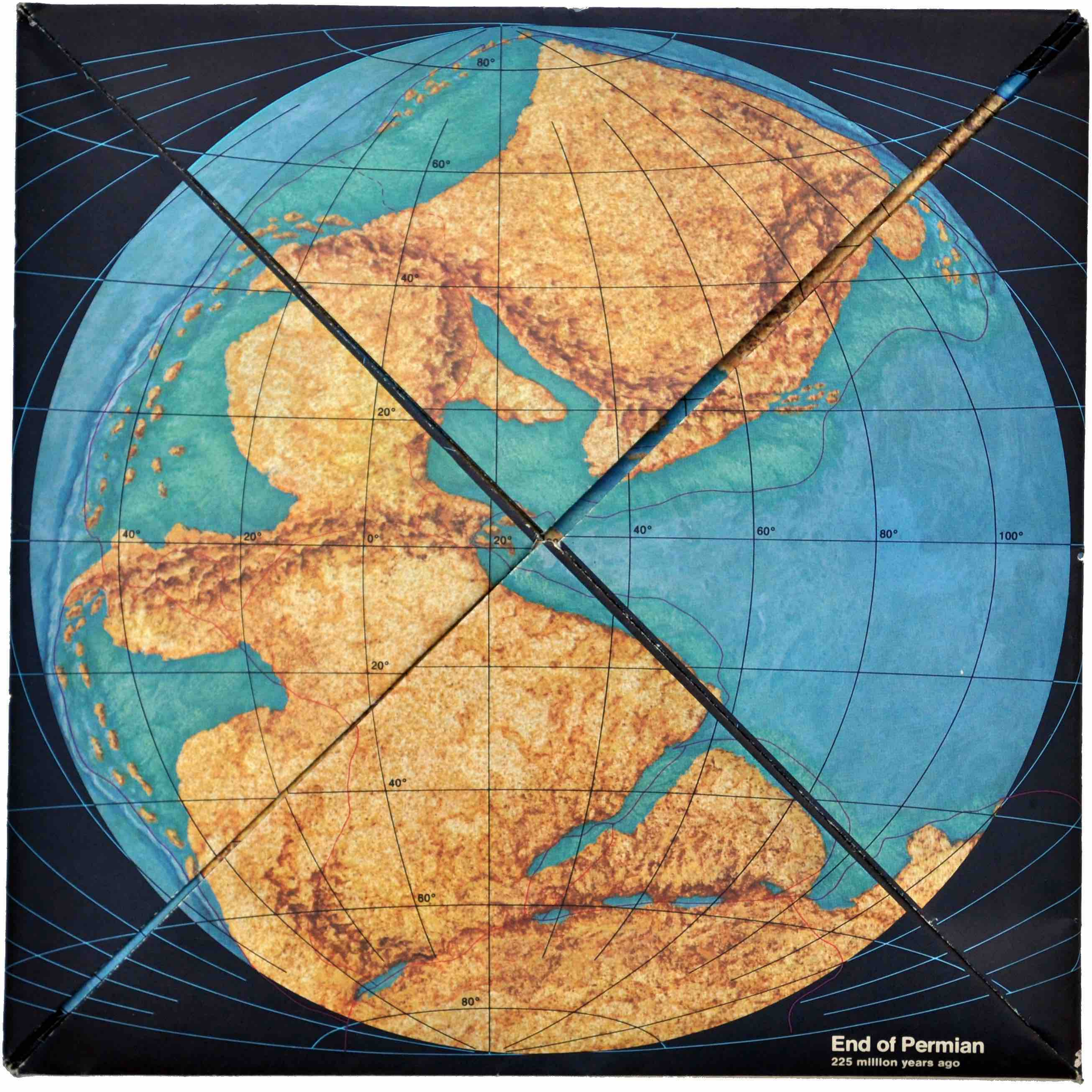

80°
60°
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