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–751

DESCRIPTION OF MAP UNITS

Qb *Beach deposits,* sand composed of rounded grains of quartz, volcanic rock, and shell; includes low longitudinal dunes west of Punta Corozo. Generally 1–5 m thick.

Qbr *Beach rock,* layers of beach sand west of Palo Seco cemented by calcium carbonate into beach rock. Generally 1 m or less thick.

Qr *Reef deposits,* at Punta Corozo and Punta Salinas coarse calcarenite contains many shells and corals; overlain at Punta Corozo by beach sand, at Punta Salinas by eolianite.

Qs *Swamp deposits,* sandy muck and clayey sand; some areas underlain by peat (Roberts and others, 1942). Much of the area now covered by fill was originally swamp deposit. Generally less than 10 m thick.

Ql *Landslide deposits,* masses of soil, calcareous clay, and limestone rubble, containing blocks of limestone as long as 25 m.

Qa *Alluvium,* sand, clay, and sandy clay; beds of sand containing gravel and cobbles in valleys of Río de Bayamón and Río de la Plata; mostly sandy clay in other valleys. The seaward parts of the valleys of the Río de Bayamón and the Río de la Plata are apparently deltas of the two rivers which built out into a lagoon now filled in by alluvium to form the large swamps in the northern part of the quadrangle. Thickness variable; as much as 25 m has been penetrated in some wells.

Qt *River-terrace deposits,* sandy clay and gravel containing cobbles and boulders of volcanic rock and silicified hydrothermally altered rock. Generally less than 10 m thick.

Qss *Silica sand,* very pure quartz sand derived from the more sandy parts of the blanket deposits by leaching. The sand is generally more than 99 percent silica (Meyerhoff and Frazier, 1945), but locally contains organic matter. The deposits grade downward into compact ferruginous sand mapped as blanket deposits. The surface is characterized by low dunes and shallow deflation hollows. Thickness ranges from 1–4 m.

Qe *Eolianite,* friable to consolidated, crossbedded calcareous eolian sandstone composed of fine to coarse grains of shell fragments and quartz. Maximum thickness about 25 m.

QTb *Blanket deposits,* principally compact fine-grained yellow to white semiconsolidated generally crossbedded quartz sandstone; locally grades into deposits of red sandy clay. Much of the sandstone is strongly jointed, especially near Arenas, at La Arena, and in River View. Grades upward at some places into silica sand. Locally more than 15 m thick.

Tay *Aymamón Limestone,* white to very pale orange, locally pale-yellow and grayish-pink, massive to thick-bedded very pure fossiliferous limestone; generally indurated by secondary cementation into finely crystalline rather dense limestone (Monroe, 1966); locally a rubble of recemented solution breccia. Commonly solution riddled and weathered on surface into dense limestone having abundant sharp spires as much as 30 cm high. Contact with underlying Aguada Limestone apparently gradational in this area. Maximum exposed thickness about 65 m.

Ta *Aguada Limestone,* alternating thick beds of indurated very pale orange to pink fine calcarenite and grayish-orange to very pale orange clayey and chalky limestone, locally containing scattered grains of quartz; locally fossiliferous. In the map area both upper and lower contacts appear to be gradational, except in the western part where the top of the formation contains abundant thin-bedded limestone. At west edge of quadrangle about 70 m thick. The lower, more sandy and clayey part of the Aguada intertongues with the Cibao Formation between Toa Alta and Bucarabones, and farther east, the formation is only about 35 m thick.

Tcu *Cibao Formation, upper member,* chalk, soft limestone, and very pale orange sandy clay. Upper part intertongues with the Aguada Limestone in western quarter of quadrangle. Lower part grades laterally eastward into Mucarabones Sand. Thickness ranges from 35–65 m.

Tcmi *Cibao Formation, Miranda Sand Member,* mottled pink to white clayey fine quartz sand that fills channel in Quebrada Arenas Limestone Member. Recognizable only near Bucarabones, where it reaches a maximum thickness of about 15 m.

Tcq *Cibao Formation, Quebrada Arenas Limestone Member,* alternating thick beds of very pale orange indurated limestone and soft marly limestone. Pinches out east of Las Arenas, probably by grading into the Mucarabones Sand. 0–30 m thick.

Tcr *Cibao Formation, Río Indio Limestone Member,* yellowish-orange indistinctly bedded earthy limestone, some thick beds of sandy clay and sandy limestone. Lower part grades eastward into sand, sandy limestone, and clay of Mucarabones Sand near Bucarabones; upper 25 m grades eastward into fine yellow sand of Mucarabones near Las Arenas. Maximum thickness in western part of quadrangle about 70 m.

