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This article explores how ocean-floor spreading in the north and central Atlantic Ocean is related to the disappearance of an older ocean—the Tethys—and the growth of the present-day Mediterranean. [The *SCI*® indicates that this paper has been cited in more than 165 publications.]

Charting the Vanished Tethyan Ocean

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I suppose it started with the so-called "Bullard fit" of the circum-Atlantic continents, made at the suggestion of E.C. (Teddy) Bullard, by Jim E. Everett and me in 1963, published in 1965.[1] This fit depended on using Euler's fixed point theorem to move continents around on a globe. The resulting picture became something of a geological icon. Like an icon, it was static, showing only how these continents might have been clustered together at some past time. The reassembly opens a large wedge-shaped space between Africa and Europe, narrowing westward, presumably representing a former ocean. Geologists had long postulated the existence of such an ocean—the Tethys—between Europe and Africa. Clearly, to get from the past to the present, the Tethyan Ocean had largely vanished and Europe and Africa had collided; but in 1964, the outlines of these changes were unknown.

During the 1960s, the plausibility of Hess's hypothesis of ocean-floor spreading was demonstrated by Vine and Matthews's interpretation of the magnetic stripes on the ocean floor. Deep-sea drilling enabled researchers to date the floor itself relatively precisely. Seismology showed that the present-day Earth was subdivided into plates—rigid areas in relative motion. The continuity and linearity of the magnetic stripes, together with Wilson's interpretation of oceanic fracture zones as transform faults, suggested that the ocean floor was rigid except along narrow seismic belts. Although we could not see the ocean floor directly, its tectonics suddenly appeared to be very simple.

I realized that the corollary of rigidity is that the relative motion between Africa and Europe was determined by the spreading history of the Atlantic Ocean between Europe and North America and between North America and Africa. Thus, by modeling the opening of the Atlantic, it was possible for the first time to quantify the relative motions of two colliding continents and compare these estimates with field observations.

An important consequence of the modeling is that no part of the older Tethyan Ocean could have been part of the present-day Mediterranean. The Tethys must have lain to the north and east of it and must have been floored by ocean floor, which has largely vanished. It must also have been bordered by continental margins that had not been identified by 1971. Subsequently, these margins have been located, particularly by A.M. Celal Sengor in Istanbul, who has tracked their continuation throughout much of central Asia.[2]

Despite the great increase in data over the past two decades, there is still no satisfactory model describing how the smaller continental fragments between Africa and Europe may have moved within the shrinking Tethyan Ocean. I find it surprising that the rigorous mathematical framework of plate tectonics, which for the first time made tectonics a science, is still not used in most such analyses. There is almost as much work to do on these problems as there was when they were first raised some 20 years ago.

1. **Bullard E C, Everett J E & Smith A G.** The fit of the continents around the Atlantic. *Phil. Trans. Roy. Soc. London A* 258:41-51, 1965. (Cited 520 times.)
2. **Sengor A M C.** The Cimmeride orogenic system and the tectonics of Eurasia. *Geological Society of America Special Paper 195.* 1984. 82 p.

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