Mineral Resources of the San Juan Primitive Area, Colorado

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With a section on IRON RESOURCES IN THE IRVING FORMATION

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STUDIES RELATED TO WILDERNESS—PRIMITIVE AREAS

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An evaluation of the mineral potential of the area

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STUDIES RELATED TO WILDERNESS

PRIMITIVE AREAS

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 San Juan and the Upper Rio Grande primitive areas, Colorado. The area discussed in the report corresponds to the area under consideration for wilderness status. It is not identical with the San Juan and the Upper Rio Grande Primitive Areas as defined because modifications of the boundary have been proposed for the area to be considered for wilderness status. The area that was studied is referred to in this report as the San Juan primitive area.

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

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MINERAL RESOURCES OF THE SAN JUAN PRIMITIVE AREA, COLORADO

By T. A. STEVEN and L. J. SCHMITT, JR., U.S. Geological Survey, and M. J. SHERIDAN and F. E. WILLIAMS, U.S. Bureau of Mines

SUMMARY

A mineral survey was made by the U.S. Geological Survey and the U.S. Bureau of Mines of the adjoining San Juan and Upper Rio Grande Primitive Areas, southwestern Colorado, and of adjacent areas proposed for inclusion in the National Wilderness Preservation System. The combined area covers about 500 square miles of rugged terrain in the San Juan Mountains and is described in this report as the San Juan primitive area. Investigations of the primitive area were made by the U.S. Geological Survey during 1965–68, and those by the U.S. Bureau of Mines were made during 1967–68. Although little mineral production has been recorded from the primitive area, the area borders several highly productive mining districts, and minable mineral deposits probably exist within parts of the primitive area as well.

One hundred ninety-six patented claims and about 425 located claims are within or adjacent to the San Juan primitive area. Most of the patented claims are in the Needle Mountains mining district in the southwestern part of the primitive area, whereas most of the located claims are in a narrow belt peripheral to the primitive area. Gold, silver, copper, lead, zinc, uranium, and sulfur ores valued at about $257,000 have been mined from within or near the San Juan primitive area, and the Beartown (Bear Creek) mining district along the northwest margin of the primitive area is credited with about 78 percent of this total.

Geologically, the San Juan primitive area is divisible into two parts that contrast strongly in age, rock types, structures, and conditions of origin. The western part of the area is underlain by Precambrian metamorphic rocks, which are intruded by granitic rocks. Most of the remainder of the area is covered by volcanic rocks of middle Tertiary age. Sedimentary rocks of Paleozoic and Mesozoic ages are exposed along the south margin of the area and extend under the volcanic rocks in the eastern part of the area.

In appraising the mineral-resource potential of the primitive area, special attention was given to all the mining districts and to the geologic environments most likely to have mineral deposits associated with them. All areas of hydrothermally altered rocks in the volcanic field, and in Precambrian rocks near volcanic or intrusive centers, were examined and sampled, as were possible fossil

gold placers, pyritic black slates, and iron-formation in Precambrian rocks. Sedimentary rocks underlying the volcanic cover in the eastern half of the area contain potential oil- and gas-bearing reservoir rocks, and the possibilities of such occurrences were assessed. Foot traverses aggregating more than 1,000 miles in length were made in the area, and samples were taken of all rocks that appeared possibly mineralized and of stream sediments along all streams. These samples were analyzed by spectrographic and chemical methods to determine metal content, and the analytical data are presented in the report. Areas found to be anomalously high in metal content were further investigated.

Within and near the primitive area, evidence of mineral deposits of commercial or near-commercial value was found in four areas.

1. The Needle Mountains mining district, in the southwestern part of the primitive area, contains disseminated molybdenite in a hypabyssal intrusive plug, and the surrounding rock is cut by numerous metalliferous veins, some of which have economic potential.
2. Whitehead Gulch, in the northwestern part of the primitive area, contains many small veins and sporadic deposits, some of which are of commercial grade.
3. The Beartown mining district, along the north margin of the primitive area, contains a number of gold-telluride veins that yielded high-grade ore in the late 1800's. Exploration targets still exist, and, with improved access, the district could again become productive.
4. The Trout Creek–Middle Fork Piedra River area, in and adjacent to the northeastern part of the primitive area, contains deposits of native sulfur in highly altered volcanic rocks.

Of the four areas, only the Needle Mountains mining district contains appreciable acreage within the primitive area. The mineral potential of the four areas could be determined only with extensive exploration, which would be beyond the scope of this investigation.

Elsewhere in and near the primitive area, small bodies of lead-zinc ore occur in Cave Basin near Runlett Park along the south margin of the area, and a small amount of uranium ore has been produced west of the Animas River near the west margin of the primitive area. In the past, a few other localities yielded small quantities of high-grade ore, which was packed out on horses and mules. None of these deposits appears to be large enough to have economic potential.

No indications were seen elsewhere in the primitive area that point toward economic or subeconomic mineral resources in a near-surface environment. The possibility of deep metallic mineralization near some of the volcanic centers cannot be eliminated, however, and oil and gas conceivably could exist in hidden traps in the sedimentary rocks beneath volcanic cover.

INTRODUCTION

The San Juan primitive area covers about 500 square miles of rugged mountainous terrain in southwestern Colorado (fig. 1). The scenery in the western third of the area is particularly spectacular, as streams and glaciers have carved deep canyons into ancient Precambrian metamorphic and granitic rocks and have left intervening serrated ridges with many peaks extending more than 14,000 feet above sea level. Farther east, the primitive area consists of a deeply dissected volcanic plateau, whose south margin forms a precipitous wall, 3,000–5,000 feet high, breached by many nearly impassable gorges cut by headwater branches of the Piedra and San Juan Rivers. Where not too steep and rocky, the lower slopes are generally mantled by dense forests of fir, pine, spruce, and aspen, but great areas extend above timberline as bold rocky peaks or as grass- and flower-carpeted tablelands. The western two-thirds of this wild terrain is easily accessible by many well-maintained trails and serves the recreational needs of a wide variety of outdoorsmen. The eastern third, on the other hand, is poorly accessible, and large areas are penetrated by few other than sheepmen and some of the more adventuresome hunters.

In the larger context, the San Juan primitive area is a part of a great area of similarly spectacular mountainous terrain known generally as the San Juan Mountains. These mountains have served as a treasure house of natural resources for nearly a century, and in this time they have provided more than 1 billion dollars' worth of valuable metals to the nation, have pastured countless cattle and sheep, have furnished many millions of board feet of lumber, and have attracted an ever-growing host of tourists and vacationers. The deep snows that accumulate each winter provide water for human needs as far away as California and Texas. No single aspect of this area can be

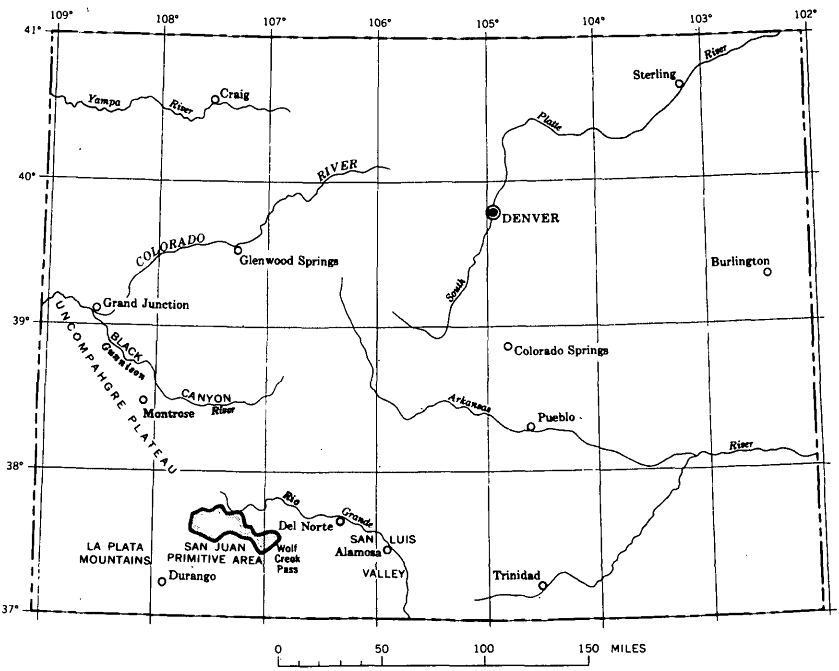

FIGURE 1.—Index map of Colorado, showing area of this report.

considered separately from all the others, and the mineral appraisal presented in this report should be considered in relation to the other natural resources with which the region is so richly endowed.

PREVIOUS INVESTIGATIONS

Beginning with the nearly simultaneous discovery of gold in 1869–70 in Arrastra Gulch, in the western San Juan Mountains, and at Summitville, in the eastern San Juans, mining activity has been intense in the more obviously mineralized parts of the mountains (fig. 2), and has spurred many successive generations of study and exploration. The resulting geologic and mine-development literature is so voluminous that it is practical to cite here only those few articles which best reflect the evolution of geologic thought or the history of mining in the area. Thus, many excellent articles of more specific application are not mentioned.

Exclusive of the very early broad reconnaissance connected with the Hayden Surveys, the first comprehensive program of geologic studies was by Whitman Cross and associates of the U.S. Geological Survey, who mapped a succession of 15-minute quadrangles covering the highly mineralized areas in the western San Juan Mountains. The results were published in a remarkable series of geologic folios on the Telluride (Cross and Purington, 1899), Silverton (Cross, Howe, and

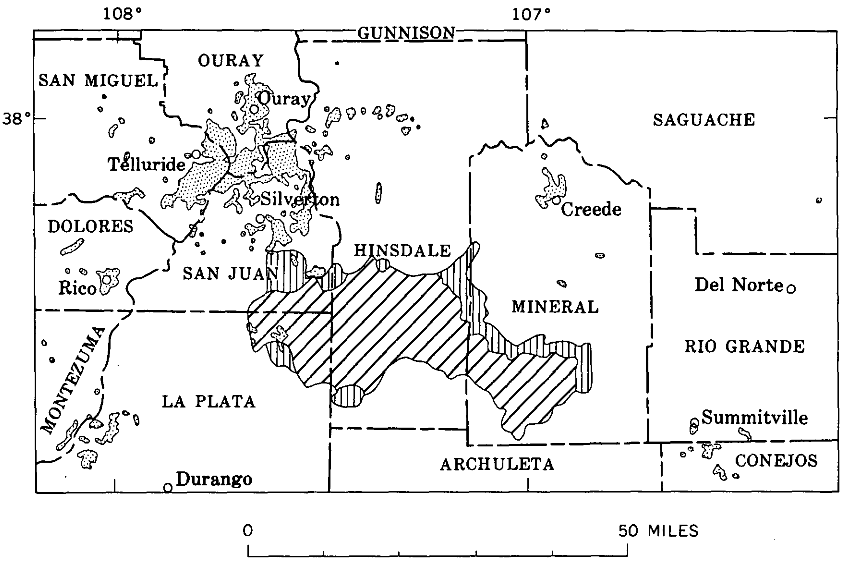

FIGURE 2.—Relation of the San Juan primitive area to nearby areas (stippled) with numerous mines and prospects. Diagonal lines indicate Primitive Area; vertical lines indicate additional areas proposed for inclusion in the Wilderness System.

Ransome, 1905), Rico (Cross and Ransome, 1905), Needle Mountains (Cross, Howe, Irving, and Emmons, 1905), Ouray (Cross and others, 1907), and Engineer Mountain (Cross and Hole, 1910) quadrangles, which established the general geology of that area on a firm basis. These studies led directly into a broad regional investigation of the whole San Juan area, first by Whitman Cross and E. S. Larsen, Jr., and then by Larsen and associates (Cross and Larsen, 1935; Larsen and Cross, 1956). The physiographic history that led to the present spectacular landscape was studied at about the same time by W. W. Atwood and K. F. Mather (Atwood and Mather, 1932). More local studies of individual mining districts were carried out apace, such as the Creede district by Emmons and Larsen (1923) and the Summitville district by Patton (1917).

In the early 1930's, W. S. Burbank began what has developed into the present comprehensive program of studies with his detailed investigation of the Bonanza mining district (Burbank, 1932). This was followed by detailed studies of individual mineralized areas in the western San Juan Mountains (Burbank, 1940, 1941; Varnes, 1963; Vhay, 1962), where the existence of volcano-tectonic subsidence structures (cauldrons) was established and the relationship of mineralization to them demonstrated. These investigations were largely suspended during World War II and following years, but were reactivated in the 1950's, when T. A. Steven and J. C. Ratté studied the Summitville district (Steven and Ratté, 1960) and the Creede district (Steven and Ratté, 1965) in the eastern and central San Juans, and Luedke and Burbank began continuing detailed regional studies in the western San Juans (Luedke and Burbank, 1962, 1968; Burbank and Luedke, 1964, 1966). These detailed studies indicated that the general geology of the whole San Juan region required significant revision, and in 1964 a mapping program—at a scale of 1:250,000—was initiated for the Durango 1° × 2° quadrangle. This program, under the direction of T. A. Steven, is still underway. The entire San Juan primitive area is within the Durango quadrangle. To a considerable extent, the regional mapping program and the mineral appraisal given in this report were carried out simultaneously.

PRESENT INVESTIGATION

The geologic map (pl. 1) included in this report was prepared as a part of the geologic mapping of the Durango 1° × 2° quadrangle. In this program, W. J. Hail, Jr., was responsible for mapping the sedimentary rocks in the San Juan Basin, generally south of the San Juan primitive area; Fred Barker studied the Precambrian rocks in the Needle Mountains, which comprise most of the western third of the primitive area; and T. A. Steven, assisted at different times by R. R. Roberts (in 1965), Grant Heiken (in 1966), and W. K. Mensing (in 1967), mapped most of the volcanic rocks in the eastern two-thirds of the primitive area. In 1965, P. W. Lipman mapped the geology in the drainage area of north-flowing Weminuche Creek and in a strip several miles wide along the east margin of the primitive area, all within the volcanic terrane.

Collection of stream-sediment and bedrock samples was concurrent with the geologic mapping throughout most of the volcanic area. Most of the bedrock samples were collected by T. A. Steven, and the stream-sediment samples were collected mainly by R. R. Roberts, Grant Heiken, Russ Burmester, R. E. Van Loenen, and W. K. Mensing. The upper Red Mountain Creek area, where regional mapping disclosed an intensely altered and pyritized area around several intrusive centers, was studied in greater detail by L. J. Schmitt, Jr., and sampled by Schmitt and Van Loenen.

The mineral appraisal of the Precambrian terrane in the Needle Mountains was made separately from the regional mapping program. Fred Barker sampled several metaconglomerate and pyritic slate units as part of a separate investigation for heavy metals by the U.S. Geological Survey during the summer of 1966. In specific investigations connected with the primitive area mineral appraisal during July 1967, J. E. Gair and Harry Klemic made a reconnaissance of the Irving Formation, adjacent to Vallecito Creek, seeking out and sampling layers of iron-formation; L. J. Schmitt, Jr., and W. H. Raymond made a detailed study of the Needle Mountains mining district; T. A. Steven investigated outlying mineralized areas; and R. E. Van Loenen, W. K. Mensing, and T. A. Steven collected stream-sediment samples along all the main drainage systems.

Geochemical anomalies disclosed by chemical analyses of stream-sediment and rock samples collected in 1967 were checked in the field by Steven and Van Loenen in the summer of 1968.

Investigations by the U.S. Bureau of Mines focused on the economic aspects of the mineral resources in and near the San Juan primitive area. M. J. Sheridan, F. E. Williams, and Paul McIlroy examined the records of the U.S. Bureau of Land Management and of the U.S. Forest Service in Denver, Colo., to determine the locations of patented claims; they also examined the county records of San Juan County (in Silverton), La Plata County (in Durango), Hinsdale County (in Lake City), Mineral County (in Creede), and Archuleta County (in Pagosa Springs) to determine the locations of unpatented claims. Mineral production data were compiled by Sheridan and Williams, largely from the Needle Mountains Folio 131 (Cross, Howe, Irving, and Emmons, 1905), numerous volumes of

"Mineral Resources of the U.S." (U.S. Bur. Mines and U.S. Geol. Survey), reports of the Director of the Mint dating to the 1880's, various reports of the Colorado Bureau of Mines, and file records of the U.S. Bureau of Mines. Information relative to minerals included in the Mineral Leasing Act of 1920 was obtained from the Conservation Division of the U.S. Geological Survey, Denver, Colo.

Fieldwork by U.S. Bureau of Mines personnel was conducted in mineralized areas in and near the San Juan primitive area during the summers of 1967 and 1968. In 1967, M. J. Sheridan and Paul McIlroy of the U.S. Bureau of Mines, and L. J. Schmitt, Jr., and W. H. Raymond of the U.S. Geological Survey made an aerial reconnaissance of the entire primitive area, and Sheridan, McIlroy, G. R. Leland, and R. B. Raabe examined and sampled the mineral deposits in the Needle Mountains mining district in considerable detail. In 1968, Sheridan and Williams examined and sampled additional mineral deposits in the Beartown, Elk Park, Cave Basin, Trout Creek–Middle Fork Piedra River, and Vallecito Creek areas.

Many of the studies, particularly those by the U.S. Bureau of Mines, were hampered by the lack of adequate base maps. Discrepancies in the positions of township lines with respect to natural features among different available maps made it impossible to plot the locations of many of the mining claims accurately, and for certain areas, no reliable surveys exist. For all such areas, maps in this report show the positions of the different claims relative to each other accurately, but the actual positions on the ground are generalized.

ACKNOWLEDGMENTS

The mineral appraisal of the San Juan primitive area has benefited from the wholehearted cooperation of many local residents—ranchers, mining men, resort operators, and county officials. To work in an area where such friendly cooperation is commonplace is a privilege. We were assisted greatly by discussions with claim owners, lessees, or their representatives; we would particularly like to acknowledge the help so received from Mr. John Ashback, Mr. E. L. Gorsuch, Mr. Gordon Hosselkus, Mr. C. Hosselkus, Mr. Charles A. Kipp, Mr. John Kroeger, Mr. Howard Lamb, Mr. G. T. McCall, Mr. Eugene McClure, Mr. Loren E. Smith, Mr. Carroll Wetherill, and Mr. Clinton White. In 1968, Mr. Barney Yeager guided U.S. Geological Survey personnel to many obscure mineralized areas and assisted U.S. Bureau of Mines investigators in locating abandoned mines.

R. U. King of the U.S. Geological Survey spent several days in the Needle Mountains mining district assisting us with the investigation of the disseminated molybdenum deposit located there.

GEOLOGIC APPRAISAL

By T. A. STEVEN and L. J. SCHMITT, JR., U.S. Geological Survey

Geologically, the San Juan primitive area is divisible into two parts that contrast so strongly in age, rock types, structures, and conditions of origin that they are best considered separately. The older, western part of the primitive area consists of the Precambrian terrane of the Needle Mountains; this terrane consists of two sequences of metamorphic rocks cut by a succession of plutonic intrusive rocks, the youngest of which, the Eolus Granite, is approximately 1.46 b.y. (billion years) old. Most of the remainder of the area is covered by a younger assemblage of volcanic rocks of middle Tertiary age, whose complex history of eruption and accumulation bears little relation to the Precambrian geology exposed in the Needle Mountains. The Paleozoic and Mesozoic sedimentary rocks that intervene these widely differing assemblages of rocks in adjacent areas are exposed all along the south margin of the primitive area, but they extend into the area only locally at the surface. At depth, however, the sedimentary rocks extend under the edge of the volcanics from south-flowing Weminuche Creek eastward, and probably underlie the entire eastern half of the primitive area.

PRECAMBRIAN ROCKS [1]

The oldest unit in the Precambrian terrane of the Needle Mountains is the Vallecito Conglomerate, which forms a thick mass of metaconglomerate and pebbly quartzite near Vallecito Creek and Los Pinos River in the southern part of the San Juan primitive area. The fragments range from subangular to rounded, and most are less than 4 inches across, although boulders as large as 12 inches across occur locally. The fragments consist of quartz, varicolored chert, argillite, ferruginous quartzite, and other minor rock types and are set in a densely recrystallized matrix that once was a poorly sorted impure quartz sand. In outcrop the rock is generally gray but it locally varies to pink or purple. Bedding is generally clearly apparent, and ranges from thick to thin, commonly with prominent cross-stratification.

The Irving Formation, as redefined by Barker (1968), stratigraphically overlies the Vallecito Conglomerate with little or no apparent discordance. In the Vallecito Creek area near the exposed Vallecito Conglomerate, the Irving Formation consists of a varied assemblage of probably metavolcanic rocks with minor local siliceous beds containing enough magnetite to be called "iron-formation." The rocks are generally dark completely recrystallized gneisses and schists that vary widely in composition. They commonly contain 35–65 percent intergrown quartz and plagioclase, and the rest generally consists of micas

[1] Abstracted largely from unpublished data by Fred Barker, U.S. Geological Survey.

and epidote, or hornblende, micas, and epidote. Comparisons of chemical analyses suggest that they were derived by intense metamorphism of basalt, andesite, dacite, and rhyodacite volcanic rocks. (For details of the Irving Formation in this area, see p. F43–F51.)

Other rocks in the Irving Formation are exposed in the canyon of the Animas River along the west margin of the primitive area and along the north edge of the Needle Mountains south of Silverton. In contrast with those exposed along Vallecito Creek, the rocks along the east rim of the canyon of the Animas River consist of interlayered fine-grained amphibolite, plagioclase-quartz-biotite gneiss, sericite-biotite-chlorite schist, and minor quartz-microcline-biotite-garnet gneiss. These rocks contain much chlorite, epidote, calcite, and sericite which formed by retrograde metamorphism when the younger Uncompahgre Formation was folded and metamorphosed to low rank. Eastward, along the northern edge of the Needle Mountains, the proportion of amphibolite decreases, and fine- to medium-grained gray well-foliated partly banded plagioclase-quartz-biotite gneiss predominates. This rock probably is metavolcanic; some of the interlayered amphibolite is certainly metavolcanic, for it shows well-defined pillow structure.

Following accumulation of the ancestral materials of the Irving Formation, the rocks were tightly folded along northerly to northeasterly trends and were metamorphosed to high rank. Plutonic intrusive masses of Twilight Gneiss, Tenmile Granite, and Bakers Bridge Granite were emplaced in and near the western part of the primitive area during the folding and metamorphism. As reported by Silver and Barker (1968), isotopic age determinations indicate that the Twilight Gneiss is about 1.76 b.y. old, and the Tenmile and Bakers Bridge Granites are about 1.72 b.y. old. Only the Tenmile Granite is exposed within the primitive area; this rock is pink to light-gray medium- to coarse-grained quartz monzonite in which the original microcline, sodic oligoclase, quartz, and biotite grains are strained and broken, and in part altered to chlorite, sericite, and clay. The minerals were strained and altered when the overlying Uncompahgre Formation was folded and slightly metamorphosed.

After erosion cut deeply into the old rocks and exposed the high-grade metamorphic and plutonic igneous rocks, the succeeding conglomerates, sandstones, and black pyritic shales of the Uncompahgre Formation were deposited upon them with profound unconformity. These sedimentary rocks, in turn, were folded isoclinally along easterly to southeasterly trends, and were metamorphosed to quartzite, slate, and phyllite. Erosion of the steeply inclined hard quartzites of the Uncompahgre Formation has resulted in some of the most spectacular scenery of the Needle Mountains area in the Grenadier Range between Elk and Tenmile Creeks.

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Late in the second period of Precambrian deformation and metamorphism, a quartz diorite mass along the Los Pinos River, two batholiths of Eolus Granite, a smaller pluton of Trimble Granite, and a body of mafic quartz syenite along Ute Creek invaded the earlier rocks, and, in places, the generally low to medium rank pelitic metamorphic rocks in the Uncompahgre Formation were converted to schist. According to Silver and Barker (1968), the Eolus Granite is about 1.46 b.y. old, as determined by isotopic age methods. The quartz diorite of Los Pinos River is an older mass of brownish-gray massive medium- to coarse-grained biotite-hornblende quartz diorite that is completely enclosed in Eolus Granite. The Eolus Granite is largely gray, pink, or brick-red massive biotite-hornblende quartz monzonite that contains blocky phenocrysts of microcline. This rock type is intruded by a minor, but widespread, hornblende-free variant. The Trimble Granite cuts the Eolus in the southwestern part of the primitive area; for the most part the Trimble is a pale-pink massive homogeneous fine- to medium-grained biotite granite containing 1 to 5 percent of blocky to tabular phenocrysts of microcline.

A mass of mafic quartz syenite of Precambrian age is exposed in an erosional window cut through Tertiary volcanic rocks along Ute Creek. The syenite is a coarse- to medium-grained rock that appears to have crystallized in a fairly deep environment; it cuts quartzites of the Uncompahgre Formation along its northeast margin, and it is possibly comparable in age with the Eolus Granite. The mafic syenite is a dark-gray massive homogeneous rock that consists of 40 to 60 percent dark minerals; biotite and hornblende are the most abundant of these, but clinopyroxene and ilmenite are found throughout. Microcline and cuneiform intergrowths of microcline and quartz in roughly equal amounts form the bulk of the light minerals, but plagioclase and sparse quartz grains are widespread. Quartz in the discrete grains rarely exceeds 1 or 2 percent of the rock, but when that in the intergrowths is included, it constitutes 5 percent or more of most of the exposed body.

SEDIMENTARY ROCKS

Few sedimentary rocks crop out in the San Juan primitive area, and these are almost entirely of the older Paleozoic formations that form the southward-dipping flank of the Needle Mountains upwarp along the south margin of the primitive area. Farther south, in the San Juan Basin, is a thick section of sedimentary rocks ranging from Cambrian to early Tertiary in age. The upper part of this section projects beneath the Tertiary volcanic rocks in the eastern half of the primitive area. Table 1 summarizes the stratigraphic succession in the San Juan Basin adjacent to the primitive area.

TABLE 1.—*Stratigraphic succession in the San Juan Basin near the San Juan primitive area*

[Prepared by W. J. Hail, Jr., U.S. Geol. Survey]

System	Series	Stratigraphic unit		Thickness (ft)	Description
Tertiary	Eocene	Blanco Basin Formation		50–350	Red, yellow, and white claystone; arkosic mudstone, grit, and conglomerate.
		——Unconformity——			
	Paleocene	Animas Formation		800-1,000	Dark varicolored claystone, shale, and siltstone; light gray to dark varicolored sandstone and conglomerate; contains abundant volcanic and arkosic debris; lower part may contain thin lateral equivalents of Kirtland Shale, Fruitland Formation, and Pictured Cliffs Sandstone.
——?——	——?——				
Cretaceous	Upper Cretaceous	Lewis Shale		2,500–2,700	Dark clay shale; contains rusty-weathering concretionary masses in lower part.
		Mesaverde Formation		250–300	Thin sandstones interbedded with dark clay shale.
		Mancos Shale		2,000–2,400	Mostly dark clay shale; lower part contains at least three calcareous units: Niobrara equivalent (150–200 ft thick) consisting of light-gray-weathering limy shale, about 1,100 to 1,400 ft above base of Mancos; Juana Lopez Member (25–40 ft thick) consisting of thin interbedded calcarenite and clay shale, about 300 to 500 ft above base of Mancos; and Greenhorn Limestone equivalent (5–15 ft thick) about 30 to 50 ft above base of Mancos.
		Dakota Sandstone		180–220	Light-brown to gray quartzose sandstone in upper part; carbonaceous shale, siltstone, and sandstone in middle part; light-brown to gray conglomeratic chert-pebble sandstone in lower part.
		—— Disconformity ——			
	Lower Cretaceous	Burro Canyon Formation		20–120	Light-green and greenish-gray claystone; lenticular sandstone and chert-pebble conglomeratic sandstone.
		—— Disconformity ——			
Jurassic	Upper Jurassic	Morrison Formation		350–600	Varicolored claystone and mudstone; sandstone (mostly in lower part), conglomerate, and minor limestone near base.
		Wanakah Formation	Junction Creek Sandstone Member	30–150	Light-gray crossbedded sandstone.
			Unnamed member	40–60	Limy shale, siltstone, and sandstone.
			Pony Express Limestone Member	20–80	Thin-bedded petroliferous limestone and limestone breccia; locally contains gypsum.

TABLE 1.—*Stratigraphic succession in the San Juan Basin near the San Juan primitive area*—Continued

System	Series	Stratigraphic unit	Thickness (ft)	Description
Jurassic	Upper Jurassic	Entrada Sandstone	150–250	Light-gray crossbedded sandstone.
		—Unconformity—		
Triassic	Upper Triassic	Dolores Formation	100–400	Mostly nonmarine red beds: shale, siltstone, sandstone, and limestone conglomerate.
		—Unconformity—		
Permian	Lower Permian	Cutler Formation	500–2,000	Mostly nonmarine red beds: shale, siltstone, mudstone, sandstone, arkosic grit, and conglomerate.
Pennsylvanian	Middle Pennsylvanian	Hermosa Formation	1,000–2,000	Intertonguing marine and nonmarine beds. Near Animas River almost entirely dark marine shale, limestone, and sandstone. West-pointing nonmarine tongues increase in number and thickness eastward toward Piedra River; consist of red shale, siltstone, mudstone, and sandstone, and arkosic grit and conglomerate.
		Molas Formation	85–125	Mostly nonmarine red beds: basal breccia, shale, siltstone, sandstone, and conglomeratic limestone.
		—Disconformity—		
Mississippian	Lower Mississippian	Leadville Limestone	80–100	Light- to dark-gray coarsely crystalline limestone; medium to thin bedded, locally cherty and brecciated.
		—Disconformity—		
Devonian	Upper Devonian	Ouray Limestone	45–150	Light-gray siliceous limestone; sandy to argillaceous limestone; thin bedded to massive; minor siltstone, sandstone, and shale.
		Elbert Formation	25–65	Red and green shale, siltstone, sandstone, and limestone.
		—Unconformity—		
Cambrian	Upper Cambrian	Ignacio Quartzite	20–50	Arkosic quartzitic sandstone, grit, and conglomerate.
		—Unconformity—		

For purposes of this mineral appraisal, it is of particular interest to establish which of these formations are beneath the volcanic cover. The Tertiary volcanics in the San Juan region cover the southeast end of the old Uncompahgre-San Luis highland, a major element in the ancestral Rocky Mountains in late Paleozoic and early Mesozoic time. Erosion stripped most of the pre-Jurassic sedimentary rocks off the higher parts of this old upland and exposed the Precambrian basement. The beveled edge of the tilted sedimentary rocks along the southern flank of this upland is exposed in the canyon of the Piedra River, about 15 miles downstream from the edge of the primitive area.

It projects northwestward across the northern part of the Needle Mountains to the vicinity of Silverton. Younger rocks, beginning with the Entrada Sandstone of Late Jurassic age, extend northward across this beveled edge and, in the eastern part of the primitive area, pass beneath the Tertiary volcanics. Along the northern flank of the volcanics, however, in the area south of the Gunnison River, the basal sedimentary unit ranges from the Wanakah Formation near the Black Canyon of the Gunnison to the lower part of the Morrison Formation in local areas farther east.

Sedimentation predominated across the old highland area from Late Jurassic to Late Cretaceous, and a thick sequence of rocks was laid down. During the Laramide orogeny, in Late Cretaceous and early Tertiary time, the old Uncompahgre-San Luis highland area was again uplifted, along with a southwestward projection in the area of the present Needle Mountains. Resulting erosion removed much of the sedimentary cover and exposed the underlying Precambrian rocks in the Needle Mountains and the area to the north. East of the Needle Mountains upwarp, only the uppermost units were eroded from the area near the south margin of the primitive area, and all the units—from the Entrada to a position within the Lewis Shale—underlie the volcanics. On the northern flank of the San Juan Mountains, however, most of the Mesozoic rocks were removed, and the volcanics rest in large part on the Precambrian but locally on patches of sediments ranging up to the lower part of the Mancos Shale. Indirect evidence concerning the origin of the travertine in the Creede Formation near the center of the volcanic pile suggests that one or more of the limy units in the Mesozoic succession probably underlie that area (Steven and Friedman, 1968). Although no other control is known to establish the position of the wedging edges of the eroded formations, most of them probably extend as far as the northern limit of the primitive area, which lies south of the area containing the Creede Formation.

Volcanic debris in the Animas Formation of Late Cretaceous and Paleocene age indicates a volcanic episode in the San Juan region at that time. The only centers definitely identified as active at this time are near Ouray, where Burbank (1940, p. 199–200) described intrusive bodies that Dickinson, Leopold, and Marvin (1968, p. 130) considered to be sources for nearby volcanic accumulations in Upper Cretaceous and Paleocene sedimentary rocks. Shoemaker (1956, p. 162) noted that the volcanic debris in the Animas Formation in the San Juan Basin is coarsest and most abundant in the vicinity of the La Plata intrusive center and postulated that this was one of the sources; the Rico intrusive center similarly might have been active at this time. Mineral deposits are associated with all three of these possibly Late Cretaceous intrusive centers.

During early Tertiary erosion, streams deposited fluvial gravels and sands along the flanks of the Laramide upwarps to form the Blanco Basin Formation, which has been correlated tentatively on stratigraphic and lithologic grounds with the San Jose Formation of early Eocene age in the central part of the San Juan Basin.

VOLCANIC ROCKS

The volcanic rocks comprise a complexly intertonguing assemblage of lava and pyroclastic units derived from many different centers. Some of these local centers are marked by intrusive cores, but others are obscured by their own or younger accumulations, or by volcano-tectonic subsidence structures (cauldrons) that formed time and again in response to different eruptive episodes. With the background of long-continued geologic studies in the San Juan Mountains, it has been possible to decipher most of the interrelationships of the different units within the primitive area, but the resulting picture is so complex as to defy simple explanation. In this report the approach will be basically chronologic; the major source areas will be defined, the stratigraphy presented largely in tabular form, and the succession of geologic events recounted as nearly as possible in historical sequence.

As described by Steven, Mehnert, and Obradovich (1967), volcanic activity in the San Juan Mountains took place largely in mid-Tertiary time. The beginning of activity has not been fixed closely, except that it was after accumulation of the fluvial Telluride and Blanco Basin Formations in early Eocene time. The end of major volcanic activity in the vicinity of the San Juan primitive area is well established by potassium-argon dating; the Fisher Quartz Latite, the youngest of the intermediate to silicic units, was erupted about 26 million years ago, and the later basalt flows of the Hinsdale Formation, between 12 and 15 million years ago.

SOURCE AREAS

The volcanic rocks in the San Juan primitive area came from three major source areas, as well as scattered local centers. The Conejos Formation, the oldest volcanic unit in the southern and eastern parts of the primitive area, consists largely of conglomeratic debris that formed an outwash apron, marginal to a series of composite volcanoes of andesitic to rhyodacitic composition in the eastern San Juan Mountains. Cores of some of these old volcanoes are now exposed in the vicinity of Summitville, about 15 miles east of the primitive area, and in the Summer Coon (Lipman, 1968) and Embargo Creek areas, 30–40 miles northeast of the primitive area.

The great sequence of ash-flow deposits and related quartz latitic to rhyolitic lava flows overlying the Conejos Formation was derived largely from a great cauldron complex that extends from the eastern part of the primitive area northward across the central part of the San Juan Mountains. Recurrent eruption of large volumes of ash led to recurrent collapse of the roof of the underlying magma chamber, and the whole complex, at least 50 miles long north-south and 15 to 25 miles wide east-west, is believed to mark the broken roof of a shallow batholith that was the source of much of the volcanic material in the eastern half of the primitive area.

The volcanic rocks in the western part of the primitive area, on the other hand, were derived largely from another cauldron complex in the western part of the San Juan Mountains (Luedke and Burbank, 1963, 1968). The earliest rocks derived from this source make up the San Juan Formation—a great accumulation of rhyodacitic breccias and minor flows that originally formed a series of volcanoes extending northeastward, from a few miles north of Silverton to the vicinity of the Lake Fork of the Gunnison River. Eruptions from these volcanoes culminated in collapse of the vent areas to form the San Juan depression, which is about 30 miles long and 15 miles wide. Renewed eruptions deposited the alternating sequence of lava- and ash-flow deposits of the Silverton Volcanic Group, largely within, but in minor volume adjacent to, the San Juan depression, which continued to subside in response to the eruptions. In the final phase of activity, ash flows spread widely within and adjacent to the depression, and the nearly circular Silverton and Lake City cauldrons collapsed within it. The San Juan Formation is exposed in the western part of the primitive area, and the younger ash-flow deposits spread eastward into the central part of the primitive area, where they intertongue with the rock sequence derived from the central San Juan source area.

Local centers, generally of andesitic to rhyodacitic composition, occur here and there throughout the volcanic terrane, and the related lava flows and volcanic breccias form local accumulations at many different stratigraphic positions.

VOLCANIC SUCCESSION

The complex sequence of events recorded by the volcanic rocks (table 2) began with eruption of dark lavas and breccias from volcanoes both east and north of the San Juan primitive area. Outflow from these volcanoes deposited aprons of volcanic mudflow (laharic) debris and stream gravels (conglomerates), with local lava flows, to form the San Juan Formation in the northwestern part, and the Conejos Formation in the central and eastern parts, of the primitive area. In

TABLE 2.—*Volcanic succession in the San Juan primitive area*

	HINSDALE FORMATION Basalt flows	
CREEDE FORMATION Stream and lake sediments; travertine		FISHER QUARTZ LATITE Quartz latite flows
	SNOWSHOE MOUNTAIN QUARTZ LATITE Crystal-rich biotite-pyroxene quartz latite welded tuff	
	WASON PARK RHYOLITE Moderately crystal-rich biotite rhyolite welded tuff	
	TUFF OF SEVENMILE CREEK Crystal-rich biotite-pyroxene quartz latite welded tuff	
BRECCIA OF SIMPSON MOUNTAIN Dark andesitic lahar breccia		VOLCANICS OF TABLE MOUNTAIN Heterogeneous rhyodacite to quartz latite flows and breccias
	CARPENTER RIDGE TUFF Crystal-poor rhyolite welded tuff	
	RHYOLITE WELDED TUFF ALONG RIO GRANDE Moderately crystal-rich rhyolite welded tuff	
	HUERTO FORMATION Dark andesitic flows and breccias	
	FISH CANYON TUFF Crystal-rich biotite-hornblende quartz latite welded tuff	

[Age relations between units older than Fish Canyon Tuff in the eastern and western parts are not known]

WESTERN PART

BRECCIA OF CARSON CAMP
Dark andesitic lahar breccia

GILPIN PEAK TUFF
Crystal-poor to moderately crystal-rich biotite rhyolite welded tuff

LOCAL ANDESITIC FLOWS AND BRECCIAS

WELDED TUFF AND QUARTZ MONZONITE INTRUSIVES ALONG UTE CREEK
Crystal-rich quartz latite welded tuff, cut by quartz monzonite intrusive bodies. Age known only as pre-Gilpin Peak Tuff

SAN JUAN FORMATION
Rhyodacitic tuff breccia and lahar breccia

TUFF OF THE NOTCH
Crystal-rich biotite-pyroxene quartz latite welded tuff

EASTERN PART

MAMMOTH MOUNTAIN RHYOLITE
Crystal-rich biotite pyroxene quartz latite welded tuff

QUARTZ LATITE OF LEOPARD CREEK
Quartz latite flows

SHEEP MOUNTAIN FORMATION
Dark andesite flows and breccias

TREASURE MOUNTAIN RHYOLITE
Crystal-poor to moderately crystal-rich biotite rhyolite welded tuff

CONEJOS FORMATION
Dark andesitic flows, lahar breccia, and conglomerate

volume, these two formations overshadow all other volcanic units in the San Juan Mountains; however, only relatively thin marginal wedges of each extend into the primitive area. The light-gray breccias in the San Juan appear to be largely of laharic origin and seem to have accumulated nearer to their eruptive sources than did the largely conglomeratic deposits in the Conejos. No direct evidence of the relative ages of the Conejos and San Juan is yet available, but both formations were deposited directly on the prevolcanic fluvial Telluride and Blanco Basin Formations, and they probably accumulated at about the same time.

Only a partial history of volcanic events in the interval immediately following accumulation of the San Juan Formation can be deciphered from exposures in the western part of the San Juan primitive area. None of the units of the Silverton Volcanic Group, which accumulated largely within the San Juan depression a few miles to the north, can be identified with certainty in the primitive area. A few dark andesitic flow and breccia units locally intervene between the San Juan Formation and the younger ash-flow deposits, but their equivalencies have not been established. Of more significance, however, is an erosional window through the younger ash-flow deposits along Ute Creek that exposes a thick mass of welded tuff cut by three hypabyssal intrusive masses of intermediate (quartz monzonitic) composition. The relations exposed in this window indicate the following sequence of events:

1. Accumulation of a sequence of densely welded, moderately crystal rich ash-flow tuffs to a thickness of more than 2,000 feet.
2. Downfaulting of this sequence against the Precambrian Uncompahgre Formation and quartz syenite to the south. Offset on the fault is more than 1,000 feet.
3. Intrusion of three bodies of quartz monzonitic rock into the faulted assemblage, one of which occupies all of the fault within the erosional window. Hydrothermal activity related to the intrusives altered the welded tuffs widely and formed disseminated pyrite in much of the altered rock.
4. Erosion cut a hilly topography, with a local relief of more than 1,000 feet across the area. All the volcanic rocks were stripped from the block south of the fault and the hypabyssal intrusive masses which cut welded tuff along and north of the fault were exposed.
5. Subsequent eruptions covered the whole area with younger volcanic rocks.

The relations outlined above, particularly the thick local sequence of welded tuff downfaulted against older rocks, with hypabyssal intrusive masses along and near the bounding fault, closely correspond to similar relations observed in cauldron complexes elsewhere in the San Juan Mountains, and erosion by Ute Creek may have fortuitously exposed the margin of an early volcanic subsidence structure (cauldron) of unknown size. The equivalence of this local mass of welded tuff with other units in the San Juan Mountains was not established; certainly, however, this welded tuff has no counterpart in any of the ash-flow units derived from the central San Juan cauldron complex that have been mapped throughout the central and eastern parts of the volcanic field. Because of the known association of mineralization with cauldron structures elsewhere in the San Juan Mountains, the altered and pyritized rock exposed in the erosional window along Ute Creek was sampled carefully. Analytical results from these samples were largely negative, but the details will be discussed in later sections dealing with mineral resources.

Following a significant period of time after accumulation of the San Juan Formation, which included eruption of all units within the Silverton Volcanic Group in the western San Juan Mountains, as well as erosion of the hilly topography on the Precambrian rocks and the welded-tuff–intrusive complex along Ute Creek, a great mass of ash-flow tuffs (Potosi Volcanic Group, as used by Luedke and Burbank, 1963) spread southeastward from centers in the western San Juan Mountains. All this rock in the San Juan primitive area belongs to the Gilpin Peak Tuff, which forms a great wedge of distinctive pink welded tuff, ranging in thickness from more than 3,000 feet adjacent to the Rio Grande east of the confluence of Bear and Pole Creeks, to a featheredge along the west wall of Williams Creek canyon in the central part of the primitive area. The wedge of Gilpin Peak Tuff rests directly on Conejos Formation for the eastern 9 miles of its extent. According to Luedke and Burbank (1968, p. 196), the Silverton and Lake City cauldrons, nested within the older San Juan depression, formed in response to eruptions of the Potosi Volcanic Group. Fractures related in origin to the Silverton cauldron are mineralized in the northwestern part of the primitive area.

No significant erosional break marks the change from deposition of the outwash facies of the Conejos Formation in the eastern part of the San Juan primitive area to accumulation of the overlying ash-flow deposits derived from a source in the central San Juan cauldron complex. Although the oldest known unit in the ash-flow sequence—the Treasure Mountain Rhyolite—rests with apparent conformity on the Conejos, the time interval for the period of nondeposition between the Conejos and Treasure Mountain cannot now be estimated.

The Treasure Mountain Rhyolite in its type section on Treasure Mountain, about 4 miles east of the primitive area, consists of a sequence of welded ash-flow tuffs about 1,000 feet thick. This sequence thins westward toward the primitive area, and wedges out a few miles inside the primitive area boundary. The Treasure Mountain Rhyolite is overlain conformably by an assemblage of dark andesitic to rhyodacitic flows and breccias of the Sheep Mountain Formation (the

Sheep Mountain Quartz Latite of Larsen and Cross, 1956, p. 124), which intertongues westward and northward with densely welded ash-flow tuffs belonging to the tuff of The Notch. The intertonguing relations have been recognized for as much as 6 miles into the southeastern part of the primitive area—well beyond the western limit of the Treasure Mountain Rhyolite. From here westward to the vicinity of Williams Creek, the tuff of The Notch rests directly on the Conejos Formation, in an equivalent position to that of the Gilpin Peak Tuff farther west. However, the Gilpin Peak Tuff was nowhere seen southeast of Williams Creek, and the tuff of The Notch is not exposed northwest of Williams Creek, so the relative stratigraphic positions of the two ash-flow-tuff units are not known.

Marginal parts of several volcanic formations extend into the San Juan primitive area in the stratigraphic position above the tuff of The Notch. To the northeast, a thick accumulation of quartz latite flows and minor breccias, informally called the quartz latite of Leopard Creek, covers the Sheep Mountain Formation and tuff of The Notch along Goose Creek in a local exposure just above the mouth of Fisher Creek. Vents from which these flows were erupted are exposed from the vicinity of Goose Creek northeastward to the mouth of Leopard Creek. The flows were viscous and piled up near the vents to form a steep-sided accumulation that appears to have been a ring-dome complex along the margin of an earlier cauldron farther north. The Mammoth Mountain Rhyolite, one of the most widespread ash-flow sheets derived from the central San Juan cauldron complex, accumulated against the steep eastern flank of the flow mass in the vicinity of present upper Leopard Creek, and a thin wedge extends west from Wolf Creek Pass barely to the east edge of the primitive area. During the same general interval, a local mass of dark andesitic to rhyodacitic lavas and breccias was erupted in the vicinity of the old mining camp of Carson, about 6 miles north of the Rio Grande above the mouth of Ute Creek. A great mass of laharic breccia extends south from this center, and wedges out in the area west of lower Ute Creek, just inside the primitive area.

Some time after deposition of the Sheep Mountain Formation and tuff of The Notch, and perhaps after deposition of the Mammoth Mountain Rhyolite, the eastern part of the primitive area was disrupted structurally. This is the first disturbance that can be documented in the southern part of the central San Jan cauldron complex. Evidence for this disturbance can be seen in the drainage basin of Fourmile Creek in the southernmost part of the primitive area, where erosional windows show a contact between Sheep Mountain rocks and the tuff of The Notch at two different levels, and both of these are below the level of the tuff of The Notch in the area immediately northwest. Seemingly, a minimum of two faults now buried by younger volcanic rocks is required to account for these structural discordances. In addition, near the head of Leopard Creek, about 4 miles northeast of the primitive area, the flat-lying Mammoth Mountain Rhyolite is cut off abruptly to the southeast, and the next youngest formation, the Fish Canyon Tuff, was deposited against a steep wall that may have been a fault scarp.

The structurally disturbed terrane in the eastern part of the primitive area was covered by the Fish Canyon Tuff, which was erupted from vents within the disrupted area. The Fish Canyon is the most voluminous ash-flow unit in the San Juan Mountains, and it extends northward from this source area for more than 65 miles to the Gunnison River, and eastward for more than 45 miles to the San Luis Valley at Del Norte. It is more than 3,500 feet thick along the east margin of the primitive area. From the edge of the underlying structurally disturbed area near the East Fork Piedra River northwestward, the Fish Canyon Tuff forms a great wedge that covers the smooth surface on top of the tuff of The Notch as far as Williams Creek, and from here to its wedge-out near Ute Creek, it covers the eastward-extending tongue of Gilpin Peak Tuff. North of the Rio Grande Reservoir, a tongue of laharic breccia derived from the Carson volcanic center intervenes between the Gilpin Peak and Fish Canyon Tuffs. Isotopic age determinations indicate that the Fish Canyon Tuff is about 27 million years old (Steven and others, 1967).

The source area of the Fish Canyon Tuff is marked by volcanic breccias mixed with the predominant ash-flow tuffs, largely in the drainage basins of Fourmile, Turkey, and Beaver Creeks. In addition, two of the vents were seen; one of these, along the west side of Eagle Mountain between Fourmile and Turkey Creeks, consists of a mass of flows, flow breccias, and pyroclastic breccias surrounding an intrusive core, and the other, along Turkey Creek, is a volcanic neck consisting of dikelike masses of welded tuff cutting a core of flow-type rocks.

Accumulation of the Fish Canyon Tuff was followed immediately by eruption of the dark andesitic to rhyodacitic lavas and breccias of the Huerto Formation. In the area from Williams Creek and Trout Creek northwestward, a large shield volcano formed from many successive outpourings of fluid lava. In the upper drainage basins of Squaw and Little Squaw Creeks, these flat-lying flows have an aggregate thickness of more than 2,000 feet, but northward and westward the assemblage thins greatly, and it wedges out under the ridge east of Ute Creek, and within 1 or 2 miles north of the Rio Grande. Southeastward, the shield volcano passes into a great mass of intermixed flows, volcanic breccias, and laharic breccias. In the vicinity of the known Fish Canyon vents in the Fourmile Creek–Turkey Creek area, the Huerto contains abundant quartz latitic debris identical with rocks in the underlying Fish Canyon Tuff. Inasmuch as some of this material appears to represent primary volcanic breccia, some Fish Canyon volcanoes presumably remained active into the period of Huerto eruptions. The vent area of a Huerto volcano in the Trout Creek drainage was intensely altered by fumarolic activity, and native sulfur was deposited locally.

Some evidence exists for structural disruption between accumulation of the Fish Canyon Tuff and the Huerto Formation, but in general, disruption seems to have been local. The most apparent feature developed at that time is the abrupt scarp on Fish Canyon Tuff, now covered by Huerto breccias along the West Fork San Juan River just west of Beaver Creek; there, the thickness of the Huerto changes abruptly from more than 1,500 feet west of the scarp to less than 200 feet east of the scarp.

The greatest structural disturbance documented in the volcanic rocks of the San Juan primitive area took place after the Huerto Formation was erupted, and it was at this time that most of the faults in the southern part of the central San Juan cauldron complex had their major displacement. The northwestern limit of the faulted area is marked by the Williams Creek fault, which extends northeastward across the primitive area in the drainage basins of Williams Creek and Trout Creek. Southeast of this bounding fault, the volcanic rocks are riven by many predominantly northwest-striking faults that slice the terrane into a complex mosaic of elongated blocks. Most of the faults dip steeply, and although the direction of displacement varies, the general result of the faulting was to depress the blocks progressively downward toward the center of the cauldron complex to the north. Little or no faulting is evident in the sedimentary rocks of the San Juan Basin, south of the mountain front. The southwesternmost block of volcanic rocks is tilted 20°–30° NE.; the formations show little displacement at the mountain front, but are strongly discordant a short distance northeast. The next block inward is anomalous in being an upfaulted horst, but from there northeastward, the post-Huerto faulting displaced most of the blocks generally down toward the cauldron complex.

A single ash flow, called informally the rhyolite welded tuff along Rio Grande, forms a lobate tongue along the north margin of the primitive area. It was deposited shortly after the Huerto Formation accumulated; limited evidence suggests that it originated in the western San Juan source area and flowed down a broad valley along the north margin of the Huerto shield volcano. No evidence was seen to date its eruption relative to the post-Huerto period of faulting in the eastern part of the primitive area.

Rhyolitic ash flows spread widely over the San Juan volcanic area after the post-Huerto period of faulting to form the Carpenter Ridge Tuff. The general distribution indicates a source somewhere within the central San Juan cauldron complex, but no vents have been identified yet. The formation is thickest in the upper Trout Creek–Piedra Peak area, where it covered rough topography left by the post-Huerto faulting, and at least locally it is more than 1,500 feet thick. The Carpenter Ridge Tuff thins westward and wedges out against the older mass of Gilpin Peak Tuff west of Ute Creek, but to the north, it extends as far as the Gunnison River, and to the east, as far as the San Luis Valley. A large mass of Carpenter Ridge Tuff and older rocks in the upper Trout Creek–Red Mountain Creek area was intensely altered by hydrothermal activity shortly after the Carpenter Ridge Tuff was erupted.

Faulting was renewed in the southern part of the central San Juan cauldron complex following eruption of the Carpenter Ridge Tuff. For the most part, faults formed earlier were reactivated, but some new fractures formed. The largest fault formed at this time bounds the recurrently active fault mosaic on the east, along the general trend of Beaver Creek.

Two local assemblages of lavas and breccias were deposited on top of the Carpenter Ridge Tuff. The largest of these is a heterogeneous assemblage of rhyodacitic to quartz latitic flows, breccias, and conglomerates that extends eastward from Piedra Peak to Table Mountain in the eastern part of the primitive area. The rocks range from dark fine-grained rhyodacites to light-gray coarsely porphyritic quartz latites, and the composite mass is extremely complex. For convenience of reference, this assemblage will be called the intermediate volcanics of Table Mountain. The other local accumulation that formed at this time is a mass of monolithologic rhyodacitic lahar breccia on Simpson Mountain east of Ute Creek. The source of the breccia of Simpson Mountain seems to have been near Simpson Mountain, where one of the possible feeding dikes was mapped.

A local welded ash-flow tuff unit called informally the tuff of Sevenmile Creek was deposited along the west side of the central San Juan cauldron complex within and north of the San Juan primitive area. The largest remaining body in the vicinity of the primitive area is on the ridge between Trout and Red Mountain Creeks, where it rests on Carpenter Ridge Tuff. A few small remnants cap ridges farther south and southeast, and one of these rests on intermediate volcanics of Table Mountain. The tuff of Sevenmile Creek overlies rough fault-block topography in the area north of the San Juan primitive area in the Bristol Head quadrangle (Steven, 1967). A local thick quartz latite lava flow overlies the tuff of Sevenmile Creek along the lower slopes west of lower Trout Creek.

Marginal tongues of two other ash-flow tuff units, the Wason Park Rhyolite and the Snowshoe Mountain Quartz Latite, derived from the general Creede caldera area, near the middle of the central San Juan cauldron complex, extend into the northeastern part of the San Juan primitive area. Within or near the primitive area, the distinctive Wason Park Rhyolite rests in one place or another on Carpenter Ridge Tuff, the tuff of Sevenmile Creek, the intermediate volcanics of Table Mountain, and the Fish Canyon Tuff, and it clearly wedged out southward. The Snowshoe Mountain Quartz Latite occurs in the primitive area as a single remnant on top of Wason Park Rhyolite on the ridge between Trout and Red Mountain Creeks.

Eruption of the Snowshoe Mountain Quartz Latite was accompanied by final collapse of the Creede caldera, north of the eastern part of the San Juan primitive area, and the core of the caldera was resurgently domed shortly after collapse (Steven and Ratté, 1965). The faults extending northwest from lower Trout Creek, just outside the primitive area, mark the southwest margin of the Clear Creek graben, which formed at about the same time as the Creede caldera and from related causes. A stream flowing westward and then northward into the collapsed area cut a deep valley in the present upper Goose Creek–Red Mountain Creek area prior to renewed volcanic eruptions.

Viscous quartz latitic to rhyolitic lavas of the Fisher Quartz Latite were erupted locally in the structural moat around the margin of the resurgently domed Creede caldera, and ashy sediments of the Creede Formation were deposited concurrently in the adjacent lowlands. In and near the San Juan primitive area, the Fisher lavas and breccias filled the stream valley in the upper Goose Creek–Red Mountain Creek area, and sediments of the Creede Formation intertongue with the Fisher rocks along the flanks of lower Red Mountain Creek.

Eruption of the Fisher Quartz Latite about 26 million years ago (Steven and others, 1967) marked the end of major intermediate to silicic volcanic activity in the central San Juan area. After several millions of years, however, volcanic activity again broke out, and basaltic lavas of the Hinsdale Formation were erupted widely; the Hinsdale basalts in the San Juan primitive area appear to have been erupted about 12–15 million years ago (Steven and others, 1967). Only a few scattered remnants of the late basalt flows remain in the San Juan primitive area.

Probably sometime during the main period of intermediate to silicic volcanic activity in the San Juan Mountains, hypabyssal rocks were intruded in the Precambrian rocks of the Needle Mountains near the head of present-day Needle Creek. This intrusive center may mark the roots of a volcano that has since been completely eroded away. The intrusive rocks were highly altered by hydrothermal activity and were widely mineralized with disseminated pyrite and molybdenite; numerous fractures adjacent to the center were mineralized as well, thereby forming veins containing copper, lead, zinc, silver, and gold. This area is discussed in detail on pages F55–F67.

The present spectacular scenery of the San Juan primitive area has resulted largely from erosion of the great volcanic plateau in late Cenozoic time. Erosion of relatively hard volcanic rocks overlying the soft sedimentary rocks in the San Juan basin has resulted in the abrupt rugged mountain front that characterizes the eastern part of the primitive area. The volcanic cover was eroded from the Precambrian rocks of the Needle Mountains, and the superimposed streams have cut the present rugged terrain. Glaciation during the Pleistocene Epoch etched all the higher parts of the primitive area and converted an already rugged mountain mass to the present spectacular landscape.

MINERAL RESOURCES

In appraising the mineral-resource potential of the San Juan primitive area and of a zone several miles wide peripheral to it, special attention was given to the known types of deposits and the geologic environments most likely to have mineral deposits associated with them. Thus, all areas of hydrothermally altered rocks in the volcanic field, in Precambrian rocks near volcanic centers, or around intrusive centers that are probably volcanics associated, were examined and sampled. Two old mining districts in the Needle Mountains area—the Needle Mountains district and the Beartown district—were studied in more detail. As iron-formation had been reported from the Irving Formation by earlier workers, a special reconnaissance study was made to assess its economic potential. Precambrian metaconglomerates in the Irving and Uncompahgre Formations were sampled to determine whether they contain ancient placer gold deposits, and the pyritic black slate in the Uncompahgre Formation was sampled to determine its metal content.

The sedimentary rocks underlying volcanic rocks in the eastern half of the primitive area contain potential oil- and gas-bearing reservoir

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rocks, and the possibilities of such occurrences have been assessed.

In addition to these specific studies, routine stream-sediment samples were taken along all the streams in the primitive area, and the samples were analyzed by spectrographic and chemical methods to determine whether any of the drainage systems have anomalous metal content worthy of more careful investigation.

Data resulting from these investigations indicate that only four areas in or near the San Juan primitive area appear to have a potential for developing significant economic mineral resources under present conditions (fig. 3). One area, the Needle Mountains mining district, has disseminated molybdenite in some of the intrusive rock that forms its center, and the surrounding Precambrian granitic rocks are cut by numerous related veins, some of which contain copper, lead, zinc, silver, and gold in economic or near-economic concentrations. The mineral-producing potential of this district seems good. The Beartown mining district has many small veins containing local shoots of rich gold-telluride ore. Although the small size of the veins and the

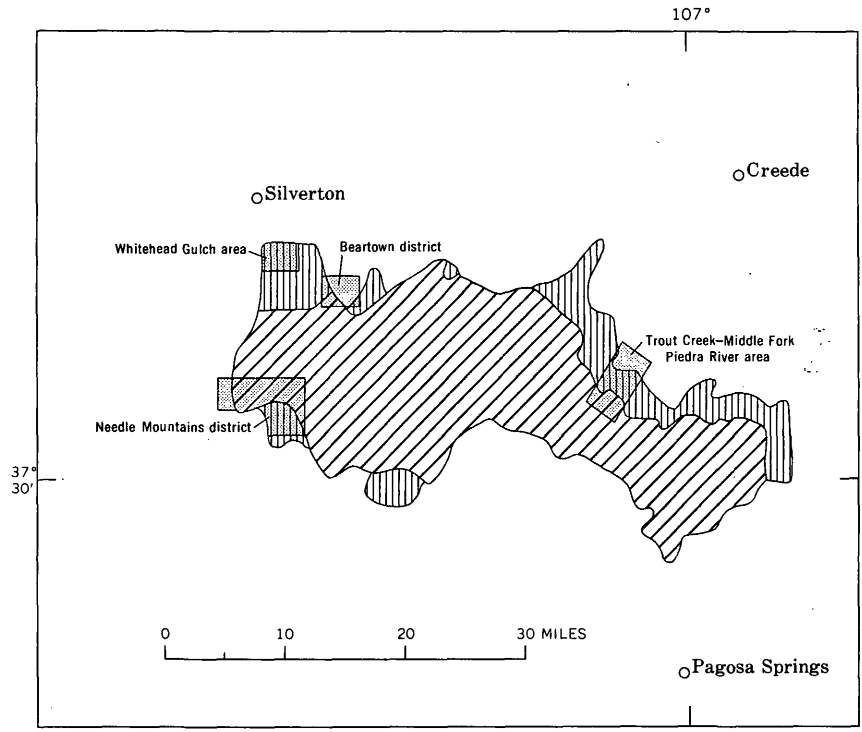

FIGURE 3.—Relation of the San Juan primitive area to main mineralized areas (stippled). Diagonal lines indicate Primitive Area; vertical lines indicate additional areas proposed for inclusion in the Wilderness System.

sporadic distributions of the shoots militate against a large potential production, the district probably could support a small mining industry if access were improved. Whitehead Gulch lies along the south margin of a highly mineralized area along the southern flank of the Silverton cauldron that has produced more than $70 million worth of base and precious metals. Veins in the Whitehead Gulch area are numerous but generally short and narrow, and the metal values are irregularly distributed in them. Although there seems to be little chance of a large mine being developed in this area, the potential for several small mines clearly exists. Native sulfur has been mined from the Trout Creek area adjacent to the northeast margin of the primitive area, and scattered occurrences farther south indicate an area at least 3 miles across in which similar deposits might occur. Dense timber, soil cover, glacial drift, and younger volcanic rocks obscure relations in much of the area of interest, and physical exploration is needed to fully assess the mineral-resource potential. Such a program by private industry was just beginning as this report was in its final stages of preparation.

The four areas with current economic potential—the Needle Mountains mining district, the Beartown mining district, the Whitehead Gulch area, and the Trout Creek–Middle Fork Piedra River area—are around the periphery of the San Juan primitive area. Of the four areas, only the Needle Mountains mining district has significant acreage within the primitive area.

SAMPLING AND ANALYTICAL TECHNIQUES

The sampling and analytical techniques used in this study were chosen to obtain the maximum information consistent with very rapid coverage of the ground. An attempt was made to sample sediments along trunk streams and larger tributaries every quarter to half mile, and most of the minor tributaries were sampled near their mouths. In general, a handful or two of the finest sediments available were taken. Ideally, such a sample should have contained a significant proportion of clay- and silt-sized material, but many of the sampled streams are too torrential for much of the finer sediment to remain, and it was impossible to get abundant clay and silt in all samples. The small size of individual samples ruled out analyzing the fine fractions only; therefore, the total sample was dried and ground before analysis. Because much of the metal content in stream sediments is adsorbed on the finer particles, the net effect of the above-described procedure was to subdue differences and to make areas with anomalously high metal contents more difficult to identify.

In sampling the altered rocks or veins, an attempt was made to seek out and sample the material most likely to contain the highest amounts of metal. Siliceous altered rock containing unoxidized pyrite was taken wherever possible, although other types were also sampled for comparison. This deliberate high-grading technique was used to find whatever abnormal metal concentrations were present, with the thought that any so discovered could be more fairly assessed by later field checking. In the more detailed investigations of those areas known to contain ore minerals, on the other hand, attempts were made to obtain representative samples of the different types of veins and altered rocks so that appraisals of the economic potential could be made.

Almost all samples were scanned spectrographically for a wide variety of elements. In addition, most samples were analyzed chemically for gold, copper, lead, and zinc; many, for molybdenum; and a few, for mercury and arsenic. The analyses were made over a 4-year span by a large number of analysts in several Geological Survey laboratories. In addition, analytical techniques were modified and refined during this span, and the limits of detection for different elements were changed from time to time. In tabulating the analytical results, it was not feasible to separate the results from all the different analytical techniques employed and still have easily usable tables; thus, the numbers shown are not strictly comparable, but represent general orders of concentration only.

In addition to variations resulting from differences in analytical techniques and from instrumental errors, operator bias, and sample variations, the semiquantitative character of many of the tests makes close comparison of the numerical results undesirable, particularly in the low-concentration ranges characteristic of most of the samples. The great differences in background values of certain of the elements from such widely differing sources as the Precambrian terrane and the Tertiary volcanic terrane also make close comparison of the numerical results from widely separated areas untrustworthy.

To judge whether a given set of analytical data was normal or anomalous, the spectrographic results and chemical results were compared to see if they were consistent, and then both were considered in the light of the geologic context of the samples they represented. If the results from the different analytical methods disagreed greatly, the analysis whose method was judged most likely to be in error was repeated, and most of these repeated analyses gave more consistent results. Most analytical results were compatible with the geologic environment from which the samples were taken, and when discrepancies were found, the given area was rechecked in the field. As a result, all those analytical results showing anomalous metal content are known to come from areas with visible evidence of mineralization. The majority of samples with background metal contents were collected from areas showing no surface evidence for mineralization. The greatest seeming disparity in results involved samples from hydrothermally altered areas that contained only background values of the different metals. Many of these altered areas were resampled, and the new analyses corroborated the original negative results.

The three-way check of spectrographic analyses, chemical analyses, and geologic context, combined with the facts that all areas with anomalous metal content can be related to known mineralization and that all areas known to contain metalliferous deposits are surrounded by halos with anomalous metal content, gives credence to the results of this appraisal. Small masses of mineralized rock might easily have been missed, but it is unlikely that a large mass of mineralized rock in a near-surface environment was missed.

Analysts in Geological Survey laboratories who have contributed data used in this report are: W. L. Campbell, J. B. Cathrall, C. W. Cole, G. L. Crenshaw, K. J. Curry, J. V. Desmond, L. Dickson, G. W. Dounay, A. Farley, Jr., J. L. Finley, C. L. Forn, J. G. Frisken, T. G. Ging, Jr., W. D. Goss, J. C. Hamilton, R. F. Hansen, T. F. Harms, J. L. Harris, M. Huber, Claude Huffman, Jr., H. D. King, E. Martinez, S. K. McDanal, J. B. McHugh, A. Meier, F. J. Michaels, R. L. Miller, E. L. Mosier, J. Motooka, K. R. Murphy, H. G. Neiman, S. Noble, G. A. Nowlan, D. K. Parker, S. Rickard, L. B. Riley, T. A. Roemer, Z. C. Stephenson, J. A. Thomas, B. L. Tobin, A. J. Toevs, R. B. Tripp, W. R. Vaughn, J. G. Viets, K. C. Watts, and C. L. Whittington.

RÉSUMÉ OF STREAM-SEDIMENT SAMPLING PROGRAM

Stream sediments were sampled widely throughout the San Juan primitive area to obtain rapid geochemical coverage (table 3, p. F122; pl. 2). All samples were analyzed by semiquantitative, spectrographic, and colorimetric methods, and some by atomic-absorption methods. The results, arranged according to the drainage basin, are shown in table 3.

Many of the differences between samples reflect contrasts in the source areas of the sediments. For example, chromium and nickel tend to be low in stream sediments derived from the Vallecito Conglomerate, Uncompahgre Formation, or Eolus Granite, but are appreciably more abundant in sediments derived from metavolcanic rocks in the Irving Formation. Strontium is generally low in sediments from metasedimentary or granitic Precambrian rocks, somewhat more abundant from metaigneous rocks in the Irving Formation, and distinctly more abundant from Tertiary volcanic rocks. Titanium, on the other hand, tends to reflect the degree of concentration of magnetite-ilmenite grains in the individual sediment sample and is largely independent of the source terrane. These and other differences reflecting contrasting source areas will be discussed in somewhat more detail as individual drainage basins are described.

Of all the metallic elements, silver, molybdenum, lead, and zinc were found to be the most sensitive indicators of proximity to metalliferous deposits. Tin and bismuth were detected locally in a halo around the Needle Mountains mining district. Copper generally was a poor indicator and, in places, seemed to reflect more the rock type traversed than proximity to mineral deposits.

Anomalous metal contents are defined as those that deviate significantly from the apparent background values characteristic of any local area. Thus, contents that appear anomalously high in any one area may be merely background or, conceivably, even anomalously low in another. In dealing with the stream-sediment samples from the San Juan primitive area (table 3, p. F122), if silver is detected at all, it is considered to be present in anomalous concentration. The same is true for both bismuth and tin. Molybdenum contents of 10 ppm (parts per million) or more are considered to be anomalous, and of 20 ppm or more to be strongly anomalous. Copper, lead, and zinc are more erratic in their behavior, and it is very difficult to establish firm lower limits to anomalous concentrations. As a first approximation, 50 ppm copper is taken as the change from background to anomalous concentrations, but in places the cutoff seems to vary from as low as 30 ppm to as high as 70 ppm. In general, any concentration of more than 50 ppm lead is considered as possibly anomalous, and a concentration of more than 100 ppm, as definitely anomalous. Most concentrations of zinc less than 150 ppm are considered as probably background; 150–200 ppm, as possibly anomalous; and more than 200 ppm, as definitely anomalous.

