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Lawrence J. Herber, 1963, pp. 180-184

in:

Socorro Region, Kuellmer, F. J.; [ed.], New Mexico Geological Society 14th Annual Fall Field Conference Guidebook, 204 p.

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PRECAMBRIAN ROCKS OF LA JOYITA HILLS

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INTRODUCTION

A Precambrian gneiss complex composed of predominant coarse gneiss, amphibolite, epidosite schist, biotite schist, and quartzo-feldspathic schist comprises the eastern part of La Joyita Hills. The steeply dipping East Joyita Fault (dipping easterly) forms the eastern boundary, whereas most of the western boundary of the complex is an unconformity overlain by post-Mississippian sediments (fig. 1B). Several easterly trending faults cut the gneiss complex.

Lithologies of the gneiss complex, lineation, schistosity, relic bedding, joints, and small fold axes were plotted on enlarged aerial photographs (scale approximately 1:14000). Field mapping in conjunction with routine petrographic work suggests that the gneiss complex was derived from metamorphosed argillaceous, arenaceous, and basic volcanic sediments that underwent a subsequent period of deformation.

GEOMORPHIC CHARACTER

Air photo and field studies of the gneiss complex indicate that it can be divided into two parts:

1. An orange-colored gneiss characterized by low, gently rounded hills and a partially developed rectangular drainage pattern comprising the northern two thirds of the complex.
2. A dark-colored gneiss characterized by low, rugged hills and an irregular drainage pattern comprising the southern one third of the complex. The geomorphic divisions of the gneiss complex coincide with textural and compositional variations.

Factors significant to the landform evolution are as follows:

1. *Faulting*. Transverse faulting, faulting in an east-west direction, controls some of the westward-flowing streams in the northern part and has, in conjunction with foliation, divided the orange-colored gneiss into a series of rectangular blocks. Transverse faulting on the west side of the southern part of the gneiss is less obvious, as is also a rectangular pattern.
2. *Lithology*. Locally, in the northern part, topographic highs are mostly quartz-potassium feldspar schist and quartz-potassium feldspar-biotite schist. In the southern part, weathering of the less resistant amphibolites has produced low areas (or notches) in the dark gneiss.

Although differences of elevation are greater in the southern part of the gneiss complex, relief of two hundred feet is seldom exceeded.

PETROLOGY AND PETROGRAPHY

The rock units recognized in the gneiss complex are as follows:

GNEISS SERIES

The gneiss series comprises about 75 percent of the area mapped and is composed of two similar units, both containing large (up to 2 cm) microcline crystals. A light-colored quartz-potassium feldspar gneiss, showing conspicuous foliation, is predominant in the northern two thirds of the area (fig. 2C). In the southern third the gneiss contains, in addition to quartz and alkali feldspar, more biotite, finer grains, and a less pronounced foliation. The contact between the gneisses is gradational. Petrographically no essential differences were found between the two gneisses.

AMPHIBOLITE

The amphibolite schists range from three to thirty feet in thickness, are most abundant in the biotite-rich gneiss, and generally are in sharp contact with the gneiss. However, many gneiss zones adjacent to the amphibolites are richer in biotite than the quartz-potassium feldspar-biotite gneiss. Some of the amphibolites contain stringers of subrounded zircon grains that parallel the foliation. The primary minerals are hornblende and oligoclase. Some contain more than five percent quartz.

QUARTZ-POTASSIUM FELDSPAR SCHIST AND QUARTZ-POTASSIUM FELDSPAR-BIOTITE SCHIST

These units are very similar in appearance but

1. Present address: Mackey School of Mines, Reno, Nevada. This study received a student grant from the New Mexico Geological Society.

