STUDIES RELATED TO WILDERNESS
WILDERNESS AREAS

SAN PEDRO PARKS, NEW MEXICO

GEOLOGICAL SURVEY BULLETIN 1385-C

Mineral Resources of the San Pedro Parks Wilderness and Vicinity, Rio Arriba and Sandoval Counties, New Mexico

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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 in the San Pedro Parks Wilderness and vicinity, New Mexico. The area discussed in this report includes the wilderness, as defined, and some bordering areas.

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MINERAL RESOURCES OF THE SAN PEDRO PARKS WILDERNESS AND VICINITY, RIO ARRIBA AND SANDOVAL COUNTIES, NEW MEXICO

By Elmer S. Santos and Robert B. Hall, U.S. Geological Survey, and Robert C. Weisner, U.S. Bureau of Mines

SUMMARY

This report on the San Pedro Parks Wilderness is the result of a study made by the U.S. Geological Survey and the U.S. Bureau of Mines from 1970 to 1972. The wilderness occupies 62.7 square miles of the Santa Fe National Forest in Rio Arriba County, north-central New Mexico. It is at the north end of the granite-cored San Pedro Mountains–Sierra Nacimiento range, which is flanked by strata of Paleozoic, Mesozoic, and Tertiary age. The range is bounded on its west side by the Nacimiento fault; north- and east-trending faults juxtaposition sedimentary rocks and granite in the northern, southern, and southeastern parts of the wilderness.

Sedimentary formations exposed in the wilderness are, from oldest to youngest, the Arroyo Penasco Formation of Mississippian age, the Madera Limestone of Pennsylvanian age, the Cutler Formation of Permian age, and the lowermost beds of the Chinle Formation of Triassic age. Except for some beds of Miocene age, strata younger than the Chinle Formation do not extend into the wilderness but are exposed nearby.

Included in the study were investigations of mining claim locations within and adjacent to the wilderness, investigations of the present status of the mineral industry in the general region, and a field evaluation of all known mining claims and prospect workings.

Sixty-eight stream sediment samples and 188 rock samples were collected in and near the wilderness. These were analyzed by chemical and spectrographic methods that permit the detection of minute amounts of metals. Several of these samples contain anomalous concentrations of some elements but no significant mineral deposits were found and no geologic evidence exists that would indicate unusual concentrations of metals below the surface. Several samples collected at prospects also contain anomalous concentrations of a few elements. The extent of mineralization and the low concentration of metals in these prospects preclude their economic recovery.

The results of the geochemical sampling and geologic observations indicate that there are no exploitable mineral deposits, fossil fuels, or geothermal energy resources in the San Pedro Parks Wilderness.

INTRODUCTION

This report summarizes the geology and mineral-resource potential of the San Pedro Parks Wilderness. Located in the southwestern part of Rio Arriba County in north-central New Mexico, the area comprises 62.7 square miles of the Santa Fe National Forest (fig. 1).

The area may be easily reached from the villages of Cuba, Regina, and Gallina, along New Mexico Highways 44, 96, and 126. Approaches to the wilderness boundary are provided by numerous U.S. Forest Service roads that join the State highways, and many hiking trails maintained by the U.S. Forest Service provide access to most of the wilderness.

Elevations in the wilderness range from 8,400 feet at the northeast corner to 10,600 feet at San Pedro Peaks. A rolling surface of low to moderate relief occupies a large area near the summit. This relatively flat upland drops off steeply to the north and west and less steeply to the south and east. Nine perennial streams and numerous intermittent tributaries form a radial drainage pattern. Stream courses occupy broad shallow valleys near the summit and deep steep-walled canyons along the steep flanks of the upland.

Vegetation is typical of that in the southern Rocky Mountains and consists of several varieties of conifers including Ponderosa pine, scattered stands of aspen, and scrub oak. The thick forest cover is interrupted locally by open grassy meadows or "parks" for which the wilderness is named. These are covered by a variety of dryland grasses, reed grasses, and wet meadow carex.

No record of rainfall exists for the area within the wilderness. The nearest rain gage is at Cuba, 4 miles west of the wilderness area and at an elevation of 7,045 feet. Here the mean annual precipitation is 13.8 inches and the wettest months are July and August. Most of the wilderness area is above 9,000 feet elevation and probably receives at least 20 inches of rainfall annually.

Principal industries in the region are cattle raising, truck farming, and lumbering. The mining of stratabound copper deposits was recently resumed near Cuba. An open-pit operation began delivery of ore to a mill having a capacity of 3,000 tons per day in June of 1971.

PREVIOUS STUDIES

The San Pedro Mountains and environs were reconnoitered by several geologists during the period 1850-1950. The region was visited in 1859 by Newberry (1876) and later by Cope (1875), who mentioned "red feldspar-porphyry" in the Sierra Nacimiento. Shaler (1907) described gypsum deposits and some geologic features in the district. Gardner (1909) described coal-bearing strata and mentioned "the old Mexican town of Nacimiento, known to the post-office officials as Cuba." Schrader (1910) described early mining operations in sedimentary

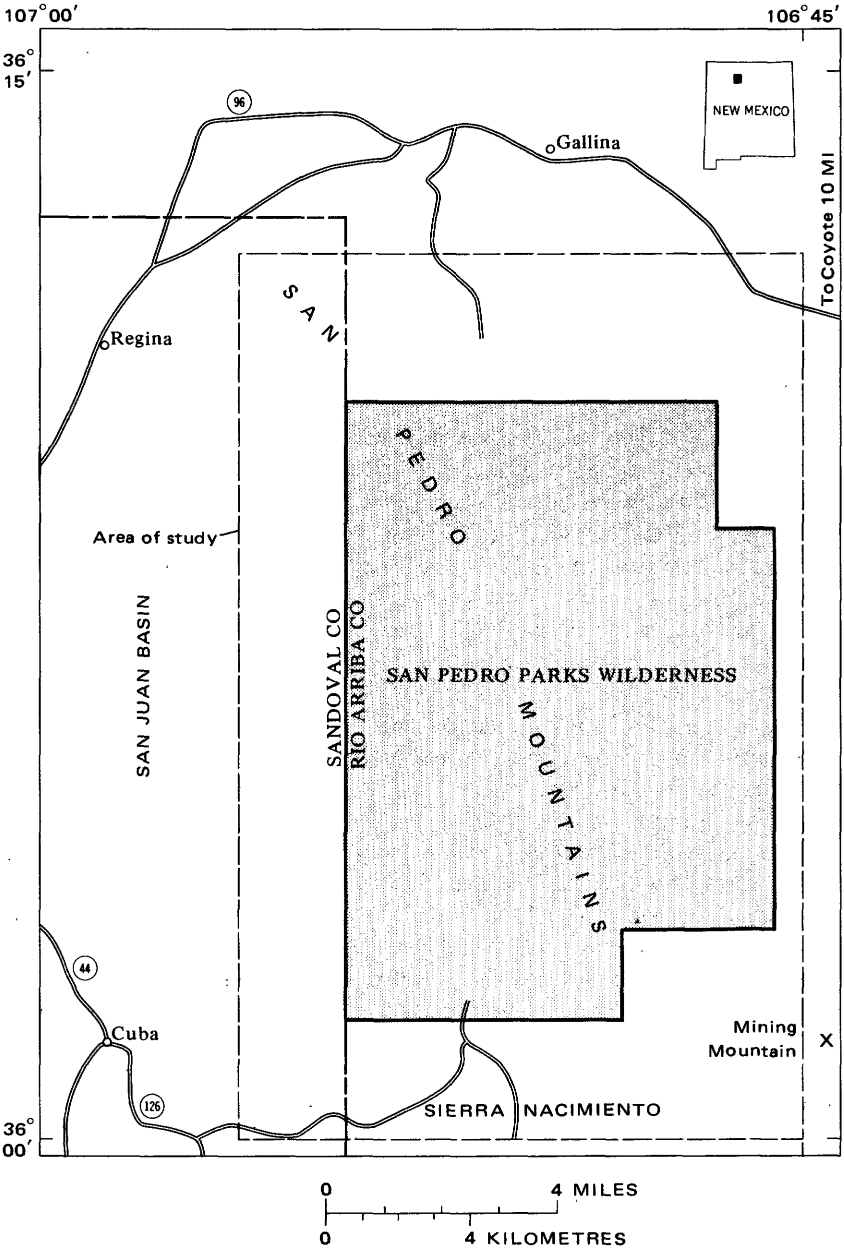

FIGURE 1.—Location of the San Pedro Parks Wilderness and vicinity, Rio Arriba and Sandoval Counties, N. Mex.

copper deposits south of the San Pedro Mountains although mining had been abandoned at the time of his visit in 1906. Darton (1922, 1929) referred to the Nacimiento "uplift" and the San Pedro Mountains and also to copper deposits in Triassic red beds south of the latter. Renick (1931) studied and mapped the geology of the Cuba district. Although his map did not include the San Pedro Mountains, Renick described the coarse red granite and the sedimentary formations surrounding it. He may have been the first to apply the term "Sierra Nacimiento overthrust" to the fault along the west side of the mountain. Church and Hack (1939) demonstrated that the relatively flat summit of the San Pedro Mountains is an old erosion surface, which locally is capped by a layer of chert. A reconnaissance geologic map made by Northrop and Wood (1946) includes San Pedro Mountain and environs. Studies were made of existing and potential deposits of manganese by Farnham (1961), of copper by Soulé (1956), and of uranium by Brown (1955) and by Hilpert (1969).

PRESENT STUDY AND ACKNOWLEDGMENTS

Investigations by Santos and Hall were done in September to mid-October 1970, and in May 1971. The investigations by Weisner were begun in 1971 and concluded in 1972. A reconnaissance geologic map was made of the wilderness and a part of the adjacent area (pl. 1). Records at the courthouses of Rio Arriba and Sandoval Counties were examined by U.S. Bureau of Mines personnel for claim location notices. Claims and prospect workings were visited, sampled, and evaluated and stream-sediment samples were taken from all principal streams and their main tributaries. Samples were also taken of the various rock types exposed in the area. The localities of samples collected for analyses are shown on plate 1 along with the approximate localities of groups of claims.

Six-step semiquantitative spectrographic analyses for 31 elements in all samples were made in the U.S. Geological Survey laboratories in Denver, Colo., or at the U.S. Bureau of Mines Laboratories in Reno, Nev. Colorimetric analyses of cold-extractable copper and total heavy metals, and atomic absorption spectrometer analyses of copper, cobalt, arsenic, and molybdenum were made for some samples in a mobile field laboratory at Cuba, N. Mex. Some samples were analyzed by chemical and fire-assay methods by the U.S. Bureau of Mines in Reno, Nev. The results of these analyses are shown on tables 2 and 3.

The assistance and cooperation of many people associated with the University of New Mexico and with various State and Federal agencies is gratefully acknowledged. We also thank Mr. Lyle Talbot and Mr. William Armstrong, of the Earth Resources Co., and Mr. Cosme Herrera, of Cuba, N. Mex., for their help.

GEOLOGY

GEOLOGIC SETTING

The San Pedro Parks Wilderness is located in the San Pedro Mountains, which are part of the Southern Rocky Mountains Province.

The Sierra Nacimiento, which is similar to the San Pedro Mountains, extends southward from them for 28 miles. The San Pedro Mountains—Sierra Nacimiento range thus forms the southernmost extension of the Rocky Mountains (Fenneman, 1931, p. 105). The range is bounded on the east by young volcanic rocks and on the west by the San Juan Basin, which is, in turn, a part of the Colorado Plateaus Province.

The San Pedro Mountains have an exposed core of Precambrian granite. Sedimentary rocks of Carboniferous and Permian age unconformably overlie the granite along the flanks of the mountains. The strata of Permian age are unconformably overlain by the Chinle Formation of Triassic age. Exposed nearby are strata of Jurassic, Cretaceous, and early Tertiary age, but none of these extend into the wilderness. Strata of Miocene age lap across older beds and onto the granite core within the wilderness. The geologic formations exposed in and near the wilderness are listed in table 1.