CRYSTAL VALLEY–MISSOURI GULCH AREA

(Table 3–A)

Veins containing both precious and base metal minerals extend from the Chicago Basin–Vallecito Basin area to the north into Crystal Valley and Missouri Gulch (fig. 6), and the stream-sediment samples taken from these drainages (pl. 2) contain anomalously high concentrations of some of the metallic elements. Silver was detected, and is therefore anomalous, in all the samples from Crystal Valley (samples 1–7) and in samples from the upper part of Missouri Gulch (samples 9, 11, and 12), but is below the limit of detection in the lower reaches of Missouri Gulch. Molybdenum was detected throughout both drainage systems, and is in anomalously high concentrations locally. Spectrographic analyses indicate that lead is above background throughout both drainages, but chemical analyses indicate that only a few samples from Crystal Valley are above background. Low concentrations of tin were detected along both streams. Zinc is in anomalously high concentrations in Crystal Valley, according to both spectrographic and chemical analyses, and is above background in several of the samples from Missouri Gulch. Copper, on the other hand, appears uniformly background in all samples. None of the samples contain detectable gold.

When compared with stream-sediment sample analyses from other parts of the San Juan primitive area, the results from the Crystal Valley–Missouri Gulch area show anomalously high metal concentrations, and obviously reflect the known metalliferous veins exposed in the headwaters.

NEEDLE CREEK DRAINAGE

(Table 3–B)

Although Needle Creek drains the heart of the old Needle Mountains mining district, which includes a highly altered intrusive center with known disseminated molybdenite, the geochemical anomaly obtained from the stream-sediment sample is surprisingly weak. Samples 1–20 and 34–39 were taken along the main Needle Creek, beginning adjacent to the mineralized intrusive center and extending approximately 3 miles downstream; samples 21–33 were collected along New York Gulch, a major tributary of Needle Creek that has known mineralized ground only near its mouth. Silver is the best indicator of nearby mineral deposits; it was detected in 13 of the 26 samples taken along Needle Creek, but it was detected in only one of the 13 samples taken along New York Gulch. Low concentrations of molybdenum (generally 5–10 ppm) were detected spectrographically from the upper part of Needle Creek, whereas most of the samples along New York Gulch contained less than 5 ppm, and chemical analyses indicate similar disparate concentrations. The molybdenum values from Needle Creek, however, seem to be exceedingly low, considering that molybdenite is disseminated in the altered rock near the head of the creek. Most lead and zinc values obtained by either spectrographic or chemical methods from the Needle Creek samples are near or only slightly above the background indicated by the New York Gulch samples, and even the most anomalous samples do not deviate greatly from the same general range. Tin was detected in 9 of the 26 samples from Needle Creek, and perhaps after silver is the best indicator of nearby mineral deposits. In all, the metal anomaly is much more obscure in the Needle Creek drainage than it is in adjacent mineralized areas, such as the Crystal

Valley–Missouri Gulch area just discussed, or in the Johnson Creek–Grizzly Gulch area next discussed.

A possible explanation for the relatively low metal concentrations in the stream-sediment samples collected below the known mineralized area in the upper part of Needle Creek may lie in the acidity of the water. The intrusive center and adjacent wallrocks in Chicago Basin near the head of Needle Creek are highly altered and contain widespread disseminated pyrite. It is reasonable to assume that ground water draining through these altered rocks may pick up appreciable sulfuric acid from the oxidizing pyrite. When discharged into the stream, such acid might well increase the solubility of some of the metal ions, particularly molybdenum and zinc, and inhibit their adsorbtion on the clay fractions in the stream sediments.

JOHNSON CREEK–GRIZZLY GULCH AREA

(Table 3–C)

Johnson Creek (samples 1–14) and Grizzly Gulch (samples 15–22) drain the eastern part of the Needle Mountains mining district, and the geochemical anomaly indicated by the stream-sediment samples is the strongest measured in the San Juan primitive area. Silver was detected in 12 of the 14 samples taken along Johnson Creek, and in all of the eight samples taken along Grizzly Gulch. Bismuth was detected in three of the samples from Johnson Creek; these are the only stream-sediment samples from the entire primitive area that contain measurable bismuth. Molybdenite occurs along fractures in Eolus Granite at places adjacent to upper Johnson Creek, and the sediment samples taken downstream contain appreciably more than background values in molybdenum. Molybdenum values in samples from Grizzly Gulch, however, are much more erratic and generally in lower concentration. Lead is well above background in both spectrographic and chemical analyses from both stream systems, although the values from Johnson Creek are, in general, appreciably higher. Zinc is relatively high in samples from Johnson Creek. Tin occurs in all the samples from Johnson Creek and Grizzly Gulch, and in a few, the concentrations are several times the limit of detection. Two samples from Grizzly Gulch contain 0.3 ppm gold.

The metal anomalies in the stream sediments from Johnson Creek clearly have their origin in the numerous well-mineralized veins near the head of the stream. The source of the anomalies along Grizzly Gulch, however, is more obscure, as only a few veins extend into this drainage area. It seems likely that significant metal was dispersed into minor fracture zones in a halo around the more obviously mineralized area, and that this provided the anomalous metal contents found in the stream sediments from Grizzly Gulch.

RUBY CREEK DRAINAGE

(Table 3–D)

Ruby Creek is a short precipitous tributary of the Animas River that heads in a high cirque basin just within the western boundary of the primitive area. Five stream sediment samples were collected in this cirque basin; three of these are from just above a small tarn (Ruby Lake), and two from just below. No obvious indication of mineralization was seen in the cursory examination made when the samples were collected.

The three samples collected above Ruby Lake (samples 1, 2, and 3) contain no more than background concentrations of any of the common metals, and can be considered effectively negative. The two samples from just below Ruby Lake (samples 4 and 5), on the other hand, contain distinctly higher concentrations of Cr, Mo, and Ni according to spectrographic analyses, and higher Cu, Pb, Zn, and Mo by chemical analyses. Because of extreme difficulty of access, the minor anomaly indicated by these analyses was not checked in the field, and we can only speculate as to its cause. The Cr and Ni seem most readily derived from particulate fragments of metaigneous rocks in the Irving Formation which extend southward as a marginal tongue into Eolus Granite in the vicinity of Ruby Lake (pl. 1). The Cu, Pb, Zn, and Mo, on the other hand, might have come from marginal mineralization near the contact of the Eolus Granite batholith with the Irving Formation, perhaps similar to that noted near the head of Leviathan Gulch. (See p. F34.)

NONAME CREEK DRAINAGE

(Table 3–E)

Noname Creek is the next stream north of the mineralized area along upper Needle Creek. No persistent mineralized veins were seen in the Noname Creek drainage basin, but a few rusty fractures with minor selvages of altered rock contain irregular quartz veinlets with local pyrite grains. Three samples of these rusty fracture zones were analyzed, but no significant concentrations of metal were found. The stream-sediment samples, on the other hand, indicate that some sort of a metalliferous halo extends along the north margin of the Needle Mountains mining district into the Noname Creek drainage basin. Minor concentrations of silver were detected along the upper part of Noname Creek (samples 1–10), about opposite the main center of mineralization to the south, and five of these samples also contain detectable tin. Molybdenum is difficult to assess; by spectrographic methods none of the samples contains detectable Mo, whereas by chemical methods most of the samples contain 2–7 ppm Mo. This range is significantly higher than results from the Needle Creek drainage to the south, and considerably above the less than 1- to 2-ppm range in the geologically similar Tenmile Creek drainage to the north (table 3–G, p. F126). Lead and zinc values are erratic and generally low, and the one high chemical analysis for zinc (sample 9) was not substantiated by the spectrographic analysis.

LEVIATHAN GULCH AND SUNLIGHT CREEK

(Table 3–F)

As shown by spectrographic analyses, threshold or near-threshold values in silver were detected in all but two of the stream-sediment samples from Leviathan Gulch (samples 1–9), molybdenum is above background in four of the samples, lead in two, and bismuth and tungsten in one each of the samples. Chemical analyses indicate that at least three samples contain anomalous quantities of zinc. Field examination showed that the top of a cupola of Eolus Granite is exposed in Leviathan Gulch, and along the apex of this cupola the contact with the adjacent Uncompahgre Formation is marked by a zone of feldspathic gneisses formed by metasomatic processes. High-temperature quartz-tourmaline veins and pegmatitic stringers cut the outer part of the cupola and the surrounding feldspathic gneisses, and samples from these veins and stringers contain sufficient silver, bismuth, molybdenum, lead and tungsten (table 9–A, p. F156) to account easily for the anomalies noted in the stream sediments.

Scattered samples from Sunlight Creek (samples 10–26, table 3–F) contain anomalous concentrations of molybdenum and lead. These values probably reflect a halo effect around the known mineralized area in the Needle Mountains mining district to the west and south, as a vein that extends eastward out of upper Chicago Basin into the headwaters of Sunlight Creek was noted in the field. A sample collected from this vein contains distinctly anomalous silver, but all other metallic constituents are background in value. Other parts of this vein or other less conspicuous veins, however, might contain sufficient metal to account for the diffuse anomalies noted in the stream-sediment samples.

TENMILE CREEK DRAINAGE

(Table 3–G)

Very minor quantities of silver were detected here and there in the stream-sediment samples from Tenmile Creek, and two samples contained detectable tin. Of the other metallic elements, only zinc showed any notable concentration; chemical analyses of samples 8, 9, and 12 showed 200–240 ppm Zn, but none of these values was substantiated by spectrographic analyses. No pattern was discerned in the analytical results that seemed to indicate any local anomalous concentrations of metals worthy of further investigation.

ELK CREEK DRAINAGE

(Table 3–H)

Elk Creek heads along the Continental Divide adjacent to the Beartown gold-telluride district, and stream sediments from headwater tributaries contain anomalous concentrations of some of the metals, which reflect the presence of known veins. The southernmost tributary is represented by samples 1–5, and in these silver, copper, and zinc are clearly anomalous, and molybdenum and lead appear slightly above background in two samples each. Samples 6–12 represent a central headwater tributary and a trunk stream below the confluence of this and the southernmost tributary, and in these only zinc appears in anomalous concentration. A northern headwater tributary, represented by samples 13–19, shows local anomalous concentrations of silver, copper, zinc, and perhaps molybdenum.

Stream sediments from the main Elk Creek show anomalous zinc values for about 2 miles downstream from the confluence of the headwater tributaries (samples 20–25, 36), but the other metallic constituents seem largely in background concentrations. Samples from a major tributary from the south (samples 26–35) also indicate metal concentration largely within background ranges.

Field examination has disclosed widely scattered small quartz-pyrite veins cutting the Precambrian rocks in the headwaters area of Elk Creek between the Beartown mining district and a somewhat similar mineralized area in Whitehead Gulch, about 5 miles west-northwest. Some of these veins contain above background concentrations of silver, copper, molybdenum, lead, and zinc (table 11, p. F168) and they probably account in part for the anomalies found in the stream sediments.

WHITEHEAD GULCH DRAINAGE

(Table 3–I)

Numerous quartz-pyrite veins are exposed in the Whitehead Gulch drainage basin, and some of these have local ore shoots containing significant quantities of galena and sphalerite. Stream sediments from the upper part of the drainage basin (samples 1–4) contain metal concentrations only slightly above background, but farther downstream (samples 5–8) the cumulative effect of the veins is clearly apparent, and silver, copper, and zinc concentrations are distinctly above background, and molybdenum shows a slight increase in abundance according to the spectrographic analyses. Tin was also detected in one of these downstream samples.

VALLECITO CREEK DRAINAGE

(Table 3–J)

Vallecito Creek heads in the quartzites and slates of the Uncompahgre Formation and passes downstream through the marginal part of an Eolus Granite batholith—one of the larger areas of metavolcanic rocks in the Irving Formation—and through the Vallecito Conglomerate. With this heterogeneity in source rocks, it is no surprise that the stream-sediment analyses show erratic results, but most of the metal concentrations are quite low. Only two patterns were discerned that seem to be significant in terms of probable metal concentrations. Zinc is erratically above background throughout the length of Vallecito Creek, and probably much of the zinc so indicated was derived from the pyritic black slates in the Uncompahgre Formation in the headwaters of the drainage system. Superimposed on this pattern, however, is an anomaly in zinc, lead, molybdenum, and tin that is clearly proximal to the east margin of the Needle Mountains mining district.

The halo effect of the mineralized district to the west is well displayed by molybdenum, which shows a marked increase in concentration between the mouths of Sunlight and Johnson Creeks. Chemical analyses indicate this increase in sample 37, whereas spectrographic analysis did not detect it until sample 41, but in both the increase is marked, and the samples downstream indicate that the higher level of concentration continues for several miles. An interesting check on the validity of this anomaly is provided by samples 52–54, which were collected from Irving Creek, a minor tributary from the east that drains unmineralized Irving Formation only; these samples contain negligible molybdenum and contrast markedly with the relatively high molybdenum values obtained from samples collected along the main stream both above and below the mouth of Irving Creek. The molybdenum anomaly becomes erratic downstream and cannot be recognized in chemical analyses below sample 59, or in spectrographic analyses below sample 64.

Lead is difficult to assess. Differences in chemical analyses seem almost too minor to be significant, although the zone opposite the mineralized area in the Needle Mountains district contains slightly higher concentrations than that in the upstream areas. Spectrographic analyses, however, show a clear-cut but erratic increase in lead content in sample 33, and another increase in sample 47 below the mouth of Johnson Creek, the main tributary entering from the known mineralized area to the west. As true of molybdenum, lead content of samples from Irving Creek is markedly less than in samples from Vallecito Creek.

The tin anomaly is fully as clear-cut as the molybdenum anomaly. Tin was first detected in sample 40, and was found in nine of the next 13 samples taken along Vallecito Creek (samples 41–51, 55, and 56). Samples 52–54 taken from Irving Creek contained no detectable tin, again confirming the anomaly. Downstream from sample 56, tin was only erratically detected, indicating that the anomaly tails off and becomes weaker downstream.

Inasmuch as the zinc anomaly opposite the known mineralized area is superimposed on drainagewide erratically high zinc concentrations, only the more obvious local halo effects can be discerned. Samples 45–50, opposite and below the mouth of Johnson Creek, however, contain much higher concentrations of zinc than any others obtained along Vallecito Creek, and these seem obviously derived in major part from the mineralized area to the west.

ROCK CREEK, LAKE CREEK, AND FLINT CREEK DRAINAGES

(Table 3–K, L, and M)

Stream sediment samples from these stream systems draining different parts of the Precambrian terrane were all effectively negative insofar as indicating metal concentrations of possible economic interest. Here and there, scattered samples show lead or zinc to be somewhat above background by chemical analyses, but in general, these apparently higher values were not substantiated by spectrographic analyses, nor were they closely enough associated geographically to indicate significant areas of concentration.

The influence of source areas on the abundance of some of the minor elements is well illustrated by the samples from Lake Creek. Above Emerald Lake (samples 1–9), the drainage is confined to the metavolcanic rocks of the Irving Formation, and chromium, nickel, and strontium are relatively abundant. Emerald Lake serves as a barrier to the passage of stream sediments at about the south margin of the outcrop area of the Irving Formation. Below the lake (samples 11–17), the stream traverses Eolus Granite and Vallecito Conglomerate, and sediment samples contain distinctly lower concentrations of these same elements. Apparently, these elements traveled in detrital grains and not in solution.

LOS PINOS RIVER DRAINAGE

(Table 3–N)

Los Pinos River is one of the largest streams draining the San Juan primitive area. Although it heads within the volcanic terrane, most of its course in the primitive area is within a large batholith of Eolus Granite or in Vallecito Conglomerate. No evidence for mineral deposits was seen anywhere along Los Pinos River, and the stream-sediment samples confirm this apparent lack. Although sporadic analyses by spectrographic or chemical methods indicate higher than normal values, the alternative method of analysis almost always indicates such a sample to be within background ranges, and no local areas with anomalous metal concentrations were discerned.

A downstream increase in iron and titanium content of the stream sediments is particularly marked along Los Pinos River, and is believed to reflect the concentration of resistant magnetite-ilmenite grains (black sand) by the stream and the selective removal of less resistant mineral grains and rock fragments.

UTE CREEK DRAINAGE

(Table 3–O)

Ute Creek heads in quartzites and slates of the Uncompahgre Formation and passes progressively downstream through Tertiary andesitic flows and breccias and rhyolitic welded tuff, Precambrian augite syenite, and a thick mass of Tertiary welded tuff that is cut and altered by three quartz monzonitic intrusive bodies. The Tertiary intrusives and associated altered rocks appear to be possible hosts for mineral deposits, and numerous stream-sediment samples (samples 1–13) were collected near them. Samples 1 and 2, representing soil along the projected trend of an east-striking fault just north of the primitive area, contained 700 ppm zinc by chemical analyses, but less than 200 ppm by spectrographic analyses. All other analyses of samples taken near the altered rocks were effectively negative.

Upstream, zinc was anomalously high all along the west fork of Ute Creek (samples 19–20, 35–39), and copper was high in one of these (sample 38). This anomaly was traced upstream to a pyritic black slate unit within the Precambrian Uncompahgre Formation. The slate was carefully sampled and analyzed (table 8, p. F154), and the metal content was found to be within normal ranges for typical organic black shales elsewhere in the world. (For description, see p. F50.)

STREAM DRAINAGES IN THE CENTRAL PART OF THE PRIMITIVE AREA

(Table 3–P through T)

The central part of the San Juan primitive area is largely in an outflow area of ash-flow tuffs and includes the northern flank of a large shield volcano within the Huerto Formation. The main streams draining this area are north-flowing Weminuche Creek (tributary to the Rio Grande), south-flowing Weminuche Creek (tributary to the Piedra River), Hossick Creek, Squaw Creek, and Little Squaw Creek. No indication of significant mineralized rock was seen in any of these drainage systems, and the stream-sediment samples collected within them are uniformly negative. The relatively high zinc values shown in table 3–T (p. F140) for Little Squaw Creek reflect the fact that these samples were the only ones collected from the primitive area that were concentrated by panning prior to being analyzed. Magnetite-ilmenite grains were thus concentrated in the retained residue, and chemical tests indicate that these grains contain appreciable zinc within them. Zinc-bearing magnetite-ilmenite is common and of no economic importance.

STREAMS DRAINING THE EASTERN PART OF THE PRIMITIVE AREA

(Table 3–U through Z, and AA through CC)

The eastern part of the San Juan primitive area covers the southern part of the central San Juan cauldron complex, a structurally disturbed area of recurrent cauldron subsidence related to volcanic eruptions—largely of great ash flows—in latest Oligocene time. Despite the numerous faults of several ages that cut the cauldron complex area (pl 1), surface evidence for mineralization is vanishingly small everywhere except in some areas of highly altered rock in the upper part of Trout Creek and adjacent areas, and some altered and pyritized rock around intrusive plugs in the headwaters of the East Fork Piedra River, the West Fork San Juan River, Goose Creek, and Red Mountain Creek. Stream-sediment samples collected along all streams draining the cauldron complex contained no anomalous concentrations of metals anywhere, including the areas with highly altered rocks that appeared in the field to be favorable for the occurrence of hydrothermal mineral deposits. The uniformly negative results indicate a poor likelihood that any metalliferous deposits will be found here in a near-surface environment, despite local evidence for intensive hydrothermal activity.

MINERAL RESOURCES OF PRECAMBRIAN AGE

In appraising the potential mineral resources in the Precambrian rocks of the San Juan primitive area, the possibility of both original sedimentary deposits and later epigenetic deposits was considered. The conglomerate beds in the Vallecito Conglomerate and the Uncompahgre Formation were considered potential sources of gold of placer origin, and were the subject of a separate study connected with the Heavy Metals Program of the U.S. Geological Survey. Sparse sulfides are widely but erratically disseminated in some of the old metamorphic rocks, and locally they have been prospected rather extensively. Iron-formation was reported to be interlayered with metavolcanic rocks of the Irving Formation by Cross and Howe (in Cross, Howe, Irving, and Emmons, 1905), and a special reconnaissance survey was made to assess its potential. Many of the black slates in the Uncompahgre Formation contain significant quantities of pyrite; these slates are believed to be slightly metamorphosed equivalents of organic black shales that in many places throughout the world contain abnormal quantities of metals.

In addition to the specific attention given to the potential sources of mineral commodities mentioned above, the halos around Precambrian intrusive masses were considered as possible loci for mineral deposits. A few small quartz-tourmaline veins and pegmatitic quartz veins associated with a cupola of Eolus Granite in Leviathan Gulch contain low concentrations of different metals, but otherwise no mineral deposits associated with Precambrian intrusives were noted in the field.

PLACER GOLD POTENTIAL IN PRECAMBRIAN CONGLOMERATES

The gold potential of Precambrian clastic rocks of southwestern Colorado and northern New Mexico was studied by Barker (1969) in connection with the Heavy Metals Program of the Geological Survey. Mr. Barker kindly supplied the data on which the following discussion is based.

The Vallecito Conglomerate is the basal exposed unit in the Precambrian sequence in the Needle Mountains. A large sample (about 170 pounds) of this unit was taken in the canyon of Vallecito Creek, and five smaller samples (about 5 lb each) were taken along the Lake Fork Los Pinos River. The large sample was crushed, and the heavy minerals were separated and sieved into four size fractions. None of these fractions contained detectable gold (limit of detection is 0.02 ppm for two of the fractions, 0.3 ppm for one, and 0.1 ppm for another). The five smaller samples were crushed and assayed; these, too, did not contain detectable gold. Barker concluded that the gold potential of this formation is low.

A conglomerate marking the base of the Uncompahgre Formation was also considered to be a possible host for placer gold. Ten samples taken from the west side of Snowden Peak were analyzed, and all contain less than the limit of detection (0.1 ppm) of gold. One sample taken from the east bank of the Animas River, and two samples taken from the west wall of the Animas River canyon at about 10,120 feet altitude showed similar negative results.

Some of the quartzite layers higher in the Uncompahgre Formation contain local conglomeratic lenses. Thirteen of these conglomeratic beds were sampled at different places in the Needle Mountains, and none contained detectable gold. Barker concluded that the coarser clastic rocks in the Uncompahgre Formation also were poor potential sources for gold.

Stream-sediment samples taken in connection with the present mineral appraisal were collected from streams draining the Precambrian terrane, and were analyzed for gold (table 3, p. F122). The few samples that showed detectable gold are all from streams draining areas known to contain metalliferous vein deposits.

SULFIDE DEPOSITS IN OLDER PRECAMBRIAN ROCKS

Sparsely disseminated sulfides—generally pyrite but locally minor chalcopyrite—were seen at many places in the older Precambrian rocks. For the most part, these disseminated sulfides are in the metavolcanic rocks of the Irving Formation in the Vallecito Creek-Lake Fork area, where they are in erratically distributed small masses a few feet to a few tens of feet across. Two larger areas several hundred feet across were seen along reconnaissance traverses investigating the iron-formation in the Irving Formation. (See next section.) The sulfides are generally disseminated through the gneissic rocks, and no control on their distribution was discerned in the field. Most outcrops are marked by a rusty-brown stain from oxidized pyrite; green malachite stains derived from oxidized chalcopyrite coat a few minor fractures in some places, but generally these are very sparse and obscure. None of the sulfide-bearing metavolcanic rocks contain more than a few percent sulfides, and most of this is pyrite. This fact and the small size of most of the sulfide-bearing masses indicate a low economic potential.

Engineers of the U.S. Bureau of Mines examined one sulfide deposit of this general type in the older Precambrian rocks near the ridge crest west of Emerald Lake. It contained a 1-inch-wide stringer of sulfide minerals within a 5-foot zone of rusty iron-stained schist. (For further description, see p. F111–F112.) Although some of the assayed samples contained low-grade lead and silver, only a small tonnage of mineralized material is indicated by surface exposures.

Some irregular quartz veins containing sparse sulfide minerals are associated with granitic dikes cutting the Vallecito Conglomerate. One such occurrence on the east wall of the Vallecito Creek canyon, about 1 mile inside the San Juan primitive area (Gold Nugget 1, 2, and 3 claims), was examined in 1952 by E. N. Harshman of the U.S. Geological Survey in connection with an application for an exploration loan from the Defense Minerals Exploration Administration. The history of mine development is given on page F112 of this report. According to E. N. Harshman (written commun., 1968), low-grade copper mineralization has occurred along the contact between a granite porphyry dike and the Vallecito Conglomerate and in a pegmatitic quartz vein that cuts the conglomerate nearby. The vein crops out over a vertical span of about 50 feet and a lateral distance of several hundred feet and is about 700 feet above the main creek level. As exposed in a small cut, the vein is 4–5 feet wide, and strikes N. 45° E., and dips 65° N. The primary vein material consists largely of quartz containing scattered grains of pyrite and chalcopyrite; secondary sulfide minerals are sparse covellite and bornite, and some malachite forms a green coating on fractures near the surface. A sample of the highest grade part of the vein (about 1 ft wide) exposed in the cut contains 0.42 percent Cu, and 0.03 oz Au. The contact deposit was developed by a 200-foot drift and a 40- to 50-foot winze some time early in the century. These workings followed a weak silicified zone, 6 to 12 inches wide, that contains pyrite, chalcopyrite, bornite, covellite, and gold. One sample across this zone shows 0.25 percent Cu and 0.75 oz Au.

Because of the small size and low grade of these deposits, Harshman considered their economic potential to be low.

Another deposit containing gold, silver, and copper occurs in small pegmatitic quartz veins that cut the metavolcanic gneisses in the Irving Formation. It is developed by the old Copper Queen (Grizzly King) workings on the east side of Vallecito Creek, south of Second Creek and approximately 1,500 feet above the main creek level. This area was examined jointly with engineers of the U.S. Bureau of Mines, who discuss the property further on pages F109–F111 of this report. Scattered prospect pits expose widespread pyrite with local chalcopyrite disseminated through the dark gneisses and in small pegmatitic quartz veins cutting them. Most of the pyrite is in narrow discontinuous pegmatitic quartz veins a few inches wide and a few tens of feet long, or in narrow shear zones of about the same dimensions. These are widely scattered over an area at least half a mile across, and no persistent trend or particular localizing feature was noted in the field.

Of the two main workings, the lower one is a tunnel about 85 feet long that was dug along the trend of some minor discontinuous quartz veins that strike about N. 70° E. and dip 75°–80° SE. On the surface, these veins cannot be traced for more than a few feet beyond the opencut at the portal of the tunnel; underground, the tunnel cuts unmineralized metagabbro for most of its length. The upper workings, several hundred yards farther east and about 300 feet higher, consist of a small opencut that supplied most of the production credited to the property. The cut exposes discontinuous quartz pods, 6–8 inches wide, along a minor shear zone in the metavolcanics that strikes N. 20° E. and dips 80° NW. Pyrite occurs widely through the quartz pods, and some is disseminated in the adjacent sheared gneisses as well. Local pockets in the quartz veins as much as 6 inches across consist predominantly of pyrite.

Seven samples of the pegmatitic quartz veins and of pyritic gneisses near the veins range in content from 0.08 ppm to 95 ppm gold, with the highest grade material coming from a pyritic pocket in the quartz vein exposed in the upper workings. Silver in the same samples ranges in content from 0.5 ppm to 16 ppm, and copper, from less than 10 to 20,000 ppm (2 percent). Silver and copper are each high in the same samples.

These analytical results indicate that the pyritic sheared zones and quartz veins in and near the Copper Queen property locally contain abnormal but very erratic concentrations of gold, silver, and copper. In places, these metals are sufficiently abundant to be of ore grade, and indeed some of the higher grade material was packed out on muleback in the early days and shipped directly to the smelter. The very small size of the veins and the erratic distribution of ore-grade material within them, however, make it unlikely that they could be operated profitably, even if they were in a more readily accessible location.

IRON RESOURCES IN THE IRVING FORMATION

By JACOB E. GAIR and HARRY KLEMIC, U.S. Geological Survey

Cross and Howe (in Cross, Howe, Irving, and Emmons, 1905, p. 2) described a "15-foot band of more or less siliceous magnetic iron" interbedded with siliceous schists or mashed quartzite on the west side of Irving Peak, in the east-central part of the Needle Mountains. In 1966, Fred Barker of the U.S. Geological Survey (oral commun., 1968) found a bed of laminated magnetite-quartz rock at an altitude of approximately 11,000 feet on the main west ridge of Irving Peak that may be the same occurrence. These rocks are typical of an assemblage of iron-rich rocks generally known as iron-formation, although strictly speaking, this term is limited to rocks containing 15 percent or more Fe (James, 1966, p. W1, W46–W47). In the present study of the Irving Formation, five localities containing laminated magnetic iron-formation or similar rock with somewhat less than 15 percent Fe were found in beds that range in thickness from about 4 inches to 50 feet. Because of their small size and low grade, none of these occurrences appears to have commercial potential.

In seeking out the iron-rich rocks in the Irving Formation, the outcrop area of the formation in the Vallecito Creek–Lake Fork area was systematically traversed on foot. A preliminary traverse was made along Vallecito Creek, and 14 other traverses (T–1 through T–12, T–14, and T–15) were made, so far as possible, across the structural trend of the formation (fig. 4). The rock along the traverses was examined visually and measurements were made with a magnetometer at intervals of approximately 20–100 feet, samples collected, and individual specimens tested with a hand magnet.

DESCRIPTION OF THE IRVING FORMATION

Cross and Howe (in Cross, Howe, Irving, and Emmons, 1905, p. 2) noted that the Irving Formation contains schists, greenstones, and subordinate quartzites—mainly unstratified metavolcanic rocks intruded by other metaigneous rocks—characterized by rather uniform compositions and a wide variety of textures. Poorly layered and unlayered greenstone schist is the predominant type, but well-laminated greenstone schist is common and widespread in the Irving Formation. The

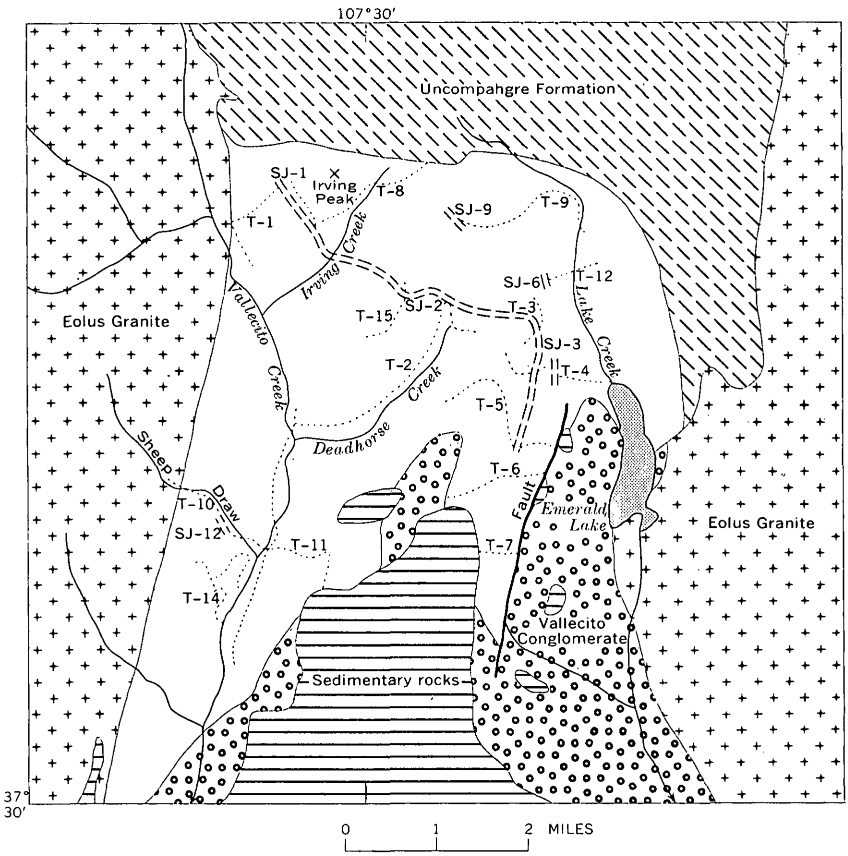

FIGURE 4.—Geology of the Irving Peak–Emerald Lake area. T–1, traverses; SJ–1, samples; double-dashed line, known exposures of laminated greenstone and iron-formation within the Irving Formation (unpatterned).

greenstone schist commonly contains 35–65 percent intergrown quartz and plagioclase, and much of the rest of the rock consists of micas and epidote, or hornblende, micas, and epidote. The dark color is due largely to the biotite and hornblende. Basaltic to rhyodacitic parent rocks are suggested by the mineralogic and chemical compositions of the Irving Formation (table 4).

TABLE 4.—*Abundance of major oxides in samples of magnetite iron-formation, amphibolitic schist, and greenstone of the Irving Formation, Hinsdale and La Plata Counties, Colo., as calculated from chemical analyses of magnetic and nonmagnetic separates*

[Total H_2O in each sample is 1-2+ percent. Combined P_2O_5, MnO_2, and CO_2 in each sample is 1-2 percent]

	Abundance of major oxides (in percent) in samples (by No.)									
	SJ-1	SJ-2C	SJ-3	SJ-6	SJ-6A	SJ-6B	SJ-6C	SJ-9	SJ-12	SJ-12A
SiO_2	54.44	61.38	47.69	47.82	68.69	49.21	63.82	50.22	54.49	50.10
Al_2O_3	17.75	16.51	16.37	17.03	11.92	15.83	14.40	8.38	8.91	8.04
Fe_2O_3	4.45	1.85+	10.16	7.52	3.51	8.61	1.63+	18.78	14.19	17.79
FeO	6.11	4.15+	9.17	9.17	6.21	12.0	6.24+	11.7	11.9	14.02
MgO	3.49	2.33	2.75	1.44	.81	2.51	1.57	2.12	2.77	2.65
CaO	6.83	1.85	3.82	11.29	1.75	3.22	1.35	4.35	2.09	1.81
Na_2O	3.45	3.29	.95	0	2.00	1.47	3.02	.66	.94	.69
K_2O	.65	2.92	4.49	.80	2.74	2.02	2.54	1.1	1.49	1.17
TiO_2	.42	.68	1.60	.56	.25	.68	.60	.38	.30	.30
Total	97.59	94.96+	97.00	95.63	97.88	95.55	95.17+	97.69	97.08	96.57

The magnetite content of the greenstone schist in the Irving Formation is generally less than 5 percent—except for that in the five localities found to have ferruginous rock approaching iron-formation in composition. At these localities the combined magnetite and iron-bearing silicates constitute nearly half the content of the rock, and total iron ranges from about 8 to 23 percent. Chemical analyses of the iron-formation (table 4, samples SJ-6B, 9, 12, 12A) show that the Al_2O_3, Na_2O, and K_2O are high compared with the amounts found in most sedimentary iron-formations (James, 1966, tables 8–19). The high amounts of these oxides are probably due to the relatively low total Fe and the presence of intermixed—rather felsic—volcanic material in the iron-formation in the Irving Formation.

IRON-FORMATION AND SIMILAR LAMINATED FERRUGINOUS ROCK

During reconnaissance of the Irving Formation, iron-formation and similar laminated magnetic rock, containing somewhat less than 15 percent Fe, were found on traverses 1, 3, 4, 9, and 10. Traverse 1 crossed what is probably the same occurrence described by Cross and Howe (in Cross, Howe, Irving, and Emmons, 1905) and found again by Barker in 1966 at an altitude of approximately 11,000 feet on the west ridge of Irving Peak. Magnetite-rich laminated rock (sample SJ-1, fig. 4) occurs in vertical beds trending S. 25° E.; these beds range in thickness from 4 inches to 2 feet, and total about 4 feet of the 15-foot thickness of greenstone. The magnetic zone can be followed for 20 to 30 feet along the trend of the beds and does not appear to extend northwest or southeast of the crest of the ridge. The maximum magnetic value is 2,400 gammas.

On traverse 3, exposures of magnetite-rich quartz-plagioclase-biotite-muscovite-epidote-garnet schist (samples SJ–6 through SJ–6C, fig. 4) were found on the second creek from west, north of Emerald Lake, at an altitude of approximately 10,900 feet. The magnetite-rich bed strikes S. 30° E. and dips 45° SW., and is about 30 to 35 feet thick. It does not reach the south fork of the creek, 200–300 feet away, on the trend of the formation. No attempt was made to follow the magnetic zone up the precipitous slope to the northwest. Magnetic rock was not found on the trend of the formation in the next east-trending valley to the north.

Iron-formation was seen on traverse 4 along the first creek from the west, north of Emerald Lake, at an altitude of approximately 11,700 feet. The iron-formation is a 3-foot-thick bed; it was not sampled.

Along traverse 9, iron-formation is exposed in the cirque near the head of the third creek from west, north of Emerald Lake, at an altitude of approximately 12,400 feet. Beds of magnetite-rich iron-formation (sample SJ–9, fig. 4), as much as 1 foot thick and several feet long, are interbedded with poorly laminated greenstone through a zone about 50 feet wide. The zone including iron-formation strikes S. 45° E. and dips 60° SW., and is less than 200 feet long.

Magnetic garnet-rich iron-formation (samples SJ–12 and SJ–12A, fig. 4) was found on traverse 10 along the southwest side of Sheep Draw, west of Vallecito Creek, and was traced for about 1,000 feet between the altitudes of approximately 9,400 and 9,800 feet. The iron-formation forms a 25-foot-thick bed near the altitude of 9,800 feet, but near the altitude of 9,600 feet, it forms two beds—one about 50 feet, and the other about 5 feet thick—separated by about 10 feet of nonmagnetic rock. The aggregate thickness of about 55 feet at the last location was the maximum thickness of iron-formation seen in the Irving Formation. The iron-formation trends about N. 40° W., and dips 80° SW. Evidently, it crosses to the north side of Sheep Draw and extends into an impassably steep slope up toward the intrusive contact with Eolus Granite, about 4,000 feet away. To the southeast, the iron-formation ends abruptly at a fault or intrusive contact with a small mass of granitic rock.

ANALYTICAL DATA

Ten samples of magnetic iron-formation and similar laminated ferruginous rock, magnetite-bearing amphibolitic schist, and greenstone were selected for analyses. To determine the composition of the whole rock and a magnetic concentrate from the rock, each sample was ground to pass through a 100-mesh screen, and the ground samples were separated into magnetic and nonmagnetic fractions by using a hand magnet.

The results of the magnetic and nonmagnetic fractions of −100-mesh size are given below. Only five samples yielded magnetic concentrates of 30 percent or more of the total rock. The magnetic fractions of the others were less than 20 percent.

Sample No.	Magnetic fraction (percent)	Nonmagnetic fraction (percent)	Sample No.	Magnetic fraction (percent)	Nonmagnetic fraction (percent)
SJ-1	10.0	90.0	SJ-6B	36.3	63.7
SJ-2C	7.7	92.3	SJ-6C	4.0	96.0
SJ-3	73.2	26.8	SJ-9	75.3	24.7
SJ-6	10.8	89.2	SJ-12	31.5	68.5
SJ-6A	17.7	82.3	SJ-12A	40.3	59.7

Separate chemical analyses were made of the magnetic and nonmagnetic fraction of each sample. The chemical analyses of the whole rock (table 4) were computed by using the above data on the magnetic and nonmagnetic fractions of the rock and the analytical data in tables 5 and 6.

The results of the chemical analyses indicate that some rock originally named in the field as iron-formation, on the basis of appearance and magnetic properties, does not contain sufficient iron to be so classified. The iron content of the whole-rock samples as calculated from the analyses of their magnetic and nonmagnetic separates is reported in table 7.

Because of the low iron content of the samples and the relatively limited volumes of magnetite-bearing rock they represent, none of the units sampled can be classed as iron ore deposits of economic value. Although it is unlikely that all occurrences of iron-formation in the Irving were seen, it is certain that the traverses crossed no significant zones of undiscovered iron-formation. Other possible occurrences would probably be of the same range of thickness as the known iron-formation, would have to be of shorter strike length than the distances between traverses, and, so, would not be economic in size. The absence of tight folding along the main belt of well-laminated schist tends to rule out the possibility of significant thickening of thin beds of iron-formation by folding.

TABLE 5.—*Chemical analyses of magnetic concentrates from iron-formation, amphibolitic schist, and greenstone of the Irving Formation, Hinsdale and La Plata Counties, Colo.*

[Rapid rock analyses by Paul Elmore, Lowell Artis, S. D. Botts, G. W. Chloe, J. L. Glenn, James Kelsey, and Hezekiah Smith. SJ-6A, sample number; (W169236), laboratory number]

	Magnetic concentrates (in percent)									
	SJ-1 (W169227)	SJ-2C (W169229)	SJ-3 (W169231)	SJ-6 (W169233)	SJ-6A (W169235)	SJ-6B (W169237)	SJ-6C (W169239)	SJ-9 (W169241)	SJ-12 (W169243)	SJ-12A (W169245)
Fe_2O_3	17.5	(1)	12.1	15.9	11.5	16.0	(1)	23.0	40.7	40.9
FeO	15.2	(1)	10.8	37.0	25.3	17.6	(1)	14.0	25.8	25.9
SiO_2	42.2	38.3	45.6	26.5	53.3	40.8	23.5	45.2	22.3	22.1
Al_2O_3	13.7	10.5	15.7	9.8	5.0	13.6	4.8	7.8	5.0	4.7
MgO	1.6	1.3	2.6	.91	.50	2.0	.76	1.9	1.4	1.4
CaO	4.4	1.3	3.6	6.3	1.1	2.9	.37	4.1	1.2	1.4
Na_2O	3.1	2.0	.95	0	.65	1.4	1.0	.63	.37	.27
K_2O	.48	1.9	4.3	.39	1.11	1.7	1.0	1.0	.60	.52
H_2O-	.09	.13	.13	.13	.15	.15	(2)	.16	.11	.09
H^2O+	.89	.87	1.9	1.4	.74	2.5	.93	1.1	.84	.85
TiO_2	.43	.45	1.6	.45	.16	.56	.20	.36	.17	.16
P_2O_5	.17	.20	.15	.23	.10	.28	.20	.22	.15	.20
MnO	.16	.29	.10	.81	.36	.36	.36	.32	1.4	1.6
CO_2	.05	.05	.55	.05	.05	.05	.92	.05	.05	.05
Total [3]	100	(1)	100	100	100	100	(1)	100	100	100

[1] Not calculated because of slight contamination with metallic iron.
[2] Total H_2O.
[3] Totals are rounded to the nearest whole precent.

TABLE 6.—*Chemical analyses of nonmagnetic separates from iron-formation, amphibolitic schist, and greenstone of the Irving Formation, Hinsdale and La Plata Counties, Colo.*

[Rapid rock analyses by Paul Elmore, Lowell Artis, S. D. Botts, G. W. Chloe, J. L. Glenn, James Kelsey, and Hezekiah Smith. SJ-6A, sample number; (W169236), laboratory number]

	Nonmagnetic separates (in percent)									
	SJ-1 (W169228)	SJ-2C (W169230)	SJ-3 (W169232)	SJ-6 (W169234)	SJ-6A (W169236)	SJ-6B (W169238)	SJ-6C (W169240)	SJ-9 (W169242)	SJ-12 (W169244)	SJ-12A (W169246)
Fe_2O_3	3.0	2.0	4.9	6.5	1.8	4.4	1.7	6.2	2.0	2.2
FeO	5.1	4.5	4.7	5.8	2.1	8.8	6.5	4.7	5.5	6.0
SiO_2	55.8	63.3	53.4	50.4	72.0	54.0	65.5	65.5	69.3	69.0
Al_2O_3	18.2	17.0	18.2	17.9	13.4	17.1	14.8	10.2	10.7	10.3
MgO	3.7	2.2	3.2	1.5	.87	2.8	1.6	2.8	3.4	3.5
CaO	7.1	1.9	4.4	11.9	1.9	3.4	1.4	5.1	2.5	2.1
Na_2O	4.6	3.4	.94	0	2.3	1.5	3.1	.78	1.2	.97
K_2O	.67	3.0	5.0	.85	3.1	2.2	2.6	1.4	1.9	1.6
H_2O-	.11	.10	.13	.10	.13	.16	.13	.21	.13	.16
H_2O+	1.0	1.6	2.1	2.1	1.1	3.2	1.8	1.4	1.5	1.6
TiO_2	.43	.70	1.6	.57	.27	.75	.61	.43	.36	.43
P_2O_5	.12	.18	.11	.21	.07	.28	.14	.25	.26	.35
MnO	.21	.11	.07	1.8	.27	.45	.09	.39	1.3	1.7
CO_2	.05	.05	.52	.05	.05	.05	.05	.05	.05	.05
Total[1]	100	100	99	100	99	100	100	99	100	100

[1] Totals are rounded to the nearest whole percent.

TABLE 7.—*Iron content of whole-rock samples, calculated from analyses of magnetic and nonmagnetic separates*

Sample No.	Fe (*percent*)	*Sample No.*	Fe (*percent*)
SJ-1	7. 83	SJ-6B	15. 26
SJ-2C	[1] 7	SJ-6C	[1] 7
SJ-3	14. 18	SJ-9	22. 15
SJ-6	12. 33	SJ-12	19. 09
SJ-6A	7. 24	SJ-12A	23. 34

[1] Contamination with metallic iron in magnetic separates resulted in slightly inaccurate total percentage of Fe.

PYRITIC BLACK SLATES

Black slate and phyllite are major constituents of the Uncompahgre Formation, and many of these rocks contain significant quantities of pyrite and organic carbon. They clearly are slightly metamorphosed organic black shales of the type that commonly contains above-background quantities, and in a few places economic quantities, of metals. Pyrite in some of the slate is estimated to constitute 20–25 percent of the rock, although generally it is considerably less. The carbon content of one of the darker and more organic appearing black slates was determined to be 4.78 percent. Ground water issuing from springs near some of the more pyritic slate is strongly acid; elsewhere, stream sediments below outcrops of the slate contain erratically anomalous quantities of zinc and copper.

The pyritic black slates in the Uncompahgre Formation were investigated by two separate projects. Fred Barker of the U.S. Geological Survey collected 12 samples of the pyritic slate from different places in the Needle Mountains during his reconnaissance study of the heavy-metals potential of Precambrian metasedimentary rocks in the area (Barker, 1969), and he has kindly given us his analytical results (samples prefixed BSJ, table 8, p. F154). In the present mineral appraisal of the San Juan primitive area, a zinc-copper anomaly in the strea msediments along west Ute Creek was traced upstream to a layer of pyritic black slate about 140 feet thick; this unit was carefully sampled at regular intervals, and 11 of the samples were analyzed (samples prefixed Ds, table 8).

The analytical data (table 8, p. F154) indicate that all metal contents of the pyritic black slate in the Uncompahgre Formation are well within the normal ranges for other organic black shales reported by Vine (1966, table 1). Silver, molybdenum, vanadium, and zinc are highest in the slates containing most organic carbon and pyrite (Ds125g, h, j, k, l, m, n, o), whereas cobalt, chromium, nickel, and lead seem somewhat higher in the more silty rocks (Ds125, b, d, f). Copper shows minor enrichment in some samples, but in most it is low. The analyses representing the sequence of samples taken across a single exposure (Ds125b–o) show far greater variation in metal values than do the other analyses which represent single samples taken at different locations. This probably means that the pyritic slate units cannot be adequately represented by single samples; however, neither the single samples from different locations nor the multiple samples from a single location show any unusual concentrations of elements that might indicate mineral resources of present economic value. Sediment samples taken from streams draining the exposed Uncompahgre Formation gave no indication that any of the unsampled areas of black slate contain metal concentrations higher than those analyzed.

COAL, OIL, AND GAS POTENTIAL [2]

A thick section of sedimentary rocks underlies the volcanic rocks in the eastern part of the San Juan primitive area, and some of these possibly might contain significant resources of fossil fuels. The main coal-bearing units in the San Juan Basin to the south—the Kirtland Shale and Fruitland Formation—were largely eroded from the vicinity of the primitive area prior to volcanic activity in middle Tertiary time, so the coal-resource potential seems negligible. An oil and gas potential cannot be summarily dismissed, however, as the sedimentary section beneath the volcanic cover includes many potential reservoir rocks which conceivably might contain local accumulations of hydrocarbons if suitable traps exist.

Sandstone units that might serve as oil-bearing reservoirs are the Entrada Sandstone, the Junction Creek Sandstone Member of the Wanakah Formation, several sandstone beds in the lower part of the Morrison Formation, the Burro Canyon Formation, and the Dakota Sandstone. Of these, the Dakota Sandstone is the source of the oil produced from the Gramps field (Waldschmidt, 1946), about 25 miles southeast of the primitive area, which at one time was deeply covered by the volcanic rocks. Other sedimentary units also might serve as reservoir rocks, as fractured shale and siltstone in the lower part of the Mancos Shale have yielded small quantities of oil in the Chromo field (Cox, 1962), about 25 miles south of the primitive area.

Important gas-bearing strata in the northern San Juan Basin south of Durango, Colo., are in the Dakota Sandstone (Bowman, 1962), several sandstone beds in the Mesaverde Group, the Pictured Cliffs Sandstone (Cornell, 1962), and the Fruitland Formation. Of these, only the Dakota Sandstone is present beneath the eastern San Juan primitive area; the Fruitland and Pictured Cliffs were eroded from the area prior to volcanic activity, and the Mesaverde sandstones have graded laterally northeastward into predominantly shaly rocks.

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[2] Data for this section were supplied largely by W. J. Hail, Jr., U.S. Geological Survey.

The oil and gas potential in the sedimentary strata beneath the volcanic rocks in the eastern part of the San Juan primitive area depends largely on the presence or absence of suitable traps for which no surface evidence is known. Anticlines are fairly numerous in the exposed sedimentary rocks in the San Juan Basin south of the primitive area, and some of these have produced significant quantities of both oil and gas. Minor petroleum shows have been reported near Pagosa Springs, Colo. (Wood and others, 1948), 10 to 20 miles south of the primitive area, but tests in this same area have as yet failed to develop significant reserves. The sedimentary rocks beneath the San Juan primitive area dip gently northeastward off the northeastern flank of the Archuleta anticlinorium. No reversals of dip or subsidiary folds that might give closure to a potential oil- or gas-bearing structure are known in this vicinity, but unknown traps of this kind might well exist beneath the volcanic cover. In addition, depositional pinch-outs of some of the lower sandy units against underlying Precambrian rocks might provide stratigraphic traps for oil or gas.

A possible reason for postulating a low potential for the oil and gas in the sedimentary rocks in this vicinity is the highly faulted character of the overlying volcanic rocks in the southern part of the central San Juan cauldron complex, which occupies most of the possible oil- and gas-bearing area. This faulting has cut the whole area into a complex mosaic, but despite the abundance of fractures, no surface indication of petroleum was observed. In addition, the faulting depressed the blocks progressively downward to the north, which makes exploration increasingly difficult and more expensive in this direction.

In summary, although no positive indications of oil or gas beneath the eastern San Juan primitive area were seen, potential reservoir rocks certainly exist there, and if appropriate structural or stratigraphic traps are present, oil and gas accumulations might well be present in them. Lacking definite evidence for any such traps, however, we cannot now postulate any oil or gas resources within the San Juan primitive area.

DEPOSITS OF UNKNOWN AGE

Some of the scattered small mineralized areas around the periphery of the San Juan primitive area cannot be assigned to known epochs of mineralization on the basis of available data. Two of these areas were examined by personnel of the U.S. Bureau of Mines, and one, by the U.S. Geological Survey.

URANIUM DEPOSITS WEST OF THE ANIMAS RIVER

Uranium has been produced from veins along the west side of the Animas River about opposite the mouth of Elk Creek. Although these deposits are several miles outside the primitive area, deposits similar to them conceivably could occur within the primitive area. The deposits were examined by M. J. Sheridan and F. E. Williams, of the U.S. Bureau of Mines, who report (p. F88–F89) small lenticular shoots containing pitchblende and secondary uranium minerals along sheared zones in Precambrian metasedimentary rocks.

RUNLETT PARK–CAVE BASIN AREA

Silver, copper, lead and zinc deposits have been reported from the Runlett Park–Cave Basin area along the south margin of the primitive area between Los Pinos River and Vallecito Creek. These deposits were examined in 1968 by M. J. Sheridan and F. E. Williams of the U.S. Bureau of Mines. The metals are in replacement deposits in lower Paleozoic sandy limestones. These deposits are discussed more fully on page F113.

MINERALIZED FAULT NEAR MILK CREEK

A north-northeast-trending fault zone separates Precambrian rocks on the west from Mesozoic sedimentary rocks on the east near the confluence of Milk Creek and south-flowing Weminuche Creek along the south-central margin of the San Juan primitive area (pl. 1). Some strands of the fault that separate quartzites and gneisses of the Irving Formation from the Eolus Granite appear largely healed by quartz veins and silicified material and may mark segments whose displacement was Precambrian in age. The main fault between Precambrian and Mesozoic rocks is much more granulated, and appears to have been active largely during the Laramide orogeny, inasmuch as the adjacent Jurassic and Cretaceous rocks are deformed, but the overlying Tertiary volcanic rocks farther north are unbroken.

The fault zone is marked by reddish hematitic soils and by hematite- and limonite-stained breccia and quartz veins. In places, iron-oxide pseudomorphs of former pyrite crystals can be recognized. The abundance of iron-oxide staining on the rocks and soils indicates the former presence of relatively abundant pyrite, and the whole zone is considered to be a possible host for mineral deposits.

A series of samples was collected from three localities along the fault zone within and immediately adjacent to the San Juan primitive area. Spectrographic and chemical analyses (table 9–B, p. F156) indicate that copper is in concentrations slightly above background in a few of the samples, but that none of the other metals is noticeably anomalous. Stream-sediment samples collected along Milk Creek and south-flowing Weminuche Creek in this same area (table 3–O, p. F136) are similarly negative.

POSSIBLE MINERAL DEPOSITS OF LATE CRETACEOUS OR EARLY TERTIARY AGE

The intrusive center at Ouray, Colo., is known to be of Late Cretaceous or early Tertiary age (Burbank, 1940; Dickinson and others, 1968), and Burbank (1933, p. 297–298) has suggested that similar intrusive centers at Rico and in the La Plata Mountains were probably intruded at about the same time. All three centers have associated mineral deposits.

The center of Ouray is still largely covered by younger volcanic rocks of mid-Tertiary age, and the intrusive rocks and associated mineral deposits were exposed only by an accident of erosion by the Uncompahgre River. Very possibly, other intrusive centers of this age, perhaps with associated mineral deposits, exist elsewhere beneath the volcanic cover, even though no evidence was seen for any such center. The mineralized district centered on the subvolcanic intrusive center in Chicago Basin near the head of Needle Creek is perhaps of this age. Though it lacks any definite evidence, discussion of it is included in the section "Mineralized Areas Associated With Mid-Tertiary Volcanic Activity."

MINERALIZED AREAS ASSOCIATED WITH TERTIARY VOLCANIC ACTIVITY

The mineral deposits in the San Juan primitive area having the greatest economic potential all appear to be related to Tertiary volcanic activity. The Needle Mountains mining district, in the southern Needle Mountains, is associated with a composite hypabyssal intrusive plug of probable Oligocene age; the veins in the Whitehead Gulch area, in the northern Needle Mountains, form the southern fringe of a highly productive mineralized area along the southern flank of the Silverton volcanic cauldron; the epithermal gold-telluride veins in the Beartown mining district, farther east in the northern part of the Needle Mountains, probably are related to the nearby volcanic activity; and the native sulfur in the Trout Creek–Middle Fork Piedra River area in the northeastern part of the primitive area was deposited in fumarolic areas associated with Huerto Formation volcanoes. Elsewhere, highly altered and pyritized rocks are associated with volcanic or hypabyssal intrusive centers along Ute Creek, and in the headwaters of Trout Creek, Red Mountain Creek, East Fork Piedra River, West Fork San Juan River, and Goose Creek.

Studies in the major mining districts of the San Juan Mountains suggest that any mineral appraisal of the volcanic areas of the San Juan primitive area should be concentrated on areas near volcanic centers, or within or around volcanic subsidence structures (cauldrons). As described by Steven (1968), mineral deposits in the central San Juan Mountains are generally in fissure veins associated with the youngest subsidence structures in the central San Juan cauldron complex and in hydrothermally altered areas associated with local volcanic centers that were active late in the local sequence of igneous events. This generalization applies in the western San Juan Mountains as well, where the mineralized areas are clustered around the Silverton cauldron and around local volcanic centers.

The volcanic rocks in the central part of the primitive area are largely outflow facies ash-flow tuff deposits derived from source areas in the western and central San Juan cauldron complexes, or are andesitic to rhyodacitic lavas and breccias of local derivation that are intermediate in age in the local volcanic sequence. The only potentially mineralized ground seen in this part of the primitive area is along Ute Creek, where erosion has exposed a series of intrusive masses cutting one of the older ash-flow tuff units; the structural environment and the widespread hydrothermally altered rocks exposed here indicate that ore deposits may exist.

Although not exposed within the primitive area, one other environment deserves consideration in any appraisal of the mineral potential of the San Juan primitive area. A thick section of sedimentary rocks from the Entrada Sandstone of Jurassic age to the Lewis Shale of Late Cretaceous age extends under the volcanics in the eastern half of the primitive area, and these rocks are almost certainly present under most of the southern part of the central San Juan cauldron complex. As this cauldron complex marks the surface above a major volcanic source area, intrusive masses may well exist at depth, and such masses might have related ore deposits in the surrounding lower volcanic or subvolcanic rocks. The limestone beds in the sedimentary sequence might thus have been the loci of important mineralization.

NEEDLE MOUNTAINS MINING DISTRICT

The Needle Mountains mining district is within the headwaters of Needle Creek, Johnson Creek, Missouri Gulch, and Crystal Valley, in the southwestern part of the San Juan Primitive Area (fig. 3). The veins and mine workings in Chicago Basin at the head of Needle Creek and in Vallecito Basin at the head of Johnson Creek are within the San Juan Primitive Area as now constituted, whereas those in the Missouri Gulch and Crystal Valley drainages to the south are within a marginal area proposed for inclusion within the Wilderness System.

A Tertiary composite hypabyssal intrusive plug of probable Oligocene age cuts Precambrian granitic rocks in Chicago Basin at the head of Needle Creek. The intrusive bodies and adjacent granitic rocks are highly altered and locally contain disseminated molybdenite, and the surrounding Precambrian rocks are cut by widespread metal-bearing quartz veins. The metalliferous deposits represent a typical example of epithermal mineralization associated with a shallow, possibly subvolcanic intrusive center, and they clearly have the best potential for economic development of any of the mineral deposits seen in or near the San Juan primitive area.

The geologic setting of the Needle Mountains mining district is remarkably simple. The Precambrian host rocks for the hypabyssal intrusives and related veins consist of a large mass of coarse-grained Eolus Granite cut by a smaller body of fine-grained Trimble Granite (pl. 1). A few thin outliers of Paleozoic sedimentary rocks remain uneroded, resting on a smooth surface cut on the granitic rocks near the southwest and west margins of the mineralized area. As seen on aerial photographs, the granitic rocks are broken by a conjugate joint system composed of steeply dipping generally north trending and east trending joints of regional extent that are older than the overlying Paleozoic sedimentary rocks. Other widely but irregularly spaced fracture zones also cut the granitic rocks, generally at angles somewhat divergent to the trends of the regional joints, and at least one of these fracture zones deforms the overlying sedimentary rocks as well. None of the fracture zones examined in the field appeared to have had significant displacement, and faulting in the district is believed to have been minor.

The intrusive center in Chicago Basin is about 2,600 feet wide N.–S., and about 3,500 feet wide E.–W. The center formed in three intrusive episodes. The oldest rocks form an outer ring of intensely altered rocks comprising several textural varieties. Marginal rocks in contact with the surrounding Eolus Granite have a fine-grained aphanitic to microcrystalline groundmass containing a few rounded quartz phenocrysts and conspicuous flow layers. This apparently chilled rock grades inward into a more massive rock with a finely granular, saccharoidal groundmass, abundant rounded quartz phenocrysts, and no flow structures. The contact with the Eolus Granite is generally steeply inclined, and ranges from sharp smooth surfaces to irregular zones in which the Eolus Granite is complexly penetrated by numerous tongues of porphyry. Few dikes radiate more than a few feet from the main porphyry body, however.

A younger pluglike mass of less altered porphyry occupies the south-central part of the intrusive center (fig. 5). The contact with the older porphyry on the north and east sides of the plug is sharp and regular, and dips 75°–80° inward. Locally, particularly along the southeast side of the plug, the younger porphyry has conspicuous contorted flow layers rudely parallel to the margin of the plug, and all thin sections studied showed flow structures in the matrices. The younger intrusive is a rhyolite porphyry consisting of strongly resorbed quartz, feldspar, and biotite phenocrysts set in an aphanitic to microcrystalline groundmass. Although the plug is widely altered, the degree of alteration is distinctly less than that which affected the older body and is considerably more variable from place to place.

A small dike of darker rock of perhaps more mafic composition cuts both of the main porphyry bodies. The dike is only weakly altered and consists largely of phenocrysts of quartz, feldspar, and pyroxene set in a finely granular dark-gray matrix.

The fine-grained porphyries with locally conspicuous flow layering indicate emplacement in a shallow hypabyssal environment. No evidence was seen, however, to indicate whether magma represented by either of the main intrusive episodes actually reached the surface to feed volcanoes similar to those that constitute the great volcanic field of the San Juan Mountains to the north and northeast. The older intrusive rock probably extended up at least as far as the base of the Paleozoic sedimentary rocks, for inclusions of a quartzite conglomerate very similar to those in the Cambrian Ignacio Quartzite have been found near the east margin of the intrusive center. Cross and Howe (in Cross, Howe, Irving, and Emmons, 1905, p. 8–9) believed these inclusions to be fragments of the Precambrian Uncompahgre Formation rafted up from below during intrusion. It is difficult to envision how any Uncompahgre quartzites could be present deep in the Eolus batholith in this vicinity (pl. 1), and it seems more plausible that the inclusions sank from the Ignacio Quartzite, which projects over the intrusive center at a level about 2,000 feet above the present surface. No way is known to determine the position of the ground surface above the Ignacio Quartzite at the time of porphyry intrusion, let alone to establish whether any volcanic materials were erupted onto it. If the intrusion took place in Late Cretaceous or early Tertiary time, at about the same time that the intrusions at Ouray, and perhaps Rico, and in the La Plata Mountains were emplaced, a significant section of sedimentary rocks could have existed above the Ignacio Quartzite; but if the intrusion took place in middle Tertiary time, during the main period of volcanism in the San Juan Mountains, the sedimentary section might have been relatively thin and the volcanic venting, considerably more likely.

HYDROTHERMAL ALTERATION

The three main rock types in the intrusive center in Chicago Basin differ so sharply in degree of alteration that separate periods of hydrothermal activity related to each of the intrusive episodes seem to be required (fig. 5). Inasmuch as the molybdenite mineralization is restricted to the oldest and most intensely altered rock, the history of alteration and intrusion has definite economic significance.

The intensely altered older porphyry body forming the outer ring of the intrusive center appears in the field as a rusty bleached silicified rock containing abundant disseminated pyrite. The alteration has generally so modified the rock that the original textures are difficult to discern. These rocks are mostly aggregates of quartz-sericite-pyrite or quartz-sericite-kaolinite-pyrite, in which the term "sericite" includes all fine-grained muscovitelike minerals which give reasonably distinct X-ray diffraction profiles. According to the classification of Yoder and Eugster (1955), 1Md, 1M, and 2M polytypes of sericite have been recognized and have been interpreted as indicating an increasing intensity of hydrothermal alteration.

The altered rocks constituting the older porphyry mass are well exposed only along the flanks of three tributary gullies that join in the northwestern part of the intrusive center and drain northward into Needle Creek (fig. 5). The rocks are most intensely altered near the

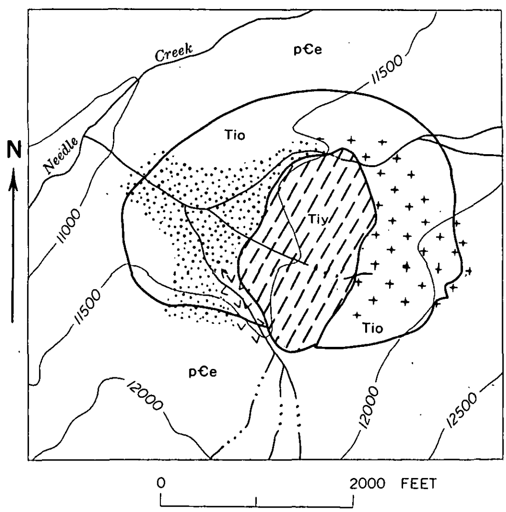

FIGURE 5.—Alteration minerals in rocks of the Chicago Basin area. p€e, Eolus Granite of Precambrian age; Tio, older intrusive porphyry; Tiy, younger intrusive porphyry, both of Tertiary age. Stipple, predominantly 2M sericite; crosses, 2M and 1M sericite; checks, predominantly 1M sericite; diagonal lines, 1M and 1Md sericite. Patterns shown only in areas of good exposure. Base from U.S. Geological Survey Needle Mountains quadrangle map, 1: 62,500 (1902).

junction of these tributaries where they consist largely of quartz, 2M sericite and pyrite. 1M sericite is present in many of these rocks, but nearly always is greatly subordinate to the 2M sericite. Kaolinite ranges from a very minor constituent to even more abundant than the associated 2M sericite. This same area has the highest concentrations of molybdenum, copper, and other metals in the intrusive center. (See p. F59–F61.) Elsewhere in the older intrusive body, 1M sericite, with or without associated kaolinite, is markedly more abundant, and either equals or is more abundant than 2M sericite in the eastern and southern parts of the body, as well as in the highly altered Eolus Granite immediately adjacent to the intrusive center.

In contrast to the older porphyry which is highly altered throughout, the younger main intrusive body is very irregularly altered, and ranges from nearly fresh rock to rusty bleached clayey rocks with locally disseminated pyrite. The less altered younger intrusive is somewhat more resistant to erosion than the surrounding older porphyry, and stands as a low knob within the intrusive center. X-ray diffraction studies have shown that even the most thoroughly altered younger porphyry is considerably less altered than the quartz-sericite rocks in the older intrusive. Biotite is altered in greater or lesser degree to chlorite and 1Md sericite, plagioclase, to 1Md sericite and locally to dickite or kaolinite; and the groundmass is bleached and variably changed to similar minerals.

The small dike of dark porphyry near the south margin of the intrusive center is nearly fresh and contains minor chlorite and carbonate minerals formed by weak propylitic alteration.

DISSEMINATED MOLYBDENITE IN THE INTRUSIVE CENTER

The highly altered older porphyry body in the intrusive center in Chicago Basin is locally crackled and traversed by myriadfold white to bluish-gray quartz veinlets. Pyrite, which is widely disseminated through the rock, also occurs along some of these quartz stringers, and, in places, sparse tiny bluish-gray flakes of molybdenite can be recognized. A few grains of chalcopyrite also were noted. More commonly, however, near-surface weathering and oxidation have resulted in a mask of red, brown, and yellow-brown iron oxides that covers all fracture surfaces and obscures the original appearance of the rock sufficiently to make visual appraisal of surface samples unreliable. As a means of testing the mineral content of the older intrusive body, 61 samples—including all rock types—were submitted for spectrographic and chemical analyses. The results are given in table 10–A, p. F158.

The geochemical data establish the presence of a strong molybdenum anomaly on the northwestern and western sides of the intrusive center. Approximately coincident with the molybdenum anomaly are weaker anomalies in silver, arsenic, gold, copper, lead, tin, and perhaps bismuth and antimony. These anomalies also approximately coincide with the most highly altered part of the oldest porphyry intrusive body, as defined by the distribution of 2M sericite.

Arsenic has such a high limit of detection by spectrographic methods (200 ppm) that it generally cannot be used as an indicator of anomalous metal concentrations. On the other hand, where it is detected, as in samples CB5a, 5b, 7, 9, 10, 41, and 125 (table 10, p. F158), it is distinctly anomalous. All these samples are within the area of the strong molybdenum anomaly.

Gold, if detected at all, is assumed to be present in anomalous concentrations. All the samples (except sample CB22) from the older porphyry that contain detectable gold are from the western part of the intrusive center, or from the highly altered Eolus Granite adjacent to the west margin of the center. Gold, like silver, has a distribution similar to that of molybdenum, except that it is somewhat more diffused through the adjacent rocks.