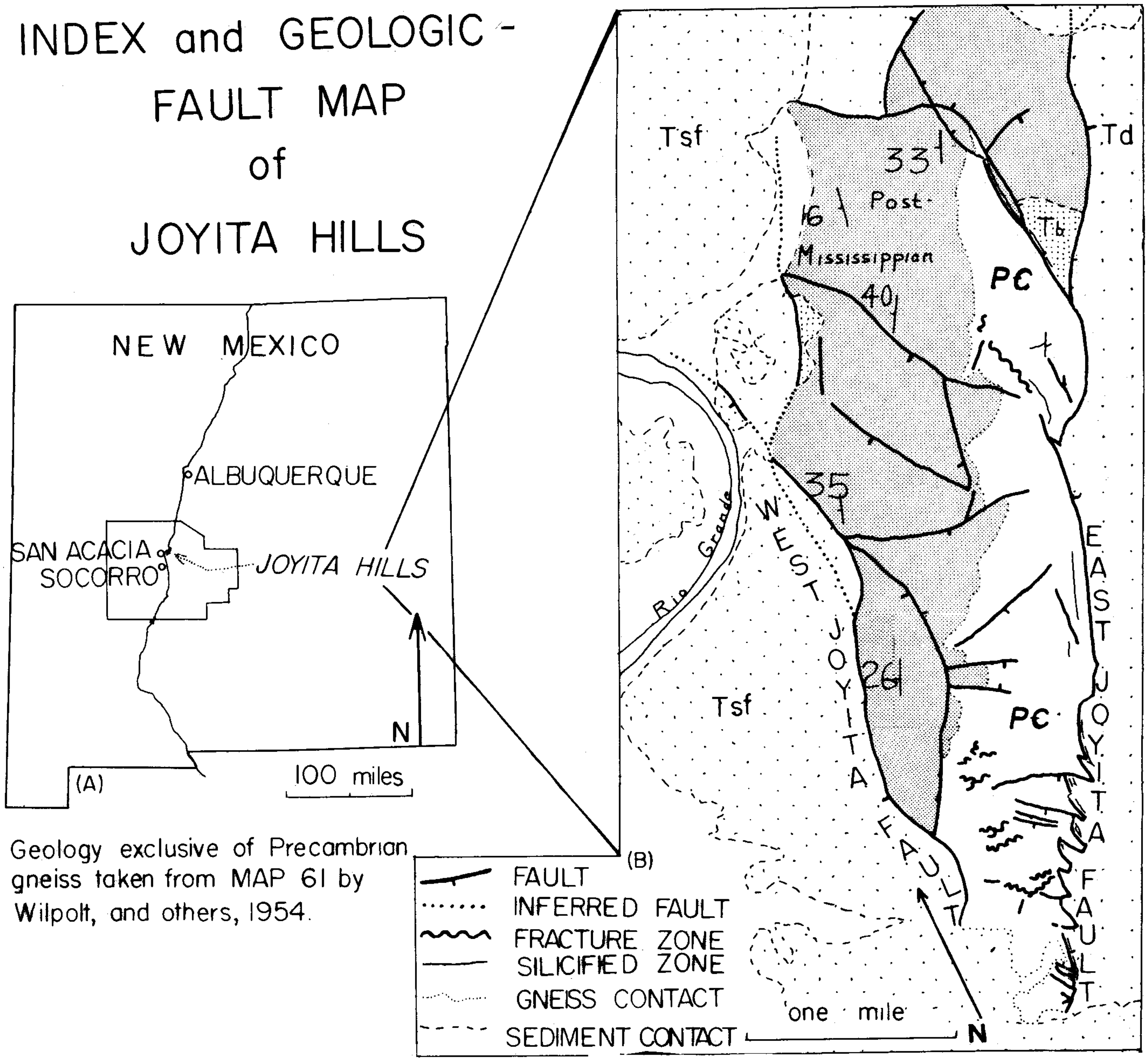

FIGURE 1

differ megascopically in biotite content. They seldom exceed two feet in thickness, are generally in sharp contact with the gneiss, and grade laterally and vertically into one another. A few of the thicker quartzo-feldspathic schists at the north end exhibit a gradational contact with the light-colored gneiss. Stringers of subrounded grains of zircon are also present in the quartzo-feldspathic schists.

Epidosite

Epidosite occurs in tabular, discontinuous outcrops and ranges in thickness from five to fifty feet. Epidote, orthoclase, and quartz are the essential minerals.

Pegmatites

Quartz-microcline pegmatite dikes from one inch to three feet thick occur throughout the area in sharp contact with the gneiss. The pegmatites locally split and contain fragments of undisturbed gneiss. A few zoned (quartz core with microcline rim) lenticular pegmatites with a long axis from five inches to six feet were observed.

Aplite Dikes

Stringers of aplite are commonly associated with the pegmatites. In this occurrence, the aplites bifurcate and enclose pieces of undisturbed gneiss. Other large aplites, up to 12 feet thick, are restricted to the

