Self-Organized Breakup of Gondwana

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Gondwana broke apart along a geometrically-regular fracture system that minimized total crack length and therefore required the least work to nucleate and propagate fractures across the supercontinent. Fracture spacing was a function of the strength of the Gondwana lithosphere, and fracture arrangement met conditions imposed by Euler's rule for ordering convex polyhedrons on a spherical shell. The tensile stress field that initiated the fractures appears to have been self-organized by the pre-existing geometry of Gondwana.

Tensile hoop stress followed the Gondwana periphery. Regularly-spaced radial fractures abutted the periphery at T intersections, showing that it acted as a free surface; these defined the lateral edges of Australia, India, Arabia, Libya, and northwest Africa. Approximately1000-1500 km inward from the periphery, each of these radial fractures branched into two fractures at approximately 120 degrees. The branches linked into a surprisingly regular polygonal network that was congruent with a truncated icosahedron and symmetrical about the center of Gondwana. The fracture system may have formed in response to uplift and stretching of Gondwana above upper mantle that was thermally expanding because it was insulated by the slow-moving supercontinent (see Anderson, 1982, Nature).

The uplift and fracturing may have culminated during the Triassic sea-level low-stand. The fragments later separated diachronously as demanded by plate tectonics, leading to outbreaks of large igneous provinces along fracture intersections. Many of the fractures evolved into hydrocarbon-rich passive continental margins, others formed productive failed rifts in continental interiors. This study argues against the deep mantle plume paradigm for breakup of Gondwana.