss	qtz	quartz	vnt(s)	veinlet(s)
gr	granitic rock	rep	representative	w	with
				z	zone

TABLE 6.—*Analyses of rock samples from the Gore*

Sample	Ti (20)	Mn (10)	Ag (.5)	As (200)	Ba (20)	Be (1)	Cd (20)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sb (100)
	Semiquantitative spectrographic analyses[1] (ppm)															
778	3,000	200	1.0	N	1,000	2.0	N	10	70	150	50	N	10	20	70	N
779	700	700	N	N	500	1.5	N	10	10	30	70	N	L	15	20	N
780	700	100	L	N	>5,000	2	N	5	5	30	70	N	L	10	100	N
781	2,000	2,000	.5	N	1,500	1	N	20	20	70	200	N	L	15	200	N
782	3,000	500	N	N	700	1.5	N	20	100	30	50	N	10	30	10	N
783	2,000	700	N	N	700	N	N	15	20	70	150	N	L	10	50	N
784	2,000	300	N	N	>5,000	2	N	10	10	20	70	N	L	10	50	N
785	2,000	700	1	N	300	5	N	20	30	70	200	N	L	20	100	N
786	700	150	L	N	300	2	N	5	5	20	30	N	10	7	70	N
787	3,000	300	N	N	300	2	N	20	70	30	100	N	10	30	15	N
788	3,000	150	.5	N	300	2	N	10	30	10	300	N	10	15	70	N
789	700	300	N	N	300	2	N	15	10	15	20	N	L	20	15	N
793	2,000	700	N	N	300	2	N	15	30	15	50	N	15	20	20	N
794	1,000	200	N	N	300	2	N	7	5	100	20	N	L	5	20	N
795	1,000	500	L	N	700	3	N	15	10	150	20	N	L	10	30	N
797	1,000	300	N	N	300	1.5	N	7	30	20	20	N	L	10	10	N
798	500	500	N	N	100	2	N	5	15	100	20	N	L	7	N	N
799	700	1,500	N	N	100	1.5	N	20	20	50	30	N	L	20	50	N
800	700	200	N	N	150	3	N	5	L	100	30	N	L	5	50	N
801	1,000	200	L	N	300	3	N	10	30	150	30	N	L	15	100	N
802	1,000	1,000	N	N	300	3	N	15	30	20	70	N	L	30	70	N
803	1,500	2,000	N	N	700	1	N	50	150	150	70	N	L	100	50	N
804	700	1,500	2	N	3,000	1.5	N	15	10	70	30	N	L	20	100	N
805	2,000	1,500	.5	N	1,500	2	N	30	20	70	50	N	10	30	50	N
806	700	700	N	N	700	1.5	N	15	10	10	50	N	10	15	20	N
807	500	200	N	N	300	2	N	5	5	20	30	N	10	7	L	N
808	700	200	L	N	>5,000	1	N	10	7	30	20	N	L	10	50	N
809	2,000	500	2	N	500	2	N	20	50	150	50	N	10	30	700	N
810	5,000	1,000	N	N	100	2	N	50	300	30	200	N	10	150	20	N
868	1,000	700	1	N	300	1.5	N	10	L	15	70	N	10	10	20	N
869	1,000	1,500	L	N	500	2	N	30	20	50	70	N	15	50	50	N
870	700	2,000	N	N	700	1	N	50	30	20	50	N	L	70	70	N
871	1,000	1,000	1	N	300	5	N	20	50	20	20	N	L	30	150	N
872	500	1,500	N	N	300	1	N	30	5	30	70	N	L	30	100	N
873	2,000	3,000	N	N	3,000	1.5	N	15	150	5	30	N	10	30	300	N
874	700	1,000	N	N	1,000	1	N	10	10	10	20	5	10	10	70	N
875	2,000	500	1	N	1,000	1	N	L	70	700	50	50	15	15	200	N
876	1,500	1,000	N	N	1,500	1.5	N	10	30	5	30	N	L	15	200	N
877	1,500	1,000	1	N	500	1	20	15	50	5	50	N	10	20	2,000	N
878	2,000	100	3	N	>5,000	2	N	5	150	50	70	30	20	5	20,000	N
879	700	150	.5	N	300	3	N	5	15	15	20	N	15	7	100	N
880	500	5,000	N	N	>5,000	N	N	20	15	150	L	N	N	20	15	N
881	1,500	300	N	N	100	L	N	10	20	L	30	5	N	10	L	N
882	1,000	2,000	N	N	150	1	N	20	50	5	20	5	N	20	70	N
883	3,000	300	N	N	700	1	N	7	7	10	30	N	L	10	15	N
884	500	2,000	N	N	200	L	N	15	5	10	N	N	L	15	20	N
885	700	3,000	N	N	700	L	N	20	15	30	50	N	L	15	50	N
886	2,000	3,000	N	N	700	1.5	N	10	20	10	70	5	20	15	150	N
887	1,000	3,000	N	N	700	L	20	30	30	7	30	N	N	50	70	N
889	500	3,000	20	N	>5,000	1	100	15	10	70	L	N	N	20	2,000	N
890	2,000	2,000	N	N	700	L	N	15	50	5	30	N	L	15	15	N
891	500	2,000	L	N	200	L	200	20	10	5	30	N	L	30	5,000	N
892	1,500	3,000	L	N	700	1.5	30	30	10	10	30	N	10	30	2,000	N
893	3,000	1,000	N	N	700	1	30	15	70	N	100	N	15	20	2,000	N
897[7]	300	100	5	1,000	70	1	N	5	10	2,000	N	N	L	5	700	700

7/ 15 ppm Bi.

Range in the Gore Creek-Booth Creek area—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)						Chemical analyses (ppm)						
Sample	Sn (10)	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
778	L	300	150	15	200	150	L	0.8	83	30	190	0.35	FeO st alt gr w qtz vn.
779	10	200	70	15	N	70	L	L	L	L	50	.04	FeO st alt gr.
780	L	1,000	15	15	N	50	L	L	37	40	50	.80	FeO st shd alt gr.
781	N	500	100	20	500	200	L	.8	41	100	300	.09	FeO qtz carb vnts.
782	10	200	150	20	L	150	L	L	26	L	80	.03	FeO st alt gr.
783	L	150	70	15	N	100	L	L	24	L	40	.03	Do.
784	L	300	50	15	N	100	L	L	L	30	40	.11	Do.
785	N	700	100	20	1,000	70	L	1.2	47	70	620	.80	Do.
786	10	200	20	20	N	70	L	L	L	L	40	.10	FeO st shd alt gr.
787	10	150	150	20	N	70	L	L	13	L	100	.08	FeO st chloritized gr.
788	L	500	70	20	N	70	L	.8	19	L	80	.10	FeO st alt gr.
789	N	100	50	10	700	70	L	L	L	L	390	.09	FeO st alt gr, qtz vnts.
793	20	200	100	15	N	70	L	L	13	L	60	.05	FeO st frd gr.
794	10	150	50	15	N	70	L	L	63	L	L	.05	15' hem sh z.
795	10	200	70	L	N	70	L	L	150	L	30	.06	15' hem sh z w mal.
797	N	100	50	10	N	100	L	L	11	L	40	.06	Qtz vn w tr mal.
798	N	N	100	L	N	10	L	L	20	L	L	.04	Qtz hem vn w carb.
799	N	150	50	10	700	10	L	.8	L	25	490	.06	Qtz carb vn.
800	L	200	10	10	N	70	L	L	90	50	90	.18	Qtz vns w FeO.
801	N	200	50	10	N	70	L	L	120	50	130	.35	Do.
802	N	300	70	15	300	70	L	.8	L	40	230	.26	Carb vnts w FeO.
803	N	300	100	15	300	30	L	1.6	43	30	240	.13	Carb FeO, qtz hem vns.
804	N	300	50	L	200	70	L	.8	33	30	150	.07	FeO st sh z w carb.
805	N	500	100	10	200	100	L	.8	11	L	170	.15	Qtz carb vnts.
806	L	200	50	15	N	70	L	.4	L	L	40	.05	Hem my w carb.
807	N	100	20	L	N	50	L	L	L	L	L	.05	FeO st sh z.
808	N	1,000	30	10	N	50	L	L	30	L	50	.13	Qtz vn.
809	10	150	100	15	700	150	L	.6	110	1,000	560	.26	FeO st frd gr.
810	N	150	150	50	500	100	L	L	28	25	390	.40	FeO carb vn.
868	L	1,000	10	15	N	50	L	L	23	L	100	.13	FeO st fr gr w qtz vnts.
869	N	500	70	15	300	70	L	.2	17	L	260	.08	Carb FeO vn.
870	N	300	100	30	700	50	L	1.6	L	50	580	.07	Do.
871	N	300	100	15	2,000	70	L	1.	10	60	1,500	.06	Qtz carb vnts.
872	N	300	70	20	700	70	L	1.4	15	70	710	.06	Do.
873	N	1,000	70	30	1,500	100	L	.4	L	250	1,900	.11	Do.
874	L	300	50	50	300	100	L	L	L	30	300	.05	Do.
875	10	200	100	20	N	200	L	2	930	220	80	.09	My w sul, mal
876	N	300	70	30	500	70	L	.4	L	240	600	.18	Carb vn.
877	N	200	70	30	2,000	200	L	1.6	L	2,700	3,900	.35	1-2' carb qtz vn w sul.
878	10	700	100	30	L	300	L	2	55	5,500	240	1	3" qtz vn w 1/4" sul vnt.
879	N	L	20	10	200	100	L	L	29	320	330	.22	Carb vn.
880	N	200	70	50	L	N	L	1.6	920	40	240	.06	Qtz vn.
881	N	L	500	10	N	30	L	L	L	L	80	.07	Shd gr w hem.
882	N	1,000	70	10	200	70	L	1.2	L	L	310	.05	Lim carb vn.
883	N	L	300	20	L	300	L	.2	L	L	80	.18	Hem vnts.
884	N	150	10	15	L	N	L	1	33	30	150	.07	Siderite vn.
885	N	700	50	30	L	20	L	1.4	98	40	310	.09	FeO carb vn.
886	N	100	70	50	1,000	200	L	.2	18	70	740	.22	FeO st alt gr.
887	N	200	100	30	1,500	30	L	1.4	19	50	2,400	.10	Qtz carb FeO vn.
889	N	700	30	20	10,000	100	L	14	100	1,500	25,000	.28	Do.
890	N	200	70	70	200	150	L	1.2	13	30	400	.10	Carb vn.
891	N	200	50	20	>10,000	30	L	1.6	10	3,300	32,000	.08	Do.
892	N	100	100	20	>10,000	200	L	.8	19	3,400	21,000	.40	FeO st alt gr.
893	L	700	150	50	3,000	150	0.24	1.2	L	1,600	7,800	.06	Carb vn.
897	N	N	150	100	500	L	L	11	2,900	1,300	290	10	6" qtz vn w Cu mins.

TABLE 6.—*Analyses of rock samples from the Gore*

Sample	Ti (20)	Mn (10)	Ag (.5)	As (200)	Ba (20)	Be (1)	Cd (20)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sb (100)
	Semiquantitative spectrographic analyses[1] (ppm)															
898	1,000	150	L	N	300	1.0	N	5	15	15	N	N	10	5	15	N
899[7]	700	100	70	7,000	700	1	50	5	15	15,000	20	N	L	5	3,000	1,500
900[8]	700	500	15	N	700	1	N	7	15	7,000	30	N	L	15	700	200
901	700	700	1	N	500	2	L	10	20	50	50	N	10	15	1,000	N
903	300	300	20	100	200	1.5	N	5	L	20,000	20	N	10	5	50	N
905	1,500	150	1.5	150	2,000	2	N	5	50	150	70	N	10	10	70	L
907	2,000	300	2	N	1,000	1	L	10	100	20	L	N	10	15	1,500	N
908	1,000	700	1	N	1,000	1	N	10	15	50	20	N	L	10	1,000	N
909	1,500	300	N	N	1,000	1	N	7	15	10	50	N	10	15	30	N
910	1,500	700	L	N	1,000	1	N	10	20	10	30	N	L	15	30	N
911	700	200	L	N	700	1.5	N	7	15	10	20	N	10	15	50	N
912	700	150	L	N	200	2	N	5	10	10	20	N	10	5	150	N
914	3,000	2,000	N	N	1,000	1	N	30	150	20	30	7	L	50	100	N
915	1,000	1,000	1	500	700	2	N	20	20	20	20	70	10	20	300	100
916	1,000	20	150	700	>5,000	1.5	30	N	30	7,000	20	N	10	7	>20,000	1,000
917	2,000	300	1.5	N	500	2	N	15	100	15	20	N	15	20	300	N
918	1,000	500	L	N	500	2	N	10	70	70	30	N	10	20	70	N
919	700	700	N	N	500	3	N	20	70	5	20	N	L	30	20	N
920	1,000	2,000	N	N	150	2	N	50	30	5	L	N	L	30	70	N
921	1,000	2,000	N	N	200	1	N	30	70	5	30	N	L	50	70	N
922	700	1,000	N	N	300	1.5	N	15	30	5	20	N	10	20	15	N
923	700	2,000	.5	N	2,000	1	N	10	10	300	150	N	10	10	15	N
924	1,500	500	.5	N	700	1.5	N	7	5	70	20	N	10	5	50	N
925	500	200	N	N	50	1.5	N	10	10	15	20	N	10	5	70	N
926	1,000	200	10	>10,000	>5,000	3	50	15	30	1,500	20	70	L	15	3,000	1,500
928	1,500	200	.7	N	5,000	N	N	10	70	20	30	N	10	15	300	N
929	5,000	700	N	N	700	3	N	15	150	150	50	N	15	30	L	N
930	3,000	500	N	N	1,000	1.5	N	10	150	10	50	N	15	15	50	N
933	1,500	500	N	N	1,500	2	N	15	150	10	20	N	15	15	70	N
934	1,500	1,000	L	N	1,000	1.5	N	15	100	70	20	N	L	30	20	N
936	3,000	150	1	500	200	2	N	10	50	150	50	N	L	15	300	L
937	1,500	70	.7	300	200	3	N	5	70	50	30	5	L	5	200	L
938	1,000	100	L	1,500	300	5	N	5	30	70	20	5	15	10	70	L
939	1,500	100	L	1,500	700	1	20	5	10	70	50	15	15	5	150	100
941	700	100	L	7,000	>5,000	1.5	N	20	30	70	30	50	N	30	500	150
942	700	150	L	N	500	1	N	5	10	70	20	N	10	7	70	N
944	1,500	200	1	200	200	3	N	5	50	70	20	15	L	5	50	L
945	700	2,000	N	N	1,500	L	N	20	30	20	50	N	N	20	50	N
946	1,500	100	N	N	1,500	1	N	7	5	30	100	N	10	L	10	N
947	700	500	N	N	500	1.5	N	15	5	70	20	N	10	20	10	N
948	500	700	N	N	700	L	N	15	20	10	20	N	L	30	50	N
949	700	150	N	N	700	L	N	7	30	20	50	N	L	L	30	N
950	300	1,500	N	N	300	L	N	10	15	10	20	N	N	15	30	N
951	1,000	2,000	N	N	500	L	N	15	50	10	30	N	L	15	50	N
957	3,000	700	N	N	700	10	N	15	300	10	30	N	10	30	30	N
961	1,000	2,000	N	N	700	1	N	10	30	50	100	N	L	15	20	N
964	7,000	70	N	N	500	1	N	15	20	100	30	N	N	50	20	N
965	1,000	500	N	N	500	1.5	N	10	150	10	20	N	L	15	10	N
966	2,000	150	N	N	500	2	N	7	30	15	50	N	10	15	15	N
970	1,500	70	L	200	500	1.5	N	5	150	20	20	N	10	10	20	L
971	1,000	100	L	200	700	1.5	N	7	70	30	30	20	10	15	100	L
972[6]	300	700	N	N	300	1	N	7	10	100	70	N	L	15	L	N
973	300	700	L	N	300	1.5	N	7	10	100	50	N	L	10	10	N
976	3,000	100	1.5	N	50	1.5	N	10	150	100	70	N	10	10	30	N
977	2,000	100	N	1,500	700	1.5	N	7	20	70	30	20	10	10	300	100

8/ 10 ppm Bi.

Range in the Gore Creek-Booth Creek area—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)						Chemical analyses (ppm)						
Sample	Sn (10)	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
898	N	100	20	10	N	200	L	L	20	40	40	0.50	Alt hem gr w qtz vns.
899	N	100	30	10	700	20	0.12	120.0	20,000	3,700	770	>10	7" qtz vn w Cu mins.
900	N	200	70	20	1,000	30	.12	13	3,700	690	1,700	>10	Rep of vn from dump.
901	N	300	50	10	2,000	30	L	.8	20	580	2,100	.45	Vein w brown carb.
903	L	500	15	10	200	30	.02	40	20,000	L	310	2	Typical better Cu ore.
905	N	500	50	10	L	150	L	.8	100	60	140	.28	FeO st shd alt gr.
907	10	100	100	10	200	150	L	2.4	43	980	260	.18	Qtz vns w FeO.
908	N	200	50	15	L	150	L	.4	94	780	230	.15	Lim hem vn.
909	L	300	70	L	N	200	L	L	L	L	40	.06	FeO st fr alt gr.
910	N	300	70	L	N	150	L	.4	22	L	50	.22	FeO st qtz carb vn w Cu.
911	N	100	30	L	L	20	L	L	23	40	160	.10	Frd, alt rock w FeO.
912	10	L	20	10	L	50	L	L	25	300	150	.10	Do.
914	N	150	300	70	300	30	L	.8	43	80	320	.15	Carb vn.
915	N	200	20	50	1,000	150	L	1.2	47	1,100	100	1.10	FeO st qtz lens.
916	N	150	50	15	3,000	150	.04	340	2,300	70,000	3,600	>10	Sul vn.
917	L	L	100	15	300	200	L	1.6	20	410	460	.30	FeO st sh z.
918	N	L	70	30	200	150	L	.4	140	80	210	.24	FeO qtz vnts.
919	N	L	50	10	L	150	L	L	L	40	210	.40	FeO st sh z.
920	N	300	70	100	200	70	L	1.6	L	60	280	.06	Carb vn.
921	N	150	100	50	700	70	L	1.6	15	70	590	.10	Do.
922	N	200	70	30	L	50	L	.8	L	L	160	.07	Qtz carb vnts.
923	N	200	50	70	L	100	L	1.6	520	L	150	.10	Carb vnts w mal.
924	N	200	20	10	N	100	L	L	140	L	60	.06	MnO vnt.
925	N	150	15	L	N	30	L	L	33	130	60	.20	Qtz vn.
926	N	1,000	30	20	3,000	50	L	14	680	55,000	1,800	>10	Qtz carb vn w ba.
928	10	300	70	50	N	150	L	L	22	200	30	.20	FeO st fr alt gr.
929	N	200	100	50	N	300	L	L	220	L	120	.09	FeO st sh z.
930	N	200	100	30	L	200	L	L	L	L	180	.05	FeO st my.
933	N	300	70	10	L	200	L	L	L	L	120	.55	FeO st sh z.
934	N	300	70	10	N	200	L	.8	L	L	150	.07	Qtz carb vn.
936	N	150	70	15	1,500	150	L	1.2	49	370	1,000	>10	FeO qtz carb vn.
937	N	100	70	L	200	300	L	.8	38	430	310	10	Do.
938	N	N	50	15	700	150	L	.2	17	100	1,100	.30	Do.
939	10	200	30	30	500	150	L	L	L	200	640	5	Vuggy breccia.
941	N	300	20	20	3,000	70	L	1.2	L	800	1,300	>10	FeO st qtz carb ba vn.
942	N	100	20	10	300	30	L	L	L	L	420	.18	FeO st sh z.
944	N	100	30	L	L	100	L	1.6	L	70	240	.60	Sil sh z w FeO.
945	N	150	100	150	L	20	L	2.4	39	50	140	.05	Carb vn.
946	N	150	10	30	N	300	L	L	100	L	50	.04	FeO st sh z.
947	N	200	10	15	N	100	L	L	L	L	90	.30	Do.
948	N	700	30	15	L	20	L	L	L	L	90	.05	Do.
949	N	150	70	30	L	150	L	L	L	L	70	.04	Hematitic gr.
950	N	150	50	30	L	20	L	2.0	34	30	150	.05	Carb vn w hem vnts.
951	N	100	50	100	L	30	L	2.8	20	40	110	.05	Carb vn.
957	N	100	150	10	L	150	L	.8	L	L	170	.04	FeO st sh z.
961	N	200	50	50	N	30	L	1.6	21	L	100	.05	Carb vnt.
964	N	100	200	50	N	10	L	L	121	L	L	.05	Hematitic my.
965	N	100	200	30	N	50	L	.6	L	L	70	.03	Hematitic carb my.
966	N	100	50	20	N	150	L	L	L	L	90	.55	Sil my w carb hem vnts.
970	N	100	50	L	N	150	L	.8	L	40	30	2.20	FeO st qtz vn.
971	N	100	50	L	200	100	L	.4	L	150	310	4	Sil alt gr w carb vnts.
972	N	L	20	30	N	10	L	1.2	11	L	50	.07	Qtz carb vn.
973	N	L	20	20	N	30	L	1.2	28	L	70	.45	Do.
976	N	150	70	30	700	700	L	2.4	40	80	690	3.50	FeO qtz vnts.
977	N	100	30	10	N	150	L	L	L	370	80	3	FeO st pegmatite.

