The Río Abajo, Pitahaya, and Daguao Formations in Eastern Puerto Rico

GEOLOGICAL SURVEY BULLETIN 1435-B

The Río Abajo, Pitahaya, and Daguao Formations in Eastern Puerto Rico

By JOHN W. M'GONIGLE

CONTRIBUTIONS TO STRATIGRAPHY

GEOLOGICAL SURVEY BULLETIN 1435-B

A description of three largely volcaniclastic units, which are assigned an Early Cretaceous age

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1977

UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, *Secretary*

GEOLOGICAL SURVEY

V. E. McKelvey, *Director*

Library of Congress Cataloging in Publication Data

M'Gonigle, John W
The Rio Abajo, Pitahaya, and Daguao Formations in eastern Puerto Rico.
(Contributions to stratigraphy) (Geological Survey bulletin; 1435-B)
Includes bibliographical references.
1. Geology, Stratigraphic--Cretaceous. 2. Volcanism--Puerto Rico.
3. Geology--Puerto Rico. I. Title. II. Series. III. Series: United States.
Geological Survey. Bulletin; 1435-B.
QE75.B9 no. 1435-B 557.3 08s [551.7 7] 77-3911

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402
Stock Number 024-001-02989-8

CONTENTS

ILLUSTRATION

CONTRIBUTIONS TO STRATIGRAPHY

THE RIO ABAJO, PITAHAYA, AND DAGUAO FORMATIONS IN EASTERN PUERTO RICO

By JOHN W. M'GONIGLE

ABSTRACT

The largely volcaniclastic Río Abajo, Pitahaya, and Daguao Formations of the Humacao, Naguabo, and Punta Puerca quadrangles, eastern Puerto Rico, are described and assigned an Early Cretaceous age. The Río Abajo and Pitahaya Formations are tentatively correlated with the informally named formation A of the Cayey quadrangle and the overlying Torrecilla Breccia, respectively, of east-central Puerto Rico. The Daguao Formation, which contains two hypabyssal bodies that may represent conduits that supplied much of the volcanic material in the formation, appears to be gradational into the overlying Figuera Lava. The Figuera Lava and the Daguao Formation may be partly correlative in age with the Río Abajo Formation.

INTRODUCTION

This report discusses three new units—the Río Abajo, Pitahaya, and Daguao Formations—that were established during geologic mapping in the Humacao, Naguabo, and Punta Puerca quadrangles, Puerto Rico.

Two major northwest-trending transcurrent fault zones divide Puerto Rico into northeast, central, and southwest tectonic-stratigraphic blocks. The Cerro Mula fault zone separates the northeast block from the central block (fig. 1). The San Lorenzo batholith, the largest of two granodiorite batholiths in the central block, underlies much of the western part of the study area. Offset along the Cerro Mula fault zone is left lateral and is estimated to have been at least 33 km (Briggs and Pease, 1968, and oral commun., 1976). Volcanic units cannot be correlated across the fault zone. A left-lateral offset of about 3 km took place along the Peña Pobre fault zone. Plutonic rocks along the trend of the zone (fig. 1) may have been emplaced after faulting had ceased.

The three new formations discussed below are in rocks originally called the "older series" by Berkey (1915), a term also used by Fettke (1924) in his report on the Humacao area. Meyerhoff and