Some physiographic features of the San Pedro Mountains suggest the possibility of Alpine glaciation in Pleistocene time. Smooth rounded outcrops of granite resemble roches moutonnées especially at San Pedro Peaks. The upper Canon Madera has a broad, smooth U-shaped valley where it drains the flat summit area, and it changes rapidly into a sharp V-shaped valley where the gradient steepens on the west slope. Some of the meadows or parks near the summit are poorly drained shallow marshy swales like those common in glaciated terrain. Although they mentioned no glacial features, Church and Hack (1939, p. 623) noted the remarkable resemblance of the flat summit area to the glaciated Canadian Shield. Other features that would indicate the possibility of glaciation, such as striae, moraines, till, and erratic boulders, were not observed.

IGNEOUS ROCKS

Crystalline rocks of Precambrian age, which consist mainly of red granite and granite porphyry, compose the bedrock over approximately 70 percent of the wilderness. A fine-grained pink felsic facies of the granite is locally common, especially in the northwest part of the area. Greenstone and dark-green diorite orthogneiss are rare and were observed mostly in float and rarely in dikes. Some schist was observed in float but is apparently very rare in the San Pedro Mountains. Individual facies within the crystalline rocks were not mapped because the rocks are poorly exposed.

GRANITE AND GRANITE PORPHYRY

Red granite, which consitutes the bulk of the crystalline rocks, is composed of orthoclase, quartz, plagioclase, and biotite. Microcline is also present but is subordinate to orthoclase. Accessory minerals are apatite, zircon, sparse magnetite, and leucoxene. The plagioclase,

$Ab_{75}An_{25}$, is almost invariably clouded by saussurite and sericite. Average grain size is 1–5 mm, but dark-pink potassic feldspar phenocrysts in the porphyritic facies are as large as 2.5 cm. A gneissoid foliation was observed locally but most of the granite is massive and without notable orientation of crystals. Alteration seen in the plagioclase and in partially chloritized biotite may be due to regional metamorphism but more likely is due to weathering.

APLITIC GRANITE

Fine-grained pink aplitic granite is common, and locally, in a roughly

TABLE 1.—*Geologic formations exposed in the San Pedro Parks Wilderness*

SYSTEM	STRATIGRAPHIC UNIT		THICKNESS (FT)	DESCRIPTION
Tertiary	Abiquiu Tuff of Smith (1938)	Pedernal Chert Member of Church and Hack (1939)	0-20	Light-gray bedded chert
		Clastic unit	0-70	Dull-grayish-orange sandstone and conglomerate.
Triassic	Chinle Formation	Poleo Sandstone Lentil	0-75	Grayish-orange and light-gray sandstone and conglomerate.
		Salitral Shale Tongue	0-30	Variegated purple, red, and green mudstone and siltstone.
		Agua Zarca Sandstone Member	0-4	Greenish-gray conglomeratic sandstone.
Permian	Cutler Formation		0-1,100	Interbedded reddish-brown, orange, and pink sandstone, arkose, mudstone, and siltstone.
Pennsylvanian	Madera Limestone		0-700	Interbedded gray and red limestone, arkose, and shale.
	Sandia Formation		-----	Red and orange arkosic sandstone, shale, and conglomerate. May be absent in the wilderness.
?——? Mississippian	Arroyo Penasco Formation		0-130	Light-gray and tan limestone underlain by white and pink conglomeratic sandstone.
Precambrian	Granitic rocks		-----	Mostly coarse-grained red granite and granite porphyry. Some fine-grained pink granite, greenstone, and dark-green diorite orthogneiss.

circular area about 2 miles in diameter near the northwestern part of the wilderness, it comprises the bulk of the exposed crystalline rocks. It differs from the predominant granite facies only in grain size. Most grains are 0.1–0.2 mm long; some quartz phenocrysts are as much as 2 mm long. Alteration is limited mostly to a slight sericitization of feldspar; typically, outcrops of aplitic granite are less weathered then the coarse-grained granite. A faint foliation is apparent in some hand specimens but is not evident in thin sections.

GREENSTONE

Dark-green to almost black metadiabase rarely occurs in outcrops but is fairly common in the float throughout the area. Composed of subhedral to euhedral plagioclase prisms in a mesostasis of uralite, the rock has a fine-grained subophitic texture. Twinning in the calcic plagioclase is blurred or obliterated by saussurite. Relict augite is rare, in as much as most of it has been uralitized. A coarse-grained metagabbro facies of the greenstone occurs locally. Compositionally it is similar to the metadiabase except that the metagabbro locally contains chlorite, sparsely disseminated pyrite, and as much as 5 percent magnetite. Alteration of the greenstone is probably the result of low-grade regional metamorphism, although it may be due in part to weathering. The greenstone bodies are of very limited extent and are interpreted to be diabase dikes. None could be traced for more than a few yards because of soil and humus cover.

DIORITE GNEISS

A dark-green fine-grained crystalline rock with well-developed fine banding or foliation is exposed locally along La Jara Creek immediately west of the wilderness boundary. The rock consists of sodic andesine ($Ab_{70}An_{30}$) as the main component with biotite as the essential mafic mineral. Potassic feldspar, hornblende, and tiny crystals of apatite are sparse accessory minerals. The sodic andesine occurs as subhedral to euhedral equidimensional crystals that are about 0.1 mm across. The feldspar is clouded by saussurite and sericite and the biotite is partially chloritized.

Thin sections of two specimens taken a half mile apart show a marked contrast in composition; one contains virtually no quartz and is a biotite diorite gneiss, the other is quartz rich and is classified as melatrondhjemite gneiss.

SEDIMENTARY ROCKS

STRATA OF PRE-PERMIAN AGE

Strata of pre-Permian age in the wilderness consist of thickly to thinly interbedded limestone, sandstone, arkose, and shale. The limestone is generally light gray, less commonly pale grayish brown, and rarely grayish red. The sandstone and arkose are pinkish gray, light gray, grayish yellow, and grayish red. The shale is mostly reddish brown and less commonly medium gray. The limestone ranges in composition from nearly pure to dolomitic or very sandy, from coarsely crystalline to nearly lithographic, and from very fossiliferous to nonfossiliferous. Some limestone beds contain angular clasts of granite, greenstone, and orthoquartzite. Much of the sandstone and arkose is conglomeratic and contains abundant calcareous or siliceous cement.

The thickness of the carbonate beds ranges from less than 5 to 120 feet, that of shale beds from less than 5 to 130 feet, and that of sandstone and arkose from less than 5 to 15 feet. The total thickness of the pre-Permian strata varies greatly throughout the area. The strata are absent along part of the west and south sides of the San Pedro Mountains, but are as much as 800 feet thick near the northwest corner of the wilderness.

The Arroyo Penasco Formation, of Mississippian age, and the Sandia Formation and Madera Limestone, both of Pennsylvanian age, compose the pre-Permian sedimentary rocks a few miles south of the wilderness. In this area the Sandia Formation was called the Log Springs Formation by Armstrong (1967, p. 31).

With the possible exception of the Sandia Formation, these units are present in parts of the wilderness. The Arroyo Penasco Formation is as much as 130 feet thick in the northwestern part of the wilderness; it extends across the northern part of the area as far as the Rio Gallina but elsewhere is absent from the wilderness. Northrop and Wood (1946) considered the Sandia Formation to be absent in the northern part of the area covered by their mapping, an area that includes a part of the wilderness. In the forest soil near the northwestern part of the wilderness Armstrong (1967, p. 31) observed float which resembles the Sandia Formation. The float here also resembles rock derived from parts of the Madera Limestone so it is not certain that the Sandia is present.

The Madera Limestone overlies the Arroyo Penasco Formation in the northwestern part of the wilderness. On the northeastern, eastern, and southeastern margins it rests directly on Precambrian crystalline rock. It may be as much as 700 feet thick near the northwestern part of the wilderness, but elsewhere it is commonly less than 400 feet thick.

Outcrops of strata underlying the Cutler Formation are few and of small extent, and so most of the mapping was of necessity done on float in the forest soil. Because of the similarity of the rock types in the various units present, it was impractical to try to map individual formations on the basis of the float. Following the scheme of Northrop and Wood (1946), we show all the pre-Permian strata as a single unit on plate 1.

Float composed of sedimentary rocks covers large areas of the north slope up to an elevation of 10,300 feet. In addition to the float, orthoquartzite and limestone crop out locally. To distinguish the rocks in place from float and to map the extent of the outcrops in this area were too time consuming to be warranted on the basis that the results would be of little value within the scope of the investigation. Areas on the north slope, where thin outcrops of sedimentary rocks may be present, are shown as Precambrian granite.

CUTLER FORMATION

Strata of Permian age south of the wilderness consist of the Abo, Yeso, and San Andres Formations. In the wilderness these units cannot be distinguished and the entire Permian section is included in the Cutler Formation (Northrop and Wood, 1946).

The Cutler Formation in and near the wilderness consists of interbedded sandstone, arkose, sandy mustone, and siltstone. Most of these are reddish brown, orange, and pink. A few sandstone beds are grayish yellow and light gray. Much of the sandstone and arkose is conglomeratic, cross-stratified, and lenticular. Sandstone and arkose constitute more than 50 percent of the formation in some places and as little as 10 percent in others. Beds of sandstone and arkose range in thickness from less than 5 to about 135 feet; beds of mudstone and siltstone, from less than 5 to about 165 feet.

The Cutler is exposed on all sides of the wilderness but extends into the area only on the northeastern, southeastern, and southwestern sides. It is about 1,100 to 1,200 feet thick north of the wilderness and as little as 500 feet thick in the southwestern part of the area.

The Cutler Formation conformably overlies the Madera Limestone along a graditional contact, and many of the arkosic beds in the Madera Limestone closely resemble those in the Cutler Formation. The contact is chosen at the top of the first limestone bed below the thick sequence of red clastic rocks that characterize the Cutler Formation. Along the west and part of the south sides of the wilderness the Cutler Formation rests directly on Precambrian crystalline rocks.

CHINLE FORMATION

The Chinle Formation of Late Triassic age, about 700–800 feet thick, unconformably overlies the Cutler Formation in the vicinity of the wilderness. The formation consists of the Agua Zarca Sandstone Member at the base overlain successively by the Salitral Shale Tongue, the Poleo Sandstone Lentil and, at the top, the Petrified Forest Member. Momper (1957, p. 92) considered the Agua Zarca and Salitral to be part of the Moenkopi Formation of Early and Middle(?) Triassic age. Only the three lowermost units extend into the wilderness, in the northeast corner of the area.

The Agua Zarca Sandstone Member is 80–100 feet thick on Eureka Mesa south of the wilderness. North of the wilderness it is only 4 feet thick and is locally absent. At Eureka Mesa the member consists of crossbedded, mostly light-gray and light-yellowish-gray sandstone and conglomerate. The sandstone is quartzose and the conglomerate consists of well-rounded quartz, quartzite, and chert pebbles as much as 4 inches in diameter. Channels at the base of the member are scoured into the Cutler Formation. North of the wilderness the member consists of greenish-gray conglomeratic sandstone with rounded quartz pebbles in a fine-grained sandstone matrix.

The Salitral Shale Tongue is about 20–30 feet thick and consists of variegated purple, red, and green mudstone and siltstone. South of the wilderness where the Poleo Sandstone Lentil pinches out, these strata cannot be distinguished from the Petrified Forest Member.

The Poleo Sandstone Lentil is about 75 feet thick and consists of interbedded sandstone and conglomerate. It is mainly grayish orange and light gray; the top 3–5 feet weathers to dark brown. The conglomerate is composed of well-rounded quartz, chalcedony, and limestone pebbles that average one-half inch in diameter. The sandstone is mostly medium grained.

The Petrified Forest Member is absent in the wilderness, but parts of it are exposed in narrow slices along a fault zone near the western boundary. It consists of a colorful sequence of variegated red, purple, green, and brown mudstone and siltstone interrupted by a few lenticular beds of sandstone, conglomerate, and limestone.

STRATA OF POST-TRIASSIC AGE

Formations younger than Triassic age are exposed near the wilderness boundary, but, except for some strata of Miocene age, they are absent in the wilderness. These include the Entrada Sandstone, the Todilto Formation, and the Morrison Formation all of Late Jurassic age. Strata of Cretaceous age, shown on plate 1 as a single undifferentiated unit, include the Dakota Sandstone, the Mancos Shale, the Mesaverde Group (composed of the Point Lookout Sandstone, the Menefee Formation, and the La Ventana Tongue of the Cliff House Sandstone), the Lewis Shale, the Pictured Cliffs Sandstone, the Fruitland Formation, and the Kirtland Shale. Strata of early Tertiary age, shown undifferentiated on plate 1, include the Ojo Almo Sandstone and the Nacimiento Formation, both of Paleocene age, and part of the San Jose Formation of Eocene age.

