Geophysical Research Abstracts, Vol. 7, 04954, 2005
SRef-ID: 1607-7962/gra/EGU05-A-04954

Extensive magmatism during the formation of the Laxmi Ridge rifted margin, NW Indian Ocean

Lane, C. I. (1); Minshull, T. A. (1); Collier, J. S. (2); Whitmarsh, R. B. (1); Sansom, V. (2) Evain, M. M. (1)

(1) Southampton University, Southampton Oceanography Centre, European Way, Southampton, SO14 3ZH United Kingdom(2) Dept. Earth Sciences and Engineering, Imperial College, Prince Consort Road, London, SW7 2BP United Kingdom (cil1@soc.soton.ac.uk / Fax: +44 (0)23 8059 6554 / Phone: +44 (0)23 8059 6554

The rate of strain that continental lithosphere experiences during rifting could control the architecture of the resulting rifted margins, and the volume and distribution of any melt that is generated during extension. The most widely studied continental margins are those of the North Atlantic, where the rate of extension was typically 10-20mm/a half-rate. In order to determine whether strain rate is a controlling factor on rift architecture and syn-rift magmatism, it is important to also study margins that were rifted more rapidly.

Seismic profiles were acquired in January-February 2003 across the Laxmi Ridge margin, and its conjugate, the Seychelles Bank. These margins are thought to have formed under a relatively high strain rate (59mm/a half-rate). Here, we present data collected data from Chron 27, the earliest undisputed seafloor spreading anomaly, to the continental rise of western India. The main seismic line trends N-S for 480km. 32 ocean bottom instruments where deployed in the study area, and they recorded shots from a 6920cu.in airgun source, fired every 60s. Coincident MCS profiles were recorded with a 2.4km 96-channel streamer, and part of the main line was re-shot with a 3890cu.in source, fired every 30s.

Laxmi Ridge is a NW-SE trending basement high. It is 200km wide at its widest point, extends for 1200km, and rises up to 1400m above the adjacent basement relief. The northern limit of Laxmi Ridge abuts Gop Rift. Within Gop Rift the magnetic field consists of a series of high-amplitude, linear, positive and negative SSE-NNW trending magnetic anomalies, whose origin is currently unresolved.

We have modelled the velocity structure of the Laxmi Ridge margin by inverting the travel-times of reflected and refracted phases recorded on the ocean bottom instruments. The crustal thickness was calculated from both reflections and refractions from the Moho, with further constraint from modelling the free-air gravity profile. Generally, the crust thickens to the north, from $\sim$7 km seaward of Laxmi Ridge, to $\sim$12 km at the continental rise, and beneath Laxmi Ridge the crust is $\sim$9 km thick. Within Gop Rift, the crust is around 6 km thick, and the provenance of this structure is still unresolved. P-wave velocities of 3.7 km. $^{-1}$ at top basement, increasing to 7.4 km s^{-1} in the lower crust, are observed at the southern (oceanic) end of the model. Velocities increase from 3.5 km s^{-1} to 7.2 km s^{-1} at the northern (continental) end. The modelling has revealed blocks of high velocity material (up to 7.5 km s^{-1}) underlying thin crust in two regions: beneath the lower continental rise of northwest India, and to the south beneath Laxmi Ridge. We interpret this material to be magmatic underplate. The volume of underplate is estimated as at least 60,000 km^3under this section of Laxmi Ridge alone. If the underplate continues with the same cross-sectional area for the full 1200 km extent of Laxmi Ridge, the volume could be as great as 7.2 x 10^5 km^3. If this volcanism is related to the emplacement of the Deccan Large Igneous Province (LIP), it would increase the current estimate for the total volume of magmatism associated with the Deccan event by 8 %.

Two phases of rifting are inferred to have caused the observed underplate and crustal geometry, although the ages of rifting are not yet well constrained. The first phase occurred north of Laxmi Ridge and emplaced large volumes of igneous material beneath the thinned continental crust. The crust was thinned to around a fifth of its original thickness and, if instantaneous rifting is assumed, a thermal anomaly of $\sim$ 100 ºC existed in the mantle at this time. Thermal weakening resulting from this anomaly may have allowed strain to localise beneath the crust, leading to the initiation of rifting. This thermal anomaly may be related to that which caused the Deccan LIP. The second phase of rifting, which was relatively amagmatic but shows seaward-dipping reflector sequences on both margins, separated Laxmi Ridge from the Seychelles Plateau. The thickness and seismic velocity of the new crust constructed during both rift phases suggest that active upwelling did not influence melt generation during either phase.