Copper is perhaps more nearly coincident with molybdenum in its distribution than any other element, except that the higher concentrations (above 100 ppm Cu) are even more closely restricted to the areas of most intense hydrothermal alteration. Samples CB1, 3, 4, 5a, 5b, 6, 7, 9, 10, and 12 (table 10) are all from the area containing abundant 2M sericite near the confluence of tributaries in the northwestern part of the intrusive center; sample CB60 is from a small outlying area with abundant 2M sericite near the west margin of the intrusive center; and only sample CB46 comes from an area characterized by abundant 1M sericite.

Lead is erratically distributed through most of the older porphyry body in the intrusive center. It is most consistently present, however, in the most intensely altered area with abundant 2M sericite near the confluence of tributaries, where it coincides with the other metal anomalies.

Tin was widely detected and is therefore anomalous throughout most of the older porphyry body, and no particular concentration was noted in the areas of most intensely altered rock. The only notably high sample was CB125, which represents the molybdenite-bearing inclusion in the younger porphyry body. The widespread presence of tin in the altered and mineralized older porphyry stands in marked contrast with its generally low concentration in nearby associated rocks.

The most intensely altered area near the confluence of the three tributaries in the northwestern part of the intrusive center was tested in 1960, when American Metal Climax, Inc., drilled a 1,000-foot-deep hole near the middle of the area having most of the anomalous metal concentrations. Through the courtesy of that company, we had the opportunity to examine the drill core. Altered porphyry was found throughout the core, and disseminated molybdenite was seen locally in the core, but so far as we could judge, no significant segments of ore-grade material were present.

In strong contrast with the highly altered older porphyry containing widespread anomalous metal concentrations, the younger and less altered porphyry body forming the core is nearly devoid of significant metal concentrations (table 10–B, p. F160). Silver is anomalous in samples CB134, 184, 185a, 186, and 187, and lead and zinc seem to be erratically above background in a few scattered samples, but no pattern was discerned to indicate that any local areas are worthy of more detailed study. The contrast is particularly emphasized by comparing the inclusion of molybdenite-bearing older porphyry (table 10–A, sample CB125) with samples of the enclosing younger porphyry (table 10–B, samples CB184 and CB185a) near the south margin of the intrusive center. Silver, copper, molybdenum, lead, antimony, and tin are all anomalously high in the inclusion, whereas the enclosing younger porphyry has anomalously high silver only.

In summary, the older porphyry body in Chicago Basin has many attributes suggesting that disseminated molybdenum, possibly in economic concentrations, may exist somewhere at depth. The geologic environment is right (a composite hypabyssal intrusive of intermediate to silicic composition), the pattern of hydrothermal alteration is favorable (a zoned arrangement of quartz-sericite-pyrite rocks, shown in fig. 5), and the well-defined metal anomalies coincide with the alteration pattern. Disseminated molybdenite has been observed locally in outcrop and in drill core. All these factors are favorable indications, but without additional physical exploration, it is not possible to determine whether ore-grade material exists in economic quantities. Experience elsewhere has shown that the most favorable surface indications need not coincide precisely with the position of a buried ore body, and the entire older intrusive body and adjacent highly altered Eolus Granite should be considered as a potential target. The lack of ore-grade material in the drill core from the hole drilled by American Metal Climax, Inc., is somewhat discouraging. However, the molybdenite-bearing fragments of older porphyry now enclosed in the nearly barren younger porphyry near the south margin of the intrusive center enlarge the area of potential interest. These fragments indicate that disseminated molybdenite could exist at depth, and suggest that an economic-sized ore body may occur in the area, particularly in the more highly altered western part of the intrusive center.

VEIN DEPOSITS

The area near the Chicago Basin intrusive center contains many irregularly distributed vein-type deposits that range from altered fissure zones with disseminated pyrite to quartz veins with or without sulfide and minor gangue minerals (fig. 6). The area containing veins is less than 1 mile wide around the northern periphery of the intrusive center, but its width varies considerably elsewhere. To the west, scattered veins cut the Precambrian rocks on both sides of Needle Creek as far as the Animas River, about 5 miles distant. To the south, veins are found on East Silver Mesa, in Crystal Valley, and near Castilleia Lake as far as 3½–4 miles from the intrusive center. To the southeast and east, many veins are exposed in Vallecito Basin at the head of Johnson Creek ½–1½ miles distant, and a few of these extend into the head of Grizzly Gulch, 2–2½ miles distant. The veins are most numerous in Vallecito Basin, which appears to have served as a focus for at least part of the vein-type mineralization.

Nearly all the veins dip steeply or are vertical, and appear to represent open-space fillings along fissures. Most trend a few degrees west of north, parallel to the dominant regional joint system in the Precambrian granitic host rocks. These veins are relatively small and range in length from a few tens of feet to about half a mile, and in width from 0 to 6 feet. Superimposed on this pattern are three local sets of partially vein filled fracture zones, all of which are significantly longer and have more persistent vein fillings than those following the regional joint system. A radial set of fractures and veins extends outward from the intrusive center in Chicago Basin, and includes: the great Aetna vein, which extends south from the intrusive center across Aztec Mountain parallel to the regional joint set; the altered fracture zone extending southeast from the center across Columbine Pass into Vallecito Basin; a series of east-trending veins projecting through Hazel Lake into the head of Grizzly Gulch; the northeast-trending veins at the head of Needle Creek; and some northwest- to west-trending veins and fractures north of Needle Creek and northwest of the intrusive center. The second local set includes two strong east-trending fractures that extend from the northern part of West Silver Mesa, across the head of Missouri Gulch, to East Silver Mesa, where they diverge near Trimble Pass into east-northeast- and east-southeast-striking branches. Farther south on East Silver Mesa, a third set is manifested by several prominent north-northeast-trending fractures that cut across the older regional joint set, and the southern extension of one of these deforms lower Paleozoic sedimentary rocks on the southern part of West Silver Mesa.

The veins following the regional joint trend are most abundant in an elongate zone, about 2 miles wide, extending from the vicinity of Needle Creek near the intrusive center southward to the latitude of the old townsite of Logtown, near the present Durango Reservoir. These veins appear to have filled preexisting fractures opened by tensional spreading that was possibly caused by local arching. The radial set of fractures around the Chicago Basin intrusive center seems most easily explained by spreading related to forceable emplacement of the porphyry intrusive bodies in the center. In the absence of knowledge on the direction or amount of displacement on the east-trending fractures along the north margins of West and East Silver Mesas, it is difficult to interpret their possible causes. Vertical forces resulting in uplift or subsidence of either the northern or the southern block seems a plausible explanation. The north-northeast-trending fracture zones on East Silver Mesa are similarly difficult to explain with the meager data now available; the general restriction of these fracture zones to the vicinity of the mineralized fissures that follow the regional joint set would seem to imply a related origin.

The widely scattered veins between the Chicago Basin intrusive center and the Animas River have diverse trends, and our present data are too limited to permit structural interpretation. As described by Irving and Emmons (in Cross, Howe, Irving, and Emmons, 1905, p. 12), many of these veins, particularly those within the schists and gneisses of the Irving Formation, are not simple fissure fillings, but consist of sheeted zones containing numerous thin anastomosing quartz veins. These sheeted zones range from narrow veinlets to zones 5 feet or more wide.

The local concentration of veins along the regional joint set in Vallecito Basin probably reflects locally concentrated tensional spreading related to greater local uparching. Certain patterns of metal distribution in the veins in this same area, to be discussed later, apparently mark a local center, or focus, for hydrothermal activity as well. These factors suggest local causes not directly connected with the intrusive center in Chicago Basin, and the postulated uparching and local hydrothermal center may be manifestations of another intrusive body underlying Vallecito Basin and perhaps part of the more highly veined area to the south.

Most of the old mine and prospect workings are inaccessible or are almost completely obscured by secondary mineral encrustations, so none of the veins was examined or sampled underground. Most of our samples were taken from dumps; therefore, only general mineralogy and mineral relationships could be established. Critical economic factors, such as widths of veins and dimensions of ore shoots, cannot

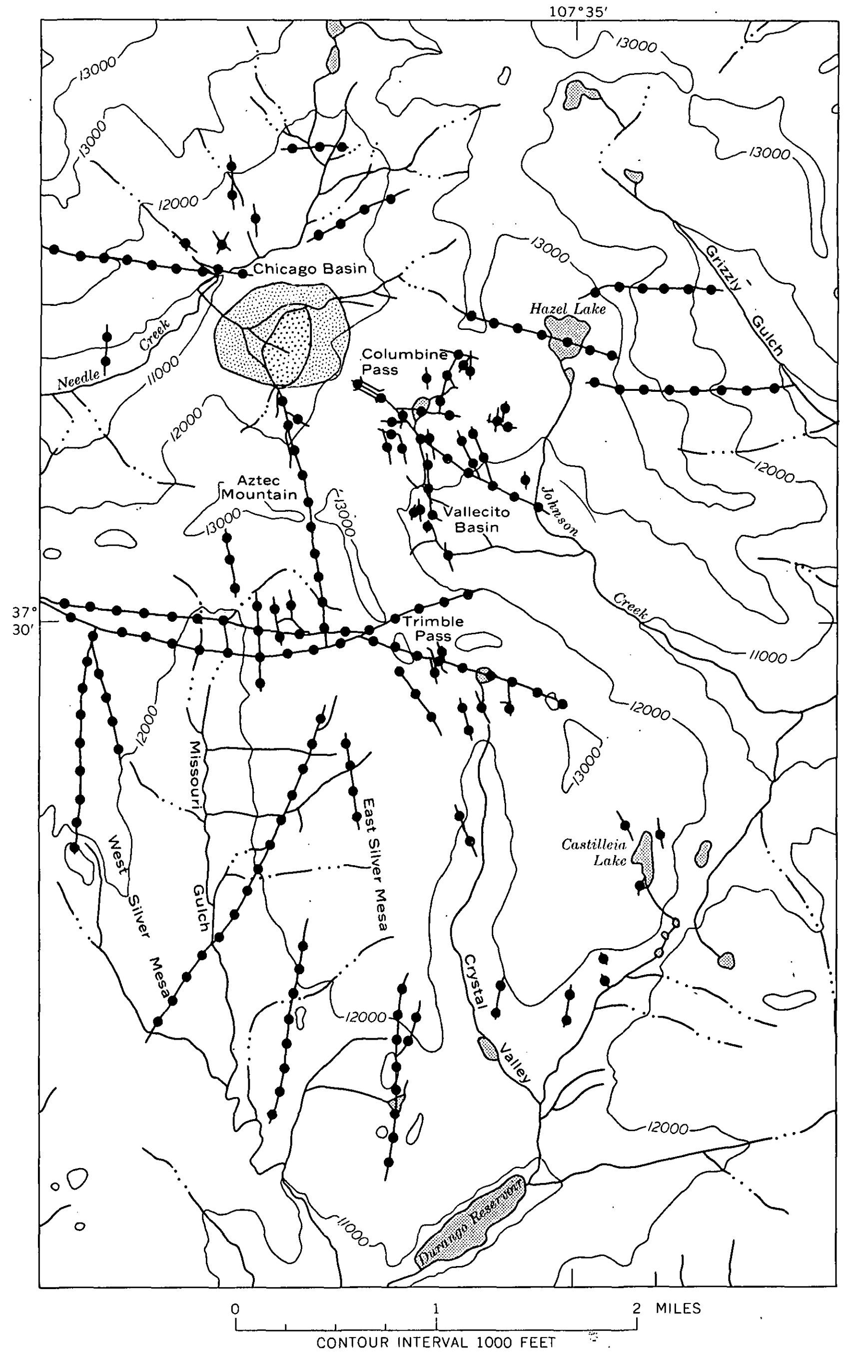

FIGURE 6.—Distribution of major veins and fissure zones in the Needle Mountains mining district. Vein and fissure-zone locations taken in part from aerial photographs; coarse stipple, older porphyry body, and fine stipple, younger porphyry body, both of which are in the Chicago Basin intrusive center. The

be determined from the data available. In addition, the analytical methods employed in testing the samples were largely those most sensitive to low levels of concentration, and are not intended to deal with high concentrations found in many of our samples of ore-grade or near-ore-grade material. Many of the analytical data given in table 10–C through F (p. F160–F167), therefore, indicate orders of magnitude only, and should not be used in lieu of assays for economic evaluation. They do, however, provide a measure of geologic favorability, and indicate the general distribution of metals.

The vein minerals were deposited in three general stages. Quartz and pyrite were deposited in the first stage and form the bulk of most of the veins. The quartz-pyrite veins were refractured in places, and during a second stage local ore shoots containing other metallic sulfide and minor gangue minerals were deposited in the open cracks. These ore shoots commonly contain one or more of pyrite, galena, sphalerite, chalcopyrite, tetrahedrite (tennantite?), rhodochrosite, calcite, and fluorite. Local fracturing continued, and, in the third general stage of mineralization, white comb quartz and locally fluorite were deposited in the available open spaces. Although most veins contain fresh sulfide minerals to within a few feet of the surface, some, particularly those higher along the ridges, have been oxidized to depths of several tens to perhaps several hundred feet. These more oxidized veins provided most of the ore extracted during the early periods of mining, and Irving and Emmons (in Cross, Howe, Irving, and Emmons, 1905, p. 13) reported argentite, wire silver, and wire gold in the oxidized ores.

Some gold and silver seem to have been deposited with the quartz and pyrite of the first stage, but our limited data suggest that the values are generally low and erratically distributed. Most of our samples of this material (table 10–C through F, p. F160–F167) contain from less than 0.5 to 10 ppm Ag, but a few contain as much as 70 ppm; gold ranges from less than 0.02 ppm to 1.4 ppm, but most of the samples contain less than 0.1 ppm.

Most copper, lead, and zinc, as well as silver and gold, were deposited during the second stage of mineralization, and are most abundant where intramineralization fracturing provided greatest permeability. The character of our sampling procedure discourages close comparison of the analytical results, but certain broad generalizations can be

Needle Creek, Johnson Creek, and Grizzly Gulch drainages are within the San Juan Primitive Area as now constituted; the Missouri Gulch and Crystal Valley drainages are in a marginal area proposed for inclusion in the Wilderness System. U.S. Geological Survey Needle Mountains quadrangle map, 1:62,000 (1902).

made. The analyses indicate that ore-grade or near-ore-grade material occurs at least locally in many veins. A higher percentage of the samples taken from Vallecito Basin were in this category than from any other part of the mineralized area; however, at least some samples of the higher grade material were obtained throughout the area with abundant veins. Lead, zinc, copper, and silver are the most valuable metallic constituents in the veins, and gold and perhaps cadmium are potentially valuable byproducts. Molybdenum and tin are spottily high among the samples, but our present data suggest that these samples are exceptional. Wherever visible copper, lead, and zinc sulfides or minor gangue minerals are present, many other metals such as Ag, As, Au, Ba, Bi, Cd, Mn, Mo, Sb, Sn, and W tend to be present in anomalously high concentrations.

Where one metal is present in high concentration, it is generally accompanied by other metals in high concentration, but the distribution of metals is not uniform. Zinc, accompanied by cadmium, is more abundant than lead in Chicago and Vallecito Basins, whereas lead is equal to or more abundant than zinc farther south. Although present in anomalous concentrations throughout the mineralized area, copper is most abundant in Vallecito Basin. Silver also is anomalously abundant throughout the mineralized area, but tends to be somewhat more abundant in Vallecito Basin and along the east side of East Silver Mesa than elsewhere. Anomalous concentrations of antimony, arsenic, bismuth, tin, and tungsten are largely in Vallecito Basin, although a few were detected in samples from Chicago Basin and East Silver Mesa. Of the minor gangue minerals, fluorite is widely distributed in Vallecito Basin and the northeastern part of Chicago Basin, but is very local elsewhere.

The abundance of veins, the higher ratio of samples containing second-stage minerals, the generally higher grade of individual samples, and the localization of minor metal anomalies all point to the Vallecito Basin area as a center, or focus, of vein-type mineralization in the Needle Mountains mining district.

The scattered veins between Chicago Basin and the Animas River are too dispersed to fit in any pattern of metal distribution that might be devised from available data. Some of the samples (table 10–F, p. F166) are among the highest grade analyzed from the district, yet others are virtually negative. There, the association of relatively high silver with high copper, lead, zinc, and, in some places, antimony is common to the other veins in the district as well. Gold is somewhat more abundant between Chicago Basin and the Animas River than in the veins of Chicago Basin and Vallecito Basin, and in this respect the veins more closely resemble the outlying veins in lower Crystal Valley and adjacent areas south of the intrusive center. Arsenic and gold tend to be high in the same samples, reflecting the common association of gold and arsenopyrite.

The third, or final, stage of mineralization deposited white comb quartz and local fluorite accompanied by little if any metal. Most of these minerals form local vuggy pods in earlier veins, but in a few places such barren white quartz makes up nearly the entire vein.

Ore shoots in the veins seem limited to local areas affected by intramineralization fracturing, and long stretches of many of the veins consist largely of low-grade early quartz-pyrite. Ore shoots exist in at least some of the veins in all parts of the mineralized area, however, and appear to be most numerous in the Vallecito Basin area. The scope of this investigation did not include outlining individual ore shoots or target areas for exploration, but the general geologic environment seems favorable for the occurrence of deposits of economic grade and size, and further exploration and possible mining in the district are to be expected.

BEARTOWN MINING DISTRICT

Numerous gold-bearing quartz veins cut the Precambrian rocks near the divide between Bear Creek and Elk Creek on the north margin of the Needle Mountains (figs. 3, 7). Most of the veins are in the Bear Creek drainage, just outside the study area, but those few in the Elk Creek drainage are within the study area; thus the whole district is of direct concern to this report.

Outcrops of the various formations in the area were mapped (fig. 7), but scant attention was given to internal structures or to distribution of rock types within the formations. The oldest rocks are highly metamorphosed gneisses of the Irving Formation, which underlie the northern part of the district. The foliation of the gneisses strikes slightly north of west and dips steeply over most of this area. As shown by Cross, Howe, Irving, and Emmons (1905, areal geology map), these rocks are in steep fault contact with the younger Precambrian Uncompahgre Formation. The Uncompahgre Formation consists of interbedded quartzites and slates that have been tightly compressed into generally east-trending folds, and have been cut by several east-trending faults approximately parallel to the contact with the adjacent Irving gneisses (Cross, Howe, Irving, and Emmons, 1905, areal geology map). All the Precambrian rocks are overlain unconformably by Tertiary volcanic rocks; within the Beartown district (fig. 7) these Tertiary rocks comprise the San Juan Formation and, overlying it locally, an andesitic lava flow. Quaternary glacial drift covers the lower parts of the valleys, and large landslides obscure the bedrock on some of the steeper slopes.

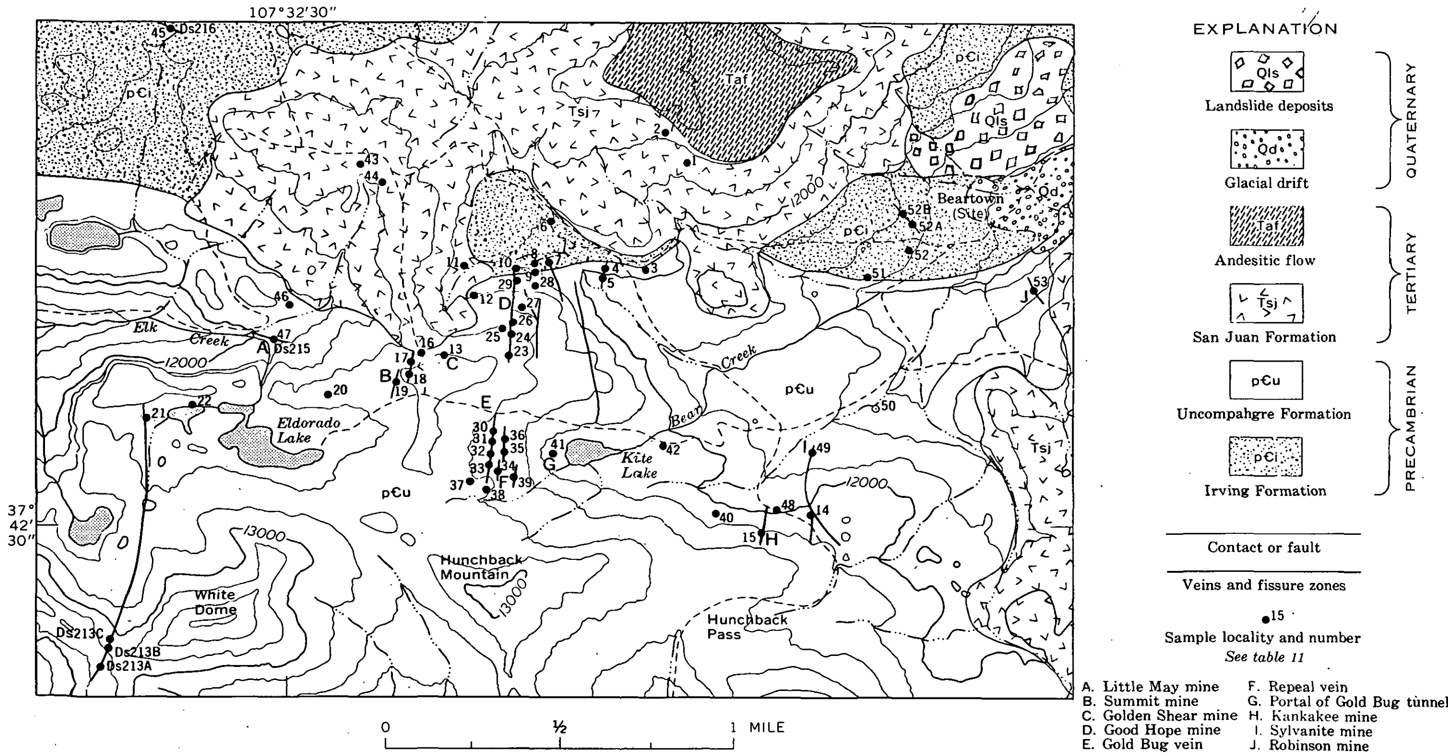

FIGURE 7.—Distribution of geologic units in the Beartown mining district. Base from U.S. Geological Survey Storm King Peak quadrangle, 1 : 24,000, 1967.

The Precambrian rocks are cut by numerous north-trending fissure zones, and locally these are filled with narrow metal-bearing quartz veins. The distribution of fissures shown in figure 7 was determined partly from field mapping, and partly from examination of aerial photographs. The fissure zones cut nearly at right angles across the foliation in the older gneisses in the Irving Formation and across the trends of the folds and faults in the Uncompahgre Formation. The fissure zones are most clear-cut where they transect hard quartzites or siliceous slates in the Uncompahgre Formation, and in these places little if any displacement of rock units could be discerned.

The fissures formed subsequent to the youngest deformation and metamorphism of the Precambrian rocks, but their relation to the softer Tertiary volcanic rocks is not known with certainty. No undoubted example of a mineralized fissure zone passing from metamorphic into volcanic rocks was seen, but a few local hydrothermally altered sheared zones were noted and sampled within the San Juan Formation, suggesting that the mineralization and perhaps the fissuring are of Tertiary age.

The veins consist largely of quartz, which filled open spaces along the fissure zones. In places the quartz forms a single well-defined vein, but elsewhere it forms a series of interlacing veinlets, or cements breccia fragments of the older wallrocks. The veins range from mere seams to local pods several feet thick, but most are a foot or less thick. A maximum vein width of 6 feet has been reported from the Gold Bug mine (Cross, Howe, Irving, and Emmons, 1905, p. 13). Pyrite is widely distributed in the quartz veins, and local pockets and ore shoots contain significant quantities of ore minerals. As reported by Irving and Emmons (in Cross, Howe, Irving, and Emmons, 1905, p. 13), the metallic minerals are a telluride of gold and silver (probably petzite), tetrahedrite, pyrite, marcasite, chalcopyrite, bornite, galena, sphalerite, arsenopyrite, limonite, hematite, malachite, and azurite. Minor gangue minerals include calcite, barite, and a white clay. The telluride and tetrahedrite are the most valuable ore minerals.

Most of the past production has come from the Good Hope, Gold Bug, and Repeal veins, which follow a zone of discontinuous fissures extending from west of Kite Lake northward about 4,000 feet to the vicinity of the fault contact between the Irving and Uncompahgre Formations. The Sylvanite mine about 3,000 feet east of Kite Lake also was rather extensively developed. Smaller mines, such as the Little May, Summit, Golden Shear, Kankakee, and Robinson, were dug on widely scattered small veins, and numerous prospect pits expose other minor mineralized fissure zones throughout the district. Samples were collected from dumps at most of the mine workings and prospect pits in the district (table 11, p. F168); these are largely samples of vein material and were generally of the highest grade material seen. They are, thus, not representative either of the veins as a whole or of the very high grade ore packed out by mule train in the early days of mining. The range in values, however, probably encompasses the range in grade that can be expected from all but the richest ore shoots along the veins. Also, the distribution of metals in more than background quantities gives some pleasure of the favorability for discovery or development of additional ore deposits.

The analyses (table 11, p. F168) indicate a very wide range in values for the dump samples, from nearly barren vein material to high-grade gold-silver ore. (Compare, for example, sample BT 10a from the Good Hope mine, and sample BT 18 from the Summit mine.) The samples containing the highest gold and silver values also contain the most tellurium and antimony, corroborating the earlier observation by Irving and Emmons (in Cross, Howe, Irving, and Emmons, 1905, p. 13) that most of the value of the ore comes from telluride minerals or tetrahedrite. Copper, lead, and zinc also tend to be high in the same samples, indicating that all the metals are concentrated in the same ore shoots. Both high-grade and nearly barren samples were collected from all the larger vein zones (Good Hope, Gold Bug–Repeal, Sylvanite), and the scattered samples from minor vein zones show a similar erratic variation. All these data are consistent with the descriptions by Irving and Emmons that the metallic minerals form local high-grade pockets along generally low grade quartz veins. These local pockets occur on both the larger and smaller veins throughout the district.

Of special interest are the veins in the headwaters of Elk Creek within the marginal study area proposed for inclusion in the Wilderness System. The Summit mine is just west of the divide northwest of Kite Lake; samples BT 16–19 (table 11–A, p. F168), representing several minor veins on this property contain 29–260 ppm Ag (chemical methods), 9.6–190 ppm Au, 100–1,500 ppm Sb (spectrographic methods), and 90–580 ppm Te, and are among the highest grade samples that we collected in the Beartown district. Our samples from the Little May mine (BT 47; Ds215, table 11–A) were very low grade, but Prosser (1911) reported that high-grade ore was produced there during 1893. Other samples from scattered prospect pits (BT 20, 21, 22, 46) and vein float (Ds213a–213c) from this western area were all low grade. The analytical results (table 11), together with the historical data from Prosser, indicate that the better ore is largely near the divide between Elk and Bear Creeks, from the Little May mine eastward toward the heart of the Beartown district.

Numerous small veins exist in the headwaters area of Elk Creek northwest of the Beartown district, and among these two general types were noted. Two small veins near the northwest corner of figure 7 (one vein just outside figure area) consist of sheared mafic pods in the Irving Formation containing abundant pyrite. The easternmost vein (samples BT 45 and Ds216, fig. 7) consists of sheared chloritic quartzite from a few inches to 1½ feet wide. This zone can be traced only a few feet beyond the pit that exposes it. Quartz veinlets with pyrite follow the sheared zone, but most of the pyrite is in the sheared country rock. The sheared zone strikes east and is nearly vertical, and it rudely parallels the foliation in the surrounding gneisses. Another sheared mafic pod with abundant pyrite (sample Ds217a, table 11) is exposed about 1,400 feet farther west. This pod consists of chloritic to biotitic quartzite, biotite gneiss, and vermiculitic schist; it is no more than a few hundred feet long and 20–30 feet wide, and is enclosed in granitic gneiss. A sheared zone through this pod contains abundant pyrite. Samples from these two zones (BT 45; Ds216, 217a) indicate that copper is strongly anomalous and that silver is slightly above background, but all the other metallic constituents are in very low concentration. The impression gained in the field was that these zones differed greatly from all other metalliferous deposits nearby, and perhaps might be related genetically to the enclosing gneisses.

Quartz-pyrite veins typical of the early veins found in the Whitehead Gulch area a few miles to the northwest were noted and sampled in the headwaters of Elk Creek northwest of the area shown in figure 7. (See also pl. 2.) Samples of these veins (Ds217a, 219, 220, 221, 222, table 11–A, p. F168) locally contain anomalous concentrations of silver, copper, molybdenum, lead, and zinc, but at no place were the values high enough to even approach ore grade. The veins differ in general aspect from the telluride-bearing quartz veins in the Beartown district, and are believed to have resulted from hydrothermal activity along the southern periphery of the highly mineralized south margin of the Silverton cauldron, and thus are broadly related to similar veins in the Whitehead Gulch discussed in the next section of this report.

Of all the metalliferous deposits in and near the Beartown district, the zone of fissures developed by the Good Hope and Gold Bug–Repeal mines appears to have the best potential for the discovery of significant quantities of valuable metals. Small veins adjacent to this more favorable zone, including those in the study area west of the divide between Elk and Bear Creeks, contain local pods of high-grade ore, but the enclosing fissures seem to be too small to contain large bodies of ore. Local high metal contents in scattered veins were found much farther east of the more favorable zone than west of it. With improved access, the veins in the Beartown district could be expected to be further explored.

WHITEHEAD GULCH AREA

Whitehead Gulch is in the northwestern part of the San Juan primitive area (fig. 3), and along the south margin of a highly mineralized area bordering the south side of the Silverton cauldron. The first discoveries of gold in the intensely mineralized western San Juan Mountains were made in 1869 along Arrastra Gulch within this mineralized area, which has supported a fluctuating mining industry ever since. As reported by Varnes (1963, table 6), mineral production from the area south of the Silverton cauldron aggregated about $61 million from 1901 through 1957.

Most of the mineral production from the south margin of the Silverton cauldron has come from a highly broken triangular-shaped area bounded on the north by the ring-fracture zone of the cauldron, on the southwest by the Titusville vein zone, and on the east and southeast by an arcuate fracture zone discontinuously filled by granite porphyry dikes (Varnes, 1963). The southern apex of this triangle is about 2 miles north of upper Whitehead Gulch. The most productive veins within the triangular block follow northwest-trending shear faults, or related north-trending diagonal tension fractures. Several other shear and tensional fault systems are recognized by Varnes, but these have yielded little ore. The area south of the broken triangular block is cut by numerous veins, but most are small, and none has had significant production. Mines on two of these veins in the Deer Park area north of Whitehead Gulch—the Montana mine and the Mabel mine—have dumps large enough to indicate at least several hundreds of feet of underground development, and both have old stopes open to the surface. The other veins in this peripheral area have only small underground workings or shallow surface pits, and probably have had little if any actual production.

Most of the veins in the Deer Park–Whitehead Gulch area are in Precambrian rocks, and generally follow north- to northeast-trending fractures that do not correspond to any of the fracture systems described by Varnes (1963) in the volcanic rocks of the more productive block to the north. As seen on aerial photographs, the fracture systems in Deer Park and Whitehead Gulch are prominent in the Precambrian rocks, but cannot be discerned in the overlying volcanic units. Most of the veins and altered zones are likewise restricted to the Precambrian rocks, although in a few places some altered and pyritized fractures cut the lower part of the volcanic sequence. These relations suggest that the veins in this peripheral zone were deposited in old fractures in the Precambrian basement that were only locally reactivated during the Tertiary volcanic activity and related mineralization.

Most of the veins seen in the Deer Park–Whitehead Gulch area are short and rarely more than a few hundred feet long. Many are altered fracture zones, but others contain quartz and quartz-pyrite veins that range from thin seams to pods 6 feet or more across. Some of the dominant quartz-pyrite veins are broken, and the fractures filled with later galena and sphalerite to form local ore shoots. Final vein deposition commonly consisted of barren white comb quartz.

Samples were taken from many of the veins or mine dumps in the Deer Park–Whitehead Gulch area, and the analytical results are given in table 9–C, p. F156. All the samples contained anomalous quantities of metals, but only a few were of ore grade. Most of the samples of quartz-pyrite vein material or of altered and pyritic wallrocks were very low in grade, but samples containing visible galena and sphalerite were generally considerably higher in grade, and some are of economic interest. The ore shoots are thus likely to coincide with those parts of the veins that were broken in the course of mineralization and the fractures filled with galena and sphalerite. This conclusion has a degree of confirmation from the samples taken from the dumps of the Mabel and Montana mines in Deer Park (Ds137a through 137c; Ds138a through 138e, table 9–C, p. F156). Stopes open to the surface indicate that ore-grade material once was present in the veins, yet samples of the quartz-pyrite vein material from the dumps is as low in grade as similar material from veins that have had no production. The one sample containing a few visible grains of galena (Ds138b), however, has a significantly higher Ag content and probably reflects the type of material mined.

The small size of the veins and the erratic distribution of the refractured zones containing galena and sphalerite make it unlikely that a major mine will be developed in the Whitehead Gulch area. The relatively high grade determined from random samples of the local shoots containing galena and sphalerite indicates that ore-grade material is present in the area, and potentially it seems quite possible that several small producing mines could be developed after careful study and exploration.

ALTERED ROCKS ALONG UTE CREEK

The canyon of Ute Creek exposes a section of densely welded tuff more than 2,000 feet thick, downfaulted against Precambrian rocks to the south, and cut by three quartz monzonitic intrusive stocks. Hydrothermal activity associated with the intrusive episode altered large volumes of rock in and adjacent to the stocks, and pyrite is widely disseminated in the bleached and altered rocks. Field relations indicate that this is an environment in which mineral deposits might have formed. To test this possibility, stream sediments from Ute Creek and its tributaries in this vicinity were sampled on about twice

353-110 O—69——6

the normal density used for streams elsewhere in the primitive area, and 17 samples of the altered bedrock were taken. Analytical results are shown in tables 3–O (p. F122) and 12 (p. F172).

Correspondence of data is poor between spectrographic and chemical analyses of the stream sediments taken from the Ute Creek drainage. Of the samples of concern here (1–13, table 3–O, p. F136), the spectrographic analyses detected nothing of interest, whereas chemical analyses indicate two samples (1 and 2) abnormally high in Zn, two (1 and 8) slightly above background in Cu, one (9) above background in Pb, and all but three with detectable Au. The samples containing the apparent high Zn values were taken along the trend of a late fault that extends about S. 80° E. across lower Ute Creek near the primitive area border. Exposures are poor, and the fault could not be seen anywhere near the localities of the samples. The rocks nearby are green chloritized sedimentary breccias of the San Juan Formation. Possibly the high zinc values are related to minor mineralization associated with the fault, or possibly the zinc values are spurious as suggested by the negative spectrographic results. The copper and lead values that slightly exceed nearby backgrounds are too low and sporadic to deserve particular attention without confirmation from spectrographic analyses. The values of detectable gold do not vary greatly throughout the Ute Creek drainage basin, and no local anomalous content is indicated for the area of altered rocks. Analytical bias is suspected for these gold values.

Of the 17 samples of altered and generally pyritized rock taken from the area of altered rocks, only two (Ds48f and Ds55c, table 12 p. F172) show any indication of anomalous metal content by either spectrographic or chemical analyses. Sample Ds48f indicates an anomalous Pb content by both spectrographic and chemical analyses, and sample Ds55c shows a slightly anomalous Zn content by spectrographic analysis. These indications were considered too weak to warrant further investigation.

The altered and mineralized rock along Ute Creek has been exposed only locally by erosion, and perhaps it would be fortuitous if erosion were to have exposed the most favorable part of a potentially mineralized area. The exposures available are too limited to give any obvious indications of which might be a more favorable direction to investigate, and the time available did not permit the detailed studies necessary to delineate any subtle clues that might exist. Thus, the only conclusion that can be given here is that despite the apparently favorable environment, nothing was seen on the ground or from analyses of bedrock and stream-sediment samples that would indicate potential mineral resources in a near-surface environment within the erosional window along Ute Creek.

NATIVE SULFUR DEPOSITS

"Sulfur beds" in the upper Trout Creek drainage basin and near the head of the Middle Fork Piedra River (fig. 3) have been known since the early part of the century (Larsen and Hunter, 1913, p. 363–365). The largest known deposits are just north of the San Juan primitive area in the valley of the east fork of Trout Creek, about 1 mile above its junction with the west fork. The area is heavily timbered; much is covered by soil, landslides, and glacial drift; and exposures are very poor. The old mine workings are largely caved and inaccessible; therefore the following description is based on observations of sparse natural exposures, slumped pits, old roadcuts, and mine dumps.

The sulfur deposits are in highly altered lavas and breccias of the Huerto Formation. The lavas and breccias appear to be a near-source volcanic facies, and are cut by minor intrusive bodies. In one place, a nearly unaltered dike cuts highly altered and sheared volcanic breccia. The general impression gained in the field was that the altered rock and sulfur resulted from fumarolic activity in and near a local Huerto vent. The altered rocks are overlain by completely unaltered densely welded tuffs of the Carpenter Ridge Tuff, further indicating a Huerto age for the fumarolic alteration and sulfur deposition.

Most of the sulfur seen on the dumps of the old mine workings has impregnated thinly laminated ashy sediments that appear to have been water laid. Some of the laminae are nearly pure sulfur, but most contain some fine volcanic ash. The highly altered volcanic breccia associated with the sulfur is bleached and altered to yellow clay, or is silicified and contains disseminated pyrite. The association with altered near-source volcanic breccias and intrusive rocks suggests deposition in a crater lake or other relatively stable body of water ponded within the area of fumarolic activity. It is not known whether there was one pond or several. The laminated sediments are commonly considerably broken and recemented with similar sulfur-bearing ash. According to old reports, the sulfur beds dip steeply, implying, along with the common brecciation, that the originally nearly flat beds were considerably deformed subsequent to deposition. Any such deformation had to precede deposition of the overlying Carpenter Ridge Tuff, and may have taken place during the post-Huerto period of faulting that disrupted nearly all of the southern part of the central San Juan cauldron complex to the south (p. F22).

Two closely associated samples of native sulfur from Trout Creek were analyzed spectrographically to determine the minor element content (table 9–D, p. F156). One of these samples (Ds59a) showed several minor elements—Ti, Ag, Ba, Bi, Cu, La, Pb, Zn, and Zr—to be present. The other sample (Ds59b) was analyzed to check this assemblage, and in contrast contained detectable quantities of Ti, Ba, Cu, Pb, and Zr only. The presence of Ba, Cu, and Pb in both samples, and of Ag, Bi, and Zn in one, is of considerable interest, inasmuch as the samples formed in a very near surface solfataric environment. The question of what materials might have been deposited deeper in the same hydrothermal system cannot be answered from the present limited data, but the possibility of metalliferous deposits cannot be dismissed.

The altered area containing sulfur deposits along Trout Creek is outside the primitive area, but other areas of altered rock of comparable age occur within the primitive area in the upper reaches of the east and west forks of Trout Creek and across the Continental Divide to the south in the headwaters of the Middle Fork Piedra River. Larsen and Hunter (1913, p. 366) reported two exposures of native sulfur in the Middle Fork area, and one of these was examined by us. Larsen (1913) also described abundant alunite in altered rocks nearby. As in the vicinity of the Trout Creek deposits, the Middle Fork area is densely timbered and outcrops are few. Highly altered Huerto breccias and flows are exposed here and there, but the extent or continuity of the altered rocks could not be determined. The one outcrop containing sulfur that was examined is exposed along a streambank; it is only about 10 feet long and 3 feet high, and consists of highly altered Huerto lava veined and impregnated by native sulfur.

None of the stream-sediment samples taken along Trout Creek or the headwaters of the Middle Fork Piedra River indicate anomalous metal contents, and samples of altered rock from the headwaters of the Middle Fork are similarly negative.

On the basis of these reconnaissance sampling results, it is not possible to postulate any significant sulfur resources in the San Juan primitive area, but neither is sufficient evidence available to preclude such resources. Altered rocks of the Huerto Formation containing at least local sulfur deposits are exposed over an area more than 3 miles across in the Trout Creek–Middle Fork Piedra River area. Much of this extent is densely timbered and covered by thick soil or glacial drift, and the ridge between the Trout Creek and Piedra River drainages is capped by younger Carpenter Ridge Tuff; therefore, direct observation of natural exposures is of little help in making an appraisal. Further exploration is needed to assess the resource potential properly. Such a program by private industry was just beginning as this report was being prepared, but no results were available. Our observations near the known deposits suggest that the sulfur occurs in discontinuous masses of variable size whose distribution was probably controlled by proximity to local volcanic vents or fumarolic basins, and by the size and distribution of local lakes within these areas. The crucial economic questions of actual size and specific distribution of the sulfur-bearing masses cannot be answered from the data available.

Most of the altered rocks, as well as the larger of the known sulfur deposits, are within the Trout Creek drainage basin, and thus outside the boundary of the present primitive area. However, most of these altered rocks and, thus, much potentially sulfur bearing ground lie within the area proposed for inclusion in the Wilderness System (pl. 1).

CENTRAL SAN JUAN CAULDRON COMPLEX

Known mineral deposits in the central San Juan Mountains are in the major Creede mining district (Steven and Ratté, 1965), the smaller Spar City district (Steven, 1964), and the Wagon Wheel Gap fluorspar district, which are, respectively, 20, 6, and 10 miles north of the eastern part of the San Juan primitive area. All these districts are within the central San Juan cauldron complex, and the veins containing most of the ore are along fractures formed in response to the repeated eruptions and related cauldron subsidences that developed the complex. As described by Steven (1968), the known mineralized districts are all peripheral to the youngest subsidence structure in the complex, the Creede caldera, and the main mineralized faults all were active very late in the local sequence of volcanic events. In addition, several of the younger volcanic centers (active during eruption of the Fisher Quartz Latite) in nearby areas have large masses of pervasively altered rock around them, and appear likely places to prospect for ore deposits of the type found in the Summitville district (Steven and Ratté, 1960), some 30 miles to the southeast.

Inasmuch as the southern part of the central San Juan cauldron complex occupies nearly all the eastern third of the San Juan primitive area, the possibility seemed good that somewhat comparable mineralized areas might exist here as well. Although reconnaissance mapping disclosed a complex mosaic of fault blocks in this area (pl. 1), evidence for hydrothermal activity is generally meager, and is limited largely to the vicinity of intrusive centers near the headwaters of Trout Creek, Red Mountain Creek, the East Fork Piedra River, and the West Fork San Juan River.

FAULT BLOCK MOSAIC

Despite the large number of faults that cut the southern part of the cauldron complex, evidence for hydrothermal activity is extremely sparse. Altered rocks were seen only in the vicinity of intrusive centers discussed in later sections. Warm springs were found along the Middle Fork Piedra River, the West Fork San Juan River, and upper Goose Creek, but almost no altered rock is associated with them, and samples of spring muck or of the nearby wallrocks show no anomalous quantities of metals. Sediment samples from the streams draining the fault mosaic were uniformly background in metal content (table 3–U, V, Y, Z, AA, BB, p. F142–F151).

The only possible exception noted was in the Turkey Creek drainage just inside the primitive area, where evidence for some early prospecting and mining activity was seen. We were not aware of this area of former activity until late in 1968, after all the higher mountains were covered by snow, so field checking was restricted to the lower slopes. An old wagon road, now a pack trail up Turkey Creek, was built from Snowball Park about 5 miles south of the primitive area, to the area of former mining activity along an east fork of Turkey Creek, about 1 mile inside the primitive area and 1 mile east of the main channel of Turkey Creek. Considerable machinery was hauled in, and at least one tunnel of unknown length was dug along a major north-northwest-trending fault. The site of the tunnel is now marked by two iron rails protruding from a grassy slope; the tunnel portal is completely caved, and the old dump has largely slumped away. An old dug trail leads into a heavily timbered slope above, but deep snow prevented following it more than about a quarter of a mile. No evidence for hydrothermal activity or mineralization was seen anywhere near the old workings. Two samples were taken from the old dump; one soil sample, from a spring along the fault about a quarter of a mile above the dump; seven stream-sediment samples, from the east fork of Turkey Creek below the old workings; and six stream-sediment samples from the main channel of Turkey Creek above its confluence with the east fork. None of these samples contained more than background values of any of the metallic elements. Although the character of the examination does not eliminate the possibility of mineralization along faults in this vicinity, the absence of anomalous metal contents in any of the soil and stream-sediment samples suggests that no major resource can be expected.

A possible explanation for the lack of hydrothermal effects or other evidence for potential mineral deposits lies in part in the age of the faulting. All the known mineral deposits in the central San Juan Mountains formed late in the local sequence of volcanic events and are localized by young faults or structures. The faults in the southern part of the cauldron complex, on the other hand, all were active at early or middle intervals during the period of volcanic eruptions and show no evidence for late movement. The earliest disruption in this part of the cauldron complex took place after accumulation of the tuff of The Notch and the Sheep Mountain Formation. Later displacements followed eruption of the Fish Canyon Tuff, eruption of the Huerto Formation (the major period of disturbance), and eruption of the Carpenter Ridge Tuff. Younger displacements possibly related to late subsidence of the Creede caldera can be identified adjacent to lower Trout Creek just north of the primitive area, but nowhere to the south. As faulting in the cauldron complex resulted largely from magmatic movements, this relative structural quiescence during the later volcanic eruptions can be interpreted to indicate the absence of shallow magmatic activity beneath this part of the cauldron complex, and, thus, the absence of related hydrothermal activity.

ROCKS ALTERED AFTER ERUPTION OF THE CARPENTER RIDGE TUFF

A large area of intensely altered rocks in the upper Trout Creek–Red Mountain Creek area includes Carpenter Ridge Tuff, but the overlying tuff of Sevenmile Creek is completely unaltered. The altered rock was largely converted to soft yellow clay that erodes easily and commonly forms bare gullied slopes locally stained red from oxidized pyrite. The area was mapped hurriedly, with the thought that stream-sediment samples would lead to any area of possible economic significance which could then be studied in more detail. Analyses of the stream-sediment samples, however, did not disclose any anomalous concentrations of metals (table 3–W, X, p. F144–F146), and the time available did not permit later field checking of the altered rocks for other indications of possible mineral deposits.

The present limited data do not permit postulating any potential mineral resources, but neither do the data exclude them.

PIEDRA PEAK–RED MOUNTAIN AREA

Intrusive plugs surrounded by halos of altered rock form the prominent highly colored Piedra Peak, at the head of Red Mountain Creek, and Red Mountain between the East Fork Piedra River and the West Fork San Juan River. (Another Red Mountain nearby, north of Piedra Peak and east of Red Mountain Creek is not of interest here.) Many smaller intrusive dikes and small plugs cut the rocks east and southeast of Piedra Peak and Red Mountain, and some of these bodies are also accompanied by halos of altered rock.

The Piedra Peak–Red Mountain area was extensively prospected in years past, and the presence of gold deposits in this vicinity is widely rumored. The close similarity between the geologic environment and the type and degree of alteration here and at Summitville (Steven and Ratté, 1960), 25 miles to the east, seemed to lend credence to these rumors. As a result, the highly altered areas around both Piedra Peak and Red Mountain were sampled carefully; the analytical results (table 13–A, p. F122), however, are discouraging.

Of the nearby intrusive plugs, the largest is about 4 miles east of Piedra Peak along the divide between Goose Creek and Beaver Creek. The plug is smaller, and the halo of altered rocks is smaller than those at the Piedra Peak and Red Mountain centers. However, the alteration is of comparable degree, and the rocks were also sampled carefully (table 13–B), but with similar discouraging results.

The age of the intrusive plugs is an important factor in considering the economic potential of the area. Seemingly they might be related to the volcanics of Table Mountain which some of them cut, or they could be associated with the nearby Fisher Quartz Latite which was erupted late in the volcanic sequence and is much more nearly comparable in age with the known mineralization to the north. The best evidence is in the upper Red Mountain Creek area, where some of the Fisher Quartz Latite lavas are within the halo of altered rocks around Piedra Peak; this plug at least appears to be of Fisher Quartz Latite age. Red Mountain, to the south, cuts Carpenter Ridge Tuff at the surface, and the surrounding halo of altered rocks is largely limited to this formation. Nearby dikes, however, cut a thin wedge of the volcanics of Table Mountain, and some of the altered Carpenter Ridge Tuff is overlain by completely unaltered tuff of Sevenmile Creek and the Wason Park Rhyolite. The Red Mountain intrusive therefore seems likely to be related to the volcanics of Table Mountain, and, despite its proximity and general similarity, to be appreciably older than the alteration around Piedra Peak.

The plug between Goose and Beaver Creeks is in the middle of an accumulation of lavas and breccias in the volcanics of Table Mountain, and can reasonably, but not surely, be assigned to that period of volcanism.

Regardless of age, the altered rocks around all three intrusive centers are similar. The most weakly altered are the greenish propylitized rocks containing abundant chlorite and widely disseminated pyrite. With an increase in degree of alteration, the rocks were progressively argillized to yellowish mixtures of clay (kaolinite) and sericite (hydromica-muscovite), also containing abundant disseminated pyrite. The most highly altered rocks are silicified masses with abundant alunite and widespread pyrite. In a few places alteration progressed until only porous quartz remains.

The largest masses of intensely altered quartz-alunite rock are in the headwaters of the east fork of Red Mountain Creek, east of Piedra Peak, and this same area has been most extensively prospected in the past. An adit called the Colorado tunnel was driven approximately 300 feet into the largest silicified mass exposed. All the quartz-alunite bodies were carefully sampled, and many samples were taken from the less extensively altered argillic rocks, as well. Samples were specifically taken from rocks believed most likely to contain the highest content of metal, particularly gold. Representative samples of the different types of altered rock were also collected. The results, shown in table 13–A (p. F174), indicate no anomalous Au or Ag in any of the samples. Few samples contain more than 100 ppm Cu by either spectrographic or chemical analytical methods, and most contain only background values. Similarly, few samples showed lead above background levels, and generally samples that are slightly high by one method of analysis are background by another; zinc values are erratic but again few are appreciably above background. In view of the effort made to obtain "high-grade" samples, these analytical results can be considered as effectively negative, and the potential for exploitable mineral deposits near the levels now exposed seems to be low.

The rock around the Red Mountain center is broadly and pervasively altered, but only locally was the degree of alteration sufficiently intense to form quartz-alunite pods. The pattern of analytical results shown in table 13–A (p. F174) is closely similar to that at Piedra Peak, except that chemically analyzed copper is somewhat higher in a few of the samples. The differences are not considered to be significant, however, and the potential for near-surface mineral deposits associated with this center also is considered to be low.

The intrusive plug between Goose and Beaver Creeks contained one quartz-alunite mass about 100 feet across, surrounded by a bleached argillic envelope. Samples of the more alunitic rock from the core (table 13–B, p. F176) contained slightly anomalous quantities of lead, but no more than background amounts of the associated metals, copper, zinc, gold, and silver. This area, too, is considered to have a low potential for the discovery of significant mineral deposits.

Altered rocks are exposed here and there along upper Goose Creek north of this latter intrusive plug. Analyses of representative samples of these altered rocks, plus one sample of muck collected from the orifice of a warm spring, all gave negative results (table 13–C, p. F176).

POSSIBLE ORE DEPOSITS AT DEPTH

Many of the known metalliferous deposits in the San Juan Mountains, in common with other epithermal deposits in similar environments, were formed in the lower part of the associated volcanic piles, or in the older rocks just below the volcanic rocks. In contrast, many of the hydrothermally altered rocks exposed in and near the central San Juan cauldron complex in the eastern part of the San Juan primitive area were formed in very near surface solfataric environments. The altered rocks associated with the native sulfur deposits in the upper drainage basins of Trout Creek and Middle Fork Piedra River, the intensely altered Carpenter Ridge Tuff along upper

Trout and Red Mountain Creeks, and the altered volcanics of Table Mountain in upper Goose Creek were all formed sufficiently near the surface so that they are within a few hundred feet of unaltered rocks in the next succeeding volcanic formation that covered them. The altered Fisher Quartz Latite near Piedra Peak belongs to the youngest volcanic formation to have been erupted in this vicinity. The alteration responsible for all these intensely modified rocks took place much nearer the surface than the ore deposition in the major mining camps of the western San Juan Mountains, or in the Needle Mountains district, Beartown district, or Whitehead Gulch area described elsewhere in this report. Some ore in the San Juan Mountains, as in the Summitville district (Steven and Ratté, 1960) and Creede district (Steven and Ratté, 1965), seems to have been deposited relatively near the surface, but in both of these areas, at least some and perhaps most of the deposits formed blind ore bodies that did not extend to the original surface.

Thus, the apparently negative results reported from stream-sediment and altered-rock samples taken in the eastern part of the San Juan primitive area may reflect only the relatively barren near-surface parts of hydrothermal systems of several ages, and have little meaning concerning the potential for ore deposits in the deeper volcanic or subvolcanic environments.

The present state of the ore-finding art is not sufficiently advanced for subtle clues of possible deeply buried metalliferous deposits to be recognized by rapid field coverage. Detailed geologic and related studies have led to the discovery of some buried ore deposits, but it seems certain that many remain to be discovered as new technology develops.

In specific terms, that part of the marginal study area fringing the northeastern part of the San Juan primitive area from lower Trout Creek east to upper Goose Creek contains rocks altered by near-surface solfataric activity during at least four separate hydrothermal episodes. Reconnaissance sampling of three of these altered areas, and detailed sampling of a fourth near Piedra Peak, failed to disclose evidence for near-surface mineral deposits other than the native sulfur associated with altered Huerto Formation. Though discouraging, this evidence is not considered to be adequate to rule out ore deposits at deeper levels. Not only are the lower volcanic and subvolcanic levels generally more favorable for epithermal ore deposits, but limestone beds in the wedge of Mesozoic sedimentary rocks that almost certainly underlie this area offer favorable hosts for possible ore deposits. Proper assessment of the potential for deep-lying ore deposits would require much more detailed geologic study, supplemented by extensive geochemical, mineralogic, and geophysical work leading to exploratory drilling.

Little of this area containing altered rocks of several ages is actually within the San Juan Primitive Area as now constituted. Most of it, however, is within the area proposed for Wilderness classification north of the Continental Divide in the upper Trout Creek and Red Mountain Creek drainages (pl. 1).

ECONOMIC APPRAISAL

By M. J. SHERIDAN and F. E. WILLIAMS, U.S. Bureau of Mines

Minerals produced from the San Juan primitive area and from small mining districts adjacent to it have an estimated value of $257,000. Of this total, only about $12,500 came from the primitive area, mainly the Needle Mountains mining district, about $200,000 from the Beartown mining district near the north margin of the primitive area, and the remainder from small scattered mineralized areas. In the past, ores in this region have been mined mainly for gold, but silver, copper, lead, zinc, sulfur, and uranium have also been produced. Most of this production was prior to 1900, when gold sold for $20.67 per ounce. Future production from these districts would be expected to most probably be largely silver, molybdenum, copper, lead, and zinc, except in the Beartown district, where gold would be a major product, and from the Trout Creek area, where sulfur is the main valuable mineral.

At the time of the Bureau of Mines field investigations (1967–68), most mine workings in the study area were caved or flooded, and could not be entered safely. These workings are numerous in the Needle Mountains mining district, but only a few are more than a few tens of feet long, and it was not possible to make detailed investigation of more than limited segments of individual veins. Some veins in the Beartown mining district were rather extensively developed, but most of the workings are now inaccessible. In consequence, the sampling procedures used varied widely from vein to vein, and the results are not closely comparable. Where possible, the veins were sampled underground; these samples are believed to be representative of the veins where sampled, but the small number of samples from individual veins does not adequately represent the overall ranges in metal contents. Where workings could not be entered, selected samples were taken from the dumps; these samples could be quite misleading as to mineral potential of a particular vein. The types of samples taken at any given locality are indicated in the sample descriptions in tables 14 and 15, which present the analytical results of the chip samples and dump samples, respectively.

CLAIM COVERAGE

Patented and unpatented claims are shown in figures 9, 10, 17, 18, and 19. The relative positions of these mineral areas are indicated in figure 8.

PATENTED CLAIMS

Patented claim locations as reported herein were obtained from Bureau of Land Management and Forest Service maps and files. The claims are plotted on their respective maps as accurately as possible so as to be tied to natural features rather than to projected survey lines. Exact locations for many of the claims were difficult to establish, owing to the lack of adequate base maps or accurate surveys during the early days when most of the claims were filed. In addition, many claims are fractional or in some way overlap others, and it is difficult to plot these accurately with respect to other claims nearby.

The San Juan primitive area and the contiguous study zone contains 196 claims surveyed for patent. Of this total, 125 lie within the San Juan and Upper Rio Grande Primitive Areas as now constituted, and 71 are in a peripheral study zone. Thirty of these 196 claims are in the vicinity of Molas Lake, Deer Park, and Whitehead Gulch, 23 in the Beartown mining district (fig. 9), and 142 in the Needle Mountains mining district (fig. 10). One claim is along Needle Creek. Most of the patents were issued before 1900.

UNPATENTED CLAIMS

The unpatented claim records in San Juan, La Plata, Hinsdale, Mineral, and Archuleta Counties extend over at least 80 years and are too numerous and complex to permit a complete search of courthouse records in the five counties. Accordingly, the investigation was limited to: (1) claims for which affidavits were filed for the purpose of recording annual labor performed during recent assessment years; (2) claims so recently located that assessment work and corresponding affidavits of labor would not have been legally required as of the dates of the search; and (3) claims located and recorded in the 10-year period prior to the dates of the search, regardless of whether or not affidavits of assessment work had been filed. Although this procedure failed to identify many of the older claims, it is believed that most of the claims of current interest were identified, and that the requirements of this mineral appraisal were met.

Other claims that are so poorly described that they could not be located on our maps or physically located in the field have been disregarded in this appraisal. About 60 such location notices were encountered in the investigation of the county records.

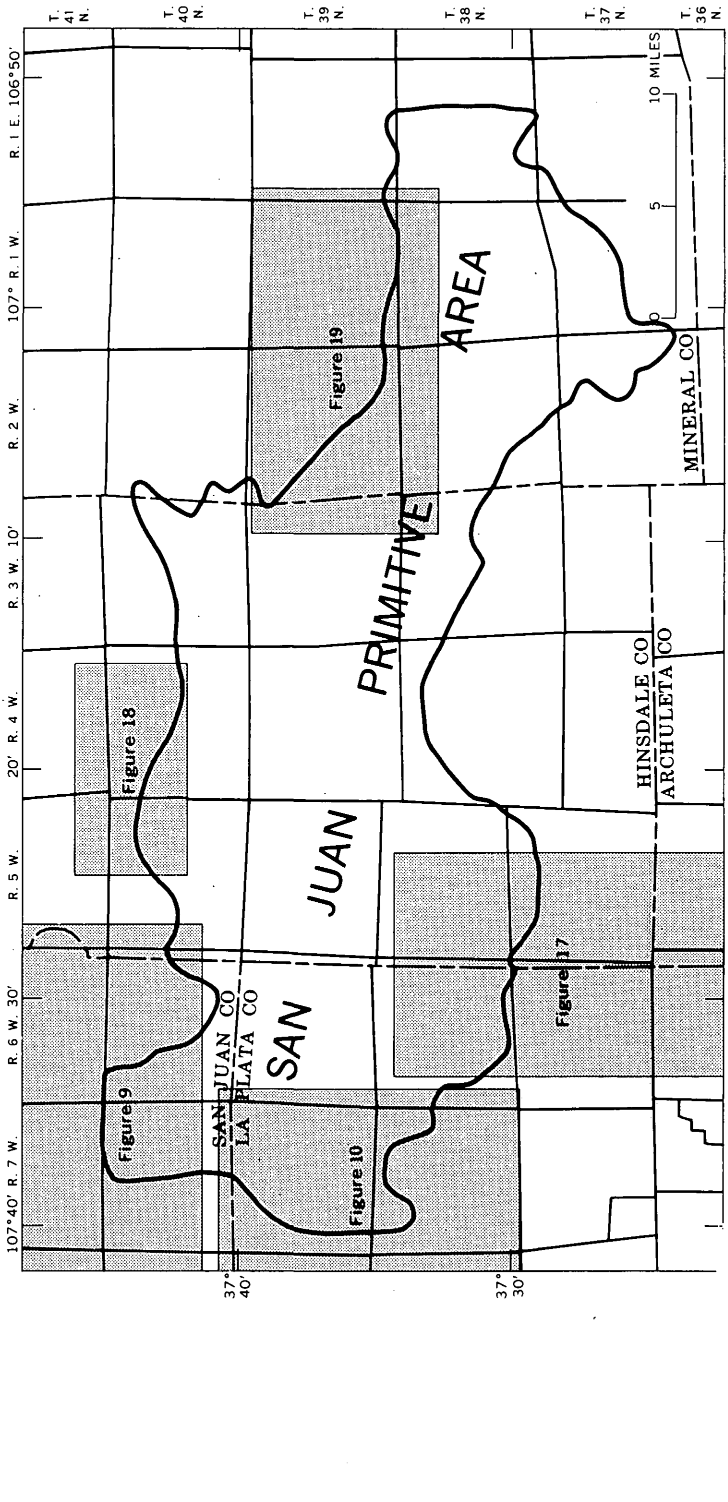

FIGURE 8.—Mineral areas studied in relation to the San Juan primitive area.

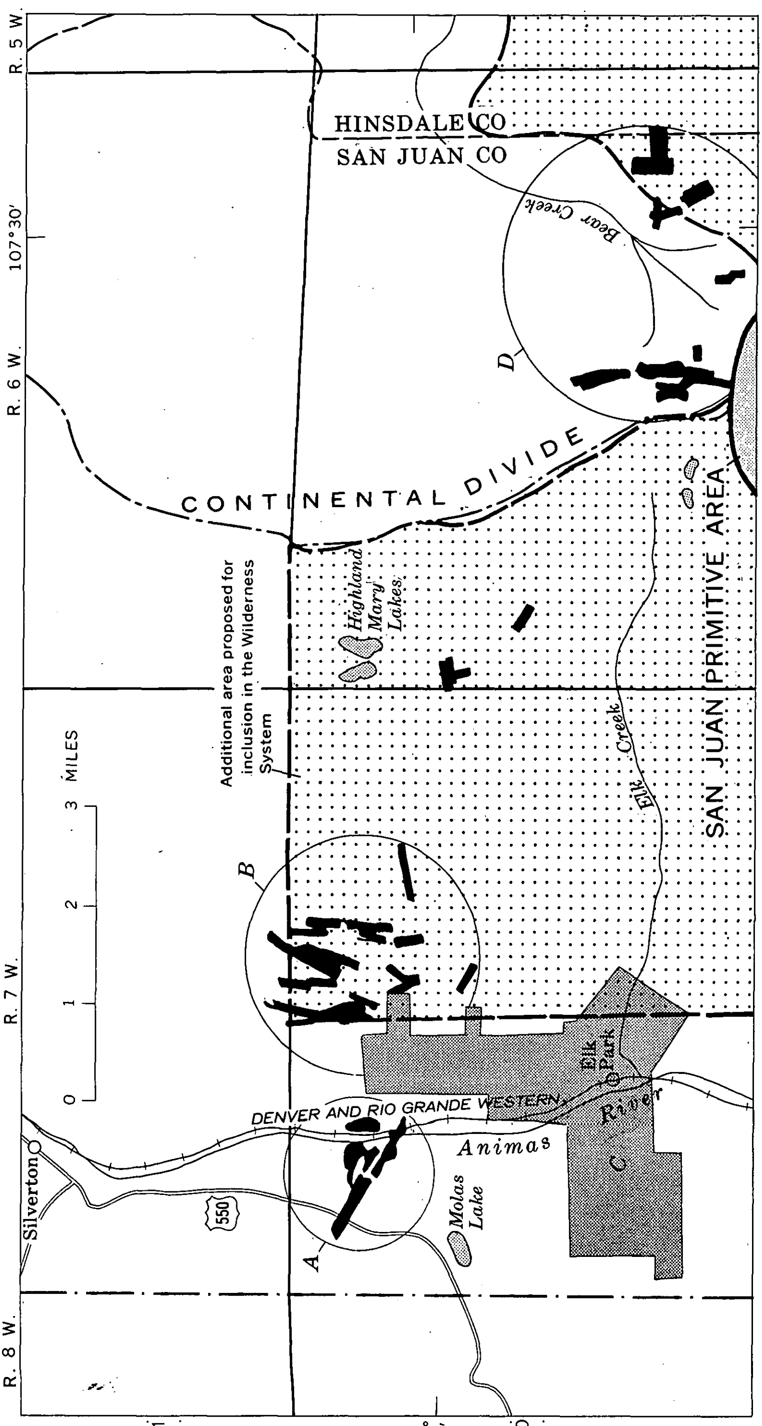

FIGURE 9.—Claims in the Molas Lake (*A*), Deer Park–Whitehead Gulch (*B*), and Elk Park areas (*C*), and the Beartown mining district (*D*). Solid black, patented claims; stippled, unpatented claims.

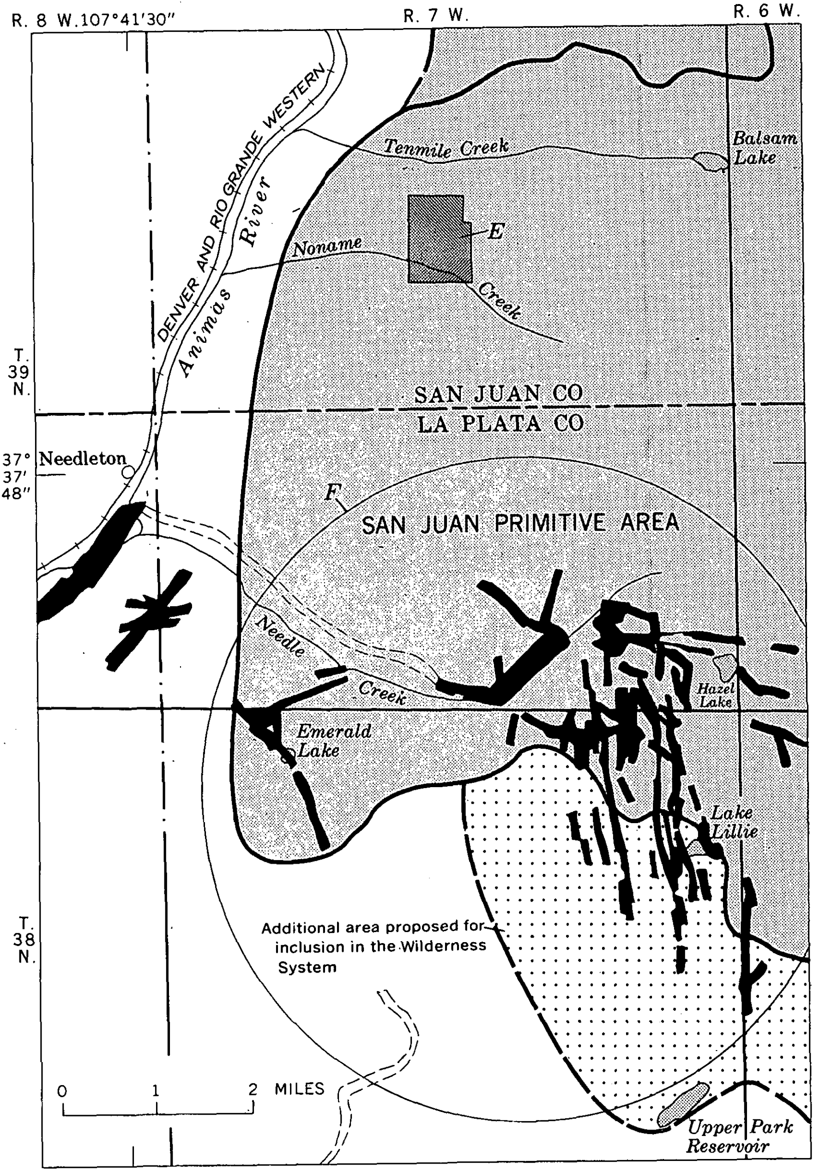

FIGURE 10.—Claims in the Noname–Tenmile Creek area (*E*) and the Needle Mountains mining district (*F*). Solid black, patented claims; stippled, unpatented claims. See figure 11 for mine locations in the Needle Mountains district.

Figures 9, 10, 17, 18, and 19 show the locations or approximate locations of about 400 unpatented claims within the San Juan primitive area and the perimeter study zone. Another 25 unpatented claims overlap or lie so close to patented claims—particularly in the Needle Mountains mining district—that plotting their locations would contribute little to an overall concept of claim coverage or the location of mineral deposits.