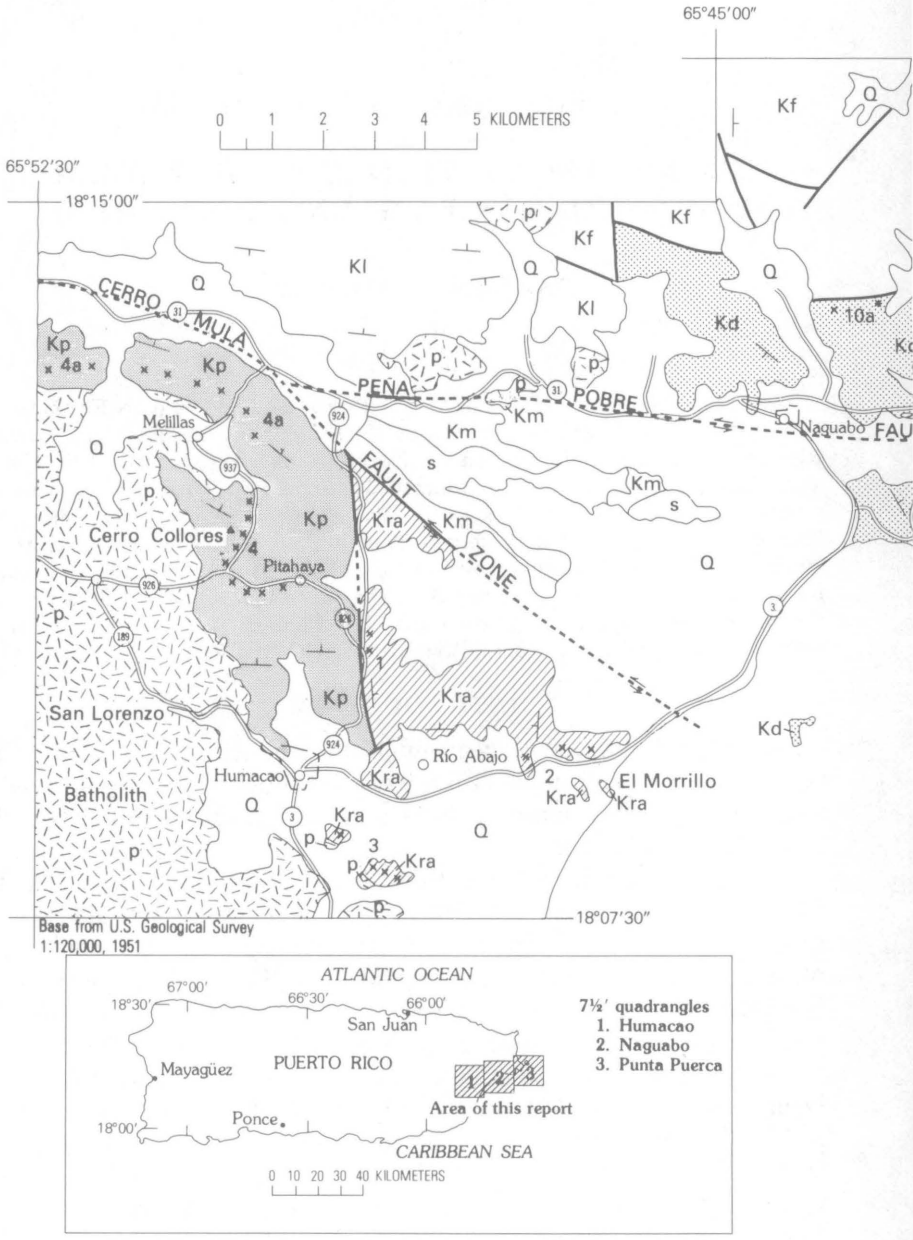
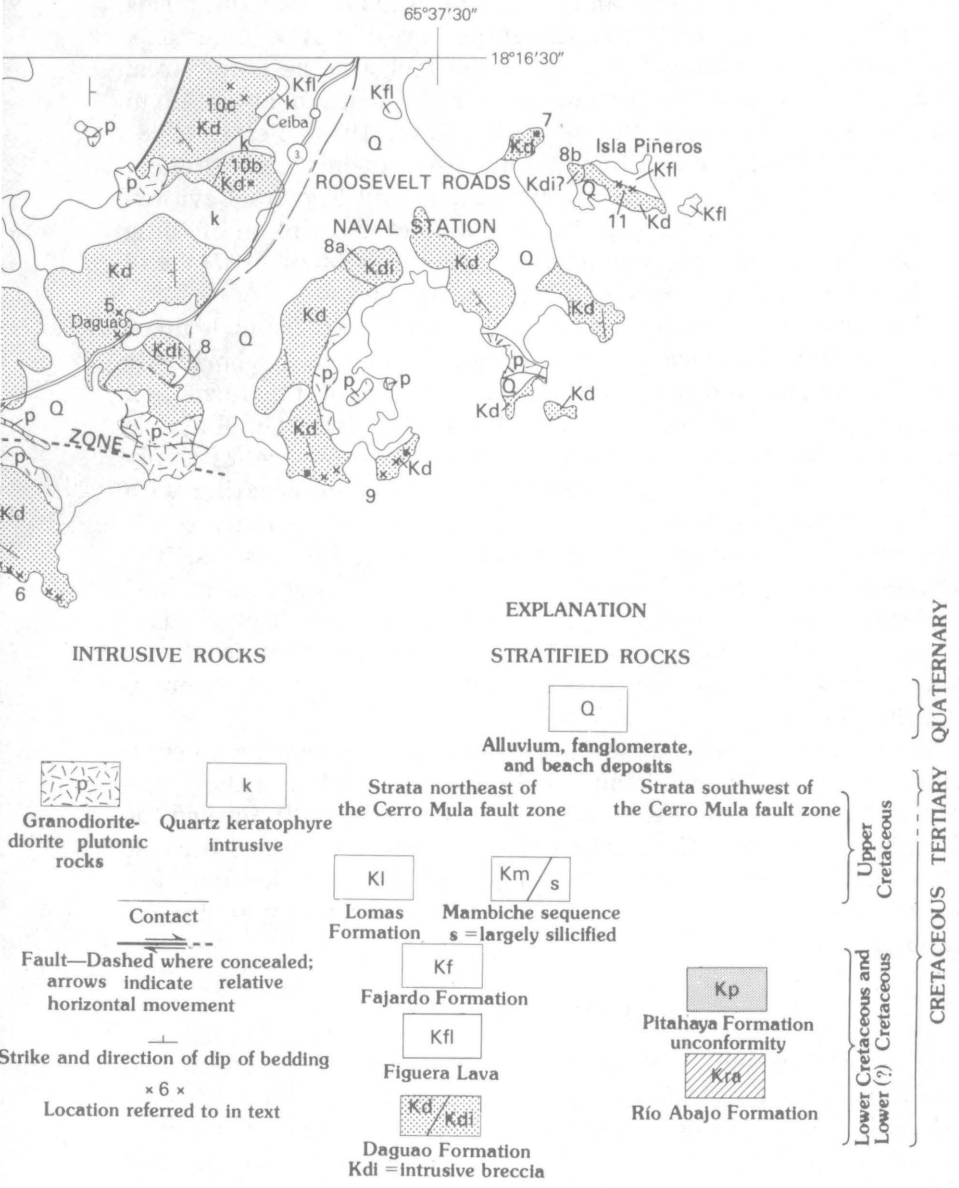


