DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF PUERTO RICO
DEPARTMENT OF NATURAL RESOURCES

MISCELANEOUS INVESTIGATIONS
MAP I - 735

# GEOLOGIC MAP OF THE RÍO DESCALABRADO QUADRANGLE, PUERTO RICO

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## EXPLANATION

### UNCONSOLIDATED SURFICIAL DEPOSITS

**Qf** — Alluvial fan deposits
*Mixed sand, silt, and gravel*

**Qap / Qaps** — Alluvial plain deposits
**Qap**, *sand, gravel, silt, and clay in varying proportions*
**Qaps**, *saline deposits of similar composition*
*0–1,000 m thick*

**Ql** — Landslide deposits

**Qc** — Colluvium
*Sand, gravel, and silt in varying proportions*

**Qa** — Alluvium
*Sand, gravel, silt, and clay in varying proportions*

**Qat** — Alluvial terraces
*Sand, gravel, silt and clay in varying proportions*

QUATERNARY

UNCONFORMITY

### STRATIFIED ROCKS

**Tp** — Ponce Limestone
*Thin- to thick-bedded, light-gray to buff soft limestone. Matriz partly to completely recrystallized and locally dolomitic. Greater than 380 m thick*

Upper Oligocene and lower Miocene

**Tjd** — Juana Díaz Formation
*Conglomeratic sandstone and conglomerate, calcareous lithic arenite and minor limestone; medium bedded to massive. Greater than 200 m thick*

Lower and middle Oligocene

UNCONFORMITY

**Tds, Tdl, Tds, Tdc** — Río Descalabrado Formation
*Dacitic and andesitic tuff and mudstone, Tds; minor thin limestone lenses, Tdl; and rare pebble to cobble conglomerate, Tdc. Mostly thin to medium bedded; common graded bedding and small-scale crossbedding. Tuffaceous strata are commonly greenish gray to light olive gray plankton-rich microfauna. Greater than 500 m thick*

**Tgb** — Guayo Formation
*Conglomeratic lapilli tuff, tuff, and minor mudstone, thick bedded and massive. Interfingers with Río Descalabrado Formation. Greater than 200 m thick*

**Tc** — Cuevas Limestone
*Algal limestone (biomicrite) with an intact framework of coarse to fine fragments of calcareous red algae; thick-bedded or massive, less commonly thin bedded; nearly white but the basal impure facies may be grayish red. 35 m thick*

Middle Eocene

Jacaguas Group

**Tlpt, Tlps, Tlpt, Tlpt** — Los Puertos Formation
*Tuff breccia and conglomeratic tuff breccia, Tlpt; tuff, Tlps; minor limestone, Tlpl. Mostly pyroxene and feldspathic-andesite in massive to thick-bedded units; grayish-red-purple to pale-brown. Interbeds of plankton-bearing tuffaceous mudstone. Some reworked rudistids. Grades laterally into the Raspaldo Formation. Base concealed by faulting. Greater than 350 m thick*

**Trs, Trl, Trs** — Raspaldo Formation
*Dacitic and andesitic tuff and mudstone, Trs; minor limestone, Trl; and minor conglomerate, (not mapped). Tuff and mudstone are light olive gray to yellowish gray; thin- to medium-bedded, with common graded bedding and some small-scale crossbedding. The fauna is plankton-rich. Rudistids reworked from older formations are rare to common. Greater than 600 m thick*

Lower Paleocene to lower Eocene

**TKmi, TKmil, TKmi** — Miramar Formation
*Coarse, red volcanic-wacke conglomerate with abundant reworked dacite tuff, TKmi; medium- to thick-bedded; contains an oyster-rich limestone at and near the tops, TKmil. About 700 m thick*

Upper Cretaceous to Eocene

Maastrichtian

UNCONFORMITY

**Kcot < Kcof** — Coamo Formation
*Massive to thick-bedded coarse pyrozene-andesite tuff breccia and tuff, Kcot; dark-gray to reddish- and greenish-black predominate; pyrozene-andesite lava, Kcof. Greater than 1500 m thick*

Campanian or Maastrichtian

**Kl** — Limestone in Esmeralda fault breccia (mb)

**Kmab, Kmal, Kmas, Kmad** — Maravillas Formation
*Hornblende-rich, andesitic, marine-deposited lapilli tuff, Kmab and San Diego Member, Kmad; tuff and tuffaceous mudstone, Kmas; Santa Ana Limestone Member, Kmaa and a younger limestone, Kmal. Maravillas Formation undivided, Kmau. All coarse pyroclastic units tend to be massive and thick bedded. Abundant macrofossils, planktonic and benthonic microfossils. 460 to 1400 m thick.*

Upper Cretaceous
Upper Santonian(?), Campanian, Maastrichtian(?)

