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PRECAMBRIAN ROCKS OF THE SOUTHERN SIERRA NACIMIENTO NEW MEXICO

by

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INTRODUCTION

This report is a generalized summary taken from University of New Mexico M.S. and Ph.D. theses by Reed (1971), Schumacher (1972), DuChene (1973), and Martinez (1974) and unpublished work by Woodward. The distribution and brief lithologic descriptions of the rock units are given in a series of $7^1/_2$-minute quadrangle maps at 1:24,000 scale published by the New Mexico State Bureau of Mines and Mineral Resources (Fig. 1).

The rocks discussed in this report are considered to be of Precambrian age insofar as rocks of similar stratigraphic position in the northern part of the Sierra Nacimiento have been radiometrically dated as about 1.8 billion years old (Brookins, 1974). Most of the Precambrian rocks of the southern Sierra Nacimiento are coarsely crystalline and are unconformably overlain by strata of Mississippian, Pennsylvanian, and Permian age (Armstrong, 1955).

ROCK UNITS

The rocks are described in their suggested chronologic order from oldest to youngest. In many cases the structural and chronologic relationships are not known. Also, there are no published radiometric ages for any of these rocks. The major chronologic problem concerns the relations between the gneissic units in the northern and southern parts of the area, as they are separated by a younger intrusive granitic body. Thus, the chronologic order is uncertain and subject to revision.

Distribution of the major rock units is shown on Figure 2, a generalized geologic map. Those readers interested in more precise locations of the various rocks are referred to the 1:24,000 scale maps published by the New Mexico State Bureau of Mines and Mineral Resources (Fig. 1).

Mafic Xenoliths

Mafic xenoliths ranging in size from a few inches to several tens of feet in diameter are found in the gneissic and granitic units. The xenoliths are generally dark greenish gray, fine-grained, with schistosity ranging from weak to strong. Most specimens are composed of nearly equal amounts of plagioclase (An_{40-50}) and common hornblende, with trace amounts of apatite, sericite, zircon, epidote, and opaque minerals. Some samples also contain minor amounts of quartz and (or) biotite.

Schistosity in some of the xenoliths is truncated by the enclosing gneissic rocks, suggesting that the xenoliths underwent regional synkinematic metamorphism prior to being engulfed by the igneous parents of the gneissic rocks. The stable association of andesine with calcium-bearing minerals indicates that the grade of metamorphism reached the staurolite-almandine subfacies of the amphibolite facies (Winkler, 1965). These mafic rocks appear to be remnants of basic igneous rocks into which the igneous parent rocks of the gneisses were emplaced.

Muscovite-Quartz Schist

A few lenses of pinkish gray, fine-grained, muscovite-quartz schist are enclosed by muscovite-biotite quartz monzonitic gneiss south of Pajarito Peak (Fig. 2, loc. 1). Locally, the foliation of the schist is sharply truncated by the gneiss, suggesting that the schist was metamorphosed prior to being engulfed by the igneous parent of the gneiss.

The schist occurs in lenses up to 4 feet in width and several hundred feet in length. Average composition of the schist is about 60 percent quartz, 35 percent muscovite, and minor amounts of garnet and biotite. Schistosity is strong and is marked by thin layers of aligned muscovite and elongate, intensely sutured quartz. Idiomorphic garnet porphyroblasts have bowed out the schistosity. The schist was derived from argillaceous, quartzose sandstone.

Horn blend ite

A body of hornblendite about 200 feet across is rimmed by amphibolite that grades into the surrounding San Miguel Gneiss. The hornblendite is black, fine grained, and consists of 85 percent common hornblende, 7 percent orthopyroxene, 6 percent biotite, 1 percent plagioclase, and trace amounts of apatite, opaque minerals, and chlorite. There is a weak schistosity marked by elongate hornblende and biotite. Relict orthopyroxene, rimmed by hornblende, has the optical properties of enstatite, but microprobe analysis indicates its composition is that of bronzite. The margin of the horn blendite body grades into amphibolite containing nearly equal amounts of hornblende and andesine. The amphibolite in turn merges with the surrounding gneiss.

