UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Mineral Resources of the Pecos Wilderness and adjacent areas, Santa Fe, San Miguel, Mora, Rio Arriba, and Taos Counties, New Mexico

by
U.S. Geological Survey, U.S. Bureau of Mines,
and New Mexico Bureau of Mines and Mineral Resources

Chapter A. Geology of the Pecos Wilderness and adjacent areas, Santa Fe, San Miguel, Mora, Rio Arriba, and Taos Counties, New Mexico
By Robert H. Moench, U.S. Geological Survey, and James M. Robertson, New Mexico Bureau of Mines and Mineral Resources

Chapter B. Geological, geochemical, and geophysical evaluation of the mineral resources of the Pecos Wilderness and adjacent areas, Santa Fe, San Miguel, Mora, Rio Arriba, and Taos Counties, New Mexico
By Robert H. Moench, U.S. Geological Survey, James M. Robertson, New Mexico Bureau of Mines and Mineral Resources, and Stephen J. Sutley, U.S. Geological Survey, with a section "Interpretation of aeromagnetic data," by Lindreth Cordell, U.S. Geological Survey

Chapter C. Mines, prospects, and mineralized areas in the Pecos Wilderness and adjacent areas, Santa Fe, San Miguel, Mora, Rio Arriba, and Taos Counties, New Mexico
By Michael E. Lane, U.S. Bureau of Mines

Open-File Report 80-382
1980

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STUDIES RELATED TO WILDERNESS

In accordance with the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and the Joint Conference Report on Senate Bill 4, 88th Congress, the U.S. Geological Survey and U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Studies and reports of all primitive areas have been completed. Areas officially designated "wilderness," "wild," or "canoe" when the Act was passed were incorporated into the National Wilderness Preservation System, and some of them are currently being studied. The Act provided that areas under consideration for Wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. This report discusses the results of a mineral survey of the Pecos Wilderness and six proposed additions to this Wilderness in northern New Mexico.

Mineral resources of the Pecos Wilderness and adjacent areas,

Santa Fe, San Miguel, Mora, Rio Arriba,

and Taos Counties, New Mexico

Summary

by

U.S. Geological Survey, U.S. Bureau of Mines,

and New Mexico Bureau of Mines and Mineral Resources

A mineral survey of the Pecos Wilderness and six proposed additions by the U.S. Geological Survey in cooperation with the New Mexico Bureau of Mines and Mineral Resources, and by the U.S. Bureau of Mines covers 381 square miles (987 square km, 24,384 acres) in the Santa Fe and Carson National Forests, northern New Mexico. This area, on the southern end of the Sangre de Cristo Range, was evaluated for its mineral potential by geological mapping, geochemical sampling, and interpretation of aeromagnetic data by the U.S. Geological Survey and the New Mexico Bureau of Mines and Mineral Resources, and by the examination of mines, prospects, and mineralized areas by the U.S. Bureau of Mines. Figure 1 shows two small areas of high mineral potential in the south, the Macho Canyon and Doctor Creek areas. Other areas of lower potential are numbered from 2 to 6, in decreasing order of importance of mineral potential. The Pecos Wilderness has little or no potential for oil, gas, coal, and geothermal energy. The potential for uranium and some associated elements was examined only in selected areas, and found there to be very low or nil. Production in and near the area is limited to small amounts of beryllium and mica from pegmatites in the northeastern part of the area, as well as gold, silver, copper, lead, and zinc from the Pecos mine, just south of the area. From 1927 to 1939 the Pecos mine was the largest producer of these metals in New Mexico.

The area is underlain by metamorphic and igneous rocks of Precambrian X age (about 1.7 or 1.8 billion years old) and granitic and syenitic rocks that are mainly 1.65 or 1.7 billion years old, but some possibly as young as Precambrian Y age (about 1.4 billion years). Rocks of all groups are cut by many small bodies of pegmatite, composed mainly of quartz, feldspar, and white mica. In much of the eastern part of the area these rocks are covered by marine sedimentary rocks of Mississippian and Pennsylvanian age. The most

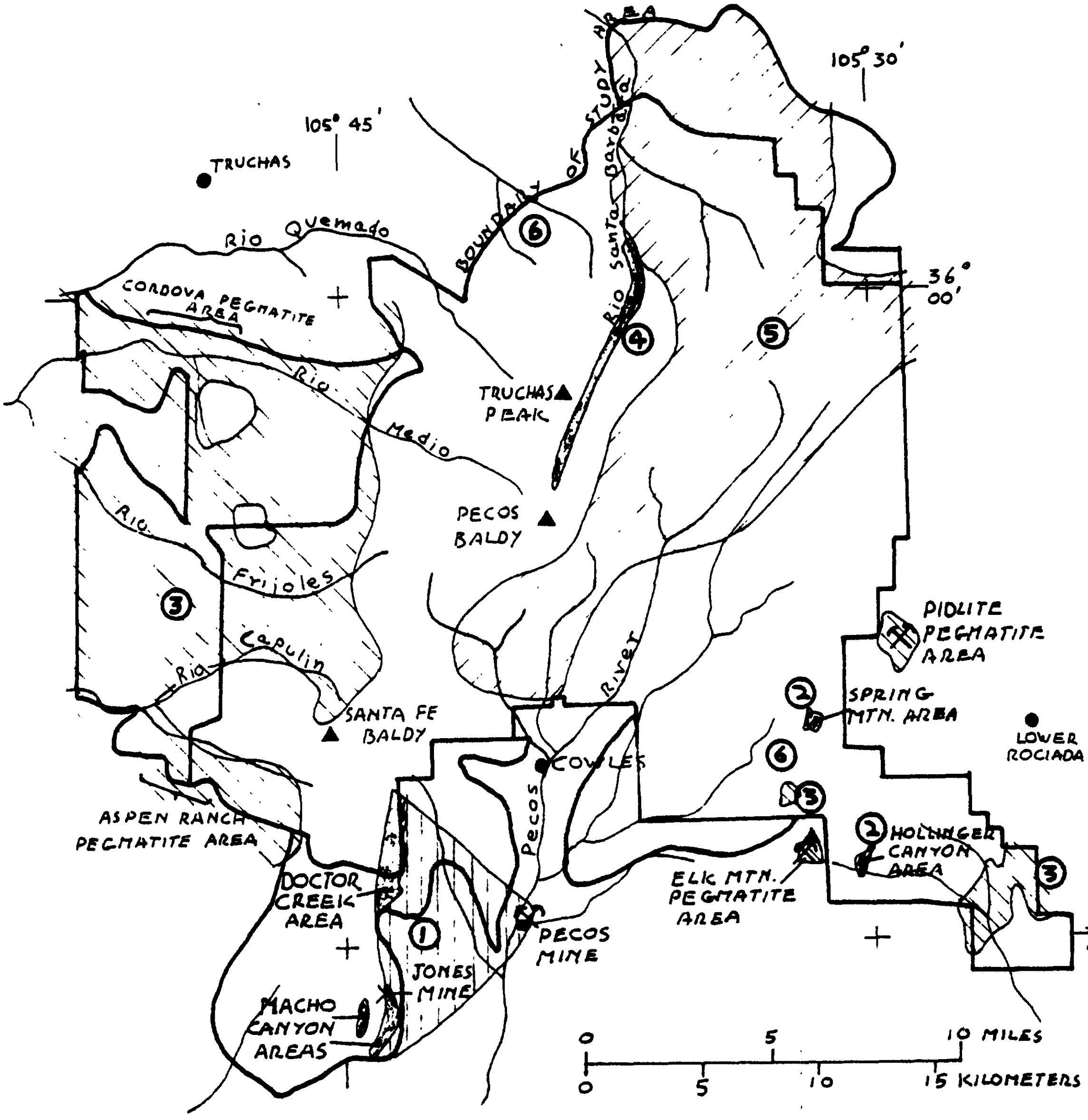

FIGURE 1.--Map of the Pecos Wilderness and adjacent areas showing area of mineral potential, numbered in approximate order of decreasing importance.

1. High potential for Precambrian volcanogenic massive-sulfide deposits--Shaded where favorable rocks are exposed; vertically lined where favorable rocks probably extend beneath Paleozoic sedimentary rocks
2. Low potential for volcanogenic massive-sulfide deposits
3. Low potential for scrap mica and other commoditis in Precambrian pegmatites.
4. Low potential for uranium and other elements along the Jicrilla fault
5. Low potenial for sedimentary accumulations of copper, zinc, and molybdenum in Pennsylvanian sedimentary strata
6. Low potenial for metals in two small geochemical anomalies of unknown bedrock source

conspicuous structural feature of the area is the north-trending Pecos-Picuris fault, which extends diagonally across the high axis of the Sangre de Cristo Range. In the north, subparallel to this fault and about 3 miles (4.8 km) farther east, is the Jicarilla fault, an east-directed thrust fault. About 6 miles (9.6 km) west of the Pecos-Picuris fault is the north-trending Borrego lineament, undoubtedly the line of a fault but of unknown dip direction and displacement.

The most significant mineral potential in the area is the likely occurrence of Precambrian volcanogenic massive-sulfide deposits similar to the deposit at the Pecos mine. The reinterpretation of the Pecos deposit as a massive-sulfide deposit suggests that several other deposits of the same class are likely to occur within 10 miles or so of the Pecos mine, for such deposits are elsewhere known to occur in clusters in similar geologic settings. Favorable host rock associations have been delineated by geologic mapping, and a high potential is assigned to two such areas (fig. 1, Macho Canyon and Doctor Creek) and a lower potential to two others (Hollinger Canyon and Spring Mountain). The two areas of highest potential show convincing evidence of mineralization in outcrops or prospect pits and in the geochemical data. These two highly favorable areas can be connected, beneath Paleozoic rock cover, with the Pecos mine to delineate an area of about 15 square miles that has high potential for volcanogenic massive-sulfide deposits. A distinctly lower potential is assigned to the Hollinger Canyon and Spring Mountain areas because they contain smaller areas of favorable host rocks and have less convincing evidence of significant mineralization. Unlike the Macho Canyon-Doctor Creek-Pecos mine area, no large tract of favorable ground can be defined from presently available information that extends between the Hollinger Canyon and Spring Mountain areas. From the Pecos River east to the boundary of the study area only widely scattered areas of mixed metavolcanic rocks have been mapped; granitic rocks, amphibolites, and metasedimentary rocks are greatly predominant in outcrop and must be predominant beneath the Paleozoic cover.

Low potential for scrap mica and other commodities exists in areas containing abundant pegmatites (fig. 1). Small amounts of lithium occur in pegmatites of the Pidlite area, immediately east of the Wilderness boundary (fig. 1), but no lithium-rich pegmatites are known to occur within the area. The pegmatites of the Pidlite area also contain tantalum, but the tantalum resource here is small, as shown by a previous study by the U.S. Bureau of Mines. Geochemical data suggests that pegmatites west of the Pecos-Picuris fault may have small amounts of niobium; that those of the southeast may have minor amounts of beryllium, tungsten, and bismuth; and that small amounts of tin may be present in pegmatites exposed throughout the study area.

A low potential for uranium, zinc, niobium, antimony, and beryllium is assigned to a narrow area along the West Fork of Rio Santa Barbara, along the line of the Jicarilla fault (fig. 1, no. 4). This potential is indicated by rather high abundances of zinc, niobium, antimony, and beryllium in heavy-mineral concentrates from stream sediments, and by somewhat high abundances of radon in water obtained primarily from springs. The radon indicates the possibility of concentrations of uranium. Radon-222 (the principal isotope of radon present) is a radioactive decay product of radium-226, which in turn is a daughter of uranium-238. The amounts of radon, measured in picocuries per liter (pC/L), range from nil to nearly 2,500 pC/L. The highest amounts, detected nearest to the fault, are too small to suggest the near presence of a minable uranium deposit.

Low potential for metallic deposits is assigned to the central and northeastern part of the area (fig. 1, no. 5), an area underlain mainly by Paleozoic strata. Concentrations of heavy minerals from stream sediments in that area have 70-300 ppm copper, 15-50 ppm molybdenum, and 200-2,000 ppm zinc. Because most of these samples are from streams that drain only Pennsylvanian rocks, the metal must have their source in the sedimentary rocks. No economic concentrations are suspected, however, because no exceptionally high values for these elements were obtained, with the exception of zinc in three samples from streams that cross the Jicarilla fault, the locus of a different geochemical anomaly.

Two small geochemical anomalies are defined by two samples each (fig. 1, no. 6). The northern anomaly, about 5 miles (8 km) north of Truchas Peak, is in an area underlain mainly by Precambrian quartzite. The anomaly is defined by high abundances of tungsten, niobium, and antimony. The bedrock source is unknown; a pegmatitic source might possibly contribute the tungsten and niobium. The southern anomaly is about 5.5 miles (9 km) east of Cowles in a stream that drains Precambrian quartz porphyry in fault contact with basaltic amphibolite. The anomaly is defined by high abundances of lead, molybdenum, bismuth, and tungsten. It is confined to that part of the stream that crosses the quartz porphyry, which shows no sign of alteration or mineralization.

Chapter A

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Robert H. Moench, U.S. Geolgical Survey

and

James M. Robertson, New Mexico Bureau of Mines and Mineral Resources

Introduction

A mineral survey of the Pecos Wilderness and six proposed additions to the Wilderness was conducted in 1976 and 1977 by the U.S. Geological Survey in cooperation with the New Mexico Bureau of Mines and Mineral Resources and by the U.S. Bureau of Mines. This work was done in compliance with the Wilderness Act. The Pecos Wilderness covers 263 square miles, and the proposed additions cover an additional 118 square miles, for a total of 381 square miles (984 square km, 24,384 acres). The study area is a short distance northeast of Santa Fe, New Mexico, at the southern end of the Sangre de Cristo Range, the southernmost major range of the Rocky Mountains. The area lies between latitudes 35°42′ and 36°07′, and longitudes 105°25′ and 105°52-1/2′ (fig. 2, pl. 1).

The principal peaks of the area are distributed along the north-trending axis of the Sangre de Cristo Range (pl. 1). They are alpine in nature, standing 12,400 to 13,000 feet above sea level, well above tree line, about 12,000 feet at this latitude. On the west the range slopes steeply and then more gradually to the arid Rio Grande valley, at 7,000 to 5,500 feet above sea level. East of the high peaks the study area extends over a broad high, largely forested plateau that is deeply dissected by canyons and tributaries of the Pecos River in the south and Rio Santa Barbara in the north. Along the divide between the Pecos River and Rio Santa Barbara, the plateau, with ridges and peaks, extends above tree line. The eastern side of the plateau coincides approximately with the eastern side of the study area, and is marked by a spectacular 2,000- to 3,000-foot scarp. In the distance to the east and southeast are the Great Plains and the region of Las Vegas, New Mexico.

Access to the study area is gained by many horse trails shown on a visitor's guide that may be obtained from the U.S. Forest Service ranger

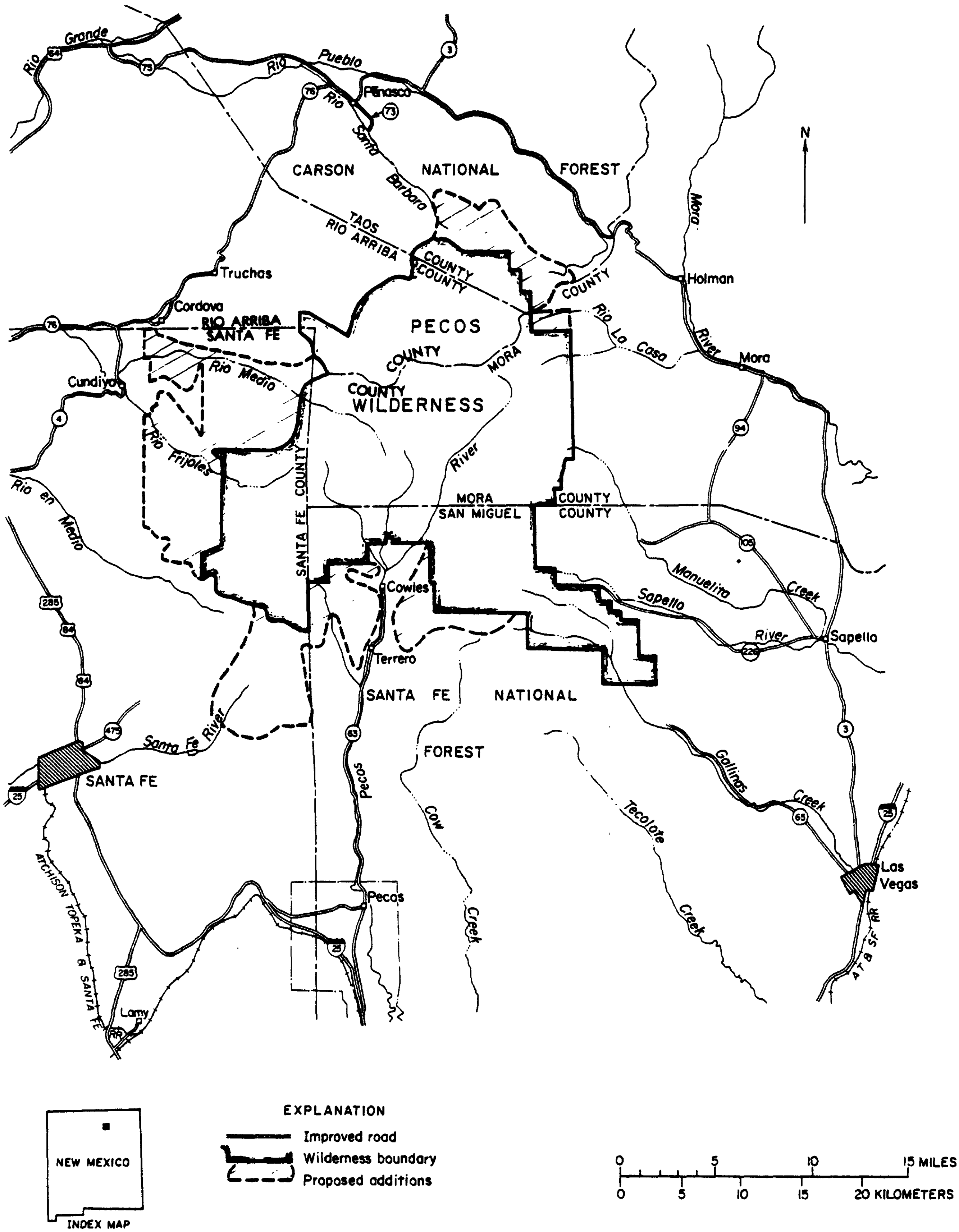

FIGURE 2.--Location map of the Pecos Wilderness and adjacent areas.

station in the vicinity (Santa Fe, Penasco, Las Vegas, Espanola, and Pecos). All the major trail heads are easily reached by paved roads or well-maintained dirt roads. Published U.S. Geological Survey topographic maps (scale 1:24,000) are available for the entire study area. The base map for plate 1, prepared by the U.S. Geological Survey, is a mosaic of all these quadrangles reduced to a scale of 1:48,000.

Previous and concurrent investigations

More than 90 percent of the Pecos Wilderness and proposed additions was mapped previously, mainly during the 1950's by Miller, Montgomery, and Sutherland (1963). Miller's work was almost complete at the time of his tragic death from bubonic plague in 1961. The mapping by Miller and colleagues, published at 1:62,000, was reconnaissance in nature, but it provided an excellent base for our work. Miller studied the surficial deposits of the area, Sutherland the Paleozoic sedimentary rocks, and Montgomery the Precambrian rocks. Because the focus of this project is on the Precambrian rocks, Montgomery's work has been of greatest value to us. The southern corner of the study area was mapped by Baltz (1972). He did not subdivide the Precambrian rocks, but his mapping in the Paleozoic rocks and the principal faults that he mapped were used in the present study, with minor simplifications.

During this investigation Jeffrey Grambling mapped the Precambrian rocks of the Truchas Peaks-Pecos Baldy area east of the Pecos-Picuris fault (pl. 1) as part of his Ph.D. dissertation at Princeton University. His fieldwork was supported by the New Mexico Bureau of Mines and Mineral Resources. His mapping is shown on plate 1, with minor simplification. Also during this investigation Marcus Moench mapped Precambrian rocks in parts of the canyons of Rio Mora, Rio Valdez, and the Pecos River. He generously made his work available to us, and it is shown in simplified form on plate 1.

In 1975 and 1976 David Mathewson mapped Precambrian rocks in the Cowles, Elk Mountain, Rosilla Peak, and Honey Boy Ranch quadrangles. The work is part of his Ph.D. dissertation (not yet completed) at the New Mexico Institute of Mining and Technology, and it was supported by the New Mexico Bureau of Mines and Mineral Resources. Because his mapping was reconaissance in nature, most of the area that he mapped within the study area was remapped during this investigation. However, his mapping provided an excellent guide for the present study, and it furnished valuable information on areas not traversed during this study.

Riesmeyer (1978) has completed a thorough study of an assemblage of Precambrian metavolcanic rocks and associated intrusive rocks in the northwest corner of the Rosilla Peak quadrangle for his M.S. thesis at the University of New Mexico. He furnished us a much simplified copy of his mapping and the metavolcanic stratigraphic concepts that he developed in the course of his study were a strong influence on this investigation.

Krieger (1932) and Harley (1940) have described the Pecos mine, at the mouth of Willow Creek about 6 km (4 mi) south of Cowles (pl. 1), a major producer of base and precious metals during the 1920's and 30's. This deposit was by far the most important source of economic minerals near the Pecos Wilderness, and it is of prime importance to this investigation. Krieger's and Harley's interpretations were closely in accord with Lindgren's hydrothermal theory of sulfide ore deposition. The present authors and other geologists who are familiar with the Pecos deposit and the Jones deposit (pl. 1, about 6.5.km to the southwest) and their geologic settings now recognize that they are volcanogenic massive-sulfide deposits (Giles, 1974, 1976; Stacey and others, 1977, p. 9-10), a class of ore deposits that was not fully recognized and defined until the 1960's. As discussed in Chapter B of this paper, the distinction between hydrothermal deposits and volcanogenic deposits has a crucial bearing on exploration in any appropriate geologic terrane, and on the evaluation of mineral resources in the Pecos Wilderness study area. Readers are referred to Sangster (1972) and Hutchinson (1973) for excellent summary descriptions of volcanogenic massive-sulfide deposits and their geologic setting.

Present investigations and acknowledgments

Fieldwork for the present investigation was conducted by Moench in July of 1976 (July 4-20), and in 1977 by Moench and Robertson from May 28 to July 28 and from September 9 to 16. In 1976 Moench was ably assisted on an unpaid basis by his son, Marcus, who during the 1977 effort also mapped parts of the canyons of Rio Mora, Rio Valdez, and the Pecos River. The results of his mapping have been incorporated on plate 1. From May 29 to June 2, 1977, a backpack traverse through the upper Rio Mora Canyon from the Pidlite mine area to Gascon Point (pl. 1) was made by Moench and M. J. O'Neill of the U.S. Geological Survey. During the main effort from June 8 to July 29 a helicopter was used daily to shuttle two or more field parties from the Santa Fe project base to various parts of the study area. At this time Moench and Robertson were assisted in the field by Bruce Gamble, Suzann Hess, and Sally King.

In June and July of 1977 the project was supported by a mobile spectrographic and sample preparation laboratory based in Santa Fe. More than 500 panned heavy-mineral concentrates were collected during the period and were prepared and analyzed in the field laboratory. These samples, supplemented by a few samples of stream sediments, soils, and rocks, formed the basis of the geochemical survey. The samples were prepared for analysis by Dean McCallum, Paul Melita, and Sally King, and were analyzed spectrographically by Stephen J. Sutley.

The fieldwork consisted of foot traverses that were planned in advance to complete the geologic map at 1:48,000, and to collect the samples in a minimum amount of time with helicopter support. The reconnaissance nature of the mapping is emphasized by the wide spacings of the foot traverses (pl. 1). We stress that much more work is needed on many aspects of the geology of the study area.

We gratefully acknowledge the close cooperation and support of the supervisors and staff of the Santa Fe and Carson National Forests. We are grateful also to Jeffrey Grambling, W. D. ("Dunc") Riesmeyer, Marcus Moench, and David Mathewson for allowing us to incorporate some of the results of their geological studies on plate 1.

Geology

Geologic setting

The Sangre de Cristo Range is a huge uplifted block of Precambrian and Paleozoic rocks that is bordered on the west by the Rio Grande depression, and on the east by a broad tract of folded and thrust-faulted Mesozoic, Paleozoic, and Precambrian rocks. Farther east this tract passes into the Great Plains Province, where subhorizontal Mesozoic and Paleozoic sedimentary rocks are partly covered by Tertiary and younger deposits. In Late Cretaceous to mid-Tertiary time what is now the Sangre de Cristo Range was the eastern flank of a broad highland that extended north and northwest along the Sawatch Range and San Juan Mountains and the Uncompahgre Uplift in Colorado (Tweto, 1975, p. 27-31). Tweto (1975, p. 27) called this highland the Laramide or rejuvenated San Luis highland. He noted (p. 31) that the Sangre de Cristo

Range probably "did not become an entity separate from the Laramide San Luis highland until mid-Tertiary time." At that time the highland was broken along a north-south line by the Rio Grande depression, which from Albuquerque north to central Colorado then became the site of the most active block faulting in the southern Rocky Mountains. The depression--downdropped several kilometers relative to the uplifted range--received a huge volume of upper Cenozoic clastic deposits (Bryan, 1938; Kelley, 1956) known as the Santa Fe Group. These deposits and the principal mid-Tertiary and younger faults of the depression lay west of the study area. As interpreted by Cordell (1978), the depression (or graben system) with its fill is only one manifestation of the Rio Grande rift, which also encompass the bordering horsts, such as the Sangre de Cristo Range.

