Wandering Poles and Colliding Continents

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A record of India's impressive northward journey of more than 6000 km over the past 80 million years has been preserved in sediments and rocks and revealed by ocean drilling (Figure 1). Cores recovered during ODP and DSDP legs at sixteen sites in the Indian Ocean provide crucial data on the rate of India's motion and the timing of India's collision with Eurasia (Klootwijk et al., 1991; Acton 1999).

The paleomagnetic signal recorded in the sediment and basalt from the drill cores provides a means of determining the position of the plate relative to the spin axis, which gives the latitude of the lithospheric plates through time. For India, the change of latitude has been large and rapid, particularly prior to India's collision with Eurasia. That collision resulted in an abrupt slow down in the rate of northward motion of India, which paleomagnetic data show occurred at 57±3 million years ago (Figure 2).

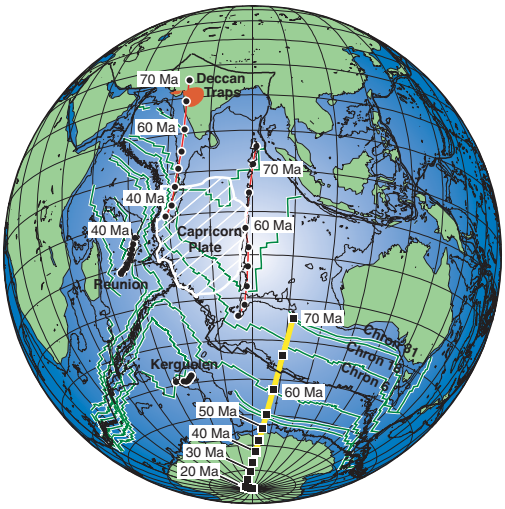

Figure 1: Motion of the Indian Plate. Location map showing paleomagnetic poles, from which the past motions of the Indian plate relative to the spin axis are estimated (yellow line with squares plotted every 5 Myr), two hotspot tracks (Reunion and Kerguelen), from which the past motions of the Indian plate relative to the mantle are estimated (red lines with solid circles plotted every 5 Myr), the current plate boundaries (bold black lines), the past locations of the plate boundary at 20, 41, and 67 million years ago obtained from marine magnetic lineations and fracture zones, from which the past motions of the Indian plate relative to surrounding plates are estimated (green lines), and the 3000 m bathymetric contour.

In addition to showing plate movement, the cores also provide information on mantle movement. The motion of India over the mantle can be estimated from hotspot tracks, which are linear chains of volcanoes and seamounts that form when a plate passes over a hotspot (a rising plume of mantle). The motion of India relative to the mantle differs from its motion relative to the spin axis, with the differences providing insights into how a significant portion and perhaps the entire mantle has been moving since the Late Cretaceous.

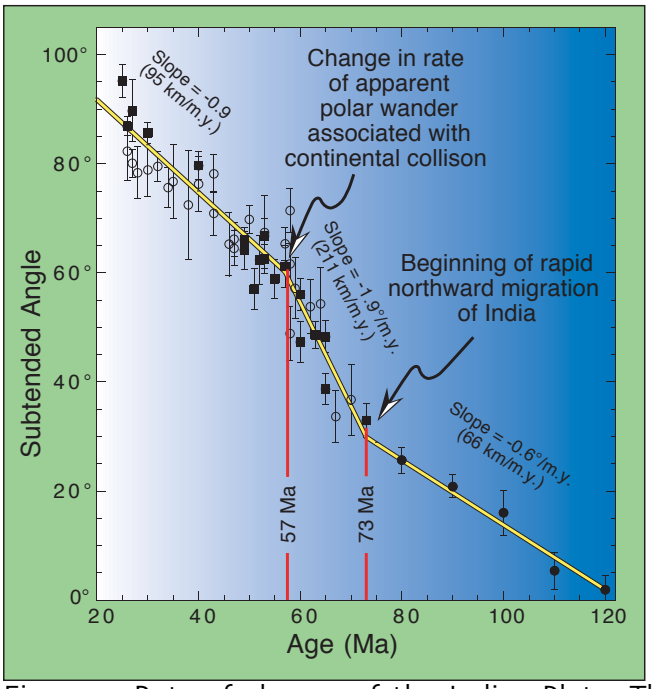

Figure 2: Rate of change of the Indian Plate. The subtended angles of paleomagnetic poles (squares and solid circles; see Acton [1999] for details) and ODP/DSDP paleocolatitudes (hollow circles) along India's apparent polar wander path are plotted versus age. The slopes of the best fitting lines (thick curve) give the rate of apparent polar wander, which is equivalent to the rate that India moves relative to the paleomagnetic or spin axis. The abrupt change in rate at 57 million years ago corresponds to when the collision or suturing of India with Eurasia began to impede India's northward progression.

References

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