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PRECAMBRIAN ROCKS OF THE ZUNI MOUNTAINS

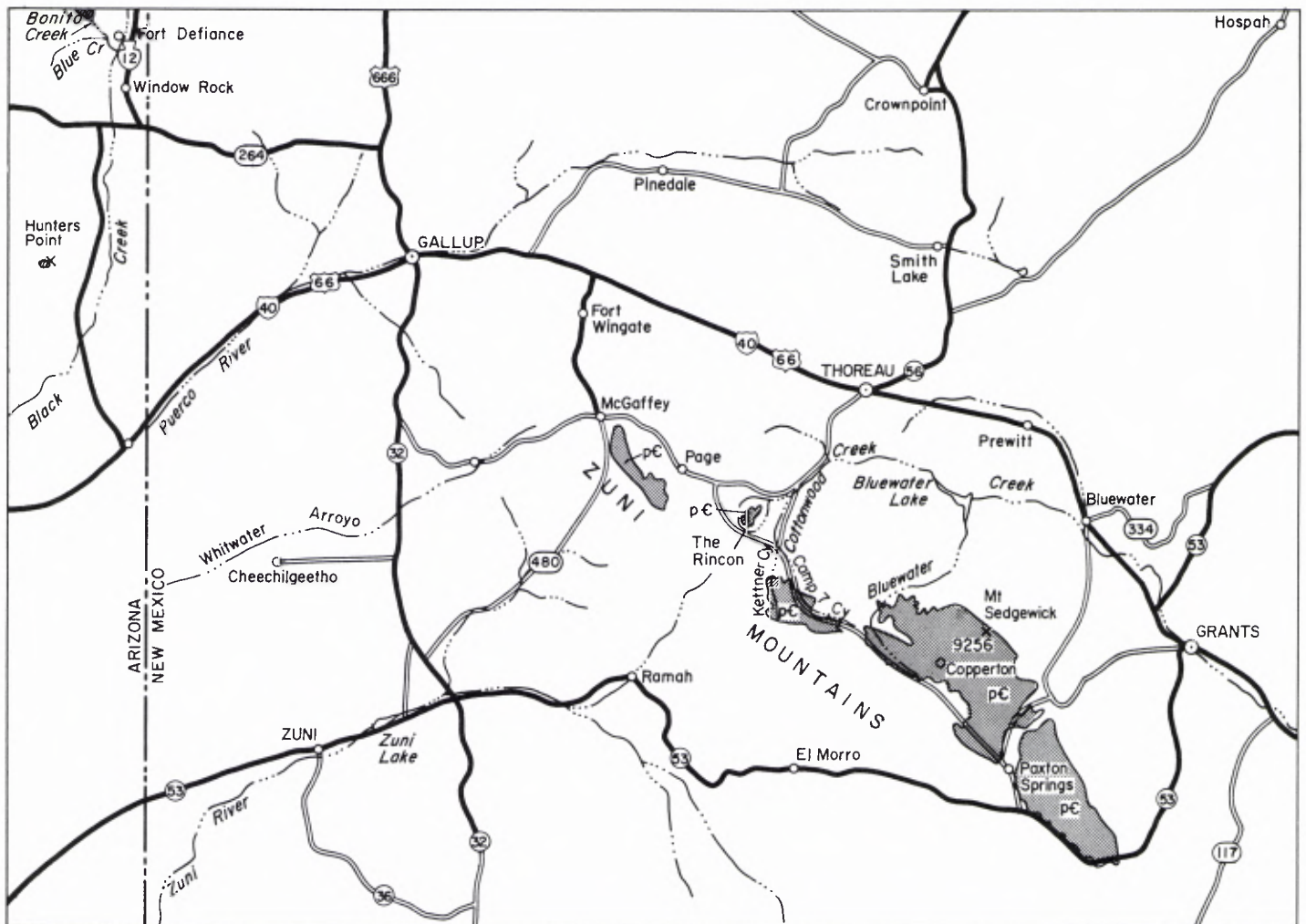
By

J. PAUL FITZSIMMONS

The University of New Mexico, Albuquerque, New Mexico

Rocks of presumed, but almost certain, Precambrian age are extensively exposed along the crestal zone of the Zuni Mountains. These exposures are found in four separate areas: the largest forms the main southeastern part of the range—a zone almost 30 miles long ranging in width from 4 to 7.9 miles—and includes the highest peak of the range, Mt. Sedgwick; two areas of exposed Precambrian rocks lie along Cottonwood Creek, the larger, about 3 x 5 miles occurring chiefly between Kettner and Camp Seven Canyons, at the headwaters of Cottonwood Creek, the other, covering less than a square mile, being about 5 miles covering less than a square mile, being about 5 miles downcreek, along the east side; and the fourth area, an elongated crest, 7 x 1 miles, extends southeastward from McGaffey (See index map).