FIGURE 1.—Generalized geologic map of the Humacao,



Naguabo, and Punta Puerca quadrangles, Puerto Rico.

Smith (1931) and Colony and Meyerhoff (1935) used the terms Hata Puerco tuffs, La Muda limestone, Trujillo Alto limestone, and Luquillo formation for some of the rocks in the study area. The first three units have since been redefined and are used in other parts of northern Puerto Rico (Kaye, 1959; Pease, 1968; Seiders, 1971); the name Luquillo has been abandoned. Although the Lomas Formation, Fajardo Formation, and Figuera Lava extend into the study area (fig. 1), only a brief description of these units is given here; the reader is referred to Seiders (1971) and to Briggs (1973) for more detailed descriptions.

The Lomas Formation (Upper Cretaceous) is largely made up of thick- to very thick bedded volcaniclastic breccia and subordinate tuff, sandstone, and lava. Volcaniclastic rocks of the formation usually contain pumice and vesicular lava clasts. The Fajardo Formation (Lower Cretaceous) contains thick sequences of thinly bedded fine-grained volcanic sandstone and tuff, alternating with thick sequences of thick-bedded volcaniclastic breccia that usually contains tuff clasts in a clinopyroxene-bearing tuff matrix. The Figuera Lava (Lower Cretaceous) is a thick series of fine-grained andesitic lava that commonly contains scattered small plagioclase phenocrysts and veins and blebs of quartz and that locally is amygdaloidal. A few volcaniclastic units are scattered throughout the Figuera.

A sequence of medium- to thick-bedded pumice-bearing volcaniclastic tuff, breccia, sandstone, and minor lava between the Cerro Mula and Peña Pobre faults (fig. 1) is here informally termed the Mambiche sequence. Correlation of these rocks is difficult because they are extensively hydrothermally altered and locally very sheared. Tentatively, I suggest that the sequence may be part of the Lomas Formation.

RIO ABAJO FORMATION

A mostly andesitic volcaniclastic rock sequence is here named the Río Abajo Formation for exposures near Río Abajo (fig. 1), which is designated the type area. The rocks are Early(?) Cretaceous in age. The formation thickness is uncertain, but at least 600 m is present in the Humacao quadrangle. The formation is faulted against other stratigraphic units, and its top and bottom are not exposed. Coarse light-colored feldspar crystals in both matrix and clasts give a characteristically speckled aspect to most volcaniclastic rocks of the formation. Coarse- to fine-grained crystal and crystal-lithic tuffs predominate slightly; they are

