Chapter 3

PLATE TECTONICS:
THE UNIFYING THEORY
OF GEOLOGY

The jigsaw-puzzle fit of the continents bordering the Atlantic Ocean formed the basis of Alfred Wegener’s theory of continental drift. In his book *The Origin of Continents and Oceans*, Wegener cited as additional evidence the similarity of geologic features on opposite sides of the Atlantic. The matchup of ancient crystalline rocks in adjacent regions of South America and Africa and of North America and Europe is shown here. (Geographic fit from data of E. C. Bullard; geologic data from P. M. Hurley.)

Fossils of the freshwater reptile *Mesosaurus*, 300 million years old, are found in South America and Africa and nowhere else in the world.

*If Mesosaurus* could swim across the South Atlantic Ocean, it should have been able to cross other oceans and should have spread more widely.

Marie Tharp and Bruce Heezen inspect a map of the seafloor. Their discovery of active rifts on the mid-ocean ridges provided important evidence for seafloor spreading. [The Earth Institute at Columbia University.]
Earth's surface is a mosaic of 13 major plates of rigid lithosphere, as well as a number of smaller plates, that move slowly over the ductile asthenosphere. Arrows give the relative plate speeds in millimeters per year.

Interactions at plate boundaries depend on the direction of relative plate movement and the type of crust involved.

The Mid-Atlantic Ridge, a divergent plate boundary, rises above sea level in Iceland. This crack-like rift valley, filled with newly formed volcanic rocks, indicates that plates are being pulled apart. [Gudmundur E. Sigvaldason, Nordic Volcanological Institute.]
A view northwest along the San Andreas fault in the Carrizo Plain of central California. The San Andreas is a transform fault, forming a portion of the sliding boundary between the Pacific Plate (left) and the North American Plate (right). Notice how plate movement on the fault has offset the streams flowing across it. [John Shelton.]
isochron map shows the ages of rocks on the seafloor. The isochrons give the age of the seafloor in millions of years since its creation at mid-ocean ridges. Light gray indicates land; dark gray indicates shallow water over continental shelves.

3.16 Continental rifting, drifting, and collisions assembled and then disassembled the supercontinent Pangea. [Paleogeographic maps by Christopher R. Scotese, 2003 PALEOMAP Project (www.scotese.com).]

Two competing hypotheses about the mantle convection system.

Illustration of the mantle plume hypothesis.

Breakup of Pangea