Sangre de Cristo Formation. In the field, however, no angularity was observed along the contact between the two formations. Tectonic activity in the region prior to Sangre de Cristo time seems to have been localized tilting and broad uplift, as shown by the dips across the Sangre de Cristo quadrangle and southwest of Las Vegas where the Sangre de Cristo Formation rests directly on Precambrian rocks.

In the Glorieta quadrangle, the Sangre de Cristo Formation is a typical red-bed sequence of dark maroon silts and mudstones, with interbedded calcites, cross-beded sandstones and arkosic sandstones. The sandstones are highly discontinuous, and beds as thick as 20 feet wedge out laterally in a few hundred feet. The Sangre de Cristo Formation is extensively exposed in the mountains of northern New Mexico and southern Colorado, and was as a floodplain deposit on the flanks of the late Pennsylvanian positive areas.

The Sangre de Cristo Formation is estimated to be over 2,000 feet thick near Glorieta, but only 435 feet is present along Galisteo Creek, three and one-half miles southwest of Callicanto.

PERMAN ROCKS

Yeo Formation

The Yeo Formation, which conformably overlies the Sangre de Cristo Formation, consists of a sequence of siltstones and fine- to medium-grained, highly calcareous quartz sandstones. These rocks form a prominent slope on Glorieta Mesa and crop out below the more resistant Glorieta Sandstone. The lower 75 feet of the formation are orange to yellow in color, and the upper 75 feet are brown to dark brown in the upper part of the sequence. In SW1 sec. 13, T 15 N., R. 10 E. (unseen) the Yeo Formation has been folded and the sandstones traversed by numerous slickensided fractures, causing the formation to stand in relief (fig. 4, at rear).

The Yeo Formation varies in thickness from 460 feet south of Glorieta to 390 feet northeast of Lamy. Needham and Bates (1943, p. 1622) reported a thickness of 305 feet for the Yeo Formation in Glorieta Mesa one mile west of the village of Rowe in western San Miguel County.

Glorieta Sandstone

The Glorieta Sandstone, prominently capping much of Glorieta Mesa, rests conformably on the Yeo Formation. The sandstone is massive and thick bedded and consists of medium- to coarse-grained quartz with a slightly siliceous and ferruginous cement. Locally, the amount of oxidized iron minerals increases considerably, and rounded quartz grains up to one inch in diameter are present. Cross bedding is well-developed; pebble beds consist of fragments composed of quartz, chert, and rare limestone.

The combined thickness of Glorieta Sandstone and overlying San Andres Limestone varies from 140 feet near the town of Glorieta to 80 feet northeast of Lamy. Needham and Bates (1943) designated and measured a type section of the Glorieta Sandstone one mile west of Rowe, San Miguel County, where 136 feet of Glorieta Sandstone is exposed.

San Andres Limestone

Only a thin remnant of this limestone is present with about 20 feet of dark-gray, impure, silty limestone cropping out on Glorieta Mesa. The limestone is poorly exposed and as it becomes more silty to the west, has not been mapped as a separate unit southwest of Callicanto, but has been included with the underlying Glorieta Sandstone.

Bernal Formation

Underlying most of Glorieta Mesa, and consequently much of the southeast part of the map area, is the Santa Rosa Sandstone, a sequence of brown, thick-bedded, conglomeratic sandstones and intervening mudstones. These rocks disconformably overlie the Bernal Formation. The sandstones are characterized by their untorn character, quartz pebbles in the conglomeratic layers, and silicified wood fragments.

CENOZOIC ROCKS

Ancha Formation

In the extreme southwest corner of the quadrangle, sands and gravels of the Ancha Formation unconformably overlie older red-bed rocks ranging in age from sec. 14, T 15 N., R. 10 E. (unseen) the Bernal Formation to group status, and separated a lower clastic unit, Texaque Formation, from an unconformable overlying sand and gravel unit, the Ancha Formation. Galusha and Blick (1971, p. 78) consider the Ancha Formation Pleistocene and include these beds in the Santa Fe Group. The Ancha Formation is extensively present in the Seton Village quadrangle to the west. Here, the Ancha is in depositional contact with Precambrian rocks. Its main lithological characteristics are the arkoic nature of the sandstones and the presence of gravel lenses.

Gravels

Terrace deposits, made up of rounded granite and metamorphic rock pebbles and cobbles, occur in several widely-scattered places. Near the northeast corner of sec. 25, T 15 N., R. 10 E. a small gravel patch overlies Santa Rosa Sandstone at an elevation of 7,200 feet. Gravels of similar type, usually weathered and unconsolidated, occur on the divides between canyons in the western part of the map area underlain by Precambrian rocks. These gravel patches and remnants may represent a northeastern continuation of an old erosion surface, named Plains surface by Spiegel and Baldwin (1963). This surface has a slope varying from 50 feet per mile to 140 feet per mile near the mountains. In the southwest part of the Glorieta quadrangle, a similar surface has a southwest slope of 150 feet per mile, increasing to a south slope of 250 feet per mile in the northwest part of the quadrangle.

Recognition of old erosion surfaces may be an important clue to the superimposed origin of the Sangre de Cristo Mountains. The fourths of each landform of the Sangre de Cristo Mountains has been dated at 6,000,000 years by radiocarbon dating (Braun, 1953, p. 37). The Sangre de Cristo Mountains have undergone several periods of deformation, some of which were accomplished by regional metamorphism and igneous activity. Within the Glorieta quadrangle, geologic evidence indicates (1) tectonic and magmatic activity during Precambrian time, (2) tectonic activity during late Paleozoic time, and (3) tectonic deformation beginning at the end of the Mesozoic Period.