Most of the faulting and folding on the east side of the study area and farther east took place earlier, largely during the Laramide orogeny, but perhaps also during Pennsylvanian uplift (Baltz, oral commun., 1978). Baltz also believes that some high-angle faults in this tract are late Tertiary, Pleistocene, or even Holocene in age. A complex pattern of high-angle faults and steeply to gently west-dipping thrust faults belonging to the eastern tract crosses the southeast corner of the study area (pl. 1).

As shown on plate 1, the Pecos-Picuris fault divides the study area into a western Precambrian terrane underlain by batholithic granitic rocks and high-rank gneisses, and an eastern tract underlain by Paleozoic sedimentary rocks that rest unconformably on Precambrian intrusives and folded Precambrian stratified rocks of variable metamorphic rank. Miller and others (1963) interpreted the Pecos-Picuris fault as a major right-slip Precambrian fault that was reactivated as a dip-slip fault with upthrow to the northwest, in Pennsylvanian and Late Cretaceous times. As interpreted by Tweto

(1975, p. 30), the fault became the eastern border of a San Luis highland in both the Pennsylvanian and Late Cretaceous.

For convenience in this report the eastern tract is further divided into a northern and a southern Precambrian terrane (pl. 1) along an east-striking boundary. The northern terrane is composed of compositionally mature quartzites, aluminous pelitic schists (or metashales), and minor amphibolitic rocks of probable basaltic origin. This terrane is intruded only by pegmatites and by a small body of quartz-feldspar porphyry exposed about 3 km west of Pecos Baldy. The southern terrane--recently called the Pecos greenstone belt by Robertson and Moench (1979)--contains a more complex assemblage of immature clastic metasedimentary rocks; abundant metavolcanic rocks--primarily basaltic, but with local rhyolites; and an inferred subvolcanic complex of metadiabases, quartz diorites, tonalites, and trondhjemites. The southern terrane is intruded by granitic rocks of probably the same general age and origin as those of the western batholithic terrane.

We have chosen not to use stratigraphic names for Precambrian rocks, such as Embudo Granite, Ortega Quartzite, and Vadito Formation. These names were applied by Montgomery (1953) to the Precambrian of the Picuris Range and later to the Precambrian of the Pecos Wilderness (Miller and others, 1963). Although Embudo-like granitic types are abundantly represented in the study area, we cannot be certain that all of the varied granitic rocks of the study area are approximately the age of the Embudo of the Picuris Range. Long (1974), moreover, has divided the Embudo of Montgomery (1963) in the Picuris Range into four contrasting units, plus pegmatite. The ages of all of these units have not been established satisfactorily. Many types also exist in the study area, and clearly more thorough mapping and isotopic studies are needed. Furthermore, the proposed amendment to the stratigraphic code concerning terminology for igneous and high-grade metamorphic rocks recommends that only the more uniform and larger intrusive bodies should be given names of formation rank (Sohl, 1977, p. 250). Rocks that have been called Embudo Granite are hardly uniform.

Montgomery (Miller and others, 1963) applied the name Ortega Formation to the assemblage of pure quartzites, aluminous schists, and minor amphibilitic rocks of our northern terrane, and Vadito Formation to the assemblages of metavolcanic rocks and immature metasedimentary rocks found in our southern terrane, on the basis of striking lithologic similarities to the Ortega and Vadito of the Picuris Range. We believe that these correlations are mainly valid. Both assemblges, however, apparently contain a more complex stratigraphic order than their presumed equivalents in the Picuris Range. Moreover, mapping by Grambling in the Truchas Peaks area (written commun., 1977) has shown that the most logical placement of the Ortega-Vadito contact in the study area needs reexamination. We feel that formal names should not be applied until the internal stratigraphy of the northern and southern terranes is more completely worked out, and the relationship between the two terranes is understood.

We use the terminology of Baltz (1972) for the Pennsylvanian rocks of the study area, rather than that of Sutherland (Miller and others, 1963). Although Baltz's Madera and Sandia Formations are not separated on plate 1, both can be recognized and could have been mapped if more time were devoted to this work. The Del Padre Sandstone of Sutherland (Miller and others, 1963) has been adopted recently as the basal member of the Espiritu Santo Formation. The distribution of the Mississippian rocks is in part from Sutherland's mapping.

Precambrian rocks

Migmatitic gneisses of the western Precambrian terrane

The western Precambrian terrane is part of a large granitic batholith with gneissic inclusions, screens, and roof pendants that extends about 60 km north to south between the Picuris Range and the village of Glorietta, and about 15 km east to west between the Pecos-Picuris fault and the gravels of the Santa Fe Group. Montgomery recognized that the batholith contains abundant gneissic rocks, but for lack of time he did not map them. We consider the distribution of gneissic rocks shown in the western terrane on plate 1 to be a conservative minimum, for large areas were not traversed during this study. Parts of the gneissic areas that are shown on plate contain large bodies of granitic rocks that would be mappable at 1:24,000. In addition, many outcrops--particularly of biotite gneisses--are migmatitic, having 50 percent or more of thin semiconcordant layers and dikelets of granite.

Three principal varieties of layered gneisses are recognized: biotite gneiss, felsic gneiss, and amphibolite. These are the main types that constitute most of the pre-1,700 m.y. metamorphic complex of Colorado (Tweto, 1977, p. D3-D10). The high rank metamorphic style of the gneisses in the study area is much the same as that of the Leadville, Colo., $1^{o}x2^{o}$ quadrangle (Tweto and others, 1978).

Because the felsic and hornblendic gneisses invariably are intimately associated in Colorado, Tweto (1976) chose to combine them on the Colorado State Geologic map. This close association holds as well for the felsic gneiss and amphibolite of the western terrane. The felsic gneiss is typically light-colored fine-grained quartz-feldspathic rock characterized by a faint to conspicuous compositional lamination. Although we have not examined these rocks in thin section, they probably have the composition of granodiorite or trondhjemite, having 25 percent or so quartz, abundant oligoclase, less abundant to no microcline, and 10 percent or less of biotite and sparse hornblende. Small amounts of muscovite can be seen locally indicating a peraluminous composition. Similar rocks in Colorado are interpreted to be of igneous origin (Barker and others, 1976): the discordant bodies as plutonic intrusives and the concordant bodies as metamorphosed tuffs of the same composition. Our mapping in the western terrane was not detailed enough to determine whether or not the felsic gneiss is concordant or discordant. We interpret the amphibolite, composed of hornblende, calcic plagioclase, and minor quartz, as metamorphosed mafic igneous rocks.

The felsic gneiss and amphibolite seems most akin to the quartz diorite, tonalite, trondhjemite. The quartz-feldspar granofels of the southern terrane is metamorphosed feldspathic sandstone that contains much more quartz than the felsic gneiss.

The biotite gneisses are bedded aluminous metashales (sillimanitic gneiss and schist) and immature, probably volcanoclastic metagraywacke (biotite-quartz-plagioclase gneiss). Although the biotite gneisses are similar compositionally to the pelitic schists of the southern terrane, we have no way of knowing if they are stratigraphically related to those schists. More likely, the biotite gneisses are related to a different assemblage of rocks that is generally more pelitic and aluminous than that of the southern terrane as a whole.

Stratified rocks of the northern Precambrian terrane

The northern terrane is underlain by an assemblage of compositionally mature quartzite, aluminous pelitic schist, and minor stratified amphibolites. These rocks have been tightly folded along east-west trends, and refolded, as shown on plate 1. In the Truchas Peaks-Pecos Baldy area, Grambling (written commun., 1978) has established, by careful mapping, the following stratigrapic sequence (simplified from his descriptions) in ascending order: (1) quartzite (nearly 1,100 m); (2) pelitic schist and minor quartzite (0-350 m); (3) quartzite (about 500 m); (4) a complex assemblage of interstratified amphibolite, schist, micaceous quartzite, quartz-muscovite schist and minor calc-silicate rocks; this assemblage intertongues southward with thick quartzite forming a total package as much as 600 m thick; and (5) quartzite identical to the other pure quartzite of the area (at least 180 m). This sequence undoubtedly occurs also in the easternmost exposures of the northern terrane, where only reconnaissance has been done. Tentatively, pyrrhotite-bearing metashales and associated nonsulfidic metashale exposed 2 km west of Pecos Baldy may be equivalent to similar rocks exposed along the Pecos River north of Beatty Creek and along Rio Mora, 2 km or so north of the northern-southern terrane boundary. If so, quartzite that lies above that metashale in the Truchas Peaks area (unit 3) is equivalent to the main quartzite south of Beatty Creek and along the south side of the northern terrane farther east (pl. 1). Grambling preferred to correlate only units 1 and 2 with the Ortega Quartzite of the Picuris Range. Relationships mapped by Marcus Moench along Rio Mora suggests that a major unconformity exists there between quartzite (unit 3 of Truchas Peaks area?) and the rocks of the southern terrane. The stratigraphically higher rocks of units 4 and 5 mapped by Grambling along the Truchas Peaks represent a mature Ortega-like sequence (despite the amphibolite) that probably has been eroded at the terrane boundary in Rio Mora.

Nearly pure quartzite is by far the predominant rock in the northern terrane. It is white, gray or pinkish, vitreous in appearance, and composed almost entirely of quartz, with minor detrital heavy minerals. The quartzite is variably thin bedded to thickly bedded, and commonly it has thin partings or thin interbeds of pelitic schist. The beds are rarely conspicuously graded, but crossdbedding is commonly well-preserved.

The pelitic schists of the northern terrane are aluminous metashales, metamorphosed to ranks that range from the garnet zone to the sillimanite and kyanite zones. Although we did not map metamorphic isograds, the general rank of metamorphism is shown by letter symbols on plate 1.

In two areas--one about 2 km west of Pecos Baldy, the other along Rio Mora about 1.3 to 3 km north of the southern-northern terrane boundary--the pelitic schists are dark and rusty weathering. In Rio Mora canyon they contain conspicuous small lenses of pyrrhotite that are alined along the foliation. These rocks resemble the Pilar Phyllite Member of the Ortega Quartzite of the Picuris Range, and both Grambling (written commun., 1978) and Montgomery (Miller and others, 1963) have made that correlation. Where Rio Mora crosses these exposures, and for some distance downstream, the gravels are strongly iron stained. At one locality on the bank of Rio Mora in the area of exposed pyrrhotite schist, iron brought into solution by weathering of the pyrrhotite has been reprecipitated as limonite on the stream's bank, producing a limonite-cemented talus and gravel.

In the Truchas Peaks area Grambling (written commun., 1978) has mapped three extensive layers (comprising unit 4) of complexly interbedded amphibolite, pelitic schist, micaceous quartzite or quartz-muscovite schist, and minor but conspicuous quartz-epidote gneiss and pink manganiferous piemontite-thulite bearing calc-silicate rocks. These rocks are metamorphosed basaltic flows and tuffs, and shaly to sandy and locally manganiferous sedimentary rocks. From structural evidence, according to Grambling, the two southern layers are tongues of the thicker northern one repeated on opposite limbs of a tight, overturned syncline. The youngest unit recognized by Grambling is massive gray quartzite (unit 5) mapped by him along the trough line of the syncline.

The complexly stratified amphibolite-bearing layers of the Truchas Peaks area are on-strike with a similar assemblage of rocks at the eastern margin of the area north of Gascon Point (pl. 1). Here feldspathic quartzite (or quartz-feldspar granofels) amphibolite and pelitic schists are exposed in the trough of an inferred east-plunging overturned syncline. The granofels is similar to that of the southern Precambrian terrane, and it is likely that mapping east of the study area in the Gascon quadrangle will show that they join.

In the canyon of Rio Mora, the southern boundary of the northern terrane is placed at the south contact of a layer of brick-red hematitic sillimanite-quartz schist or sillimanitic muscovite-quartz schist. This distinctive rock was found in float 3 km or so to the east, but not to the west along Rio Valdez or the Pecos River. On the basis of its bulk composition--silica, alumina, and iron oxide--this rock is interpreted as metamorphosed laterite, and as such it may represent a time of weathering along an unconformity below the presumed basal conglomerates in the southern terrane.

In the canyon of Rio Valdez, the southern boundary of the northern terrane is placed for convenience at the south side of a large body of quartzite. This boundary is probably a Precambrian fault (pl. 1), which is well defined in the canyon of the Pecos River, mapped by Marcus Moench. North of the fault in the Pecos River area is a north-facing succession of quartzite and aluminous pelitic schist apparently repeated as shown across an overturned syncline. Although the schists and quartzites that seem to be repeated across the syncline are not exactly comparable, opposed facing directions are shown by excellent crossbedding; the simplest interpretation is that the structure is a north-overturned syncline. Immediately on the north side of the fault the quartzite is broken into a rubble of subrounded boulders of quartzite in a matrix of quartz sandstone, probably of the basal Paleozoic sequence. This rubble is interpreted as a fault-line talus, possibly rounded by spheroidal weathering before the Paleozoic sediments were deposited.

Stratified rocks of the southern Precambrian terrane

Stratified rocks of the southern terrane comprise the Pecos greenstone belt of Robertston and others (1978) and Robertson and Moench (1979). This terrane is a complex assemblage of metamorphosed compositionally immature marine sedimentary rocks, submarine basalts, and local accumulations of silicic volcanics and iron-formation. A few thin beds of nearly pure quartzite may be found; some of these may be distal accumulations of cherty iron formation, but others probably are of continental provenance--possibly the same continent that shed the pure quartz sands of the northern terrane. The environment that is represented by these assemblages of rocks probably was one of deep to shallow marine sedimentation, submarine volcanoes, and volcanic islands. In contrast to the extensive layering shown by the northern terrane, this environment produced no sedimentary layers that might be traced more than a kilometer or two. Instead, major abrupt facies changes are the rule. Tectonically the environment probably was one of extensionl rifting accompanied by bimodal basalt-rhyolite volcanism (Condie, 1975). On the assumption that the sulfide deposits at the Pecos and Jones mine are in fact submarine volcanic-exhalative in origin, as we believe, the lead isochron model ages of 1,710 and 1,720 m.y. determined by Stacey and others

(1977, table 2), provide reasonable Precambrian ages for both the sulfide deposits and the host rocks.

The conglomeratic rocks described below are thought to represent the lower part of the stratigrahic pile in the southern terrane, in part in fault contact with the northern terrane, and in part resting unconformably on the quartzite-schist assemblage of the northern terrane. Although the internal stratigraphy of the southern terrane has not been worked out, our reconnaissance mapping suggests that the metaconglomerates are part of a thick clastic succession that passes to the south by facies change into a thick assemblage of metavolcanics.

As interpreted by Marcus Moench (written commun., 1978), metaconglomerates exposed at the north side of the southern terrane in the canyon of Rio Mora appear to rest unconformably on the red hematitic sillimanite-quartz schist of inferred lateritic origin. The presumed basal metaconglomerates on the north are quartz-rich, having abundant rounded clasts of gray quartzite derived from quartzites of the northern terrane, and stretched clasts of quartz-rich metasandstones that may represent fragments of less consolidated sandstones whose grains also were derived from the northern terrane (Marcus Moench, written commun., 1978). These clasts are in a matrix of micaceous metasandstone and mica-rich pelitic schist. Farther south is a lens of more feldspathic pale-orange to gray metasandstone (granofels), and to the south of this is a second conglomeratic layer. Both the clasts and the matrix of the southern metaconglomerate contain abundant microcline feldspar, suggesting a felsic tuffaceous origin. Only about 1 percent of the clasts are of quartzite. The matrix of the metaconglomerate is in part metashale (sillimanitic 2-mica schist) and in part feldspathic metatuff(?), suggesting that the layer as a whole is a volcanic mudflow deposit. The southern metaconglomerate is bordered on the south by quartz-feldspar granofels (exposed mainly on the canyon's east side), pelitic schist (mainly on the west side), and a thin but extensive layer of pure quartzite. The quartzite is an unusual rock, having coarsely intergrown quartz with conspicuous hematite along the grain boundaries. The relationships that are shown in this area on plate 1 suggest a facies change from predominant feldspathic sandstones in the east to shales in the west, and that the quartzite was deposited in a single layer from one facies into the other.

No conglomeratic rocks were found in the canyon of Rio Valdez, but exposed on the west wall of the Pecos River canyon is a graded metabreccia that contains angular clasts as large as small boulders of micaceous granofels and mica schist in a matrix of muscovite schist. Only small differences can be seen between the clasts and the matrix. The clasts become smaller to the south, suggesting that stratigraphic tops are in that direction. The metabreccia is underlain to the north by dark magnetite-bearing quartzite (a variety of iron-formation) and bedded pelitic schist; it is overlain to the south by bedded pelitic schist with a single layer of quartz, and farther south by a succession of strongly metamorphosed metabasalt, mixed metavolcanics and quartz-feldspar granofels (pl. 1). In this context the metabreccia probably represents a submarine debris flow or mudflow derived largely from semiconsolidated shale or mudstone.

Extending along the east side of the study area in the southern terrane is a broad primarily metasedimentary tract underlain mainly by quartz-feldspar granofels (interpreted as feldspathic metasandstone) and subordinate amphibolilte. The granofels is fine grained, pale orange or gray, and faintly to conspicuously laminated. Locally it is spectacularly cross laminated. Most of the amphibolite is layered; it may be basaltic tuff, although some may be deformed pillow basalt. Also exposed, as shown, is pelitic schist; thin but extensive layers of calc-silicate rocks and marble; a few lenses of metaconglomerate; sparse layers of iron-formation; and two large bodies of metarhyolite (along Johns Canyon and Left Hand Sapello River). We were unable to determine whether these rhyolite bodies are domes or hypabyssal intrusives. The iron-formation is commonly a rather massive dark-purplish quartz-rich variety that may or may not be magnetic. A thick lens of volcanic metaconglomerate is exposed about 3 km southwest of the Pidlite mine (pl. 1). It contains clasts of felsite, feldspathic granofels, amphibolite, and iron-formation in a mafic matrix of chlorite-amphibole schist. The largest clasts are small boulders, suggesting that the source volcanic rock was not far away.

Farther south and southwest the quartz-feldspar granofels and associated rocks pass gradationally into a tract of predominant metabasalt, as an apparent lateral facies change. Pillows are well displayed high on the east-facing scarp about 4 to 5 km northeast of Elk Mountain. Pillows have been found elsewhere, grading with increasing deformation to irregularly layered and laminated amphibolite. Locally, the pillowed metabasalt has abundant phenocrysts of plagioclase as much as 1/2 cm across. The metabasalt is intruded by coarser grained massive amphibolite that probably represents feeders for higher basaltic flows. The areas that are underlain mainly by metabasalt also contain chloritic amphibole schist (mafic metashale); quartz-feldspar granofels like that of the northern part of the southern terrane; and local thin layers of iron-formation.

Of prime importance to this study are the areas shown as mixed metavolcanic rocks on plate 1: several areas in the southeastern part of the study area; at the Pecos mine; and along and immediately east of the

Pecos-Picuris fault. These areas are extremely complex lithologically, and only in small areas along traverse lines have we attempted to show different rock types. The main varieties of rocks in these areas are metabasaltic flows, metarhyolitic, or metadacitic domes, flows, and tuffaceous deposits, mixed pyroclastic deposits, iron-formation, mafic metashale, and pelitic metashale with volcaniclastic metagraywacke of turbidite aspect. The rhyolitic and dacitic lavas and pyroclastics appear to be sodic and are probably low in potassium, for they are composed largely of quartz, ablite, a few percent of biotite and hornblende, but little or no potassium feldspar. Most of the iron-formation is recrystallized layered or laminated quartz-magnetite rocks; hematitic and pyritic iron-formation has been found. Pyroclastic deposits are exceptionally well exposed in the belt of mixed metavolcanics 6 km or so northwest of the Pecos mine, along Doctor Creek and on the ridgetop nearly 2 km north of Doctor Creek.

Intrusive rocks

Three main suites of Precambrian intrusive rocks are exposed in the study area: (1) an inferred subvolcanic complex composed of mafic amphibolite and distinctly more silicic quartz diorite, tonalite and trondhjemite--probably the same general age as the volcanic pile of the southern terrane; (2) a batholithic complex of tonalite, granodiorite, granite and pegmatite, at least partly related to the 1,700-m.y.-age group of intrusives in Colorado (Tweto, 1977); and (3) a suite of syenite and melasyenite, possibly belonging (perhaps with some of the granite of the batholithic complex) to the 1,400-m.y.-age group of Tweto (1977). Petrographic names that are applied to these rocks are in accord with the nomenclature recommended by the IUGS Subcommission on the

Systematics of Igneous Rocks (Streckeisen, 1973). Most identifications were made in the field, based on past experience elsewhere, and were supplemented by only a few thin sectons.

Subvolcanic complex

Parts of the inferred subvolcanic complex are exposed 3-5 km northwest of Hermit Peak in the extreme southeast; along the canyons 1-12 km northeast of the Pecos mine; and in Macho Canyon in the extreme southwest. Mapping by W. D. Riesmeyer (oral commun., 1977) in the Macho Canyon area has shown that laminated plutonic rocks of probable trondhjemitic composition lie below a thick differentiated metavolcanic pile, and that small bodies of this rock intrude only the lower portion of the pile. Intrusive amphibolite that is intimately mixed with minor amounts of quartz dioritic to trondhjemitic rocks are exceptionally well exposed along Lower Rio Mora. Features seen here suggest that these rocks crystallized at depths adequate for rather slow crystallization and differentiation. The amphibolite is rather massive and approximately 1 mm grained. A rude layering (shown by the foliation symbols on pl. 1) strikes approximately east and dips south. This layering is produced by inhomogeneities in the amphibolite, and by anastomosing dikelets of light-colored quartzo-feldspathic rocks.

Many small dikes and sills of massive amphibolite and a few bodies of tonalite and related rocks intrude the stratified rocks of the southern terrane well away from the main areas of the inferred subvolcanic complex. These small bodies are probably related to the complex, as feeders to higher parts of the volcanic pile.

Batholithic complex

The batholithic complex contains a wide textural and compositional variety of granitic rocks and pegmatite that intrude the gneisses of the western terrane and the stratified and presumed subvolcanic rocks of the southern terrane. Rocks of the northern terrane are intruded only by pegmatite and by quartz-feldspar porphyry west of Pecos Baldy. Judged from the complex metamorphic zoning in that area, however, the stratified rocks of the northern terrane may be underlain at a depth of a kilometer or so by the batholith complex. Some large batholiths in other metamorphic terranes (in New England, for example) appear to be extensive but rather thin (3-5 km), subhorizontal sheets that were emplaced 10-15 km below the surface (Nielson and others, 1976; Moench and Zartman, 1976). If this concept can be applied to the study area, the batholithic complex of the western terrane may be a subhorizontal sheet that extends beneath the metamorphics of the northern and southern terranes as well. If so, the sheet has been displaced by major Precambrian right-slip offset along the Pecos-Picuris fault, and by upthrow in the west along this fault in Pennsylvanian time and during the Laramide orogeny.

Most and possibly all of the batholithic complex probably is related to the 1,700-m.y.-age group of igneous rocks in Colorado (Tweto, 1977, p. D12). Some of the granite may be found to belong to Tweto's 1,400-m.y.-age group, along with the syenite and melasyenite. Samples of the Embudo Granite that were obtained from the region immediately north of the study area have yielded a whole-rock Rb-Sr isochron that indicates a crystallization age of 1,673±41 m.y. (Fullager and Shiver, 1973). Four of the samples came from exposures along Rio de Las Trampas only a few kilometers north of the Pecos Wilderness study area. This age is consistent with an age of 1,650 m.y. determined by L. T. Silver for relatively undeformed granites in the southern part of the batholith (Stacey and others, 1977, p. 10).

Rocks of the batholithic complex were emplaced in the order from dark to light. The darker rocks are mainly gray hornblende-biotite tonalite, or biotite tonalite, granodiorite, and possibly granite; most have a conspicuous secondary foliation. Unfoliated fine-grained muscovite granite is common in and near the migmatitic gneiss of the western terrane. These gray granitic rocks occur mainly in the western terrane. Pink coarse-grained or medium-grained alkali-feldspar biotite granite is exposed both west and east of the Pecos-Picuris fault. The coarse-grained granite apparently grades to pink quartz porphyry and porphyritic granite of hypabyssal aspect. This gradation is exposed south of Macho Canyon in the western terrane, and along the eastern tributaries of Rio Mora, and at the head of Bear Creek in the southern terrane. Both the coarse-grained granite and the porphyry may be massive or conspicuously foliated; all gradations exist. Further studies may show that the pink granite and granite porphyry are significantly younger than the gray granite, granodiorite, and tonalite. As noted in the following sections, pink granite and nearby syenite and melasyenite of the southeast corner of the study area may belong to the 1,400-m.y.-age group, an association that has been documented in Colorado.

As shown on plate 1, pegmatites are widely distributed in the study area, and they are particularly abundant in large parts of the western terrane. Jahns (1946, 1953) has described the Elk Mountain and Pidlite pegmatites in the southeast (pl. 1) and Redmon (1961) has examined pegmatites near the boundary of the study area in the west. Most are subvertical dikes, but some are rolling subhorizontal sheets that may be tens of meters thick. The subhorizontal attitude of the sheets can be seen in canyon walls and along ridgetops in the western terrane. The pegmatites are the youngest known intrusives in the study area, and they may be as much as 250 m.y. younger than the granite rocks of the batholithic complex, as suggested by isotopic ages on materials from the Harding pegmatite in the Picuris Range, and by meager geologic evidence (see Gresens, 1975). Pegmatites are difficult to date from geologic evidence as well as isotopically, however, and in the absence of conclusive evidence to the contrary we assume that they are related to the principal rocks of the batholithic complex.