MOLAS LAKE AND DEER PARK–WHITEHEAD GULCH AREAS

Two groups of patented claims are within or adjoin the study area contiguous with the northwest corner of the San Juan primitive area (fig. 9). Group *A* near Molas Lake, and group *B*, in Deer Park and Whitehead Gulch, are along the south margin of a highly mineralized area south of Silverton which has been reported by Varnes (1963). The geology was described in the section of this report dealing with the Whitehead Gulch area. Formerly active mines in groups (areas) *A* and *B* include the Molas, Maybell, Montana, Mammoth, and Mabel mines which, during 1902–50, yielded $24,000, mostly in gold and silver. These properties were inactive in 1968.

Production from these areas was obtained from quartz veins containing gold and silver, along with minor amounts of the base metals. Of the total of $24,000 produced, only 4½ percent is attributed to copper, lead, and zinc.

Some of the veins in the vicinity of Whitehead Gulch are in the perimeter study area as outlined in this report (fig. 9). Although this area may not have large tonnages of ore reserves, it does have some potential as a producer from small-scale mining operations.

ELK PARK AREA

Claim group *C* (fig. 9) consists of 140 lode locations held by American Sovereign Mines, Ltd., and the Whitehead Mining Co. American Sovereign Mines, Ltd., staked the ground in 1956 to cover radioactivity anomalies discovered in eastward-trending shear zones in Precambrian metasedimentary rocks. Subsequent surface and underground exploration disclosed several lenticular occurrences of pitchblende and secondary uranium minerals in one zone. About 22 tons of ore containing 0.9 percent U_3O_8 was mined and stockpiled.

In 1957 American Sovereign Mines, Ltd., applied for a Defense Mineral Exploration Assistance (DMEA) loan to explore two surface exposures. After examinations by U.S. Geological Survey and Bureau of Mines field teams, a DMEA contract was made, authorizing a lessee, Gaddis Mining Co., to drive 450 feet of tunnel to intersect and explore the structure at depth. About 300 feet of crosscut was driven in the summer of 1958. The target structure was not reached because its dip was considerably flatter than that originally projected. However, an estimated 200 tons of ore-grade material was developed near the portal of the crosscut.

Since 1958 the crosscut has been extended an additional 150 feet on the original bearing, S. 30° W., to a point where a fracture zone striking west and dipping 45° S. was intersected. The workings were continued for 50 feet west along the zone to test the mineral content. This fractured zone consists of 3 feet of quartz, gouge, and soft schistose rock; sample 113 taken across the fracture contained no uranium.

Thirty-one tons of ore containing 0.47 percent U_3O_8 was shipped in 1959 by Gaddis Mining Co. to the Gunnison Mining Co. mill at Gunnison, Colo. Another 200 tons of ore estimated to contain 0.20 percent U_3O_8 is stockpiled at the mine. The present lessee, a former partner of the now-defunct Gaddis Mining Co., stated, in August 1968, that long-hole drilling had disclosed a 2-foot-wide extension of the ore shoot below the present level. Additional drilling is planned by the present lessee.

The general area of Elk Park may prove to be productive of uranium ores, but extensive drilling will be required to develop reserves that could be considered competitive. However, the Elk Park area is about 3 miles northwest of the west boundary of the San Juan primitive area, and no comparable uranium anomalies are now known within the primitive area, although some conceivably could exist there.

BEARTOWN MINING DISTRICT

The claims in Group *D* (fig. 9) are in the Beartown mining district and include the once-productive Gold Bug, Good Hope, Kankakee, Sylvanite, and Little Giant mines. Of the total estimated production of $257,000 from mines in the San Juan primitive area and surrounding study area, 78 percent, or $200,000, is estimated to have been produced from mines in the Beartown district prior to 1900 (Cross, Howe, Irving, and Emmons, 1905 p. 13). Output from the district since 1900 was about 160 tons, from which were recovered 332 ounces of gold, 2,497 ounces of silver, 264 pounds of copper, and 2,867 pounds of lead, which altogether was valued at $10,500. The most recent production was from the Little Giant mine in 1961. When the area was visited in 1968, all the workings were caved or flooded and no in-place samples were obtainable.

The Beartown mining district has had the largest mineral production of any area in or near the San Juan primitive area. Inasmuch as

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none of the mines seems extensive enough to have exhausted the mineralized ground, it is likely that more production can be expected. Veins are known to extend to within half a mile of the northern boundary of the primitive area, and some mineralization may extend southward into the primitive area.

NONAME–TENMILE CREEK AREA

Seventeen unpatented claims (area *E*, fig. 10) lie between Noname and Tenmile Creeks within the primitive area. One of the claimants was interviewed in Durango and accompanied a U.S. Bureau of Mines representative into the claimed area. Three samples (Nos. 114–116) collected from better mineralized zones contained only trace amounts of precious and base metals.

No workings or record of previous mining activity were found. Assay data showed no appreciable mineral content, and stream sediment samples collected by the U.S. Geological Survey contained only background values of metals along both Noname and Tenmile Creeks. Therefore, the area is not considered to contain minerals in quantities that might be mined economically.

NEEDLE MOUNTAINS MINING DISTRICT

The area of Group *F* (fig. 10) includes 125 of 141 patented claims, or claims surveyed for patent, in the Needle Mountains mining district. About 25 unpatented claims that are fractions or extensions of patented claims are not shown. Patented claims shown in figure 10, but not included in the *F* group, are outside the present Primitive Area and were not investigated.

Physiographically, the district comprises four subareas: (1) Chicago Basin, which is drained principally by Needle Creek, a tributary of the Animas River; (2) Vallecito Basin, which is drained mainly by Johnson Creek, a tributary of Vallecito Creek; (3) East Silver Mesa and West Silver Mesa, drained by Missouri Gulch, and (4) the Crystal Valley area (fig. 11).

The claims are plotted in figure 11 and discussed subsequently according to a double-letter coding. In Chicago Basin the claims are coded AA through BI: in Vallecito Basin, BJ through CQ; in East Silver Mesa and West Silver Mesa, by CR through DF; and, in the Crystal Valley drainage, eight claims are coded DG through DN. Also included as part of the Chicago Basin area are four workings in the vicinity of Emerald Lake (La Plata County), coded herein as DO through DR. These latter four workings, coded as such, are included with the Chicago Basin area (fig. 10) to avoid confusion with workings reported

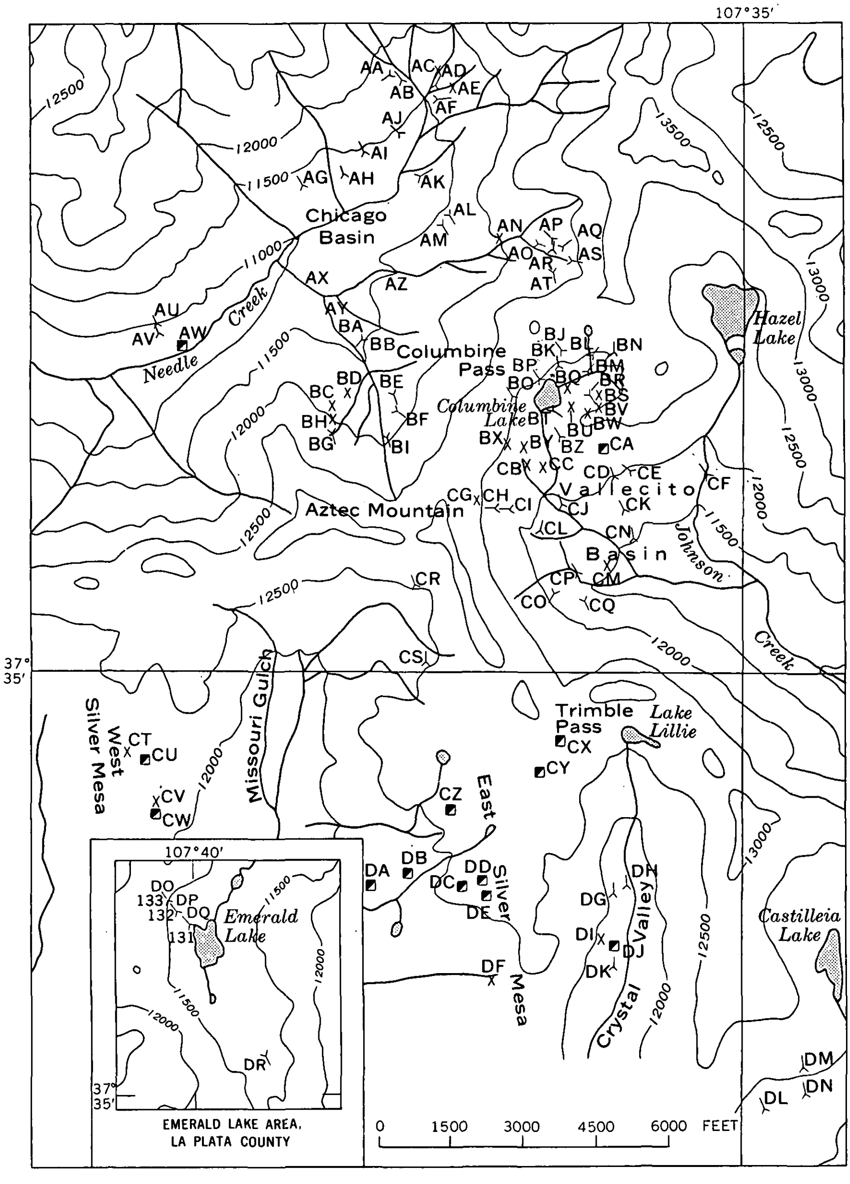

FIGURE 11.—Location of mine workings, Needle Mountains mining district. Double letters indicate workings discussed in text. See figure 10 for location of the Emerald Lake area relative to the Needle Mountains mining district.

further on as claim group *H* near another lake also called Emerald Lake (fig. 17).

Mining activity in the Needle Mountains mining district began in 1881, and continued intermittently through 1917. Activity was renewed briefly in 1934 after the price of gold increased to $35 an ounce. Early production was mainly from hand-sorted gold-silver ore because this was the only material that could be mined and transported economically from the rugged mountain district. Gold was a minor constituent and was present in paying quantities only in local, oxidized parts of the veins.

The early history of mining in the Needle Mountains mining district is so fragmentary that no accurate determination of early production can be made. U.S. Geological Survey, "Mineral Resources of the United States" and Reports of the Director of the Mint record production from the Eureka mine for 1887–90 and 1917; from the Pittsburg mine for 1890; from the Aetna mine for 1904–06; and from the Aztec mine for 1901. Occasional statements in these publications discuss mining activity during other years but make no mention of mineral output. On the basis of these data, the district is estimated to have yielded about $12,500 worth of ore, all but $300 of which is accredited to gold and silver. Individually, the Eureka and the Aetna each produced about $5,000, the Pittsburgh $2,000, and the Aztec $500.

The mining district was not accessible to vehicles in late 1968. However, an old La Plata County public wagon road from the Denver & Rio Grande Western Railroad siding at Needleton, on the Animas River, parallels Needle Creek into Chicago Basin (fig. 12). This road could be repaired to provide access for exploration crews and equipment during the summer when the railroad operates. Access roads for year-round movement of ore or concentrates could be constructed by extending existing logging roads from the south into Chicago and Vallecito Basins, or by rebuilding a stage road from U.S. Highway 550 to Cascade, 4 miles south of Needleton, on the Animas River. Access roads for sustained mineral output would require major costs which would have to be justified by development of extensive ore reserves.

The Needle Mountains mining district contains numerous shafts, drifts, crosscuts, and trenches that are caved, flooded, or only partially accessible due to oxygen deficiency within the workings. Those that were accessible were examined and sampled during the field seasons in 1967–68.

The following discussion on the economic potential of the Needle Mountains mining district is based on data collected in the field and on information obtained through library research.

Nearly all the workings in the district were cut on quartz fissure veins that showed little or no distortion. Most of these undistorted

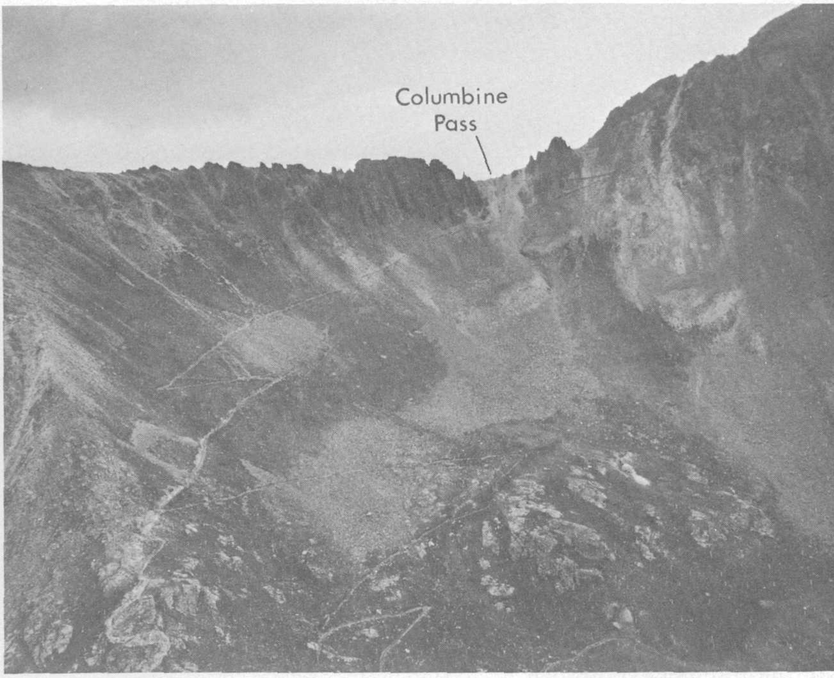

FIGURE 12.—Chicago Basin (eastward view, toward Columbine Pass).

veins are short and rapidly pinch out into country rock. In at least one place, however, the vein was followed by drifting for about 1,500 feet (Aztec mine), and the vein was traced on the surface for more than 1 mile (Irving and Emmons, in Cross, Howe, Irving, and Emmons, 1905, p. 12). It was also noted by Irving and Emmons (p. 12), and corroborated by the Bureau of Mines investigation, that little work was done at depth. The fissure veins in the district are irregular and vary from knife-edge thicknesses to more than 10 feet.

Irving and Emmons (in Cross, Howe, Irving, and Emmons, 1905, p. 13) stated that "the veins already discovered are very numerous and the outcroppings are so prominent * * * that it seems improbable that any should have escaped the diligent eye of the prospector. * * * That any of the veins so far opened should constitute the basis of extensive commercial enterprises seems very improbable, but worked on a small scale with proper methods of concentration the ores may yet be made profitable." These discouraging appraisals by the early workers are now countered by geophysical and geochemical techniques for finding hidden ore bodies, and by metallurgical methods for concentrating low-grade ores. Consequently, the resource potential of the once-worthless unoxidized parts of the veins in the Needle Mountains district needs reappraisal.

The veins are not uniformly mineralized. Early low-grade quartz-pyrite material is the most widespread. This material was later cut by fractures carrying sulfides of copper, lead, zinc, and silver. The size and distribution of such ore shoots are irregular. Extensive drilling is required to determine ore reserves of the area. If mineralized material occurs in volume, modern milling techniques, better access, and far better transportation will completely change the present mineral economics of the area.

Of particular interest is the disseminated molybdenum occurrence in Chicago Basin described in detail in the present report by Steven and Schmitt (p. F59–F61). Should deep exploration prove molybdenum to be present in significant quantities, a large-scale mining operation may be developed.

DESCRIPTION OF WORKINGS

Mine workings examined in the Needle Mountains mining district are marked by double letters in figure 11. Workings from which samples were obtained for assay are also identified by location and sample number in tables 14 and 15. Each working that was studied is described separately below and is identified by double letter and by sample number(s), shown in parentheses.

AA(1) : The upper of two workings at the Mount Eolus mine is a 265-foot drift on a vein striking S. 65° W. and dipping 83° NW. The vein appears to be about 10 feet wide at the portal. A 5-foot chip sample (1 foot of gouge and 4 feet of quartz) was taken at the face of the drift. The sample contained 3.52 ounces of silver per ton and traces of gold and base metals. The full vein width is not exposed at the face.

AB(2) : A lower crosscut to the Mount Eolus vein bears N. 50° W. and is flooded and inaccessible. A sample from the dump, consisting of quartz and sparse iron sulfide (pyrite), contained 0.01 ounce of gold and 0.80 ounce of silver per ton and traces of base metals.

AC: This small opencut is on the strike of vein AD, described next. No sample was obtained.

AD(3, 4) : A crosscut, bearing N. 30° E., intersects a vein at 85 feet and then follows the vein N. 75° E. for 110 feet. The vein is largely quartz with minor amounts of manganese carbonate (rhodochrosite) and iron sulfide (pyrite). A 5-foot chip sample (No. 3) taken at the face contained 1.60 ounces of silver per ton and 0.05 percent copper. A sample (No. 4) of vein material on the dump assayed 0.01 ounce of gold and 2.16 ounces of silver per ton and traces of base metals.

AE(5) : A 10-foot opencut exposes a quartz vein, 6 feet wide, in granite. A chip sample (No. 5) taken across the vein contained 0.10 ounce of silver per ton and 0.38 percent zinc. A sample from the dump (No. 6), consisting of vein material from opencut AE and crosscut AF, described next, assayed 0.44 ounce of silver per ton, 0.52 percent lead, and 0.78 percent zinc.

TABLE 14.—*Assay data from chip samples taken in the San Juan primitive area*

[Tr., trace]

Sample: Location	Sample: Number	Gold (oz per ton)	Silver (oz per ton)	Copper (percent)	Lead (percent)	Zinc (percent)	Sample description
AA	1	Tr.	3.52	Tr.	Tr.	Tr.	Face.
AC	3	Tr.	1.60	0.05	Tr.	Tr.	Do.
AE	5	Tr.	.10	Tr.	Tr.	0.38	Do.
AG	7	0.01	Tr.	Tr.	Tr.	Tr.	Do.
AH	8	Tr.	.52	Tr.	Tr.	Tr.	Do.
AK	12	.04	1.92	Tr.	Tr.	Tr.	Do.
AK	13	Tr.	2.44	.28	0.40	4.40	Do.
AM	14	Tr.	Tr.	Tr.	Tr.	Tr.	Do.
AM	15	Tr.	.12	.02	.20	Tr.	Muck.
AM	16	Tr.	Tr.	.02	Tr.	Tr.	Face.
AM	17	Tr.	.32	Tr.	Tr.	Tr.	Do.
AN	19	Tr.	.36	Tr.	2.10	Tr.	Do.
AP	22	.01	4.28	3.12	Tr.	.25	Back.
AP	23	.01	3.60	.26	Tr.	Tr.	Face.
AU	26	.02	4.86	.51	.40	.76	Back.
AT	30	Tr.	.60	Tr.	Tr.	Tr.	Face.
AX	32	.06	.05	Tr.	Tr.	Tr.	Outcrop.
AX	33	.01	.07	Tr.	Tr.	Tr.	Do.
AX	34	Tr.	Tr.	.03	Tr.	Tr.	Do.
AY	35	Tr.	Tr.	Tr.	Tr.	Tr.	Do.
AY	36	Tr.	.08	.01	Tr,	Tr.	Do.
AY	37	Tr.	.07	.06	Tr.	Tr.	Do.
AZ	38	Tr.	Tr.	.03	Tr.	Tr.	Do.
AZ	39	.01	.91	Tr.	Tr.	Tr.	Do.
BA	40	Tr.	Tr.	.01	Tr.	Tr.	Wall.
BB	41	.01	1.19	Tr.	Tr.	.10	Outcrop.
BF	45	Tr.	Tr.	.01	Tr.	Tr.	Face.
BG	47	Tr.	.04	Tr.	.30	Tr.	Do.
BI	49	.02	8.58	.11	.96	2.54	Back.
BI	50	.03	7.37	Tr.	Tr.	Tr.	Wall.
BI	51	.02	3.78	.18	.76	1.04	Do.
BI	52	.01	.50	Tr.	Tr.	Tr.	Do.
BI	53	.01	.15	Tr.	Tr.	Tr.	Do.
BI	54	Tr.	Tr.	Tr.	Tr.	Tr.	Do.
BI	55	Tr.	Tr.	Tr.	Tr.	Tr.	Do.
BI	56	Tr.	.12	Tr.	Tr.	Tr.	Do.
BN	61	Tr.	1.40	Tr.	.32	Tr.	Back.
BN	62	Tr.	1.68	.15	.66	.65	Do.
BU	64	.03	5.57	.09	.48	.42	Face.
BZ	66	.01	4.90	.13	Tr.	.92	Do.
CI	71	.02	3.94	.63	Tr.	.72	Do.
CI	72	.01	3.44	.16	1.04	1.20	Do.
CI	73	Tr.	Tr.	Tr.	Tr.	Tr.	Wall.
CJ	76	Tr.	1.50	.92	Tr.	.10	Face.
CO	80	Tr.	6.32	2.01	.30	.30	Do.
CQ	83	Tr.	Tr.	.03	Tr.	Tr.	Do.
CW	90	.02	Tr.	Tr.	Tr.	Tr.	Do.
DH	101	.02	.12	.06	Tr.	Tr.	Do.
DI	102	.01	1.73	.08	.33	.10	Do.
DJ	103	.02	1.77	.10	.74	2.28	Wall.
DK	104	.02	4.50	.60	.65	.48	Back.
DL	105	.02	.88	.12	Tr.	Tr.	Face.
DM	106	.02	9.68	.12	1.08	1.76	Back.
DO	108	.02	4.12	Tr.	.21	Tr.	Face.
DO	109	.01	.72	.02	.21	Tr.	Do.
DR	112	.01	.13	.01	Tr.	Tr.	Back.
Group *C*	[1] 113	------	------	------	------	------	Do.
Group *E*	114	Tr.	Tr.	Tr.	Tr.	Tr.	Outcrop.
Group *E*	115	Tr.	Tr.	Tr.	Tr.	Tr.	Do.
Group *E*	116	Tr.	Tr.	Tr.	Tr.	Tr.	Do.
Group *G*	117	1.20	.04	.19	Tr.	Tr.	Face.

See footnote at end of table.

TABLE 14.—*Assay data from chip samples taken in the San Juan primitive area*—Continued

Sample		Gold (oz per ton)	Silver (oz per ton)	Copper (percent)	Lead (percent)	Zinc (percent)	Sample description
Location	Number						
Group *G*	118	0.70	0.04	0.04	Tr.	Tr.	Face.
Group *G*	119	.40	1.14	.60	0.26	0.08	Do.
Group *G*	120	.02	.06	.02	Tr.	Tr.	Do.
Group *H*	121	Tr.	.88	Tr.	2.64	.22	Back.
Group *H*	122	Tr.	.50	.08	Tr.	.12	Do.
Group *M*	[2] 124						Do.
Group *M*	[3] 125						Wall.
Group *M*	[4] 126						Outcrop.
Group *N*	[5] 127						Do.
Group *N*	[6] 128						Do.
Group *N*	[7] 129						Do.
Group *N*	[8] 130						Do.

[1] U_3O_8, 0.00 percent.
[2] Elemental S, 53.40 percent. Total S, 54.00 percent.
[3] Elemental S, 50.50 percent. Total S, 52.16 percent.
[4] Elemental S, 38.00 percent. Total S, 39.85 percent.
[5] Elemental S, 46.85 percent. Total S, 47.50 percent.
[6] Elemental S, 0.50 percent. Total S, 5.29 percent.
[7] Elemental S, 0.75 percent. Total S, 1.07 percent.
[8] Elemental S, 0.40 percent. Total S, 4.62 percent.

AF(6): A crosscut intersects the vein at 10 feet, then follows it 30 feet on a strike of S. 30° E. The vein, which dips 60° SW., is better exposed at opencut AE, immediately upslope from the crosscut.

AG(7): A 130-foot drift follows a vein which strikes N. 35° W. The vein ranges in width from 2 to 5 feet. A 5-foot chip sample taken across the vein at a point 90 feet from the portal contained 0.01 ounce of gold per ton and traces of silver and base metals.

AH(8): This adit runs 45 feet N. 15° W. and, thence, 85 feet N. 38° W. It is entirely within a 40- to 50-foot-wide zone of silicified and brecciated granite containing streaks of metallic sulfides. A 4-foot chip sample cut across the face contained 0.52 ounce of silver per ton and traces of gold and base metals.

AI(9): A caved drift strikes N. 7° W. in a 20-foot-wide zone in altered granite. A selected dump sample assayed 0.22 ounce of silver per ton and traces of gold and base metals.

AJ(10): An adit, now caved, follows a series of thin parallel vertical quartz veinlets striking N. 5° W. A selected sample from the small dump contained traces of base and precious metals.

AK(11, 12, 13): The Little Jim mine consists of a 470-foot drift along a vertical vein striking N. 75° E. Both walls along the drift are in vein material that is 10 feet wide at the portal. The gangue minerals are quartz, rhodochrosite (manganese carbonate), and fluorite; sulfide minerals identified are pyrite, sphalerite, and argentite. Minor amounts of native silver are also present. A selected dump sample (No. 11) showed traces of base and precious metals, indicating that the shipments were probably hand sorted. A 5-foot chip sample (No. 12), cut across the face of a right-hand stub drift 390 feet from the portal, assayed 0.04 ounce of gold and 1.92 ounces of silver per ton. Another 5-foot chip sample (No. 13), cut at the face of the main adit, contained 2.44 ounces of silver per ton, 0.28 percent copper, 0.40 percent lead, and 4.40 percent zinc.

TABLE 15.—*Assay data from dump samples taken in the San Juan primitive area*

[Tr., trace]

Sample		Gold (oz per ton)	Silver (oz per ton)	Copper (percent)	Lead (percent)	Zinc (percent)	Sample description
Location	Number						
AB	2	0.01	0.80	Tr.	Tr.	Tr.	Selected.
AD	4	.01	2.16	Tr.	Tr.	Tr.	Do.
AF	6	Tr.	.44	Tr.	0.52	0.78	Do.
AI	9	Tr.	.22	Tr.	Tr.	Tr.	Random.
AJ	10	Tr.	Tr.	Tr.	Tr.	Tr.	Selected.
AK	11	Tr.	Tr.	Tr.	Tr.	Tr.	Do.
AL	18	Tr.	Tr.	Tr.	Tr.	Tr.	Do.
AO	20	Tr.	.06	0.08	Tr.	Tr.	Waste.
AO	21	.01	.92	Tr.	7.08	.18	Selected.
AR	24	.01	.32	1.14	1.68	2.82	Do.
AU	25	.02	2.70	.26	Tr.	.52	Do.
AV	27	.01	3.60	.43	Tr.	Tr.	Do.
AW	28	Tr.	.10	.03	Tr.	Tr.	Random.
AS	29	Tr.	1.40	.08	.56	.90	Selected.
AT	31	.02	10.18	.10	2.02	6.24	Do.
BC	42	Tr.	.56	Tr.	Tr.	Tr.	Random.
BD	43	Tr.	.18	Tr.	Tr.	Tr.	Selected.
BE	44	.02	4.28	.41	2.44	3.86	Do.
BF	46	.02	.44	Tr.	Tr.	Tr.	Do.
BG	48	Tr.	.56	Tr.	Tr.	Tr.	Do.
BI	57	.01	5.13	.56	1.84	5.96	Do.
BK	58	.01	1.40	1.04	3.40	5.98	Random.
BL	59	.02	25.48	1.23	4.95	5.94	Selected.
BM	60	.02	11.98	.63	3.88	5.10	Do.
BO	63	Tr.	Tr.	.03	Tr.	Tr.	Do.
BX	65	Tr.	2.16	.18	Tr.	1.22	Do.
CA	67	Tr.	1.16	.10	Tr.	.15	Random.
CA	68	Tr.	10.17	2.09	Tr.	Tr.	Stockpile.
CE	69	.02	27.94	1.36	.90	Tr.	Selected.
CG	70	.02	2.98	.43	1.24	3.05	Do.
CI	74	.04	37.56	.20	.36	.65	Do.
CJ	75	.01	3.49	1.72	.24	.25	Do.
CK	77	Tr.	.70	.16	.20	.56	Do.
CL	78	.24	49.80	2.48	Tr.	Tr.	Do.
CL	79	.04	10.96	2.88	Tr.	.20	Do.
CO	81	Tr.	4.77	.84	.08	.26	Do.
CP	82	Tr.	2.68	.58	Tr.	.48	Do.
CR	84	.02	6.84	1.08	1.20	2.36	Do.
CR	85	Tr.	3.30	.04	Tr.	Tr.	Gossan.
CS	86	.01	1.20	Tr.	.76	.24	Selected.
CT	87	Tr.	.26	.03	Tr.	Tr.	Do.
CU	88	.01	.28	Tr.	Tr.	Tr.	Do.
CW	89	.01	Tr.	Tr.	Tr.	Tr.	Random.
CX	91	.06	7.94	.47	Tr.	.48	Selected.
CX	92	.02	12.82	.03	.64	.10	Gossan.
CY	93	Tr.	1.76	.06	1.08	.30	Selected.
CZ	94	Tr.	Tr.	.05	.24	.10	Do.
DA	95	Tr.	Tr.	.08	Tr.	Tr.	Do.
DB	96	Tr.	.76	.06	.40	.66	Do.
DC	97	.04	83.66	.18	.73	.12	Do.
DD-DE	98	Tr.	1.56	Tr.	.30	Tr.	Do.
DF	99	.04	11.56	.07	10.92	1.45	Do.
DG	100	.02	1.32	.06	Tr.	Tr.	Do.
DN	[1] 107	.16	1.24	.06	Tr.	Tr.	Do.
DP	110	.04	2.02	.06	Tr.	Tr.	Stockpile.
DQ	111	.01	.27	.01	Tr.	Tr.	Selected.
Group *J*	123	.01	.64	2.84	.46	5.88	Stockpile.

[1] MoS_2, megascopic, trace.

AL(18): An inaccessible 50-foot (estimated) adit was driven along a zone of altered granite containing parallel quartz veinlets. The adit strikes S. 45° E. A dump sample of selected vein material contained traces of base and precious metals.

AM(14, 15, 16, 17): These workings were cut in altered granite. The main adit bears S. 59° E. for 118 feet and thence S. 15° E. for 80 feet. At that point, it branches into three drifts, one bearing S. 62° E. for 60 feet, one bearing S. 65° W. for 157 feet, and the third continuing S. 15° E. for 75 feet. All workings are in brecciated host rock containing mineralized veinlets. One chip sample (No. 14), taken at the face of the 157-foot drift, contained traces of base and precious metals. A second sample (No. 15), taken 50 feet S. 15° E. from the drift confluence, assayed 0.12 ounce of silver per ton, 0.02 percent copper, and 0.20 percent lead. A third sample (No. 16), taken at the face of the 75-foot extension drift, showed 0.02 percent copper. The final sample (No. 17), taken across the face of the 60-foot drift, assayed 0.32 ounce of silver per ton.

AN(19): An opencut, 5 feet long, exposes a vertical quartz vein 3 to 10 feet wide striking N. 4° W. This vein is also exposed 100 feet south of the pit. A chip sample, cut across an 8-foot face in the opencut, contained 0.36 ounce of silver per ton and 2.10 percent lead. The sample also showed visible traces of molybdenite.

AO(20, 21): An adit, new caved, apparently was driven eastward as a crosscut to northerly striking veinlets observed in the immediate area. The dump consists of fresh granite containing minor amounts of pyrite, chalcopyrite, and molybdenite. A sample of dump material (No. 20) assayed 0.06 ounce of silver per ton and 0.08 percent copper. A sample of selected vein material (No. 21) contained 0.01 ounce of gold and 0.92 ounce of silver per ton, 7.08 percent lead, and 0.18 percent zinc.

AP(22, 23): A 25-foot drift extends along a mineralized zone 30 feet wide, striking N. 35° W. and dipping 70° E. A 5-foot chip sample (No. 22), taken across the back at the portal, contained 0.01 ounce of gold and 4.28 ounces of silver per ton, 3.12 percent copper, and 0.25 percent zinc. A 5-foot chip sample at the face (No. 23) assayed 0.01 ounce of gold and 3.60 ounces of silver per ton, and 0.26 percent copper.

AQ: This adit is 75 feet southeast from the drift at site AP and about 30 feet higher. The now inaccessible adit was driven N. 65° E. for an estimated 50 feet, where it turns to the right. It apparently did not cut mineralized rock, as the sump is barren.

AR(24): The Lillie mine consists of a drift about 50 feet long that follows a narrow mineralized zone striking N. 5° W. and dipping 78° E. in granite. Although the vein is 5 feet wide at the portal, it narrows to a few inches above the portal. The workings were flooded and inaccessible in 1967. A dump sample of selected vein material assayed 0.01 ounce of gold and 0.32 ounce of silver per ton, 1.14 percent copper, 1.68 percent lead, and 2.82 percent zinc.

AS(29): The Black Giant mine consists of an adit driven into a mineralized zone that is 120 feet wide, strikes S. 77° E., and dips 48° to 58° N. The zone is easily recognized at the ridge crest between Chicago Basin and Vallecito Basin, about 300 feet above the mine. Here, the zone widens to about double its width at the working. A sample of selected vein material, taken from an estimated 350-ton dump, contained 1.40 ounces of silver per ton, 0.08 percent copper, 0.56 percent lead, and 0.90 percent zinc.

AT(30, 31): This 125-foot drift was driven along a fracture zone striking S. 10° E. On the surface near the portal, the zone is about 65 feet wide and contains minor cross fractures striking S. 54° E. This zone can readily be traced to the crest, where it narrows to about 10 feet. A 5-foot chip sample (No. 30), taken at the face, contained 0.60 ounce of silver per ton and traces of gold and base metals. A dump sample (No. 31) contained 0.02 ounce of gold and 10.18 ounces of silver per ton, 0.10 percent copper, 2.02 percent lead, and 6.24 percent zinc.

AU and AV(25, 26, 27): The upper main drift of the Sheridan mine, location AU, is caved and flooded but follows a vertical mineralized zone in granite that strikes N. 10° W. The zone is approximately 30 feet wide at the portal, but tapers to about 10 feet wide at a point 250 feet northward. Sample 25, from the upper dump, contained 0.02 ounce of gold and 2.70 ounces of silver per ton, 0.26 percent copper, and 0.52 percent zinc. Sample 26, a 5-foot chip sample taken from the back of the upper portal, contained 0.02 ounce of gold and 4.86 ounces of silver per ton, 0.51 percent copper, 0.40 percent lead, and 0.76 percent zinc. A lower drift, location AV, is also caved. Sample 27, taken from the dump of the drift, assayed 0.01 ounce of gold and 3.60 ounces of silver per ton, and 0.43 percent copper.

AW(28): This working is a 25-foot shaft on a mineralized zone striking N. 5° E. A selected dump sample contained 0.10 ounce of silver per ton and 0.03 percent copper.

AX(32, 33, 34): At this locality, three large samples of altered rock material were collected by taking chips on 20-foot centers. The southernmost sample (No. 32), representing 200 feet of altered rock material, contained 0.06 ounce of gold and 0.05 ounce of silver per ton and traces of the base metals. Sample 33, representing 230 feet of altered rock material, contained 0.01 ounce of gold and 0.07 ounce of silver per ton, and traces of the base metals. The northernmost sample (No. 34), representing 200 feet of altered material, contained 0.03 percent copper and traces of base and precious metals (fig. 13).

AY(35, 36, 37): At this locality (fig. 13), three samples of altered rock were obtained by taking chips on 10-foot centers. The southernmost sample (No. 35) represents 100 feet of altered rock. It contained traces of base and precious metals. The next sample northward (No. 36), representing 100 feet of altered rock, contained 0.08 ounce of silver per ton and 0.01 percent copper. The northernmost sample (No. 37), representing 100 feet of altered material, assayed 0.07 ounce of silver per ton and 0.06 percent copper.

AZ(38, 39): Two chip samples of altered rock material were taken at this locale (fig. 13). The southernmost sample (No. 38), representing 25 feet of altered rock, contained 0.03 percent copper and traces of gold, silver, lead, and zinc. Sample 39, representing 25 feet of altered rock immediately north of sample 38, contained 0.01 ounce of gold and 0.91 ounce of silver per ton, and traces of the base metals.

BA(40): At this site (fig. 13), an 80-foot adit bears N. 50° E. in iron-stained gossan. The adit cuts two thin quartz veins near the portal which strike approximately N. 40° W. A chip sample, cut at 5-foot intervals along the

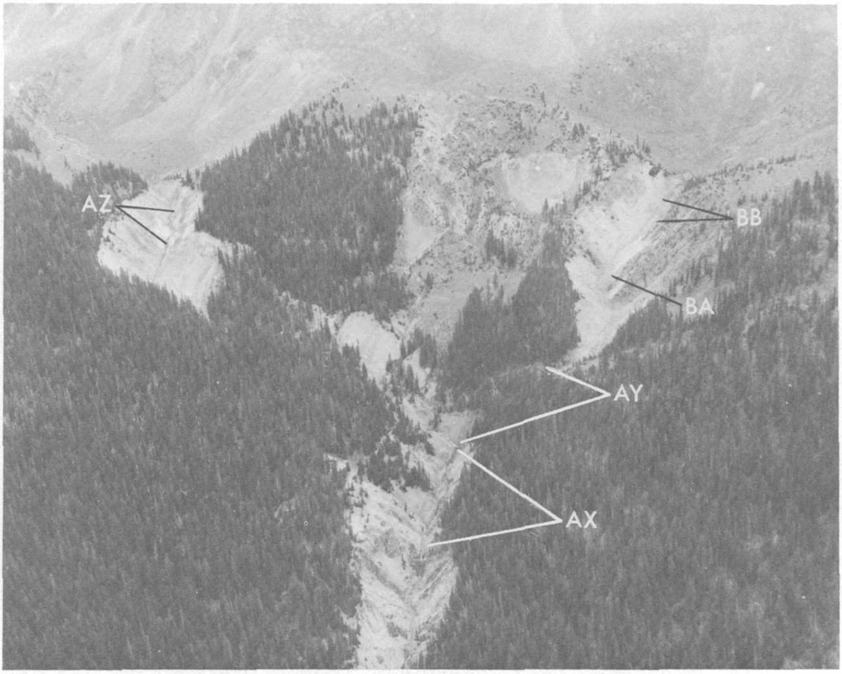

FIGURE 13.—Intrusive in Chicago Basin, showing mine workings AX, AY, AZ, BA, and BB (described in text). View is to the southeast.

adit wall, contained 0.01 percent copper and traces of gold, silver, lead, and zinc.

In 1960 American Metal Climax, Inc., optioned 32 patented claims and staked 14 others to cover and protect a copper-molybdenum geochemical anomaly in the altered intrusive rock roughly outlined by the deep erosion scars visible in figure 13. This altered intrusive is described on pages F56–F59. Exploration drilling equipment was packed by horse and flown by helicopter into the primitive area. One core hole, about 80 feet north of location BA, was drilled to a depth of 1,000 feet (fig. 13). The core assayed about 0.03 percent MoS_2 from the collar to 500 feet, and about 0.01 MoS_2 from 500 to 800 feet; the core showed insufficient molybdenite to warrant assay from 800 to 1,000 feet. The company then relinquished mineral interest to the patented claims and abandoned its located claims. However, the patented claims have recently been optioned by American Minerals, Inc., of Boulder, Colo., additional unpatented claims have been staked, and a more comprehensive exploration program has been planned.

BB(41): At this location (fig. 13), about 150 feet upstream from BA, a chip sample was taken of gossan containing manganese oxide and pyrite for 25 feet along the creek bed. The sample contained 0.01 ounce of gold and 1.19 ounces of silver per ton, 0.10 percent zinc, and traces of copper and lead.

BC(42): At this locale a crosscut trench begins in the east wall of a wide quartz vein striking N. 4° E. and dipping 70° E. The vein, ranging from 45

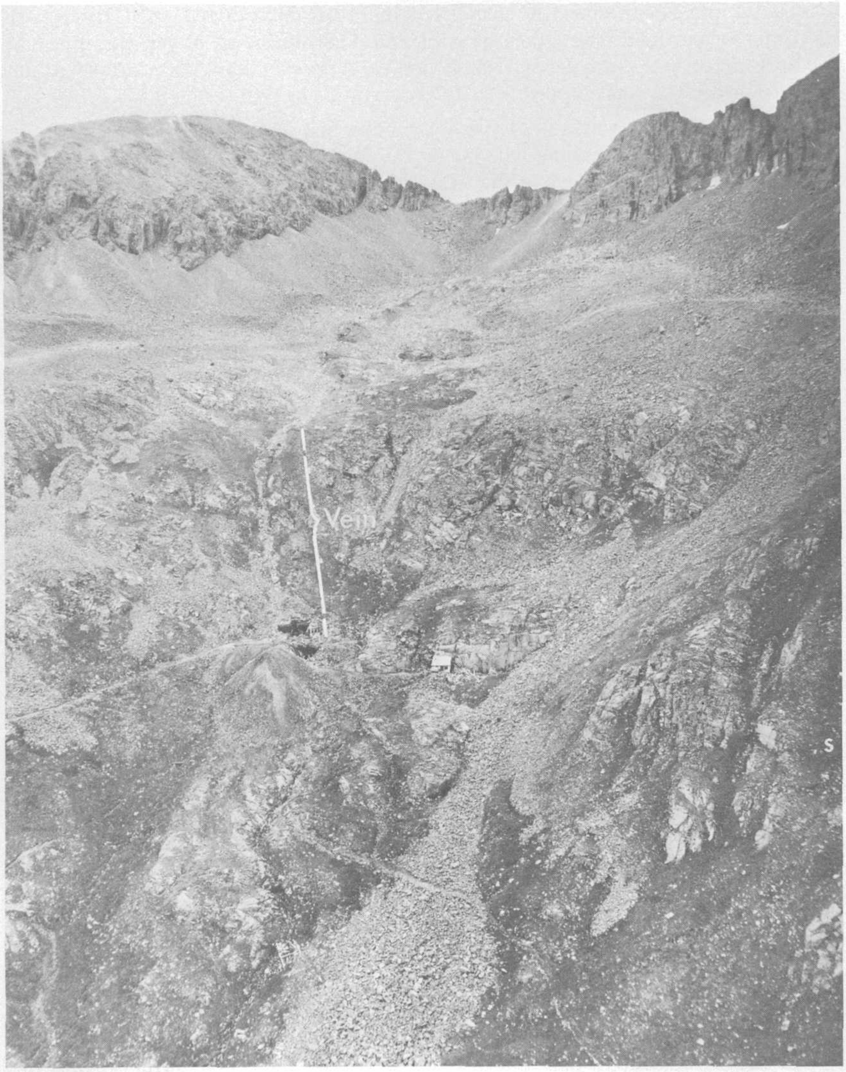

FIGURE 14.—Aetna mine on the Aztec vein. View to the south, toward crest between Chicago Basin and East Silver Mesa.

to 65 feet in width, was observed over a strike length of about 100 feet. A random sample from the trench dump assayed 0.56 ounce of silver per ton and traces of base and precious metals.

BD(43) : A 20-foot-long crosscut trench was excavated at this site in a vertical mineralized zone 70 feet wide, striking N. 1° W. A dump sample of vein material assayed 0.18 ounce of silver per ton and traces of base metals.

BE(44) : At the Aztec mine, a 50-foot adit bears S. 10° W. in a wide shear zone which strikes S. 54° E. A small opencut about 20 feet southeast also tested the shear zone. A selected sample of mineralized rock from both dumps contained 0.02 ounce of gold and 4.28 ounces of silver per ton, 0.41 percent copper, 2.44 percent lead, and 3.86 percent zinc. Ore valued at an estimated $500 was shipped from the Aztec mine in 1901.

BF(45, 46): Another working at the Aztec mine is a drift on a quartz vein striking S. 35° E. and dipping 63° W. At 115 feet it turns to a bearing of S. 55° E. and continues 80 feet to the face. At the face the vein, striking S. 55° E., intersects a vertical vein striking N. 3° W. A 5-foot chip sample at the face (No. 45) assayed 0.01 percent copper and traces of gold, silver, lead, and zinc. Sample 46, from the dump, assayed 0.02 ounce of gold and 0.44 ounce of silver per ton and traces of the base metals.

BG(47, 48): At this site a drift follows the hanging wall of a mineralized zone 13 feet wide, strikes S. 7° E., and dips 74° E. The drift turns at 50 feet and continues about 20 feet on a small vein striking east. A 4-foot chip sample (No. 47), cut across the face of the east-striking vein, contained 0.04 ounce of silver per ton and 0.30 percent lead. Sample 48, from selected vein material on the dump, assayed 0.56 ounce of silver per ton and traces of gold and the base metals.

BH: An opencut, 10 feet long, exposes a face, about 10 feet deep, apparently on the strike of the vein at site BG. No sample was obtained.

BI(49–57): The Aetna mine produced about $5,000 worth of ore from the Aztec vein in 1904–06. A dump sample and eight drift samples were taken at the property in September 1967.

The mine was excavated on a mineralized zone about 40 feet wide. The zone varies in strike and dip, but at the portal of the adit, the zone strikes S. 2° W. and dips 80° E. The adit follows the west wall of the mineral zone for an undetermined length along a bearing of about S. 20° E. The zone continues southward across the crest to East Silver Mesa, where excellent exposures were examined and sampled (fig. 14). The mineral zone is marked with test pits and stub drifts southward (upslope) from the main adit; these excavations were not examined. Apparently, higher grade ore material (in gossan) was selectively mined at these places.

The main adit was examined for 530 feet from the portal; oxygen deficiency made further penetration unsafe. A 70-foot crosscut bears 20° to the left at 360 feet from the portal. A 7-foot chip sample (No. 49) was obtained at the intersection of this crosscut with the main adit. Chip samples (Nos. 50–56) also were taken at 10-foot intervals in the crosscut. Sample 57 was selectively taken from the dump.

The silver content of samples from the Aetna mine is of primary interest. Sample 49 contained 8.58 ounces of silver per ton; No. 50, 7.37 ounces; No. 51, 3.78 ounces; No. 52, 0.50 ounce; and Nos 53–56 showed traces of as much as 0.15 ounce per ton. The dump sample (No. 57) showed 5.13 ounces of silver per ton.

BJ: A 20-foot flooded adit at this locality bears N. 20° W. It is considered to be part of the Eureka mine. No samples were obtained.

BK(58): The main part of the Eureka mine is a 395-foot drift on a southward-trending vein, 3 feet wide, which dips 45° to 65° E. Two crosscuts, 35 and 50 feet long, explored the hanging wall. A selected dump sample assayed 0.01 ounce of gold and 1.40 ounces of silver per ton, 1.04 percent copper, 3.40 percent lead, and 5.98 percent zinc. This mine is credited with production of $5,000 worth of ore valued mainly for its gold and silver content.

BL(59): This working is known as the Jennie Hayes mine. An inaccessible (caved) drift on a vein striking northeastward constitutes the workings. A selected dump sample assayed 0.02 ounce of gold and 25.48 ounces of silver per ton, 1.23 percent copper, 4.95 percent lead, and 5.94 percent zinc.

BM(60): A drift, now caved, was cut on the vein about 50 feet below the main working of the Jennie Hayes mine. A selected dump sample contained 0.02 ounce of gold and 11.98 ounces of silver per ton, 0.63 percent copper, 3.88 percent lead, and 5.10 percent zinc.

BN(61, 62): The Apache mine is a 550-foot drift that explored a mineralized zone, 4 feet wide, containing an 8- to 10-inch quartz vein. The vein strikes north and dips steeply. Two overhand stopes, about 10 to 15 feet long by 20 to 30 feet high, were excavated about 100 and 400 feet from the portal, respectively. A winze, said to be 30 feet deep, was sunk 425 feet from the portal. This winze was flooded and was not entered.

Sample 61, a 4-foot chip sample across the back of the drift at the winze, assayed 1.40 ounces of silver per ton and 0.32 percent lead. Sample 62, a chip sample across the back at the south stope (100 feet from portal), contained 1.68 ounces of silver per ton, 0.15 percent copper, 0.66 percent lead, and 0.65 percent zinc.

BO(63): This working is a trench and caved drift on a 27-inch quartz vein striking N. 50° W. A selected sample from an estimated 300- to 500-ton dump contained 0.03 percent copper and traces of gold, silver, lead, and zinc.

BP: This caved prospect on the north side of Columbine Lake is part of the Eureka mine (location BK), No sample was obtained at this small barren-appearing dump.

BQ: A trench explores a 2-foot quartz vein striking N. 10° E. and dipping 80° SE. No sample was taken.

BR: A drift, probably part of the Dolly Varden mine, bearing S. 35° E. and estimated to be 60 feet long, follows a prominent vein. This drift was unsafe to enter. No sample was taken.

BS: A partially caved 40-foot-long trench was excavated in a gossan zone east of Columbine Lake. Because no vein structure was visible, no sample was taken.

BT: A 50-foot drift, probably the Mountain King mine, was driven on a quartz vein 2 feet wide, striking S. 50° E. and dipping 60° NE. The working may be on the same vein that is explored by the Moonstone mine at site BU. No sample was taken.

BU(64): What is probably the Moonstone mine consists of a 20-foot trench and a short drift driven on 4-foot quartz vein striking N. 55° W. and dipping 70° NE. A 4-foot chip sample, cut across the vein, assayed 0.03 ounce of gold, and 5.57 ounces of silver per ton, 0.09 percent copper, 0.48 percent lead, and 0.42 percent zinc.

BV: A 30-foot trench at this locale bears S. 25° E. Although the dump shows traces of galena (lead sulfide), no sample was taken.

BW: Two shallow trenches have been dug on a vein that strikes N. 10° E. and dips 75° W. A parallel vein crops out about 20 feet to the west. Each vein is about 2 feet wide. No samples were obtained.

BX(65): A 50-foot trench bearing N. 35° W. exposes quartz, fluorite, and some pyrite in a poorly defined vein. A selected dump sample contained 2.16 ounces of silver per ton, 0.18 percent copper, and 1.22 percent zinc.

BY: A 25-foot trench, cut to a maximum depth of 7 feet, exposes quartz and pyrite. This is probably an extension of the vein at site BX.

BZ(66): A 25-foot trench and 10-foot drift were cut on a vertical vein, 3½ feet wide, that strikes N. 20° W. This prospect is west-northwest of the Cross shaft (site CA). A chip sample, cut across the vein, assayed 0.01 ounce of gold, and 4.90 ounces of silver per ton, 0.13 percent copper, and 0.92 percent zinc.

CA(67, 68): The Cross shaft is flooded to within 15 feet of the surface. According to Barney Yeager of Durango, Colo. (oral commun., 1967), the shaft is at least 95 feet deep—he had sampled at that depth previously. The vein structure strikes N. 20° W. and dips 80° E. At the surface the vein is 1½ to 2 feet wide, but it widens to 5 feet just a few feet below the collar of the shaft. A random sample (No. 67) from the east dump assayed 1.16 ounces of silver per ton, 0.10 percent copper, and 0.15 percent zinc. A small sample (No. 68) from the west dump—probably a stockpile—contained 10.17 ounces of silver per ton and 2.09 percent copper.

CB: This working is locally called the St. Paul. It consists mainly of a north-striking trench and adit that total about 100 feet long. No metallic minerals were seen, and no sample was taken.

CC: A 30-foot trench and 10-foot adit cut a quartz vein 2 feet wide, striking N. 45° W. and dipping 65° NE. Apparently, this is the same structure described at sites BX and BY. No sample was taken.

CD: What is probably the Allie Davis mine consists of an 80-foot adit that intersects three thin northwest-striking quartz veinlets. Owing to the scarcity of sulfide minerals, no samples were taken.

CE(69): A 125-foot adit, probably the Neglected mine, intersects a vein which strikes northwest. The vein is 60 feet from the portal and can be followed for 25 feet; from there, the adit continues on its original course for 40 feet to the face. Sample 69, a selected dump sample, assayed 0.02 ounce of gold, and 27.94 ounces of silver per ton, 1.36 percent copper, and 0.90 percent lead.

CF: A 25-foot drift was cut on a quartz vein 1 to 12 inches wide that strikes north and dips 70° W. No metallic mineralization was evident, and no sample was taken.

CG(70), CH, and CI (71–74): These workings comprise three levels of the Black Horse mine. All are crosscut adits to a vein which bears N. 10° E. The highest adit, at site CG, is 10 feet long. A dump sample (No. 70) contained 0.02 ounce of gold and 2.98 ounces of silver per ton, 0.43 percent copper, 1.24 percent lead, and 3.05 percent zinc.

The middle adit, CH, is estimated to be 50 feet long and is caved and flooded. No sample was taken.

The lower adit, CI, consists of a crosscut to the vein, a drift on the vein, a winze, a 50-foot raise, and a sublevel off the raise. The vein explored by the sublevel is 2 feet wide at the face. Sample 71, taken over a width of 16 inches from the south side of the face of the sublevel, assayed 0.02 ounce of gold and 3.94 ounces of silver per ton, 0.63 percent copper, and 0.72 percent zinc. Sample 72, taken over a width of 8 inches from the north side of the sublevel face, contained 0.01 ounce of gold and 3.44 ounces of silver per ton, 0.16 percent copper, 1.04 percent lead, and 1.20 percent zinc. Sample 73, taken in the main drift across a 2-foot width of the vein where the vein appears to swing into the west wall, contained only trace amounts of base and precious metals. Sample 74, a selected dump sample from this lower working, assayed 0.04 ounce of gold and 37.56 ounces of silver per ton, 0.20 percent copper, 0.36 percent lead, and 0.65 percent zinc.

CJ(75, 76): A shaft of unknown depth (flooded) was sunk on a vein striking N. 10° W. and dipping 83° E. Sample 75, selected from the dump, contained 0.01 ounce of gold and 3.49 ounces of silver per ton, 1.72 percent copper, 0.24 percent lead, and 0.25 percent zinc. Chip sample 76, cut across 2 feet of vein material above the collar of the shaft, assayed 1.50 ounces of silver per ton, 0.92 percent copper, and 0.10 percent zinc.

CK(77): This working is probably the Clipper mine. It consists of about 700 feet of crosscuts and drifts that intersect and follow several veins. There is no reported production from these relatively extensive workings. A selected dump sample contained 0.70 ounce of silver per ton, 0.16 percent copper, 0.20 percent lead, and 0.56 percent zinc.

CL(78, 79): A 50-foot drift was driven N. 20° W. along two quartz stringers—5 inches and 4 inches wide at the face—in altered granite. A selected dump sample (No. 78) assayed 0.24 ounce of gold and 49.80 ounces of silver per ton, 2.48 percent copper, and traces of lead and zinc. Another dump sample (No. 79) contained 0.04 ounce of gold and 10.96 ounces of silver per ton, 2.88 percent copper, and 0.20 percent zinc.

CM: A trench was dug at this location on a 15-inch north-striking vertical quartz vein. Owing to the sparsity of sulfides on the dump, no sample was taken.

CN: A drift, now caved, but estimated to be 50 to 60 feet long, was driven on a 2- to 3-inch-wide quartz vein striking N. 10° W. and dipping 77° SW. Although the dump is estimated to contain 200 or 300 tons of material, no sample was taken because only a trace of sulfide minerals was observed.

CO(80, 81): An adit at this site extends 30 feet to the southwest, where it crosscuts a nearly vertical vein that is 3 to 4 feet wide. A drift follows the vein for 85 feet to the south. Chip sample 80, cut across 3 feet of vein material at the face of the drift, assayed 6.32 ounces of silver per ton, 2.01 percent copper, 0.30 percent lead, and 0.30 percent zinc. A selected dump sample (No. 81), contained 4.77 ounces of silver per ton, 0.84 percent copper, 0.08 percent lead, and 0.26 percent zinc.

CP(82): What is probably the Mayflower mine consists of a 100-foot drift that was driven on a steeply dipping vein, 1–3 feet wide, that strikes N. 25° W. A selected dump sample assayed 2.68 ounces of silver per ton, 0.58 percent copper, and 0.48 percent zinc.

CQ(83): A 130-foot drift was driven on a 3- to 4-foot-wide vertical quartz vein striking S. 10° W. A 3-foot chip sample, cut from the vein at the face of the drift, assayed 0.03 percent copper and traces of gold, silver, lead, and zinc.

CR(84, 85): A caved drift comprising part of the Pittsburg mine follows a steeply dipping vein which strikes N. 10° W. (See also site DC.) Sulfide minerals are abundant on the dump. Although the vein at the portal is only 3 feet wide, the outcrop of the vein at the crest of the divide (as viewed to the north, toward Chicago Basin) is about 50 feet wide (fig. 15). A selected

FIGURE 15.—Part of Pittsburg mine, showing vein extending over the crest (mine working CR, in fig. 11).

dump sample (No. 84) assayed 0.02 ounce of gold and 6.84 ounces of silver per ton, 1.08 percent copper, 1.20 percent lead, and 2.36 percent zinc. A selected gossan sample from the dump (No. 85) assayed 3.30 ounces of silver per ton, 0.04 percent copper, and traces of gold, lead, and zinc. The mine is credited with producing about $2,000 worth of ore.

CS(86): This is probably the Phoenix mine. It consists of a 70-foot drift that was driven on a 6-inch-wide vertical quartz vein striking N. 10° W. This vein may be a southern extension of the Pittsburg vein. A dump sample assayed 0.01 ounce of gold and 1.20 ounces of silver per ton, 0.76 percent lead, and 0.24 percent zinc.

CT(87): A small opencut was dug at this site on a 2-foot-wide vertical vein that strikes N. 10° W. A dump sample, consisting of selected vein material, contained 0.26 ounce of silver per ton and 0.03 percent copper.

CU(88): A now-flooded shaft was sunk in a 50- to 60-foot-wide shear zone in granite. Within this zone is a vertical quartz vein, 4 to 5 feet wide, that strikes N. 15° W. A sample of vein material from the dump assayed 0.01 ounce of gold and 0.28 ounce of silver per ton and traces of base metals.

CV and CW(89, 90): An inclined shaft (CW) was sunk about 30 feet at the intersection of two veins. One vein, coarsely crystalline, is 6–7 feet wide, strikes N. 10° W., and dips 85° NW. Intersecting this vein is a narrow vertical vein striking N. 40° W. About 50 feet north, on the strike of the wider vein, is a shallow prospect pit, CV. One sample (No. 89), consisting of selected quartzitic vein material, assayed 0.01 ounce of gold per ton. Sample 90, representing selected crystalline calcite, assayed 0.02 ounce of gold per ton.

CX(91, 92): This is a flooded prospect working which appears to be the beginning of an adit or inclined shaft. It is on a vertical vein 8–10 feet wide, striking N. 15° W. Sample 91, consisting of selected sulfide matter, assayed 0.06 ounce of gold and 7.94 ounces of silver per ton, 0.47 percent copper, and 0.48 percent zinc. Sample 92, consisting of selected gossan material, contained 0.02 ounce of gold and 12.82 ounces of silver per ton, 0.03 percent copper, 0.64 percent lead, and 0.10 percent zinc.

CY(93): An inclined shaft, now caved to within 20 feet of the collar, was dug at this location on a vein, 4 to 5 feet wide, that strikes N. 30° W. and dips 85° E. A dump sample assayed 1.76 ounces of silver per ton, 0.06 percent copper, 1.08 percent lead, and 0.30 percent zinc.

CZ(94): A shaft estimated to be 50 feet deep was sunk at this site on a vertical quartz vein, 1–1½ feet wide, that strikes N. 5° W. A selected dump sample contained 0.05 percent copper, 0.24 percent lead, 0.10 percent zinc, and traces of gold and silver.

DA(95): The mine working consists of a now-flooded shaft, estimated to be 50 feet deep, sunk on a vertical quartz vein, 2 feet wide, that strikes N. 20° E. A dump sample contained 0.08 percent copper and traces of gold, silver, lead, and zinc.

DB(96): A flooded shaft at this site is estimated to be about 20 feet deep. It was sunk on a vertical vein, 1 to 2 feet wide, that strikes N. 10° W. A dump sample contained 0.76 ounce of silver per ton, 0.06 percent copper, 0.40 percent lead, and 0.66 percent zinc.

DC(97): The Pittsburg shaft (fig. 16), now inaccessible, was sunk on a vein that strikes northerly and dips steeply east. A selected dump sample consisting of sulfides (mainly pyrite) assayed 0.04 ounce of gold and 83.66 ounces of silver per ton, 0.18 percent copper, 0.73 percent lead, and 0.12 percent zinc. (See also mine working CR.)

DD and DE(98): Two shafts about 50 feet apart and about 20 feet deep were sunk at this site on a vein striking N. 5° E. and dipping steeply east. The vein is approximately 2 feet wide. A combined grab sample from the dumps assayed 1.56 ounces of silver per ton and 0.30 percent lead.

DF(99): A trench about 50 feet long, 5 feet deep, and 8 feet wide, exposed a 5-foot-wide vein at this locality. The vein strikes northward and dips steeply east. No sulfides were found in place, but the dump contains abundant galena. A dump sample assayed 0.04 ounce of gold and 11.56 ounces of silver per ton, 0.07 percent copper, 10.92 percent lead, and 1.45 percent zinc.

DG(100): A drift, now caved, was driven at this site on a vertical vein striking N. 15° W. The drift length, estimated from the size of the dump, may be about 150 feet. As the portal is completely covered with talus, there was no opportunity to observe the width of the vein, but the mineralized outcrop, about 150 feet above the portal, is estimated to be 3–5 feet wide. A dump sample containing only vein material assayed 0.02 ounce of gold and 1.32 ounces of silver per ton and 0.06 percent copper.

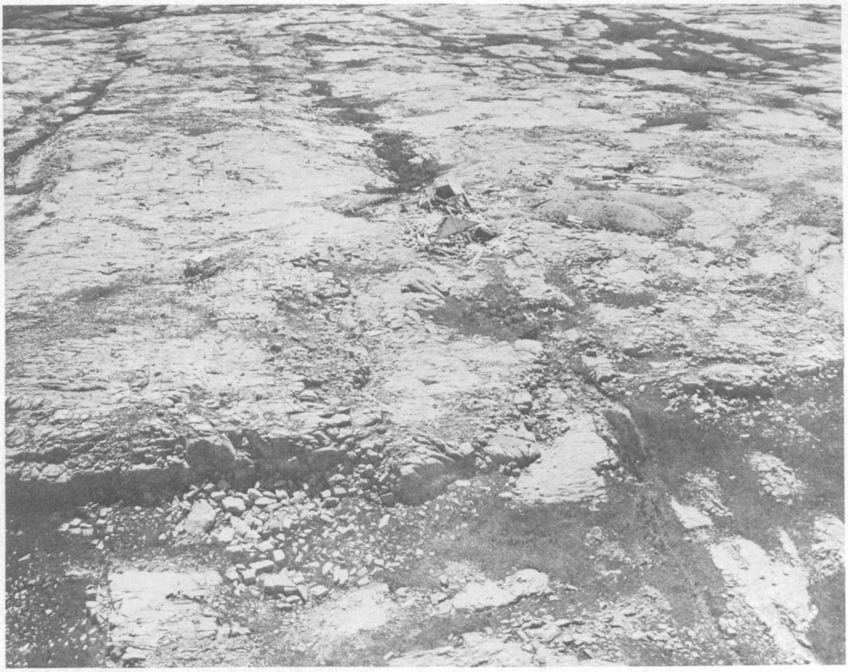

FIGURE 16.—*Pittsburg shaft, showing vein structure. View to the south (mine working* DC, *in fig.* 11).

DH(101): A quartz vein 3 feet wide in a pegmatite-granite contact zone was explored at this locality by a 10-foot trench and a 10-foot drift. The contact zone bears north and dips 78° E. A 3-foot chip sample, cut across the vein at the face of the drift, assayed 0.02 ounce of gold and 0.12 ounce of silver per ton and 0.06 percent copper. Sparse molybdenite was observed in the 15-foot-wide pegmatite dike.

DI(102): At this locality a trench and short drift expose an altered zone 6 feet wide in granite. The zone is vertical and strikes N. 65° W. In it are three quartz stringers, each 1 to 2 inches wide, and each containing sulfides. A chip sample of selected vein material from the outcrop over the portal assayed 0.01 ounce of gold and 1.73 ounces of silver per ton, 0.08 percent copper, 0.33 percent lead, and 0.10 percent zinc.

DJ(103): A shaft 10 feet deep exposes a vertical north-trending quartz vein. A 3-foot chip sample from the vein assayed 0.02 ounce of gold and 1.77 ounces of silver per ton, 0.10 percent copper, 0.74 percent lead, and 2.28 percent zinc.

DK(104): A trench 10 feet long and a drift 30 feet long expose a quartz vein, 3 feet thick, that strikes N. 10° W. and dips 75° E. A sample cut from the vein at the back at the drift portal assayed 0.02 ounce of gold and 4.50 ounces of silver per ton, 0.06 percent copper, 0.65 percent lead, and 0.48 percent zinc.

DL(105): A drift follows a vertical north-trending vein in coarse granite for 30 feet. A chip sample, cut at the face of the drift across a width of 12 inches, contained 0.02 ounce of gold and 0.88 ounce of silver per ton, 0.12 percent copper, and 0.36 percent zinc.

DM and DN (106, 107) : Workings at this locality explored a north-trending fracture zone in granite. The dump volume suggests that total drift length is probably 75 to 100 feet. The drift at site DM is now caved. It explored a quartz vein 12 inches thick. Chip sample 106, taken from the vein at the portal of the caved drift, assayed 0.02 ounce of gold and 9.68 ounces of silver per ton, 0.12 percent copper, 1.08 percent lead, and 1.76 percent zinc. The drift at site DN was flooded at the portal. The vein explored by this drift consists of five 1- to 2-inch-wide quartz stringers over a 5-foot width of altered granite. A selected dump sample (No. 107) assayed 0.16 ounce of gold and 1.24 ounces of silver per ton and 0.06 percent copper. Disseminated molybdenite was observed in the granite dump rock and in the vein zone, but in sparse amounts.

DO, DP, DQ (108, 109, 110, 111) : The principal workings on claims in the vicinity of Emerald Lake (La Plata County) are three now-caved adits about 400 feet (DO), 300 feet (DP), and 50 feet (DQ) above the lake; the workings are alined, and the highest adit is about 1,000 feet N. 40° W. from the lowest. A 20-foot trench at the portal of the highest adit, DO, provides the only exposure of the vein, which is 6 feet wide, strikes N. 40° W., and dips 70° S. If this dip is constant, the lower workings would have to be crosscuts in order to intersect the vein. Estimates based on dump volumes suggest that the upper adit consists of 50 to 75 feet of workings; the middle adit, 100 to 125 feet; and the lower adit, 300 to 400 feet.

The vein was chip sampled in two 3-foot sections at the trench in the upper working. Sample 108, on the footwall side which consists of quartz and oxidized sulfides, contained 0.02 ounce of gold and 4.12 ounces of silver per ton and 0.21 percent lead. Sample 109, made up of quartz and sparse sulfides from the hanging wall, assayed 0.01 ounce of gold and 0.72 ounce of silver per ton, 0.02 percent copper, and 0.21 percent lead. Combined, the samples average 2.42 ounces of silver per ton.

The middle dump, DP, consists of schistose wallrock and a stockpile of vein material estimated to be 50 tons. Random sample 110, from the stockpile, contained 0.04 ounce of gold and 2.02 ounces of silver per ton and 0.06 percent copper.

The lowest dump consists of schist and pegmatite material with minor quartz and calcite. Selected dump sample No. 111, consisting of quartz, calcite, and iron-stained schist, assayed 0.01 ounce of gold and 0.27 ounce of silver per ton and 0.01 percent copper.

DR (112) : A short prospect drift about 2,000 feet southeast of Emerald Lake follows a steep northeast-striking 3-foot-wide quartz vein. A chip sample, taken across the vein at the back at the drift portal, assayed 0.01 ounce of gold and 0.13 ounce of silver per ton and 0.01 percent copper.

