GEOLOGIC MAP 22

Geology of Brazos Peak Quadrangle, New Mexico

by WILLIAM R. MUEHLBERGER

1968

STATE BUREAU OF MINES AND MINERAL RESOURCES
NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY
CAMPUS STATION SOCORRO, NEW MEXICO

NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY
Stirling A. Colgate, President

STATE BUREAU OF MINES AND MINERAL RESOURCES
Frank E. Kottlowski, Acting Director

For sale by the New Mexico Bureau of Mines and Mineral Resources
Campus Station, Socorro, N. Mex.--Price $1.00

Brazos Peak Quadrangle

The highest part of the Tusas Mountains, the extension of the San Juan Mountains into New Mexico, lies along the ridge including Brazos Peak and Grouse Mesa. From this ridge, the range slopes gently eastward to the Rio Grande on the Taos Plateau and drops sharply nearly 3000 feet westward into the San Juan Basin. A part of this abrupt front is in the southwest corner of the quadrangle. Except for the deep canyons of the Rio Brazos and the Rio de los Pinos, the remainder of the area is above 9500 feet, with broad, gently east-sloping mesas above 10,000 feet.

The Paleozoic and Mesozoic rock units exposed along the western margin of the quadrangle (pl. 1) have been described in detail in the report on the Chama quadrangle (Muehlberger, 1967). The rock descriptions for the northeast quarter are abstracted from Trice (1957).

PRECAMBRIAN ROCKS

The stratigraphic sequence within the Precambrian units is not known with any degree of assurance because of faulting and extensive cover. There are four major rock unit areas in the Precambrian of the Brazos Peak quadrangle: quartzite in the southwest, schist in the center, gneiss and schist in the northeast, and two types of granitic rocks, quartz-eye granite in the southeast and granite of two distinct intrusive phases in the northeast. They are discussed in their probable sequence of formation.

Quartz-feldspar-biotite gneiss crops out in the northeast quarter. Medium- to coarse-grained, in shades of gray or pinkish gray, depending on the quantity of biotite present, it is foliated and banded. Microcline (60 to 70 per cent), quartz (20 to 30 per cent), biotite (5 per cent), and oligoclase (3 per cent) are the main constituents, with muscovite, hornblende, augite, apatite, sphene, and magnetite comprising the remainder. It grades into quartz-biotite schist with an average mineral composition of 40 to 50 per cent microcline, 25 to 30 per cent quartz, 15 to 20 per cent biotite, 5 per cent andesine, and 2 per cent muscovite, with accessories of garnet, sphene, apatite, augite, and magnetite. Amphibolite (70 to 88 per cent hornblende, 10 to 15 per cent andesine, 1 to 5 per cent quartz, 1 to 3 per cent augite, and 2 per cent microcline with accessory minerals biotite, sphene, apatite, and zircon) and migmatite are locally important in the gneiss areas.

In contrast to the above, the main schist outcrops (the upper Brazos Box and Poso Park) contain very little gneiss. Fine-grained chlorite and hornblende schist are the dominant rock types; biotite and muscovite- biotite schist interlayered with quartzite and pebbly quartzite layers occur in lesser amounts. Greenschists with prophyroblasts of ankerite, hornblende, or pyrite are common in the Brazos Box. In upper Chaves Canyon, they are interbedded with pebbly quartzite. This schist sequence may be equivalent to Barker's (1958) Moppin metavolcanic series.

The white to pale-purplish quartzite sequence appears to be stratigraphically above the schist sequence. It is nearly pure quartz sand and pebbly sand with cross-bedding in sets 3 inches to 2 feet wide. Hematite outlines bedding and secondary cleavage. Total thickness is unknown, but if the lower Canones Box is unfaulted as shown, then at least 5000 feet are present. These microcline and quartz constitute the bulk of the rock, with oligolclase, biotite, Kiawa Mountain Formation (Barker). Gray to tan metasilstone occurs in the Canones Box in graded beds, which give tops consistent with the quartzite cross-bedding.

Metarhyolite crops out in one small locality near the center of the quadrangle, as thin bands in quartzite in Chaves Canyon, and in the schists of the upper Brazos Box. It is typical of that found in the southern Tusas Mountains (Just, 1937; Barker; Bingler, 1965) in being brick red, with relict quartz and microcline phenocrysts and with flow banding still visible.