medium gray to brownish gray, commonly massive, but also medium bedded and graded. Lithic clasts are principally tuff and less commonly fine-grained lava and lava containing feldspar phenocrysts. The matrix is mainly plagioclase (andesine) grains; hornblende is the usual mafic mineral, and clinopyroxene is less common. The rocks are commonly altered, containing epidote, chlorite, calcite, and zeolites as the secondary minerals. Crystal-lithic tuff units are well exposed in roadcuts and in a quarry along Highway 924 between 37,500 to 38,200N and 217,900E[1] (loc. 1, fig. 1). Graded tuff beds are exposed in a small borrow pit along Route 3 at 35,500N and 222,300E. Less prevalent sandstone units are lithologically similar to the tuff; bedding is generally thin to thick. Minor siltstone beds are reddish brown and thin bedded.

Polymict volcanic breccia units are widespread and irregularly interbedded with the tuff units. The breccia units are purplish and medium gray to light olive or brownish gray and thick bedded to massive. Clasts are of several kinds of subrounded to subangular tuff, dark porphyritic andesite containing feldspar phenocrysts, and light-colored porphyritic lava containing hornblende and pyroxene phenocrysts; locally the clasts are more than 20 cm in diameter. Pumice and vitrophyric clasts are rare. The matrix is generally tuffaceous and lithologically like the tuff units, but sometimes is wholly epiclastic. Minor medium-gray brownish-gray pebble to cobble conglomerate units are thick to very thick bedded, have clasts like those of the breccias, and a volcanic sandstone matrix.

Breccia and some conglomerate units are well exposed in borrow pits and quarries east of Río Abajo on the north side of Route 3 at 35,400N and 220,700E, 221,200E, and 221,800E (loc. 2, fig. 1).

Some thin dark-gray aphanitic lava flows, lava containing plagioclase phenocrysts, and autoclastic lava breccia flows are interbedded with the volcaniclastic units; a relatively thick lava unit, which has clinopyroxene phenocrysts replaced by amphibole and an epidotized chloritized matrix, may be seen near the base of the exposed section along Route 3 at 35,600N, 223,000E and at Punta El Morrillo at 34,800N, 222,800E. The volcaniclastic units are locally phyllitic. Some of the volcaniclastic units along the San Lorenzo batholith (loc. 3, fig. 1) have been metamor-

[1] Puerto Rico rectangular coordinate system in meters. Tick marks for this system are placed on the margins of all U.S. Geological Survey topographic maps of Puerto Rico, but they are not shown on figure 1 of this report because of scale.

phosed to hornblende and mica schists, in which bedding and clastic textures remain discernible.

No fossils were found in the Río Abajo Formation, and its Early(?) Cretaceous age is uncertain. However, it is lithologically similar to the informally named formation A of the Cayey quadrangle (Berryhill and Glover, 1960), which is west of the intervening San Lorenzo batholith, and the units are tentatively correlated. Formation A is unconformably overlain by the Torrecilla Breccia (Lower Cretaceous) and hence is considered to be Lower Cretaceous also (Briggs, 1969).

PITAHAYA FORMATION

A thick interbedded sequence of lava, autoclastic breccia, tuff, and tuff breccia exposed in the Humacao and Juncos quadrangles is here named the Pitahaya Formation. The type area is in the Humacao quadrangle, near the town of Pitahaya, Municipio de Humacao. Typical exposures are present along Route 926 west from Pitahaya and north along Route 937 (extended) along the side of Cerro Collores towards the town of Melillas (from 38,900N and 216,300E to 40,700N and 215,900E; loc. 4, fig. 1). A reference exposure is in a housing development cut west of Juncos at 45,000N and 205,000E, west of the study area. The Pitahaya Formation in the Humacao quadrangle is estimated to be about 2,000 m thick; the top and bottom are not exposed.

Lava flows seemingly are more abundant in the upper half of the formation. These flows are dark-greenish-gray to olive or brownish-black andesite, locally thick bedded to massive. Varieties include lava containing many clinopyroxene phenocrysts, amygdaloidal lava, fine-grained lava, and autoclastic lava breccia. The lava most commonly occurs as irregular layers, lenses, pods, and fragments within coarse-grained massive to thick-bedded pyroxene-rich crystal-lithic tuff. This lava and tuff mixture forms a distinctive and characteristic lithology of the formation. Flows having coarse (1 cm) plagioclase phenocrysts in a dark aphanitic matrix are randomly distributed throughout, a few lenses and pods of hornblende andesite are present, and massive pillow lava is found at several intervals near the top of the exposed section. Most lava flows are altered; plagioclase crystals are saussuritized, and secondary minerals include epidote, chlorite, tremolite-actinolite, and iron oxide. Local limestone fillings between lava pillows are recrystallized to marble.