TABLE 6.—*Analyses of rock samples from the Gore*

Semiquantitative spectrographic analyses[1/]

Sample	Ti (20)	Mn (10)	Ag (.5)	As (200)	Ba (20)	Be (1)	Cd (20)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sb (100)
	(ppm)															
978	1,500	50	5	1,500	>5,000	1.5	N	5	50	70	300	30	10	5	200	150
979	1,000	200	L	N	5,000	3	N	10	30	15	20	5	10	15	10	100
980	700	1,500	N	N	300	1.5	N	20	300	7	100	5	N	100	100	N
981	3,000	200	N	N	700	1.5	N	5	200	70	70	7	10	15	30	N
982	2,000	150	N	N	500	2	N	7	150	50	20	N	10	15	30	L
983	1,000	150	N	N	300	1.5	N	7	20	50	20	N	15	15	15	N
984	1,500	500	2	N	150	2	N	5	20	50	30	30	10	7	100	100
985	1,500	200	N	N	700	2	N	7	50	7	30	N	L	15	10	N
986	1,500	700	L	N	700	1.5	N	10	50	7	50	50	10	20	70	100
987	1,000	100	N	500	700	2	N	5	30	70	30	15	10	5	50	100
989	1,500	700	N	N	700	1	N	15	30	150	20	N	L	20	70	N
991	700	1,500	N	N	500	L	N	15	50	30	20	N	N	30	50	N
992	1,000	150	N	N	700	L	N	10	50	20	70	N	L	15	10	N
1016	1,500	150	N	N	500	3	N	10	70	10	70	5	15	20	30	N
1017	5,000	1,000	N	N	700	2	N	50	30	15	30	N	15	50	300	N
1200	1,000	1,000	7	N	1,000	2	N	10	10	700	150	N	10	10	300	N
1209	7,000	500	N	N	1,000	1	N	15	50	10	50	N	10	20	50	N

Gore fault on the rim above Gore Creek are anomalous in lead and zinc, and one is highly anomalous in arsenic (samples 856–859, 1174–1175, table 5).

The Frontal fault is not exposed along the base of Buffalo Mountain, but abundant vein quartz in the preglacial colluvium indicates that large quartz veins exist along it. One sample from a small quartz vein west of the main fault (68, table 5) was anomalous in arsenic.

The area near Chief Mountain and the lower part of the North Fork of Tenmile Creek contains veins that are anomalous in several metals (figs. 12–19), but this area was not examined closely or completely because it is far removed from the Primitive Area. Mines along the canyon of Tenmile Creek have been described briefly by Bergendahl (1963).

Stream-sediment samples from near the head of Meadow Creek and in the middle part of the North Fork of Tenmile Creek drainage showed 5 to 15 ppm molybdenum (table 8J, K), although no molybdenum was detected in bedrock samples from these drainages (table 5). This suggests that fractures anomalous in molybdenum exist on the rubble-covered slopes at the head of Meadow Creek and in a part of the North Fork of Tenmile drainage, probably to the south of the Creek. Otherwise, the sediment samples show few anomalies in this area (table 8J, K, L). One sample (87), from the gulch north of Meadow Creek, was anomalous in zinc,

Range in the Gore Creek-Booth Creek area—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)						Chemical analyses (ppm)						
Sample	Sn (10)	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2]
978	N	1,000	30	70	300	100	L	8.0	32	700	440	6.0	Barite qtz lens.
979	N	L	50	10	L	150	L	.4	15	40	40	2.60	FeO qtz vn.
980	N	L	70	100	L	N	L	1.4	L	70	100	.05	FeO carb vnt.
981	N	100	100	50	N	200	L	L	16	L	90	2.60	FeO qtz carb lens.
982	N	L	100	20	N	150	L	.4	L	L	100	1.30	FeO st sh z.
983	N	L	50	20	N	50	L	L	L	L	110	.06	Do.
984	N	150	50	L	300	70	L	5.6	16	300	550	.60	FeO, MnO st sh sil gr.
985	N	150	70	15	N	100	L	L	L	L	50	.06	FeO st my gn.
986	N	200	30	30	300	150	L	.4	L	80	430	2.60	Qtz vn.
987	N	150	70	10	N	100	L	.4	L	50	50	.60	Lim sil fault z.
989	N	500	100	50	200	70	L	1.2	60	40	310	.30	Qtz carb vn.
991	N	500	70	30	N	15	L	1.2	43	30	100	.04	Carb vn.
992	N	200	70	15	N	30	L	.4	L	L	50	.04	Chloritized sh gr.
1016	N	L	70	10	L	200	L	L	L	30	110	.65	Sil my w FeO.
1017	N	100	150	30	500	N	L	.4	19	260	670	.30	Carb FeO vnts.
1200	N	150	30	30	200	150	L	7.2	400	290	260	.07	Qtz carb vn.
1209	L	700	200	30	N	100	L	L	L	L	120	.02	FeO st frd gr.

suggesting that the Frontal fault, a short distance upstream, is anomalous in zinc. Streams on the south side of Gore Creek near the highly anomalous vein discussed previously also are anomalous in zinc (samples 860, 863, table 8M). One sample from the North Fork of Tenmile Creek drainage (400) was anomalous in copper. This sample was from a small stream draining a basin that contains a fracture zone anomalous in copper. (See samples 1138 and 1139, table 5.)

Old placer workings in Saltlick Gulch southwest of Silverthorne are in the drift of an early glacier from the Tenmile Creek drainage. This drift is characterized by rocks derived from the Kokomo-Climax area, and the gold in it undoubtedly came from that same source rather than from the slopes of the Gore Range to the west.

GORE CREEK-BOOTH CREEK AREA

The area on the west side of the range from Gore Creek northwestward to the head of Booth Creek (area E, pl. 2) contains numerous geochemically anomalous fracture zones. At three localities, on Deluge, Bighorn, and Pitkin Creeks, it contains small mine workings and patented claims (pl. 2). The workings on Deluge and Bighorn Creeks, and also many of the geochemical anomalies, are on a major west-northwest-trending fault zone (fig. 11) or closely related fractures. This fault zone is the one that deflects the Gore fault near Bald Mountain and Booth Creek. From there it continues generally eastward across the range to the vicinity of the Frontal fault near Willow Lakes (pl. 1). Through much of its length from Pitkin Creek eastward it is anomalous principally in zinc, lead, and silver. At Bighorn and Deluge Creeks, however, it is anomalous in copper and other metals as well. Inasmuch as these localities are in deep canyons whereas many of the other sample localities are on ridgetops, on this fault lead and zinc are evidently supplemented downward by copper and associated metals.

The mine on Bighorn Creek (see "Bighorn Creek area" in "Economic appraisal") and various prospect holes in the vicinity are on branch or subsidiary fractures of the main fault. Some of these are marked by well-defined quartz veins several inches wide which are locally copper-stained and contain scattered blebs of dark copper minerals. Others are silicified zones several feet wide that are more or less veined by quartz but show little sign of metallic minerals. The mine adit was driven to intersect a copper-bearing quartz vein 6 to 8 inches wide exposed on the cliffs above the portal (samples 897, 898, table 6). The mine, now caved, was examined briefly in 1942 by T. S. Lovering of the U.S. Geological Survey; he found little sign of metallic minerals and no evidence of stoping in about 1,000 feet of workings. The only vein matter now exposed on the dump consists of small plates from carbonate veinlets, anomalous in lead and zinc. Samples from the vicinity of the mine showed anomalous arsenic, bismuth, antimony, silver, mercury, and a little gold, as well as copper, lead, and zinc (samples 897–901, table 6).

The so-called mine on Deluge Creek (see "Deluge Lake area" in "Economic appraisal") consists of several small opencuts and shallow shafts along a broad shear zone south of Deluge Lake (at head of Deluge Creek; not depicted on base map, pls. 1, 2). This zone, here more than 500 feet wide, contains near its southern edge an irregular silicified and quartz-veined zone a few feet to 25 feet wide. The siliceous zone contains scattered blebs, small pods, or thin veinlets of bornite in places and also is heavily stained by red hematite and is locally veined by specular hematite. Although selected samples contained some silver and gold as well as copper (samples 681 and 682, table 6), the richest parts of the siliceous zone are estimated to contain less than 1 percent of veinlets and nodules of copper minerals though widths of 5 to 10 feet. According to prospectors who, as of the early 1940's, had had some earlier familiarity with the area, a small amount of selected high-grade ore was picked from the siliceous zone in the opencuts and hauled out by burro.

Elsewhere in the shear zone at Deluge Lake, fracture surfaces in the hematite-stained rock are locally spotted with malachite or azurite stain, but the metal content is low (samples 794 and 795, table 6).

Small mine workings on three patented claims in the Pitkin Creek drainage (see "Pitkin Creek area" in "Economic appraisal") are located on cliffy slopes northeast of Pitkin Lake. These workings are on narrow quartz-carbonate veins that trend nearly north. Locally, the veins contain vuggy masses, a few inches in diameter, of copper and lead sulfide minerals and colorless barite crystals. The veins are anomalous in silver, arsenic, cadmium, molybdenum, antimony, and mercury as well as in copper, lead, and zinc (samples 915–916, 926, table 6). Very high arsenic (>10,000 ppm) suggests that one of the dark gray or black minerals may be tennantite. Small quartz-carbonate veins and hematitic fracture zones to the south and east have geochemical characteristics similar to those of the Pitkin Lake veins (samples 936–939, 941, table 6).

Several fracture zones in the area between Pitkin Lake and the head of Booth Creek are, variously, anomalous in antimony, arsenic, molybdenum, silver, or mercury (figs. 15, 17, 18, 19), although only mildly anomalous—if at all—in copper, lead, and zinc. These fractures are of various trends, and most of them contain thin quartz or carbonate veins or veinlets at the sample site. In a few fractures, these veinlets contain barite.

The main young strand of the Gore fault is distinctly anomalous in copper, silver, lead, and zinc where it crosses Gore Creek (locality 1200, pl. 2), although only fractured rock, slightly iron-stained, is visible there. Rock samples from older fractures of the fault (samples 450–452, pl. 2 and table 6) showed no comparable anomalies, but a stream-sediment sample at the same general locality (sample 453, table 8M) showed anomalous zinc and lead which might have been derived from this east-trending fracture zone farther upstream. In the bottom of a roadcut about 1,000 feet west of the locality of samples 450–452, a small sulfide vein reported to assay high in silver was encountered when the Vail Pass highway was under construction in 1940–41. No anomalies in the bedrock were detected along the Gore fault northwest of Gore Creek in this area, but sediment samples from small streams on the south slope of Bald Mountain (samples 962 and 963, table 8P) were anomalous in zinc, suggesting some mineralization on the Gore fault.

Stream-sediment samples from some tributaries of Gore Creek from the north are slightly anomalous in silver, and one is anoma-

TABLE 7.—*Analyses of rock samples from the Gore*

[For sample locations see plate 2. Numbers in parentheses indicate sensitivity limit of method used. The symbol > indicates that an undetermined amount of the element is present above

Semiquantitative spectrographic analyses[1/]

Sample	(ppm)															
	Ti (20)	Mn (10)	Ag (.5)	B (10)	Ba (20)	Be (1)	Cd (20)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)
232	7,000	700	N	L	3,000	L	N	10	5	50	150	L	10	L	30	7
233	1,000	150	N	15	1,000	L	N	L	20	30	70	N	L	15	30	L
234	10,000	300	N	10	3,000	L	N	15	10	20	100	N	15	10	30	7
239	10,000	300	N	15	1,500	L	N	20	15	50	200	L	15	10	50	7
240	10,000	700	N	10	1,500	L	N	20	5	30	150	L	15	5	30	10
241	3,000	200	N	10	300	N	N	L	30	70	50	N	L	10	30	5
242	7,000	300	N	10	500	N	N	15	70	300	L	L	10	20	50	7
243	5,000	300	0.7	30	>5,000	N	N	L	30	300	50	L	10	10	20	10
244	7,000	3,000	N	50	>5,000	N	N	30	70	500	100	5	20	50	30	15
245	10,000	3,000	1	20	700	L	N	30	70	300	100	10	20	50	100	15
246	7,000	150	N	10	700	1	N	L	10	7	70	N	10	5	70	L
526	10,000	700	N	20	1,500	1	N	20	200	20	L	5	20	30	70	20
527	3,000	700	N	10	1,000	L	N	20	20	30	50	L	10	30	70	10
528	1,500	2,000	N	20	100	L	N	50	50	30	L	5	20	100	100	100
540	10,000	700	N	20	700	L	N	30	300	20	L	L	20	70	20	20
541	>10,000	700	.5	20	1,000	L	N	30	300	70	100	5	20	100	50	20
542	10,000	500	N	20	700	2	N	30	150	20	L	L	20	30	20	20
543	10,000	700	N	20	700	2	N	20	300	10	50	L	20	30	20	30
544	2,000	1,500	N	20	200	2	N	30	150	10	50	L	10	70	100	20
559	10,000	700	N	20	1,500	L	N	20	150	30	50	L	20	30	50	20
560	2,000	3,000	N	50	1,000	5	N	70	100	30	50	10	20	150	50	20
561	500	3,000	N	30	150	L	N	20	10	10	50	5	20	20	100	L
562	2,000	5,000	N	50	2,000	L	N	30	20	20	50	10	20	50	200	20
563[3/]	3,000	100	150	50	>5,000	5	N	L	70	1,000	50	L	20	5	>20,000	5
564	2,000	1,000	2	50	1,500	2	N	20	20	15	100	L	20	10	100	10
584	300	2,000	N	10	100	2	N	7	15	100	N	N	50	10	50	L
585	500	2,000	N	10	200	1	L	30	20	70	20	N	15	30	70	5
586	200	1,500	N	L	300	1	N	10	10	100	20	N	10	15	150	N
587[4/]	200	2,000	N	10	300	2	N	15	10	30	30	15	20	10	70	L
588	1,500	2,000	N	15	200	1.5	N	15	20	70	N	N	15	20	70	L
589	2,000	1,500	N	L	500	1.5	N	20	30	20	30	N	20	30	100	5
622	1,000	2,000	N	20	500	1.5	N	30	20	10	L	N	10	30	150	7
623[5/]	700	50	N	10	300	1.5	N	15	10	15	20	10	20	10	20	5
624	5,000	70	N	L	300	2	N	5	70	5	L	N	20	20	20	7
625	1,500	1,000	N	L	300	1	N	30	30	50	50	7	10	50	50	5
994	2,000	200	N	20	700	L	N	7	20	50	70	N	L	5	15	7
995	5,000	200	N	10	200	1	N	10	70	10	30	N	10	15	L	10
996	500	700	N	20	700	1	N	10	5	10	20	N	L	15	10	L
998	700	500	N	15	500	1.5	N	7	5	15	70	N	L	10	15	L
999	1,500	500	5	15	3,000	2	N	7	100	10	50	15	L	15	150	7
1005	5,000	500	L	10	700	2	N	10	300	20	50	N	10	20	200	20
1007	2,000	3,000	N	L	500	1	N	15	150	7	30	N	L	50	70	20
1009	1,500	700	N	10	500	2	N	10	50	10	30	N	10	20	100	5
1011	2,000	150	1.5	10	500	3	N	5	70	50	50	N	10	10	1,000	7
1012	1,500	1,000	N	L	700	1	N	15	50	10	50	N	L	20	100	10
1013	1,000	1,000	N	L	700	1	N	15	100	7	20	N	L	30	70	7
1014	3,000	500	3	20	1,000	5	N	5	70	15	100	N	10	15	1,000	5
1015	2,000	150	N	20	300	5	N	5	70	15	20	10	20	15	70	10
1018	1,000	1,500	N	15	700	5	N	15	30	15	70	N	15	30	70	7
1019[6/]	1,500	150	50	20	300	5	N	10	20	70	30	10	15	20	3,000	10

1/ Also looked for spectrographically but not found except as noted: As(200), Au(10), Bi(10), Sb(100), and W(50). Except as noted, Sn <10 ppm. Values for Y (<150 ppm) not listed for brevity.

3/ 500 ppm Sb.

4/ 300 ppm As

5/ 10 ppm Bi

6/ 100 ppm Bi.

Range in the northwestern area (area F, pl. 2)

the number shown; L indicates that an undetermined amount of the element is present below the sensitivity limit; N indicates the element was looked for but was not found.]