Available evidence suggests that the hornblendite was originally an ultramafic rock composed principally of orthopyroxene that later was uralitized and marginally feldspathized by granodioritic magma. The hornblendite and surrounding granodiorite underwent regional synkinematic metamorphism that reached the lower amphibolite facies and imparted the northeast-trending foliation to the hornblendite and the surrounding San Miguel Gneiss.

Quartz Diorite Gneiss

Dark gray, faintly to moderately foliated, medium-grained, quartz diorite gneiss occurs near Los Pirlos Canyon (Fig. 2, loc. 2). The gneiss consists of 50 percent plagioclase (An_{35-38}), 20 percent quartz, 12 percent hornblende, 12 percent biotite, and minor amounts of opaque minerals, chlorite, epidote, sphene, and apatite. Normally zoned plagioclase is sub- to euhedral and has bent and broken twin lamellae. Mafic minerals are also sub- to euhedral, whereas the quartz is interstitial and anhedral.

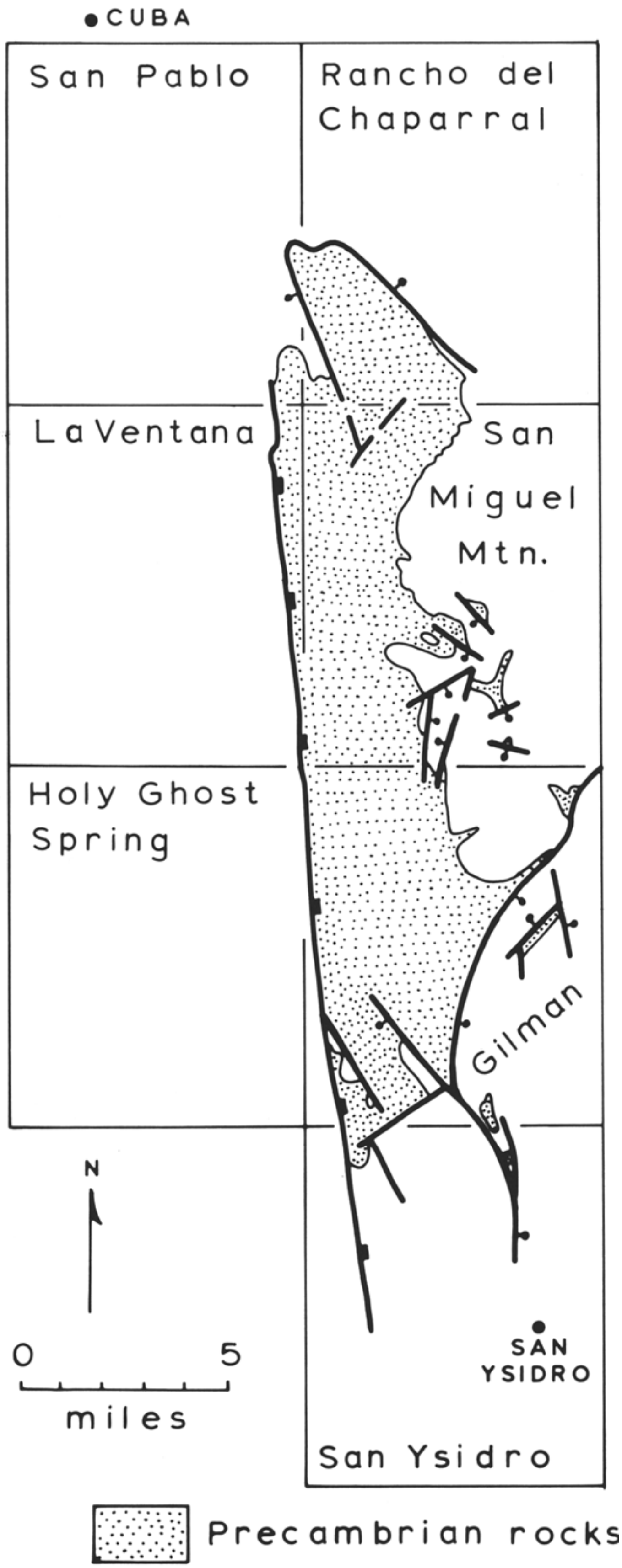

Figure 1. Index map showing 7½-minute quadrangles covered in this report.

