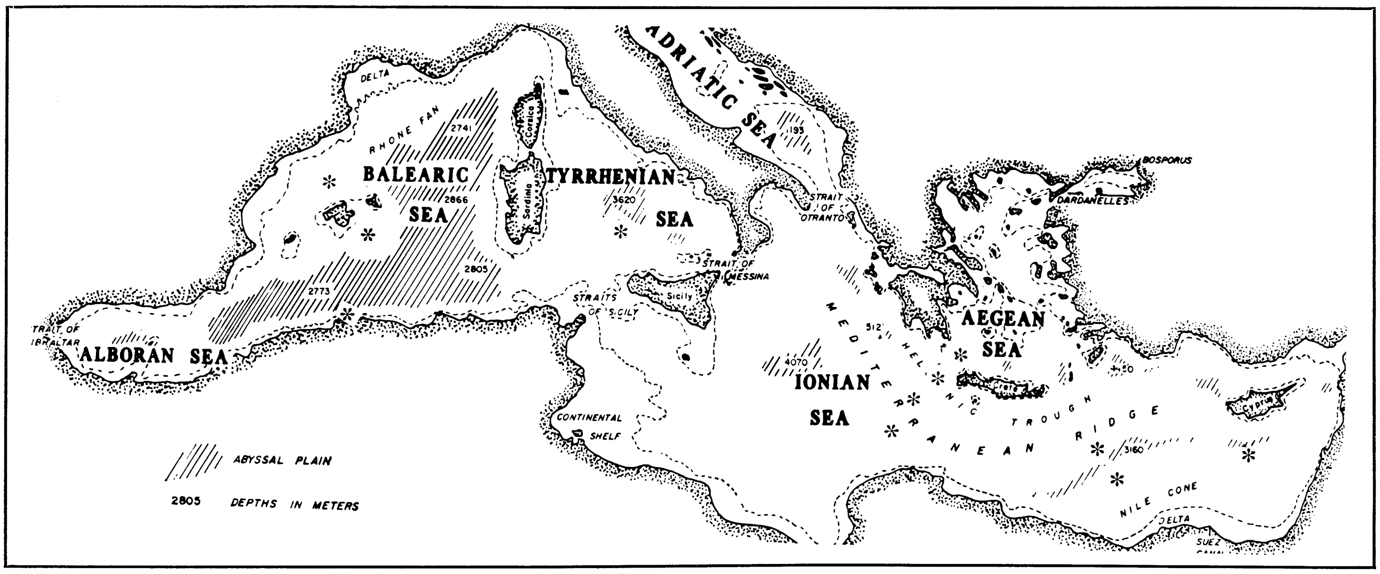
Probing the Mediterranean's hidden geological past

Next month the Glomar Challenger is due to enter the Mediterranean Sea to retrieve the first deep sedimentary cores from beneath its floor. Hypotheses about the sea's origin and evolution will be clarified.



Eleven of the 18 proposed sites for Deep Sea Drilling Project's Mediterranean leg are rated top priority.

To travelers and poets, the Mediterranean Sea evokes images of sunshine and serenity—quiet coastal villages, grapes ripening on the vine, fishing boats returning with their day's catch: a picture of tradition and permanence.