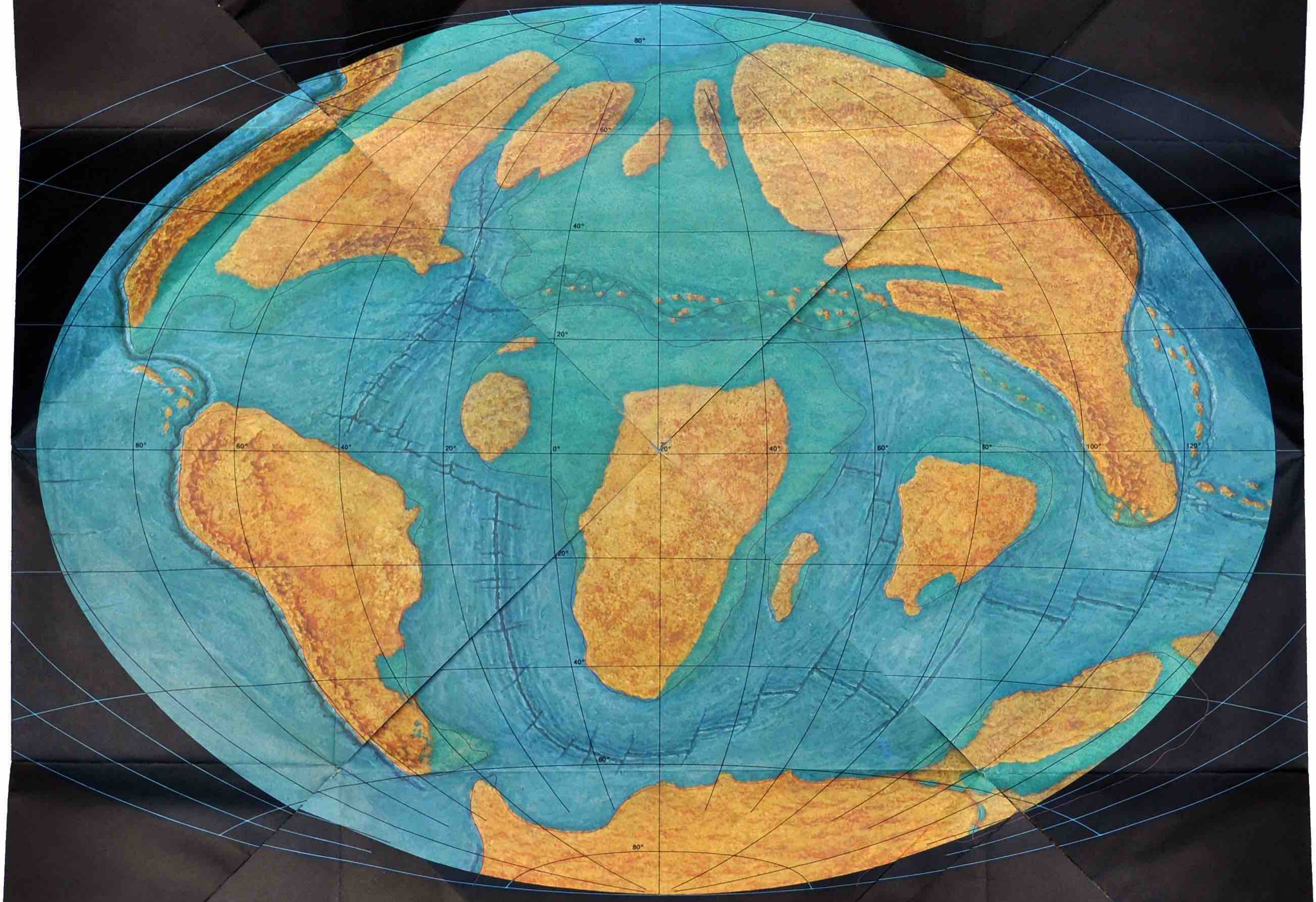
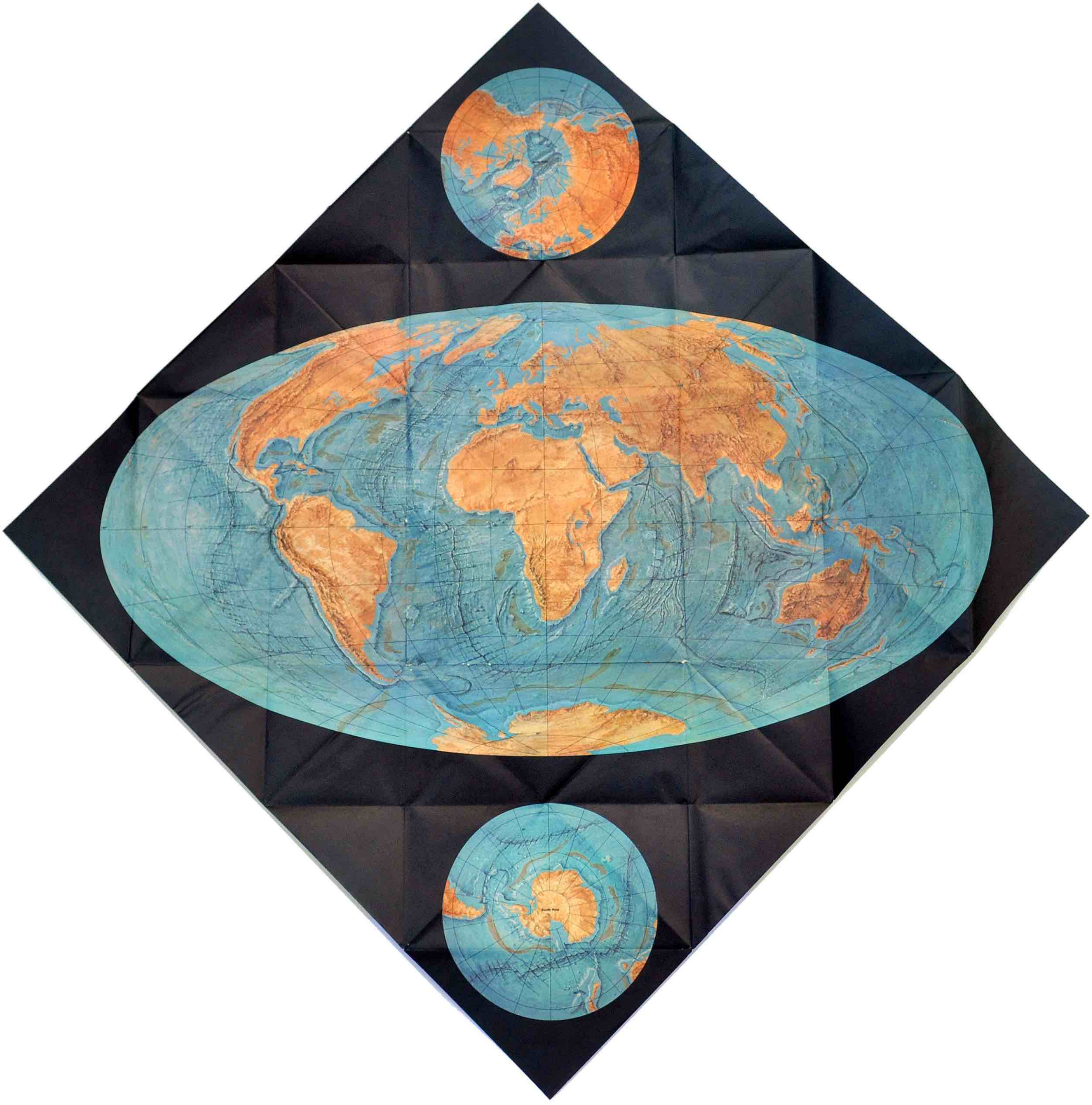
End of Permian
225 million years ago

