

The Utuado quadrangle was mapped as part of a program of geologic mapping and mineral resource investigations by the U.S. Geological Survey in cooperation with the Economic Development Administration of Puerto Rico. Field work was started in November 1963 and completed in June 1964. W. H. Monroe mapped most of the northern part, and A. E. Nelson mapped the rest of the quadrangle.

Both general and detailed geologic mapping has been done previously in parts of the Utuado quadrangle. Meyerhoff (1932), McGuinness (1948), and Mitchell (1954) show the general outline of the plutonic rocks; Kaye (1957) did a detailed study of tephrite near Caonillas Reservoir and Weaver (1958) mapped and studied the Utuado pluton.

STRATIFIED ROCKS

Consolidated rocks, ranging from Cretaceous to middle Tertiary in age, are exposed in the Utuado quadrangle. The Cretaceous and lower tertiary rocks are mostly of volcanic derivation and consist of epiclastic and pyroclastic deposits and lava. Middle Tertiary rocks, mostly marine limestone and related deposits, rest unconformably on the Cretaceous and lower Tertiary rocks.

Jobs Formation.—A thick sequence of massively bedded volcanic breccia and associated rocks is here named the Jobs Formation from the Quebrada Jobsa west of Lago Dos Bocas. The type section is about 3 km north-northeast of Quebrada Jobsa on the east side of the Rio Grande de Arecibo at coordinates 127°29'–26'30". The lower contact is placed at the base of the lowermost massively bedded volcanic breccia that overlies relatively thin bedded volcanic sandstone and siltstone at the top of the Yunes Formation. In general, this contact appears to be conformable, but locally it may be disconformable. The formation overlies with angular unconformity by limestone of Oligocene age. Most exposures of the Jobs are in the valley of the Rio Grande de Arecibo, but inliers, probably eroded buried hills, are present in the area of outcrop of the Oligocene limestones. An estimated 170 m of the Jobs is exposed in the quadrangle. As the formation overlies the upper Paleocene to middle Eocene Yunes Formation and is unconformably overlain by Oligocene limestone, the Jobs is probably Eocene in age.

INTRUSIVE ROCKS

In the southern part of the quadrangle, a large body of intrusive rock, consisting mostly of granodiorite, forms part of the Utuado pluton (Weaver, 1958, which underlies a large part of west-central Puerto Rico. The pluton has been placed in the axial region of the island anticlinorium. It has an overall lenticular shape, which in detail is very irregular, and there are several embayments into the older rocks. The contact of the intrusive rock with older layered rocks is sharp, and in general the contact dips steeply away from the pluton except in the area north of Lago Caonillas where the contact is gently inclined to the north (Kaye, 1957, p. 106). Most commonly the plutonic rocks are massive, but in places, a faint foliation is present. Usually these rocks are fine grained, but medium-grained rocks are not uncommon; coarse-grained rocks are rare.

Gray to light-gray hornblende granodiorite makes up most of the pluton in the Utuado quadrangle. Facies of quartz monzonite, quartz diorite, diorite, and gabbro also occur, but the areas underlain by these rock types are small, and their contact relations with the granitoid rocks are concealed by deep tropical weathering and dense vegetation. They are not differentiated on the map.

Mattson (written commun., 1964) in his work in the Adjuntas and Jayuya quadrangles determined that the Utuado pluton was emplaced in the Campanian to Eocene interval. He reports that these rocks, on the basis of lead-alkali age determinations, are 60 (±10) million years old. In the Utuado quadrangle, the pluton intrudes the Alamosa Formation of probable late Campanian to Maestrichtian age, but does not intrude the younger Yunes Formation of late Paleocene to middle Eocene age. Therefore, age relations in the Utuado quadrangle suggest the pluton was emplaced between late Maestrichtian and middle Paleocene times.

MINOR BODIES OF GRANODIORITE AND DIORITE

Numerous small irregular dioritic bodies and dikes have intruded the Cretaceous rocks and the Utuado pluton; only the larger bodies are shown on the map. Most of these intrusive rocks are close to the pluton, but some occurring farther away are localized along faults. These dioritic rocks are contemporaneous with or slightly younger than the pluton, and are believed to have formed from the same parent magma.