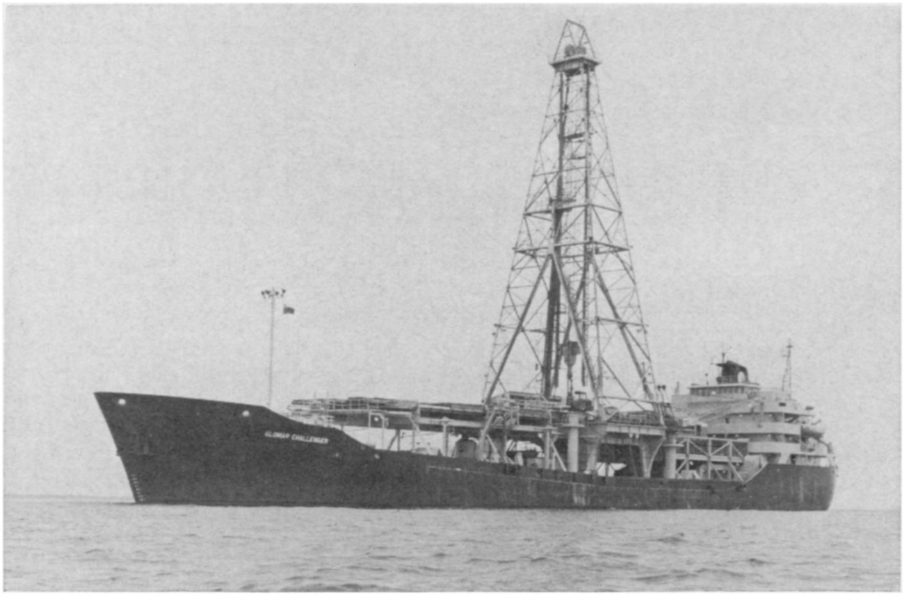
But to geologists, whose clocks tick off not minutes but millions of years, the floor of the Mediterranean carries a turbulent story of the earth's changing face. The story, as yet only partially read and incompletely understood, tells of massive wrenching forces at work deforming sediments, uplifting mountains, depressing portions of dry land. It tells something of past climates, of oscillating sea levels, of changing ocean conditions. It relates part of the past history of marine life, evolving in a sea at least partially cut off and perhaps at times totally isolated from the large oceans of the world.

Next month, if all goes well, scientists from many countries will obtain the first look at the deep sediments now lying far beneath the Mediterranean floor. These sediments from perhaps as much as 1,000 meters below the seabottom should reveal much of the unseen history of the Mediterranean region and help earth scientists gain a clearer understanding of the origin and evolution of a classic small ocean basin. The deepest cores now available from the Mediterranean, obtained from piston-driven tubes rather than drilling, are from no more than about 20 meters beneath the bottom.

The effort marks the first entry of the Glomar Challenger, still the only vessel in the world capable of drilling into deep ocean sediments, into the Mediterranean. The ship's previous voyages—the twelfth is now under way between New York and Lisbon—have been in the Atlantic and Pacific Oceans and the Gulf of Mexico. The Challenger's entire two-month Leg 13 will be devoted to the waters separating Europe and Africa.

Although the Deep Sea Drilling Project is funded by the National Science Foundation under the auspices of a consortium of five United States oceanographic centers, the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), the Mediterranean leg has been planned with the assistance of scientists from all over the world. One of the two co-chief scientists, Dr. Kenneth J. Hsü, although an American citizen, is permanently affiliated with the Institute of Geology of the Federal Polytechnical School in Zurich, Switzerland. The other is Dr. William B. F. Ryan of Columbia University's Lamont-Doherty Geological Observatory. As now planned, all the other scientists on board will be from European countries, including England, Italy, France, Rumania, Austria and Germany.

The samples they retrieve should help geologists choose among a number of hypotheses concerning the origin and evolution of the Mediterranean Sea.



Scripps Institution of Oceanography

Glomar Challenger: First deep scientific drilling in the Mediterranean.

Long before the existence of the present Mediterranean, perhaps a quarter of a billion years ago, a giant waterway, the Tethys, extended across southern Europe, Iran and southern China to the Pacific Ocean. The Mediterranean is generally considered to be a remnant of the Tethys.

Some geologists believe signs of very old crust from the period of the Tethys may still exist beneath the present Mediterranean floor. In the eastern Mediterranean, where the sedimentary sequences have been thinned and structurally exposed, there may be ancient sediments and crust from the Paleo-Tethys, predating the birth of the Atlantic Ocean about 180 million years ago (SN: 6/6, p. 547).

Others, however, believe the floor of the ancient Tethys is not beneath the eastern Mediterranean at all but farther north in the present mountains of Europe. The Mediterranean leg may help show which view is correct.

The present Mediterranean is divided into western and eastern halves by a submarine ridge extending across the narrows between western Sicily and Cape Bon, Tunisia. The configurations of the seafloor of the two portions are remarkable different.