Crystal tuff and volcanic sandstone units, largely of clinopyrox-

ene and plagioclase crystals, are medium to brownish gray, thin to medium bedded, and locally graded. Lapilli tuff, tuff breccia, and infrequent conglomerate units are similarly colored and generally thicker bedded. Clasts are polymict, largely of various lavas as described above, but tuff fragments are not uncommon; a few units have some pumice or vitrophyre clasts. Volcaniclastic units are usually epidotized and chloritized; some tuff is phyllitic. Limestone (marble) beds, as much as a meter thick, are scattered through upper parts of the section on Cerro Collores and in the hill east of Melillas; in a few places skarn has formed. Fairly pure massive magnetite forms thin (30 cm) lenses and massive bodies in the same approximate stratigraphic position; these appear to replace the carbonate beds.

The similarity of the lithologic sequence exposed northeast and northwest of Melillas (loc. 4a, fig. 1) to the sequence exposed on Cerro Collores to the south suggests that the units have been repeated by faulting.

Fieldwork suggests that the Pitahaya Formation represents, at least in part, an eastern facies of the Torrecilla Breccia (Lower Cretaceous). During 1976, C. L. Rogers and I traced upper parts of the Torrecilla Breccia from the Comerío quadrangle eastward across the Caguas and Juncos quadrangles to the Humacao quadrangle. These volcanic facies, undivided on the west, trace into a narrow zone of the upper part of the Pitahaya Formation in the study area along the north side of the San Lorenzo batholith (fig. 1). The Río Abajo and Pitahaya Formations are in fault contact in the Humacao area, but I postulate that the regional unconformity between the Torrecilla Breccia and underlying formations, such as formation A (Briggs, 1969), probably extends this far east and is present between the Pitahaya and the underlying Río Abajo Formation.

DAGUAO FORMATION

The Daguao Formation is here named for interbedded volcanic breccia, lava, and subordinate volcanic sandstone and crystal tuff that crop out in the Humacao, Naguabo, and Punta Puerca quadrangles. The formation is centered on the town of Daguao, Municipio de Naguabo, which is designated as the type area. In the Naguabo quadrangle, the Daguao Formation is estimated to be at least 1,000 meters thick.

The volcanic breccia is medium gray, massive, and contains

dark-gray irregularly shaped subangular to subrounded granule- to pebble-sized andesitic lava clasts in a medium-gray, coarse-grained plagioclase and clinopyroxene crystal tuff matrix. The breccia units are commonly cut by both fine-grained and porphyritic lava dikes. Breccia beds are poorly exposed and are generally only found in artificial excavations; float seen on natural slopes is largely lava clasts.

Lava flows are principally medium-dark-gray andesite that has a pilotaxitic texture and andesine-clinopyroxene phenocrysts; the lava is locally amygdaloidal. Some of this lava is autoclastic breccia that contains porphyritic andesite clasts, locally reaching a diameter of more than 5 cm, in a matrix of macerated andesite. Some dark-greenish-gray very fine grained flows are also autobrecciated.

Rocks of the Daguao Formation are altered much like those in the Río Abajo and Pitahaya Formations, but, in general, less intensively.

Typical massive tuff-breccia can be seen in housing excavations just northwest of Daguao at 44,000N, 231,500E (loc. 5, fig. 1); good breccia and lava exposures can be found along the coast, starting at 39,300N, 229,200E (loc. 6, fig. 1). A very coarse breccia, which contains lava clasts ranging from pebble to boulder size in a tuff matrix, can be seen on the point at 47,800N, 239,800E in the Punta Puerca quadrangle (loc. 7, fig. 1).

Two sizable hypabyssal intrusive bodies of andesite breccia, each about 500 m wide and locally very epidotized, were mapped in the Naguabo quadrangle. These intrusive bodies are approximately centered at 43,500N, 232,500E and 45,200N, 236,600E (loc. 8 and 8a, fig. 1). These rocks contain subangular clasts, ranging from 2 to 15 cm in diameter, of andesite that has coarse clinopyroxene and plagioclase phenocrysts in a brecciated matrix of the same composition. A similar intrusive body, which has clasts as much as 90 cm in diameter, may be present on the northwestern corner of Isla Piñeros, in the Punta Puerca quadrangle (loc. 8b, fig. 1). Presumably these intrusive bodies represent volcanic necks or conduits for much of the andesitic material in the Daguao Formation; in particular, lava clasts in the tuff breccias and the autoclastic lavas seem to be identical in composition with the intrusive bodies. Some of the autoclastic lavas that are interlayered with tuffs and breccias in the hills south of location 8a (fig. 1) may, in fact, be sills rather than flows.

