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Possible Structural Link between Yucatán and Cuba[1]

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Abstract Oceanographic investigations along the eastern margin of the Yucatán Peninsula (Quintana Roo Territory) have revealed the presence of two ridges separated by a depression, which parallel the Yucatán coast. The strike of the eastern, or Outer Ridge (north-northeast) changes to northeast at the northern end of this ridge and reaches toward the Cuban shelf. The origin of the Outer Ridge is unknown, but possibly it is a remnant of a Paleozoic fold belt that connects the basement rocks beneath the ridge east of British Honduras (Turneffe Island well) with basement rocks on the Isle of Pines (Cuba).

Introduction

Oceanographic investigations off the east coast of Quintana Roo Territory of the Mexican Yucatán Peninsula have revealed the presence of shelf-margin structures. These structures may be important in unraveling Gulf of Mexico-Caribbean Sea geologic history.

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Previous Information

Navy Hydrographic Office chart BCO904N shows details of the bathymetry of the continental margin off Quintana Roo. Murray (1961) reviewed the evidence for an onshore, northeast-southwest-trending fault zone (Río Hondo fault zone) which parallels the coast from British Honduras into Quintana Roo Territory. Dengo and Bohnenberger (1969) postulated that the eastern margin of the Yucatán Peninsula ". . . ends abruptly along a series of small, stepped submarine scarps, probably fault-controlled, parallel with the coastline of Belice and Quintana Roo. . . ." Bowin (1968) published free-air and Bouguer gravity-anomaly maps of the western Caribbean Sea and found several linear features which are parallel with and offshore from the coast of Quintana Roo. The sediments of the continental margin off the east coast of Yucatán have received little study. Griffin and Goldberg (1969) reported data from several surface samples in this region.

Bathymetry

Several linear bathymetric prominences are visible on the U.S. Navy Hydrographic chart BCO904N (1962). In the north, a prominent northeast-southwest-trending bathymetric high is defined by Banco Arrowsmith and Isla Cozumel (Fig. 1). A southwestward continuation of this feature would intersect the coast of Quintana Roo Territory near Punta Nohku. Seaward from this topographic ridge, an extensive linear depression as deep as 600 fm is present. The eastern limit of this basin is an elongate series of isolated bathymetric highs. Seaward