VALLECITO CREEK–EMERALD LAKE AREA

A group of nine unpatented claims—group *G* (fig. 17)—called the Copper Queen and Lucky claims, cover ground originally staked as the Grizzly King, Bobby, and Lost claims. The workings are immediately south of Second Creek and one-half mile east of and about 1,500

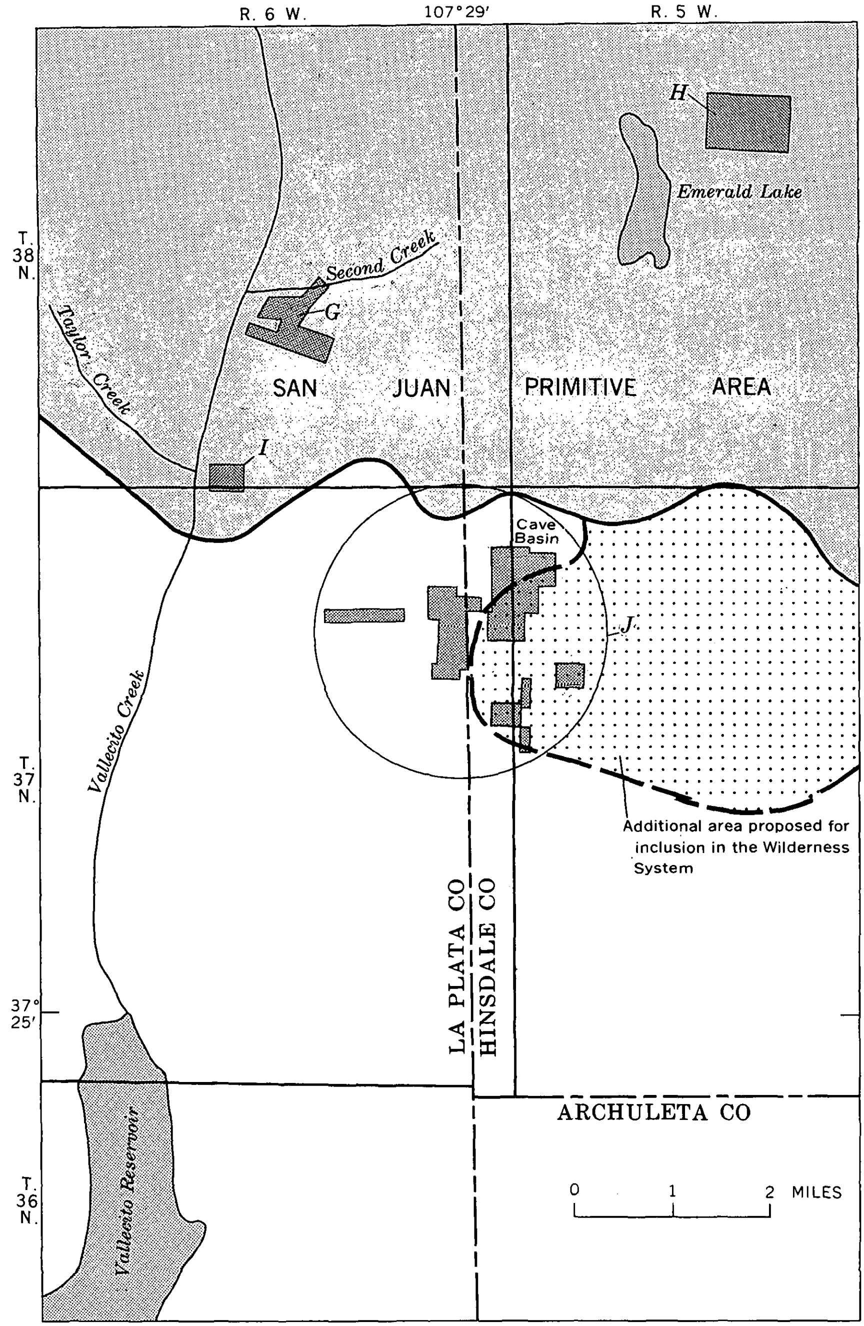

FIGURE 17.—Claims in the Vallecito Creek–Emerald Lake (*G*, *H*, *I*) and Cave Basin (*J*) areas. Stipple, unpatented claims.

feet higher than Vallecito Creek. Recorded production during 1934–36 was 68 tons of ore containing 109 ounces of gold and minor amounts of silver and copper; value of the output was about $3,800.

The property was examined in July 1968. The workings are herein described as three parts—upper, middle, and lower. The upper workings consist of an opencut and an 8-foot drift on a vein striking N. 20° E. and dipping 80° NW. The face of the drift exposes a 12-inch-wide quartz vein in schist. Sample 117, chipped across the vein, contained 1.20 ounces of gold and 0.04 ounce of silver per ton and 0.19 percent copper.

About 250 feet vertically below the upper workings are two surface cuts (middle workings) 10 feet apart and excavated to test two parallel veins striking N. 70° E. and dipping 75° SE. One short discontinuous vein is 4 to 6 inches wide and consists of quartz and sparse sulfides. Sample 118, chipped from this vein, assayed 0.70 ounce of gold and 0.04 ounce of silver per ton and 0.04 percent copper. The other short vein is about 3 feet wide, and consists of about 10 inches of quartz and 2 feet of soft gouge. Sample 119, from the 10-inch-wide quartz vein, assayed 0.40 ounce of gold and 1.14 ounces of silver per ton, 0.60 percent copper, 0.26 percent lead, and 0.08 percent zinc. Sample 120, from the adjoining 2 feet of rock and gouge, assayed 0.02 ounce of gold and 0.06 ounce of silver per ton and 0.02 percent copper.

An 85-foot adit, about 30 feet vertically below the middle workings, runs 65 feet at N. 80° E. and 20 feet at S. 70° E. None of the veins mentioned above however, is exposed in the adit. Because of the small size and discontinuity of the veins, this area is not considered to have significant reserves.

A group of 15 unpatented claims, identified as *H* (fig. 17), is described in location notices filed in the Hinsdale County Courthouse as lying about 2 miles northeast of Emerald Lake. The claimant was interviewed in Durango and agreed to send his representative to assist Bureau personnel in an investigation of his holdings. Timing and terrain dictated the use of helicopter. The examining team was directed to a deposit which is north of Dollar Lake and about 1 mile west of the north end of Emerald Lake. The apparent discrepancy was later explained by the claimant who implied that his claims actually total more than 15 and surround Emerald Lake completely.

The property examined is about 2,000 feet above Lake Creek, which flows into Emerald Lake, and lies about 100 feet below, and on the north side of, an extremely sharp ridge. A partially caved drift follows a 5-foot-wide zone of soft iron-stained schist striking S. 68° E. and dipping 67° SW. Minor iron staining appears to color the schist for about 25 feet on each side of the drift. In the center of the 5-foot zone is an irregular dike like zone containing a 1-inch veinlet containing sulfide minerals. Two samples were taken from the 5-foot zone at the back of the drift above the portal. Sample 121, which included 1 foot of altered schist and the streak of sulfide minerals, assayed 0.88 ounce of silver per ton, 2.64 percent lead, and 0.22 percent zinc. Sample 122, representing the remaining 4 feet of the zone, contained 0.50 ounce of silver per ton, 0.08 percent copper, and 0.12 percent zinc. The entire 5-foot zone averages about 0.6 ounce of silver per ton. The deposit appears to have little economic significance.

The claims in group *I* (fig. 17) comprise three lode locations recorded as Gold Nugget 1, 2, and 3. They are about one-half mile east of Vallecito Creek opposite its confluence with Taylor Creek. The property was originally staked prior to 1900 as the Old Dominion, and a stamp mill was erected on Vallecito Creek for treatment of the ore. Some gold is said to have been shipped, but there is no record of the early production. In 1933 the property was leased to three Bayfield, Colo., residents, who shipped about 5 tons of gold-copper ore to the American Smelting & Refining Co. plant at Leadville. One of the lessees advised Bureau of Mines investigators that the ore was mined from a vein, 1–8 inches wide, above the portal of a 210-foot drift, and that smelter returns did not cover production costs.

The property was abandoned for several years but was restaked in about 1948 as the Golden Nugget 1, 2, and 3. In 1952 the present claimant applied for a DMEA loan to explore for copper, and the deposit was examined by Geological Survey and Bureau of Mines representatives. Their joint report (written commun., 1968) described a shallow surface cut, showing copper and iron sulfides and oxides disseminated along the hanging wall of a 4- to 5-foot-wide, steeply dipping pegmatitic quartz vein in Precambrian conglomerate. A selected specimen of the mineralized rock assayed 0.42 percent copper and 0.03 ounce of gold per ton.

The DMEA report also described a separate deposit developed by a 210-foot drift and a 40-foot winze driven on an east-striking contact between Precambrian conglomerate and granite. A weakly silicified zone in the granite, 6 to 12 inches wide, contains iron and copper sulfides and minor scheelite (a tungsten mineral). A sample taken across 10 inches of the silicified zone assayed 0.52 percent copper and 0.75 ounce of gold per ton, according to the DMEA report.

The immediate area near claim group *I* shows potential for a small reserve of gold-bearing material. Further appraisal of the area would require additional exploration.

CAVE BASIN AREA

Claims in group *J* (fig. 17) are in the Cave Basin district, on the La Plata–Hinsdale County line.

Base and precious metals occur in replacement-type deposits in lower Paleozoic sedimentary rocks less than 100 feet stratigraphically above the Precambrian basement complex. The main host rock is a 50-foot-thick bed of hematitic sandy limestone containing relatively small fault-controlled deposits scattered over an area of about 5 square miles. Formerly producing mines and numerous prospects are now wholly or partly caved or flooded. Deposits in accessible mine faces and stockpiles of assorted ore show chalcocite, malachite, azurite, calcite, siderite, hematite, and limonite.

Recorded production from the district, derived mainly from the Holbrook, Mary Murphy, and Silver Reef mines during 1913–16, 1921, 1924, and 1928, totals 54 tons of ore, from which were recovered 12 ounces of gold, 237 ounces of silver, 2,900 pounds of copper, and 1,700 pounds of lead. Value of the output was assessed at $3,200. Random sample 123, from one 5-ton stockpile, contained 0.01 ounce of gold and 0.64 ounce of silver per ton, 2.84 percent copper, 0.46 percent lead, and 5.88 percent zinc.

An organized program of relatively shallow drilling would probably discover small deposits of additional ore in this area.

RIO GRANDE RESERVOIR AREA

The claim group *K* (fig. 18) comprises 22 lode locations staked to cover a radioactive anomaly discovered by local ranchers. Considerable bulldozer trenching failed to disclose sufficient ore-grade material to warrant additional exploration, and the claims have been abandoned. No ore-grade radioactive materials were found during the Bureau of Mines field investigation. The anomaly on which the claims were staked is a "higher-than-background" count of radioactivity in Precambrian granite exposed by the Rio Grande. Sample 131, of the better material, contained 0.13 percent U_3O_8.

Fifteen claims (group *L*, fig. 18) were recorded in 1935 and were described only generally as to their location. A field search in the area disclosed no claim markers, nor discovery work, nor mineralized rock other than local iron-oxide staining on intrusive rock masses.

Deposits in the general area of the Rio Grande Reservoir have a doubtful economic potential.

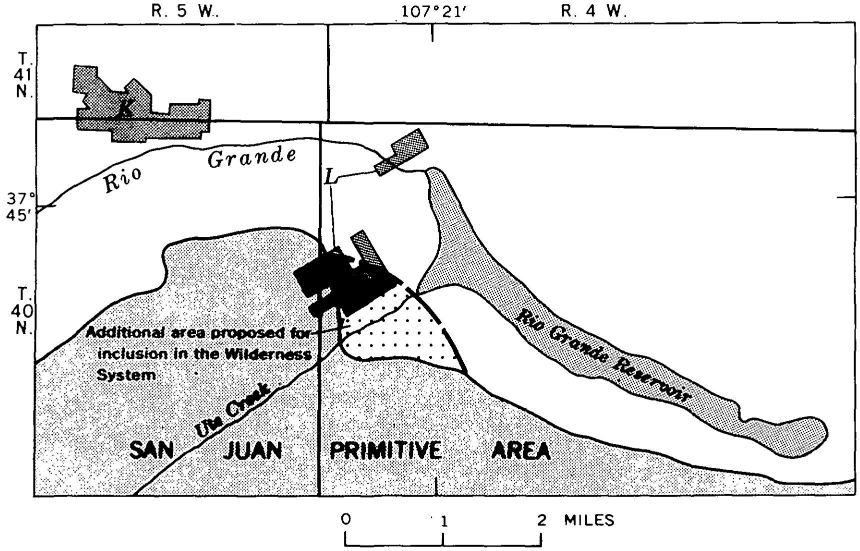

FIGURE 18.—Claims in the Rio Grande Reservoir area. *K*, *L*, patented claims; stipple, unpatented claims.

TROUT CREEK–MIDDLE FORK PIEDRA RIVER AREA

Area *M* (fig. 19) comprises some 70 placer claims partially overlapped by 60 lode locations staked to hold two sulfur deposits. The claims cover approximately 4 square miles along the east fork of Trout Creek in Mineral County, about 2 miles north of the Continental Divide between the altitudes of 9,000 and 11,000 feet; they are accessible from Creede over 25 miles of dirt road, partly passable only by four-wheel-drive vehicles. Early in 1968 the claim group was leased to the Arizona-Colorado Cattle Co. of Phoenix, Ariz.

The larger of the two deposits was discovered before 1900 and was acquired by the American Sulphur Co. in 1901. American Sulphur leased to the Colorado Sulphur Co. in 1906. Exploration by tunneling and drilling is said to have outlined a deposit containing 30,000 tons of materials averaging 50 percent sulfur (Metallurgical and Chemical Engineering, 1917). A retorting plant was constructed, and some refined sulfur was shipped in 1917 (Argall, 1949, p. 445), but no production by the Colorado Sulphur Co. was officially recorded. The mine and plant were operated by the Buffalo Sulphur Refining Co. in 1920 and 1921, when 40 tons of refined sulfur valued at $800 was produced. However, since then, there is no record of operation. Foundations and parts of retorts and other equipment are still at the site.

Prior to operation by the Colorado Sulphur Co., the deposit was examined by Larsen and Hunter (1913), who stated that, at the time of their investigation, underground workings were not accessible, and

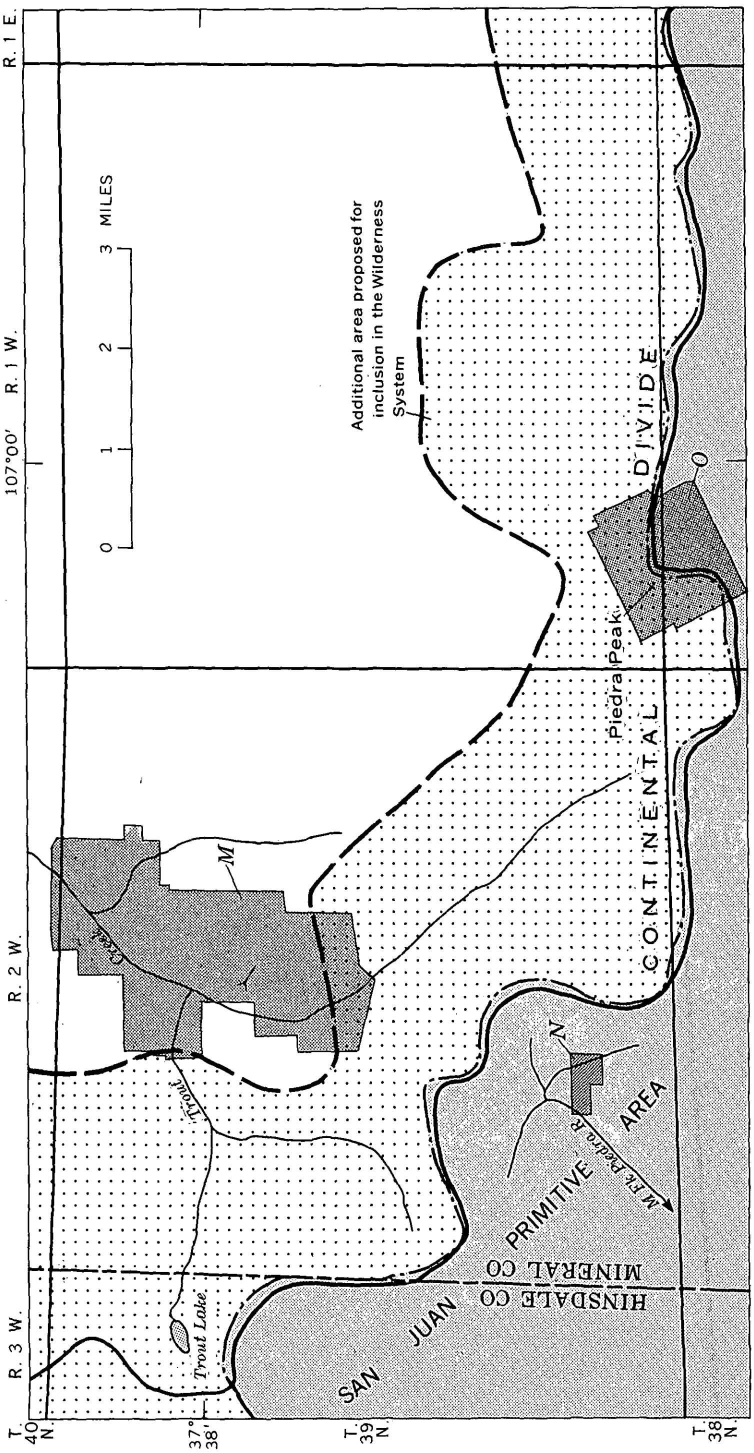

FIGURE 19.—Unpatented claims in the Trout Creek-Middle Fork Piedra River (*M*, *N*) and Piedra Peak (*O*) areas.

that some of the information in their report was obtained from reliable persons who were familiar with early exploratory work. They described the sulfur as filling irregular, nearly vertical openings and the greatest observed thickness as about 16 feet. A selected specimen taken during this early examination contained 63.4 percent sulfur; 35.5 percent combined silica, water, and carbon; and 1 percent combined aluminum, iron, and magnesium and calcium oxides.

When the property was examined in July 1968, the Arizona-Colorado Cattle Co. was starting a program of sulfur drilling (fig. 20) to define the limits and the grade of the deposit. However, because of mud resulting from daily summer rainfall, the movement of vehicles and drilling equipment, as well as the construction of roads, became virtually impossible. The project was postponed before significant data were obtained.

The sulfur-bearing rock crops out on the south side of a steep gulch (adit, fig. 19) adjacent to an outcrop of pyritic porphyry. It is also exposed just below the outcrop in caved underground workings disclosed in July 1968 during construction of a drill road, and in a caved adit of unknown length. The adit, bearing S. 70° E., is timbered and tightly lagged from the entrance to the caved point about 100 feet from the portal. Sample 124, taken from the walls and back of the

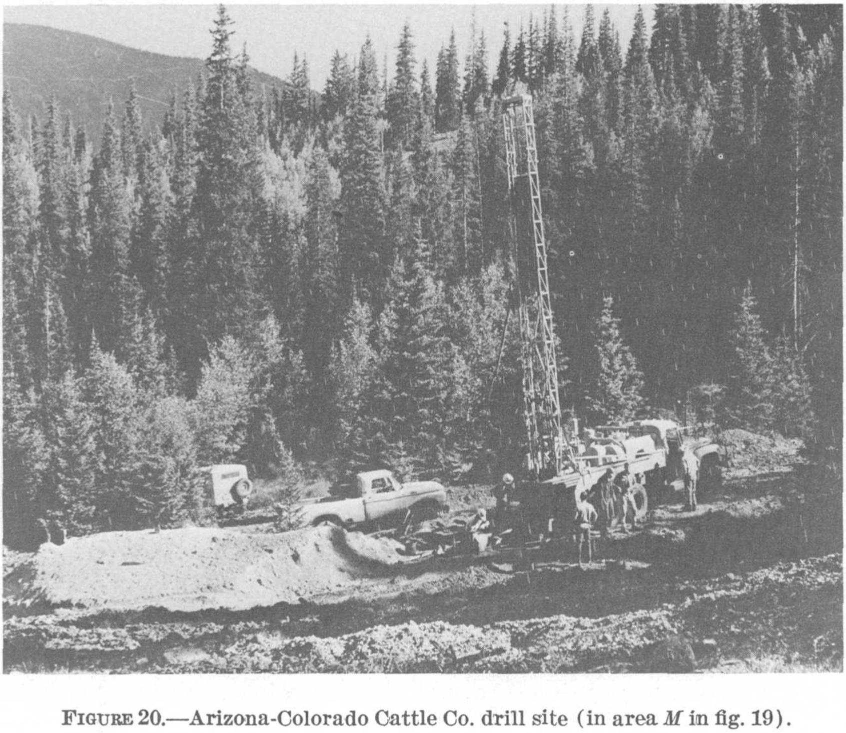

FIGURE 20.—Arizona-Colorado Cattle Co. drill site (in area *M* in fig. 19).

adit, 100 feet from the portal, contained 53.40 percent sulfur. Sample 125, from a 10-foot vertical cut of material in place at the caved underground working on the drill road about 150 feet east of the adit portal and some 40 feet higher, contained 50.50 percent sulfur. Sample 126, a 17-foot horizontal cut across the outcrop 150 feet east of the portal and about 60 feet higher, assayed 38.00 percent sulfur. This sample included some soft altered claylike rock. All assays represent elemental sulfur only. Total sulfur assay results were less than 2 percent higher.

Actual limits of the occurrence laterally and at depth can be determined only by detailed mapping and through rehabilitation and extension of the underground workings, or by drilling from the surface. The Arizona-Colorado Cattle Co. may do additional drilling in the fall of 1969, according to information obtained in mid-1968.

No sulfur was observed in place or as float during a cursory examination of adjacent gulches that cut altered bleached iron-stained extrusive rocks to the north of the deposit. An adit about 1 mile south of the deposit, locally known as the Joe Wolfe adit, is said by the claim owners to show sulfur-bearing rock of lower grade than that of the principal workings. It was not examined.

The area shows resource potential as a minor source of elemental sulfur, but whether sulfur could be produced commercially from the area is not known.

Five lode claims, group *N* (fig. 19), cover an occurrence of sulfur on a north-flowing tributary at the headwaters of the Middle Fork Piedra River at an altitude of 11,000 feet, about 8 miles by trail northeast from Williams Creek Reservoir and about half a mile west of the Continental Divide. Soil masks much of the bedrock in the immediate vicinity of the sulfur outcrop, but inflowing spring water has removed the soil cover along the base of the west bank of the tributary for about 120 feet.

The southernmost exposure is light-gray banded sulfur-bearing rock similar to that of the previously described deposit on the east fork of Trout Creek, some 3 miles to the north. The sulfur occupies about 10 feet of the exposure, and dark-blue-gray pyritic clay, containing pyritic rock fragments, and orange-yellow clay mixed with weathered, iron-stained rock make up the remainder.

Four samples (Nos. 127–130), taken at about equal intervals from south to north along the 120-foot exposure, contained 46.85, 0.50, 0.75, and 0.40 percent elemental sulfur, respectively. Total sulfur contents were only slightly higher.

The deposit was also described by Larsen and Hunter (1913), who observed sulfur in a few short prospect adits now completely caved and obliterated. No reliable estimate of the extent of the deposit can be made without additional data.

Owing to limited exposures, tonnage estimates of the higher grade sulfur-bearing material cannot be made; however, U.S. Geological Survey and Bureau of Mines investigators agreed that the deposit is of fumarolic origin and of probably limited horizontal and vertical extent.

PIEDRA PEAK AREA

Claim group *O* (fig. 19) consists of 42 unpatented locations on both the northern and southern flanks of the Continental Divide between the altitudes of 12,000 and 13,000 feet, about 25 miles from Creede. The claims cover Piedra Peak and adjacent areas, where many of the rocks are highly altered and stained by limonitic gossan.

U.S. Bureau of Mines and Geological Survey investigators observed the property in 1967 during an aerial reconnaissance of the primitive areas, but they did not conduct an on-site examination of the claims because the geochemical analyses of outcrop and tunnel samples previously taken by Geological Survey personnel indicated no anomalous amounts of valuable metals (p. F80–F81). The limonite is believed by Geological Survey geologists to have resulted from oxidation of pyrite that is widely disseminated through the altered rocks.

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TABLES 3, 8–13

TABLE 3.—*Analyses of*

Semiquantitative spectrographic analyses

Sample	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
	(ppm)											
	A--Stream sediments from Crystal Valley and Missouri Gulch											
1	2,000	1,000	0.5	<200	300	5	30	30	5	7	200	<100
2	2,000	1,500	1.5	<200	500	5	15	30	20	5	300	<100
3	2,000	200	.5	<200	300	5	50	30	10	5	200	<100
4	2,000	150	.5	<200	500	<5	15	30	5	10	200	<100
5	2,000	700	1.5	<200	300	5	20	50	20	7	300	<100
6	2,000	500	.5	<200	300	5	30	30	15	5	150	<100
7	2,000	700	.5	<200	500	5	15	30	10	5	200	<100
8	2,000	700	<.5	<200	500	5	<5	20	<5	2	100	<100
9	3,000	500	.7	<200	700	5	20	30	<5d	<5	150	<100
10	3,000	700	<.5	<200	700	5	5	5	<5d	<5	50	<100
11	3,000	700	<.5d	<200	700	7	20	50	7	5	150	<100
12	2,000	700	<.5d	<200	500	5	10	20	<5d	5	100	<100
13	2,000	1,000	<.5	<200	1,500	10	15	20	<5	5	150	<100
14	2,000	300	<.5	<200	700	5	20	30	<5d	5	150	<100
15	2,000	700	<.5	<200	500	7	10	50	5	7	150	<100
16	2,000	700	<.5	<200	700	7	15	30	5	7	200	<100
17	2,000	700	<.5	<200	500	5	15	20	5	5	70	<100
18	3,000	700	<.5	<200	500	10	15	20	15	15	150	<100
19	3,000	500	<.5	<200	700	7	15	20	10	70	100	<100
20	5,000	1,000	<.5	<200	700	10	15	10	10	10	150	<100
21	7,000	700	<.5	<200	700	15	50	15	5	15	70	<100
	B--Stream sediments from Needle Creek drainage											
1	2,000	700	.5	<200	700	7	7	20	<5d	<5	70	<100
2	3,000	700	.5	<200	700	7	7	30	7	<5	100	<100
3	3,000	700	<.5	<200	500	5	7	30	100	<5	150	<100
4	5,000	1,000	<.5	<200	1,000	7	7	30	<5	<5	100	<100
5	3,000	500	<.5d	<200	500	5	7	10	7	<5	50	<100
6	3,000	700	.5	<200	500	7	10	30	7	<5	150	<100
7	3,000	700	<.5d	<200	500	5	7	7	7	<5	100	<100
8	3,000	700	<.5	<200	700	5	5	7	5	<5	70	<100
9	2,000	500	<.5	<200	500	5	7	20	<5d	<5	50	<100
10	2,000	500	<.5	<200	500	5	5	30	<5	<5	50	<100
11	2,000	1,000	.7	<200	700	5	5	30	7	<5	150	<100
12	3,000	700	.5	<200	500	5	5	10	<5	<5	70	<100
13	3,000	700	.5	<200	700	7	7	20	10	<5	100	<100
14	5,000	700	<.5	<200	700	7	7	20	<5d	<5	50	<100
15	5,000	1,500	.5	<200	700	7	5	30	5	<5	150	<100
16	3,000	500	<.5	<200	700	5	<5	7	<5	<5	30	<100
17	5,000	1,000	<.5	<200	1,000	7	5	30	<5	<5	70	<100
18	3,000	700	<.5	<200	700	7	5	10	5	<5	50	<100
19	5,000	1,500	.7	<200	700	10	30	50	5	10	150	<100
20	3,000	500	<.5	<200	1,000	5	15	30	<5	<5	30	<100
21	3,000	1,000	<.5	<200	700	7	5	5	5	<5	70	<100
22	3,000	500	<.5	<200	700	5	5	20	<5	<5	70	<100
23	2,000	500	<.5	<200	700	5	5	10	<5	<5	70	<100
24	1,500	300	<.5d	<200	300	<5	<5	5	<5	<5	30	<100
25	3,000	700	<.5	<200	700	5	7	30	<5	<5	150	<100
26	3,000	500	<.5	<200	500	5	<5	20	<5	<5	50	<100
27	3,000	700	<.5	<200	500	7	5	<5	<5d	<5	30	<100
28	2,000	300	<.5	<200	500	5	5	30	<5	<5	30	<100
29	5,000	700	<.5	<200	500	10	7	20	<5	<5	100	<100
30	3,000	500	<.5	<200	500	7	5	20	<5	<5	30	<100
31	5,000	700	<.5	<200	500	5	7	20	<5	<5	70	<100
32	5,000	700	<.5	<200	500	5	5	30	<5d	<5	150	<100
33	2,000	500	<.5	<200	500	5	5	15	<5	<5	30	<100
34	3,000	500	<.5	<200	500	5	5	20	<5	<5	50	<100
35	5,000	1,000	<.5	<200	700	10	7	15	5	5	50	<100

stream-sediment samples

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				(percent)			Chemical analyses (ppm)				
	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
A--Stream sediments from Crystal Valley and Missouri Gulch												
1	<10d	<100	70	<200	2.0	0.7	0.2	<0.02	10	100	250	4
2	<10d	<100	70	200	2	.5	.3	<.02	10	50	220	6
3	<10d	<100	70	300	1.5	.5	.2	<.02	<10	50	260	6
4	<10d	<100	50	<200	1.5	.5	.2	<.02	10	100	170	2
5	<10d	<100	100	200	3	.7	.3	<.02	10	50	280	6
6	<10	<100	100	<200	2	.7	.2	<.02	15	100	280	8
7	<10	<100	50	<200	2	.5	.3	<.02	15	100	210	6
8	<10d	<100	20	<200	2	.5	.2	<.02	10	50	85	4
9	<10d	<100	50	<200	2	.7	.2	<.02	<10	50	120	2
10	<10d	<100	50	<200	3	.7	.2	<.02	<10	50	60	2
11	15	<100	70	<200	3	1	.3	<.02	<10	<25	210	4
12	<10d	<100	50	<200	2	.7	.3	<.02	10	50	100	2
13	10	<100	70	<200	3	.7	.2	<.02	<10	<25	60	1
14	<10d	<100	50	<200	2	.7	.2	<.02	<10	30	160	4
15	10	<100	50	<200	3	.7	.2	<.02	10	<25	85	4
16	15	<100	50	<200	3	.7	.3	<.02	<10	50	100	4
17	<10	<100	30	<200	2	.5	.2	<.02	<10	<25	110	5
18	<10	<100	50	<200	5	.7	.3	<.02	<10	35	120	<1
19	<10	<100	70	<200	5	1	.3	<.02	<10	<25	140	<1
20	<10	<100	70	<200	7	1	.5	<.02	<10	<25	210	2
21	<10	<100	70	<200	7	1.5	.7	<.02	<10	40	80	1
B--Stream sediments from Needle Creek drainage												
1	<10	100	100	<200	3	.7	.2	<.02	<10	28	78	4
2	10	100	70	<200	3	.7	.3	<.02	12	50	90	2
3	<10d	100	70	<200	3	.7	.2	.06	10	30	120	2
4	<10	100	100	<200	3	.7	.5	<.02	<10	26	80	8
5	<10	<100	70	<200	3	.7	.3	<.02	<10	28	92	2
6	<10	<100	100	<200	3	.7	.2	<.02	12	52	130	5
7	10	<100	70	<200	3	.7	.2	<.02	<10	34	68	2
8	<10	100	70	<200	3	.7	.3	<.02	10	48	110	2
9	<10	<100	50	<200	2	.5	.3	<.02	<10	<25	50	4
10	<10	<100	30	<200	2	.3	.2	<.02	<10	<25	40	1
11	<10d	<100	30	200	3	.5	.2	<.02	16	64	190	5
12	<10d	<100	50	<200	2	.5	.2	<.02	17	60	160	2
13	<10d	100	70	<200	3	.7	.3	<.02	10	40	140	5
14	<10	<100	50	<200	5	.7	.5	<.02	<10	25	76	1
15	10	<100	70	200	3	.7	.3	<.02	12	58	190	4
16	<10	<100	50	<200	3	.5	.3	<.02	10	<25	50	12
17	<10	<100	50	<200	7	.7	.3	<.02	<10	28	100	<1
18	<10	<100	70	<200	3	.7	.3	<.02	<10	37	130	4
19	<10	<100	100	200	5	1	.5	<.02	18	50	200	<1
20	<10	<100	70	<200	3	.7	.5	<.02	12	<25	46	2
21	<10	<100	15	<200	3	.7	.2	<.02	<10	<25	58	<1
22	<10	<100	20	<200	3	.5	.15	<.02	<10	25	52	<1
23	<10	<100	20	<200	3	.7	.2	<.02	<10	<25	30	<1
24	<10	<100	10	<200	2	.5	.15	<.02	<10	38	92	2
25	<10	<100	30	<200	3	.7	.15	<.02	<10	25	62	1
26	<10	<100	20	<200	3	.5	.15	<.02	<10	30	74	2
27	<10	<100	30	<200	3	.7	.2	<.02	<10	<25	50	2
28	<10	<100	10	<200	2	.5	.2	<.02	<10	<25	50	<1
29	10	<100	30	<200	5	1	.2	<.02	<10	27	66	<1
30	<10	<100	20	<200	3	.5	.2	<.02	<10	25	58	1
31	<10	<100	30	<200	5	.7	.2	<.02	<10	26	70	1
32	<10	<100	30	<200	5	.7	.15	<.02	<10	30	74	2
33	<10	<100	20	<200	3	.7	.15	<.02	<10	<25	54	1
34	<10d	<100	20	<200	5	.7	.2	<.02	<10	<25	62	<1
35	<10	<100	100	200	5	.7	.2	<.02	12	48	170	2

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
B--Stream sediments from Needle Creek drainage--Continued												
36	1,500	1,000	<0.5d	<200	700	5	20	70	<5	<5	70	<100
37	3,000	1,500	<.5d	<200	1,000	10	70	50	<5	20	30	<100
38	3,000	1,000	<.5d	<200	700	7	5	50	10	<5	150	<100
39	3,000	700	<.5	<200	500	5	5	30	<5	<5	50	<100
C--Stream sediments from Johnson Creek and Grizzly Gulch												
1	3,000	1,000	<.5d	<200	500	10	15	20	20	10	100	<100
2	1,500	3,000	1.	<200	500	5	10	30	7	10	300	<100
3	2,000	5,000	1.	<200	700	5	7	50	20	10	1,000	<100
4	2,000	5,000	.7	<200	700	7	10	50	30	15	1,000	<100
5	1,500	2,000	.5	<200	500	5	5	20	10	10	300	<100
6 1/	2,000	3,000	.5	<200	500	5	5	70	15	15	1,000	<100
7	2,000	3,000	1.	<200	500	5	10	30	50	15	700	<100
8	2,000	1,500	<.5d	<200	300	5	5	30	20	10	300	<100
9 1/	2,000	1,000	<.5d	<200	200	5	7	30	10	10	200	<100
10 1/	2,000	1,000	<.5d	<200	300	5	5	30	10	10	200	<100
11	3,000	1,000	<.5	<200	500	5	10	20	5	10	200	<100
12	1,500	700	<.5	<200	700	5	5	30	10	10	200	<100
13	5,000	1,000	<.5d	<200	300	5	10	30	20	10	150	<100
14	5,000	1,000	<.5d	<200	300	5	10	30	10	10	200	<100
15	5,000	1,500	1.	<200	300	7	10	30	10	10	300	<100
16	10,000	2,000	1.	<200	300	20	20	70	7	20	150	<100
17	5,000	1,500	.5	<200	300	7	5	15	10	5	150	<100
18	5,000	1,500	.5	<200	300	7	10	70	10	10	200	<100
19	5,000	1,500	.5	<200	500	10	10	50	10	5	200	<100
20	5,000	1,000	<.5d	<200	300	10	10	30	30	10	200	<100
21	5,000	1,500	<.5d	<200	500	10	5	100	5	5	200	<100
22	7,000	2,000	.5	<200	500	10	15	50	50	10	300	<100
D--Stream sediments from Ruby Creek drainage												
1	5,000	700	<.5	<200	300	<5d	20	30	<5d	<5d	100	<100
2	3,000	500	<.5	<200	500	5	5	30	<5	<5d	70	<100
3	5,000	700	<.5	<200	700	7	5	30	<5	<5d	50	<100
4	1,000	2,000	<.5d	<200	150	5	50	30	30	10	70	<100
5	700	2,000	<.5	<200	150	5	70	20	20	15	50	<100
E--Stream sediments from Noname Creek drainage												
1	5,000	300	<.5d	<200	300	5	70	70	<5	10	100	<100
2	5,000	1,000	<.5	<200	700	7	50	20	<5	5	50	<100
3	5,000	700	<.5	<200	1,000	10	30	30	<5	5	70	<100
4	5,000	700	<.5d	<200	700	7	20	20	<5	<5	100	<100
5	7,000	700	<.5	<200	700	10	15	30	<5	<5	50	<100
6	3,000	500	<.5	<200	500	5	5	5	<5	<5	50	<100
7	5,000	1,000	<.5d	<200	700	10	10	30	<5	<5	150	<100
8	3,000	700	<.5d	<200	700	7	10	20	<5	<5	100	<100
9	3,000	1,000	.7	<200	500	15	30	30	<5	15	100	<100
10	5,000	700	<.5d	<200	500	10	30	30	<5	10	150	<100
11	1,500	500	.5	<200	300	5	10	10	<5	5	100	<100
12	3,000	1,000	<.5	<200	700	7	7	20	<5	5	70	<100
13	5,000	500	<.5	<200	500	5	7	20	<5	<5	70	<100
14	5,000		<.5	<200	500	5	5	20	<5	<5	50	<100
15	5,000	1,500	<.5	<200	500	15	15	10	<5	10	30	<100
16	5,000	1,000	<.5	<200	700	10	10	20	<5	5	100	<100
17	2,000	1,500	<.5	<200	1,000	5	7	15	<5	5	70	<100
18	3,000	1,500	<.5	<200	700	5	10	20	<5	5	50	<100
19	2,000	700	<.5	<200	700	5	15	50	<5	5	50	<100
20	3,000	1,500	<.5	<200	1,000	5	10	30	<5	5	70	<100

1/ Ten ppm bismuth was detected spectrographically in samples 6, 9, and 10 from Johnson Creek and Grizzly Gulch.

sediment samples—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sn	Sr	V	Zn	(percent) Fe	Mg	Ca	Chemical analyses (ppm) Au	Cu	Pb	Zn	Mo
B--Stream sediments from Needle Creek drainage--Continued												
36	<10	<100	50	<200	2.0	1.0	0.7	<0.02	17	38	68	1
37	<10	100	150	<200	5	1	.1	<.02	20	<25	56	1
38	<10d	<100	70	<200	3	.7	.3	<.02	14	60	200	5
39	<10	<100	50	<200	3	.7	.3	<.02	10	36	120	2
C--Stream sediments from Johnson Creek and Grizzly Gulch												
1	10	<100	150	<200	7	1	.5	<.02	<10	40	89	4
2	<10d	<100	50	700	5	.7	.5	<.02	19	150	410	1
3	10	<100	70	1,000	7	1	.2	<.02	24	330	460	5
4	10	<100	70	1,000	7	1	.3	<.02	20	150	480	5
5	10	<100	50	<200	5	.7	.3	<.02	<10	<25	150	2
6	10	<100	70	700	5	1	.2	<.02	20	180	310	4
7	10	<100	100	700	7	1	.3	<.02	12	70	400	4
8	15	<100	70	500	5	.7	.5	<.02	<10	25	230	2
9	15	<100	50	500	5	.5	.5	<.02	<10	<25	310	4
10	10	<100	50	<200	5	.5	.5	<.02	<10	70	110	6
11	20	<100	100	<200	7	1	.7	<.02	<10	25	110	1
12	15	<100	70	<200	5	.7	.3	<.02	<10	<25	100	1
13	15	<100	150	<200	7	1	.5	<.02	<10	40	140	2
14	100	<100	100	<200	7	1	.5	<.02	11	40	150	2
15	15	<100	100	<200	7	1	.5	<.02	<10	70	170	4
16	10	<100	300	<200	10	1.5	.5	.3	35	40	150	1
17	10	<100	100	<200	7	1	.5	<.02	<10	70	150	7
18	15	<100	100	<200	7	1	.5	.3	20	70	150	5
19	15	<100	150	200	10	1.5	.5	<.02	10	70	140	2
20	10	<100	150	<200	7	1	.5	<.02	15	70	180	2
21	10	<100	150	<200	7	1.5	.5	<.02	13	70	200	2
22	20	<100	200	200	10	1.5	1	<.02	<10	<25	150	2
D--Stream sediments from Ruby Creek drainage												
1	<10	<100	100	<200	2	.7	.5	<.02	13	60	120	2
2	<10	<100	70	<200	2	.7	.3	<.02	<10	34	86	2
3	<10	100	30	<200	3	.7	.7	<.02	<10	30	80	<1
4	<10	<100	150	<200	1.5	.5	.3	<.02	40	92	170	18
5	<10	<100	150	<200	1	.5	.3	<.02	40	96	170	18
E--Stream sediments from Noname Creek drainage												
1	<10	<100	100	<200	1.5	.7	.2	<.02	14	48	48	1
2	<10	100	100	<200	3	.7	.5	<.02	10	30	110	2
3	10	100	100	<200	5	.7	1	<.02	<10	<25	72	4
4	<10d	100	70	<200	3	.5	1	<.02	11	48	70	2
5	<10d	<100	70	<200	7	.7	.5	<.02	10	31	110	2
6	<10	<100	30	<200	3	.5	.2	<.02	<10	26	72	2
7	10	<100	50	<200	5	.7	.5	<.02	<10	32	84	5
8	10	<100	70	<200	3	.7	.3	<.02	<10	30	80	6
9	<10	<100	100	<200	3	.7	.5	<.02	14	32	240	5
10	10	<100	70	<200	3	.7	.3	.04	10	40	120	6
11	<10	<100	20	<200	2	.5	.2	<.02	<10	25	48	7
12	<10	<100	30	<200	3	.7	.2	<.02	<10	28	66	4
13	<10	<100	30	<200	5	.7	.2	<.02	<10	<25	50	5
14	<10	<100	30	<200	3	.7	.2	<.02	<10	<25	60	5
15	<10	<100	50	<200	5	.5	.15	<.02	<10	<25	86	5
16	<10d	<100	30	<200	3	.7	.3	<.02	<10	<25	88	5
17	<10	100	20	<200	3	.7	.5	<.02	<10	<25	70	4
18	<10	100	30	<200	3	.7	.5	<.02	<10	<25	96	4
19	<10	100	50	<200	3	.7	.7	<.02	16	<25	52	4
20	<10	<100	70	<200	3	.7	.7	<.02	10	<25	86	4

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses

Sample	(ppm) Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
					E--Stream sediments from Noname Creek drainage--Continued							
21	700	300	<0.5	<200	100	<5	20	20	<5	<5	30	<100
22	3,000	1,000	<.5	<200	700	7	15	20	<5	5	50	<100
23	2,000	1,000	<.5	<200	700	10	15	20	<5	7	30	<100
24	1,500	700	<.5d	<200	700	5	15	30	<5	7	70	<100
					F--Stream sediments from Leviathan Gulch and Sunlight Creek							
1	2,000	700	<.5	<200	200	70	30	50	<5	30	50	<100
2 2/	2,000	200	<.5d	<200	300	70	20	30	15	30	70	<100
3 3/	2,000	1,000	<.5d	<200	300	50	30	20	15	30	50	<100
4	3,000	3,000	<.5d	<200	300	<5d	15	20	10	7	50	<100
5	1,500	700	.7	<200	200	20	7	15	7	15	30	<100
6	5,000	500	<.5	<200	500	7	50	15	<5d	20	20	<100
7	3,000	700	.5	<200	500	30	70	30	<5d	30	100	<100
8	2,000	1,000	.5	<200	200	30	30	30	<5d	30	70	<100
9	3,000	1,000	.7	<200	300	30	50	50	<5d	50	150	<100
10	10,000	1,500	<.5	<200	700	10	10	30	5	10	70	<100
11	10,000	1,500	<.5	<200	700	10	10	30	5	5	50	<100
12	7,000	1,500	<.5	<200	1,000	10	5	30	5	5	70	<100
13	5,000	200	<.5d	<200	300	5	30	20	5	15	30	<100
14	3,000	2,000	<.5	<200	500	5	15	20	15	7	150	<100
15	5,000	2,000	<.5	<200	500	5	20	30	10	10	100	<100
16	7,000	2,000	<.5	<200	700	7	10	20	5	5	100	<100
17	5,000	1,500	<.5	<200	500	5	30	30	20	15	70	<100
18	10,000	2,000	<.5	<200	700	10	30	30	10	10	70	<100
19	5,000	1,500	<.5	<200	500	7	20	20	20	15	100	<100
20	5,000	1,500	<.5	<200	500	7	20	20	20	15	100	<100
21	5,000	1,500	<.5	<200	700	7	20	30	5	10	100	<100
22	>10,000	2,000	<.5	<200	1,000	10	20	30	5	10	70	<100
23	5,000	1,500	<.5	<200	700	5	30	20	5	10	100	<100
24	5,000	1,500	<.5	<200	1,000	10	15	20	<5	15	100	<100
25	1,000	1,500	<.5	<200	500	5	15	20	<5	5	50	<100
26	5,000	1,500	<.5	<200	700	5	5	10	5	10	100	<100
					G--Stream sediments from Tenmile Creek drainage							
1	1,500	500	<.5	<200	300	5	70	20	<5	5	100	<100
2	5,000	700	<.5	<200	300	7	50	30	<5	7	30	<100
3	2,000	700	<.5	<200	300	7	70	20	<5	15	100	<100
4	1,000	3,000	<.5	<200	200	100	10	50	<5d	30	30	<100
5	2,000	1,000	<.5d	<200	300	5	70	50	5	20	150	<100
6	700	1,500	<.5	<200	100	30	50	70	5	20	50	<100
7	1,000	500	<.5	<200	200	5	70	50	<5	10	50	<100
8	700	1,500	<.5	<200	100	30	50	30	<5d	20	70	<100
9	1,500	2,000	<.5	<200	200	50	70	70	5	50	70	<100
10	1,500	500	<.5	<200	200	5	100	30	<5	20	50	<100
11	2,000	500	<.5d	<200	300	5	30	50	<5	10	70	<100
12	1,000	1 500	<.5	<200	150	70	70	70	5	50	50	<100
13	1,500	700	<.5d	<200	300	7	70	50	<5	15	70	<100
14	5,000	1,000	<.5	<200	300	15	30	30	<5	30	30	<100
15	1,000	300	<.5	<200	150	<5	50	30	<5	5	20	<100
16	1,500	700	<.5d	<200	200	5	50	50	10	5	30	<100
17	5,000	1,500	<.5	<200	300	15	15	30	<5	30	30	<100
18	2,000	700	.7	<200	300	7	70	70	<5	10	70	<100
19	3,000	1,000	<.5d	<200	300	20	70	70	<5	30	70	<100
20	-----	-----	---	----	---	---	---	---	---	---	---	----
21	-----	-----	---	----	---	---	---	---	---	---	---	----

2/ Threshold value of bismuth (<10 ppm) was detected spectrographically in sample 2 from Leviathan Gulch and Sunlight Creek.

sediment samples—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sn	Sr	V	Zn	(percent) Fe	Mg	Ca	Chemical analyses (ppm) Au	Cu	Pb	Zn	Mo
						E--Stream sediments from Noname Creek drainage--Continued						
21	<10	<100	70	<200	1	0.15	0.3	<0.02	23	<25	54	<1
22	<10	<100	70	<200	3	.7	.5	<.02	12	25	100	4
23	<10	100	100	<200	3	.7	.5	<.02	<10	<25	74	8
24	<10	100	70	<200	2	.7	.5	<.02	<10	<25	48	4
						F--Stream sediments from Leviathan Gulch and Sunlight Creek						
1	<10	<100	70	<200	2	.7	.2	.04	53	110	320	4
2	<10	<100	50	<200	2	.7	.2	<.02	24	40	290	12
3	<10	<100	50	<200	2	.5	.2	<.02	12	110	220	12
4	<10	50	30	<200	1	.2	.1	----	---	---	---	7
5	<10	50	30	<200	1.5	.15	.01	----	---	---	---	2
6	<10	<50d	70	<200	5	.5	.2	----	---	---	---	1
7	<10	300	70	<200	5	.5	.2	----	---	---	---	2
8	<10	50	50	<200	1.5	.3	.2	----	---	---	---	4
9	<10	100	70	<200	5	.7	.2	----	---	---	---	5
10	<10	<100	100	200	15	1.5	1	<.02	17	70	200	1
11	<10	<100	100	<200d	15	1.5	1	<.02	11	70	140	2
12	<10	100	100	<200	10	1	2	<.02	11	40	88	1
13	<10	<100	100	<200	5	1.5	.7	<.02	<10	35	75	2
14	<10	<100	50	<200	7	1	.5	<.02	<10	40	81	5
15	<10	<100	70	<200	10	1	.7	<.02	<10	<25	120	4
16	<10	<100	70	<200d	10	1.5	1	<.02	<10	40	160	2
17	<10	<100	70	<200	7	1.5	.5	<.02	10	40	88	4
18	<10	<100	100	300	15	1.5	1.5	<.02	14	70	160	2
19	<10	<100	70	<200	7	1	.7	<.02	12	70	110	10
20	<10	<100	70	<200	10	1	.7	<.02	<10	<25	120	6
21	<10	<100	70	<200	10	1.5	1	<.02	<10	40	140	2
22	<10	<100	100	<200	15	1.5	3	<.02	<10	40	150	2
23	<10	<100	70	<200	7	1	1	<.02	12	70	120	4
24	<10	<100	70	<200	10	1	1	<.02	16	70	170	2
25	<10	<100	70	<200	10	1.5	1	<.04	<10	70	66	2
26	10	<100	70	<200	10	1.5	1	<.02	12	70	160	2
						G--Stream sediments from Tenmile Creek drainage						
1	<10	<100	100	<200	1.5	.5	.2	<.02	16	50	28	1
2	<10	<100	100	<200	3	.7	.2	<.02	10	<25	56	<1
3	<10	100	150	<200	2	.5	.3	<.02	10	30	48	<1
4	<10d	<100	50	<200	2	.3	.1	<.02	30	<25	82	2
5	<10d	<100	100	<200	3	.7	.3	<.02	40	86	190	4
6	<10	<100	100	<200	1.5	.2	.05	<.02	58	48	130	2
7	<10	<100	150	<200	2	.5	.3	<.02	40	50	110	1
8	<10	<100	100	<200	1	.15	.1	<.02	62	100	220	4
9	<10	<100	100	<200	2	.5	.2	<.02	41	48	200	1
10	<10	<100	150	<200	2	.7	.7	<.02	19	36	52	<1
11	<10	<100	70	<200	2	.7	.7	<.02	<10	<25	38	<1
12	<10	<100	150	<200	1.5	.2	.15	<.02	48	54	240	2
13	<10	<100	150	<200	2	.7	.7	<.02	34	48	90	<1
14	<10	100	70	<200	3	.7	.7	<.02	12	<25	60	1
15	<10	<100	100	<200	1	.3	.7	<.04	63	50	140	<1
16	<10	<100	150	<200	2	.5	.7	<.02	31	<25	60	<1
17	<10	<100	70	<200	3	.7	.5	<.02	12	<25	70	<1
18	<10	<100	100	<200	5	1	1	<.02	24	<25	34	<1
19	<10	<100	150	<200	3	1	.5	<.02	20	30	110	1
20	---	----	---	----	---	---	---	<.04	---	---	---	1
21	---	----	---	----	---	---	---	<.02	16	25	92	<1

3/ One hundred ppm tungsten was detected spectrographically in sample 3 from Leviathan Gulch and Sunlight Creek.

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses

Sample	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
	(ppm											
				H--Stream sediments from Elk Creek drainage								
1	7,000	1,000	30.0	<200	700	30	150	70	7	50	70	<100
2	10,000	1,000	.7	<200	1,000	20	150	50	<5	50	70	<100
3	7,000	700	1	<200	1,000	20	200	150	<5	70	100	<100
4	7,000	1,500	.7	<200	700	30	150	100	<5	50	100	<100
5	5,000	1,000	.5	<200	700	20	150	70	<5	50	70	<100
6	10,000	2,000	<.5	<200	1,000	30	50	30	<5	30	70	<100
7	10,000	2,000	<.5	<200	700	30	70	50	<5	50	70	<100
8	10,000	1,000	<.5	<200	700	30	70	50	<5	30	70	<100
9	2,000	1,500	<.5	<200	700	5	100	50	<5	30	70	<100
10	10,000	5,000	<.5d	<200	1,500	30	30	50	<5	30	70	<100
11	3,000	1,000	<.5	<200	500	<5	30	20	<5	15	30	<100
12	7,000	2,000	1.5	<200	700	30	30	50	<5	30	100	<100
13	7,000	2,000	4	<200	700	50	30	30	<5d	20	20	<100
14	7,000	1,500	1	<200	3,000	30	50	100	<5d	50	100	<100
15	10,000	3,000	1.5	<200	700	50	50	30	<5	20	50	<100
16	5,000	1,500	<1	<200	700	30	50	50	<5	30	50	<100
17	5,000	1,500	<1	<200	700	30	50	150	<5	30	70	<100
18	10,000	3,000	<.5	<200	1,500	30	20	30	<5	20	30	<100
19	10,000	3,000	<1	<200	700	30	30	30	<5	15	30	<100
20	7,000	2,000	<1	<200	500	70	50	30	<5	70	30	<100
21	5,000	1,000	<1	<200	700	30	70	15	<5	30	50	<100
22	5,000	1,000	<.5	<200	300	30	50	50	<5	50	50	<100
23	5,000	2,000	<.5	<200	500	30	50	70	<5	70	50	<100
24	5,000	2,000	<.5	<200	500	30	50	30	<5	70	30	<100
25	5,000	1,500	<.5	<200	300	20	30	30	<5	50	30	<100
26	5,000	300	<.5	<200	300	5	50	50	<5	15	150	<100
27	3,000	500	<.5	<200	200	<5	50	20	<5	7	70	<100
28	5,000	1,000	<.5	<200	300	15	70	50	<5	30	100	<100
29	3,000	500	<.5	<200	300	10	50	30	<5	20	50	<100
30	5,000	700	<.5	<200	300	15	70	70	<5	20	50	<100
31	5,000	500	<.5	<200	300	10	70	70	<5	20	70	<100
32	5,000	500	5	<200	300	7	50	50	<5	20	70	<100
33	2,000	700	<.5	<200	200	7	30	20	<5	15	30	<100
34	3,000	700	<.5	<200	200	7	70	30	<5	15	70	<100
35	1,500	1,500	<.5	<200	200	7	20	20	<5	15	30	<100
36	7,000	2,000	<.5	<200	300	30	50	70	<5	70	50	<100
37	2,000	500	<.5	<200	200	7	70	20	<5	15	30	<100
38	3,000	500	<.5d	<200	300	5	20	30	<5	10	70	<100
39	3,000	1,000	<.5	<200	300	30	50	50	<5	50	30	<100
40	3,000	700	<.5	<200	300	20	50	20	<5	30	10	<100
				I--Stream sediments from Whitehead Gulch								
1	------	-----	---	----	---	---	---	---	---	---	---	----
2	-----	-----	---	----	---	---	---	---	---	---	---	----
3	10,000	1,500	<.5	<200	1,000	50	30	30	<5	15	150	<100
4	7,000	2,000	<.5	<200	1,000	50	100	50	<5	20	50	<100
5	10,000	500	.5	<200	1,000	30	30	50	<5	15	70	<100
6	10,000	2,000	.7	<200	1,000	50	30	100	7	15	70	<100
7	10,000	2,000	1	<200	1,000	50	30	100	5	15	70	<100
8	10,000	2,000	.5	<200	700	30	15	100	5	15	70	<100
				J--Stream sediments from Vallecito Creek								
1	7,000	300	<.5	<200	300	7	50	50	<5	15	100	<100
2	3,000	700	<.5	<200	300	20	20	30	<5	50	20	<100
3	7,000	1,000	<.5	<200	700	50	150	70	<5	30	70	<100
4	5,000	1,000	<.5	<200	700	15	30	30	<5	50	150	<100
5	7,000	3,000	<.5	<200	300	70	50	50	<5	50	50	<100
6	1,000	1,500	<.5	<200	700	30	150	20	<5	30	50	<100
7	7,000	5,000	<.5	<200	700	70	70	30	<5	70	30	<100
8	7,000	3,000	<.5	<200	500	70	30	70	<5	100	70	<100
9	7,000	3,000	<.5	<200	700	70	50	70	<5	150	150	<100
10	7,000	1,500	<.5	<200	300	20	50	30	<5	50	50	<100

sediment samples—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
H--Stream sediments from Elk Creek drainage												
1	<10	<100	70	<200	15.0	1.5	0.3	<0.02	63	70	190	7
2	<10	<100	50	<200	15	1.5	.5	<.02	25	40	50	4
3	<10	200	50	700	10	1.5	.3	<.02	48	<25	170	2
4	<10	200	50	700	7	1	.5	<.02	70	40	250	2
5	<10	<100	50	<200	10	1.5	.15	<.02	39	40	130	2
6	<10	150	150	300	15	1	.7	<.02	25	<25	110	2
7	<10	150	70	300	15	1	.7	<.02	25	40	180	2
8	<10	<100	100	500	15	1	.7	<.02	38	70	250	2
9	<10	<100	30	<200	3	1	1.5	<.02	50	70	120	---
10	<10	300	150	300	15	1.5	.7	<.02	24	35	190	2
11	<10	200	30	<200	5	1	1	<.02	15	<25	50	4
12	<10	200	50	700	15	1	.7	.02	31	70	280	2
13	<10	100	300	200	10	1.5	.7	<.02	24	40	88	1
14	<10	<100	200	<200	7	1.5	.7	.04	25	70	73	5
15	<10	150	300	500	15	1.5	1.5	<.02	20	40	91	2
16	<10	<100	150	200	7	1.5	.7	<.02	42	40	150	6
17	<10	<100	200	<200	7	2	1.5	<.02	67	40	86	4
18	<10	300	100	300	15	1.5	1	<.02	21	40	200	2
19	<10	200	300	500	10	1.5	1	<.02	15	40	180	2
20	<10	<100	200	200	10	1.5	.5	<.02	<10	40	100	1
21	<10	<100	150	<200	7	1.5	.2	<.02	12	40	87	1
22	<10	100	150	200	3	1	.5	<.02	28	36	280	<1
23	<10	100	150	200	5	1	.5	<.02	23	32	220	<1
24	<10	100	150	200	5	1	.3	<.02	22	34	210	<1
25	<10	100	150	200	5	.7	.2	<.02	20	28	180	<1
26	<10	100	100	<200	2	1	.2	<.02	23	90	96	<1
27	<10	<100	100	<200	1.5	.5	.15	<.02	29	100	84	<1
28	<10	100	150	<200	3	.7	.3	<.02	25	66	140	<1
29	<10	<100	150	<200	3	.7	.15	<.02	11	32	80	<1
30	<10	<100	150	<200	3	.7	.07	<.02	17	38	56	<1
31	<10	<100	150	<200	3	.7	.15	<.02	10	34	60	<1
32	<10	<100	150	<200	2	.7	.15	----	14	40	56	1
33	<10	<100	50	<200	1.5	.2	.2	<.04	18	54	140	<1
34	<10	<100	150	<200	2	.5	.3	<.02	24	56	130	<1
35	<10	<100	50	<200	1.5	.3	.5	<.04	26	64	150	<1
36	<10	100	200	200	5	1	.3	<.02	26	36	250	<1
37	<10	<100	70	<200	3	.7	.2	<.02	<10	30	60	<1
38	<10	<100	100	<200	3	.7	.2	----	11	40	40	<1
39	<10	100	150	<200	3	1	.2	<.02	20	32	140	<1
40	<10	<100	100	<200	3	.7	.15	<.02	15	<25	120	<1
I--Stream sediments from Whitehead Gulch												
1	---	----	---	----	---	---	---	<.02	<10	25	74	1
2	---	----	---	----	---	---	---	<.02	11	90	100	<1
3	<10	300	300	<200d	15	1.5	1	<.02	17	70	76	1
4	<10	<100	300	<200d	15	3	7	<.02	27	40	100	1
5	30	150	300	700	15	1.5	1	<.02	50	40	120	2
6	<10	200	300	1,500	20	2	1.5	<.02	68	70	310	2
7	<10	300	300	500	15	2	1	<.02	45	<25	220	2
8	<10	300	300	1,000	15	1.5	1.5	<.02	77	70	350	2
J--Stream sediments from Vallecito Creek												
1	<10	<100	150	<200	5	.7	.3	<.02	<10	<25	65	1
2	<10	<100	150	<200	7	.5	.2	<.02	20	40	100	<1
3	<10	<100	200	<200	15	1.5	.3	<.02	<10	<25	100	1
4	<10	<100	150	<200	7	.7	1	<.02	<10	70	130	<1
5	<10	<100	150	<200	7	.7	.3	<.02	21	<25	150	<1
6	<10	<100	200	<200	10	1.5	.3	<.02	17	<25	100	<1
7	<10	<100	150	300	7	.7	.2	<.02	32	35	160	<1
8	<10	<100	150	200	7	.7	.5	<.02	16	40	120	<1
9	<10	<100	150	300	7	.7	.7	<.02	17	<25	300	<1
10	<10	<100	150	<200	5	.7	.3	<.02	13	<25	180	<1

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses

Sample	Ti (ppm)	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
J--Stream sediments from Vallecito Creek--Continued												
11	10,000	1,500	<.5	<200	700	20	70	30	<5	30	70	<100
12	7,000	1,500	<.5	<200	500	30	100	50	<5	50	50	<100
13	5,000	2,000	<.5	<200	300	30	70	70	<5	50	50	<100
14	7,000	2,000	<.5	<200	500	30	100	50	<5	70	50	<100
15	7,000	1,500	<.5	<200	500	20	70	20	<5	30	50	<100
16	7,000	5,000	<.5	<200	500	100	100	70	20	70	70	<100
17	5,000	1,500	<.5	<200	300	20	70	20	<5	30	30	<100
18	1,000	1,500	<.5	<200	500	20	70	20	<5	30	50	<100
19	5,000	1,000	<.5	<200	300	20	50	20	5	30	20	<100
20	7,000	1,000	<.5	<200	500	20	100	30	<5	50	50	<100
21	7,000	2,000	<.5	<200	500	50	150	50	<5	50	30	<100
22	7,000	2,000	<.5	<200	500	50	100	50	15	50	50	<100
23	7,000	1,500	<.5	<200	500	50	150	30	<5	50	30	<100
24	3,000	700	.5	<200	300	5	30	20	10	30	50	<100
25	7,000	700	<.5	<200	500	10	100	30	<5	20	50	<100
26	5,000	1,000	<.5	<200	500	50	100	30	<5	50	20	<100
27	5,000	700	<.5	<200	300	5	50	50	<5	10	30	<100
28	5,000	1,000	<.5	<200	300	30	50	50	<5	30	30	<100
29	3,000	1,500	<.5	<200	300	50	70	50	<5d	30	20	<100
30	5,000	1,500	<.5	<200	300	50	70	50	<5d	30	20	<100
31	1,000	500	<.5	<200	1,000	5	5	10	<5	10	70	<100
32	5,000	1,500	<.5	<200	500	30	20	30	<5d	20	30	<100
33	7,000	1,500	<.5	<200	500	5	10	20	5	5	100	<100
34	7,000	2,000	<.5	<200	500	50	50	50	5	50	50	<100
35	2,000	500	<.5	<200	700	<5	<5	10	5	5	100	<100
36	5,000	1,500	<.5	<200	300	30	50	50	<5	50	30	<100
37	2,000	1,000	<.5	<200	300	<5	20	20	<5	5	30	<100
38	3,000	700	<.5	<200	700	<5	5	30	5	2	100	<100
39	5,000	2,000	<.5	<200	500	70	50	50	<5	50	50	<100
40	3,000	700	<.5	<200	500	5	<5	15	<5	10	100	<100
41	5,000	2,000	<.5	<200	500	50	20	30	5	30	70	<100
42	3,000	1,000	<.5	<200	700	5	5	20	7	5	50	<100
43	2,000	700	<.5	<200	500	5	5	20	10	10	100	<100
44	5,000	2,000	<.5	<200	500	70	15	50	10	50	70	<100
45	5,000	2,000	<.5	<200	500	70	20	30	10	50	70	<100
46	7,000	2,000	<.5	<200	300	100	20	20	10	50	50	<100
47	5,000	2,000	<.5	<200	700	70	50	50	10	50	150	<100
48	5,000	1,000	<.5d	<200	500	30	15	20	7	30	100	<100
49	5,000	2,000	<.5	<200	500	100	10	30	30	50	150	<100
50	5,000	1,000	<.5d	<200	300	50	15	50	10	50	150	<100
51	5,000	1,000	<.5	<200	700	10	15	50	15	15	100	<100
52	5,000	2,000	<.5	<200	500	50	200	100	<5	50	50	<100
53	5,000	1,500	<.5	<200	500	50	200	100	<5	30	50	<100
54	3,000	1,000	<.5	<200	500	30	150	70	<5	30	30	<100
55	3,000	1,500	<.5	<200	500	50	5	30	10	20	100	<100
56	3,000	1,500	<.5	<200	500	50	7	30	5	30	100	<100
57	2,000	1,500	<.5	<200	700	50	15	30	5	30	100	<100
58	1,500	300	<.5	<200	300	5	10	30	<5	5	50	<100
59	5,000	2,000	<.5	<200	500	70	20	50	7	70	150	<100
60	7,000	1,500	<.5	<200	300	50	300	70	<5	50	30	<100
61	7,000	1,000	<.5	<200	300	30	150	70	<5	30	20	<100
62	3,000	1,000	<.5	<200	500	7	20	20	<5	10	50	<100
63	5,000	2,000	<.5	<200	700	70	20	50	10	30	100	<100
64	500	5,000	<.5	<200	150	5	5	5	5	10	20	<100
65	2,000	1,500	<.5	<200	500	50	5	20	<5	30	70	<100
66	3,000	1,500	<.5	<200	700	50	15	20	<5	30	70	<100
67	2,000	700	<.5	<200	200	7	150	50	<5	20	50	<100
68	2,000	1,500	<.5	<200	500	20	10	50	<5	30	70	<100
69	2,000	1,500	<.5	<200	500	20	20	50	<5	30	100	<100
70	3,000	1,000	<.5	<200	500	20	20	30	<5	30	100	<100

sediment samples—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
					J--Stream sediments from Vallecito Creek--Continued							
11	<10	100	200	<200	7.0	1.5	0.7	<0.02	14	35	140	<1
12	<10	<100	300	<200	10	1	.3	<.02	37	35	100	1
13	<10	<100	200	300	7	1	.2	<.02	21	<25	260	<1
14	<10	<100	200	500	7	1.5	.3	<.02	32	35	200	<1
15	<10	<100	200	<200	7	1	.7	<.02	19	40	120	<1
16	<10	<100	200	200	1	.2	.7	<.02	21	<25	150	1
17	<10	<100	200	<200	7	1	.2	<.02	15	35	88	<1
18	<10	100	200	<200	7	1.5	.5	<.02	<10	<25	87	<1
19	<10	<100	100	<200	5	1	.3	<.02	20	35	140	<1
20	<10	<100	200	<200	7	1.5	.5	<.02	12	<25	170	<1
21	<10	<100	300	<200	10	1.5	.2	<.02	20	<25	130	1
22	<10	<100	200	200	10	1.5	.3	<.02	23	<25	160	1
23	<10	<100	300	<200	10	1.5	.2	<.02	20	40	130	1
24	<10	<100	200	<200	5	.7	.5	<.02	19	70	130	2
25	<10	<100	200	<200	7	1	.2	<.02	16	40	90	1
26	<10	<100	200	<200	7	1	.2	<.02	26	40	130	1
27	<10	<100	100	<200	5	.7	.5	.02	15	<25	60	<1
28	<10	<100	100	<200	5	.7	.2	<.04	27	25	180	<1
29	<10	<100	100	200	7	1	.2	<.02	44	70	220	2
30	<10	<100	100	<200	7	1	.2	<.02	37	70	190	2
31	<10	<100	20	<200	3	.5	.7	.02	<10	40	44	1
32	<10	<100	70	<200	7	.7	1	<.02	14	40	110	2
33	<10	<100	50	<200	15	1	1	<.02	13	70	140	2
34	<10	<100	100	300	10	1	.7	<.02	<10	<25	87	2
35	<10	<100	20	<200	5	.5	.7	<.02	12	35	170	1
36	<10	<100	100	200	7	.7	.5	<.02	14	25	120	2
37	<10	<100	50	<200	5	.7	2	<.02	24	40	220	5
38	<10	<100	20	<200	10	.7	.5	<.02	<10	35	60	2
39	<10	<100	150	300	10	1	.7	<.02	19	40	170	4
40	10	<100	30	<200	7	.7	.5	<.02	<10	40	70	4
41	10	<100	100	200	10	1	.7	<.02	12	40	120	5
42	10	<100	30	<200	10	.5	.5	<.02	<10	35	110	2
43	<10	<100	30	<200	7	.5	.7	<.02	<10	<25	160	2
44	<10	<100	50	500	10	1	.7	<.02	14	40	190	4
45	<10	<100	100	200	10	1	.5	<.02	19	40	220	5
46	<10	<100	100	200	10	1	.5	<.04	24	40	280	5
47	10	<100	100	200	10	1.5	.7	<.02	23	40	200	5
48	<10d	<100	70	<200	7	1		<.04	22	40	320	5
49	15	<100	70	500	7	1	.5	<.02	13	40	240	6
50	10	<100	70	500	7	1	.5	<.02	15	40	230	6
51	10	<100	100	<200	10	1.5	.7	<.02	19	35	110	5
52	<10	500	300	<200	15	5	3	<.02	50	<25	170	<1
53	<10	300	300	<200	10	3	5	<.02	57	<25	150	<1
54	<10	300	200	<200	10	2	3	<.02	35	<25	120	<1
55	<10d	<100	70	<200	7	.7	.5	<.02	19	35	170	2
56	<10d	<100	50	<200	7	.7	.5	<.02	<10	35	120	2
57	<10	<100	50	<200	7	.7	.5	<.02	10	70	110	1
58	<10	<100	30	<200	2	.5	.7	<.02	14	40	56	2
59	10	<100	70	300	7	1	.7	<.02	14	<25	240	4
60	<10	200	300	<200	15	3	5	<.02	55	35	110	<1
61	<10	200	200	<200	7	1.5	3	<.02	21	<25	150	<1
62	<10	<100	100	<200	7	1	1	<.02	13	<25	72	1
63	10	<100	100	300	10	1.5	1	<.02	11	<25	190	2
64	<10	1,500	20	<200	10	1	>20	<.02	12	<25	50	1
65	<10d	<100	50	<200	5	.7	1	<.02	10	<25	87	1
66	<10d	<100	70	200	7	1	.7	<.02	11	40	110	1
67	<10	150	200	<200	3	1	1	<.02	43	44	92	2
68	<10	<100	30	<200	3	.5	.5	<.02	10	28	120	2
69	<10	<100	70	<200	3	.7	.3	<.02	20	40	180	2
70	<10	<100	70	<200	3	.7	.5	<.02	14	34	160	2