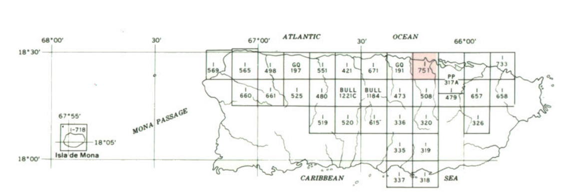
Tm *Mucarabones Sand,* in southwestern part of quadrangle grayish-orange to yellowish-brown crossbedded medium to coarse calcareous sand. Farther east successively higher parts of the Cibao Formation intertongue and grade laterally eastward into the Mucarabones Sand. In Bayamón the lower part of the sand, resting sharply on the San Sebastián Formation, consists of grayish-orange to dark-yellowish-orange clayey medium to coarse sand. Still farther east near Villa España the lower part of the formation consists of crossbedded coarse quartz sand containing lenses of subangular to subrounded gravel and lenses of greenish-gray sandy clay. The upper part, laterally equivalent to the upper part of the Río Indio Limestone consists of distinctive grayish-orange to yellow crossbedded fine to medium sand. Scattered through the middle and upper parts of the formation are lenses of sandy limestone and very pale orange to grayish-brown sandy clay, both richly fossiliferous; cuts on a hill 1.2 km west of Escuela Alberto Schweitzer yielded many large oysters and large echinoid spines as much as 10 cm long. Thickness varies greatly because of intertonguing with the Cibao Formation, and reaches a maximum of about 120 m south of Hato Tejas; farther east, unit appears to thin to about 90 m near the eastern boundary of the map area.

Ts *San Sebastián Formation,* red and gray mottled clayey sand containing lenses of gray and purple mottled sandy clay, some lenses of coarse quartz sand. In southeastern part of quadrangle mostly breccia of sandy clay containing pebbles and cobbles of silicified volcanic rock. Thickness varies because of unconformable contact with underlying units. Average thickness about 70 m.

Tr *Río Piedras Siltstone,* well-stratified, thin-bedded, partly laminated, mostly fine-grained tuffaceous siltstone and sandstone. In fresh exposures unit is medium gray, but in most outcrops it is weathered to yellowish, reddish, and greenish gray and brown. More than 1,000 m thick in exposures in the quadrangle.

TKd *Quartz diorite,* small patches of weathered yellowish-gray friable rock containing hornblende and hexagonal gold-brown biotite flakes crop out beneath the San Sebastián Formation along the southern border of the quadrangle.

af *Artificial fill,* sand, limestone, and volcanic rock transported to fill in valleys, swamps, and locally part of Bahía de San Juan. Much of the topography of the built-up area of the quadrangle has been altered by bulldozers. Only the larger masses of fill are shown. Generally less than 5 m thick.



Base from U.S. Geological Survey, 1969
2000-meter grid based on Puerto Rico system

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1973—G72130

Geology by W. H. Monroe, 1959, 1960, 1962, 1969; rocks older than San Sebastián Formation. mapped by M. H. Pease, Jr., 1960

SCALE 1:20 000

1 MILE · 7000 FEET · 1 KILOMETER

$7\frac{1}{2}$° TRUE NORTH MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1969

