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TERTIARY AND LATER IGNEOUS ROCKS OF THE SAN JUAN BASIN

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Published work on the San Juan Basin indicates that the central part of the Basin is nearly free of bodies of igneous rock. However, the outer margin is ringed by scattered igneous masses. Most of these masses are erosional remnants and many are landmarks that have a prominence out ofproportion to their areal extent. The exact age of almost all of the igneous rock bodies is unknown. The accumulation of great piles of volcanics in the San Juan Mountains that extend beyond the margin of the Basin from the vicinity of Durango, Colorado to that of Chama, New Mexico, is believed to have begun in Oligocene time and to have extended well into Pliocene time. The central part of Mount Taylor may be as old as late Miocene but most of the associated volcanics are probably much younger. Large parts of the Jemez volcanic sequence east of the Basin are probably of Pleistocene age. Many of the volcanic necks and associated flows on the west side of the Basin are probably of Pliocene age. The valley flows along U. S. Highway 66 are probably of late Pleistocene age and the McCartys flow may be less than 1,200 years old. Evidence of volcanic activity earlier than the mid-Tertiary, has been found at the north side of the Basin. Those who took the field trip of the Society in 1950 will remember the andesitic volcanic debris in the sedimentary Animas and McDermott formations of uppermost Cretaceous and possibly Paleocene age.

Aside from the San Juan and Jemez volcanics, which are considered as being outside the Basin, the flow rocks and volcanic necks are dominantly of basaltic or basaltic-andesite composition and appearance. Those at the west side of the Basin are abnormal in having the low silica content of basaltic rocks but a high content of potash which is suggested mineralogically in their content of biotite and, in some localities, of leucite. These rocks are therefore classified as trachybasalt and minette. Rhyolite, trachyte, latite, and andesite occur in the core of Mount Taylor and make up the greater proportion of the rocks of the Jemez and San Juan Mountains. The larger intrusive bodies are of dioritic or monzonitic composition.

As summarized by Cross and Larsen (1935, pp. 50-54) the volcanic sequence of the San Juan Mountains began with Lake Fork andesite of probably early Miocene age. Any earlier volcanic center that supplied debris to the Animas and McDermott formations was destroyed by erosion during early Tertiary time. The andesite was followed by the latitic San Juan tuff and by a host of rhyolitic, latitic and andesitic flows and tuff-breccias. These eruptions were followed by an erosion interval which produced the San Juan peneplain. Volcanism later than the peneplain supplied thin accumulations of rhyolite and tuff and was followed in the Rio Grande drainage area by basaltic eruptions which yielded rocks grouped as the Hinsdale formation of Pliocene age. Some intrusive rocks in the Ouray region are earlier than the erosion-surface at the base of the volcanic succession. Later, granular intrusive rocks are almost wholly restricted to the lower part of the volcanic sequence. Recent work in the San Juan region has indicated that the beginning of volcanic accumulation may well have been in Oligocene time.

The LaPlata Mountains northwest of Durango, Colorado, contain a variety of porphyritic rocks intermediate between diorite and monzonite, and even-granular syenite, monzonite, and diorite intruded into sedimentary rocks as young as the Mancos shale. No extrusive rocks occur in this area. Eckel, (1949, p. 32) , states that these intrusive rocks may be late Cretaceous or early Tertiary. An early mid-Tertiary age is suggested by analogy with other eruptive areas in New Mexico and Colorado.

Ute Mountain southwest of Cortez, Colorado, is a steep-sided mass which rises 3,000 feet above the surrounding surface. It is briefly described by (Coffin 1921, p. 121) as a stock and the rock was interpreted for Coffin as an andesite porphyry.

The many small bodies of igneous rock that occur along the western side of the Basin between the Four Corners and Gallup have been studied by Howel Williams (1936, pp. 111-172). Aside from the diorite porphyry laccolith of Carrizo Mountain, the rocks are alkaline and are characterized by a high content of potash even though the content of silica is low. Though identical mineralogically, the flow rocks are called trachybasalt, and the dike rocks are called minette, which is a basaltic-appearing rock with abundant biotite

flakes. Most of the volcanic necks contain large amounts of fragments of pre-Cambrian basement rocks and some consist largely of sedimentary rock debris. From data in the Hopi Buttes area in Arizona, it is judged that the age of most if not all of these igneous bodies is Pliocene. Notes on the various bodies taken from Williams' account follow.