**Kc, Kcc** — Cariblanco Formation
*Coarse bimodal conglomerate of well-rounded pebbles; cobbles, and boulders of pyrozene-andesite lava and dacite welded tuff, Kcc; coarsely conglomeratic rocks grade into fine conglomerate and reworked tuff and tuffaceous mudstone, Kcs; minor limestone, Kcl. Cariblanco undivided, Kc. Most rocks are drab shades of green and gray. 800 to 1000 m thick*

**Ka** — Achiote Conglomerate
*Red tuffaceous-wacke conglomerate and tuffaceous wacke. Very well rounded cobbles and boulders of pyrozene-andesite lava and dacite welded tuff. Medium- to thick-bedded. Interfingers with the Cariblanco Formation. About 800 m thick*

Santonian

CRETACEOUS

### FRAGMENTAL ROCK

**mB** — Megabreccia formed by recurrent movement along fault; contains fragments and blocks of all units from the Río Descalabrado Formation to the Coamo Formation, and may possibly contain some fragments as old as the Robles Formation (Albian to Santonian)

CRETACEOUS(?) OR TERTIARY(?)

### INTRUSIVE IGNEOUS ROCKS

**TKd** — Dacite and quartz-microdiorite dikes
*Some dikes may be of latest Cretaceous age, others may be as young as middle Eocene*

TERTIARY

CRETACEOUS

**Kca** Zanja Blanca diorite stock; **Kcd** Pyroxene andesite dikes

Upper Cretaceous

**hd** — Hornblende diorite

AGE UNKNOWN

Contact
*Long dashed where approximately located; short dashed where indefinite; dotted where concealed; queried where doubtful*

Fault, showing dip
*Long dashed where approximately located; short dashed where indefinite; dotted where concealed; queried where doubtful. U, upthrown side; D, downthrown side. Arrows show relative horizontal movements. Small (D) and (U), in parentheses, indicate minor earlier or later movement directions*

Thrust fault
*Sawteeth on upper plate. Long dashed where approximately located; short dashed where indefinite; dotted where concealed; queried where doubtful*

Fault plane in section
*T, toward observer; A, away from observer*

Anticline
*Showing crestline and direction of plunge. Dotted where concealed*

Syncline
*Showing troughline and direction of plunge. Dashed where approximately located*

Inclined · Approximate · Overturned (Graded bedding observed) · Horizontal · Vertical · Overturned (Based on structural interpretation)

Strike and dip of beds
*Position of 90 on vertical bed indicates top. Ball indicates top of beds known from sedimentary structures*

Strike and direction of dip of beds

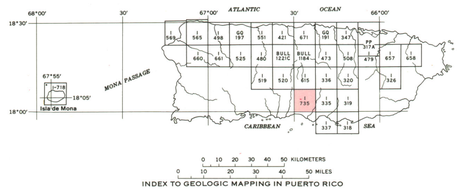
Inclined · Vertical
Strike and dip of joints

