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The terrace like feature in the mid-continental slope region off Trivandrum and a plausible model for India–Madagascar juxtaposition in immediate pre-drift scenario

V. Yatheesh [a,*], G.C. Bhattacharya [b], K. Mahender [c]

[a] National Centre for Antarctic and Ocean Research, Headland Sada, Vasco-da-Gama, Goa 403 804, India
[b] Geological Oceanography Division, National Institute of Oceanography, Dona Paula, Goa 403 004, India
[c] Department of Earth Science, Goa University, Taleigao Plateau, Goa 403 206, India

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Abstract

Bathymetry of the southwestern continental margin of India reveals the presence of an anomalous terrace like feature in the mid-continental slope region off Trivandrum. The genesis of this terrace of large areal extent (~9000 sq. km.) is yet to be established. Based on exercises with several existing paleogeographic reconstruction models and updated compilation of identified offshore tectonic elements, this study attempts to identify a plausible model of India–Madagascar juxtaposition in immediate pre-drift scenario, which provides idea about genesis of this terrace. It is inferred that the terrace off Trivandrum and an anomalous bathymetric notch located in the northern Madagascar Ridge are conjugate features related to India–Madagascar separation and the rifted and sheared segments of the pre-drift plate boundary have shaped their outlines. The drifting of India from Madagascar is suggested to have commenced at about 86.5 Ma.

Keywords: Terrace; Madagascar Ridge; India–Madagascar juxtaposition; Paleogeographic reconstruction; Shear zones

1. Introduction

The continental shelf of west coast of India (Fig. 1), limited by the 200 m isobath, has variable width. Towards the north this shelf is relatively wider, being more than 300 km in the areas north off Mumbai coast, whereas towards the south this width gradually narrows down to about 50 km off Trivandrum. As compared to the continental shelf, the continental slope in most of this region is relatively narrow and parallels the trend of the continental shelf edge. However, the continental slope region off Trivandrum (Fig. 1) interestingly depicts the presence of an anomalous broad terrace like feature, which has not drawn much attention of the researchers so far. The western continental margin of India, to which this terrace belongs, is considered to be a passive continental margin (Biswas, 1982, 1987), which evolved during the process of rifting and drifting of Madagascar, Seychelles and India. Even though researchers agree on the concept of a welded Madagascar–Seychelles–India continental block, but opinion differs regarding their immediate pre-drift juxtaposition and consequential early post drift positions. Probably lack of distinct and dependable "piercing points" such as onshore tectonic lineaments, which could have constrained this juxtaposition, is one of the reasons for those varied inferences. The other reason could be the absence of India–Madagascar break-up related magnetic isochrons, which could have allowed arriving at consistent rotation parameters for constraining early India–Madagascar separation, as that break-up took place during Cretaceous long normal superchron.

It was also observed that the outline of this terrace appears in the post anomaly 34 paleogeographic reconstructions of Norton and Sclater (1979) as well as of Besse and Courtillot (1988). However, those studies, apparently due to their emphasis on broader perspective, did not pay specific attention to this terrace or looked for its conjugate feature. Rao and Bhattacharya (1975) analyzed magnetic and seismic data in the northern part (off

* Corresponding author. Fax: +91 832 2520877.
E-mail address: yatheesh@ncaor.org (V. Yatheesh).

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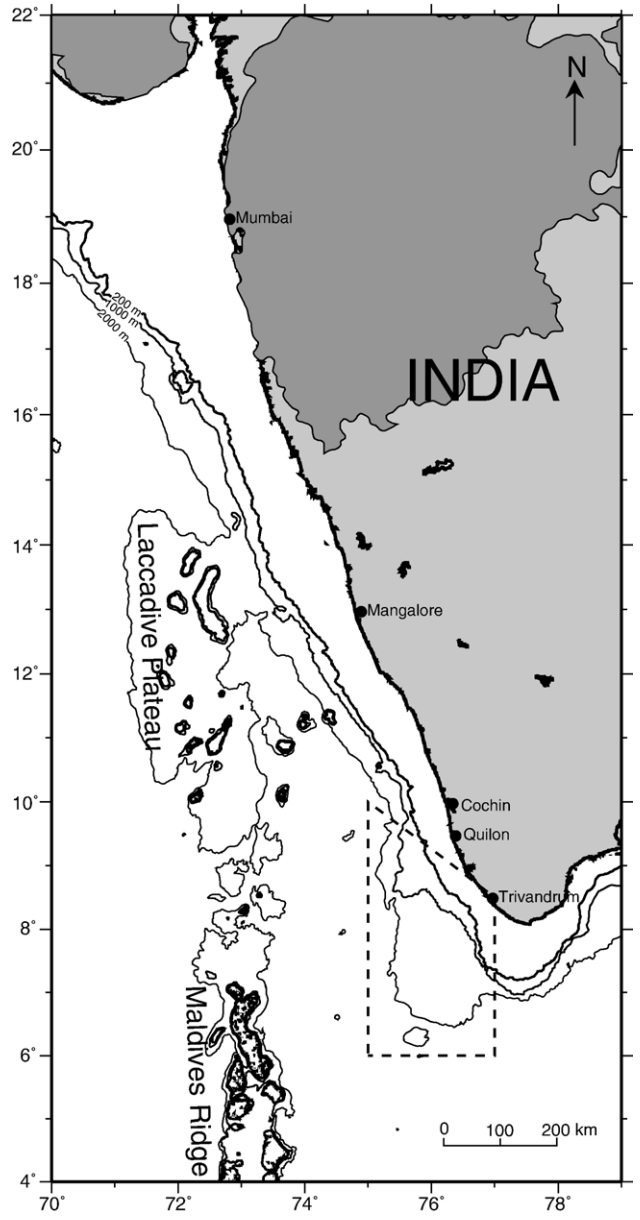