The Carrizo laccolith which covers an area of 100 square miles is the only large intrusive body in the group on the west side of the Basin. It consists entirely of diorite porphyry in which there are large phenocrysts of hornblende and andesine and smaller quartz and biotite in a microgranular intergrowth of quartz and orthoclase.

The dikes and necks in the Redrock Valley area, including Mitten Rock and Thumb Rock, are composed mainly of minette lava rather than breccia, though some such as Thumb Rock contain many foreign inclusions.

Igneous bodies in the Chuska Mountains are both necks and remnants of flows. Black Pinnacle is a neck of minette. Sandstone in contact with it was changed to quartzite or to buchite, a silica glass formed by melting of the sandstone. Tubby Butte is a neck composed of tuff-breccia containing large blocks of sandstone and shale. It is cut by a dike of platy minette. Lava caps occur on Palisades and Sonsela Buttes. In Washington Pass flows are either coarse-grained with large crystals of olivine, augite, biotite, and sanidine or fine-grained with sporadically distributed phenocrysts. Flows of trachybasalt also occur in the Lukachukai Mountains.

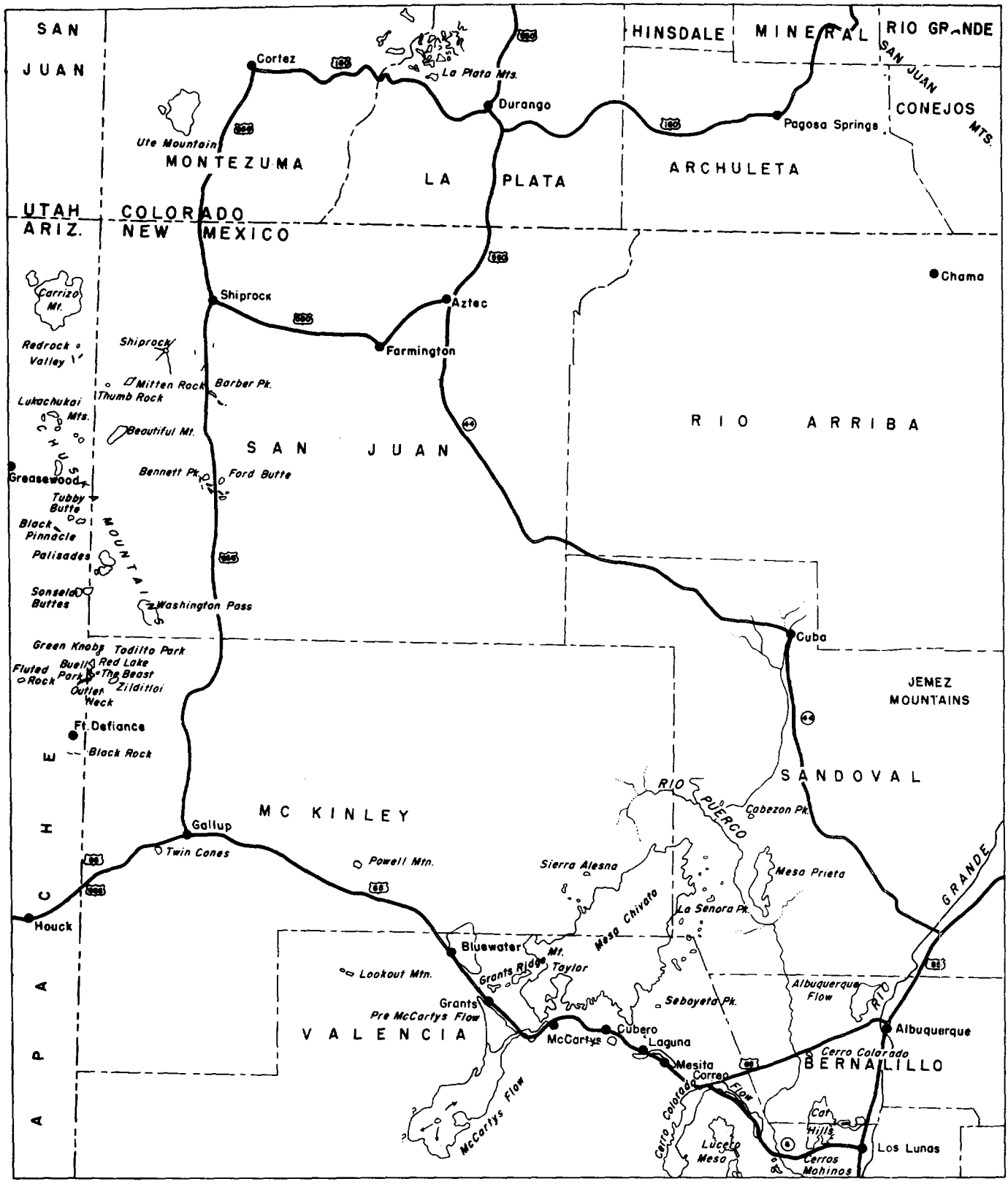
Of the several igneous structures near Ft. Defiance, the most interesting is Buell Park. This circular depression in sandstone is regarded by Williams as having been formed by cauldron subsidence. A cylindrical block about $2\frac{1}{2}$ miles in diameter dropped at least 1,000 feet, probably after the eruptions of lava and green lapilli tuffs. Outlet neck and The Beast are necks differing somewhat in internal structure. Outlet neck has a core of blocky minette surrounded by a sheath of breccia of the enclosing sedimentary rocks. Some of the sedimentary material is vitrified. The Beast is mainly tuff-breccia with dikes that show transition from minette to monchiquite. The Green Knobs are remnants of a neck which is made up of a minette that weathers readily and contains an abundance of rock fragments from the pre-Cambrian basement. This and other igneous masses are the source of the pyrope garnets and the olivine or peridot crystals that are found in this region. Zilditloi Mountain has a lava cap 250 feet thick composed of trachybasalt. Fluted Rock is a small laccolith of minette.

