

INTRODUCTION

This report has been prepared as part of a continuing cooperative program of the U. S. Geological Survey and the Puerto Rico Economic Development Administration. It is one of a series of maps and reports in preparation of a large-scale geologic map of Puerto Rico. This report stresses the economic and engineering aspects of the geology of the Barranquitas quadrangle.

In October 1956 R. Briggs began fieldwork in the Barranquitas quadrangle, and he was joined in March 1957 by P. A. Gelabert. Mapping was completed in February 1958. The authors were assisted by A. J. Berryhill during the field parties. Previously, the area of the Barranquitas quadrangle was included in reconnaissance geologic maps made under the auspices of the New York Academy of Sciences during 1915 (Semmes, 1919; Hodge, 1920).

GEOGRAPHY

The Barranquitas quadrangle includes an area of about 183 square kilometers in the mountainous east-central part of the island of Puerto Rico. It is bounded on the north by the Corozal quadrangle and clockwise from there by the Maricao, Comerio, Grosvenor, and Cayey (Berryhill and Glover, 1961), Coamo (Glover, 1961), Rio Descalabrado, Orocovis, and Ciales quadrangles. The Barranquitas quadrangle includes almost all the Municipio of Barranquitas and parts of the Municipios of Alibonito, Coamo, Comerio, Grosvenor, Naranjito, and Corozal. There are two towns in the quadrangle, centrally located Barranquitas, population 4,268 in 1950 (Junta de Planificación, 1957, p. 5), from which the quadrangle takes its name, and Alibonito, population 1,129 in 1950 in the southern part of the quadrangle. The population of the quadrangle is about 30,000 (Junta de Planificación, Mapas de Municipios y Barrios) or approximately 180 people per square kilometer.

Cultivated and upland roads serve much of the area. The only sections that have limited access are the roads just east of the town of Alibonito and the high relief in the southwest part of the quadrangle and the valleys of the Rio Usabón and the Rio Hondo in the eastern and northeastern portions of the quadrangle.

Locations of specific points within the Barranquitas quadrangle are referred to a meter grid based on the Puerto Rico coordinate system. Ticks along the borders of the map are at 2,000-meter intervals.

Three fairly distinct physiographic regions are present in the Barranquitas quadrangle. The first region, principally in the west-central and western parts of the quadrangle, has moderately steep slopes and moderate relief, with elevations that are commonly well above 600 meters and with a number of peaks above 1,000 meters. The highest peak, 1,630 meters (5,348 feet), is Cerro de la Cruz, situated in the eastern part, has elevations between 530 and 660 meters and is characterized by moderately low to low local relief. This region, which has quadrangle area of 100 square kilometers, is the area of the "Saint John Penelapne" (Lopez, 1922, p. 312-315; it is now referred to as the "Saint John Penelapne" (Meek, 1927, p. 214). The third region, generally lower in average elevation than the second, has moderately low to low relief and is the area of the Rio Usabón and the Rio Hondo in the lowest point in the quadrangle, 185 meters above sea level, is in the Rio Coamo in the southwestern corner of the area.

The Cordillera Central, the high "spine" of Puerto Rico, passes through the eastern part of the quadrangle. However, the greater part of this divide flows to the Atlantic Ocean; those to the south flow to the Caribbean Sea.

STRATIGRAPHY

CRETACEOUS SYSTEM

All the stratified rocks and extrusive igneous rocks exposed in the Barranquitas quadrangle are believed to be Cretaceous in age. Their maximum exposed thickness at the eastern end of the quadrangle is probably as much as 6,200 meters (20,300 feet). The exposed section is divided into five broad units, including an informal group and four formations. The stratigraphic relations of the rocks in the Barranquitas quadrangle to those in the adjacent quadrangles are discussed in a summary report by Berryhill, Briggs, and Glover (1960).

Pre-Robles rocks

A thick sequence of generally massive volcanic rocks that underlie the Robles formation in east-central and eastern Puerto Rico is informally called the pre-Robles rocks because no satisfactory criteria have been found on which consistent subdivisions and formal nomenclature can be based. In the Coamo and Grosvenor quadrangles, the rocks are the Cayey quadrangle (Berryhill and Glover, 1961), volcanic rocks about 5,000 meters (about 16,500 feet) thick are stratigraphically beneath the Robles formation. In the Cayey quadrangle these rocks were tentatively divided into four formations: the Rio Usabón and the Rio Hondo (J and K) which were tentatively defined in the Comerio quadrangle.