Foliation, defined by elongate clusters of mafic minerals, trends about N. 20° E.

The quartz diorite gneiss grades into the surrounding quartz monzonitic gneisses through a zone up to 1000 feet wide where microcline euhedra up to 5.0 cm long occur in medium-grained matrix of quartz diorite.

The texture of the quartz diorite gneiss clearly indicates it was derived from an igneous parent rock, as the plagioclase and mafic minerals are mostly euhedral and the quartz is interstitial. The marginal zone of feldspathization and the occurrence of inclusions of the quartz diorite gneiss within the surrounding quartz monzonitic gneisses suggests that the quartz monzonitic rocks were emplaced as a magma that stoped and partially feldspathized the quartz diorite.

San Miguel Gneiss

The most extensive Precambrian unit in the northern part of the area is quartz monzonitic to granodioritic gneiss that is named for exposures on San Miguel Mountain (Fig. 2, loc. 3). The gneiss is salmon-pink to light pinkish gray and fine- to coarse-grained with lenticular foliation that trends northeasterly.

The San Miguel Gneiss is composed of 16 to 32 percent microcline, 29 to 36 percent plagioclase (An_{27-33}), 25 to 30 percent quartz, 2 to 9 percent biotite, and minor amounts of opaque minerals, muscovite, chlorite, and myrmekite. Trace amounts of zircon, apatite, sphene, epidote, and sericite are present. Plagioclase occurs as subhedra in the groundmass and as subhedral megacrysts up to 5.0 mm across; some grains have bent or broken twin lamellae. Anhedral to subhedral microcline forms crystals in the groundmass as well as megacrysts up to 12.0 mm in diameter. Undulatory, sutured, anhedral quartz forms aggregates that are elongate in the foliation. Dark brown biotite is present as fine-grained plates aligned in lenses in the foliation. Gneissic texture is due to segregation of biotite into lenses and to elongate quartz lenses and feldspar megacrysts.

Within the outcrop area of the San Miguel Gneiss (Fig. 2) there are subordinate zones where the rock is best described as biotite-quartz-feldspar schist or as schistose gneiss. Texture ranges from fine grained and schistose to gneissose layering of coarse-grained quartz-feldspar lenses with fine-grained schist. The schist contains about 15 percent biotite that at some localities is mostly chloritized. As much as 11 percent microcline is present in some specimens, but much of the microcline has been mylonitized and sericitized. Fine-grained quartz and plagioclase (An_{25-30}) make up about 30 percent each of the schist.

Contacts between the schistose rock and the more abundant variety of San Miguel Gneiss are gradational and are transected by the trend of foliation. The outcrops of schistose rocks are not shown on Figure 2, but Reed (1971) mapped them separately at a scale of 1:12,000. Reed (1971, p.85) suggested that the schist, which differs from the ordinary San Miguel Gneiss in being slightly richer in biotite and more strongly sheared, represents zones of assimilation of mafic rock by the igneous parent of the gneiss. He further suggested that the schist was more intensely sheared as a result of the greater abundance of biotite.

Thus, the San Miguel Gneiss is a granodioritic to quartz monzonitic pluton that underwent regional syn kinematic metamorphism, resulting in the northeasterly trending foliation. The grade of metamorphism probably reached the lower