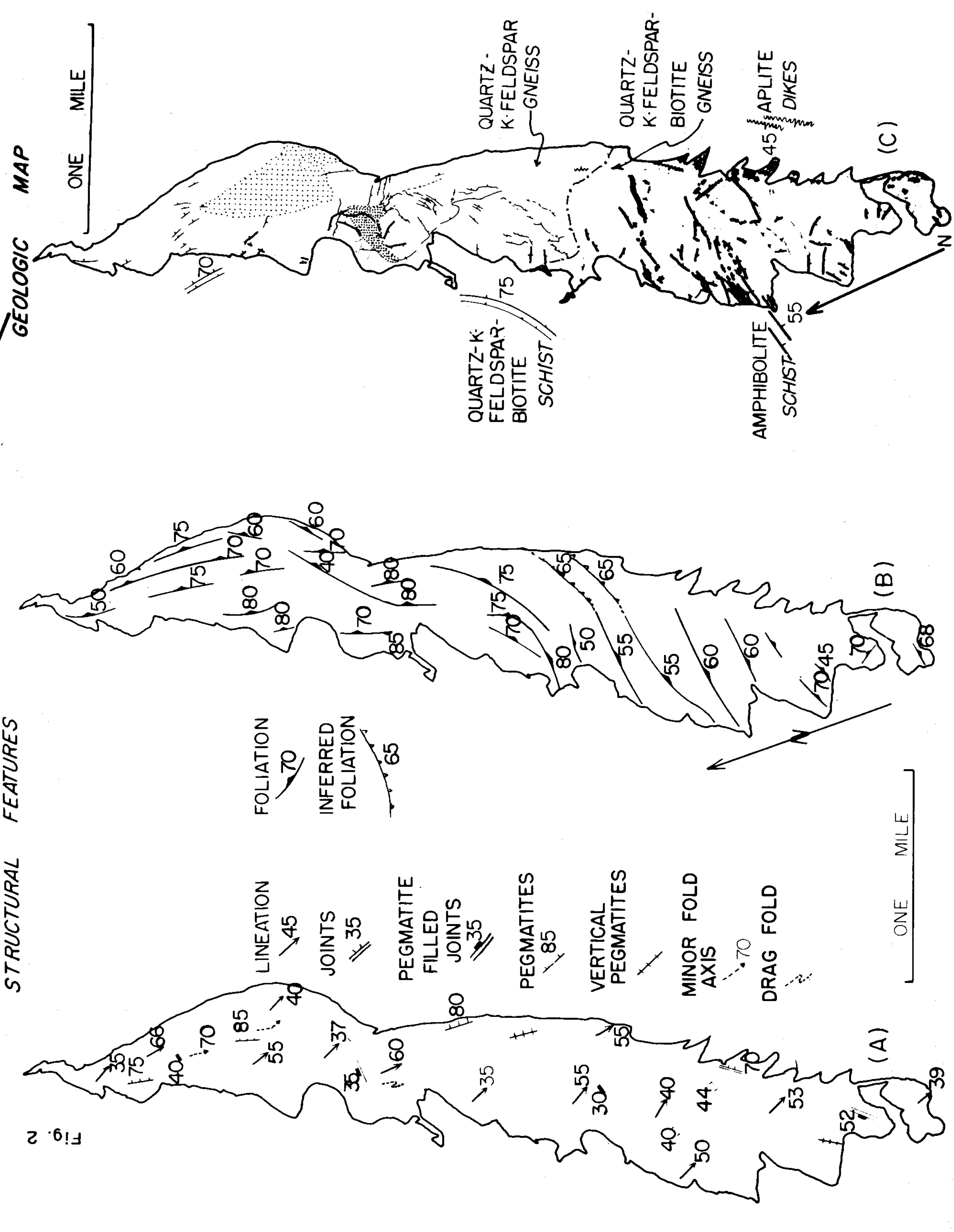

FIGURE 2

Structural and geologic features of Precambrian rocks of La Joyita Hills.

eastern side of the dark quartz-potassium feldspar-biotite gneiss, do not branch out, and only locally are associated with pegmatites.

Finer-Grained Zones

Several patches of rock finer-grained than the enclosing gneiss occur in the quartz-potassium feldspar gneiss. These zones have gradational boundaries with the gneiss, appear to be unrelated to trends established in the schists, and include light- and dark-colored schists. Foliation in parts of the finer-grained zones is better developed than in the surrounding gneiss; however, the reverse is also observed. Compared with the gneiss series, the features most characteristic of the finer-grained zones are their irregular shape, smaller potassium feldspar crystals, and lighter color. Locally, highly schistose zones at the boundary serve to differentiate the gneiss from the finer-grained zones.

STRUCTURAL FEATURES

A mineral lineation is the most conspicuous structural feature mapped. It is present in all rocks except the pegmatites and aplites. The attitude of the lineation is uniform and similar to the attitudes of the axes of small folds (fig. 2A).

In the gneiss complex, bedding and schistosity are closely related. The recorded schistosity measurements were obtained largely from the schist. Schistosity is also locally well developed in the northern part of the quartz-potassium feldspar gneiss. Measurements of schistosity in the quartz-potassium feldspar-biotite gneiss could be made only in the biotite-rich zones adjacent to some of the amphibolite schists.

Relic beds were distinguished from the enclosing gneiss by a combination of two or more of the following:

1. *Grain size.* The amphibolites and the quartzo-feldspathic schists are finer-grained than the gneiss series.
2. *Outcrop pattern.* The quartzo-feldspathic schists form small folds in the otherwise homogeneous gneiss series. Also, prominences of quartzo-feldspathic schists and notches of amphibolite schist have resulted from differential weathering.
3. *Color.* The amphibolite schists are darker than the gneiss series.

