DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF PUERTO RICO

HYDROLOGIC INVESTIGATIONS
ATLAS HA-197

Base by U.S. Geological Survey, 1952

Hydrology by C. L. McGuinness, 1946; and P. E. Ward, 1964

SCALE 1:240 000

10 0 10 20 30 MILES

10 0 10 20 30 40 KILOMETERS

EXPLANATION

QUATERNARY

Pleistocene and (or) Recent

Qa — Alluvial deposits

Sand, silt, clay, and gravel floodplain and terrace deposits, and piedmont fan deposits; also includes colluvium at margins of alluvial deposits
**Yield variable, depending on thickness and grain size. Contain large quantities of water and have large yield in fans on south coastal plains where deposits are thickest and are recharged readily from surface-water sources. Wells in thick gravel beds yield as much as 4,000 gpm. Yield large volumes of water in some valleys along larger streams. Water usually is hard, but otherwise suitable for most purposes*

Ql — Landslide deposits

Commonly composed of blocks and residual boulders 10 feet or more across in a matrix of clay, sand, and gravel
Mostly dry. Small supplies may issue from lower part of slides

Qb — Beach and dune deposits

Largely calcite, quartz, and (or) volcanic-rock-fragment sand with locally conspicuous magnetite; includes pebble and cobble deposits and organic reef rubble, especially along the south coast; locally includes cemented sand (beach-rock) in bands parallel to the shore; includes some made-land at San Juan, Mayagüez, and Playa de Ponce
Usually contain salt water. In some areas where rainfall is high and recharge conditions are favorable, small quantities of water suitable for domestic supplies can be skimmed from the upper part of the ground-water body

Qs — Swamp and marsh deposits

Largely organic swamp muck, locally sandy or silty, and peat; water in these swamps is commonly moderately saline; includes some made-land at San Juan, Mayagüez, Playa de Ponce, and near Punta Puerca
Usually contain brackish water near shoreline, but in a few areas contain fresh water

Pleistocene

Qd — Compound dunes

Friable eolianite and marine sandstone largely composed of calcite and quartz; some hard calcarenite beds 10 feet or less in thickness; located principally along the north coast
Probably contain salt water in most areas

TERTIARY

Miocene to Recent

QTb — Blanket deposits

Quartz sand, clayey sand, sandy clay, and clay; principally in the north coastal plain and in areas of karst topography developed on strata of Oligocene and Miocene age
May contain small perched water bodies where underlain by impermeable beds. Unimportant except for small domestic supplies

NORTHERN PUERTO RICO

QUATERNARY / TERTIARY — *Miocene*

Tc — Camuy Formation

Punky fragmental limestone and marl containing some sandstone and hard limestone beds; some discontinuous dolomite beds. Maximum thickness about 600 feet
May contain considerable amounts of water where formation extends down to water table

UNCONFORMITY

Ta — Aymamón Limestone

Thick-bedded and massive dense limestone and calcarenite; some dolomite beds. Rocks in natural outcrops are commonly hard as a result of surficial recrystallization, but rocks are commonly soft and chalky in excavations. Thickness ranges from about 630 feet to possibly 1100 feet
Yield variable because water occurs in fractures and solution cavities, which may or may not be present at a particular site; in general yields are large. Wells between Arecibo and Toa Baja yield from 10 to as much as 3,600 gpm. Water levels inland are deep below land surface, and the base of the formation is above the regional water table in the southern part of the outcrop area. Large supplies of water can be developed from this formation between Aguadilla and Toa Baja. Heavy pumping near the ocean would induce salt-water intrusion. Water hard, but otherwise suitable for most purposes

