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1960, pp. 45-47. <https://doi.org/10.56577/FFC-11.45>

in:

Rio Chama Country, Beaumont, E. C.; Read, C. B.; [eds.], New Mexico Geological Society 11th Annual Fall Field Conference Guidebook, 129 p. <https://doi.org/10.56577/FFC-11>

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PRECAMBRIAN ROCKS OF THE TUSAS MOUNTAINS, RIO ARRIBA COUNTY, NEW MEXICO*

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INTRODUCTION

Precambrian rocks of the Tusas Mountains are varied and interesting. The Petaca and Ojo Caliente pegmatite districts have supplied large amounts of mica since the seventeenth century. In recent years, they have also supplied commercial amounts of beryl, feldspar, columbite-tantalite, and other minerals. The Bromide-Hopewell mining district has produced gold and silver intermittently from quartz veins. The rocks range from incredible thicknesses of nearly pure quartzite through metasedimentary and metavolcanic rocks of many varieties to several types of intrusive granitic rocks.

Two belts of Precambrian rocks are found north from Ojo Caliente in the Tusas Mountains. The western belt is composed principally of quartzite which holds up the high mountains and cliffs of the La Madera Mountains, Ortega Mountains, Kiawa Mountain, Quartzite Peak, Jawbone Mountain and the Brazos, Chavez, and Canones boxes. The eastern belt consists of the metasedimentary, metavolcanic, and intrusive igneous rocks of the Ojo Caliente area, La Jarita Mesa, Tusas Mountain, Tres Piedras, and the Precambrian inliers north and south of the Lagunitas Lakes region in the main portion of the Tusas Mountains. Folding of the Precambrian sequence results in a zig-zag boundary between the two belts of rocks.

Graton (Lindgren, et al., 1910, p. 124-133) described the geology and mineral deposits of the Bromide-Hopewell district. Just (1937) made a reconnaissance geologic map of the region between Ojo Caliente and Jawbone Mountain and described all the active mica mines. Jahns (1946) and assistants studied in detail all the economically important pegmatites of the Petaca and Ojo Caliente districts. Barker (1958) studied the Las Tablas quadrangle which occupies a large part of the main area of Precambrian outcrops. His terminology is used in this paper because the same rock units can be traced into adjacent areas. The descriptions of the rock types that follow are in large part condensed from his writing. Trice (1957) studied the Precambrian and Tertiary rocks northeast of the Lagunitas Lakes. Studies by H. H. Doney and W. R. Muehlberger north and west of Barker's map area and by R. H. Jahns, C. T. Smith and W. R. Muehlberger in the Ojo Caliente quadrangle are as yet unpublished but this paper provides a brief synopsis of their work.

STRATIGRAPHY

Ortega Quartzite

The Ortega quartzite of the Ortega Mountains and La Madera Mountain consists of 14,000-20,000 feet of "light-gray to pink vitreous quartzite; with tabular cross-bedding, hematite-ilmenite laminae, and pebbly beds" (Barker, 1958, p. 10). The hematite-ilmenite laminae lie in the plane of the crossbeds so that original tops of beds are easy to determine. Layers of rounded quartz pebbles are common. The quartzite contains 90-95% of quartz in the Ortega Mountains but includes abundant muscovite

farther east nearer to the metasomatic belt of Petaca schist. Accessory kyanite is present along bedding planes, in veinlets, and with hematite in original sedimentary laminae.

Amphibolite consisting of hornblende, oligoclase, epidote, and chlorite, occurs as thin layers in the quartzite and is probably the product of metamorphism of basalt flows or sills.

Moppin Metavolcanic Series

Several thousand feet of greenschist and amphibolite, with minor amounts of conglomerate, phyllite, gneiss, and schist comprise the rocks of the Moppin metavolcanic series. These rocks were called the Hopewell Series by Just (1937, p. 42), a name that was preoccupied, however. They extend from just north of Brazos Peak, southeastward through Hopewell, through the Las Tablas quadrangle, and to the vicinity of Ojo Caliente. The series is intruded by sills and dikes of Burned Mountain metarhyolite and by sills, dikes, and plutonic masses of Maquinita granodiorite and Tres Piedras granite.

The greenschists are composed of chlorite, albite, epidote, and calcite in varying amounts. Aggregates of chlorite, interpreted by Barker (1958, p. 15), as being retrograde porphyroblasts of amphibole, are common in the greenschist. Relict phenocrysts of plagioclase are common also.

Barker (1958 p. 19) located the facies boundary between the greenschists and amphibolites as trending southeast from just west of Tusas Mountain. Hornblende-oligoclase and hornblende-oligoclase-epidote amphibolites are common and relict phenocrysts of epidotized and fractured andesine may be present in amounts comprising up to 15 percent of the rock.

The thin units of metasedimentary rocks included in this series are not extensive enough to map as members.