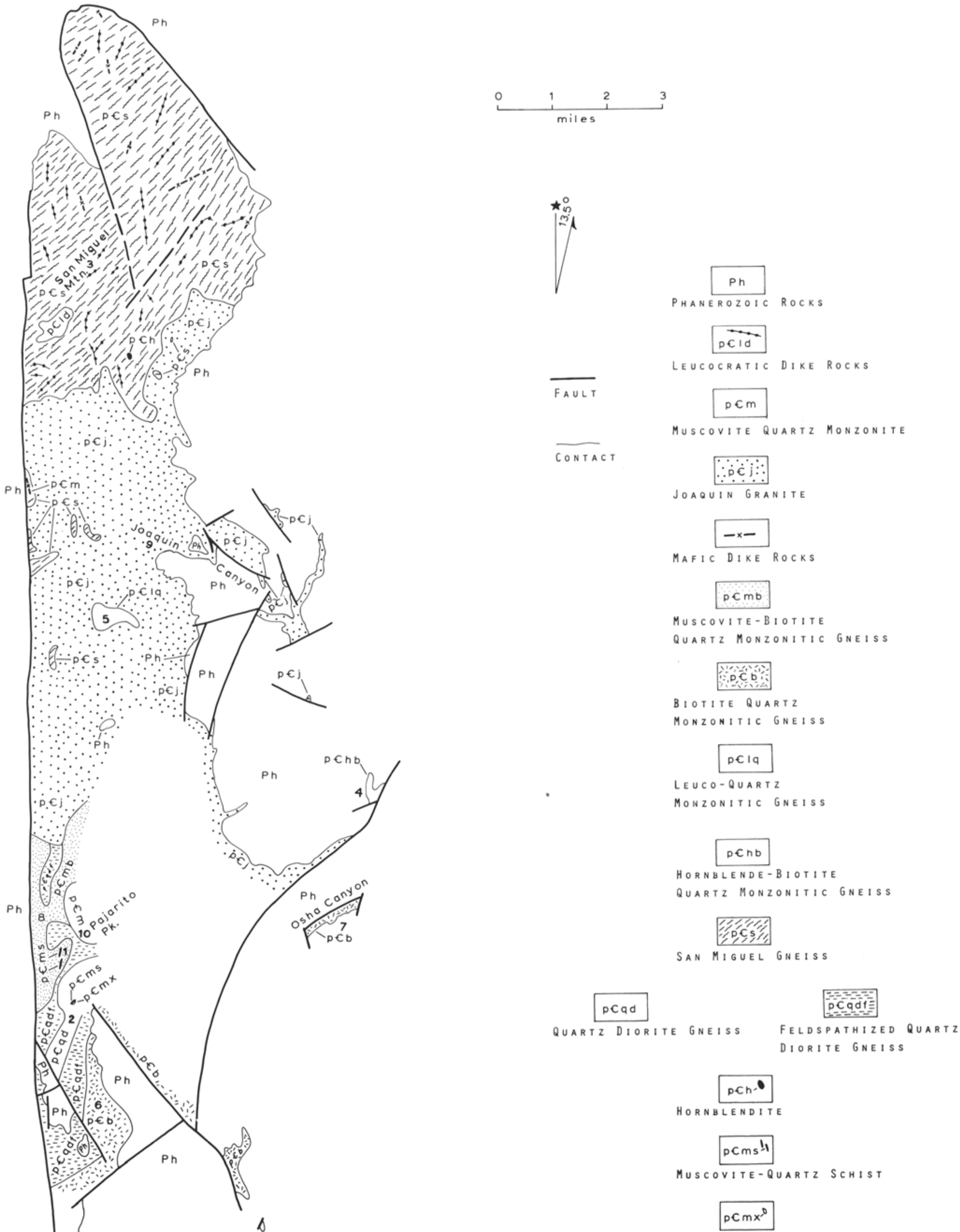

Figure 2. Generalized geologic map of Precambrian rocks of southern Sierra Nacimiento.

amphibolite facies, as judged from the mineral assemblage of the synchronously metamorphosed hornblende body.

Hornblende-Biotite Quartz Monzonitic Gneiss

Hornblende-biotite quartz monzonitic gneiss is exposed at an erosional inlier at the Guadalupe Box (Fig. 2, loc. 4). Contacts with the other Precambrian units are covered by younger strata and therefore the structural and chronologic relations are not known.

The gneiss is pinkish gray and coarsely foliated, with microcline porphyroblasts up to 1.5 cm in diameter in a coarse-grained matrix of plagioclase, quartz, and mafic minerals. Average composition of the gneiss is 33 percent plagioclase (An_{27}), 24 percent microcline, 23 percent quartz, 4 percent hornblende, and 4 percent biotite. There are minor amounts of chlorite, sphene, opaque minerals, and epidote along with traces of apatite, calcite, zircon, myrmekite, and leucoxene.