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
					J--Stream sediments from Vallecito Creek--Continued							
71	2,000	1,500	<.5	<200	500	20	15	20	<5	20	100	<100
72	3,000	1,500	<.5	<200	500	20	30	50	<5	20	150	<100
73	3,000	1,500	<.5	<200	300	30	30	20	<5	30	50	<100
74	3,000	1,500	<.5	<200	500	20	20	20	<5	30	70	<100
75	2,000	700	<.5	<200	300	7	70	50	<5	15	50	<100
76	3,000	1,500	<.5	<200	500	20	50	30	<5	30	100	<100
77	3,000	1,000	<.5	<200	300	15	30	30	<5	20	100	<100
78	5,000	1,000	<.5	<200	700	10	50	30	<5	7	70	<100
79	3,000	1,000	<.5	<200	500	30	15	30	<5	30	70	<100
80	3,000	1,000	.7	<200	500	30	20	50	<5	30	70	<100
					K--Stream sediments from Rock Creek							
1	7,000	1,000	<.5	<200	500	5	50	15	<5	10	30	<100
2	5,000	700	<.5	<200	500	<5	30	20	<5	15	70	<100
3	3,000	1,000	<.5	<200	300	<5	30	15	<5	15	<10	<100
4	5,000	1,500	<.5	<200	700	20	50	30	<5	20	50	<100
5	5,000	700	<.5	<200	500	10	30	20	<5	20	30	<100
6	3,000	700	<.5	<200	300	7	50	15	<5	15	20	<100
7	5,000	1,500	<.5	<200	500	7	30	30	<5	10	30	<100
8	7,000	700	<.5	<200	500	15	70	15	<5	20	50	<100
9	3,000	700	<.5	<200	300	10	20	10	<5	10	15	<100
10	3,000	700	<.5	<200	300	20	30	20	<5	15	30	<100
11	5,000	2,000	<.5	<200	500	70	50	30	10	70	50	<100
12	3,000	700	<.5	<200	300	30	30	50	<5	20	20	<100
13	3,000	700	<.5	<200	300	7	20	30	<5	15	30	<100
14	7,000	1,000	<.5	<200	700	20	70	30	<5	30	70	<100
15	7,000	1,000	<.5	<200	700	30	70	30	<5	30	50	<100
					L--Stream sediments from Lake Creek							
1	3,000	1,000	<.5	<200	500	20	150	70	<5	30	30	<100
2 4/	5,000	1,500	<.5	<200	500	30	150	50	<5	50	20	<100
3	5,000	1,500	<.5	<200	500	50	200	50	5	50	30	<100
4	5,000	1,500	<.5	<200	500	50	200	100	<5	50	50	<100
5	5,000	1,000	<.5	<200	300	50	200	70	<5	70	30	<100
6	5,000	1,000	<.5	<200	300	50	150	30	<5	50	30	<100
7	5,000	1,000	<.5	<200	300	30	150	100	<5	30	10	<100
8	5,000	1,000	<.5	<200	500	50	150	70	<5	50	30	<100
9	5,000	1,500	<.5	<200	300	50	150	30	<5	50	20	<100
10	5,000	1,000	<.5	<200	700	20	20	30	7	20	50	<100
11	7,000	1,000	<.5	<200	500	15	30	30	<5	15	50	<100
12	7,000	1,000	<.5	<200	700	30	20	20	<5	10	20	<100
13	7,000	1,000	<.5	<200	500	30	20	30	<5	20	50	<100
14	7,000	1,000	<.5	<200	500	10	15	30	<5	15	50	<100
15	10,000	1,000	<.5	<200	300	20	50	30	<5	20	50	<100
16 4/	5,000	1,000	<.5	<200	1,000	10	10	30	5	15	70	<100
17	7,000	1,000	<.5	<200	700	20	50	50	<5	50	30	<100
					M--Stream sediments from Flint Creek							
1	5,000	3,000	<.5	<200	300	10	30	50	<5	15	70	<100
2	2,000	1,500	<.5	<200	200	10	50	50	<5	20	50	<100
3	2,000	150	<.5	<200	200	<5	30	20	<5	7	30	<100
4	3,000	2,000	<.5	<200	300	20	70	50	<5	20	50	<100
5	3,000	1,500	<.5	<200	300	5	30	30	5	15	50	<100
6	5,000	2,000	<.5	<200	500	20	70	70	<5	30	50	<100
7	1,000	200	<.5	<200	150	5	70	20	<5	5	30	<100
8	3,000	1,500	<.5	<200	1,000	5	7	30	<5	5	50	<100
9	7,000	1,500	<.5	<200	1,000	10	15	20	5	<5	50	<100
10	5,000	1,500	<.5	<200	1,000	10	15	20	<5	15	50	<100

4/ Fifty ppm tungsten was detected spectrographically in samples 2 and 16 from Lake Creek.

sediment samples—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sn	Sr	V	Zn	(percent) Fe	Mg	Ca	Chemical analyses (ppm) Au	Cu	Pb	Zn	Mo
J--Stream sediments from Vallecito Creek--Continued												
71	<10	<100	70	<200	3.0	0.7	0.5	<0.02	13	30	130	1
72	<10	<100	70	<200	3	.7	.7	<.02	16	38	140	5
73	<10	<100	70	<200	3	.7	.3	<.02	15	32	190	2
74	<10	<100	70	<200	3	.7	.5	<.02	12	26	150	5
75	<10	<100	150	<200	3	.7	1.5	<.02	19	28	68	<1
76	<10	<100	70	<200	3	.7	.7	<.02	15	28	140	2
77	<10	<100	70	<200	2	.5	.5	<.02	70	60	200	5
78	<10	100	150	<200	5	1	.7	<.02	19	36	94	2
79	<10	<100	70	<200	3	.7	.3	<.02	14	30	150	6
80	<10d	<100	100	<200	5	.7	.5	<.02	12	27	140	2
K--Stream sediments from Rock Creek												
1	<10	150	150	<200	7	.7	.7	<.02	<10	<25	79	<1
2	<10	<100	150	<200	3	.7	1.5	<.02	17	70	49	<1
3	<10	<100	150	<200	3	.3	.5	<.02	<10	70	70	<1
4	<10	100	200	<200	5	.7	.7	.02	16	110	78	1
5	<10	100	150	<200	3	.7	.5	<.02	<10	<25	50	1
6	<10	<100	150	<200	3	.7	.5	<.02	<10	25	72	1
7	<10	<100	150	<200	5	.5	.3	.04	<10	<25	57	<1
8	<10	<100	300	<200	7	.7	.3	<.02	15	40	180	1
9	<10	<100	150	<200	3	.3	.3	<.02	14	40	77	<1
10	<10	<100	150	<200	3	.5	.3	<.02	25	40	100	1
11	<10	100	150	<200	3	.7	.3	<.02	16	<25	220	1
12	<10	<100	150	<200	3	.5	.3	<.02	10	<25	90	<1
13	<10	<100	200	<200	7	.5	.3	<.02	17	<25	50	1
14	<10	<100	150	<200	10	1.5	.7	<.02	<10	<25	72	1
15	<10	150	150	<200	7	.7	.5	<.02	<10	<25	74	<1
L--Stream sediments from Lake Creek												
1	<10	300	200	<200	7	1.5	3	<.02	15	<25	140	2
2	<10	200	200	<200	10	2	3	<.02	14	<25	120	1
3	<10	200	200	<200	10	2	3	<.02	45	40	74	1
4	<10	300	200	<200	10	2	2	<.02	16	<25	130	1
5	<10	300	300	<200	10	2	2	<.02	18	<25	120	1
6	<10	150	200	<200	7	1.5	1.5	<.02	13	<25	81	1
7	<10	150	200	<200	7	1.5	2	<.02	24	40	61	1
8	<10	200	300	<200	10	2	3	<.02	11	<25	68	1
9	<10	100	300	<200	10	2	3	<.02	<10	<25	49	2
10	<10	100	150	<200	7	1	.7	<.02	<10	<25	81	2
11	<10	100	200	<200	7	1.5	1	<.02	41	70	130	1
12	<10	100	200	<200	10	1.5	1.5	<.02	16	40	84	1
13	<10	100	150	<200	7	1.5	1	<.02	29	<25	110	1
14	<10	100	100	<200	7	1	1	<.02	15	<25	140	1
15	<10	100	200	<200	10	1	1	<.02	16	70	68	1
16	<10	100	100	<200	7	.7	.7	.02	18	40	50	1
17	<10	100	150	<200	5	1	1	<.02	22	40	53	<1
M--Stream sediments from Flint Creek												
1	<10	<100	100	<200	2	.5	.2	<.02	10	<25	50	<1
2	<10	<100	70	<200	2	.3	.15	<.02	15	50	85	<1
3	<10	<100	70	<200	1	.3	.1	<.02	15	25	90	<1
4	<10	<100	100	<200	3	.7	.2	<.02	10	25	140	1
5	<10	100	150	<200	3	.5	.5	<.02	15	<25	140	4
6	<10	<100	150	<200	5	1	.15	<.02	15	30	100	2
7	<10	<100	150	<200	1.5	.2	.15	<.02	15	50	100	2
8	<10	200	100	<200	3	.7	.5	<.02	<10	30	50	1
9	<10	200	150	<200	5	.7	.7	<.02	15	50	60	1
10	<10	200	100	<200	3	.7	.5	<.02	<10	50	60	1

TABLE 3.—*Analyses of stream-*

Sample	Semiquantitative spectrographic analyses (ppm) Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
					M--Stream sediments from Flint Creek--Continued							
11	5,000	1,500	<0.5	<200	1,000	7	7	50	<5	5	70	<100
12	5,000	1,500	<.5	<200	1,000	10	20	50	<5	5	70	<100
13	7,000	1,500	<.5	<200	1,000	10	20	30	<5	7	70	<100
14	3,000	1,500	<.5	<200	700	10	30	30	<5	10	50	<100
15	5,000	1,500	<.5	<200	1,000	10	20	30	<5	10	70	<100
16	5,000	500	<.5	<200	300	5	30	50	<5	10	30	<100
17	5,000	1,000	<.5	<200	1,000	7	20	20	<5	5	50	<100
18	7,000	1,500	<.5	<200	1,000	10	20	30	<5	15	70	<100
19	7,000	1,000	<.5	<200	1,000	15	50	50	<5	15	70	<100
20	7,000	1,000	<.5	<200	1,000	15	30	30	<5	15	50	<100
21	5,000	700	.7	<200	500	10	50	30	<5	15	70	<100
22	7,000	1,000	<.5	<200	700	10	50	30	<5	5	70	<100
23	5,000	1,000	<.5	<200	500	5	30	30	<5	15	30	<100
24	5,000	1,500	<.5	<200	700	15	20	30	<5	10	50	<100
25	7,000	1,500	<.5	<200	700	15	30	50	<5	10	70	<100
26	7,000	1,000	<.5	<200	1,000	10	20	20	<5	7	30	<100
27	7,000	1,000	<.5	<200	1,000	10	20	30	<5	7	30	<100
28	7,000	1,500	<.5	<200	1,000	15	15	30	<5	5	50	<100
29	>10,000	2,000	<.5	<200	500	15	50	30	<5	7	50	<100
30	7,000	1,500	<.5	<200	1,000	15	15	20	<5	7	30	<100
					N--Stream sediments from Los Pinos River							
1	3,000	1,500	<.5	<200	1,000	5	5	7	<5	<5	50	<100
2	5,000	1,500	<.5	<200	1,500	7	10	20	<5	<5	70	<100
3	5,000	2,000	<.5	<200	1,500	7	5	50	<5	<5	70	<100
4	3,000	1,500	<.5	<200	1,500	7	10	30	<5	<5	50	<100
5	3,000	1,500	<.5	<200	1,500	7	5	30	<5	7	70	<100
6	10,000	1,500	<.5	<200	1,000	15	30	30	<5	7	100	<100
7	5,000	1,000	<.5	<200	1,000	7	20	30	<5	5	70	<100
8	5,000	1,500	<.5	<200	1,000	10	30	10	<5	<5	50	<100
9	5,000	700	<.5	<200	1,000	10	15	30	<5	<5	70	<100
10	7,000	1,500	<.5	<200	1,000	10	7	7	<5	<5	50	<100
11	3,000	1,500	<.5	<200	1,000	7	15	20	<5	5	30	<100
12	3,000	1,000	<.5	<200	1,000	10	10	20	<5	5	50	<100
13	10,000	1,500	<.5	<200	1,000	10	15	20	<5	5	70	<100
14	7,000	1,500	<.5	<200	1,000	15	50	70	<5	15	70	<100
15	5,000	1,000	<.5	<200	1,000	7	10	20	<5	5	70	<100
16	5,000	1,500	<.5	<200	700	10	20	50	<5	7	30	<100
17	10,000	1,500	<.5	<200	700	15	30	50	<5	15	70	<100
18	10,000	1,500	<.5	<200	500	10	30	30	<5	7	30	<100
19	5,000	500	<.5	<200	700	7	20	30	<5	7	50	<100
20	3,000	700	<.5	<200	700	7	15	30	<5	5	70	<100
21	5,000	1,000	<.5	<200	1,500	15	15	50	<5	15	70	<100
22	5,000	1,000	<.5	<200	1,000	10	10	20	<5	5	30	<100
23	3,000	700	<.5	<200	1,000	5	5	20	<5	<5	50	<100
24	5,000	1,000	<.5	<200	1,000	7	15	30	<5	<5	30	<100
25	5,000	1,000	<.5	<200	1,000	7	15	30	<5	<5	70	<100
26	5,000	1,000	<.5	<200	1,000	5	5	30	<5	<5	50	<100
27	>10,000	2,000	<.5	<200	700	15	70	20	<5	10	20	<100
28	7,000	1,500	<.5	<200	3,000	15	30	30	5	5	50	<100
29	>10,000	3,000	<.5	<200	1,000	70	150	30	<5	50	30	<100
30	>10,000	1,000	<.5	<200	2,000	30	50	50	15	30	100	<100
31	10,000	1,500	<.5	<200	1,500	10	20	30	<5	20	70	<100
32	7,000	1,500	<.5	<200	2,000	10	15	30	<5	5	150	<100
33	>10,000	2,000	<.5	<200	1,500	30	70	20	<5	30	70	<100
34	>10,000	2,000	<.5	<200	1,500	30	30	30	<5	15	70	<100
35	>10,000	2,000	<.5	<200	1,500	20	30	30	<5	15	70	<100

sediment samples—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses			
	(ppm)				(percent)			(ppm)			
Sample	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
					M--Stream sediments from Flint Creek--Continued							
11	<10	200	70	<200	3	0.7	0.7	<0.02	<10	50	25	2
12	<10	200	100	<200	3	.7	.7	<.02	<10	50	40	2
13	<10	300	150	<200	5	.7	.7	<.02	10	30	50	2
14	<10	100	50	<200	3	.7	.7	<.02	<10	50	40	2
15	<10	150	200	<200	5	.7	.7	<.02	<10	50	25	2
16	<10	<100	50	<200	3	.5	.2	<.02	10	50	40	<1
17	<10	100	70	<200	3	.5	.5	<.02	<10	25	50	<1
18	<10	200	150	<200	5	1	.7	<.02	10	10	50	2
19	<10	200	150	<200	5	1.5	1	<.02	10	<25	85	1
20	<10	150	150	<200	5	1	.7	<.02	10	50	140	2
21	<10	100	70	<200	3	.7	.7	<.02	30	100	85	2
22	<10	150	150	<200	5	.7	.7	<.02	10	50	60	2
23	<10	100	100	<200	3	.5	.7	<.02	15	50	85	2
24	<10	150	100	<200	5	1	.7	<.02	<10	50	85	2
25	<10	150	150	<200	5	1	.7	<.02	10	50	100	2
26	<10	150	150	<200	5	.7	.7	<.02	15	50	50	2
27	<10	150	150	<200	3	.7	.7	<.02	10	100	40	1
28	<10	200	150	<200	5	.7	1.5	<.02	10	50	85	2
29	<10	100	200	<200	7	1	1.5	<.02	10	30	85	2
30	<10	200	150	<200	7	1	1.5	<.02	15	380	140	1
					N--Stream sediments from Los Pinos River							
1	<10	200	100	<200	3	.7	.7	<.02	<10	26	25	<1
2	<10	300	150	<200	3	.7	.7	<.02	<10	<25	26	<1
3	<10	300	70	<200	5	.7	.7	<.02	<10	25	25	<1
4	<10	300	100	<200	3	.7	.7	<.02	<10	25	25	<1
5	<10	500	70	<200	3	.7	1	<.02	<10	<25	76	<1
6	<10	300	200	<200	7	1	1.5	<.02	<10	38	64	1
7	<10	500	200	<200	5	.7	1.5	<.02	<10	<25	34	<1
8	<10	500	150	<200	5	1	1	<.02	<10	25	32	<1
9	<10	500	200	<200	5	.7	1.5	<.02	11	25	28	<1
10	<10	500	150	<200	5	.7	1.5	<.02	<10	<25	26	<1
11	<10	700	150	<200	3	.7	2	<.02	<10	<25	30	<1
12	<10	500	150	<200	3	.7	1.5	<.02	<10	<25	30	<1
13	<10	500	200	<200	7	.7	1	<.02	<10	<25	28	<1
14	<10	700	300	<200	7	1	2	<.02	21	28	60	<1
15	<10	500	150	<200	3	.7	1	<.02	<10	25	25	1
16	<10	500	150	<200	3	.7	2	<.02	23	32	50	2
17	<10	200	200	<200	7	1.5	1.5	<.02	<10	36	68	2
18	<10	100	150	<200	5	.7	1.5	<.02	<10	36	66	5
19	<10	300	150	<200	3	.7	1	<.02	53	28	25	5
20	<10	200	150	<200	3	.7	1	<.02	<10	28	34	2
21	<10	300	150	<200	7	1	1.5	<.02	<10	37	68	2
22	<10	300	150	<200	7	.7	1.5	<.02	<10	<25	40	2
23	<10	500	100	<200	3	.7	1.5	<.02	<10	<25	28	2
24	<10	300	100	<200	5	.7	1	<.02	<10	<25	32	2
25	<10	300	100	<200	5	1	1.5	<.02	<10	25	36	2
26	<10	300	70	<200	3	.7	1.5	<.02	<10	25	32	2
27	<10	300	200	<200	10	2	3	<.02	<10	<25	36	2
28	<10	1,000	100	<200	7	1	5	<.02	<10	<25	50	1
29	<10	700	300	<200	15	3	5	<.02	10	35	100	1
30	<10	700	300	<200	15	1.5	3	<.02	<10	<25	65	1
31	<10	500	200	<200	7	1.5	3	<.02	<10	<25	50	1
32	<10	700	150	<200	10	1.5	3	.02	<10	<25	55	<1
33	<10	700	500	<200	15	2	7	<.02	10	<25	75	<1
34	<10	700	300	<200	15	1.5	5	<.02	<10	<25	64	<1
35	<10	300	200	<200	15	1.5	7	<.02	<10	40	220	<1

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses

Sample	Ti (ppm)	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
					N--Stream sediments from Los Pinos River--Continued							
36	>10,000	3,000	<0.5	<200	1,500	30	50	70	<5	15	100	<100
37	>10,000	3,000	<.5	<200	2,000	50	70	50	10	20	50	<100
38	>10,000	2,000	<.5	<200	1,000	20	20	30	<5	15	70	<100
39	>10,000	2,000	<.5	<200	1,000	30	30	30	<5	15	70	<100
40	>10,000	2,000	<.5	<200	2,000	30	50	70	<5	15	70	<100
41	>10,000	1,500	<.5	<200	1,000	20	30	50	<5	15	50	<100
42	>10,000	1,500	<.5	<200	1,000	20	20	30	<5	15	70	<100
43	>10,000	1,500	<.5	<200	2,000	20	70	30	<5	15	70	<100
44	>10,000	2,000	<.5	<200	1,500	20	30	70	<5	15	70	<100
45	10,000	700	<.5	<200	1,000	15	30	20	<5	15	50	<100
46	>10,000	1,500	<.5	<200	2,000	20	30	70	<5	15	70	<100
47	>10,000	1,500	<.5	<200	1,000	15	20	30	<5	15	100	<100
48	>10,000	2,000	<.5	<200	1,000	15	30	30	30	15	70	<100
49	10,000	1,500	<.5	<200	1,500	15	15	30	<5	15	70	<100
50	>10,000	2,000	<.5	<200	1,000	20	30	20	<5	15	70	<100
51	>10,000	2,000	<.5	<200	1,500	30	30	30	30	15	70	<100
52	>10,000	3,000	<.5	<200	1,500	20	30	30	<5	15	70	<100
53	7,000	1,000	<.5	<200	700	10	20	10	<5	15	50	<100
54	7,000	1,500	<.5	<200	1,000	10	15	10	<5	10	30	<100
55	7,000	1,000	<.5	<200	1,000	10	15	15	<5	10	70	<100
56	>10,000	1,500	<.5	<200	700	15	15	15	<5	10	50	<100
57	>10,000	1,500	<.5	<200	1,000	20	20	30	<5	15	100	<100
58	>10,000	1,500	<.5	<200	1,000	20	20	20	<5	15	70	<100
59	10,000	1,500	<.5	<200	700	20	20	20	15	15	50	<100
60	7,000	1,500	<.5	<200	700	20	100	30	<5	30	50	<100
61	10,000	2,000	<.5	<200	1,000	20	50	20	<5	10	30	<100
62	10,000	1,500	<.5	<200	1,500	20	30	30	<5	15	70	<100
63	10,000	1,500	<.5	<200	700	20	20	20	<5	15	30	<100
64	>10,000	1,500	<.5	<200	1,000	20	30	30	<5	15	50	<100
65	>10,000	1,500	<.5	<200	700	30	30	30	<5	15	30	<100
66	10,000	1,500	<.5	<200	700	30	30	30	<5	15	30	<100
67	>10,000	1,500	<.5	<200	700	30	20	20	<5	15	30	<100
68	>10,000	1,000	<.5	<200	700	20	20	20	<5	15	30	<100
					O--Stream sediments from Ute Creek drainage							
1	5,000	700	<1	<2,000	1,500	15	50	10	5	20	30	<200
2	5,000	700	<1	<2,000	1,500	15	50	15	5	20	20	<200
3	3,000	500	<1	<2,000	1,500	10	15	10	<3	10	20	<200
4	3,000	700	<1	<2,000	1,500	10	15	10	<3	5	30	<200
5	5,000	700	<1	<2,000	1,500	15	30	15	5	15	20	<200
6	2,000	500	<1	<2,000	1,500	7	30	10	<3	15	30	<200
7	2,000	500	<1	<2,000	1,500	10	20	15	<3	10	30	<200
8	5,000	700	<1	<2,000	1,500	10	70	15	5	20	30	<200
9	2,000	500	<1	<2,000	1,500	5	15	10	<3	5	50	<200
10	3,000	700	<1	<,2000	2,000	10	30	10	<3	15	30	<200
10a	1,500	700	<1	<2,000	2,000	7	30	10	<3	15	30	<200
10b	2,000	700	<1	<2,000	1,500	7	15	7	<3	7	30	<200
10c	3,000	700	<1	<2,000	1,000	10	30	15	<3	20	20	<200
11	2,000	500	<1	<2,000	1,500	10	100	15	<3	50	20	<200
12	2,000	500	<1	<2,000	2,000	7	15	7	<3	5	30	<200
13	2,000	1,000	<1	<2,000	1,500	7	30	15	<3	10	20	<200
15	2,000	700	<1	<2,000	1,500	7	50	10	<3	20	20	<200
16	3,000	500	<1	<2,000	1,500	10	20	10	5	10	20	<200
17	1,500	300	<1	<2,000	1,500	0	7	5	<3	5	20	<200
18	1,500	500	<1	<2,000	1,500	0	7	7	<3	50	30	<200
19	5,000	700	<1	<2,000	1,500	15	15	10	5	10	20	<200
20	3,000	700	<1	<2,000	1,500	15	30	10	7	7	20	<200
21	2,000	500	<1	<2,000	1,500	7	10	7	<3	0	20	<200
22	2,000	500	<1	<2,000	1,000	10	20	10	<3	10	20	<200
23	3,000	500	<1	<2,000	1,500	10	20	15	<3	10	20	<200

sediment samples—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
					N--Stream sediments from Los Pinos River--Continued							
36	<10	700	300	200	15.0	1.5	5.0	<0.02	<10	<25	59	1
37	<10	700	500	300	20	1.5	5	<.02	<10	<25	54	1
38	<10	200	200	<200	15	1.5	3	<.02	<10	<25	77	1
39	<10	500	200	<200	15	1.5	3	<.02	<10	<25	66	1
40	<10	700	200	<200	20	1.5	3	<.02	<10	<25	56	1
41	<10	700	150	<200	15	1.5	3	<.02	<10	<25	46	1
42	<10	200	200	<200	10	1.5	3	<.02	14	35	120	1
43	<10	700	200	<200	15	1.5	5	<.02	<10	<25	55	1
44	<10	700	200	<200	15	1.5	7	<.02	15	<25	42	1
45	<10	100	100	<200	10	1.5	3	<.02	10	<25	58	1
46	<10	700	200	<200	15	1.5	3	<.02	<10	70	50	1
47	<10	150	150	<200	15	1.5	2	<.02	<10	145	87	1
48	<10	700	150	<200	15	1.5	3	<.02	<10	<25	89	<1
49	<10	500	150	<200	10	1.5	3	<.02	<10	<25	85	1
50	<10	700	150	<200	15	1.5	3	<.02	<10	<25	67	<1
51	<10	500	150	<200	15	1.5	5	<.02	<10	40	48	<1
52	<10	500	150	<200	15	1.5	7	<.02	<10	40	88	<1
53	<10	150	150	<200	7	1.5	1.5	<.02	<10	<25	68	<1
54	<10	300	70	<200	7	1.5	3	<.02	<10	25	70	<1
55	<10	200	100	<200	7	1.5	2	<.02	<10	<25	38	<1
56	<10	300	200	<200	10	1.5	3	<.02	<10	35	60	1
57	<10	500	150	<200	10	1.5	3	<.02	<10	<25	85	1
58	<10	700	150	<200	15	1.5	3	<.02	<10	<25	47	1
59	<10	300	150	<200	15	1.5	2	<.02	<10	<25	50	1
60	<10	150	200	<200	7	1.5	1.5	<.02	13	<25	88	1
61	<10	500	150	<200	15	1.5	3	<.02	<10	40	88	1
62	<10	200	150	<200	15	1.5	2	<.02	<10	40	100	1
63	<10	100	150	<200	15	1.5	1.5	<.02	14	110	110	1
64	<10	300	200	<200	15	1.5	3	<.02	15	40	77	1
65	<10	200	150	<200	15	1.5	2	<.02	10	40	150	1
66	<10	300	150	<200	15	1.5	2	<.02	<10	35	89	1
67	<10	300	150	<200	10	1.5	2	<.02	10	25	90	1
68	<10	300	150	<200	15	1.5	2	<.02	<10	25	63	1
					O--Stream sediments from Ute Creek drainage							
1	<10	700	150	<200	7.0	0.7	0.7	<.02	80	25	700	<2
2	<10	700	150	<200	7	.7	1.5	<.02	20	25	700	<2
3	<10	500	70	<200	3	.7	1.5	<.02	15	25	75	---
4	<10	1,000	70	<200	2	.3	1.5	<.02	60	25	50	---
5	<10	1,000	150	<200	5	1	1.5	<.02	30	25	100	---
6	<10	700	70	<200	2	.7	1	<.02	60	25	25	---
7	<10	500	100	<200	3	.7	1	<.02	60	25	100	---
8	<10	1,000	150	<200	5	.7	1.5	<.02	100	25	100	<2
9	<10	500	70	<200	2	.5	1	<.02	20	75	75	<2
10	<10	700	100	<200	3	.7	1.5	<.02	40	25	75	---
10a	<10	1,000	70	<200	2	.7	1	<.02	60	25	50	---
10b	<10	700	50	<200	2	.5	1	<.02	70	25	50	---
10c	<10	1,000	70	<200	3	.7	1.5	<.02	40	25	75	---
11	<10	1,000	70	<200	3	.7	1	<.02	30	25	75	---
12	<10	1,000	70	<200	2	.5	1	<.02	60	25	50	---
13	<10	500	70	<200	2	.5	1	<.02	30	25	75	---
15	<10	300	50	<200	2	.7	.7	<.02	40	<25	50	---
16	<10	700	100	<200	5	.7	1	<.02	40	<25	75	---
17	<10	300	30	<200	1.5	.5	.5	<.02	50	<25	25	---
18	<10	300	30	<200	1	.5	.7	<.02	40	<25	50	---
19	<10	500	150	<200	7	.5	1	<.02	20	25	300	<2
20	<10	500	150	<200	7	.7	1	<.02	60	25	300	4
21	<10	500	70	<200	3	.5	.7	<.02	60	50	75	<2
22	<10	500	70	<200	3	.7	1	<.02	20	<25	75	---
23	<10	700	70	<200	3	.7	1.5	<.02	20	<25	50	---

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses

Sample	Ti (ppm)	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
O--Stream sediments from Ute Creek drainage--Continued												
23a	2,000	300	<1	<2,000	1,500	7	7	10	<3	7	20	<200
24	2,000	300	<1	<2,000	2,000	5	5	7	<3	5	20	<200
25	2,000	500	<1	<2,000	2,000	5	7	7	<3	5	30	<200
26	3,000	500	<1	<2,000	1,500	7	15	10	<3	5	20	<200
27	3,000	500	<1	<2,000	1,000	10	70	15	<3	15	20	<200
28	3,000	700	<1	<2,000	1,000	15	50	20	<3	15	20	<200
29	2,000	150	<1	<2,000	700	0	30	15	<3	15	20	<200
30	3,000	500	<1	<2,000	1,000	15	50	20	<3	15	20	<200
31	2,000	500	<1	<2,000	700	15	30	15	<3	15	15	<200
32	3,000	300	<1	<2,000	700	15	50	20	<3	20	15	<200
33	2,000	500	<1	<2,000	500	10	50	15	<3	15	15	<200
34	2,000	500	<1	<2,000	1,000	10	10	15	<3	15	20	<200
35	3,000	500	<1	<2,000	1,500	15	10	10	<3	15	20	<200
36	1,500	300	<1	<2,000	1,000	10	10	10	<3	7	20	<200
37	2,000	500	<1	<2,000	1,000	15	15	20	5	50	20	<200
38	2,000	700	<1	<2,000	700	30	15	200	<3	100	20	<200
39	3,000	500	<1	<2,000	1,500	15	30	30	5	30	20	<200
P--Stream sediments from north-flowing Weminuche Creek drainage												
2a	3,000	700	<1	<2,000	700	15	15	10	<3	10	15	<200
2b	2,000	300	<1	<2,000	500	7	20	20	<3	7	20	<200
3	2,000	700	<1	<2,000	1,000	10	10	20	<3	5	30	<200
4	2,000	700	<1	<2,000	1,000	10	30	15	<3	15	15	<200
5	3,000	500	<1	<2,000	1,000	10	15	20	<3	10	30	<200
6	3,000	700	<1	<2,000	700	10	20	20	<3	15	30	<200
7	2,000	150	<1	<2,000	700	5	15	20	<3	5	20	<200
8	2,000	500	<1	<2,000	1,000	10	20	15	<3	15	20	<200
9	2,000	700	<1	<2,000	1,000	10	15	30	<3	7	20	<200
10	1,500	500	<1	<2,000	1,000	0	2	7	<3	5	20	<200
11	2,000	500	<1	<2,000	1,000	7	15	10	<3	10	20	<200
12	2,000	500	<1	<2,000	1,000	7	15	10	<3	7	20	<200
14	2,000	500	<1	<2,000	1,000	10	10	30	<3	7	30	<200
Q--Stream sediments from south-flowing Weminuche Creek drainage												
1a	5,000	700	<1	<2,000	700	15	30	50	<3	10	15	<200
1b	3,000	500	<1	<2,000	700	10	15	30	<3	7	15	<200
2	3,000	700	<1	<2,000	700	15	20	50	<3	10	20	<200
3a	7,000	700	<1	<2,000	700	20	50	30	<3	15	15	<200
3b	3,000	500	<1	<2,000	700	10	15	30	<3	5	20	<200
4	3,000	700	<1	<2,000	700	10	20	50	<3	7	20	<200
5	5,000	700	<1	<2,000	700	15	30	30	<3	10	10	<200
6	3,000	1,000	<1	<2,000	700	15	30	50	<3	7	15	<200
7	5,000	700	<1	<2,000	700	15	30	30	<3	10	15	<200
8	3,000	700	<1	<2,000	1,000	15	15	50	<3	7	20	<200
9	3,000	500	<1	<2,000	700	10	5	20	<3	3	15	<200
10	5,000	700	<1	<2,000	700	15	3	20	<3	3	10	<200
11	5,000	700	<1	<2,000	700	15	7	20	<3	3	10	<200
12	7,000	700	<1	<2,000	1,000	20	20	30	<3	7	15	<200
13	5,000	700	<1	<2,000	1,000	15	7	20	<3	5	10	<200
14	5,000	700	<1	<2,000	1,000	15	10	30	<3	5	10	<200
15	5,000	700	<1	<2,000	1,000	15	7	20	<3	5	10	<200
16	5,000	700	<1	<2,000	1,000	20	5	20	<3	5	10	<200
17	5,000	700	<1	<2,000	1,000	15	7	20	<3	3	10	<200
18	5,000	700	<1	<2,000	1,000	20	7	20	<3	5	15	<200
19	5,000	700	<1	<2,000	1,000	20	10	20	<3	5	10	<200
20	5,000	700	<1	<2,000	1,000	20	10	20	<3	5	10	<200
21	5,000	700	<1	<2,000	1,000	15	7	20	<3	5	10	<200
22	5,000	1,000	<1	<2,000	1,000	15	7	20	<3	5	15	<200
23	5,000	500	<1	<2,000	1,000	15	7	20	<3	5	10	<200

sediment samples—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				(percent)			Chemical analyses (ppm)				
	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
O--Stream sediments from Ute Creek drainage--Continued												
23a	<10	700	70	<200	3.0	0.7	1.5	<0.02	40	<25	50	---
24	<10	500	50	<200	2	.5	.7	<.02	30	<25	50	---
25	<10	500	50	<200	2	.5	.7	<.02	20	<25	50	---
26	<10	500	50	<200	2	.7	1	<.02	20	25	75	---
27	<10	300	100	<200	3	.7	1	<.02	40	<25	75	---
28	<10	500	100	<200	3	.5	1	<.02	60	<25	75	---
29	<10	300	50	<200	1	.5	.5	<.02	20	<25	75	---
30	<10	700	100	<200	5	.5	1.5	<.02	40	25	75	---
31	<10	300	70	<200	2	.5	.5	<.02	60	<25	75	---
32	<10	300	100	<200	5	.5	1	<.02	70	<25	75	---
33	<10	150	70	<200	3	.5	.3	<.02	70	<25	50	---
34	<10	500	70	<200	2	.5	.7	<.02	60	<25	75	---
35	<10	100	50	<200	5	.5	.7	<.02	70	<25	200	---
36	<10	700	50	<200	2	.3	1	<.02	30	<25	75	---
37	<10	500	100	<200	3	.5	1	<.02	70	<25	200	---
38	<10	300	70	500	3	.5	.7	<.02	300	25	800	6
39	<10	500	100	<200	3	.7	1	<.02	60	<25	200	---
P--Stream sediments from north-flowing Weminuche Creek drainage												
2a	<10	1,000	200	<200	7	.5	2	<.1	20	<25	300	---
2b	<10	300	50	<200	1.5	.5	1	<.1	15	<25	25	---
3	<10	700	70	<200	3	.5	1.5	<.1	60	<25	50	---
4	<10	1,000	70	<200	3	.5	1.5	<.1	60	<25	50	---
5	<10	1,000	100	<200	3	.5	2	<.1	30	<25	50	---
6	<10	500	70	<200	3	.7	1.5	<.1	30	<25	50	---
7	<10	500	50	<200	1.5	.3	1	<.1	15	<25	25	---
8	<10	700	70	<200	3	.7	1.5	<.1	15	<25	50	---
9	<10	700	70	<200	3	.5	1.5	<.1	40	<25	50	---
10	<10	300	30	<200	2	.2	.7	<.1	50	<25	25	---
11	<10	700	70	<200	2	.5	1.5	<.1	15	25	50	---
12	<10	500	70	<200	2	.5	1	<.1	20	25	50	---
14	<10	500	70	<200	3	.3	1.5	<.1	50	<25	50	---
Q--Stream sediments from south-flowing Weminuche Creek drainage												
1a	<10	500	200	<200	7	1.5	3	---	20	<15	125	---
1b	<10	300	150	<200	5	1	2	---	30	<15	50	---
2	<10	300	150	<200	5	1.5	3	---	40	<15	75	---
3a	<10	300	500	<200	10	1	2	---	15	<15	150	---
3b	<10	300	100	<200	5	1.5	2	---	30	<15	75	---
4	<10	300	150	<200	5	1	2	---	40	<15	50	---
5	<10	300	200	<200	7	1.5	3	---	20	<15	100	---
6	<10	300	150	<200	5	1	2	---	30	<15	50	---
7	<10	500	300	<200	7	1.5	3	<.2	15	<15	150	---
8	<10	500	15	<200	7	1.5	3	---	30	<15	75	---
9	<10	500	100	<200	5	1	3	---	20	<15	75	---
10	<10	500	150	<200	7	1.5	3	---	15	<15	75	---
11	<10	500	150	<200	7	1.5	3	<.2	10	<15	100	---
12	<10	500	150	<200	10	1	5	---	10	<15	75	---
13	<10	500	150	<200	7	1	5	---	15	<15	75	---
14	<10	500	150	<200	7	1	5	<.2	20	<15	75	---
15	<10	500	150	<200	7	1	5	---	10	<15	75	---
16	<10	500	150	<200	7	1.5	5	<.2	15	<15	75	---
17	<10	500	150	<200	7	1	5	<.2	20	<15	75	---
18	<10	500	150	<200	7	1.5	5	<.2	20	<15	100	---
19	<10	500	150	<200	10	1.5	5	---	15	<15	100	---
20	<10	500	200	<200	10	1	5	<.2	15	<15	100	---
21	<10	500	150	<200	7	1	5	---	10	<15	75	---
22	<10	500	150	<200	7	1	5	---	15	<15	50	---
23	<10	500	150	<200	7	1	3	<.2	15	<15	50	---

TABLE 3.—*Analyses of stream-*

Sample	Semiquantitative spectrographic analyses (ppm)											
	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
	Q--Stream sediments from south-flowing Weminuche Creek drainage--Continued											
24	3,000	700	<1	<2,000	1,000	15	7	20	<3	5	10	<200
25	5,000	700	<1	<2,000	1,000	15	7	20	<3	5	15	<200
26	5,000	700	<1	<2,000	1,000	15	5	20	<3	5	15	<200
27	5,000	700	<1	<2,000	700	15	10	20	<3	5	10	<200
28	5,000	700	<1	<2,000	700	15	3	20	<3	5	10	<200
	R--Stream sediments from Hossick Creek drainage											
1	3,000	300	<1	<2,000	700	10	30	100	<3	10	100	<200
2	3,000	300	<1	<2,000	700	7	30	70	<3	10	15	<200
3	3,000	700	<1	<2,000	1,000	10	30	70	<3	7	20	<200
4	3,000	500	<1	<2,000	700	10	20	50	<3	7	50	<200
5	3,000	500	<1	<2,000	700	10	30	50	<3	7	50	<200
6	3,000	700	<1	<2,000	700	10	15	50	<3	5	20	<200
7	5,000	700	<1	<2,000	500	15	30	30	<3	7	30	<200
8	5,000	700	<1	<2,000	1,000	15	10	30	<3	5	20	<200
9	2,000	700	<1	<2,000	700	10	7	30	<3	5	30	<200
10	5,000	700	<1	<2,000	700	15	20	30	<3	7	30	<200
11	7,000	1,000	<1	<2,000	700	20	5	20	<3	3	10	<200
12	5,000	700	<1	<2,000	700	15	10	20	<3	3	20	<200
13	7,000	1,000	<1	<2,000	1,000	20	5	20	<3	3	10	<200
14	3,000	1,000	<1	<2,000	1,000	15	10	30	<3	5	20	<200
15	7,000	1,000	<1	<2,000	1,000	20	7	20	<3	5	10	<200
	S--Stream sediments from Squaw Creek drainage											
1	5,000	500	<1	<2,000	150	20	70	50	<3	15	0	<200
2	3,000	500	<1	<2,000	150	20	30	20	<3	10	15	<200
2a	1,000	500	<1	<2,000	50	10	10	30	<3	7	0	<200
3	2,000	500	<1	<2,000	100	15	30	30	<3	10	0	<200
4	5,000	700	<1	<2,000	150	20	50	70	<3	15	0	<200
5	2,000	700	<1	<2,000	100	15	20	50	<3	15	0	<200
6	3,000	500	<1	<2,000	150	20	30	50	<3	15	15	<200
8	3,000	700	<1	<2,000	100	15	15	30	<3	15	15	<200
9	2,000	700	<1	<2,000	100	15	15	20	<3	15	0	<200
10	5,000	700	<1	<2,000	150	20	50	50	<3	15	15	<200
11	3,000	500	<1	<2,000	100	15	30	50	<3	10	15	<200
12	3,000	700	<1	<2,000	100	15	10	50	<3	7	20	<200
13	2,000	500	<1	<2,000	70	10	15	30	<3	7	15	<200
14	3,000	700	<1	<2,000	100	15	15	30	<3	10	15	<200
15	1,000	1,500	<1	<2,000	30	7	15	20	<3	5	15	<200
16	5,000	700	<1	<2,000	200	15	20	20	<3	15	15	<200
17	5,000	700	<1	<2,000	200	20	50	50	<3	15	20	<200
18	3,000	700	<1	<2,000	100	15	15	30	<3	10	15	<200
19	5,000	700	<1	<2,000	150	20	30	50	<3	15	10	<200
20	3,000	700	<1	<2,000	100	15	7	20	<3	7	0	<200
21	2,000	700	<1	<2,000	100	10	5	10	<3	7	10	<200
22	3,000	700	<1	<2,000	150	15	15	20	<3	7	15	<200
23	5,000	500	<1	<2,000	150	20	30	50	<3	20	15	<200
24	3,000	700	<1	<2,000	500	15	7	15	<3	5	20	<200
	T--Stream sediments from Little Squaw Creek drainage (panned concentrates)											
1	5,000	500	<1	<2,000	700	15	30	70	<3	15	10	<200
2a	7,000	500	<1	<2,000	1,000	20	20	30	<3	10	10	<200
2b	5,000	700	<1	<2,000	700	50	100	30	<3	30	15	<200
3a	5,000	500	<1	<2,000	1,000	15	15	50	<3	7	20	<200
3b	5,000	500	<1	<2,000	1,000	20	30	50	<3	10	20	<200
4	7,000	500	<1	<2,000	700	30	70	70	<3	15	15	<200
5a	7,000	700	<1	<2,000	700	30	70	50	<3	15	15	<200
5b	7,000	1,500	<1	<2,000	1,000	30	20	30	<3	20	15	<200
6	10,000	700	<1	<2,000	700	50	100	70	<3	20	15	<200
7	10,000	700	<1	<2,000	700	30	70	50	<3	15	15	<200

sediment samples—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
Q--Stream sediments from south-flowing Weminuche Creek drainage--Continued												
24	<10	500	150	<200	7.0	1.0	3.0	<0.2	15	<15	100	---
25	<10	500	150	<200	7	1	3	---	30	<15	100	---
26	<10	500	150	<200	7	1	3	<.2	10	<15	50	---
27	<10	500	150	<200	7	1	5	<.2	10	<15	75	---
28	<10	500	150	<200	7	1.5	5	---	20	<15	50	---
R--Stream sediments from Hossick Creek drainage												
1	<10	300	100	<200	7	1	1.5	---	40	<15	75	---
2	<10	300	100	<200	5	1	1.5	---	40	<15	50	---
3	<10	500	100	<200	7	1	2	---	40	<15	50	---
4	<10	500	150	<200	7	1	2	---	20	<15	75	---
5	<10	300	100	<200	5	1.5	2	---	20	<15	50	---
6	<10	300	70	<200	5	1	1.5	---	20	<15	50	---
7	<10	300	150	<200	7	1	2	---	15	<15	100	---
8	<10	500	150	<200	7	1	3	---	30	<15	75	---
9	<10	500	100	<200	5	1.5	2	---	20	<15	75	---
10	<10	500	200	<200	7	1	3	<.02	20	<15	100	---
11	<10	500	200	<200	10	2	5	---	5	<15	100	---
12	<10	500	150	<200	7	1.5	3	<.2	20	<15	100	---
13	<10	500	200	<200	10	2	5	---	15	<15	100	---
14	<10	500	100	<200	7	1.5	3	---	20	<15	75	---
15	<10	500	300	<200	10	2	5	---	15	<15	100	---
S--Stream sediments from Squaw Creek drainage												
1	<10	700	150	<200	7	1	2	<.1	30	<25	200	---
2	<10	1,500	150	<200	5	.7	5	<.1	80	<25	75	---
2a	<10	300	50	<200	2	.3	1.5	<.1	60	<25	50	---
3	<10	700	100	<200	5	.7	2	<.1	80	<25	75	---
4	<10	1,000	150	<200	7	1	5	<.1	150	<25	75	<2
5	<10	700	100	<200	3	.7	2	<.1	60	<25	100	---
6	<10	1,000	150	<200	5	1	3	<.1	40	<25	75	---
8	<10	1,500	100	<200	5	.7	5	<.1	40	<25	50	---
9	<10	1,000	100	<200	5	.7	2	<.1	100	<25	75	---
10	<10	700	150	<200	5	.7	2	<.1	40	<25	50	---
11	<10	700	100	<200	5	.7	2	<.1	60	<25	50	---
12	<10	1,000	100	<200	5	1	3	<.1	70	<25	50	---
13	<10	500	70	<200	3	.7	2	<.1	60	<25	50	---
14	<10	700	100	<200	3	.7	3	<.1	60	<25	75	---
15	<10	150	30	<200	1.5	.5	1	<.1	40	<25	75	---
16	<10	1,000	200	<200	5	1	2	<.1	100	<25	150	---
17	<10	500	200	<200	5	1	2	<.1	60	<25	100	---
18	<10	700	100	<200	5	.7	2	<.1	40	<25	75	---
19	<10	700	150	<200	5	.7	2	<.1	80	<25	75	---
20	<10	700	100	<200	3	.7	2	<.1	100	<25	100	---
21	<10	1,000	100	<200	3	.7	2	<.1	100	<25	50	---
22	<10	700	150	<200	5	.7	2	<.1	70	<25	75	---
23	<10	700	150	<200	5	1	3	<.1	100	<25	150	---
24	<10	700	500	<200	3	.7	2	<.1	80	<25	75	---
T--Stream sediments from Little Squaw Creek drainage (panned concentrates)												
1	<10	700	150	<200	5	1	3	<.1	100	<25	75	---
2a	<10	1,000	200	<200	7	1	5	<.1	80	<25	75	---
2b	<10	700	700	<200	>10	1	3	<.1	200	<25	500	<2
3a	<10	1,000	150	<200	5	1	5	<.1	60	<25	75	---
3b	<10	1,000	200	<200	7	1	5	<.1	100	<25	150	---
4	<10	1,000	200	<200	7	1.5	5	<.1	150	25	75	<2
5a	<10	700	300	<200	>10	1	3	<.1	40	<25	200	---
5b	<10	1,500	300	<200	7	1.5	>10	<.1	60	<25	150	---
6	<10	1,500	500	<200	>10	1.5	5	<.1	60	<25	400	<2
7	<10	1,500	500	<200	>10	1	5	<.1	60	<25	300	<2

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
T--Stream sediments from Little Squaw Creek drainage (panned concentrates)--Continued												
8	3,000	500	<1	<2,000	1,000	20	15	50	<3	10	15	<200
9	10,000	700	<1	<2,000	1,000	30	100	50	<3	20	15	<200
10	7,000	700	<1	<2,000	1,000	20	20	30	<3	10	10	<200
11	5,000	700	<1	<2,000	1,000	20	30	70	<3	10	15	<200
12	7,000	1,500	<1	<2,000	1,000	30	30	50	<3	20	15	<200
13	10,000	700	<1	<2,000	1,000	30	50	50	<3	20	10	<200
14	5,000	700	<1	<2,000	1,000	20	30	50	<3	15	15	<200
15	7,000	700	<1	<2,000	700	30	70	50	<3	20	15	<200
16	5,000	700	<1	<2,000	700	20	30	50	<3	15	15	<200
17	5,000	700	<1	<2,000	1,000	20	20	50	<3	10	15	<200
U--Stream sediments from Williams Creek drainage												
1	5,000	700	<1	<2,000	700	15	20	100	<3	10	15	<200
2	5,000	700	<1	<2,000	1,000	15	10	30	<3	5	70	<200
3	7,000	700	<1	<2,000	700	20	30	50	<3	10	20	<200
4	5,000	700	<1	<2,000	1,000	15	10	30	<3	5	15	<200
5	5,000	700	<1	<2,000	700	15	15	30	<3	7	20	<200
6	5,000	700	<1	<2,000	1,000	15	20	30	<3	7	20	<200
7	5,000	700	<1	<2,000	700	20	50	50	<3	10	15	<200
8	5,000	500	<1	<2,000	700	15	20	30	<3	7	15	<200
9	5,000	700	<1	<2,000	700	15	20	50	<3	10	20	<200
10	7,000	700	<1	<2,000	700	20	50	50	<3	15	20	<200
11	5,000	700	<1	<2,000	700	15	20	50	<3	7	20	<200
12	3,000	700	<1	<2,000	1,000	15	20	50	<3	7	20	<200
13	3,000	700	<1	<2,000	700	10	15	30	<3	5	20	<200
14	3,000	700	<1	<2,000	1,000	15	15	50	<3	7	20	<200
15	5,000	700	<1	<2,000	1,000	15	20	50	<3	7	15	<200
16	5,000	1,000	<1	<2,000	1,000	15	30	50	<3	7	15	<200
17	3,000	500	<1	<2,000	700	10	30	50	<3	5	20	<200
18	2,000	500	<1	<2,000	1,000	7	10	20	<3	3	15	<200
19	5,000	700	<1	<2,000	1,000	20	30	50	<3	7	15	<200
20	5,000	700	<1	<2,000	1,000	15	20	30	<3	5	20	<200
21	5,000	700	<1	<2,000	1,000	20	30	30	<3	5	15	<200
22	5,000	700	<1	<2,000	700	15	15	50	<3	7	15	<200
23	5,000	700	<1	<2,000	1,000	10	20	30	<3	7	20	<200
24	5,000	500	<1	<2,000	700	15	20	50	<3	10	20	<200
25	2,000	700	<1	<2,000	700	7	15	20	<3	5	20	<200
26	3,000	700	<1	<2,000	1,000	15	20	30	<3	7	15	<200
26a	5,000	700	<1	<2,000	1,000	15	20	50	<3	7	15	<200
27	5,000	700	<1	<2,000	1,000	20	10	20	<3	7	15	<200
28	5,000	1,000	<1	<2,000	1,000	20	5	20	<3	5	15	<200
29	5,000	500	<1	<2,000	700	15	15	30	<3	5	15	<200
30	5,000	700	<1	<2,000	1,000	15	7	20	<3	5	10	<200
31	3,000	700	<1	<2,000	700	10	15	50	<3	5	15	<200
32	3,000	700	<1	<2,000	1,000	10	10	15	<3	5	15	<200
32a	3,000	700	<1	<2,000	1,000	10	15	30	<3	7	15	<200
33	7,000	700	<1	<2,000	700	30	30	30	<3	10	15	<200
34	3,000	700	<1	<2,000	1,000	15	15	30	<3	5	15	<200
35	5,000	700	<1	<2,000	1,000	15	15	30	<3	5	15	<200
36	3,000	1,500	<1	<2,000	700	15	15	30	<3	7	20	<200
37	5,000	1,000	<1	<2,000	1,000	15	15	50	<3	7	15	<200
38	2,000	700	<1	<2,000	700	5	7	20	<3	0	20	<200
39	2,000	1,000	<1	<2,000	700	7	20	30	<3	3	15	<200
40	7,000	700	<1	<2,000	700	20	10	15	<3	5	10	<200
41	5,000	700	<1	<2,000	700	15	15	20	<3	5	15	<200
41a	3,000	700	<1	<2,000	700	10	10	50	<3	5	50	<200
42	5,000	700	<1	<2,000	700	15	10	20	<3	5	15	<200
43	5,000	1,000	<1	<2,000	1,000	20	7	20	<3	5	15	<200
44	5,000	700	<1	<2,000	1,000	15	30	20	<3	7	20	<200
45	5,000	1,000	<1	<2,000	700	20	30	20	<3	7	15	<200
46	5,000	700	<1	<2,000	1,000	15	7	15	<3	3	15	<200
46a	5,000	700	<1	<2,000	1,000	15	15	20	<3	7	15	<200

sediment samples—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sn	Sr	V	Zn	(percent) Fe	Mg	Ca	Chemical analyses (ppm) Au	Cu	Pb	Zn	Mo
T--Stream sediments from Little Squaw Creek drainage (panned concentrates)--Continued												
8	<10	1,500	150	<200	7.0	1.0	5.0	<0.1	80	<25	150	---
9	<10	1,000	700	<200	>10	1.5	5	<.1	100	<25	400	<2
10	<10	1,000	200	<200	7	1	5	<.1	100	<25	150	---
11	<10	1,000	200	<200	7	1	5	<.1	100	<25	150	---
12	<10	1,500	300	<200	>10	1	7	<.1	100	<25	150	---
13	<10	1,500	300	<200	7	1	5	<.1	100	<25	200	---
14	<10	1,500	200	<200	7	.7	5	<.1	100	<25	200	---
15	<10	1,000	700	<200	>10	1	5	<.1	80	<25	200	---
16	<10	1,000	300	<200	>10	1	5	<.1	80	<25	75	---
17	<10	1,000	200	<200	7	1	5	<.1	60	<25	75	---
U--Stream sediments from Williams Creek drainage												
1	<10	500	500	<200	7	1.5	2	---	40	<15	75	---
2	<10	700	200	<200	7	1.5	3	---	20	25	50	---
3	<10	500	300	<200	10	1.5	3	---	20	<15	75	---
4	<10	500	150	<200	7	1	3	---	20	15	50	---
5	<10	500	150	<200	7	1	3	---	20	<15	75	---
6	<10	500	200	<200	7	1.5	3	---	20	20	75	---
7	<10	500	200	<200	10	1.5	2	---	20	<15	75	---
8	<10	500	200	<200	7	1.5	3	---	20	<15	75	---
9	<10	500	150	<200	7	1.5	2	<.2	30	15	100	<1
10	<10	500	300	<200	10	1.5	2	---	30	<15	100	---
11	<10	500	150	<200	7	1	2	---	15	<15	50	---
12	<10	500	150	<200	7	1.5	2	---	20	<15	50	---
13	<10	300	100	<200	5	1	1.5	---	20	<15	50	---
14	<10	500	150	<200	7	1.5	3	---	20	<15	75	---
15	<10	500	150	<200	7	2	3	---	30	15	75	---
16	<10	500	200	<200	7	1.5	3	---	20	<15	75	---
17	<10	500	100	<200	5	1	2	---	20	<15	50	---
18	<10	500	70	<200	5	1.5	2	---	10	<15	50	---
19	<10	700	200	<200	7	1	2	<.2	30	<15	100	---
20	<10	500	150	<200	7	1	3	---	20	<15	75	---
21	<10	500	200	<200	7	1.5	3	---	20	<15	150	---
22	<10	500	150	<200	7	1.5	3	---	40	<15	75	---
23	<10	500	150	<200	7	1.5	3	---	30	<15	75	---
24	<10	500	150	<200	7	1.5	3	---	40	<15	75	---
25	<10	300	100	<200	5	1	1.5	---	15	<15	50	---
26	<10	500	150	<200	7	1.5	3	---	30	<15	75	---
26a	<10	500	200	<200	7	1.5	3	---	30	<15	100	---
27	<10	500	200	<200	10	1.5	5	---	20	<15	125	---
28	<10	500	200	<200	7	2	5	---	5	<15	100	---
29	<10	500	150	<200	7	1.5	3	---	20	<15	50	---
30	<10	500	150	<200	7	2	3	---	10	<15	75	---
31	<10	500	150	<200	7	1.5	3	---	20	<15	75	---
32	<10	500	100	<200	5	2	3	---	20	<15	75	---
32a	<10	500	150	<200	7	1.5	3	---	15	<15	75	---
33	<10	500	300	<200	M	1	3	<.2	15	<15	200	<1
34	<10	700	150	<200	7	1.5	3	<.2	20	<15	50	---
35	<10	700	150	<200	7	1.5	3	<.2	15	<15	75	---
36	<10	500	150	<200	7	1	3	---	20	<15	75	---
37	<10	700	150	<200	7	2	3	---	30	<15	75	---
38	<10	300	100	<200	5	.5	1.5	---	10	<15	50	---
39	<10	200	100	<200	5	.7	1	---	15	<15	50	---
40	<10	500	200	<200	10	2	5	---	20	<15	150	---
41	<10	500	150	<200	7	2	3	---	10	<15	75	---
41a	<10	500	150	<200	7	2	3	---	20	25	50	---
42	<10	500	150	<200	7	2	3	---	10	<15	75	---
43	<10	500	200	<200	7	3	3	<.2	5	<15	175	---
44	<10	500	300	<200	10	1.5	3	<.2	20	<15	125	---
45	<10	500	200	<200	10	1.5	3	<.2	15	<15	250	<1
46	<10	700	150	<200	7	2	3	<.2	15	<15	100	---
46a	<10	700	200	<200	10	1.5	3	<.2	20	<15	125	---

TABLE 3.—*Analyses of stream-*

	Semiquantitative spectrographic analyses (ppm)											
Sample	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
					U--Stream sediments from Williams Creek drainage--Continued							
47	3,000	700	<1	<2,000	1,000	5	30	15	<3	3	15	<200
48	5,000	500	<1	<2,000	1,000	10	15	20	<3	5	15	<200
49	2,000	500	<1	<2,000	700	3	15	20	<3	7	15	<200
50	5,000	500	<1	<2,000	1,000	10	15	20	<3	7	15	<200
51	5,000	1,000	<1	<2,000	1,000	15	7	20	<3	5	10	<200
52	5,000	1,000	<1	<2,000	1,000	15	10	20	<3	7	15	<200
53	3,000	700	<1	<2,000	1,000	10	10	20	<3	7	20	<200
54	5,000	500	<1	<2,000	1,000	15	10	20	<3	7	15	<200
55	2,000	300	<1	<2,000	700	7	30	20	<3	10	20	<200
56	2,000	300	<1	<2,000	700	10	100	30	<3	20	20	<200
					V--Stream sediments from Middle Fork Piedra River drainage							
1	1,500	1,000	<1	<2,000	700	5	7	10	<3	3	50	<200
2	2,000	1,000	<1	<2,000	700	10	15	20	<3	5	50	<200
3	2,000	1,500	<1	<2,000	700	7	10	15	<3	3	30	<200
4	3,000	1,500	<1	<2,000	700	10	15	20	5	3	50	<200
5	5,000	2,000	<1	<2,000	1,000	10	15	15	3	5	50	<200
6	3,000	2,000	<1	<2,000	1,000	10	10	20	3	7	50	<200
7	3,000	1,500	<1	<2,000	700	5	15	20	3	7	30	<200
8	2,000	500	<1	<2,000	700	10	20	20	<3	7	30	<200
9	7,000	1,500	<.5	<200	700	30	15	30	<5	10	50	<100
10	3,000	1,000	<1	<2,000	700	15	15	20	<3	7	30	<200
11	10,000	1,500	<.5	<200	700	30	15	30	15	15	30	<100
12	2,000	1,500	<1	<2,000	700	10	10	20	3	5	50	<200
13	7,000	1,500	<1	<2,000	500	15	15	30	<3	7	20	<200
14	7,000	1,500	<1	<2,000	700	15	15	30	<3	7	30	<200
15	5,000	1,500	<1	<2,000	1,000	10	15	20	<3	5	30	<200
16	3,000	1,500	<1	<2,000	700	10	15	30	<3	5	20	<200
17	2,000	700	<1	<2,000	700	10	15	15	<3	5	15	<200
18	3,000	500	<1	<2,000	700	10	10	15	<3	5	20	<200
19	5,000	1,000	<1	<2,000	700	15	15	30	<3	7	30	<200
20	2,000	700	<1	<2,000	500	15	15	30	<3	7	30	<200
21	3,000	700	<1	<2,000	700	15	30	30	<3	7	30	<200
22	3,000	700	<1	<2,000	700	10	10	15	<3	3	15	<200
23	5,000	2,000	<1	<2,000	700	15	15	20	<3	7	20	<200
24	7,000	2,000	<1	<2,000	1,000	10	15	15	<3	5	20	<200
25	5,000	700	<1	<2,000	700	15	10	20	<3	5	20	<200
26	3,000	500	<1	<2,000	1,000	15	15	20	<3	7	20	<200
27	5,000	1,500	<1	<2,000	700	15	10	15	<3	5	15	<200
28	5,000	1,000	<1	<2,000	700	15	7	20	<3	5	20	<200
29	3,000	1,000	<1	<2,000	700	15	15	15	<3	7	20	<200
30	7,000	1,500	<1	<2,000	700	15	10	15	<3	7	15	<200
31	7,000	1,500	<1	<2,000	700	15	10	15	<3	7	15	<200
32	7,000	1,500	<1	<2,000	700	15	10	20	<3	5	20	<200
33	3,000	700	<1	<2,000	700	10	15	15	<3	7	30	<200
34	3,000	1,000	<.5	<200	700	10	<5	20	<5	10	70	<100
35	3,000	700	<.5	<200	500	5	<5	15	<5	10	50	<100
36	3,000	1,000	<.5	<200	700	5	<5	15	<5	5	100	<100
37	3,000	700	<.5	<200	500	5	<5	20	<5	10	50	<100
38	3,000	1,000	<.5	<200	700	5	<5	20	<5	5	100	<100
39	7,000	1,000	<1	<2,000	700	15	7	20	<3	7	20	<200
40	7,000	2,000	<1	<2,000	700	15	15	20	<3	7	20	<200
41	7,000	2,000	<1	<2,000	700	15	15	15	<3	5	15	<200
42	7,000	2,000	<1	<2,000	700	20	15	15	<3	7	15	<200
					W--Stream sediments from Trout Creek drainage							
1	3,000	300	<1	<2,000	700	10	7	15	<3	7	15	<200
2	5,000	500	<1	<2,000	1,000	20	15	20	<3	10	50	<200
3	3,000	500	<1	<2,000	500	10	7	15	<3	5	30	<200
4	2,000	500	<1	<2,000	500	10	10	15	<3	5	10	<200
5	3,000	500	<1	<2,000	700	15	10	15	<3	7	15	<200

sediment samples—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
	U--Stream sediments from Williams Creek drainage--Continued											
47	<10	700	100	<200	5.0	1.5	3.0	---	40	<15	50	---
48	<10	700	150	<200	7	1.5	3	---	10	<15	75	---
49	<10	150	500	<200	2	.7	2	---	15	<15	50	---
50	<10	500	150	<200	7	1.5	2	<0.2	20	<15	75	---
51	<10	500	150	<200	7	2	3	---	20	<15	50	---
52	<10	700	200	<200	10	2	3	---	15	<15	75	---
53	<10	500	100	<200	5	1.5	2	---	20	<15	75	---
54	<10	700	100	<200	7	1	3	---	15	<15	75	---
55	<10	100	70	<200	2	.7	.7	---	20	<15	50	---
56	<10	150	150	<200	5	1.5	1	---	20	15	100	---
	V--Stream sediments from Middle Fork Piedra River drainage											
1	<10	150	30	<200	1.5	.5	.7	---	10	15	75	---
2	<10	300	100	<200	3	.7	.7	---	15	<15	75	---
3	<10	150	30	<200	3	.7	.7	---	20	<15	75	---
4	<10	300	150	<200	5	.7	.7	---	30	15	75	---
5	<10	300	150	<200	7	.7	.7	---	10	15	75	---
6	<10	300	150	<200	7	.7	.7	---	15	<15	50	---
7	<10	300	150	<200	7	.7	1.5	---	20	<15	75	---
8	<10	300	100	<200	3	.7	.5	---	20	<15	50	---
9	<10	300	200	<200	7	1	1.5	<.02	<10	70	47	1
10	<10	300	150	<200	7	1	1.5	---	20	15	75	---
11	<10	300	300	<200	15	1.5	2	<.02	15	<25	86	1
12	<10	500	150	<200	5	.7	1.5	---	20	<15	50	---
13	<10	300	300	<200	7	1.5	5	<.2	20	<15	75	---
14	<10	500	200	<200	7	1.5	3	---	20	<15	50	---
15	<10	300	150	<200	7	1	1.5	---	15	<15	50	---
16	<10	500	150	<200	7	1	3	<.2	20	15	50	---
17	<10	300	150	<200	7	1	2	---	20	<15	50	---
18	<10	300	150	<200	5	1	2	---	20	<15	50	---
19	<10	300	150	<200	7	1	2	<.2	15	<15	50	<1
20	<10	300	150	<200	7	1	2	---	20	<15	50	---
21	<10	300	150	<200	5	.7	2	<.2	20	<15	75	1
22	<10	700	150	<200	7	1	3	---	20	<15	50	---
23	<10	500	300	<200	7	1.5	3	---	10	<15	75	---
24	<10	500	150	<200	7	1.5	3	---	15	<15	50	---
25	<10	500	150	<200	7	1.5	2	---	20	<15	75	---
26	<10	700	150	<200	7	1	3	---	15	<15	75	---
27	<10	700	200	<200	7	2	5	<.2	20	<15	150	---
28	<10	700	150	<200	7	1.5	5	<.2	20	<15	50	---
29	<10	500	150	<200	7	1.5	3	---	20	<15	100	---
30	<10	500	300	<200	7	1.5	3	---	15	15	75	---
31	<10	500	200	<200	7	1.5	3	---	15	<15	100	---
32	<10	500	150	<200	7	1.5	3	---	20	<15	50	---
33	<10	300	150	<200	7	1	2	---	15	<15	50	---
34	<10	200	100	<200	5	.7	1.5	---	45	25	52	---
35	<10	150	50	<200	3	.5	.7	---	40	50	49	---
36	<10	150	50	<200	3	.5	.5	---	33	50	42	---
37	<10	100	30	<200	2	.5	.5	---	45	100	34	---
38	<10	200	20	<200	3	.7	.7	---	45	125	48	---
39	<10	500	150	<200	7	1.5	3	---	15	<15	50	---
40	<10	700	200	<200	7	1.5	5	<.2	20	<15	100	---
41	<10	500	200	<200	7	1.5	3	<.2	20	<15	100	---
42	<10	500	300	<200	7	1.5	3	---	15	<15	150	---
	W--Stream sediments from Trout Creek drainage											
1	<10	700	100	<200	3	.5	1.5	<.1	60	<25	50	---
2	<10	1,000	200	<200	5	1	.3	<.1	100	<25	75	---
3	<10	300	100	<200	3	.7	1.5	<.1	60	<25	75	---
4	<10	500	70	<200	2	.7	1.5	<.1	40	<25	50	---
5	<10	700	150	<200	3	.7	2	<.1	70	<25	50	---