Unconformably overlying the Chinle Formation is the Entrada Sandstone which is 170–235 feet thick and consists of light-brown and grayish-white medium- and fine-grained crossbedded sandstone. The Todilto Formation conformably overlies the Entrada Sandstone and consists of 6–10 feet of limestone overlain by 90–100 feet of white gypsum. The Morrison Formation conformably overlies the Todilto Formation and is about 800 feet thick. The lowermost 400 feet consists of white and grayish-orange very fine and fine-grained sandstone. Above this is about 300 feet of greenish-gray mudstone and thin beds of grayish-orange medium- and fine-grained sandstone. The upper 100 feet consists of interbedded conglomerate, sandstone, and greenish-gray mudstone.

The Dakota Sandstone, about 200 feet thick, overlies the Morrison Formation along an erosion surface. It consists of gray and grayish-orange fine- to coarse-grained sandstone interbedded with dark-gray carbonaceous shale and thin seams of coal. Strata above the Dakota Sandstone consist of alternating units of marine, marginal marine, and terrestrial origin. The units of marine origin consist mainly of light-and dark-gray shale with thin beds of sandstone and nodular limestone. The units of marginal marine origin are mainly thick-bedded and massive, light-gray and grayish-orange sandstone. The units of terrestrial origin are mainly light- and dark-gray carbonaceous shale interbedded with coal seams. The total thickness of the strata of Cretaceous age is about 5,500 feet.

Strata of Tertiary age consist of grayish-orange and brown medium- to very coarse-grained sandstone overlain by thinly interbedded olive-gray shale and soft white sandstone. The sandstone unit is 80–170 feet thick; the interbedded shale and sandstone unit is 800–1,000 feet thick.

Strata of Miocene age crop out in the southeastern part of the wilderness and in places near the summit of San Pedro Mountain. Equivalent strata east of the wilderness were named Abiquiu Tuff by Smith (1938, p. 944). Budding, Pitrat, and Smith (1960, p. 84) reduced the unit to the rank of member, calling it the Abiquiu Tuff Member of the Santa Fe Formation. Church and Hack (1939, p. 618) named a chert bed in this unit the Pedernal Chert Member of the Abiquiu Tuff.

ABIQUIU TUFF OF SMITH (1938)

In the southeastern part of the wilderness the Abiquiu Tuff consists of a clastic unit at the base and the Pedernal Chert Member at the top. The clastic unit is as much as 70 feet thick but wedges out abruptly. It overlies an erosion surface carved on Paleozoic strata and Precambrian crystalline rocks. The basal unit is composed mostly of dull-grayish-orange conglomeratic sandstone and conglomerates. In some places yellow sandstone underlies the conglomeratic beds and is in turn underlain by light-gray and pale-red claystone. Clasts in the conglomerate are as much as 5 inches in diameter and consist of rounded and angular chert, quartz, granite, schist, and a variety of sedimentary rocks. The sandstone is crossbedded and contains abundant interstitial clay- and silt-sized material as well as scattered pebbles of the same rocks that occur in the conglomerate lenses.

The Pedernal Chert Member conformably overlies the clastic unit and extends beyond its limit of deposition where it rests on Precambrian crystalline rocks. Some flat areas near the summit of the San

Pedro Mountains are covered by blocky chert float, and in places a veneer of chert may be present. Where it overlies the clastic unit the member is 12–20 feet thick and consists of a single massive bed of light-gray chert whose top surface has a gnarled or rough knobby appearance. Although most of the chert is light gray, many pieces of float are mottled tan, yellow, brown, bluish gray, and red.

STRUCTURE

The dominant structural feature in the area is the north-trending Nacimiento fault zone that bounds the west side of the mountain range whose north end is called the San Pedro Mountains. The Precambrian granite core of the range is tilted eastward, plunges sharply to the north, and is dropped to the north by southeast-trending faults. The San Pedro Mountains are separated from the southern extension of the range by a gentle sag where sedimentary rocks extend over the crest.

The Nacimiento fault zone appears to consist of a fairly straight continuous fault plane with several subsidiary fault traces branching from the main fault locally. It was described as a thrust fault by Renick (1931, p. 71) and by Northrop and Wood (1946). Actually the main fault plane dips about 80° E. and is more correctly described as a high-angle reverse fault.

A number of faults on the southern side and near the southeastern side of the wilderness are inferred from the close juxtaposition of strata with granite outcrops that are at a higher elevation than the strata. The juxtaposition could be interpreted to be the result of deposition on an erosion surface of great relief, but more likely it is the result of strata having been dropped along faults.

Strata dip away from the exposed granite core on all sides of the San Pedro Mountains. Dips range from 3° to 40° and locally, as in some faulted blocks on the north side, are as much as 55°. Along the Nacimiento fault zone strata dip steeply to the west, are vertical, or are overturned and dip steeply to the east.

The deformation that produced the present structural features probably began in late Paleocene or early Eocene time and continued episodically into late Tertiary time. Near the Nacimiento fault zone just west of the wilderness, strata of Paleocene age dip 85° and are overlain by strata of Eocene age that dip 69° W. (Baltz, 1967, p. 41). Elsewhere in the same general area the contact between these strata is an erosional unconformity with no angular discordance. The deformation during this period is interpreted to be one of local folding rather than broad regional tilting. Other episodes of deformation during Tertiary time are indicated by intraformational unconformities in and tilting of strata of Eocene age. Maximum uplift occurred along the Nacimiento fault zone which formed during or shortly after late Eocene time. The attitude of the Abiquiu strata indicates some tilting of the range to the southeast during or after Miocene time.

SUMMARY OF DEPOSITIONAL AND TECTONIC HISTORY

Prior to the deposition of the earliest known Paleozoic sediments, erosion had reduced the Precambrian basement to a peneplain containing scattered monadnocks. The Arroyo Penasco Formation was deposited on this surface during a marine invasion in Mississippian time. Most of these strata were then removed by erosion during a period of uplift that preceded the deposition of younger strata. The Sandia Formation was then deposited and, in turn, removed during another episode of uplift and erosion in Pennsylvanian time. Later in Pennsylvanian time, a sea again covered the region but a part of the area remained above sea level and supplied the clastic material which, interbedded with limestone, constitutes the Madera Limestone. This episode of deposition continued into Permian time when sedimentation became continental due to extensive basin filling. During this time, the Cutler Formation was deposited on the ancient Nacimiento–San Pedro landmass. A period of erosion followed the deposition of the Cutler Formation; subsequently, flood-plain sediments of Triassic age, the Chinle Formation, were deposited. After a period of erosion, flood-plain sediments of Jurassic age were deposited on the Chinle Formation.

During Cretaceous time, shallow epicontinental seas periodically covered the region, and marine, marginal marine, and terrestrial sediments in alternating succession, were deposited. After the deposition of terrestrial sediments in early Tertiary time uplift occurred along the Nacimiento fault zone, and by Miocene time erosion once again exposed the granite core. Coarse clastic rocks and bedded chert of Miocene age were deposited on the granite surface as well as on older strata east of the uplift. After the deposition of these strata the uplifted rocks were tilted slightly to the southeast.

Subsequent erosion has removed much of these latest deposits and carved deep canyons in the flanks of the uplift. During Pleistocene time a glacier may have covered the summit of the San Pedro Mountains.

MINING CLAIMS INVESTIGATIONS

Information in this part of the report was collected by personnel of the U.S. Bureau of Mines and U.S. Geological Survey working independently and at different times. The information has been consolidated in the interest of brevity. The analyses of samples collected by the U.S. Bureau of Mines are shown in table 3 and the sample localities are shown on plate 1. U.S. Bureau of Mines samples 2303, 2304, 2317, 2325, 2360, and 2370 as well as U.S. Geological Survey samples 15, 53, 91, 96, and 137 were collected from areas close to but beyond the area of plate 1.

Mining claims within and adjacent to the area were examined and their approximate locations are shown on plate 1. About 300 claims and 22 location notices are in the study area. Location corners and excavations could not be found for most of the claims. The excavations sampled that appear to be prospect workings are mostly on ground where no location notices have been recorded.

RIO PUERCO AND MORNING STAR GROUPS

Two groups of claims are located in the west and central parts of the study area. The Rio Puerco group is contiguous to the wilderness in sec. 12, T. 21 N., R. 1 W.; the Morning Star group is just within the wilderness in unsurveyed sec. 31, T. 22 N., R. 1 E. Between these are several excavations for which no claim notices are recorded. In a trench excavated on the Rio Puerco group, a sheared metadiabase dike 5–8 feet wide contains sparse pyrite and minor flecks of malachite 1–3 mm across. The analyses of samples 204, 205, 206 and 2312, which were collected from the dike and associated gouge, indicate that the material is below ore-grade and cannot be mined economically. One sample (2318), made up of selected material containing the highest sulfide concentrations, assayed 0.4 ounce of gold per ton.

On the Morning Star claims, samples 2340 and 2342 from a small prospect pit that contains a manganese mineral along joints in the granite contain 6 percent manganese and 0.9 percent barium. A sample (2341) of the granite host rock near the pit contains 0.2 percent manganese.

Three samples (207, 2349, and 2350) taken from several pits between the Rio Puerco and Morning Star groups are anomalously high in manganese. The pits are cut into manganiferous material tentatively classified as wad. The manganiferous material is a filling between fragments of granite at the surface. The claim holder stated that it contains appreciable amounts of silver, but only a trace was detected in one sample.

SAN JOSE CREEK CLAIMS

Several claims have been located in secs. 1 and 12, T. 22 N., R. 1 W., over outcrops of granite and steeply dipping beds of the Cutler Formation. Azurite- and malachite-bearing sandstone of the Cutler Formation here contains as much as 0.5 percent copper (samples 2316 and 2319); granite adjacent to the copper-bearing sandstone contains 0.005 percent copper (sample 196). The deposit resembles many others in the Cutler Formation near the wilderness which have proved to be too small or too low grade to be recovered economically.

SAN PEDRO NOS. 1-10, SAN PEDRO NOS. 1-18, AND MARY LEE GROUPS

County records indicate three groups of claims in the northern part of the wilderness area. One group, San Pedro Nos. 1–10, is at the headwaters of Dove Creek in unsurveyed W½ sec. 8, T. 22 N., R. 1 E. Another group, San Pedro Nos. 1–18, is near Cave Creek in unsurveyed secs. 9, 10,15, and 16, T. 22 N., R. 1 E. A third group, the Mary Lee, is adjacent to the southern boundary of the San Pedro Nos. 1–18 group in unsurveyed secs. 15 and 16, T. 22 N., R. 1 E. Chip samples (2301 and 2302) of quartz stringers from two small prospect pits on the San Pedro Nos. 1–10 group contain more than 0.5 percent manganese and are anomalous in barium. No other mineralized areas were found on these claims.

Several small pits and a shaft about 160 feet deep are on the San Pedro Nos. 1–18 claims. All of the eight samples collected (2331–2338) are anomalously high in manganese. One sample contains 10 percent barium and a selected sample (2335) from what appeared to be an ore stockpile near the shaft contains 6 percent manganese. The area has been prospected extensively but no significant quantities of minable minerals have been found.

No evidence of prospecting activity was found in the area of the Mary Lee group.

NORTHERN BORDER CLAIMS

Numerous unpatented mining claims are located within 2 miles of the northern border of the wilderness but only one group extends into the wilderness. Numerous prospect pits and claim posts without identification were found. Samples 2354, 2355, 2359, 2361, and 2362, which contain 0.04–4 percent copper, were taken from prospect pits in conglomeratic sandstone of the Cutler Formation. The Cutler Formation extends into the wilderness along the eastern and southern borders, but the formation appears to be devoid of copper mineralization within the wilderness.

OTHER CLAIMS AND PROSPECTS

Two adjoining groups of claims, Alarco A1 to A40 and Alameda 1 to 16, are located less than 1 mile southwest of the wilderness. Some of these claims include sedimentary formations which, to the south, contain minable copper deposits; the other claims are on barren granite. Sample 203 from an adit in a sheared greenstone dike contains anomalous amounts of lead, zinc, silver, and tin. Sample 2306, also from the adit, contains only zinc and silver in anomalous amounts. The concentration of these metals is far below ore grade, so it is unlikely that the dike could be exploited economically.