Syenite and melasyenite

Pink syenite and associated small bodies of alkali-feldspar melasyenite are exposed in a narrow north-trending belt no more than 5 km long in the southeast corner of the study area (pl. 1). In the field the syenite was distinguished from nearby pink granite by the absence or paucity of quartz and by a conspicuous "tabby" texture, produced by subparallel closely packed blocky or tabular alkali feldspars. The melasyenite was distinguished from nearby amphibolite by greater massiveness and by the presence of conspicuous randomly oriented books of biotite a few millimeters across. Three suites of specimens were obtained from exposures on ridges near the north and south ends of the belt, and the ridge between Beaver Creek and Left Hand Sapello River. The freshest material came from the southernmost outcrops. Here, pink slightly deformed biotite-hornblende syenite and dark augite-biotite alkali-feldspar melasyenite are exposed. The syenite is composed of closely packed subparallel blocky crystals of perthite that enclose sparse euhedral or subhedral crystals of plagioclase and a few small books of biotite. Plagioclase, sodic oligoclase to albite in composition, also occurs as large anhedral patches showing albite polysynthetic twins. The principal mafic mineral (about 10 percent of the rock) is pleochroic blue to green to pale-yellow hornblende, as anhedral blades that are commonly intergrown in clots along with biotite, epidote, and scattered magnetite. Apatite is an abundant accessory mineral; allanite and zircon were observed. Melasyenite at this locality has about 70 percent of intergrown biotite and augite (augite slightly subordinate), poikilitically enclosed in a matrix of poorly twinned, alkali feldspar. Isolated crystals of augite are euhedral or subhedral, well twinned, and they commonly show continuous zoning. Apatite is an abundant accessory mineral; allanite and a few grains of zircon were seen. Alkalic rocks from the two more northerly localities are more deformed and metamorphosed. Some of the syenites here have minor amounts of quartz; they range from biotite-hornblende syenite to biotite-quartz syenite in composition. The associated mafic rocks are biotite-hornblende alkali feldspar melasyenite, having no pyroxene. Accessory minerals in the syenite and melasyenite at the northern localities are apatite, sphene, allanite, and sparse zircon, in approximate order of decreasing abundance.

As shown on plate 1, the alkalic rocks crop out in a narrow belt that is subparallel to nearby pink granite, also exposed in part in a narrow north-trending belt. Age relationships among these diverse rocks were not determined, and further studies are needed to determine whether or not a complete gradation exists from syenite through quartz syenite to granite. Tentatively, the data listed in table 1 suggest that the rocks of granitic and syenitic composition are unrelated, for the syenite has far greater abundances of Ba and Sr, and consistently higher abundances of several metals than the sampled quartz porphyry. However, the granite closest to the syenite was not sampled.

Alkalic rocks of Proterozoic and early Paleozoic age occur at widely separate localities in southern Colorado (Barker and others, 1970; Olson and others, 1977). There, the older group was emplaced about 1,350 to 1,400 m.y. ago, during or shortly after emplacement of the 1,400-m.y.-age group of

Table 1.--Uranium and thorium determinations and semiquantitative spectrographic analyses of quartz porphyry, syenite, and melasyenite from the Pecos Wilderness and adjacent areas

[Uranium determined by fluorometric method; thorium determined by colorimetric method; Delmont M. Hopkins, analyst. All others by semiquantitative spectrographic analysis, Branch of Exploration Research, Steven J. Sutley, analyst. Lower limits of determinations are in parentheses: N, not detected; L, detected but below limit of determination. Looked for but not detected: Ag (.5), As (200), Au (10), Bi (10), Cd (20), Mo (5), Sb (100), Sn (10), W (50), Zn (200) Sample locations: Field no. 554, 7.1 km, S. 51° W. from Pidlit mine; 555,3.6 km west of summit of Pecos Baldy; 557, 558, 559, 8.6 km, S. 19° W. from Pidlite mine; 560, 561, 562, 4.6 km, S. 30°W. from Pidlite mine; 563, 7.5 km, S. 41° W. from Pidlite mine; 564, 565, 7 km, S. 23° W. from Pidlite mine.]

Rock type -----------		Quartz porphyry				Syenite					Melasyenite		
Field No. ---------		554	555	556	563	557	558	560	561	564	559	562	565
Tag No. -----	EDM-	618	619	620	627	621	622	624	625	628	623	626	629
U	PPM	5.0	1.0	2.0	3.0	1.2	0.8	1.1	0.8	1.4	1.0	2.3	1.6
Th	PPM	10.5	<2.5	11.0	4.0	7.5	15.0	21.0	2.5	8.0	26.0	33.0	31.5
Fe (.05)	Percent	0.7	0.7	2.0	0.1	2.0	2.0	2.0	2.0	1.5	3.0	5.0	5.0
Mg (.02)		0.02	0.02	0.3	0.05	1.0	1.0	0.3	0.5	0.7	5.0	5.0	3.0
Ca (.05)		0.2	L	0.15	0.2	0.7	0.7	0.3	0.5	0.5	5.7	5.0	3.0
Ti (.002)	Percent	0.05	0.07	0.2	0.07	0.2	0.2	0.2	0.1	0.15	0.3	0.3	0.3
Mn (10)	PPM	200	50	700	500	700	500	500	500	300	700	1000	1000
B (10)		N	N	L	L	L	L	N	N	N	L	L	10
Ba (20)		700	500	500	700	3000	1500	700	1500	2000	2000	2000	2000
Be (1)		3	1.5	1	1.5	1	1	L	N	1	1	1	2
Co (5)		N	N	N	N	10	7	N	5	7	50	30	20
Cr (10)		N	N	N	L	20	20	N	L	L	1000	500	500
Cu (5)		L	L	L	L	70	10	L	20	10	100	L	100
La (20)		70	L	20	50	50	50	150	N	50	100	100	50
Nb (20)		L	L	N	N	N	N	N	N	N	N	N	N
Ni (5)		L	L	N	5	30	50	N	5	10	200	150	150
Pb (10)		15	15	20	20	30	50	50	70	50	20	50	30
Sc (5)		7	7	10	5	7	7	5	10	L	20	20	20
Sr (100)		N	N	L	N	1500	1000	1000	1000	2000	700	1000	1000
V (10)		N	N	N	L	70	70	20	30	30	100	70	100
Y (10)		50	50	30	50	L	10	50	10	10	20	30	10
Zr (10)	PPM	100	100	200	100	150	300	300	100	150	20	70	70

predominantly granitic intrusions (Tweto, 1977). Judged from their weakly to rather strongly deformed and metamorphosed character, the alkalic rocks of the study area seem most akin to the older group in Colorado. In mineral and minor element composition the melasyenites of the study area are very similar, in fact, to the melasyenites of Ute Creek in the San Juan Mountains, Colorado (table 1; Barker and others, 1970, p. C8 and description). Isotopic age determinations indicate that both the melasyenite of Ute Creek and the nearby batholith of Eolus Granite in the San Juan Mountains belong to the 1,400-m.y.-age group (Barker and others, 1970, table 2; Olson and others, 1977, table 1). Accordingly, in the study area the alkalic rocks and at least some of the nearby granites may well be found to belong to the Precambrian Y, 1,400-m.y.-age group.

The discovery of alkalic rocks is important to this study, because of the known association of thorium-bearing veins with alkalic rocks in southern Colorado (Olson and others, 1977). Although Olson and others (1977) recognized the possibility that some thorium-bearing veins may be associated with alkalic rocks of 1,400-m.y.-age group, they noted (p. 685) that the great majority, if not all, of thorium-bearing veins in southern Colorado appear to be associated with the Cambrian or Early Ordovician alkalic intrusions. In the Mountain Pass district, California, rare-earth mineral deposits are associated with 1,400-m.y.-old alkalic rocks that are not unlike those of the study area (Olson and others, 1954).

Paleozoic rocks

In ascending order the Paleozoic sedimentary succession includes: (1) Mississippian clastic and carbonate rocks, no more than 60 m thick, that have been divided into the Espiritu Santo and Tererro Formations; and (2) Pennsylvanian marine shale, sandstone, conglomerate, and limestone, about

1,000 m thick, of the Sandia and Madera Formations. Reasons for using the nomenclature of Baltz (1972) rather than that of Miller and others (1963) for the Pennsylvanian rocks have been stated previously in this report. Descriptions in the cited reports are adequate for this study, and are not repeated here. We have little new information.

As shown on plate 1, the Mississippian carbonate rocks of the Espiritu Santo and Tererro Formations are absent from most of the area of the northern Precambrian terrane. These rocks were found only locally near the western boundary of the southern terrane along the Pecos-Picuris fault, but additional mapping here may reveal more of the carbonate sequence than we found. Where the carbonate sequence is absent, Miller and others (1963, pl. 1) showed the Del Padre Sandstone, now considered the basal member of the Espirito Santo Formation, along the Paleozoic/Precambrian unconformity. We are uncertain, however, whether all or some of this sandstone actually is Del Padre Member, or in part a basal unit of the Sandia Formation. Clean quartz sandstone of the Del Padre and of the basal Sandia are not easy to distinguish. Accordingly, the isolated patches of basal Paleozoic sandstone are unnamed on plate 1.

Structure

The post-Precambrian structure of the study area is dominated by the Pecos-Picuris fault, which separates the western batholithic Precambrian terrane from the eastern tract of largely flat-lying Paleozoic strata with a basement of tightly folded Precambrian stratified rocks and plutons. As discussed by Cordell in Chapter B, this fault has conspicuous expression in the aeromagnetic data (pl. 5). This fault extends at least 85 km from near Glorietta, N. Mex., north to the Picuris Range and beyond (Miller and others, 1963, p. 47). Based on his correlations of the Ortega Quartzite and Vadito

Formation between the Picuris Range and the Pecos Wilderness, Montgomery inferred that about 37 km of right-slip displacement took place along the Pecos-Picuris fault prior to deposition of the Paleozoic strata (Miller and others, 1963, p. 16). This displacement juxtaposed two rather different metamorphic terranes, as described previously. Apparent large-scale drag of shale units in quartzites in the northern Precambrian terrane east of the Pecos-Picuris fault suggests significant right slip on the fault. According to Sutherland, the Paleozoic sedimentary rocks east of the fault were downthrown at least 460 m during the Laramide orogeny.

Meager evidence that the fault was active in Pennsylvanian time is seen in the tributaries and ridges west of Holy Ghost Creek, where sedimentary strata are upturned against Precambrian rocks (pl. 1). Here, Mississippian carbonate rocks are exposed at the bottom of two canyons, but not on the adjacent ridges, where Pennsylvnian strata rest directly on Precambrian rocks. This relationship suggests that some upturning along the fault took place during or prior to the Pennsylvanian, resulting in partial erosion of the Mississippian carbonate sequence. Furthermore, at one locality near the head of Holy Ghost Creek (1.6 km east-southeast of Spirit Lake) Mississippian carbonate rocks are preserved in a fault sliver only 300 m west of where basal Pennsylvnian sandstone rests on Precambrian rocks. This relationship suggests that the carbonate rocks in the sliver were deposited, downdropped, and preserved in the sliver before the upturning and erosion that preceded deposition of the Pennsylvanian clastic deposits. Unidentified quartz sandstones are preserved in other downdropped slivers, perhaps recording a similar tale at different times. All these reported relationships, however, need testing by more detailed mapping.

An outcrop of the fault was seen at the dip symbol on the fault (75° W) northwest of Pecos Baldy. Here, phyllite is intensely sheared and weakly mineralized where it abuts against granite on the west. The granite is undeformed, but the phyllite is sheared over a width of about 30 m east of the fault; the intensity of shearing diminishes gradually eastward through this width. The outcrop at the dip symbol farther north (80° SW) is on a branch of the fault. The rock here is horizontally slickensided mylonite. Due west of Pecos Baldy, Precambrian quartzite is brecciated in a large area immediately east of the fault. Here, angular fragments of quartzite are in a matrix of undeformed well indurated quartz sandstone that is identical to that found at the base of the Paleozoic sequence. We interpret the breccia as a talus along a fault-line scarp that existed when the basal Paleozoic sands were laid down. Similar relationships were observed along the east-trending fault that marks the boundary between the northern and southern terranes in the Pecos River canyon.

The Jicarilla fault is the next major fault to the east, marking the eastern boundary of the resistant quartzite of the Truchas Peaks area. The expression of the fault in the aeromagnetic data is discussed by Cordell in Chapter B. The trace of the fault is sinuous and no uniform dip can be inferred from its map pattern. Sutherland considered the fault to be a west-dipping reverse fault, and he reported a dip on the fault of 67°-70° west where it is exposed 3.4 km north of Chimayosos Peak (Miller and others, 1963, p. 48). On the east shoulder of Chimayosos Peak, Pennsylvanian strata are overturned to the southeast, and they are complexly folded in a belt about 200 m wide east of the fault. From topographic evidence we drew a branch of the fault through the saddle west of Chimayosos Peak and along the West Fork of the Rio Santa Barbara. About 2 km south of the junction of the Middle and

West Forks of Rio Santa Barbara, the fault is bracketed between outcrops of west-dipping black shale of the Sandia Formation and east-dipping unidentified quartz sandstone. West of the fault the sandstone rests unconformably on Precambrian quartzite and forms several rather poorly exposed east-dipping flatirons.

The axial traces of the Holy Ghost and Chimayosos synclines mark the eastern limits of upturning along the Pecos-Picuris and Jicarilla faults. These synclines are asymmetrical, as shown, and in broad areas farther east the Paleozoic strata dip generally 10 degrees or less. This wide subhorizontal tract is broken on the southwest by a complex pattern of northeast-trending faults (pl. 1).

Five to seven miles (8-11 km) west of the Pecos-Picuris fault is a conspicuous north-trending topographic lineament that crosses the western batholithic terrane, and named the Borrego lineament on plate 1. This lineament is almost surely the line of a fault, but no clues to the fault's dip or displacement were found during mapping. The same lineament extends south into the Glorietta quadrangle, where it is the Garcia Ranch fault of Budding (1972), expressed as a narrow belt of Paleozoic sedimentary rocks that are tightly folded between opposing blocks of Precambrian granitic rocks.

Other lineaments are conspicuous west of the Pecos-Picuris fault, particularly a northeast-trending lineament along stretches of Rio Capulin and upper Rio Frijoles (pl. 1). These lineaments may be expressions of fracture zones, or faults of small displacement.

The gneissic roof pendants of the western Precambrian batholithic terrane are large irregular slivers and slabs that appear to dip mainly west, southwest, and south at moderate angles. These relationships are suggested tentatively by the attitudes of foliation, and by the topographic expression of contacts (not adequately mapped) between the layered gneisses and the enclosing granitic rocks. As one might expect from their setting, the gneisses have been deformed at least twice, but their structure has not been worked out.

The structure of the northern Precambrian terrane east of the Pecos-Picuris fault is dominated by a pattern of tight east-trending upright and overturned folds, mapped in detail in the Truchas Peaks-Pecos Baldy area by Grambling (written commun., 1978), who made ample use of sedimentary top-facing criteria. As shown on plate 1, the east-trending folds of that area have been warped along north-south trends that are subparallel to the Pecos-Picuris fault. The east-trending pattern of early folds is represented in the Pecos River canyon immediately north of the southern-northern terrane boundary, and probably along the eastern side of the study area. In upper Rio Mora to the extreme eastern edge of the study area, the early folds have been strongly redeformed and bedding has been warped to north-south strikes and rather gentle dips to the west. In this area, west-dipping bedding and foliation surfaces commonly have slickensides and mullions that plunge southwest, suggesting at least some of the refolding was produced by northeast-directed thrusting.

The southern terrane east of the Pecos-Picuris fault is dominated by northeast trends that curve locally to east-west or north-south. Stratigraphically, the rocks of this terrane are characterized by abrupt facies changes, and layers that can be traced long distances are lacking; top-facing criteria such as pillows in metabasalts, graded bedding, and crossbedding are well exposed only locally. For these reasons the structure of the southern terrane is less well known than that of the northern terrane, and is more difficult to map. Tight east-trending or northeast-trending folds with axial plane foliation are exposed in outcrops, and the map patterns suggest the presence of larger ones as well.

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Chapter B

Geological, geochemical, and geophysical evaluation of the mineral resources of the Pecos Wilderness and adjacent areas, Santa Fe, San Miguel, Mora, Rio Arriba, and Taos Counties, New Mexico

by

Robert H. Moench, U.S. Geological Survey,

James M. Robertson, New Mexico Bureau of Mines and Mineral Resources

and

Stephen J. Sutley, U.S. Geological Survey

With a section, "Interpretation of aeromagnetic data," by Lindreth Cordell, U.S. Geological Survey

Types of mineral deposits

Two types of mineral deposits have been extensively prospected or mined near the boundaries of the Pecos Wilderness and adjacent areas: (1) Precambrian pegmatite dikes, worked mainly for scrap mica, but locally also for beryl; and (2) Precambrian volcanogenic massive-sulfide deposits, represented by the Pecos mine, a major producer during the 1920's and 1930's of zinc, lead, copper, silver, and gold. The pegmatites, and more importantly the massive-sulfide deposits, are the major concerns of this project; other types of deposits that are suggested by the geochemical data are also discussed in the section on geochemical investigations. Although the geochemical data show evidence of mineralization along the Jicarilla fault, as described later, other faults in the study area do not appear to be significantly mineralized.

Unwary prospectors might be attracted to pyrrhotite-bearing schists of the northern terrane that are exposed west of Pecos Baldy and in the canyon of Rio Mora (pl. 1). For several kilometers downstream from the Rio Mora exposures, stream gravels and talus are heavily iron stained; at one locality where Rio Mora crosses pyrrhotite-bearing schist, talus and gravel are solidly cemented by iron oxides. Neither the schists nor the heavy-mineral concentrates from the stream sediments downstream from the schists have unusual metal contents. Spectrographic analyses of two samples of dark pyrrhotite-bearing schists from the Rio Mora exposure show: 0.5 ppm and no silver; 10 ppm and barely detectable copper (detections limit 5 ppm); 10 ppm molybdenum in both; 20 ppm lead in both; and no zinc in either.

Pegmatites

As shown on plate 1, Precambrian pegmatite dikes are widely distributed in the area. The pegmatite (composed largely of coarse-grained white feldspar, quartz, and mica) are far more resistant to weathering and erosion than most of the Precambrian rocks they intrude. They cap hills and ridges, form ribs and cliffs, and they form conspicuous regolithic float and rubble. The important question is not the likely presence of undiscovered pegmatites within the study area, but instead whether pegmatites in and around the study area constitute a major resource.

In shape the pegmatites range from extensive thin dikes to thick pods; the dikes are several hundred meters long and perhaps 3 or 5 m thick and the pods are 20 m or so long and no more than about 5 m thick. Most of the dikes and pods strike north-northeast to north-northwest and dip steeply; some are subhorizontal. As described in detail by Johns (1953), the Pidlite pegmatite in the east-central part of the map area is a pod about 23 m long, and 6 m wide at the most; it strikes N. 10^{o} E. and is about vertical.

The Elk Mountain (Kept Man) pegmatite in the southeast part of the map area (pl. 1) appears to dip rather gently northwest (Jahns, 1946, p. 279). Jahns (1946, p. 275) has noted that most pegmatites in the southeastern part of the Pecos Wilderness study area occur in schist rather than in the massive granitic rocks and his observation applies to other parts of the study area as well.

The principal minerals in all the pegmatites are, in decreasing order of abundance, microcline, quartz, albite, and mica. Most of the pegmatites have little else, except for accessory magnetite and garnet, and possibly sparse beryl and columbite. A few of the pegmatites, most notably the lithium- and tantalum-bearing Pidlite pegmatite (pl. 1; Jahns, 1953; Sheffer and Goldsmith, 1969), have a complex assemblage of accessory minerals. The Pidlite contains a complex suite of accessory minerals (Jahns, 1953, table 1) that provides at least a partial guide to the interpretation of our geochemical data. The presence of bismuth and bismutite in the pegmatite suggests that the bismuth detected in many panned concentrates from the southeastern part of the study area represents bismuth minerals that came from the pegmatites.

Geochemical data suggest the presence of unrecognized minerals in the pegmatites. The Pidlite pegmatite may contain scheelite, for example, as suggested by 1,500 ppm tungsten that was spectrographically determined in the nonmagnetic heavy-mineral fraction of panned concentrate obtained down-drainage from the mine (pl. 3B). The geochemical data show that bismuth and tungsten are widespread in the concentrates from the region south and southwest of the Pidlite mine, suggesting that minerals of these elements occur in pegmatites of that are as well (pls. 3B, C).

Uranium in pegmatites is a possible source for the radon detected in springs and small streams, as described under geochemical investigations. According to Redmon (1961, p. 55-61), several claims in the Cordova pegmatite claim area were located in 1954 or 1955 as a result of the discovery of radioactive minerals in the pegmatites. Jahns (1946, p. 275) listed uraninite and secondary uranium minerals in pegmatites of the Elk Mountain area; these pegmatites also contain accessory garnet, fluorite, columbite, rare beryl and monazite, and other minerals.

Volcanogenic massive-sulfide deposits

From 1927 to early 1939 the Pecos mine, near the southern border of the study area, was New Mexico's largest producer of base and precious metals. Long considered a hydrothermal replacement (Krieger, 1932; Harley, 1940), the Pecos deposit is now recognized to belong to a class known as volcanogenic massive-sulfide deposits (Giles, 1974, 1976; Stacey and others, 1977; Robertson and others, 1978; Riesmeyer, 1978; Robertson and Moench, 1979). Because most deposits of this class are confined to very specific volcanic or metavolcanic rock associations, the favorable ground is restricted to areas that are underlain by rocks of that association. However, it should be recognized that wide areas of Precambrian metavolcanic rocks are covered by Paleozoic strata, and many so far unrecognized occurrences of favorable lithologies may exist. The critical rock assemblage is, with variations, in ascending order: submarine basalt, commonly pillowed; differentiated intermediate to silicic volcanics (or predominant rhyolites, especially as rhyolitic domes, flows and proximal pyroclastic deposits); iron-formation; and immature volcanogenic marine sedimentary rocks (Sangster, 1972). In some massive-sulfide-bearing terranes this succession is repeated in whole or in part in a crude cyclic manner. The massive-sulfide ores are typically associated with the rhyolites, and characteristically with only one rhyolitic member of a cyclic repetition of the succession. The ores are thought to have precipitated on the sea floor, and very close to an explosive rhyolitic vent.

Areas that have parts or all of the favorable volcanic-sedimentary association are delineated on plate 1, as areas of mixed metavolcanic rocks (vm). The most important mixed metavolcanic areas are at the Pecos mine; in Macho Canyon and vicinity; and along Doctor Creek and vicinity (fig. 1). The favorable association probably extends between these areas, beneath the Paleozoic sedimentary cover. Mixed metavolcanic rocks also are exposed in Hollinger Canyon; on the east side of Spring Mountain; and in a few smaller areas (pl. 1). Although the Pecos mine yielded only about 2.3 million tons of ore, massive-sulfide deposits containing as much as 100 million tons are known in the Canadian Archean (Walker and others, 1975). Moreover, massive-sulfide deposits tend to occur in clusters within areas that are 15-30 km or so across (Sangster, 1972, p. 5). A high potential thus exists for the discovery of other massive-sulfide deposits at places within and outside the study area. Much larger parts of the study area, however, have no potential for this type of deposit.

As summarized in chapter A, available isotopic evidence suggests that the granites of the region were emplaced about 1,650 m.y. ago, and that the ores at the Pecos and Jones mines formed somewhat earlier, about 1,710 m.y. ago (Stacey and others, 1977, p. 10, table 2). These data support our contention that the granites are distinctly younger than the ores. The lead isochron model ages of 1,710 and 1,720 m.y. of Stacey and others are reasonable ages of ore formation and of the submarine volcanism that is presumed to have accompanied mineralization.

Geochemical investigations

Introduction

Geochemical sampling was done in accord with the results of a pilot study, carried out in September of 1976 by Wallace R. Griffitts and other personnel of the U.S. Geological Survey. The purpose of the pilot study was to design a program of sampling, laboratory preparation, and chemical analysis that would be most appropriate for assesment of the types of deposits that were considered likely to occur within the Pecos Wilderness study area, and for the limited time that was available for the major effort of this investigation. The recommended procedure was to collect heavy-mineral concentrations by panning stream sediments, to further concentrate them in the laboratory, and to analyze them spectrographically by semiquantitative techniques for 30 elements. This method of geochemical surveying is based on the principle that the heavy economic minerals, mainly in oxidized forms, are weathered and eroded from mineral deposits that are exposed at the surface, and accumulate along drainages downstream from the deposits.

Approximately 500 heavy-mineral concentrates were collected during this investigation. Each sample was prepared as follows in the mobile field laboratory: After drying, the light minerals (mainly quartz and feldspar) were removed by flotation in bromoform and discarded. Magnetite was then removed from the heavy fraction using a hand magnet. The nonmagnetic-paramagnetic fraction was then run through a Franz Isodynamic magnetic separator[1/] at 0.2 amperes (side tilt 15°, forward tilt 25°) to remove all

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1/ The use of trade names is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

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remaining magnetite, ilmenite, and pyrrhotite. The nonmagnetic fraction was then rerun at 0.5 amperes, and the magnetic fraction was stored for possible further analysis. The nonmagnetic fraction was rerun at 1 ampere, and the resulting magnetic and nonmagnetic fractions were used for the geochemical survey.