Dark- to medium-gray volcaniclastic sandstone and tuff are found in stratigraphic units that are seldom more than a few meters thick. These strata are usually laminated to thinly bedded and graded, locally crossbedded, and locally thick bedded to massive. A few crystal tuff layers are hornblende rich; most sandstone and tuff beds are composed mainly of plagioclase and some clinopyroxene grains, like the matrix of the massive volcanic breccia. Laminated to thin-bedded tuff may be seen along the railroad cut that runs through Daguao, but the most extensive, thickest, and best exposed sections are found along the coast in the housing area on Roosevelt Roads Naval Station, from 41,000N, 235,500E, to 41,800N, 237,600E (loc. 9, fig. 1).

On Isla Piñeros (46,800N, 241,400E; loc. 11, fig. 1) the Figuera Lava (Lower Cretaceous) directly overlies the Daguao Formation, but elsewhere the top of the Daguao is probably gradational with the overlying Figuera Lava. Breccia and lava of the upper parts of the Daguao are seen to be intercalated with the typical fine-grained Figuera Lava in a few places (loc. 10a, b, and c, fig. 1). The base of the Daguao Formation is not exposed, but the formation is perhaps the oldest unit exposed in northeastern Puerto Rico and is considered to be entirely Early Cretaceous in age. Briggs (1969) believed that the Fajardo Formation could be correlated with the Torrecilla Breccia of similar (Albian) age, and that the Figuera Lava, which lies conformably beneath the Fajardo, could be correlated with pre-Torrecilla volcanic rocks (including formation A) of the central tectonic-stratigraphic block (Briggs, 1973). Thus, the Fajardo Formation is probably the same age as at least part of the Pitahaya Formation, and the Figuera Lava and the underlying Daguao Formation may be, in part, the same age as the Río Abajo Formation.

REFERENCES CITED

Berkey, C. P., 1915, Geological reconnaissance of Porto Rico: New York Acad. Sci. Annals, v. 26, p. 1–70.

Berryhill, H. L., Jr., and Glover, Lynn, 3d, 1960, Geology of the Cayey quadrangle, Puerto Rico: U.S. Geol. Survey Misc. Geol. Inv. Map I–319.

Briggs, R. P., 1969, Changes in stratigraphic nomenclature in the Cretaceous System, east-central Puerto Rico: U.S. Geol. Survey Bull. 1274–0, 31 p.

——— 1973, The Lower Cretaceous Figuera Lava and Fajardo Formation in the stratigraphy of northeastern Puerto Rico: U.S. Geol. Survey Bull. 1372–G, 10 p.

Briggs, R. P., and Pease, M. H., Jr., 1968, Large- and small-scale wrench faulting in an island-arc segment, Puerto Rico [abs.]: Geol. Soc. America Spec. Paper 115, p. 24.

Colony, R. J., and Meyerhoff, H. A., 1935, The magnetite deposit near Humacao, Puerto Rico: Am. Inst. Mining Metall. Eng. Trans., v. 115, p. 247–272.

Fettke, C. R., 1924, The geology of the Humacao district, Porto Rico: New York Acad. Sci., Sci. Survey Porto Rico and Virgin Islands, v. 2, pt. 2, p. 117–197.

Kaye, C. A., 1959, Geology of the San Juan metropolitan area, Puerto Rico: U.S. Geol. Survey Prof. Paper 317–A, 48 p.

Meyerhoff, H. A., and Smith, I. F., 1931, The geology of the Fajardo district, Porto Rico: New York Acad. Sci., Sci. Survey Porto Rico and Virgin Islands, v. 2, pt. 3, p. 201–360.

Pease, M. H., Jr., 1968, Cretaceous and lower Tertiary stratigraphy of the Naranjito and Aguas Buenas quadrangles and adjacent areas, Puerto Rico: U.S. Geol. Survey Bull. 1253, 57 p.

Seiders, V. M., 1971, Cretaceous and lower Tertiary stratigraphy of the Gurabo and El Yunque quadrangles, Puerto Rico: U.S. Geol. Survey Bull. 1294–F. 58 p.

☆ U.S. Government Printing Office: 1977—240–961/81