STUDIES RELATED TO WILDERNESS

LA GARITA WILDERNESS, COLORADO

GEOLOGICAL SURVEY BULLETIN 1420

Mineral Resources of the La Garita Wilderness, San Juan Mountains, Southwestern Colorado

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With a section on GEOPHYSICAL INTERPRETATION
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STUDIES RELATED TO WILDERNESS—WILDERNESS AREAS

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An evaluation of the mineral potential of the area

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STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

Under the Wilderness Act (Public Law 88-577, Sept. 3, 1964) certain areas within the National Forests previously classified as "wilderness," "wild," or "canoe" were incorporated into the National Wilderness Preservation System as wilderness areas. The act provides that the Geological Survey and the Bureau of Mines survey these wilderness areas to determine the mineral values, if any, that may be present. The act also directs that results of such surveys are to be made available to the public and submitted to the President and Congress.

This bulletin reports the results of a mineral survey of the La Garita Wilderness, Colorado.

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MINERAL RESOURCES OF THE LA GARITA WILDERNESS, SAN JUAN MOUNTAINS, SOUTHWESTERN COLORADO

By THOMAS A. STEVEN, U.S. Geological Survey, and
C. L. BIENIEWSKI, U.S. Bureau of Mines

SUMMARY

The La Garita Wilderness covers about 197 square kilometres (76 square miles) or about 19,700 hectares (48,600 acres) of rugged terrain in the central San Juan Mountains of southwestern Colorado. Altitudes range from less than 3,050 m (10,000 ft) to 4,274 m (14,014 ft) at the top of San Luis Peak. The geology of the wilderness was mapped by the U.S. Geological Survey at various times during the 1960's, as part of other geologic studies in the central San Juans. Specific studies of mineralized areas and general stream-sediment sampling of the whole wilderness were conducted by U.S. Geological Survey personnel in 1967-68 and 1971. Investigations by the U.S. Bureau of Mines were done largely in 1971, when claim records and locations were investigated, and all mine workings that could be found were examined and sampled.

The La Garita Wilderness is underlain entirely by volcanic rocks or related intrusives that formed during a brief interval of less than 2 m.y. (million years) between 28 and 26 m.y. ago. These rocks record only a small part of the volcanic activity that took place during the 2-m.y. span; further, the geology of the wilderness can be understood only in the context of the geologic history of the whole central San Juan area.

The central San Juan Mountains were a major source area for voluminous ash flows, which spread as avalanches of incandescently hot ash that congealed into widespread sheets of densely welded tuff after deposition. Major volcanic subsidence structures (calderas) formed at the sources of most of these ash flows; five calderas have been recognized near the La Garita Wilderness, and two more may have formed but, if so, they were obliterated by younger calderas or were covered by younger rocks. Subsidence generally took place concurrently with eruption of the ash flows, and the calderas commonly are filled with masses of densely welded tuff as much as 1,220 m (4,000 ft) thick. The entire La Garita Wilderness lies within two nonconsecutive calderas that are part of the central San Juan caldera complex. The eastern two-thirds of the wilderness is within the large La Garita caldera, the oldest subsidence structure in the vicinity of the wilderness, and the western third is within the San Luis caldera, the third youngest of the subsidence structures.

Hydrothermal activity affected rocks in or near the La Garita Wilderness at least four times during volcanic activity. The intrusive core of an old andesite central volcano is exposed on the east wall of the La Garita caldera east of the wilderness; this core and the adjacent rocks are irregularly altered and are cut by local quartz-pyrite veins. Valuable minerals are sparse in the exposed parts of this center, and the

mineralized area is entirely outside the La Garita Wilderness; thus, virtually no potential for mineral resources related to this center can be postulated for adjacent parts of the wilderness.

The thick mass of densely welded Nelson Mountain Tuff in the core of the San Luis caldera was pervasively propylitized during postemplacement intrusive and extrusive activity and resurgent doming. Many minor quartz-pyrite and quartz-calcite-pyrite veins were formed along minor fractures during this period of hydrothermal activity, and some of these veins near the northwest margin of the wilderness contain local concentrations of lead, zinc, and silver of economic interest. Most of the deposits containing valuable minerals are adjacent to the Bondholder Meadows, 0.8–1.6 km (0.5–1 mi) outside the wilderness, but some deposits along lower Cascade Creek are adjacent to the boundary and some extend within the wilderness. All these veins are small, however, and the concentrations of valuable minerals are so erratically distributed that no major mineral resource can be postulated. Larger veins, with more persistent valuable metal concentrations, would have to be found in order to support even a small mining industry in the area under existing economic conditions.

A series of intrusive plugs marking the roots of former volcanoes extends from the western edge of the La Garita Wilderness westward for about 14.4 km (9 mi), to the vicinity of Spring Creek Pass. Many of the centers were intensely altered by hydrothermal activity during waning stages of volcanic activity, and local areas containing somewhat anomalous metal concentrations have been identified. A low-level zinc anomaly was detected in stream-sediment samples from upper Cascade Creek and from East Mineral Creek in and adjacent to the wilderness. No deposits containing concentrations even remotely approaching ore grade were seen, however, and no mineral resources of economic significance can be postulated from present information.

The most important mineralized area in the central San Juan Mountains is in the Creede mining district 5–13 km (3–8 mi) south and southwest of the La Garita Wilderness. The ores here were deposited after development of the Creede caldera, and are localized along a series of faults that extend radially north to northwest out from the caldera. None of the faults that host the ores extend into the La Garita Wilderness, and it is unlikely that any mineral resources related to the Creede center of mineralization exist within the wilderness.

Glassy rhyolite flows confined within the northern part of the San Luis caldera 2.4-3.2 km (1.5-2 mi) northwest of the La Garita Wilderness, have been extensively hydrated to perlite. Many of these flows consist almost wholly of thoroughly hydrated glass; some are thick and widespread and contain large tonnages of potentially valuable perlite. Although little perlite was seen within the wilderness itself, a major resource exists a short distance northwest of the boundary. No evidence was seen for geothermal energy or fossil-fuel resources within the La Garita Wilderness.

Known mineralization in the central part of the San Juan volcanic field is thus largely outside the La Garita Wilderness, and extends into it only in the western part where small and generally low-grade veins cut the core of the San Luis caldera. No evidence was seen even here to encourage extensive prospecting or exploration, and the remainder of the wilderness is seemingly devoid of indications of mineral deposits.

INTRODUCTION

The La Garita Wilderness was established as a Primitive Area in 1932 and was reclassified in 1961 as a Wild Area. In 1964, the name was changed to La Garita Wilderness in accordance with the Wilderness Act. The wilderness covers about 197 km^2 (76 mi^2), or about 19,700 ha (48,600 acres), of the rugged central San Juan Mountains in Saguache County, southwestern Colorado (fig. 1). The south boundary lies along the drainage divide north of the Rio Grande, and the

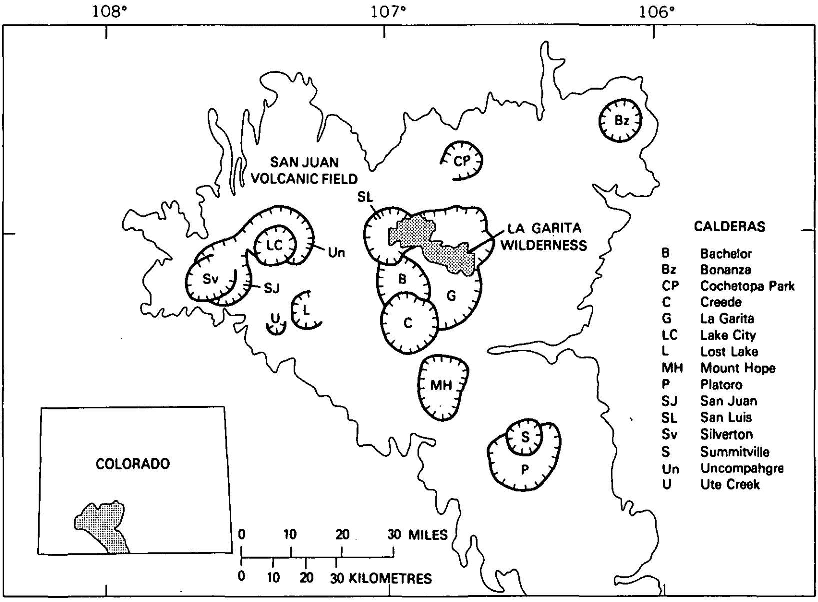

FIGURE 1.—Map showing location of the La Garita Wilderness in relation to calderas in the San Juan volcanic field, southwestern Colorado.

wilderness includes the headwaters of Spring Creek (tributary to Cebolla Creek), Cochetopa Creek, and Saguache Creek. The Continental Divide splits the wilderness, with the west half being in the Gunnison National Forest and the east half in the Rio Grande National Forest. The northern boundary of the wilderness is readily accessible by roads and jeep trails along all the major streams, but the southern boundary is more remote and can be approached by jeep trails only near the southwestern and southeastern edges.

The La Garita Wilderness is a rugged area of high mountain peaks, alpine meadows, and deeply incised stream canyons. Altitudes range from 3,050 m (10,000 ft) along some of the major streams to over 4,270 m (14,000 ft); San Luis Peak (4,274 m; 14,014 ft), Stewart Peak (4,263 m; 13,983 ft), La Garita Mountains (4,238 m; 13,895 ft), and Baldy Chato (4,087 m; 13,401 ft) are the major mountain summits. Because of weather and snow conditions, the high mountains are usually accessible only during the summer and early autumn months.

MINERAL RESOURCE INVESTIGATIONS

The geology and mineral resources of the central San Juan Mountains, including the area of the La Garita Wilderness, have been studied in the course of several other investigations by the U.S. Geological Survey and the U.S. Bureau of Mines, as well as in specific investigations that have led to the mineral appraisal given in this report. The geology and mineral deposits in the Creede mining district were studied in detail by Steven and Ratté (1965), and their geologic map covers much of the area south of the western half of the wilderness. The petrology and petrography of many of the rocks in and near the Creede district were considered in greater detail in a separate report by Ratté and Steven (1967). As the detailed work in the Creede district showed that previous regional geologic interpretations in the San Juan Mountains (Larsen and Cross, 1956) were inadequate to delineate the geology, a program of geologic mapping at a scale of 1:62,500 of the areas adjacent to the Creede district was begun in 1961 by T. A. Steven. The Bristol Head quadrangle west of the Creede district was completed (Steven, 1967), and most of the Creede quadrangle and the northern part of the Spar City quadrangle were mapped during this phase of the investigations. In 1964, the scope of the regional work was enlarged to embrace the entire Durango 1°×2° quadrangle at a scale of 1:250,000 (Steven and others, 1974). In this latter study, T. A. Steven and P. W. Lipman mapped the volcanic rocks of the central and eastern San Juan Mountains, with Steven having responsibility for most of the mapping in and near the La Garita Wilderness. In the course of the broad regional studies, geologic mapping was completed in the remainder of the Creede 15-minute quadrangle (Steven and Ratté, 1973) and of the Spar City 15-minute quadrangle (Steven and Lipman, 1973).

Reconnaissance geologic mapping by Steven in the southern part of the Montrose 1°×2° quadrangle, covering the northern part of the La Garita Wilderness and adjacent areas, was done during parts of the field seasons of 1968–71 as an adjunct to the Durango quadrangle mapping and as part of a continuing program of 1:250,000-scale mapping in south-central Colorado.

Specific studies of mineralized areas near the northwest side of the La Garita Wilderness were begun in 1967 by L. J. Schmitt, Jr., who sampled stream sediments, altered rocks, and vein deposits along Spring and Mineral Creeks as part of the program of the U.S. Geological Survey. The results of this sampling have not been reported previously, and are incorporated in the present report.

Prior to investigations connected with the present mineral appraisal, the U.S. Bureau of Mines made a study of the silver potential of the Creede mining district (Meeves and Darnell, 1968).

In connection with the mineral appraisal of the La Garita Wilderness, T. A. Steven sampled stream sediments along all the main streams, as well as all the areas of altered rocks and veins noted during earlier geologic mapping. The analytical results from this sampling program were integrated with the analytical results obtained earlier by Schmitt.

In 1971, the Bureau of Mines conducted an investigation of the La Garita Wilderness to assess its economic potential. Under the field direction of C. L. Bieniewski, records of Saguache, Hinsdale, and Mineral Counties were examined for mining claims in or near the wilderness. The U.S. Forest Service, Bureau of Land Management, mining companies, and local residents were contacted for information as to mining activity. Bureau of Mines records were checked for mineral production. In the field, all mine and prospect workings that could be found were examined and sampled. Many of the mine workings in and near the western part of the wilderness were examined jointly by Bieniewski and Steven.

ACKNOWLEDGMENTS

Investigations leading to this report were facilitated in various ways by the cooperation of many people living in the central San Juan Mountains near the La Garita Wilderness. Particular mention should be made of the willing cooperation received from John J. Jackson and Eugene Wardell of the Bonnez Mining Company. Special thanks are due Mr. Jackson for providing valuable information about the location of mining prospects and the history of mining activity in and around the La Garita Wilderness. Forest Cadwell, of Powderhorn, Colo., shared his extensive knowledge of the western part of the wilderness with us, and thereby contributed greatly to the progress of our work. The assistance of the Mineral, Saguache, and Hinsdale County Clerks in searching the county records is appreciated. The cooperation of the Forest Service and Bureau of Land Management is hereby acknowledged.

GEOLOGIC APPRAISAL

By THOMAS A. STEVEN, U.S. Geological Survey

The La Garita Wilderness is underlain entirely by volcanic rocks or related intrusives (pl. 1) that formed during a brief interval of less than 2 m.y. (million years), between 28 and 26 m.y. ago. This span was near the culmination of a period of intense volcanic activity in south-central Colorado that extended through Oligocene time (Steven and Epis, 1968). The wilderness is entirely within the eroded remnants of two major volcanic subsidence structures (calderas) (fig. 1) that formed in response to major ash-flow eruptions. These calderas and related rocks record only a small part of the volcanic activity that took place during the 2 m.y. span; perhaps as many as five other calderas formed nearby in the central part of the volcanic field.

Some of the calderas and related volcanic centers in the central San Juan Mountains were mineralized during the successive eruptive periods. The most important of these mineralized areas is the currently active Creede mining district (Steven and Ratté, 1965) near the southwest margin of the La Garita Wilderness; most of the productive mines in the Creede district are 5–13 km (3–8 mi) south of the wilderness boundary, but the outlying Equity mine is within 2.4 km (1.5 mi) of the boundary. The core of the San Luis caldera, which embraces the western quarter of the La Garita Wilderness, is cut by many mineralized veins. Most of these veins are small and contain only minor quantities of valuable metals, and thus the potential for developing major mineral resources seems small. A series of intrusive plugs, marking the roots of former volcanoes, extends westward for about 14.4 km (9 mi) from the La Garita Wilderness. Many of these intrusive bodies are surrounded by halos of altered rock that are locally cut by mineralized veins. Anomalous quantities of metal were present in some of the stream-sediment samples taken near one of these altered areas, in the headwaters of Cascade and Mineral Creeks, along and near the western margin of the wilderness. The Sky City mine area adjacent to the eastern edge of the wilderness is localized in and near an altered intrusive center; considerable prospecting has been done in the past, but no significant production has been recorded.

GEOLOGY

The rocks in the central San Juan Mountains, including the La Garita Wilderness, consist largely of a sequence of major ash-flow tuff units; a series of calderas formed concurrently with the ash-flow eruptions, and together they form a composite structural depression about 40 by 48 km (25 by 30 mi) across (fig. 1). The La Garita Wilderness covers only a small part of the complex area of recurrent ash-flow eruptions and related caldera subsidences in the central San Juan Mountains. The wilderness extends across parts of the resurgent core of the nonconsecutive La Garita and San Luis calderas, and includes a sequence of moat-filling ash-flow tuff units on the east side of the La Garita caldera and parts of two postsubsidence accumulations of lavas and breccias around the San Luis caldera. These units represent such fragmentary parts of the geologic history of the central San Juan area that no coherent story of development or understanding of the possible mineral potential can be gained by limiting consideration to the area embraced strictly by the wilderness boundary.

This discussion will thus summarize the geologic history of the whole central San Juan area, and will fit the specific geology of the wilderness within this framework. Plate 1 shows the boundary of the La Garita Wilderness, additional areas adjacent to the wilderness that were studied as part of this mineral resource appraisal, and sufficient nearby geology to illustrate some of the regional relations bearing on this appraisal. A generalized sequence of major units exposed in and near the La Garita Wilderness is given in table 1, and

TABLE 1. — *Volcanic sequence in the central San Juan Mountains*

Lavas and breccias of intermediate to silicic composition	Ash-flow sequence (related caldera)
	Snowshoe Mountain Tuff—biotite-pyroxene quartz latite ash-flow tuff containing 35–60 percent phenocrysts, mainly plagioclase, biotite, and augite (Creede caldera).
Quartz latite of Baldy Cinco—predominantly coarsely porphyritic quartz latite flows and breccias.	
	Tuff of Cochetopa Creek—biotite-augite-plagioclase quartz latite ash-flow tuff containing about 30 percent phenocrysts (Cochetopa Park caldera).
Volcanics of Stewart Peak—porphyritic rhyodacite, quartz latite, and rhyolite flows and breccias. Some rhyolite flows consist largely of perlite.	
	Nelson Mountain Tuff—biotite-augite-plagioclase quartz latite ash-flow tuff containing about 30 percent phenocrysts (San Luis caldera).
Local volcanoes—coarsely porphyritic quartz latite and rhyolite flows, breccias, and volcanic necks.	Rat Creek Tuff—crystal-poor, largely non- to slightly-welded rhyolite ash-flow tuff.
	Wason Park Tuff—red rhyolitic ash-flow tuff containing about 30 percent phenocrysts of tabular feldspar, platy biotite, and sparse augite. White tridymitic collapsed pumice fragments are characteristic.
	Mammoth Mountain Tuff—compositionally zoned ash-flow tuff sheet, ranging from biotite-augite-plagioclase quartz latite with 30–50 percent phenocrysts in upper part, to crystal-poor rhyolite with less than 10 percent phenocrysts in lower part.
	Carpenter Ridge Tuff—crystal-poor rhyolite ash-flow tuff; in part streaked and layered by secondary flow (Bachelor caldera).
	Fish Canyon Tuff—biotite-hornblende-plagioclase quartz latite containing about 50 percent phenocrysts (La Garita caldera).
Conejos Formation—predominantly dark, fine-grained andesitic to rhyodacitic lavas and breccias; local monzonitic intrusives in source areas.	

the different units will be discussed in historical order in the following paragraphs.

The volcanic history of the central San Juan Mountains (Lipman and others, 1970) began some time in latest Eocene or earliest Oligocene time, when andesitic volcanoes formed widely over much of south-central Colorado (Steven and Epis, 1968). This andesitic volcanism was widespread and intense in the San Juan Mountains during the interval between 35 and 30 m.y. ago, and the lavas and breccias erupted from the different volcanoes coalesced to form a large composite field. Dark lavas of this age, called Conejos Formation, are exposed along the flanks of Wannamaker Creek just east of the La Garita Wilderness. Partly altered and mineralized intrusive plugs that fed one of these volcanoes are now exposed near the Sky City mine about 1.6 km (1 mi) east of the wilderness (pl. 1).

About 30 m.y. ago the character of volcanism in the San Juan Mountains began to change; ash-flow eruptions of more silicic magma became dominant, and subcircular calderas subsided concurrently in the source areas. At first, the ash-flow eruptions alternated with continuing eruption of andesitic lavas and breccias that commonly accumulated within the subsided basins of the calderas. As time progressed, the andesitic volcanism diminished in volume and became less closely associated in space with the caldera source areas. Porphyritic rhyodacitic to rhyolitic lavas, closely related in composition to the ash flows, erupted from vents near the marginal ring-fracture zones and accumulated within and adjacent to the successive calderas, generally late in a local cycle of caldera development.

The earliest calderas formed near Bonanza in the northeastern part of the San Juan volcanic field (Knepper and Marrs, 1971, p. 261), near Platoro in the southern part of the field (Lipman and Steven, 1970), and in the headwaters of the Rio Grande and near Silverton and Lake City in the western part of the field (Lipman and others, 1973) (fig. 1). None of the products erupted from these early caldera sources is exposed within the La Garita Wilderness.

About 28 m.y. ago, the ash-flow eruptions shifted to the central part of the San Juan volcanic field, where more than 2,000 km^3 (500 mi^3) of incandescent ash was erupted to form the Fish Canyon Tuff, and the La Garita caldera, about 40 km (25 mi) across, subsided in the source area (fig. 1). Subsidence was at least in part concurrent with eruption, as the intracaldera La Garita Member of the Fish Canyon Tuff is more than 1,220 m (4,000 ft) thick, whereas the outflow sheet is generally less than 180 m (600 ft) thick.

Only the eastern topographic wall of the La Garita caldera is preserved near the wilderness; other parts of the margin, particularly to the south and west, have been destroyed by later caldera subsidences, or have been covered by younger rocks. The eastern wall is well displayed near Wannamaker Creek, just east of the La Garita Wilderness (pl. 1), where younger welded ash-flow tuff units filling a topographic trough around the margin of the caldera lap out against a steep slope of precaldera andesitic flows and breccias of the Conejos Formation. Intracaldera tuffs of the La Garita Member underlie these younger ash-flow tuffs at the caldera margin, whereas equivalent outflow tuffs rest on the Conejos lavas, high on top of the eastern wall.

Following subsidence, the core of the La Garita caldera was broadly domed, presumably by upward pressure of resurgent magma. Only the northeastern part of the resurgent dome has been preserved; the southern and western parts have since subsided into younger calderas and have been covered by younger rocks. The part of the resurgent dome still preserved has more than 1,220 m (4,000 ft) of structural relief, from below 3,050 m (10,000 ft) altitude in the marginal moat along Saguache Creek, to nearly 4,270 m (14,000 ft) at the top of the high mountain at the west end of the La Garita Mountains (well known locally as La Garita Mountain). Attitudes of compaction foliation are nearly flat in the higher parts of the dome, but dip 5°–10° northeast and east along the exposed flanks. Tensional fractures, formed during uplift, separate the flat from the inclined parts of the dome, and separate segments of inclined rocks that dip in different directions.

No evidence of postsubsidence igneous activity was seen along the eastern margin of the La Garita caldera. The rhyolite of Miners Creek along the west side of the Creede mining district (Steven and Ratté, 1965, p. 19) may have constituted a ring dome extruded along the western margin of the caldera, but relations are now too obscured by younger rocks to be certain.

Highly differentiated crystal-poor rhyolite ash flows of Carpenter Ridge Tuff were erupted in large volume from a source along the southwest flank of the La Garita caldera, certainly less than 1 m.y. and perhaps less than ½ m.y. after the Fish Canyon Tuff was erupted. The Bachelor caldera (fig. 1), centered near the present town of Creede, sank in response to these renewed ash-flow eruptions, taking with it most of the southwest flank of the resurgent core of the La Garita caldera. The northeast margin of the Bachelor caldera crosses East Willow Creek just downstream from the mouth of Whited Creek, and extends under younger rocks on either side. The margin projects under the east side of Nelson Mountain (7 km north of Creede) and between the upper courses of Deerhorn and Whited Creeks. The original shape of the Bachelor caldera is difficult to establish but it appears to have been elongated northwest-southeast; remnants still exposed indicate that it may have been somewhat more than 16 km (10 mi) long, and less than 16 km (10 mi) wide. The southern part of the Bachelor caldera has subsequently collapsed under the younger Creede caldera.

