DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF PUERTO RICO
ECONOMIC DEVELOPMENT ADMINISTRATION
INDUSTRIAL RESEARCH DEPARTMENT

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I–525

INTRODUCTION

Two rock sequences are exposed in the Bayaney quadrangle. The older sequence consists of about 4,600 meters of deformed Cretaceous to lower Tertiary volcanogenic deposits intruded by dioritic rocks; the younger sequence, which rests unconformably on the older rocks, consists of about 550 meters of essentially undeformed middle Tertiary calcareous and associated deposits. A deep saprolite covers much of the bedrock in the quadrangle.

Appreciation is expressed to Messrs. Gustavo Aguilar, Rigoberto Reynoso, and Charles Phillips, geologists with the Bear Creek Mining Co., Lares, Puerto Rico, for their helpful discussions during the field mapping. Mr. Reynoso kindly showed the authors several key outcrops in the quadrangle.

The proposed classification of Fisher (1961) is used in the description of the volcanic rocks.

STRATIGRAPHIC RELATIONS

The Cretaceous and lower Tertiary rocks are divided into five formations, listed from oldest to youngest: Robles Formation (Pease and Briggs, 1960), Alonso Formation (Nelson and Monroe, 1966), Matilde and Milagros Formations (Nelson and Tobisch, 1967), and Jobos Formation (Nelson, 1967). The Alonso and the Jobos Formations are erosional inliers in the middle Tertiary rocks, and the other formations are exposed in the south and southwest parts of the quadrangle.

The Robles Formation in the Bayaney quadrangle is probably of Early to Late Cretaceous age and was intruded by the Utuado pluton. The upper part of the Robles is disconformably overlain in the southwestern part of the quadrangle by the lower Tertiary Matilde Formation, which is conformably overlain by the lower Tertiary Milagros Formation.

Middle Tertiary rocks are divided into three formations, listed from oldest to youngest: San Sebastián Formation (Zapp and others, 1948), Lares Limestone (Zapp and others, 1948), and the Cibao Formation (Monroe, 1962). These rock units strike westward and dip northward in the northern part of the quadrangle.

The San Sebastián Formation is of middle Oligocene age and rests with angular unconformity on the older rocks; it is conformably overlain by the Lares Limestone of Oligocene age, which, in turn, is overlain by the Cibao Formation of Oligocene and Miocene age. The Cibao consists of both a limestone and marl member: in the eastern part of the quadrangle the Cibao corresponds to the Montebello Limestone Member of the Cibao that has been mapped to the east (Nelson, 1967); the marl member corresponds in part to the Guajataca Member of the Cibao (Zapp and others, 1948).

INTRUSIVE ROCKS

UTUADO PLUTON

A large area in the southern part of the quadrangle is underlain by the Utuado pluton (Weaver, 1958). Contacts with older rocks are sharp and, in general, dip steeply. Age relations in the adjoining Utuado quadrangle suggest the pluton was emplaced in the late Maestrichtian to middle Paleocene interval.

MINOR STOCKS AND DIKES

Numerous small dikes and stocks intrude the Cretaceous and lower Tertiary rocks. Those small igneous bodies in close proximity to the pluton may be its apophyses, but those that intrude the lower Tertiary rocks are younger than the Paleocene to Eocene age of the Matilde Formation.

HYDROTHERMAL ALTERATION

Parts of the older rock sequence have been hydrothermally altered; this is shown by an overprint on the map. In many places, the alteration has destroyed the original textures, thus making identification of the original rocks difficult or impossible; this is especially true in the intensively altered zone in the valley of the Quebrada de los Platanos near Milagros.

In the Bayaney quadrangle, hydrothermal alteration is believed to have occurred during the late Eocene. Intrusive rocks that are younger than Eocene(?) strata have not been altered. P. H. Mattson (written commun., 1964) indicates that hydrothermal alteration of the rocks in the Adjuntas quadrangle probably occurred during the middle or late Eocene.