Tag — Aguada Limestone

Hard, thick-bedded to massive calcarenite and dense limestone interbedded with chalky limestone and marl; commonly contains some quartz grains; locally thin-bedded near top. Thickness ranges from 100 to possibly 580 feet
Yield variable because water occurs in fractures and solution cavities which may or may not be present at a particular site. Wells yield from 1 to more than 2,000 gpm, but most have large yields. Large supplies probably can be developed between Aguadilla and Sabana Seca. However, the water table in the formation is near sea level and where land altitudes are high, water levels are deep. Base is above the regional water table in the southern part of outcrop area where formation probably does not contain water except where perched water bodies occur. Large withdrawals of water from this formation near the ocean probably will induce salt-water intrusion. Water hard, but otherwise suitable for most purposes

Tcb — Cibao Formation

Interbedded marl, chalk, and limestone; some thin sand and clay beds; occasional conglomerate lenses; grades eastward into the upper part of the Lares Limestone between the Río Camuy and the Río Grande de Arecibo and westward into the upper part of the Lares Limestone between the Río Grande de Arecibo and the Río Grande de Manatí; grades eastward into the San Sebastián Formation near Bayamón; apparently pinches out westward near Aguadilla. Thickness ranges from 0 to about 1000 feet
Yield small to moderate in areas where formation is below regional water table; unlikely that large supplies can be developed

Oligocene

Tl — Lares Limestone

Thick-bedded to massive dense limestone and calcarenite; grades eastward into the San Sebastian Formation near Toa Alta; pinches out westward near Moca; in central area upper part grades eastward and westward into the Cibao Formation. Thickness ranges from 0 to about 1650 feet
Yield varies from less than 1 to 200 gpm, but wells intercepting solution channels should have large yields. May be dry in areas where base of formation is considerably above sea level

Tss — San Sebastián Formation

Largely composed of clay and sand beds with conglomerate near the base; some limestone lenses; does not crop out in the central part of northern Puerto Rico. Thickness ranges from 0 to possibly 1075 feet
Not known to contain water west of Río Grande de Arecibo. One well in Bayamón area is reported to obtain moderate supplies from this formation

SOUTHERN PUERTO RICO

UNCONFORMITY

Tpu / Tpl — Ponce Limestone

Tpu, upper member, hard thick-bedded and finely crystalline limestone and calcarenite; locally contains beds of shale. Maximum thickness about 1310 feet. Upper member is of Miocene age
Dry in most areas; probably contains salt water near the sea
Tpl, lower member, chalky, thin- to medium-bedded limestone; some massive limestone; locally contains beds of shale and sand. Maximum thickness about 2950 feet. Lower member ranges in age from Oligocene to Miocene
Yield small to moderate. In general, best yields are obtained where unit is near sea level. Water usually is hard

Tj — Juana Díaz Formation

Shale, sandy limestone, and sandy conglomerate; does not crop out in the area just west of Peñuelas. Thickness ranges from 0 to 2150 feet
Yield small and water usually has high content of chloride and sulfate. Locally contains fresh water

Tu — Marine sedimentary rocks, undivided

In southwestern Puerto Rico includes strata probably equivalent to the Juana Díaz Formation and (or) the Ponce Limestone; on Isla Caja de Muertos includes strata probably equivalent to the Ponce Limestone; on Isla Mona includes the Isla Mona Limestone of Miocene age and the Lirio Limestone of Pliocene or Pleistocene age; on Vieques includes the Puerto Ferro Limestone of Miocene age
Probably contain salt water in most areas due to nearness to the sea. May contain a lens of fresh water on salt water on Isla Mona

TERTIARY

Paleocene and Eocene

Ts / Tsl — **Siltstone, sandstone, conglomerate, lava, and tuff

Probably mostly deposited in a marine environment; Tsl, extensive algal limestone beds, locally at base. Locally deeply weathered. Unit as shown on map probably includes some plutonic rocks and some hydrothermally altered rocks and may include some strata of Cretaceous age. Total thickness may exceed 6000 feet
Yield small to moderate. A few wells were abandoned because of low yields. Limestone units have best potential for moderate yields

LOCAL UNCONFORMITY

Upper Cretaceous

Kt / Ktl — **Tuffaceous sandstone, siltstone, breccia, and conglomerate, lava, and tuff