The volcanic necks in the Chuska Valley along the highway between Gallup and Shiprock are perhaps the most striking of all. Shiprock, which rises over 1,400 feet above its base, is composed of tuff-breccia traversed by a few dikes of minette. The crude bedding of the tuff-breccia and its dip toward the center suggest that there were probably no lava flows from this neck. The radiating en echelon dikes of minette are also a source of great interest. Bennett Peak and Ford Buttes are made up of fragments of sedimentary rocks rarely more than an inch in diameter and cut by a few small dikes of minette.

The Twin Cones near Gallup consist of 90 percent of comminuted Cretaceous sandstone and only a small fraction of admixed minette. A few large blocks of alaskite and Jurassic sandstone as well as other sedimentary rocks occur in these necks.

Remnants of basaltic flows occur at Powell Mountain and Lookout Mountain on either side of U. S. Highway 66 between Gallup and Grants.

On the south side of the Basin the most prominent feature is the Mount Taylor volcanic field, ably described by C. B. Hunt (1938, pp. 51-80). Mount Taylor is a low cone set on a platform, the Mesa Chivato, which is surrounded by steep slopes leading down to the valley of the Rio Puerco and to that of the Rio San Jose whose course is followed by U. S. Highway 66. The platform is an old erosion surface cut on Cretaceous rocks, which reach upward to a point about 2,000 feet below the crest of the mountain. Volcanic necks occur on all sides of the Mount Taylor area but are especially numerous in the valley of the Rio Puerco. Hunt shows that the central core of Mount Taylor consists of rhyolite tuff, rhyolite, trachyte, and latite. The rhyolitic vitric tuff is the earliest and most widespread of the eruptive materials. Hunt regards this material as of probable late Miocene age. The silicic group of rocks was almost covered by porphyritic andesite as possibly the latest phase of the Mount Taylor eruptive sequence. In the southeastern margin of the mountain, pumiceous tuff containing fragments of sand-