Medium-grained granite and related pegmatite dikes intrude the gneisses and associated schists in the northeastern area. Pinkish microcline and quartz consitiute the bulk of the rock, with oligoclase, biotite, and muscovite in lesser amounts. A biotite-rich phase intruded a biotite-poor phase prior to complete consolidation of the earlier biotite-rich phase.

Quartz-eye granite, medium-grained and gray to light tan in color, crops out over a large area in the southeast quadrant. It is similar in composition to that just described except for ovoid polycrystalline "eyes" of quartz, 0.5 to 1 inch in diameter, that show sweep extinction and that are present both in the granite and in mafic inclusions. The outcrop area along the Rio Brazos shows biotite lineation down the dip of foliation. Both the granites described might be variants of the Tres Piedras Granite (Barker, p. 59-62).

CENOZOIC ROCKS

Larsen and Cross (1956) described the Tertiary units of the San Juan Mountains and set up the stratigraphy used herein. Butler (1946) made an extensive study of the Tertiary volcanic and structural history of the Tusas Mountains that includes the northeast quadrant of this quadrangle, an area studied in greater detail by Trice. Adams (1957) studied a strip along the northwest quadrant.

El Rito Formation, a well-cemented conglomerate composed of rounded clasts of Precambrian quartzite in a red-colored matrix of quartz sand and silt, occurs in patches and strips along the southwestern edge of the quadrangle. North of the Canones Box, it interfingers with the Blanco Basin Formation. Typical Blanco Basin Formation, exposed in the northwestern corner of the quadrangle, is a well-cemented red siltstone, coarse-grained arkose, and conglomerate composed of clasts and mineral grains derived from a granitic and metamorphic source. El Rito Formation is typically less than 100 feet thick, whereas the Blanco Basin is 250 to 350 feet thick. Both are alluvial fan deposits and are coarse upslope facies of the Eocene Wasatch Formation exposed to the west in the eastern San Juan Basin (Muehlberger). The Blanco Basin Formation underlies the lower member of the Conejos Quartz Latite. El Rito Formation underlies Ritito Conglomerate along the western edge of the quadrangle, basal Los Pinos Gravel along the southern edge, and upper Los Pinos in the Next Quadrangle south (Doney, 1966).

Ritito Conglomerate (Barker), the basal unit of the volcanic sequence, has clasts of Precambrian rocks in a lightly cemented tuffaceous matrix. The clasts appear to be locally derived and reflect types exposed in the quadrangle or in the Blanco Basin Formation. It interfingers upward into the conglomerate of volcanic clasts (dark-colored volcanics for the most part), tuff, and tuffaceous sandstone (pinkish to white in color) that comprises the lower member of the Conejos Quartz Latite. Both units vary in thickness but average 200 feet each.

The upper member of the Conejos Quartz Latite, dominantly reddish-brown to purplish to dark-gray basaltic andesite and flow breccia, forms rubbly cliffs. The breccia pieces range in size from 2 inches to 3 feet across, with 6- to 8-inch diameters being most abundant. Small phenocrysts of plagioclase, pyroxene, and amphibole are set in an aphanitic matrix. The breccia is thickest in the north and thins rapidly to the south. It rests directly on quartzite in the southwest quadrant, indicating about 500 feet of relief in this region. More than 1000 feet of relief on the Precambrian surface are seen in the Rio de los Pinos and another 300 to 500 feet where the Precambrian extends upward into the overlying Treasure Mountain Rhyolite. Manganese mineralization coats fracture surfaces of breccia pieces near the confluence of Beaver and Diablo creeks; copper mineralization is present in vesicle fillings a mile downstream.

Disconformities of unknown importance are well displayed at many localities within the Conejos sequence; the best are in the railroad cuts in the northeastern corner of the quadrangle. The extensive float cover in the lower canyon walls of the Rio de los Pinos prevented separation of the lower clastic member from the overlying volcanic member; there probably are at least 200 feet of the clastic member exposed locally.

