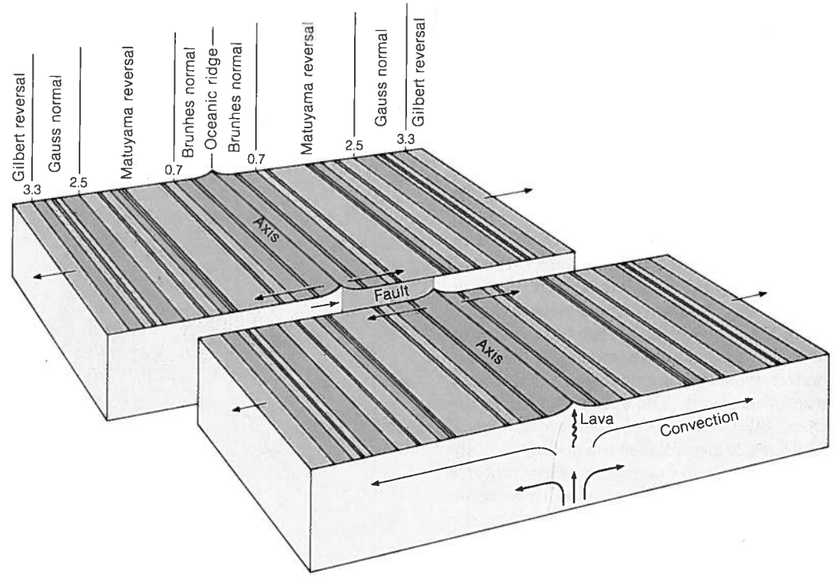

Figure 18-17
The succession of normal and reversed magnetic anomalies on the sea floor provides strong support for the concept of sea-floor spreading. Rocks of normal, or present-day, polarity are shown in shades of brown; rocks of reversed polarity are in shades of gray. The symmetry of the magnetic stripes and the correlation with the time scale of reversals worked out from lava flows on land suggests that molten rock upwelling along the ridge axis became magnetized as it cooled, was pushed out on both sides, and gradually moved outward with the separating plates. The separation of the two blocks represents a transform fault. The diagram is based on the studies of many scientists. [After "The Confirmation of Continental Drift" by P. M. Hurley. Copyright © 1968, by Scientific American, Inc. All rights reserved.]

sea-floor spreading (Fig. 18-17). They argued that the ocean progressively widens as new sea floor is created along a crack that follows the crest of mid-ocean ridges. Lava flowing up from the interior solidifies in the crack and becomes magnetized with either normal or reversed magnetization, depending on the direction of the Earth's field at the time. As the sea floor spreads away from the ridge, approximately half the newly magnetized material moves to one side and half to the other, forming two symmetrical, magnetized bands. Newer material fills the crack, continuing the process. In this way, the sea floor acts like a tape recorder that encodes, by magnetic imprinting, the history of the opening of the ocean in terms of the history of reversals of the geomagnetic field. By discovering how to "replay the tape"—that is, by dating the magnetic bands on the sea floor using the magnetic stratigraphy of Figure 18-14 worked out from lavas on land—geophysicists showed that the magnetic data could indicate how fast the ocean opened up. We would expect the rocks on the crest of the ridge to be normally magnetized, because they were extruded during the present normal magnetic epoch. Reversely magnetized rocks corresponding to a magnetic epoch of about one million years ago have been displaced some distance from the ridge—say, about 15 kilometers on each side of the ridge crest if the spreading rate is 1.5 centimeters per year. The reversal time scale can actually be followed through many oscillations of the Earth's field, and the corresponding magnetic bands extend out to many hundreds of kilometers from the ridge crest (Fig. 18-18).

The magnetized strips of sea floor provided a powerful tool to extend the history of magnetic-field reversals back in time almost 200 million years into the Jurassic Period. Precise dating of reversals (and therefore of spreading rates) goes back only about 5 million years, because the radiometric method of dating lava flows on land loses accuracy beyond this time. By simply assuming the spreading rate determined for the past 5 million years to be representative of a much longer period, the older normal and reversed magnetic epochs could be correlated over all the oceans and assigned dates. Figure 18-19 shows the sequence of 171 reversals, extending back 76 million years to the Cretaceous Period, as they were worked out by this method. The magnetized strips on the sea floor are shown schematically below the observed magnetic anomalies. Note that the spacing of the strips differs in the several oceans because the sequence of reversals can be compressed or stretched out according to slower or faster spreading.