Three groups of claims, Copper Hill Nos. 1–10, Palo Seco 10, 14, and 16, and Harvey Nos. 1–14, are located outside the southeast corner of the wilderness. The Madera Limestone and Cutler Formation are exposed in the claim area but no evidence of metallic minerals was found. The St. Jude Nos. 1–16 claims are located in the southeastern part of the wilderness where 40 feet of the Abiquiu Tuff rests on granite. No metallic minerals were found in these claims. Farnham (1961) mentioned a "Besre" manganese deposit in sedimentary rocks said to be within the wilderness area of the Santa Fe National Forest. This deposit is probably in the Cutler Formation, but its exact location is unknown.

MINING ACTIVITY IN ADJACENT AREAS

There is no recorded mineral production from inside the San Pedro Parks Wilderness. Copper (Schrader, 1910; Soulé, 1956), coal (Gardner, 1909), gypsum (Shaler, 1907), manganese (Farnham, 1961), and uranium (Brown 1955; Hilpert, 1969) have been mined from adjacent areas.

COPPER

The "red bed" copper deposits in the Agua Zarca Member of the Chinle Formation just south of the wilderness have been known since 1859 and have been mined intermittently to the present time. Newberry (1876) noted the occurrence in 1859. Emmons (1904), Lindgren, Graton, and Gordon (1910), Soulé (1956), and Elston (1967) have reported on the deposits. The Nacimiento mine operated by the Earth Resources Co. began producing ore in late 1970. The mine is 2.25 miles south-southwest of the southwest corner of the wilderness. The ore consists mainly of chalcocite and small amounts of malachite, azurite, chrysocolla, and melaconite, which are disseminated in sandstone or which replace coalified wood fragments. The deposit is reported to contain 5–7 million tons of ore with an average grade of greater than 0.5 percent copper (William Armstrong, Earth Resources Co., written commun., 1971).

The Agua Zarca Member is present over a small area in the northeast corner of the wilderness, where its maximum thickness is only 4 feet.

Although many prospects exposing copper-bearing strata in the Cutler Formation are present around the perimeter of the wilderness, the only production, judging from the extent of the workings, seems to have been at Mining Mountain 3 miles southeast of the wilderness.

URANIUM

During the height of uranium prospecting activity in the 1950's and early 1960's numerous claims were staked on the Cutler Formation and younger strata adjacent to the wilderness. Brown (1955) investigated 11 occurrences described as the Vegitas cluster (fig. 2). Two small shipments of mineralized rock were made from the area to the mill at Shiprock, N. Mex. (E. A. Youngberg, written commun., 1971). No payment was made for either shipment because of their low grade. One shipment of 20 tons was made in 1956 from sec. 25, T. 23 N., R. 1 W., and assayed 0.03 percent U_3O_8 and 0.06 percent V_2O_5. Another shipment of 4 tons was made in 1954 from the Whiteflo claims (fig. 2) which assayed 0.08 percent U_3O_8.

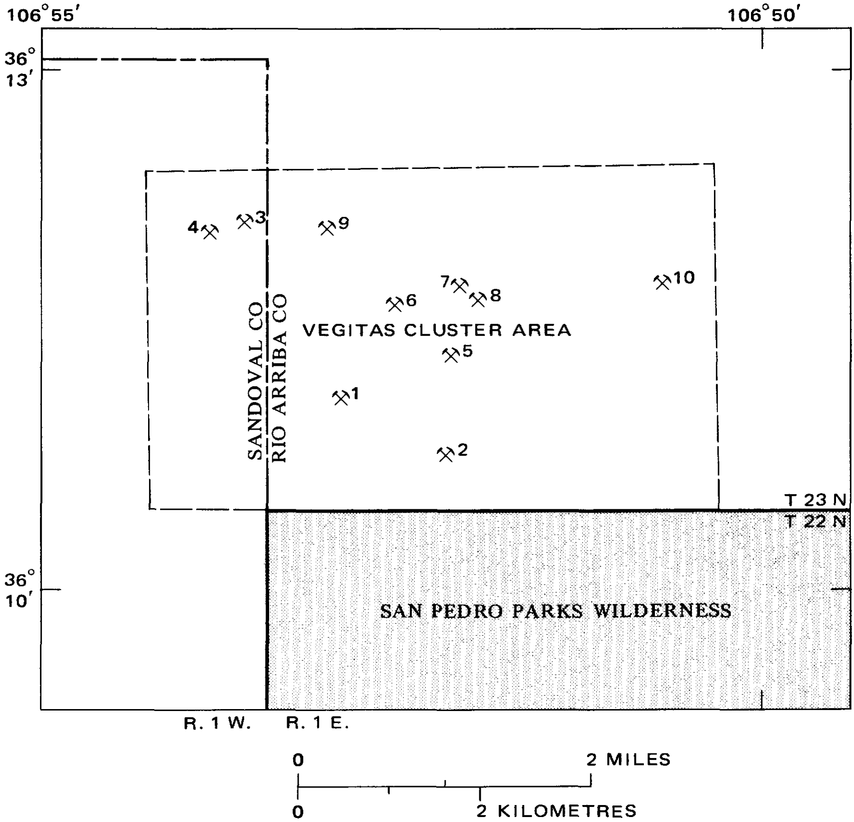

FIGURE 2.—Location of the Vegitas cluster of uranium deposits:

1. Pajarito Azul	6. Yellow Bird No. 2
2. Paradise	7. E & B No. 1
3. Corral No. 1	8. E & B No. 3
4. Corral No. 5	9. Whiteflo No. 1
5. TJBD No. 1	10. O'Brien No. 1

OTHER COMMODITIES

Coal, oil, gas, and gypsum have been produced in areas adjacent to the wilderness, but the strata that contain these commodities do not extend into the wilderness area. No hot springs or other evidence of geothermal energy is present.

CONCLUSIONS

The results of the geochemical sampling, geological observations, and investigation of prospects indicate that the possibility of discovering exploitable metallic mineral or fossil fuel deposits or geothermal energy resources in the wilderness is poor. The Precambrian granite and related crystalline rocks, for the most part, contain only traces of metals. The sedimentary rocks that contain minable deposits of copper in the vicinity are 4 feet thick, at most, where they cover a small part of the wilderness. Deposits of copper or uranium in the Cutler Formation within the wilderness, like those in the adjacent area, are likely to be too small and too low grade to be of economic interest.

Construction materials would have a potential were it not for the presence of large quantities of such materials located closer to points of use.

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TABLE 2.—*Analyses of samples collected by U.S. Geological Survey personnel from*

[For sample localities see pl. 1. Atomic-absorption and colorimetric analyses were made by R. M. O'Leary; spec-
Numbers in parentheses indicate lower limits of determination. Elements looked for spectrographically but not
to the nearest number in a series 1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1, which represent approximate midpoints of group
about 30 percent of the time. G, greater than; H, interference; N, not detected; L, detected, but below limit of
equivalent zinc; ppm, parts per million; * refers to footnote at end of table]

	Atomic Absorption (ppm)				Semiquantitative spectrographic analyses (ppm)											
Sample	Cu (5)	Co (5)	As (10)	Mo (4)	Cu (5)	Pb (10)	Zn (200)	Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	La (20)	Mn (10)	Nb (10)
1	10	5	L	N	10	10	N	N	L	500	1.5	7	20	20	700	N
2	20	L	---	N	10	L	N	N	L	500	1.5	5	L	N	150	N
3	---	---	---	---	10	10	N	N	L	500	L	10	50	20	500	N
4	---	---	---	---	5	10	N	N	L	500	L	70	50	20	1,000	20
5	---	---	---	---	5	20	N	N	10	500	L	10	50	20	1,000	10
6	---	---	---	---	10	20	N	N	15	500	1	7	20	20	500	N
7	---	---	---	---	20	20	N	N	10	500	1	10	70	20	1,000	N
8	---	---	---	---	5	30	N	N	20	300	1	10	70	30	1,000	10
9	---	---	---	---	5	20	N	N	10	500	1	10	50	20	1,000	N
10	---	---	---	---	5	15	N	N	20	500	1	10	70	100	1,000	10
11	10	H10	L	N	5	70	N	N	20	1,000	L	7	20	N	2,000	N
12	---	---	---	---	5	10	N	N	20	500	1	7	70	70	700	10
13*	---	---	---	---	300	50	N	N	20	500	L	10	500	100	1,000	10
14	---	---	---	---	10	30	N	N	20	500	1.5	10	70	20	700	10
15*	---	---	---	---	5	10	N	N	20	500	1.5	10	70	20	1,000	10
16	---	---	---	---	20	10	N	N	15	500	1	10	50	20	1,000	10
17*	---	---	---	---	10	10	N	N	20	700	1	10	70	20	1,000	10
18*	---	---	---	---	30	20	N	N	10	300	L	10	100	20	500	N
19	---	---	---	---	5	10	N	N	10	500	L	7	20	N	1,000	10
20	L	L	---	N	5	10	N	N	N	700	3	N	10	20	1,000	N
21	---	---	---	---	10	10	N	N	N	700	L	7	L	N	300	N
22	5	5	---	N	20	L	N	N	N	1,000	1	7	70	N	500	N
23	20	5	---	N	20	L	N	N	N	300	1.5	10	20	30	700	N
24	---	---	---	---	5	L	N	N	10	500	1	10	15	20	500	10
25	L	5	---	N	30	20	N	N	L	700	1.5	5	L	N	200	N
26*	55	5	---	N	30	L	N	N	10	1,500	2	7	15	N	G5,000	N
27	70	20	---	N	30	10	N	N	10	700	L	70	200	30	1,000	N
28	---	---	---	---	10	20	N	N	30	500	1	10	100	20	1,000	10
29	5	5	---	N	10	20	N	N	L	700	1.5	7	10	20	500	N
30	---	---	---	---	10	20	N	N	15	500	1.5	10	50	30	700	10
31	15	85	---	N	5	N	N	N	L	70	N	70	L	N	3,000	N
32	5	10	---	N	5	L	N	N	L	700	1.5	5	20	N	1,000	10
33	10	H25	---	N	L	L	N	N	N	N	N	N	L	N	500	N
34	25	H25	L	N	L	L	N	N	N	N	N	N	L	N	500	N
35	40	H10	---	N	10	L	N	N	N	L	N	N	20	N	3,000	N
36	5	5	L	N	10	N	N	N	N	300	1.5	N	70	N	200	N
37	120	30	---	N	50	10	N	.5	10	150	N	70	100	N	1,500	N
38	---	---	---	---	5	10	N	N	10	300	L	7	50	N	500	N
39	---	---	---	---	L	L	N	N	10	300	L	5	70	N	500	N
40	L	L	L	N	10	N	N	N	N	70	N	N	L	N	50	N
41	---	---	---	---	15	20	N	N	20	700	1	10	70	20	1,000	N
42	---	---	---	---	20	20	N	N	50	700	1	7	70	N	1,000	N
43	15	5	---	N	10	20	N	N	L	700	1.5	7	20	20	500	N
44	---	---	---	---	5	10	N	N	15	700	L	5	50	20	500	10
45	L	5	---	N	20	10	N	N	L	700	1	7	15	20	300	N
46	---	---	---	---	7	30	N	N	15	700	1	10	70	30	1,000	N
47	---	---	---	---	5	30	N	N	10	700	1	10	70	50	1,500	20
48	---	---	---	---	5	20	N	N	20	500	L	7	50	20	500	10
49	15	20	L	N	15	L	L	N	L	500	1	30	70	20	1,500	N
50*	10	5	N	N	30	L	N	N	L	700	1.5	7	20	20	500	N
51	---	---	---	---	10	20	N	N	20	500	1	5	50	20	1,000	N
52	L	N	---	N	5	N	N	N	10	70	L	N	L	N	30	N
53*	L	L	L	N	5	N	N	N	30	100	L	7	L	N	70	N
54	5	N	---	N	7	10	N	L	L	700	1.5	N	L	N	70	N
55	L	L	---	N	5	10	N	L	L	700	2	N	L	20	500	10
56	L	L	---	N	L	L	N	L	10	500	1.5	5	15	20	150	N
57	10	5	---	N	10	L	N	N	10	700	2	5	50	20	500	N
58	130	L	---	N	5	L	N	N	10	500	L	5	50	20	100	N
59	15	5	---	N	15	10	N	N	30	500	2	15	20	20	200	N
60	5	N	---	N	5	N	N	N	L	70	L	N	L	N	50	N

the San Pedro Parks Wilderness study area, Rio Arriba County, New Mexico

trographic analyses were made by R. N. Babcock, G. W. Day, C. L. Forn, R. T. Hopkins, and C. D. Smith, Jr. found: Sb (100), Bi (10), Cd (20), Au (10), Mo (5), and W (50). Results of the semiquantitative analyses are reported data on a geometric scale. The assigned groups for semiquantitative results will include the quantitative values determination; ---, not looked for; cxCu, cold extractable copper; cxHM, citrate-soluble heavy metals expressed as

