k35 The supercontinent cycle

< duration of a supercontinent is short, time between is 600 ±100 My>

Alter erit tum Tiphys et altera quae vehat Argo / delectos heroas; —Virgil.[1]

Continents by their motions today are opening the Arctic, Atlantic, Indian, and Southern oceans, and are closing the Pacific ocean.

How long can continents stay their course before the Pacific is fully closed and they are collided into one land? How far and fast have they come? The latter is easy to answer as a detailed record of their path and speed is in the rocks of the seafloor that has opened since Pangea.

As Earth is a sphere, the oceans between passive continental margins have a maximum rate of spreading on a great circle that can be found. Spreading rates are centimeters per year. Because rate of seafloor spreading can be different to either side of a ridge, spreading rates, in the literature, are usually given as half-rates, which also can be the speed of subduction. The full-rate of great circle opening of the Southern Ocean between Antarctica and Australia is 7.4 cm/yr and of southern North Atlantic is 2.8 cm/yr. Using these as examples of fast and slow continental-separation rates we can estimate the time between breakup and coalescence of supercontinents to be ~600 My (*see* Topic *k36*).

Pangea was in existence for 40 My in the interval 180-220 Ma. Rodinia was forming in one place while breaking up in another for 345 My in the interval 755-1100 Ma and was briefly together ~870 Ma. The time between coalescence of Pangea and Rodinia is ~670 My. On uniformitarian grounds supercontinents will have existed before Rodinia.[2] And this evidently was so (*recall* Topic *k34*).

To summarize: A rough estimate of the time between supercontinents is 600±100 My. The supercontinents themselves evidently have a relatively short duration or are never wholly formed and are breaking up in one place as they are forming elsewhere.

Fragmentation of a supercontinent is not along lines of prior continent sutures except, by chance, locally, and there, only approximately. New oceans unrelated to old ones are opened. For example, Gondwanaland that separated from Laurasia ending the existence of Pangea was minus the area that is Florida from the Gondwana that had sutured into Pangea. Subduction that begins after continental fragments have coalesced, is not a reversal of the subduction that closed oceans between them.

What initiates breakup is a subject that has generated much speculation. A long standing suggestion is that the blanketing effect of continental crust is a factor.[3] The continental crust has a concentration of radioactive elements that warms it. The underlying asthenosphere thus thickens, with the effect of isostatic upward-flexing of the continental crust. The outward slope from the center of uplift engenders gravitational collapse fragmentation and an outward push that initiates subduction at some remove. Then proceeds the separation of the continental plate fragments and the opening of deep ocean floor between. Some would have hotspot intrusions of mantle material beneath the continental lithosphere initiate the breakup, and they point to triple junctions which they infer to be where the breakup began. An initiating upward bulge could also result from asthenosphere intrusive replacement of a relatively cool subcrust that delaminates and sinks into the mantle. However, more certain is that a subducting slab can pull on a plate that elsewhere is fractured along a line. And there the asthenosphere will isostatically upwell to fill between retreating plate edges to give by its higher stand than the level of the ocean deeps, an ongoing fare-thee-well push.

What initiates subduction is an unsolved problem. ❑