The Bachelor caldera sank concurrently with related ash-flow eruptions, inasmuch as 1,070–1,220 m (3,500–4,000 ft) of the intracaldera Bachelor Mountain Member of the Carpenter Ridge Tuff accumulated within the core, whereas the outflow sheet is generally less than 150 m (500 ft) thick.

The core of the Bachelor caldera was strongly domed shortly after collapse, and a cross section of the uplift can be seen in the north wall of the younger Creede caldera near the town of Creede. About 610 m (2,000 ft) of structural relief is apparent between the crest of the dome (between East and West Willow Creeks) and the eastern flank west of Bellows Creek (10 km southeast of Creede) and the western flank along Shallow Creek (12.5 km west of Creede). Tensional faults, formed during doming, extend northwestward down the flank of the dome; these mark the initial faulting in the zone that was later reactivated and mineralized to form the veins of the Creede mining district.

The best exposures of the intracaldera Bachelor Mountain Member of the Carpenter Ridge Tuff are in the Creede mining district south of the area shown on plate 1. One triangular fault block exposes more than 460 m (1,500 ft) of these rocks adjacent to upper West Willow Creek, within the area of plate 1 and just south of the western part of the wilderness. Other small exposures of rocks that possibly belong to the Bachelor Mountain Member flank Spring Creek approximately 2 km (1.25 mi) north of the wilderness. Carpenter Ridge Tuff outflow fills the lower part of the topographic moat along the east side of the older resurgent La Garita caldera on either side of both Wannamaker Creek and South Fork of Saguache Creek, just east of the wilderness, and spreads widely over adjacent parts of the central San Juan Mountains.

Only a small part of the Mammoth Mountain Tuff is exposed within the area of plate 1, and none at all within the La Garita Wilderness. To the south, however, the tuff forms a thick wedge of densely welded rhyolitic tuff grading upward into quartz latitic tuff that fills the topographic moat along the east side of the resurgent Bachelor caldera. The source of the Mammoth Mountain Tuff appears to have been largely in the area of the younger Creede caldera, where it is now deeply buried by younger volcanic rocks. Adjacent parts of the Mammoth Mountain Tuff in the Bellows Creek area southeast of Creede are thick and show evidence of deformation during the course of eruption and accumulation, possibly reflecting nearby caldera collapse. The southern part of the resurgent core of the La Garita caldera apparently was deeply downfaulted at this time, either as part of the presumed Mammoth Mountain caldera, or along a fault marginally related to such a structure. Most of the source area of the Mammoth Mountain Tuff is now obscured by a cover of younger rocks, either Wason Park Tuff on the north, or Snowshoe Mountain Tuff and Creede Formation filling the younger Creede caldera to the south.

Wason Park Tuff is a distinctive densely welded rhyolitic ash-flow tuff that appears to have been derived from a source now deeply buried beneath the fill in the younger Creede caldera. Near the La Garita Wilderness, the Wason Park Tuff accumulated largely within the topographic moats around the earlier resurgent calderas. It was confined on the east by the wall of the La Garita caldera, wedged out laterally against the resurgent cores of both the La Garita and Bachelor calderas, and thinned markedly over thick Mammoth Mountain Tuff near the presumed source area of the Mammoth Mountain rocks west of Bellows Creek. Densely welded Wason Park Tuff forms a prominent ledge in the middle slopes in and adjacent to the eastern part of the La Garita Wilderness, and it forms a broad flat bench in the type area of Wason Park just south of the wilderness.

Scattered quartz latite and rhyolite volcanoes formed south of the La Garita Wilderness after the Wason Park Tuff was emplaced. A quartz latite flow that underlies Silver Park south of the eastern part of the wilderness was erupted from a neck just west of the park, and two local volcanoes formed within the Creede mining district, one just north of Nelson Mountain and the other along West Willow Creek. Rocks derived from the volcanic center near West Willow Creek are closely similar to the overlying Rat Creek Tuff and may represent an early accumulation related to the Rat Creek eruptive cycle.

Eruption of Rat Creek Tuff caused subsidence of a small caldera (covered by younger rocks within the area of pl. 1) in the upper Miners Creek area, 6 km (4 mi) southwest of the La Garita Wilderness. The northeast half of the caldera was obliterated by subsidence of the younger main San Luis caldera. The Rat Creek ash flows are rhyolitic in composition; they spread widely to form a sheet of generally poorly welded to nonwelded tuff that was in large part lithified by zeolitic alteration to a soft but compact rock. One layer of densely welded tuff is present near the top of the Rat Creek Tuff in the Creede mining district. The spectacular erosional topography displayed in the Wheeler Geologic Area, south of the eastern part of the wilderness, was cut from the soft outflow tuffs.

Renewed eruptions of quartz latite ash flows deposited the Nelson Mountain Tuff throughout the central San Juan Mountains. The San Luis caldera began to subside at about the same time. Eruptions continued concurrently with subsidence and a mass of densely welded ash-flow tuff, more than 1,220 m (4,000 ft) thick, accumulated within the subsiding core. Where relatively unaltered by later hydrothermal activity, these quartz latitic tuffs are closely similar to densely welded quartz latitic tuffs in the widespread outflow sheet of Nelson Mountain Tuff.

Postsubsidence activity at the San Luis caldera was complex, involving partial filling of the caldera with quartz latite and rhyolite lavas and breccias of the volcanics of Stewart Peak, eruption of the tuff of Cochetopa Creek and collapse of the Cochetopa Park caldera 32 km (20 mi) to the northeast (fig. 1), strong resurgence of the San Luis caldera core, and later development of a series of quartz latitic volcanoes (quartz latite of Baldy Cinco) that extended westward from the La Garita Wilderness for about 14 km (9 mi) to the vicinity of Spring Creek Pass (Steven, 1967). Alteration and local mineralization accompanied emplacement of both the volcanics of Stewart Peak and the quartz latite of Baldy Cinco.

The volcanics of Stewart Peak form a complex assemblage of irregular lava flows and related breccias that extend around the eastern and northern periphery of the San Luis caldera. These rocks range from dark quartz latite porphyries to phenocryst-poor perlitic rhyolites. Related quartz monzonitic plugs cut the underlying Nelson Mountain welded tuffs in the northeastern part of the caldera; numerous dikes of similar rock are widespread throughout the remainder of the caldera core. Although the volcanics of Stewart Peak and the related intrusive rocks are believed to represent extrusion and high-level intrusion of the magma responsible for resurgent uplift of the caldera, most of the volcanic eruptions apparently preceded the strongest doming of the core. Resurgence evidently began earlier, however, as the volcanics of Stewart Peak are limited to the northern and eastern parts of the San Luis caldera, and interlayered Stewart Peak lavas and layers of the tuff of Cochetopa Creek along the southeastern side of the caldera were deposited against irregular higher topography toward the caldera core.

Early eruptions of the volcanics of Stewart Peak and concurrent minor doming were accompanied by renewed downfaulting of the eastern margin of the San Luis caldera from Cochetopa Creek northward for more than 5.6 km (3.5 mi). This faulting had ceased by the time that the tuff of Cochetopa Creek accumulated, however, as the fault is clearly overlapped by unbroken ledges of this unit north of upper Nutras Creek (pl. 1).

Later, during accumulation of the volcanics of Stewart Peak, ash flows of the tuff of Cochetopa Creek were erupted from the Cochetopa Park area about 32 km (20 mi) northeast of the San Luis caldera (fig. 1). These spread widely southwestward to the vicinity of the San Luis caldera, where they intertongue with and wedge out against Stewart Peak lavas along the northern and southeastern sides of the caldera. Elsewhere, the Cochetopa Creek ash flows followed the nearly filled moat around the eastern side of the La Garita caldera and flowed around both the north and southeast sides of the San Luis caldera. Following eruption of these widespread ash flows, the source area collapsed into the partly evacuated magma chamber to form the Cochetopa Park caldera.

Although some evidence exists to indicate that resurgence began during eruption of the volcanics of Stewart Peak, the strongest uplift of the core of the San Luis caldera took place after the tuff of Cochetopa Creek had been emplaced. All the densely welded Cochetopa Creek ledges around the north flank of the caldera dip 20°–25° outward near the covered caldera rim, but are nearly flat a few kilometers outside the caldera area.

The core of the San Luis caldera was widely propylitized during subsidence of the caldera, its filling with Nelson Mountain welded tuff, eruption of the volcanics of Stewart Peak, and strong resurgence of the core. Plagioclase phenocrysts were partly converted to clay and carbonate, and the ferromagnesian phenocrysts and matrix were partly altered to clay and chlorite minerals. Although dense and hard, the rocks in the fill have a greasy green appearance, and most have obviously been pervasively altered to some degree. Locally, the alteration was intense, particularly along fractures and near small monzonitic dikes; some of the fractures are followed by bleached clayey rocks and, in places, contain quartz-pyrite veins. Some of these veins contain minor quantities of lead, zinc, and silver minerals, particularly along the Spring Creek drainage near the northwestern boundary of the La Garita Wilderness.

After resurgence of the core of the San Luis caldera, a series of volcanoes formed in an area from the vicinity of San Luis Pass westward for about 14 km (9 mi) to the vicinity of Spring Creek Pass (Steven, 1967). These volcanoes erupted coarsely porphyritic lavas and breccias (the quartz latite of Baldy Cinco), and hydrothermal activity altered and mineralized some of the feeding necks and adjacent rocks. Erosion has exposed several of the necks in the Cascade and Mineral Creek drainage basins, where they cut the lower part of the quartz latite of Baldy Cinco or the underlying caldera fill of Nelson Mountain Tuff. Alteration and mineralization associated with these necks apparently are responsible for a low-magnitude zinc anomaly disclosed by analyses of stream-sediment samples from Cascade Creek and the East Fork of Mineral Creek.

The complexly overlapping volcanic events that accompanied development of the San Luis and Cochetopa Park calderas were followed very shortly by eruption of large ash flows of crystal-rich quartz latite which formed the Snowshoe Mountain Tuff. These ash flows were derived from the Creede caldera source area (fig. 1) south of the town of Creede, where a cylindrical block 16–19 km (10–12 mi) across sank concurrently with the pyroclastic eruptions (Steven and Ratté, 1965). Only scattered remnants of the outflow sheet of Snowshoe Mountain Tuff have survived subsequent erosion; three of these are within 0.4 km (0.25 mi) of the southeast margin of the La Garita Wilderness (pl. 1). The core of the Creede caldera was resurgently domed following subsidence and the marginal moat was filled in part with pyroclastic deposits, stream and lake sediments, and travertine of the Creede Formation.

A graben extending radially north-northwest from the Creede caldera formed shortly after the Creede Formation was deposited; this graben followed generally along the same zone that was broken by tensional faults during resurgence of the Bachelor caldera. Mineralizing solutions pervaded the newly developed fractures and deposited the rich silver-lead-zinc ores that have been exploited in the Creede mining district (Steven and Ratté, 1965). The most productive mines in the district are 5.6–11.2 km (3.5–7 mi) south of the La Garita Wilderness, but the outlying Equity mine has produced more than $100,000 worth of silver and gold ore from an area about 4 km (2.5 mi) south of San Luis Pass and outside of the wilderness. All of the faults in the Creede graben appear to die out northward, and none has been traced into the La Garita Wilderness.

MINERAL DEPOSITS

Four episodes of hydrothermal activity affected the rocks in or near the La Garita Wilderness. The oldest of these altered and mineralized the rock within and around a series of intrusive plugs near Wannamaker Creek, east of the wilderness; these intrusives mark the core of an andesite volcano in the Conejos Formation. Numerous prospect pits and small mine workings in the Sky City mine area, 1.5–2.5 km (1–1.5 mi) east of the wilderness, explore this mineralized area.

The second and third episodes of hydrothermal activity took place during the complex sequence of postsubsidence events that accompanied development of the San Luis caldera. During resurgence and concurrent emplacement of the volcanics of Stewart Peak and related intrusives, the core of the San Luis caldera was pervasively propylitized, and small quartz-pyrite veins containing sparse local concentrations of valuable metals were formed over a wide area. Some of these quartz-pyrite veins are within the La Garita Wilderness, and two areas along and adjacent to the northwestern boundary have been explored in recent years. Some glassy rhyolite flows in the volcanics of Stewart Peak along the north margin of the caldera, 1.6–3.2 km (1–2 mi) outside the wilderness, were converted to perlite of possible economic interest during or shortly after emplacement. Following resurgence of the San Luis caldera, a series of quartz latitic volcanoes (quartz latite of Baldy Cinco) formed across the western edge of the caldera from San Luis Pass in the western part of the La Garita Wilderness to the vicinity of Spring Creek Pass, some 14 km (9 mi) farther west. The cores of some of these volcanoes were altered by intense hydrothermal activity, and some altered rocks contain anomalous contents of metals. Early prospectors dug many shallow pits in these areas of altered rocks, but no deeper exploration has been attempted.

The final episode of mineralization accompanied and followed a period of faulting that took place shortly after development of the Creede caldera, south of the La Garita Wilderness. This mineralization formed the rich ores exploited in the Creede mining district; although ores of this age occur within 2.4 km (1.5 mi) of the wilderness boundary, no mineralized rock related to this episode of hydrothermal activity is known to extend within the wilderness.

GEOCHEMICAL RECONNAISSANCE

Stream-sediment samples were taken at irregular intervals along all the major drainage systems within and adjacent to the La Garita Wilderness (pl. 2, table 2). The density of sampling varied greatly, depending largely on whether or not surface evidence for mineralization was discerned nearby. Many more samples were taken within the widely altered areas drained by Mineral and Spring Creeks than were taken along the streams in the central and eastern parts of the wilderness where virtually no surface evidence of hydrothermal activity was seen. Initial sampling in the Mineral and Spring Creek drainages was done in 1967 by L. J. Schmitt, Jr., as part of a reconnaissance survey connected with Heavy Metals Investigations of the U.S. Geological Survey; the localities for these samples are shown on the main map on plate 2. Analytical problems developed while these samples were being treated in the laboratories, and many of the samples were used up before reliable results were assured. As a consequence, stream sediments were sampled again in 1970 by Steven (inset map, pl. 2; table 3). Analytical results from these samples were virtually the same as the final results obtained for the 1967 samples, and thus both sets of data are believed to be reliable.

Samples were taken from a wide variety of vein material and altered bedrock, wherever hydrothermally altered rock was encountered during field mapping (pl. 2; tables 4, 5). Most of this material was either silicified or clayey altered rock or veins of quartz and calcite. Most of these samples were taken from old prospect pits but some were from natural outcrops. Although all types of occurrences of potentially mineralized rock were sampled in order to assess the geologic probability of finding ore in the different local environments, no attempt was made to obtain complete coverage of all veins or

TABLE 2.—*Analyses of*

[For sample localities see main map, plate 2. Numbers in parentheses indicate sensitivity limit of method used; present is less than the number shown; CxCu indicates the amount of copper extracted from a sample by leaching cold citrate reagent]

Sample	Semiquantitative spectrographic analyses (ppm)									
	Mn (10)	Ag (.5)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	Mo (5)	Ni (5)	Pb (10)
A. Mineral Creek										
1	1,000	N	500	2	10	7	30	N	5	30
2	1,500	N	700	2	10	5	30	N	5	20
3	1,500	N	700	2	10	5	20	N	5	15
4	1,500	N	700	2	10	5	7	N	7	20
5	1,000	N	700	2	10	5	50	N	7	20
6	1,500	N	700	2	15	7	20	N	7	20
7	1,000	N	700	2	10	<5	10	N	7	20
8	1,000	N	700	2	15	5	30	N	7	20
9	1,500	N	700	2	15	5	30	N	7	20
10	1,000	N	700	2	10	5	30	N	7	20
11	2,000	N	700	2	15	10	20	N	7	20
12	1,500	N	700	2	15	10	7	N	5	20
13	1,500	N	700	2	20	15	10	N	10	30
14	1,000	N	700	2	15	15	20	N	10	30
15	1,500	N	700	2	15	15	30	N	10	30
16	1,500	N	700	2	15	10	7	N	5	30
17	700	N	700	2	15	15	20	N	10	30
18	1,000	N	700	2	20	15	30	N	20	20
19	1,500	N	700	2	15	10	7	N	7	20
20	1,500	N	700	2	15	15	30	N	10	30
21	1,500	N	700	2	20	15	10	N	10	15
22	1,000	N	700	2	20	15	30	N	10	30
23	1,500	N	700	2	15	7	30	N	5	30
24	5,000	N	500	5	20	7	10	5	15	30
25	1,500	N	700	3	15	5	10	N	7	30
26	1,500	N	500	2	10	10	20	N	7	50
27	1,500	N	700	2	10	5	20	N	10	30
28	500	N	700	1.5	5	10	20	N	5	70
29	2,000	N	700	2	30	7	30	N	7	50
30	2,000	N	1,000	3	30	10	30	N	7	30
31	1,500	N	700	2	20	7	20	N	10	30
32	1,500	N	700	2	20	10	30	N	10	30
33	1,500	N	700	3	20	7	20	N	10	30
34	1,500	N	1,000	3	20	10	30	N	10	30
35	1,500	N	700	2	20	10	20	N	10	20
36	1,500	N	500	2	15	5	30	N	7	50
37	1,500	N	700	2	15	5	15	N	5	30
38	1,500	N	700	2	20	5	20	N	7	20
B. Spring Creek										
1	700	N	700	2	15	10	20	N	15	20
2	1,000	N	700	2	15	15	30	N	7	30
3	500	N	700	1	15	30	10	N	5	15
4	700	N	1,000	2	15	7	10	N	5	20
5	1,000	N	700	2	15	10	20	N	10	20
6	700	N	1,000	2	15	10	20	N	10	30
7	500	N	1,000	2	10	7	10	N	7	15
8	700	N	1,000	2	7	7	30	N	5	50
9	1,000	N	500	2	10	7	30	N	10	20
10	700	N	700	2	15	7	50	N	10	30
11	700	N	1,000	2	15	15	30	N	10	30
12	2,000	N	700	2	10	7	20	N	10	20
13	700	N	700	1.5	15	10	20	N	10	20
14	700	N	700	1.5	15	7	10	N	10	15
15	1,000	N	700	1	15	15	20	N	10	15
16	1,000	N	700	1.5	15	15	20	N	10	10
17	1,000	N	700	1.5	15	15	20	N	10	15
18	1,000	N	700	2	10	5	7	N	7	15
19	1,500	N	1,000	2	20	10	20	N	10	20
20	1,000	N	1,000	1.5	15	7	20	N	7	20

stream-sediment samples

ppm, parts per million; N indicates that the element was looked for but not found; < indicates that the amount
with cold acid; CxHM indicates the amount of copper, lead, and zinc extracted from a sample by leaching with a

Sample	Semiquantitative spectrographic analyses--Continued (ppm)					Chemical analyses (ppm)			
	Sr (100)	V (10)	W (50)	Zn (200)	Zr (10)	Cu	Pb	Zn	Mo
A. Mineral Creek--Continued									
1	300	150	N	N	200	<10	<25	46	<1
2	300	150	N	N	200	<10	<25	46	1
3	500	150	N	N	200	10	<25	60	1
4	300	150	N	N	150	<10	<25	52	1
5	300	150	N	N	150	10	<25	52	1
6	500	200	N	N	200	<10	<25	54	1
7	300	150	N	N	200	10	<25	40	<1
8	300	150	N	N	200	12	<25	50	<1
9	300	150	N	N	200	13	<25	54	1
10	700	150	N	N	150	<10	<25	38	1
11	500	150	N	N	200	<10	<25	60	1
12	300	150	N	N	200	<10	<25	74	1
13	500	300	N	N	150	<10	<25	78	2
14	500	200	N	N	150	<10	<25	50	1
15	500	200	N	N	150	<10	<25	40	2
16	500	150	N	N	150	<10	<25	36	<1
17	500	150	N	N	150	10	<25	44	<1
18	700	200	N	N	150	15	<25	52	<1
19	500	200	N	N	300	<10	<25	40	<1
20	700	200	N	N	200	<10	<25	32	1
21	500	300	N	N	150	11	<25	40	<1
22	500	300	N	N	200	13	<25	48	<1
23	300	150	N	N	150	<10	<25	30	1
24	300	150	N	<200	150	<10	<25	160	1
25	300	150	N	N	200	<10	<25	32	<1
26	300	150	N	N	200	<10	<25	52	2
27	300	150	N	N	150	<10	<25	30	1
28	200	150	N	N	150	<10	<25	<25	1
29	300	200	N	N	200	12	<25	60	1
30	300	150	N	<200	150	10	25	130	2
31	300	150	N	N	150	10	25	120	2
32	300	200	N	N	150	10	32	130	1
33	300	150	N	N	150	12	30	160	2
34	300	200	N	<200	150	12	30	140	2
35	300	200	N	N	150	12	30	86	1
36	200	100	N	N	150	<10	26	66	2
37	200	100	N	N	150	<10	32	68	2
38	200	150	N	N	150	13	32	96	2
B. Spring Creek--Continued									
1	700	150	N	N	150	13	<25	58	1
2	500	200	N	N	200	10	<25	52	2
3	500	200	N	N	150	<10	<25	56	2
4	700	150	N	N	150	<10	<25	50	2
5	500	200	N	N	300	<10	<25	54	<1
6	700	200	N	N	200	<10	<25	50	2
7	500	150	N	N	200	<10	<25	52	1
8	500	100	N	N	300	14	30	84	2
9	500	150	N	N	150	12	<25	57	1
10	500	150	N	N	200	<10	<25	52	1
11	700	150	N	N	200	11	<25	64	1
12	500	150	N	N	200	<10	<25	56	2
13	500	200	N	N	200	11	<25	54	1
14	500	150	N	N	200	10	<25	44	1
15	500	200	N	N	200	12	<25	52	<1
16	500	200	N	N	150	12	<25	50	<1
17	500	200	N	N	150	10	<25	44	1
18	500	150	N	N	200	<10	<25	42	<1
19	500	150	N	N	200	10	<25	56	1
20	500	150	N	N	200	11	<25	50	<1

TABLE 2.—*Analyses of stream-*

Semiquantitative spectrographic analyses--Continued (ppm)