VEINS, DIKES, AND SILL

Numerous, small discontinuous tabular andesite (?) and aplite dikes and veins too small to map cut the older rocks of the quadrangle but are most common within the pluton. Some of the andesite (?) dikes resemble lavas in the Manayoa Formation, some contain hornblende phenocrysts in an aphanitic groundmass, and some are very fine grained and characterized by tiny needles of both plagioclase and hornblende.

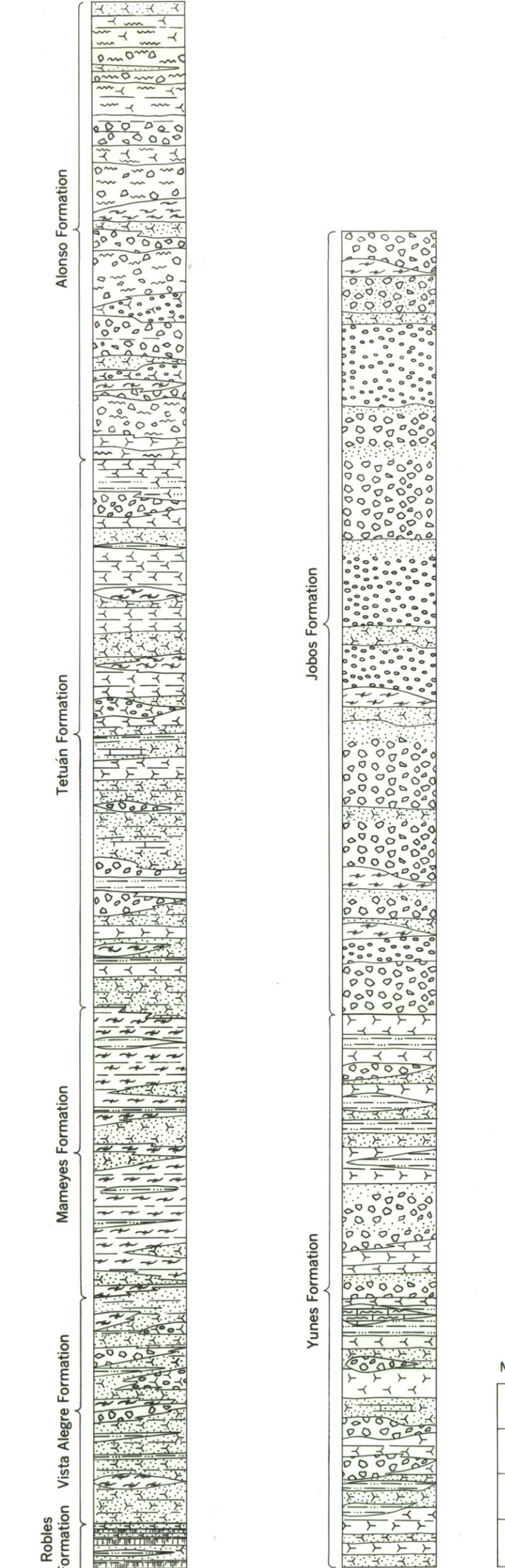
The aplite dikes consist of pink potassic (?) feldspar and quartz; some of the dikes, however, are white or gray and contain plagioclase and quartz. Locally, veinlets of zeolites are found.

Massive, fine-grained bluish-gray andesite, is sporadically exposed along Highway 10 between coordinates 124,600–52,700 and 124,740–52,700. This lenticular body of andesite apparently is concordant with the bedding of the Yunes Formation and probably is a sill; it is not shown on the map.

Most of the dikes and veins intrude the pluton, and the andesite sill intrudes the lower Tertiary Yunes Formation. These rocks are, therefore, early Tertiary in age and were probably emplaced after deposition of the Yunes Formation, and possibly later.

HYDROTHERMAL ALTERATION

Intense hydrothermal alteration, while not common, is present in several places in the Utuado quadrangle, especially



GENERALIZED COLUMNAR SECTIONS SHOWING THE LITHOLOGY OF SOME FORMATIONS IN THE UTUADO QUADRANGLE, PUERTO RICO

along the Caniaco fault.