Treasure Mountain Rhyolite unconformably overlies the older rocks. Three mappable subdivisions are delineated and best displayed in the northeast quadrant (Trice). The basal map unit is composed of two black, perlitic, vitric, porphyritic, andesite ignimbrites and a more abundantly porphyritic and persistent brown andesite flow. Maximum thickness near the north edge of the map is 50 feet; it wedges out southward near the center of the map. Conformably overlying the basal unit are up to 250 feet of vitric tuff, tuff breccia, and tuffaceous conglomerate and sandstone whose clasts and grains are rhyolitic to quartz latitic in composition. Both the clastic unit and the overlying unit wedge out southward against hills of the quartz-eye granite. The upper unit is a distinctive, slabby weathered, light-gray to moderate pink, porphyritic, rhyolitic ignimbrite that caps broad, gently sloping mesas. Quartz, biotite, plagioclase, and scattered prisms of green pyroxene are the common phenocrysts. Generally 20 to 25 feet thick over the outcrop area, it ranges from a maximum of nearly 50 feet at the north edge of the map to 8 feet at the southeastern exposures.

Los Pinos Gravel appears to rest disconformably on the Treasure Mountain Rhyolite over much of the quadrangle. However, in the southeast part, all pre-Los Pinos units are missing, and Los Pinos is observed resting directly on Precambrian along the walls of the Brazos Box and on El Rito Formation along Gavilan Creek. Farther south and east, Los Pinos rests on Conejos and Treasure Mountain again (Barker; Doney). This pre-Los Pinos valley (or at least the north wall) has controlled the location of the present Rio Brazos and thus the position of the Brazos Box. Olivine basalt is found at the base of Los Pinos Gravel only in the pre-Los Pinos valley. Elsewhere, the basal unit is composed of conglomerate (clasts of volcanic rock), tuffaceous sandstone, and tuff. Against the buried hills of Precambrian rocks, the conglomerate clasts are locally derived. The Jarita Basalt Member of the Los Pinos Formation (Butler) extends into the eastern edge of the quadrangle. Younger volcanic and clastic formations preserved to the east and southeast have built the Taos Plateau to its present level (Butler).

A cluster of four cinder cones and associated flows straddles the Brazos Box. One lies within the qudrangle. Basalt from a second covers a bench along the south wall of the Box, with the base of the bench about 300 feet above present stream grade. The cluster south of the Box appears to be along the Brazos fault zone, a major west-trending fault that extends into the San Juan Basin (Muehlberger). Two other basalt cones and flows at about five-mile intervals lie on a south-trending line that passes through the Brazos Box cluster (Doney). The westward continuation of the basalt that flowed into the Brazos Box caps a broad terrace from the mouth of the Box past Tierra Amarilla toward El Vado (Dane, 1948). This terrace is one of those correlated up the Chama River as one of the outwash terraces of the Durango glaciation (Muehlberger).

Glacial erosion and deposition are evident throughout the quadrangle. The best developed Wisconsin cirques are along the north and east sides of Grouse Mesa; the lateral and terminal moraines are outlined by their topographic expression shown on the map. Many fragments of recessional moraines of the Wisconsin glaciation are in Wolf Creek (northwest corner). Along the axes of many of the broad valleys, flanked by Precambrian quartzite outcrops, are angular quartzite boulder fields of ground moraine from which the fine material has been washed out. At first glance, these blocks appear to be rock glaciers that have been stabilized. The many slot canyons and deep gorges ("boxes" of local terminology) can be shown to be the direct results of glacial meltwater. The abundant postglacial landslides probably are largely moraine or ice-loosened material that slid after the region thawed. The best displays of earthflow features are those on the Lagunitas Lakes slide and the large one on the north wall of the Brazos Box. Deposits of earlier glaciations occur in nearby region (Atwood and Mather, 1932; Muehlberger), but appear to have been reworked in the latest glacial events of this high region.

GEOLOGIC STRUCTURE

Structural history of this area is intimately related to that of the Chama quadrangle (see Muehlberger, 1967, for detailed discussion). The only mapped structures in the Precambrian are the broad, gently west- to to northwest-plunging folds recognized in the quartzite. The quartzite of Jawbone Mountain (southeast corner) contains a west-trending, locally important fracture cleavage. In the upper Brazos Box, axes of small, tight folds, as well as elongation of pebbles in the conglomeratic quartzite, plunge steeply southeast.