Sample	Mn (10)	Ag (.5)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	Mo (5)	Ni (5)	Pb (10)
				B. Spring Creek--Continued						
21	1,500	N	1,000	2	15	7	30	N	10	50
22	2,000	N	700	3	20	5	20	N	10	30
23	1,000	N	700	2	15	5	30	N	7	50
24	1,500	N	700	2	15	5	20	N	7	30
25	1,500	N	700	2	10	10	30	N	7	50
				C. Cascade Creek						
1	1,500	0.7	700	2	15	7	30	N	10	200
2	2,000	N	700	2	15	7	30	N	10	20
3	1,000	N	1,500	1.5	10	<5	30	N	5	20
4	1,500	N	700	2	15	5	30	N	10	30
5	1,500	N	700	2	15	10	30	N	7	30
6	1,500	N	1,000	2	15	5	30	N	5	30
7	1,500	N	700	2	15	7	20	N	7	20
8	1,500	N	700	2	15	7	30	N	7	30
9	1,500	N	1,000	2	15	10	30	N	10	30
10	1,500	N	1,500	2	15	N	30	N	10	30
11	1,500	N	700	3	20	7	30	N	7	30
12	1,500	N	500	2	20	5	30	N	7	30
13	1,500	N	700	2	20	7	20	N	7	15
14	1,500	N	1,000	2	20	7	30	N	7	50
15	1,500	N	700	2	20	7	30	N	7	30
16	1,500	N	700	2	15	5	30	N	7	20
17	1,500	N	700	2	15	5	20	N	7	20
18	2,000	N	700	3	20	10	20	N	7	20
19	1,500	N	500	2	15	7	150	N	7	30
20	1,500	N	700	3	15	7	20	N	7	20
21	1,500	N	700	3	15	7	50	N	7	30
22	1,500	N	500	2	10	7	30	N	7	30
23	1,500	N	700	3	15	5	10	N	7	20
24	1,500	N	700	2	15	7	10	N	7	15
25	1,500	N	700	1.5	15	10	50	N	7	30
26	1,500	N	1,000	2	15	7	30	N	7	30
27	1,000	N	700	3	10	20	30	N	7	50
28	1,500	N	1,000	3	15	5	30	N	15	30
29	1,500	N	700	2	15	7	20	N	7	30
				D. "Noname" Creek						
1	1,000	N	1,000	2	15	10	30	N	10	30
2	700	N	500	2	10	7	10	N	5	30
3	1,000	N	700	2	10	7	20	N	5	30
4	1,500	N	1,000	2	20	10	50	N	15	20
5	1,500	N	1,000	2	15	7	20	N	5	20
6	1,000	N	700	2	15	10	30	N	7	30
7	1,000	N	1,000	2	20	10	30	N	5	30
8	1,000	N	1,000	2	20	10	50	N	5	20
9	700	N	1,000	2	20	10	30	<5	15	20
				E. Sheep Creek						
1	1,000	N	1,000	2	30	20	50	N	10	10
2	1,000	N	1,500	2	30	10	50	N	7	30
3	2,000	N	1,500	2	30	10	50	N	10	30
4	1,500	N	700	1	15	10	20	N	15	20
5	1,000	N	700	2	20	10	20	N	15	20
6	1,500	N	700	2	20	10	30	N	15	20
7	1,500	N	700	2	20	10	30	N	15	20
8	1,000	N	700	2	20	15	30	N	10	20
9	1,000	N	1,000	2	20	15	20	N	15	20
10	1,000	N	700	2	20	15	20	N	10	10

sediment samples—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)					Chemical analyses--Continued (ppm)			
	Sr (100)	V (10)	W (50)	Zn (200)	Zr (10)	Cu	Pb	Zn	Mo
B. Spring Creek--Continued									
21	500	150	N	N	150	11	<25	54	<1
22	300	100	N	N	150	12	<25	100	2
23	700	200	N	N	200	11	<25	60	<1
24	700	200	N	N	200	10	<25	46	1
25	500	150	N	N	200	10	<25	56	1
C. Cascade Creek--Continued									
1	300	150	N	200	200	14	120	210	2
2	300	150	N	N	200	11	25	84	2
3	300	150	N	N	150	14	<25	72	2
4	300	150	N	N	200	12	27	90	2
5	300	150	N	N	150	14	29	92	1
6	300	150	N	N	150	13	30	100	2
7	300	150	N	N	200	12	<25	81	1
8	300	150	N	N	150	12	25	74	1
9	300	150	N	N	200	14	30	110	2
10	300	100	N	<200	150	11	<25	120	1
11	300	150	N	N	300	12	25	94	2
12	300	150	N	N	200	12	26	100	2
13	300	200	N	N	200	13	25	80	1
14	500	200	N	N	150	10	25	70	1
15	300	150	N	N	200	10	25	96	4
16	300	150	N	N	150	11	<25	78	1
17	200	150	N	N	150	13	29	84	1
18	300	150	N	N	150	12	28	90	1
19	300	150	N	N	150	12	30	84	<1
20	300	150	N	N	150	11	30	84	1
21	300	150	N	N	150	13	30	86	<1
22	300	150	N	N	200	<10	25	68	1
23	300	150	N	N	200	12	29	84	1
24	300	150	N	N	150	14	<25	86	1
25	200	150	N	N	200	12	25	72	1
26	300	150	N	N	150	12	<25	76	1
27	300	150	N	N	150	22	30	80	1
28	300	150	N	<200	150	16	28	110	1
29	500	150	N	N	150	10	<25	60	<1
D. "Noname" Creek--Continued									
1	500	200	N	N	200	14	<25	55	2
2	300	150	N	N	150	10	<25	48	2
3	500	150	N	N	150	15	<25	62	2
4	700	300	N	N	150	14	<25	62	2
5	300	150	N	N	150	10	<25	76	4
6	500	200	N	N	150	14	<25	58	2
7	700	200	N	N	200	16	<25	60	2
8	700	200	N	N	200	17	<25	60	2
9	700	200	N	N	200	16	<25	56	2
E. Sheep Creek--Continued									
1	700	300	N	N	150	19	<25	50	2
2	700	150	N	N	150	20	<25	50	2
3	700	200	N	N	200	21	<25	53	2
4	500	200	N	N	150	22	<25	56	2
5	700	200	N	N	150	20	<25	52	2
6	700	300	N	N	150	24	<25	56	2
7	700	200	N	N	150	24	<25	58	2
8	500	200	N	N	150	18	<25	56	2
9	700	300	N	N	150	14	<25	37	1
10	700	300	N	N	200	18	<25	49	1

TABLE 2.—*Analyses of stream-*

Sample	Mn (10)	Ag (.5)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	Mo (5)	Ni (5)	Pb (10)
	Semiquantitative spectrographic analyses--Continued (ppm)									
	E. Sheep Creek--Continued									
11	1,000	N	1,000	2	20	15	20	N	15	10
12	1,000	N	700	1	20	15	30	N	10	20
13	1,000	N	700	2	20	10	30	N	15	20
14	700	1.5	700	2	15	10	20	N	10	30
15	700	N	700	2	15	5	20	N	20	20
16	1,000	N	700	1.5	15	10	20	N	15	20
	F. Nutras Creek									
1	1,500	N	300	1	15	<10	15	N	5	15
2	1,000	N	300	<1	15	<10	15	N	7	15
3	1,500	N	300	1	15	10	20	N	7	15
4	500	N	200	1	15	<10	10	N	5	<10
5	700	N	200	1	10	<10	10	N	5	10
6	1,500	N	300	1	15	10	20	N	7	15
7	700	N	300	1	15	10	15	N	5	10
	G. Stewart Creek									
1	1,000	N	300	<1	20	10	15	N	5	10
2	1,000	N	300	<1	15	15	15	N	5	10
3	700	N	300	1	15	10	15	N	5	10
4	700	N	300	1	15	10	15	N	5	10
5	700	N	300	<1	20	<10	15	N	7	15
6	1,000	N	300	<1	15	<10	15	N	5	15
7	1,000	N	300	1	20	10	15	N	7	10
8	1,000	N	500	1	15	10	20	N	5	15
9	1,000	N	300	<1	20	10	20	N	7	15
	H. Cochetopa Creek									
1	1,000	N	500	1	20	15	15	N	5	15
2	1,000	N	500	1	15	15	15	N	5	10
3	700	N	300	<1	20	20	15	N	7	10
4	1,500	N	300	<1	20	20	15	N	10	10
5	700	N	500	1	10	<10	7	N	5	15
6	700	N	300	1	15	10	15	N	5	10
7	1,000	N	300	<1	15	15	15	N	7	10
8	700	N	300	1	15	15	15	N	7	10
9	1,000	N	300	<1	15	15	15	N	5	10
10	1,000	N	300	<1	15	10	15	N	5	10
11	700	N	300	<1	20	15	15	N	5	10
	I. Middle Fork Saguache Creek									
1	700	N	300	<1	20	15	15	N	5	10
2	500	N	300	1	15	15	10	N	5	10
3	700	N	200	<1	15	10	10	N	<5	10
4	1,000	N	200	1	15	10	15	N	5	10
5	1,000	N	200	1	15	10	10	N	5	10
6	700	N	200	1	15	<10	10	N	5	10
7	500	N	200	1	10	<10	15	N	<5	10
8	700	N	200	1	15	10	10	N	5	10
9	700	N	200	1	10	<10	7	N	5	10
10	700	N	200	<1	15	10	15	N	5	10
11	1,000	N	200	1	15	15	15	N	5	15
12	700	N	150	1	10	<10	7	N	<5	10
13	700	N	200	1	15	10	15	N	5	10
14	1,000	N	300	<1	15	10	15	N	5	15
15	700	N	200	1	15	<10	15	N	5	10
16	500	N	200	1	10	<10	10	N	<5	10

sediment samples—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sr (100)	V (10)	W (50)	Zn (200)	Zr (10)	Chemical analyses--Continued (ppm) Cu	Pb	Zn	Mo
				E. Sheep Creek--Continued					
11	500	500	N	N	200	16	<25	40	1
12	700	300	N	N	150	22	<25	68	2
13	500	300	N	N	200	23	<25	54	2
14	500	200	N	N	150	22	40	57	2
15	700	200	N	N	150	18	<25	40	1
16	700	300	N	N	150	24	<25	70	1
				F. Nutras Creek--Continued					
						Au	CxCu	CxHM	Mo
1	500	100	N	N	150	<0.02	<0.5	1	<4
2	500	100	N	N	150	<.02	<.5	3	<4
3	500	150	N	N	200	<.02	<.5	3	<4
4	300	100	N	N	100	<.02	<.5	3	<4
5	300	70	N	N	200	<.02	<.5	3	<4
6	500	200	N	N	200	<.02	<.5	4	<4
7	500	100	N	N	100	<.02	2	4	<4
				G. Stewart Creek--Continued					
1	700	100	N	N	100	<0.02	<0.5	3	<4
2	500	100	N	N	200	<.02	2	3	<4
3	500	100	N	N	300	<.02	1	3	<4
4	300	70	N	N	150	<.02	2	3	<4
5	300	100	N	N	150	<.02	2	3	<4
6	500	70	N	N	100	<.02	2	3	<4
7	700	150	N	N	150	<.02	2	4	<4
8	700	100	N	N	150	<.02	<.5	4	<4
9	500	150	N	N	150	<.02	1	3	<4
				H. Cochetopa Creek--Continued					
1	700	150	N	N	200	<0.02	<0.5	3	<4
2	700	100	N	N	150	<.02	<.5	3	<4
3	500	150	N	N	150	<.02	<.5	3	<4
4	700	150	N	N	100	<.02	1	2	<4
5	500	70	N	N	100	<.02	<.5	3	<4
6	500	100	N	N	300	<.02	<.5	4	<4
7	700	150	N	N	50	<.02	<.5	4	60
8	300	100	N	N	70	<.02	<.5	2	<4
9	500	150	N	N	100	<.02	1	4	<4
10	700	70	N	N	70	<.02	4	4	<4
11	700	150	N	N	100	<.02	1	4	<4
				I. Middle Fork Saguache Creek--Continued					
1	500	150	N	N	300	<0.02	2	2	<4
2	300	70	N	N	200	<.02	1	2	<4
3	300	70	N	N	200	<.02	<.5	3	<4
4	300	100	N	N	300	<.02	<.5	3	<4
5	300	100	N	N	300	<.02	<.5	4	<4
6	300	100	N	N	150	<.02	1	3	<4
7	300	70	N	N	200	<.02	1	.5	<4
8	300	70	N	N	70	<.02	<.5	2	<4
9	300	50	N	N	100	<.02	1	1	<4
10	300	70	N	N	100	<.02	<.5	3	<4
11	300	70	N	N	150	<.02	1	5	<4
12	200	70	N	N	300	<.02	<.5	3	<4
13	300	70	N	N	150	<.02	<.5	3	<4
14	500	100	N	N	70	<.02	2	3	<4
15	300	70	N	N	100	<.02	<.5	7	<4
16	300	70	N	N	150	<.02	<.5	2	<4

TABLE 2.—*Analyses of stream-*

Sample	Semiquantitative spectrographic analyses--Continued (ppm)									
	Mn (10)	Ag (.5)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	Mo (5)	Ni (5)	Pb (10)
	J. South Fork Saguache Creek									
1	1,000	N	200	1	10	<10	7	N	<5	20
2	1,500	N	150	1	15	<10	5	N	<5	10
3	700	N	150	1	10	<10	7	N	<5	15
4	700	N	150	1	10	20	10	N	7	15
5	700	N	150	1.5	15	15	10	N	5	10
6	700	N	150	1	5	10	7	N	<5	15
7	1,500	N	200	1	15	15	15	N	5	15
8	1,000	N	200	1	10	<10	10	N	5	10
9	1,500	N	150	1	7	<10	10	N	<5	15
10	700	N	150	1	7	<10	7	N	<5	15
11	700	N	200	1	10	<10	7	N	<5	15
12	700	N	200	1	5	<10	7	N	<5	10
13	1,000	N	200	<1	15	20	5	N	<5	10
14	700	N	150	1	7	15	15	N	5	10
15	700	N	200	1	10	<10	7	N	<5	20
	K. Wanamaker Creek									
1	700	N	200	1	15	10	30	N	5	15
2	500	N	500	<1	15	10	20	N	5	15
3	500	N	300	1	15	<10	15	N	5	10
4	700	N	300	1	15	10	20	N	7	15

altered zones. A more comprehensive program of sampling of all known mine workings and prospect pits was carried out by the U.S. Bureau of Mines in making their economic appraisal, which is discussed in a separate section of this report.

All samples taken by the U.S. Geological Survey were analyzed by semiquantitative spectrographic methods to scan for anomalously abundant elements. In addition, many of the samples were analyzed for the more common ore metals by colorimetric or atomic absorption methods. Samples were analyzed over a span of 5 years, from 1966 to 1971, and some of the analytical techniques and methods were changed during the course of the investigation. No discrepancies were noted between duplicate samples analyzed early and late within this span and the results obtained are believed to be generally comparable.

Analysts in laboratories of the U.S. Geological Survey who contributed data to this report are E. F. Cooley, G. C. Crenshaw, M. S. Erickson, C. F. Forn, J. R. Hassemer, J. D. Hoffman, K. E. Kulp, E. E. Martinez, R. L. Miller, J. M. Motooka, R. M. O'Leary, T. A. Roemer, C. D. Smith, Jr., Z. C. Stephenson, A. J. Toeves, J. G. Viets, L. A. Vinnola, and F. N. Ward.

SKY CITY MINE AREA

The Sky City mine area is centered on a monzonitic intrusive plug that marks the core of an andesitic volcano in the Conejos Formation. Most of the mine and prospect workings are on the east side of Wannamaker Creek, about 1.6 km (1 mi) east of the La Garita

sediment samples—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sr (100)	V (10)	W (50)	Zn (200)	Zr (10)	Chemical analyses--Continued (ppm) Au	CxCu	CxHM	Mo
J. South Fork Saguache Creek--Continued									
1	300	70	N	N	200	<0.02	<0.5	2	<4
2	200	70	N	N	300	<.02	<.5	4	<4
3	300	30	N	N	200	<.02	<.5	3	<4
4	300	70	N	N	150	<.02	2	2	<4
5	300	70	N	N	300	<.02	<.5	1	<4
6	300	50	N	N	150	<.02	2	1	<4
7	300	70	N	N	100	<.02	<.5	2	<4
8	300	70	N	N	150	<.02	<.5	3	<4
9	200	50	N	N	150	<.02	<.5	5	<4
10	300	50	N	N	150	<.02	1	3	<4
11	300	50	N	N	100	<.02	1	2	<4
12	300	50	N	N	200	<.02	2	2	<4
13	300	200	N	N	100	<.02	<.5	1	<4
14	150	50	N	N	200	<.02	<.5	11	<4
15	200	50	N	N	150	<.02	<.5	1	<4
K. Wanamaker Creek--Continued									
1	300	70	N	N	150	<0.02	2	1	<4
2	300	100	N	N	150	<.02	2	3	<4
3	300	70	N	N	100	<.02	2	1	<4
4	500	100	N	N	150	<.02	2	2	<4

Wilderness. A few of the workings are on the west side of the creek, but none are within the wilderness.

Most of the intrusive plug appears fairly fresh or only slightly propylitized. The plug is cut by numerous fracture zones of diverse trends; many of these are altered and some contain quartz-pyrite veins. Most of the mine workings and prospect pits are dug on the altered zones or veins. Exposures are poor, and none of the mine workings was accessible at the time this investigation was made. Inasmuch as all the discernible mineralized ground was outside the boundary of the wilderness, no attempt was made to determine the pattern of fracturing or the extent or grade of the veins. The U.S. Bureau of Mines, however, examined and sampled the district in somewhat more detail in their appraisal of the economic potential of the La Garita Wilderness and adjacent areas.

Judging from materials on mine dumps, the quartz-pyrite veins range from mere seams to veins 0.5 m (1.5 ft) or more wide. These veins are generally within walls of highly argillized rock; in places, the soft altered rock contains abundant pyrite. Some carbonate gangue was deposited at a late stage in the development of the veins, but no base-metal sulfides were noted. Four samples of stream sediments were collected along Wannamaker Creek below the mine area (table 2K), but none of these contained anomalous quantities of metals.

All mineralized rock in the Sky City mine area is confined to the Conejos Formation in the outer wall of the La Garita caldera. Younger post-mineral ash-flow tuff units filling the moat depression

TABLE 3.—*Analyses of stream-sediment*

[For sample localities see inset map, plate 2. Numbers in parentheses indicate sensitivity limit of method used. ppm, amount present is less than the number shown. CxCu indicates the amount of copper extracted from a sample by with a cold citrate reagent]

Sample	Semiquantitative spectrographic analyses (ppm)									
	Mn (10)	Ag (.5)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	Mo (5)	Ni (5)	Pb (10)
	A. Mineral Creek									
1	700	N	500	1	15	<10	15	N	<5	20
2	1,000	N	500	1	15	<10	15	N	5	20
3	1,000	N	300	1	15	<10	20	N	5	20
4	700	N	300	1	15	<10	15	N	5	20
5	1,500	N	500	<1	30	<10	30	N	5	20
6	500	N	300	1	15	<10	15	N	<5	15
7	1,000	N	500	1	20	<10	20	N	5	20
8	1,000	N	500	<1	20	<10	20	N	5	20
9	1,000	N	500	1	15	20	20	N	5	20
10	700	N	300	1	15	15	15	N	<5	20
11	700	N	300	1	15	10	15	N	<5	20
12	1,000	N	300	1	20	<10	15	N	<5	15
13	2,000	N	200	1.5	10	<10	15	N	<5	10
14	700	N	300	1	15	<10	15	N	<5	15
15	700	N	300	1	15	<10	15	N	<5	15
16	700	N	300	1	15	<10	15	N	<5	15
17	500	N	300	1	15	50	15	N	5	15
18	1,000	N	500	1	15	<10	15	N	5	15
19	700	N	200	1.5	15	<10	15	N	<5	10
20	1,500	N	200	1.5	15	15	15	N	5	10
21	1,500	N	300	1.5	10	20	15	N	5	15
22	700	N	300	1.5	10	20	15	N	5	15
23	700	N	300	1.5	15	15	15	N	7	10
	B. Spring Creek									
1	1,000	N	300	1	15	10	20	N	5	10
2	1,500	N	500	<1	20	10	20	N	5	15
3	1,500	N	300	<1	70	10	30	N	10	15
4	1,000	N	500	<1	15	10	15	N	5	15
5	700	N	300	<1	15	15	15	N	5	20
6	700	N	500	<1	15	15	20	N	5	20
7	1,000	1	300	<1	30	<10	30	N	10	15
8	700	N	300	<1	15	15	15	N	5	30
9	1,500	N	200	1.5	10	15	10	N	5	20
10	700	N	300	1	15	10	15	N	5	15
11	500	N	300	1	15	<10	15	N	5	30
12	700	N	300	1	15	<10	20	N	5	200
13	500	N	200	1.5	15	<10	15	N	5	10
14	700	N	200	1.5	15	<10	20	N	7	10
15	300	N	200	1	10	<10	15	N	<5	10
16	200	N	150	1.5	10	<10	15	N	<5	10
17	300	N	200	1.5	10	<10	10	N	<5	10
18	1,000	N	300	1	20	20	20	N	10	10
19	1,000	N	200	1	15	30	15	N	10	15
20	1,500	N	200	1	20	15	20	N	10	15
21	700	N	300	1	15	15	20	N	7	15
22	700	N	300	1	15	<10	20	N	7	15
23	200	N	150	1	N	<10	15	N	5	<10
24	700	N	200	1	20	20	20	N	10	15
25	1,000	N	300	1	15	<10	20	N	7	15
26	1,000	N	300	1	15	<10	10	N	7	15
27	700	N	300	1	15	<10	15	N	5	15
28	700	N	150	1.5	15	<10	10	5	10	10
29	1,000	N	300	1	15	15	15	N	5	10
30	1,500	N	300	1.5	20	10	15	N	5	15

samples taken in 1970 to check earlier results

parts per million; N indicates that the element was looked for but not found. The symbol < indicates that the
leaching with cold acid. CxHM indicates the amount of copper, lead, and zinc extracted from a sample by leaching

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sr (100)	V (10)	W (50)	Zn (200)	Zr (10)	Chemical analyses (ppm) Au	CxCu	CxHM	Mo
	A. Mineral Creek--Continued								
1	300	100	N	N	150	<0.02	2	5	<4
2	300	100	N	N	100	<.02	2	5	<4
3	300	100	N	N	150	<.02	.5	5	<4
4	300	150	N	N	300	<.02	1	5	<4
5	300	200	N	N	200	<.02	4	3	<4
6	300	150	N	N	150	<.02	<.5	7	<4
7	500	200	N	N	200	<.02	2	1	<4
8	700	200	N	N	150	<.02	2	1	<4
9	500	100	N	N	150	<.02	<.5	5	<4
10	300	100	N	N	150	<.02	<.5	5	<4
11	300	100	N	N	100	<.02	<.5	3	<4
12	700	150	N	N	150	<.02	<.5	.5	<4
13	150	70	N	N	300	<.02	<.5	14	<4
14	300	100	N	N	200	<.02	<.5	7	<4
15	300	100	N	N	300	<.02	<.5	7	<4
16	300	100	N	N	300	<.02	<.5	9	<4
17	500	100	N	N	300	<.02	2	3	<4
18	300	100	N	N	100	<.02	<.5	11	<4
19	200	100	N	N	200	<.02	<.5	11	<4
20	300	70	N	N	150	<.02	<.5	11	<4
21	300	100	N	N	300	<.02	<.5	11	<4
22	300	70	N	N	100	<.02	<.5	7	<4
23	300	100	N	N	100	<.02	<.5	7	<4
	B. Spring Creek--Continued								
1	300	150	N	N	300	<0.02	1	3	<4
2	700	150	N	N	200	<.02	2	3	<4
3	500	300	N	N	150	<.02	4	3	<4
4	500	150	N	N	300	<.02	1	3	<4
5	500	100	N	N	150	<.02	1	3	<4
6	500	100	N	N	150	<.02	1	5	<4
7	300	150	N	N	150	<.02	.5	5	<4
8	300	70	N	N	100	<.02	<.5	5	<4
9	200	50	N	N	150	<.02	<.5	11	<4
10	300	70	N	N	200	<.02	<.5	5	<4
11	300	70	N	N	150	<.02	1	11	<4
12	300	100	N	300	150	<.02	1	27	<4
13	300	100	N	N	300	<.02	<.5	1	<4
14	300	100	N	N	150	<.02	<.5	7	<4
15	300	70	N	N	150	<.02	<.5	3	<4
16	300	70	N	N	300	<.02	<.5	5	<4
17	200	70	N	N	700	<.02	<.5	7	<4
18	500	150	N	N	150	<.02	2	3	<4
19	200	70	N	N	300	<.02	1	1	<4
20	300	150	N	N	70	<.02	1	5	<4
21	300	100	N	N	150	<.02	<.5	1	<4
22	500	70	N	N	100	<.02	1	3	<4
23	150	50	N	N	100	<.02	<.5	1	<4
24	300	100	N	N	150	<.02	<.5	1	<4
25	500	70	N	N	100	<.02	2	1	<4
26	500	100	N	N	100	<.02	1	3	<4
27	500	100	N	N	100	<.02	2	1	<4
28	150	50	N	N	70	<.02	<.5	1	<4
29	500	150	N	N	300	<.02	<.5	5	<4
30	500	100	N	N	100	<.02	4	1	<4