Schistosity-bedding relationships are as follows:

1. In the quartz-potassium feldspar-biotite gneiss and in the northern part of the quartz-potassium feldspar gneiss, the attitude of the schistosity is nearly parallel to the attitude of the beds. Both the schistosity and the bedding dip more steeply in the northern part than in the southern part of the mapped area.
2. In the southern part of the quartz-potassium feldspar gneiss, large parts of the beds and the coincident schistosity have been deformed. The deformation produced broken beds of schist, locally disturbed the schistosity, and resulted in a broad warping which changed the strike of the foliation from a northerly to an easterly direction (fig. 2B).
3. In the central part of the quartz-potassium feldspar gneiss and on the noses of small folds, the schistosity cuts across the trend of the bedding.

The quartz-potassium feldspar schists in the northern part of the quartz-potassium feldspar gneiss trend uniformly about north-south and dip steeply east; the amphibolite schists in the quartz-potassium feldspar-biotite gneiss trend uniformly about east-west and dip moderately steeply to the south. The configuration of beds in the central and southern parts of the quartz-potassium feldspar gneiss is suggestive of either an anticline or a syncline. Because of drag fold relationships and the observed relationship between the direction of plunge of other small folds and the southeast plunge of the mineral lineation (fig. 2A), the structure is considered to be a deformed southeastward-plunging syncline.

Most of the faults (fig. 1B) are transverse to the trend of the gneiss complex, local in extent, and dip steeply to the south. A few are parallel or subparallel to the contact of the gneiss complex. Some of the faults contain calcite, barite, fluorite, and galena; however, most of the faults are either barren or contain only a coating of iron oxides. Silicification is largely restricted to the East Joyita fault. Because of the relative homogeneity of the gneiss complex, most of the faults are difficult to trace unless cross-cutting relationships with dikes or bedding are observed.

One joint orientation, striking nearly east-west and dipping from 30 to 35 degrees to the northwest is present. Another possible orientation, weakly expressed, strikes north-northwest and dips steeply to the east (fig. 1A). Joint plans of the east-west orientation are regular, can be traced locally for hundreds of feet, and commonly contain pegmatite about five inches thick. The spacing of the east-west orientation is variable; however, some of the canyon walls are well-jointed, with the spacing seldom exceeding four feet. The joint planes of north-northeast orientations are irregular and discontinuous.

Pegmatites also occur with two orientations. The east-west striking, northwest-dipping orientation is the same as the more prominent joint orientation. Seldom was an east-west joint orientation measured without the observation that one or more of the joints was occupied by a pegmatite along its entire strike. Locally, however, the pegmatite outcrop is discontinuous while its host joint continues. The other pegmatite orientation strikes north-northeast, dips steeply either east or west or vertically, and is less prominent. No pegmatite of the north-northeast orientation was observed, where the dominant joints had this trend.

SUMMARY AND CONCLUSIONS

The Precambrian gneiss complex appears to be of metasedimentary origin for the following reasons:

1. The attitudes, spatial distribution, and composition of the schist layers suggest that the schists are metasediments.
2. The lateral gradation of quartz-potassium feldspar schist into amphibolite schist; the local lateral and vertical gradation of quartz-potassium feldspar schist into quartz-potassium feldspar-biotite schist; and the local gradational contacts of the schists with the gneiss series all suggest a metasedimentary history.
3. Zircon stringers which parallel the foliation are indicative of relic bedding. Because of the refractory nature of zircon, rounded zircon grains in metamorphic rocks are considered to be evidence that the rock is a metasediment.

The composition and texture of the gneiss series, quartz-potassium feldspar schists, quartz-potassium feldspar-biotite schists, amphibolites and epidosite can be explained by regional metamorphism of arenaceous, impure calcareous, or basic volcanic sediments that have been selectively feldspathized.

The structural history may be summarized as follows:

1. Sedimentation, deposition of arenaceous, impure calcareous, or basic volcanic sediments.
2. Regional metamorphism and deformation producing isoclinal folding which resulted in the formation of axial plane cleavage (foliation) and a b lineation. Simultaneous development of schistosity within axial plane cleavage.
3. Deformation (broad warping) which disrupted the structure pattern of the earlier regional deformation.
4. Alkali feldspathization which may have occurred later than the regional deformation but earlier, during, or later than the second deformation.
5. Jointing which because of its uniform orientation throughout the area occurred later than either deformation.
6. Pegmatization and probably the formation of aplite dikes.
7. Faulting and fracturing which may be temporally related to the jointing and pegmatization or may be occurring at the present time.