STRUCTURAL GEOLOGY

The most prominent structural feature in the Bayaney quadrangle is the unconformity between the middle Tertiary strata and older rocks. Less prominent features include minor folds, faults, and joints.

Cretaceous and lower Tertiary rocks in the southern part of the quadrangle are on the south flank of the island anticlinorium. Mapping in quadrangles to the east (Nelson and Monroe, 1966; Nelson, 1967) suggests that the projected west-northwest-trending axial trace of the crestal anticline enters the Bayaney quadrangle near the middle of the east edge. The older strata generally strike roughly parallel to the projected anticlinal trace.

Middle Tertiary rocks are only slightly deformed, having been tilted 4° to 9° north. Faults have not been observed cutting these rocks in the Bayaney quadrangle.

ECONOMIC GEOLOGY

Metallic mineral deposits.—Copper is the principal metallic mineral deposit in the quadrangle; some gold and silver may be associated with the copper deposits. Two copper deposits of probable economic value are known. They are in small intrusive bodies and adjacent volcanic rocks on the west side of the Río Tanamá near the southern border of the map. Other deposits may be present in the hydrothermally altered areas in and near intrusive rocks. In Quebrada de los Platanos, intrusive rocks are hydrothermally altered, and in several places chalcopyrite was observed. Some copper deposits may also occur in altered parts of the Utuado pluton, especially in the area near the Río Camuy and its tributaries about 1-1½ km southeast of Escuela Segunda Unidad de Josefa Linares, where some chalcopyrite occurs.

The chief hypogene sulfide minerals in the hydrothermally altered areas are pyrite and chalcopyrite. Supergene enrichment of covellite and chalcocite has taken place in the Río Tanamá area. Locally, siderite and magnetite are present.

Large rounded boulders of magnetite were found in creek bottoms immediately south of and about 1 km east of Escuela Virgilio Acevedo, but none of the rock was found in situ.

Nonmetallic mineral deposits.—Nonmetallic mineral resources include large quantities of pure limestone, some sand and gravel deposits in stream valleys, and rock that could be used for fill material or crushed for concrete aggregate, highway aggregate, and riprap. Residual clays cover a large area in the southern part of the quadrangle and might possibly serve as a source of brick and ceramic clay, but tests would have to be made to determine their suitability.

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Base by U.S. Geological Survey, 1957

Geology mapped in 1964–65

SCALE 1:20 000

CONTOUR INTERVAL 10 METERS
DATUM IS MEAN SEA LEVEL

EXPLANATION

QUATERNARY — Pleistocene(?) and Recent

Ql — Landslide deposits

Qat — Alluvium and terrace deposits

UNCONFORMITY

TERTIARY

Oligocene and Miocene

Tc / Tcl — Cibao Formation

Tc, *marl member; red to yellow to brown to gray marl; also includes poorly cemented silt and sand, rare pebbly beds and thin beds of hard chalky or dense limestone*

Tcl, *limestone member, pale ivory to slightly yellowish chalky limestone, medium- to thick-bedded; includes some interbeds of hard dense limestone and locally some marl. Maximum thickness about 160 meters*

Oligocene

Tl — Lares Limestone

Basal 50 to 80 meters consists of yellowish to white thin-bedded to massive crumbly limestone in which brown limonitic specks are common. Lowermost beds contain some light- to dark-gray calcareous sandstone layers. Overlying the basal beds are 230 to 260 meters of hard ivory to yellowish dense limestone, which is locally somewhat chalky or crumbly. Foraminifera, pelecypods, and corals are common. Maximum thickness 310 meters

Ts — San Sebastián Formation

Brown to red to yellow to orange poorly consolidated sandstone, siltstone, shale, clay, and conglomerate with some calcareous layers near top of formation. Sandstone ranges from fine to coarse grained and commonly contains clay between well-rounded grains. Conglomerate contains pebbles and cobbles of older rocks. Maximum thickness 80 meters. Landslides commonly occur in the formation

UNCONFORMITY

Ti — Intrusive rocks

Massive gray to light-gray diorite and quartz diorite. Mostly fine-grained, textures range from granitic to xenomorphic granular; locally porphyritic

Upper Paleocene and Eocene(?)