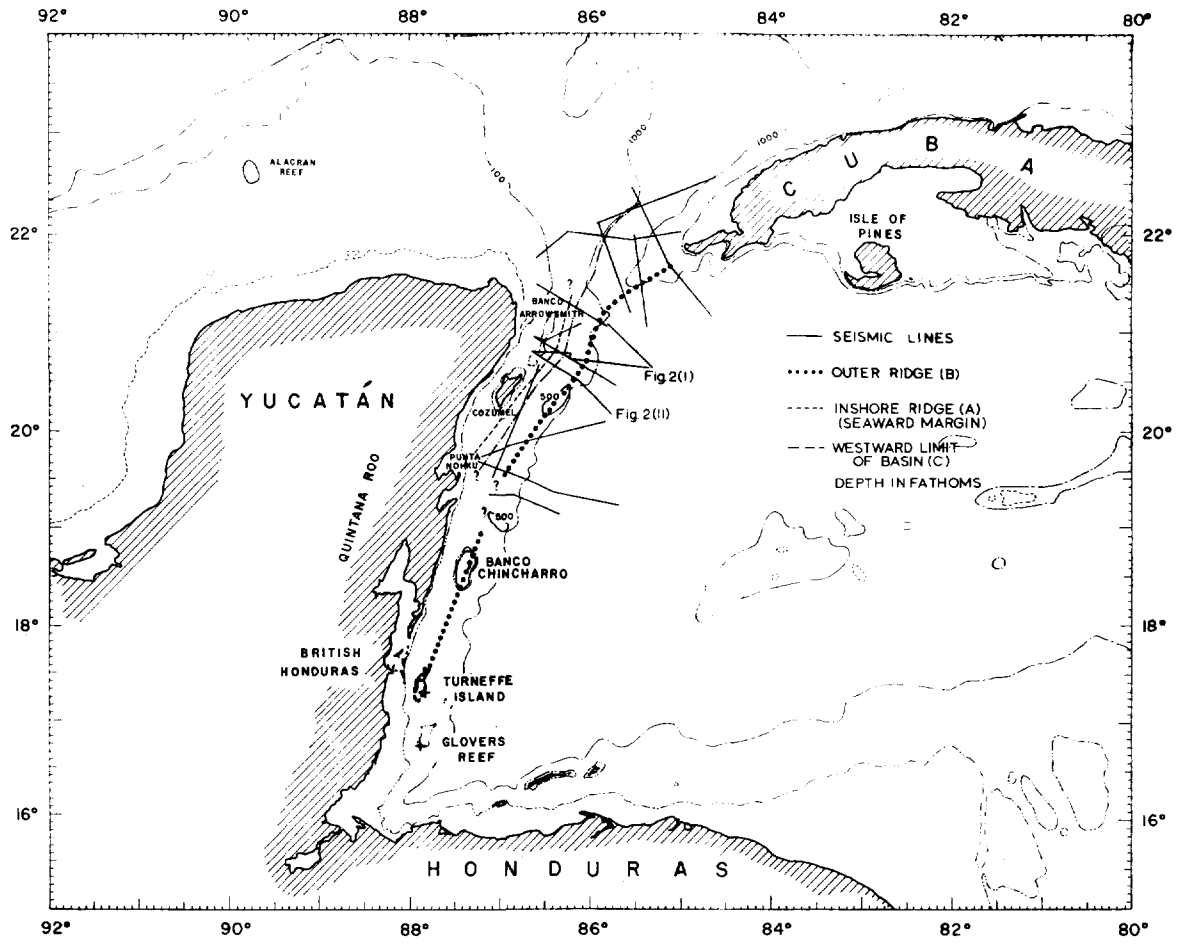

FIG. 1.—Marginal structures off Quintana Roo Territory, Mexico.

from these, the bottom deepens abruptly down an escarpment to the Yucatán basin (2,400 fm). Bathymetric records on file at Texas A&M University and at Lamont-Doherty Geological Observatory indicate that these "isolated highs" actually form a linear, probably continuous, topographic ridge (Outer Ridge, Fig. 1) which can be traced for at least 60 n. mi along the coast between lat. 20°00′N and 21°00′N. This ridge has a northeast-southwest-trend and a 500 fm rise from the floor of the inshore depression to the crest. All crossings of the Yucatán basin escarpment show a topographic ridge of varying relief near its crest. The depression is present shoreward from this ridge on most of the continental margin north of lat. 20°00′N. A series of bathymetric highs, including Banco Chincharro and Turneffe Island, could represent a southwestern extension of the Outer Ridge. Stoddart (1970, written commun.) reported that diorite basement was reached beneath a 1,219-m limestone cap and 915 m of a clay series on Turneffe Island, by Shell Development Company. Northward at about 21°00′N the trend of the Outer Ridge curves gently to an east-northeast orientation, crosses the Yucatán Channel and strikes toward Cuba (Fig. 1).

Seismic-Reflection Profiles

The internal structure of the marginal features is shown in Figure 2. The reflection profile represents two crossings perpendicular to the series of features described previously (Fig. 1). The central bathymetric high (*A*) is the nearshore trend. The large depression between the two topographic highs (*A* and *B*) contains at