Kiawa Mountain Formation

Barker (1958, p. 24) distinguished five members in the Kiawa Mountain formation: the Big Rock conglomerate, the Jawbone conglomerate, an amphibolite member, and two quartzite members. This formation occurs in the belt from Quartzite Peak and Kiawa Mountain to the Brazos, Chavez, and Canones boxes. The rock types are very similar to those already described.

The Big Rock conglomerate, exposed in the central Las Tablas quadrangle, overlies the Ortega quartzite, and is the basal member of the Kiawa Mountain quartzite. It contains less feldspathic quartzite in its eastern portion. The well-rounded pebbles are now deformed and elongate and define a prominent down-dip lineation.

The Jawbone conglomerate, exposed on Jawbone Mountain north of Hopewell, lies between the Moppin metavolcanic series and the upper member of the Kiawa Mountain quartzite. It resembles the quartz-pebble beds in the Ortega and Kiawa Mountain quartzites in being mostly quartz-pebble conglomerate. The quartz pebbles are light-gray, red, and black in color.

The amphibolite member separates the two quartzite members in the central part of the Las Tablas quadrangle.

*Publication authorized by Director, New Mexico Bureau of Mines and Mineral Resources, Socorro.

The amphibolites are composed of chlorite, epidote, oligoclase, hornblende, magnetite-ilmenite and minor amounts of quartz, biotite, saussurite, apatite, and leucoxene.

The lower quartzite member lies between the Big Rock conglomerate member and the amphibolite member. West of Kiawa Lake it is light gray, commonly vitreous, and massive. East of Kiawa Lake it is muscovitic.

The upper quartzite member lies on the amphibolite member and crops out from the central Las Tablas quadrangle northwestward to the east central margin of the Chama quadrangle in the Canones Box. It is well exposed on Kiawa Mountain, Quartzite Peak, and in the Brazos, Chavez, and Canones Boxes. The Jawbone conglomerate appears to be a local basal member of the main upper quartzite which is typically a dense, vitreous, light bluish-gray quartzite that contains irregularly distributed pebbly layers with frequent crossbedded units. Barker (1958, p. 31) points out that this member and the Ortega quartzite exposed west of the Rio Vallecitos, are essentially indistinguishable in outcrop.

Nearly 5,000 feet of this crossbedded quartzite is exposed in a continuous unit in the Canones Box before an interlaminated amphibolite is reached. Probably another 5,000 feet or more is present below the amphibolite layer. Barker estimates there to be from 5,000 to 10,000 feet of the upper quartzite member in the Las Tablas quadrangle. The northwest plunge of folds into the Brazos Peak and Chama quadrangles suggests the possibility that the Canones Box section lies above the beds recognized by Barker in the Las Tablas quadrangle.

Such incredible thicknesses of clean quartz sand do not fit into our schemes of sedimentary tectonics. They are generally recognized as being thin and widespread. Barker (1958, p. 33) suggests that "the Precambrian strata . . . could be reconciled with these tectonic schemes by changing the definition of eugeosyncline to a thick basin filling of either graywacke or quartzose sandstone with intercalated igneous rocks, or by changing the definition of a miogeocline to include igneous rocks."

Petaca Schist

Typical Petaca schist is a muscovitized variant of parts of the rock sequences already described and includes layers of Burned Mountain metarhyolite. This unit underlies much of La Jarita Mesa and is the host rock of most of the pegmatites of the Petaca district. It is commonly a light-gray, schistose, slabby to massive, muscovite quartzite. In addition layers of muscovitized conglomerate, amphibolite, and metarhyolite can be recognized where the alteration has not been too intense.

INTRUSIVE IGNEOUS ROCKS

Burned Mountain Metarhyolite

The Burned Mountain metarhyolite (Vallecitos metarhyolite of Just, 1937, p. 44) is exposed as tabular bodies throughout the Tusas Mountains. It is brick red to light pink in color, and contains relict quartz and microcline phenocrysts and, rarely, albite-oligoclase, in a granular mosaic matrix of quartz, microcline, albite-oligoclase, with minor muscovite, magnetite, and apatite. Relict flow banding, commonly drag-folded, is clearly visible in most outcrops.

The layers are almost always concordant with the surrounding strata. Just believed they were flows; Barker believed they were sills and dikes, and possibly in small part, flows. In the Ojo Caliente district, a breccia of amphibolite fragments in a matrix of metarhyolite suggests

that this mass, at least, is intrusive. Elsewhere on Cerro Colorado (Ojo Caliente Mountain) giant inclusions of Ortega quartzite can be found in the main mass of metarhyolite.

Maquinita Granodiorite

The Maquinita granodiorite is gray, homogeneous, well foliated, and strongly lineated. Biotite knots outline both the foliation and lineation. The granodiorite is composed of moderately altered albite-oligoclase, orthoclase and microcline, quartz, biotite, epidote, and accessory magnetite-ilmenite, apatite, and calcite.

