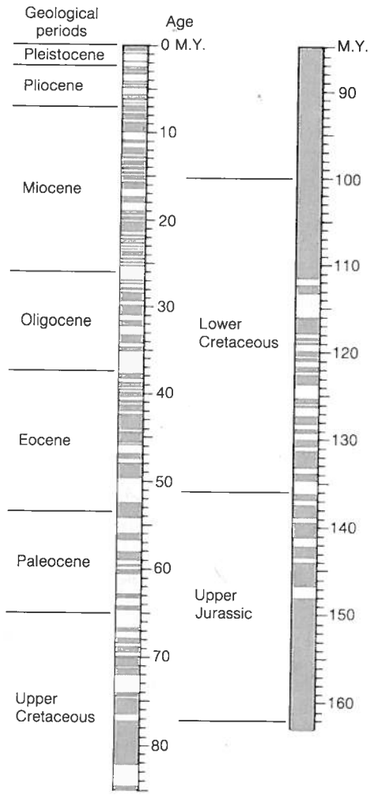

Figure 18-20
Geomagnetic reversal time scale from the present to the base of the Upper Jurassic 162 million years ago. Shaded intervals are normal; white intervals are reversed field directions. [After J. R. Heirtzler, R. L. Larson, and W. C. Pitman III.]

section, as in Figure 18-20, showing the historical sequence of worldwide magnetic reversals back in geological time to the Jurassic Period.

The power and convenience of the new magnetic stratigraphy in working out the history of ocean basins cannot be overemphasized. Simply by steaming back and forth, measuring the magnetic field of the magnetized rocks of the sea floor, and correlating the pattern of reversals with the sequence shown in the preceding two figures, ages can be assigned to different regions of the sea floor without even examining rock samples! All one needs is a good magnetic record, and these have already been obtained and interpreted for large sections of the world's oceans.

Isochrons (contours of the age of the sea floor) obtained in this way show the time that has elapsed and the amount of spreading that has occurred since the magnetized rocks were injected as lava into a mid-ocean rift. Note how the isochrons in Figure 18-21 show progressively older sea floor on both sides of the major ocean-ridge rifts, the more widely spaced isochrons of the east Pacific signifying a faster spreading rate than those of the Atlantic. We will see in the next chapter that these "magnetic ages" were verified when the deep-sea drilling project brought back rock samples from the sea floor that could be dated in the laboratory using fossils and radiometric methods. What a coup for the scientists who discovered this tool!

Magnetized Moon Rocks—A Puzzle. Unlike the Earth, the Moon has no planet-wide magnetic field. There is no question about this. Soviet and American spacecraft have been unable to detect such a field after several efforts. Yet magnetized rocks have been found lying on the lunar surface. Discordant data are the stuff of great discoveries, and planetary scientists are vying to explain these seemingly contradictory results. The leading hypothesis at this time proposes that the Moon rocks, in their remanent magnetism, "remember" an earlier period of lunar history some 3–4 billion years ago (the age range of the rocks), when the Moon did have a planetary magnetic field. This implies also the existence, at this early time, of a small liquid iron core that has since cooled and solidified. Is there a better way to manifest the power of modern geological and geophysical methods than to return a rock from the lunar surface, date it, measure its magnetic field, and then describe the physical state at the center of the Moon billions of years earlier?

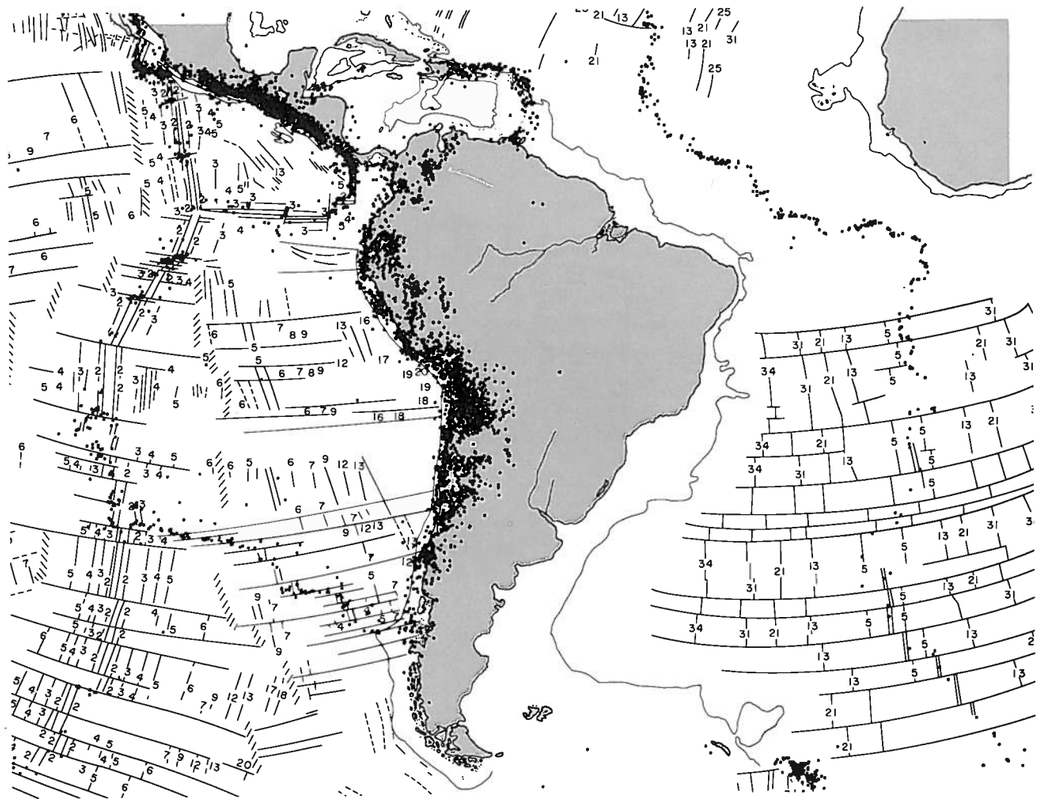

Figure 18-21
Isochrons derived from magnetic-anomaly patterns for the oceans around South America. Isochrons are numbered from 1, the youngest, located at the axis of a mid-ocean ridge spreading center. Dots show that most earthquakes originate at plate boundaries, where spreading and subduction are underway. They outline the Peru-Chile trench subduction zone along the west coast of South America. [From map by Walter C. Pitman III, Roger L. Larson, and Ellen M. Herron, Lamont-Doherty Geological Observatory; drawn by Mildred M. Alvarez, Hester Cason, 1974. Geological Society of America.]

EXPLORING THE EARTH WITH GRAVITY

The Indian Puzzle. Some 150 years ago, during the great land survey of India, a curious discrepancy was uncovered by the British surveyors. The distance between Kaliana, some 100 kilometers (60 miles) south of the Himalaya range, and Kalianpur, 600 kilometers (375 miles) farther south, was determined in two precise ways—by measurement over the surface and by reference to astronomical observations—and the results disagreed by some 150 meters (500 feet) in 600 kilometers. This may seem like a small amount, but it was an intolerable surveying error even by nineteenth-century standards. The astronomical method of measuring distance uses the angles of stars with respect to the vertical, which is defined by a plumb line (a weight suspended on a string). To account for the difference, it was proposed that the plumb line was tilted toward the Himalayas because of the gravitational attraction of the mountains on the plumb bob, causing an error in the distance measurement. When the calculation was actually made, it was found that the mountains should