TABLE 3.—*Analyses of stream-*

Sample	Semiquantitative spectrographic analyses (ppm)											
	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
W--Stream sediments from Trout Creek drainage--Continued												
6	3,000	500	<1	<2,000	700	10	15	20	<3	7	15	<200
7	5,000	700	<1	<2,000	700	15	15	15	<3	5	15	<200
8	3,000	300	<1	<2,000	500	10	10	15	<3	5	20	<200
9	5,000	700	<1	<2,000	500	20	30	20	<3	10	15	<200
10	3,000	200	<1	<2,000	500	10	15	30	<3	3	15	<200
11	3,000	500	<1	<2,000	700	15	15	20	<3	10	15	<200
12	5,000	700	<1	<2,000	700	30	20	30	<3	15	10	<200
13	5,000	500	<1	<2,000	700	15	20	15	<3	10	15	<200
14	2,000	300	<1	<2,000	500	7	10	20	<3	0	20	<200
15	2,000	300	<1	<2,000	500	5	7	20	<3	3	20	<200
16	2,000	300	<1	<2,000	500	7	5	15	<3	5	30	<200
17	3,000	700	<1	<2,000	700	20	7	30	<3	10	0	<200
18	1,000	300	<1	<2,000	500	5	5	10	<3	2	20	<200
19	2,000	700	<1	<2,000	500	15	7	15	<3	5	15	<200
20	2,000	300	<1	<2,000	700	7	5	10	<3	3	20	<200
21	2,000	300	<1	<2,000	700	5	5	10	<3	2	20	<200
22	1,500	500	<1	<2,000	1,000	0	3	7	<3	0	20	<200
X--Stream sediments from Red Mountain Creek drainage												
1	5,000	500	<1	<2,000	1,000	15	20	15	<3	10	15	<200
2	3,000	500	<1	<2,000	1,000	10	15	15	<3	7	15	<200
3	3,000	700	<1	<2,000	1,000	15	20	20	<3	10	20	<200
4	3,000	700	<1	<2,000	1,000	10	15	15	<3	10	20	<200
5	3,000	700	<1	<2,000	1,000	15	20	15	<3	15	15	<200
6	2,000	700	<1	<2,000	700	10	15	15	<3	10	20	<200
7	3,000	700	<1	<2,000	1,000	15	7	15	<3	10	15	<200
8	1,500	500	<1	<2,000	500	7	10	10	<3	3	20	<200
9	1,500	500	<1	<2,000	700	7	10	7	<3	5	20	<200
10	1,500	700	<1	<2,000	700	7	10	7	<3	5	20	<200
11	1,500	700	<1	<2,000	700	7	15	10	<3	7	20	<200
12	1,000	700	<1	<2,000	700	<3	3	5	<3	<3	20	<200
13	1,000	500	<1	<2,000	500	<3	3	3	<3	<3	20	<200
14	1,000	700	<1	<2,000	500	<3	2	5	<3	<3	20	<200
15	5,000	1,500	<.5	<200	1,000	20	50	50	<5	15	20	<100
16	3,000	1,000	<1	<2,000	1,000	20	30	50	<3	15	15	<200
17	3,000	1,500	<.5	<200	1,000	15	30	30	<5	15	10	<100
18	5,000	1,500	<.5	<200	1,000	20	50	50	<5	15	15	<100
19	3,000	1,500	<.5	<200	1,000	15	30	20	<5	15	10	<100
20	3,000	1,000	<.5	<200	1,000	15	20	20	<5	10	10	<100
21	5,000	1,500	<.5	<200	1,000	20	20	30	<5	10	10	<100
22	5,000	1,000	<.5	<200	1,000	15	50	50	<5	15	15	<100
23	3,000	1,500	<.5	<200	1,000	15	20	20	<5	15	10	<100
24	5,000	2,000	<.5	<200	1,000	20	30	20	<5	15	15	<100
25	3,000	1,000	<.5	<200	1,000	15	15	50	<5	10	10	<100
26	5,000	1,500	<.5	<200	1,000	15	30	50	<5	15	<10	<100
27	3,000	1,500	<.5	<200	1,000	15	50	50	<5	15	10	<100
28	5,000	1,000	<.5	<200	1,000	15	30	30	<5	10	10	<100
29	3,000	1,000	<.5	<200	700	15	20	20	<5	15	15	<100
30	3,000	1,000	<.5	<200	700	15	30	20	<5	15	15	<100
31	3,000	700	<1	<2,000	700	3	30	30	<3	<3	30	<200
32	3,000	700	<1	<2,000	700	3	15	30	<2	<3	30	<200
Y--Stream sediments from East Fork Piedra River drainage												
1	3,000	1,000	<.5	<200	1,000	7	<10	15	<5	5	15	<100
2	2,000	1,000	<.5	<200	700	5	<10	15	<5	5	20	<100
3	3,000	1,000	<.5	<200	700	5	<10	15	<5	5	10	<100
4	2,000	500	<.5	<200	700	5	<10	10	<5	5	10	<100
5	2,000	1,000	<.5	<200	700	5	<10	15	<5	5	15	<100

sediment samples—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sn	Sr	V	Zn	(percent) Fe	Mg	Ca	Chemical analyses (ppm) Au	Cu	Pb	Zn	Mo
W--Stream sediments from Trout Creek drainage--Continued												
6	<10	500	100	<200	3.0	0.5	1.5	<0.1	70	<25	75	---
7	<10	700	150	<200	5	.7	2	<.1	60	<25	75	---
8	<10	500	100	<200	2	.5	1	<.1	50	25	50	---
9	<10	700	300	<200	7	1	2	<.1	60	50	200	2
10	<10	500	100	<200	3	.7	1	<.1	40	25	25	---
11	<10	500	200	<200	5	1	2	<.1	30	<25	50	---
12	<10	1,000	200	<200	7	1.5	5	<.1	30	<25	75	---
13	<10	700	200	<200	5	.7	3	<.1	30	<25	200	---
14	<10	300	70	<200	3	.5	.7	<.1	20	25	25	---
15	<10	300	70	<200	3	.5	.7	<.1	30	<25	25	---
16	<10	500	70	<200	2	.5	1	<.1	20	<25	25	---
17	<10	1,000	150	<200	5	1	5	<.1	70	<25	50	---
18	<10	300	50	<200	1.5	.3	1	.1	20	<25	25	---
19	<10	500	100	<200	5	.7	1.5	<.1	60	50	50	2
20	<10	500	50	<200	1.5	.3	1	<.1	50	<25	25	---
21	<10	500	50	<200	1.5	.3	.7	.1	50	<25	25	---
22	<10	500	30	<200	1.5	.3	1	<.1	10	<25	25	---
X--Stream sediments from Red Mountain Creek drainage												
1	<10	1,500	200	<200	7	1	2	<.1	40	<25	150	---
2	<10	1,000	100	<200	3	.7	2	<.1	40	<25	50	---
3	<10	1,000	150	<200	5	.7	2	<.1	30	<25	50	---
4	<10	1,000	100	<200	3	.7	2	<.1	20	<25	50	---
5	<10	1,000	150	<200	5	.7	3	<.1	40	<25	50	---
6	<10	700	70	<200	3	.7	2	<.1	20	<25	50	---
7	<10	1,000	100	<200	3	1	3	<.1	30	<25	75	---
8	<10	300	50	<200	1.5	.5	1.5	<.1	15	<25	50	---
9	<10	500	50	<200	1.5	.5	1	<.1	15	<25	50	---
10	<10	500	70	<200	2	.3	1	<.1	15	<25	50	---
11	<10	300	70	<200	2	.5	1	<.1	20	<25	50	---
12	<10	300	20	<200	1	.2	.5	<.1	10	<25	25	---
13	<10	200	15	<200	1	.2	.5	<.1	15	<25	25	---
14	<10	200	15	<200	1	.2	.5	<.1	20	<25	25	---
15	<10	500	200	<200	10	2	1	.1	20	<25	100	---
16	<10	700	100	<200	.7	1	1.5	<.05	30	<25	150	---
17	<10	500	150	<200	7	1.5	1	<.1	20	<25	100	---
18	<10	500	150	<200	10	2	1.5	<.1	<10	37	<50	---
19	<10	300	150	<200	10	1.5	1.5	<.1	20	37	100	---
20	<10	300	150	<200	10	1.5	1.5	<.1	10	<25	100	---
21	<10	300	150	<200	10	1.5	1	<.1	20	<25	<50	---
22	<10	500	200	<200	10	2	1.5	<.1	<10	40	<50	---
23	<10	500	200	<200	10	1.5	1.5	<.1	20	30	<50	---
24	<10	300	200	<200	10	2	1	<.1	<10	<25	<50	---
25	<10	500	150	<200	10	1.5	2	<.1	40	<25	100	---
26	<10	500	200	<200	10	1.5	2	<.1	40	<25	100	---
27	<10	300	150	<200	10	1.5	1	<.1	20	40	100	---
28	<10	500	200	<200	10	1.5	2	<.1	40	<25	50	---
29	<10	300	100	<200	10	1.5	2	<.1	10	<25	100	---
30	<10	200	150	<200	10	1.5	.5	<.1	40	<25	<50	---
31	<10	300	70	<200	5	1.5	.3	.16	20	<25	50	<10
32	<10	300	100	<200	7	1.5	.5	.2	30	<25	25	<10
Y--Stream sediments from East Fork Piedra River drainage												
1	<10	500	100	<200	7	1	1.5	<.1	<10	30	50	---
2	<10	100	70	<200	5	.7	.5	<.1	<10	<25	<50	---
3	<10	500	150	<200	7	1	1.5	<.1	10	<25	<50	---
4	<10	300	70	<200	5	.7	.7	<.1	10	30	<50	---
5	<10	200	100	<200	7	1	.3	<.1	10	<25	50	---

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses

Sample	Ti	Mn	Ag	As	Ba (ppm)	Co	Cr	Cu	Mo	Ni	Pb	Sb
					Y--Stream sediments from East Fork Piedra River drainage--Continued							
6	3,000	1,000	<0.5	<200	1,000	7	<10	10	<5	5	10	<100
7	2,000	1,000	<.5	<200	300	<5	<10	10	<5	5	15	<100
8	3,000	1,000	<.5	<200	1,000	5	<10	5	<5	5	20	<100
9	2,000	1,000	<.5	<200	700	7	<10	10	<5	5	15	<100
10	2,000	1,500	<.5	<200	500	<5	<10	5	<5	5	10	<100
11	2,000	500	<.5	<200	700	<5	<10	10	<5	5	20	<100
12	3,000	1,000	<.5	<200	1,000	5	<10	10	<5	5	15	<100
13	3,000	500	<.5	<200	1,000	10	<10	10	<5	5	10	<100
14	2,000	700	<.5	<200	1,000	5	<10	10	<5	5	10	<100
15	3,000	1,000	<.5	<200	700	7	<10	10	<5	5	15	<100
16	2,000	1,000	<.5	<200	1,000	5	<10	10	<5	5	15	<100
17	3,000	1,000	<.5	<200	1,000	10	<10	20	<5	7	15	<100
18	2,000	500	<.5	<200	700	5	<10	10	<5	5	10	<100
19	7,000	1,500	<.5	<200	1,000	20	20	20	<5	10	10	<100
20	5,000	1,000	<.5	<200	700	10	10	10	<5	5	10	<100
21	5,000	700	<.5	<200	700	<5	15	30	<5	5	20	<100
22	10,000	3,000	<.5	<200	500	70	30	50	<5	15	20	<100
23	7,000	3,000	<.5	<200	500	20	<5	20	<5	5	15	<100
24	7,000	2,000	<.5	<200	500	20	5	15	<5	5	20	<100
25	5,000	1,000	<.5	<200	500	20	5	20	<5	<5	30	<100
26	7,000	3,000	<.5	<200	500	20	5	30	<5	10	20	<100
27	10,000	1,500	<1	<2,000	700	30	50	30	<3	15	20	<200
28	5,000	1,500	<1	<2,000	1,000	15	15	20	<3	7	20	<200
29	7,000	1,500	<1	<2,000	1,000	15	10	20	<3	7	20	<200
30	7,000	1,500	<1	<2,000	1,000	15	5	20	<3	3	10	<200
31	7,000	1,500	<1	<2,000	1,000	15	15	20	<3	7	20	<200
32	7,000	1,500	<1	<2,000	1,000	15	15	20	<3	7	20	<200
33	-----	1,500	<1	<2,000	700	30	30	30	<3	10	15	<200
34	5,000	1,500	<1	<2,000	1,500	10	15	15	<3	7	20	<200
35	7,000	1,500	<1	<2,000	1,500	20	7	30	<3	7	20	<200
36	7,000	1,500	<1	<2,000	1,000	15	15	20	<3	7	20	<200
					Z--Stream sediments from Fourmile Creek drainage							
1	7,000	1,500	<1	<2,000	700	10	15	20	<3	7	30	<200
2	5,000	1,000	<1	<2,000	1,000	10	7	30	<3	7	20	<200
3	7,000	1,500	<1	<2,000	700	15	10	15	<3	7	20	<200
4	3,000	1,000	<1	<2,000	1,000	10	7	20	<3	5	20	<200
5	7,000	2,000	<1	<2,000	1,000	15	20	50	<3	10	20	<200
6	3,000	1,000	<1	<2,000	1,000	15	15	70	<3	5	30	<200
7	3,000	1,500	<1	<2,000	1,000	10	7	15	<3	3	30	<200
8	7,000	1,500	<1	<2,000	1,500	15	10	30	<3	10	30	<200
9	7,000	1,500	<1	<2,000	700	15	10	20	<3	7	20	<200
10	7,000	1,000	<1	<2,000	700	10	15	20	<3	5	20	<200
11	3,000	500	<1	<2,000	1,000	7	20	20	<3	7	30	<200
12	7,000	1,500	<1	<2,000	1,000	15	15	20	<3	7	20	<200
13	3,000	1,000	<1	<2,000	1,000	7	7	15	<3	5	30	<200
14	3,000	1,000	<1	<2,000	1,000	7	10	10	<3	3	30	<200
15	3,000	200	<1	<2,000	700	5	20	15	<3	5	20	<200
16	3,000	1,000	<1	<2,000	700	7	10	10	<3	5	30	<200
					AA--Stream sediments from Turkey Creek drainage							
1	5,000	1,000	<1	<2,000	1,000	15	15	20	<3	10	20	<200
2	5,000	1,000	<.5	<200	700	15	15	20	<5	20	20	<100
3	7,000	3,000	<.5	<200	500	15	<5	20	<5	10	70	<100
4	5,000	2,000	<.5	<200	500	5	<5	15	<5	10	50	<100
5	10,000	2,000	<.5	<200	700	15	5	20	<5	15	50	<100

sediment samples—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
Y--Stream sediments from East Fork Piedra River drainage--Continued												
6	<10	200	150	<200	7.0	1.0	0.2	<0.1	<10	<25	<50	---
7	<10	100	70	<200	3	.7	.2	<.1	<10	<25	<50	---
8	<10	200	100	<200	5	1	.2	<.1	<10	<25	<50	---
9	<10	200	50	<200	5	.7	.5	<.1	<10	<25	<50	---
10	<10	100	50	<200	5	.7	.5	<.1	<10	<25	<50	---
11	<10	100	50	<200	3	1	.5	<.1	<10	<25	<50	---
12	<10	300	100	<200	5	1	.5	<.1	<10	<25	<50	---
13	<10	500	150	<200	7	1	1.5	<.1	10	<25	<50	---
14	<10	500	70	<200	5	1	1.5	<.1	<10	<25	<50	---
15	<10	300	100	<200	5	1	1	<.1	10	<25	<50	---
16	<10	200	100	<200	5	1	1	<.1	<10	<25	50	---
17	<10	500	150	<200	7	1.5	1.5	<.1	20	<25	50	---
18	<10	200	70	<200	3	1	1	<.1	10	<25	<50	---
19	<10	500	200	<200	15	1.5	2	<.1	20	<25	<50	---
20	<10	500	200	<200	10	1.5	2	<.1	<10	<25	50	---
21	<10	150	50	<200	15	1.5	.5	---	35	50	120	---
22	<10	500	500	<200	10	1.5	3	---	10	25	110	---
23	<10	500	200	<200	10	1	3	---	10	25	65	---
24	<10	500	100	<200	7	1.5	5	---	10	<25	60	---
25	<10	500	100	<200	5	.5	3	---	10	<25	64	---
26	<10	500	150	<200	7	1	5	---	18	25	90	---
27	<10	500	500	<200	7	1	3	<.2	10	<15	200	<1
28	<10	500	150	<200	7	1.5	3	---	20	<15	75	---
29	<10	500	150	<200	7	1.5	3	<.2	20	<15	50	<1
30	<10	500	150	<200	7	1.5	5	---	20	<15	75	---
31	<10	500	200	<200	7	1.5	3	---	15	<15	75	---
32	<10	500	200	<200	7	1.5	3	---	15	<15	75	---
33	<10	500	500	300	M	1.5	3	<.2	10	<15	300	<1
34	<10	700	150	<200	7	1	5	---	15	<15	75	---
35	<10	500	200	<200	7	1.5	7	<.2	30	<15	50	<1
36	<10	500	200	<200	7	1.5	5	---	15	<15	100	---
Z--Stream sediments from Fourmile Creek drainage												
1	<10	500	150	<200	7	1	3	---	10	<15	50	---
2	<10	500	100	<200	7	1.5	3	<.2	20	<15	50	---
3	<10	500	150	<200	7	1	5	---	15	<15	75	---
4	<10	500	70	<200	5	1	3	---	20	<15	50	---
5	<10	700	150	<200	7	1.5	.7	---	30	<15	75	---
6	<10	300	100	<200	7	1.5	3	---	40	<15	50	---
7	<10	500	100	<200	7	1	5	---	15	<15	50	---
8	<10	300	100	<200	7	1.5	3	---	20	<15	50	---
9	<10	500	150	<200	7	1.5	5	---	15	<15	75	---
10	<10	300	100	<200	7	1.5	3	---	20	<15	75	---
11	<10	300	100	<200	5	7	2	---	5	<15	50	---
12	<10	300	150	<200	7	1.5	5	---	15	<15	50	---
13	<10	300	70	<200	3	1	3	---	10	<15	50	---
14	<10	300	100	<200	3	1	3	---	10	<15	50	---
15	<10	200	70	<200	2	.7	.7	---	15	<15	25	---
16	<10	500	70	<200	5	1	2	---	10	<15	50	---
AA--Stream sediments from Turkey Creek drainage												
1	<10	1,000	150	<200	7	1.5	5	---	20	<15	50	---
2	<10	500	200	<200	3	5	5	---	25	50	57	---
3	<10	300	200	<200	5	7	2	---	25	100	78	---
4	<10	200	100	<200	5	2	1.5	---	45	300	77	---
5	<10	300	200	<200	15	7	2	---	13	50	50	---

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses

Sample	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
	(ppm)											
	BB--Stream sediments from West Fork San Juan River drainage											
1	3,000	700	<0.5	<200	200	<5	<5	7	<5	<5	15	<100
2	3,000	1,000	<.5	<200	300	5	<5	15	<5	<5	50	<100
3	2,000	700	<.5	<200	200	5	<5	7	<5	<5	30	<100
4	3,000	700	<.5	<200	300	5	<5	10	<5	<5	10	<100
5	5,000	1,000	<.5	<200	500	15	<5	15	<5	10	20	<100
6	5,000	1,500	<.5	<200	700	30	5	20	<5	10	50	<100
7	3,000	2,000	<.5	<200	500	15	5	30	<5	10	50	<100
8	2,000	2,000	<.5	<200	700	10	<10	20	<5	10	10	<100
9	5,000	2,000	<.5	<200	700	20	5	20	<5	10	50	<100
10	3,000	700	<.5	<200	700	10	<5	15	<5	5	50	<100
11	5,000	1,000	<.5	<200	700	30	<5	30	<5	5	20	<100
12	3,000	1,000	<.5	<200	700	10	<10	10	<5	5	10	<100
13	5,000	1,500	<.5	<200	500	10	<5	30	<5	5	30	<100
14	3,000	1,500	<.5	<200	500	15	5	30	<5	10	50	<100
15	5,000	1,500		<200	700	15	15	30	<5	10	15	<100
16	3,000	1,000	<.5	<200	500	10	5	30	<5	10	50	<100
17	3,000	1,000	<.5	<200	500	5	5	15	<5	10	70	<100
18	3,000	1,000	<.5	<200	500	5	5	15	<5	10	70	<100
19	3,000	1,000	<.5	<200	500	5	<5	15	<5	10	70	<100
20	3,000	1,000	<.5	<200	500	15	5	20	<5	10	50	<100
21	3,000	1,000	<.5	<200	500	15	5	30	<5	10	70	<100
22	3,000	1,000	<.5	<200	500	20	10	20	<5	10	50	<100
23	3,000	1,000	<.5	<200	300	5	5	15	<5	<5	20	<100
24	5,000	1,000	<.5	<200	700	15	15	30	<5	5	10	<100
25	5,000	700	<.5	<200	500	5	<5	15	<5	5	30	<100
26	5,000	1,000	<.5	<200	500	10	5	20	<5	5	30	<100
27	3,000	1,000	<.5	<200	700	7	10	15	<5	3	30	<100
28	3,000	1,000	<.5	<200	1,000	<5	<10	10	<5	5	20	<100
29	3,000	700	<.5	<200	500	5	<5	15	<5	<5	50	<100
30	2,000	500	<.5	<200	200	5	<5	7	<5	<5	10	<100
31	3,000	1,000	<.5	<200	300	10	<5	15	<5	<5	30	<100
32	5,000	1,000	<.5	<200	300	15	5	10	<5	5	20	<100
33	5,000	1,000	<.5	<200	1,000	15	20	20	<5	10	10	<100
34	7,000	2,000	<.5	<200	500	10	5	20	<5	5	20	<100
35	5,000	500	<.5	<200	500	<5	<5	<5	<5	<5	30	<100
36	10,000	3,000	<.5	<200	300	30	15	20	<5	5	30	<100
37	5,000	1,000	<.5	<200	500	10	<5	20	<5	5	20	<100
38	5,000	1,500	<.5	<200	500	5	<5	20	<5	<5	20	<100
39	5,000	1,000	<.5	<200	500	10	10	20	<5	5	20	<100
40	5,000	1,000	<.5	<200	500	20	<5	20	<5	<5	20	<100
41	5,000	1,000	<.5	<200	500	10	5	15	<5	<5	20	<100
42	3,000	1,000	<.5	<200	500	5	<5	10	<5	<5	20	<100
43	7,000	1,000	<1	<2,000	700	15	15	20	<3	5	20	<200
44	1,500	1,000	<1	<2,000	700	7	7	10	<3	3	30	<200
45	2,000	1,000	<1	<2,000	700	7	15	20	<3	3	30	<200
46	5,000	1,500	<1	<2,000	700	10	15	15	<3	5	20	<200
47	5,000	1,500	<1	<2,000	700	10	10	15	<3	5	30	<200
48	5,000	1,000	<1	<2,000	700	10	30	15	<3	7	15	<200
49	3,000	1,500	<1	<2,000	700	7	7	15	<3	3	30	<200
	CC--Stream sediments from Goose Creek drainage											
1	7,000	1,500	<.5	<200	1,000	20	10	50	<5	7	15	<100
2	7,000	1,500	<.5	<200	1,500	20	10	30	<5	7	20	<100
3	7,000	1,500	<.5	<200	1,000	20	10	30	<5	7	30	<100
4	7,000	1,500	<.5	<200	1,000	20	10	50	<5	7	30	<100
5	7,000	2,000	<.5	<200	1,000	20	15	50	<5	7	20	<100
6	7,000	1,500	<.5	<200	700	20	10	30	<5	7	20	<100
7	5,000	1,000	<.5	<200	700	15	30	30	<5	7	30	<100
8	7,000	2,000	<.5	<200	700	20	15	50	<5	7	30	<100
9	7,000	1,500	<.5	<200	1,000	20	30	50	<5	10	50	<100
10	5,000	1,500	<.5	<200	1,000	10	15	20	<5	7	20	<100

sediment samples—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
					BB--Stream sediments from West Fork San Juan River drainage							
1	<10	100	30	<200	2.0	0.7	0.5	---	15	25	56	---
2	<10	150	50	<200	3	1	1	---	<10	<25	42	---
3	<10	150	20	<200	2	.7	1	---	23	50	67	---
4	<10	500	70	<200	3	.7	2	---	30	75	88	---
5	<10	500	150	<200	5	1.5	2	---	35	100	76	---
6	<10	700	150	<200	5	1.5	3	---	20	<25	87	---
7	<10	300	100	<200	5	1.5	2	---	30	50	74	---
8	<10	300	100	<200	5	1.5	2	<0.1	<10	<50	<50	---
9	<10	500	100	<200	5	1.5	3	---	18	<25	76	---
10	<10	500	70	<200	5	1	2	---	13	<25	68	---
11	<10	1,000	150	<200	7	1.5	5	---	18	<25	73	---
12	<10	500	150	<200	10	1.5	1.5	<.1	<10	<25	56	---
13	<10	700	100	<200	7	1	3	---	12	<25	52	---
14	<10	500	100	<200	5	1.5	3	---	13	36	50	---
15	<10	500	200	<200	10	2	2	---	---	---	---	---
16	<10	500	70	<200	5	1	2	---	12	34	47	---
17	<10	200	50	<200	3	1	.7	---	10	36	45	---
18	<10	200	50	<200	3	.7	1	---	10	34	40	---
19	<10	100	30	<200	3	1	.7	---	<10	32	36	---
20	<10	700	70	<200	5	1.5	2	---	11	25	42	---
21	<10	500	70	<200	5	1.5	2	---	15	32	49	---
22	<10	500	70	<200	5	1.5	2	---	12	32	46	---
23	<10	300	70	<200	3	.7	2	---	14	36	78	---
24	<10	300	300	<200	15	1.5	2	.1	11	25	68	---
25	<10	200	70	<200	7	.7	2	---	25	50	56	---
26	<10	700	100	<200	7	1	3	---	18	50	54	---
27	<10	300	70	<200	7	1	1.5	---	15	<15	50	---
28	<10	300	70	<200	3	1	1	---	---	---	---	---
29	<10	200	30	<200	2	.7	1.5	---	10	25	45	---
30	<10	200	30	<200	2	.5	1.5	---	18	50	59	---
31	<10	500	50	<200	5	1	2	---	15	50	61	---
32	<10	700	100	<200	5	1	3	---	20	50	96	---
33	<10	500	150	<200	7	1.5	2	---	---	---	---	---
34	<10	300	100	<200	10	1	2	---	20	25	70	---
35	<10	100	15	<200	2	.5	2	---	10	25	31	---
36	<10	200	150	<200	10	.7	2	---	13	25	110	---
37	<10	500	70	<200	5	1	2	---	15	25	46	---
38	<10	500	70	<200	5	1	2	---	13	<25	40	---
39	<10	700	100	<200	5	1.5	3	---	<10	<25	51	---
40	<10	500	70	<200	5	1	3	---	18	25	67	---
41	<10	700	100	<200	5	1	3	---	13	<25	65	---
42	<10	700	70	<200	3	.7	2	---	10	50	76	---
43	<10	500	50	<200	7	1	3	---	10	<15	125	---
44	<10	300	50	<200	3	.7	1.5	---	10	<15	50	---
45	<10	300	50	<200	2	.5	1.5	<.2	15	<15	50	<1
46	<10	500	150	<200	7	1	2	---	15	<15	100	---
47	<10	500	150	<200	7	1	3	---	15	<15	100	---
48	<10	500	150	<200	7	1	3	---	15	<15	100	---
49	<10	300	100	<200	7	.7	2	---	15	<15	75	---
					CC--Stream sediments from Goose Creek drainage							
1	<10	1,000	300	<200	5	1.5	3	<.02	<10	<25	80	4
2	<10	1,000	300	<200	5	2	3	<.02	<10	<25	40	<4
3	<10	700	200	<200	5	1.5	3	<.02	15	<25	48	<4
4	<10	700	200	<200	5	1.5	3	<.02	26	<25	52	<4
5	<10	700	200	<200	5	2	3	<.02	10	<25	46	<4
6	<10	700	200	<200	5	1.5	3	<.02	12	<25	56	<4
7	<10	700	200	<200	3	1	3	<.02	<10	<25	44	<4
8	<10	700	300	<200	7	1.5	3	<.02	10	<25	60	8
9	<10	1,000	300	<200	5	2	3	<.02	10	<25	70	<4
10	<10	700	150	<200	3	.7	2	<.02	10	<25	40	<4

TABLE 3.—*Analyses of stream-*

Semiquantitative spectrographic analyses

(ppm)

Sample	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
CC--Stream sediments from Goose Creek drainage--Continued												
11	7,000	2,000	<.5	<200	700	15	20	30	<5	7	30	<100
12	5,000	1,500	<.5	<200	700	15	15	30	<5	10	20	<100
13	5,000	1,500	<.5	<200	1,000	15	30	50	<5	7	50	<100
14	5,000	1,000	<.5	<200	700	10	15	20	<5	5	30	<100
15	7,000	1,500	<.5	<200	700	15	20	50	<5	10	50	<100
16	5,000	2,000	<.5	<200	700	15	15	30	<5	7	30	<100
17	5,000	2,000	<.5	<200	1,000	15	10	20	<5	7	20	<100
18	7,000	2,000	<.5	<200	700	15	20	20	<5	7	20	<100
19	5,000	1,500	<.5	<200	700	10	30	30	<5	5	50	<100
20	5,000	1,500	<.5	<200	700	15	15	30	<5	7	30	<100
21	7,000	1,500	<.5	<200	700	15	15	30	<5	5	30	<100
22	7,000	2,000	<.5	<200	700	15	10	70	<5	7	50	<100
23	3,000	1,500	<.5	<200	1,000	10	10	20	<5	5	20	<100
24	5,000	1,500	<.5	<200	1,000	15	10	30	<5	7	30	<100
25	5,000	1,500	<.5	<200	1,000	15	15	30	<5	10	50	<100
26	5,000	1,500	<.5	<200	1,000	15	10	20	<5	10	20	<100

sediment samples—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sn	Sr	V	Zn	Fe	Mg	Ca	Au	Cu	Pb	Zn	Mo
	CC--Stream sediments from Goose Creek drainage--Continued											
11	<10	700	200	<200	5.0	1.5	3.0	<0.02	15	<25	66	<4
12	<10	700	200	<200	5	1	1.5	<.02	15	<25	100	<4
13	<10	700	200	<200	5	1.5	2	<.02	17	<25	84	<4
14	<10	500	200	<200	3	1	1.5	<.02	13	<25	120	<4
15	<10	700	200	<200	5	1.5	1.5	<.02	16	<25	96	<4
16	<10	500	150	<200	5	1	1.5	<.02	14	<25	140	<4
17	<10	700	200	<200	5	.7	3	<.02	<10	<25	52	<4
18	<10	700	300	<200	5	1.5	2	<.02	10	<25	100	<4
19	<10	500	150	<200	3	1	2	<.02	11	<25	120	<4
20	<10	500	200	<200	5	1.5	1.5	<.02	10	<25	94	<4
21	<10	700	200	<200	5	1	2	<.02	12	<25	68	<4
22	<10	700	200	<200	5	1	2	<.02	11	<25	68	4
23	<10	700	150	<200	5	1	2	<.02	11	<25	46	<4
24	<10	700	150	<200	5	1.5	3	<.02	10	<25	36	<4
25	<10	700	200	<200	5	1	2	<.02	10	<25	92	<4
26	<10	700	200	<200	5	1	2	<.02	10	<25	96	4

TABLE 8.—*Analyses of samples of pyritic*

Semiquantitative spectrographic analyses

Sample	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb	Sn	Sr
	(ppm)													
Ds125b	10,000	1,500	<0.5	<200	700	50	150	20	<5	100	100	<100	<10	<100
Ds125d	10,000	1,000	<.5	<200	500	30	150	30	<5	150	50	<100	<10	<100
Ds125f	10,000	500	<.5	<200	1,500	20	150	50	<5	30	70	<100	<10	<100
Ds125g	3,000	200	<.5	<200	700	<5	30	15	50	10	30	<100	<10	<100
Ds125h	5,000	700	1	<200	500	<5	30	50	70	30	50	<100	<10	<100
Ds125j	3,000	500	.5	<200	700	10	50	70	30	30	<10	<100	<10	<100
Ds125k	2,000	70	.7	<200	700	5	30	5	30	15	<10	<100	<10	<100
Ds125l	3,000	300	.5	<200	1,000	<5	30	30	70	150	<10	<100	<10	<100
Ds125m	10,000	300	.7	<200	700	<5	30	10	50	15	<10	<100	<10	<100
Ds125n	5,000	150	.5	<200	700	<5	30	20	50	50	30	<100	<10	<100
Ds125o	3,000	500	<.5	<200	700	30	50	150	10	30	70	<100	<10	<100
BSJ142	7,000	500	<.5	<200	500	<5	100	70	<2	15	15	<100	<10	50
BSJ145	7,000	300	<.5	<200	200	<5	100	50	<2	15	10	<100	<10	50
BSJ146	10,000	20	<.5	<200	200	5	70	50	<2	30	<10	<100	<10	50
BSJ148	7,000	30	<.5	<200	300	<5	50	20	<2	<2	10	<100	<10	<50
BSJ153	7,000	150	<.5	<200	150	5	70	20	<2	15	<10	<100	<10	<50
BSJ154	5,000	100	<.5	<200	300	<5	150	10	<2	10	20	<100	<10	<50
BSJ155	5,000	500	<.5	<200	200	5	150	30	<2	15	10	<100	<10	<50
BSJ156	7,000	50	<.5	<200	500	<5	30	20	15	<2	10	<100	<10	<50
BSJ157	3,000	500	<.5	<200	500	5	50	50	<2	15	10	<100	<10	<50
BSJ186	2,000	200	<.5	<200	200	50	50	150	<2	50	70	<100	<10	<50
BSJ190	3,000	100	<.5	<200	200	<5	20	30	20	10	<10	<100	<10	<50
BSJ198	5,000	200	<.5	<200	200	<5	100	5	<2	5	10	<100	<10	50

black slate from the Uncompahgre Formation

Sample	Semiquantitative spectrographic analyses--Continued (ppm) V	Zn	(percent) Fe	Mg	Ca	Chemical analyses (ppm) Au	Cu	Pb	Zn	Mo	Sample description
Ds125b	200	200	15.0	1.5	0.05	<0.02	24	40	160	<1	Silty sandstone.
Ds125d	200	<200	15	1.5	.05	<.02	59	70	89	<1	Siltstone and sandstone.
Ds125f	500	<200	15	3	.15	<.02	92	70	100	1	Black slate
Ds125g	700	<200	2	.7	.07	<.02	18	40	67	12	Do.
Ds125h	700	1,000	7	2	.7	<.02	67	110	510	11	Do.
Ds125j	300	<200	5	1	.5	<.02	22	<25	340	5	Black slate; pyrite.
Ds125k	300	<200	.7	.5	.3	<.02	<10	<25	200	6	Black slate.
Ds125l	500	<200	2	1.5	1.5	<.02	12	<25	92	18	Black slate; pyrite.
Ds125m	700	<200	1.5	1	.5	<.02	<10	<25	120	8	Do.
Ds125n	500	<200	3	.7	.7	<.02	12	35	20	12	Do.
Ds125o	300	<200d	7	1.5	.7	<.02	100	<25	180	1	Do.
BSJ142	100	<200	5	1	.2	<.02	---	---	---	---	Do.
BSJ145	100	<200	3	1	.2	<.02	---	---	---	---	Do.
BSJ146	100	<200	2	.5	.05	<.02	---	---	---	---	Do.
BSJ148	200	<200	1	.5	.05	<.02	---	---	---	---	Do.
BSJ153	50	<200	7	1	.05	<.02	---	---	---	---	Do.
BSJ154	150	<200	3	.7	<.05	<.02	---	---	---	---	Do.
BSJ155	100	<200	5	1	<.05	<.02	---	---	---	---	Do.
BSJ156	200	<200	1	.5	.5	<.02	---	---	---	---	Do.
BSJ157	50	<200	5	1	<.05	<.02	---	---	---	---	Do.
BSJ186	50	<200	7	1	<.05	<.02	---	---	---	---	Do.
BSJ190	200	<200	1.5	.7	.1	<.02	---	---	---	---	Do.
BSJ198	150	<200	5	1	<.05	<.02	---	---	---	---	Do.

TABLE 9.—*Analyses of samples from*

Semiquantitative spectrographic analyses

Sample	(ppm) Ti	Mn	Ag	As	Ba	Bi	Cd	Co	Cr	Cu	Mo	Ni	Pb
A--Leviathan Gulch area													
Ds209a	200	100	15.0	<200	150	500	<20	<5	5	5	300	5	300
Ds209b	700	300	10	<200	30	200	<20	<5	<10	<5	100	<5	100
Ds209d	300	150	1	<200	150	20	<20	<5	5	<5	30	7	20
Ds209e	2,000	1,000	.5	<200	100	30	<20	<5	5	7	20	7	50
Ds209f	150	700	<.5	<200	100	10	<20	<5	<5	5	<5	10	100
B--Mineralized fault zone near Milk Creek													
Ds76a	2,000	700	<1	<2,000	700	<10	<50	7	50	100	<3	15	70
Ds76b	1,500	700	<1	<2,000	700	<10	<50	7	30	100	<3	10	15
Ds76c	1,500	500	<1	<2,000	50	<10	<50	7	30	100	<3	10	15
Ds76d	300	500	<1	<2,000	5	<10	<50	<5	7	20	<3	7	<10
Ds76e	1,000	100	<1	<2,000	10	<10	<50	<5	20	50	7	10	15
Ds76f	150	700	<1	<2,000	10	<10	<50	5	3	300	10	10	<10
Ds79a	1,500	500	<1	<2,000	30	<10	<50	10	15	50	15	70	10
Ds79b	1,500	200	<1	<2,000	20	<10	<50	5	10	50	10	50	20
Ds80a	100	500	<1	<2,000	70	<10	<50	3	3	70	<3	7	<10
Ds80b	300	150	<1	<2,000	50	<10	<50	3	15	200	10	10	70
C--Whitehead Gulch area													
Ds127	700	100	3	10,000	300	<10d	<20	<5	5	30	<5	10	70
Ds128	1,500	200	7	<200	1,500	<10	<20	<5	10	150	700	10	2,000
Ds129d	700	200	1,000	1,500	>5,000	<10	>500	5	<5	1,500	15	10	>20,000
Ds130	200	200	3	700	300	<10	<20	150	5	30	<5	15	300
Ds131	700	300	70	3,000	1,000	<10	30	5	7	150	30	7	300
Ds132	30	300	10	700	50	<10	70	300	<5	>20,000	<5	20	150
Ds133b	3,000	100	1,500	500	1,000	<10	<20	<5d	<5	1,000	30	5	>20,000
Ds134a	2,000	200	1,500	500	300	<10	<20	10	<5	300	50	7	2,000
Ds134b	3,000	300	15	700	700	<10	<20	15	5	70	15	10	1,500
Ds135	7,000	200	3	10,000	700	<10	<20	15	70	30	30	30	1,000
Ds136a	1,500	300	15	500	1,500	<10	<20	<5d	7	30	70	15	1,000
Ds136b	700	500	3,000	1,000	1,000	<10	20	<5d	30	1,000	100	30	1,500
Ds137a	3,000	500	3	<200	200	<10	<20	10	<5d	30	300	15	100
Ds137b	3,000	300	3	<200	700	<10	<20	30	10	20	200	20	70
Ds137b	700	1,500	3	<200	100	<10	<20	30	15	50	300	30	200
Ds137c	1,500	>5,000	3	<200	<20d	<10	<20	150	150	700	10	500	30
Ds138a	1,000	2,000	1.5	<200	5,000	<10	<20	<5	5	50	100	15	500
Ds138b	1,500	700	30	<200	3,000	<10	150	20	15	1,000	150	20	>20,000
Ds138c	1,500	500	15	<200	700	<10	<20	30	10	30	15	30	3,000
Ds138e	5,000	500	7	700	700	<10	<20	20	15	70	100	20	3,000
D--Altered rock and native sulfur from Trout Creek - upper Middle Fork Piedra River area													
Ds140a	5,000	15	<.5	<200	500	<10d	<20	<5	5	20	<5	<5d	30
Ds140e	>10,000	100	<.5	<200	1,500	<10	<20	20	15	30	20	15	<10
Ds166a	10,000	300	<.5	<200	700	<10	<20	30	7	70	<5	5	20
Ds166b	1,000	100	<.5	<200d	700	<10	<20	<5d	30	70	<5	7	30
Ds167d	5,000	300	<.5	<200	700	<10	<20	5	5	100	<5d	5	70
Ds167e	5,000	50	<.5	<200	500	<10	<20	7	10	100	<5	5	30
Ds 59a	7,000	<10	5	<200	3,000	20	<50	<5	<2	5	<2	<2	100
Ds 59b	3,000	<1d	<1	<2,000	700	<10d	<50	<3	1.5	7	<3	<3	15

scattered mineralized areas

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sb	Sn	Sr	V	W	Zn	Chemical analyses (ppm) Au	Cu	Pb	Zn	Sample description 1/
						A--Leviathan Gulch area					
Ds209a	<100	<10	<100	<10	5,000	<200	<0.02	<10	160	110	Qtz vn; tourmaline.
Ds209b	<100	<10	<100	50	300	200	<.02	<10	150	<25	Do.
Ds209d	<100	<10	<100	10	1,200	<200	<.02	<10	29	<25	Do.
Ds209e	<100	<10	<100	150	<50	500	<.02	<10	<25	<25	Do.
Ds209f	<100	70	<100	<10	<50	<200	<.02	<10	<25	<25	Felspathic gneiss; tourmaline.
						B--Mineralized fault zone near Milk Creek					
Ds76a	<200	<10	100	50	<100	<200	<.2	60	20	125	Soil sample.
Ds76b	<200	<10	100	50	<100	<200	<.2	40	15	100	Do.
Ds76c	<200	<10	70	50	<100	<200	<.2	40	15	100	Do.
Ds76d	<200	<10	<5	15	<100	<200	<.2	5	<15	25	Breccia; qtz vn, lim.
Ds76e	<200	<10	10	70	<100	<200	<.2	300	<15	100	Do.
Ds76f	<200	<10	5	10	<100	<200	<.2	15	<15	25	Do.
Ds79a	<200	<10	20	150	<100	<200	<.2	30	<15	125	Graphitic quartzite.
Ds79b	<200	<10	15	150	<100	<200	<.2	80	20	100	Sheared quartzite.
Ds80a	<200	<10	15	10	<100	<200	<.2	30	<15	25	Breccia; lim.
Ds80b	<200	<10	<5	150	<100	<200	<.2	150	200	50	Sheared quartzite; lim.
						C--Whitehead Gulch area					
Ds127	<100	<10	<100	30	<50	<200	1.3	30	70	93	Qtz vn; py.
Ds128	700	<10	<100	50	<50	1,500	.1	120	290	470	Qtz vn; py, sph.
Ds129d	3,000	<10	3,000	30	<50	>10,000	<.02	83	220	720	Qtz vn; py, gal, sph, bar.
Ds130	<100	150	<100	10	<50	3,000	<.02	45	330	360	Py from qtz-py vn.
Ds131	300	<10	<100	30	<50	7,000	1.5	78	250	580	Qtz vn; py, gal, sph.
Ds132	<100	100	<100	<10	<50	>10,000	.08	3,200	110	700	Py from qtz-py vn.
Ds133b	3,000	<10	<100	30	<50	<200d	.4	650	220	240	Qtz vn; py, gal, bar.
Ds134a	300	<10	<100	30	<50	3,000	23.6	190	220	530	Qtz vn; py, gal.
Ds134b	<100d	<10	<100	20	<50	700	.08	43	180	260	Alt rk; py.
Ds135	500	<10	<100	50	<50	<200	.2	43	150	50	Qtz vn; py.
Ds136a	<100d	<10	<100	50	<50	700	.7	12	70	96	Do.
Ds136b	3,000	<10	<100	20	<50	7,000	16.0	530	250	550	Qtz vn; py, gal, tet.
Ds137a	<100	<10	<100	300	<50	<200	<.02	17	40	120	Qtz vn; py.
Ds137b	<100	<10	<100	200	<50	<200	<.02	18	110	88	Do.
Ds137b	<100	<10	<100	70	<50	3,000	<.02	50	150	53	Do.
Ds137c	<100	20	<100	300	<50	1,500	.08	290	35	330	Alt. rk; py.
Ds138a	<100	<10	<100	70	<50	<200d	.06	46	360	130	Alt. rk; lim.
Ds138b	300	<10	100	70	<50	>10,000	.5	510	250	660	Qtz vn; py, gal.
Ds138c	<100	<10	<100	70	<50	1,500	.02	17	220	500	Sil gneiss; py.
Ds138e	<100	<10	<100	100	<50	700	.2	43	350	320	Qtz vn; py.
						D--Altered rock and native sulfur from Trout Creek - upper Middle Fork Piedra River area					
Ds140a	<100	<10	<100	20	<50	<200	<.02	<10	56	<25	Opalized tuff; native sulfur.
Ds140e	<100	<10	<100	70	<50	<200	<.02	23	<25	75	Alt andesite breccia; py.
Ds166a	<100	<10	500	150	<50	<200	<.02	60	<25	64	Alt andesite; py.
Ds166b	<100	<10	300	50	<50	<200	<.02	41	50	<25	Do.
Ds167d	<100	<10	100	30	<50	<200	<.02	37	<25	60	Limonitic tuff.
Ds167e	<100	<10	700	200	<50	<200	<.02	70	<25	25	Alt andesite; py.
Ds 59a	<100	<10	<100	<10	<50	200	---	---	---	---	Native sulfur.
Ds 59b	<200	<10	<5	<7d	<100	<200	---	---	---	---	Do.

1/ Abbreviations used in Table:

Alt	=	altered	lim	=	limonite	rk	=	rock	tet	=	tetrahedrite
bar	=	barite	py	=	pyrite	sil	=	silicified	vn	=	vein
gal	=	galena	qtz	=	quartz	sph	=	sphalerite			

TABLE 10.—*Analyses of samples from*

Semiquantitative spectrographic analyses

Sample	Ti	Mn	Ag	As	Ba	Bi	Cd	Cr	Cu	Mo	Pb	Sb	Sn
	(ppm)												
	A--Altered rocks from the older intrusive body in the Chicago Basin intrusive center												
CB 1	700	200	1.0	<200	50	<10	<20	10	200	700	70	<100	20
CB 2	1,000	100	<.5	<200	100	<10	<20	5	5	100	15	<100	30
CB 3	500	100	1	<200	100	<10	<20	5	150	70	50	<100	10
CB 4	200	50	1.5	<200	100	<10	<20	10	300	70	50	<100	10
CB 5a	1,000	200	1	200	100	<10	<20	5	100	150	70	<100	20
CB 5b	500	100	1.5	300	200	<10	<20	5	300	70	500	<100	50
CB 6	1,000	100	1	<200	100	<10	<20	10	100	200	100	<100	10
CB 7	700	100	1	300	30	<10	<20	10	200	300	300	<100	10
CB 8	1,000	100	5	<200	150	<10	<20	10	50	200	70	150	30
CB 9	700	70	30	300	150	10	<20	10	200	300	700	200	20
CB10	700	50	7	200	150	<10	<20	15	100	300	300	<100	15
CB12	200	30	1	<200	70	<10	<20	10	100	500	20	<100	<10
CB13	2,000	150	.7	<200	70	<10	<20	5	50	100	150	<100	30
CB14	3,000	150	<.5	<200	200	<10	<20	50	30	30	50	<100	30
CB15	3,000	100	1.5	<200	150	<10	<20	5	30	200	150	<100	30
CB16	3,000	150	<.5	<200	100	<10	<20	5	30	10	50	<100	30
CB17	3,000	150	.5	<200	70	10	<20	5	20	10	200	<100	20
CB20	2,000	100	<.5	<200	100	<10	<20	<5	30	10	50	<100	10
CB21	2,000	100	<.5	<200	150	<10	<20	5	20	10	50	<100	<10
CB22	5,000	150	<.5	<200	500	<10	<20	<5	20	<5	150	<100	<10
CB23	5,000	500	<.5	<200	300	<10	<20	15	30	10	70	<100	<10
CB31	500	100	1.5	<200	100	<10	<20	5	150	50	50	<100	<10
CB32	700	50	.5	<200	50	<10	<20	5	50	70	20	<100	10
CB33	2,000	150	.5	<200	300	<10	<20	5	20	<5	100	<100	<10
CB34	2,000	100	1.5	<200	300	<10	<20	5	10	10	200	<100	<10
CB35	2,000	150	<.5	<200	700	<10	<20	5	50	<5	70	<100	<10
CB36	700	50	.5	<200	70	<10	<20	<5	5	<5	20	<100	<10
CB37	3,000	100	<.5	<200	200	<10	<20	10	30	<5	50	<100	<10
CB38	700	100	<.5	<200	100	<10	<20	5	15	7	30	<100	10
CB39	700	100	<.5	<200	150	<10	<20	<5	70	30	30	<100	30
CB40	1,000	50	.5	<200	150	<10	<20	<5	30	100	30	<100	50
CB41	700	70	7	500	150	<10	<20	5	70	500	70	100	70
CB42	1,000	100	<.5	<200	100	<10	<20	<5	30	50	30	<100	20
CB43	700	70	.7	<200	100	<10	<20	5	30	500	150	<100	30
CB44	1,000	100	.7	<200	70	<10	<20	<5	70	500	50	<100	50
CB45a	1,000	200	.7	<200	50	<10	<20	<5	50	70	20	<100	30
CB45b	1,000	500	1.5	<200	100	<10	<20	5	70	500	700	<100	<10
CB46	5,000	300	2	<200	2,000	<10	<20	10	200	70	150	100	15
CB47	5,000	200	.5	<200	500	<10	<20	7	10	100	200	<100	20
CB48	1,500	150	1	<200	700	<10	<20	5	50	5	30	<100	50
CB49	5,000	150	1.5	<200	1,000	<10	<20	5	20	<5	150	<100	30
CB50	2,000	100	.5	<200	500	<10	<20	5	50	7	200	<100	10
CB51	3,000	150	<.5	<200	200	<10	<20	5	20	5	100	<100	<10
CB58	2,000	150	<.5	<200	200	<10	<20	<5	30	<5	70	<100	<10
CB59a	2,000	200	2	<200	150	<10	<20	<5	20	300	200	<100	10
CB59b	3,000	150	.7	<200	200	<10	<20	5	20	15	100	<100	15
CB60	2,000	100	<.5	<200	150	<10	<20	5	200	5	200	<100	15
CB61	2,000	50	<.5	<200	200	<10	<20	5	70	10	100	<100	<10
CB62	7,000	70	.5	<200	1,000	<10	<20	<5	70	<5	500	<100	10
CB63	700	50	5	<200	300	<10	<20	<5	70	<5	300	300	10
CB64	2,000	100	<.5	<200	500	<10	<20	5	50	10	150	<100	<10
CB88	2,000	30	15	<200	150	<10	<20	7	30	5	300	<100	<10
CB93	1,000	200	<.5	<200	300	<10	<20	10	20	<5	30	<100	<10
CB94	1,500	2,000	<.5	<200	500	<10	<20	7	30	<5	50	<100	<10
CB95	5,000	100	.7	<200	500	<10	<20	7	30	20	100	<100	30

the Needle Mountains mining district

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sr	V	W	Zn	Chemical analyses (ppm) Au	Cu	Pb	Zn	Sb	Sample description [1/]
A--Altered rocks from the older intrusive body in the Chicago Basin intrusive center										
CB 1	<100	10	<50	<200	0.03	170	50	110	---	Drill core; moly.
CB 2	<100	10	<50	<200	.08	10	25	40	---	Alt rk; py.
CB 3	<100	10	<50	<200	.08	30	30	170	---	Do.
CB 4	<100	10	<50	<200	.02	30	50	460	---	Do.
CB 5a	<100	10	<50	<200	.1	30	100	250	---	Alt rk; qtz vns.
CB 5b	200	20	<50	<200	.4	310	560	235	---	Alt rk; lim.
CB 6	<100	10	<50	<200	.4	30	100	50	---	Alt rk; py.
CB 7	<100	10	<50	<200	.1	70	1,800	40	---	Alt rk; moly.
CB 8	<100	20	<50	<200	.1	30	25	25	---	Alt rk; py.
CB 9	<100	50	<50	200	.06	110	500	140	---	Alt rk; py, moly.
CB10	200	10	<50	<200	.1	30	100	40	---	Alt rk; qtz vns, moly.
CB12	<100	10	<50	<200	.06	30	50	25	---	Alt. rk.
CB13	<100	15	<50	<200	.06	15	<25	25	---	Alt rk; py.
CB14	<100	50	<50	<200	.08	15	<25	25	---	Alt rk.
CB15	<200	15	<50	<200	.06	15	100	40	---	Do.
CB16	<100	15	<50	<200	<.02	10	50	40	---	Alt rk; py.
CB17	<100	10	<50	<200	<.02	15	100	50	---	Do.
CB20	<100	15	<50	<200	<.02	15	<25	100	---	Do.
CB21	<200	70	<50	<200	<.02	10	30	40	---	Do.
CB22	200	30	<50	<200	.02	10	<25	<25	---	Do.
CB23	<100	70	<50	<200	<.02	15	50	25	---	Do.
CB31	<100	10	<50	<200	.04	40	50	215	---	Alt rk.
CB32	<100	10	<50	<200	<.02	30	30	85	---	Alt rk; qtz vns, moly.
CB33	100	30	<50	<200	<.02	15	50	90	---	Alt Eolus Granite.
CB34	<100	30	<50	<200	<.03	15	100	235	---	Alt Eolus Granite; py.
CB35	<100	30	<50	<200	<.03	15	50	115	---	Do.
CB36	<100	10	<50	<200	<.02	15	30	110	---	Alt rk near contact.
CB37	<100	70	<50	<200	.04	15	50	60	---	Alt rk; py.
CB38	<100	10	<50	<200	<.04	15	50	40	---	Alt rk; qtz vns, py.
CB39	<100	10	<50	<200	.04	15	25	85	---	Do.
CB40	<100	15	<50	<200	<.20	25	25	30	---	Alt rk; py.
CB41	<100	10	<50	<200	.60	30	30	50	---	Alt rk; qtz vns, py, moly.
CB42	100	10	<50	<200	.1	15	25	25	---	Alt rk; py.
CB43	<100	15	<50	<200	.08	15	25	90	---	Alt rk; py, moly.
CB44	<100	<10	<50	<200	.06	15	50	<25	---	Do.
CB45a	<100	<10	<50	<200	.1	15	30	25	---	Do.
CB45b	<100	10	<50	<200	.1	40	30	225	---	Do.
CB46	100	7	<50	300	.1	70	<25	300	---	Alt rk; qtz vns, py, moly.
CB47	<100	50	<50	<200	.04	15	100	100	---	Alt rk; py.
CB48	<100	15	<50	<200	.06	15	30	40	---	Alt Eolus Granite, py.
CB49	150	30	<50	<200	.08	15	30	100	---	Do.
CB50	100	20	<50	<200	<.04	30	50	85	---	Alt Eolus Granite.
CB51	<100	50	<50	<200	.03	15	100	25	---	Do.
CB58	100	20	<50	<200	.06	10	30	25	---	Do.
CB59a	<100	20	<50	<200	<.03	15	100	50	---	Alt rk at contact; moly.
CB59b	<100	30	<50	<200	<.06	15	100	40	---	Alt Eolus Granite; qtz vns.
CB60	150	30	<50	<200	<.03	15	50	60	---	Alt rk near contact.
CB61	<100	20	<50	<200	<.04	15	50	40	---	Alt Eolus Granite near contact.
CB62	200	70	<50	<200	.04	15	50	40	---	Alt rk; py.
CB63	200	10	<50	<200	.20	15	50	40	---	Do.
CB64	<100	50	<50	<200	<.04	15	100	40	---	Alt Eolus Granite.
CB88	300	30	<50	<200	<.02	15	100	85	---	Alt rk along contact.
CB93	<100	15	<50	<200	<.03	10	<25	<25	---	Alt rk.
CB94	<100	50	<50	<200	<.03	85	<25	190	---	Alt Eolus Granite.
CB95	<100	30	<50	<200	<.04	10	<25	25	---	Alt rk; py.

TABLE 10.—*Analyses of samples from the*

Semiquantitative spectrographic analyses

(ppm)

Sample	Ti	Mn	Ag	As	Ba	Bi	Cd	Cr	Cu	Mo	Pb	Sb	Sn
A--Altered rocks from the older intrusive body in the Chicago Basin intrusive center--Continued													
CB 96	3,000	150	0.7	<200	700	<10	<20	10	50	<5	300	<100	<10
CB122	2,000	200	.7	<200	200	<10	<20	20	<5	<5	50	<100	<10
CB123	700	150	10	<200	2,000	<10	<20	<5	20	<5	70	<100	<10
CB125	3,000	500	30	300	300	<10	<20	<5	300	500	300	300	700
CB138	7,000	150	<.5	<200	500	<10	<20	10	7	<5	200	<100	<10
CB139	700	70	1	<200	70	<10	<20	<5	30	<5	30	<100	<10
B--Altered rocks from the younger intrusive body in the Chicago Basin intrusive center													
CB 11	1,500	200	.7	<200	100	<10	<20	5	50	70	100	<100	10
CB 18	3,000	500	<.5	<200	500	<10	<20	5	30	20	70	<100	<10
CB 19	3,000	200	<.5	<200	700	<10	<20	5	30	15	50	<100	<10
CB 24	3,000	200	<.5	<200	500	<10	<20	<5	15	7	70	<100	<10
CB 25	2,000	1,500	<.5	<200	300	<10	<20	5	20	7	30	<100	<10
CB 26	2,000	500	<.5	<200	300	<10	<20	5	7	<5	20	<100	<10
CB 27	1,500	500	<.5	<200	300	<10	<20	5	5	<5	30	<100	<10
CB 28	1,500	1,500	<.5	<200	300	<10	<20	5	10	<5	20	<100	<10
CB 29	1,000	300	<.5	<200	300	<10	<20	5	10	<5	15	<100	<10
CB 30	1,500	1,000	<.5	<200	300	<10	<20	5	7	5	100	<100	<10
CB 53	2,000	1,500	<.5	<200	500	<10	<20	5	30	5	50	<100	<10
CB 54	2,000	1,500	<.5	<200	300	<10	<20	5	7	7	30	<100	<10
CB 55	2,000	1,000	<.5	<200	500	<10	<20	20	7	15	20	<100	<10
CB 56	2,000	1,500	<.5	<200	500	<10	<20	5	10	5	20	<100	<10
CB 57	3,000	1,500	<.5	<200	500	<10	<20	5	7	5	30	<100	<10
CB 84	3,000	1,500	.5	<200	500	<10	<20	10	70	20	150	<100	<10
CB 85	2,000	1,000	<.5	<200	500	<10	<20	10	50	5	20	<100	<10
CB 86	2,000	1,500	<.5	<200	300	<10	<20	5	10	<5	50	<100	<10
CB 87	2,000	200	.5	<200	300	<10	<20	5	20	10	150	<100	<10
CB 89	2,000	150	.5	<200	300	<10	<20	<5	10	<5	100	<100	<10
CB 90	2,000	1,500	<.5	<200	300	<10	<20	5	7	<5	30	<100	<10
CB 91	2,000	2,000	<.5	<200	300	<10	<20	5	20	<5	50	<100	<10
CB 92	1,500	1,500	<.5	<200	300	<10	<20	5	10	<5	30	<100	<10
CB134	2,000	20	7	<200	100	10	<20	<5	10	<5	200	<100	<10
CB135	1,500	1,500	<.5	<200	300	<10	<20	<5	5	<5	30	<100	<10
CB184	1,500	700	20	<200	300	<10	<20	<5	20	<5	50	<100	<10
CB185a	2,000	300	7	<200	300	<10	<20	<5	10	7	70	<100	<10
CB186	1,500	1,000	5	<200	300	<10	<20	<5	<5	<5	30	<100	<10
CB187	1,500	1,000	2	<200	300	<10	<20	<5	10	<5	30	<100	<10
C--Vein material and associated altered rock from Chicago Basin													
CB 52	1,000	100	.7	<200	300	<10	<20	<5	20	15	300	<100	<10
CB 65	2,000	150	<.5	<200	500	<10	<20	10	20	10	20	<100	<10
CB 66	3,000	70	<.5	<200	150	<10	<20	10	100	10	70	<100	<10
CB 67	3,000	50	.5	<200	150	<10	<20	5	30	<5	30	<100	<10
CB 68	3,000	20	5	<200	70	<10	<20	15	20	10	30	<100	<10
CB 69	3,000	200	.5	<200	300	<10	<20	10	50	10	30	<100	<10
CB 70	700	200	<.5	<200	300	<10	<20	5	30	5	20	<100	<10
CB 71	7,000	200	<.5	<200	700	<10	<20	5	20	5	30	<100	<10
CB 72	2,000	50	<.5	<200	200	<10	<20	20	50	10	70	<100	<10
CB 73	5,000	200	<.5	<200	500	<10	<20	10	30	5	30	<100	10
CB 74	1,000	300	2	<200	300	<10	<20	7	50	15	100	<100	<10
CB 75	1,500	150	<.5	<200	1,000	<10	<20	5	30	<5	30	<100	<10
CB 76	700	200	20	<200	200	<10	<20	10	30	30	150	<100	<10
CB 77	3,000	700	<.5	<200	100	<10	<20	10	7	<5	10	<100	<10
CB 78	1,000	100	7	<200	500	<10	<20	10	70	50	100	<100	<10
CB 79	500	>5,000	1,000	<200	300	<10	30	<5	7,000	30	>20,000	3,000	<10
CB 80	200	2,000	70	<200	100	<10	200	<5	2,000	7	20,000	<100	<10
CB 81	1,500	500	7	<200	200	<10	<20	5	70	200	300	<100	<10
CB 82	5,000	1,000	70	<200	300	<10	<20	5	50	30	100	<100	<10
CB 83	200	>5,000	30	<200	100	<10	20	30	150	500	700	<100	<10

Needle Mountains mining district— Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sr	V	W	Zn	Chemical analyses (ppm) Au	Cu	Pb	Zn	Sb	Sample description 1/
A--Altered rocks from the older intrusive body in the Chicago Basin intrusive center--Continued										
CB 96	150	150	<50	<200	<0.02	10	<25	50	---	Alt rk; py.
CB122	150	100	<50	<200	<.02	<10	<25	120	---	Breccia pipe.
CB123	100	10	<50	<200	<.02	<10	48	50	---	Alt rk.
CB125	100	10	<50	<200	<.02	270	<25	83	100	Inclusions with moly.
CB138	300	300	<50	<200	.02	<10	<25	<25	2	Alt brec; py.
CB139	<100	10	<50	<200	<.02	<10	<25	<25	1	Alt rk near contact.
B--Altered rocks from the younger intrusive body in the Chicago Basin intrusive center										
CB 11	<100	15	<50	<200	.06	15	100	25	---	Alt rk.
CB 18	<100	15	<50	<200	.02	15	100	40	---	Do.
CB 19	<200	20	<50	<200	.02	10	30	40	---	Highly alt rk.
CB 24	100	20	<50	<200	<.03	10	100	40	---	Alt rk.
CB 25	100	20	<50	<200	<.02	15	50	85	---	Do.
CB 26	100	10	<50	<200	<.02	15	50	60	---	Do.
CB 27	100	10	<50	<200	<.06	15	50	40	---	Mod alt rk.
CB 28	<100	10	<50	<20	<.02	10	50	155	---	Nearly fresh rk.
CB 29	<100	10	<50	<200	<.02	10	<25	40	---	Mod alt rk.
CB 30	<100	10	<50	<200	<.02	10	<25	200	---	Highly alt rk.
CB 53	100	20	<50	<200	<.03	30	100	130	---	Mod alt rk.
CB 54	100	20	<50	<200	<.04	10	100	60	---	Do.
CB 55	<100	15	<50	<200	<.06	15	50	90	---	Do.
CB 56	<100	20	<50	<200	.04	10	50	90	---	Do.
CB 57	<100	15	<50	<200	.02	15	50	60	---	Do.
CB 84	<100	20	<50	<200	<.08	15	30	85	---	Alt rk.
CB 85	<100	30	<50	<200	<.04	10	25	40	---	Do.
CB 86	100	20	<50	<200	<.02	10	25	60	---	Do.
CB 87	<100	20	<50	<200	<.10	10	<25	<25	---	Highly alt rk.
CB 89	100	20	<50	<200	<.04	<10	50	40	---	Alt rk.
CB 90	100	10	<50	<200	<.02	10	25	60	---	Mod alt rk.
CB 91	100	20	<50	<200	<.04	<10	25	190	---	Do.
CB 92	100	20	<50	<200	<.06	10	<25	60	---	Do.
CB134	200	30	<50	<200	.02	<10	190	52	5	Alt rk.
CB135	<100	20	<50	<200	.02	<10	25	44	1	Mod alt rk.
CB184	<100	10	<50	<200	<.02	<10	54	44	---	Host, moly-bearing inclusion.
CB185a	100	20	<50	<200	<.02	<10	46	<25	3	Do.
CB186	<100	30	<50	<200	<.02	<10	27	<25	2	Nearly fresh rock.
CB187	<100	20	<50	<200	<.02	<10	27	40	1	Do.
C--Vein material and associated altered rock from Chicago Basin										
CB 52	<100	10	<50	<200	.04	15	250	25	---	Qtz vn along dike.
CB 65	<100	30	<50	<200	<.05	10	50	25	---	Alt Eolus Granite.
CB 66	<100	50	<50	<200	<.02	10	50	60	---	Alt Eolus Granite; py.
CB 67	<100	50	<50	<200	<.04	<10	100	85	---	Do.
CB 68	<100	10	<50	<200	.04	<10	30	<25	---	Qtz vn; gal.
CB 69	<100	30	<50	<200	<.02	<10	100	90	---	Alt Eolus Granite; py.
CB 70	<100	15	<50	<200	<.02	<10	50	<25	---	Alt Eolus Granite.
CB 71	<100	50	<50	<200	.02	<10	50	<25	---	Alt Eolus Granite; py.
CB 72	<100	70	<50	<200	<.02	10	50	40	---	Qtz vn; py.
CB 73	<100	70	<50	<200	<.03	10	50	40	---	Alt Eolus Granite.
CB 74	<100	20	<50	<200	.06	15	50	200	---	Qtz vn; py.
CB 75	<100	15	<50	<200	.02	15	100	360	---	Do.
CB 76	<100	10	<50	500	.04	10	30	40	---	Qtz vn; py, sph.
CB 77	<100	30	<50	<200	<.02	10	50	190	---	Alt Eolus Granite; py.
CB 78	<100	10	<50	<200	.02	15	50	60	---	Qtz vn; py.
CB 79	<100	50	<50	>10,000	.30	4,600	2,500	5,300	---	Qtz vn; gal, sph, cp, tet, fl, rho.
CB 80	<100	<10	<50	>10,000	.1	1,100	300	>10,000	---	Qtz vn; gal, sph, cp.
CB 81	<100	50	<50	200	<.02	15	100	170	---	Qtz vn; py.
CB 82	<100	70	<50	<200	.04	30	50	85	---	Do.
CB 83	<100	10	<50	>10,000	.20	30	560	3,000	---	Qtz vn; py, gal, sph, rho.

