1. INTRODUCTION

"He had long ago decided, since he was a serious scholar, that the caves of ocean bear no gems, but only soggy glub and great gobs of mucky gump."

James Thurber

During the first eleven legs of the Deep Sea Drilling Project, D.V. *Glomar Challenger* had operated in the tropical and subtropical regions of the ocean confined to a belt of 40° north and south of the Equator in order to obtain the best chances of success in the calmer waters prevailing there. With the experience gained on these legs, it was believed possible to extend the capabilities of deep sea drilling into higher latitudes where the weather conditions are considerably less reliable, and where it was anticipated that the percentage of days on which drilling could be carried out would be significantly lower.

The northern North Atlantic provided an area where the weather is notoriously unpredictable because of the passage of depressions traveling up the East coast of North America and crossing the Atlantic in a northeast direction towards northern Europe. The path of these depressions is largely controlled by the position of the polar front and by the development of the Azores high pressure area. Additional hazards exist on account of the interaction between the Gulf stream and the cold Labrador current producing fog, and from the southward passage of icebergs from the Labrador Sea. In order to minimize these hazards, the northern North Atlantic leg was chosen during the summer months of June, July and August.

Scientifically the North Atlantic provided a number of important and interesting problems which could be tackled by deep sediment drilling. It is an area where considerable oceanographic and marine geological and geophysical research has been conducted during the past few decades both by North American and European laboratories. The geography of the region is extremely complex (Figure 1). The continental margins surrounding it (Figure 2) are very irregular comprising a number of large embayments, such as the Labrador Sea, the Irminger Sea, the Iceland Basin, Rockall Trough and the Bay of Biscay, separating a number of land masses, all of which are continental excepting Iceland, which is entirely volcanic, being a subaerial part of the mid-Atlantic Ridge. Associated with the continental margins are also a number of shoal areas ranging in size from Rockall Plateau to Orphan Knoll which are believed also to be continental although subsequently subsided to their present depths. In many places the continental shelf is very wide, such as the area of the Grand Banks off Newfoundland; whereas, elsewhere such as off the northcoast of Spain, it is relatively narrow. Many of the pre-Mesozoic structures on the continents strike toward the continental margins as if they have been truncated.

In the deep ocean, the mid-Atlantic Ridge strikes northward from the Azores Plateau, is offset to the west by a series of fracture zones–the largest of which is the Charlie Gibbs Fracture Zone–and then continues north and northeast towards Iceland as the Reykjanes Ridge, becoming progressively narrower and shallower. The volcanic basalts of Iceland are associated with the generation of oceanic crustal material, although the very large quantity generated has built up the island by near-horizontal sills in contrast to the near vertical dikes believed to be at the axes of mid-ocean ridges. Iceland is linked to Greenland by the relatively shoal Denmark Straits, and to the Faroe Island Plateau by the Iceland-Faroe Ridge. Both are believed to have a relatively thin cover of sediment and, therefore, are major structural features in the basement. Their origin is not yet well understood. North of Iceland, the mid-ocean ridge continues through the Norwegian Sea, and is linked by several fracture zones to the Nansen Ridge in the Arctic Ocean.

Between the mountainous region of the mid-ocean ridge and the continental margins various sedimentation processes have covered the basement topography and have resulted in the thick sediments of the continental rise, the flat abyssal plains and the swale topography of the basins more remote from the margins.

The theory of plate tectonics has shown that subsequent to the breakup of supercontinents, the continental fragments, together with the new oceanic lithosphere generated at the spreading axes, behave as rigid plates and that their relative motions can be determined by an analysis of the magnetic anomaly patterns. Such analyses depend upon the correct age identification of the magnetic anomalies. Although this can often be done unambiguously by comparison with the Heirtzler time scale if the linearity and orientation of the anomalies have been established, in the North Atlantic the pattern of magnetic anomalies is complex and the survey data often inadequate to map the trends. Both to verify the ages of identified anomalies and to make new identifications, the age of the ocean crust can be determined by the age of the oldest sediments lying above it, as had been done in the South Atlantic (Leg 3) and in the Pacific (Legs 5 and 9).

A principle scientific objective of Leg 12, therefore, was to sample the sediments immediately above the basement at a number of sites, to determine the age of the crust, and hence to provide some key data in the evolutionary history of the North Atlantic. Sites were chosen in the Labrador Sea, the Reykjanes Ridge, the Iceland Basin, Rockall Trough and the Bay of Biscay with these objectives in view.