	Semiquantitative spectrographic analyses--Continued											Colorimetric		
	(ppm)							(percent)				(ppm)		
Sample	Ni (5)	Sc (5)	Sn (10)	Sr (100)	V (10)	Y (10)	Zr (10)	Fe (.05)	Mg (.02)	Ca (.05)	Ti (.002)	cxCu (1)	cxHM (1)	Sample description
1	7	10	N	100	30	30	150	1.5	0.5	1	0.2	---	---	Granite.
2	5	5	N	100	20	10	50	.5	.2	.2	.1	---	---	Do.
3	30	5	10	100	100	30	100	2	.5	.2	.3	20	20	Stream sediment.
4	10	15	N	150	100	50	1,000	5	.2	.5	.5	5	5	Do.
5	10	15	N	150	100	50	700	5	.5	.5	.5	5	11	Do.
6	20	7	N	100	50	30	200	2	.5	.5	.3	4	5	Do.
7	30	7	15	150	50	30	300	2	.5	.5	.3	10	17	Do.
8	20	15	N	100	100	50	G1,000	3	.5	.3	.5	5	9	Do.
9	20	7	10	L	50	30	500	2	.5	.5	.5	5	11	Do.
10	20	10	10	L	50	50	500	3	.5	.3	.5	5	20	Do.
11	7	15	N	150	20	50	30	.5	2	15	.05	---	---	Limestone.
12	10	7	10	L	50	50	G1,000	3	.5	.5	.5	5	11	Stream sediment.
13*	300	7	100	N	30	G200	500	2	.2	.5	.5	90	60	Do.
14	30	10	N	100	50	30	150	3	.5	2	.5	5	11	Do.
15*	30	7	N	N	50	30	500	2	.5	1	.5	5	17	Do.
16	10	10	N	100	50	100	300	3	.5	.5	.5	5	11	Do.
17*	30	10	10	150	50	50	500	3	.5	.5	.5	5	11	Do.
18*	70	10	15	150	50	20	200	2	.5	.2	.3	20	40	Do.
19	10	15	10	150	30	30	G1,000	1.5	.2	.2	.5	1	9	Do.
20	L	10	N	1,000	100	30	200	3	.05	.5	.2	---	---	Green veinlet.
21	5	5	N	100	10	20	200	1	.1	.2	.2	4	3	Stream sediment.
22	7	10	N	150	30	20	200	1.5	.5	1	.2	---	---	Granite.
23	7	20	N	150	70	70	500	3	.7	1	.3	---	---	Gray granite.
24	5	7	N	100	30	20	300	1.5	.2	.2	.2	5	9	Stream sediment.
25	5	5	N	150	20	30	150	1	.2	.5	.1	---	---	Granite.
26*	7	15	N	150	50	30	300	2	.5	.1	.3	---	---	Do.
27	70	30	N	200	150	50	100	3	2	3	.2	---	---	Greenstone.
28	30	10	15	100	50	30	1,000	3	.5	.3	.5	20	17	Stream sediment.
29	7	5	N	200	30	30	150	1	.3	1	.2	---	---	Granite.
30	20	10	10	100	70	50	150	2	.3	.3	.2	4	17	Stream sediment.
31	150	N	N	N	70	N	N	10	3	.05	.015	---	---	Green veinlet.
32	7	10	N	100	20	30	200	2	.5	.5	.2	---	---	Greenstone.
33	N	N	N	100	10	N	N	.07	.2	G20	.005	---	---	Limestone.
34	L	N	N	100	10	N	N	.07	.2	20	.005	---	---	Do.
35	L	N	N	100	15	N	N	.07	1	20	.005	---	---	Fetid limestone.
36	5	15	N	150	10	20	150	2	.1	.5	.1	---	---	Granite.
37	70	30	N	200	300	30	100	10	3	5	.5	---	---	Greenstone, float.
38	10	5	N	100	20	20	150	1.5	.2	7	.2	1	9	Stream sediment.
39	7	L	N	100	20	10	200	1	.1	10	.2	4	5	Do.
40	5	N	N	N	15	L	150	.2	.05	.05	.05	---	---	Sandstone.
41	20	15	N	100	100	30	200	2	.5	.7	.2	5	17	Stream sediment.
42	30	15	10	100	100	30	150	2	.5	1	.2	10	11	Do.
43	7	15	N	150	30	30	200	1.5	.1	.7	.2	---	---	Granite.
44	7	5	N	100	50	20	500	2	.2	.2	.3	2	7	Stream sediment.
45	7	7	N	200	30	30	100	1.5	.5	.7	.15	---	---	Granite.
46	10	15	N	150	100	50	300	5	.5	.5	.3	4	11	Stream sediment.
47	10	15	N	150	70	50	300	3	.5	.5	.5	4	7	Do.
48	7	15	N	150	50	30	500	2	.5	.5	.5	2	9	Do.
49	30	30	N	300	100	30	150	5	1.5	2	.7	---	---	Greenstone.
50*	7	10	N	100	30	30	200	1.5	.5	.5	.2	---	---	Granite.
51	10	5	N	100	50	20	200	2	.5	1	.3	10	7	Stream sediment.
52	L	N	N	N	15	N	N	.05	L	.2	.003	---	---	Chert float.
53*	7	5	N	N	30	N	30	1	.1	.1	.05	---	---	Quartz vein.
54	L	N	N	N	10	20	200	.5	.02	.1	.1	---	---	Sheared granite.
55	L	7	10	100	10	30	150	1	.1	.2	.2	---	---	Granite.
56	7	7	N	200	50	20	200	1.5	.5	.5	.2	---	---	Sandstone.
57	7	7	N	200	100	20	300	1.5	.5	.5	.3	---	---	Do.
58	5	5	N	300	50	30	100	1.5	.5	15	.15	---	---	Do.
59	20	10	N	200	70	10	200	2	.5	.7	.2	---	---	Red shale.
60	L	N	N	N	10	N	30	.1	.07	.1	.02	---	---	Chert.

TABLE 2.—*Analyses of samples collected by U.S. Geological Survey personnel from the*

Sample	Atomic Absorption (ppm)				Semiquantitative spectrographic analyses (ppm)											
	Cu	Co	As	Mo	Cu	Pb	Zn	Ag	B	Ba	Be	Co	Cr	La	Mn	Nb
	(5)	(5)	(10)	(4)	(5)	(10)	(200)	(.5)	(10)	(20)	(1)	(5)	(10)	(20)	(10)	(10)
61	L	L	---	N	5	L	N	N	L	500	1.5	N	10	N	70	N
62	L	L	---	N	7	L	N	L	L	500	1.5	N	L	N	100	N
63	---	---	---	---	5	30	N	N	15	700	1.5	5	20	N	1,000	10
64	L	N	---	N	5	20	N	L	L	20	2	N	L	N	150	10
65	L	L	---	N	5	L	N	N	L	700	1	N	L	N	500	N
66	L	L	---	N	5	10	N	N	L	700	1	N	L	20	150	N
67	---	---	---	---	5	20	N	N	15	700	1.5	7	50	20	1,500	N
68	---	---	---	---	5	20	N	N	10	700	1.5	10	50	N	1,500	N
69	L	N	---	N	5	30	N	L	L	L	1.5	N	L	N	700	30
70	10	L	---	N	L	L	N	N	L	20	N	N	20	N	700	N
71	L	N	---	N	10	30	N	L	10	50	2	N	L	N	100	30
72	---	---	---	---	5	20	N	N	20	1,000	1.5	5	70	50	1,500	20
73	15	L	---	N	10	20	N	L	N	700	1.5	N	L	N	200	N
74	L	L	---	N	5	N	N	N	N	30	L	N	L	N	30	N
75	L	N	---	N	5	30	N	L	10	70	1.5	N	L	N	100	30
76	---	---	---	---	20	100	N	N	20	700	2	10	20	150	3,000	30
77	L	N	---	N	L	70	N	L	10	L	1.5	N	L	N	700	30
78	L	N	---	N	5	20	N	N	10	L	1.5	N	L	N	200	20
79	10	5	---	N	L	10	N	L	N	700	1	5	L	N	200	N
80	25	N	L	N	10	L	N	N	N	700	L	N	L	N	100	N
81	---	---	---	---	10	30	N	N	10	700	1.5	20	70	20	1,000	N
82	---	---	---	---	10	20	N	N	L	700	1	10	70	20	1,500	10
83	35	30	N	N	20	L	N	N	N	1,500	L	70	20	50	1,000	N
84	L	N	L	N	5	N	N	N	N	70	N	N	L	N	50	N
85	10	H5	---	N	20	L	N	N	15	5,000	L	N	10	N	1,500	N
86	10	H5	N	N	L	L	N	N	N	50	N	N	15	N	1,000	N
87	5	H10	---	N	5	L	N	N	N	70	N	N	10	N	500	N
88	5	15	---	N	5	20	N	N	20	700	1.5	5	L	20	150	10
89	L	N	N	N	L	L	N	N	N	100	N	N	L	N	50	N
90	---	---	---	---	7	30	N	N	20	700	3	10	20	30	1,000	10
91*	---	---	---	---	5	30	N	N	20	700	2	7	20	20	1,000	30
92	---	---	---	---	5	10	N	N	15	500	1	5	50	N	700	30
93	L	N	---	N	5	N	N	N	N	200	L	N	L	N	50	10
94	5	H5	---	N	L	L	N	N	N	50	L	N	20	N	500	N
95	L	N	---	N	L	L	N	L	N	700	1	N	10	N	100	10
96*	---	---	---	---	5	20	N	N	15	300	1.5	15	50	30	700	20
97	20	10	---	N	5	L	N	N	L	300	1	30	20	50	1,000	10
98	5	H5	---	N	L	N	N	N	N	N	N	N	L	N	200	N
99	140	N	---	N	50	N	N	N	N	300	L	5	L	N	50	N
100	---	---	---	---	5	30	N	N	10	500	1.5	10	70	30	700	20
101	5	H10	---	N	5	N	N	N	20	500	1	5	L	N	200	N
102	10	L	---	N	L	L	N	N	N	50	N	N	N	N	500	N
103	---	---	---	---	L	10	N	N	10	300	1	5	20	150	1,000	30
104	40	25	---	N	100	10	N	N	15	1,000	L	70	150	30	1,500	N
105	50	20	---	N	70	10	N	N	20	200	L	70	1,000	20	1,500	N
106	---	---	---	---	30	20	N	N	L	500	1	20	70	30	1,000	10
107	---	---	---	---	20	10	N	N	10	300	1	30	150	20	1,000	N
108	5	15	---	N	10	15	N	N	L	300	2	L	15	20	300	N
109	5	5	---	N	15	15	N	N	L	500	1.5	L	10	30	300	N
110	L	10	---	N	15	10	N	N	L	300	1.5	10	70	100	1,500	N
111	L	L	---	N	15	10	N	N	N	500	L	N	L	L	30	N
112	5	5	---	N	30	15	N	N	N	300	1	L	15	20	3,000	N
113	L	L	N	N	10	L	N	N	10	L	1	L	L	L	20	N
114	L	N	N	N	15	N	N	N	10	20	L	L	70	L	70	N
115	5	5	N	N	10	10	N	N	L	300	L	L	50	30	300	N
116	5	5	N	N	5	L	N	N	L	100	L	L	L	20	700	N
117	5	L	L	N	20	10	N	N	20	300	1.5	10	15	30	700	N
118	---	---	---	---	7	30	N	N	20	500	1.5	10	70	20	1,000	10
119	L	10	N	N	5	10	N	N	10	300	L	L	L	20	2,000	N
120	---	---	---	---	5	L	N	N	20	300	1	5	150	20	500	10