In the most intensely altered area, about 1.5 km northeast of Caycos, the original textures of both the intrusive rocks and those of the Alamosa Formation have been destroyed, and contacts between them cannot be accurately defined. The exact age of the hydrothermal alteration is unknown, but it is believed to have occurred between the late Paleocene and late Eocene. In the Utuado quadrangle, intrusive rocks, which may be as young as late Paleocene, are altered, but the Yunes Formation of late Paleocene to middle Eocene age is not altered. In the adjoining Florida quadrangle, however, large boulders of hydrothermally altered rocks are present within an area of the Yunes Formation, but it is not known whether they are actually altered Yunes or whether they represent boulders from other formations that were deposited on the Yunes (Nelson and Monroe, 1966). Mattson (written commun., 1964) suggests that hydrothermal alteration of the rocks in the Adjuntas quadrangle is probably middle or late Eocene in age.

STRUCTURAL GEOLOGY

Most of the Utuado quadrangle is located on the north flank of the principal fold of the Puerto Rico anticlinorium. Mapping in quadrangles to the east and southeast (Nelson and Monroe, 1966; Mattson, written commun., 1964) suggests that the axis of the principal fold of the anticlinorium is near the southern boundary of the quadrangle. Even though the older stratified rocks have been folded and faulted, in general they strike parallel to the projected axial trace of the anticlinorium.

The middle Tertiary rocks are only slightly deformed. They have been uniformly tilted about 4° to 5° N., and locally they have been gently warped.

FOLDS

With the exception of the intrusive rocks, all the pre-Oligocene rocks are folded. The largest mapped fold is a westerly plunging syncline just north of the northern limit of the Utuado pluton. The axial plane of this fold has been slightly refolded, and it is believed the smaller north-trending folds on the north flank formed simultaneously with the folding of the axial plane. The trace of the axial plane of this fold extends west to near the Rio Grande de Arecibo and then trends to the north-northeast. The presence of this structure near the border of the pluton suggests that its south limb was arched up when the pluton was emplaced, and undoubtedly some of the strata immediately adjacent to the pluton were deformed during intrusion.

Other smaller folds are most easily seen in the well-bedded strata. Folds in the Yunes Formation trend essentially parallel to the Caniaco fault; some of them plunge gently to the east and some plunge gently west; some near the Caniaco fault are overturned.

FAULTS

Deformation by fracturing has had a pronounced effect on the Cretaceous and lower Tertiary rocks, and most of the rock units are faulted and jointed. The faults are either steeply dipping or vertical, and the amount of stratigraphic displacement varies widely. In the Utuado quadrangle, the northwest- and northeast-trending faults are the oldest; the Caniaco fault is the youngest.

JOINTS

Joints are widely dispersed in all the pre-Oligocene rocks exposed in the Utuado quadrangle. Although most of the joints dip steeply or are vertical, some have shallow dips. Even though there are many diverse strike directions, the contour diagram shows two predominant, one about N. 25° E., and the other about N. 25° W.

ECONOMIC GEOLOGY

Limestone, sand, and gravel are the principal mineral resources in the Utuado quadrangle. Both the Lare and Chao Formations contain large quantities of very pure limestone. The greatest source of sand and gravel is in the valley of the Rio Grande de Arecibo. Sand and gravel are currently being extracted from the valley of the Rio Grande de Arecibo at coordinate point 124,480–52,680, and smaller deposits of sand and gravel occur locally in other streams.

Rock suitable for use as highway aggregate, fill, and riprap are available at many places in the quadrangle. The intrusive rocks and volcanic breccia of the Jobs Formation could be a source of crushed stone for base course, coarse aggregate, and riprap; and much of the volcanic sandstone and siltstone could be used as fill. Granodiorite weathers to a granular material that is easily worked with a shovel, and locally provides a good source of fill material that is used on some of the highways and roads that cross the Utuado pluton.

The sulfide minerals pyrite and chalcopyrite are present in the quadrangle; the pyrite is widespread, but the chalcopyrite has been found only in trace amounts in quartz veins and rarely in the pluton. These veins are in the pluton and occur in the southwest part of the quadrangle along the northeast-trending road between coordinate points 120,870–46,430 and 124,000–46,370.