TABLE 3.—*Analyses of stream-sediment samples*

Sample	Semiquantitative spectrographic analyses--Continued (ppm)									
	Mn (10)	Ag (.5)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	Mo (5)	Ni (5)	Pb (10)
	B. Spring Creek--Continued									
31	700	N	200	1	5	10	10	N	5	10
32	1,000	N	200	1.5	10	15	10	N	5	10
33	700	N	300	1.5	15	15	20	5	10	20
34	700	N	200	1.5	15	10	15	N	5	10
36	1,000	N	300	<1	50	15	30	N	10	10
37	1,500	N	300	<1	50	15	20	N	10	10
38	1,500	N	500	<1	50	10	30	N	10	10
39	1,000	N	300	<1	50	10	30	N	10	10
40	300	N	300	<1	15	10	15	N	5	10
41	500	N	300	1	15	15	15	N	7	10
42	500	N	300	1	15	<10	15	N	5	10
43	700	N	300	1	15	<10	15	N	7	15
44	1,000	N	300	<1	30	<10	20	N	10	10
45	300	N	300	1	15	<10	20	N	7	15
46	300	N	200	<1	15	<10	15	N	7	10
47	1,000	N	500	1	15	10	30	N	7	15
48	700	N	500	<1	20	10	30	N	10	10
49	500	N	500	1	10	<10	15	N	5	15
50	1,000	N	300	1	15	<10	20	N	7	10
51	1,000	N	300	1	15	15	15	N	7	10

TABLE 4.—*Analyses of mineralized material,*

[For some sample localities see main map, plate 2. Numbers in parentheses indicate sensitivity limit of method number shown; > and >> indicate that the amount present

Sample[1]	Semiquantitative spectrographic analyses (ppm)											
	Mn (10)	Ag (.5)	Ba (20)	Be (1)	Cd (20)	Co (5)	Cr (10)	Cu (5)	Mo (5)	Ni (5)	Pb (10)	Sr (100)
JJ1	1,500	100	500	2	<20	5	5	30	<5	5	1,000	100
JJ2	1,000	2,000	100	3	>500	<5	<5	1,500	<5	<5	>20,000	>100
Ds64A	---	---	---	---	---	---	---	---	---	---	---	---
Ds64C	---	---	---	---	---	---	---	---	---	---	---	---
JJ3	>5,000	700	200	7	<20	<5	<5	150	70	<5	>20,000	200
Bs8	500	1,000	70	3	300	<5	<5	700	3	<2	10,000	<50
Bs9	700	500	30	2	>500	<5	<5	700	<2	<2	700	<50
JJ4	>5,000	150	1,000	3	<20	<5	<5	20	20	5	200	200
JJ6	3,000	7	1,500	2	150	10	5	1,500	<5	10	20,000	100
JJ7	1,500	5	5,000	3	150	<5	<5	1,500	<5	<5	15,000	100
JJ8	2,000	3	<5,000	1	100	15	10	2,000	<5	10	>20,000	150
Ds64I	---	---	---	---	---	---	---	---	---	---	---	---
Cas 1E-A	>5,000	20	<50	7	500	<5	10	100	2	<2	>20,000	<50
Cas 1E-B	>5,000	20	150	2	500	5	5	5,000	<2	2	>20,000	150
JJ5	5,000	20	1,000	2	200	15	10	>5,000	<5	5	>20,000	100
Ds64G	---	---	---	---	---	---	---	---	---	---	---	---
Ds64K	---	---	---	---	---	---	---	---	---	---	---	---
Cas 2E	1,500	700	<50	2	>500	5	<5	5,000	<2	2	>20,000	>50

[1]Sample locality and description:

JJ1, Woodmansee 1 tunnel (near Spring Creek stream-sediment sample locality 8); gouge-filled seam.
JJ2, Woodmansee 1 tunnel, 500 feet in from portal; quartz-sulfide vein.
Ds64A, Woodmansee 1 tunnel dump; quartz-sulfide vein.
Ds64C, Woodmansee 1 tunnel, footwall vein; quartz-manganese oxide vein.
JJ3, Woodmansee 3 tunnel, 90 feet in from portal (same locality as sample Bs8); gouge-filled seam.
Bs8, Woodmansee 3 tunnel dump; vein material.
Bs9, Woodmansee 4 tunnel dump; vein material.
JJ4, Woodmansee 4 tunnel (same locality as sample Bs9); breast-cut across fault.
JJ6, Lower Cascade tunnel (same locality as sample Bs1); chip sample of gouge-filled seams.

taken in 1970 to check earlier results—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)					Chemical analyses--Continued (ppm)			
	Sr (100)	V (10)	W (50)	Zn (200)	Zr (10)	Au	CxCu	CxHM	Mo
				B. Spring Creek--Continued					
31	300	70	N	N	150	<0.02	<0.5	5	<4
32	300	70	N	N	200	<.02	<.5	3	<4
33	300	70	N	N	200	<.02	<.5	5	<4
34	300	100	N	N	150	<.02	.5	1	<4
36	500	150	N	N	150	<.02	4	3	<4
.37	500	150	N	N	150	<.02	5	3	<4
38	500	200	N	N	150	<.02	5	3	<4
39	500	200	N	N	150	<.02	4	3	<4
40	300	70	N	N	150	<.02	<.5	3	<4
41	300	70	N	N	200	<.02	<.5	2	<4
42	300	70	N	N	200	<.02	<.5	3	<4
43	300	70	N	N	150	<.02	1	3	<4
44	500	100	N	N	100	<.02	4	4	<4
45	300	100	N	N	200	<.02	1	1	<4
46	300	70	N	N	150	<.02	2	3	<4
47	500	150	N	N	100	<.02	4	5	<4
48	500	150	N	N	150	<.02	1	3	<4
49	300	70	N	N	150	<.02	.5	2	<4
50	500	150	N	N	100	<.02	<.5	4	<4
51	300	100	N	N	100	<.02	<.5	1	<4

Woodmansee and Cascade mines

used. . . . ., indicate that the element was not looked for; < indicates that the amount present is less than the is respectively more and much more than the number shown]

Sample[1]	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses--Continued (ppm)							
	V (10)	W (50)	Zn (200)	Zr (10)	Au	Cu	Pb	Zn	Hg	As	Sb	Te
JJ1	200	<50	5,000	150	<0.1	---	---	---	1.0	---	---	---
JJ2	<10	<50	>10,000	100	<.1	---	---	---	.9	---	---	---
Ds64A	---	---	---	---	.35	---	---	---	.5	400	1,700	0.2
Ds64C	---	---	---	---	.07	---	---	---	.06	150	30	.1
JJ3	10	<50	1,000	150	<.1	---	---	---	1.0	---	---	---
Bs8	<10	<50	>10,000	30	.18	700	11,200	37,000	.03	---	---	---
Bs9	<10	<50	>>10,000	<10	.1	660	2,000	180,000	.03	---	---	---
JJ4	<10	<50	300	100	<.1	---	---	---	.21	---	---	---
JJ6	100	<50	>10,000	150	<.1	---	---	---	1.7	---	---	---
JJ7	70	50	>10,000	50	<.1	---	---	---	.8	---	---	---
JJ8	150	<50	>10,000	200	<.1	---	---	---	1.4	---	---	---
Ds641	---	---	---	---	<.05	---	---	---	.4	100	12	.5
Cas 1E-A	30	<50	>10,000	10	.1	70	23,000	55,000	---	10	---	---
Cas 1E-B	50	<50	>10,000	50	<.1	1,600	40,000	100,000	---	20	---	---
JJ5	200	<50	>10,000	150	.1	---	---	---	.21	---	---	---
Ds64G	---	---	---	---	.05	---	---	---	.06	15	3	.1
Ds64K	---	---	---	---	<.05	---	---	---	.05	<10	55	.5
Cas 2E	100	<50	>10,000	20	.3	2,400	28,000	92,000	---	40	---	---

[1]Sample locality and description:

JJ7, Lower Cascade tunnel, 90 feet from portal; 14-inch cut across footwall vein.
JJ8 Lower Cascade tunnel, end of tunnel; argillized wallrock and veinlets.
Ds641, Lower Cascade tunnel; gouge-filled vein.
Cas 1E-A, Lower Cascade tunnel; quartz-rhodochrosite-sulfide vein.
Cas 1E-B, Lower Cascade tunnel dump; chip sample of vein material.
JJ5, Upper Cascade tunnel (same locality as sample Bs1); chip sample throughout.
Ds64G, N. 80° W. vein, Cascade Creek (same locality as sample Bs1); quartz-calcite vein.
Ds64K, N. 80° W. vein, Cascade Creek; quartz-sulfide vein.
Cas 2E, Upper Cascade tunnel dump; chip sample of vein material.

TABLE 5.—*Analyses of altered rock*

[For sample localities see main map, plate 2. Numbers in parentheses indicate sensitivity limit of method used. number shown; > and >> indicate that the amount present

Sample[1]	Semiquantitative spectrographic analyses											
	Mn (10)	Ag (.5)	Ba (20)	Be (1)	Cd (20)	Co (5)	Cr (10)	Cu (5)	Mo (5)	Ni (5)	Pb (10)	Sr (100)	V (10)
Bs1A	3,000	2	1,500	1	<20	7	7	70	<2	5	500	300	70
Bs1B	300	50	>5,000	1	300	<5	5	300	<2	<2	>20,000	1,500	70
Bs1C	150	2	1,500	1	<20	<5	7	50	<2	2	7,000	200	70
Bs2	200	3	700	2	<20	<5	<5	10	<2	2	150	200	10
Bs3	300	.5	70	3	<20	<5	<5	3	<2	2	150	<50	10
Bs4	300	<.5	1,500	2	<20	5	5	7	<2	3	70	150	50
Bs5A	700	<.5	700	3	<20	7	5	10	<2	5	70	700	30
Bs5B	150	<.5	150	5	<20	<5	<5	15	2	2	50	<50	50
Bs6	1,500	<.5	300	3	<20	<5	<5	30	<2	2	70	100	20
Bs7A	>5,000	1	30	3	<20	<5	<5	70	<2	<2	300	500	30
Bs7B	500	7	70	2	300	<5	<5	70	<2	2	20,000	<50	20
Bs10	>5,000	30	<10	<1	<20	<5	<5	15	<2	<2	300	700	<10
Bs11	5,000	3	700	2	<20	10	15	20	<2	10	70	500	70
Bs12	500	.5	1,500	1	<20	20	20	50	15	7	50	300	70
Bs13	70	.5	50	2	<20	<5	<5	7	30	2	50	<50	50
Ds424A	200	<.5	500	1.5	<20	<5	<10	15	<5	<5	20	100	100
Ds424B	300	.5	200	1.5	<20	5	<10	15	20	<5	10	150	50
Bs14	700	.5	1,500	3	<20	<5	<5	5	<2	3	30	70	20
Bs15	300	<.5	70	5	<20	<5	<5	3	<2	<2	30	<50	10
Bs16	150	<.5	50	3	<20	<5	<5	3	<2	<2	30	<50	10
Bs17	5,000	<.5	1,000	50	<20	15	<5	10	<2	7	15	<50	300
Bs19A	200	.7	300	7	<20	<5	<5	3	<2	<2	70	50	20
Bs19B	300	<.5	700	3	<20	10	<5	3	<2	<2	10	<50	20
Bs21	500	<.5	300	5	<20	<5	<5	15	<2	<2	15	70	30
Bs22	70	1	70	3	<20	<5	<5	2	<2	2	20	<50	10
Bs23	500	.7	700	1	<20	7	5	3	<2	3	30	300	30
Bs24	150	<.5	70	2	<20	<5	<5	3	<2	2	20	700	15
Bs25	300	<.5	150	2	<20	<5	<5	5	<2	2	10	100	15
Bs26	150	<.5	1,000	2	<20	<5	5	20	<2	2	30	500	50
Ds406	3,000	<.5	300	1.5	<20	30	10	10	<5	5	15	300	100
Ds425B	70	2	300	1	<20	5	10	20	<5	<5	50	200	30
Ds455A	500	<.5	500	2	<20	5	<10	30	<5	5	30	700	100
Ds455B	300	<.5	500	3	<20	5	<10	30	15	5	20	200	100
Ds455C	20	<.5	150	1	<20	<5	<10	10	10	<5	7,000	100	100
Ds455D	50	<.5	500	1.5	<20	5	<10	50	<5	7	50	500	100
Ds456	>5,000	<.5	500	5	<20	100	10	100	10	50	30	300	100
Ds457	100	3	150	1.5	<20	<5	<10	10	<5	5	<10	<100	20
Ds458	500	2	500	1	<20	<5	<10	15	70	5	10	200	30

[1]Sample description:

Bs1A, Altered rock in footwall of fault.
Bs1B, Quartz-sulfide vein along fault.
Bs1C, Altered rock in hanging wall of fault.
Bs2, Fractured, silicified rock.
Bs3, Silicified rock with coarse quartz crystals.
Bs4, Quartz vein in silicified rock.
Bs5A, Quartz-pyrite veinlet from dump of short adit.
Bs5B, Silicified rock from dump of short adit.
Bs6, Quartz vein showing slickensides.
Bs7A, Calcite-manganese oxide vein.
Bs7B, Calcite-manganese oxide vein containing sphalerite.
Bs10, Calcite veinlets cutting propyllitized rock.
Bs11, Calcite veinlets cutting propyllitized rock.
Bs12, Limonite-stained rock.
Bs13, Quartz vein cutting propyllitized rock.
Ds424A, Same locality as Bs13; altered fines from dump.
Ds424B, Same locality as Bs13; quartz-pyrite vein from dump.
Bs14, Quartz vein cutting propyllitized rock.
Bs15, Limonite-stained rock with quartz veinlet.

and vein material from scattered localities

. . . ., indicate that the element was not looked for; < indicates that the amount present is less than the is respectively more and much more than the number shown]

Sample [1]	Semiquantitative spectrographic analyses--Continued (ppm) W (50)	Zn (200)	Zr (10)	Chemical analyses (ppm) Au	Cu	Pb	Zn	Hg	Ag	As	Sb	Mo
Bs1A	<50	700	150	<0.1	40	220	400	0.04	---	---	---	---
Bs1B	<50	>>10,000	100	<.1	240	26,000	34,000	.07	---	---	---	---
Bs1C	<50	300	70	<.1	30	1,800	250	.06	---	---	---	---
Bs2	<50	<200	70	<.1	<10	60	50	.06	---	---	---	---
Bs3	<50	<200	50	<.1	<10	160	50	.03	---	---	---	---
Bs4	<50	<200	100	<.1	<10	10	50	.03	---	---	---	---
Bs5A	<50	<200	100	<.1	10	30	85	.04	---	---	---	---
Bs5B	<50	<200	150	<.1	<10	20	35	.03	---	---	---	---
Bs6	<50	<200	70	<.1	<10	30	<25	.02	---	---	---	---
Bs7A	<50	200	10	<.1	60	120	290	.02	---	---	---	---
Bs7B	<50	>10,000	70	<.1	60	20,000	40,000	.02	---	---	---	---
Bs10	<50	700	<10	<.1	<10	100	690	.03	---	---	---	---
Bs11	<50	<200	70	<.1	20	50	100	.08	---	---	---	---
Bs12	<50	<200	200	.1	40	50	110	.03	---	---	---	---
Bs13	<50	<200	50	<.1	10	20	<25	.09	---	---	---	---
Ds424A	<50	<200	150	.02	15	15	30	---	0.6	120	3	4
Ds424B	<50	<200	100	.06	15	15	30	---	.6	120	2	15
Bs14	<50	<200	70	<.1	10	40	45	.02	---	---	---	---
Bs15	<50	<200	70	<.1	<10	10	50	.09	---	---	---	---
Bs16	<50	<200	200	<.1	<10	20	20	.05	---	---	---	---
Bs17	<50	200	10	<.1	30	30	330	.03	---	---	---	---
Bs19A	<50	<200	100	<.1	<10	20	50	.03	---	---	---	---
Bs19B	<50	<200	70	<.1	10	10	25	.03	---	---	---	---
Bs21	<50	200	70	<.1	30	20	30	.05	---	---	---	---
Bs22	<50	<200	100	<.1	10	<10	180	.05	---	---	---	---
Bs23	<50	<200	50	<.1	10	<10	50	.09	---	---	---	---
Bs24	<50	<200	50	<.1	10	<10	<25	.03	---	---	---	---
Bs25	<50	<200	50	<.1	<10	<10	<25	.06	---	---	---	---
Bs26	<50	<200	100	<.5	10	<10	25	.05	---	---	---	---
Ds406	<50	<200	150	.06	15	10	60	---	.4	20	<.5	<4
Ds425B	<50	<200	150	.08	15	40	35	---	4	800	50	4
Ds455A	<50	<200	500	.04	15	35	45	---	---	---	---	---
Ds455B	<50	<200	300	.06	15	35	110	---	---	---	---	---
Ds455C	<50	<200	500	.04	<5	15	30	---	---	---	---	---
Ds455D	<50	<200	500	.06	20	40	15	---	---	---	---	---
Ds456	<50	500	300	.08	70	85	400	---	---	---	---	---
Ds457	<50	<200	100	.16	<5	10	15	---	---	---	---	---
Ds458	<50	<200	200	.04	<5	10	15	---	---	---	---	---

[1]Sample description:

Bs16, Quartz vein.
Bs17, Manganese oxide in opal.
Bs19A, Silicified rock containing vuggy quartz veinlet.
Bs19B, Altered rock containing limonite and manganese oxide.
Bs21, Limonite-stained rock.
Bs22, Altered rock from old pit.
Bs23, Altered rock from sheared zone.
Bs24, Quartz vein.
Bs25, Quartz vein.
Bs26, Altered rock with quartz vein from sheared zone.
Ds406, Altered rock with quartz-pyrite veinlets along fault.
Ds425B, Quartz-pyrite veinlets cutting altered rock.
Ds455A, Silicified monzonite containing pyrite.
Ds455B, Altered fault gauge.
Ds455C, Altered fault gouge.
Ds455D, Silicified monzonite containing pyrite.
Ds456, Talus breccia cemented by manganese oxide.
Ds457, Quartz vein.
Ds458, Silicified rock containing pyrite.

around the caldera cover the Conejos rocks just west and north of the prospected area; no related mineralized rock is exposed within the La Garita Wilderness. No evidence was seen to indicate that mineralized rock exists far from the exposed intrusive plug in the Sky City mine area, and none may be present under adjacent parts of the La Garita Wilderness. Even if peripheral deposits, or even different mineralized centers of Conejos age, do exist at depth within the wilderness, they would be deeply covered by younger rocks outside the buried ring fracture zone of the La Garita caldera, or would have sunk far below any present practical level of discovery or exploration inside the zone.

CENTRAL AND EASTERN AREAS

No evidence of mineralization was seen anywhere in the central or eastern part of the La Garita Wilderness during regional geologic mapping. As a check for this visual appraisal, stream-sediment samples were collected along all the main streams—Nutras, Stewart, Cochetopa, Middle Fork Saguache, and South Fork Saguache Creeks (pl. 2). Analytical results (tables 2F–J) from those samples were uniformly negative except for one sample from Cochetopa Creek (sample 7, table 2H) which showed 60 ppm Mo by chemical analysis. Spectrographic analysis of the same sample failed to detect any Mo, and so this one anomalous value probably has no significance. Thus no mineral deposits of economic value can be postulated within these parts of the wilderness.

Although no samples were taken by the U.S. Geological Survey in the Wheeler Geologic Area south of the eastern part of the wilderness, the geologic environment is closely similar to that in the area to the north, and no evidence of mineralization was noted there during field mapping.

SPRING CREEK DRAINAGE

Spring Creek and its tributaries drain most of the resurgent core of San Luis caldera. Evidence of minor hydrothermal activity is widespread throughout this drainage basin. Some vein deposits just within and adjacent to the northwest part of the La Garita Wilderness were prospected widely in early days, and recently (1966-70), the Bonnez Mining Co. drove several exploratory tunnels. As a consequence, the Spring Creek drainage was examined more closely than the other parts of the La Garita Wilderness; numerous samples were taken and analyzed.

Most of the prospecting was done in what may be called the Bondholder district, which extends from the lower part of Cascade Creek, just within the La Garita Wilderness, down Spring Creek to the mouth of Sheep Creek, about 2.4 km (1.5 mi) north of the wilderness. Workings are concentrated near the Cascade mine, located very close to the wilderness boundary, and in the Woodmansee mine area on the east side of Spring Creek, about 0.8 km (0.5 mi) north and west of the wilderness boundary.

Most stream-sediment samples taken from the Spring Creek drainage (tables 2B–E, 3B) contained negligible quantities of valuable metals. Samples containing slightly anomalous metal contents were located here and there throughout the drainage basin, but the only consistently anomalous area found was the Cascade Creek drainage where the zinc content of many of the samples was slightly above background.

Of the stream-sediment samples taken along the main course of Spring Creek in 1967 (table 2B), sample 8, taken just below the Woodmansee mine area, had slightly anomalous contents of lead (30 ppm) and zinc (84 ppm). Sample 10, taken between the Cascade and Woodmansee mine areas, contained slightly anomalous copper (50 ppm) when tested by spectrographic methods, but this anomaly was not confirmed by chemical methods. Samples 21, 22, and 23, from upper Spring Creek, contained slightly above-background contents of lead (30–50 ppm, spectrographic) and zinc (54–100 ppm, chemical), but these values were not confirmed by the alternate analytical method; these samples were collected near minor quartz-pyrite veins (sample Ds 457, table 5). No reason is known for the slightly anomalous content of copper (30 ppm, spectrographic) in sample 25, from near the head of Spring Creek.

Samples 1, 2, and 3 from Sheep Creek (table 2E) show slightly anomalous contents of copper (50 ppm) and lead (30 ppm) by spectrographic methods, but only background quantities by chemical methods. Silver was slightly anomalous (1.5 ppm) in the spectrographic analysis of sample 14; considering the low content of other metals indicated by both spectrographic and chemical methods, this isolated, relatively high value for silver probably has little significance. The unnamed eastern tributary of Spring Creek south of Sheep Creek was called "Noname" Creek for convenience in identifying samples; all stream sediment samples taken along this drainage contained only background contents of metals (table 2D).

Stream-sediment samples taken along Cascade Creek (table 2C), the western tributary into Spring Creek, contained the only consistently anomalous concentrations of metals of any of the drainage basins within the La Garita Wilderness. Sample 1, from the immediate vicinity of the Cascade mine near the mouth of Cascade Creek, contained clearly anomalous quantities of silver (0.7 ppm, spectrographic), lead (200 ppm, spectrographic), and zinc (210 ppm, chemical) — the same metals contained by the veins explored by the mine workings. Elsewhere, anomalous copper and lead were indicated in scattered localities by spectrographic analyses (but not by chemical analyses), and slightly anomalous zinc (chemical) was found virtually throughout the drainage basin. The significance of this zinc anomaly will be discussed in the section on the Mineral Creek drainage.