Laramide deformation severely affected the western margin of the area. Along this zone, the Tusas Mountains were uplifted, turning up the Mesozoic and older units along the mountain front. In contrast, Chaves fault, West Brazos Peak fault, and the northwestern extension of the Lagunitas fault (pl. 2) had large throws down to the east at this time. It is possible that the shear zone displayed in the quartzite in the Brazos Box is a Laramide feature and that both the Chaves and West Brazos Peak faults turn east and constitute the shear zone.

Only late Cenozoic post-Los Pinos Gravel movements can be proved for the other faults of the quadrangle. Most of the faults are upthrown on the east; thus, the same stratigraphic units are repeated several times. This pattern continues to the east and southeast in the adjacent quadrangles (Butler; Barker). East and West Brazos Peak faults appear to be exceptions. They bound a horst block with about 1000 feet of throw on the bounding faults. To the north, this displacement is distributed over three faults; to the south, displacement appears to decrease abruptly at the Brazos Box. The shear zone in the Box may be the cross structure that terminates the horst, or, more likely, the main displacement was pre-Los Pinos Gravel, and post-Los Pinos displacement was modest.

Notice that the West Brazos Peak fault has reversed sense of throw between the Laramide and the younger movement. Similarly, the northwest end of the Lagunitas fault has reversed its throw (1100 feet down to the east in Laramide, 100 feet down to the west in late Cenozoic in the northeast Chama quadrangle). Possible reversal of throw on the East Brazos Peak fault is responsible for the observed geometry (down to the east, pre-Los Pinos, at least post-Conejos, and probably post-Treasure Mountain; down to the west, a small amount, post-Los Pinos). The regional east tilt is post-Los Pinos. Structure contouring (pl. 3) of the base of the upper ignimbrite unit of the Treasure Mountain Rhyolite shows that the Lagunitas fault markes a distinct change in strike.

References

Adams, G. E. (1957) *Geology of Chama area, Rio Arriba County, New Mexico,* unpub. M.A. thesis, Univ. Texas.

Atwood, W. W., and Mather, K. F. (1932) *Physiography and Quaternary geology of the San Juan Mountains, Colorado,* U.S. Geol. Surv., Prof. Paper 166, 176 p.

Barker, Fred (1958) *Precambrian and Tertiary geology of Las Tablas quadrangle, New Mexico,* N. Mex. Inst. Min. and Tech., State Bur. Mines and Mineral Res., Bull. 45, 104 p.

Bingler, Edward C. (1965) *Precambrian geology of La Madera quadrangle, Rio Arriba County, New Mexico,* N. Mex. Inst. Min. and Tech., State Bur. Mines and Mineral Res., Bull 80, 132 p.

Butler, A. P. (1946) *Tertiary and Quaternary geology of the Tusas-Tres Piedras area, New Mexico,* unpub. Ph.D. dissertation, Harvard Univ.

Dane, Carle H. (1948) *Geologic map of part of eastern San Juan Basin, Rio Arriba County, New Mexico,* U.S. Geol. Surv., Oil and Gas Inv., Prelim. Map 78.

Doney, Hugh H. (1966) *Geology of the Cebolla quadrangle, Rio Arriba County, New Mexico.* unpub. Ph.D dissertation, Univ. Texas.

Just, Evan (1937) *Geology and economic features of the pegmatites of Taos and Rio Arriba counties, New Mexico,* N. Mex. Inst. Min. and Tech., State Bur. Mines and Mineral Res., Bull. 13, 73 p.

Larsen, E. S., Jr., and Cross, Whitman (1956) *Geology and petrology of The San Juan region, Southwestern Colorado,* U.S. Geol. Surv., Prof. Paper 258, 303 p.

Muehlberger, William R. (1967) *Geology of the Chama quadrangle, New Mexico,* N. Mex. Inst. Min. and Tech., State Bur. Mines and Mineral Res., Bull. 89, 114 p.

Trice, E. L., Jr. (1957) *Geology of Lagunitas Lakes area, Rio Arriba County, New Mexico,* unpub. M.A. thesis, Univ. Texas.