Plunging · Horizontal
Bearing and plunge of minor fold axis

Paleoslope direction inferred from sedimentary feature

Thermal Spring · Quarry · Portal of adit

Veins
Cu, *copper minerals*
Mn, *manganese minerals*

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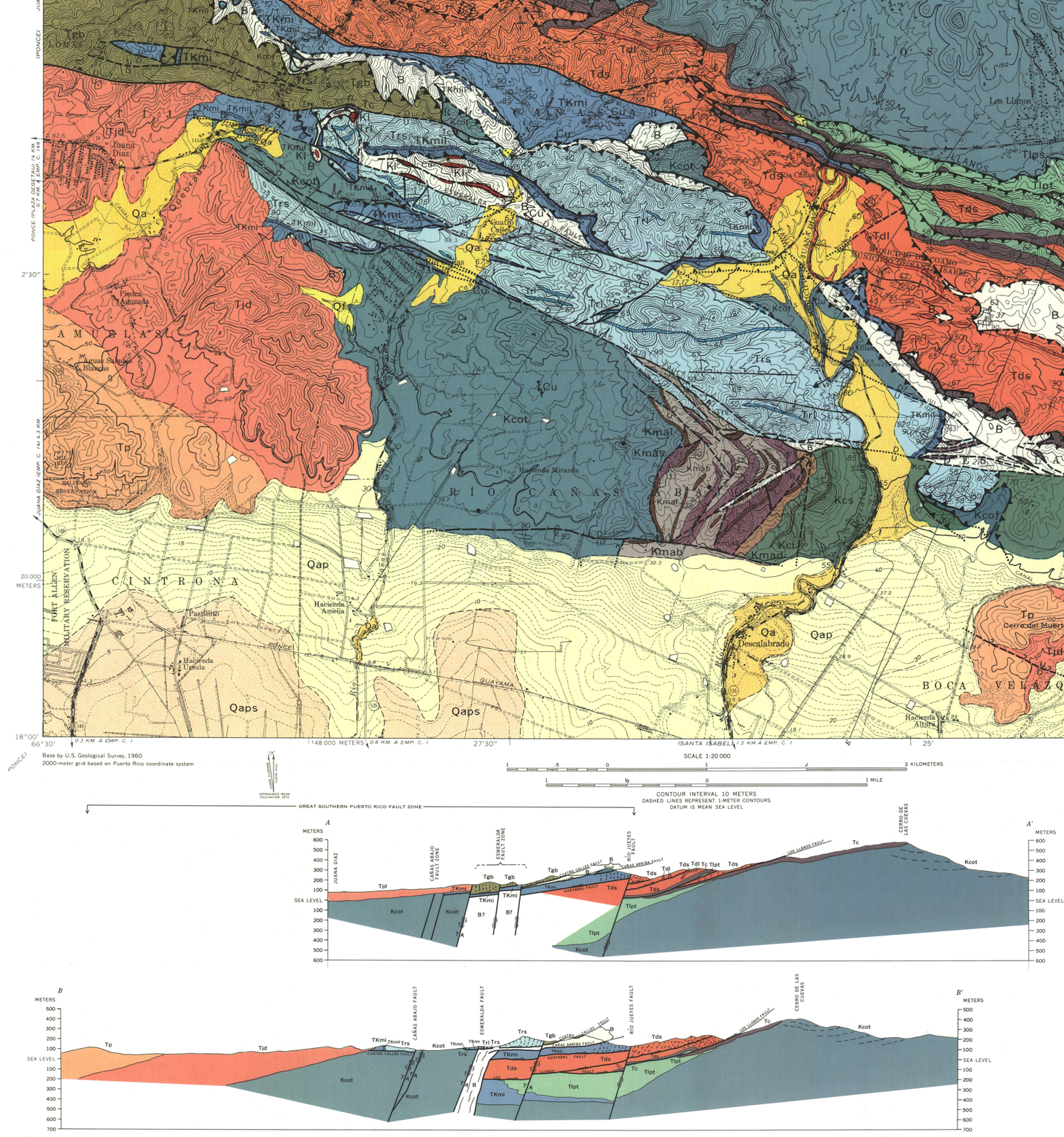


## ECONOMIC AND ENGINEERING GEOLOGY

*Copper.*—Copper mineralization was discovered at 13 localities during the course of fieldwork (shown as Cu on map). At nine of these localities, all in the south-central part of the quadrangle, the country rock or pieces of float are coated with small patches of malachite. At the other four localities, the copper minerals are in vein deposits. Malachite and azurite are the most abundant copper-bearing minerals in the veins; chalocoite and bornite are sparse; possibly some cuprite is present. Quartz is the most abundant gangue mineral. The three northernmost veins are in the megabreccia unit, tuffaceous conglomerate of the Miramar Formation, and tuff breccia of the Coamo Formation and strike west-northwestward. The southernmost vein is in Coamo tuff breccia and strikes northward. Most veins consist of anastomosing veinlets in zones a few inches to a maximum of about three feet wide. Though individual veinlets appear quite rich, they probably make up less than 10 percent of the total volume of the zones.

*Manganese.*—Manganese deposits were first worked in northern Barrio Tijeras, northeast of Juana Díaz in 1915. In 1938, the deposits were abandoned because of increased costs of production. Failure to maintain sufficient proved reserves was also possibly a factor in the decision to close. J. V. N. Dorr (written commun., 1943) quoting H. C. Ray, estimated that 55,000 to 65,000 tons of battery grade ore were produced during the life of the mine. Dorr believed that the manganese deposits are genetically related to hydrothermal activity, and that:

> The present exposures in the manganese districts of Puerto Rico do not justify further investigation by the Geological Survey during the war; when the pressure of work is less, the Juana Diaz deposits should be studied in more detail.

The nature of the present study does not constitute the detailed investigation of the Juana Diaz deposit recommended by Dorr. The broader approach has, however, brought out new stratigraphic and structural information bearing on the deposits that a detailed investigation of a smaller area might not yield.

Manganese prospects seen during the course of the present investigation are shown on the map by the symbol Mn. With the exception of the small outcrop of manganese in the Río Cañas, all of these prospects are in the Cuevas Limestone. As in the past, future prospecting will probably concentrate on this formation. Past estimates of reserves depended on as many as three "Cuevas Limestones," with individual thicknesses as much as 3,800 ft. Instead, the limestone is a single unit having a fairly constant thickness of about 35 m (114 ft). It is duplicated at the surface as many as four times by thrust faulting.