Special hematite has been found in a quartz-epidote vein 4 inches wide that occurs in granodiorite in the southeastern part of the quadrangle at coordinate point 129,100–47,420, but similar veins have not been found elsewhere in the quadrangle. Springs in cliffs in the middle Tertiary limestones occur locally in the valley of the Rio Grande de Arecibo. These springs are a part of the underground drainage net, and large amounts of groundwater could probably be obtained from wells strategically placed in the limestones.

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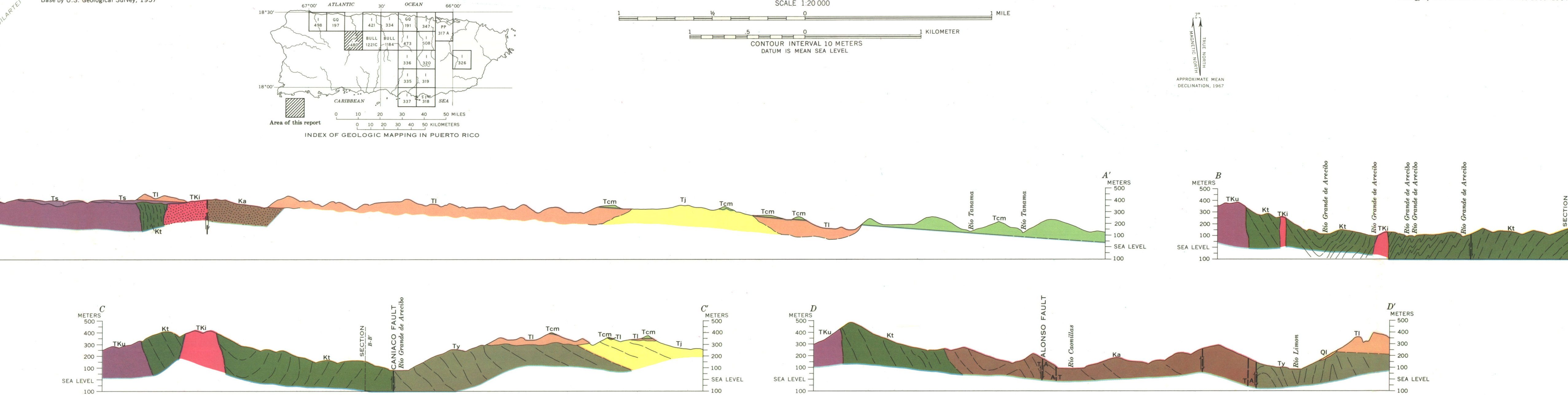
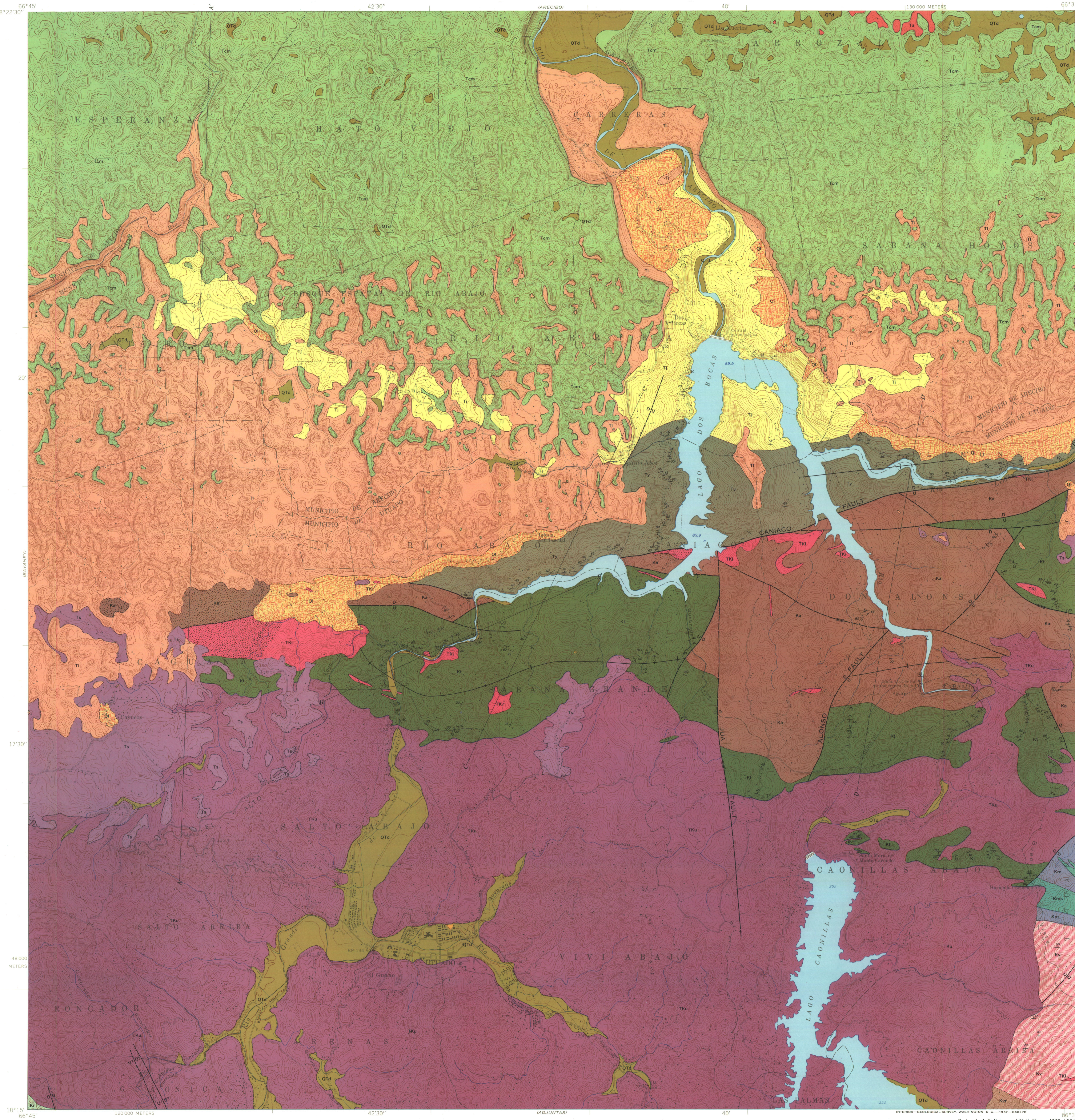
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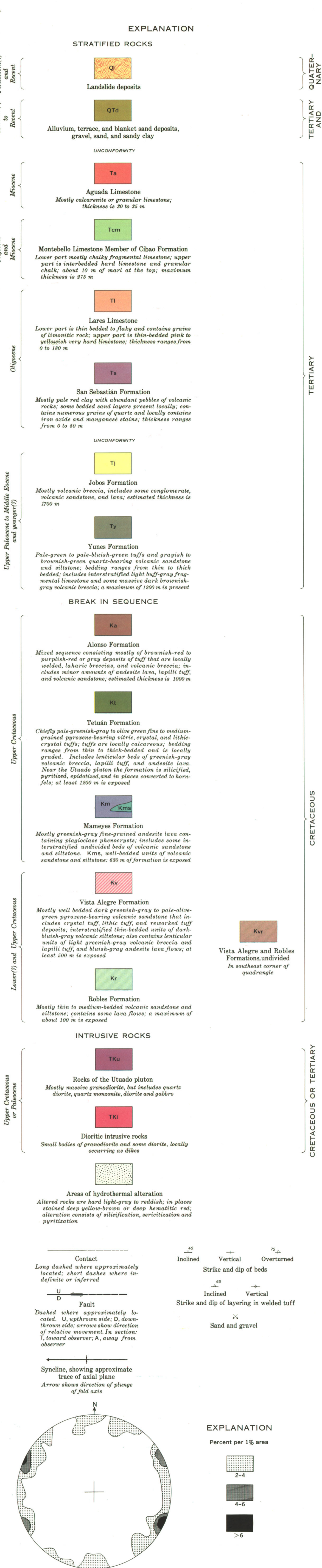
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GEOLOGIC MAP OF THE UTUADO QUADRANGLE, PUERTO RICO

By
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1967



CONTOUR DIAGRAM OF 559 JOINTS OCCURRING IN THE CRETACEOUS AND LOWER TERTIARY ROCKS IN THE UTUADO QUADRANGLE, PLOTTED ON LOWER HEMISPHERE OF EQUAL AREA NET