This work was supplemented by spectrographic analyses of 42 samples of soils, 17 bulk samples of stream sediments, and 20 rocks (in addition to the granites and syenite listed in table 1). Of the 42 soil samples, 37 were collected in the Doctor Creek area of mixed metavolcanic rocks (pl. 1; fig. 1) at 200-foot intervals along two traverse lines. One line followed the Doctor Creek canyon bottom, and the other the ridge to the north between the Pecos-Picuris fault and the tilted Paleozoic strata. These samples yielded inconclusive information, but the samples having the most copper, lead, iron, and maganese suggest the presence of at least a weakly mineralized zone, as described later. The other soils were collected from the traces of the Pecos-Picuris and Jicarilla faults; they showed no evidence of mineralization. The bulk samples of stream sediments were collected immediately downstream from the Pecos-Picuris and Jicarilla faults, and from suspected mineralization in metavolcanic rocks. The rocks were collected from rusty mylonites, breccia with gossan, rusty materials associated with mixed metavolcanic rocks and iron formation, and from obviously mineralized materials in prospect pits. The results of the analyses are cited where appropriate.

In addition to this work, Walter S. Ficklin (U.S. Geological Survey) collected and analyzed 60 samples of water at 55 sites for radon content, measured and reported in picocuries per liter (pc/L) of radon-222 plus daughters. The purpose of this work was to provide a quick guide to possible uranium occurrences, based on the principle that radon (mainly derived by radioactive decay of radium-226, in turn a decay product of uranium 238) is carried by ground water that has passed through concentrations of uranium. The water samples were obtained from springs and a few streams. Because it was not possible to obtain samples from the whole study area, owing to time limitations, this work was concentrated in areas underlain by quartzites of the northern terrane, considered possible hosts for Blind River-type deposits. The results, in picocuries per liter, are shown on plate 3B. Because radon, being a gas, is quickly lost to the atmosphere from turbulent mountain streams, spring waters yield the most accurate data on radon in ground-water systems. Accordingly, springs were sampled wherever possible. Samples from springs and streams are distinguished on plate 3B.

The magnetic and nonmagnetic fractions at 1 ampere and the available magnetic concentrates at 0.5 ampere were analyzed spectrographically by Sutley for 30 elements, and the data for the most important 13 elements are displayed on the geochemical maps (pls. 2, 3, 4). For all elements except niobium, the nonmagnetic fractions of the heavy-mineral concentrates provided the most useful information. Plate 4B shows the highest range of values obtained for the 13 spectrographically determined elements, and the sites of four water samples that contained more than 1,000 pc/L radon. This map summarizes all the important geochemical data, and is the main geochemical basis for assessing the mineral resources of the study area.

Possible metalliferous concentrations in Pennsylvanian sedimentary rocks

The geochemical data suggest that the Sandia and Madera Formations contain unusual amounts of copper, molybdenum, and zinc (pls. 2A, B; pl. 4A). Samples from broad areas that are underlain by these formations commonly have 70-300 ppm copper and 10-30 ppm molybdenum (also 50 ppm Mo in two samples, and 70 ppm Mo in one) in the magnetic heavy-mineral fractions. The magnetic and nonmagnetic fractions of many samples from the same area also show 700-3,000 ppm zinc, which also tends to be high in samples from streams that drain areas of Precambrian quartzite. The copper, molybenum, and zinc in the samples came from deposits along streams that drain only Pennslyvanian beds, and must have their sources in the sedimentary rocks.

Sedimentary copper deposits have been mined or prospected at several localities in northern New Mexico, but all are in redbed sandstones of Pennsylvanian, Permian, and Triassic age that were deposited under subaerial conditions (LaPoint, 1976). These sandstones are younger than the marine shales, limestones, and sandstones of the Sandia and Madera Formations, the most widespread sedimentary units in the study area. It is possible, however, that the metals are in deposits analogous to the stratiform copper deposits of western Oklahoma, which occur in shallow marine and brackish water shales of the Permian Flowerpot Shale (Johnson, 1976). As shown by Johnson (1976, fig. 3), the Flowerpot is a prodelta shaly facies between a coarsely clastic deltaic complex on the east and an evaporite basin facies on the west--all on the east side of the Permian Hollis basin. This setting is comparable to that of the Sandia and Madera Formations of the study area, in the sense that these formations represent a marine facies that accumulated next to the eastern margin of the Pennsylvnian San Luis highland of Tweto (1975, fig. 2). Because sedimentary copper deposits are unknown in marine Pennsylvanian rocks elsewhere in New Mexico, we believe that the potential for this type of deposit in the study area is small. The wide disribution of medium-level abundance and the lack of high-level abundances of copper, molybdenum, and zinc in the geochemical data suggests that these elements are dispersed through the rocks and are not concentrated in high-grade deposits. However, the possibility remains that new types of stratabound metalliferous deposits might occur in the marine Pennsylvanian, and this possibility might provide an important focus for continuing research on the Pennsylvanian in New Mexico.

Possible mineralization along the Jicarilla fault

Evidence of sparse mineralization has been found along the Jicarilla fault, as rusty-weathering mylonite, sparse pockets of gossan in breccia, and sulfides in adjacent sedimentary rocks. A spectrographic analysis of gossan from brecciated Precambrian quartzite near the fault west of Pecos Baldy Lake indicated 1.5 ppm silver, and 50 ppm molybdenum; 2 ppm silver also was detected in a bulk sample of stream sediment from a tributary of Pecos Baldy Lake that drains the area of the same brecciated quartzite. Immediately north of Chimayosos Peak, Montgomery (Miller and others, 1963, p. 55) found abundant pyrite and sparse galena and copper carbonates in Pennsylvanian rocks where bedding is turned up against Precambrian quartzite along the fault. A spectrographic analysis of rusty sandstone exposed immediately east of the fault on Chimayosos Peak indicated 50 ppm lead and 7 ppm molybdenum, which are higher than normal abundances.

As shown on plate 4B, the highest values for antimony, zinc, niobium, and beryllium in heavy-mineral concentrates, and radon in water are distributed along the trend of the Jicarilla fault, particularly along the inferred segment along the West Fork of Rio Santa Barbara. Of 12 samples that contained detectable amounts of antimony, 11 were obtained from tributaries to the West Fork (pl. 4B). The two highest values for beryllim in the study area and three of the four samples of water that contained more than 1,000 pc/L radon have their sites near the trace of the fault, as shown on plates 2D, 3B, and 4B.

Of the five elements that define the anomaly, uranium (indicated by radon) is most important, as an energy-related commodity. Only minor concentrations of uranium are suspected, because even the highest values are not exceptionally high and could be explained, for example, by small amounts of uranium in pegmatites that may well be cut and crushed along the Jicarilla fault. Moreover, the high values are scattered along the fault, interspersed with much lower values. This relationship suggests that the uraniferous sources are likewise scattered. All the detected radon in water samples obtained from the vicinity of the Jicarilla fault was determined in samples that came from springs, having little opportunity for loss of radon to the atmosphere. Spring samples yield the most accurate data on radon in the ground-water system, and we are confident that the highest values indicate only minor accumulations of uranium along the fault.

The origin of the geochemical anomaly along the Jicarilla fault is not understood. Although the radon data suggest the presence of only minor amounts of uranium along the fault, the abundances particularly of niobium and zinc are unusual. Our data do not include the possibility that all the elements that define the anomaly are related to a large mineralized system at depth. Alternatively, it should be noted that the elements of the anomaly represent an unusual association, and it seems likely that they became concentrated along the trace of the fault by different processes. Whereas the zinc and antimony may represent sulfides that were precipitated (along with the sparse observed sulfides and detected silver and molybdenum) from warm waters that circulated through fractured wallrocks, the niobium and beryllium may represent grains of columbite and beryl that were freed from pegmatites by crushing along the fault. These minerals are known to occur in pegmatites of the study area. Normally, in unfaulted areas they may be carried in their quartz-feldspar hosts long distances downslope, but along an important fault a higher proportion of these grains might be released from the hosts and accumulate in relatively high abundances in stream sediments along the fault.

Favorable areas for the occurrence of massive-sulfide deposits

Four small areas have been delineated that are favorable for the occurrence of massive sulfide deposits, for convenience called the Macho Canyon, Doctor Creek, Hollinger Canyon, and Spring Mountain areas (pl. 4B). These areas are underlain by mixed assemblages of metavolcanic rocks, having the now classic volcanogenic massive-sulfide associations. The economic potential of each of these areas is a function of the size of the favorable area (that is, the amount of room that is available for one deposit), and the extent to which the favorable rock associations are supported by evidence of mineralization in outcrop or in the geochemical data. On this basis the Macho Canyon and Doctor Creek areas are by far the most promising, in our opinion. Highly favorable rocks may well extend from the Macho Canyon and Doctor Creek areas along the Pecos-Picuris fault east to the Pecos mine, beneath a thick cover of Paleozoic strata. Mixed metavolcanic rocks are exposed also along the Pecos River north of Noisy Brook and along the South Fork of Bear Creek, but these areas are small and no evidence of sulfide mineralization was found in them.

The Macho Canyon area lies on the extreme southern boundary of the study area (pl. 4B). It contains two tracts of mixed metavolcanic rocks, one in a downdropped sliver along the Pecos-Picuris fault, the other in a belt extending south from the Jones mine. In the southern part of the sliver, a complex assemblage of metavolcanic rocks and metashale is overlain by unidentified Paleozoic sandstone. Where the sandstone overlies the metavolcanic rocks, copper carbonate minerals are present in the sandstone, suggesting the presence of copper-bearing sulfides in the subjacent metavolcanics. Similar relationships are exposed at the portal to the adit shown by Miller and others (1965, pl. 1) at the Pecos mine.

The eastern belt in the Macho Canyon area is the more promising one. It is underlain by an assemblage of metabasalts, silicic metavolcanics, iron-formation, and immature metasedimentary rocks of probable volcanic composition. In addition to the prospected sulfide minerlization at the Jones mine (Harley, 1940, p. 51), analyses of eight heavy-mineral concentrates that were obtained from a small area in Macho Canyon show high abundances of tin, tungsten, bismuth, lead, coppper, and silver (pl. 4B, and other maps). Although tin, bismuth, and tungsten are not generally considered to be common elements in massive-sulfide deposits, at least tin is an important minor constituent in two Canadian deposits, as stannite in the Lake Dufault deposit, and cassiterite in the Kidd Creek deposit (Sangster, 1972, table 12; Walker and others, 1975, p. 86). Alternatively, it is possible that tin, tungsten, and bismuth came from the granite that intrudes the mixed metavolcanics, or that these elements are in unrecognized types of mineral deposits.

The Doctor Creek area is underlain by a block of metasedimentary and mixed metavolcanic rocks that extends from Doctor Creek north about 4 km to a tributary of Holy Ghost Creek. The block lies between a segment of the Pecos-Picuris fault and the upturned basal Paleozoic rocks on the east. The Precambrian rocks here are currently being studied by one of us (Robertson). Though extremely complex, they are only moderately metamorphosed and primary sedimentary, pyroclastic, and magmatic features are exceptionally well preserved. The block is identified as exceptionally favorable for the occurrence of massive-sulfide deposits on the strength of the presence of rhyolitic and dacitic pyroclastics, abundant quartz-magnetite and quartz-hematite iron-formation, local visible copper mineralization, and the geochemical data.

Of 25 soil samples that were collected along Doctor Creek between the Pecos-Picuris fault and the Paleozoic beds, 70 ppm copper was detected in three. The same amount of copper was detected in two of 12 samples that were collected along the ridge to the north. Copper abundances in the remaining 32 samples ranged from 5 to 50 ppm. Although 70 ppm copper is not unusually high, the distribution of the high-copper samples coincides with high abundances of iron and manganese in the soil samples, and suggests the presence of at least a weakly mineralized zone near the fork of Doctor Creek at 8,950 ft elevation, and on the top and east side of knoll 9730 to the north. These two sites are roughly on-strike, and they may represnt a single mineralized zone.

Conspicuous evidence of copper is found at the prospect pit on the ridge 2 km north of Doctor Creek (pl. 1). Here, copper carbonate minerals and tourmaline are in coarse-grained massive amphibolite, possibly of intrusive origin. Downslope to the west is dense metabasalt; a small amount of metarhyolite(?) is exposed near the contact between the metabasalt and the massive amphibolite. Spectrographic analyses of two specimens from the prospect pit show 1,000 and 700 ppm boron, and 2,000 and 5,000 ppm copper, respectively. None of the other elements are exceptionally abundant. Tourmaline is a common gangue mineral at the Pecos mine (Kieger, 1932, p. 463). Analyses of two heavy-mineral concentrates from the tributary to Holy Ghost Creek that drains the south side of the same ridge show 70 ppm silver, and 5,000 ppm copper--the highest amounts of these metals that were found in all of our samples from the study area (pl. 4B). This ridge and the tributary to the south seem to be the most favorable ground in the Doctor Creek area.

A small area in Hollinger Canyon is underlain by mixed metavolcanic rocks, containing distinctive layers of metarhyolite and iron-formation. These rocks are bordered east and west by metabasalt and intrusive amphibolite, and to the south they evidently pass to a sedimentary assemblage of feldspathic metasandstone (quartz-feldspar granofels). No evidence of mineralization was found in the outcrops, but the analysis of a heavy-mineral concentrate from Hollinger Creek, a short distance downstream from the area of mixed metavolcanics, showed 3 ppm silver and more than 1,000 ppm bismuth, at least five times the abundance of bismuth in other samples from Hollinger Canyon (pls. 3C, 4B). Spectrographic analyses of two bulk sediment samples from streams that drain the metavolcanic area indicate more than usual amounts of copper: 70 ppm Cu in one, and 50 ppm Cu and 70 ppm Bi in the other. The bismuth-bearing samples were obtained from the site of the heavy-mineral concentrate that yielded 3 ppm Ag and 1,000 ppm Bi. Because this area is small and the evidence of mineralization is scant, the likelihood that a massive- sulfide deposit actually occurs here is small.

Four other heavy-mineral concentrates from Hollinger Canyon, one upstream and three downstream from the area of mixed metavolcanic rocks, show high concentrations of tungsten, lead, and copper (pl. 4B). It is unlikely that these samples are expressions of massive sulfide deposits. Three of the samples were obtained from sites on mapped faults, and one (showing 700 ppm copper) is from a stream that flows mostly through Pennsylvanian sedimentary rocks.

On the top and east side of Spring Mountain is an area of slightly less than 1 km^2 that is underlain by rather poorly exposed mixed metavolcanic rocks and iron-formation. The foliation of these rocks strikes northeast. On-strike to the northeast these metavolcanic rocks pass into a metasedimentary assemblage of quartz-feldspar granofels (feldspathic metasandstone), pelitic schist, and thin units of calc-silicate rocks; to the southwest they pass to predominant metabasalt. Evidence of mineralization in the Spring Mountain metavolcanic area is shown by the analysis of one heavy-mineral concentrate, which showed >500 ppm gold, 10 ppm silver, and more than 1,000 ppm bismuth (pl. 4B). Evidently the concentrate contained at least one fragment of gold, a possible indicator of massive-sulfide deposits such as the Pecos. The concentrate was obtained from the mouth of a tributary of Daily Creek that drains the northeastern part of the Spring Mountain area of mixed metavolcanics. The area of mineralization is probably small, however, for little evidence of mineralization is seen in other heavy-mineral concentrates that were obtained from the east side of the study area between the Pidlite mine and Hollinger Canyon (see pls. 2, 3, 4). The available evidence suggests that favorable ground for volcanogenic massive sulfide deposits is restricted to the small mapped Spring Mountain area of mixed metavolcanics that is shown on the geologic map.

Other geochemical anomalies

Two anomalies are defined by a pair of samples, each pair having the highest range of two or more elements (pl. 4B). One anomaly is at the northwestern border of the study area in the canyon of Rio de las Trampas. The other is in the south part of the study area, on a tributary to Bear Creek.

The Rio de las Trampas anomaly is defined by high concentratons of tungsten and niobium, and detectable antimony in one sample; both samples also have moderately high abundances of zinc. The streams from which the samples were obtained drain a Precambrian quartzite terrane. Although these streams do not cross known faults, small faults that are host to mineral deposits may be present. Alternatively, the anomaly may be related to pegmatites.

High concentrations of molybdenum, lead, bismuth, and tungsten in two samples define the Bear Creek anomaly. The high bismuth and tungsten sample also contained 70 ppm Pb, and the high lead and molybdenum sample contained 300 ppm W (pls. 2B, 3B, 3C, 3D, 4B). This anomaly is on a tributary that drains well-exposed quartz porphyry that shows no signs of alteration or mineraliztion along the traverse lines (pl. 1). The anomaly could be related to the fault on the upstream side of the quartz porphyry, but the sample that was obtained from the site between the fault and the anomaly contained no evidence of mineralization, with the possible exception of bismuth (pl. 3C). A source for the anomaly in the metabasalt that was mapped in float east of the fault is unlikely, because two samples that were obtained from that area did not reveal much of interest.

Interpretation of aeromagnetic data

by

Lindrith Cordel

The aeromagnetic map of the Pecos Wilderness study (pl. 5) shows total magnetic intensity relative to an arbitrary datum at a contour interval of 20 gammas. The survey was flown in 1970 at a constant barometric elevation of 13,500 feet above sea level. Flight lines were east-west, spaced approximately 1 mile apart. Ground elevation of the area ranges from 7,500 feet to over 13,000 feet, consequently, there is a variation from 500 to 6,000 feet of vertical distance between the magnetometer and magnetic sources.

The most prominent aeromagnetic feature is a north-northeast-trending gradient associated with the Pecos-Picuris fault (PP on pl. 5). This gradient slopes eastward and separates an area of subcircular magnetic high anomalies over granitic and gneissic plutonic rocks, characteristic of the western Precambrian terrane (pl. 1), from east-northeast-trending magnetic low anomalies over stratified metasedimentary and metavolcanic rocks characteristic of the northern and southern Precambrian terranes. Lack of correlation of magnetic features across the Pecos-Picuris trend and the markedly differing signature pattern on either side of the trend indicate a major fault. There is no basis either in these or in regional aeromagnetic maps (Cordell, 1978) for determining the amount of inferred strike-slip movement on the Pecos-Picuris fault. East of the Pecos-Picuris fault, in the area of the geochemical anomaly along the Jicarilla fault (J on pl. 5), magnetic contours crudely parallel the S-shaped trend of the fault and the Chimayosos syncline. This probably is a result of the broken Precambrian terrane along the fault.

Several aeromagnetic anomalies over the plutonic western Precambrian terrane are very prominent. At least two are associated with mountain summits along the axis of the Sangre de Cristo Range and these are labeled "T" (for terrain) on plate 5. Other prominent aeromagnetic highs in this area are not associated with terrain features and indicate areas of more magnetic rock. Even the terrain-related anomalies may be indirectly associated with lithologic variation, inasmuch as the terrain features themselves may be related to lithology.

Magnetic anomalies in the eastern part of the area, associated with the stratified Precambrian metasedimentary and metavolcanic rocks, trend generally east-northeast and northeast and these trends probably reflect the regional strike of these units. There is no magnetic expression of a contact separating the northern from the southern Precambrian terranes. Low magnetic anomalies and generally lower background intensity is associated with the metavolcanic and metasedimentary Precambrian terrane. In part, this is because this area is structurally somewhat lower and these rocks occur at slightly greater distance from the magnetic sensor. However, magnetic low anomaly trends cross prominent high ridges, indicating that the rocks themselves are probably more weakly magnetized than those of the plutonic terrane to the west.

Three aeromagnetic anomalies that occur east of the Pecos-Picuris fault require interpretation within the context of the geological and geochemical data (pl. 5, anomalies S, D, and H). A strong positive anomaly having a linear east-northeast-trending magnetic gradient along its northern edge occurs at locality S (for Spring Mountain) of plate 5. Anomaly S is centered over a topographic ridge (elevation 11,000 feet), and is at least in part associated with this ridge. The anomaly extends beyond the ridge on the east and west, however, in a manner suggesting that the source is a tabular feature whose effect at the ridge is exaggerated because it is closer to the magnetic sensor. The east-northeasterly trend of the anomaly is alined with the geologic strike in this area, and is subparallel with an east-northeast-trending layer of metabasalt(?) west of the anomaly. By inference, anomaly S and its possible extension to the east-northeast and to the west-southwest could represent a zone within the Precambrian metavolcanic and metasedimentary terrane of concentrated metabasalt and possibly iron-formation. Moderately extensive geochemical data in the area, however, show no geochemical anomalies associated with the aeromagnetic anomaly.

In the Doctor Creek area of high potential for massive-sulfide deposits (labeled D on pl. 5), a bulge on the east side of one of the terrain-related anomalies may reflect a local residual magnetic positive anomaly. This anomaly is barely resolvable due to interference with the large anomaly immediately to the west. It would not be noteworthy except for the presence of anomalous metal concentrations in the vicinity. The anomaly suggests the presence of relatively magnetic rock in the vicinity of Doctor Creek from the edge of the Precambrian outcrop eastward for a distance of about 1 mile.

At locality H another very subtle positive residual magnetic anomaly occurs in association with a small mapped body of probable iron-formation. This anomaly seems to have a generally east-west strike and is more or less lined with geologic strike of the area. Again, fairly extensive geochemical data indicate no anomalous metal concentrations in the area.

The aeromagnetic data reveal generalized structural grain within the contrasting Precambrian terranes of the study area, but the data do not directly indicate any areas favorable for mineralization. Relatively strongly magnetized rocks which, by inference, could contain metabasalt or iron-formation associated with the volcanogenic suite occur locally as noted. However, the strongest positive magnetic indication, at locality S, is not associated with a geochemical anomaly, whereas only very small magnetic anomalies are noticed in the area of high potential for massive-sulfide deposits at Doctor Creek. Moreover, the Pecos mine itself is in an area of rather low magnetic intensity, and the positive magnetic anomalies cannot be taken as a favorable indication of volcanogenic massive-sulfide deposits.

Conclusions

Small parts of the Pecos Wilderness and adjacent areas have a high to low potential for the occurrence of massive-sulfide deposits containing zinc, copper, lead, silver, and gold, and possibly significant amounts of tin, tungsten, and bismuth as byproducts. A large part of the study area has a low potential for Paleozoic sedimentary accumulations of copper, zinc, and molybdenum. A small part of the area along the Jicarilla fault has a low potential for uranium and associated antimony, zinc, niobium, and beryllium. The study area has no potential for oil and gas, coal, and geothermal resources. A low potential for scrap mica and other pegmatite-related commodities exist west of the Pecos-Picuris fault and on the east side of the area.

Massive-sulfide deposits

The Macho Canyon and Doctor Creek areas of mixed metavolcanic Precambrian rocks (pls. 1 and 4B) have a very high potential for zinc, copper, lead, silver, gold, and other commodities that may be associated with massive-sulfide deposits. The geochemical data indicate that tin, tungsten, and bismuth may be important byproducts. These areas show evidence of mineralization in outcrops and in the geochemical data, and both are within 7 km of the Pecos mine, a major producer of metals in the 1920's and 30's.

The favorable rocks probably extend east to the vicinity of the Pecos mine beneath a thick cover of Paleozoic strata, in an area that probably overlaps the boundary of the study area. This entire area has high potential for massive sulfide deposits. The Hollinger Canyon and Spring Mountain areas have a much lower potential, because the areas that are underlain by favorable host rocks are much smaller, and because evidence that significant mineralization actually occurs there is less conclusive.

Jicarilla fault

A geochemical anomaly defined by antimony, niobium, beryllium, zinc, and radon coincides with the Jicarilla fault and is most conspicuous on the fault segment that is inferred to extend along the upper reaches of the West Fork of Rio Santa Barbara. Evidence of sparse mineralization was found in outcrops. The radon indicates the presence of uranium, but the potential for minable uranium deposits along the fault is low. While the anomaly might reflect a more extensive mineralized system at depth, it is equally possible that it reflects a combination of unrelated processes that were controlled by the fault: precipitation of sulfides from warm water that circulated through the broken rocks of the fault to account for the zinc and antimony; release of radon to the water from uraniite in crushed pegmatite; release of columbite and beryl from pegmatites (now eroded) by crushing in the vicinity of the fault to account for the niobium and beryllilum in the panned concentrates. These unrelated processes would account for the uncommon association of zinc-antimony with niobium-beryllium; uranium might normally occur with either.

Pegmatites

Pegmatites exposed in the southeastern part of the study area and west of the Pecos-Picuris fault have low potential for scrap mica. The potential for other commodities that may be associated with the pegmatites also is low.

Beryl is a sparse constituent of many pegmatites. The Pidlite pegmatite is known for its lithium content and for the presence of sparse tantalum, shown by Sheffer and Goldsmith (1969) to occur there in much less than economic abundance. The majority of the pegmatites in the study area are mineralogically simple, but the geochemical data suggest that the pegmatites and possibly some of the granites contain at least traces of tin, tungsten, bismuth, beryllium, niobium, and rare-earth minerals. The pegmatites, however, cannot be considered an important resource of these elements under present economic conditions.

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Chapter C

Mines, prospects, and mineralized areas in the Pecos Wilderness and adjacent areas, Santa Fe, San Miguel, Mora, Rio Arriba, and Taos Counties, New Mexico

by

U.S. Bureau of Mines

Introduction

In this chapter, work done by the U.S. Bureau of Mines is discussed. Individual prospects and areas with past or present mining activity are discussed in detail. More emphasis is placed on areas of mining activity or where sample analysis indicated high mineral content. All analysis information is available at the U.S. Bureau of Mines, Intermountain Field Operations Center, Building 20, Denver Federal Center, Denver, Colorado 80225.

Previous studies

Matson and Hoag (1930) describe the mining methods at the Pecos mine, and Bemis (1932) the milling methods of the Pecos concentrator. Metzger (1938), in discussing gold mining in New Mexico, briefly describes the geology, development, mining, and milling methods of the Pecos mine and mill. The Pecos mine, which is at the junction of Willow Creek and the Pecos River, was a substantial source of base and precious metals, accounting for $36 million of mineral production between 1927 and 1939.