There is considerable geological evidence that before the formation of the three basins that comprise the present western Mediterranean—the Alboran, Balearic and Tyrrhenian—much of the region was dry land. This has been taken by some to be convincing evidence for the processes of subsidence and oceanization—a sinking of the land followed by a gradual conversion of the crust from the type normally composing continents to the type usually found beneath the oceans. Others, in contrast, have proposed that the western basins were formed by the generation of new oceanic crust associated with the horizontal movements of small continental pieces. One major objective of the Mediterranean deep drilling is to gain information to help decide between these two hypotheses.

The eastern Mediterranean, in striking contrast to the western half, contains no major areas of broad, flat sea-bottom plains or of well-ordered, neatly arranged sediment layers. Instead, most of the basin floor is severely deformed, as though it had been squeezed in a vise. The complex, fractured subsurface Mediterranean Ridge extends from southeast of Italy, below Greece and Crete, toward Cyprus. Along the northern, concave side of the curved ridge is the Hellenic Trough, a long trench containing the deepest waters—5,092 meters, west of the Peloponnesus—in the Mediterranean.

Geologists are not entirely clear what process has caused the uplift of the ridge, but it seems due to a slow relative movement of Africa and Europe toward each other. As expressed in terms of plate tectonics, Africa and Europe are both moving generally east. But they are advancing at slightly different rates and directions. The net result has been a slow convergence of Africa and Europe during the last 6 million to 10 million years.

Some scientists think the Mediterranean Ridge was formed when the excess ocean crust merely thickened, rather than descending into the mantle below, as it seems to do in other parts of the world, such as in the trenches of the western Pacific Ocean. To study the processes of compressional tectonics the scientists of Leg 13 plan to drill a series of deep holes across a section of the Hellenic Arc/Hellenic Trough-Mediterranean Ridge complex. The core through the top of the ridge should record the timing of the uplift.

The geologists also have high hopes that the deep sedimentary cores will shed light on the role the opening of the Atlantic Ocean played in the creation of large mountain ranges, such as the Alps, in Europe. The collisions of large crustal plates envisioned in seafloor-spreading theory seem to provide an explanation for the massive horizontal compression responsible for the uplift of mountains. But detailed data are necessary.

One problem concerns timing. "We have to get a timetable accurate to within a million years if we are going to explain the evolution of mountain chains in Europe by the movements responsible for the widening of the Atlantic," says Dr. Ryan. The scientists hope the sedimentary sequences in the cores they will obtain will be sufficient for detailed comparison with the beaufully preserved and thoroughly studied strata of the Alps and Apennines.

In many ways the Mediterranean is like an Atlantic Ocean in miniature. Because it is shallower, it is easier to study. Its sediments should contain a more complete record of its past life forms than the Atlantic, where some kinds of organic deposits dissolve at its great depths.

The repeated periods of isolation and semi-isolation of the Mediterranean in the last 20 million years have caused its microscopic marine life to evolve somewhat differently than in the Atlantic. These fluctuations have also undoubtedly had a profound effect on bottom water temperatures, salinity and degree of oxygen ventilation in the individual enclosed basins. If the geologists can get a good record of the sequence of the strata, they believe they will be able to determine the chronology of faunal changes. This they would do by radiometric dating of the abundant layers of volcanic ash deposited in the sea by nearby Mediterranean volcanoes.

Probes into the thick sediments deposited by the major rivers flowing into the Mediterranean are also expected to prove valuable. Some idea of the past motions of currents may be obtained by studying the pattern of sediment distribution. The scientists hope to obtain one core from the deep Nile Cone—the wedge of sediments deposited by the Nile River. The sediments probably record each of the major sea-level regressions of the Pleistocene glaciation as well as periods of intense contributions of wind-blown sand from the North African desert.

Eighteen tentative drilling sites have been proposed for the Glomar Challenger's exploration into Mediterranean history. Since no one expects it to be possible to drill at all 18, only 11 have been given highest priority. □