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						
Sample	Sr (100)	V (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2/]
232	300	100	N	300	L	L	22	L	110	0.03	FeO st mylonite.
233	100	30	N	150	L	L	20	L	L	.03	FeO st qtz.
234	300	150	N	500	L	L	24	L	110	.03	FeO st dike.
239	300	150	N	700	L	L	40	L	80	.08	FeO st pegmatite.
240	500	150	N	300	L	0.4	28	L	160	.03	Pyrite in dike rock.
241	L	70	N	70	L	.2	80	L	L	.03	FeO st gn.
242	150	100	N	300	L	.4	250	30	80	.03	FeO st fractured gr.
243	>5,000	70	N	150	L	.4	130	L	40	.03	Qtz ba vn, FeO st gn.
244	700	150	N	150	L	.8	360	L	130	.03	Ba carb vn.
245	300	150	1,000	300	L	.8	170	30	870	.15	FeO st gr.
246	300	70	200	150	L	L	L	L	170	.07	FeO qtz vn.
526	200	100	700	1,000	L	L	19	L	760	.03	3' sil sh z w FeO.
527	200	70	300	300	L	L	48	L	360	.04	FeO st sh z.
528	150	100	200	50	L	1.8	44	50	210	.03	Carb vnts.
540	100	150	L	500	L	.4	24	L	100	L	FeO st sh z.
541	200	150	L	300	L	.8	64	L	60	.03	Do.
542	200	150	L	300	L	.2	13	L	60	.03	Do.
543	200	150	L	300	L	.4	L	L	50	.01	Do.
544	2,000	100	L	100	L	1.4	11	40	200	.01	FeO st sh z w carb vns.
559	100	150	L	200	L	L	38	L	110	.05	FeO st sh z.
560	200	150	500	200	L	1.2	30	30	440	.03	Carb vn.
561	200	50	200	20	L	1.6	L	80	320	.03	Do.
562	200	150	3,000	150	L	1.6	L	280	5,100	.05	Do.
563	2,000	50	2,000	150	L	150	900	15,000	1,700	>10	Qtz vn w ba, sph, Cu mins.
564	1,000	50	L	150	L	.8	L	L	100	.03	Qtz carb vnts.
584	L	20	200	20	L	.4	39	50	210	.14	FeO st sh z, qtz carb vnts.
585	150	50	700	30	L	1.6	L	30	1,000	.07	Carb vn.
586	150	15	L	20	L	1.2	27	90	130	.22	Carb qtz vn.
587	100	15	200	30	L	1.2	24	90	180	.24	Do.
588	150	30	L	30	L	1.8	L	50	150	.08	Do.
589	100	50	200	70	L	1.2	L	60	230	.10	Carb vn.
622	150	50	700	50	L	1	15	L	1,100	.09	Do.
623	L	30	N	70	L	L	25	L	30	.18	FeO st sh z.
624	L	50	N	200	L	L	L	L	90	.05	Do.
625	100	70	L	70	L	1.2	51	L	200	.06	Carb vn.
994	300	70	N	150	L	L	L	L	30	.06	FeO st fractured gr.
995	150	100	N	150	L	.2	L	L	80	.08	FeO st chlor sh gr.
996	200	20	200	20	L	1.2	L	L	230	.06	FeO carb vn.
998	700	10	N	300	L	L	L	L	100	.06	FeO-rich fault z.
999	100	70	500	150	L	10	L	350	650	.60	Vuggy FeO MnO sh z.
1005	100	150	500	150	L	.4	48	190	510	.18	FeO st sh z.
1007	100	70	200	70	L	2	14	50	170	.45	Carb vn.
1009	200	50	300	150	L	.8	L	110	410	.24	Qtz carb vn.
1011	100	70	200	150	L	3.2	78	1,200	330	.60	Qtz vn.
1012	150	70	L	100	L	1.6	28	90	160	.04	FeO carb vn.
1013	150	70	L	150	L	1.6	L	50	140	.06	Carb vn.
1014	200	70	N	150	L	3.2	16	1,000	40	1.20	Qtz carb FeO vn.
1015	L	100	L	200	L	L	24	90	160	.40	FeO st sil my.
1018	500	70	300	150	L	.8	23	60	250	.09	Carb vn.
1019	100	70	1,500	150	L	64	100	1,800	1,200	>10	FeO st sil sh z.

2/ Abbreviations used in table:

alt	altered	gn	gneiss	sil	silicified
ba	barite	gr	granitic rock	sph	sphalerite
br	breccia	hem	hematite	st(d)	stain(ed)
carb	carbonate	lim	limonite	vn(s)	vein(s)
chlor	chloritized	min(s)	mineral(s)	vnt(s)	veinlet(s)
Cu	copper	qtz	quartz	w	with
FeO	iron oxide	sh(d)	shear(ed)	z	zone

TABLE 7.—*Analyses of rock samples from the*

Semiquantitative spectrographic analyses[1/]

(ppm)

Sample	Ti (20)	Mn (10)	Ag (.5)	B (10)	Ba (20)	Be (1)	Cd (20)	Co (5)	Cr (15)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)
1020	1,500	1,000	L	10	700	1.5	N	20	30	30	150	N	10	30	200	10
1021	700	2,000	N	10	200	1.5	N	30	30	10	20	N	L	100	150	7
1022	2,000	100	N	20	700	3	N	7	70	5	30	N	10	15	20	15
1023	1,000	1,000	N	15	150	3	N	10	15	200	50	N	10	15	70	10
1024	500	1,500	N	10	500	2	N	20	30	10	50	N	10	50	70	5
1025[7/]	2,000	100	2	50	1,500	3	N	10	70	50	50	5	15	15	300	10
1026	200	150	N	15	300	3	N	5	L	20	N	N	20	15	70	L
1027	1,500	150	N	20	300	3	N	7	30	15	50	N	15	20	L	10
1028	700	200	N	20	500	3	N	7	10	10	50	N	L	10	50	L
1029	2,000	1,500	N	20	700	5	N	15	100	10	50	N	10	50	20	15
1030[8/]	700	150	N	20	300	2	N	5	10	10	20	N	30	7	20	5
1031	1,000	200	N	100	300	2	N	10	15	5	30	N	10	20	15	5
1032	700	700	N	20	700	1.5	N	10	15	5	70	N	10	15	50	L
1033	700	1,500	N	30	700	1.5	N	20	20	15	20	N	10	50	70	7
1034	1,000	50	1.5	70	300	3	N	5	30	10	30	N	10	15	100	5
1035	2,000	150	L	20	300	3	N	15	70	10	50	N	10	50	70	10
1036	5,000	100	N	20	200	5	N	7	70	5	50	N	15	20	15	15
1037	2,000	150	.7	50	700	5	N	7	50	10	50	5	10	15	70	7
1038	700	2,000	N	10	500	2	N	30	50	5	150	5	N	50	15	7
1039	700	2,000	10	L	>5,000	1.5	L	15	10	10	30	5	L	20	3,000	7
1040	2,000	2,000	L	L	700	1.5	150	20	70	50	20	5	L	50	1,500	20
1041	5,000	1,500	.5	30	1,000	2	N	30	150	5	100	N	L	50	300	10
1042	5,000	1,500	N	20	300	3	N	15	30	50	30	N	10	30	70	20
1043[9/]	1,000	70	L	30	100	5	N	5	30	5	20	10	10	10	50	7
1044	3,000	500	N	10	700	2	N	10	100	70	30	10	10	20	30	10
1045	5,000	5,000	.5	10	700	2	N	70	150	70	50	N	15	150	300	50
1046	7,000	100	N	L	700	1.5	N	15	30	10	30	N	10	15	200	20
1048	1,000	2,000	3	L	30	L	50	50	70	10	N	5	N	100	2,000	20
1051	2,000	150	N	10	1,000	L	N	5	20	7	50	N	L	7	50	10
1052	3,000	150	L	20	500	L	N	10	50	15	L	N	L	15	20	10
1053	1,500	150	N	L	1,000	L	N	5	20	7	150	N	L	10	70	5
1054	1,500	100	N	10	700	1.5	N	5	15	7	20	N	L	10	70	5
1056	2,000	300	N	10	2,000	N	N	10	30	5	20	N	L	15	70	10
1060[10/]	700	100	N	10	700	1.5	N	7	30	5	N	N	L	15	20	10
1064	700	700	1.5	L	1,000	3	N	7	15	700	150	N	L	10	20	10
1066	5,000	700	L	L	700	2	N	15	10	7	100	N	10	15	70	10
1068	1,000	700	N	15	150	1.5	N	50	70	5	L	7	L	100	70	10
1069	5,000	1,000	N	10	700	2	30	30	20	7	100	5	L	70	500	15
1070	1,500	>5,000	N	L	100	2	20	70	200	10	20	N	N	200	500	20
1071	1,500	700	N	10	100	3	N	15	70	15	20	N	L	30	100	15
1072[11/]	2,000	200	L	15	100	3	N	5	100	5	20	N	10	15	70	5
1073	1,000	700	N	10	100	1.5	N	15	70	10	20	N	L	50	70	5
1076	2,000	150	N	20	500	3	N	10	70	10	50	N	10	30	15	7
1085	3,000	150	N	10	700	1	N	15	150	5	30	N	10	20	10	10
1086	2,000	200	N	20	1,000	1.5	N	10	150	10	50	N	20	30	10	10
1092	700	150	N	20	700	2	N	7	100	10	30	N	L	10	15	L
1093	700	500	N	20	700	1.5	N	7	7	5	70	7	L	10	30	L
1094	2,000	500	N	15	300	3	N	15	150	15	20	N	10	30	10	15
1095	1,500	150	N	15	1,000	2	N	5	5	10	100	N	20	5	20	5
1096	2,000	700	N	15	700	1.5	N	15	150	70	20	N	10	20	15	10
1097	1,000	700	5	70	300	2	N	5	20	10,000	20	N	L	7	200	5
1098	700	2,000	N	10	>5,000	2	N	20	50	10	70	L	L	100	100	5
1099	2,000	500	L	20	700	1	N	30	70	100	70	N	L	30	20	10
1100	7,000	500	N	20	700	2	N	15	200	300	20	N	10	50	10	20
1101	3,000	500	70	20	700	5	N	20	100	>20,000	150	N	L	50	10	5

7/ 100 ppm Sb

8/ 15 ppm Sn.

9/ 1,000 ppm As

Gore Range in the northwestern area—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						Sample description[2]
	Sr (100)	V (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	
1020	300	100	200	100	L	1.6	14	100	230	0.45	Carb FeO vnts.
1021	200	100	500	50	L	2	L	80	470	.16	Qtz carb vnts.
1022	L	70	L	300	L	L	L	L	150	.35	FeO st sil sh z.
1023	100	50	L	70	L	1.2	230	80	120	.06	Qtz carb vn.
1024	300	70	200	70	L	1.4	L	40	190	.05	Carb vnts.
1025	500	100	L	200	L	1.2	37	170	130	8	Qtz vn.
1026	100	10	N	30	L	L	L	L	L	.06	FeO st fault.
1027	100	50	N	300	L	L	L	L	40	.35	Do.
1028	200	30	N	150	L	L	L	L	30	.05	FeO st gr.
1029	150	100	L	200	L	.4	L	L	120	.06	FeO st alt gr.
1030	100	50	N	30	L	L	L	L	L	.03	Fault in qtz, hem.
1031	200	50	200	200	L	L	L	L	110	.06	Lim qtz alt.
1032	1,000	50	N	100	L	L	L	L	30	.02	Do.
1033	700	70	L	200	L	1.2	L	40	90	.04	Fault w carb, lim.
1034	150	50	200	150	L	1.6	11	110	150	1.10	Qtz vnts w FeO.
1035	L	70	200	200	L	L	L	50	130	.20	Sil sh z w FeO.
1036	100	100	L	150	L	L	L	L	110	.10	Qtz vnts.
1037	150	50	L	200	L	1.2	10	70	120	.60	FeO st qtz vn.
1038	100	70	200	100	L	1.6	11	30	190	.02	Qtz carb vn.
1039	700	70	2,000	10	L	5.6	14	1,600	1,300	5.50	Do.
1040	100	100	>10,000	100	L	2	40	1,100	1,600	.08	Do.
1041	700	200	3,000	200	L	1.8	L	260	1,500	.24	Do.
1042	500	70	700	150	L	.4	22	30	530	1.80	Qtz vn w FeO, MnO.
1043	100	50	200	100	L	.4	L	80	190	2.10	Vuggy sh z w FeO, MnO.
1044	500	70	L	200	L	.4	41	L	160	.07	Sh z w FeO.
1045	700	300	3,000	200	L	1.4	60	390	1,500	1.80	Sh z w carb vnts.
1046	100	100	500	70	L	.2	24	240	320	.30	FeO st sh z.
1048	150	70	>10,000	70	L	5	21	1,100	1,700	.05	Sh z w carb lim vnts.
1051	200	70	L	150	L	L	L	L	100	.01	FeO st migmatite.
1052	200	300	N	300	L	L	34	L	30	.03	Gr w hem.
1053	500	300	N	10	L	L	L	L	L	.02	Do.
1054	150	30	N	50	L	L	L	L	L	.03	Do.
1056	700	100	N	50	L	.2	L	L	50	.04	FeO st gr.
1060	100	100	N	50	L	L	L	L	L	.02	FeO st mylonite.
1064	L	50	N	20	L	2.4	540	50	L	.07	FeO st sh z w qtz vnts.
1066	100	70	1,500	500	L	.2	L	40	1,400	.28	Pyrite in dike rock.
1068	200	70	300	50	L	1.6	L	50	270	.02	Carb vn.
1069	300	100	1,000	300	L	1.2	14	400	900	.07	5' carb vn, br.
1070	100	100	1,500	100	L	1.6	L	390	1,400	.04	4' qtz carb FeO vn.
1071	300	70	300	100	L	.8	32	100	370	.09	Qtz carb FeO vn. br.
1072	150	70	N	100	L	L	11	110	100	.45	2' qtz vn.
1073	200	70	300	70	L	1.2	L	100	410	.11	Qtz carb vn.
1076	100	70	700	200	L	L	16	L	720	.08	Hem st alt migmatite.
1085	L	100	N	150	L	.4	L	L	70	.04	Alt migmatite w FeO.
1086	100	200	N	200	0.06	L	15	L	60	.07	Hem alt migmatite.
1092	150	70	N	200	L	L	L	L	L	.05	Hem fractured migmatite.
1093	150	30	N	30	L	L	L	L	30	.04	Fractured gr w qtz, lim.
1094	100	150	N	150	L	L	14	L	90	.05	Limonitic fault.
1095	200	30	N	500	L	L	L	L	40	.05	Lim hem fault.
1096	100	100	N	200	L	.4	37	L	80	.06	Chloritic hem fault.
1097	100	50	N	150	L	12	12,000	380	60	.06	Sandstone w malachite.
1098	700	50	200	70	.04	1.2	27	70	180	.01	Fault gouge, br w FeO.
1099	200	100	N	100	L	.6	200	L	50	.05	FeO st rock.
1100	100	200	L	200	L	.8	300	L	100	.06	FeO st sh z.
1101	500	150	N	150	L	120	82,000	L	50	.06	Shd gr w azurite.

10/ 10 ppm Sn.

11/ <100 ppm Sb.

TABLE 7.—*Analyses of rock samples from the*

	Semiquantitative spectrographic analyses[1] (ppm)															
Sample	Ti (20)	Mn (10)	Ag (.5)	B (10)	Ba (20)	Be (1)	Cd (20)	Co (5)	Cr (15)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)
1102	700	700	2	50	100	1	N	5	7	1,000	20	N	L	5	N	L
1103	700	100	N	30	70	L	N	5	10	5	20	N	L	5	N	L
1115	700	500	N	20	300	1	N	7	20	10	30	N	L	10	20	L
1116	500	150	N	10	50	1	N	L	10	30	20	N	L	5	L	L
1192	3,000	70	N	N	150	2	N	7	70	20	70	N	20	10	10	10
1193	300	100	7	100	50	N	N	5	30	2,000	L	100	N	7	10	L

lous in zinc (samples 790–791 and 866, table 8M). These streams drain areas that contain fractures that are anomalous particularly in zinc (fig. 14). Many of the sediment samples from upper Bighorn and Pitkin Creeks were anomalous in zinc and lead, and some were anomalous in silver (table 8N, O), as might be expected in these areas of strongly anomalous fracture zones in the bedrock.

NORTHWESTERN AREA

The area including the Piney River, Meadow Creeks, and North Fork of Piney drainages (area F, pl. 2) contains geochemical anomalies, but it contains no mines or patented claims and very few prospect diggings. The anomalies are mainly on the faults of the Gore fault system that had late movement—that is, the faults that trend N. 20° to 25° W. and are southwest of Mount Powell and in the upper Piney River drainage (fig. 3). These faults are broad fracture zones that in places contain streaks a few inches to a few feet wide that are veined by carbonate or quartz. Many such streaks are anomalous in zinc, and some are anomalous in lead and cadmium. They also contain traces of silver, and a branch fracture of one is anomalous in arsenic (samples 245–246, 526, 1042–1048, 1066–1070, 1076, table 7). Faults with these characteristics lie only on the east side of the upper Piney River. Faults of similar trend on the west side of the river contain very little quartz or carbonate and are not anomalous geochemically.

A few north-trending fractures bridging between the persistent north-northwest-trending faults are anomalous, in one place or another, in silver, copper, lead, zinc, and mercury (samples 563, 622, 1019, 1039–1041, table 7). Fractures related to a prominent fault of east-west trend that turns to N. 75° E. and extends all the way across the range (pl. 1) are anomalous in places in lead, copper, and silver (samples 1011, 1014, 1064, table 7).

North of the Piney River, the main Gore fault shows evidence of mineralization near East Meadow Creek. At the locality of samples

Gore Range in the northwestern area—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						
Sample	Sr (100)	V (10)	Zn (200)	Zr (10)	Au (.02)	Ag (0.2)	Cu (10)	Pb (25)	Zn (25)	Hg (.01)	Sample description[2]
1102	100	20	N	500	L	1.6	1,600	L	L	.02	FeO st sandstone.
1103	L	20	N	300	L	L	25	L	L	.06	Do.
1115	100	50	N	70	L	L	18	L	60	.05	FeO st fractured migmatite.
1116	L	N	L	150	L	L	10	20	150	.11	Br w FeO; qtz.
1192	L	70	N	500	L	L	L	L	L	.02	Sandstone.
1193	500	50	N	L	L	8.8	1,700	50	L	.06	Limestone w azurite.

1101–1103 (pl. 2), sheared granite in a small exposure is stained by azurite. This material is anomalous in silver as well as copper, as is adjoining brecciated and iron-stained sandstone (table 7). About 1¼ miles farther north, upturned sandstone of the Morrison Formation bordering the fault is splotched with malachite through a zone about 7 feet wide. The malachite is concentrated along bedding planes but occurs also in disseminated small grains. A selected sample (1097, table 7) of the richest material contained 12,000 ppm copper (1.2 percent) and a little silver by chemical analysis. Several samples from the fault zone farther north were not anomalous except that two showed a trace of gold (samples 1086, 1098, table 7).

Most of the stream-sediment samples from the northwestern area showed no anomalous features. Two samples from the Piney River drainage showed anomalous zinc (table 8R). These were from small streams draining slopes cut by fracture zones anomalous in zinc. Samples from a small area in the North Fork of the Piney drainage near the Gore fault were mildly anomalous in molybdneum (samples 1087–1089, 1191, table 8T). They suggest that traces of molybdenum may occur on this part of the fault, although only one rock sample (1093, table 7) among several from the fault in this same area showed molybdenum.

SUMMARY AND ANALYSIS OF MINERALIZATION FEATURES

Visible indications of metalliferous deposits in the Gore Range are sparse. Of 791 samples representing the most mineralized materials that were found, only 57 contained visible ore minerals. In many of these, the ore minerals constituted no more than a few grains or a thin veinlet, or a film of copper carbonate. Except at the Boss mine, the best "ore" seen was no better, in terms of mineral composition, than material to be found on the waste dumps of mines in the nearby producing districts or material exposed in the undeveloped prospect pits of those districts. The paucity of sulfide minerals is not to be attributed to destruction by oxidation. In this intensely glaciated range, oxidized zones were removed by the deep glacial erosion, and too little time has elapsed since glaciation for new ones to develop, except incipiently. Incipient oxidation accounts for the iron stain on the fractured rocks, but sulfide minerals, including the readily oxidizable pyrite, sphalerite, and copper minerals, are still present essentially at the surface.