A second objective of the leg was to drill into two features, Orphan Knoll and Rockall Plateau, which were believed, on geophysical grounds, to be fragments of sunken continent. It was expected, if it was found that they were continental in origin, that the sediments would contain evidence of the subsidence history which might relate to the North Atlantic evolution.

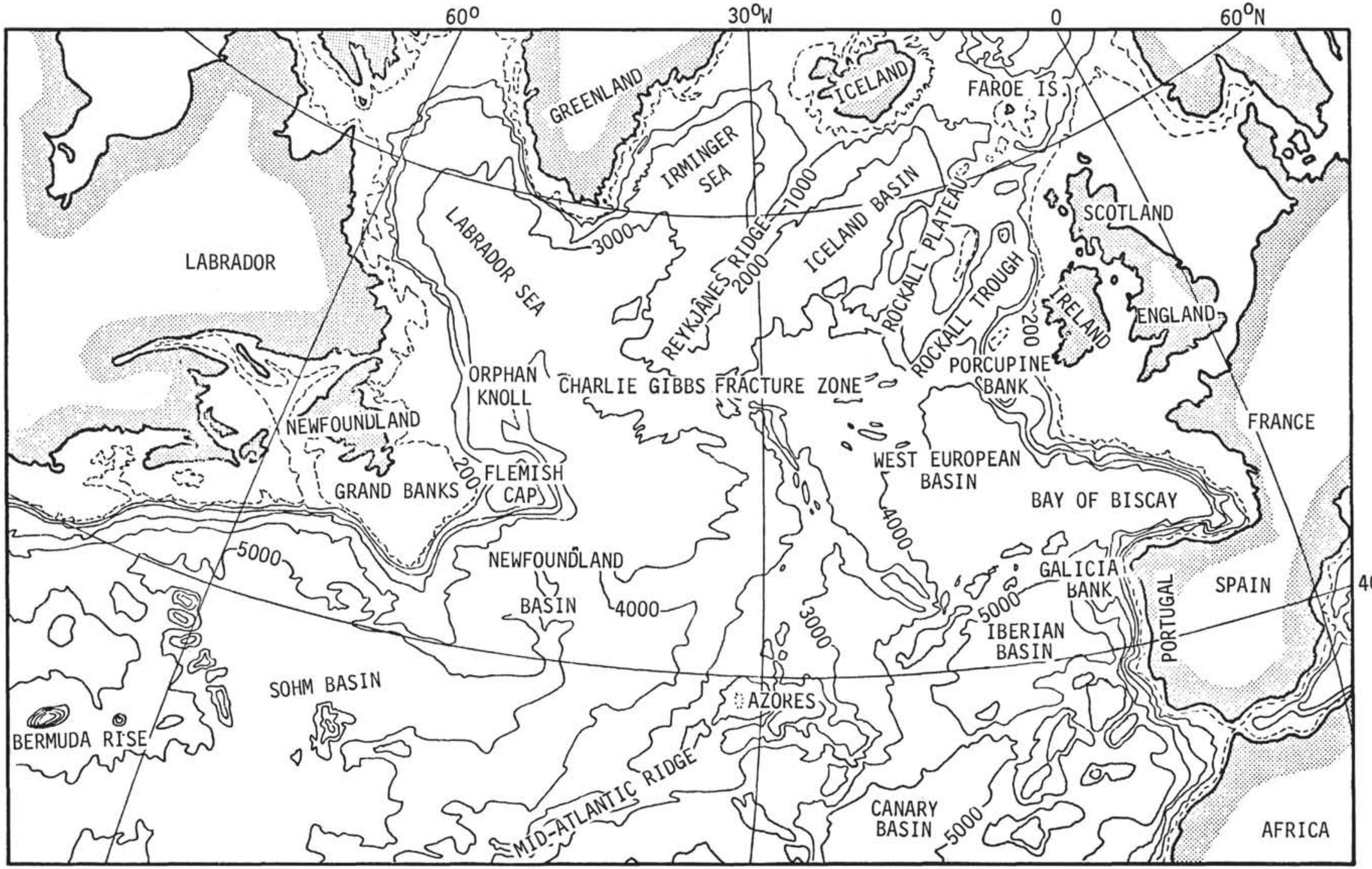

Figure 1. *Bathymetry of North Atlantic (based on topography by Dietrich and Ulrich, 1968).*