The principal pre-Robles rock types in the Barranquitas quadrangle are lava and flow breccia, but massive tuffaceous conglomerate and tuffaceous breccia are common; tuffaceous sandstone and siltstone and water-laid lapilli tuff occur locally. The lavas are probably intermediate to basaltic.

At least 1,200 meters (3,950 feet), and possibly as much as 1,800 meters (5,900 feet), of pre-Robles rocks are exposed in the Barranquitas quadrangle. In the east-central and northeastern parts of the quadrangle they are coextensive with the upper part of formation K of the Comerio quadrangle. In the western part of the quadrangle they are probably equivalent to formation K, but some may be older.

Age.—An amonite identified by N. F. Sahl of the Geological Survey as *Puzosia* sp. was found in the upper part of the pre-Robles section approximately 110 meters below the top of the pre-Robles section (38,660; 170,230E; P. R. meter grid). He referred it to the early Late Cretaceous Coniacian stage. It is probable, therefore, that most of the pre-Robles rocks in the Barranquitas quadrangle are Late Cretaceous in age, though some may have been deposited earlier.

Robles formation

The Robles formation was named by Pease and Briggs (1961) in their report on the geology of the Comerio quadrangle. The type area for this formation is barrio Robles of the Municipio of Alibonito, a small part of which is in the Barranquitas quadrangle. The type area was assigned to formation K (pre-Robles rocks). Mapping of areas to the north of the Barranquitas and Comerio quadrangles has confirmed the formation L designation of these rocks (M. H. Pease, Jr., oral communication). Tentatively, that part of the formation beneath the limestone unit may be in part correlative with the Las Tetas lava member of the Robles formation, the two units may be correlative with a limestone unit and associated sandstone and siltstone that crop out in the eastern part of the quadrangle. However, the unit is disconformably above the Las Tetas member in the Cayey quadrangle (Berryhill and Glover, 1961), and the upper part of formation L may be equivalent to lava flows that crop out locally at the base of the Caribbean formation in the Coamo quadrangle (Glover, 1961). Formation L is the western extension of formation L in the northwestern part of the Comerio quadrangle (Pease and Briggs, 1961).

Limestone unit.—The limestone unit typically occurs in barrio Barranquitas of the Municipio of Barranquitas in the north-central part of the Barranquitas quadrangle, at the Falcon quarry (44,170 N; 164,110 E; P. R. meter grid). The unit is principally medium-dark-gray to grayish-black crystalline limestone that is very fossiliferous at a number of places. It occurs in lenses with a maximum thickness of 60 meters (200 feet) along the north side of the Quebrada El Gato fault and in fault slices in the upper part of the Rio Hondo valley. Two minor limestone occurrences south of the Rio Hondo in the northeastern quarter of the quadrangle are also assigned to the limestone unit.

Tuffaceous siltstone unit.—The type locality, and apparently the thickest section, of this unit is along a rural road that parallels the Rio Grande de Manatí on its west side north of the Quebrada El Gato fault. Its principal constituents are tuffaceous sandstone and siltstone and clayey siltstone. It is present in fault slices in the area bounded by the Quebrada El Gato and Rio Hondo faults east of the Rio Grande de Manatí. It also crops out in poorly defined bands north and south of the Rio Hondo. Its general range is from 30 meters (100 feet) to a maximum in the Rio Grande de Manatí of about 120 meters (400 feet), although it is locally absent. The tuffaceous sandstone and siltstone unit overlies the limestone unit lenses where they are present, and its position roughly marks the mid-portion of formation L. Locally it interfingers with lava flows of formation L.

Age.—Formation L overlies the Robles formation of Late Cretaceous age in the northern part of the Barranquitas quadrangle; it is older than the Coamo formation that has been assigned a Late Cretaceous age. Therefore, formation L is also assigned a Late Cretaceous age.

Caribbean formation
The type area of the Caribbean formation is in the Coamo quadrangle (Glover, 1961). In the Barranquitas quadrangle it crops out along the southern border; and rocks that lie along the northern border are tentatively assigned to the Caribbean formation. The dominant rock type in the Caribbean formation is a conglomerate containing lava cobbles as large as 20 cm. in diameter. In places the conglomerate is crudely stratified, and at a number of places it contains bedded tuffaceous sandstone and siltstone. In the northern part of the quadrangle, the conglomerate is the most common rock types in the strata that may be equivalent to the Caribbean formation, although tuffaceous siltstone, water-laid lapilli tuff, and tuffaceous conglomerate crop out at many places. In the northeastern part of the quadrangle the formation has a maximum thickness of about 400 meters (1,300 feet), whereas the thickness of rocks tentatively assigned to the Caribbean in the northern part of the quadrangle is probably only 100 to 200 meters.