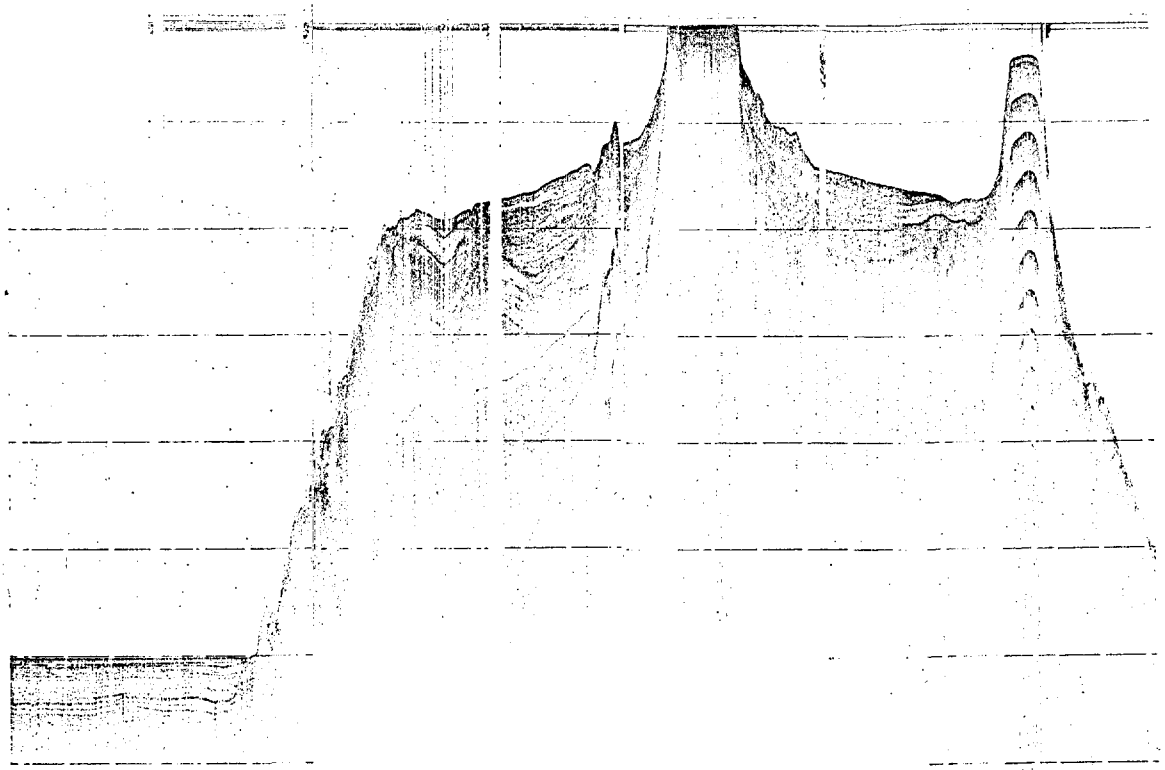

FIG. 2.—Seismic-reflection profile of marginal features off Quintana Roo Territory. Conrad 12, 148–151, Lamont-Doherty Geological Observatory.

least 2 km (1 second) of stratified sediment. The Outer Ridge (*B*) is poorly developed on the left side of Figure 2, but its presence is reflected in the subbottom. Several other profiles (Fig. 1) support this interpretation. A thin "cap" of sediment is present on several of the larger peaks.

SEDIMENTS

Analyses of several cores, *e.g.*, RC10-260, from the central depression show that rates of accumulation were rather slow. The slow rate of deposition shows the effective role of the inshore ridge in preventing terrestrial sediment from reaching the basin. The slow rate of accumulation and the amount of sediment present in the slope basin imply that older sediment would be found in the deeper layers of the sediment column, possibly even pre-Tertiary deposits. Because the reflector horizon of the Outer Ridge underlies these sediments, it is necessarily older and dredging would be fruitful.

Core RC10-260 (19°27′N; 87°10.3′W) is characterized by sharp basal contacts, several color laminations, very slight amounts of burrowing, and the presence of some sulfides. On the basis of a foraminifera zonation a Pliocene-early Pleistocene date had been assigned to its base (210 cm) by Burkle (personal commun., 1968). An estimate of the rate of accumulation made from this date is on the order of 1 mm/1000 years—a slow rate for Pleistocene pelagic sedimentation. This slow rate also could be related to the strong surface currents known to exist along the Yucatán coast.

Core RC12-18 (20°44′N; 86°15′W) contains 10 m of foraminiferal marl with abundant laminations of foraminiferal sands. A turbidite origin for at least part of this core is suggested by the presence of slight burrowing, sharp basal contacts, and coral fragments in the foraminiferal sand zones.

INTERPRETATION OF OUTER RIDGE

The origin of the Outer Ridge is unknown, but some speculation appears to be justified, inasmuch as this is the first possible structural link that has been found between Cuba and

Yucatán. Since the earliest syntheses of Caribbean geology (*e.g.*, Suess, 1909), geologists have attempted to link the geology of Cuba with that of Central America.

Basement was reached at 2,134 m in the Turneffe Island well (Hadley and Neff, 1968, p. 1388; Stoddart, 1969, p. 438) and 68 km south of Turneffe Island, at 959 m (Maya Mountain Series) in Glover's Reef no. 1 well. This basement has been dated as 290±30 m.y. (Pennsylvanian) (Dixon, 1956; Bass and Zartman, 1969) in the Maya Mountains of British Honduras and in deep wells drilled on the Yucatán Peninsula by Pemex.

In southern Cuba, Meyerhoff and Hatten (1968) and Khudoley and Meyerhoff (1970) presented evidence that the oldest metamorphic rocks of the Isle of Pines and the Trinidad Mountains are late Paleozoic. The Outer Ridge connects the Turneffe Island well basement rocks with Cuba and, at the northeastern end, the Outer Ridge is on strike with and less than 200 km from the Isle of Pines. Possibly, the Outer Ridge is the remnant of a Paleozoic fold belt linking Yucatán-British Honduras with southern Cuba.

This hypothesis is wholly speculative. Seismic, gravimetric, magnetic, and dredging or coring studies are needed to acquire sufficient data to prove or disprove this hypothesis.

Summary

Most available evidence suggests the presence of a series of marginal structures off the coast of Quintana Roo, Mexico, which along strike appear to provide a structural link between western Cuba and the Yucatán Peninsula of Mexico. The effect of these features on the sediment dispersal patterns of the area has been noted. Hedberg (1970) commented on the importance of marginal barriers as zones for future oil exploration. The presence of a thick sedimentary section with numerous demonstrated carbonate sand layers would also increase the interest of those in the petroleum industry.

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