DEEP SEA DRILLING PROJECT

UNIVERSITY OF CALIFORNIA, SAN DIEGO

SCRIPPS INSTITUTION OF OCEANOGRAPHY

Scientific Objectives and Highlights
(Leg 38 Onward)

LEG 38

Significant new information regarding the evolution of the Norwegian and Greenland Seas was uncovered during Leg 38. This cruise, which took place during August and September 1974, was under the leadership of Dr. Manik Talwani, director of Lamont-Doherty Geological Observatory at Columbia University, and Dr. Gleb Udintsev, a member of the P.P. Shirshov Institute of Oceanology, USSR Academy of Sciences, and took the Glomar Challenger into the Arctic for the first time. The results of drilling on Leg 38 show that the connection between Eurasia and North America was severed by the separation of Greenland from Norway, 55 m.y. ago. The separation of Greenland from Norway was quite complicated. From 55 to 30 m.y. ago gradual separation created the Norway Basin. Opening of the Norway Basin then stopped and the line of rifting shifted some 100 miles to the west. Separation along this new line took place between 15 and 30 m.y. ago and resulted in a part of East Greenland being broken off and subsiding below the ocean surface to become the submerged plateau known as the Jan Mayen Ridge. At 15 m.y. ago the line of rifting moved again, this time to its present location, passing through Iceland.

Drilling on the Iceland-Faeroe Ridge showed that a land connection between Eurasia and North America continued to exist after the opening of the Norway Sea commenced and the Ridge was not submerged until about 20 m.y. ago. Drilling at most sites, including one within 800 miles of the North Pole, shows that glaciation in the Northern hemisphere may have started 5 m.y. ago, somewhat earlier than had been previously believed.

LEG 39

Leg 39, under the leadership of Dr. Katharina Perch-Nielsen of the Geological Institute, Zurich, Switzerland and Dr. Peter Supko of Scripps Institution of Oceanography, took the Glomar Challenger the length of the Atlantic Ocean from Amsterdam to Cape Town, South Africa. A major goal of the voyage was the recovery of long sections of ocean floor sediments and their contained fossils. Analysis of these fossils will allow scientists to start piecing together the complex story of the history of the South Atlantic Ocean beginning with its very formation. It is presently believed this occurred about 120 million years ago when South America and Africa broke apart and began drifting away from each other.

The sedimentary sections of the seven sites drilled show a coherent picture beginning to emerge.

Normal oceanic sedimentation was stopped for millions of years in at least three major periods of geologic time. At several of the sites, expected deposits of fossiliferous sediments at the boundary of the Cretaceous and Tertiary Eras (about 65 million years ago), the boundary of the Eocene and Oligocene epochs (about 40 million years ago) and in the middle Miocene period (about twelve million years ago) are missing. Scientists on the CHALLENGER believe these missing sediments were the result of oceanographic conditions which changed drastically at these times.

The sediments may have been dissolved away as a result of great changes in the physical chemistry of the water itself. Such changes in oceanographic conditions are thought to result, in some cases, from large scale geological processes. For example, when Australia broke free from Antarctica some fifty million years ago and began to drift northward, the globe-circling West Wind Drift Current around Antarctica formed and intensified over the course of millions of years. This huge current affected the bottom currents of all major oceans and may explain the missing sediment section forty million years ago.

LEG 40

Further information on the formation and evolution of the South Atlantic was uncovered by scientists on Leg 40 which took place off the southeast coast of Africa during December, 1974 and January, 1975. The co-chief scientists were Dr. William B. F. Ryan of Lamont-Doherty Geological Observatory at Columbia University, and Dr. H. M. Bolli of the Geological Institute, Zurich, Switzerland. The South Atlantic started as a narrow crack which widened continuously, eventually to split Africa entirely from South America. Fossils in the cores collected by Glomar Challenger indicate that the crack was first occupied by deep fresh-water lakes similar to the present day East African rift-valley lakes. Despite vast amounts of sand and mud pouring into the basins from the adjacent continents, the floor of the expanding lakes progressively deepened and their waters changed from fresh to saline. Because of its landlocked character however, strong circulation could not develop and the waters of this youthful seaway remained stagnant and unoxygenated.

As the split between the continents extended northward, marine waters from the stagnant seaway seeped north across the already forming Walvis Ridge towards the equator. The rate of evaporation exceeded the rate of water input and a massive layer, some 8 thousand-feet composed of evaporite minerals and rock salt, was deposited along the axis of the splitting crust. That entire body of salt which stretches from the Walvis Ridge to Nigeria was deposited in only a few million years.

The period of salt deposition ended abruptly for unknown reasons as cool marine water of normal salinity invaded the area from the south. But stagnation similar to that of the Cape Basin to the south developed and lasted much longer in the north than it did in the south. It did not end, in fact, until the westward drift of South America slid the right-angled coastline of what is now Brazil totally clear of the bulge of West Africa.

LEG 41

The early evolution of the eastern North Atlantic has been investigated during Leg 41. The scientific party was led by Dr. Yves Lancelot, of Lamont-Doherty Geological Observatory, Columbia University, and Professor Eugen Seibold, of the Geological Institute of the University of Kiel, West Germany. The results of Leg 41 show that the eastern Atlantic basin evolution is remarkably similar to that of their western counterpoint off the eastern coast of the United States since at least one Middle to Upper Jurassic (about 160 million years ago).

After receiving calcareous deposits while still relatively shallow, the basins sank to deeper levels where calcareous material is dissolved by cold and aggresive waters, and for most of their history, they received only fine clays, silts and occasionally sands from the nearby African continent. During an episode of about 15 million years, between 95 and 110 million years ago, circulation of water along the sea floor was so reduced that accumulations of carbonaceous matter was buried and preserved within the sediments.

Volcanic eruptions during the early to Middle Tertiary not only brought Cape Verde and the Canary Islands above the sea level, but also injected slabs of basaltic lavas within the sediment layers beneath the sea floor, raising the sea floor some 1,000 meters in places and so creating the Cape Verde Rise. Some black carbonaceous shales when submitted to the considerable heat generated the lava could produce minute quantities of extractable hydrocarbons. Such findings might provide important clues regarding the fundamental problem of the generation of hydrocarbons in oceanic sediment layers. The continental slope off Africa has been found to be an area of almost pure pelagic sedimentation where calcareous and siliceous microfossils are slowly accumulating, while the Terrigenous detritus from the nearby continent either accumulate on the continental shelf or find their way to the deep basin through submarine canyons. That slope has been as deep as it is today since at least the Early Cretaceous (about 110 million years ago) and must have foundered very early after the separation of America from Africa.

LEG 42A