In the northern part of the quadrangle strata tentatively assigned to the Caribbean formation rest conformably upon rocks of formation L; however, in the southern part of the quadrangle the Caribbean formation may rest unconformably on strata of the Robles formation. This possible unconformity is indicated in the southwestern part of the quadrangle by an apparent thinning of the Robles formation above the Las Tetas lava member northward by as much as 100 meters per kilometer. This thinning may have been caused by post-Robles erosion prior to the deposition of the Caribbean, although no unconformity was observed in the area.

No fossils.—No fossils have been recovered from the Caribbean formation in the Barranquitas quadrangle. However, it overlies the Robles formation of Late Cretaceous age in the southern part of the quadrangle, and is beneath the Coamo formation of Late Cretaceous age in the northern part of the quadrangle. This relationship is indicated in the southwestern part of the quadrangle by an apparent thinning of the Robles formation above the Las Tetas lava member northward by as much as 100 meters per kilometer. This thinning may have been caused by post-Robles erosion prior to the deposition of the Caribbean, although no unconformity was observed in the area.

Hydrothermally altered rocks.—Hydrothermally altered rocks crop out in at least four areas in the Barranquitas quadrangle. The largest area is adjacent to the southern and eastern boundaries of the Barranquitas stock. In this area rock types grouped under the map symbol for altered rocks are generally grayish-red to brown, and the most prevalent is probably pyrite-sericite quartzite. Although not exposed, lava and sandstone that show various degrees of replacement and rock that may have been hornblende diorite prior to alteration occur as fault breccias in the area. The alteration is similar to that of the rocks in this area probably emanated from the magma that formed the Barranquitas stock.

Two bodies of hydrothermally altered rocks, which are principally composed of white to grayish-red-purple quartz and kaolinite, are associated with the hornblende diorite intrusive bodies in the southwestern part of the quadrangle. The westernmost outcrop is wholly within the Coamo Arriba stock, and the other area is at the west end of the small hornblende diorite stock on Cerro El Pico. The rocks probably were altered concurrently with the last stages of emplacement of the intrusive bodies.

In the north-central part of the quadrangle, between the Quebrada El Gato fault and the Rio Hondo fault, there is a small, irregularly shaped constituent is hydrothermal quartzite associated with some kaolinitic clay.

Other small areas within the Barranquitas quadrangle contain rocks whose appearance suggests possible activity by hydrothermal solutions on the northern border of the quadrangle in an area bounded by faults most of the outcropping rock is quartz vein material; along Highway 143 southwest of Barranquitas some outcrops of the Robles formation are white to grayish-red-purple, similar in color to quartz-kaolinitic altered rocks; and in the west-central part of the quadrangle an area of tripoli may be underlain by rocks of the Robles formation that have been silicified by hydrothermal solutions.

Rocks subjected to low grade metamorphism.—In the northeastern part of the quadrangle, to the north and in the Rio Hondo valley, there are rocks, mostly lava flows, that have apparently undergone moderate metamorphism. These rocks, which are tentatively assigned to formation L, and the Robles rocks, contain secondary pyrite and some ferromagnesian minerals that have reacted to chlorite. This alteration contains many quartz veins as well. Slight metamorphism is evident in many of the rocks elsewhere in the quadrangle.

Terrace deposits at levels higher than present stream action.—In the valleys of the Rio Usabón, the Rio Hondo, and the Rio Coamo, and in areas just to the east and southeast of Barranquitas small sand and gravel deposits form terraces at levels well above the range of present stream action. The rapid incision of the streams in these areas suggests that these deposits are older than early Recent.

Alluvium, flood plain deposits, and low level terrace deposits.—At many points in river and stream valleys of the Barranquitas quadrangle much alluvium occurs in the channels, and flood plains have formed. The channel alluvium generally above water level except during periods of heavy rain when adjacent flood plains are also likely to be in part inundated. At a number of places adjacent to and interfingering with the flood plain deposits are low-level terrace deposits that include some debris from earth flows and avalanches as well as alluvial sand, gravel, and clay.

Deposits of debris resulting from earth and rock flow and debris avalanches.—Earth and rock flow debris and the deposits of debris avalanches occur at many places in the quadrangle. Most earth and rock flows are sheet-like deposits on relatively gentle slopes, whereas most debris avalanches occur on steep slopes and usually are restricted to narrow tracks. However, the deposits are generally of limited extent, and they are usually restricted to the immediate vicinity of their source and are not separated and only the larger deposits are shown.

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