TABLE 10.—*Analyses of samples from the*

Semiquantitative spectrographic analyses

(ppm)

Sample	Ti	Mn	Ag	As	Ba	Bi	Cd	Cr	Cu	Mo	Pb	Sb	Sn
C--Vein material and associated altered rock from Chicago Basin--Continued													
CB 97	100	3,000	30.0	<200	70	<10	70	<5	5,000	100	>20,000	<100	<10
CB 98	2,000	200	.7	<200	100	<10	<20	5	50	<5	150	<100	<10
CB 99	1,500	300	10	<200	70	<10	<20	5	70	<5	1,000	<100	<10
CB100	2,000	300	7	<200	200	<10	<20	7	15	7	50	<100	<10
CB101	700	>5,000	5	<200	150	<10	<20	<5	70	100	100	<100	<10
CB102	50	>5,000	7	<200	70	<10	<20	<5	500	<5	100	<100	<10
CB103	2,000	500	50	<200	1,000	<10	<20	5	50	300	300	<100	<10
CB104	30	>5,000	50	<200	1,500	<10	<20	<5	70	<5	150	<100	<10
CB105	1,500	700	15	<200	1,000	<10	<20	5	30	20	150	<100	<10
CB106	700	300	2	<200	100	<10	<20	<5	20	20	300	<100	<10
CB107	50	>5,000	5	<200	700	<10	<20	<5	50	20	200	<100	<10
CB108	700	1,500	70	700	1,500	20	200	7	1,500	50	5,000	1,000	<10
CB109	1,500	200	50	300	30	10	<20	7	5,000	<5	150	200	30
CB110	150	2,000	100	300	100	<10	>500	<5	500	30	>20,000	100	<10
CB111	500	>5,000	70	<200	100	10	>500	<5	700	100	>20,000	300	<10
CB112	<10	>5,000	100	<200	100	<10	70	<5	1,000	70	>20,000	100	<10
CB113	1,000	5,000	5	<200	700	<10	<20	5	70	70	700	<100	<10
CB114	1,500	1,500	1	<200	100	<10	<20	5	50	5	100	<100	<10
CB115	1,500	500	<.5	<200	150	<10	<20	10	30	5	150	<100	<10
CB116	1,500	200	50	<200	200	<10	<20	5	200	50	300	300	<10
CB117	1,000	200	15	<200	300	<10	<20	5	50	50	300	<100	30
CB118	700	100	2	<200	150	<10	<20	10	150	<5	70	<100	<10
CB119	1,000	150	1.5	<200	100	<10	<20	5	30	10	50	<100	<10
CB120	1,500	500	5	<200	700	30	<20	5	50	500	300	<100	10
CB121	3,000	500	1	<200	700	<10	<20	<5	100	7	1,500	<100	<10
CB124a	1,500	700	1,000	>10,000	300	500	<20	5	>20,000	2,000	10,000	>10,000	>1,000
CB124b	300	200	1,000	>10,000	300	200	<20	15	20,000	500	1,000	>10,000	>1,000
CB127a	700	2,000	70	<200	300	<10	<20	<5	1,500	30	1,000	1,000	<10
CB129	1,500	100	1.5	200	300	<10	<20	5	50	15	200	<100	<10
CB130	1,000	50	70	700	500	1,000	50	5	3,000	5	3,000	1,500	150
CB141	2,000	150	.5	<200	300	<10	<20	5	30	<5	30	<100	<10
CB142	1,500	30	5	<200	300	<10	<20	5	7	<5	10	<100	<10
CB143a	700	300	3	<200	200	<10	<20	<5	<5	5	<10	<100	<10
CB143b	700	150	2	<200	200	<10	<20	<5	<5	<5	20	<100	<10
CB147a	1,000	300	10	<200	100	<10	<20	<5	7	30	30	<100	<10
CB147b	300	300	3	<200	150	<10	<20	<5	5	30	150	<100	<10
CB147c	200	300	1	<200	150	<10	<20	<5	7	20	20	<100	<10
CB153	500	300	.5	<200	300	<10	<20	<5	5	10	20	<100	<10
CB154	1,000	300	2	<200	500	<10	<20	<5	<5	50	30	<100	<10
D--Vein material from Vallecito Basin													
CB201	1,000	100	30	200	200	50	<20	<5	1,000	150	500	300	<10
CB202	50	500	1,000	300	2,000	50	>500	7	2,000	20	>20,000	200	<10
CB203	50	2,000	150	<200	200	10	>500	<5	1,000	15	>20,000	200	<10
CB204	200	>5,000	150	700	3,000	200	>500	5	5,000	15	>20,000	3,000	150
CB205	10	2,000	50	500	70	<10	>500	<5	1,000	7	>20,000	1,500	<10
CB205a	200	1,500	30	<200	2,000	15	>500	<5	700	7	>20,000	150	15
CB206	50	>5,000	20	<200	150	<10	<20	<5	150	20	500	150	<10
CB207	70	300	100	700	1,500	<10	100	5	300	50	10,000	200	<10
CB208	150	200	100	<200	300	<10	>500	<5	300	100	20,000	500	<10
CB209	150	1,500	30	<200	700	<10	<20	<5	200	10	500	<100	<10
CB210	20	500	100	200	100	20	<20	7	3,000	5	300	150	<10
CB210a	150	>5,000	10	<200	500	<10	200	<5	200	<5	300	<100	<10
CB211	20	700	70	200	1,000	150	70	7	700	5	500	100	<10
CB212	150	150	50	<200	2,000	150	<20	5	1,500	<5	500	300	300
CB213	150	70	300	300	1,000	500	<20	5	7,000	20	1,000	700	<10
CB214	30	70	200	500	1,500	200	<20	5	20,000	15	500	700	<10
CB220	20	700	70	<200	>5,000	10	500	<5	700	15	3,000	<100	<10
CB221	300	150	100	200	1,000	700	<20	5	5,000	50	500	300	<10
CB222	200	700	70	<200	>5,000	20	500	<5	1,000	200	>20,000	100	<10
CB223	2,000	150	20	<200	150	<10	<20	5	50	<5	300	<100	<10

Needle Mountains mining district— Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sr	V	W	Zn	Chemical analyses (ppm) Au	Cu	Pb	Zn	Sb	Sample description [1]
										C--Vein material and associated altered rock from Chicago Basin--Continued
CB 97	<100	15	150	>10,000	0.04	1,600	560	>10,000	---	Qtz vn; py, gal, sph, cp, fl.
CB 98	<100	15	<50	<200	.04	15	100	115	---	Qtz vn; py, gal.
CB 99	<100	10	<50	3,000	.04	30	250	3,400	---	Qtz vn; py, gal. sph.
CB100	<100	20	<50	<200	.20	10	25	50	---	Qtz vn; py.
CB101	300	15	<50	<200	<.02	30	100	190	---	Qtz vn; py, fl, cal.
CB102	500	10	<50	<200	<.02	430	30	40	---	Qtz vn; py, cp, fl, rho, cal.
CB103	<100	50	<50	<200	.08	10	190	200	---	Qtz vn; py, fl.
CB104	<100	20	<50	<200	.06	<10	25	140	---	Qtz vn; rho.
CB105	<100	30	<50	200	.06	<10	100	315	---	Qtz vn; py, sph, cp.
CB106	<100	10	<50	<200	<.03	<10	<25	<25	---	Qtz vn; py.
CB107	<100	10	<50	700	<.03	15	100	515	---	Do.
CB108	<100	10	<50	>10,000	.10	200	440	>10,000	---	Qtz vn; py, gal, sph, cp, fl, rho.
CB109	<100	15	<50	300	.30	>5,000	190	155	---	Qtz vn; py, cp.
CB110	<100	10	<50	>10,000	.06	700	190	>10,000	---	Qtz vn; py, gal, sph.
CB111	<100	15	<50	>10,000	.04	700	310	>10,000	---	Qtz vn; py, gal, sph, rho.
CB112	<100	10	<50	>10,000	.02	1,400	5,000	9,000	---	Qtz vn; py, gal, sph, cp, fl, rho.
CB113	<100	15	<50	300	.04	15	<25	190	---	Qtz vn; py.
CB114	<100	20	<50	<200	.10	15	50	90	---	Do.
CB115	<100	20	<50	<200	<.02	15	100	85	---	Do.
CB116	100	20	<50	<200	.06	170	25	85	---	Qtz vn; py, tet?
CB117	100	10	<50	500	.02	60	100	490	---	Qtz vn; py, gal, sph.
CB118	<100	30	<50	<200	<.02	70	100	115	---	Qtz vn; py.
CB119	<100	15	<50	<200	<.02	30	50	85	---	Do.
CB120	<100	20	<50	700	.08	40	250	480	---	Qtz vn; py, moly, rho.
CB121	<50	50	<50	<200	<.02	12	250	37	1	Alt Eolus Granite; qtz vns, py.
CB124a	70	200	100	1,500	.06	50,000	2,100	3,800	>100	Qtz vn; py, tet?
CB124b	<100	100	100	500	.02	18,000	1,400	880	>100	Do.
CB127a	<100	10	<50	3,000	.2	5,000	2,500	3,100	>100	Qtz vn; gal, sph, cp, tet.
CB129	<100	20	<50	200	.2	15	140	190	6	Qtz vn; py.
CB130	200	20	<50	5,000	.4	7,800	4,000	6,000	>100	Qtz vn; py, gal, sph, cp.
CB141	<100	50	<50	<200	<.02	17	<25	<25	3	Alt Eolus Granite.
CB142	<100	30	<50	<200	.02	<10	<25	<25	3	Qtz vn; py.
CB143a	<100	70	<50	<200	1.9	<10	<25	<25	3	Alt Eolus Granite; qtz vns.
CB143b	<100	100	<50	<200	.04	<10	25	<25	2	Alt dike, py.
CB147a	<100	20	<50	<200	.02	<10	34	<25	5	Qtz vn.
CB147b	<100	30	<50	<200	<.02	20	260	100	6	Do.
CB147c	<100	20	<50	<200	<.02	18	54	44	2	Do.
CB153	<100	10	<50	<200	.04	<10	<25	<25	4	Do.
CB154	<100	20	<50	<200	<.02	20	<25	<25	4	Qtz vn; py.
										D--Vein material from Vallecito Basin
CB201	<100	15	<50	1,000	.10	2,200	2,000	680	>100	Qtz vn; py, gal, sph, cp, fl.
CB202	100	10	<50	>10,000	1.2	5,400	7,400	84,000	>100	Do.
CB203	<100	15	<50	>10,000	.20	1,200	9,000	24,000	>100	Do.
CB204	150	20	70	>10,000	.10	7,000	13,000	120,000	>100	Qtz vn; py, gal, sph, fl, rho.
CB205	<100	10	<50	>10,000	.10	1,500	10,000	250,000	>100	Do.
CB205a	100	15	<50	>10,000	.06	860	14,000	120,000	>100	Do.
CB206	<100	15	<50	1,500	.20	370	1,100	1,600	>100	Qtz vn; py, gal, fl, rho.
CB207	150	30	300	>10,000	5.8	480	26,000	15,000	>100	Qtz vn; py, gal, sph.
CB208	<100	20	<50	>10,000	.90	190	28,000	84,000	>100	Qtz vn; py, gal, sph, fl.
CB209	<100	20	<50	300	.20	130	900	270	6	Qtz vn; py, fl.
CB210	<100	<10	<50	2,000	1.3	3,500	900	2,500	70	Qtz vn; py, gal, sph, rho.
CB210a	<100	10	50	>10,000	.02	160	600	17,000	2	Do.
CB211	<100	<10	<50	10,000	.20	1,000	1,000	7,200	60	Qtz vn; py, gal, sph.
CB212	200	30	<50	1,500	.20	1,800	1,500	1,400	>100	Qtz vn; py, gal, sph, rho.
CB213	100	<10	<50	700	.50	7,000	2,500	800	>100	Qtz vn; py, sph, cp, fl.
CB214	<100	10	<50	700	.50	17,000	1,300	880	>100	Do.
CB220	700	15	<50	>10,000	.30	1,000	4,000	52,000	>100	Qtz vn; py, gal, sph, cp, rho, sid.
CB221	<100	20	<50	300	.30	5,500	1,000	90	40	Qtz vn; py, cp, fl, sid.
CB222	700	20	<50	>10,000	.30	1,100	24,000	48,000	>100	Qtz vn; py, gal, sph, cp, fl.
CB223	<100	50	<50	<200	.02	10	230	64	20	Qtz vn; py.

TABLE 10.—*Analyses of samples from the*

Semiquantitative spectrographic analyses

Sample	Ti	Mn	Ag	As	Ba	Bi	Cd	Cr	Cu	Mo	Pb	Sb	Sn
	(ppm)												
D--Vein material from Vallecito Basin--Continued													
CB224	10	500	700·0	<200	300	<10	500	<5	700	50	>20,000	500	<10
CB224a	50	500	50	<200	3,000	50	<20	5	1,000	<5	500	<100	300
CB225	10	100	300	700	3,000	1,000	<20	5	20,000	70	2,000	2,000	71,000
CB226	10	>5,000	150	<200	200	70	<20	<5	1,500	15	3,000	<100	30
CB229	1,000	300	3	<200	700	<10	<20	<5	20	<5	300	<100	<10
CB230	200	>5,000	200	<200	>5,000	150	>500	<5	>20,000	50	>20,000	<100	<10
CB231	3,000	3,000	.7	<200	1,000	<10	<20	<5	70	<5	50	<100	<10
CB232	100	2,000	50	<200	500	<10	>500	<5	500	30	>20,000	<100	<10
CB233	70	1,000	70	<200	5,000	<10	>500	<5	300	50	5,000	<100	<10
CB234	70	5,000	30	500	1,000	<10	>500	<5	700	50	>20,000	<100	<10
CB235	70	500	30	300	3,000	<10	<20	5	500	30	300	<100	<10
CB236	70	>5,000	20	<200	2,000	70	<20	5	5,000	20	300	<100	50
CB237	200	500	30	<200	1,500	<10	>500	<5	700	100	10,000	<100	<10
CB237a	100	2,000	70	200	2,000	1,000	<20	5	>20,000	30	500	150	30
CB238	50	150	70	<200	2,000	100	50	5	700	300	5,000	<100	<10
CB239	50	150	100	<200	>5,000	30	<20	<5	500	500	500	<100	<10
CB240	300	500	70	<200	500	50	<20	<5	200	150	3,000	<100	<10
CB241	50	100	150	<200	700	100	50	5	10,000	20	7,000	200	<10
CB242	100	150	50	<200	300	1,000	<20	5	15,000	50	500	<100	30
CB250	70	>5,000	100	<200	>5,000	<10	>500	<5	700	30	>20,000	150	<10
Ds205b	5,000	200	1	<200	700	<10	<20	10	30	15	20	<100	<10
Ds205c	5,000	1,500	<.5	<200	700	10	<20	5	200	7	100	<100	<10
Ds205d	5,000	700	<.5	<200	700	<10	<20	5	70	10	30	<100	<10
Ds205e	3,000	300	5	<200	500	10	<20	10	200	30	30	<100	<10
Ds206	700	500	20	<200	700	<10	<20	5	70	5	1,000	<100	<10
Ds208	700	200	2	<200	200	<10	<20	<10	10	7	20	<100	<10
Ds211	1,500	150	7	<200	500	<10	<20	<5	5	10	<10	<100	<10
E--Vein material from Missouri Gulch and Crystal Valley drainage basins													
CB165a	50	700	30	<200	150	<10	50	5	500	50	700	<100	<10
CB165b	700	100	1	<200	300	<10	<20	<5	10	<5	200	<100	<10
CB166	20	200	100	<200	500	50	300	<5	1,500	30	20,000	150	<10
CB168	700	30	10	<200	500	<10	<20	<5	7	<5	70	<100	<10
CB170	10	2,000	70	<200	100	<10	>500	<5	150	500	>20,000	150	10
CB171	700	100	.5	<200	300	<10	<20	<5	7	<5	70	<100	<10
CB172	500	1,500	30	<200	300	<10	<20	<5	30	20	700	<100	<10
CB173	100	>5,000	100	<200	700	<10	70	<5	200	200	5,000	100	<10
CB174	50	5,000	30	<200	300	<10	50	<5	150	150	>20,000	<100	<10
CB175	300	>5,000	20	200	150	<10	50	<5	50	200	2,000	<100	<10
CB176	150	1,500	50	700	1,500	<10	100	<5	150	150	3,000	<100	<10
CB177	700	150	30	<200	150	<10	<20	<5	<5	50	30	<100	<10
CB178	500	150	7	<200	300	<10	<20	5	5	<5	20	<100	<10
CB179	700	150	7	<200	300	<10	<20	<5	20	<5	50	<100	<10
CB180	2,000	150	1.5	<200	500	<10	<20	7	<5	7	150	<100	<10
CB181	700	15	20	<200	100	<10	70	<5	150	100	5,000	<100	<10
CB182	20	30	5,000	200	3,000	<10	<20	5	2,000	100	500	1,500	<10
CB183	700	50	70	<200	200	<10	<20	5	30	50	300	<100	<10
CB190	300	20	70	300	1,000	<10	<20	<5	30	30	200	<100	<10
CB190a	700	20	7	300	300	<10	<20	5	30	20	200	<100	<10
CB190b	200	1,500	70	<200	70	<10	<20	5	300	30	500	<100	<10
CB191	300	50	300	<200	5,000	<10	<20	7	1,500	<5	700	<100	<10
CB192	20	50	300	<200	5,000	20	150	5	1,500	10	20,000	<100	<10
CB193	1,000	500	10	<200	300	<10	<20	7	30	<5	300	<100	<10
CB194	150	150	300	300	3,000	<10	70	5	300	70	5,000	<100	<10
CB195	100	100	100	700	1,000	<10	100	5	300	500	>20,000	200	<10
CB195a	100	2,000	20	200	100	<10	<20	<5	30	50	700	<100	<10
CB196	300	70	200	500	300	<10	100	<5	150	150	>20,000	150	<10
CB216	20	100	70	200	200	20	<20	<5	150	50	150	100	<10
CB217	100	1,500	1.5	<200	200	<10	<20	<5	20	<5	30	<100	<10

Needle Mountains mining district—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)					Sample description [1]
	Sr	V	W	Zn	Au	Cu	Pb	Zn	Sb	
										D--Vein material from Vallecito Basin--Continued
CB224	<100	10	<50	>10,000	2.5	1,000	35,000	35,600	25	Qtz vn; py, gal, fl.
CB224a	300	20	<50	3,000	.20	1,100	800	2,100	50	Qtz vn; py.
CB225	150	200	50	1,500	.70	35,000	2,000	2,000	2	Qtz vn; py, gal, sph, cp, fl, rho.
CB226	200	10	<50	3,000	.30	30,000	5,400	2,600	1	Qtz vn; py, gal, sph, cp, cal.
CB229	<100	30	<50	<200	.02	<10	600	40	2	Alt rk.
CB230	300	10	<50	>10,000	.20	20,000	14,000	72,000	10	Qtz vn; py, gal, sph, cp, fl, rho.
CB231	100	100	<50	1,500	<.02	26	56	1,100	1	Felsite dike; py.
CB232	<100	10	<50	>10,000	.06	880	15,000	84,000	25	Qtz vn; py, cal, sph, cp.
CB233	300	15	<50	>10,000	.40	120	17,000	48,000	20	Qtz vn; py, gal, sph.
CB234	500	10	<50	>10,000	.20	940	22,000	150,000	8	Qtz vn; py, gal, sph, cp, fl, rho.
CB235	150	15	<50	500	.30	820	600	520	20	Qtz vn; py, cp.
CB236	<100	10	<50	500	.06	8,300	600	600	15	Qtz vn; py, cp, rho.
CB237	<100	20	<50	>10,000	.02	1,400	31,000	40,000	30	Qtz vn; py, gal, sph, cp, rho.
CB237a	<100	15	<50	1,000	.10	20,000	2,000	1,200	15	Qtz vn; py, cp.
CB238	<100	50	<50	10,000	.40	1,100	11,000	6,400	10	Qtz vn; py, gal, sph, cp.
CB239	500	70	<50	200	.30	660	1,100	270	8	Qtz vn; py.
CB240	<100	30	<50	700	.40	950	7,600	760	5	Qtz vn; py, gal.
CB241	<100	20	<50	>10,000	2.2	9,000	10,000	4,800	>100	Qtz vn; py, gal, sph, cp.
CB242	<100	20	50	300	.30	20,000	900	320	15	Qtz vn; py, gal, sph, cp, hem.
CB250	500	10	150	>10,000	.20	800	27,000	68,000	>100	Qtz vn; py, gal, sph, rho, cal, bar.
Ds205b	<100	150	<50	<200	<.02	14	<25	<25	---	Qtz vn.
Ds205c	100	150	<50	<200	<.02	17	<25	98	---	Wallrock for B.
Ds205d	<100	150	<50	<200	<.02	13	<25	42	---	Do.
Ds205e	<100	150	<50	<200	<.02	<10	<25	<25	---	Qtz vn.
Ds206	<100	10	<50	10,000	.60	11	800	5,800	---	Qtz vn; py, gal, sph.
Ds208	<100	10	<50	<200	.10	<10	<25	<25	---	Alt Eolus Granite.
Ds211	<100	<10	<50	<200	<.02	<10	<25	<25	---	Qtz vn; py.
										E--Vein material from Missouri Gulch and Crystal Valley drainage basins
CB165a	<100	20	<50	2,000	.10	1,100	2,200	3,900	10	Qtz vn; py, gal, sph.
CB165b	<100	30	<50	<200	<.02	14	160	<25	2	Alt Trimble Granite.
CB166	<100	20	<50	>10,000	.30	3,000	20,000	6,000	50	Qtz vn; py, gal, sph.
CB168	<100	20	<50	<200	.02	20	<25	110	1	Qtz vn; py.
CB170	<100	15	<50	>10,000	.04	100	20,000	10,000	50	Qtz vn; py, gal, sph.
CB171	<100	20	<50	<200	<.02	<10	40	36	1	Qtz vn; py.
CB172	<100	30	<50	300	1.2	43	2,000	320	8	Do.
CB173	<100	100	50	>10,000	1.7	400	7,000	12,000	40	Qtz vn; py, sph.
CB174	<100	10	<50	10,000	.20	360	34,000	13,000	30	Qtz vn; py, gal, sph, moly.
CB175	<100	10	<50	>10,000	.08	50	4,000	12,000	15	Qtz vn; py, sph, moly.
CB176	150	70	<50	>10,000	2.3	110	9,000	14,000	20	Qtz vn; py, gal, sph.
CB177	<100	50	<50	<200	.40	<10	56	60	3	Qtz vn; py.
CB178	<100	15	<50	<200	.10	<10	28	28	1	Qtz vn.
CB179	<100	20	<50	<200	.30	15	42	56	2	Do.
CB180	<100	70	<50	<200	.02	<10	150	<25	2	Alt Trimble Granite.
CB181	<100	50	<50	2,000	.02	120	18,000	2,900	10	Dump sample, locality CB180.
CB182	<100	10	<50	200	5	1,900	800	220	>100	Qtz vn; py, gal, sph, cp.
CB183	<100	30	<50	<200	.08	<10	800	44	10	Qtz vn.
CB190	<100	20	<50	500	1.1	21	250	760	6	Qtz vn; py.
CB190a	<100	20	<50	200	.02	<10	210	200	4	Alt rk; py.
CB190b	300	20	<50	<200	2.4	380	230	280	8	Do.
CB191	100	10	<50	300	.10	3,400	1,100	250	4	Qtz vn; py, gal, sph.
CB192	100	<10	<50	>10,000	.40	1,600	10,000	30,000	25	Do.
CB193	<100	30	<50	<200	.02	<10	310	48	2	Alt Eolus Granite.
CB194	150	20	70	>10,000	.70	640	6,000	14,000	25	Qtz vn; py, gal, sph.
CB195	<100	100	<50	>10,000	1.6	120	24,000	12,000	50	Do.
CB195a	<100	70	<50	200	.70	<10	1,800	140	10	Alt Eolus Granite.
CB196	<100	15	<50	>10,000	5.6	94	32,000	7,200	45	Qtz vn; py, gal.
CB216	<100	20	<50	<200	.10	170	180	92	40	Qtz vn; py.
CB217	<100	10	<50	<200	<.02	20	42	<25	1	Qtz vn.

TABLE 10.—*Analyses of samples from the*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Mn	Ag	As	Ba	Bi	Cd	Cr	Cu	Mo	Pb	Sb	Sn
E--Vein material from Missouri Gulch and Crystal Valley drainage basins--Continued													
CB218	70	150	500.0	<200	5,000	15	70	<5	300	50	500	300	<10
CB258	50	>5,000	50	<200	70	30	50	<5	200	50	700	200	70
CB259	20	200	100	<200	70	10	100	<5	300	200	>20,000	200	20
CB260	200	>5,000	30	<200	150	<10	<20	10	30	50	700	<100	<10
CB261	500	700	10	3,000	200	<10	<20	<5	10	30	200	200	<10
CB262	1,000	700	.5	<200	500	<10	<20	10	5	<5	30	<200	<10
CB263	200	300	1	300	200	<10	<20	15	15	10	100	<200	<10
CB300	300	2,000	10	<200	500	<10	<20	10	50	500	500	<200	<10
CB301a	500	50	300	500	200	<10	30	<5	500	150	>20,000	500	<10
CB301b	700	70	10	700	300	<10	<20	<5	20	50	1,000	<200	<10
F--Vein material and associated altered rock from lower Needle Creek drainage area													
CB131	150	300	.7	<200	200	<10	<20	<5	20	<5	10	<100	<10
CB132	1,000	20	20	2,000	300	<10	<20	5	30	7	30	100	<10
CB133	700	20	20	700	150	<10	<20	10	7	30	30	100	<10
CB145	1,000	150	7	700	200	<10	<20	<5	7	<5	30	<100	<10
CB145c	500	20	30	>10,000	150	<10	<20	7	100	<5	200	3,000	<10
CB145d	700	30	1	3,000	300	<10	<20	<5	5	5	70	<100	<10
CB145e	700	500	.5	<200	500	<10	<20	10	10	<5	100	<100	<10
CB146	1,500	2,000	2	<200	200	<10	<20	30	100	<5	20	<100	<10
CB251	700	300	2	1,500	700	<10	<20	<5	50	<5	<10	<100	<10
CB252	1,000	50	300	1,000	500	50	<20	<5	>20,000	10	1,000	1,000	300
CB253	500	100	2	<200	200	<10	<20	<5	150	10	30	<100	<10
CB254	1,000	2,000	200	<200	300	10	20	50	>20,000	15	>20,000	<100	<10
CB255	500	150	100	1,000	70	<10	<20	50	50	150	100	<100	<10
CB256	500	50	10	5,000	100	<10	<20	70	10	<5	50	300	<10

Needle Mountains mining district— Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)					Sample description [1/]
	Sr	V	W	Zn	Au	Cu	Pb	Zn	Sb	
E--Vein material from Missouri Gulch and Crystal Valley drainage basins--Continued										
CB218	300	20	<50	>10,000	2.7	160	1,200	12,000	>100	Qtz vn; py, gal, sph.
CB258	150	20	<50	10,000	5.6	180	4,200	16,000	---	Do.
CB259	<100	50	<50	10,000	.02	280	56,000	20,000	---	Do.
CB260	<100	70	50	3,000	.9	28	1,600	6,200	---	Qtz vn; py, moly.
CB261	<100	10	<50	<200	4.4	<10	280	160	---	Qtz vn; py, arsenopy.
CB262	<100	20	<50	<200	<.02	<10	34	58	---	Sil shear zone.
CB263	<100	15	<50	<200	.02	<10	150	58	---	Sil shear zone; lim.
CB300	<100	70	<50	700	4	48	1,400	840	---	Qtz vn; py.
CB301a	<100	50	<50	>10,000	4.4	500	22,000	98,000	---	Qtz vn; py, gal, sph.
CB301b	<100	15	<50	1,000	4.2	18	1,600	160	---	Alt Eolus Granite; py.
F--Vein material and associated altered rock from lower Needle Creek drainage area										
CB131	<100	15	<50	<200	<.02	14	<25	<25	4	Qtz vn.
CB132	<100	15	<50	<200	.9	19	48	44	30	Qtz vn; py, cal.
CB133	<100	20	<50	<200	1.4	13	48	<25	20	Qtz vn; py.
CB145	<100	10	<50	<200	.04	43	35	32	6	Alt Eolus Granite; py.
CB145c	<100	10	<50	<200	19.0	13	<25	<25	>100	Alt Eolus Granite; qtz vn, py, arsenopy.
CB145d	<100	<10	<50	<200	.5	<10	34	<25	---	Alt Eolus Granite, py, arsenopy.
CB145e	<100	20	<50	<200	<.02	12	68	<25	---	Alt Eolus Granite; qtz vn, py.
CB146	150	150	<50	<200	.02	<10	<25	25	6	Alt rk; py.
CB251	<100	30	<50	<200	1.1	78	<25	34	---	Alt. Eolus Granite; qtz vn, py.
CB252	<100	15	<50	1,000	2.2	20,000	2,100	1,700	---	Qtz vn; py, cp, tet.
CB253	<100	30	<50	<200	.2	92	30	<25	---	Sil shear zone; py.
CB254	<100	50	<50	10,000	<.02	14,000	30,000	18,000	----	Qtz vn; py, gal, sph, cp.
CB255	<100	150	<50	<200	2.3	60	140	26	---	Qtz vn; py.
CB256	<100	30	<50	<200	6.7	11	52	<25	---	Do.

[1/] Abbreviations used in Table:

alt	= altered	cp	= chalcopyrite	mod	= moderately	rk	= rock
arsenopy	= arsenopyrite	fl	= fluorite	moly	= molybdenum	sid	= siderite
bar	= barite	gal	= galena	py	= pyrite	sil	= silicified
brec	= breccia	hem	= hematite	qtz	= quartz	sph	= sphalerite
cal	= calcite	lim	= limonite	rho	= rhodochrosite	tet	= tetrahedrite
						vn(s)	= vein, veins

TABLE 11.—*Analyses of vein samples*

A--Semiquantitative spectrographic analyses

Sample	(ppm) Ti	Mn	Ag	As	Ba	Bi	Cd	Co	Cr	Cu	Mo	Ni	Pb
BT 1	7,000	500	<0.5	<200	200	<10	<20	10	7	15	<5	7	15
BT 2	7,000	100	.7	<200	150	<10	<20	15	<5	50	<5	7	20
BT 3	700	70	700	<200	300	200	70	<5	10	7,000	70	20	200
BT 4	300	30	15	1,500	100	<10	<20	<5	<5	700	<5	5	70
BT 5	1,500	50	3	<200	100	15	<20	<5	10	30	7	5	15
BT 6	1,000	50	.7	<200	500	<10	<20	<5	7	100	<5	7	50
BT 7	1,000	70	5	<200	300	<10	100	<5	5	150	20	2	30
BT 8	1,000	5,000	1,000	<200	100	<10	50	<5	5	5,000	<5	2	300
BT 9	2,000	<5	100	700	150	<10	<20	<5	15	150	<5	3	100
BT 10	300	>5,000	1,000	<200	15	<10	20	<5	<5	5,000	<5	2	500
BT 10a	500	700	5,000	700	20	<10	30	<5	<5	15,000	<5	5	500
BT 11	500	50	1.5	1,500	70	<10	<20	<5	<5	70	<5	5	<10
BT 12	2,000	50	<.5	<200	50	<10	300	<5	15	15	7	2	<10
BT 13	5,000	70	.7	<200	500	<10	<20	<5	300	20	<5	70	300
BT 14	1,500	50	7	<200	1,000	<10	<20	<5	20	20,000	<5	5	20
BT 15	2,000	50	1.5	<200	100	<10	<20	70	30	70	5	30	70
BT 16	1,000	30	150	500	100	<10	<20	<5	15	3,000	<5	2	50
BT 17	3,000	70	30	<200	300	<10	<20	<5	15	30	<5	2	50
BT 18	700	70	200	500	300	<10	<20	<5	5	300	<5	2	50
BT 19	300	150	7	<200	200	<10	<20	<5	15	50	7	3	100
BT 20	300	30	<.5	<200	50	<10	<20	<5	<5	10	<5	2	<10
BT 21	1,500	100	1.5	1,000	1,000	<10	70	15	15	20	30	150	150
BT 22	100	70	<.5	<200	70	<10	<20	<5	<5	10	<5	5	<10
BT 23	700	150	<.5	<200	1,000	<10	<20	<5	5	30	5	10	70
BT 24	70	70	<.5	<200	100	<10	<20	<5	30	7	<5	15	<10
BT 25	3,000	30	1	<200	300	<10	<20	5	<5	20	<5	10	50
BT 26	30	50	10	<200	150	<10	<20	5	<5	10	<5	10	100
BT 27	300	70	1	<200	150	<10	<20	<5	5	50	<5	7	15
BT 28	3,000	50	150	<200	300	<10	<20	<5	10	100	<5	5	30
BT 29	2,000	200	150	<200	70	<10	<20	<5	20	150	7	15	15
BT 30	1,500	200	3	<200	150	<10	<20	15	15	100	15	20	20
BT 31	1,500	300	.7	700	100	<10	<20	10	10	70	5	10	20
BT 32	2,000	300	3	<200	500	<10	<20	15	15	30	<5	15	50
BT 33	300	150	2	<200	70	<10	<20	<5	<5	30	<5	10	15
BT 34	1,500	100	1.5	<200	200	<10	<20	<5	15	20	<5	5	30
BT 35	2,000	700	.7	<200	200	<10	50	<5	20	30	<5	15	20
BT 36	1,500	200	1	<200	150	<10	<20	<5	10	20	<5	7	20
BT 37	5,000	100	3	500	1,000	<10	<20	10	300	20	<5	30	150
BT 38	5,000	200	.5	200	500	<10	<20	15	700	30	<5	70	70
BT 39	500	50	1	200	150	<10	<20	5	7	20	<5	15	30
BT 40	5,000	500	<.5	<200	700	<10	<20	5	70	20	<5	15	50
BT 41	1,500	200	20	<200	700	<10	100	10	30	100	30	20	70
BT 42	5,000	500	<.5	<200	700	<10	<20	5	50	7	<5	10	20
BT 43	7,000	1,500	<.5	<200	1,500	<10	<20	50	10	50	<5	10	15
BT 44	7,000	70	<.5	<200	700	<10	<20	<5	7	3	<5	5	<10
BT 45	700	700	.7	<200	<10	<10	<20	70	7	1,000	<5	7	15
BT 46	3,000	200	<.5	<200	150	<10	<20	<5	30	10	<5	10	15
BT 47	300	30	1.5	700	100	<10	<20	<5	<5	30	<5	20	15
BT 49	500	70	20	<200	300	<10	>500	<5	10	700	<5	10	300
BT 50	5,000	300	<.5	<200	700	<10	<20	150	70	100	<5	150	150
BT 51	10,000	2,000	<.5	<200	3,000	<10	<20	15	300	20	10	70	30
BT 52	700	100	1.5	<200	100	<10	<20	<5	<5	30	<5	10	10
BT 52a	700	70	2	300	300	<10	<20	>2,000	15	100	<5	30	15
BT 53	500	50	<.5	<200	300	<10	<20	10	10	30	<5	20	<5
Ds213a	3,000	70	<.5	200	300	<10	<20	<5	100	200	<5	5	100
Ds213b	1,500	50	<.5	200	3,000	<10	<20	<5	10	5	20	5	15
Ds213c	7,000	150	<.5	<200	150	<10	<20	<5	200	<5	<5	10	10
Ds214	5,000	70	.5	200	3,000	<10	<20	<5	300	5	<5	15	<5
Ds215	1,000	70	5	700	300	<10	<20	7	5	7	<5	100	20
Ds216	1,500	500	1	<200	100	<10	<20	100	5	2,000	<5	5	30

from the Beartown mining district

A--Semiquantitative spectrographic analyses--Continued

Sample	Sb	Sn	Sr	V	W	Zn	Fe	Mg	Ca	Sample description [1/]
	(ppm)									
BT 1	<100	<10	150	100	<50	<200	3.0	1.0	3.0	Alt San Juan Fm.
BT 2	<100	<10	150	150	<50	<200	2	.2	.15	Do.
BT 3	>10,000	70	300	70	<50	1,500	5	.02	<.05	Qtz vn; py, tet.
BT 4	700	<10	<100	50	<50	<200	.07	.03	<.05	Do.
BT 5	200	<10	<100	70	<50	<200	2	.07	<.05	Do.
BT 6	100	<10	200	30	<50	<200	2	.05	<.05	Qtz vn; py.
BT 7	100	<10	<100	30	<50	10,000	3	.03	<.05	Qtz vn; py, sph, tet.
BT 8	3,000	<10	<100	20	<50	1,000	1	.15	.2	Qtz vn; py, tet.
BT 9	500	<10	<100	30	<50	<200	5	.07	<.05	Qtz vn; py.
B 10	1,500	<10	<100	20	<50	1,500	<.05	1	1	Qtz vn; py, tet, sid.
BT 10a	3,000	<10	<100	70	<50	2,000	.7	1.5	.05	Qtz vn; py, tet.
BT 11	<100	<10	<100	20	<50	<200	1	.07	.07	Alt San Juan Fm; py.
BT 12	<100	<10	<100	30	<50	>10,000	3	.05	<.05	Qtz vn; py, sph.
BT 13	<100	<10	1,000	150	<50	<200	2	.2	.15	Qtz vn; py.
BT 14	700	<10	<100	70	<50	300	5	.05	<.05	Qtz vn; py, cp, tet.
BT 15	<100	<10	700	70	<50	<200	3	.05	.07	Qtz vn; py.
BT 16	1,000	<10	150	30	<50	300	.2	.05	<.05	Qtz vn; py, tet.
BT 17	100	<10	150	70	<50	<200	1	.05	<.05	Qtz vn.
BT 18	1,500	<10	<100	30	<50	<200	.07	.05	<.05	Qtz vn; lim.
BT 19	200	<10	100	30	<50	<200	15	.05	<.05	Qtz vn; py.
BT 20	<100	<10	<100	20	<50	<200	.7	.05	<.05	Do.
BT 21	150	<10	700	50	<50	7,000	15	.05	.1	Qtz vn; py, sph.
BT 22	<100	<10	<100	20	<50	<200	1	.05	<.05	Qtz vn; py.
BT 23	<100	10	300	70	<50	<200	10	.05	.07	Qtz vn; lim.
BT 24	<100	<10	<100	50	<50	<200	7	.05	<.05	Do.
BT 25	<100	<10	300	50	<50	<200	2	.03	.07	Qtz vn; py.
BT 26	200	<10	<100	20	<50	2,000	.03	.03	<.05	Qtz vn; py, sph.
BT 27	200	<10	200	30	<50	<200	3	.03	.05	Qtz vn; py.
BT 28	1,000	<10	<100	50	<50	200	2	.05	<.05	Do.
BT 29	700	<10	<100	70	<50	<200	3	.15	<.05	Qtz vn; py, tet.
BT 30	200	<10	<100	50	<50	1,500	7	.15	.2	Qtz vn; py, sph.
BT 31	<100	<10	100	50	<50	<200	5	.1	1.5	Qtz vn; py.
BT 32	<100	<10	<100	70	<50	<200	3	.2	.15	Do.
BT 33	<100	<10	<100	30	<50	300	5	.1	<.05	Do.
BT 34	<100	<10	<100	70	<50	<200	2	.15	.15	Do.
BT 35	<100	<10	<100	70	<50	500	3	.2	<.05	Do.
BT 36	<100	<10	<100	70	<50	<200	3	.1	.05	Do.
BT 37	<100	<10	300	150	<50	<200	3	.3	.15	Pyritic phyllite.
BT 38	<100	<10	<100	150	<50	<200	3	1	<.05	Alt rk; py.
BT 39	<100	<10	<100	50	<50	500	7	.07	<.05	Qtz vn; py.
BT 40	<100	<10	100	150	<50	<200	5	.5	<.05	Alt slate; lim.
BT 41	<100	10	<100	50	<50	7,000	15	.15	<.05	Qtz vn; py, sph, tet.
BT 42	<100	<10	<100	70	<50	200	7	.3	<.05	Alt phyllite; lim.
BT 43	<100	<10	1,500	100	<50	<200	7	1	7	Alt rk; py.
BT 44	<100	<10	100	150	<50	<200	3	.05	.05	Do.
BT 45	<100	30	<100	70	<50	<200	20	.05	<.05	Sheared zone; py.
BT 46	<100	<10	300	50	<50	<200	2	.03	.5	Do.
BT 47	<100	<10	<100	15	<50	<200	15	.03	<.05	Do.
BT 49	500	<10	100	30	<50	>10,000	15	.03	.05	Qtz vn; py, sph.
BT 50	<100	20	<100	150	<50	<200	20	1.5	.05	Alt rk; py.
BT 51	<100	<10	100	70	<50	<200	5	1.5	3	Do.
BT 52	<100	<10	<100	50	<50	<200	3	.05	.05	Qtz vn; py.
BT 52a	<100	<10	<100	70	<50	<200	>20	.15	.07	Do.
BT 53	<100	70	<100	30	<50	<200	10	.07	<.05	Do.
Ds213a	<100	<10	200	150	<50	<200	20	.15	<.05	Gossan.
Ds213b	<100	<10	500	20	<50	<200	2	.03	.05	Do.
Ds213c	<100	<10	150	1,000	<50	<200	3	.15	<.05	Breccia zone.
Ds214	<100	<10	300	150	50	<200	3	.5	<.05	Qtz vn; py.
Ds215	<100	<10	100	<10	<50	<200	7	.02	<.05	Sheared zone; py.
Ds216	<100	<10	<100	70	<50	<200	>20	.05	<.05	Do.

TABLE 11.—*Analyses of vein samples from*

A--Semiquantitative spectrographic analyses

Sample	Ti	Mn	Ag	As	Ba	Bi	Cd	Co	Cr	Cu	Mo	Ni	Pb
	(ppm)												
DS217a	3,000	1,000	<0.5	<200	300	<10	<20	30	5	1,000	<5	<5	20
Ds219	3,000	700	5	5,000	700	<10	<20	20	500	20	<5	200	100
Ds220	2,000	100	<.5	<200	1,500	<10	<20	<5	<5	7	5	7	15
Ds221	10,000	1,000	30	200	500	<10	<20	50	20	200	100	50	300
Ds222	1,500	200	20	<200	2,000	<10	<20	5	5	10	70	15	500

B--Chemical analyses (Samples BT 1-34)

Sample	Au	Cu	Pb	Zn	Mo	As	Sb	Hg	Te	Ag	Sample description [1]
	(ppm)										
BT 1	<0.02	<10	<25	64	30	30	1	0.02	0.4	0.6	Alt San Juan Fm.
BT 2	<.02	110	<25	<25	30	20	2	.04	.3	1.4	Do.
BT 3	8.4	200	56	1,100	16	10	>100	>6.0	1,400	11	Qtz vn; py, tet.
BT 4	.3	6,000	680	1,100	8	30	>100	.28	150	1,300	Do.
BT 5	.04	14	36	<25	8	40	15	.55	90	1.2	Do.
BT 6	<.02	19,000	48	1,400	8	10	2	1.3	20	560	Qtz vn; py.
BT 7	.1	920	28	110	20	120	8	.85	17	36	Qtz vn; py, sph, tet.
BT 8	30	42	36	63	8	120	>100	3.5	820	8	Qtz vn; py, tet.
BT 9	2	100	130	42	8	150	>100	.80	52	120	Qtz vn; py.
BT 10	26	6,600	1,400	1,500	8	20	>100	5	680	760	Qtz vn; py, tet, sid.
BT 10a	140	16,000	1,400	2,000	30	30	>100	>6	1,200	2,600	Qtz vn; py tet.
BT 11	.1	100	<25	41	8	70	25	.16	23	60	Alt San Juan Fm; py.
BT 12	.02	27	28	13,000	16	100	4	>6	3.9	44	Qtz vn; py, sph.
BT 13	.3	18	52	140	16	<10	2	1	6.3	4.6	Qtz vn; py.
BT 14	19	24,000	44	320	12	<10	>100	.50	38	64	Qtz vn; py, cp, tet.
BT 15	.04	80	<25	<25	30	30	30	.16	.6	2.6	Qtz vn; py.
BT 16	9.6	5,200	48	340	16	20	>100	2.6	580	150	Qtz vn; py, tet.
BT 17	21	48	<25	<25	12	10	>100	>6	100	96	Qtz vn.
BT 18	190	240	<25	38	8	150	>100	>6	350	260	Qtz vn; lim.
BT 19	110	72	32	60	8	50	>100	4	90	29	Qtz vn; py.
BT 20	.2	<10	<25	<25	8	20	8	>6	5.2	10	Do.
BT 21	.04	14	150	8,000	8	<10	>100	>6	1.5	4.2	Qtz vn; py, sph.
BT 22	.02	<10	<25	54	16	10	1	.60	.3	<.1	Qtz vn; py.
BT 23	.02	32	110	190	8	10	6	2.4	11	1.2	Qtz vn; lim.
BT 24	<.02	39	<25	<25	8	10	20	.12	11	.6	Do.
BT 25	.04	<10	<25	<25	8	<10	6	.12	4.1	1.2	Qtz vn; py.
BT 26	1.7	12	240	880	8	20	>100	>6	340	15	Qtz vn; py, sph.
BT 27	.04	60	28	<25	8	80	>100	.60	5.9	1.4	Qtz vn; py.
BT 28	4	260	48	72	60	10	>100	1.3	85	320	Do.
BT 29	9.2	380	28	70	8	10	>100	.75	90	300	Qtz vn; py, tet.
BT 30	.2	56	40	460	16	<10	>100	.07	5.6	7.4	Qtz vn; py, sph.
BT 31	.04	16	32	130	8	10	15	.08	1.5	1.6	Qtz vn; py.
BT 32	11	15	150	40	8	30	4	.15	80	14.6	Do.
BT 33	.3	22	<25	180	16	<10	3	.20	8.1	5.4	Do.
BT 34	.08	13	40	<25	60	<10	2	.05	2.6	1.4	Do.

the Beartown mining district— Continued

A--Semiquantitative spectrographic analyses--Continued

Sample	(ppm) Sb	Sn	Sr	V	W	Zn	Fe	Mg	Ca	Sample description 1/
DS217a	<100	<10	<100	150	<50	<200	20.0	3.0	0.3	Sheared zone, py.
Ds219	<100	<10	<100	100	<50	<200	14	.15	.2	Quartz vn; py.
Ds220	<100	<10	<100	30	<50	<200	2	.5	1	Alt rk.
Ds221	<100	<10	<100	300	<50	<200	10	2	2	Qtz vn; py.
Ds222	<100	<10	<100	70	<50	<200	2	.3	.1	Alt rk.

B--Chemical analyses (Samples BT 35-Ds222)

Sample	(ppm) Au	Cu	Pb	Zn	Mo	As	Sb	Hg	Te	Ag	Sample description 1/
BT 35	0.02	11	32	210	30	10	6	0.13	2.4	1.2	Qtz vn; py.
BT 36	.1	18	32	<25	30	<10	4	.09	2.8	3.2	Do.
BT 37	.06	10	140	<25	30	40	8	.03	.3	.8	Pyritic phyllite.
BT 38	.08	17	48	<25	8	<10	8	.03	1.5	.8	Alt rk; py.
BT 39	.06	36	<25	<25	120	80	15	.32	7.3	4	Qtz vn; py.
BT 40	<.02	<10	<25	38	8	30	4	.03	<.2	2	Alt slate; lim.
BT 41	6.8	130	32	12,000	12	<10	20	.16	80	24	Qtz vn; py, sph, tet.
BT 42	.02	56	96	150	8	30	2	.34	<.2	1.2	Alt phyllite; lim.
BT 43	<.02	<10	<25	50	16	<10	2	.13	<.2	<.1	Alt rk; py.
BT 44	.06	<10	<25	<25	<4	<10	1	.03	<.2	<.1	Do.
BT 45	.02	610	36	70	16	10	1	.15	5.6	1.2	Sheared zone; py.
BT 46	<.02	<10	<25	<25	12	<10	8	.90	.6	<.1	Do.
BT 47	<.02	<10	<25	38	8	30	8	1.3	.3	<.1	Do.
BT 49	.02	10	200	5,000	8	20	>100	1.6	36	46	Qtz vn; py, sph.
BT 50	<.02	<10	<25	180	8	20	10	.04	.3	.4	Alt rk; py.
BT 51	<.02	18	<25	100	8	20	3	.03	.4	.8	Do.
BT 52	.1	40	56	420	8	10	3	.05	5.6	2.8	Qtz vn; py.
BT 52a	.04	76	40	130	<4	40	4	.55	7.2	5.6	Do.
BT 53	<.02	<10	<25	<25	8	10	6	.32	<.2	.9	Do.
Ds213a	<.02	150	<25	<25	4	---	---	---	---	.6	Gossan.
Ds213b	<.02	<10	<25	<25	8	---	---	---	---	<.2	Do.
Ds213c	<.02	<10	<25	<25	<2	---	---	---	---	<.2	Breccia zone.
Ds214	<.02	<10	<25	<25	<2	---	---	---	---	.5	Qtz vn; py.
Ds215	<.02	<10	<25	28	4	---	---	---	---	4	Sheared zone; py.
Ds216	<.02	960	25	40	4	---	---	---	---	2.1	Do.
Ds217a	.02	650	<25	54	<2	---	---	---	---	1.1	Sheared zone; py.
Ds219	.08	28	46	170	4	---	---	---	---	5.3	Quartz vn; py.
Ds220	<.02	<10	<25	<25	<2	---	---	---	---	<.2	Alt rk.
Ds221	<.02	180	67	200	40	---	---	---	---	15	Qtz vn; py.
Ds222	.6	14	160	140	40	---	---	---	---	2.3	Alt rk.

1/ Abbreviations used in Table:

alt = altered	lim = limonite	rk = rock	tet = tetrahedrite
cp = chalcopyrite	py = pyrite	sid = siderite	vn = vein
fm = formation	qtz = quartz	sph = sphalerite	

TABLE 12.—*Analyses of altered*

Semiquantitative spectrographic analyses

Sample	Ti	Mn	Ag	As	Ba	Bi	Cd	Co	Cr	Cu	Mo	Ni	Pb	Sb	Sn	Sr
	(ppm)															
Ds48a	2,000	100	<1	<2,000	1,000	<10	<50	<3	2	3	5	3	30	<200	<10	150
Ds48b	3,000	700	<1	<2,000	1,500	<10	<50	20	150	20	<3	30	20	<200	<10	1,000
Ds48c	1,500	70	<1	<2,000	1,000	<10	<50	<3	5	3	<3	<3	30	<200	<10	200
Ds48d	1,000	50	<1	<2,000	700	<10	<50	<3	2	5	<3	<3	<10	<200	<10	150
Ds48e	1,000	150	<1	<2,000	500	<10	<50	<3	1	10	<3	<3	<10	<200	<10	70
Ds48f	3,000	70	<1	<2,000	1,500	<10	<50	<3	1	15	5	<3	200	<200	<10	200
Ds48g	2,000	70	<1	<2,000	700	<10	<50	<3	1	10	5	<3	70	<200	<10	100
Ds48h	2,000	30	<1	<2,000	700	<10	<50	<3	3	20	5	<3	30	<200	<10	200
Ds48i	2,000	50	<1	<2,000	1,000	<10	<50	<3	3	2	<3	<3	20	<200	<10	200
Ds48j	1,500	20	<1	<2,000	200	<10	<50	<3	5	5	<3	<3	15	<200	<10	30
Ds50	2,000	70	<1	<2,000	1,500	<10	<50	<3	3	5	<3	<3	30	<200	<10	500
Ds53a	3,000	700	<1	<2,000	1,500	<10	<50	20	50	15	<3	20	15	<200	<10	1,000
Ds53c	3,000	1,000	<1	<2,000	1,500	<10	<50	15	50	15	<3	15	20	<200	<10	1,500
Ds55a	2,000	20	<1	<2,000	700	<10	<50	<3	3	10	<3	<3	<10	<200	<10	100
Ds55b	1,500	20	<1	<2,000	1,000	<10	<50	<3	2	7	5	<3	10	<200	<10	150
Ds55c	3,000	1,500	<1	<2,000	1,500	<10	<50	15	70	10	<3	30	<10	<200	<10	1,000
Ds56	2,000	70	<1	<2,000	200	<10	<50	<3	3	15	<3	<3	<10	<200	<10	30

rock from the Ute Creek area

Sample	Semiquantitative spectrographic analyses--Continued (ppm) V	W	Zn	(percent) Fe	Mg	Ca	Chemical analyses (ppm) Au	Cu	Pb	Zn	Mo	Sample description 1/
Ds48a	30	<100	<200	1.0	0.3	0.15	<0.1	80	25	<25	<2	Alt intrusive.
Ds48b	150	<100	<200	5	3	3	<.1	150	25	75	<2	Do.
Ds48c	50	<100	<200	1	.3	.3	<.1	40	25	25	<2	Alt welded tuff.
Ds48d	20	<100	<200	1	.2	.2	<.1	60	25	<25	<2	Do.
Ds48e	15	<100	<200	.7	.3	.07	<.1	80	25	25	<2	Do.
Ds48f	50	<100	<200	3	.2	.1	<.1	70	125	<25	<2	Do.
Ds48g	30	<100	<200	2	.3	.07	<.1	60	25	<25	2	Do.
Ds48h	30	<100	<200	.5	.2	.2	<.1	80	25	<25	2	Alt welded tuff; py.
Ds48i	30	<100	<200	1.5	.5	.2	.2	50	25	<25	<2	Do.
Ds48j	20	<100	<200	.5	.1	.02	<.1	60	25	<25	<2	Alt welded tuff.
Ds50	50	<100	<200	1	.3	.3	<.1	60	<25	25	<2	Do.
Ds53a	150	<100	<200	7	.7	3	.2	80	<25	50	<2	Alt intrusive.
Ds53c	150	<100	<200	5	.5	2	<.1	70	<25	75	<2	Do.
Ds55a	30	<100	<200	1	.15	.05	<.1	100	<25	<25	<2	Alt welded tuff; py.
Ds55b	20	<100	<200	1.5	.2	.07	<.1	100	25	<25	6	Do.
Ds55c	200	<100	<200	5	1.5	2	<.1	150	25	200	<2	Alt intrusive; py.
Ds56	20	<100	<200	1	.2	.07	<.1	70	25	<25	2	Sil intrusive; py.

1/ Abbreviations used in Table: Alt = altered; py = pyrite; sil = silicified.

TABLE 13.—*Analyses of altered and mineralized rock in*

Semiquantitative spectrographic analyses

Sample	Ti (ppm)	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
A--Altered and mineralized rock near Red Mountain and Piedra Peak												
LS 1	7,000	700	<0.5	<200	1,500	5	50	70	<2	10	50	<100
LS 4	7,000	700	<.5	<200	1,000	<5	15	100	<2	<2	50	<100
LS 5	7,000	700	<.5	<200	1,000	<5	30	70	<2	7	30	<100
LS 6	5,000	300	<.5	<200	1,500	<5	30	150	<2	<2	50	<100
LS 8	7,000	500	<.5	<200	1,000	<5	<5	100	<2	<2	50	<100
LS 9	5,000	200	<.5	<200	1,500	<5	7	100	<2	<2	20	<100
LS10a	500	50	<.5	<200	100	<5	50	100	<2	<2	<10	<100
LS10b	7,000	1,000	<.5	<200	1,500	<5	<5	100	<2	<2	15	<100
LS12	7,000	200	<.5	<200	1,500	<5	15	100	<2	7	30	<100
LS14	10,000	700	<.5	<200	300	15	30	100	<2	10	20	<100
LS15	5,000	100	<.5	<200	500	<5	15	70	<2	<2	70	<100
LS20a	10,000	1,500	<.5	<200	1,000	10	<5	100	<2	30	30	<100
LS20b	7,000	200	<.5	<200	700	<5	70	30	<2	<2	70	<100
LS21	5,000	300	<.5	<200	700	<5	<5	5	<2	<2	50	<100
LS22	3,000	>5,000	<.5	<200	500	<5	<5	100	<2	<2	30	<100
LS24	5,000	700	<.5	<200	300	<5	<5	150	<2	<2	50	<100
LS29	7,000	1,500	<.5	<200	1,500	<5	20	70	<2	<2	30	<100
LS31	7,000	500	<.5	<200	1,500	<5	<5	150	<2	<2	70	<100
LS32	7,000	700	<.5	<200	1,500	<5	5	100	<2	<2	50	<100
LS33	5,000	500	<.5	<200	1,500	<5	<5	50	<2	<2	50	<100
LS36	7,000	70	<.5	<200	2,000	<5	<5	50	10	<2	30	<100
LS38	10,000	1,000	<.5	<200	1,500	10	<5	100	<2	<2	20	<100
LS39	10,000	700	<.5	<200	1,500	<5	50	100	<2	10	30	<100
LS41	1,000	200	<.5	<200	2,000	<5	<5	70	<2	<2	30	<100
LS42	7,000	2,000	<.5	<200	1,000	5	200	70	<2	50	20	<100
LS43	5,000	1,500	<.5	<200	1,500	<5	200	150	<2	30	20	<100
LS45	7,000	1,000	<.5	<200	1,000	5	100	100	<2	30	20	<100
LS47	5,000	20	<.5	<200	1,000	<5	<5	100	5	<2	100	<100
LS48	7,000	1,500	<.5	<200	1,000	<5	70	200	<2	10	10	<100
LS49	7,000	1,500	<.5	<200	1,000	<5	70	100	<2	20	10	<100
LS51	5,000	2,000	<.5	<200	700	<5	70	200	<2	15	15	<100
LS52	5,000	1,000	<.5	<200	700	<5	100	100	<2	<2	30	<100
LS53	1,500	70	<.5	<200	700	<5	<5	50	<2	<2	150	<100
LS54	2,000	70	<.5	<200	500	<5	<5	100	<2	<2	100	<100
LS57	1,500	50	<.5	<200	300	<5	<5	100	<2	<2	70	<100
LS57a	1,500	50	<.5	<200	500	<5	<5	20	<2	<2	20	<100
LS62	10,000	1,500	<.5	<200	700	<5	10	200	<2	<2	20	<100
LS63	5,000	2,000	<.5	<200	2,000	<5	10	150	<2	<2	20	<100
LS64	3,000	100	<.5	<200	200	<5	<5	70	<2	<2	150	<100
LS65	10,000	1,000	<.5	<200	2,000	<5	20	50	<2	<2	20	<100
LS68	7,000	15	<.5	<200	1,500	<5	<5	70	<2	<2	30	<100
LS69	2,000	300	<.5	<200	300	<5	<5	10	<2	<2	30	<100
LS73	3,000	300	<.5	<200	700	<5	<5	50	<2	<2	30	<100
LS74	5,000	1,000	<.5	<200	1,000	<5	10	50	<2	<2	20	<100
LS76	5,000	70	<.5	<200	700	<5	30	70	<2	<2	15	<100
LS77	2,000	200	<.5	<200	700	<5	<5	70	10	<2	30	<100
LS94	10,000	<5	<.5	<200	5,000	<5	<5	150	<2	<2	<10	<100
LS94a	10,000	10	<5	<200	150	<5	5	70	<2	<2	<10	<100
Ds104	5,000	200	<.5	<200	1,500	<2	50	10	<5	5	15	<100
Ds109a	2,000	<10	<.5	<200	500	10	50	100	<5	20	10	<100
Ds109b	5,000	<10	<.5	<200	500	<5	50	10	<5	5	10	<100
Ds109c	3,000	1,000	<.5	<200	700	15	20	10	<5	10	<10	<100
Ds109d	7,000	1,000	<.5	<200	1,000	20	50	50	<5	15	10	<100
Ds109e	5,000	<10	<.5	<200	1,000	5	30	10	<5	10	<10	<100
Ds109f	3,000	<10	<.5	<200	500	<5	30	10	<5	<5	30	<100
Ds109g	700	<10	<.5	<200	300	<5	30	5	<5	<5	30	<100

the Red Mountain–Piedra Peak–upper Goose Creek area

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)							
Sample	Sn	Sr	V	Zn	Au	Cu	Pb	Zn	Mo	As	Hg	Sample description[1]
					A--Altered and mineralized rock near Red Mountain and Piedra Peak							
LS 1	<10	700	150	<200	1.2	225	100	<50	30	<10	0.2	Int rk; py.
LS 4	<10	700	100	<200	<.1	325	50	50	3	<10	.3	Do.
LS 5	<10	1,000	100	<200	<.1	112	100	50	<1	<10	.2	Do.
LS 6	<10	1,000	100	<200	<.1	112	50	50	<1	<10	.2	Do.
LS 8	<10	2,000	150	<200	<.1	60	50	<50	<1	10	.1	Alt int rk.
LS 9	<10	1,500	100	<200	<.1	60	50	<50	<1	10	.1	Alt int rk; lim.
LS10a	<10	<50	<10	<200	<.1	30	50	<50	<1	<10	.1	Granular qtz.
LS10b	<10	1,500	100	<200	<.1	60	50	100	<1	20	.1	Int rk.
LS12	<10	1,000	100	<200	<.1	60	50	<50	<1	<10	.1	Int rk; py.
LS14	<10	1,500	150	<200	<.1	60	50	<50	<1	10	.2	Do.
LS15	<10	100	30	<200	<.1	30	50	<50	2	20	.1	Alt rk nr int.
LS20a	<10	2,000	200	<200	<.1	112	50	150	<1	10	.1	Sil int rk; py.
LS20b	<10	200	50	<200	<.1	60	50	<50	4	20	.1	Sil rk.
LS21	<10	150	10	<200	<.1	60	50	<50	<1	20	.1	Do.
LS22	<10	150	50	<200	<.1	60	50	<50	<1	10	.2	Do.
LS24	<10	150	20	<200	<.1	225	50	<50	<1	10	.1	Do.
LS29	<10	2,000	100	<200	<.1	112	50	<50	<1	<10	.1	Alt rk; py.
LS31	<10	700	100	<200	<.1	112	50	<50	<1	<10	.1	Sil rk; py.
LS32	<10	700	30	<200	<.1	30	50	<50	<1	10	.1	Int rk.
LS33	<10	1,000	30	<200	<.1	30	50	<50	<1	20	.1	Sil rk.
LS36	<10	200	50	<200	<.1	15	<50	250	<1	20	.2	Argillized tuff.
LS38	<10	2,000	150	<200	<.1	60	<50	300	<1	<10	.1	Sil int; py.
LS39	<10	1,500	150	<200	<.1	30	<50	150	10	<10	.1	Int rk; py.
LS41	<10	700	70	<200	<.1	30	<50	50	10	10	.1	Alt tuff; py.
LS42	<10	500	150	<200	<.1	60	<50	300	10	<10	.1	Do.
LS43	<10	700	150	<200	<.1	112	<50	200	4	10	.1	Do.
LS45	<10	500	150	<200	<.1	112	<50	50	<1	30	.2	Do.
LS47	<10	500	150	<200	<.1	60	<50	50	<1	15	.2	Sil tuff; py.
LS48	<10	700	150	<200	<.1	112	<50	200	<1	15	.2	Do.
LS49	<10	700	200	<200	<.1	60	<50	50	<1	10	.1	Alt rk.
LS51	<10	1,000	150	<200	<.1	112	<50	50	<1	20	.2	Sil rk; py
LS52	<10	500	150	<200	<.1	60	<50	<50	<1	15	.1	Do.
LS53	<10	500	70	<200	<.1	30	<50	<50	<1	15	.1	Qtz-alunite rk.
LS54	<10	500	30	<200	<.1	30	<50	<50	<1	20	.2	Do.
LS57	<10	200	20	<200	<.1	15	<50	<50	<1	15	.2	Qtz rk; py.
LS57a	<10	<50	20	<200	<.1	15	<50	<50	<1	15	.1	Do.
LS62	<10	2,000	150	<200	<.1	<15	<50	50	<1	10	.1	Propylitized tuff.
LS63	<10	2,000	100	<200	<.1	30	<50	250	<1	10	.1	Do.
LS64	<10	<50	15	<200	<.1	<15	100	<50	<1	15	.1	Granular qtz rk.
LS65	<10	700	150	<200	<.1	30	<50	200	<1	15	.2	Alt tuff; py.
LS68	<10	300	30	<200	<.1	<15	<50	100	<1	15		Argillized tuff.
LS69	<10	<50	<10	<200	<.1	<15	<50	250	<1	15	.1	Do.
LS73	<10	<50	70	<200	<.1	30	<50	<50	<1	15	.1	Alt rk.
LS74	<10	1,000	100	<200	<.1	15	<50	250	<1	10	.1	Int rk; py.
LS76	<10	300	150	<200	<.1	15	<50	50	<1	10	.2	Alt tuff; py.
LS77	<10	100	15	<200	<.1	15	<50	<50	<1	20	.2	Sil tuff; py.
LS94	<10	<50	<10	<200	<.1	30	<50	<50	<1	15	.1	Sil rk; barite.
LS94a	<10	70	10	<200	<.1	15	<50	<50	<1	15	.1	Do.
Ds104	<10	200	150	<200	<.02	10	<25	26	2	10	.56	Alt rk.
Ds109a	<10	200	150	<200	<.02	100	<25	<25	2	<10	3.8	Sil rk; py.
Ds109b	<10	700	200	<200	<.02	20	<25	<25	2	<10	1.1	Do.
Ds109c	<10	100	70	<200	<.02	30	<25	56	2	<10	1.9	Argillized rk; py.
Ds109d	<10	300	200	<200	<.02	30	<25	146	2	<10	1.3	Alt rk; py.
Ds109e	<10	200	100	<200	<.02	20	<25	<25	2	<10	2.7	Qtz-alunite rk.
Ds109f	<10	500	150	<200	<.02	10	<25	<25	2	<10	3	Qtz rk; py.
Ds109g	<10	500	150	<200	<.02	20	<25	<25	2	10	5.8	Do.

TABLE 13.—*Analyses of altered and mineralized rock in the Red*

Semiquantitative spectrographic analyses

Sample	Ti	Mn	Ag	As	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sb
	(ppm)											
B--Altered intrusive plug along divide between Goose and Beaver Creeks												
Ds107a	5,000	300	<0.5	<200	1,000	5	<10	20	<5	5	<10	<100
Ds107b	3,000	500	<.5	<200	1,000	10	<10	20	<5	5	<10	<100
Ds107c	5,000	100	<.5	<200	1,000	5	30	20	<5	5	10	<100
Ds107d	3,000	<10	<.5	<200	300	<5	15	10	<5	<5	300	<100
Ds107e	1,500	<10	<.5	<200	300	<5	15	20	<5	<5	300	<100
Ds107f	1,500	<10	<.5	<200	200	<5	15	20	<5	<5	200	<100
Ds107g	5,000	150	<.5	<200	1,000	5	20	10	<5	5	10	<100
C--Altered rock along upper Goose Creek												
Ds170	5,000	1,000	<.5	<200	700	10	10	20	<5	10	<10	<100
Ds171a	3,000	1,500	<.5	<200	500	10	10	20	<5	10	20	<100
Ds171b	7,000	300	<.5	<200	200	7	10	30	<5	5	10	<100
Ds172	500	2,000	<.5	<200	70	<5d	<5d	70	5	5	<10	<100
Ds173a	3,000	1,000	<.5	<200	1,500	5	5	15	<5	7	10	<100
Ds173b	5,000	1,500	<.5	<200	1,000	<5d	10	20	<5	5	100	<100

Mountain–Piedra Peak–upper Goose Creek area—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sn	Sr	V	Zn	Chemical analyses (ppm) Au	Cu	Pb	Zn	Mo	As	Hg	Sample description 1/
					B--Altered intrusive plug along divide between Goose and Beaver Creeks							
Ds107a	<10	500	150	<200	<0.02	10	<25	29	2	<10	0.42	Propylitic alt rk; py.
Ds107b	<10	500	150	<200	<.02	10	<25	70	2	<10	.06	Do.
Ds107c	<10	300	150	<200	<.02	20	<25	26	2	<10	1.3	Argillic alt rk; py.
Ds107d	<10	500	70	<200	<.02	10	200	<25	2	<10	.08	Qtz-alunite rk.
Ds107e	<10	500	70	<200	<.02	10	150	<25	2	40	1.8	Qtz-alunite rk; py.
Ds107f	<10	300	70	<200	<.02	10	<25	<25	2	10	1.1	Do.
Ds107g	<10	500	150	<200	<.02	40	<25	26	2	<10	1.8	Do.
					C--Altered rock along upper Goose Creek							
Ds170	<10	700	150	<200	<.02	19	<25	36	<4	---	.34	Alt int; py.
Ds171a	<10	500	150	<200	<.02	24	<25	190	<4	---	.54	Do.
Ds171b	<10	500	200	<200	<.02	15	<25	<25	<4	---	.16	Alt lava nr int.
Ds172	<10	<100d	30	<200	.04	30	<25	80	<4	---	.11	Alt rk; qtz vns.
Ds173a	<10	150	150	<200	<.02	12	<25	110	<4	---	..65	Alt lava, py.
Ds173b	<10	150	200	<200	<.02	11	38	52	4	---	.05	Warm spring muck.

1/ Abbreviations used in Table:

alt = altered
int = intrusive
lim = limonite
nr = near
py = pyrite
qtz = quartz
rk = rock
sil = silicified
vns = veins

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[Italic page numbers indicate major references]