In 1963, the U.S. Bureau of Mines conducted a program of sampling pegmatites, primarily for tantalum, near Rociada (Sheffer and Goldsmith, 1969).

Included in the study of 90 pegmatites in north-central New Mexico by the Bureau of Mines, about 1960, were some pegmatites in and near the Pecos Wilderness and additions (Redmon, 1961). The geology and composition of the pegmatites and any mining are described and production data, if any, is mentioned. The predominant valuable product of these pegmatites was scrap and sheet mica.

In 1944, exploration work was done by the U.S. Bureau of Mines at the Elk Mountain mica deposit (Holmquist, 1946). This deposit and other pegmatites in the Elk Mountain disrict are described by Redmon (1961).

Present investigation

Prior to the start of the fieldwork in 1976, a search was made of available literature concerning mineral activity in and near the Pecos Wilderness and the six proposed additions. Records at the U.S. Bureau of Mines office in Denver, Colo., were examined for mineral production. The courthouse records of Mora, Rio Arriba, San Miguel, Santa Fe, and Taos Counties were examined for location notices of unpatented mining claims that may be in or near the areas under study. The records of the U.S. Bureau of Land Mangement office in Santa Fe, N. Mex., were checked for the existence of patented mining claims and mineral leases. The locations of those unpatented mining claims that had exact descriptions as to their locations and the patented mining claims are shown on plate 6. Numerous unpatented mining claims were on record that had vague descriptions and therefore could not be shown on plate 6. However, during the field investigtions, the approximate areas indicated by the vague descriptions were examined for any mineral activity. State agencies, companies, and individuals were contacted regarding knowledge of mineral activity in and near the area under study.

During the summers of 1976 and 1977, fieldwork was conducted in the Pecos Wilderness, the six proposed additions, and nearby places of mineral interest. This work consisted mostly of examining all known mines and prospect workings, and mineralized areas. The fieldwork was done by Michael Lane and Joseph Gersic, assisted by Richard Smith, Randy Niece, and Curtis Clifton.

Acknowledgments

The cooperation of county officials, personel of state agencies and the U.S. Forest Service, company employees, and individuals who provided information during the study is greatly appreciated. Special thanks are

extended to Michael Wirtz of the Pecos District Forest Service office and to Richard Dixon and W. D. Reismeyer of Continental Oil Company (Conoco), for providing information about Conoco's exploration work and sharing their knowledge of the geology of the southern part of the general area studied.

Sampling and analytical results

A total of 285 samples was taken in the study area from mineralized veins and zones, waste dumps, major drainages, and outcrops. The locations of these samples are shown on plate 6. A grid system was used for sampling dumps, when applicable, and, in some cases, samples were taken of selected dump material to determine possible maximum values of amounts of minerals. Panned concentrate samples were obtained by panning stream sediment and collecting the concentrate for analysis without removing magnetite.

Following standard U.S. Bureau of Mines procedures, all samples were analyzed by a six-step semiquantitative spectrographic method for 40 elements and fire assayed for gold and silver. In addition, samples showing anomalous results were analyzed by atomic adsorption, radiometric, X-ray fluorescence, or neutron activation methods. The fire-assay results and the results of the special analytical methods are listed in table 2. The results of the spectrographic analysis are on file and available for inspection at the Intermountain Field Operations Center of the U.S. Bureau of Mines in Denver, Colorado.

Table 2.--Fire assay, atomic absorption, and X-ray fluorescence analyses for samples from the Pecos Wilderness and adjacent areas

(The analyses were performed at the Reno Metallurgy Research Center, U.S. Bureau of Mines, Reno, Nevada. Symbols used: STR, designates location of sample by township (T) north, range (R) east, and section (S); *, additional data given by sample number at end of table; T, trace amount; n.d., not detected; , less than amount shown; u, unsurveyed section; ---, not determined.)

Sample No.	Location S	T	R	Fire Assay (troy oz/ton) Au	Ag	Atomic Absorption percent Cu	Li	Pb	Zn	X-Ray fluorescence percent Ti	Remarks
1	u32	21	14	n.d.	T	—	0.006	—	—	0.50	Adit-dump-grab random
2	u32	21	14	n.d.	T	—	—	—	—	.35	Do.
3	u32	21	14	0.01	n.d.	—	—	—	—	.13	Adit-dump-grab-select
4	u32	21	14	n.d.	n.d.	—	—	—	—	.15	Outcrop-chip-2.5 ft (0.8 m)
5	18	19	14	.03	n.d.	—	.001	—	—	.05	Outcrop-chip-random
6	18	19	14	n.d.	T	—	.002	—	—	.08	Do.
7	18	19	14	n.d.	0.1	—	.055	—	—	.06	Outcrop-chip-random
8	18	19	14	n.d.	.1	—	.340	—	—	.05	Pit-dump-grab-random
9	18	19	14	n.d.	.1	—	.290	—	—	.07	Outcrop-chip-3 ft (0.9 m)
10	17/18	19	14	n.d.	.1	—	.140	—	—	.05	Outcrop-chip-6 ft (1.8 m)
11	17/18	19	14	T	.1	—	.140	—	—	.05	Trench-chip-4 ft (1.2 m)
12	17/18	19	14	n.d.	.2	—	.140	—	—	.19	Trench-dump-grab-random
13	18	19	14	n.d.	.1	—	.450	—	—	.05	Stockpile-dump-grab-random
14	18	19	14	n.d.	.1	—	.480	—	—	.05	Do.
15	18	19	14	T	.1	—	.590	—	—	.05	Trench-chip-10 ft (3.1 m)
16	18	19	14	n.d.	.1	—	.004	—	—	.32	Shaft-dump-grab-random
17	17	19	14	n.d.	.2	—	.450	—	—	.05	Adit-wall-chip-6 ft (1.8 m)
18	17	19	14	n.d.	.2	—	.280	—	—	.05	Adit-wall-chip-5 ft (1.5 m)
19	17	19	14	n.d.	.1	—	.087	—	—	.06	Adit-wall-chip-5.5 ft (1.7 m)
20	18	19	14	n.d.	.2	—	.037	—	—	.07	Outcrop-grab-random
21	17	19	14	n.d.	n.d.	—	.071	—	—	.05	Trench-chip-8 ft (2.4 m)
22	u16	19	14	n.d.	.1	—	.400	—	—	.07	Trench-chip-random
23	u16	19	14	n.d.	.2	—	.160	—	—	.06	Outcrop-chip-2 ft (0.6 m)
24	17	19	14	T	.1	—	.001	—	—	.08	Pit-dump-grab-random
25	17	19	14	T	.1	—	.022	—	—	.06	Trench-chip-5 ft (1.5 m)
26	18/19	19	14	n.d.	T	—	.005	—	—	.47	Shaft-wall-chip-10 ft (3.1 m)
27	18/19	19	14	n.d.	.1	0.23	.003	—	—	.52	Shaft-wall-chip-2 ft (0.6 m)
28	18/19	19	14	T	.3	.47	.004	—	—	.42	Shaft-dump-grab-3 ft (0.9 m) grid
29	18/19	19	14	n.d.	.2	—	.004	—	—	.47	Do.
30	18	19	14	T	.2	—	.011	—	—	.54	Shaft-dump-grab-random
31	18	19	14	n.d.	.2	—	.001	—	—	.22	Shaft-wall-chip-8 ft (2.4 m)
32	18	19	14	n.d.	.3	—	.001	—	—	.27	Shaft-dump-grab-random
33	6	17	15	T	T	—	.003	—	—	—	Shaft-wall-chip-5 ft (1.5 m)
34	6	17	15	n.d.	T	.16	.001	—	—	—	Shaft-dump-grab-random
35	6	17	15	n.d.	T	—	.001	—	—	—	Do.
36	1	17	14	n.d.	T	—	—	—	—	—	Adit-dump-grab-10 ft (3.1 m) grid
37	1	17	14	n.d.	T	.031	.001	—	—	—	Do.
38	1	17	14	n.d.	T	.030	.001	—	—	—	Adit-back-chip-6 ft (1.8 m)
39	1	17	14	n.d.	T	.002	.005	—	—	—	Adit-wall-chip-random
40	14	18	13	n.d.	T	—	—	—	—	—	Adit-dump-grab-random
41	u23	18	13	n.d.	.1	—	—	—	—	—	Do.
42	u23	18	13	n.d.	.2	—	—	—	—	—	Do.
43	u23	18	13	n.d.	.1	—	—	—	—	—	Adit-dump-grab-10 ft (3.1 m) grid
44	u23	18	13	n.d.	.2	—	—	—	—	—	Outcrop-chip-6 ft (1.8 m)
45	u23	18	13	n.d.	.1	—	—	—	—	—	Trench-dump-grab-random
46	u23	18	13	T	.1	—	—	—	—	—	Do.
47	u23	18	13	n.d.	.1	—	—	—	—	—	Do.
48	u23	18	13	n.d.	.1	—	—	—	—	—	Outcrop-chip-15 ft (4.6 m)
49	u23	18	13	n.d.	.1	—	—	—	—	—	Trench-grab-random
50	u14	18	13	n.d.	.1	—	—	—	—	—	Outcrop-chip-random
51	u14	18	13	n.d.	n.d.	—	—	—	—	—	Outcrop-chip-2 ft (0.6 m)
52	u14	18	13	n.d.	.2	—	—	—	—	—	Outcrop-chip-1 ft (0.3 m)
53	34	18	12	.01	n.d.	—	—	—	—	—	Pit-dump-grab-random
54	33	18	12	n.d.	n.d.	—	—	—	—	—	Pit-dump-grab-select
55	27	18	12	n.d.	n.d.	—	—	—	—	—	Pit-dump-grab-random
56	27	18	12	.14	.5	.33	—	—	1.6	—	Outcrop-chip-6 in (15 cm) intervals over 6 ft (1.8 m)
57	27	18	12	.02	.3	.53	—	—	2.6	—	Outcrop-chip-9 ft (2.8 m)
58	27	18	12	n.d.	n.d.	—	—	—	—	—	Trench-chip-6 ft (1.8 m)
59	u24	18	11	T	.1	—	—	—	—	—	Adit-dump-grab-random
60	u24	18	11	T	n.d.	—	—	—	—	—	Adit-dump-grab-5 ft (1.5 m) grid
61	u13	18	11	n.d.	T	—	—	—	—	—	Pit-wall-chip-4 ft (1.2 m)
62	u13	18	11	n.d.	T	—	—	—	—	—	Adit-dump-grab-random

Table 2.--Fire assay, atomic absorption, and X-ray fluorescence analyses for samples from the Pecos Wilderness and adjacent areas--Continued

(The analyses were performed at the Reno Metallurgy Research Center, U.S. Bureau of Mines, Reno, Nevada. Symbols used: STR, designates location of sample by township (T) north, range (R) east, and section (S); *, additional data given by sample number at end of table; T, trace amount; n.d., not detected; , less than amount shown; u, unsurveyed section; ---, not determined.)

Sample No.	Location S	T	R	Fire Assay (troy oz/ton) Au	Ag	Atomic Absorption percent Cu	Li	Pb	Zn	X-Ray fluorescence percent Ti	Remarks
63	1	17	11	0.04	0.5	0.16	---	0.024	0.077	---	Trench-dump-grab-random
64	1	17	11	.16	1.8	1.7	---	.46	.20	---	Shaft-dump-grab-5 ft (1.5 m) grid
65	1	17	11	n.d.	n.d.	.004	---	.006	.40	---	Pit-dump-grab-random
66	1	17	11	n.d.	.2	.72	---	.080	.17	---	Adit-wall-chip-5 ft (1.5 m)
67	1	17	11	.03	.1	.63	---	.038	.070	---	Do.
68	1	17	11	.03	.1	1.1	---	.17	.073	---	Adit-wall-chip-3 ft (0.9 m)
69	1	17	11	n.d.	n.d.	.54	---	.032	.057	---	Adit-dump-grab-5 ft (1.5 m) grid
70	1	17	11	.06	n.d.	.44	---	.021	.056	---	Do.
71	1	17	11	.01	.3	.61	---	.13	.18	---	Do.
72	1	17	11	.04	.1	.34	---	.025	.11	---	Do.
73	1	17	11	.01	T	1.1	---	.33	.74	---	Adit-face-chip-3 ft (0.9 m)
74	1	17	11	n.d.	T	1.1	---	.21	2.8	---	Adit-back-chip-3 ft (0.9 m)
75	1	17	11	n.d.	T	.053	---	.014	.032	---	Adit-caved material-grab-random
76	1	17	11	n.d.	T	.35	---	.016	.057	---	Do.
77	1	17	11	n.d.	.1	.0031	---	.006	.0089	---	Adit-face-grab-random
78	1	17	11	n.d.	T	.0055	---	.006	.021	---	Trench-wall-chip-5 ft (1.5 m) intermitte
79	1	17	11	n.d.	n.d.	.0035	---	.006	.005	---	Pit-dump-grab-random
80	1	17	11	T	.1	.016	---	.006	.028	---	Do.
81	1	17	11	n.d.	.1	.045	---	.006	.019	---	Shaft-dump-grab-random
82	1	17	11	n.d.	.1	.018	---	.006	.016	---	Shaft-wall-chip-5 ft (1.5 m)
83	1	17	11	n.d.	n.d.	.0033	---	.006	.005	---	Trench-dump-grab-random
84	1	17	11	n.d.	.1	.078	---	.006	.011	---	Pit-dump-grab-random
85	1	17	11	T	n.d.	.062	---	.006	.013	---	Shaft-dump-grab-random
86	1	17	11	n.d.	T	.037	---	.006	.011	---	Shaft-wall-chip-6 ft (1.8 m) 3 in (8 cm) intervals
87	1	17	11	n.d.	.1	.002	---	.006	.005	---	Pit-wall-chip-5 ft (1.5 m)
88	1	17	11	n.d.	.1	.054	---	.006	.022	---	Pit-wall-chip-random
89	1	17	11	T	.1	.17	---	.006	.026	---	Pit-wall-chip-6 ft (1.8 m)
90	1	17	11	.01	T	.052	---	.006	.019	---	Do.
91	1	17	11	n.d.	n.d.	.022	---	.006	.011	---	Pit-dump-grab-random
92	1	17	11	n.d.	.1	.039	---	.006	.009	---	Adit-dump-grab-5 ft (1.5 m) grid
93	1	17	11	n.d.	T	.044	---	.006	.006	---	Adit-wall-chip-5 ft (1.5 m)
94	1	17	11	T	.1	.026	---	.006	.0135	---	Do.
95	12	17	11	T	.1	.002	---	.006	.008	---	Adit-face-chip-5 ft (1.5 m)
96	12	17	11	T	.1	.0015	---	.006	.002	---	Adit-wall-chip-5 ft (1.5 m)
97	12	17	11	T	.1	.0015	---	.006	.006	---	Adit-wall-chip- 12 in (30 cm)
98	12	17	11	T	n.d.	.089	---	.006	.007	---	Pit-wall-chip-5 ft (1.5 m)
99	12	17	11	n.d.	.1	.048	---	.006	.010	---	Pit-wall-chip-4 ft (1.2 m)
100	12	17	11	n.d.	.1	.022	---	.006	.004	---	Trench-wall-chip-4 ft (1.2 m)
101	12	17	11	n.d.	n.d.	.20	---	.006	.007	---	Adit-wall-chip-10 ft (3.1 m)
102	12	17	11	n.d.	.1	.026	---	.006	.010	---	Adit-wall-chip-12 ft (3.7 m)
103	12	17	11	n.d.	.1'	.063	---	.006	.013	---	Adit-wall-chip-7 ft (2.1 m)
104	12	17	11	n.d.	n.d.	.024	---	.006	.008	---	Adit-dump-grab-random
105	12	17	11	.01	n.d.	.0015	---	.006	.005	---	Adit-face-chip-random
106	12	17	11	T	n.d.	.19	---	.006	.011	---	Adit-dump-grab-random
107	12	17	11	n.d.	T	.034	---	.006	.014	---	Adit-wall-chip-2 ft (0.6 m)
108	12	17	11	.01	T	.0044	---	.006	.0026	---	Adit-wall-chip-8 in (20 cm)
109	12	17	11	.01	T	.073	---	.006	.016	---	Adit-dump-grab-random
110	11	17	11	T	T	.0031	---	.006	.004	---	Adit-wall-chip-2 ft (0.6 m)
111	12	17	11	T	.1	.0017	---	.006	.0028	---	Trench-wall-chip-8 ft (2.4 m)
112	11	17	11	.01	T	.049	---	.006	.011	---	Adit-dump-grab-5 ft (1.5 m) grid
113	12	17	11	T	T	.005	---	.006	.0085	---	Do.
114	12	17	11	T	.1	.068	---	.006	.014	---	Pit-wall-chip-3 ft (0.9 m)
115	12	17	11	T	T	.0053	0.033	.006	.0067	---	Adit-wall-chip-18 in (46 cm)
116	12	17	11	T	.1	.0063	---	.006	.0045	---	Adit-dump-grab-random
117	12	17	11	T	.1	.002	---	.006	.0013	---	Pit-wall-chip-3 ft (0.9 m)
118	12	17	11	.01	.1	.030	---	.006	.033	---	Adit-wall-chip-12 in (30 cm)

Table 2.--Fire assay, atomic absorption, and X-ray fluorescence analyses for samples from the Pecos Wilderness and adjacent areas--Continued

(The analyses were performed at the Reno Metallurgy Research Center, U.S. Bureau of Mines, Reno, Nevada. Symbols used: STR, designates location of sample by township (T) north, range (R) east, and section (S); *, additional data given by sample number at end of table; T, trace amount; n.d., not detected; , less than amount shown, u, unsurveyed section; ---, not determined.)

Sample No.	Location S	T	R	Fire Assay (troy oz/ton) Au	Ag	Atomic Absorption percent Cu	Li	Pb	Zn	X-Ray fluorescence percent Ti	Remarks
119	11	17	11	T	n.d.	0.023	---	0.012	0.010	---	Adit-back-chip-18 in (46 cm)
120	11	17	11	T	n.d.	.0074	---	.0082	.012	---	Adit-wall-chip-2 ft (0.6 m)
121	11	17	11	0.01	0.1	.035	---	.006	.034	---	Adit-dump-grab-random
122	11	17	11	T	T	.0175	---	.006	.013	---	Adit-dump-grab-5 ft (1.5 m) grid
123	11	17	11	T	T	.011	---	.006	.014	---	Adit-face-chip-3 ft (0.9 m)
124	13	18	10	T	.1	---	0.0006	---	---	---	Pit-dump-grab-random
125	u6	18	11	n.d.	T	---	.0006	---	---	---	Do.
126	u6	18	11	T	.2	---	---	---	---	---	Pit-wall-chip-4 ft (1.2 m)
127	u6	18	11	n.d.	.2	---	.0015	---	---	---	Pit-grab-random
128	u6	18	11	n.d.	n.d.	---	.0012	---	---	---	Do.
129	12	18	10	.01	.1	---	.001	---	---	---	Do.
130	12	18	10	n.d.	n.d.	---	.0041	---	---	---	Pit-dump-grab-random
131	12	18	10	n.d.	n.d.	---	.0037	---	---	---	Do.
132	12	18	10	n.d.	n.d.	---	---	---	---	---	Pit-wall-chip-random
133	1	18	10	n.d.	n.d.	---	.0026	---	---	---	Stockpile-grab-random
134	1	18	10	T	n.d.	---	---	---	---	---	Do.
135	1	18	10	n.d.	n.d.	---	.0033	---	---	---	Do.
136	1	18	10	n.d.	T	---	.0006	---	---	---	Trench-grab-random
137	1	18	10	n.d.	n.d.	---	.0024	---	---	---	Adit-face-chip-5 ft (1.5 m)
138	1	18	10	n.d.	T	---	.0052	---	---	---	Trench-chip-9 ft (2.8 m)
139	1	18	10	n.d.	n.d.	---	.005	---	---	---	Pit-wall-chip-random
140	1	18	10	n.d.	n.d.	---	.0041	---	---	---	Trench-dump-grab-random
141	1	18	10	n.d.	T	---	.0061	---	---	---	Pit-wall-chip-6 ft (1.8 m)
142	1	18	10	n.d.	.1	---	.0061	---	---	---	Trench-chip-10 ft (3.1 m)
143	1	18	10	n.d.	n.d.	---	.0026	---	---	---	Trench-dump-grab-random
144	1	18	10	n.d.	n.d.	---	.0024	---	---	---	Trench-well-chip-random
145	1	18	10	n.d.	T	---	.0014	---	---	---	Do.
146	1	18	10	n.d.	n.d.	---	.0082	---	---	---	Adit-wall-chip-18 in (46 cm)
147	1	18	10	n.d.	n.d.	---	.0006	---	---	---	Adit-wall-chip-random
148	1	18	10	n.d.	T	---	.0044	---	---	---	Adit-wall-chip-5 ft (1.5 m)
149	1	18	9	n.d.	n.d.	---	.0056	---	---	---	Adit-wall-chip-6 ft (1.8 m)
150	1	18	10	n.d.	n.d.	---	.0031	---	---	---	Trench-grab-random
151	u6	11	18	n.d.	T	---	.0061	---	---	---	Trench-wall-chip-random
152	u6	11	18	n.d.	n.d.	---	.0013	---	---	---	Trench-wall-chip-18 in (46 cm)
153	u6	11	18	n.d.	n.d.	---	.0014	---	---	---	Trench-wall-chip-4 ft (1.2 m)
154	u6	11	18	T	n.d.	---	.0018	---	---	---	Trench-wall-chip-random
155	u6	11	18	n.d.	.1	---	.0006	---	---	---	Trench-dump-grab-random
156	u6	11	18	.01	.2	---	.0013	---	---	---	Trench-wall-chip-random
157	u6	11	18	.01	T	---	.0008	---	---	---	Trench-dump-grab-random
158	u6	11	18	T	.2	---	.0008	---	---	---	Do.
159	u6	11	18	T	.2	---	.001	---	---	---	Do.
160	u6	11	18	n.d.	.1	---	.0015	---	---	---	Trench-dump-grab-random
161	5	19	10	.01	.2	---	.0006	---	---	---	Trench-grab-random
162	34	20	10	.01	.2	---	---	---	---	---	Pit-wall-chip-random
163	3	20	10	n.d.	n.d.	---	---	---	---	---	Trench-wall-chip-3 ft (0.9 m)
164	2	20	10	.01	T	---	---	---	---	---	Trench-wall-chip-20 ft (6.1 m) at 1 ft (0. intervals
165	2	20	10	n.d.	n.d.	---	---	---	---	---	Trench-grab-select
166	2	20	10	n.d.	n.d.	---	---	---	---	---	Pit-wall-chip-14 ft (4.3 m) at 6 in (15 c intervals
167	2	20	10	n.d.	n.d.	---	---	---	---	---	Trench-wall-chip-12 ft (3.7 m) at 6 in (1 intervals
168	2	20	10	n.d.	n.d.	---	---	---	---	---	Trench-wall-chip-random over 85 ft (25.9
169	2	20	10	n.d.	n.d.	---	---	---	---	---	Adit-dump-grab-random
170	2	20	10	n.d.	n.d.	---	---	---	---	---	Adit-dump-grab-select

Table 2.--Fire assay, atomic absorption, and X-ray fluorescence analyses for samples from the Pecos Wilderness and adjacent areas--Continued

(The analyses were performed at the Reno Metallurgy Research Center, U.S. Bureau of Mines, Reno, Nevada. Symbols used: STR, designates location of sample by township (T) north, range (R) east, and section (S); *, additional data given by sample number at end of table; T, trace amount, n.d., not detected; , less than amount shown, u, unsurveyed section; ---, not determined.)