The Precambrian rocks exposed in the large area to the southeast have been mapped recently in detail by E. N. Goddard (1966) in connection with studies of fluor spar that occurs in fracture zones of the Precambrian. The map has been published as Map I-454 by the U. S. Geological Survey. Goddard has subdivided the Precambrian of the eastern area into 17 units, many very minor, some not previously reported in the literature, including a brown quartzite that occurs in small lenses and pods. Most of the others appear to be textural or compositional variations of the rocks already discussed. The unit Goddard has called gneissic aplite corresponds to the dominant rock type observed in the northwestern areas through which the 18th Field Conference will pass. This paper is concerned only



Index map including areas of outcrop of Precambrian Rocks (pC) in the Zuni Mountains, New Mexico.

with the Precambrian rocks exposed in the two smaller areas to the northwest.

The rocks are mainly granitic and dominantly red or reddish, but numerous variations may be observed. Some varieties are barely pinkish or are gray, but these are very minor. A characteristic feature is the paucity of dark minerals. Biotite is by far the most common mafic constituent, but it is seldom present in amounts greater than 4-5 percent, more commonly only 2-3 percent, and in some specimens it is difficult to find any at all. The biotite that is present commonly is more or less chloritized. The feldspar is chiefly microcline perthite, is generally red, and is moderately sericitized and kaolinized. Oligoclase, the common plagioclase, is usually present in amounts of 5 to 15 percent and generally is more strongly altered than the potash feldspar, though some very fresh grains may be present. Quartz is present in elongated, stretched, shattered grains and aggregates, exhibiting marked undulose extinction under the microscope.

Almost all rock specimens from the western exposures show severe strain and shattering. They also exhibit a kind of subtle gneissic structure. A few schistose and other foliated rocks obviously occur, but in many places one may observe jointing in great and closely spaced profusion, perhaps representing zones of distributive faulting of almost insignificant displacement along any single surface, possibly resulting from the upward movements that have repeatedly affected these rocks and are responsible for the present eminence of the Zuni crest.

Microscopic examination of these "gneissic" granites gives one the impression of mechanical shearing with only minor rehealing, and he can but wonder if the processes that have produced the rock as we see it are entirely Precambrian or if they may not be in part, perhaps in great part, subsequent processes, spread over much of later geologic time.

But this is speculation. What is readily evident from the detailed, and even casual, examination of outcrops is that massive granite is more abundant in the eastern part of the range, from the Mt. Sedgwick and Copperton areas eastward and southeastward. It is coarse- to medium-grained, consists of microcline, microcline micropertite, saussuritized plagioclase, brown biotite, very minor apatite and sphene, and, locally in appreciable quantities, black tourmaline.

To the west and north of the Mt. Sedgwick and Copperton areas, granite porphyry becomes the dominant rock. This is Lindgren's term. By subsequent workers the rock has been called quartz porphyry or, more commonly in recent years, metarhyolite. Lindgren noted two phases, one that appeared to be mainly pyroclastic, the other principally a porphyritic flow rock, consisting of quartz and orthoclase or perthite phenocrysts surrounded by a microcrystalline aggregate of quartz and potassium feldspar exhibiting flow lines. The phenocrysts are generally corroded, and scattered flakes of brown biotite, partially altered to green chlorite are sparsely present. This rock, too, is generally reddish in outward appearance.

The dominant rock in the western part of the mountains, in all three of the smaller outcrop areas of Precambrian rocks, is gneissic granite, the type described briefly above. In many of the exposed masses, the color is a deeper red than found in the other types farther east, though paler varieties are present. The composition is similar, but tourmaline is not found, or only rarely, and the amount of biotite is less, rarely over 2-3 percent.

The preceding statements indicate dominant types. No type is confined strictly to the areas outlined, nor are these the only types of rocks found.