Fig. 1. Generalized map of the southwestern continental margin of India along with selected (200, 1000 and 2000 m) bathymetric contours obtained from recent GEBCO digital data set (Intergovernmental Oceanographic Commission et al., 2003). The dashed box indicates the area of the terrace like feature located off Trivandrum.

Quilon) of this terrace and attributed its genesis to block faulting of the basement. As mentioned by Storey et al. (1995), the eastern part of the northern Madagascar Plateau and a bathymetric high on the west side of the southern tip of India was inferred by Dyment (1991) to be conjugate with respect to the Mascarene Basin spreading ridge. However, subsequent researchers could not identify those inferred conjugate features and make their use to constrain the India–Madagascar juxtaposition, since they were not depicted in publication. In view of this, an attempt has been made in this paper to identify those conjugate features distinctly through exercises with several available paleogeographic reconstruction models and use those conjugate features to arrive at a close fit model of the India–Madagascar juxtaposition in their immediate pre-drift scenario.

2. The topography of the terrace like feature off Trivandrum

The bathymetry contour map (Fig. 1), shows a conspicuously wide low gradient zone in the mid-continental slope region off Trivandrum. This zone broadly lies between 1000 and 2000 m isobaths and covers an area of about 9000 sq. km. Eight available bathymetric transects (Figs. 2 and 3) across this zone suggest this terrace as a relatively flat zone bounded by a steep ascending (by about 1000 m) seafloor to the adjacent continental shelf on the easterly side and a comparable steep descending seafloor towards the deep sea in the westerly side. This topography appears to be anomalous as compared to the general topography depicted by contours and two bathymetric transects (Fig. 3) across the normal shelf–slope configuration in the north. This wide zone is considered to qualify well as a 'terrace' following the definition of Lapedes (1978) and for further reference in this study we denote this feature as 'Terrace off Trivandrum (TOT)'.

3. India–Madagascar juxtaposition at anomaly 34 time — varied inferences

For tracing the India–Madagascar separation one need to start with the India–Madagascar juxtaposition. The aspect of paleogeographic juxtaposition of India and Madagascar has been directly addressed or indirectly depicted in number of studies. The

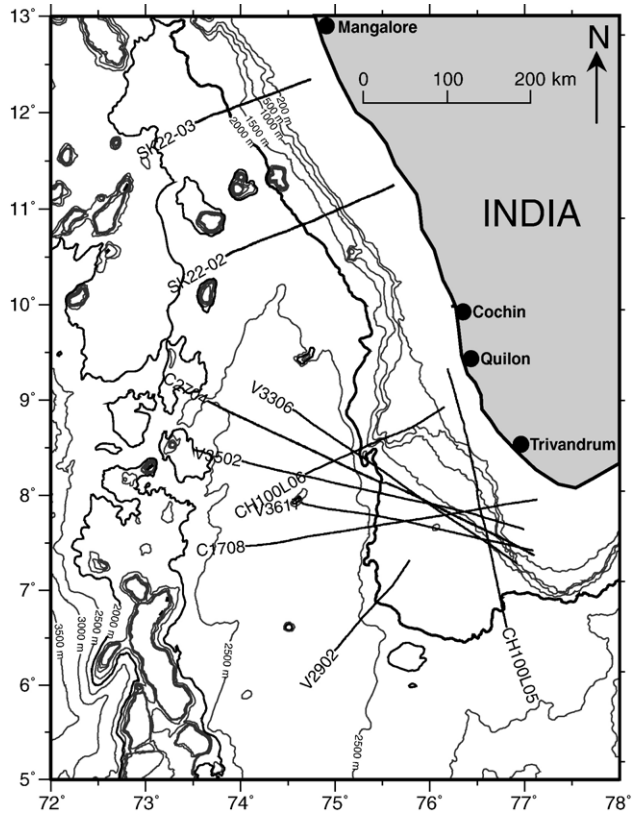

Fig. 2. Map showing location of selected bathymetry profiles across the southwestern continental margin of India along which the sectional views have been presented in Fig. 3. These bathymetry profiles have been obtained from the National Geophysical Data Centre (1998) and National Institute of Oceanography (NIO) databases. Other details as in Fig. 1.