

## **How India parted company from Gondwana: constraints of space and time**

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India formed an integral part of the Gondwana 'supercontinent' throughout Paleozoic times. Disruption of Gondwana started early in the Jurassic but it was not until late in the Cretaceous, 100 myr later, that India began its well-known rapid journey northwards, eventually to collide with Asia and form the Himalaya. Data from the southern oceans – primarily ocean-floor topography and marine magnetic anomalies – have been used to investigate (a) the precise configuration of the present-day continents within reassembled Gondwana and (b) the processes of disruption that determined the paleogeography of the southern continents in the 100 myr interval from 184.2 Ma (start Toarcian) to 83.64 Ma (C34, start Campanian).

The most recent 40 myr of this interval (i.e. 121.4 to 83.64 Ma) are devoid of marine magnetic anomalies and so demand some conservative plate-tectonic assumptions in addition to careful interpretation of the ocean-floor topography created. Plate-tectonic modelling software (Atlas, Cambridge) has been used to model both continental positions and the likely geometry and behaviour of the mid-ocean ridges across the entire Gondwana-wide system of plates from the onset of disruption to 83.64 Ma, by which time India had begun its rapid northward journey.

From this analysis it emerges that initial disruption into East and West Gondwana accelerated early in the Cretaceous (from 142.3 Ma, Berriasian). By 121.4 Ma (M0, start Aptian) most of the well-known continental outlines had been established, many of them in the shorter interval 130-125 Ma (Hauterivian-Barremian). These events are attributed to the more-or-less simultaneous outbreak at this time of the Kerguelen and Tristan mantle plumes. The former created the (Greater) India-Australia-Antarctica triple junction, the latter started the main phase of South Atlantic opening. At about the same time, re-ignition of the Bouvet plume, located perpetually midway between Africa and Antarctica (and responsible for the original 184 Ma Gondwana disruption) ensured continuity of new mid-ocean ridge systems from West Africa to western Australia, a distance of more than 11 000 km, by Albian times. From early in the Cretaceous the entire India plate, confined at its southern continental tip (along with Sri Lanka) between Africa (including Madagascar) and Antarctica, rotated counter-clockwise by way of two major dextral strike-slip transforms, one off western Australia and the other off Arabia-Somalia. This continued until an 'escape route' to the north became possible at about 90 Ma (Turonian) with the outbreak of the Marion plume.

The work has been conducted under the umbrella of IGCP-628 ([www.gondwana.geologia.ufri.br/en/](http://www.gondwana.geologia.ufri.br/en/)) which will shortly publish the new geological map of Gondwana. Animations and explanatory text concerning the work described here may be found at [www.reeves.nl/gondwana](http://www.reeves.nl/gondwana). The timescale of GTS2020 ([www.timescalefoundation.org](http://www.timescalefoundation.org)) has been used throughout.