The rock is slightly to intensely sheared, feldspars have been sericitized and slightly saussuritized. Barker (1958, p. 59) interprets the shearing to be the result of intrusion during orogeny.

The Maquinita granodiorite is found as small plutons north from Tusas Mountain to the Lagunitas Lakes region.

Tres Piedras Granite

Barker (1958, p. 59) recognizes two types of Tres Piedras granite. The more extensive type, well exposed at Tres Piedras and along Tusas Canyon, "is a pink, flesh-colored, or reddish-orange, faintly to well-foliated, fine-to medium-grained, quartz-microcline-albite-biotite-muscovite granite". The Tusas Mountain pluton differs in being finer grained and markedly porphyritic. The phenocrysts are of microcline and quartz. The quartz occurs in ovoid to crudely bipyramidal shapes. The phenocrysts may form as much as one-half the rock.

Porphyritic Tres Piedras granite is exposed over a large area south of Lagunitas Lakes. Much of Cerro Colorado (Ojo Caliente Mountain) is composed of a porphyritic rock that resembles the porphyritic phase of the Tres Piedras granite, although here it was mapped as a porphyritic inner phase of the metarhyolite intrusive core of the district.

Non-porphyritic Tres Piedras granite is also found as the principal Precambrian rock exposed north of Lagunitas Lakes as well as in the Las Tablas quadrangle.

Barker (1958, p. 61) demonstrated the similarity in composition of the Tres Piedras granite and the Burned Mountain metarhyolite. His sequence of intrusions has the metarhyolite as pre-orogenic, the Maquinita granodiorite as syn-orogenic, and the Tres Piedras granite as post-orogenic. He points out that it is difficult to visualize a magma chamber surviving unchanged through an orogeny and that it may be that fusion of similar rocks low in the crust at different times produced the similar magmas.

Pegmatites

The granitic pegmatites of the Petaca and Ojo Caliente districts have been described in detail by Jahns (1946). The bodies are dikes, sills, and pods ranging in outcrop length from 75 to 1430 feet (figures only for pegmatites that have been mined for mica).

"The pegmatites on La Jarita Mesa commonly are zoned as follows: border zone of fine-to medium-grained microcline and quartz with a little mica; wall zone of coarse microcline and quartz with minor mica, garnet, fluorite, and beryl; intermediate zones (rarely complete) of variable composition, such as coarse blocky microcline, coarse graphic granite, or massive quartz with disseminated microcline; cores, commonly of massive quartz, plus or minus scattered microcline. These zones vary widely in degree of development in the various pegmatites. Fracture fillings, generally of quartz with or without albite, samarskite, fine-grained mica, sulfides, and bismuth minerals,

are present in many of the pegmatites. Replacement bodies, controlled largely by fractures in preexisting pegmatite and consisting chiefly of albite and muscovite, occur in most of the bodies as veinlets or other secondary masses" (Barker, 1958, p. 63).

STRUCTURE

The Precambrian layered rocks have been folded into several major folds. The traces of these folds are shown on figure 1 of the structure paper by Muehlberger in this guidebook. The folds in places are isoclinal and overturned with the axial planes dipping steeply southwest. Folds of similar magnitude probably exist in the Lagunitas Lakes region but the extensive cover of Tertiary rocks precludes their accurate delineation. Minor folds are abundant and range in size from a fraction of an inch to several thousand feet across.

The shapes of the smaller folds can be seen to change from round-crested to sharp-crested chevron folds. Flattening of pebbles down the dip of the axial planes of the folds give an indication of the increase in height of the fold by solid flowage and the flattening normal to the axial planes.

The faulting appears to be the result of post-Precambrian deformations because the Precambrian deformations are dominated by folding and flowage rather than fracture.

A broad view of the structural picture is of major northwest-plunging folds. The trough of one major syncline includes the Ortega Mountains and the Ojo Caliente region (probably the reason for the west trends of structures there); the next syncline north, the Kiawa syncline, includes Quartzite Peak, Kiawa Mountain and La Jarita Mesa. Along the east flank of this syncline both the lower

quartzite and amphibolite members of the Kiawa Mountain formation wedge out northward. South and southwest from the southern end, the underlying Moppin meta-volcanic series thins, possibly by facies changes, into the Ortega quartzite. If the cover of Tertiary rocks were not so extensive, it might be possible to demonstrate lateral facies changes from nearly pure quartzite in the western belt (Ortega quartzite) eastward into the mixed meta-volcanics and quartzite and quartzite of the eastern belt. The eastern belt appears to be eugeosynclinal in nature and has been extensively intruded in contrast to the relatively simply folded miogeosynclinal-nature of the western belt. The northern syncline through Jawbone Mountain may actually join with the syncline in the upper Canones Box just west of Brazos Peak (see fig. 1, structure article by Muehlberger, this guidebook) under the cover of the Tertiary rocks. This syncline is, thus far, recognizable only in the upper quartzite units; the underlying rocks to the southeast are buried by Tertiary rocks.

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