San Pedro Parks Wilderness study area, Rio Arriba County, New Mexico—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ni (5)	Sc (5)	Sn (10)	Sr (100)	V (10)	Y (10)	Zr (10)	(percent) Fe (.05)	Mg (.02)	Ca (.05)	Ti (.002)	Colorimetric (ppm) cxCu (1)	cxHM (1)	Sample description
61	7	L	N	100	20	10	30	0.3	0.1	0.2	0.05	---	---	Sandstone.
62	5	5	N	100	10	30	150	.5	.1	.2	.1	---	---	Granite.
63	7	7	N	100	30	30	500	1.5	.2	.2	.3	L	11	Stream sediment.
64	L	L	N	N	10	30	100	.2	.02	.05	.03	---	---	Granite.
65	L	7	N	100	10	30	150	1	.1	.2	.15	---	---	Do.
66	L	L	N	N	15	50	300	1	.03	.1	.1	---	---	Do.
67	7	10	N	150	30	30	300	2	.2	.5	.3	10	9	Stream sediment.
68	7	7	10	150	30	30	300	3	.2	.3	.2	1	11	Do.
69	L	L	N	N	20	70	70	.5	.02	.05	.05	---	---	Granite.
70	L	N	N	500	20	N	20	1	.2	20	.01	---	---	Limestone.
71	5	5	L	N	10	70	100	.3	.05	.1	.1	---	---	Granite.
72	7	7	N	100	20	70	500	1.5	.2	.2	.3	1	7	Stream sediment.
73	L	L	N	N	10	30	200	1	.05	.1	.1	---	---	Greenstone.
74	L	N	N	N	15	10	30	.07	.02	L	.05	---	---	Quartzite.
75	L	5	L	N	20	70	30	.3	.05	.1	.05	---	---	Granite.
76	7	10	10	N	50	300	200	1.5	.2	.15	.3	2	11	Stream sediment.
77	L	15	10	N	10	100	30	.3	.05	.07	.05	---	---	Granite.
78	L	15	L	N	10	30	30	.2	.05	.07	.02	---	---	Do.
79	5	10	N	200	30	20	150	2	.5	1	.2	---	---	Do.
80	L	5	N	N	10	20	100	.5	.02	.1	.1	---	---	Do.
81	10	15	10	150	50	50	500	3	.5	.7	.3	2	11	Stream sediment.
82	10	15	L	150	70	50	200	3	.5	.7	.3	2	7	Do.
83	50	15	N	700	200	30	150	5	2	2	.5	---	---	Gabbro float.
84	5	L	N	N	30	15	30	.2	.05	.1	.1	---	---	Sandstone.
85	5	L	N	200	100	10	30	.15	.1	5	.05	---	---	Do.
86	7	L	N	500	20	30	20	1	.5	20	.01	---	---	Limestone.
87	5	N	N	200	10	15	10	.2	.2	20	.01	---	---	Do.
88	7	5	N	100	30	20	100	1.5	.2	.5	.1	---	---	Granite.
89	5	L	N	N	10	N	20	.07	.02	.15	.02	---	---	Sandstone.
90	20	10	15	N	70	150	200	2	.3	.3	.3	2	7	Stream sediment.
91*	7	5	N	100	50	70	300	1.5	.2	.2	.2	2	5	Do.
92	7	5	N	100	70	30	700	2	.2	.2	.5	2	3	Do.
93	5	L	N	N	20	N	20	.15	.05	.05	.015	---	---	Sandstone.
94	L	L	N	150	20	20	20	.2	.2	20	.02	---	---	Limestone.
95	L	5	N	100	10	20	150	1	.1	.2	.15	---	---	Granite.
96*	20	7	N	L	50	50	200	1.5	.3	1	.2	2	7	Stream sediment.
97	7	15	N	150	100	30	200	5	.5	2	.5	---	---	Greenstone.
98	L	N	N	150	10	N	L	.05	.1	20	.005	---	---	Limestone.
99	7	L	N	N	10	N	50	.1	.1	.15	.05	---	---	Sandstone.
100	20	7	N	L	50	70	200	1.5	.2	.15	.2	2	7	Stream sediment.
101	5	5	N	100	20	15	50	.2	.1	.2	.1	---	---	Sandstone.
102	L	N	N	700	10	N	N	.07	.2	20	.01	---	---	Limestone.
103	20	10	N	N	70	150	700	2	.2	.2	.5	2	7	Stream sediment.
104	100	30	N	500	200	70	150	3	3	3	.7	---	---	Greenstone.
105	500	30	N	700	150	10	70	3	5	5	.3	---	---	Do.
106	30	15	N	200	50	30	200	5	1	1	.5	4	2	Stream sediment.
107	100	15	N	200	100	20	200	5	2	2	.5	4	3	Do.
108	10	5	N	200	30	10	70	1	.2	.5	.2	---	---	Conglomerate.
109	5	10	N	150	20	70	150	1	.3	.7	.2	---	---	Granite.
110	15	15	N	300	50	70	200	1.5	1	1.5	.3	---	---	Gneiss.
111	5	N	N	100	L	N	L	.1	.03	.07	.03	---	---	Quartz vein.
112	5	5	N	150	30	30	50	.2	.15	10	.05	---	---	Sandstone.
113	5	L	N	N	L	L	L	L	L	.3	.002	---	---	Chert.
114	10	L	N	N	10	L	L	.2	L	.7	L	---	---	Do.
115	10	10	N	150	30	20	70	1.5	.3	20	.2	---	---	Sandstone.
116	L	5	N	150	15	20	50	.5	.3	15	.07	---	---	Tuffaceous sandstone.
117	15	7	N	200	70	20	150	1	.7	1	.2	---	---	Sandstone.
118	10	10	N	100	50	50	500	5	.5	.5	.5	2	11	Stream sediment.
119	5	7	N	150	20	70	100	.7	.7	15	.07	---	---	Sandstone.
120	7	7	N	100	50	70	700	1.5	.2	.2	.5	2	7	Stream sediment.

TABLE 2.—*Analyses of samples collected by U.S. Geological Survey personnel from the*

Sample	Atomic Absorption (ppm) Cu (5)	Co (5)	As (10)	Mo (4)	Semiquantitative spectrographic analyses (ppm) Cu (5)	Pb (10)	Zn (200)	Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	La (20)	Mn (10)	Nb (10)
121	---	---	---	---	20	L	N	N	20	500	1	5	50	N	500	N
122	L	5	---	N	7	10	N	N	L	300	2	10	L	30	700	N
123	30	90	N	N	70	15	200	N	20	200	1.5	150	100	N	700	N
124	15	N	N	N	15	L	N	N	N	50	L	L	30	L	15	N
125	L	L	N	N	10	10	N	N	N	300	1	N	L	30	15	N
126	5	5	---	N	10	15	N	N	N	G5,000	1	L	20	20	3,000	N
127	5	5	---	N	10	20	N	N	10	200	L	5	L	20	3,000	N
128	15	L	---	N	15	20	N	N	15	500	2	5	15	30	300	N
129	10	N	---	N	15	N	N	N	N	L	L	L	L	L	300	N
130	L	N	---	N	10	L	N	N	N	30	L	L	L	20	L	N
131	10	N	---	N	15	20	N	N	L	500	2	10	20	20	1,000	N
132	---	---	---	---	15	15	N	N	15	200	1.5	10	50	20	1,000	N
133*	3,200	N	---	N	G20,000	20	N	20	70	300	L	L	15	20	20	N
134	400	L	---	N	100	10	N	N	L	200	1	N	L	L	700	N
135	25	10	---	N	70	L	300	N	50	150	L	70	150	N	G5,000	N
136	15	L	---	N	20	L	N	N	L	700	1	N	L	N	500	N
137	L	N	N	N	5	N	N	N	10	70	N	N	10	N	50	N
138	20	N	---	N	10	20	N	N	L	500	1.5	5	20	N	200	10
139	---	---	---	---	5	20	N	N	15	500	1	7	70	20	1,500	10
140	---	---	---	---	5	10	N	N	10	700	L	10	70	20	5,000	10
141	L	L	---	N	7	10	N	L	L	500	1	N	L	N	70	N
142	L	L	L	N	5	N	N	N	10	70	N	N	L	N	50	N
143	L	N	L	N	L	N	N	N	10	70	N	N	15	N	50	N
144	10	5	---	N	7	10	N	L	L	700	1	5	20	N	700	N
145	---	---	---	---	20	30	N	N	50	1,000	1	50	70	50	5,000	10
146	---	---	---	---	5	20	N	N	20	700	L	7	50	20	2,000	10
147	---	---	---	---	10	30	N	N	10	700	1	10	50	30	2,000	N
148	---	---	---	---	10	20	N	N	10	700	1	30	70	20	3,000	N
149	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
150*	---	---	---	---	20	50	N	N	20	700	1.5	5	70	300	700	N
151*	L	N	L	N	L	N	N	N	300	30	L	N	L	N	70	20
152	L	N	---	N	L	70	300	N	L	70	2	N	L	N	300	70
153	L	L	10	N	L	20	N	L	L	700	1	N	L	N	100	30
154	L	N	---	N	30	30	N	N	L	L	1	N	L	N	70	20
155	2	N	10	N	L	20	N	L	N	300	1	N	L	50	50	20
156	---	---	---	---	5	30	N	N	20	700	1.5	10	70	20	700	20
157	5	N	L	N	5	N	N	N	15	70	L	N	15	N	50	N
158*	L	N	10	N	30	30	N	N	L	G5,000	1	N	L	N	300	N
159	N	N	L	N	10	N	N	N	L	1,500	N	N	L	N	20	N
160	5	N	---	N	10	20	N	N	10	1,500	2	N	L	20	150	10
161	---	---	---	---	5	30	L	N	L	300	1	20	70	20	1,000	10
162	10	5	L	N	10	10	N	N	10	500	2	5	L	20	500	L
163	L	N	L	N	L	N	N	N	10	70	N	N	L	N	70	N
164	---	---	---	---	L	30	N	N	20	500	2	10	50	50	1,500	30
165	L	N	---	N	L	L	N	N	N	200	1.5	N	L	N	100	20
166	---	---	---	---	7	70	N	N	30	300	2	7	70	30	1,500	30
167	5	H5	N	N	L	L	N	N	N	30	N	N	L	N	500	N
168	---	---	---	---	5	30	N	N	20	500	1.5	7	50	20	1,000	20
169	L	N	L	N	5	20	N	N	N	70	L	N	L	N	50	20
170	---	---	---	---	20	30	N	N	10	500	2	7	50	20	1,500	20
171	L	N	---	N	L	20	N	N	N	70	L	N	L	N	70	20
172	L	N	---	N	L	N	N	N	N	200	L	N	L	N	100	N
173	5	H5	---	N	L	N	N	N	N	N	N	N	10	N	200	N
174	5	5	N	N	5	L	N	N	N	500	L	5	L	N	200	10
175	10	H10	N	N	L	L	N	N	N	N	N	N	L	N	1,000	N
176	5	5	---	N	15	15	N	N	L	300	1.5	10	15	30	700	N
177	---	---	---	---	10	30	N	N	10	300	1	7	20	20	500	N
178	---	---	---	---	10	20	N	N	N	500	1.5	5	L	N	700	N
179	10	5	---	N	50	10	N	N	10	300	2	10	15	20	3,000	N
180	L	N	---	N	10	N	N	N	N	L	N	L	15	L	50	N