Leuco-Quartz Monzonitic Gneiss

Leuco-quartz monzonitic gneiss crops out as an irregularly shaped inclusion or roof pendant within the Joaquin Granite (Fig. 2, loc. 5). This gneiss is fine- to medium-grained, light pinkish gray, and has subtle, but coarse, foliation. Folia consist of quartzose layers that alternate with feldspar-rich layers. In contrast with the other gneisses, this unit is conspicuous in lacking large microcline crystals.

Contacts with the surrounding Joaquin Granite are sharp but highly sinuous, with projections of granite exending into the gneiss. Thus, at the scale of the map the contact is approximate and has a straighter trace than seen on the outcrop. Foliation of the gneiss is sharply truncated by the contact with the granite.

The leuco-gneiss is composed of 33 percent plagioclase (An_{25}), 28 percent microcline, 32 percent quartz, and 4 percent biotite. There are minor amounts of epidote and opaque minerals and traces of white mica, apatite, and myrmekite.

Biotite Quartz Monzonitic Gneiss

Biotite quartz monzonitic gneiss occurs at two localities in the southern part of the Sierra Nacimiento, at Jack Rabbit Flats (Fig. 2, loc. 6) and east of Osha Canyon (loc. 7). Because these two gneissic bodies are separated by a cover of younger sedimentary rocks, their relations to each other are uncertain. However, because of lithologic similarity they are described under the same heading.

Fine- to coarse-grained, pinkish gray to dark gray, faintly foliated gneiss underlies most of Jack Rabbit Flats. The gneiss is mostly quartz monzonitic, but locally is granodioritic. Numerous inclusions of quartz diorite gneiss are present in this unit. Average composition is 35 percent microcline, 33 percent quartz, 26 percent plagioclase (An_{26-28}), 5 percent brown biotite, and traces of opaque minerals and apatite. Foliation, defined by biotite lenses and elongate microcline porphyroblasts, trends N. 20° E. to N. 45° W.

On the east side of Osha Canyon (Fig. 2, loc. 7) pink, biotite quartz monzonitic gneiss is exposed. Locally, weathered mafic minerals give the exposed surfaces a greenish tinge. This gneiss is coarsely foliated with microcline porphyroblasts up to 8.0 mm in diameter in a medium-grained matrix of quartz, plagioclase, and biotite.

The gneiss consists of 36 percent plagioclase (An26), 33 percent microcline, 20 percent quartz, and 9 percent biotite. There are minor amounts of opaque minerals, epidote, muscovite, sphene, and leucoxene along with traces of apatite, hornblende, chlorite, and zircon.

Muscovite-Biotite Quartz Monzonitic Gneiss

Fine- to medium-grained, orange-pink gneiss forms the steep scarp west of Pajarito Peak (Fig. 2, loc. 8). This rock is principally quartz monzonitic in composition, but locally is granodioritic. The average composition is 39 percent quartz, 31 percent microcline-microperthite, 23 percent plagioclase (An_{24-28}), 4 percent brown biotite, and 2 percent muscovite. Foliation trends north and is defined by lenses of biotite plates showing a weak preferred orientation.

A few lenses and layers of mica-quartz schist up to 400 feet long are enclosed by the gneiss. It appears that the mica-quartz schist was engulfed and partly assimilated by the igneous parent of the gneiss. Thus, the high quartz content and the presence of muscovite in the gneiss may be due to assimilation. This in turn suggests that the muscovite-biotite quartz monzonitic gneiss and the biotite quartz monzonitic gneiss previously described may have formed from the same parent magma. The adjacent quartz diorite body was locally feldspathized by the quartz monzonitic magma.

Mafic Dike Rocks

Mafic dikes up to 4 feet in width were emplaced in the San Miguel Gneiss and related rocks prior to regional synkinematic metamorphism. Although the dike rocks are commonly schistose, they show relict lamprophyric texture insofar as the phenocrysts are ferromagnesian and the groundmass also contains idiomorphic ferromagnesian minerals. Hornblende spessartite is the most common type of mafic dike rock, containing about 50 percent hornblende, 25 percent plagioclase (An_{40-50}), and minor amounts of quartz, epidote, biotite, and potassium feldspar.

The mafic dike rocks are fine grained and dark green to black. Most of the dikes are poorly exposed and only those that are longitudinally continuous are shown on the geologic map (Fig. 2).