Marine lava, tuff, and volcanic sandstone and siltstone predominate in lower part; in upper part marine and subaerial tuffaceous conglomerate and subaerial and marine tuff and tuffaceous breccia predominate; Ktl, some pure and impure limestone lenses most common in the southwestern and south-central parts of the map; some hydrothermally altered rocks. Extensive deep weathering. Unit as shown on map includes all Cretaceous strata believed to be stratigraphically above the base of the Robles Formation (Pease and Briggs, 1960.) However, the lower part of the Robles Formation may be of Early Cretaceous age. As shown also may include some strata of Paleocene and (or) Eocene age. Total thickness may exceed 20,000 feet
Yield variable, usually small, but limestone units may yield as much as 1,500 gpm to wells. Moderate supplies obtained where overlain by water-bearing alluvium

LOCAL UNCONFORMITY

Lower Cretaceous

Kl / Kll — **Lava, lava breccia, tuff, and tuffaceous breccia

Largely deposited in a marine environment; some thin-bedded sandstone and siltstone; Kll, some limestone lenses; some hydrothermally altered rocks; some amphibolite. Extensive deep weathering. Some strata of Late Cretaceous age may be included within this map unit. Total thickness may exceed 30,000 feet
Yield small to moderate. Best yields obtained where unit is overlain by water-bearing alluvium

UNCONFORMITY

TKs / TKsl — **Volcanic rocks, undivided

Sandstone, siltstone, conglomerate, lava, tuff, and tuffaceous breccia largely deposited in a marine environment. TKsl, some limestone on Isla de Vieques. Extensive deep weathering. Unit as shown on map contains a few localities from which Paleocene and (or) Eocene fossils have been recovered, but other evidence indicates that most of these rocks may be Late Cretaceous in age
Yield variable. Limestone units in places may yield moderate to large quantities of water. Several wells near Rincón yield 5 to 250 gpm

TKp — **Plutonic rocks

Largely granodiorite and quartz diorite; some diorite; minor quartz porphyry, gabbro, and amphibolite; believed to have been emplaced during the Late Cretaceous, Paleocene, and Eocene. Includes some hydrothermally altered rock and some areas of complexly and intimately associated plutonic and volcanic rock. Locally deeply weathered
Yield small, generally less than 10 gpm. Important only for small domestic supplies

Ks — Serpentinite

Serpentinized peridotite(?); probably emplaced during the Early or early Late Cretaceous. Includes small areas of volcanic rocks of Early Cretaceous(?) age. Extensive deep weathering
Yields small supplies in some areas, but not a good source of water. Water occurs in fractures and in weathered zones

TERTIARY — CRETACEOUS AND TERTIARY — CRETACEOUS — CRETACEOUS(?)

Contact
Dashed where gradational or position uncertain, dotted where concealed

Fault
Dashed where approximately located, queried where doubtful or inferred, dotted where concealed; U, indicates upthrown side, D, downthrown side; arrows show directions of apparent strike-slip movement; teeth on upper plate of thrust fault

Crest of anticline
Showing direction of plunge. Dashed where approximately located, queried where inferred

Trough of syncline
Showing direction of plunge

Overturned syncline

Strike and direction of dip
Shows general attitude of strata in vicinity of symbol

Strike and direction of dip of overturned strata

Horizontal strata

*In reference to yield "small" means less than 50 gpm (gallons per minute), "moderate" means 50 to 250 gpm, and "large" means more than 250 gpm

**These rocks are extensively shattered by faulting and locally, especially near larger streams, may yield moderate to large quantities of water. Springs having small discharge are common in these rocks

REFERENCES

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HYDROGEOLOGIC MAP OF PUERTO RICO AND ADJACENT ISLANDS

By
Reginald P. Briggs and J. P. Akers
1965

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For sale by U.S. Geological Survey, price 75 cents