Sample No.	Location S	T	R	Fire Assay (troy oz/ton) Au	Ag	Atomic Absorption percent Cu	Li	Pb	Zn	X-Ray fluorescence percent Ti	Remarks
171	2	20	10	0.03	T	---	---	---	---	---	Trench-wall-chip-3 ft (0.9 m)
172	2	20	10	n.d.	n.d.	---	---	---	---	---	Trench-grab-random
173	2	20	10	n.d.	n.d.	---	---	---	---	---	Trench-wall-chip-3 ft (0.9 m)
174	2	20	10	n.d.	n.d.	---	---	---	---	---	Trench-dump-grab-random
175	2	20	10	T	T	---	---	---	---	---	Trench-wall-chip-3 ft (0.9 m)
176	36	21	10	n.d.	n.d.	---	---	---	---	---	Trench-bottom-chip-4 ft (1.2 m)
177	36	21	10	n.d.	n.d.	---	---	---	---	---	Trench-wall-chip-15 ft (4.6 m) at 6 in (15 intervals
178	1	20	10	n.d.	n.d.	---	---	---	---	---	Trench-wall-chip-10 ft (3.1 m)
179	1	20	10	n.d.	n.d.	---	---	---	---	---	Trench-grab-random
180	1	20	10	n.d.	n.d.	---	---	---	---	---	Trench-wall-chip-50 ft (15.3 m) at 2 ft (0. intervals
181	1	20	10	n.d.	0.1	---	---	---	---	---	Trench-wall-chip-random
182	1	20	10	n.d.	.1	---	---	---	---	---	Do.
183	1	20	10	n.d.	n.d.	---	---	---	---	---	Do.
184	1	20	10	n.d.	T	---	---	---	---	---	Trench-grab-random
185	1	20	10	T	T	---	---	---	---	---	Trench-wall-chip-over 12 ft (3.7 m) at 3 in (7.6 cm) intervals
186	1	20	10	T	T	---	---	---	---	---	Trench-dump-grab-random
187	1	20	10	T	T	---	---	---	---	---	Trench-wall-chip-at 6 in (15 cm) intervals over 40 ft (12.2 m)
188	1	20	10	T	.7	---	---	---	---	---	Trench-wall-chip-random
189	1	20	10	T	n.d.	---	---	---	---	---	Stockpile-grab-random
190	1	20	10	T	.1	---	---	---	---	---	Trench-grab-random
191	1	20	10	n.d.	.1	---	---	---	---	---	Do.
192	36	21	10	T	.1	---	---	---	---	---	Pit-wall-chip-7 ft (2.1 m)
193	36	21	10	T	.1	---	---	---	---	---	Pit-wall-chip-56 ft (17 m) at 2 ft (0.6 m) intervals
194	36	21	10	T	T	---	---	---	---	---	Pit-wall-chip-35 ft (10.7 m) at 1 ft (0.3 m intervals
195	36	21	10	n.d.	.1	---	---	---	---	---	Trench-wall-chip-10 ft (3.1 m)
196	7	20	11	T	.1	---	---	---	---	---	Trench-grab-random
197	7	20	11	T	T	---	---	---	---	---	Trench-face-chip-random
198	7	20	11	T	T	---	---	---	---	---	Trench-wall-chip-4 ft (1.2 m)
199	6	20	11	T	.1	---	---	---	---	---	Pit-face-chip-random
200	6	20	11	T	n.d.	---	---	---	---	---	Pit-grab-random
201	5/6	20	11	n.d.	n.d.	---	---	---	---	---	Trench-grab-random
202	6	20	11	T	n.d.	---	---	---	---	---	Do.
203	6	20	11	n.d.	n.d.	---	---	---	---	---	Trench-wall-chip-40 ft (12.m) not continuou
204	6	20	11	T	n.d.	---	---	---	---	---	Trench-grab-random
205	6	20	11	n.d.	n.d.	---	---	---	---	---	Pit-dump-grab-random
206	5	20	11	T	n.d.	---	---	---	---	---	Trench-face-chip-random
207	5	20	11	n.d.	n.d.	---	---	---	---	---	Pit-dump-grab-random
208	32	21	11	.02	T	---	---	---	---	---	Trench-wall-chip-random
209	32	21	11	n.d.	n.d.	---	---	---	---	---	Do.
210	32	21	11	n.d.	n.d.	---	0.003	---	---	---	Do.
211	32	21	11	n.d.	n.d.	---	---	---	---	---	Do.
212	4	21	11	T	T	---	---	---	---	---	Trench-dump-grab-random
213	4	20	11	n.d.	n.d.	---	---	---	---	---	Trench-well-chip-random
214	4	20	11	n.d.	n.d.	---	---	---	---	---	Trench-wall-chip-8 ft (2.4m) not continuous
215	4	20	11	n.d.	n.d.	---	---	---	---	---	Trench-dump-grab-random
216	9	21	11	n.d.	n.d.	---	---	---	---	---	Do.
217	1	20	11	n.d.	.1	---	---	---	---	---	Outcrop-chip-random
218	1	20	11	n.d.	T	---	---	---	---	---	Outcrop-grab-random
219	7	20	11	n.d.	n.d.	---	---	---	---	---	Pit-dump-grab-random
220	31	21	12	T	.2	---	---	---	---	---	Pit-wall-chip-2 ft (0.6 m)
221	19	21	12	n.d.	.1	---	---	---	---	---	Trench-wall-chip-2 ft (0.6 m)
222	19	21	12	T	T	---	---	---	---	---	Trench-wall-chip-6 ft (1.8 m)
223	20	21	12	T	.2	---	---	---	---	---	Trench-dump-grab-10 ft (3.1 m) grid
224	20	21	12	n.d.	n.d.	---	---	---	---	---	Pit-wall-chip-4 ft (1.2 m)
*225	u16	19	14	*	*	---	---	---	---	4.3	Panned concentrate sample
*226	u21	19	14	*	*	---	---	---	---	---	Do.
*227	u20	19	14	*	*	---	---	---	---	---	Do.
*228	19	19	14	*	*	---	---	---	---	---	Do.
229	19	19	14	n.d.	.1	---	---	---	---	---	Do.
230	19	19	14	n.d.	.2	---	---	---	---	---	Do.
*231	19	19	14	*	*	---	---	---	---	---	Do.
*232	19	19	14	*	*	---	---	---	---	---	Do.
233	u14	18	13	T	.1	---	---	---	---	---	Do.
234	u13	18	13	T	.1	---	---	---	---	---	Do.

Table 2.--Fire assay, atomic absorption, and X-ray fluorescence analyses for samples from the Pecos Wilderness and adjacent areas--Continued

(The analyses were performed at the Reno Metallurgy Research Center, U.S. Bureau of Mines, Reno, Neveda. Symbols used: STR, designates location of sample by township (T) north, range (R) east, and section (S); *, additional data given by sample number at end of table; T, trace amount, n.d., not detected; , less than amount shown, u, unsurveyed section; ---, not determined.)

Sample No.	Location S	T	R	Fire Assay (troy oz/ton) Au	Ag	Atomic Absorption percent Cu	Li	Pb	Zn	X-Ray fluorescence percent Ti	Remarks
235	u13	18	13	n.d.	0.1	---	---	---	---	---	Panned concentrate sample
236	18	18	14	n.d.	.1	---	---	---	---	---	Do.
237	19	18	14	n.d.	.1	---	---	---	---	---	Do.
238	20	18	14	n.d.	.1	---	---	---	---	---	Do.
239	21	18	14	n.d.	.1	---	---	---	---	---	Do.
240	21	18	14	n.d.	.1	---	---	---	---	---	Do.
241	27	18	14	n.d.	.1	---	---	---	---	---	Do.
242	27	18	14	n.d.	.1	---	---	---	---	---	Do.
243	34	18	14	n.d.	.1	---	---	---	---	---	Do.
244	2	17	14	T	.1	---	---	---	---	---	Do.
245	2	17	14	T	T	---	---	---	---	---	Do.
246	36	18	14	0.01	.1	---	---	---	---	---	Do.
247	25	18	13	T	1.7	---	---	---	---	---	Do.
248	25	18	13	T	2.2	---	---	---	---	---	Do.
249	25	18	13	n.d.	T	---	---	---	---	---	Do.
*250	23	18	13	*	*	---	---	---	---	---	Do.
*251	23	18	13	*	*	---	---	---	---	---	Do.
*252	25	18	12	*	*	---	---	---	---	---	Do.
253	22	18	12	n.d.	.2	---	---	---	---	---	Do.
254	14/23	18	12	n.d.	.2	---	---	---	---	---	Do.
255	u27	19	12	T	.7	---	---	---	---	---	Do.
256	u27-24	19	12	n.d.	.1	---	---	---	---	---	Do.
*257	u27-24	19	12	*	*	---	---	---	---	---	Do.
258	u5	19	12	.04	.8	---	---	---	---	---	Do.
259	u25	19	11	.02	.4	---	---	---	---	---	Do.
260	u30	18	12	n.d.	n.d.	---	---	---	---	---	Do.
*261	17	18	12	n.d.	.2	---	---	---	---	3.3	Do.
*262	17	18	12	*	*	---	---	---	---	---	Do.
263	20	18	12	T	.2	---	---	---	---	1.9	Do.
264	20	18	12	n.d.	.2	---	---	---	---	---	Do.
265	u4	18	11	.20	.1	---	---	---	---	---	Do.
266	u4	18	11	T	.1	---	---	---	---	---	Do.
267	u5	18	11	n.d.	T	---	---	---	---	---	Do.
268	u5	18	11	T	.1	---	---	---	---	---	Do.
269	u31	19	11	T	n.d.	---	---	---	---	---	Do.
270	u31	19	11	n.d.	.1	---	---	---	---	---	Do.
271	u31	19	11	.01	T	---	---	---	---	---	Do.
272	36	19	10	.02	.1	---	---	---	---	---	Do.
273	36	19	10	n.d.	T	---	---	---	---	---	Do.
*274	12	18	10	n.d.	.2	---	---	---	---	4.2	Do.
275	12	18	10	n.d.	.1	---	---	---	---	4.5	Do.
276	34	20	10	n.d.	n.d.	---	---	---	---	6.36	Do.
277	34	20	10	n.d.	n.d.	---	---	---	---	6.0	Do.
*278	27	20	10	n.d.	n.d.	---	---	---	---	7.2	Do.
279	27	20	10	n.d.	n.d.	---	---	---	---	5.4	Do.
*280	u30	20	11	n.d.	n.d.	---	---	---	---	5.2	Do.
*281	u30	20	11	n.d.	.2	---	---	---	---	5.1	Do.
282	19	20	11	n.d.	.6	---	---	---	---	---	Do.
*283	18	20	11	n.d.	.1	---	---	---	---	5.7	Do.
284	7	20	11	n.d.	.1	---	---	---	---	---	Do.
*285	30	21	12	n.d.	.1	---	---	---	---	1.6	Do.

225, not enough sample to assay for Au and Ag
226-228, 231-232, 250-252, 257, panned concentrate—not enough concentrate to assay
261, also contained 1.5% WO_3 and 0.52% Zr
262, panned concentrate—not enough concentrate to assay
274, also contained 0.26% WO_3
278, panned concentrate—not enough concentrate to assay for Au and Ag
280, also contained 0.22% Zr
281, also contained 0.28% Zr
283, also contained 0.30% Zr
285, also contained 0.33% Zr

Mining history and production

The Pecos Wilderness study area has had small production of beryllium and mica from the pegmatites in the northeast part of the study area. Production from the pegmatites is discussed in more detail in later sections. The proposed additions to the wilderness are close to other localities having had production. The largest producing mine in the vicinity was the Pecos mine, the history of which is discussed in the Tererro section of this report. The mine produced nearly 2.3 million tons (2.1 million t) of ore from 1927 to 1939.

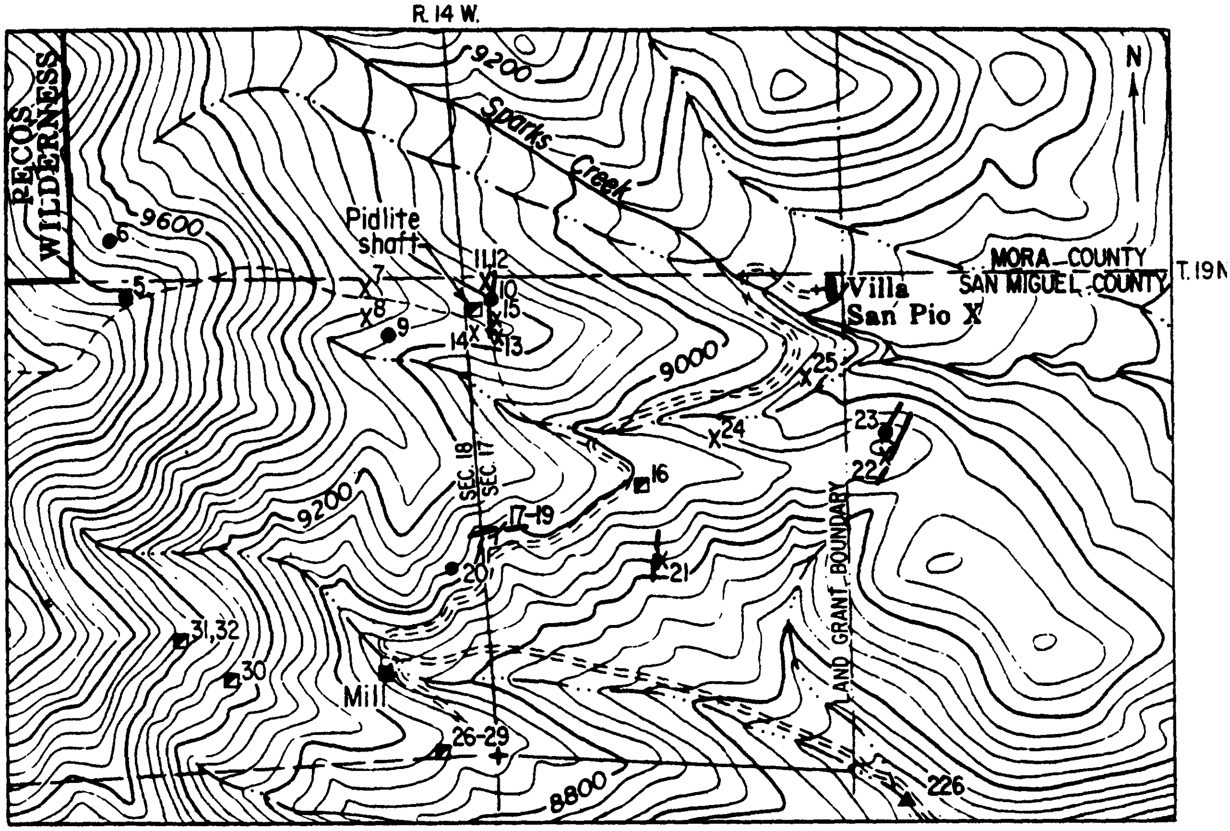
Mines and prospects

The majority of mining and prospecting activity in the study area was concentrated in the pegmatites and metavolcanic rocks. The sampled areas described in this part are only those which contained significant mineral content. Many samples showed little or no mineral value and, consequently, are not discussed.

Pidlite pegmatite property

The Pidlite property is about 5 miles (8 km) west of Rociada, New Mexico, in the Rociada mining district. The area lies in secs. 7, 8, 17, and 18, T. 19 N., R. 14 E., about 3/4 mile (1 km) east of the Pecos Wilderness boundary (fig. 3). Figure 3 shows locations of prospects in the Pidlite area and samples collected from the area.

Lithium-bearing mica (lepidolite) has been the major interest in the area. Redmon (1961) reports having found highly radioactive rhabdophanite near the Pidlite shaft; however, no anomalous radioactivity was detected during the present field investigation of the area.



EXPLANATION

X Prospect pit or trench
Adit
Shaft
Outcrop sample
Panned stream sediment sample
30 Sample number
Pegmatite outcrop

0 500 1000 2000 FEET
0 300 600 METERS

FIGURE 3.--Map showing sample localities 5-32 and 226 on Pidlite property.

The property contains several lithium-bearing pegmatite dikes cropping out in amphibolite. The dikes are north-trending and have a steep dip. They range from a few inches (several cm) to over 20 feet (6 m) wide and as much as 150 feet (50 m) long.

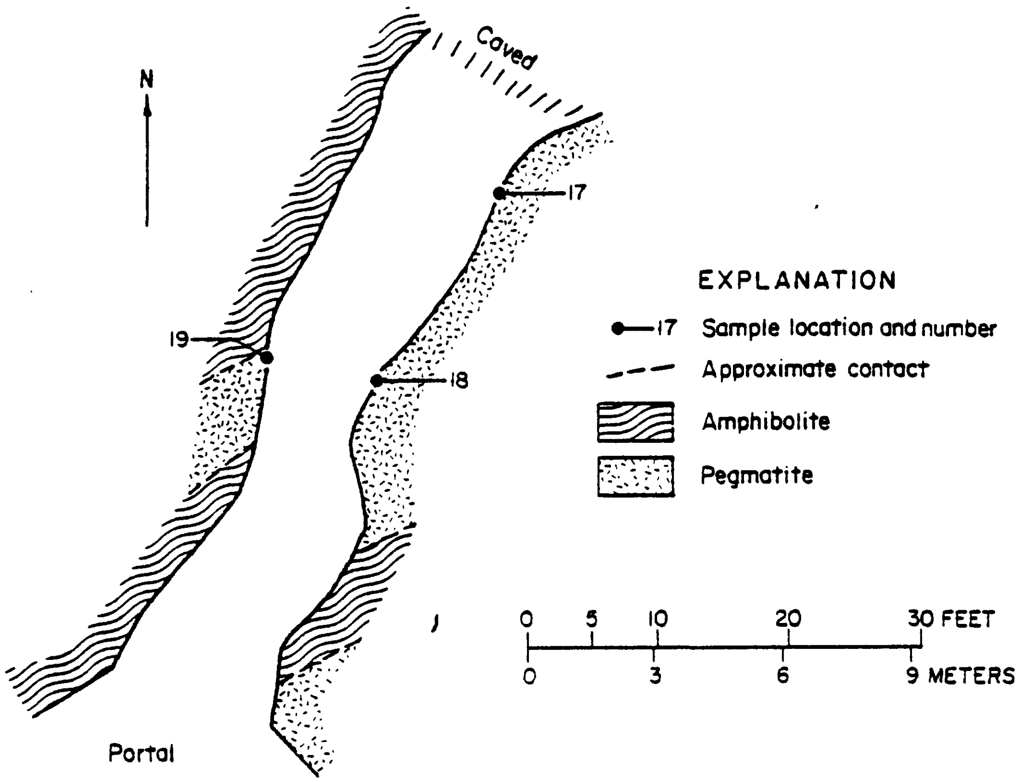
The dikes are composed mostly of feldspar, quartz, and muscovite. The inner zones are lenticular and are composed of quartz, and perthite and the outer zones are mostly albite, lepidolite, and muscovite (Jahns, 1953).

Several shafts and adits have been driven in the dikes, but most were inaccessible. Many of the prospects visited were pits or trenches in pegmatite dikes. Figure 4 shows the locations of samples taken in an accessible adit on Pidlite property.

The Hayden Mining Company conducted mining operations in the area from 1946 to 1947 (Redmon, 1961). Sheffer and Goldsmith (1969) report 372 tons (338 t) of lepidolite and 1.5 tons (1.4 t) of microlite were produced at that time.

In 1961, Rare Minerals of New Mexico, Inc., constructed a gravity separation mill. Several thousand tons (t) of the tantalum-bearing pegmatite was concentrated, but the concentrate was of unmarketable grade (Sheffer and Goldsmith, 1969). In 1977, there was no mining activity in the area.

In the summer of 1963, Sheffer and Goldsmith (1969) sampled pegmatite in the Rociada mining district for tantalum and rare-earth elements. The highest tantalum concentration in the samples was 0.115 percent Ta_2O_5. The conclusions of the report state that "The pegmatite dikes are narrow and short in horizontal extent, indicating a definitely limited reserve of pegmatitic material. Hence, significant production of tantalum, rubidium, or



Sample			Assay Data (oz/ton)		Assay Data (percent)	
No.	Type	Length	Au	Ag	Li	Remarks
17	Chip	6 ft (1.8 m)	n.d.	0.2	0.45	Medium-grained pegmatite estimated to be 20% quartz, 5-10% mica, 60% feldspar, 5-10% lepidolite.
18	Chip	5 ft (1.5 m)	n.d.	.2	.28	Same as 17 in composition, highly fractured.
19	Chip	5.5 ft (1.7 m)	n.d.	.1	.087	Pegmatite composed mostly of feldspar with some quartz and traces of lepidolite.

n.d. - not detected

FIGURE 4.—Map of adit on Pidlite property.

beryllium from the Rociada pegmatites is not possible. The quantities of minerals containing these elements found in the samples analyzed were not sufficient to justify continuing exploration or study."

The field investigation and analytical results showed that the pegmatites at the Pidlite property contain some lithium (table 3). Although the lithium values of the samples were generally low, they do indicate that the pegmatites constitute a low-grade resource of lithium.

About one-half mile (0.8 km) southwest of the Pidlite shaft are three shafts (fig. 3). At the shaft where samples 26-29 were taken, some minor copper staining was visible in a shear zone striking S. 82° W. and dipping 75° to the north. The host rock is gray to green schist. Sample 27, a 2-foot (0.6 m) chip sample taken on the south side of the shear zone, assayed 0.23 percent copper. The dump by the shaft was in two parts, one showing copper minerlization consisting of azurite and malachite, and the other, showing no visible copper mineralization. Samples 28 and 29 were grab samples taken on 3-foot (0.9 m) grids of the two parts of the dump. Sample 28 of the copper-mineralized part of the dump assayed 0.47 percent copper and sample 29 of the other part analyzed spectrographically 0.034 percent copper. The analytical results of the other samples (26 and 30-32) taken at the shafts showed 0.043 percent copper or less by spectrographic analysis.

Elk Mountain mica mine

The Elk Mountain mica mine is on the northeast flank of Elk Mountain about 0.5 miles (0.8 km) east of the study area, in secs. 14 and 23, T. 18 N., R. 13 E., between Burro Canyon and Hollinger Canyon. The mine lies at an elevation of 10,500 feet (3,202 m) and about 12 miles (17.6 km) east of Terrero.

Table 3.--Analyses of selected samples taken at the Pidlite property

[Tr - trace amount; n.d. - not detected]

Sample			Assay Data (oz/ton)	(oz/ton)	(percent)	
No.	Type	Length	Au	Ag	Li	Remarks
5	Chip	Random	0.03	n.d.	0.001	Fine-grained pegmatite, no visible lepidolite.
7	Chip	Random	n.d.	0.1	.055	Pegmatite, no visible lepidolite.
8	Grab	Random	n.d.	.1	.34	Dump by pit at pegmatite, traces of lepidolite.
9	Chip	3 ft (0.9 m)	n.d.	.1	.29	Pegmatite, no visible lepidolite.
10	Chip	6 ft (1.8 m)	n.d.	.1	.14	Pegmatite, no visible lepidolite.
11	Chip	4 ft (1.2 m)	Tr	.1	.14	Pegmatite, traces of lepidolite.
12	Grab	Random	n.d.	.2	.14	Dump by trench where sample 11 was taken, no visible lepidolite.
13	Grab	Random	n.d.	.1	.45	Stockpile near Pidlite shaft, abundant lepidolite.
14	Grab	Random	n.d.	.1	.48	Stockpile near Pidlite shaft, abundant lepidolite.
15	Chip	10 ft (3.1 m)	Tr	.1	.59	Pegmatite, abundant lepidolite.
17	Chip	6 ft (1.8 m)	n.d.	.2	.45	Pegmatite, abundant lepidolite.
18	Chip	5 ft (1.5 m)	n.d.	.2	.28	Same as 17 but more fracturing and iron staining, abundant lepidolite.
19	Chip	5.5 ft (1.7 m)	n.d.	.1	.087	Highly fractured pegmatite, traces of lepidolite.
20	Grab	Random	n.d.	.2	.037	Pegmatite float in road cut, tra[illegible] of lepidolite.
22	Chip	Random	n.d.	.1	.4	Pegmatite, abundant lepidolite.
23	Chip	2 ft	n.d.	.2	.16	Pegmatite, traces of lepidolite.

The area is covered by 12 claims located in 1936. Of the original twelve, 5 claims and 1 mill site are patented. The Elk Mountain mine is on the Kept Man patented claim and is sometime referred to as the Kept Man pegmatite deposit.

Mining began in 1942 when No. 1 cut was excavated. Several hundred tons (t) of prepared mica and 20 tons (19 t) of scrap mica was produced in 1943 (Jahns, 1946). In 1943, Colonial Mica Corporation produced 11.6 pounds (5.2 kg) of trimmed mica valued at $382.22 (Holmquist, 1946). In 1944, sheet mica and several tons of scrap mica was produced (Jahns, 1946). Total production through 1958 was estimated to be 45 tons (409 t) of sheet mica and 21 tons (19 t) of scrap mica (Redmon, 1961). Since 1958, no mining has taken place.

The U.S. Bureau of Mines did exploratory work in 1944 (Holmquist, 1946). The initial work consisted of a 460-foot (140 m) trench to locate any northern extension of the Kept Man pegmatite. After the trench was completed, holes were drilled to explore for underlying dikes. Drilling indicates that overburden was too great and the trenching was discontinued. A 273-foot (83 m) adit was driven north of the trench. At 119 feet (36 m) from the portal, the adit crossed the dike footwall. The U.S. Bureau of Mines also sampled outcrops on the Cold Bottom and Thin Top claims. Bulk samples were taken and cobb mica was recovered from the broken rock (Holmquist, 1946).

The Elk Mountain area has various pegmatites that crop out in the quartz-mica schist country rock. The pegmatites strike north-south with a steep westerly dip. They vary in size; the most extensive is about 200 feet (60 m) long. The pegmatites are zoned and have a massive quartz core which occasionally contains widely scattered crystals of blocky microcline. The medium- to coarse-grained outer zone is composed of albite, microcline, and quartz with scattered mica-rich sheets (Jahns, 1946).

The mica is usually found at the contact between the core and the albite-rich zone although some mica is also found in the outer edges of the zone and usually is associated with albite. According to Jahns (1946), the mica shoots are 3 feet to 15 feet (0.9-4.6 m) thick and are composed of about 55 percent muscovite. Most of the shoots seen were relatively small.

The mica, primarily muscovite, is colorless, hard, flat, and relatively free-splitting and contains very little mineral staining. It is severely ruled, broken and "A" structures are common, reducing the value. The muscovite sheets reach 10 inches (25 cm) in diameter, but when trimmed are only 2 inches (5 cm) or slightly larger. The mica is estimated to represent about 0.5 percent of the entire dike.

Thirteen samples were taken in the various exposures at or near the Elk Mountain mine. Except for the mica content, no mineral values were found in the samples. Some scrap mica is still in the area. The pegmatites are not extensive and are about 1 mile (0.6 km) outside the study area.