Tmv / Tmi — Milagros Formation

Medium-gray feldspathic lapilli tuff and dark-brownish-gray volcanic breccia with interbedded bluish-gray fine-grained andesite lava, and brownish-gray, bedded vitric and crystal tuff, volcanic sandstone and siltstone. Lapilli tuff consists mostly of feldspathic lava fragments in crystalline matrix rich in plagioclase, some clinopyroxene, chlorite, and minor quartz. Thickness at least 1,700 meters

Tmv, *volcanic breccia member, massively bedded having angular to subrounded fragments with wide range in size. Fragments are mostly reddish-brown andesite; matrix rich in fragments and crystals of plagioclase, some clinopyroxene, oxidized pumice, and, in places, quartz*

Tj — Jobos Formation

Dark-greenish-brown massive volcanic breccia. Fragments mostly reddish andesitic lava in matrix of crystals of plagioclase, minor amounts of pyroxene, and finer pumice particles. Thickness unknown, formation crops out only in an erosional inlier in middle Tertiary rocks

Tm — Matilde Formation

Pale-green to pale-blue fine-grained bedded tuff and grayish-brown fine- to medium-grained volcanic sandstone and siltstone. Includes some interbedded medium-gray, fine-grained andesite lava containing some plagioclase (An_{54-62}) phenocrysts. Thickness ranges from 115 to 620 meters

Tvu — Volcanic rocks, undivided

Light-gray to yellowish- to reddish-brown volcanic breccia, lapilli tuff, lava, and volcanic sandstone and siltstone. Most of these rocks have been hydrothermally altered (sericitized and silicified). Commonly rock types cannot be satisfactorily divided, and locally only a soft sericite or hard siliceous material is all that remains. Contains some small intrusive bodies

DISCONFORMITY

CRETACEOUS

Upper Cretaceous

TKu — Utuado pluton and associated rocks

Massive gray to light-gray diorite, quartz diorite, granodiorite, and some minor gabbro; mostly fine grained, but ranges to coarse grained; textures include granitic, xenomorphic granular, and porphyritic. Principal minerals are plagioclase (An_{38-58}), hornblende, and quartz; magnetite, biotite, and potassium feldspar also occur; accessory minerals include apatite, sphene, and zircon. Common secondary minerals are sericite, chlorite, biotite, calcite, and epidote

Ka — Alonso Formation

Purplish to red hydrothermally altered volcanic breccia consisting of angular to subrounded fragments of purplish-red lava embedded in tuffaceous matrix rich in plagioclase and some pyroxene fragments. Thickness unknown, formation only occurs as an erosional inlier in the middle Tertiary rocks

Lower(?) and Upper Cretaceous

Kr / Krb — Robles Formation

Dark-greenish-gray to dark-bluish-black lenticular flows of basalt interbedded with lenticular flows of andesite, discrete beds of volcanic sandstone and siltstone, lenses of volcanic breccia and associated basaltic tuff, and a small lense of dark-gray massive nonfossiliferous limestone. Basalt characterized by clinopyroxene phenocrysts embedded in fine-textured crystalline groundmass. Plagioclase phenocrysts are rare. Andesite lava is dark gray, contains phenocrysts of plagioclase with glomeroporphyritic habit set in a fine-grained groundmass with intersertal texture. Locally, small clinopyroxene phenocrysts are present but are not common. Volcanic sandstone, which is dark greenish gray to pale olive green, is tuffaceous and mostly fine to medium grained. The siltstone units, which are dark-brownish gray, are thinner, finer grained, and thinner bedded than the sandstones.