Precambrian tectonism created regionally metamorphosed rocks from pre-existing sediments and volcanics, accompanied and followed by granitic and gabbroic magmatism. Faulting took place later when the rocks were more brittle. Tectonic activity during the late Paleozoic was episodic; during this interval some of the Precambrian structural elements have been rejuvenated. In Tertiary time, further rejuvenation of Precambrian structural elements occurred and the sedimentary cover of late Paleozoic and Mesozoic rocks was folded and faulted.

Precambrian Geologic History

The southern part of the Sangre de Cristo Mountains has undergone several periods of deformation, some of which were accomplished by regional metamorphism and igneous activity. Within the Glorieta quadrangle, geologic evidence indicates (1) tectonic and magmatic activity during Precambrian time, (2) tectonic activity during late Paleozoic time, and (3) tectonic deformation beginning at the end of the Mesozoic Period.

In the Glorieta quadrangle, the Sangre de Cristo Formation exhibits much thinning from the Row-Mora basin in the east to the Uncompahgre basin in the west. A similar change, although not as striking, is indicated by the other Permian formations. During Late Pennsylvanian and early Permian time, the Glorieta area was located on the east slope of the slowly-rising Uncompahgre axis.
Laramide Structures

The time interval between Late Cretaceous and middle Tertiary, recognized throughout western North America as a time of deformation, is called the Laramide orogeny. It caused folding and faulting of the rocks of the southern Sangre de Cristo Mountains. Precise dating of the orogeny is not possible in the Glorieta quadrangle, but the Laramide orogeny was probably the major factor rejuvenating Precambrian structures and creating folds and faults within the late Paleozoic and Mesozoic sedimentary rocks.

At the end of the Mesozoic Era, the southern Sangre de Cristo Mountains consisted of a basement of crystalline Precambrian rocks overlain by several thousand feet of sediments, of which the oldest were late Paleozoic. The exact thickness of the sedimentary cover is unknown, but it may have amounted to as much as 10,000 feet. Under the influence of compressive stresses, of which the greatest were oriented in an east-west direction, the sedimentary cover was folded and faulted, while the basement deformed mainly along steep reverse faults, some of which may have been rejuvenated Precambrian structures. As a result of vertical differential movement along basement faults, the westmost blocks, west of the Deer Creek fault, became elevated and Pennsylvanian and younger sediments subsequently have been removed by erosion, exposing the Precambrian crystalline rocks. Pennsylvanian sediments, however, are preserved in a narrow, tightly-compressed synclinal structure, that coincides farther south with the Garcia Ranch fault. The lateral transition from narrow syncline in the sedimentary cover to a fault in the basement also takes place in the vertical dimension (see cross sections on geologic map). Reverse fault movement along steeply-dipping basement fractures, possibly of Precambrian origin, pinched part of the sedimentary cover into a synclinal structure.

The north-northeast Deer Creek fault also appears to be a reverse fault with the west side upthrown. In the Precambrian rocks to the west, the fault is marked by a breccia or shear zone of varying width, in which the foliation parallels the fault plane. Along the east side of the fault, Pennsylvanian beds have been tilted to the southeast. At a distance varying from 1,000 to 2,000 feet from the fault, dips diminish rapidly and the beds dip gently with angles of 10° to 12° into the Glorieta syncline.

The Glorieta syncline is the major structure in the eastern half of the quadrangle. It is a gentle, southward-plunging synclinal structure. North of Glorieta Pass, the synclinal axis plunges southward at an angle of about 10°. South of the Pass, the plunge diminishes to about eight degrees, while on Glorieta Mesa the plunge becomes less than three degrees.

The synclinal trace does not quite parallel the Deer Creek fault. The Glorieta syncline possibly developed somewhat earlier than the faulting. A syncline of greater complexity extends southwest of Canoncito and is considered to be the structural continuation of the Deer Creek fault, West of Galisteo Creek, Glorieta Sandstone and older rocks form the northwest limb with dips as steep as 60° SE. The southeast limb of this structure is mostly covered by alluvial deposits of Galisteo Creek, but northwesterly dips can be found in the sparse outcrops on the west slope of Glorieta Mesa in sec. 13, T. 15 N., R. 10 E. (unsurveyed).

In sec. 23, T. 15 N., R. 10 E. (unsurveyed), the Glorieta Sandstone is offset by a north-trending fault. This offset is probably related to the proximity of a Pennsylvanian fault in the northwest corner of this section and adjacent sections. The southeastward and upward movement of this block has resulted in the omission of the Magdalena Group and nearly all of the Sangre de Cristo Formation along its southeastern fault border, and may also be responsible for the “wrapping around” of the sedimentary cover in sec. 22, T. 15 N., R. 10 E. (unsurveyed).

The profound fault movements that in the late Tertiary created the Rio Grande rift zone to the west caused the uplift of the Sangre de Cristo Mountains relative to the graben floor. Cretaceous rocks of the Santa Fe Group. The Pleistocene Ancha Formation unconformably overlies older rocks in the southwestern part of the quadrangle.

REFERENCES


Fig. 1—Thin section of fine-grained amphibolite from sec. 8, T. 16 N., R. 11 E. Dark, prismatic mineral is hornblende, gray porphyroblast is epidote, light-colored matrix consists of quartz and plagioclase. Parallel light, magnification about 40.

Fig. 2—Photograph of aphanitic amphibolite, scale in inches. Light-colored, rounded aggregates are plagioclase in a hornblende-plagioclase matrix.

Fig. 3—Fault contact between Sangre de Cristo Formation (left) and Precambrian Granite (right). Fault plane dips about 60° toward the southwest. Photograph taken near Apache Canyon, about 3/4 mile northwest of Canoncito.