Terrero

The Terrero area, which lies in secs. 27, 33, and 34, T. 17 N., R. 12 E., is mostly noted for the Pecos mine, known in the early 1900's as the Hamilton or Cowles mine. The mine is about 0.5 miles (0.8 km) outside the study area. The property was discovered in 1881, but it was not until after American Metals Company acquired it in 1925 that the mine became a substantial producer (Matson and Hoag, 1930). The installation of modern equipment, a mill, and a 12-mile (19-km) tramway made large-scale mining possible. In 1927, the mine began production and became the largest producer of zinc, lead, gold, and silver in New Mexico for the next 12 years. The mine was closed in 1939. From 1927 to 1939, the Pecos mine produced over $36 million in gold, silver, copper, lead, and zinc (Koschman and Bergendahl, 1968), but at 1978 prices the value would be in excess of $300 million. From 1939 to 1944 there was only minor mining activity. The mine is now abandoned and inaccessible. The Pecos mine has a large dump which contains visible copper, lead, and zinc mineralization.

According to a publication on mineral and water resources of New Mexico (U.S. Senate, 1965), the Pecos mine produced 2,299,082 tons (2,085,727 t) of ore from 1927 to 1939. The metal content of the ore was 243,474 ounces gold, 7,748,006 ounces silver, 35,835,807 pounds of copper, 185,514,389 pounds of lead, and 595,355,840 pounds of zinc. Using these figures, grade computes to 0.106 ounce gold per ton, 3.37 ounces silver per ton, 0.78 percent copper, 4.03 percent lead, and 12.95 percent zinc.

Krieger (1932) described the deposit as hydrothermal containing massive-sulfide ore in two shear zones in chloritic schist. The ore is of Precambrian age and contains gold, silver, pyrite, sphalerite, galena, and chalcopyrite with minor amounts of pyrrhotite. The Precambrian rocks are overlain by Pennsylvanian sediments in which no primary sulfide minerals occur.

The deposit is believed to be volcanogenic in nature similar to the type Continental Oil Company (Conoco) is currently evaluating in Macho Canyon. Conoco's project is discussed later in the Macho Canyon section of this report. The geology of the area is disucssed in detail in Chapter A.

Sample 53 was a grab sample taken at a large pit at the contact between Precambrian rock and Pennsylvanian sediments, about 1 mile (1 km) south of the Pecos mine. The sedimentary rock is a sandstone composed mostly of pure quartz grains.

Samples 56 and 57 were taken of a prominent outcrop forming vertical ledges adjacent to the Pecos mine to the north. The outcrop is composed of metabasalt (Precambrian) with some visible pyrite, malachite, and some sphalerite. Sample 56 was a 3-foot (0.9-m) chip sample taken across filled fractures and fissures and sample 57 was a 9-foot (2.7 m) chip sample taken across a similar zone. The ore bodies are localized and do not extend into the study area. This outcrop is the extreme north extension of the Pecos mine mineralization.

Macho Canyon

Macho Canyon is in the southwestern portion of the study area about 4 miles (6 km) southwest of Terrero, New Mexico. The sampled area between Indian Creek and Dalton Canyon contains numerous workings, mostly adits and prospect pits, the largest of which is the Jones mine. There has been no recorded production from previous mining activity, although small high-grade shipments may have been made.

Prospecting has been done sporadically in the Macho Canyon area since the turn of the century. The Jones mine middle adit was advanced in the mid-1940's. Most of the adits were driven along zones of sheared mineralization in metavolcanic rocks. Prospectors were exploring for an iron-bearing bed which crops out in the area, probably thinking that it was a vein. Workings were generally driven to crosscut the iron-bearing bed at depth.

Since early 1974, Continental Oil Company (Conoco) has been actively involved in an exploration program for volcanogenic massive-sulfide deposits in the Precambrian metavolcanic rocks. In the summer and fall of 1977, several exploratory holes were drilled, and drilling was to continue throughout 1978 in search of massive-sulfide mineralization similar to that of the nearby Pecos mine.

The area of Conoco's interest coincides with that of previous prospecting activity in a belt of Precambrian metavolcanic rocks comprised of the Jones mine and Macho Canyon volcanic cycles (Riesmeyer, 1978). The greenstone belt lies between Precambrian Embudo Granite and Paleozoic sedimentary rocks. Much of the area has been intruded by fine- to medium-grained diabase.

The metavolcanic sequence forms an elongate, north-trending body about 2.3 miles (3.7 km) long and a maximum width of about 4,500 feet (1,370 km). The volcanic rocks pinch out to the north and are covered by a veneer of Paleozoic sedimentary rocks to the east and south. The volcanic block parallels the Pecos-Picuris fault and is about 3,500 feet (1,070 m) east.

Conoco drilled several holes adjacent to the Jones mine and in Macho Canyon and believes that multiple ore horizons exist in the area. Two holes were drilled east of the Jones mine through the Paleozoic sequence in search of the underlying Precambrian host rocks. The Paleozoic cover was found to be thinner than previously thought and is underlain by Precambrian metavolcanic rocks.

The journal, World Mining (1978), reported that Conoco discovered a "large and high-grade sulphide deposit" northeast of Santa Fe. Cores were reported to have assayed 7.0 percent zinc, 3.0 percent copper, and several ounces silver per ton. Conoco plans to drill throughout the 1978 field season to determine the size, shape, and grade of the deposit.

One diamond drill hole showed a true width of 70 feet (21 m) of massive-sulfide mineralization assaying 3.05 percent copper, 0.07 percent lead, 6.90 percent zinc, 0.60 ounce silver per ton, and 0.072 ounce gold per ton (Conoco, 1978, oral commun.).

The stratigraphic sections in the Macho Canyon area are quite similar to those occurring in the Noranda district of Canada and the West Shasta district in northern California. At these places, massive-sulfide deposits are synvolcanic, usually occur in "clusters" of individual deposits, and often are on the same time-stratigraphic horizon in eugeosynclinal volcanic rocks. Copper, lead, zinc, and silver from volcanogenic massive-sulfide deposits account for nearly one-third of Canada's total metal production value. The Pecos mine, reinterpreted as one such deposit, suggests that the potential exists for other concealed mineralized bodies nearby (Conoco, 1978, written commun.). Conoco's recent data strongly indicate the probability of other ore bodies.

Sixty-one samples (63-123) were taken in the area. The sample localities are shown on figure 5 and sample data for selected samples are listed in table 4. Figures 6 through 14 are maps of some underground workings showing the locations of samples taken at those places.

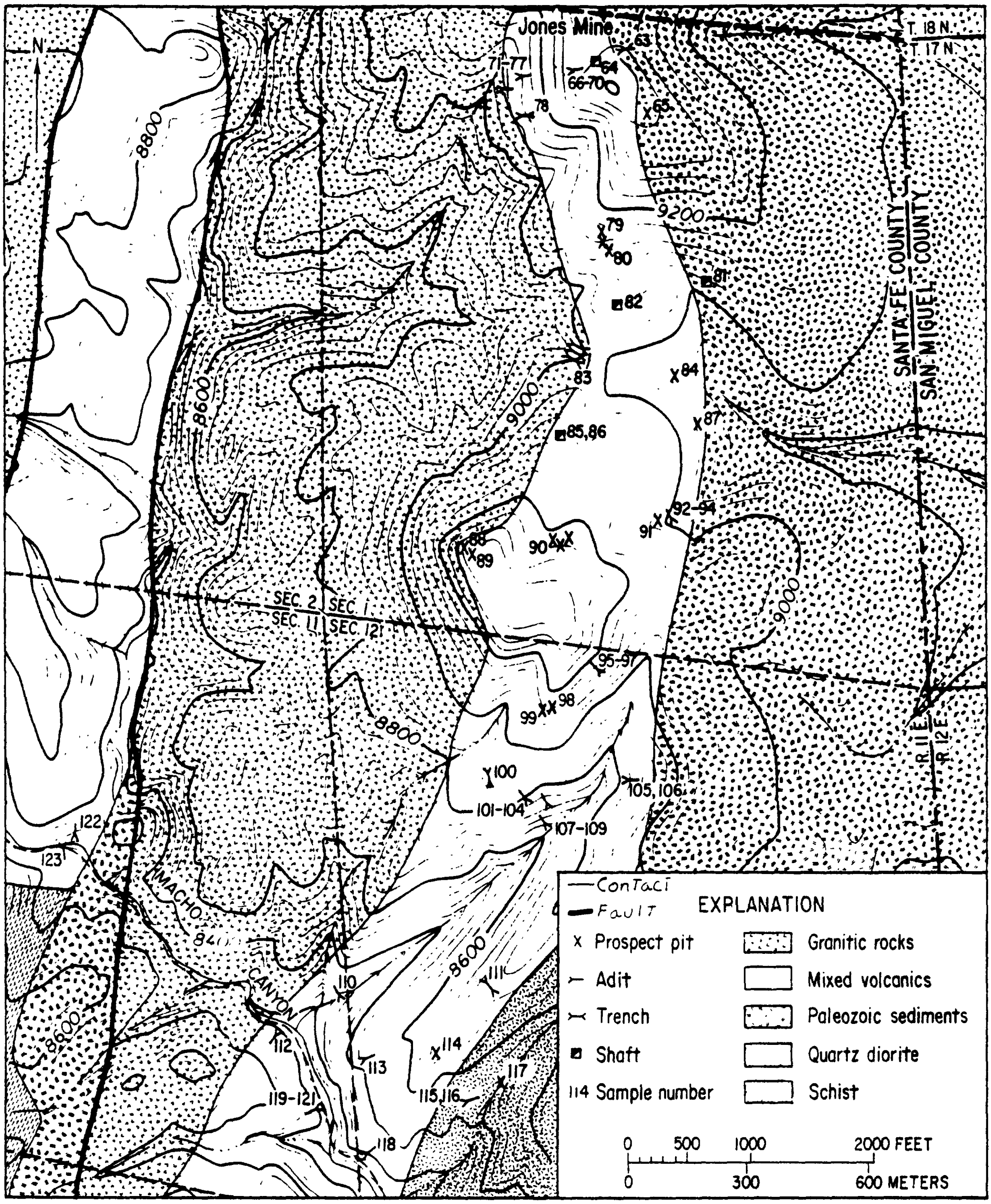
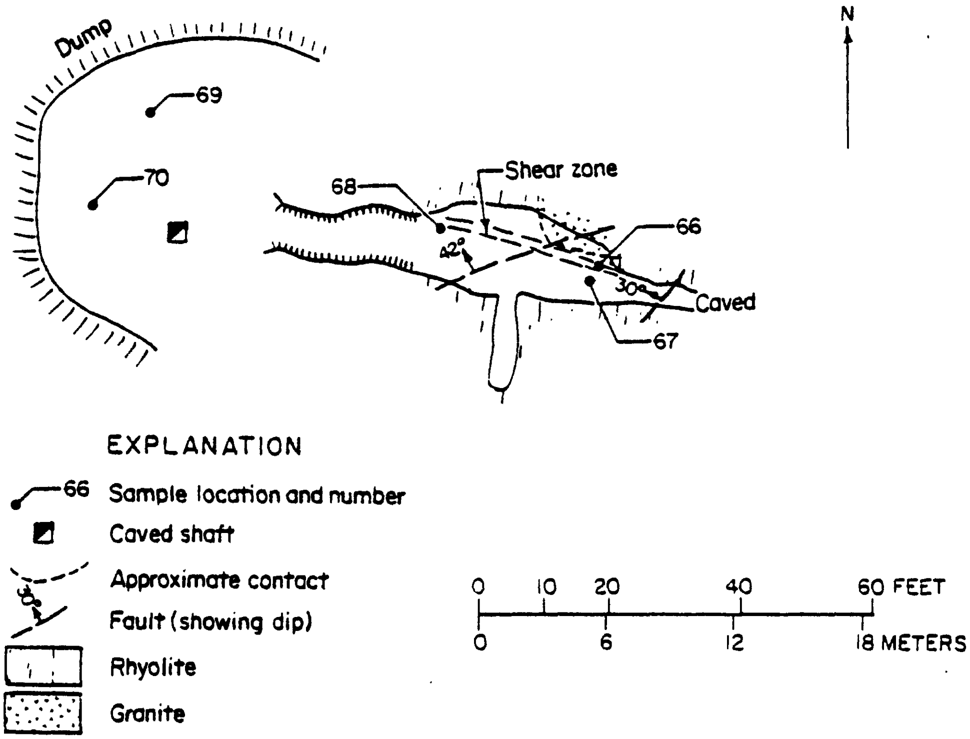


FIGURE 5.--Map showing locations of samples 63-123 in the Macho Canyon area.

Table 4.--Analyses of selected samples taken in Macho Canyon area

[Tr - trace amount; n.d. - not detected; * - 64 also contained 0.42 percent]

Sample			Assay Data					
			(oz/ton)		(percent)			
No.	Type	Length	Au	Ag	Cu	Pb	Zn	Remarks
63	Grab	Random	0.04	0.5	0.16	0.024	07	Dump by trench, material sheared with attendant slicks.
*64	Grab	5 ft (1.5 m) grid	.016	1.55	1.7	.46	.2	Dump by shaft, sheared material showing azurite, malachite and some chlorination.
65	Grab	Random	n.d.	n.d.	.004	.006	.4	Dump by pit, altered material with abundant limonite and hematite.
89	Chip	6 ft (1.8 m)	Tr	.1	.17	.006	.026	Copper-stained fracture zone.
106	Grab	Random	Tr	n.d.	.19	.006	.011	Dump by adit, material is schist containmalachite, azurite and chalcopyrite.



Sample			Assay Data (oz/ton)		(percent)			
No.	Type	Length	Au	Ag	Cu	Pb	Zn	Remarks
66	Chip	5 ft (1.5 m)	n.d.	0.2	0.72	0.08	0.17	Shear zone showing secondary copper stringers.
67	Chip	5 ft (1.5 m)	0.03	.1	.63	.038	.07	Fracture zone showing disseminated chalcopyrite and high silica content.
*68	Chip	3 ft (0.9 m)	.03	.1	1.1	.17	.073	Shear zone, visible calcanthite and chrysocolla.
*69	Grab	Random	n.d.	n.d.	.54	.032	.057	S½ of dump, composed of sheared metavolcanic rock, iron staining with no visible copper mineralization.
*70	Grab	Random	.06	n.d.	.44	.021	.056	N½ of dump, composed same as S½.

n.d. - not detected

*68, 69, and 70 also assayed 1.2, 1.0, and 0.85 percent As, respectively.

FIGURE 6.—Map of upper adit of Jones mine showing locations of samples 66-70.

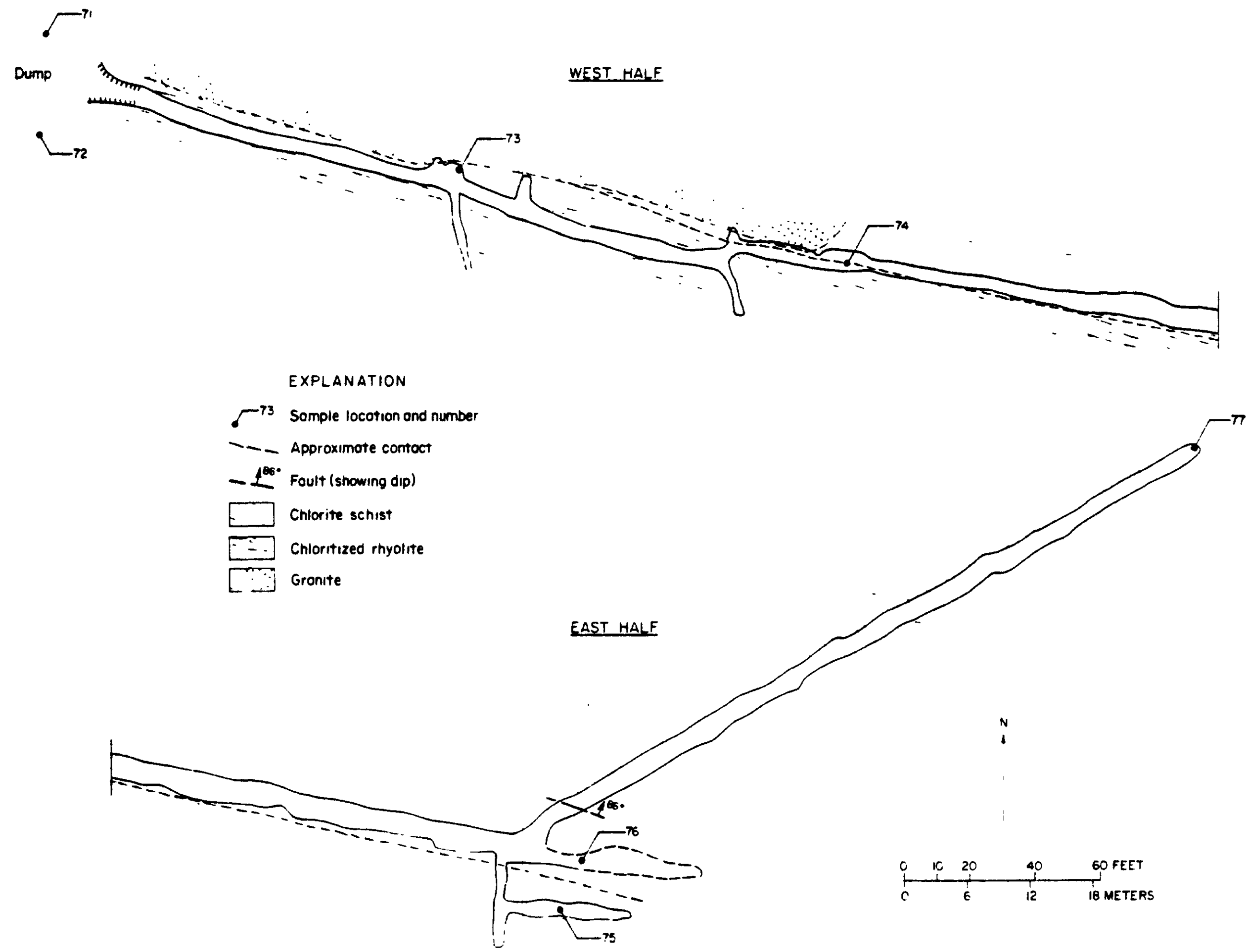
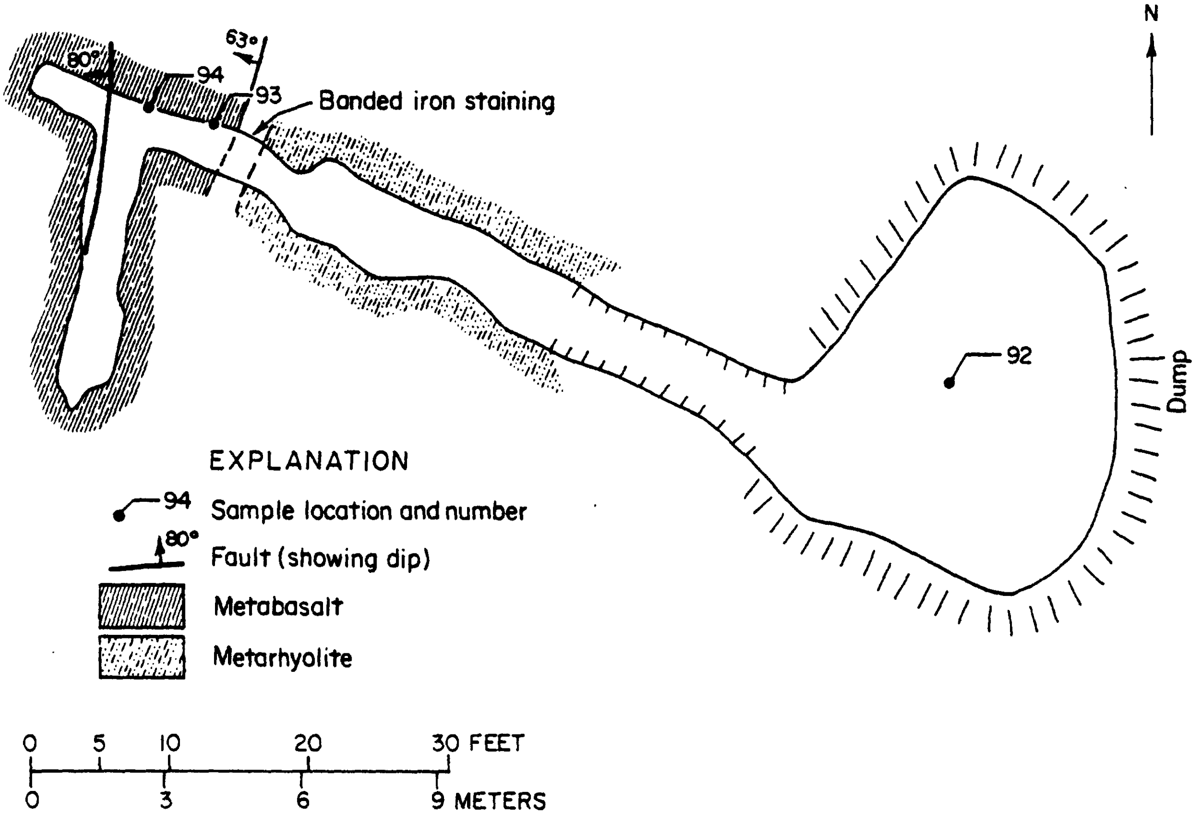


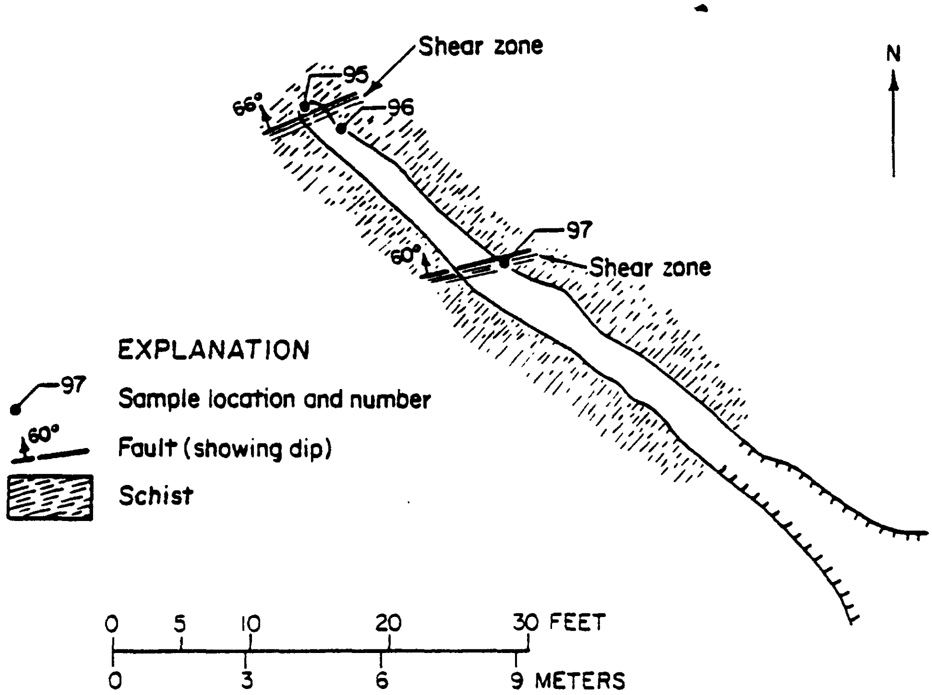
FIGURE 7.--Map of middle adit of Jones mine showing locations of samples 71-77.



Sample			Assay Data (oz/ton)		Assay Data (percent)			
No.	Type	Length	Au	Ag	Cu	Pb	Zn	Remarks
92	Grab	Random	n.d.	0.1	0.039	< 0.006	0.009	Dump material with some visible chalcopyrite and pyrite.
93	Chip	5 ft (1.5 m)	n.d.	Tr	.044	< .006	.006	Alternating bands of gray quartz with chalcopyrite and iron-rich siliceous rock.
94	Chip	5 ft (1.5 m)	Tr	.1	.026	< .006	.0135	Same as 93.

n.d. - not detected
Tr - Trace

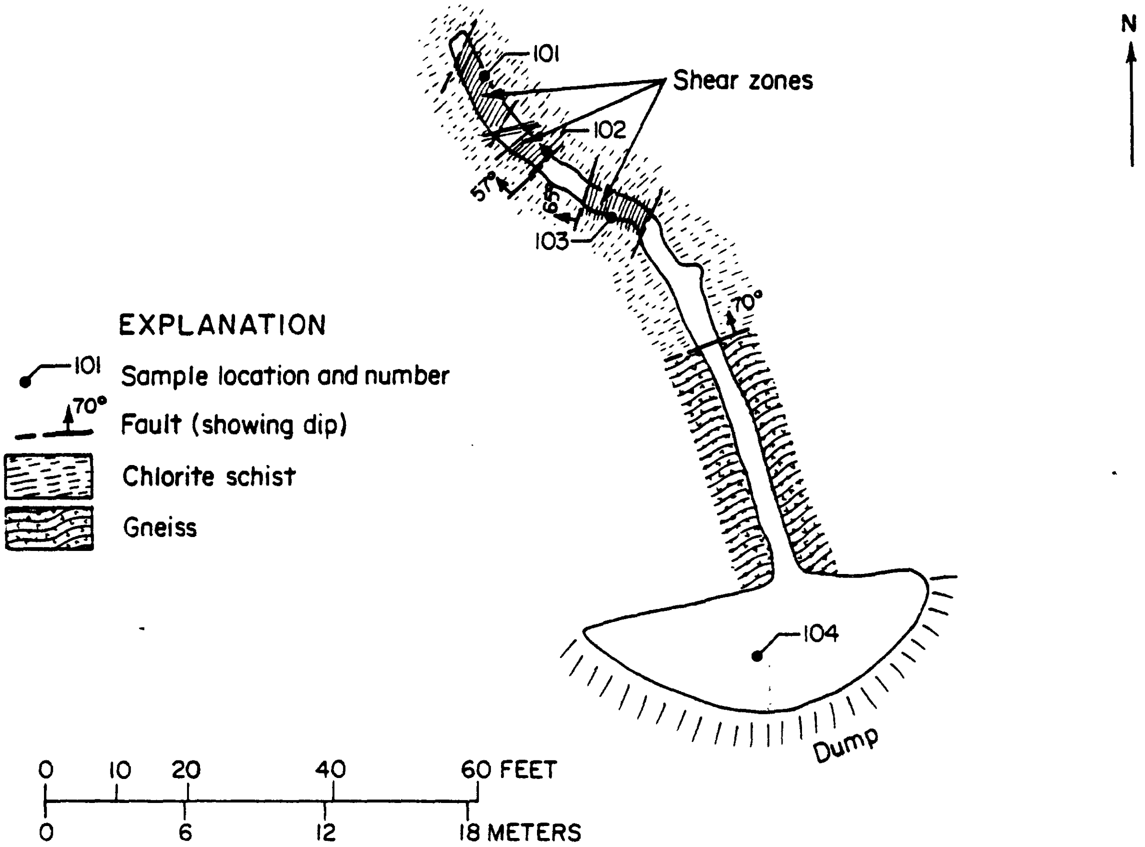
FIGURE 8.--Map of adit showing locations of samples 92-94.