Krb, *volcanic breccia member, greenish-gray to dark-greenish-black rock that weathers to olive green. Mostly contains fragments of basalt, averaging about 8 cm in diameter, scattered in matrix rich crystals and fragments of clinopyroxene and light-green pumice particles*

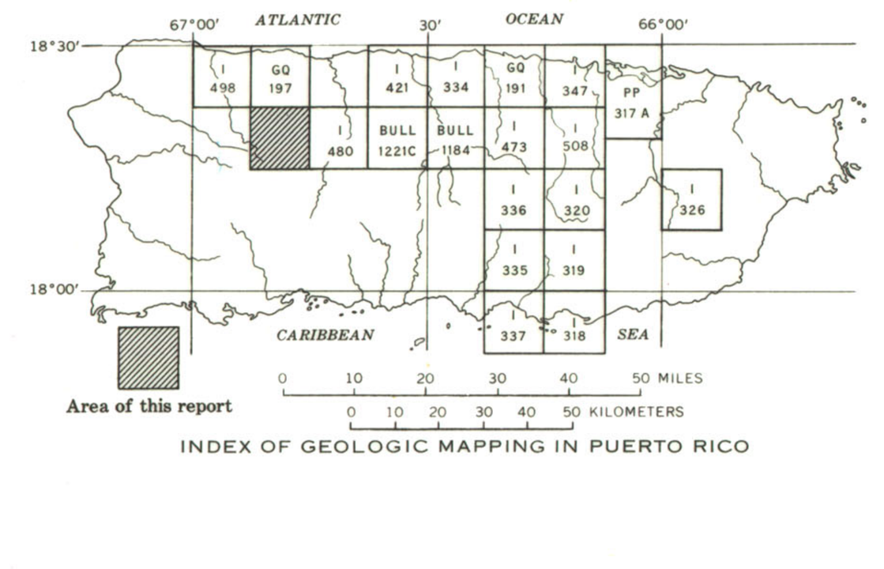
Contact, approximately located
Short dashed where inferred

Fault, approximately located
Short dashed where inferred. U, *upthrown side;* D, *downthrown side*

Strike and dip of beds

Apparent dip of beds

Area of hydrothermal alteration
Very light gray to deep-reddish-brown highly sericitized and silicified rocks. In places contains deep-yellow-brown iron oxide stain and deep-red hematite stain. Commonly contains pyrite and locally traces of chalcopyrite. Weathered sericite zones are soft, whereas siliceous zones are hard



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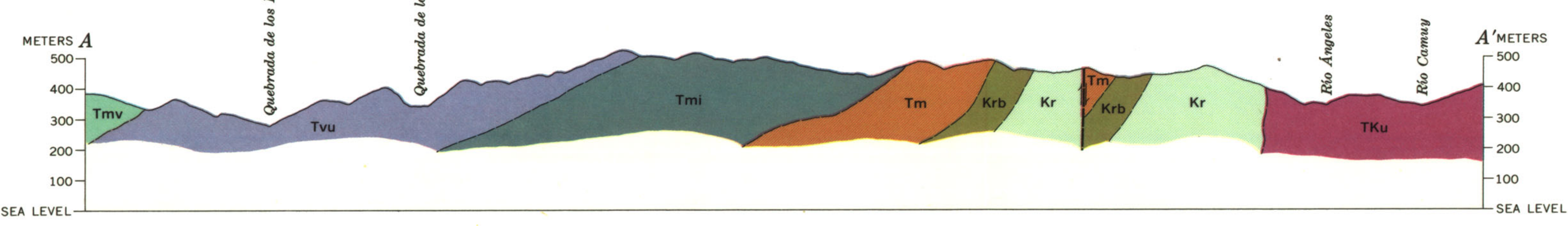

GEOLOGIC MAP OF THE BAYANEY QUADRANGLE, PUERTO RICO

By
Arthur E. Nelson and Othmar T. Tobisch

1968