Joaquin Granite

The Joaquin Granite, named for exposures along Joaquin Canyon (Fig. 2, loc. 9), is the most widespread Precambrian unit in the central part of the southern Sierra Nacimiento.

The granite is pink, fine- to medium-grained, and hypidiomorphic-granular to slightly porphyritic in some areas having microcline megacrysts. Subtle foliation is locally present and is most common in the southern part of the area. Near the contact with the older gneisses the rock may be quartz monzonitic, but the predominant lithology is granite having the following composition: 40 to 50 percent microcline-microperthite, 18 to 21 percent plagioclase (An_{24}), 24 to 37 percent quartz, 2 to 3 percent biotite, and 1 percent muscovite. Minor amounts of opaque minerals, chlorite, sericite, and myrmekite are present along with traces of apatite, sphene, zircon, and epidote. Microcline occurs as anhedral to subhedral crystals 0.5 to 1.0 mm across. Inclusions of euhedral plagioclase oriented parallel to crystal outlines of the microcline suggest a magmatic origin for the granite (Hibbard, 1965).

The granite intrudes the gneiss with sharp contacts that are locally chilled. Numerous dikes and apophyses of granite extend into the gneiss and inclusions and (or) roof pendants of gneiss are common near the margins of the granite. The contact was mapped where granite becomes the dominant lithology. Gneissic inclusions in various stages of assimilation occur in the granite, suggesting that magmatic stoping and assimilation were important factors in emplacement. Emplacement by dilation may have taken place also, but the lack of exposure of the entire margin of the Joaquin Granite pluton precludes definite proof of this possibility.

Muscovite Quartz Monzonite

Fine-grained, buff muscovite quartz monzonite underlies Pajarito Peak (Fig. 2, loc. 10). This rock has directionless texture and is in sharp contact with the adjacent gneisses.

Leucocratic Dike Rocks

Dikes and irregularly shaped bodies of aplite, pegmatite, and granite to quartz monzonite, emplaced in gneisses and the Joaquin Granite, appear to be the youngest Precambrian rocks in the area. The dikes and irregularly shaped bodies range in width from a few inches to several hundred yards. Some of the dikes can be traced for as much as one mile. Aplite, pegmatite, and granitic rocks may occur in the same dike, having both textural and compositional zoning. Microcline and quartz are the dominant minerals, with lesser amounts of sodic plagioclase and minor muscovite and biotite. These bodies appear to have been emplaced by dilation.

GEOLOGIC HISTORY

The outline of the Precambrian geologic history of the southern part of the Sierra Nacimiento, presented below, is tentative and subject to revision.

1. Argillaceous quartzose sandstone and basic igneous rocks, possibly volcanics, accumulated; the original stratigraphic relationships between the rocks is not known.
2. The basic igneous rocks and sandstone underwent regional synkinematic metamorphism, producing the schistose mafic xenoliths and muscovite-quartz schist.
3. An ultramafic body, probably consisting mostly of orthopyroxene, was emplaced or formed as a crystal cumulate.
4. Quartz diorite was emplaced in the southern part of the area. It is possible that this event is younger than emplacement of the parent of the San Miguel Gneiss.
5. The igneous parent of the San Miguel Gneiss was emplaced, at least in part, by stoping and assimilation of a terrane of mafic schist. The ultramafic body was also engulfed and probably uralitized and partly feldspathized.

Quartz monzonitic bodies in the southern part of the area may have been emplaced prior to, during, or after emplacement of the San Miguel Gneiss.

6. Mafic dike rocks were emplaced by dilation in the parent of the San Miguel Gneiss.
7. Regional synkinematic metamorphism imparted north- to northeast-trending foliation on the rocks.
8. The Joaquin Granite was emplaced as a magma, possibly by dilation with minor stoping and assimilation. Primary flow structures that formed during emplacement resulted in gneissic texture in parts of the pluton, especially near the southern end.
9. Muscovite quartz monzonite was emplaced near Pajarito Peak.
10. Leucocratic dikes and small, irregularly shaped plutons consisting of pegmatite, aplite, and granitic rocks were injected into the rock units noted previously.

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