In the westernmost area, the outcrop zone 1 to 6 miles southeast of McGaffey, the rock is mainly reddish gneissic granite, but local zones of "metarhyolite" and irregular veins and masses of bull quartz are present, increasing somewhat in abundance southeastward. A specimen of "metarhyolite" collected about a mile from the northwestern end of this area contains angular "phenocrysts" of quartz and occasional large angular plagioclase individuals in a fine aggregate of felsic material and numerous microcrystalline equant grains of a mineral of high relief, apparently epidote.

In the northern outcrop area along Cottonwood Creek, reddish, gneissic, leucocratic granite is again the dominant rock type, but a number of other varieties are readily observed. The Precambrian mass forms the main backbone of the hill called "The Rincon" on the topographic map of the Cottonwood Canyon Quadrangle. Part way up this hill from the northern edge of the Precambrian outcrop, in the canyon on the western edge of the hill, one may find good exposures of the dark red gneissic granite, but he may also find zones of dark green, almost black schistose rock. It is mainly chlorite schist, the amount of chlorite ranging from 10-15 percent in some specimens to 75-80 percent in others. The chlorite is green, strongly pleochroic in thin section, and characterized by anomalous interference colors, mostly bronze-brown to pale lavender. The other constituents are chiefly quartz, oligoclase-andesine in varieties with smaller amounts of chlorite, lesser amounts of microcline, and occasional magnetite.

The shearing that produced the foliation in the schist is manifest in stretching of the grains and shattering of the quartz. Some of these schist varieties contain up to 10 percent hornblende, aligned in the shearing planes. It is pleochroic from pale green-blue to brown. Apatite is sparsely present.

At the top of The Rincon, a pale pinkish gneiss, with finer lines of foliation, may be seen in a few small and isolated outcrops. It consists chiefly of plagioclase (apparently oligoclase), with minor quartz (15-20 percent), very minor microcline (about 5 percent), and patchy aggregates of muscovite (perhaps 1-2 percent). Veins of white bull quartz are also found in several places on this hill. Pebbles and small cobbles of this white quartz, some hardly more rounded than subangular, are common constituents of an arkosic conglomerate that overlies the Precambrian crystalline rocks.

On the basis of thin, meagerly fossiliferous limestone

locally interbedded with this arkosic conglomerate farther west (Smith, 1959), the conglomerate has been assigned to the Pennsylvanian. The upper surface of The Rincon is strewn with white pebbles that appear to have weathered out of the conglomerate, and, intermingled with them, in greater numbers, are pebbles and cobbles of purple quartzite, many of them very well rounded. This quartzite is surely Precambrian, but its source is not now known. Outcrops of such quartzite in place have not been reported in the Zuni Mountains.

Other rock types, including amphibolite, gabbro, quartz-sericite schist, and diorite have been reported from the Precambrian terrane of the Zuni Mountains, chiefly in the large easternmost zone of exposures, but they occur in very minor amounts.

The trend of foliation in the foliated rocks is highly variable. It is also, in places, very subtle and, hence, difficult to measure. A direction somewhat north of west may be measured in many places, the dip being steep to the south. A direction that trends nearly north also may be observed, with westward dips of about 60°. Lindgren (1910) considered this latter trend to be the older. However, it appears difficult to find consistent trends that may be assigned to any particular episode of strain or dislocation.

The Precambrian rocks do not differ appreciably among themselves in resistance to erosion, and they are not particularly more resistant than the overlying sedimentary strata, except for local shales and weakly cemented sandstones. What prominence the Precambrian rocks have they owe more to tectonic factors than to erosional stability.

Precambrian rocks are exposed also in few places along the Defiance uplift. A gray to purple quartzite, apparently

a metaconglomerate, with scattered mica flakes, may be found in a small canyon tributary (Blue Canyon) to Bonito Creek west of Fort Defiance. Farther south, at Hunters Point, pink, coarse-grained granite is exposed along the walls of a canyon (first canyon south of Hunters Point). About two miles south of Hunters Point, low-grade metamorphic rocks appear on the north side of a canyon, and practically unmetamorphosed rocks appear on the south side. The rocks on the north side of the canyon include schist, slightly silicified limestone, slate (or phyllite), and greenstone; on the south side occur green sandstone, blue, red and green shale, tuff, and a thin bed of silicified limestone. The exact status of the rocks in this canyon is unknown.

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