In the absence of visible ore minerals in quantity large enough to hold some economic promise, the fractures and quartz veins might still contain a generally invisible ore mineral such as gold. However, of the 791 samples, only 16—other than those from the Boss mine—contained gold in excess of 0.1 ppm (equivalent to 10 cents' worth in a ton of rock), and none of these contained as much as 1 ppm.

However, despite the absence of evident ore deposits, the area shows strong indications of having been subjected, to a degree, to a mineralizing process. Part of the evidence is easily visible in the large quartz veins that occur locally, as in the Willow Creek area, in the quartz and carbonate veins or veinlets in many of the fracture zones, and in the scattered occurrences of gangue minerals such as barite and fluorite. Invisible but strong evidence is supplied by the many geochemical anomalies. Collectively, these anomalies include a remarkably large suite of metals: copper, lead, zinc, gold, silver, molybdenum, bismuth, arsenic, antimony, cadmium, mercury, and tin. The major anomalies are orders of magnitude higher than the contents of these metals in ordinary rocks, and they are unquestionable indication that almost the entire range, through its fracture system, was permeated at least briefly by metallizing solutions or vapors.

The question is: Was this a spurt of metallizing "smoke" that left no ore deposits anywhere? Or were deposits formed at higher levels that are now eroded away? Or were deposits formed that are still hidden in the depths?

The hidden deposits, if any, are the ones of concern here. If rocks other than granite and migmatite existed at any accessible depth in the body of the range between the Gore and Frontal faults, there might be reason to look to these as potential sites of mineral deposits, but no indication of such rocks exists. Neither the geology nor the magnetic data of the area indicate any underlying intrusive body ("porphyry"), except that a small body might possibly exist beneath the valley of the south fork of Slate Creek, an area that is not particularly anomalous geochemically. Both the

Gore and Frontal faults are normal faults, dipping away from the range, and so there is no likelihood that sedimentary rocks lie beneath any part of the Precambrian rocks. No reason exists to anticipate that the Precambrian rocks change downward to a more hospitable facies, such as marbles, amphibolites, or calc-silicate rocks. In short, the granite and migmatite of the surface must be presumed to continue far below the surface. Such rocks are capable of containing ore deposits, either as veins or as disseminated deposits as at Climax, but evidence of such deposits is sparse or lacking. Such veins as are exposed are not workable, and they show no improvement with depth through the 4,000 feet of vertical relief afforded by the range. Indeed, many are more anomalous on the ridges than they are in the canyons. Disseminated ore deposits of the Climax type (Wallace and others, 1968) are normally marked by a great halo of altered rocks. Absence of any large areas of altered rocks in the main body of the Gore Range leads to a conclusion that no mineral deposits of the disseminated type are likely to exist, at least within a depth range practical for exploration.

In summary, then, the Precambrian rocks making up the main body of the range contain no known ore deposits, and no geologic evidence exists to indicate a likelihood of hidden deposits at depth. The numerous geochemical anomalies characterizing the fracture zones record the passage of metal-bearing solutions through the fracture system, but either these were in a quantity too small to create ore deposits, or they formed deposits at some higher level that has been destroyed by erosion, or no suitable trap existed and they escaped to the surface as hot springs.

Some suggestion exists that the present crest of the range may have been near the upper level of mineralization, as the elements characteristic of shallow ore deposits seem to be concentrated there. Mercury anomalies (fig. 18) definitely are concentrated along the crest of the range, and antimony, arsenic, bismuth, and silver (figs. 15, 19) show a similar, though less pronounced, pattern. The remarkable accordancy of the summits along the crest and all the high spurs of the range (figs. 9, 10) suggests that the range once had a widespread flat surface that was the starting level for erosion that carved the present topography. This flat surface probably was the surface beneath the Morrison Formation, and it probably was no more than a few hundred feet above the present crests. Thus mineralization in the Precambrian rocks could have extended only a little higher than the present crest level of the range. It might, of course, have extended into overlying sedimentary rocks, but for various reasons, not to be detailed here, these are thought to have been reduced to thin scabs by that time.

On the flanks of the range, the possibilities for ore deposits are somewhat greater than in the fault block of Precambrian rocks making up the body of the range. Both the Frontal and the Gore faults show signs of mineralization, and both bring sedimentary rocks against the Precambrian rocks, thus introducing an additional element to the geology. Of the two faults, the Frontal shows the greater evidence of mineralization. Along this fault, mineralization is greatest at the south and decreases steadily northward, as judged by the signs in the Precambrian rocks in the footwall of the fault, which are almost the only ones exposed. At least as much, and possibly more, mineralization might be expected in the sedimentary rocks of the hanging wall. These rocks are not exposed. Stream-sediment sampling does not serve to detect mineralized areas in them because all the streams flow upon the blanket of glacial deposits after crossing the Frontal fault. Only a few cobbles of quartz-veined sandstone and brown jasperoid were found in the moraines as evidence of mineralization in the sedimentary rocks, but ore, if present, would not survive glacial transportation for very far. In summary, all that can be said is that the chances seem to be somewhat greater for existence of ore deposits in the sedimentary rocks along the Frontal fault—or within the fault itself—than in the Precambrian rocks of the range, although none are known except at the Boss mine. If deposits do exist in the sedimentary rocks, they might resemble those of the Breckenridge mining district, which is in a similar stratigraphic setting (Lovering, 1934).

The main Gore fault is less mineralized than the Frontal fault, possibly because it did not undergo the large movements late in geologic time that the Frontal fault did. Exposures of sedimentary rocks along the fault are much better than along the Frontal fault, but they reveal no mineralization of these rocks except a minor amount north of the Piney River. The rocks exposed, however, are not those most hospitable to mineral deposits. The most favorable units are the limestones such as the Leadville Limestone, the Dyer Dolomite Member of the Chaffee Formation, and the Manitou Dolomite (table 1). As indicated in an earlier section, these pinch out beneath erosional unconformities approximately at the Gore fault, but the precise locations of their edges are unknown. In general, the chances for existence of these rocks, and thus for attendant mineral deposits, would increase progressively with distance westward from the outcrop of the Gore fault. Limestones in the Minturn Formation, such as the Robinson, White Quail, and Jacque Mountain Limestone Members, have not been observed to be mineralized anywhere along the Gore fault, except at the isolated locality of sample 1193 (pl. 2) at the mouth of the North Fork of the Piney, in one of the limestones of the Robinson.

The age or timing of mineralization in the range has a bearing on the significance to be attached to the geochemical anomalies. The prominence of certain elements—notably molybdenum but also including antimony, arsenic, bismuth, and silver—among the anomalies immediately suggests a relationship to an episode of widespread mineralization in Colorado in middle Tertiary time (Tweto, 1968b). However, at least a part and perhaps all of the mineralization in the Gore Range must be younger than this event. The association of geochemical anomalies with the Frontal fault and other faults that were involved in the latest uplift of the range indicates that the mineralization is younger than the major movement that occurred on these faults. This conclusion is supported by the fact that the quartz and carbonate veinlets normally are not brecciated or deformed, although they cut brecciated rocks. If the faulting that affected the Tertiary sedimentary and volcanic rocks in the northeastern part of the map area (pl. 1) was related to the faulting that produced the late uplift of the range, as seems likely, then the late uplift was younger than late Miocene, and at least some mineralization was younger yet. This mineralization therefore was no older than late Tertiary in age. It probably correlates with an episode of igneous intrusion and related mineralization dated only recently at about 10 to 12 million years ago in two widely separated localities in west-central Colorado, at Treasure Mountain, 60 miles southwest of the Gore Range (Obradovich and others, 1969) and at Hahns Peak, 80 miles northwest of Mount Powell (K. G. Segerstrom and E. J. Young, U.S. Geological Survey, written commun., 1969). The mineralization of the preglacial colluvium with fluorspar at the Hammer deposits indicates that the mineralizing process continued at least as late as late Pliocene time.

Whether all of the signs of mineralization in the range are products of this one geologically late event is uncertain, but certainly most of them are. Thus the mineralization is largely if not entirely younger than the mineralization episodes that produced the large ore deposits of Climax, Leadville, Gilman, and other districts in the mineral belt nearby (Tweto, 1968b). This considerably reduces the attractiveness of the Gore Range as a site for exploration, for aside from fluorspar (Steven, 1960; Van Alstine, 1964) and small ore deposits at Treasure Mountain (Vanderwilt, 1937) and Hahns Peak (George and Crawford, 1909), no really significant ore deposits of this young age are thus far known in Colorado.

COAL, OIL, AND GAS

No possibility exists for the presence of coal, oil, or gas within the block of Precambrian rocks between the Gore and Frontal faults. No coal is known in the sedimentary rocks to the east and west of the block of Precambrian rocks, and the possibility of its existence is slight because coal is not a component of this part of the stratigraphic column anywhere in this part of Colorado. Possibilities for the occurrence of oil and gas in the sedimentary rocks exist in theory, but in fact they appear remote. No producing well exists in Middle Park, where several tests have been drilled, and the chances for the occurrence of oil and gas are better there than in the thin and much-faulted sedimentary rocks of the lower eastern flank of the Gore Range. On the western side of the range, a far thicker and less faulted sequence of sedimentary rocks exists. The wedging of these rocks toward the Gore fault, and structural features such as the anticline beneath East Meadow Creek and the adjoining part of the Piney River, would be favorable to accumulation of oil or gas if any existed in the area, but none is known to exist. However, it has not been proved that accumulations of oil or gas do not exist. The nearest test hole in these rocks is 20 miles to the west. Neither it nor others farther to the west and northwest in the same rocks as those of the Piney River area have resulted in oil or gas production.

NONMETALLIC MINERALS

No potential for nonmetallic minerals other than some of those classed as common materials was recognized in the area of Precambrian rocks in the Gore Range. Pegmatites are numerous, but they are all of a prosaic quartz-feldspar-biotite composition. None of the commercially important pegmatite minerals such as beryl, muscovite, lepidolite, and spodumene were seen. Absence of beryl particularly is borne out by the uniformly low beryllium content of stream sediments (table 8). The rare earths lanthanum and yttrium in the stream sediments probably were derived from minerals present in trace amounts in the pegmatites. Many of the sediment samples showed zirconium in amounts exceeding 1,000 ppm (table 8). The zirconium is in zircon, an almost indestructible mineral that is a trace constituent of the granitic rocks and only a minor constituent of the stream sediments. Many stream-sediment samples showed more than 1 percent (>10,000 ppm) titanium, which

TABLE 8.—*Analyses of stream-sediment samples from the Gore Range, Colo.*

[For sample locations see plate 2. Numbers in parentheses indicate sensitivity limit of method used. The symbol > indicates that an undetermined amount of the element is present above the number shown; L indicates that an undetermined amount of the element is present below the sensitivity limit; N indicates that the element was looked for but was not found.]

Sample	Semiquantitative spectrographic analyses[1/] (ppm)																Chemical analyses[2/] (ppm)	
	Ti (20)	Mn (10)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)
	A--Stream sediments from Elliott Creek drainage																	
121	5,000	1,500	15	300	L	20	70	15	70	L	10	30	30	30	20	N	200	L(0.04)
122	5,000	700	15	300	N	15	50	20	L	L	15	20	30	30	15	N	150	L
123	5,000	700	15	300	N	15	100	15	L	L	15	20	20	30	15	N	200	L(0.04)
124	5,000	700	15	300	L	20	200	15	100	L	15	30	30	50	200	N	150	L
125	7,000	700	15	500	L	30	500	15	200	5	15	30	30	70	100	N	500	L(0.04)
126	7,000	700	30	300	1.5	15	200	10	100	L	15	50	20	100	20	N	150	L
127	5,000	700	30	300	1.5	15	100	10	150	L	10	30	20	70	30	N	300	L
128	5,000	2,000	30	300	3	20	70	15	200	5	15	30	30	70	50	N	150	L(0.04)
129	5,000	1,000	50	300	1.5	20	70	10	70	L	15	30	30	70	100	N	300	L(0.04)
130	700	2,000	20	300	L	20	30	7	50	L	10	20	20	50	15	L	150	L(0.04)
131	7,000	1,000	15	500	1.5	20	150	15	70	L	15	30	30	100	20	L	150	L(0.10)
214	7,000	700	15	300	N	15	30	7	L	N	L	15	10	50	15	N	150	L
215	7,000	1,000	20	700	N	20	150	15	N	L	10	20	15	100	15	N	100	L
216	7,000	500	50	300	L	30	700	30	1,000	10	15	70	30	700	150	N	700	L
217	5,000	1,500	20	300	N	20	150	10	50	5	15	30	20	100	15	L	200	L
218	7,000	700	20	700	N	20	300	20	100	5	15	30	20	150	70	N	200	L
219	7,000	300	30	300	N	20	500	15	70	7	15	30	30	500	30	N	200	L
	B--Stream sediments from Cataract Creek drainage																	
35	3,000	1,000	20	1,000	2	10	50	100	150	L	20	50	20	100	50	L	200	L
36	7,000	700	50	500	2	20	150	15	100	L	20	50	20	100	20	L	500	0.02
37	7,000	1,000	50	700	2	20	500	70	150	10	20	70	30	200	50	L	500	.04
38	7,000	1,500	50	700	1.5	20	100	20	100	L	20	70	20	100	50	L	500	.02
39	10,000	1,000	20	700	2	20	200	30	100	5	20	70	50	100	50	L	500	.02
40	7,000	1,000	50	500	2	20	100	20	100	5	20	50	50	100	50	L	300	L
41	10,000	1,500	50	500	2	20	100	20	100	10	20	50	50	100	30	L	500	.02
42	5,000	500	50	1,000	2	20	150	30	100	10	20	70	50	150	30	L	200	L
44	10,000	1,000	20	1,000	2	15	700	30	300	5	20	100	50	200	70	N	500	.04
181	7,000	500	15	300	L	15	300	30	150	L	15	30	30	200	150	N	700	L
196	7,000	5,000	20	700	N	20	300	15	300	5	15	30	15	150	100	N	700	L
197	3,000	700	20	300	N	15	70	10	150	L	15	15	15	100	50	N	300	L
198	2,000	700	20	700	N	20	150	30	150	L	15	30	20	150	30	N	200	L
199	7,000	700	15	300	N	15	300	20	150	L	15	30	20	300	150	N	300	L
200	7,000	300	15	300	N	15	150	15	70	L	15	30	20	150	30	N	150	L
201	7,000	700	15	300	N	15	150	10	150	L	15	30	20	70	150	N	500	L
222	7,000	150	15	300	20	15	500	15	150	L	15	30	20	200	20	N	150	L
225	7,000	300	15	500	N	20	70	15	100	L	15	30	20	100	150	N	300	L
226	7,000	300	15	300	L	15	300	15	500	5	15	70	30	150	100	N	1,000	L
227	7,000	300	20	300	1.5	15	50	15	70	L	10	20	15	70	15	N	150	L
228	7,000	700	30	300	L	20	70	15	70	L	15	30	30	70	20	N	500	L(0.10)
229	7,000	200	15	300	L	15	70	10	50	L	10	30	20	70	20	N	300	L
230	5,000	1,500	15	300	2	20	30	15	70	L	10	15	20	70	15	N	300	------
231	7,000	500	15	300	L	20	200	15	70	L	15	30	20	150	100	N	150	L
236	1,000	500	20	300	L	20	300	15	200	L	15	50	30	150	>200	N	300	L
237	5,000	500	50	300	1.5	20	150	15	70	L	10	30	30	100	15	N	150	L
238	5,000	300	30	300	1	20	300	15	700	L	10	50	50	200	200	N	150	L
296	7,000	700	10	300	1.5	20	150	70	70	L	15	70	30	100	20	N	200	L
301	5,000	700	15	700	1.5	15	70	30	70	L	15	30	30	100	20	N	300	L
303	7,000	1,000	15	700	1.5	20	100	30	100	L	15	30	200	100	20	L	300	L

1/ Also looked for spectrographically but not found: Au(10), As(200), Sb(100), and W(50). Present in some samples in amounts below sensitivity limit: Bi(10), Cd(20), Sn(10), except as noted. Values for Sr(<1,500) and Sc(<70) not listed for brevity.

2/ Sensitivity limit for gold is 0.02 ppm for normal 10 gram sample. Where insufficient sample was available, the sensitivity limit ranges up to 0.20 ppm as shown in parentheses for individual samples.

TABLE 8.—*Analyses of stream-sediment samples from the Gore Range, Colo.*—Continued

Sample	Semiquantitative spectrographic analyses[1/] (ppm) Ti (20)	Mn (10)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	V (10)	Y (10)	Zn (200)	Zr (10)	Chemical analyses[2/] (ppm) Au (.02)
	C--Stream sediments from Otter Creek drainage and to North																	
182	7,000	300	10	300	L	15	300	15	150	L	15	30	20	150	70	N	700	L
183	7,000	700	10	700	L	15	150	30	70	L	10	30	30	150	150	N	150	L
184	7,000	1,000	15	500	L	30	30	15	70	N	30	15	30	70	70	N	500	L
185	7,000	700	15	300	L	15	50	15	70	L	10	30	20	70	70	N	150	L
186	7,000	500	10	300	L	15	150	20	L	L	15	30	20	100	150	N	150	L
187	7,000	300	15	300	L	15	50	15	100	N	15	30	15	70	50	N	300	L
250	7,000	500	15	300	L	20	150	20	100	5	15	30	20	150	30	N	>1,000	L
253	7,000	700	15	500	N	15	70	10	70	L	15	20	20	70	70	N	200	L
254	7,000	700	15	300	L	15	70	10	20	L	10	20	20	70	10	N	200	L
255	7,000	500	20	500	L	20	150	20	50	L	20	30	20	100	30	N	300	L
256	7,000	500	15	300	L	15	150	20	70	L	15	30	30	100	30	N	200	L
257	7,000	700	15	500	N	15	70	15	70	L	15	30	20	70	20	N	300	L
258	7,000	700	15	500	L	15	300	15	150	L	15	30	30	150	70	N	300	L
	D--Stream sediments from Black Creek drainage																	
193	7,000	700	15	300	L	15	300	15	70	L	15	30	15	150	20	N	70	L
262	7,000	700	20	700	L	20	150	30	70	7	20	30	30	100	150	N	300	L
263	5,000	300	15	300	L	15	100	20	50	L	15	30	15	100	30	N	200	L
264	7,000	500	10	300	N	15	150	10	70	L	10	30	20	100	20	N	150	L
265	7,000	500	15	300	L	20	70	30	70	5	15	30	30	70	30	N	150	L
456	>10,000	1,500	30	1,000	1.0	30	500	50	100	5	20	100	150	200	70	L	1,000	L
457	>10,000	1,500	30	1,000	1	30	200	50	100	5	20	100	100	200	70	L	1,000	L
461	10,000	1,500	30	1,000	1	30	200	50	100	5	20	100	150	200	70	L	1,000	L
462	>10,000	1,000	30	1,000	L	30	300	50	70	5	20	150	100	200	70	N	1,000	L
466	10,000	1,000	30	1,000	L	20	300	50	100	5	20	100	150	200	70	N	1,000	L
483	10,000	1,000	20	1,000	L	30	500	50	200	5	20	70	70	200	100	L	>1,000	L
486	>10,000	1,000	20	1,000	L	30	500	50	100	5	20	70	70	200	70	L	>1,000	L
487	>10,000	1,000	50	700	1	50	300	30	150	7	20	100	70	200	100	L	1,000	L
490	>10,000	700	50	700	L	30	200	30	70	5	20	70	70	200	70	L	500	L
491	>10,000	1,000	50	700	1	30	200	50	100	7	20	70	70	200	70	L	700	L
492	>10,000	1,000	50	700	1	30	200	30	150	5	20	70	70	200	70	L	1,000	L
530	>10,000	1,000	50	1,000	L	30	500	30	100	5	20	150	70	200	70	L	500	L
532	>10,000	2,000	50	1,000	1	30	200	30	70	5	20	30	70	200	70	L	700	L
536	>10,000	1,000	50	1,000	L	30	150	30	100	5	20	30	70	200	200	L	700	L
537[3/]	>10,000	1,000	50	1,000	1	20	300	30	100	20	20	50	150	200	50	200	500	L
538	>10,000	1,000	50	1,000	1	30	200	30	70	5	20	50	70	200	30	L	700	L
539	>10,000	1,000	50	1,000	2	30	150	50	100	5	20	30	100	200	30	L	1,000	L
550	>10,000	1,000	50	1,000	1	20	200	50	100	5	20	30	150	200	30	L	1,000	L
598	>10,000	1,000	50	1,000	L	20	200	30	100	10	20	30	70	200	70	L	1,000	L
609	>10,000	1,000	50	1,000	1	20	200	30	100	10	20	30	70	200	70	L	500	L
615	>10,000	1,000	50	1,000	1	20	200	30	200	10	20	30	100	200	70	L	700	L
617	>10,000	2,000	50	1,000	1	30	150	50	100	10	20	30	100	200	50	L	500	L
619	>10,000	1,500	50	1,000	L	30	500	30	200	10	20	50	50	300	70	L	1,000	L
620	10,000	1,000	50	1,500	1	20	150	30	100	5	20	50	50	200	70	L	200	L
621	>10,000	1,000	100	700	L	20	2,000	30	50	20	20	150	30	300	100	L	>1,000	L
631	>10,000	700	50	500	1	20	200	30	100	5	20	50	100	200	100	L	1,000	L
	E--Stream sediments from Brush Creek to Hay Camp Creek drainage																	
83	5,000	300	15	500	N	7	70	7	30	N	L	15	15	70	15	N	300	L
188	7,000	700	15	300	N	10	30	7	70	N	L	15	15	70	30	N	700	L
189	7,000	700	15	300	L	15	70	15	150	L	20	20	20	150	30	N	>1,000	L
190	7,000	300	15	700	N	15	50	10	70	N	15	10	15	70	20	N	700	L
191	7,000	700	10	300	L	15	150	7	70	L	15	15	15	150	70	N	700	L

3/ 100 ppm Sb.