Stream sediments in the Spring Creek drainage were re-collected in 1970 (table 3B), to check the analyses of the earlier samples. Only one sample of this suite showed any metal concentrations above background levels; sample 12, from lower Cascade Creek below the Cascade mine, had distinctly anomalous contents of lead (200 ppm) and zinc (300 ppm).

BONDHOLDER DISTRICT

The slopes adjacent to the Bondholder Meadow, from the wilderness boundary north along Spring Creek to the mouth of Sheep Creek, were intensively prospected in early days; numerous pits and small mine workings were dug. Many of these workings expose veins along small mineralized fractures of diverse trends, and encouraging assays for lead, zinc, and silver can be obtained from many of these veins (tables 4, 5). The veins containing the highest grade material are concentrated around the Cascade mine near the mouth of Cascade Creek and in the vicinity of the Woodmansee mine along the east side of Spring Creek, about 0.8 km (0.5 mi) farther north (table 4). Both of these areas were explored by the Bonnez Mining Co. between 1966 and 1970.

The Cascade mine is developed by three short tunnels and many minor prospect pits. The tunnels were dug on irregular, curving, and branching mineralized fractures that trend generally northwest-southeast, and dip steeply. The walls of the fractures are irregularly silicified; in places they have largely been replaced by quartz. The silicified rock commonly contains pyrite, and locally contains sparse galena and sphalerite as well. Late fractures cut some of the silicified rock. Some of these fractures are followed by quartz-sulfide veins that range from mere seams to well-defined veins (1–1.4 m, 3–4 ft wide). Pyrite, galena, and sphalerite are irregularly distributed along the late veins and in places are sufficiently abundant to be of ore grade. These local concentrations of higher grade material are spotty, however; most of the veins exposed probably are too narrow or low grade to be mined economically. The mineralized fractures commonly split and die out, or link irregularly with subparallel minor fractures; no coherent fault zone was discovered anywhere in the vicinity of the Cascade mine.

Mineralization appears to be more widespread in the vicinity of the Woodmansee mine than at the Cascade mine. Numerous prospect workings extend over an area more than 305m (1,000 ft) across and over a vertical range of at least 240 m (800 ft). Vein material is exposed widely in outcrops and prospect workings, and in dumps within this area; all visible vein material appears to be along minor fractures. None could be traced far laterally, but this was due, in part, to generally poor exposures on the talus-covered slope.

In 1966-68, the Bonnez Mining Co. drove the Allara tunnel eastward about 200 m (650 ft), beneath the western part of the Woodmansee mine area, with the intent of cutting some of the exposed veins at depth. The tunnel intersected a number of minor discontinuous fractures, some of which contain galena and sphalerite. All the mineralized fracture zones exposed, however, are too small and discontinuous to be of economic significance.

Samples from mine workings and dumps in the Woodmansee mine area (table 4) indicate that lead, zinc, and silver values approaching ore grade, as well as anomalous copper and gold values, occur throughout the area. The small size of all the veins exposed and the irregular distribution of metal content along them, however, suggest that economic concentrations of metals probably are sparse.

The extent of metal-bearing minor veins in the Bondholder district indicates that mineralization pervaded a wide area. Most of the minor fracture zones contain some vein material, and locally the grade and width of the veins are sufficient to have encouraged prospecting. We carefully searched for a persistent, integrated fracture zone that might have channelled the mineralizing solutions and provided a host structure for deposition of economic veins on the slopes in and near the Bondholder area. This effort was largely futile. One north-trending fault was found where it intersected Sheep Creek about 1.2 km (0.75 mi) east of Spring Creek (pl. 1), as well as several nearby trends that might reflect the positions of faults. Because of the generally poor exposures, and the lack of marker horizons or distinctive rock units, it was nearly impossible to be certain whether these postulated faults actually exist.

No evidence for hidden mineral deposits was seen along these possible fault trends. Samples of stream sediments and altered and mineralized rock taken nearby show no anomalous contents of metals.

Because of the small size of the veins and the erratic distribution of valuable metals along them, the economic potential of the Bondholder district appears low. However, some of the exposed veins contain pods of ore-grade material that approach minable widths, although these pods are of limited lateral extent. It is conceivable that similar but somewhat larger ore bodies may exist that could yield a small mineral production. A major consideration, however, is the probable cost of discovery and development relative to the size of the deposit. No evidence was seen in either the Cascade or Woodmansee mine areas to indicate more than local concentrations of mineral resources.

SCATTERED VEINS AND ALTERED ZONES

Many minor altered zones and quartz-pyrite veins were seen along fractures cutting the resurgent core of the San Luis caldera throughout the Spring Creek drainage area. In general, these veins appear to differ from the veins in the Bondholder district in that they lack the spottily distributed galena and sphalerite found in the Cascade and Woodmansee mine areas. The veins and altered zones are localized along or near minor monzonite dikes or plugs in some places, but elsewhere there is seemingly no close association with intrusive rocks.

Most samples taken from these veins and altered zones (table 5) contain very low concentrations of valuable metals. Those peripheral to the Cascade and Woodmansee mine areas generally contain significantly more metal than samples from outlying areas. None of the scattered mineralized zones seen were large enough or had high enough grade to encourage exploration.

PERLITE DEPOSITS

Lava flows in the volcanics of Stewart Peak accumulated within the subsided basin of the San Luis caldera. These flows ranged from porphyritic rhyodacite and quartz latite, in the southeastern and eastern parts of the caldera, to glassy rhyolite in the northern part. The glassy flows were thoroughly hydrated; many of the flows in the area extending from east of Spring Creek to the vicinity of Mineral Creek were converted to perlite. Several perlitic flows near Spring Creek were examined closely in the field. Much of the rock in these flows contains very few phenocrysts and forms massive bodies of green hydrated glass. Inasmuch as all the known perlite is outside the La Garita Wilderness, no tests were made to determine the commercial value of the deposits. A subjective judgment based on field appearance, however, is that such testing would be well worthwhile. A chemical analysis of this rock is given in the Economic Appraisal section of this report.

MINERAL CREEK AREA

The headwaters of Mineral Creek drain the eroded cores of several of the volcanoes that erupted the quartz latite of Baldy Cinco, and halos of intensely altered rock surround some of the exposed volcanic necks. The name Mineral Creek derives from these areas of obviously altered rocks. In addition, the high rims of lava and breccias of the quartz latite of Baldy Cinco, surrounding the headwaters of Mineral Creek, are cut by many minor fracture-controlled zones of altered rocks. This headwaters area is immediately contiguous to the La Garita Wilderness and shares many geologic features with the adjacent Cascade Creek drainage area, just within the wilderness. For these reasons, the Mineral Creek drainage basin was studied as carefully as most of the areas within the wilderness.

Stream sediments along Mineral Creek were sampled and analyzed in 1967, and again in 1970, to check the earlier analytical work. The results of both sampling programs were largely negative, except that samples taken along East Mineral Creek in 1967 (table 2A) contained slightly anomalous quantities of zinc (30–78 ppm). These samples were thus closely similar to the samples taken along Cascade Creek, just to the east, and the combined drainages of Cascade and East Mineral Creek are parts of a single area containing anomalous zinc. The anomalous zinc might be attributed to the numerous intrusive plugs and volcanic necks, and associated altered rocks that cut the quartz latite of Baldy Cinco and underlying welded tuffs in this vicinity. No clear-cut faults or mineralized veins were seen in this area, even though the areas of intrusives and altered rocks extend well above timberline where they are well exposed.

One sample of quartz veinlets cutting altered rock was taken from a prospect pit near the confluence of East and Middle Mineral Creeks (Ds 425 B, pl. 2). This sample (table 5) showed only background contents of metals.

CREEDE MINING DISTRICT

The Creede mining district south and southwest of the La Garita Wilderness had produced about $81 million worth of valuable metals through 1970, largely from veins that follow major and minor faults in a graben extending radially north-northwest from the Creede caldera. Faulting in this graben began during resurgence of the Bachelor caldera and was reactivated several times subsequently. The most clear-cut periods of faulting accompanied resurgence of the Bachelor caldera, resurgence of the San Luis caldera, and a late stage following resurgence of the Creede caldera. Major mineralization in part accompanied and in part followed the last period of faulting. The detailed geology of the Creede district was discussed by Steven and Ratté (1965); here, attention is focused largely on the northern part of the district, and on the possible extent of mineralization in or near the wilderness.

Major production in the Creede mining district has come from the area where late faulting was particularly active. On the Amethyst and Bulldog Mountain fault zones, in the heart of the district, the main mines are 2–5 km (1.3–3 mi) north and northwest of the town of Creede. Farther north, the faults are obscured for several kilometers by landslide debris and glacial drift, and the extent of mineralization cannot be determined from surface exposures. Where faults of the Amethyst system reappear between West Willow Creek and Nelson

Mountain, mineralization-age displacement appears to have been minor; most of the fault movement here took place during resurgence of the San Luis caldera.

The northern part of the Amethyst system of faults is dominated by a triangular-shaped block that was uplifted several thousand feet during resurgence of the San Luis caldera. The base of the triangle is bounded by the east-trending Equity fault, and the sides by north and north-northwest-trending branches of the Amethyst system. The apex of the triangle is covered by unbroken lavas of the quartz latite of Baldy Cinco, which limits the age of faulting here to later stages of the San Luis caldera cycle.

Mineralization-age movement in the northern part of the Amethyst system appears to have been limited to minor fracturing along the older faults. Surface evidence of mineralization associated with the late fracturing is manifested largely by bleached and altered rocks along the trends of the faults or related minor fractures. The dump of the Captive Inca shaft near lower Deerhorn Creek consists largely of soft, argillized rock (Steven and Ratté, 1965, p. 66); Emmons and Larsen (1923, p. 169) repeated earlier word-of-mouth accounts that little or no ore had been found.

The only known ore in the northern part of the Creede district has been developed by the Equity mine which was driven eastward along the Equity fault to intersect the roots of a pod of highly silicified quartz-pyrite rock that crops out part way up the steep slope east of upper West Willow Creek. As seen underground, the quartz-pyrite rock locally replaces the rock along the Equity fault. The replacement took place following early uplift of the triangular-shaped block to the north, a block that formed during resurgence of the San Luis caldera. Where first intersected by the tunnel, the Equity fault is marked by a zone of soft, highly argillized rock. Within the ore zone, however, the fault was completely healed by silicification, and the adjacent walls were largely replaced by silica with disseminated pyrite, for widths of as much as 17 m (50 ft) (Steven and Ratté, 1965, fig. 7). The hard silicified rock was broken by late fractures that probably formed at the time of last major faulting in the main productive part of the Creede district. The silver and gold ores that have provided most of the production from the Equity mine were deposited along these late fractures; apparently the width and grade of the ore ranged widely from place to place, and most production came from a single ore shoot.

Surface geologic studies in the northern part of the Creede district demonstrated that hydrothermal activity was fairly widespread along the faults of the Amethyst system; but these earlier investigations were not sufficiently detailed, and did not include enough geochemical or geophysical coverage to outline exploration targets which might prove comparable to the Equity mine area. Significantly, however, evidence of hydrothermal activity is relatively minor north of the latitude of the Equity mine, in an area where faulting appears to have taken place largely during resurgence of the San Luis caldera and where it was unrelated to the younger mineralization-age faulting in the Creede district to the south. None of the faults mapped in the Creede district have been traced north into the La Garita Wilderness. Thus, no mineral deposits related to those in the Creede mining district can be postulated within the wilderness.

ENERGY RESOURCES

No evidence was seen for thermal spring activity within the La Garita Wilderness, and the potential for geothermal energy seems negligible. Only a thin, discontinuous wedge of Mesozoic sedimentary rocks intervenes between the Precambrian crystalline basement and Tertiary volcanic rocks along the north side of the San Juan volcanic field, 20–38 km (12–18 mi) north of the wilderness; no commercial coal is known in this wedge, and the possibility for oil or gas concentrations is slight at best.

GEOPHYSICAL INTERPRETATION

By GORDON P. EATON, U.S. Geological Survey

Published geophysical data covering the San Juan Mountains in southwestern Colorado consist of a Bouguer gravity map (Plouff and Pakiser, 1972), and an aeromagnetic map(U.S. Geological Survey, 1972). The gravity map is not adequate for mineral appraisal because fewer than five gravity stations were occupied within the La Garita Wilderness. The aeromagnetic map, on the other hand, was prepared from a survey flown in 1968 at a barometric elevation of 4.4 km (14,500 ft) and a flight-line spacing of 1.6 km (1 m); it is sufficiently detailed to aid in appraising the mineral potential of the area.

The aeromagnetic contours covering the La Garita Wilderness and adjacent areas are shown on plate 1. The following discussion interprets the features shown on this map both in the light of some modeling based on limited measurements of physical properties of some of the rocks in the area, and by analogy with interpretations of closely similar geologic settings.

EASTERN PART OF LA GARITA WILDERNESS

The eastern three-fourths of the La Garita Wilderness is marked by a large, twin-peaked, positive magnetic anomaly with an approximate total amplitude of about 1,300 gammas. It is crudely polygonal in plan and is about 24 km (15 mi) across, along a northwest-trending line, and about 20 km (12 mi) across, along a northeast-trending line. This anomaly extends several kilometres north and south of the wilderness boundaries and occupies most of the northern two-thirds of the La Garita caldera. It also coincides with a markedly elevated tract of mountains with a relief of more than 1,220 m (4,000 ft), measured from the crest of the La Garita Mountains within the wilderness to the Rio Grande Valley, 11 km (7 mi) south of the wilderness, and to the North Fork of Saguache Creek, 8 km (5 mi) north of the wilderness. The mountains, as well as the anomaly, crest along the eastern part of the boundary between Saguache and Mineral Counties, and coincide geographically with the preserved part of the resurgently domed core of the La Garita caldera.

The large magnetic anomaly in the eastern part of the wilderness is believed to be fundamentally related to the La Garita caldera; it may be associated with the 1,220 m (4,000 ft) of normally polarized intracaldera tuff in the core of the caldera, or with an underlying intrusive cupola that resurgently domed the core. None of the four episodes of hydrothermal activity and mineralization that affected rocks in or near the wilderness took place during the La Garita caldera cycle of development; thus, the major magnetic anomaly is not believed to have significant bearing on the mineral potential of the area.

In detail, this broad magnetic high is surmounted by two smaller highs, both of which rise approximately 650 gammas above the general top of the larger anomaly. One high trends northeast across the Wheeler Geologic Area and Sheep Mountain; the other lies parallel to, and is less than 1.6 km (1 mi) southwest of the Saguache-Mineral County line. Near its western end, this latter anomaly shows a north-trending lobe which lies just east of the eastern margin of the San Luis caldera. Both of these subsidiary anomalies were studied to see if they might have a bearing on the mineral potential of the area.

Depth estimates of the sources of these two subsidiary anomalies were attempted, but with limited success. Two models were assumed: (1) Vertical prisms that meet the requirements of the analytical technique of Vacquier and others (1951), and (2) horizontal slabs, modeled according to data from Andreasen and Zietz (1969). The calculation of magnetic depth estimates in terranes such as the San Juan Mountains is difficult. The pronounced topographic relief, coupled with volcanic rock types that commonly display a wide range in values of magnetic susceptibility and that have either reversed or normal remanent magnetization, results in high-amplitude, near-surface anomalies that locally tend to mask or interfere with the effects of subtler anomalies from deeper sources. Some anomalies are created by topography alone; although the topographic slopes are steep, they are not steep enough to approximate vertical prisms, and depths calculated from associated anomalies may erroneously indicate a source in the subsurface. In addition, interference between two or more anomalies makes meaningful depth estimates exceedingly difficult, at times impossible. Finally, both reversely and normally polarized ash-flow sheets are present in the shallow subsurface in this area. In places these sheets tend to suppress buried magnetic fields of opposite polarity. Under these circumstances, the interpretations presented here should be viewed as highly uncertain.

The elongate northwest-trending magnetic high, which follows the Saguache-Mineral County line, is interpreted as an expression of the topographic ridge carved from the normally polarized, intracaldera La Garita Member of the Fish Canyon Tuff. That part of the apparent continuation of this anomaly extending both north and south from the west end of the closed 2,200-gamma contour arises from a separate source in the subsurface. Its configuration, based on limited digital modeling, suggests a steepsided dikelike mass with a crest that may lie as much as 305 m (1,000 ft) below the surface.

Similarly, the local northeast-trending positive anomaly that crosses the Wheeler Geologic Area and Sheep Mountain is also believed to be related to a subsurface body. More uncertainty exists in this interpretation, however, because where the crest of the anomaly is crossed by several of the flight lines, it coincides with local topographic highs. Nevertheless, under close scrutiny this relationship is not consistent; a calculation of depth places the top of the source approximately 305 m (1,000 ft) or more below the surface. We believe this subsidiary anomaly must be caused, at least in part, by a buried source. The regional magnetic map (U.S. Geological Survey, 1972) shows that a southwesterly prolongation of the axis of this anomaly coincides with the axis of the east limb of an arcuate, high-amplitude magnetic high associated with the Creede caldera. On the basis of modeling, this coincidence is believed to be fortuitous, however, because the arcuate configuration of the Creede anomaly is due largely, but not entirely, to edge effects.

WESTERN PART OF LA GARITA WILDERNESS

The western part of the La Garita Wilderness lies entirely within the San Luis caldera. This part of the wilderness contains San Luis Peak (alt. 4,274 m, 14,014 ft) and Stewart Peak (alt. 4,263 m, 13,983 ft), and is topographically the highest area in the central San Juan Mountains. The general magnetic intensity of this area, however, is lower than that of the rest of the wilderness. San Luis Peak is carved from Nelson Mountain Tuff, which has normal remanent magnetization. The thick mass of Nelson Mountain Tuff within the San Luis caldera is widely propylitized; this alteration may have destroyed a significant part of the original magnetite and thus have sharply reduced the magnetic susceptibility. The upper part of Stewart Peak consists of relatively unaltered lavas and breccias of intermediate composition, for which we have no magnetic-property data. In general, the magnetic intensity of this area is quite similar to that farther west and south. No specific anomalies have been identified that can be related to significant mineral potential.

SUMMARY

Only two features of the magnetic map cannot be interpreted as resulting from topography or from surface geology; both are expressed as elongate magnetic highs and both trend north-northeast. These features are superimposed on a very large positive anomaly, believed to be genetically related to the structure of the La Garita caldera. Both features seem to require a subsurface source. The western feature probably reflects an elongate pluton or dike of massive dimensions. The eastern feature appears to reflect a structural trend that developed after subsidence of the La Garita caldera and may result from a local intrusion emplaced late in the related cycle. Although both features may be caused by intrusive bodies at depth, no evidence was found to suggest that either has mineralization associated with it.

ECONOMIC APPRAISAL

By C. L. Bieniewski, U.S. Bureau of Mines

HISTORY AND MINERAL PRODUCTION

Earliest records of prospecting within what is now the La Garita Wilderness date back to 1887, when three mining claims (Ruby Silver, Cascade, and Tug Wilson) were staked in the Spring Creek–Cascade Creek area. The Ruby Silver and Cascade claims were located by George Smith, C. H. Abbot, and N. C. Creede, and the Tug Wilson claim by M. E. Wilson and James Mills.

No records exist of mineral production from within the wilderness, but judging from the mineralization at some of the more extensive old workings, some ore may have been mined from early prospects in the vicinity of Spring Creek and Cascade Creek just outside the northwest border. It is doubtful, however, that production from this area amounted to more than $100,000 worth of metal. The earliest known output near the wilderness is from the Equity mine, where ore containing gold, silver, copper, lead, and zinc was mined. This mine has been worked intermittently since 1912, with the last production reported in 1966.

The Creede district, located south of the wilderness, has been a significant producer of silver, gold, copper, lead, and zinc since 1891.

The silver potential of the Creede district was recently determined by Meeves and Darnell (1968); however, the area of the La Garita Wilderness was not included. The mining history of the Creede district is briefly covered in their report, and some former and current mining and milling operations are described. An estimate of the silver reserves and resources also is presented, with an analysis of potential silver production. The report states that production of gold, silver, copper, lead, and zinc from 1891 through 1966 was valued at $69.5 million. In the next four years, $11.5 million worth of these metals was produced, making a total of $81.0 million through 1970.

SAMPLING AND SAMPLE ANALYSES

Samples were taken at all prospect workings found in and near the wilderness. These were mostly grab samples from prospect dumps, because most adits and shafts were caved and inaccessible. Dumps were sampled by combining several handfuls of rock taken at some specific interval or grid system depending on the size of the dump; the grid interval is given in table 7. Where the dumps appeared to be separated into two or more rock types, grab samples were taken of each type. Also, grab samples were taken on a systematic basis from "high-grade" stockpiles at some of the prospect workings. Some outcrops and veins exposed in prospect workings were sampled, usually by taking chip samples. Four stream-sediment samples were taken. The sample localities are shown on plate 2.

All samples were analyzed by a six-step semiquantitative spectrographic analysis for 30 elements. Except for four stream-sediment samples, they also were checked for radioactivity with a geiger counter and were fire assayed for gold and silver. Whenever spectrographic analysis showed an unexpected element to be present or an element to be present in anomalous quantity, a chemical analysis was made. The spectrographic results are shown in table 6; table 7 lists the results of the fire assaying and chemical analyses, as well as the location and the type of sample taken. None of the samples showed appreciable radioactivity.

