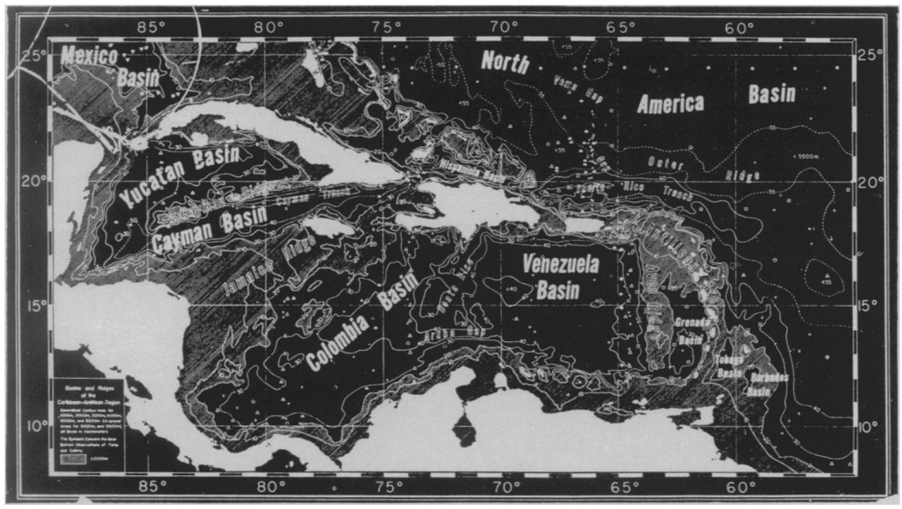
The birth of the Caribbean

Deep drilling has provided new information about the origin of the Caribbean Sea but raised other questions about the formation of ocean basins.



Fairbridge/Encyclopedia of Oceanography

Caribbean basins are much younger than predicted by present theories.

by Louise Purrett

The Caribbean Sea has never quite fit into the theories geophysicists had worked out for the formation and evolution of ocean basins and continents.

Its geological structure, according to current theory, has both oceanic and continental aspects. The earth's crust is much thicker under continents than under ocean basins. But seismic refraction profiles have shown that the crust under the Caribbean is thicker than usual for ocean basins. Beneath the Beata and Nicaragua Ridges, the crust is two and a half times thicker than in normal ocean basins.

This led some scientists to speculate that the Caribbean represents a segment of continental crust that had sunk, Atlantis-like, beneath the waters of the seas. This theory seemed to receive some support recently when three different expeditions recovered large samples of granite, a material supposedly limited to continents, from the Caribbean's Aves Ridge (SN: 1/9/71, p. 31). Previous sampling of the larger oceans had seemed to indicate that oceanic crust is composed of basalts, gabbros, serpentinites and peridotites, but never granite.

But there were several serious problems with the view of the Caribbean basin as subsided continental crust. For one, reconstructed fits of North and South America to Africa and Europe before the current era of continental drift allowed no room for the Caribbean. "The Caribbean was always a problem area," says John B. Saunders, a stratigrapher for Texaco Trinidad and co-chief scientist for Leg 15 of the United States' Deep Sea Drilling Project, sponsored by the National Science Foundation. "No matter how you join the other land masses, there's always a question of what to do with the Caribbean." Most maps avoided the problem and just shaded off North America below Mexico.

Second, the Caribbean granites are somewhat different in character from continental granites, shallower and considerably younger (about 75 million years old, compared with continental ages of up to 3.5 billion years).

Third, seismic refraction profiles for the Caribbean are anomalous, resembling neither those for continents nor ocean basins.

Two other theories assume that the Caribbean is basically oceanic. In one view, the sea opened when North and South America drifted apart; in the other, the Caribbean basin is a segment of Pacific crust that became wedged between the two large continents as they drifted westward. The classic view of the Antilles, says Saunders, is as a Pacific-type island arc. In addition, he says, the over all structure of the crust and the bottom topography of the Caribbean Sea are more similar to the Pacific than they are to the Atlantic.

It was to test these hypotheses that scientists on Leg 15 of the Deep Sea Drilling Project went into the Caribbean for a two-month period ending Jan. 26. Scientists on Leg 4 in early 1969 had limited success, but were stopped by hard layers of chert. With their new techniques for reentering a hole after a drill bit has worn out (SN: 1/16/71, p. 43), the Leg 15 researchers hoped to obtain a complete core of the Caribbean sediments.

The coring operations were highly successful. The scientists obtained several complete cores from Caribbean basins, drilling completely through sediments and into the rock basement five times. One of the cores from the Venezuela Basin, Saunders believes, "will be a standard for the Caribbean for a long time."

The findings were surprising. Each core, says Dr. Terence Edgar, co-chief scientist for the cruise and now chief scientist for the entire project, is accurately dated by microorganisms entombed in the sediments. The oldest sediments turned out to be only 75 million to 85 million years old. In contrast, the oldest part of the Atlantic is about 180 million years old, dating from the time when the continents first split and the present phase of sea-floor spreading began. If the Caribbean were formed when the continents broke up,

Dr. Edgar and Saunders point out, the Caribbean crust would be about the same age as the Atlantic. If it were a piece of Pacific crust, they say, it would be even older. The youth of the Caribbean basins, therefore, essentially eliminates these two hypotheses, the scientists conclude.

Furthermore, says Dr. Edgar, the massive occurrences of basalt in the Caribbean crust form a smooth, plate-like surface. The Atlantic floor topography is characterized by very high relief, formed by basalt created in the active process of sea-floor spreading. In the Atlantic, great mineral deposits are associated with the formation of the crust. The researchers found almost no mineralization in the Caribbean. This difference, says Dr. Edgar, will be significant to exploitation of the ocean's resources.

DSDP

Saunders, Edgar and operations head Roy Anderson examine core re-entry bit.

The researchers found deposits of volcanic ash at the eastern and western ends of the Caribbean. Geologists had previously recorded periods of volcanism at the same period in the Greater Antilles and northern South America. These two groups of evidence suggest long periods of great volcanic activity, with a slow return to quiescence about 80 million years ago, the scientists say. Dr. Edgar and Saunders suggest that South America tore apart from the Greater Antilles—Haiti, the Dominican Republic, Puerto Rico and the Virgin Islands—and a new crust slowly developed during that period of activity. They believe the final stages of crustal development in the Caribbean were completed about 75 million years ago. Sediments deposited during the ensuing millions of years contain ever-decreasing amounts of volcanic ash and debris. Since the end of the Cretaceous period about 65 million years ago, volcanic activity in the eastern Caribbean has been confined to the extreme eastern edge, where volcanoes in the Antilles are still active.

The two scientists see this limited volcanism as the result of interaction between the Caribbean and Atlantic crustal plates. Both of these plates are moving westward, but the Atlantic plate is moving faster and is being forced under the Caribbean (SN: 2/7/70, p. 153).

The results of the deep drilling in the Caribbean force some changes in the classic view of continental drift. "Our thinking in terms of formation of crust has to be modified," says Dr. Edgar. "We had been looking at deeper basins, where we thought we saw a relatively clear picture of continental drift." The Caribbean crust was apparently created by a process different from the one that created the floor of the Atlantic, he says. It appears to have been a passive process, involving creation by the breakup of two continents rather than the active process of upwelling from midoceanic ridges. But the researchers on Leg 15 as yet have no idea just what processes might be at work in the Caribbean. More detailed analyses of crust samples will have to be conducted, says Dr. Edgar. One thing for certain is that future studies of marine geology will have to give closer scrutiny to smaller oceanic basins. □