TABLE 8.—*Analyses of stream-sediment samples from the Gore Range, Colo.*—Continued

Sample	Semiquantitative spectrographic analyses[1/] (ppm)																Chemical analyses[2/] (ppm)
	Ti (20)	Mn (10)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)
	E--Stream sediments from Brush Creek to Hay Camp Creek drainage--Continued																	
192	7,000	500	L	300	L	15	70	15	70	L	15	20	15	70	15	N	300	L
194	7,000	700	20	300	L	20	300	15	300	5	20	30	20	300	>200	N	>1,000	L
195	7,000	700	15	300	L	15	150	15	70	L	15	15	20	150	30	N	700	L
202	5,000	700	15	700	N	15	50	30	70	L	15	20	20	70	30	N	300	L
203	7,000	700	15	300	N	15	70	15	L	L	30	30	20	100	20	N	300	L
204	7,000	700	15	500	N	15	70	20	100	L	10	30	15	70	20	N	150	L
305	5,000	500	10	500	1.5	10	30	10	70	L	10	10	15	70	20	N	150	L
306	7,000	700	15	300	1.5	15	70	30	70	L	15	30	15	70	30	N	700	L
307	7,000	500	L	300	1.5	15	30	15	70	L	15	15	15	70	30	N	700	L
	F--Stream sediments from Slate Creek drainage																	
48	>10,000	700	20	500	2.0	10	500	20	500	5	20	50	50	150	>200	N	>1,000	0.04
49	7,000	2,000	20	700	2	20	200	20	300	5	20	50	50	150	70	N	500	.04
50	7,000	1,000	20	700	2	15	100	30	150	L	20	50	50	100	50	N	500	.04
51	1,000	700	20	700	2	15	200	20	150	5	20	70	30	150	50	N	300	L
56	>10,000	700	10	1,000	2	10	100	15	200	5	20	20	20	100	100	N	500	.02
57	>10,000	700	10	1,000	2	10	150	20	300	L	20	20	30	100	100	N	700	.02
58	10,000	500	10	500	2	10	200	15	300	5	20	20	30	150	50	N	500	.02
78	7,000	700	15	700	N	20	70	15	70	L	10	30	20	70	20	N	300	L
79	3,000	700	15	700	N	20	70	15	70	L	L	30	20	70	20	N	150	L
80	3,000	5,000	30	700	N	30	70	15	50	10	10	30	20	100	20	N	150	L
81	7,000	700	10	700	N	5	70	7	50	L	10	15	20	70	20	L	200	L
82	10,000	700	15	300	N	7	500	15	300	5	15	30	20	300	>200	N	700	L
206	7,000	700	L	500	L	15	150	15	70	L	10	15	20	150	50	N	300	L
207	10,000	700	L	700	L	15	70	15	100	N	10	30	20	100	>200	N	700	L
208	10,000	700	10	300	L	15	300	15	50	5	10	30	15	150	20	N	700	L
209	7,000	700	10	700	L	15	150	15	70	L	15	30	20	70	150	N	700	L
330	10,000	700	20	1,000	L	20	200	20	100	L	20	20	20	200	30	L	500	L
331	10,000	1,500	20	1,000	L	20	200	20	100	L	20	20	50	200	50	L	500	L
469	>10,000	1,000	50	1,000	5	30	200	50	100	5	20	70	150	200	70	L	500	.04
471	>10,000	1,500	50	1,000	2	30	150	50	100	10	20	50	150	200	70	L	500	L
473	>10,000	1,000	50	1,000	2	20	100	20	50	5	20	30	100	200	50	L	500	L
474	>10,000	700	50	1,000	L	30	200	30	150	L	20	30	70	200	100	L	1,000	L
475	>10,000	700	50	1,000	1	30	100	30	150	5	20	30	70	200	70	L	300	L
599	>10,000	500	50	1,000	L	20	200	30	100	5	20	30	50	200	70	L	1,000	L
600	>10,000	700	50	1,000	L	20	150	30	L	5	20	30	100	200	70	L	1,000	L
601	>10,000	1,000	50	1,000	L	20	150	30	100	5	20	30	100	200	70	L	1,000	L
603	>10,000	1,000	50	700	1	20	150	20	200	10	20	30	70	200	70	L	200	L
607	>10,000	700	30	1,000	L	20	150	30	150	5	20	30	50	200	70	L	200	L
608	>10,000	1,500	10	1,000	L	20	200	10	150	L	10	30	50	200	70	L	1,000	L
	G--Stream sediments from Harrigan Creek and Boulder Creek drainages																	
23	10,000	1,000	30	700	1.5	20	300	70	300	10	20	50	50	200	50	L	700	0.02
24	7,000	700	20	300	1.5	10	100	20	100	L	20	70	50	100	30	L	200	.02
25	3,000	1,000	10	500	1.5	20	70	20	100	L	20	50	30	100	30	L	150	.02
26	10,000	1,000	20	500	2	10	100	30	100	5	20	70	50	100	70	L	200	.02
45	>10,000	700	10	700	2	20	100	20	150	5	20	50	30	150	50	N	500	L(0.04)
46	10,000	700	10	700	2	10	100	15	100	L	20	30	20	100	50	N	500	.02
47	10,000	700	20	700	2	20	100	15	200	L	20	50	50	150	>200	N	1,000	.02
52	10,000	700	20	1,000	2	20	300	30	200	5	20	70	50	150	50	N	500	.02
53[4/]	10,000	1,000	50	500	L	50	2,000	20	700	20	20	150	30	300	>200	N	1,000	.04
54	10,000	500	20	700	2	10	300	20	100	5	20	20	30	150	30	N	300	L

4/ Panned concentrate.

TABLE 8.—*Analyses of stream-sediment samples from the Gore Range, Colo.*—Continued

Sample	Semiquantitative spectrographic analyses[1] (ppm) Ti (20)	Mn (10)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	V (10)	Y (10)	Zn (200)	Zr (10)	Chemical analyses[2] (ppm) Au (.02)
G--Stream sediments from Harrigan Creek and Boulder Creek drainages--Continued																		
55	10,000	500	20	700	2	10	700	15	300	10	20	20	30	150	100	N	700	0.04
134	7,000	150	20	300	1	15	30	10	70	N	15	30	20	70	70	N	700	L
135	7,000	200	15	300	1	15	50	10	70	N	15	30	20	100	30	L	500	L
136	5,000	150	15	500	1.5	15	70	15	50	L	15	30	20	70	15	N	200	L
137	5,000	300	10	500	1.5	15	70	10	50	N	15	30	30	100	20	N	150	L
138	5,000	700	15	300	1.5	15	70	50	70	N	15	30	50	100	20	N	70	L
152	5,000	700	15	300	1.5	20	70	30	100	L	15	50	30	70	20	N	150	L
322	7,000	1,500	20	1,000	1	20	200	30	100	L	20	50	100	150	70	L	300	L
323	10,000	1,000	20	1,000	L	30	500	30	700	L	20	20	50	200	>200	L	>1,000	L
329	10,000	700	20	1,000	L	20	200	20	100	L	20	20	20	200	70	L	>1,000	L
337	10,000	2,000	30	1,000	L	30	300	50	100	5	20	30	100	300	70	L	>1,000	L
338	10,000	3,000	30	1,000	L	30	200	50	100	5	20	50	150	300	70	L	150	L
339	10,000	2,000	30	1,000	L	30	300	30	100	5	20	20	70	300	70	L	>1,000	L
340	10,000	2,000	20	1,000	L	30	200	50	100	5	20	70	70	200	70	L	500	L
341	10,000	2,000	20	1,000	L	20	150	30	100	5	20	20	150	200	70	L	1,000	L
342	10,000	2,000	20	1,000	1	30	150	30	100	7	20	20	50	300	70	L	1,000	L
343	10,000	1,000	20	700	1	20	100	30	100	5	20	30	50	200	70	L	700	L
H--Stream sediments from Pebble Creek to Maryland Creek drainages																		
10	7,000	700	50	700	2.0	20	200	30	100	5	20	70	150	100	100	L	200	0.02
11[4]	7,000	300	50	300	1	20	700	20	300	10	20	100	50	300	200	L	1,000	.02
12	10,000	700	20	700	1	20	200	20	1,000	5	20	100	70	200	>200	L	>1,000	.02
13	10,000	1,000	20	700	1	20	150	20	1,000	L	20	20	50	150	200	L	500	L
16	10,000	1,000	20	700	1.5	50	100	20	70	5	20	20	50	100	20	L	300	.02
27	10,000	700	20	500	1.5	10	500	10	700	5	20	50	50	150	>200	L	1,000	L
28	7,000	700	10	1,000	1	10	100	15	300	L	20	50	50	100	200	L	700	.02
29[4]	>10,000	1,000	20	700	L	20	500	20	700	5	20	50	50	150	200	L	>1,000	L
30	7,000	700	50	1,000	2	15	150	30	100	L	20	70	50	150	30	L	200	.02
31	5,000	1,000	10	1,000	2	20	100	15	200	L	20	50	50	100	30	L	200	L
32	5,000	1,000	20	1,000	2	10	70	15	500	5	20	50	50	100	50	L	500	.04
95	7,000	700	15	300	N	20	70	15	70	L	10	20	20	30	50	N	300	L
111	5,000	700	20	500	N	20	150	15	70	L	15	30	30	30	100	200	200	L(0.10)
112	7,000	300	10	500	L	15	70	30	70	L	15	15	30	30	30	L	>1,000	L
356	10,000	1,500	20	1,000	L	20	100	30	100	L	20	20	100	200	70	L	300	L
357	10,000	1,500	20	1,500	L	20	150	20	150	5	20	30	100	200	70	L	1,000	L
358	10,000	1,000	20	1,500	L	20	150	30	100	5	20	20	100	200	70	L	>1,000	L
359	10,000	1,000	20	1,500	1	20	100	30	100	5	20	20	100	150	70	L	>1,000	L
360	>10,000	1,000	20	1,500	L	30	150	30	100	L	20	30	70	200	50	L	200	L
361	10,000	1,000	20	1,000	1	20	150	20	500	10	20	30	70	200	70	L	300	L
362	>10,000	1,000	20	1,000	1	30	150	20	100	5	20	20	70	200	70	L	>1,000	L
367	>10,000	1,000	20	1,000	1	30	150	20	300	5	20	20	70	200	70	L	>1,000	L
381	>10,000	1,000	20	1,000	1	30	200	20	150	5	20	20	100	200	100	L	>1,000	L
407	>10,000	1,000	20	1,000	L	30	500	50	100	7	20	70	100	200	70	L	1,000	L
408	>10,000	1,000	20	1,000	1	30	300	30	100	5	20	70	150	300	70	L	1,000	L
410	>10,000	1,000	20	1,000	2	20	300	30	100	5	20	30	150	200	50	200	500	L
411	>10,000	2,000	50	1,000	2	30	300	70	100	7	20	50	150	200	150	200	500	L
413	>10,000	1,000	50	1,000	1	30	200	30	300	5	20	30	100	200	100	L	500	L
503	>10,000	1,000	50	1,000	L	30	100	30	200	L	20	30	70	200	70	L	700	L
I--Stream sediments from Willow Creek drainage																		
59	5,000	700	10	700	N	15	70	7	70	L	10	30	20	70	30	N	>1,000	L(0.10)
61	7,000	1,000	10	1,500	N	15	100	7	700	L	15	30	30	150	70	N	700	L
62	5,000	150	L	700	N	10	70	7	70	N	10	15	30	70	30	N	70	L(0.04)
63	5,000	700	L	700	N	15	70	15	150	N	10	30	50	70	30	N	700	L(0.04)
64	7,000	500	10	700	N	10	50	10	150	N	L	30	30	70	30	N	500	L(0.04)

TABLE 8.—*Analyses of stream-sediment samples from the Gore Range, Colo.*—Continued

Sample	Semiquantitative spectrographic analyses[1/] (ppm) Ti (20)	Mn (10)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	V (10)	Y (10)	Zn (200)	Zr (10)	Chemical analyses[2/] (ppm) Au (.02)
I--Stream sediments from Willow Creek drainage--Continued																		
65	5,000	500	10	700	N	15	70	7	150	L	10	70	30	70	30	N	>1,000	L
66	7,000	700	15	700	N	5	70	15	150	L	15	30	20	70	>200	N	>1,000	L
76	7,000	500	10	700	N	15	70	7	300	L	10	30	30	100	50	N	700	L(0.10)
77	5,000	700	10	700	N	10	70	10	100	L	10	30	70	70	30	N	700	L(0.04)
422	>10,000	700	50	1,000	1.0	20	100	30	150	L	20	30	150	200	70	L	>1,000	L
423	>10,000	1,000	20	1,000	L	20	100	50	150	L	20	30	150	200	70	L	300	L
430	>10,000	1,000	20	1,000	L	20	150	30	150	5	20	30	100	200	70	L	>1,000	0.06
431	>10,000	1,500	30	1,000	1	20	150	50	150	5	20	30	100	200	100	L	>1,000	L
437	>10,000	1,000	30	1,000	L	20	150	30	150	5	20	30	100	200	70	L	>1,000	L
521	>10,000	1,000	50	1,000	1	30	150	30	300	L	20	30	70	200	70	L	700	L
721	10,000	2,000	50	1,500	L	30	300	30	50	10	20	30	100	200	200	L	700	L
722	>10,000	1,000	50	1,500	1	30	200	50	150	10	20	50	100	200	50	L	700	L
723	>10,000	1,500	50	1,500	1	30	150	20	150	7	20	30	100	200	70	L	1,000	L
724	>10,000	1,500	50	1,000	1	30	100	20	200	7	20	30	70	200	70	L	1,000	L
726	10,000	700	50	1,000	1	20	100	20	200	L	20	30	50	200	70	L	1,000	L
730	10,000	700	50	1,000	L	30	150	30	200	5	20	30	50	200	70	L	1,000	L
731	10,000	1,000	50	1,000	L	20	150	20	200	L	20	20	50	200	70	L	>1,000	L
732	>10,000	2,000	50	1,000	L	20	100	20	200	10	20	20	50	200	70	L	>1,000	L
733[5,6/]	3,000	1,500	L	1,000	1	15	150	70	300	N	10	7	100	150	70	L	700	L
734[5,6/]	3,000	1,500	10	1,000	1	20	150	70	200	N	15	20	70	200	70	200	700	L
735[7/]	3,000	1,000	15	700	1.5	20	70	50	100	N	L	15	100	100	50	200	150	L
736[5,8/]	3,000	700	L	700	1	20	100	50	150	N	10	10	70	150	70	L	700	L
737[5,6/]	3,000	700	10	700	1	20	150	50	150	N	10	20	100	150	70	L	500	L
J--Stream sediments from Ryan Gulch to Meadow Creek drainages																		
84	3,000	2,000	15	300	N	15	70	7	150	L	L	15	15	70	30	N	150	L(0.04)
85	7,000	300	10	500	L	10	30	30	50	L	10	15	30	30	20	N	>1,000	L
86[7/]	7,000	2,000	15	700	L	15	70	15	500	L	15	20	30	30	100	N	500	L
87	7,000	1,000	15	700	L	20	70	15	500	L	15	30	30	30	50	200	100	L
88	5,000	3,000	20	700	L	30	200	30	50	15	15	70	30	50	20	L	500	L
89	7,000	1,500	15	500	L	30	150	30	70	L	15	50	30	50	100	N	150	L
115	5,000	1,000	15	500	L	20	70	15	500	L	15	20	30	30	100	N	100	------
119	7,000	1,000	15	700	L	20	150	15	100	L	15	30	30	70	>200	L	500	L(0.20)
120	5,000	3,000	15	500	L	30	150	30	500	10	15	70	50	30	100	N	150	L
1123	5,000	700	10	700	2.0	15	70	10	150	N	10	15	50	70	50	N	700	L
1124	3,000	300	10	700	1.5	10	100	7	500	N	10	10	30	70	70	N	700	L
1125[5/]	3,000	700	10	700	2	15	100	15	100	N	10	15	70	70	50	N	300	L
1199	3,000	300	10	500	1.5	7	70	7	70	N	10	15	50	70	30	L	500	L
K--Stream sediments from North Fork Tenmile Creek and Officers Gulch drainages																		
394	>10,000	1,000	20	1,000	L	30	50	20	200	5	20	20	70	300	200	L	1,000	L
395	>10,000	1,500	20	1,000	L	30	700	30	100	5	20	50	70	300	100	L	500	L
396	>10,000	1,500	20	1,000	L	30	500	20	200	7	20	50	50	300	100	L	700	L
397	>10,000	1,500	20	1,000	L	30	500	20	100	5	20	50	50	300	100	L	700	L
399	>10,000	1,500	20	1,000	L	30	500	30	300	7	20	50	50	300	100	L	500	L(0.05)
400	>10,000	1,000	20	1,000	1	30	700	150	100	7	20	150	50	300	100	L	>1,000	L
401	>10,000	1,000	20	1,000	L	30	500	30	200	7	20	100	70	300	70	L	500	L
402	>10,000	1,000	30	1,000	L	30	500	20	100	7	20	70	70	300	70	L	300	L
404	>10,000	1,000	20	1,000	L	30	700	20	100	7	20	70	50	300	70	L	>1,000	L
1126	5,000	500	10	700	1.5	10	150	15	150	N	10	15	30	70	50	N	700	L
1127[6/]	5,000	500	15	700	2	15	150	15	70	N	10	20	50	100	50	L	300	L
1128	7,000	500	15	700	2	15	150	15	1,000	N	15	15	70	70	150	N	700	L
1129	5,000	300	15	700	2	10	200	10	150	N	15	15	50	70	200	N	300	L
1130	7,000	700	20	700	2	15	200	15	50	N	15	30	50	100	30	L	300	L
1131	7,000	300	20	700	1.5	10	150	10	100	N	10	20	10	70	30	N	500	L

5/ 10 ppm Sn.