TERTIARY AND LATER IGNEOUS ROCKS OF THE SAN JUAN BASIN AREA

SCALE

10 0 10 20 30 40 50 Miles

stone rests on thin flows of basaltic rock and is overlain by water-laid material which is succeeded by the porphyritic andesite. The remainder of the platform is covered by basalt flows that had many local sources. Where erosion has destroyed the platform and removed the flows the numerous vents or volcanic necks stand out in relief above the dissected sedimentary rocks. Erosion has cut as much as 2,000 feet below the level of the basalt flows which Hunt regards as of probably Pliocene age.

Since Hunt's work was published the mine of the Pumice Corporation of America was opened in the pumiceous tuff near the east end of Grants Ridge. A geologic section of one of the basaltic volcanoes is well exposed at the mine. Just east of the mine the pumiceous tuff gives way to rhyolite and to masses of perlite or volcanic glass that are intimately associated with the rhyolite on the north side of the ridge. Cursory examination suggests that the rhyolite and perlite represent one or more dome eruptions at this site and are not connected with the Mount Taylor center. Exploratory work has been done on the perlite with a view to commercial utilization.

Many of the basaltic necks in the Mount Taylor region are composed of columnar masses of basalt but others are composed of basaltic breccia whose bedding tends to dip inward toward the center in a manner similar to that of the tuff breccias of the necks in the western part of the Basin. An example is the neck near Cubero. The most impressive of the volcanic necks is Cabezon Peak which rises 2,000 feet above the Rio Puerco. The exposed basaltic core is 800 feet high and 1,500 feet in diameter.

Basaltic rocks occur at several erosional levels in the area to the south of the Mount Taylor region. Basalts at three levels are distinguished in the Lucero uplift (Kelley and Wood, 1946). One caps the highest part of the Mesa Lucero. Another occurs at a lower level as the prominent cap on the Mesa Redonda near Highway 6, four miles southwest of Correo, and the third the Cerro Colorado flow which came from the south into the valley of the Rio San Jose at Correo and followed the valley for 12 miles southeastward. This latest flow is considerably eroded and is well above the present stream level below Correo. In the Rio Grande trough region outside the San Juan Basin the Santa Fe formation contains basaltic flows (Wright, 1946, pp. 412-413) and there are basalt flows and scoria overlying both the Santa Fe and later terrace sands and gravels as in the Albuquerque area.

Of particular interest to the traveler along U. S. Highway 66 between Mesita and Bluewater are the basaltic valley flows. The flow at Bluewater extends from a local source north of the highway to the carrot fields northwest of Grants. Another flow floors the valley south of the railroad at Grants from the overpass west of Grants eastward toward McCartys. This flow had its source many miles to the south in what is almost a shield area of basaltic flows. A more recent basaltic flow called the McCartys by Nichols (1946, pp. 1049-1086) is superimposed over the older flow. The McCartys flow covers a large area to the south but approaches the San Jose Valley in a very thin stream and reaches as far as McCartys. Nichols regards this flow as probably less than 1,200 years old. All the features of flows of this type, such as spatter, cones, ropy surface, pressure ridges, and tree trunk molds, are very well shown. An older flow is exposed almost continuously from the vicinity of Laguna to that of Mesita.

The Jemez Mountains in Sandoval and Rio Arriba counties east and southeast of Cuba are east of the Nacimiento uplift and are thus not in the Basin. The entire Jemez mass is being carefully mapped by C. S. Ross and Robert Smith, of the U. S. Geological Survey. Suffice to say that the Jemez area has been a volcanic center for a considerable period. Most of the features of the mountains are of post-Pliocene age. The most prominent feature is the great caldera of the Valle Grande which has been in part filled by rhyolitic domes. Visitors to Los Alamos and Frijoles Canyon in Bandelier National Monument are familiar with the great cliffs of tan colored welded tuff which issued as a kind of flow through breaks in the wall of the caldera. The Jemez region is doubtless the best example of the various facies of the rhyolitic eruptive process in the United States and the report of Ross and Smith is eagerly awaited.

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