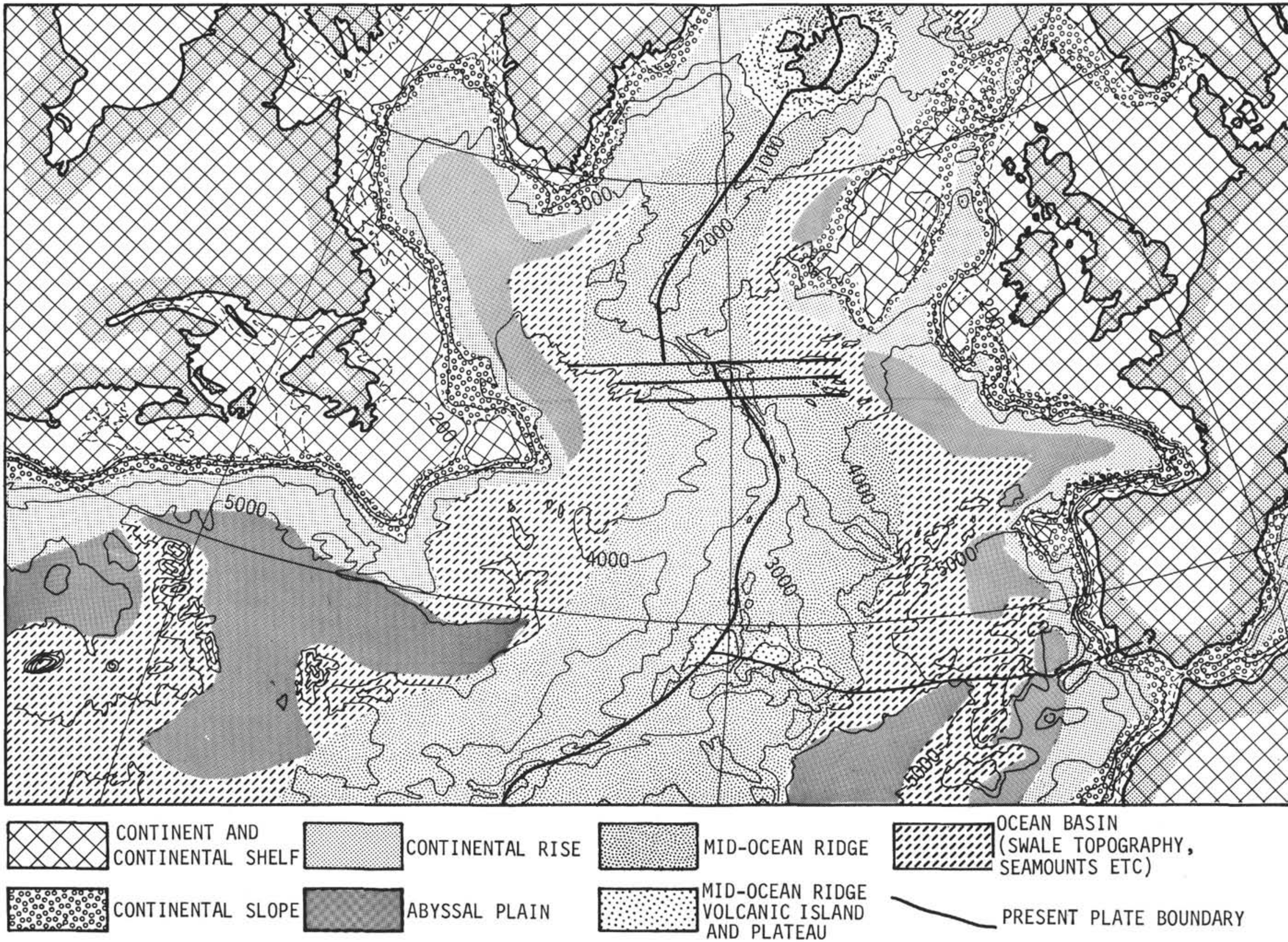

Figure 2. *Principal physiographic and structural features of the North Atlantic*

The processes of sedimentation in the North Atlantic are also complex. Near the continental margins horizontal transport of sediments by turbidity currents has played a prominent part and has given rise to the abyssal plains, particularly in the Labrador Sea and the Bay of Biscay. An extremely important part is also played by the ocean currents which carry sediment in suspension and have moulded some of the other large sediment accumulations in the North Atlantic. Most important is the Norwegian Sea overflow water circulating counter-clockwise around the North Atlantic following the topographic features of the sea bed. Sites were planned to penetrate sediment bodies laid down by this mechanism, and hence to give data about the oceanographic circulation in the Tertiary, as well as, a deeper understanding of the mechanism of transportation.