6/ <.5 ppm Ag.

7/ 1 ppm Ag.

8/ .7 ppm Ag.

TABLE 8.—*Analyses of stream-sediment samples from the Gore Range, Colo.*—Continued

Sample	Semiquantitative spectrographic analyses[1] (ppm)																Chemical analyses[2] (ppm)
	Ti (20)	Mn (10)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)
K--Stream sediments from North Fork Tenmile Creek and Officers Gulch drainages--Continued																		
1133	5,000	300	20	700	1.5	10	70	10	70	N	10	15	20	70	30	N	500	L
1134	7,000	1,000	30	700	1.5	15	200	10	150	N	15	15	70	70	30	L	200	L
1135	7,000	1,000	15	1,000	1.5	15	150	15	100	N	15	15	70	100	50	L	300	L
1136	7,000	2,000	10	700	2	20	150	20	50	N	10	20	70	100	30	L	200	L
1137	5,000	700	20	700	2	15	150	10	100	N	10	15	70	100	70	L	300	L
1140	7,000	300	20	700	2	10	150	10	70	N	15	15	20	100	50	L	500	L
1141	3,000	500	30	500	3	15	100	10	30	N	10	20	30	70	20	L	150	L
1142	3,000	500	15	500	2	15	70	10	70	N	10	20	30	70	50	L	150	L
1143	5,000	700	10	300	1.5	20	150	15	20	N	10	50	20	150	20	L	150	L
1157	3,000	200	20	500	2	10	100	7	50	N	10	20	15	70	30	N	150	L
1158	5,000	700	10	500	1	20	300	15	70	N	10	100	20	200	30	L	150	L
1159	3,000	700	20	700	2	15	200	10	100	N	10	70	30	150	150	L	700	L
1160	7,000	500	10	700	1.5	15	300	10	50	N	10	15	20	200	50	L	500	L(0.05)
1161[6]	5,000	700	15	700	3	15	150	50	100	N	10	15	70	100	100	L	500	L
1162	3,000	500	15	700	2	10	100	7	70	N	10	15	20	70	70	N	300	L
1163	3,000	1,000	10	700	1.5	10	150	10	100	5	10	30	20	70	50	L	200	L
1164	3,000	1,000	10	700	1.5	15	150	10	30	L	10	50	50	150	30	200	300	L
1165[6]	5,000	700	15	700	1.5	15	150	15	150	L	10	100	15	150	50	L	300	L
1166	3,000	1,000	20	700	1.5	10	150	30	30	N	10	100	70	100	30	L	150	L
L--Stream sediments from Black Gore Creek																		
142	5,000	700	15	300	L	15	70	30	70	L	20	30	30	70	30	N	150	L
157	7,000	300	30	700	L	15	70	10	70	L	15	30	30	70	30	N	300	L
158	3,000	700	20	700	L	15	70	30	50	L	15	20	30	70	20	N	150	L
159	7,000	300	30	300	L	15	70	30	70	L	15	20	20	70	50	N	300	L
160	3,000	700	15	700	L	15	70	70	70	L	15	20	30	70	150	N	200	L
161	5,000	700	20	300	L	15	70	30	L	L	20	30	20	70	>200	N	150	L
162	10,000	700	15	700	L	15	50	10	70	L	15	15	20	150	30	N	300	L
163	5,000	700	20	300	L	15	70	70	70	L	15	30	30	70	30	N	300	L
164	3,000	300	20	300	L	15	50	15	100	L	15	20	20	70	20	N	150	L
165	3,000	300	30	700	L	15	70	10	70	L	15	20	30	70	15	N	150	L
166	5,000	200	100	300	L	15	70	7	150	L	15	20	20	70	30	N	200	L
167	3,000	200	15	300	L	15	30	7	150	L	15	20	15	70	20	N	150	L
168	7,000	300	30	300	L	15	70	7	150	L	15	30	30	100	150	N	150	L
169	5,000	300	30	300	L	15	50	7	70	L	15	20	20	70	15	N	100	L
170	3,000	300	15	300	L	15	50	15	70	L	15	20	30	70	15	N	150	L
171	7,000	300	20	300	L	15	150	15	70	L	15	30	30	100	20	N	100	L
172	7,000	700	15	300	1.5	15	150	15	70	L	15	30	20	100	30	N	200	L
174	7,000	300	15	500	L	15	70	10	70	L	15	30	30	70	30	N	700	L
175	7,000	300	20	500	L	15	70	7	100	L	15	30	30	70	20	N	700	L
176	5,000	300	15	300	1.5	15	70	7	100	N	10	30	20	70	30	N	700	L
177	3,000	300	15	700	N	15	70	7	70	L	10	15	30	70	20	N	500	L(0.05)
178	5,000	700	15	500	N	10	70	7	30	L	L	30	20	70	30	N	300	L(0.05)
179	7,000	500	20	300	L	15	150	7	700	L	10	30	30	150	>200	N	300	L
180	5,000	700	20	700	L	15	70	15	150	10	L	30	50	100	150	N	150	L
267	5,000	500	30	500	2	15	70	20	70	L	15	30	30	70	20	N	700	L
268	5,000	500	20	300	1.5	15	70	7	70	L	10	30	30	70	20	N	300	L
269	7,000	1,500	20	700	1.5	20	70	30	70	L	15	30	30	70	30	N	300	L(0.05)
270	5,000	700	15	700	1.5	15	70	15	70	L	10	20	30	70	20	L	150	L
271	5,000	300	15	300	L	10	50	7	100	L	10	15	20	70	15	N	150	L
272	5,000	700	15	700	N	15	70	20	100	L	10	30	30	100	30	N	700	L
273	5,000	1,000	50	700	N	10	30	15	70	L	10	15	30	70	20	200	200	L
M--Stream sediments from Gore Creek drainage																		
453	>10,000	1,000	30	1,500	L	30	200	30	200	5	20	30	150	200	100	300	>1,000	L
454	10,000	1,000	30	1,000	L	20	100	20	200	5	20	20	100	150	70	L	500	L
455	2,000	150	10	1,000	L	5	30	10	500	L	20	10	100	50	50	L	100	L
672	>10,000	1,000	70	1,000	1.0	30	150	70	300	5	20	50	150	200	50	L	300	L
708	10,000	200	50	1,500	1	10	50	10	200	L	20	50	150	100	50	L	1,000	L

TABLE 8.—*Analyses of stream-sediment samples from the Gore Range, Colo.*—Continued

Sample	Semiquantitative spectrographic analyses[1/] (ppm) Ti (20)	Mn (10)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	V (10)	Y (10)	Zn (200)	Zr (10)	Chemical analyses[2/] (ppm) Au (.02)
	M--Stream sediments from Gore Creek drainage--Continued																	
712	>10,000	1,000	50	1,500	L	30	150	20	150	5	20	10	100	200	50	L	700	L
713	>10,000	1,000	50	1,500	1	30	200	20	150	5	20	20	100	200	70	L	700	L
714	>10,000	1,000	50	1,500	1	20	150	30	500	5	20	20	100	200	70	L	700	L
715	10,000	1,000	50	1,000	1	20	70	20	200	L	20	20	100	150	70	L	500	L
716	>10,000	1,000	50	1,500	L	20	100	20	200	L	20	20	100	200	70	L	700	L
718	>10,000	1,000	50	1,500	L	30	200	30	200	5	20	20	100	200	70	L	>1,000	L
719	>10,000	1,000	50	1,500	L	30	200	30	200	5	20	30	100	200	70	L	1,000	L
720	10,000	700	50	1,500	L	20	150	30	200	7	20	30	100	200	70	L	1,000	L
790[5,9/]	3,000	1,000	20	1,000	1.5	30	150	70	150	N	10	30	100	150	70	L	300	L
791[8/]	3,000	500	15	700	1.5	20	150	30	150	N	10	30	70	150	70	200	500	L
792	3,000	300	L	700	1	10	70	30	300	N	L	10	50	70	70	N	500	L
796[5/]	3,000	1,000	30	700	1.5	20	100	30	300	N	15	20	100	100	50	L	200	L
811	3,000	700	20	500	1.5	20	100	30	150	N	15	20	100	100	50	N	500	L
812	3,000	700	20	500	2	15	70	70	70	N	10	15	70	100	15	N	200	L
845	3,000	300	20	500	1.5	15	70	50	70	N	10	20	70	100	20	L	200	L
846	3,000	1,000	20	700	1.5	30	150	50	100	5	15	20	70	150	7	N	150	L
847	3,000	700	20	700	1.5	15	50	30	200	L	10	15	70	100	30	L	300	L
848	5,000	700	L	700	1.5	20	150	30	300	N	15	15	50	150	70	L	500	L
849	3,000	700	10	700	1.5	20	70	30	150	L	10	20	70	100	70	L	200	L
850[5/]	3,000	700	10	700	1.5	15	50	50	200	N	10	20	100	100	50	L	300	L
851	3,000	700	20	500	2	30	70	30	150	N	15	30	70	150	30	L	300	L
860[5/]	3,000	1,500	30	500	1.5	20	150	30	150	N	10	20	150	150	50	300	300	L
863[5/]	3,000	1,500	20	500	1.5	30	150	50	200	L	15	30	150	150	50	200	300	L
866[9/]	3,000	500	20	300	1.5	15	50	30	70	N	10	20	100	100	30	L	300	L
867	3,000	700	20	300	1	20	100	50	300	N	10	15	70	100	70	N	500	L
	N--Stream sediments from Bighorn Creek drainage																	
888[9,10/]	5,000	1,500	20	700	2.0	30	150	100	100	N	20	50	200	200	50	500	300	L
894[5/]	5,000	1,500	15	700	1.5	30	150	70	150	N	15	50	200	200	70	500	150	L
895	3,000	500	10	700	1.5	30	150	70	100	5	15	30	150	150	50	300	150	L
896[9/]	3,000	700	20	300	2	20	150	100	100	N	15	30	150	100	50	300	150	L
902	3,000	700	10	300	1.5	30	150	70	200	N	20	30	150	150	70	L	300	L
904	3,000	1,500	10	500	1.5	30	100	70	300	N	20	30	100	150	70	200	300	L
906[9/]	3,000	1,500	15	500	2	30	150	100	150	N	20	30	150	150	50	L	300	L
	O--Stream sediments from Pitkin Creek drainage																	
913	5,000	700	L	300	1.5	30	200	70	300	N	20	30	70	200	70	200	300	L
931	3,000	1,000	10	300	1.5	30	150	70	100	N	15	50	70	150	70	L	300	L
932	3,000	1,500	L	200	1.5	30	150	100	70	N	10	50	150	200	50	700	70	L
935	3,000	1,500	10	300	2	30	150	70	150	N	15	50	70	100	50	200	150	L
940	3,000	500	15	300	2	20	150	70	70	N	15	50	150	100	50	L	300	L
943	3,000	700	15	300	2	20	150	70	300	N	15	50	100	100	70	L	200	L
	P--Stream sediments from Booth Creek drainage																	
927	3,000	1,000	L	300	3.0	15	150	70	100	N	20	30	70	100	30	L	200	L
952	5,000	700	10	300	2	20	150	70	70	N	15	50	100	150	70	L	300	L
953	3,000	1,000	10	300	1.5	30	200	70	70	N	15	100	70	150	70	N	300	L
954	3,000	1,000	10	300	1.5	20	150	70	500	N	15	20	100	100	70	N	700	L
955	5,000	1,000	10	500	1.5	30	150	70	50	N	20	50	70	150	70	N	300	L
956	5,000	700	10	300	2	15	150	50	200	N	15	30	70	150	70	N	200	L
958	5,000	1,000	10	300	2	20	150	30	300	N	15	30	70	150	70	N	200	L
959	3,000	700	10	500	2	20	150	30	100	N	15	30	50	150	50	N	300	L
960	3,000	1,500	20	300	1.5	20	100	70	100	N	15	30	150	150	50	L	200	L
962	3,000	1,500	100	1,000	2	30	150	70	150	N	15	50	70	300	50	300	300	L(0.10)

9/ .5 ppm Ag.

10/ 15 ppm Sn.

TABLE 8.—*Analyses of stream-sediment samples from the Gore Range, Colo.*—Continued

Sample	Semiquantitative spectrographic analyses[1] (ppm)																Chemical analyses[2] (ppm)	
	Ti (20)	Mn (10)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)
	P--Stream sediments from Booth Creek drainage--Continued																	
963	3,000	1,500	100	1,000	3.0	30	150	70	200	5	15	50	100	300	50	200	500	L(0.04)
967	3,000	1,500	20	500	3	30	150	70	200	5	15	50	100	200	50	200	300	L(0.04)
968	3,000	700	15	500	2	50	200	70	70	N	15	70	70	200	30	L	200	L
969	3,000	700	15	700	2	30	150	70	70	N	20	20	70	200	70	L	700	L
974	3,000	700	50	500	2	30	200	70	300	N	20	50	70	200	>200	L	200	L
975	5,000	700	15	700	2	15	150	15	100	N	10	50	30	150	70	N	500	L
988	5,000	700	20	500	2	15	150	10	100	N	10	30	50	100	50	N	150	L
990	3,000	500	20	700	2	10	150	7	70	N	10	15	20	100	50	N	500	L
993	3,000	300	30	500	3	10	150	7	70	N	10	20	20	100	70	N	300	L
	Q--Stream sediments from Red Sandstone Creek and Middle Creek drainages																	
1049	5,000	300	20	500	2.0	15	150	7	200	N	10	15	50	100	200	N	700	L
1050	5,000	200	20	300	2	10	200	5	200	N	10	20	50	100	150	N	500	L
1055	5,000	300	10	500	2	15	150	10	50	N	10	20	20	150	50	N	300	L
1057	3,000	300	30	300	2	10	150	7	200	N	10	15	50	100	70	N	500	L
	R--Stream sediments from Piney River drainage																	
997	5,000	500	30	700	2.0	15	150	10	70	N	10	50	70	100	50	N	200	L
1000	5,000	500	20	500	1.5	15	150	10	70	N	10	20	20	100	50	N	150	L
1001	5,000	500	20	500	5	15	150	7	70	N	10	30	50	100	30	L	300	L
1002	5,000	300	15	500	2	15	150	10	70	N	15	20	20	100	30	L	200	L
1003	5,000	500	15	500	5	10	150	7	100	N	10	15	70	70	70	300	300	L
1004	3,000	700	15	500	3	15	150	7	50	7	10	20	50	100	20	L	150	L
1006	3,000	200	20	500	3	10	150	10	50	N	10	30	50	100	30	N	500	L
1008	3,000	150	15	500	2	10	150	10	50	N	10	20	50	100	20	L	150	L
1010	3,000	500	15	500	2	10	150	10	50	N	10	15	70	100	30	N	150	L
1047	5,000	300	50	500	2	15	150	7	150	N	10	50	50	100	50	N	150	L
1058	5,000	200	15	500	2	15	200	7	100	N	10	15	50	100	70	200	200	L
1059	5,000	300	20	500	2	10	150	7	100	N	10	15	30	100	70	N	300	L
1061	3,000	300	15	500	2	15	150	10	50	N	10	50	30	150	20	N	150	L
1062	3,000	500	20	500	1.5	15	150	10	500	N	10	50	50	100	100	N	500	L
1063	3,000	500	20	700	2	15	150	7	50	N	L	50	20	100	70	N	300	L
1065	7,000	700	20	700	2	20	200	10	150	N	10	50	50	200	70	N	700	L
1067	3,000	500	20	700	2	20	300	15	50	N	10	50	50	200	50	N	700	L
1074	5,000	500	20	700	3	20	300	50	100	N	10	100	50	200	50	L	200	L
1075	5,000	500	15	700	2	20	300	15	150	N	10	100	50	200	70	L	500	L
1077	3,000	500	20	500	2	15	300	10	700	N	15	50	30	100	100	N	150	L
1078	5,000	300	30	700	2	15	100	20	30	N	10	20	20	150	20	N	150	0.02
1079	3,000	500	20	700	2	20	300	15	150	N	10	100	70	150	70	N	500	L
1080	3,000	700	15	700	3	20	200	20	70	N	10	100	50	100	30	N	150	L
1195	3,000	150	30	700	1	10	150	5	100	N	10	15	10	100	50	N	500	L
1196	2,000	200	20	500	1	7	50	5	20	N	10	15	15	50	30	N	500	L
1198	2,000	300	20	300	1	7	70	5	150	N	10	10	10	70	50	N	500	L
	S--Stream sediments from Meadow Creek drainage																	
1081	5,000	300	20	700	2.0	15	150	10	100	5	10	50	20	100	30	N	150	L
1082	2,000	200	20	700	2	15	200	7	1,000	N	10	20	50	100	100	N	1,000	L
1104	3,000	500	30	700	2	15	200	10	700	N	10	20	20	100	100	N	700	L
1105	3,000	700	20	700	3	10	150	20	500	N	10	20	50	100	70	N	300	L
1106	3,000	1,000	50	700	2	15	100	10	70	N	10	15	20	100	30	N	300	L
1107	3,000	700	50	700	2	15	150	10	70	N	10	20	20	100	50	N	300	L
1108	7,000	500	20	700	2	15	300	15	150	N	10	50	15	200	50	N	150	L
1109	7,000	700	30	700	2	15	150	15	200	N	15	20	50	150	100	N	700	L
1110	2,000	150	50	300	1	5	50	5	30	N	10	7	L	50	10	N	700	L
1111	7,000	200	20	700	1.5	20	1,000	7	300	N	15	20	70	300	100	N	1,000	L
1112	5,000	150	70	500	1	7	150	7	100	N	10	10	10	70	50	N	>1,000	L
1113	3,000	700	50	700	1.5	7	20	5	50	N	10	10	10	70	30	N	200	L
1197	2,000	200	30	300	1	7	100	5	20	N	10	15	15	70	20	N	500	L

TABLE 8.—*Analyses of stream-sediment samples from the Gore Range, Colo.*—Continued

Sample	Semiquantitative spectrographic analyses[1/] (ppm)																	Chemical analyses[2/] (ppm)
	Ti (20)	Mn (10)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	V (10)	Y (10)	Zn (200)	Zr (10)	Au (.02)
T--Stream sediments from North Fork Piney River drainage																		
1083	3,000	300	50	500	1.5	15	200	10	70	N	10	15	20	100	20	N	200	L
1084	2,000	300	50	500	1.5	10	200	10	300	N	10	15	20	100	100	N	700	L
1087	2,000	200		700	1.5	10	100	10	50	10	10	30	15	300	30	N	150	L
1088	3,000	300	70	700	1.5	15	200	10	50	10	10	50	20	300	30	N	200	L
1089	3,000	300	70	700	1.5	15	300	15	70	5	15	70	20	300	50	N	150	L
1090	3,000	500	70	700	2	15	300	10	200	N	10	50	20	150	200	N	150	L
1091	3,000	700	50	500	2	15	150	10	200	N	10	20	30	100	70	N	200	L
1114	5,000	700	30	700	2	10	150	10	50	N	10	20	15	70	30	L	300	L
1191	3,000	150	70	700	1.5	10	100	7	20	5	10	20	10	150	20	L	200	L
1194	2,000	200	70	500	1.5	10	70	7	30	7	10	20	15	150	20	N	150	L

probably is principally in the form of ilmenite, an accessory mineral in the Precambrian rocks and a major constituent of the generally small fraction of black sand in the stream sediments. To be of any commercial interest, the titanium content of the sediments would have to be many percent, and very large deposits would have to be available.