MINES, PROSPECTS, AND MINERAL DEPOSITS

The general locations of all unpatented and patented mining claims, homesteads, and places withdrawn from mineral location, in and near the wilderness, that could be determined from official records are shown on plate 2. Because of the vagueness of the descriptions in many recorded location notices, the location of some unpatented mining claims could not be established, especially for claims filed prior to 1960. Between the patented Equity claims and the town of Creede, in an area approximately 9.6 km (6 mi) long and 8 km (5 mi) wide, there are at least 250 patented claims and 70 unpatented claims for which mineral surveys are on file with the Bureau of Land

TABLE 6.—*Results of semiquan-*

[Analyses by U.S. Geological Survey, Denver, Colo. For sample localities, see plate 2. Numbers in parentheses
above the number shown; L indicates the element is present below the

	Percent				Parts per million				
Sample	Fe (.05)	Mg (.02)	Ca (.05)	Ti (.002)	Mn (10)	Ag (.5)	As (200)	Ba (20)	Be (1)
1	10	1	0.7	0.5	1,000	N	N	1,000	1
2	5	2	.2	.7	1,000	N	N	1,000	1
3	3	1	.1	.7	200	N	N	1,500	1
4 2/	5	0.2	.3	.5	2,000	N	N	1,000	1
5	7	2	.1	.5	700	0.5	N	2,000	L
6	5	2	.5	.7	700	.5	N	5,000	L
7	5	2	.5	.5	1,000	N	N	1,500	L
8	10	2	3	.5	5,000	3	N	1,000	1
9	7	.7	20	.3	5,000	10	N	5,000	1
10	7	1	5	.3	5,000	2	N	3,000	L
11	10	.5	5	.3	1,000	1.5	N	1,500	N
12	7	.5	2	.7	1,000	1	N	2,000	N
13	5	2	2	.5	> 5,000	5	N	1,000	1
14 3/	7	.5	20	.1	2,000	20	N	300	2
15 4/	7	.5	20	.2	2,000	15	N	1,000	L
16 5/	2	.2	5	.1	5,000	7	N	5,000	1
17 6/	5	.5	2	.2	2,000	7	N	700	1
18 7/	10	2	1	1	5,000	10	N	1,000	L
19	5	2	.5	.7	1,000	1	N	1,000	L
20	7	2	3	.7	1,000	N	N	1,000	1
21	7	1	1	.7	700	N	N	700	1
22	5	1	.7	.7	700	N	N	1,000	1
23	7	2	1	.5	700	.5	N	700	L
24	7	2	.5	.3	700	.5	N	700	L
25	7	2	2	.5	5,000	1	N	1,000	L
26	5	2	.7	.5	700	N	N	700	1
27	7	2	.5	.5	2,000	N	N	700	1
28	5	1	.2	.3	5,000	1	N	1,000	1
29	5	2	2	.3	5,000	2	N	1,500	L
30	5	1	.5	.3	2,000	.5	N	1,000	L
31	10	2	.5	.1	700	N	N	1,500	L
32	10	2	.7	.7	2,000	N	N	1,000	1
33	7	2	2	.5	1,000	N	N	700	1
34	5	2	2	.5	700	.5	N	1,000	1
35 8/	5	.5	.1	.3	70	1	N	1,000	1
36	5	2	.2	.5	500	N	N	1,000	1
37	5	1	.3	.3	1,000	N	N	700	1
38	5	1	.7	.5	700	1	N	1,000	2
39	10	2	.5	.5	1,000	.5	N	2,000	L
40	5	.2	.5	.3	1,000	N	N	1,000	L
41	10	2	.5	.7	1,000	.5	N	1,000	L
42	10	3	.5	.5	1,000	1	N	1,500	L
43	5	2	1	.5	700	.5	N	1,000	L
44	7	2	.5	.5	1,000	.5	N	1,000	1
45	5	1	7	.3	1,000	.5	N	700	1
46	3	1	.5	.3	500	3	N	700	2
47	5	1	.2	.3	700	.5	N	700	1
48	5	1	.5	.3	500	.5	N	700	1
49	5	2	5	.5	1,000	.7	N	1,000	L
50	2	.5	.5	.1	1,500	20	N	700	1
51	2	1	2	.2	2,000	15	N	700	2
52 9/	5	1	1	.3	> 5,000	20	2,000	700	1
53 10/	3	.07	.2	.07	2,000	1,500	700	200	2
54	2	.2	.2	.2	500	150	300	300	1
55 11/	2	.1	.1	.1	1,000	1,000	700	200	5
56	3	1	.1	.3	700	10	N	500	2
57 12/	2	.3	.1	.2	700	150	N	300	2
58 13/	5	.05	2	.05	700	700	500	100	2
59	2	.3	.05	.2	700	30	N	300	2
60	3	.5	.05	.2	700	150	200	500	2
61	5	.2	.2	.3	> 5,000	100	700	2,000	2
62	7	.5	.1	.2	> 5,000	30	1,500	1,000	2
63	2	.2	.07	.1	5,000	150	200	700	2
64	2	.3	.05	.1	> 5,000	300	700	> 5,000	3
65	5	1	.2	.3	300	N	N	1,000	1
66	5	2	1	.5	1,000	N	N	1,000	1
67	10	2	.7	.7	1,000	.5	N	1,000	1
68	5	2	3	.3	700	.5	N	700	1

titative spectrographic analyses

indicate sensitivity limit of method used. < indicates that an undetermined amount of the element is present sensitivity limit; N indicates the element was looked for, but not found[1]]

Parts per million									
Co (5)	Cr (10)	Cu (5)	Mo (5)	Ni (5)	Pb (10)	Sr (100)	V (10)	Zn (200)	Zr (10)
10	15	50	N	7	50	300	100	N	200
10	10	20	N	5	30	300	100	N	300
5	10	20	N	5	30	300	100	N	200
30	20	50	N	10	50	300	100	N	150
20	30	50	7	7	50	500	100	N	200
10	30	50	5	5	50	500	200	N	200
20	30	50	L	10	30	500	100	N	200
10	30	500	N	10	10,000	N	150	5,000	200
7	50	1,000	5	7	20,000	200	100	5,000	100
10	30	500	N	5	7,000	300	100	5,000	150
20	70	70	10	15	5,000	300	100	2,000	150
10	70	500	10	7	7,000	300	100	700	200
10	20	100	N	7	10,000	200	100	2,000	200
20	L	3,000	N	5	> 20,000	N	200	> 10,000	70
7	10	1,500	N	5	> 20,000	200	100	> 10,000	70
5	30	700	5	5	10,000	200	70	> 10,000	100
10	50	2,000	N	7	10,000	150	100	> 10,000	100
20	30	2,000	N	10	15,000	150	200	> 10,000	200
10	70	30	7	30	50	300	150	N	100
20	50	30	N	7	50	500	100	N	150
20	30	20	N	7	30	500	150	N	150
20	30	30	N	7	200	300	150	N	150
20	30	30	N	10	70	500	150	N	200
20	20	20	N	7	70	300	150	N	100
20	30	50	7	10	300	300	150	700	200
20	20	30	N	5	100	500	150	L	150
20	30	30	N	7	150	300	150	L	150
20	30	50	L	7	500	200	100	200	150
20	50	100	5	10	1,000	300	100	2,000	200
10	70	70	5	10	500	300	50	200	150
10	20	30	10	5	150	700	200	N	200
20	30	70	5	7	150	700	150	N	200
20	30	50	5	10	150	700	150	N	700
10	30	30	5	5	200	500	100	N	100
5	10	20	100	5	100	N	100	N	150
N	10	10	L	5	50	300	100	N	200
10	30	30	5	10	50	200	70	N	150
10	30	20	15	5	30	300	100	N	150
20	50	30	10	10	30	700	100	N	150
10	20	30	N	5	30	500	70	N	150
5	70	50	10	5	50	500	150	N	200
10	30	30	10	10	30	500	100	N	200
10	20	50	5	5	30	200	100	N	200
10	50	50	5	10	30	300	100	N	150
10	20	30	5	5	30	N	70	N	150
5	30	30	L	5	N	100	70	N	70
5	30	30	5	5	30	700	70	N	150
5	20	20	L	5	30	200	70	N	150
20	20	50	5	10	150	500	200	L	100
5	20	70	5	5	2,000	100	30	3,000	100
5	10	20	L	5	1,500	100	20	1,500	100
10	20	300	10	7	7,000	100	100	10,000	100
5	10	2,000	15	5	> 20,000	100	10	> 10,000	70
5	15	50	7	5	5,000	100	30	2,000	200
5	15	700	15	5	10,000	N	10	> 10,000	100
5	10	20	L	5	300	N	30	N	300
5	10	70	5	5	5,000	N	30	L	200
5	10	100	L	5	10,000	100	20	300	70
N	10	30	5	5	1,500	100	30	N	200
5	10	50	5	5	3,000	100	50	L	200
10	15	70	30	5	200	500	100	500	100
10	20	30	15	5	500	200	70	L	200
N	15	30	10	5	200	N	10	L	100
N	20	50	20	5	300	100	20	700	100
5	30	30	20	7	20	500	70	N	150
20	30	30	5	10	30	500	100	N	200
20	50	30	5	5	50	500	150	N	200
10	30	30	N	7	70	300	100	N	100

TABLE 6.—*Results of semiquantitative*

Sample	Percent				Parts per million				
	Fe (.05)	Mg (.02)	Ca (.05)	Ti (.002)	Mn (10)	Ag (.5)	As (200)	Ba (20)	Be (1)
69	5	1	.5	.3	700	N	N	700	1
70	5	.2	.7	.5	1,000	N	N	700	1
71	2	.3	.2	.1	5,000	1	N	300	3
72	2	.3	.1	.1	2,000	2	N	300	2
73	5	1	.2	.3	300	1.5	N	> 5,000	1
74	7	1	.2	.5	700	.5	N	1,000	1
75	7	2	.5	.5	1,000	.5	N	1,000	1
76	5	2	.5	.7	1,000	N	N	1,000	1
77	5	2	.5	.7	1,000	.5	N	700	1
78	5	2	1	.5	700	.5	N	700	L
79	5	3	7	.3	2,000	N	N	1,000	1
80	5	3	5	.3	5,000	N	N	1,000	1
81	5	1	.2	.5	500	N	N	1,000	L
82	10	.2	.5	.7	1,000	N	N	1,500	L
83	2	.5	2	.1	500	N	N	700	2
84	5	1	3	.3	1,000	.5	N	1,500	1
85	10	3	5	1	2,000	.5	N	1,000	N
86	7	2	2	.5	1,000	N	N	1,000	1
87	7	2	.5	.7	1,000	1	N	1,000	1
88 14/	10	.5	.1	.2	300	20	N	700	L
89 15/	20	3	10	.1	> 5,000	10	500	700	L
90	10	5	2	1	2,000	.5	N	1,000	1
91	15	5	5	1	2,000	N	N	2,000	L
92	10	3	5	1	2,000	.5	N	2,000	L
93	10	3	5	1	2,000	N	N	2,000	L
94	5	2	1	.5	2,000	1	N	2,000	1
95 16/	7	2	1	.5	2,000	2	N	1,000	1
96 17/	7	.5	.5	.5	700	15	N	500	1
97 18/	7	.1	.2	.5	200	15	N	300	L
98 19/	20	2	5	1	1,500	N	N	1,000	L
99	10	2	5	.5	1,000	N	N	1,000	1
100	10	2	5	1	700	N	N	2,000	1
101	10	1	5	1	2,000	N	N	2,000	1
102 20/	10	1	2	.3	2,000	N	N	1,500	1
103	2	1	2	.3	2,000	N	N	3,000	1
104	2	2	3	.3	1,000	N	N	3,000	1
105	5	3	7	.5	1,000	3	N	3,000	1
106	1	1	2	.2	500	.5	N	500	2
107	3	1	2	.3	5,000	.5	N	1,500	1
108	5	1	3	.7	700	N	N	1,000	1
109	10	2	5	.5	1,000	N	N	1,000	1
110	3	1	.5	.5	200	N	N	1,000	1
111	10	2	.1	1	500	N	N	1,000	1
112	10	1	.2	.7	1,000	N	N	700	1
113	10	1	.5	1	700	N	N	2,000	L
114	3	1	.1	1	500	.5	N	2,000	1
115	10	2	.5	1	1,500	7	N	> 5,000	L
116	10	2	.2	1	1,000	N	N	1,000	L

1/ Besides the elements listed in the table, Au, Bi, Cd, Sb, Sn, and W were looked for. See footnotes. Au and W were not found in any of the samples.
2/ 10 ppm Bi
3/ > 500 ppm Cd
4/ 300 ppm Cd
5/ 70 ppm Cd
6/ 100 ppm Cd
7/ 70 ppm Cd
8/ 10 ppm Bi
9/ 70 ppm Cd
10/ > 500 ppm Cd; 1,500 ppm Sb

Management. In addition, location certificates for several hundred unpatented claims are recorded in the Mineral County courthouse.

Thirty-seven prospect workings were found inside the wilderness — 14 adits, 3 shafts, and 20 pits, cuts, or trenches. In addition, some mines, prospect workings, and outcrops within 3 km (2 mi) of the wilderness boundary were examined, but not all were sampled.

No leases have been issued for oil and gas, coal, or other leasable minerals on lands in or near the wilderness. The nearest known oil and gas fields, the Chromo and Gramps oil fields in Archuleta *spectrographic analyses*—Continued

Parts per million									
Co (5)	Cr (10)	Cu (5)	Mo (5)	Ni (5)	Pb (10)	Sr (100)	V (10)	Zn (200)	Zr (10)
10	20	15	N	7	30	300	300	N	200
10	20	30	5	5	30	300	100	N	150
5	20	10	15	5	70	N	15	N	150
5	20	5	15	5	150	N	15	N	150
5	10	20	20	5	30	500	100	N	150
20	30	20	30	7	30	300	100	N	200
20	30	50	10	7	30	300	100	N	200
20	30	30	L	7	30	300	100	N	200
20	30	30	7	7	30	300	100	N	150
10	30	50	5	5	30	300	100	N	200
20	10	50	N	7	30	700	100	N	150
20	10	20	L	7	30	300	50	N	150
10	10	30	N	5	30	200	150	N	200
20	20	50	N	7	30	200	150	N	200
5	20	5	10	5	70	700	30	N	150
10	20	30	L	5	30	500	100	N	200
20	50	50	N	10	30	700	300	200	200
15	20	50	N	7	30	700	100	N	150
10	30	70	5	5	50	100	150	N	500
5	30	70	10	5	50	100	100	N	200
10	30	200	10	5	1,500	150	70	1,000	100
20	30	70	N	20	70	100	200	200	500
30	50	100	N	20	50	300	500	N	1,000
20	70	70	5	10	500	1,000	200	N	500
20	50	70	5	10	70	700	200	N	500
10	20	70	5	5	50	100	30	N	200
10	20	70	15	10	100	100	100	200	500
5	20	100	20	5	700	200	150	300	200
5	20	150	15	5	500	100	100	N	150
30	100	50	N	20	30	700	500	300	500
20	20	30	N	10	50	700	150	N	200
20	20	70	N	10	100	1,000	200	N	500
30	50	70	5	30	100	1,000	200	N	500
5	10	50	20	5	5,000	300	200	500	200
5	10	30	L	5	70	300	30	N	200
5	10	10	L	5	50	500	30	N	200
15	20	500	L	5	50	700	100	N	200
5	30	10	N	5	30	100	30	N	100
10	10	30	L	5	50	300	50	N	200
10	20	30	N	5	50	700	100	N	100
20	20	30	N	7	50	700	100	N	200
5	10	10	L	5	30	200	100	N	200
5	20	30	N	5	50	500	150	N	200
10	30	20	N	5	30	300	200	N	200
5	70	30	N	5	50	500	200	N	200
5	20	30	L	5	300	500	200	N	200
10	20	100	5	5	1,500	700	200	N	200
20	20	50	5	5	30	500	200	N	200

11/ 70 ppm Cd; 500 ppm Sb
12/ 100 ppm Sb
13/ 300 ppm Sb
14/ 70 ppm Bi
15/ 10 ppm Bi
16/ 10 ppm Bi
17/ 10 ppm Bi
18/ L Bi
19/ 10 ppm Sn
20/ 10 ppm Bi, 10 ppm Sn

County, are 90–100 km (55–65 mi) south of the wilderness. The nearest known coal field, the Tongue Mesa field in Ouray, Montrose, and Gunnison Counties, is 65 km (40 mi) northwest of the wilderness. No other deposits of other leasable minerals (potassium, phosphate, sodium, oil shale, and tar sands) are known within 160 km (100 mi) of the wilderness.

Deposits of sand and gravel within the wilderness are too remote and too small to have commercial importance; similarly, rock for construction purposes is too remote to be quarried economically.

TABLE 7.—*Results of fire assaying and chemical analyses*

[Analyses by Charles O. Parker and Co., commercial assayers, Denver, Colo., and U.S. Bureau of Mines, Reno Metallurgical Research Center, Reno, Nev. For sample localities, see plate 2. < indicates less than the quantity shown after the symbol; Tr, trace; and . . . ., not determined]

Sample	Fire Assaying troy oz./ton [1]		Chemical Analysis Percent				Location	Type of Sample
	Au	Ag	Cu	Pb	Zn	Others		
1	0.005	0.06	---	---	---	---	Shaft dump	Grab (5-ft. intervals)
2	.005	.42	---	---	---	---	Pit dump	Grab (3-ft. intervals)
3	.005	Tr	---	---	---	---	Pit dump	Grab (3-ft. intervals)
4	.005	.26	---	---	---	0.023 Bi	Pit (face of hillside)	Chip (5 ft.)
5	.005	.40	---	---	---	---	Pit dump	Grab (5-ft.intervals)
6	.005	.18	---	---	---	---	Pit dump	Grab (5-ft.intervals)
7	.005	.04	---	---	---	---	Pit dump	Grab (3-ft. intervals)
8	.005	.20	0.060	0.96	1.04	---	Adit (inside)	Chip (10 in.)
9	.005	.40	.065	1.02	0.60	18.3 CaF_2	Adit (inside)	Chip (2 ft.)
10	.005	.24	.020	.86	1.01	---	Adit (inside)	Chip (5 ft.)
11	.005	.16	---	.16	.11	---	Adit (face)	Chip (18 in.)
12	.005	Tr	.015	.20	.05	---	Adit (inside)	Chip (2 ft.)
13	.01	.12	.025	.26	.10	1.30 Mn	Adit (inside)	Chip (12 ft.)
14	.005	.80	.320	9.30	14.65	26.8 CaF_2; 0.067 Cd	Adit (inside)	Chip (3 in.)
15	.005	.46	.175	.86	4.65	17.7 CaF_2; 0.023 Cd	Adit (inside)	Chip (2½ ft.)
16	.005	.08	.050	.56	1.83	.006 Cd	Adit (inside)	Chip (5 ft.)
17	.005	.26	.120	.96	2.22	.016 Cd	Adit (inside)	Chip (2 ft.)
18	.005	.20	.110	.92	1.46	.004 Cd	Adit (face)	Grab (handful)
19	.01	.10	---	---	---	---	Pit dump	Grab (3-ft. intervals)
20	Tr	.16	---	---	---	---	Adit dump	Grab (5-ft. intervals)
21	Tr	.30	---	---	---	---	Adit dump	Grab (7-ft. intervals)
22	Tr	.06	---	---	---	---	Pit dump	Grab (2-ft. intervals)
23	Tr	Tr	---	---	---	---	Trench dump	Grab (5-ft. intervals)
24	Tr	Tr	---	---	---	---	Pit dump	Grab (2-ft. intervals)
25	Tr	.20	---	---	---	---	Shaft dump	Grab (5-ft. intervals)
26	.005	.30	---	---	---	---	Pit dump	Grab (3-ft. intervals)
27	.005	.30	---	---	---	---	Pit dump	Grab (3-ft. intervals)
28	.005	.06	---	---	---	---	Adit (portal)	Chip (2 ft.)
29	.005	.12	.025	.06	.12	---	Adit dump	Grab (2-ft. intervals)
30	.005	.06	---	---	---	---	Adit dump	Grab (3-ft. intervals)
31	.008	.10	---	---	---	---	Pit dump	Grab (3-ft. intervals)
32	.01	.10	---	---	---	---	Adit (portal)	Chip (5 ft.)
33	.005	.12	---	---	---	---	Adit dump	Grab (3-ft. intervals)
34	.01	.30	---	---	---	---	Adit dump	Grab (5-ft. intervals)
35	Tr	.30	---	---	---	< .002 Bi; 0.009 Mo	Pit dump	Grab (1-ft. intervals)

36	Tr	.10	---	---	---	---	Pit dump	Grab (1-ft. intervals)
37	Tr	.50	---	---	---	---	Pit dump	Grab (3-ft. intervals)
38	Tr	.22	---	---	---	---	Adit and pit dump	Grab (3-ft. intervals)
39	Tr	.10	---	---	---	---	Shaft dump	Grab (3-ft. intervals)
40	Tr	.28	---	---	---	---	Pit (floor)	Chip (8 ft.)
41	.01	.22	---	---	---	---	Adit (portal)	Chip (4 ft.)
42	.01	.24	---	---	---	---	Adit (portal)	Chip (2 ft.)
43	.005	.42	---	---	---	---	Adit dump	Grab (2-ft. intervals)
44	.01	Tr	---	---	---	---	Pit (floor)	Chip (5 ft.)
45	Tr	.28	---	---	---	---	Adit (portal)	Chip (15 ft.)
46	Tr	.50	---	---	---	---	Pit dump	Grab (3-ft. intervals)
47	.005	.28	---	---	---	---	Outcrop	Chip (18 ft.)
48	.02	.12	---	---	---	---	Outcrop	Chip (20 ft.)
49	.005	.26	---	---	---	---	Pit dump	Grab (4-ft. intervals)
50	.005	.70	---	.08	.07	---	Pit dump	Grab (4-ft. intervals)
51	.01	1.74	---	.08	.06	---	Pit dump	Grab (4-ft. intervals)
52	.01	.80	.050	.50	.81	.056 As; 0.003 Cd; 0.36 Mn	Pit dump	Grab (4-ft. intervals)
53	.01	42.90	.130	8.60	12.30	.003 As; 0.052 Cd; 0.093 Sb	Adit (inside)	Chip (5 in.)
54	.00	.08	---	1.04	.05	.017 As	Adit dump	Grab (6-ft. intervals)
55	.00	.30	.040	.18	.08	.018 As; 0.003 Cd; 0.022 Sb	Adit dump	Grab (3-ft. intervals)
56	.00	.50	---	---	---	---	Adit dump	Grab (8-ft. intervals)
57	.01	3.60	---	1.44	---	.003 Sb	Adit dump	Grab (8-ft. intervals)
58	.01	21.30	.030	.48	.10	.037 As; 0.017 Sb	Adit dump	Grab (1-ft. intervals)
59	Tr	.60	---	.12	---	---	Adit dump	Grab (5-ft. intervals)
60	Tr	3.40	---	.20	---	.031 As	Adit dump	Grab (5-ft. intervals)
61	Tr	2.80	---	---	---	.062 As; 3.50 Mn	Adit (face)	Chip (2 ft.)
62	Tr	.70	---	---	---	.140 As; 0.90 Mn	Adit dump	Grab (5-ft. intervals)
63	.005	.30	---	---	---	.009 As	Pit (face of hillside)	Chip (3 ft.)
64	.005	.80	---	---	---	.029 As; 0.61 Ba; 0.90 Mn	Pit (face of hillside)	Chip (8 in.)
65	.01	.28	---	---	---	---	Adit dump	Grab (5-ft. intervals)
66	.01	.10	---	---	---	---	Pit dump	Grab (5-ft. intervals)
67	.005	.50	---	---	---	---	Adit dump	Grab (3-ft. intervals)
68	.005	.10	---	---	---	---	Pit dump	Grab (2-ft. intervals)
69	.005	1.44	---	---	---	---	Pit dump	Grab (2-ft. intervals)
70	Tr	.26	---	---	---	---	Pit dump	Grab (3-ft. intervals)
71	.005	.10	---	---	---	---	Adit dump	Grab (3-ft. intervals)
72	.005	.20	---	---	---	---	Adit (portal)	Chip (2 ft.)
73	.005	.08	---	---	---	1.6 Ba	Adit (inside)	Chip (1 ft.)
74	.005	.14	---	---	---	---	Adit dump	Grab (5-ft. intervals)
75	.005	.22	---	---	---	---	Pit dump	Grab (3-ft. intervals)
76	.01	.10	---	---	---	---	Pit (floor)	Chip (4 ft.)
77	.005	.10	---	---	---	---	Pit dump	Grab (5-ft. intervals)
78	.005	.30	---	---	---	---	Adit dump	Grab (5-ft. intervals)
79	.005	Tr	---	---	---	---	Adit dump	Grab (3-ft. intervals)
80	.005	.10	---	---	---	---	Adit (portal)	Chip (5 ft.)
81	.005	.06	---	---	---	---	Shaft dump	Grab (5-ft. intervals)

TABLE 7.—*Results of fire assaying and chemical analyses*—Continued

Sample	Fire Assaying troy oz./ton[1]		Chemical Analysis Percent				Location	Type of Sample
	Au	Ag	Cu	Pb	Zn	Others		
82	0.005	0.46	---	---	---	---	Pit (face of hillside)	Chip (5 ft.)
83	.005	.10	---	---	---	---	Pit dump	Grab (2-ft. intervals)
84	.02	.20	---	---	---	---	Outcrop	Chip (2 ft.)
85	---	---	---	---	---	---	Stream (sediments)	Grab (handful)
86	.005	.18	---	---	---	---	Trench (North wall)	Chip (2 ft.)
87	.01	.28	---	---	---	---	Adit dump	Grab (10-ft. intervals)
88	.02	.58	---	---	---	0.009 Bi 0.57 Mn	Adit dump	Grab (10-ft. intervals)
89	.02	.10	0.015	0.04	0.08	1.20 CaF_2; 0.024 As;/0.008 Bi;	Adit dump	Grab (2-ft. intervals)
90	.005	Tr	---	---	---	---	Adit (portal)	Chip (2 ft.)
91	.005	.38	.055	---	---	.04 V	Adit (portal)	Chip (6 ft.)
92	.01	.30	---	---	---	.09 Sr; 0.003 Y	Adit dump	Grab (5-ft. intervals)
93	.01	.30	---	---	---	---	Adit dump	Grab (5-ft. intervals)
94	.01	Tr	---	---	---	---	Adit dump	Grab (5-ft. intervals)
95	.01	Tr	---	---	---	< .002 Bi	Adit dump	Grab (10-ft. intervals)
96	Tr	.06	.025	---	---	< .002 Bi	Shaft dump	Grab (6-ft. intervals)
97	.005	.26	.010	---	---	---	Shaft dump	Grab (specimens)
98	.005	.26	---	---	---	.009 Sn; 0.008 V	Stream (gravel)	Panned concentrate
99	---	---	---	---	---	---	Stream (sediments)	Grab (handful)
100	.005	.24	---	---	---	.10 Sr.	Pit (face of hillside)	Chip (15 ft.)
101	.005	.36	---	---	---	.10 Sr.	Outcrop	Chip (7 ft.)
102	.005	.12	---	.14	---	.025 Bi; 0.009 Sn	Pit dump	Grab (2-ft. intervals)
103	.01	.10	---	---	---	---	Outcrop	Chip (3 ft.)
104	.01	.20	---	---	---	---	Outcrop	Chip (3 ft.)
105	.01	.03	.030	---	---	---	Outcrop	Chip (3 ft.)
106	---	---	---	---	---	---	Stream (sediments)	Grab (handful)
107	.005	Tr	---	---	---	3.2 Fe; 0.34 Mn	Alluvium deposit	Grab (10-ft. intervals)
108	.005	.24	---	---	---	---	Pit (floor)	Grab (2-ft. intervals)
109	.01	Tr	---	---	---	---	Pit (wall)	Grab (3-ft. intervals)
110	.01	.24	---	---	---	---	Pit (dump	Grab (1½-ft. intervals)
111	Tr	Tr	---	---	---	---	Pit dump	Grab (3-ft. intervals)
112	.005	.32	---	---	---	---	Pit dump	Grab (2-ft. intervals)
113	Tr	.34	---	---	---	---	Pit dump	Grab (2-ft. intervals)
114	Tr	Tr	---	---	---	---	Pit dump	Grab (5-ft. intervals)
115	Tr	.20	.030	.36	---	.67 Ba	Pit dump	Grab (3-ft. intervals)
116	---	---	---	---	---	---	Stream (sediments)	Grab (handful)

[1]1 oz/ton = 34.3 ppm.