San Pedro Parks Wilderness study area, Rio Arriba County, New Mexico—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ni (5)	Sc (5)	Sn (10)	Sr (100)	V (10)	Y (10)	Zr (10)	(percent) Fe (.05)	Mg (.02)	Ca (.05)	Ti (.002)	Colorimetric (ppm) cxCu (1)	cxHM (1)	Sample description
121	7	7	N	100	100	50	300	3	0.2	1	0.3	2	5	Stream sediment.
122	10	10	N	L	30	50	100	1	.7	.3	.2	---	---	Granite.
123	150	50	N	N	200	70	70	3	3	.07	.5	---	---	Greenstone.
124	7	L	N	N	10	L	20	.3	.1	L	.03	---	---	Chert.
125	5	10	N	L	30	50	300	.7	.3	.07	.2	---	---	Granite.
126	10	15	N	700	50	20	30	.5	.7	15	.07	---	---	Sandstone.
127	5	L	N	100	50	30	50	.7	3	15	.07	---	---	Do.
128	10	15	N	200	70	70	200	1	.5	.3	.3	---	---	Granite.
129	7	N	N	N	10	N	N	.5	L	L	.002	---	---	Quartz vein.
130	7	L	N	N	20	L	70	.05	L	L	.2	---	---	Sandstone.
131	10	15	N	300	30	30	200	1.5	.7	1	.3	---	---	Granite.
132	15	7	N	150	70	30	300	1	.7	3	.3	---	---	Stream sediment.
133*	7	7	N	N	100	15	300	.15	.07	.1	.3	---	---	Sandstone.
134	L	20	N	300	L	20	70	1.5	.2	2	.15	---	---	Granite.
135	150	70	N	150	300	20	30	7	5	7	.7	---	---	Greenstone float.
136	10	15	N	100	10	15	70	1.5	.2	1	.1	---	---	Granite.
137	L	N	N	N	15	N	20	.1	.02	.05	.015	---	---	Chert float.
138	7	7	N	100	30	20	100	1	.5	.2	.2	---	---	Granite.
139	30	15	N	100	50	50	500	2	.2	.5	.5	5	11	Stream sediment.
140	30	15	N	150	100	50	500	3	1	.7	.5	4	5	Do.
141	L	L	N	N	10	10	150	.5	.05	.15	.1	---	---	Granite.
142	L	N	N	N	20	N	30	.1	.02	L	.02	---	---	Chert float.
143	L	N	N	N	30	N	N	.5	L	L	.005	---	---	Do.
144	7	15	N	500	30	50	150	2	.5	2	.2	---	---	Granite.
145	30	5	10	100	70	70	300	5	.5	.7	.5	20	45	Stream sediment.
146	7	10	N	100	50	30	300	1.5	.3	.5	.3	5	17	Do.
147	10	15	N	100	70	50	500	5	.5	.7	.3	1	9	Do.
148	10	15	N	100	70	30	500	5	.5	.5	.3	1	17	Do.
149	---	---	---	---	---	---	---	---	---	---	---	20	35	Do.
150*	30	7	10	100	50	70	300	1	.2	.2	.3	2	15	Do.
151*	L	5	N	N	10	50	20	.1	.03	L	.01	---	---	Granite.
152	L	15	10	N	30	G200	150	1	.1	.05	.2	---	---	Do.
153	L	5	N	N	10	G200	100	.1	.02	L	.02	---	---	Aplite veinlet.
154	L	5	N	N	10	200	30	.2	.02	.1	.2	---	---	Granite.
155	L	5	N	N	20	100	30	2	.02	L	.02	---	---	Veinlet.
156	30	10	N	N	70	50	200	2	.2	.15	.2	4	17	Stream sediment.
157	L	N	N	N	20	N	N	.07	L	.1	.002	---	---	Chert.
158*	L	N	N	700	10	30	10	.3	.02	.07	.01	---	---	Granite with barite.
159	L	N	N	N	10	10	20	.1	L	L	.01	---	---	Orthoquartzite.
160	L	L	L	N	10	30	50	.5	.07	.1	.1	---	---	Granite.
161	20	15	N	150	100	70	500	5	.5	.5	.5	1	11	Stream sediment.
162	7	10	N	150	30	30	200	2	.5	1	.2	---	---	Granite.
163	L	N	N	N	10	N	50	.07	L	.1	.005	---	---	Chert float.
164	30	15	N	N	70	100	200	2	.3	.5	.5	2	9	Stream sediment.
165	5	5	N	N	10	30	100	.5	.05	.15	.15	---	---	Granite.
166	20	10	10	L	50	150	200	1.5	.2	2	.2	1	7	Stream sediment.
167	L	N	N	150	10	10	10	.07	.2	20	.01	---	---	Limestone.
168	7	7	10	100	50	50	300	1.5	.2	.2	.3	2	9	Stream sediment.
169	5	L	N	N	10	30	30	.2	.02	.1	.05	---	---	Granite.
170	7	7	N	100	30	50	200	2	.2	.2	.3	1	11	Stream sediment.
171	5	L	N	N	10	30	30	.3	.05	.15	.02	---	---	Granite.
172	7	L	N	N	15	N	30	.3	.05	.1	.05	---	---	Sandstone float.
173	L	N	N	200	15	N	10	.07	.2	20	.01	---	---	Limestone.
174	7	5	N	N	20	15	150	.5	.1	.2	.2	---	---	Sandstone.
175	N	N	N	200	10	L	10	.07	.2	20	.01	---	---	Limestone.
176	7	15	N	200	30	70	300	1	.7	1	.2	---	---	Granite.
177	7	10	N	100	50	20	500	1.5	.2	.5	.5	1	7	Stream sediment.
178	5	5	N	100	20	20	200	1.5	.1	.2	.2	2	7	Do.
179	7	30	N	300	50	50	300	2	.7	1.5	.3	---	---	Granite.
180	5	N	N	N	L	L	L	.05	L	L	.007	---	---	Vein quartz float.

TABLE 2.—*Analyses of samples collected by U.S. Geological Survey personnel from the*

Sample	Atomic Absorption (ppm)				Semiquantitative spectrographic analyses (ppm)											
	Cu (5)	Co (5)	As (10)	Mo (4)	Cu (5)	Pb (10)	Zn (200)	Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	La (20)	Mn (10)	Nb (10)
181	---	---	---	---	10	30	N	N	10	700	1.5	30	50	20	2,000	N
182	5	5	---	N	20	15	N	N	L	1,000	1	10	20	30	1,500	N
183	L	N	---	N	15	L	N	N	L	L	1	L	15	L	300	N
184	L	5	---	N	20	15	N	N	L	700	1.5	10	15	30	1,500	N
185	5	5	---	N	15	20	N	N	10	300	2	10	L	20	700	N
186	L	L	N	N	20	20	N	N	N	500	1	N	L	L	300	N
187	15	15	N	N	20	20	N	N	10	150	1	15	L	L	1,500	N
188	---	---	---	---	50	30	N	N	20	300	1.5	15	30	30	1,500	N
189	L	10	N	N	15	15	N	N	15	200	1.5	20	L	20	1,500	N
190	L	N	N	N	15	30	N	N	N	1,500	L	N	L	L	300	N
191	L	5	N	N	10	L	N	N	30	70	1	5	L	20	1,500	N
192	---	---	---	---	50	30	N	N	50	300	1.5	20	150	30	3,000	N
193	25	L	N	N	20	15	N	N	N	500	L	N	L	30	300	N
194	---	---	---	---	50	30	N	N	30	300	1.5	10	50	70	1,500	N
195	---	---	---	---	2,000	15	N	N	N	700	L	5	L	20	200	N
196	---	---	---	---	50	L	N	N	N	200	1	10	L	20	150	N
197*	---	---	---	---	10,000	15	N	15	30	1,500	1.5	5	10	N	3,000	N
198	---	---	---	---	30	10	N	N	N	500	1	5	10	20	100	N
199*	---	---	---	---	10	20	N	N	N	500	1.5	N	L	30	300	10
200	---	---	- -	---	5	10	N	N	N	300	1	L	L	L	150	N
201*	---	---	---	---	L	15	N	N	N	100	1.5	5	L	30	50	10
202*	---	---	---	---	7	L	N	N	N	200	L	5	30	20	150	N
203*	---	---	---	---	20	7,000	200	5	L	150	L	20	150	L	700	N
204*	---	---	---	---	500	15	N	N	L	700	1	5	15	30	700	10
205*	---	---	---	---	300	15	N	N	10	1,500	1	5	20	30	700	10
206*	---	---	---	---	150	15	N	N	L	1,000	1	7	10	30	700	10
207*	---	---	---	---	200	L	L	N	30	1,000	7	10	L	50	G5,000	N
208	---	---	---	---	5	L	N	N	N	700	1	L	L	L	3,000	N
209*	---	---	---	---	7	L	N	N	L	1,500	1	L	L	20	G5,000	N

13. Contains 30 ppm Mo.
15. Rito Resumidero, east of area shown on pl. 1.
17. Contains 10 ppm Mo.
18. Contains 5 ppm Mo.
26. Contains 50 ppm Mo.
50. Contains L(10) ppm Bi.
53. Precise locality unknown; not shown on map; sample allegedly taken from "silver" prospect near south edge of sec. 1, T. 22 N., R. 1 W. Sample contains no silver.
91. Rito Redondo, east of area shown on pl. 1.
96. Rito Resumidero, east of area shown on pl. 1.
133. Near Nacimiento mine, south of area shown on pl. 1.
150. Contains L(3) ppm Mo.

TABLE 3.—*Analyses of samples collected by U.S. Bureau of Mines*

[Samples 2301 through 2312 were analyzed by six-step semiquantitative spectrographic analyses by G. W. Day and W. Colo. All other samples were analyzed by semiquantitative spectrographic and fire assay methods in the U.S. Bureau Wadsworth spectrograph with 30-inch plateholder. Estimates of concentrations were made by comparing intensity of tration, is assumed for Bureau of Mines analyses. Results of the Geological Survey analyses are reported to the on a geometric scale; assigned groups for semiquantitative results will include the quantitative value about 30 per- detection for that element; where Bureau of Mines and Geological Survey limits differ for an element, the Bureau amount shown; <, less than the amount shown; Tr, trace, ---, looked for but not found and hence may occur only in made; ppm, parts per million. Sample localities are given by township, range, and section (T. R. S.); thus T. 22 N., the New Mexico meridian. The following elements (detection limit in ppm in parentheses) were looked for spec- Bi (40/10), Cd (400/20), Ga (300/N), Hf (80/N), In (100/N), Li (1,000/N), Mo (20/5), P (6,000/N), Pt (50/N), Re ing elements (detection limit in ppm in parentheses) also were determined spectrographically but were found in (30/N), Ca (200/500), Mg (4/200), Na (2,000/N), and Si (3/N)]

San Pedro Parks Wilderness study area, Rio Arriba County, New Mexico—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ni (5)	Sc (5)	Sn (10)	Sr (100)	V (10)	Y (10)	Zr (10)	(percent) Fe (.05)	Mg (.02)	Ca (.05)	Ti (.002)	Colorimetric (ppm) cxCu (1)	cxHM (1)	Sample description
181	10	10	N	100	50	30	200	5	0.5	0.2	0.5	1	9	Stream sediment.
182	15	20	N	300	50	70	200	2	.7	1.5	.3	---	---	Granite.
183	5	N	N	N	L	L	L	.07	L	.07	.002	---	---	Chert float
184	10	20	N	300	30	70	300	2	.7	1.5	.3	---	---	Granite.
185	10	10	N	300	30	20	100	1.5	.7	1.5	.3	---	---	Do.
186	L	5	N	150	15	L	70	.5	.2	.5	.07	---	---	Do.
187	5	30	N	300	70	30	30	2	2	2	.2	---	---	Diorite gneiss.
188	30	30	N	200	150	70	300	2	.7	1.5	.5	4	9	Stream sediment.
189	5	30	N	700	100	30	50	3	1.5	7	.3	---	---	Diorite gneiss.
190	5	5	N	300	20	10	L	.7	.1	1.5	.03	---	---	Pegmatite.
191	10	5	N	L	30	15	300	.7	.3	1.5	.3	---	---	Sandstone.
192	70	30	30	200	200	70	500	3	1.5	2	.5	2	5	Stream sediment.
193	7	5	N	300	15	15	100	.7	.3	.7	.07	---	---	Granite.
194	10	10	N	200	100	20	500	1	.7	.7	.3	2	7	Stream sediment.
195	5	L	N	100	15	10	50	.5	.2	.3	.1	---	---	Sandstone.
196	7	5	N	150	30	L	70	1.5	.7	.3	.15	---	---	Granite.
197*	L	5	N	150	70	20	70	15	1	7	.1	---	---	Smelter slag.
198	7	5	N	150	30	20	70	1.5	.3	1	.15	---	---	Conglomerate.
199*	L	10	N	N	15	70	20	.7	.15	.3	.1	---	---	Granite.
200	L	L	N	150	20	10	20	1	.2	15	.1	---	---	Conglomerate.
201*	7	L	N	N	15	20	70	1	2	1.5	.15	---	---	Clay shale.
202*	5	7	N	100	20	20	20	2	.3	20	.15	---	---	Sandstone.
203*	150	20	L	150	150	20	50	7	5	7	.2	---	---	Dikerock (adit).
204*	10	10	L	100	50	30	150	7	1.5	1	.3	---	---	Basalt dike.
205*	15	15	L	N	50	30	100	7	1.5	.5	.3	---	---	Do.
206*	5	10	L	100	50	70	100	3	1.5	1	.3	---	---	Do.
207*	7	7	N	100	300	150	70	15	.2	1	.07	---	---	Manganese "ore".
208	L	5	N	L	20	20	200	1.5	.2	.1	.15	---	---	Quartz vein.
209*	L	10	N	100	30	30	100	2	.5	.3	.15	---	---	Do.