On the eastern flank of the range, a definite potential for fluorspar exists in the sedimentary rocks east of the Frontal fault. The only fluorspar deposits known are the Hammer deposits, in one of the few small areas not covered by glacial drift. It is not likely that these are the only deposits in the area. Others probably exist beneath the glacial drift, but whether better, poorer, or the same as the Hammer deposits is not predictable.

Claims filed on Slate Mountain and vicinity, immediately west of the Primitive Area (see "Slate Mountain area" in "Economic appraisal"), are purportedly for silica in the Dakota Sandstone, although some of the claims are in areas where the Dakota does not exist. As exposed on Slate Mountain, the middle part of the Dakota does indeed contain beds consisting of very clean quartz sand. The individual sandstone beds are 8 to 20 inches thick and in most places they are separated by thin beds or lenses of brown, limy, clay-flecked impure sandstone. Locally, however, the clean sandstone exists in thicknesses of several feet. No attempt was made by the authors to determine whether the sandstone of this particular locality is more pure than that elsewhere in the region. Except for this question of degree of purity of certain beds, the sandstone in the Dakota in this area appears to be of the same general character as elsewhere in Colorado and adjoining States. Many occurrences of sandstone containing more than 98 percent silica are known in the Dakota of Colorado (Argall, 1949; Carter, 1964).

CONCLUSIONS

The Gore Range-Eagles Nest Primitive Area contains no known ore deposits, and no geologic evidence exists to indicate a likelihood of hidden deposits at depth beneath it, even though many fractures are geochemically anomalous. The chances for the existence of ore deposits increase eastward from the boundary of the Primitive Area, particularly at and beyond the Frontal fault and, more particularly, in the southern half of the area. However, no ore deposits are known even in this area except at the Boss mine and the economically marginal Hammer fluorspar deposits. West of the Primitive Area, the chances for ore deposits also increase with distance from the area boundary, but not as markedly as on the east side. Unlike the Frontal fault, the Gore fault is not itself a promising potential site of ore deposits, but deeply buried limestone beds to the west of it might be.

Mineral potential increases rapidly to the south of the Primitive Area as the area is adjoined on the south by the most productive segment of the Colorado mineral belt. Conversely, the potential decreases to the north.

No potential whatever for coal, oil, or gas exists within the Primitive Area, and essentially none exists to the east of it on the lower flank of the Gore Range. On the west side of the range, and west of the Primitive Area, structural and stratigraphic conditions exist that would be favorable to the accumulation of gas or oil if they exist in the area, but the possibility of their presence has not been tested.

No, or very low, potential for nonmetallic minerals—other than those classed as common materials—is recognized within the Primitive Area. East of the Primitive Area and the Frontal fault, however, a potential exists for fluorspar deposits.

ECONOMIC APPRAISAL

By Frank E. Williams, U.S. Bureau of Mines

Mining activity in the Gore Range occurred in two places, both outside the Primitive Area. The Boss Group (also known as Boss-Thunderbolt) is credited with 187 tons of ore since 1900 and slightly more than 1,900 tons of ore prior to that date. Most of the value was from gold and silver. This mining property is just east of the Primitive Area boundary along Rock Creek (pl. 2).

The other mineralized area in the Gore Range having significant exploration activity is Chief Mountain, about 4½ miles east of the southern part of the Primitive Area, near the town of Frisco. No production has been recorded although many veins and structures were explored by tunneling.

All the workings studied during this investigation are on small quartz veins or veinlets. Many are in contact zones of pegmatite dikes with surrounding country rock. Most of these workings are caved. Some workings that existed when the surveys for patent were made (described in original survey notes) have been caved or obliterated.

Where possible, rock samples collected by the U.S. Bureau of Mines were chipped across veins or shear zones. However, most handpicked specimens of vein quartz were selected from dumps. The sampled sites are shown on plate 2, on which Bureau of Mines sample numbers are marked by an underline. All samples collected were assayed (table 9). Although assays of such material do not truly represent the worth of their respective deposits, they do reflect the minerals associated with the deposit. In addition to gold and silver assays, all samples were checked for other elements by spectrograph (table 10). Samples high in base and other metal values were verified by standard assay procedures (table 9).

MINING CLAIMS

Patented lode claims are shown on plate 2. Locations of these patented claims, as reported herein, were obtained from U.S. Bureau of Land Management microfilm copy of the original surveyors' field notes, which described the location in relation to natural features rather than cultural features. The plotting on plate 2 reflects this description.

The Gore Range-Eagles Nest Primitive Area contains 24 patented claims totaling 190 acres. All were patended in 1912 or earlier. Three other claims were surveyed for patent, but a patent was not granted. Adjoining parts of the study area contain an additional 22 patented lode claims and 2 patented millsite claims. These nearby claims total 126 acres. Nine of the lode claims and a millsite claim are within 1 mile of the east-central boundary of the Primitive Area (patented in 1921 or earlier). Twelve of the lode claims and a millsite claim are 3 miles south of the southern boundary (patented 1915). One 20-acre lode claim patented in 1936 abuts the Primitive Area near Black Lake on the northern boundary.

Unpatented lode claims are also shown on plate 2. No unpatented claims are on record as being within the confines of the Primitive Area. Several location monuments were observed in the vicinity of Eagles Nest Mountain in the northern part of the area, but none of the claims were recorded in county records; one test pit of nondescript nature was seen in that area. The study area peripheral to the Primitive Area contains 37 unpatented lode claims associated with mining or exploration activity. In addition, adjoining the northwestern boundary of the Primitive Area are 337 placer claims (6,740 acres) recorded in Eagle County. These claims, covering Slate Mountain and adjacent areas, are not shown on plate 2.

Information about unpatented claims was obtained from courthouse records in Eagle (Eagle County) and Breckenridge (Summit County). All recorded claims filed in mining districts in and near the Primitive Area were noted. Some date to about 1900 but have

TABLE 9.—*Assays of vein and dump samples and Dakota Sandstone samples from the Gore Range.*

[Analyses by Charles O. Parker and Co., commercial assayers, Denver, Colo. Tr., trace; ----, not assayed]

Sample	Ounces per ton		Percent		
	Au	Ag	Cu	Pb	Zn
RED PEAK AREA					
621	0.005	0.12	-----	-----	-----
622	Tr.	Tr.	-----	-----	-----
623	Tr.	.28	0.005	-----	0.037
624	Tr.	.06	-----	-----	-----
625	Tr.	Tr.	-----	-----	-----
626	.01	.05	-----	-----	-----
627	Tr.	.48	.02	-----	-----
BIGHORN CREEK AREA					
628	Tr.	Tr.	0.21	-----	-----
629	Tr.	Tr.	-----	-----	-----
630	0.005	0.24	.23	-----	-----
KELLER MOUNTAIN AREA					
631 [1]	Tr.	0.98	0.15	-----	-----
632	Tr.	Tr.	-----	-----	-----
DELUGE LAKE AREA					
633	0.01	0.80	0.85	-----	-----
PITKIN CREEK AREA					
634	Tr.	0.14	-----	-----	-----
CHIEF MOUNTAIN AREA					
635	Tr.	Tr.	-----	0.11	0.17
636	Tr.	Tr.	-----	-----	.28
637	0.005	0.06	-----	.11	.15
638	.03	2.21	-----	.75	.28
639	.005	.14	-----	-----	-----
640	Tr.	2.70	0.019	.088	.22
641	Tr.	.08	-----	.36	.095
642	Tr.	Tr.	-----	-----	-----
643	Tr.	.04	-----	-----	-----
644	Tr.	.06	.025	.32	-----
645	Tr.	.06	-----	-----	.13
646	Tr.	Tr.	-----	-----	-----
647	Tr.	.36	.019	-----	.62
648	.01	.15	-----	-----	.23
WHEELER LAKES AREA					
649 [2]	0.01	0.27	0.34	-----	-----

DAKOTA SANDSTONE ON SLATE MOUNTAIN

Sample	Percent		
	SiO_2	Al_2O_3	Fe_2O_3
650	96.24	3.80	0.68
651	97.72	.91	1.09
652	97.18	2.04	.48

[1] Molybdenum (Mo): 0.003 percent.
[2] Antimony (Sb): 0.009 percent.

TABLE 10.—*Semiquantitative spectrographic analyses of vein and dump*

[Analyses by U.S. Geological Survey, Denver, Colo. N indicates that the element element is present below the sensitivity limit. The symbol < indicates that the determined amount of the element

Sample	Percent	Parts per						
	Ti	Mn	Ag	As	Ba	Bi	Cd	Cr
621	0.07	700	<1	N	700	N	N	15
622	.15	100	<1	N	100	N	N	20
623	.05	200	15	N	700	N	L	10
624	.10	150	1.5	N	300	N	N	15
625	.07	100	L	N	700	N	N	10
626	.05	70	2	N	100	N	N	15
627	.05	100	15	N	700	N	N	15
628	.01	70	2	N	20	N	N	15
629	.07	100	N	N	200	N	N	15
630	.05	150	5	N	200	N	N	L
631	.01	150	3	N	50	L	N	5
632	.15	150	N	N	500	N	N	70
633	.03	100	7	N	700	10	N	10
634	.01	150	10	2,000	5,000	N	N	N
635	.07	1,000	1.5	N	150	N	N	10
636	.03	300	1.5	N	100	N	N	5
637	.01	700	7	N	L	N	N	5
638	.01	200	20	500	20	N	N	10
639	.02	500	.5	N	100	N	N	5
640	.03	300	10	N	200	N	N	15
641	.50	3,000	.5	N	500	N	50	15
642	.03	300	L	N	500	N	N	10
643	.15	200	L	N	300	N	N	15
644	.20	700	1	N	500	N	N	70
645	.15	700	1.5	N	500	N	N	100
646	.03	100	N	N	100	N	N	5
647	.15	700	30	N	700	N	500	100
648	.10	500	.5	N	100	N	L	20
649	.07	70	3	200	3,000	N	N	30
650	.10	100	N	N	70	N	N	15
651	.03	70	N	N	100	N	N	5
652	.03	20	N	N	70	N	N	5

samples and Dakota Sandstone samples from the Gore Range

was looked for but was not found. L indicates that an undetermined amount of the amount present is less than the number shown. The symbol > indicates that an un- is present above the number shown]

million

Cu	Mo	Ni	Pb	Sb	Sn	Sr	V	W	Zn
50	N	15	10	N	N	100	30	N	N
10	15	7	70	N	N	L	50	N	L
500	L	10	300	N	N	150	20	N	2,000
70	L	10	70	N	N	L	50	N	L
7	N	10	20	N	N	150	30	N	N
10	50	10	70	N	N	L	20	N	N
500	N	10	70	N	N	100	20	N	N
700	N	7	500	N	N	100	10	N	N
15	N	10	20	N	10	150	30	N	N
1,500	N	5	20	N	15	150	10	N	N
1,500	150	7	300	N	N	N	10	N	300
10	N	20	10	N	10	200	70	N	N
7,000	N	5	L	N	N	L	50	N	N
70	50	5	15,000	500	N	>5,000	15	N	2,000
30	N	5	1,000	N	N	N	30	N	2,000
10	L	5	300	N	N	N	10	N	3,000
10	30	5	7,000	N	N	N	10	N	1,500
70	N	5	1,500	N	N	N	15	N	3,000
5	N	5	70	N	N	N	10	N	200
150	L	10	2,000	N	N	N	30	N	>10,000
20	N	5	1,000	N	N	L	30	N	3,000
7	N	15	100	N	N	N	30	N	L
30	N	15	100	N	N	150	50	N	N
150	N	15	5,000	N	10	N	70	N	300
20	N	20	700	N	N	L	50	N	1,500
15	N	5	50	N	L	L	10	N	N
300	N	20	200	N	N	100	70	N	>10,000
30	10	20	200	N	N	N	100	N	3,000
1,500	N	15	L	150	N	2	20	N	N
5	N	5	N	N	N	100	20	N	N
10	N	7	N	N	N	N	20	N	N
7	N	5	N	N	N	N	20	N	N

no recent filings of labor affidavits. Only those with sufficient location information are shown on plate 2. At least 80 claims listed in the county records are too vaguely described to identify as to precise geographic location. A search was made in the general areas indicated for such claims, but no evidence of current exploration activity was noted.

ECONOMIC EVALUATION

Diggings on patented claims within the Primitive Area boundary are on tight quartz veins and veinlets, along pegmatite host-rock contact zones, and on structural shear zones and jointing planes. Figure 20 illustrates the type of vein upon which most work was conducted. Virtually all the country rock in the Primitive Area consists of Precambrian granite, gneiss, and schist containing isolated pegmatites virtually devoid of metallic substance. No places were observed where residual iron staining might indicate metallic ore deposition beneath the surface.

It is doubtful that any economical lode mining of metallic minerals can be done within the Primitive Area. Placer mining is possible but doubtful. There is no leased ground for nonmetallic minerals in or near the Primitive Area. Oil and gas production potential is practically nil. The nearest well drilled in exploration for oil or gas is in sec. 9, T. 1 N., R. 80 W., about 17 miles north of the Primitive Area.

According to an unpublished Defense Minerals Exploration Administration (DMEA) report of 1959, some exploration was conducted for uranium in the Minturn Formation along U.S. Highway 6 about 11 miles east of Vail, Colo. Although a small tonnage of submarginal ore was disclosed by drilling, results were discouraging and the project was abandoned. This formation barely reaches the boundary of the Primitive Area.

DESCRIPTION OF DEPOSITS

The following descriptions of mineralized areas in or near the Primitive Area are given in order of decreasing extent of mining and exploratory workings. Five mineralized areas within the Primitive Area are: Red Peak, Bighorn Creek, Keller Mountain, Deluge Creek, and Pitkin Creek. Nearby, but outside the Primitive Area, mining or exploration has been conducted at North Rock Creek, Chief Mountain, Wheeler Lakes, South Willow Creek, Slate Mountain, and Black Lake.

RED PEAK AREA

There are seven patented and two surveyed, but unpatented, lode claims in the vicinity of Red Peak (area C, pl. 2), all above 12,000 feet altitude. Three patented claims, Silver Vault, Defiance, and Highline Chief, and the two surveyed but unpatented claims, Bell Wether and Julia, are in the NW 1/4 sec. 7, T. 5 S., R. 78 W. These claims are near the highest part of Red Peak. Three of the patented claims, Bromide, Evening, and Curtis, are in the E 1/2 sec. 12, T. 5 S., R. 79 W., just west of the saddle between the Gore Creek and South Willow Creek drainages. The seventh patented claim, Treasure Vault, is in the NE 1/4 sec. 1, T. 5 S., R. 79 W., just northwest of upper Willow Lake.

All the patents were granted before 1895. All the workings except on the Silver Vault claim are caved or otherwise inaccessible. Most of the development work indicated in the patent surveyor's original notes has been obliterated by rock talus.

Seven rock samples were taken for assay (621–627, table 9). Five samples were handpicked from dumps of silicified material from veins or pegmatites; two were collected underground. Results showed a trace to 0.01 ounce of gold per ton and a trace to 0.48 ounce of silver per ton. Samples 624 and 625 were collected underground at the Silver Vault claim. Sample 624 was gouge material which had sloughed off the back 160 feet from the portal of the 212-foot-long tunnel; sample 625 was chipped across a 5-inch vein near the portal. The vein structure exposed in the 212-foot-long tunnel consists of two tight quartz stringers, each 2 to 3 inches wide and separated by a 2-foot barren zone. The structure bears generally N. 15° W. and dips steeply southwest.

Workings on the Bromide, Evening, and Curtis claims were obliterated when examined in mid-1969 except for a shallow, water-filled shaft. Selected material (sample 623) from the dump contained a trace of gold and 0.28 ounce of silver per ton.

No sign of mining activity was evident at the Treasure Vault claim near upper Willow Lake. However, a sample (627) of pegmatite from a test pit at the inlet to lower Willow Lake contained a trace of gold and 0.48 ounce of silver per ton.

BIGHORN CREEK AREA

Nine claims were patented in the upper Bighorn Creek drainage, two (Bighorn Nos. 1–2) in 1908, and seven (Dollie Nos. 1–7) in 1912 (area E, pl. 2). The claims are in projected secs. 32 and 33, T. 4 S., R. 79 W., and lie at an altitude above 11,000 feet.

Most development work was done on the Dollie group. Several small test pits and a short tunnel were reported at the time of patent survey, but the major working at that time was a 362-foot-long crosscut tunnel reported to cut several veins. The portal of this tunnel is now caved. Two samples were taken. Sample 628 (table 9), a chip sample across a 6-inch veinlet at the portal of a 25-foot tunnel, showed traces of gold and silver. Sample 629, of handpicked quartz from the dump of the main tunnel, contained traces of gold and silver.

One opening was found on the Bighorn claims—a 40-foot tunnel driven on a shear zone in granite, but no mineralization was encountered, not even quartz.

A badly caved tunnel was found about 2 miles from the highway near the trail between U.S. Highway 6 and the Dollie group of claims. A selected dump sample (630) of copper oxides and silicified material assayed 0.005 ounce of gold and 0.24 ounce of silver per ton. The working is not known to be covered by a claim, even though it appeared to have been explored in a minor way in mid-1969.

KELLER MOUNTAIN AREA

There are two patented claims and one surveyed, unpatented claim on Keller Mountain (area C, pl. 2). All three are just above timberline on a northeast-trending ridge, above 11,000 feet. No production has been recorded.

The Orphan Boy claim, patented in 1892, is in the SE ¼ sec. 15, T. 4 S., R. 79 W. At the time of patent a 330-foot adit bearing S. 28° W. had been driven. Two other short adits had been driven. In 1969, the shorter adits were caved and the long one was too dangerous to enter, mainly because of loose talus rock overlying the portal and dry-rotted timber sets. A selected sample (631) of the vein material showing copper-oxide minerals was taken from the dump; results showed a trace of gold and 0.98 ounce of silver per ton.

The War Eagle claim, patented in 1901, is in the SW ¼ sec. 14, T. 4 S., R. 79 W. When the claim was examined in mid-1969 all the workings were caved. According to the original surveyor's notes these workings consisted of a 126-foot tunnel bearing S. 40° W., a 41-foot tunnel bearing south and southwest, and a 50-foot shaft. A dump sample (632) of vein matter, mainly quartz, was selected for assay. Assay results showed traces of gold and silver.