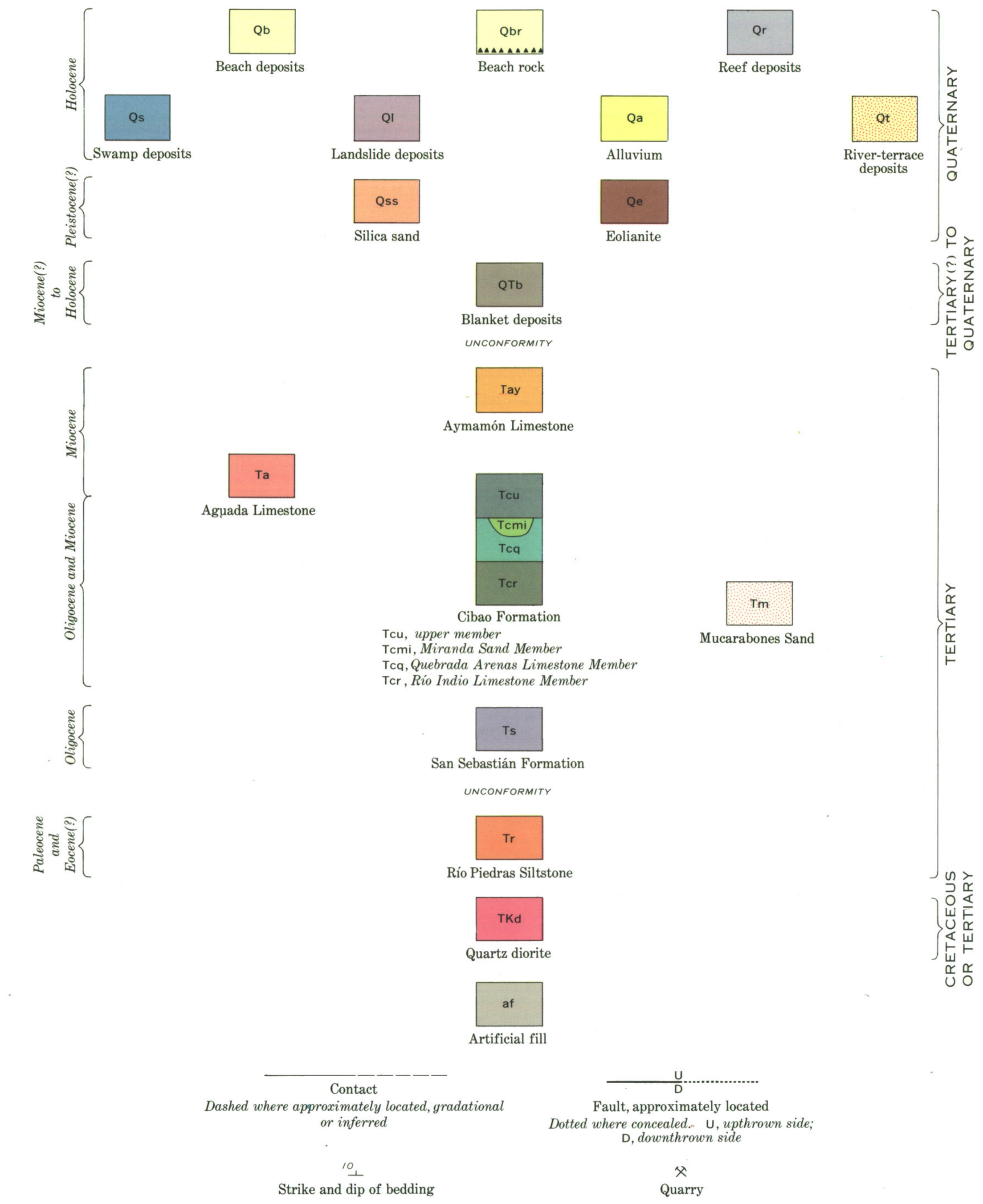
CONTOUR INTERVAL 5 METERS
DOTTED LINES REPRESENT 1-METER CONTOURS
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 0.3 METERS

PUERTO RICO
QUADRANGLE LOCATION

GEOLOGIC MAP OF THE BAYAMÓN QUADRANGLE, PUERTO RICO

By
Watson H. Monroe
1973

EXPLANATION



FACIES CHANGES

In the western part of the Bayamón quadrangle the lower part of the middle Tertiary sequence consists chiefly of carbonate rocks. These rocks grade eastward into clastic facies. This change begins about 25 km farther west in the Ciales quadrangle, where the lower 5–20 m of the Lares Limestone grades eastward into calcareous sandstone considered part of the Mucarabones Sand. The transition from Lares Limestone to Mucarabones Sand is completed in the Corozal quadrangle, just southwest of the Bayamón quadrangle. In the Bayamón quadrangle the transition continues upward into the Cibao Formation (fig. 1). In the southwestern part of the quadrangle the Cibao Formation is lithologically the same as it is farther west and consists of several limestone members, calcareous clay, and lenses of sand. Eastward, the entire lower part of the Cibao intertongues with the Mucarabones, so that in the eastern part of the quadrangle only the upper part is distinctively calcareous.

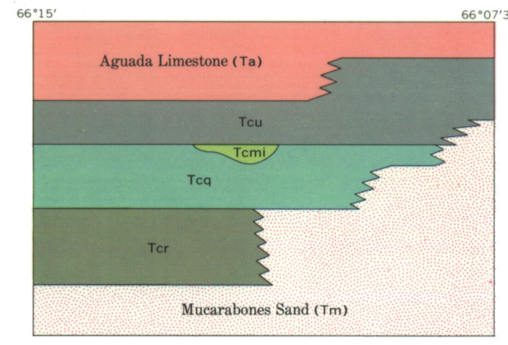


Figure 1.—Generalized facies relations of the Aguada Limestone, Cibao Formation, and Mucarabones Sand in the Bayamón quadrangle. See map for letter symbol explanation.

This facies change also affects the Aguada Limestone, which consists of alternating layers of hard and soft limestone in the adjacent (to the west) Vega Alta quadrangle. In the hills east of the Río de La Plata, however, the lower 35 m of the Aguada intertongues with calcareous clay and unconsolidated sandy limestone undistinguished from the upper member of the Cibao Formation. A thin layer of calcarenite that probably is equivalent to the basal bed of the Aguada farther west can be recognized for about a kilometer east of the Río de La Plata; farther east the calcarenite cannot be identified in the Cibao Formation.