Some of the volcanic rocks may have value for decorative use, but such rocks are abundant outside the wilderness, where they could be acquired at a substantially lower cost.

The nearest known nonmetallic mineral deposit of any significance is a perlite deposit along Spring Creek about 5 km (3 mi) north of the wilderness boundary. Two groups of placer claims cover the deposit — Perly Nos. 1–4, located in 1947, and the Cathedral Nos. 1–3, located in 1952. Perlite crops out for several hundred feet along both sides of the creek at this point, and a substantial quantity seems indicated. Drilling and additional sampling would be necessary to establish the quantity. Chemical analysis (table 8) of a 45-kg (100-pound) chip sample taken along the west side of the creek showed that the perlite is comparable in composition with commercially exploited perlites, but additional testing for expandability and for specific uses would be necessary to determine its economic value. The remoteness of this deposit presently makes it less attractive for economic development than more favorably situated deposits.

TABLE 8.—*Chemical analysis of perlite sample*

[Analysis by U.S. Geological Survey, Denver, Colo.]

Chemical component	Percent	Chemical component	Percent	Chemical component	Percent
SiO_2	72.4	CaO	0.72	TiO_2	0.14
Al_2O_3	12.5	Na_2O	3.5	P_2O_5	.03
Fe_2O_3	.62	K_2O	4.3	MnO	.09
FeO	.44	H_2O^+	4.0	CO_2	<.05
MgO	.20	H_2O^-	.30	Total	99

CASCADE CREEK

The largest and most extensive concentration of prospect workings in the La Garita Wilderness is along Cascade Creek (pl. 2; figs. 2, 3). Twenty prospects were examined; all but seven are on Cascade Creek, near the northwest boundary of the wilderness.

A caved timbered shaft, on the Continental Divide near the head of the east fork of Cascade Creek, was sunk in the quartz latite of Baldy Cinco. Based on the size of the dump (estimated 70 t, 75 tons), the two-compartment shaft was probably less than 10 m (30 ft) deep. Analysis of a grab sample from the dump (No. 1, tables 6, 7) did not reveal economically significant metal concentrations.

On the ridge between the east and west forks of Cascade Creek are two small prospect pits about 153 m (500 ft) apart. The northern pit is 4.6 m (15 ft) in diameter and 1.2 m (4 ft) in depth, and the southern pit is 6 m (20 ft) in diameter and 0.6 (2 ft) in depth. Samples (Nos. 2 and 3, tables 6, 7) of each dump around the pits contained no economically significant metal values.

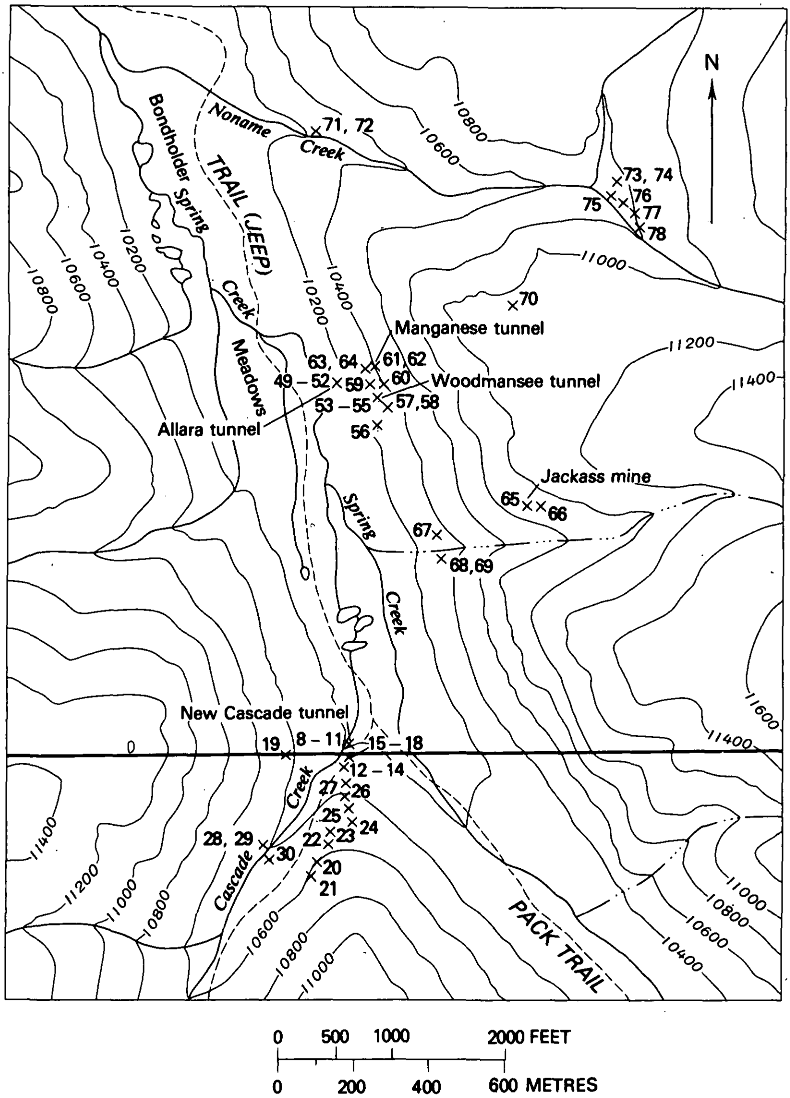

FIGURE 2.—Spring Creek–Cascade Creek area, showing U.S. Bureau of Mines sample localities.

A small pit is dug into the steep hillside 15 m (50 ft) below the crest, on the east side of the north end of the mountain between Cascade and Spring Creeks. Chip sample (No. 4) was taken across a 1.5-m-(5-ft)-wide face of densely welded tuff, cut by quartz veinlets and some gouge material. The veinlets strike S. 70° E. and dip vertically. Analysis of the sample (tables 6, 7) showed a minor amount of silver (0.26 oz/ ton, 8.9 ppm) and bismuth (0.023 percent).

West of Cascade Creek near the junction of the east and west forks are three small prospect pits that expose Nelson Mountain Tuff and

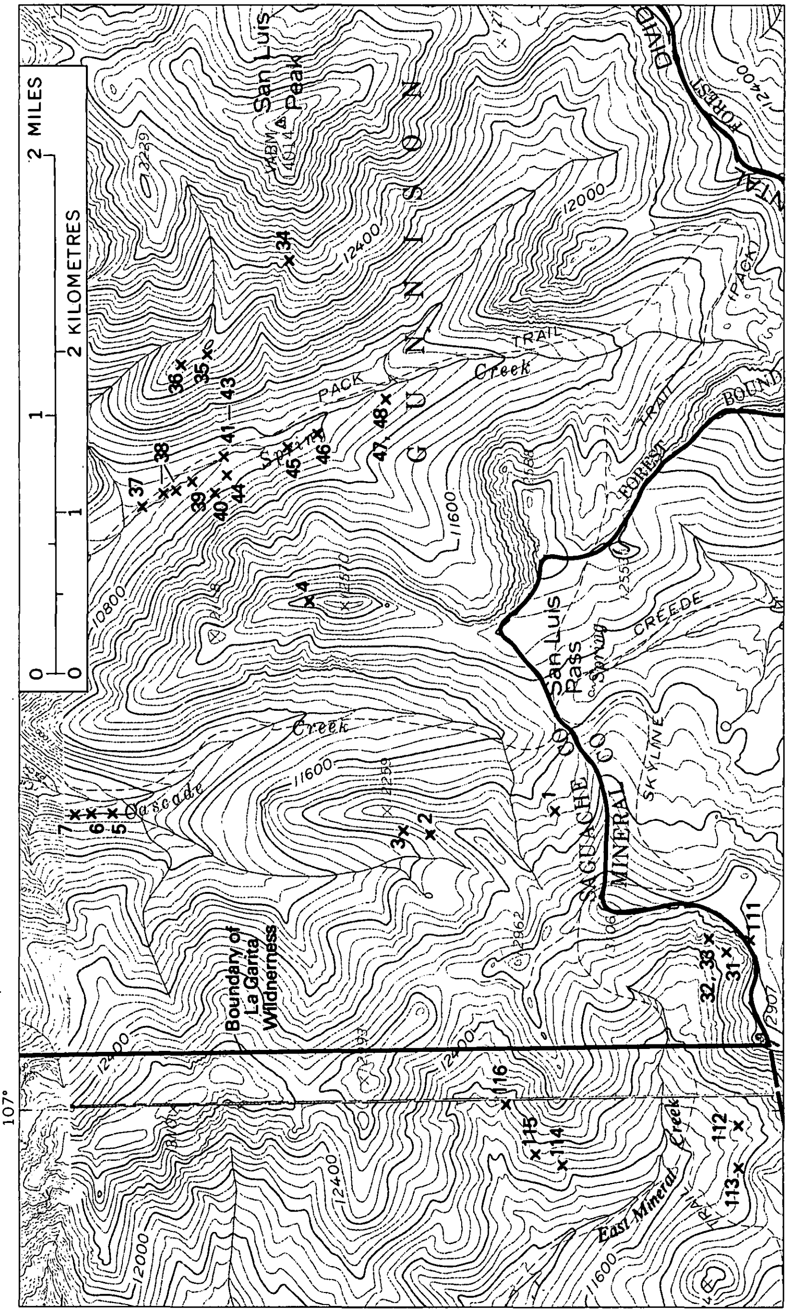

FIGURE 3.—Western part of La Garita Wilderness, showing U.S. Bureau of Mines sample localities. Base from plate 1.

some intrusive monzonite. Samples (Nos. 5, 6, and 7, tables 6, 7) of rock from the dumps contained no mineral value.

Three adits were driven in Nelson Mountain Tuff near the mouth of Cascade Creek canyon; these workings are on the northern boundary of the wilderness. (See inset map, pl. 2, samples 8–18.) The localities from which the samples were taken inside these adits are shown in figure 4.

The lower adit, called the New Cascade tunnel, is about 60 m (200 ft) long. Figure 5 is a photograph of the portal. The adit, started in 1968 by Bonnez Mining Co., was driven about 37 m (120 ft) during that year and was extended 25 m (80 ft) in 1970. The purpose of the work was to explore the ground below the two old adits southwest of the New Cascade tunnel.

Four chip samples were taken inside the lower adit (New Cascade tunnel). Sample 8 (figs 2, 4) was taken in the back across a 0.25-m (10-in.) gouge zone 23 m (75 ft) from the portal; pyrite was visible in the gouge. Sample 9 was taken in the back across a 0.6-m (2-ft) alteration zone 34 m (110 ft) from the portal, and sample 10 was taken in the back across another alteration zone 6 m (18 ft) from the end of the adit. Galena, sphalerite, and quartz were visible in the two altered zones. Sample 11 was taken at the junction of the two fracture zones 0.6 m (2 ft) above the floor in the face at the end of the adit. The sample width was 0.46 m (18 in.) and consisted of shattered rock showing some mineralization.

The two other adits above the New Cascade tunnel also were sampled (figs. 2, 4). The upper adit is 18 m (60 ft) long; a winze 8 m (25 ft) from the portal was filled with water. A 0.6-m (2-ft) chip sample (No. 12) was taken in the back 3 m (10 ft) from the portal, across a poorly defined intensely silicified area containing some visible galena and sphalerite. A chip sample (No. 13) was taken 17 m (55 ft) from the portal near the winze. This area was silicified and the mineralized structure is not well defined, but some fracturing was noted. The sample was taken diagonally in the back over a distance of 4m (12 ft). Six metres (20 ft) beyond the winze, a chip sample (No. 14) was taken across a 76 mm (3 in.) wide, highly mineralized vein exposed near the top of the west rib. Clay, quartz, galena, and sphalerite were visible in this vein.

Analyses of samples 12 and 13 (tables 6, 7) did not reveal elements of economic importance. The analysis of sample 14 indicated 0.80 ounce of silver per ton (27 ppm), 0.32 percent copper, 9.3 percent lead, 14.65 percent zinc, 26.8 percent calcium fluoride, and 0.067 percent cadmium; this high-grade sample, however, represents a vein only 76 mm (3 in.) wide. Other quartz veins seen in the vicinity of Cascade and Spring Creeks were narrow and discontinuous.

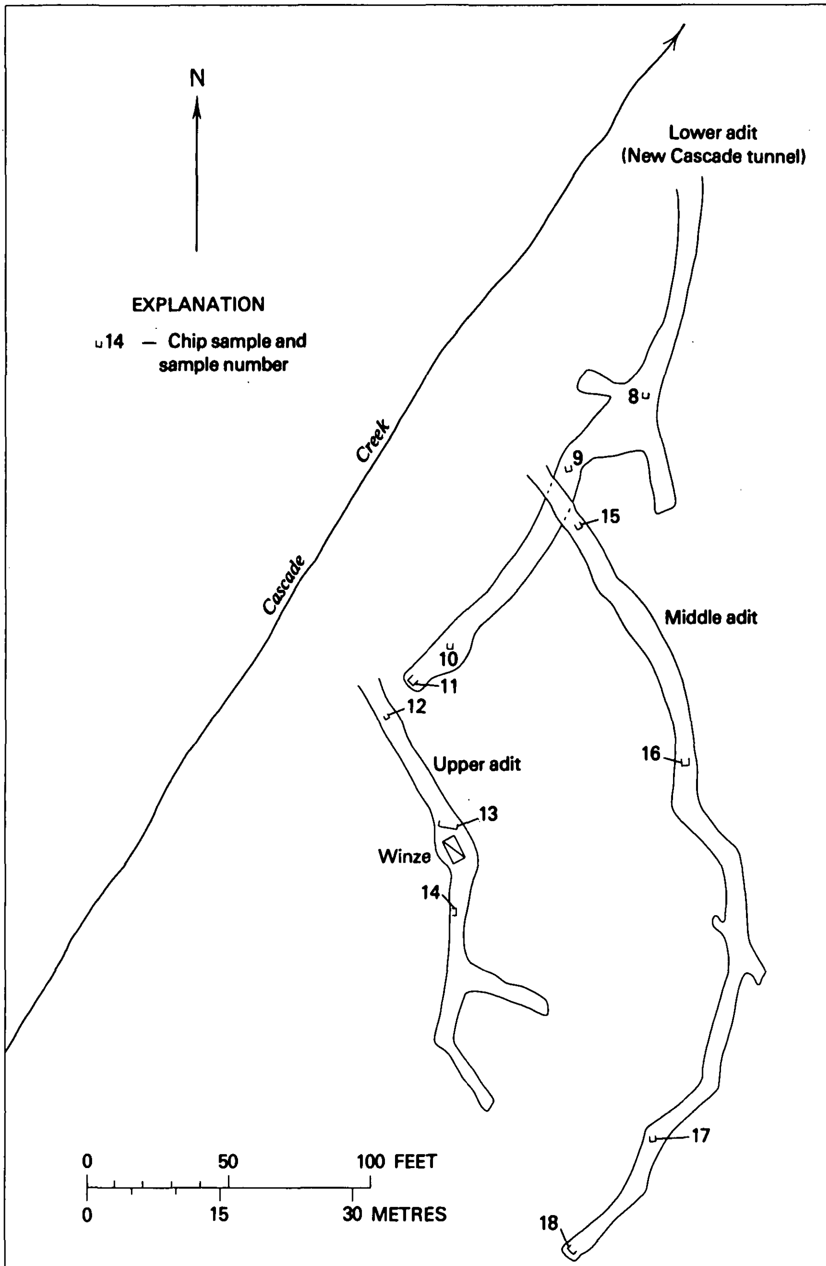

FIGURE 4.—Main prospect workings on Cascade Creek. Modified from map of John R. Jackson, Creede, Colo., and published with his permission.

The middle adit, which is between the lower and upper adits, is about 100 m (300 ft) long and follows curving, braided fracture zones. The first half of the adit exposes a silicified zone containing visible galena and sphalerite. Two chip samples were taken across the back in this zone (figs. 2, 4). One (No. 15) was 0.8 m (2.5 ft) long, taken 8 m (25 ft) from the portal, and the other (No. 16) was 1.5 m (5 ft) long, taken 34 m (110 ft) from the portal. Another chip sample (No. 17) was taken in the back across a 0.6-m (2-ft), highly silicified fracture zone 15 m (50 ft) from the end of the adit. A light-gray mud (clay) was oozing from a fracture at the end of the adit; a sample (No. 18) 1 m (3 ft) long was taken across the mud flow.

Sample 15 (tables 6, 7) contained 4.65 percent zinc, 17.7 percent calcium fluoride, and 0.23 percent cadmium. Samples 17 and 18 contained 2.22 and 1.46 percent lead respectively.

Across the creek from the three main adits, a prospect pit 4.6 m (15 ft) by 1.5 m (5 ft), and 0.6 m (2 ft) deep was dug in Nelson Mountain Tuff ; the pit is about 68 m (250 ft) higher in elevation than the adits. A sample (No. 19, fig. 2) from the dump (estimated 4.5 t, 5 tons) contained no minerals of economic significance.

Two caved adits, a timbered shaft about 8 m (20 ft) deep, four pits, and one trench are above the three main adits on the east side of the

FIGURE 5.—Portal of lower adit (New Cascade tunnel) of main prospect workings on Cascade Creek. Photo taken in 1971.

Cascade Creek trail. Samples (Nos. 20-27, tables 6, 7; fig. 2) were taken of the dumps. Five of the samples contained small quantities of silver (0.30 oz/ton, 10 ppm or less), but no other metals in significant quantities.

Two prospect workings, one on each bank of the creek, were dug in Nelson Mountain Tuff about 300 m (1,000 ft) upstream from the three main adits. A small adit, 8 m (25 ft) long and on the west bank, explored a 0.6-m (2-ft) vein striking N. 80° W. and dipping 70° N., which is exposed above the portal on the south side of the stream. A chip sample (No. 28, fig. 2), taken across the vein, did not contain minerals of economic interest. Most of the dump was washed away by Cascade Creek long ago, but a few remaining mineralized fragments (sample 29) contained minor quantities (less than 0.15 percent) of copper, lead, and zinc, and a very small amount (0.12 oz/ton, 4 ppm) of silver. An obscure caved working on the south bank about 3 m (10 ft) above Cascade Creek may have been the start of an adit. Grab sample (No. 30) of the dump contained no mineral concentrations of economic interest.

CONTINENTAL DIVIDE

Two prospects in quartz latite of Baldy Cinco are situated on the Continental Divide about 1.6 km (1 mi) southwest of San Luis Pass (fig. 3). The western working is a pit 6 m (20 ft) long, 2.5 m (8 ft) wide, and 1.5 m (5 ft) deep; sample 31 of the small dump contained no mineral concentrations of economic significance. The eastern working was the start of an adit. Neither a 1.5-m (5-ft) chip sample (No. 32) taken above the portal nor a sample (No. 33) of the small dump contained minerals of economic importance.

UPPER SPRING CREEK

Seven prospect pits, one shaft, and four adits were examined near Spring Creek, about midway between the north and south boundaries of the wilderness (fig. 3). The work may have been done in the 1890's and early 1900's, but no claims were found that covered these workings. The pits were small, less than 1.5 m (5 ft) deep, and the shaft was caved 3 m (10 ft) below the collar. From the size of the dump, the shaft is judged to have been about 7 m (20 ft) deep. Three of the adits were caved; the fourth was partly caved at the portal and the inside contained 0.6 m (2 ft) of standing water.

Except for sample 44 (tables 6, 7), which assayed a trace, all samples (Nos. 34–46) taken at the prospect workings contained from 0.10 to 0.50 ounce of silver per ton (3–17 ppm). A chemical analysis of sample 35, which was taken from a dump at a prospect pit on a northwest ridge of San Luis Peak, showed 0.009 percent molybdenum and less than 0.002 percent bismuth. The adit is about 460 m (1,500 ft) below and almost due west of the summit of San Luis Peak, and is partly filled with water. The adit may be on one of several claims located in 1892 and 1893 in this vicinity. About 180 m (600 ft) below the portal and just below timberline are the remains of an old log cabin which was used as living quarters by the prospectors. According to John R. Jackson, of Bonnez Mining Co., the adit is about 53 m (175 ft) long. The portal is in highly altered rock. The dump outside of the portal is small, as most of the mined rock had fallen or been washed down the steep slope below the portal. Grab sample 34 was taken from dump material near the portal and from what could be found on the steep slope 23 m (75 ft) below. The sample was mostly altered tuff; specks of galena were visible but not abundant. The sample assayed 0.30 ounce of silver per ton (10 ppm).