At the unpatented O. K. claim, a short caved adit is the only evidence of mining activity. No sample was taken.

DELUGE LAKE AREA

Three claims were patented prior to 1893 immediately south of a lake at the head of Deluge Creek in projected sec. 4, T. 5 S., R. 79 W. (area E, pl. 2). The K. P. Brown, Valley, and Combination claims are at an altitude of 11,500 feet, just above timberline.

At the time of patent survey, a 75-foot tunnel and several shallow test pits were reported. The only visible openings in 1969 were eight test pits excavated on shear zones in granite. One pit, about 200 feet south of the lake, was cut on a 6-inch veinlet showing copper oxides. A chip sample (633) across the veinlet assayed 0.01 ounce of gold and 0.80 ounce of silver per ton.

PITKIN CREEK AREA

Near the head of Pitkin Creek are three claims called Cascade, Elizabolt, and Silver King, all patented in 1890 (area E, pl. 2). They are in projected secs. 18 and 19, T. 4 S., R. 79 W., at an altitude of about 11,600 feet.

At the time of patent survey, three short tunnels had been cut in granite along thin quartz veins. Only one tunnel, a 40-foot tunnel on the Elizabolt claim, was still intact in mid-1968. The tunnel bears N. 71° E. for 20 feet and then follows a veinlet N. 19° W. for another 20 feet. Sample 634, chipped from 6 inches of vein material at the face, showed 0.14 ounce of silver per ton and a trace of gold.

The photograph (fig. 20) of one typical quartz-filled vein of the type that was explored in the Gore Range was taken about 500 feet south of the Cascade claim tunnel. The vein is about 8 inches thick at its widest place.

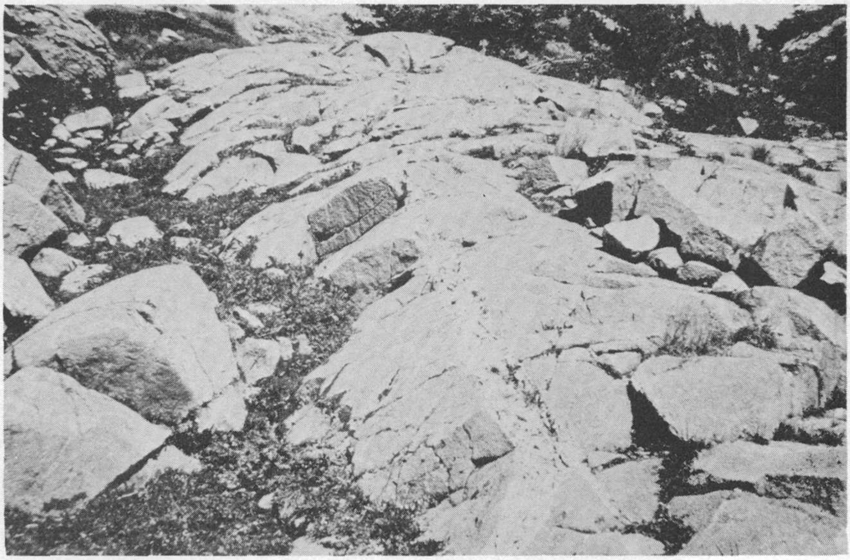


FIGURE 20.—Typical quartz vein in granite; vein is about 8 inches thick at its widest place.

NORTH ROCK CREEK AREA

The most significant mining activity in the Gore Range occurred just outside the Primitive Area along North Rock Creek. This activity was on what is herein referred to as the Boss Group. (Some records have referred to the claims as Boss-Thunderbolt.) The claims are in secs. 12, 13, 23, and 24, T. 4 S., R. 79 W., at an altitude of about 10,500 feet (area C, pl. 2).

The original Boss Group of claims consisted of four patented lode claims, 15 unpatented lode claims, and one unpatented millsite claim. The claims overlapped. The approximate location of unpatented claims with respect to patented claims, as shown on plate 2, is the result of piecing together scant information about unpatented claims recorded in the county records at Breckenridge. These records indicate that 16 unpatented and partly overlapping claims now constitute the holdings along with eight patented lode claims and one patented millsite claim. The patented claims are: Boss, Josie, Magnet, Alhambra, Denver, Wall Street, Maryanna, Independent French, and Independent French millsite. A private report by J. H. Marks[3] indicates that slightly more than 1,900 tons of ore valued at about $222,000 was mined in the period 1882–97. Production recorded by the Bureau of Mines dates from 1901. Since then a total of 187 tons valued at about $16,000 was taken in small amounts by lessees to as late as 1963. Most of the values were in gold and silver but some returns were realized from base-metal production.

The report by Marks also indicated that about 6,000 feet of workings were made on contact-fissure veins ranging in thickness from 18 inches to 12 feet. Trends of these veins vary considerably but generally are northwestward. In mid-1969, all the workings were caved at their portals, but samples from the dumps (samples 5–7, table 4) were taken. Marks obtained 14 dump samples, assay results of which indicate up to 0.40 ounce of gold and 64 ounces of silver per ton, 1.3 to 5.9 percent copper, and up to 26 percent lead. In 1945 Newmont Mining Corp. obtained dump samples for assay in behalf of the current owner; results of nine samples ranged from a trace to 0.06 ounce of gold, averaged 1.83 ounces of silver per ton, and showed 2 percent or less of lead and zinc. Figure 21 shows the site and dumps of the Boss mine as they appeared in 1969.

One claim, the Alger, was located, surveyed, and patented (1892) on an east-trending ridge about 1 mile south of the Boss

[3] Unpublished report by John H. Marks, 1928, quoting unpublished report by T. F. Van Wagenen (date unknown).

FIGURE 21.—Boss mine dumps; view looking north.

Group. No sign of mining or exploratory activity was observed when the area was visited in 1969, although two short tunnels had been reported by the original surveyor.

CHIEF MOUNTAIN AREA

At least 13 unpatented lode claims cover workings on Chief Mountain and two are reported along the North Fork of Tenmile Creek which flows eastward on the south side of the mountain (area D, pl. 2). There are 18 other lode claims on the mountain for which recorded information is so limited that the claims could not be plotted accurately.

Mining activity on the mountain was mainly in the 1920's and early 1930's. There is no record of production, however, under the names of the known unpatented claims. Probably the ores were mined chiefly for their lead and zinc, although gold and silver may have been recovered as byproducts.

Most workings were driven along pegmatitic quartz veins in gneissic or schistose rock. These veins consist mainly of quartz with abundant muscovite and other micas, with minor sulfide mineralization. Fourteen samples (635–648) were taken and assayed (table 9).

Two mine workings were intact in 1969 and were entered, mapped, and sampled. Both are on the east flank of the mountain, one at about 9,800 feet in altitude and the other about 500 feet higher.

The lower working consists of a 210-foot adit trending generally S. 25° W. along a pegmatite dike contact zone in gneiss. At the face, sample 635 was chipped from a 1-foot-wide vein structure bearing S. 10° E. and dipping 56° E. Assay results showed traces of gold and silver. Some minor stoping had been conducted on this structure beginning at about 75 feet from the portal.

The upper working consists of three levels connected by three raises. The main level was entered, mapped, and sampled, but the raises and upper two levels were too dangerous to be examined. The main (haulage) level is 340 feet long. At 120 feet from the portal one raise was driven on a 70° incline. At 250 feet from the portal a 22-foot crosscut was driven to a 1-foot-thick vein bearing N. 62° E. and dipping 53° NW. Minor stoping along the vein was done for 10 feet. Sample 637, chipped across the vein, assayed 0.005 ounce of gold and 0.06 ounce of silver per ton. At the end of the 340-foot main haulage level a major vein structure bearing N. 40° W. was explored by two raises, with chutes, spaced 45 feet apart. Quartz material in the chutes (sample 636) contained traces of gold and silver.

Three dump samples (638–640) were taken at caved workings on the east flank of the mountain. The best assay result was 0.03 ounce of gold and 2.21 ounces of silver per ton. Sample 641, cut across a mafic dike at the bottom of a 7-foot winze (at the end of a 20-foot adit), showed a trace of gold and 0.08 ounce of silver per ton.

Four selected dump samples (643–646) and one chip sample (642) were taken from caved workings on a northeastward-trending ridge of the mountain. The chip sample was taken on a 2-inch veinlet at the face of a 32-foot adit bearing S. 75° W. Its assay showed a trace of gold and silver. The best of the four selected dump samples assayed a trace of gold and 0.06 ounce of silver per ton.

Two selected samples (647–648) were taken of pegmatitic and gouge material from dumps adjacent to two caved workings along the North Fork of Tenmile Creek. One contained 0.01 ounce of gold and 0.15 ounce of silver per ton, the other showed a trace of gold and 0.36 ounce of silver per ton.

FIGURE 22.—Slate Mountain; view looking west from Elliott Ridge.

WHEELER LAKES AREA

Twelve patented lode claims, one patented millsite claim, and one unpatented lode claim are located about three-fourths of a mile west of Wheeler Lakes (area D, pl. 2). The claims are: Climax, No Name, May, Mason, Gyp, Eagle, Howard, Dry, Mildred, Little Bird, Monte, Copper Bonanza, Copper Bonanza millsite, and 3-V's (unpatented). Several hillside cuts and a dump at a caved tunnel are the only evidence of exploration activity; no production is recorded. The patents were issued in 1915; the unpatented claim was staked in the early 1960's.

According to the original surveyor's notes a 250-foot tunnel was driven along a N. 30° W. course. It probably was extended slightly during the early 1960's as evidenced by fresh rock material and an unrusted small ore car on the dump. A selected sample (649) from the dump assayed 0.01 ounce of gold and 0.27 ounce of silver per ton.

SOUTH WILLOW CREEK AREA

Two caved workings (area C, pl. 2) are in sec. 9, T. 5 S., R. 78 W., along the South Willow Creek trail. The eastern working apparently was driven on a structural weakness in granite. The size of the dump indicates at least 100 feet of workings. No veinlike

FIGURE 23.—Outcrop of Dakota Sandstone on top of Slate Mountain.

material was seen. It is believed that this working was at one time locally called the County Treasure tunnel.

The western working is a short exploration adit driven on a shear zone which strikes westward and dips about 45° S. There is no quartzitic matter on the dump. No samples were taken.

SLATE MOUNTAIN AREA

A total of 337 placer claims have been recorded in Eagle County; they are in Tps. 3 and 4 S., Rs. 81 and 82 W. (area F, pl. 2). None of these claims are in the Primitive Area but the group is adjacent to the northwest boundary on Elliott Ridge. Apparently the claims were located with the intention of mining highly silicic zones in the Dakota Sandstone. A main outcrop of such a zone is on the top of Slate Mountain. Figure 22 is a photograph of Slate Mountain as seen from Elliott Ridge, and figure 23 is a view of the Dakota outcrop, where sample 652 was collected. Three samples (localities marked on pl. 2) were assayed for silica, iron, and alumina contents (table 9).

As shown on the geologic map (pl. 1), the Dakota Sandstone dips about 8° NE. in this vicinity but it is cut off by the Gore fault and does not extend into the Primitive Area.

BLACK LAKE AREA

One claim, Rabbit Foot, patented in 1936, abuts private land surrounding Black Lake in secs. 18 and 19, T. 3 S., R. 79 W. (area B, pl. 2). The claim was not examined during the field investigation. According to a report prepared in 1935 by W. M. H. Woodward, mineral examiner for the U.S. Forest Service, one prospect pit and a short tunnel were cut in gneiss along a narrow dike. A 2-foot-wide vein structure bearing N. 20° W. and dipping 35° W. was exposed at the face in 1935. This vein contained chalcopyrite, siderite, and trace quantities of gold and silver.

REFERENCES CITED

Argall, G. O., Jr., 1949, Industrial minerals of Colorado: Colorado School Mines Quart., v. 44, no. 2, 477 p.

Barclay, C. S. V., 1968, Geology of the Gore Canyon-Kremmling area, Grand County, Colorado: U.S. Geol. Survey open-file rept., 187 p.

Bergendahl, M. H., 1963, Geology of the northern part of the Tenmile Range, Summit County, Colorado: U.S. Geol. Survey Bull. 1162–D, 19 p.

——— 1969, Geologic map and sections of the southwest quarter of the Dillon quadrangle, Eagle and Summit Counties, Colorado: U.S. Geol. Survey Misc. Geol. Inv. Map I–563.

Brennan, W. J., 1969, Structural and surficial geology of the west flank of the Gore Range, Colorado: Colorado Univ. Ph. D. thesis, 109 p.

Butler, A. P., Jr., Finch, W. I., and Twenhofel, W. S., compilers, 1962, Epigenetic uranium in the United States, exclusive of Alaska and Hawaii: U.S. Geol. Survey Mineral Inv. Resource Map MR–21, separate text.

Carter, W. D., 1964, Construction materials—Sand and gravel, *in* Mineral and water resources of Colorado: U.S. 88th Cong., 2d sess., Senate Comm. Interior and Insular Affairs, Comm. Print, p. 205–211.

Elliott, J. E., and Wells, J. D., 1968, Anomalous concentrations of gold, silver, and other metals in the Mill Canyon area, Cortez quadrangle, Eureka and Lander Counties, Nevada: U.S. Geol. Survey Circ. 606, 20 p.

Erickson, R. L., Van Sickle, G. H., Nakagawa, H. M., McCarthy, J. H., Jr., and Leong, K. W., 1966, Gold geochemical anomaly in the Cortez district, Nevada: US. Geol. Survey Circ. 534, 9 p.

George, R. D., and Crawford, R. D., 1909, The Hahns Peak region, Routt County, Colorado: Colorado Geol. Survey 1st Rept., 1908, p. 189–229.

Grossman, E. L., 1955, Do Rado claims, Vail Pass district, Eagle County, Colorado: U.S. Atomic Energy Comm. Prelim. Reconn. Rept. DEB–P–3–1756.

Hadsell, F. A., 1968, History of earthquake activity in Colorado, *in* Geophysical and geological studies of the relationships between the Denver earthquake and the Rocky Mountain Arsenal well, Part A: Colorado School Mines Quart., v. 63, no. 1, p. 57–72.

Holt, H. E., 1962, Geology of the lower Blue River area, Summit and Grand Counties, Colorado: Colorado Univ. Ph. D. thesis, 107 p.

Izett, G. A., 1968, Geology of the Hot Sulphur Springs quadrangle, Grand County, Colorado: U.S. Geol. Survey Prof. Paper 586, 79 p.

Koschmann, A. H., and Wells, F. G., 1946, Preliminary report on the Kokomo mining district, Colorado: Colorado Sci. Soc. Proc., v. 15, no. 2, p. 51–112.

Lovering, T. S., 1934, Geology and ore deposits of the Breckenridge mining District, Colorado: U.S. Geol. Survey Prof. Paper 176, 64 p.

Lovering, T. S., and Tweto, Ogden, 1944, Preliminary report on geology and ore deposits of the Minturn quadrangle, Colorado: U.S. Geol. Survey open-file rept., 115 p., map.

McCulloch, R. B., and Huleatt, W. P., 1946, Exploration of the Big Four zinc-silver mine, Summit County, Colorado: U.S. Bur. Mines Rept. Inv. 3884, 7 p.

Mutschler, F. E., and Larson, E. E., 1969, Paleomagnetism as an aid in age classification of mafic intrusives in Colorado: Geol. Soc. America Bull., v. 80, no. 11, p. 2359–2368.

Obradovich, J. D., Mutschler, F. E., and Bryant, Bruce, 1969, Potassium-argon ages bearing on the igneous and tectonic history of the Elk Mountains and vicinity, Colorado—A preliminary report: Geol. Soc. America Bull., v. 80, no. 9, p. 1749–1756.

Radabaugh, R. E., Merchant, J. S., and Brown, J. M., 1968, Geology and ore deposits of the Gilman (Red Cliff, Battle Mountain) district, Eagle County, Colorado, *in* Ridge, J. D., ed., Ore deposits of the United States, 1933–1967 (Graton-Sales volume), volume 1: New York, Am. Inst. Mining, Metall., and Petroleum Engineers, p. 641–664.

Ratté, J. C., Landis, E. R., Gaskill, D. L., and Raabe, R. G., 1969, Mineral resources of the Blue Range primitive area, Greenlee County, Arizona, and Catron County, New Mexico, *with a section on* Aeromagnetic interpretation, by G. P. Eaton: U.S. Geol. Survey Bull. 1261–E, 91 p.

Singewald, Q. D., and Butler, B. S., 1941, Ore deposits in the vicinity of the London fault of Colorado: U.S. Geol. Survey Bull. 911, 74 p.

Steven, T. A., 1960, Geology and fluorspar deposits, Northgate district, Colorado: U.S. Geol. Survey Bull. 1082–F, p. 323–422 [1961].

Taggart, J. N., 1962, Geology of the Mount Powell quadrangle, Colorado: Harvard Univ. Ph. D. thesis, 239 p.

Turekian, K. K., and Wedepohl, K. H., 1961, Distribution of the elements in some major units of the Earth's crust: Geol. Soc. America Bull., v. 72, no. 2, p. 175–191.

Tweto, Ogden, 1957, Geologic sketch of southern Middle Park, Colorado, *in* Finch, W. C., ed., Guidebook to the geology of North and Middle Parks basin, Colorado: Rocky Mtn. Assoc. Geologists, p. 18–31.

——— 1961, Late Cenozoic events of the Leadville district and upper Arkansas Valley, Colorado, *in* Short papers in the geologic and hydrologic sciences: U.S. Geol. Survey Prof. Paper 424–B, p. B133–B135.

——— 1968a, Leadville district, Colorado, *in* Ridge, J. D., ed., Ore deposits of the United States, 1933–1967 (Graton-Sales volume), volume 1: New York, Am. Inst. Mining, Metall., and Petroleum Engineers, p. 681–705.

——— 1968b, Geologic setting and interrelationships of mineral deposits in the mountain province of Colorado and south-central Wyoming, *in* Ridge, J. D., ed., Ore deposits of the United States, 1933–1967 (Graton-Sales volume), volume 1: New York, Am Inst. Mining, Metall., and Petroleum Engineers, p. 551–588.

Tweto, Ogden, and Sims, P. K., 1963, Precambrian ancestry of the Colorado mineral belt: Geol. Soc. America Bull., v. 74, no. 8, p. 991–1014.

U.S. Geological Survey, 1968, Aeromagnetic map of the Wolcott-Boulder area, north-central Colorado: U.S. Geol. Survey open-file map.

Van Alstine, R. E., 1964, Fluorspar, *in* Mineral and water resources of Colorado: U.S. 88th Cong., 2d sess., Senate Comm. Interior and Insular Affairs, Comm. Print, p. 160–165.

Vanderwilt, J. W., 1937, Geology and mineral deposits of the Snowmass Mountain area, Gunnison County, Colorado: U.S. Geol. Survey Bull. 884, 184 p. [1938].

Wallace, S. R., Muncaster, N. K., Jonson, D. C., Mackenzie, W. B., Bookstrom, A. A., and Surface, V. E., 1968, Multiple intrusion and mineralization at Climax, Colorado, *in* Ridge, J. D., ed., Ore deposits of the United States, 1933–1967 (Graton-Sales volume), volume 1: New York, Am. Inst. Mining, Metall., and Petroleum Engineers, p. 605–640.

INDEX

[Italic page numbers indicate major references]

☆U.S. Government Printing Office: 1970—O 392-594