ECONOMIC GEOLOGY

Limestone.—Limestone used mainly for fill has been quarried extensively from the Aguada Limestone in the hills south and northeast of the village of Hato Tejas and north and northwest of the Escuela Superior of Bayamón. A quarry on Highway 2 in Candelaria produces limestone used for making terrazzo tiles.

Sand and gravel.—Sand and gravel for concrete aggregate are excavated from several pits in the flood plain of the Río de La Plata south of Toa Alta, mainly just west and south of the Bayamón quadrangle. Suitable material is present within the quadrangle in the flood plain of the river as far north as San José. Quartz sand has been excavated for use as concrete aggregate in pits on the west side of the small valley west of the Puerto Rico National Cemetery.

Made land.—Large areas of the swamp at the east edge of the quadrangle south of the Bahía de San Juan have been filled in to provide land for industry and housing. Most of the valleys in the southern and southwestern parts of Bayamón have been filled in and largely paved and the streams canalized in building the many suburbs. Most of the soil in these areas has been covered with houses and streets, so that rain water no longer penetrates the sand as freely as it used to and floods are becoming progressively greater (López, 1962).

REFERENCES CITED

López, M. A., 1962, Floods at Bayamón and Cataño, Puerto Rico: U.S. Geol. Survey Hydrol. Atlas HA–77.
Meyerhoff, H. A., and Frazier, J. E., 1945, Glass sand and a glass industry in Puerto Rico: Mining Technology, v. 9, no. 6, 9 p.
Monroe, W. H., 1966, Formation of tropical karst topography by limestone solution and reprecipitation: Caribbean Jour. Sci., v. 6, nos. 1–2, p. 1–7.
Roberts, R. C., and others, 1942, Soil survey of Puerto Rico: U.S. Dept. Agriculture, Soil Survey Rept., ser. 1936, no. 8, 503 p.

ENGINEERING GEOLOGY

Rock type and geologic map symbol	Distribution	Excavation facility	Strength and stability	Utilization	Miscellaneous
Tuffaceous siltstone and sandstone, Tr	In southeastern part of quadrangle	Moderately difficult to work, probably requiring explosives except in weathered outcrops. Cleavage along bedding planes, however, facilitates excavation except at depth where rock is firmly cemented, requiring the same quarrying methods as massive rock.	Foundation strength good for most construction purposes. Slope stability generally good, but strength and stability may be poor where strata dip approximately parallel to the slope of the land surface.	Has been quarried for fill. Not recommended for use as coarse concrete aggregate.	Small quarries opened in past near southeast corner of quadrangle. In adjacent part of San Juan quadrangle, several hills of this material were scraped off and used to fill in nearby valleys.
Quartz diorite, TKd	Small areas along south-central border of quadrangle	Highly weathered material at or near surface easily worked. Unweathered rock at depth difficult to work.	Foundation strength generally good. Stability of weathered material fair.	Used only as fill.	
Limestone, Tay, Ta (upper part), Tcq, Tcr	Belts in southern half of quadrangle	Surface rock moderately difficult to work because of surficial hardening; rock below surface moderately easy to moderately difficult. Explosives generally not required.	Foundation strength generally good. Stability good except where rock is underlain by clay.	Quarried for use as fill and for terrazzo chips.	Quarry on north side of Highway 2 in Candelaria is used for production of terrazzo chips.
Calcareous clay, sandy clay, and silty clay, Ta (part), Tcu, Ts	Mostly in southern half of quadrangle	Moderately easy to work with power equipment or hand tools.	Foundation strength fair on flat ground, poor on slopes; stability poor.	Suitable for fill when mixed with limestone.	
Sand and sandstone Qb, Qbr, Qr, Qa (part), Qt, Qss, Qe, QTb, Tcmi, Tm	Throughout quadrangle	Easy to moderately easy to work using power equipment or hand tools.	Foundation strength generally good, but piling may be needed. Stability good.	Suitable for concrete aggregate except when clayey. Qss used elsewhere as glass sand.	
Swamp deposits, Qs	In northern half of quadrangle	Easy to work but excavations are wet.	Foundation strength poor, piling required.	In some areas contains peat suitable for soil conditioning.	In many areas mapped as fill, swamp has been covered.
Landslide deposits, Ql	Near San José at western edge of quadrangle and south of Fort Buchanan at eastern edge.	Easy to difficult to work. Explosives may be required to break up large blocks of limestone.	Foundation strength for large structures poor. Stability poor. Deposits may exhibit a deceptive temporary stability, but renewed movement may take place after heavy rain.	Possible use as fill, but not generally recommended.	
Fill, af	In east, south of Bahía de San Juan and south and southwest of Bayamón.	Easy to work.	Foundation strength poor where fill is laid on swamp deposits. Piling required.		