Prominent reflecting horizons have been noted on seismic records obtained in the North Atlantic and the sedimentary evolution of the regions have been discussed on the basis of age estimates of these horizons. In places these estimates were based on samples obtained from outcrops of the horizon. In other places, the horizons were compared with similar looking horizons found elsewhere in the ocean and dated by sampling. Some holes on Leg 12 were chosen to penetrate and date such distinctive horizons.

For the paleontologist, Leg 12 promised to provide the first opportunity to sample the entire Cenozoic section at high latitudes. The Cenozoic biostratigraphy of the deep Atlantic had previously been developed from low latitude core samples and drill holes and for the higher latitudes from relatively shallow penetration piston cores (mostly of Pleistocene age). The deep cores from Leg 12 were planned to cover the entire Cenozoic and to delineate the latitudinal differences of the fossil assemblages. An analysis of these might provide the paleontologist with a picture of the gradual paleoclimatic and paleogeographic changes in the North Atlantic which occurred over the past 65 million years and the concomitant provincialization of planktonic microfaunas and microfloras. These changes might, in their turn, be related to changes in paleooceanographic circulation and the progressive opening of the North Atlantic Ocean.

A particular aspect of interest to the paleontologist is the evidence of glaciation in the North Atlantic. The top sections of sediments sampled should reflect the nature and extent of glacial conditions in this area, and by means of paleontological dating, provide a time framework for the glacial events. Under appropriate conditions it might even be possible to date the initiation of glaciation itself in the North Atlantic.

NARRATIVE

Seventeen possible sites for drilling were proposed by the JOIDES Atlantic Advisory Panel based on suggestions made by scientists from the United States, Canada, United Kingdom, France and Holland. In most cases, the sites were chosen on single seismic profiles and no site surveys were available to determine the best place to drill and the local features. Site surveys were available in the Bay of Biscay, on Rockall Plateau and in Rockall Trough, carried out by R.R.S. *Discovery* in 1966 and 1970.

It was clear that only about half the sites proposed could actually be drilled in the time available. However because of the uncertainties of the weather and the need to use D.V. *Glomar Challenger* most effectively, enough sites were provided to allow flexibility in the operations. In fact, eight of the proposed sites were drilled and one additional site on Rockall Plateau was chosen to extend the results of the previous site.

D.V. *Glomar Challenger* sailed from Boston, Massachusetts, U.S.A., on June 19th 1970 and arrived at Lisbon, Portugal on August 11th. Out of 52.5 days at sea, 32 days were spent on site and 20.5 days were spent on passage. A total distance of 4215 nautical miles was steamed between ports and sites during which time underway geophysical observations were made.

Thirteen holes were drilled and cored at nine sites. A total of 1449 meters was cored, and 838 meters were recovered; giving a recovery percentage of 57.2 percent. Total penetration of the bottom was 5903 meters. A summary of the details of the holes and of the results is given in Chapter 21. A diamond bit was used on the first site only. Subsequently all holes were drilled with a three-cone tungsten carbide insert, a four-cone tungsten carbide insert or three-cone extended compact roller bits. Performance was excellent with high penetration rates and long life, although a rather high degree of disturbance was experienced.

At several sites, an 'A' hole was drilled following the completion of the first hole. In most cases this was drilled in order to sample more closely the upper layers to obtain cores spanning the period of glaciation, and it was done by withdrawing the drill to the mudline and re-entering the bottom without bringing the string to the surface.

The weather was remarkably agreeable throughout the leg, and no gales were experienced. Fog was troublesome off Newfoundland and in the Southern Labrador Sea, and slowed up passage steaming. Although iceberg reports were received, none approached the ship close enough to present any hazard. Only in one hole (117) was it necessary to withdraw the drill due to excessive heave and swell conditions (5-meter heave and 17° roll), and 12 hours operational time were lost. The site in Rockall Trough was not occupied because of bad weather predictions combined with a lack of time.

ACKNOWLEDGMENTS

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