151. Contains 7 ppm Mo.
158. Contains L(10) ppm Bi.
197. Contains 10 ppm Mo.
199. Contains L(10) ppm Bi.
201. Contains L(10 ppm Bi.
202. Contains L(10) ppm Bi.
203. Less than 20 ppm Sn determined by X-ray fluorescence by J. S. Wahlberg.
204. Contains L(10) ppm Bi.
205. Contains 10 ppm Bi.
206. Contains 10 ppm Bi.
207. Contains 10 ppm Bi, 20 ppm Mo, and 700 ppm W.
209. Contains 50 ppm W.

personnel from the San Pedro Parks Wilderness study area, New Mexico

D. Crim of the U.S. Geological Survey and by fire and chemical assay methods by C. O. Parker and Co., Denver,
of Mines Laboratories in Reno, Nev. Bureau of Mines spectrographic analyses were made using a 3.4-meter
lines in spectra of a graded series of standards. An error of plus 100 percent, minus 50 percent of the reported concen-
nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1, which represent approximate midpoints of group data
cent of the time. The numbers in parentheses beneath the element symbols represent the estimated lower limit of
value is listed first followed by the Survey value. Symbols used are: M, more than 10 percent; >, more than the
amounts below the lower detection limit; L, detected but in amounts below the sensitivity limit; N, no analysis was
R. 1 W., sec. 13 is recorded as 22-1W-13. All are north of the New Mexico base line and are designated east or west of
trographically, but were not detected except as shown in footnotes: Ag(10/0.5), As (1,000/200), Au (30/10), Be (10/1),
(50/N), Sb (300/100), Sn (20/10), Ta (80/N), Te (20,000/N), Ti (3,000/N), W (200/50), and Zn (1,000/200). The follow-
quantities considered as normal for materials in the region sampled and, hence, were not judged to be significant: Al

TABLE 3.—*Analyses of samples collected by U.S. Bureau of Mines personnel*

Sample	Location	Fire assay (ounces per ton)		Semiquantitative spectrographic analyses (ppm)							
	T. R. S.	Au	Ag	B (100/10)	Ba (1,000/20)	Co (40/5)	Cr (30/10)	Cu (20/5)	La (100/20)	Mn (30/10)	Nb (70/10)
1/ 2301	22-1E- 8	0.005	0.10	L	500	5	20	100	20	>5,000	10
2/ 2302	22-1E- 8	.005	.14	10	200	20	10	500	---	>5,000	---
3/ 2303	20-1W- 2	.005	.30	20	500	10	30	50	30	>5,000	10
4/ 2304	20-1W- 2	.01	.14	70	500	20	50	50	30	2,000	10
5/ 2305	21-1W-35	.005	.24	50	300	5	20	30	30	100	10
6/ 2306	21-1W-36	.005	.24	L	200	70	100	70	---	2,000	10
7/ 2308	21-1E-32	.005	.50	L	5,000	5	50	20,000	---	300	10
8/ 2311	21-1W-12	.005	Tr	L	1,000	10	30	700	50	1,000	20
9/ 2312	21-1W-12	.005	.10	L	500	7	30	200	30	500	10
2316	22-1W- 1	---	Tr	---	---	---	100	5,000	---	500	---
2317	21-2E-14	---	.20	---	---	---	100	40,000	---	500	---
2318	21-1W-12	.42	.10	---	---	---	50	600	---	1,000	---
2319	22-1W- 1	---	---	---	---	---	50	5,000	---	500	---
2320	22-1W- 1	---	Tr	---	---	---	100	300	---	500	---
2321	22-1W- 2	Tr	---	---	---	---	---	40	---	1,000	---
2322	22-1W- 2	---	---	---	---	---	30	60	---	500	---
2323	23-1E-30	---	---	---	---	---	30	60	---	2,000	---
2324	23-1W-25	---	---	---	---	---	100	80	---	1,000	---
10/ 2325	20-1W- 1	---	.10	---	4,000	---	50	40,000	---	8,000	---
2326	22-1W- 2	---	---	---	---	---	30	80	---	1,000	---
2327	22-1E-23	---	---	---	---	---	50	80	---	2,000	---
2330	22-1E-34	---	---	---	---	---	100	40	---	1,000	---
2331	22-1E-10	---	---	---	---	---	100	70	---	1,000	---
11/ 2332	22-1E-10	---	---	---	M	---	100	40	---	1,000	---
12/ 2333	22-1E-10	---	---	---	M	---	100	40	---	400	---
2334	22-1E-10	---	---	---	70,000	---	200	70	---	400	---
13/ 2335	22-1E-10	---	---	---	9,000	<40	50	70	---	>60,000	---
2336	22-1E-10	---	---	---	---	---	100	200	---	2,000	---
2337	22-1E-10	---	---	---	---	---	100	40	---	2,000	---
2338	22-1E-15	---	---	---	---	---	100	40	---	2,000	---
2339	22-1E-23	---	---	---	---	---	100	60	---	1,000	---
14/ 2340	22-1E-31	---	---	---	9,000	---	100	200	---	60,000	---
2341	22-1E-31	---	---	---	---	---	100	40	---	2,000	---
15/ 2342	22-1E-31	---	---	---	9,000	---	---	1,000	---	60,000	---
16/ 2349	21-1E- 6	---	---	---	---	---	60	40	---	20,000	---
17/ 2350	21-1E- 6	---	Tr	---	---	---	100	80	---	30,000	---
2354	23-1E-27	---	.10	---	---	---	100	10,000	---	2,000	---
2355	23-1E-27	---	.20	---	---	---	100	20,000	---	2,000	---
2356	23-1E-27	---	---	---	---	---	100	400	---	2,000	---
2357	23-1E-28	---	---	---	---	---	100	70	---	2,000	---
2358	23-1E-28	---	---	---	---	---	100	600	---	2,000	---
2359	23-1E-31	---	.30	---	---	---	100	5,000	---	2,000	---
2360	23-1E-17	---	---	---	---	---	100	70	---	500	---
2361	23-1E-26	---	---	---	6,000	---	100	40,000	---	1,000	---
2362	23-1E-26	---	.20	---	---	---	100	40,000	---	1,000	---
2363	23-1E-26	---	.10	---	---	---	100	1,000	---	1,000	---
2365	21-2E-19	---	.10	---	---	---	100	80	---	500	---
2366	21-2E-19	---	Tr	---	---	---	---	60	---	1,000	---
2370	22-2E-28	---	---	---	---	---	100	600	---	500	---
2372	22-1W- 1	---	Tr	---	1,000	---	60	40	---	2,000	---
2373	22-1W- 1	---	---	100	1,000	---	100	40	---	1,000	---
2374	22-1W- 1	---	---	---	2,000	---	100	40	---	2,000	---

1/ Sample 2301 contains 300 ppm Zn.
2/ Sample 2302 contains 700 ppm Zn.
3/ Sample 2303 contains 3 ppm Be, 500 ppm Sr, and 200 ppm Zn.
4/ Sample 2304 contains 3 ppm Be, 200 ppm Sr, L (0.05) ppm Ag, and L (200) Zn.
5/ Sample 2305 contains 1 ppm Ag, 1 ppm Be, and 200 ppm Sr.
6/ Sample 2306 contains 200 ppm Sr, and L (200) ppm Zn.
7/ Sample 2308 contains 10 ppm Ag, and 200 ppm Sr.
8/ Sample 2311 contains 2 ppm Be, 20 ppm Bi, 100 ppm Sr, and L (0.5) ppm Ag.
9/ Sample 2312 contains 10 ppm Bi, and 10 ppm Sn.

from the San Pedro Parks Wilderness study area, New Mexico—Continued

Semiquantitative spectrographic analyses--Continued

Sample	(ppm)						(percent)		Sample description
	Ni	Pb	Sc	V	Y	Zr	Fe	Ti	
	(20/5)	(100/10)	(50/5)	(60/10)	(10)	(70/10)	(.004/.05)	(.001/.002)	
2301	5	70	10	30	10	20	5	0.1	Quartz vein.
2302	5	50	30	30	20	20	10	.3	Pit sample.
2303	5	20	15	50	30	100	20	.1	Ferruginous shale.
2304	5	70	15	150	30	200	2	.7	Carbonaceous shale.
2305	5	30	10	70	20	200	2	.1	Dump sample.
2306	100	10	50	200	30	100	10	1	Greenstone dike.
2308	5	L	5	50	50	70	2	.05	Copper ore.
2311	7	50	15	50	70	500	5	.5	Fault gouge.
2312	7	10	10	30	20	100	5	.2	Do.
2316	---	2,000	---	<60	400	70	2	.1	Sandstone.
2317	---	---	---	400	30	70	2	.2	Sandstone specimen.
2318	---	---	---	<60	50	300	4	.2	Selected specimen.
2319	---	---	---	<60	---	<70	.4	.1	Sandstone.
2320	---	200	---	<60	---	<70	.9	.1	Do.
2321	---	---	---	---	---	70	.5	.1	Do.
2322	---	---	---	<60	---	100	.5	.1	Do.
2323	---	---	---	<60	---	<70	.5	.1	Do.
2324	---	100	---	<60	---	70	2	.2	Yellow sandstone.
2325	---	500	---	<60	---	300	M	.2	Smelter slag.
2326	---	---	---	<60	---	70	2	.1	Calcareous sandstone.
2327	---	400	---	---	400	<70	2	.1	Quartz stringer.
2330	---	100	---	---	---	100	4	.2	Quartz muscovite vein.
2331	---	200	---	---	---	200	4	.2	Dump sample.
2332	---	200	---	---	---	100	3	.1	Do.
2333	---	400	---	<60	---	70	3	.01	Do.
2334	---	100	---	<60	---	---	3	.01	Do.
2335	---	700	---	200	---	---	4	.003	Manganese specimen.
2336	---	100	---	<60	30	100	4	.02	Fault breccia.
2337	---	100	---	---	400	70	4	.2	Manganese in granite.
2338	---	200	---	<60	30	<70	3	.02	Do.
2339	---	200	---	<60	500	70	3	.01	Breccia and quartz.
2340	---	200	---	<60	30	70	5	.2	Manganese specimen.
2341	---	100	---	<60	---	100	5	.2	Granite.
2342	---	400	---	<60	---	70	7	.1	Manganese.
2349	---	---	---	<60	---	200	7	.1	Manganese in granite.
2350	---	---	---	<60	---	<70	3	.02	Do.
2354	---	<100	---	100	---	70	4	.2	Conglomerate.
2355	---	<100	---	100	---	70	4	.2	Sandstone and shale.
2356	---	<100	---	<60	---	300	4	.2	Sandstone.
2357	---	<100	---	<60	---	70	4	.1	Do.
2358	---	<100	---	<60	---	70	4	.2	Do.
2359	---	<100	---	<60	---	100	4	.1	Do.
2360	---	<100	---	<60	---	70	6	.1	Dump sample.
2361	---	<100	---	100	---	70	2	.1	Sandstone.
2362	---	<100	---	<60	---	70	2	.2	Shale.
2363	---	<100	---	<60	---	100	2	.2	Sandstone.
2365	---	<100	---	<60	---	70	2	.2	Shaly limestone.
2366	---	100	---	<60	---	---	.4	.1	Green limestone.
2370	---	100	---	<60	---	70	2	.05	Sandstone and shale.
2372	---	100	---	---	---	---	.9	.006	Sandstone.
2373	---	200	---	<60	---	70	.9	.1	Do.
2374	---	200	---	<60	---	70	.9	.2	Do.

10/ Sample 2325 contains 10 ppm Ag.
11/ Sample 2332 contains 1,000 ppm Sr.
12/ Sample 2333 contains 1,000 ppm Sr.
13/ Sample 2335 contains 30 ppm Mo.
14/ Sample 2340 contains 30 ppm Mo.
15/ Sample 2342 contains 30 ppm Mo, 40 ppm Sn, and 100 ppm W.
16/ Sample 2349 contains 30 ppm Mo, and 100 ppm W.
17/ Sample 2350 contains 20 ppm Mo, and 100 ppm W.

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