Sample			Assay Data (oz/ton)		Assay Data (percent)			
No.	Type	Length	Au	Ag	Cu	Pb	Zn	Remarks
95	Chip	5 ft (1.5 m)	Tr	0.1	0.002	< 0.006	0.008	Partly chloritized, sheared mica schist; no visible mineralization.
96	Chip	5 in (13 cm)	Tr	.1	.0015	< .006	.002	Garnetiferous schist with small quartz stringers.
97	Chip	12 in (30 cm)	Tr	.1	.0015	< .006	.002	Shear zone, no visible mineralization.

Tr - Trace

FIGURE 9.--Map of adit showing locaions of samples 95-97.



No.	Sample Type	Length	Assay Data (oz/ton) Au	Ag	(percent) Cu	Pb	Zn	Remarks
101	Chip	10 ft (3.1 m)	n.d.	n.d.	0.20	<0.006	0.007	Shear zone in chloritic schist, small amounts visible copper.
102	Chip	12 ft (3.7 m)	n.d.	0.1	.026	< .006	.007	Same as 101.
103	Chip	7 ft (2.1 m)	n.d.	.1	.063	< .006	.013	Shear zone, very small amounts copper staining.
104	Grab	Random	n.d.	n.d.	.024	< .006	.008	Dump composed of shlorite schist

n.d. - not detected

FIGURE 10.--Map of adit showing locations of samples 101-104.

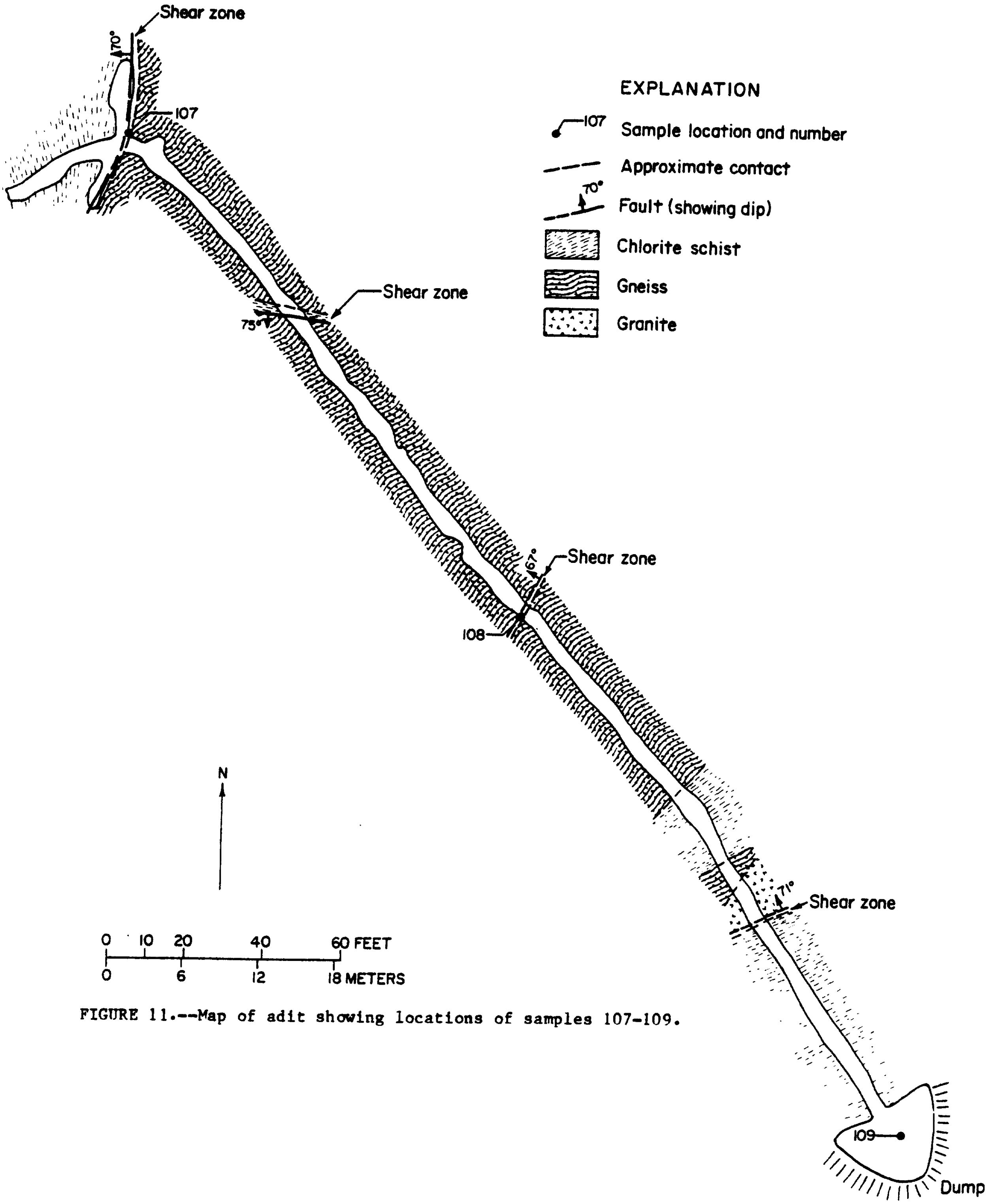


FIGURE 11.--Map of adit showing locations of samples 107-109.

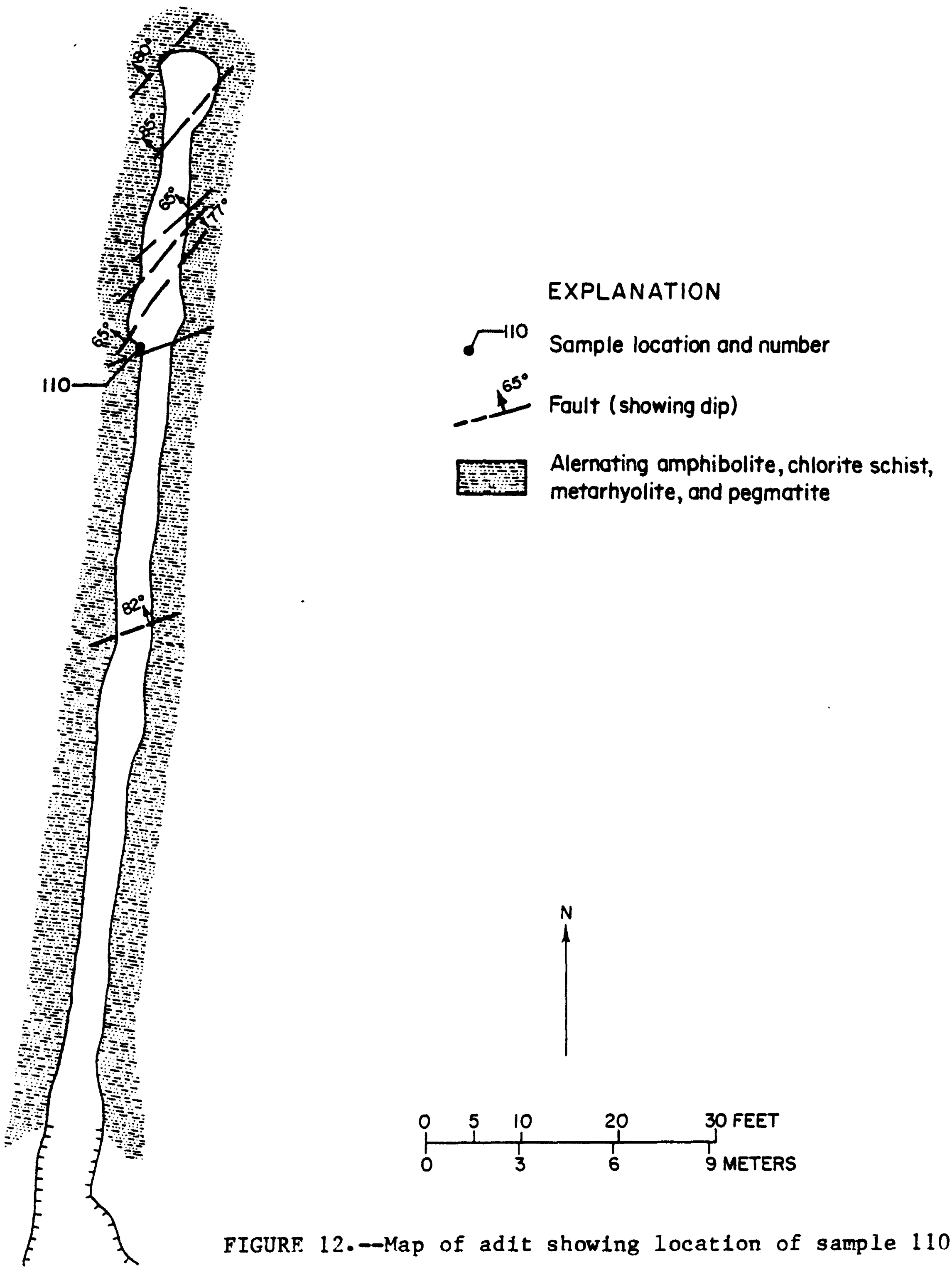
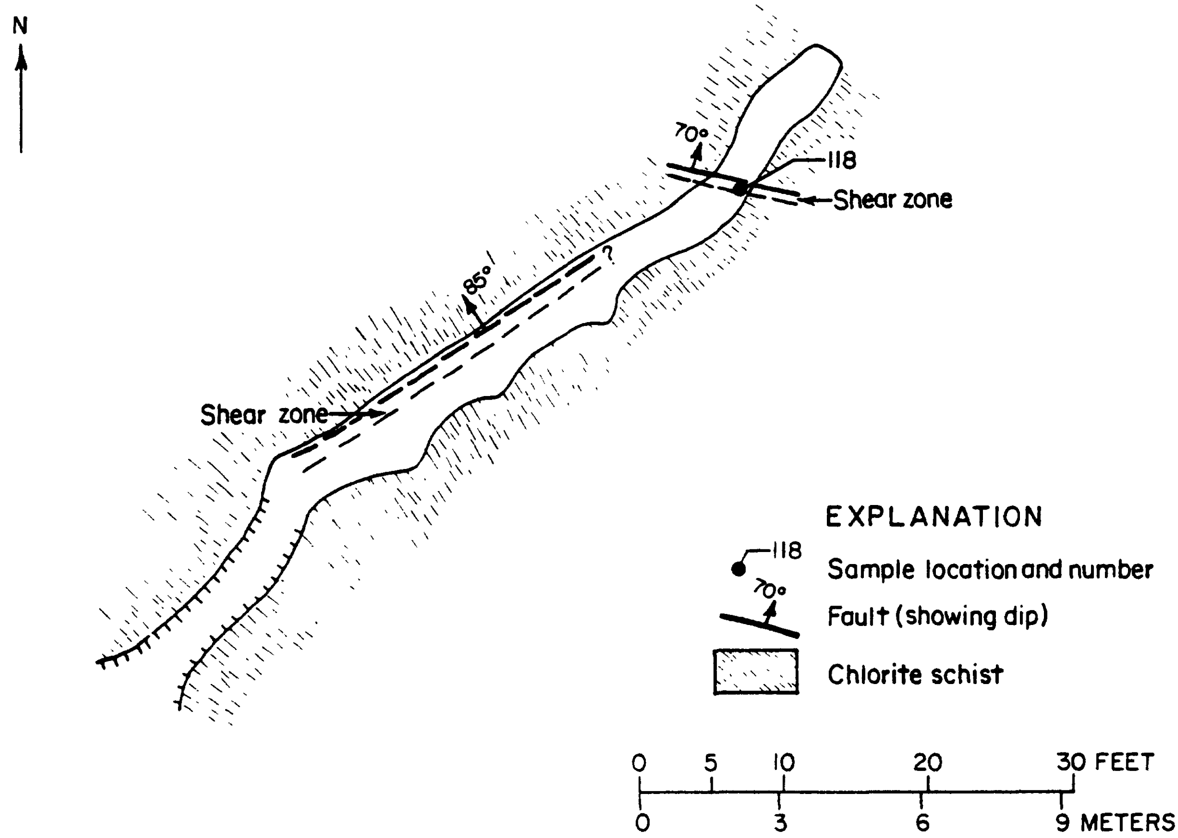
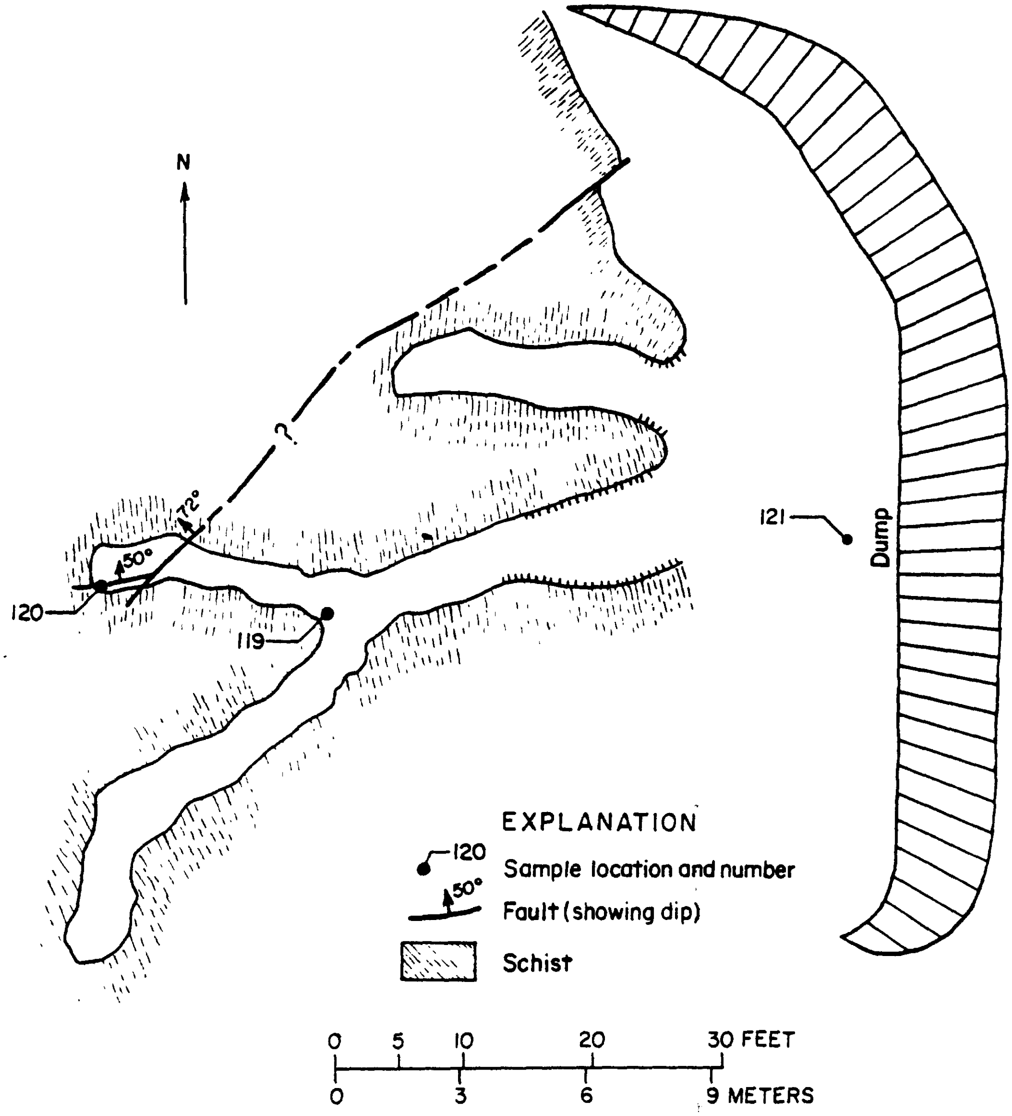


FIGURE 12.--Map of adit showing location of sample 110.



Sample			Assay Data (oz/ton)		(percent)			
No.	Type	Length	Au	Ag	Cu	Pb	Zn	Remarks
118	Chip	12 in (31 cm)	0.01	0.1	0.03	<0.006	0.033	Shear zone with no visible mineralization.

FIGURE 13.--Map of adit showing location of sample 118.



Sample			Assay Data (oz/ton)		Assay Data (percent)			
No.	Type	Length	Au	Ag	Cu	Pb	Zn	Remarks
119	Chip	18 in (46 cm)	Tr	n.d.	0.023	0.012	0.01	Siliceous shear zone showing small banding of chalcopyrite and pyrite with limonite staining.
120	Chip	2 ft (0.6 m)	Tr	n.d.	.0074	.0082	.012	Siliceous fracture zone with much iron staining, some small amounts pyrite.
121	Grab	Random	0.01	0.1	.035	.006	.034	Dump, composed of schist.

n.d. - not detected
Tr - trace

FIGURE 14.--Map of adit showing locations of samples 119-121.

Evidence of mineralization in the majority of the workings was sparse and consequently assay values were low, giving the workings more significance and exposure to stratigrahic rock units, which plays a large part in locating possible massive-sulfide mineraliztion. Some adits show signs of stringer ore associated with volcanogenic massive-sulfide deposits. Stratigraphic information of the sampled areas holds more importance than the mineral content indicates.

Aspen Ranch pegmatite area

The Aspen Ranch area is about 11 miles (17.7 km) northeast of Santa Fe in sec. 1, T. 18 N., R. 10 E., and sec. 6, T. 18 N., R. 11 E. The area is about 0.2 miles (0.3 km) north of Aspen Ranch.

From 1955 through 1957, 57 mining claims were located in the area and in 1977 were controlled by Lucky Star Mining Company. No production has been reported from the area. A 1,000-ton-per-day mill supposedly was to have been constructed in 1958 (Redmon, 1961). In 1977, no mill existed, but some old equipment was at a mill site.

The primary mining interest in the past has been for mica. Book mica in the area rarely exceeds 4 inches (10 cm) in diameter and mainly occurs in seams or vein-like structures. The mica is only good for scrap and constitutes about 1 percent of the pegmatite (Redmon, 1961).

The country rock is Precambrian gneiss and granite that has been intruded by pegmatites. The pegmatites are composed of medium- to coarse-grained quartz and feldspar with lesser muscovite.

A total of 32 samples (129-160) was taken at numerous prospects and outcrops. Most of the prospects were small pits or bulldozer trenches. Two adits, 92 and 133 feet (28 m and 40 m) long, are in the SE 1/4 sec. 1, T. 19 N., R. 10 E. the locations of samples are shown on figure 15.

Assay results show from 0 to 0.01 ounce of gold per ton, as much as 0.2 ounce silver per ton, and as much as 0.064 bismuth in spectrographic analysis; most bismuth values were between 0.04 and 0.05 percent.

Cordova pegmatite area

The Cordova area is about 4 miles (6.4 km) southeast of Cordova, New Mexico. This area was prospected mostly in 1954 and 1955. There are four major groups of claims in the area, all of which are associated with pegmatites; BAT claims, Tip Top claims, Green Rock, and Rockin Chair claims. All have similar geologic environments. Most of the mining was done for mica at small pits or bulldozer trenches. The mica is of scrap quality although 175 pounds (79 kg) of sheet mica was reportedly produced from the Green Rock property in 1956 (Redmon, 1961). About 600 pounds (183 kg) of beryl was reported to have been recovered from a pegmatite on the Rockin Chair property (Redmon, 1961).

The area is composed of Precambrian schist or granite intruded by various pegmatites. Where zoned, these pegmatites usually have a coarse-grained core made up of predominantly quartz and feldspar. The outer zones are usually finer grained, composed of quartz, feldspar, and mica (muscovite). Accessory minerals are garnet, dendritic manganese, and smaller amounts of beryl and black tourmaline (Redmon, 1961).

Fifty-four samples (163-216) were taken at various prospects, mostly pits and trenches. The samples were taken in pegmatites which crop out in the area. None of the samples analyzed showed anomalous mineral values. All the sampled pegmatites are similar in composition, the major difference being the book size and percentage of muscovite. The largest books were about 8 inches (20 cm) in diameter, but the majority were between 3 and 6 inches (8 cm and 15 cm) in diameter.

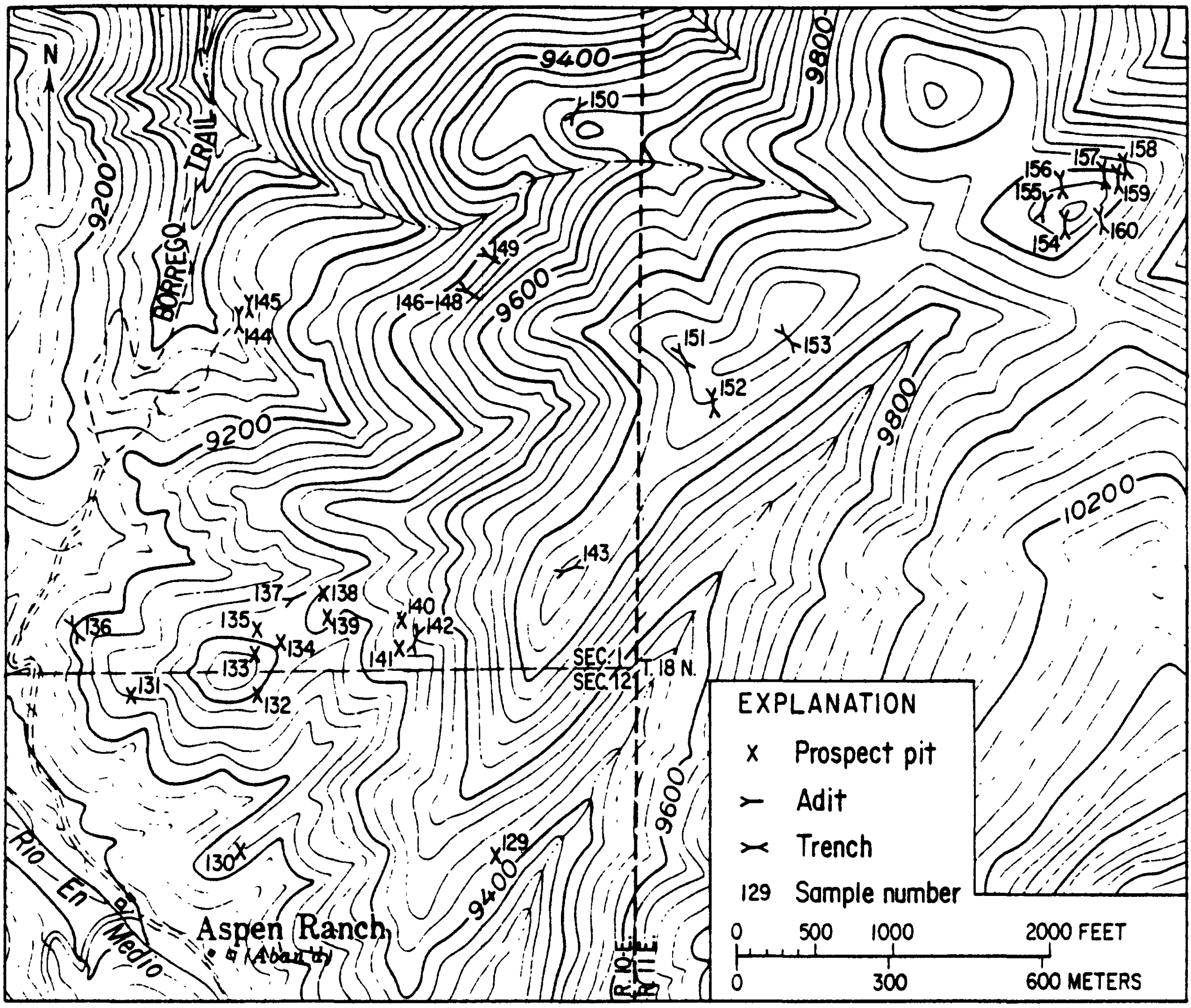


FIGURE 15.--Map showing locations of samples 129-160 in the Aspen Ranch area.

Conclusions

Certain areas in the study area have a good potential for massive-sulfide ore deposits similar to the one that had been mined at Pecos mine. The geology is strikingly similar to that in Canada where such deposits have been found in clusters. Drilling was being done by Conoco during the field investigation.

Mica and beryllium have been obtained from pegmatites in the Cordova area which is partly in the northern portion of the proposed westerly addition to the Pecos Wilderness. There exists a small potential for the mining of mica in the pegmatite areas, but this would depend on market values.

Lepidolite is present at the Pidlite property which poses a potential for lithium recovery. However, these pegmatites are relatively small in size making tonnage limited.

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