End of Jurassic
135 million years ago



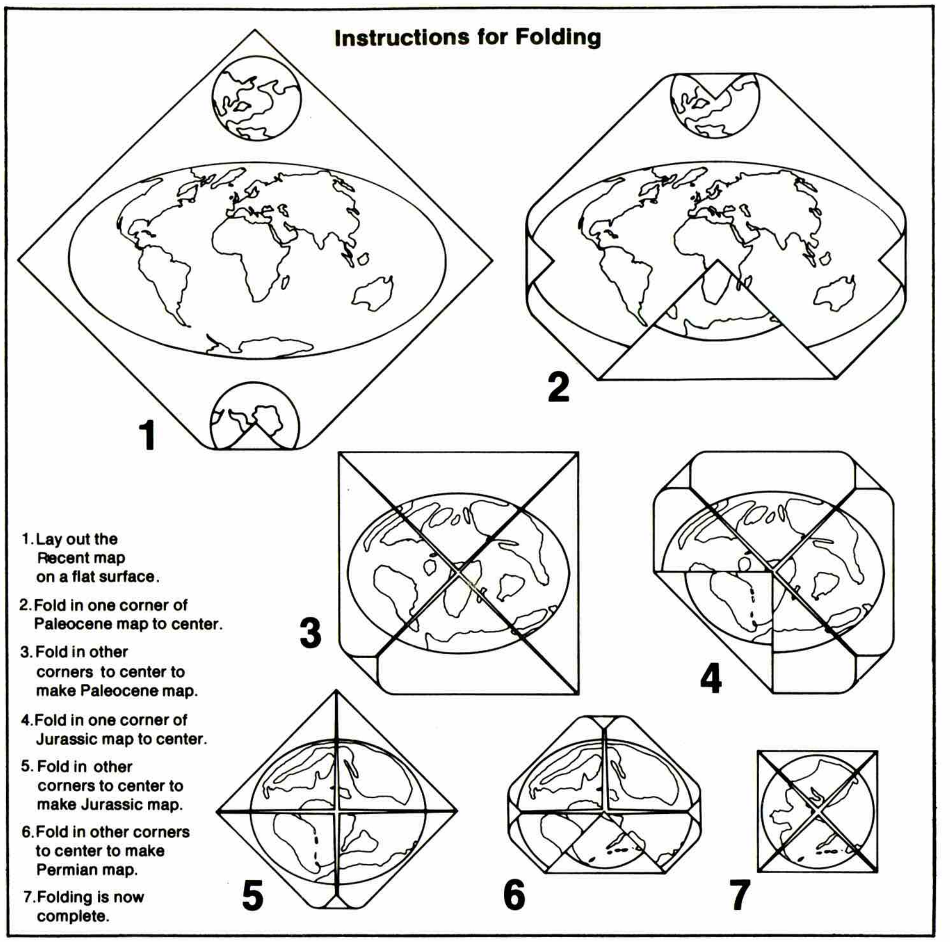
Paleocene
65 million years ago



The Folding Earth

The new hypothesis of global tectonics (including the concept of sea-floor spreading) has redefined our perception of the earth. As a result, we know that earlier ideas of the continents having remained fixed land masses throughout geologic time are inaccurate. The series of images of the dynamic crust that unfold in these maps are reconstructions of major physiographic changes that have occurred in the last 225 million years.

The following are visual keys for the maps: Aitoff projections are used on all the maps, with each succeeding projection increasing in size by 20 percent. The red outlines represent the presumed boundaries of materials contained in today's continents. Because there are unavoidable distortions in map projection and because the shapes of the ancient continents are hypothetical, the outlines of the continents are offered only for identification. Major mountain belts appear in relief, and the inland (or epicontinental) seas are distinguishable from the oceans by the seas' aqua coloring. Regions of geosynclinal activity are depicted as island systems, usually on the borders of inland seas. Trenches and mid-oceanic ridges are easily identified.



End of Permian

The Permian map shows the earth as it was 225 million years ago, when all the land was one supercontinent called Pangaea. This continent may, in turn, have resulted from preexisting continental nuclei that drifted together. Some geologists believe that the indicated mountain ranges (especially the Urals and Appalachians) have resulted from the impacts between drifting continents at the continental margins. The beginning of a break is suggested between Antarctica and Africa, although the break possibly occurred in the early Cretaceous.

End of Jurassic

By the end of the Jurassic several features of plate evolution had developed. Two large land masses existed at this time: the large northern mass made up of Europe, Asia, and North America known as Laurasia, and the southern mass (South America, Africa, Antarctica, and India) called Gondwanaland. Note that South America-Africa-India may have still been attached to Antarctica-Australia. The breakup of Gondwanaland probably happened some 25 million years later than the age depicted. The continental outline of the India-Madagascar land mass is shown both before and after it separated from Antarctica. (The dotted outline shows it at 135 million years ago, and the solid line indicates its subsequent position.) The start of a break is suggested between South America and Africa, although this break probably occurred in early Cretaceous time. Southern Europe and southeast Asia are shown as an active geosynclinal region.