After geologists study a region, they often present the sequence of rock layers extending back in geological time as a stratigraphic section. Magnetic anomalies on the sea floor enable geophysicists to plot a "magnetic-stratigraphic"

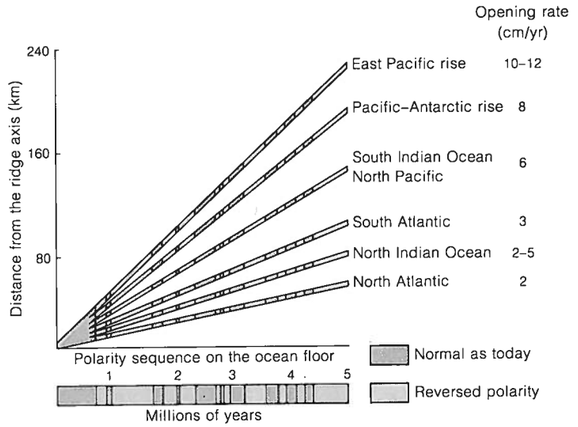

Figure 18-18
The rate of ocean spreading from magnetic anomaly patterns. The same magnetic polarity zone may be encountered at various distances from different ridges in different oceans, depending on the rate of spreading. Since the ages of the polarity zones are known from the magnetic-reversal time scale, the spreading rates can be calculated. The spreading rate of the Pacific Ocean along the East Pacific rise is the most rapid, amounting to 10–12 cm/yr. The North Atlantic shows the slowest rate, 2 cm/yr. [After *Continental Drift* by D. and M. Tarling, Doubleday Anchor Books. Copyright © 1971 by G. Bell and Sons, Ltd.]

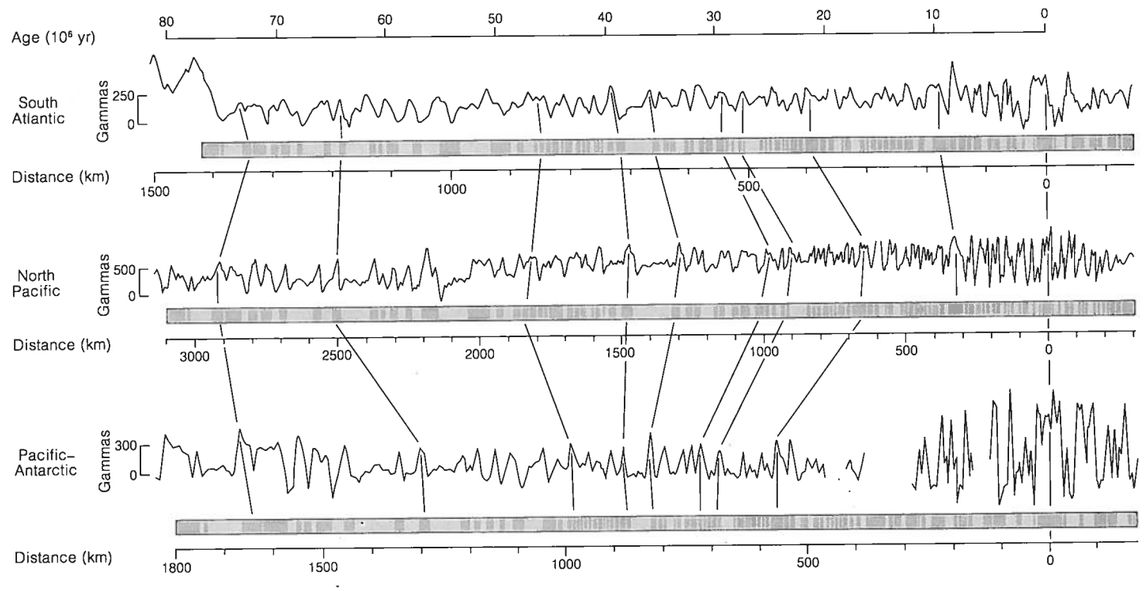

Figure 18-19
Magnetic anomalies recorded over the oceans reveal the same succession of magnetized lava formations on the seafloor, depicted by the dark and light stripes. The spacing may differ because the spreading rates vary, but each ocean shows the same sequence of some 171 reversals over the past 76 million years. The illustration shows the correlation of the anomalies from ocean to ocean. [After "Sea Floor Spreading" by J. R. Heirtzler. Copyright © 1968 by Scientific American, Inc. All rights reserved.]