An altered monzonite dike is exposed on the west bank of Spring Creek about 0.2 km (660 ft) below the junction of the east and west forks. Two adjacent chip samples (Nos. 47, 48) were taken across the exposure for a total length of 11 m (38 ft). The samples contained 0.005 and 0.02 ounces of gold per ton, respectively.

SPRING CREEK-BONDHOLDER MEADOWS

North of the wilderness, Spring Creek is flanked by a large flat area called Bondholder Meadows (pl. 2; fig. 2). An adit known as the Allara tunnel was driven into a rhyolite flow unit that forms the east wall of the valley about 1.2 km (0.75 mi) outside the north boundary of the wilderness. This adit, 200 m (650 ft) long, was driven in 1966 and 1967 by Bonnez Mining Co. to explore the ground below old workings on the hillside above. Additional exploration work was done in the fall of 1971 when a 40-m (130-ft) drift was driven north from the Allara tunnel about 100 m (320 ft) from the portal, and a diamond-drill hole 60 m (203 ft) long was drilled east from the face at the end of the main adit. The operator stated that silver, copper, lead, and zinc values were obtained in a fault zone encountered at the end of the exploration drift. Nothing of significant value was found by the diamond drilling, but the contact between the rhyolite flow exposed in the tunnel and the overlying welded tuff was encountered 37 m (122 ft) from the collar of the hole.

The Allara tunnel dump, estimated to contain 4,500 t (5,000 tons) of rock, was sampled at four places. The dump has the appearance of four stubby fingers. The samples from the most northern finger consisted of quartz latite from a dike approximately 15 m (50 ft) wide that was cut by the adit about 116 m (380 ft) from the portal. Analysis of a grab sample (No. 49) of this dump rock showed that, except for a minor amount of silver, the dike is barren of mineral values (tables 6, 7). The other three fingers of the dump consist of altered rhyolite. Grab samples (Nos. 50, 51) contained minor amounts of silver, and small quantities of lead and zinc. Grab sample 52, from the second dump finger from the north, contained small quantities of silver, copper, lead, zinc, and manganese, and anomalous quantities of arsenic and cadmium. Most of these values probably came from the many quartz veinlets that were cut by the adit.

One small pit and six adits were examined 60–90 m (200–300 ft) above the Allara tunnel; these old prospect workings probably date back to the early 1900's. The most extensive working is an adit known as the Woodmansee tunnel (fig. 2). This adit, driven around 1915, extends north for about 170 m (600 ft). A chip sample (No. 53) taken across a 13-cm (5-in) quartz vein assayed 42.90 ounces of silver per ton (1,430 ppm), and 0.01 ounce of gold per ton (0.34 ppm); chemical analysis showed 0.130 percent copper, 8.60 percent lead, 12.30 percent zinc, 0.003 percent arsenic, 0.052 percent cadmium, and 0.093 percent antimony. The vein strikes N. 20° E. and dips 60° SE., and is exposed in the floor of the adit at a winze located about 120 m (400 ft) from the portal. A grab sample (No. 54) of the dump (estimated 2,700 t, 3,000 tons) and sample 55 contain small quantities of silver, lead, zinc, and arsenic (tables 7, 8). Sample 55, of welded tuff containing quartz veinlets with showings of galena and sphalerite, also contains anomalous quantities of arsenic, cadmium, and antimony. Although it is possible that some ore-grade material was mined, no mineral production has been recorded from this vicinity.

A caved adit is 60 m (200 ft) southeast and 30 m (100 ft) below the Woodmansee tunnel. The dump consists of rhyolite. A grab sample (No. 56) of the dump (estimated 360 t, 400 tons) contained 0.50 ounce of silver per ton (17 ppm) but no other metals of economic value.

About 30 m (100 ft) above and east of the Woodmansee tunnel is a small adit 30 m (100 ft) long. The dump (estimated 135 t, 150 tons) consists of rhyolite. A grab sample (No. 57), taken every 2.5 m (8 ft) down the steep dump, contained a significant amount of silver (3.60 oz/ton, 123 ppm) and some lead and antimony (tables 6, 7). Analysis of a grab sample (No. 58) of a "high-grade" pile showed a high silver content (21.30 oz/ton, 710 ppm), small quantities of copper, lead, and zinc, and anomalous quantities of arsenic and antimony.

Grab samples (Nos. 59, 60) were taken of the dumps of two adits located about 30 m (100 ft) northwest of the Woodmansee tunnel. The dumps are composed of rhyolite. The sample (No. 59) of the dump (estimated 230 t, 250 tons) of the lower adit near an old log cabin contained a small amount of silver and lead (tables 6, 7). The sample (No. 60) of the dump (estimated 180 t, 200 tons) of the upper adit contained a significant amount of silver (3.40 oz/ton, 117 ppm), a small amount of lead, and an anomalous amount of arsenic.

A small 10-m (30-ft) adit called the Manganese tunnel is located about 120 m (350 ft) northwest of the Woodmansee tunnel (fig. 2). A

0.6-m (2-ft) chip sample (No. 61) was taken across a vein exposed in the face; the vein strikes N. 25° E. and is nearly vertical. The sample contained 2.80 ounces of silver per ton (96 ppm); 3.50 percent manganese, and 0.062 percent arsenic. A grab sample (No. 62) of the dump contained 0.70 ounce of silver per ton (23.3 ppm), 0.90 percent manganese, and 0.14 percent arsenic. Above the Manganese tunnel is a small cut into the hillside, 5 m (16 ft) long and 1.5 m (5 ft) wide. Exposed in the right side of the 3-m (10-ft) face is a nearly vertical vein, 1 m (3 ft) wide, that strikes N. 54° E. A chip sample (No. 63) across the vein contained a small amount of silver and some arsenic (tables 6, 7). A chip sample (No. 64), taken 8 cm (3 in.) across the gouge part of the vein, contained small amounts of silver and manganese, and anomalous quantities of arsenic and barium (tables 6, 7).

About 0.5 km (0.3 mi) southeast and 200 m (600 ft) above the Woodmansee tunnel is an adit called the Jackass mine by John R. Jackson of Bonnez Mining Co. Although the adit is caved at the portal, it probably was less than 15 m (50 ft) long, judging from the amount of the rock in the scattered dump. East of the portal is a cut, 7 m (20 ft) long, into the hillside. The dumps of the adit and cut consist of Nelson Mountain Tuff. A grab sample (No. 65; fig. 2) of the adit dump and (No. 66) of dump material by the cut contained insignificant metal values (tables 6, 7).

About 0.5 km (0.3 mi.) south of the Allara tunnel and 60 m (200 ft) above the valley floor, a small east-trending gulch on the east side of Bondholder Meadows contains several small prospect workings in rhyolite. A small adit 3.0 m (10 ft) long extends into the hillside on the north side of the gulch; a grab sample (No. 67, fig. 2) taken of the dump contained nothing of economic significance. On the south side of the gulch are two small pits. A grab sample (No. 68) of the dump (estimated 1 t, 1 ton) by the upper pit assayed 0.10 ounce of silver per ton (3.3 ppm) and a grab sample (No. 69) of the dump (estimated 2 t, 2 tons) at the lower pit assayed 1.4 ounces of silver per ton (46.6 ppm).

About 280 m (900 ft) above and northeasterly from the Allara tunnel is a prospect pit 5 m (17 ft) long and 2 m (6 ft) wide in Nelson Mountain Tuff. A grab sample (No. 70, fig. 2) of the dump assayed 0.26 ounce of silver per ton (9 ppm).

NONAME CREEK

"Noname" is the designation for a small unnamed creek that enters Spring Creek from the east at the northern end of Bondholder Meadows (fig. 2). About 300 m (1,000 ft) upstream from where Noname Creek enters Bondholder Meadows, there is a caved adit on the north bank of the creek. Judged from the size of the dump (estimated 27 t, 30 tons), it is doubtful that the adit was more than 8 m (25 ft) long. A grab sample (No. 71) was taken of rhyolite in the dump, and a 0.6-m (2-ft) chip sample (No. 72) was taken across a vein that strikes N. 25° E. and dips 65° SE, and that is exposed over the portal. Neither sample contains metals of economic importance (tables 6, 7).

Two adits and three small pits are located 0.8 km (0.5 mi) farther upstream, just east and above the junction of two branches of the creek. Analyses of samples (Nos. 74, 75, 77, and 78, fig. 2), taken from the dumps at the two adits and at two of the three pits, showed a minor quantity of silver (0.14–0.30 oz/ton, 5–10 ppm; tables 6, 7). A chip sample (No. 73) of a vein exposed at the portal of a small inclined adit contained 1.6 percent barium, but contained no other elements in anomalous quantities. A chip sample 1.2 m (4 ft) long (No. 76) was taken in the floor of a small pit dug into the hillside. The analysis showed no significant metal concentration.

SHEEP CREEK

Some prospect workings are along Sheep Creek, a small tributary of Spring Creek near the northwest part of the La Garita Wilderness (pl. 2). About 1.6 km (1 mi) from the junction with Spring Creek, on the north bank, is a barely discernible caved adit; most of the dump has been washed away. A grab sample (No. 79) was taken of the remaining dump (estimated 3 t, 3 tons), which consists of Nelson Mountain Tuff. A 1.5-m (5-ft) chip sample (No. 80) was taken above the portal across a nearly vertical fracture zone that strikes N. 42° W. Neither sample contains metal concentrations of economic significance.

A caved shaft and the remains of a log cabin are about 1.6 km (1 mi.) farther upstream on the south bank. A grab sample (No. 81) of the dump by the shaft contained no significant metal concentrations. Directly across from the cabin on the north bank, a large cut into the hillside exposes a gouge zone 1.5 m (5 ft) wide, striking N. 10° E. and dipping 50° SE. A chip sample (No. 82), taken across the gouge zone, contained 0.46 ounce of silver per ton (16 ppm). Both the cut and shaft are in Nelson Mountain Tuff.

About 200 m (600 ft) almost directly south of the cabin, three small prospect pits within 9 m (30 ft) of each other were dug in a little saddle on the hillside. The largest was 2.4 m (8 ft) in diameter and 0.6 m (2 ft) in depth, and the smallest was 1.2 m (4 ft) in diameter and 0.3 m (1 ft) in depth. The pits were dug in volcanics of Stewart Peak. Analysis of a grab sample (No. 83) from the dump by the largest pit showed no metal concentrations of significance.

STEWART AND NUTRAS CREEKS

About 0.4 km (0.25 mi) west of the east boundary of the wilderness, along the trail on Stewart Creek (pl. 2), are the remains of an old log cabin. Some small prospect workings reportedly exist above Stewart Creek opposite the cabin, but a search of the timbered area failed to reveal them. However, about 150 m (500 ft) above the creek, across from the cabin, an outcrop of Fish Canyon Tuff may have been blasted by prospectors. A sample (No. 84) of the outcrop was taken, but the analysis did not reveal metal concentrations of economic significance; a stream-sediment sample (No. 85) taken in the stream below the cabin also was negative (tables 6, 7).

No prospects were found in the Nutras Creek drainage.

CRYSTAL BEDS

On the north side of the Middle Fork of Saguache Creek, about 2.4 km (1.5 mi) north of the wilderness boundary, is a place known as the Crystal Beds Geological Site. The small bowl-shaped canyon, with steep walls and pinnacles at the mouth of the canyon, is a picturesque spot. In 1963 the Forest Service withdrew the area from mineral location and designated it the Crystal Beds Geological Site, so named from fragments and veinlets of calcite found here.

In 1933, a placer claim (Crazy Crystal) was located and described as "covering" the Crystal Beds, and in 1965 a group of lode claims (Queen Jean Nos. 1-5) were located on the west side of the Crystal Beds canyon. Plate 2 shows the location of the lode claims. These claims were located probably in the hope of finding a clear unflawed variety of calcite known as Iceland Spar or optical calcite, used as prisms in some optical instruments. Calcite seen during this examination was milky colored, precluding use for optical purposes. A 0.6-m-(2-ft) vertical chip sample (No. 86) of Fish Canyon Tuff was taken from the wall of a bulldozer-cut in the hillside on the Queen Jean claims. The analysis (tables 6, 7) showed the material to be barren of valuable metals.

WANNAMAKER CREEK-SKY CITY MINE AREA

The Sky City mine area is along Wannamaker Creek, 1.6 km (1 mi) east of the boundary of the Wilderness, and about 2.4 km (1.5 mi) upstream from the junction of Wannamaker Creek and the South Fork of Saguache Creek (pl. 2). A search of the U.S. Bureau of Mines records showed no mineral production attributable to this area.

Both patented and unpatented mining claims are located in the Sky City mine area. Some of the unpatented claims are known from mineral surveys filed with the Bureau of Land Management. Plate 2 shows the location of these claims.

The Sky City mine area contains numerous prospect pits, shafts, and adits. Samples were taken at the larger workings. A small mill containing some inoperative crushing equipment is near the portal of a timbered adit that is caved about 15 m (50 ft) from the portal. The dump consists of two parts, containing an estimated total of 1,800 t (2,000 tons), mostly andesite and monzonite. Sample 87 was a grab sample of the southern part of the dump and sample 88 was a similar sample of the northern part (tables 6, 7). A grab sample (No. 89), was also taken on a 0.6-m (2-ft) grid of a 1-t (1-ton) pile of highly silicified rock containing some pyrite. Analyses of all three samples showed small amounts of gold (tables 6, 7).

A caved adit a few hundred metres upstream from the Sky City mine was driven eastward into a hillside on a fractured zone 2 m (8 ft) wide that strikes S. 63° E. and dips 63° NE. A 0.6-m (2-ft) chip sample (No. 90) of the northern part of the zone did not reveal metal concentrations of significance. Analysis of a 2-m (6-ft) chip sample (No. 91) of the southern part showed a minor amount of silver (0.3 oz/ton, 13 ppm) and small quantities of copper and vanadium (tables 6, 7). The dump, estimated to contain 410 t (450 tons) of rock, consists of two distinct rock types. The northern one-third of the dump is mostly quartz monzonite, whereas the southern part is mostly andesite. Chemical analysis of grab samples (Nos. 92, 93) of each part of the dump did not reveal anything of value except that sample 92 of andesite contained anomalous amounts of yttrium (0.003 percent) and strontium (0.09 percent). However, neither of these quantities is of economic importance.

Downstream from the Sky City mine are two caved adits. The dump of the northernmost adit contained about 450 t (500 tons) of rock and the dump at the other adit contained 1,800 t (2,000 tons); analyses of grab samples (Nos. 94 and 95, respectively) of these dumps showed no metals in concentrations of importance (tables 6, 7).

About 460 m (1,500 ft) northeast and 180 m (600 ft) above the Sky City mine is a two-compartment timbered shaft with a pole headframe. A grab sample (No. 96) from the dump (estimated 450 t, 500 tons) and specimens (No. 97) from a small pile (estimated 90 kg, 200 pounds) of rocks next to the shaft contained no concentrations of valuable metals.

UPPER WANNAMAKER CREEK

Gravel from the southern end of a placer claim (Ellecks) along Wannamaker Creek, south of the Sky City mine area (pl. 2), was panned and the concentrate (sample 98, tables 6, 7) analyzed, but the results showed nothing of interest. A stream-sediment sample (No. 99) taken at the same spot also was barren.

An unpatented mining claim (Little Edan Haa), located in 1969, is on the main branch of Wannamaker Creek about 3.2 km (2 mi) south of the Sky City mine. At the place of discovery on the east side of the creek, a 4.5-m- (15-ft-) long chip sample (No. 100) was taken near the top of the bank. A 2-m- (7-ft-) long chip sample (No. 101) was taken from a nearby outcrop of andesite. Both samples assayed a minor amount of silver and an abnormally high amount of strontium (0.10 percent, tables 6, 7).

On a mountain top about 2.4 km (1.5 mi) S. 20° W. of the Sky City mine are three pits; the largest is 4 m (12 ft) in diameter and 1.5 m (5 feet) in depth. A sample (No. 102) of the dump material from the largest pit contained a minor amount of silver and lead, and an anomalous amount of bismuth and tin (tables 6, 7).

WHEELER GEOLOGIC AREA

The Wheeler Geologic Area is about 2.4 km (1.5 mi) directly south of Halfmoon Pass (pl. 2). This scenic area of eroded volcanic rock consists of cliffs, crags, and spires (fig. 6) cut in soft Rat Creek Tuff. From 1908 to 1950 the area was under the jurisdiction of the National Park Service; it was known then as the Wheeler National Monument. In 1950, the Park Service withdrew the national monument classification and the land was transferred to the U.S. Forest Service, who classified it as a geologic area and withdrew it from mineral entry. The Forest Service surveyed the area in 1969 to establish boundaries as shown in plate 2.

The eroded volcanic rocks are soft, partly welded tuffs of the Rat Creek Tuff. Three chip samples (Nos. 103, 104, and 105), each 1 m (3

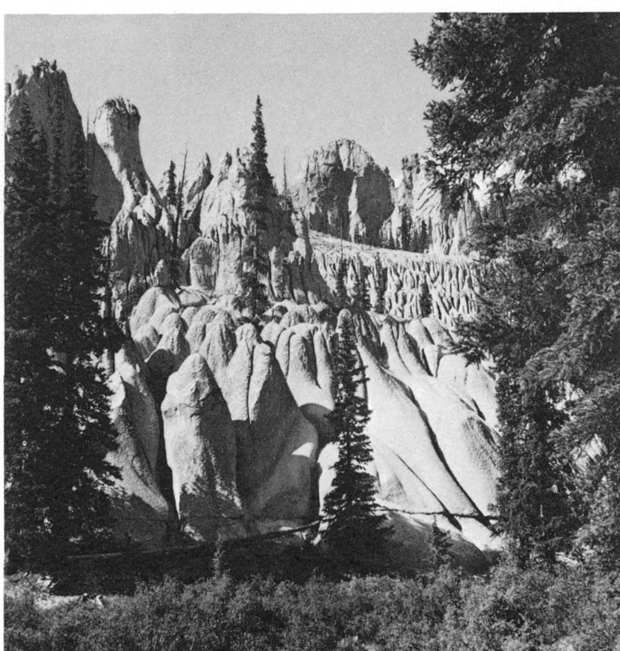

FIGURE 6.—Highly eroded Rat Creek Tuff at Wheeler Geologic Area.

ft) long, were taken inside the geologic area. Sample 103 was taken from a light-buff-colored rock near the trail below the shelter house, sample 104 in the whitish spires west of the shelter house, and sample 105 above these spires where color changes from white to buff. Plate 2 shows the approximate locality from which these samples were taken. Analyses showed no metal concentrations of significance.

LA GARITA MOUNTAIN

A stream-sediment sample (No. 106) and a grab sample (No. 107) were taken within an 18- by 9-m (60- by 30-ft) area of manganese and iron-stained gravels and talus breccia at a 0.3-m- (1-ft-) wide stream about 1.6 km (1 mi) south of La Garita Mountain. Spectrographic analysis of the stream-sediment sample showed no anomalous metal content. Chemical analysis of the grab sample showed 0.34 percent manganese and 3.2 percent iron (tables 6, 7).

WHITED CREEK

Two closely spaced bulldozer pits in Nelson Mountain Tuff are at the edge of the west cliff at the head of Whited Creek and about 0.4 km (0.25 mi) south of the wilderness boundary (pl. 2). The most northerly pit, 6 m (20 ft) long and 2.5 m (8 ft) wide, was dug at nearly right angles to the cliff. A grab sample (No. 108) was taken across the bottom of the pit near the cliff edge. The other pit was about 12 m (40 ft) long and 2.5 m (8 ft) wide, and was approximately parallel to the cliff edge. A grab sample (No. 109) was taken along the south side of the pit in the bottom near the west end. Neither sample contained metal concentrations of importance (tables 6, 7). The two pits were probably part of the exploration work done above and east of the Equity mine, where at least 23 bulldozer cuts or pits were dug along the mountain top. The two workings sampled were the ones nearest to the wilderness.

A small prospect pit, 4 m (12 ft) in diameter and 0.5 m (1.5 ft) in depth, dug in Nelson Mountain Tuff, is along the northwest part of a saddle between Whited and East Willow Creeks (pl. 2). A sample (No. 110) of the dump contained no concentrations of valuable metals (tables 6, 7).

RAT CREEK

At the head of Rat Creek and just south of the wilderness boundary, a grab sample (No. 111, fig. 3) was taken from the dump of a prospect pit, 6 m (18 ft) in diameter and 1 m (3 ft) in depth, in the quartz latite of Baldy Cinco. The samples showed nothing of economic interest (tables 6, 7). The pit was probably one of many pits and trenches dug in the late 1960's between Rat Creek and West Willow Creek as part of Homestake Mining Co.'s exploration in the Creede area.

EAST MINERAL CREEK

The southwest corner of the wilderness is adjacent to the headwaters of East Mineral Creek. Four pits are in the creek basin about 0.8 km (0.5 mi) west of the boundary of the wilderness (fig. 3). Grab samples (Nos. 112-115) were taken of dumps at the pits, dug in the quartz latite of Baldy Cinco. Samples 112 and 113 from the two pit dumps south of the creek contained minor amounts of silver (0.32 and 0.34 oz/ton, 11 and 12 ppm). Sample 114, from the dump of a large pit about 15 m (50 ft) long, 5 m (15 ft) wide, and 1.5 m (5 ft) deep, about .4 km (0.25 mi) up a minor east-trending tributary of the creek, contained nothing of economic interest. Sample 115, from a dump of a smaller pit about 46 m (150 ft) farther uphill, showed 0.20 ounce of silver per ton (7 ppm), 0.03 per cent copper, 0.36 percent lead, and 0.67 percent barium. A highly altered zone in the quartz latite of Baldy Cinco is exposed in the cliff at the head of a nearby gulch. A stream-sediment sample (No. 116) was taken about 0.4 km (0.25 mi) below the cliff; spectrographic analyses of the sample showed no anomalous concentrations of metals.

CONCLUSION

The La Garita Wilderness appears to have a poor mineral potential. Prospect work done in the wilderness so far has found nothing of economic value. The only significant mineralization is in the northwest corner of the wilderness, where an area along upper Spring Creek and at the lower end of Cascade Creek has been extensively prospected. Veins carrying silver, copper, lead, zinc, and fluorite have been found, but the known veins are narrow, ranging from a few centimetres to a metre or so wide, and do not show continuity of mineralization in sufficient grade to consider mining. Investigation of the other parts of the wilderness failed to disclose any evidence of economic mineral deposits.

The only important mineralized area containing metalliferous deposits near the wilderness is the Creede district lying south of the wilderness. The mine closest to the wilderness in this district is the Equity mine, which is 2.4 km (1.5 mi) south of the boundary. The last reported production from this mine was in 1966. An exploration program, consisting of diamond drilling, was carried out by the Homestake Mining Co. in the summer of 1971, but the results have not been released. The mines that have been major producers in the history of the Creede area are from 2.4 to 11 km (1.5 to 7 mi) south of the Equity mine. Only the Bulldog Mountain mine operated by Homestake Mining Co. and the Commodore mine of Emperius Mining Co. had production in 1971.

Major perlite deposits are exposed along Spring Creek about 5 km (3 mi) north of the La Garita Wilderness. Considerable exploration and testing would be required to determine the extent and quality of these deposits, although field estimates suggest an important potential. Transportation costs to market would be a major economic consideration.

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