The genesis of the ore, dominantly the psilomelane group, is uncertain. Most of the ore seen by the writers was probably precipitated from ground-water solutions in contact with limestone. The presence of jasper with the ore at some of the workings convinced Dorr that such deposits were of hydrothermal origin.

A detailed investigation that would include drilling in the areas of known manganese concentration seems warranted because of past production and the new data on stratigraphy and structure. Especially favorable areas are under relatively thin cover of the Río Descalabrado Formation just northeast and northwest of the quarry at the old mine site.

*Thermal springs.*—A small thermal spring along the Río Coamo about 1.5 km north of Cerro de las Cuevas was found during fieldwork. The spring is very close to the well-known Baños de Coamo thermal springs in the adjacent Coamo quadrangle and doubtless is part of the same system. According to Ted Arnow, U.S. Geological Survey (oral commun., 1969), the temperature of the small spring is 69.6°F and the Baños springs are 110°F; both have a pH of nine, a surprisingly high alkalinity. There is little precipitate around the springs; a gas issue, but no strong odor, was noted. At the Baños springs, the main spring seems to be issuing from a fissure that trends about N. 60°W. in tuffaceous conglomerate. The springs are probably fed by meteoric water rising along faults from considerable depths.

*Marble, dimension stone, crushed rock, and terrazzo chips.*—The main body of the Cuevas Limestone in the quadrangle crops out on Cerro de las Cuevas from the vicinity of Lago Guayabal, just north of the center of the western border of the quadrangle, to Lago Coamo near the southeastern corner. Along this mountain, the limestone maintains a thickness of about 35 m, and is repeated at the surface as many as four times by faulting.

Most of the Cuevas Limestone is thick- to massive-bedded white to light-pink and grayish-white pure crystalline limestone mottled with lighter colored calcareous algal fragments. This type of rock is especially abundant and accessible on Cerro de las Cuevas in the western half of the quadrangle, and has been quarried there by the Continental Marble Company of San Juan. The limestone takes a high polish producing a very attractive marble resembling a natural "terrazzo."

An impure banded variety of limestone having a red and somewhat sandy matrix between the algal fragments appears to be restricted to the general vicinity of the Río Descalabrado water gap through Cerro de las Cuevas. Because of the less resistant sandy matrix, this rock weathers differentially limiting its desirability for use as a marble. It does, however, produce an attractive dimension stone that has been widely used in Ponce.

The white variety, locally of marble grade, which is found northwest and southeast of the Río Descalabrado water gap, could also be crushed for terrazzo chips to be used in the local tile industries. A good source might be the quarry near the end of Camino Naranjo near the western end of Cerro le las Cuevas. This and the Tito Castro Corporation quarry at the mine site to the east are at present producing crushed stone for road metal and concrete aggregate.

*Guano.*—Recently, guano from Cerro le las Cuevas has appeared on the market in Ponce. Caves were not explored during the study, but the Cuevas Limestone is known to contain many caves; these might be a source of this rich natural fertilizer.

*Landslides.*—Two large landslide blocks were discovered during fieldwork. Both are crossed by important secondary roads. One is in the northeastern corner of the quadrangle and is crossed by highway 155. A distinct trench marks the intersection of the fault surface and the ground along the sides and top of the block and indicates relatively recent landsliding. A number of homes are built on this block. The other is mainly beyond the quadrangle at its central western edge and is crossed by highway 149 and a canal just west of the highway and parallel to it. The same characteristic trench marks the surface trace of the underlying fault. This slide is being undercut at its toe by the Río Jacaguas.

It is impossible to say when these slides might again become active. A particularly long rainy season, an earth tremor, or, in the case of the western slide, further undercutting by the river would be likely to begin movement. Building in these areas should be discouraged, and future highway construction should be directed around these areas.

*Ground water.*—Several dry earth dams were noted near thrust faults. The easy subsurface drainage resulting from zones of nearly horizontal thrust faults probably allows the water table to be lowered very soon after buildup during the rainy season, hence the failure of the reservoirs. On the other hand, the good fracture porosity of the rocks in the fault zones suggests the possibility of successful deep wells in the otherwise unfavorable volcanic rocks.

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Base by U.S. Geological Survey, 1960
2000-meter grid based on Puerto Rico coordinate system

Geology mapped in 1959–60

SCALE 1:20 000

1 .5 0 1 2 3 KILOMETERS
1 ½ 0 1 MILE

CONTOUR INTERVAL 10 METERS
DASHED LINES REPRESENT 1-METER CONTOURS

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

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