Paleocene

By Paleocene time a well defined series of mid-oceanic ridges had evolved between the separated continental blocks. India was drifting northward, probably colliding with Asia around 55 million years ago. This impact resulted in the formation of the Himalayan mountain range. Incipient separation is suggested between Antarctica and Australia, although the break probably occurred 43 million years ago, in the Eocene. The spreading patterns in the Indian and Atlantic oceans are fairly well known because the ocean floor is still available for inspection. In the cases of both the eastern and western Pacific the crust was consumed along the indicated trench margins, and therefore the spreading patterns can only be inferred from continental and oceanic geology.

Recent

The final and largest map shows the earth today. The much greater physiographic detail results from recent direct observation of the sea floor. Oceanographic research has yielded much information about the bathymetry of the oceans; the map shows the great and extensive system of mid-oceanic ridges, submerged islands, and deep trenches. Deep sedimentary basins produced by submarine transport of continental materials are shown in grayish brown. North and south polar projections are included, to show the poles in relatively undistorted form and to permit a more accurate depiction of sizes of the polar land masses.

Several general observations should be noted in this sequence: the recent period in geologic history is characterized by relatively high continental relief. Much of the present-day continental land mass was previously under water. Flat lying sedimentary rocks of Europe and western North America were deposited in the inland seas outlined on the maps. The once extensive oceanic and epicontinental area of southern Eurasia known as the Tethys Sea is shown in several stages of development. Its modern remnants extend through the Mediterranean from the Indian to the Atlantic oceans.

Southeast Asia and the Indian Ocean represent two areas of relative uncertainty. Recent research developments allow reconstruction of a tentative sequence of events. Complex patterns of magnetic stripes on the Indian Ocean floor indicate that India traced at least two, and probably three, distinct directions of motion, as suggested by the maps. The directional changes are manifested in the complexity of the geologic history of southeast Asia and Indonesia.

Credits

The projections and the approximate positions of land masses and ridges are based mainly on the work of Dietz and Holden, *Journal of Geophysical Research*, 75:26 (1970). The positions of the epicontinental seas are based on Kummel and other sources.

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