

NOTES

STUDYING THE INDIAN OCEAN RIDGE SYSTEM: AGENDA FOR THE NEW CENTURY

If we agree that about 25% of the Earth's total heat flux is lost to the hydrosphere through thermal convection and hydrothermal venting at the mid-oceanic ridges (MOR), it is imperative that we gather more information about this 65,000 km long globe-encircling underwater mountain chain. The Indian Ocean Ridge System (IORS), is conspicuous for more than one reason. The ridge axis melt beneath the Indian ridge axis, is isotopically distinct from the melt present in the other oceans. Secondly, the ridge system is characterised by inconsistent presence of fracture zones, the ridge axis is much more displaced south of the equator than to the north. Mixing of ridge and hotspot melts; formation of axial seamounts are other interesting aspects. Locating hydrothermally active sites along this slow to intermediate spreading ridge system has been ever elusive.

Studies on the Indian Ocean Ridge System, though sporadic, was aimed to map the complete IORS petrologically and tectonically. Three areas are placed for immediate investigation; one in the slow spreading Carlsberg Ridge area, the second, along the intermediate spreading Central Indian Ridge, and the third one at the Andaman back-arc basin. The National Institute of Oceanography, Goa, and the Geological Survey of India, Calcutta, are the organisations spearheading the work on IORS. The studies made in this direction are briefly outlined here.

Carlsberg Ridge

Recent multibeam bathymetry survey over this ridge shows a ridge axial discontinuity, with a broad axial valley, with depth varying from 2200 m to 4500 m. The backscatter amplitude data confirms sedimented rift valley, although recovery of mantle rocks such as lherzolites, gabbros, serpentinites from the inner rift valley wall indicates shallow depth of the mantle. Occurrence of pteropods in the southern part of the Carlsberg Ridge below the aragonite compensation depth (between 2000-2500 m), and their good preservation indicate the presence of possible hydrothermal activities, through increase in alkalinity in seabed sediments.

Central Indian Ridge (CIR)

The CIR activity is studying the four major intersection points between the prominent NE-SW trending fracture zones and the NNW-SSW oriented CIR between 5°S and 18°S. The morphological segmentation along the northern part of CIR is found to occur at a spacing of 30-80 km. Magnetic anomalies up to chron 5 have been identified. Evolutionary history of the CIR since 10 Ma is traced, to document that the spreading across the ridge has been asymmetric, coupled with the presence of several second order discontinuities. The difference in spreading rate along CIR suggest that the northern part in continuation with the Carlsberg ridge forms the slow accretionary boundary of the Indian plate, while the southern CIR is evolving as the intermediate spreading western boundary of the Australian plate. They converge between 6°S to 9°S region of CIR, where the wide boundary zone (WBZ) of intraplate deformation separating the Indian and Australian plates, intersects it. Under such a circumstance, the region is probably evolving as a RRTc type triple junction.

Rocks dredged from the ridge axis valley and walls are largely typical normal basalt (N-MORB), rarely transitional or enriched in large ion lithophile elements (T/E-MORBs).

Geochemical and isotopic analyses of rocks show discreet magmatic provinces. The depth, pressure and extent of melting of magma of this area characteristically differ from those found in ridge systems of other oceans. The magma is inferred to have surfaced probably from several, small, shallow-seated chambers, where melt accumulates through diapirs. Recent results confirm a slow but hot spreading centre at 19°S along the CIR, as morphological, geochemical and geophysical characters suggest ridge-hotspot interaction forming two underwater ridges. Manganese nodules, recovered from the Vityaz fracture zone area, are hydrogenetic ($Mn/Fe \leq 1$), with significant influence of hydrothermal components. Additionally, presence of nodules probably throw interesting light on the bottom water movement across the fracture zone.

Andaman Back-Arc

Within the complex morphotectonic fabric of the Andaman Back-arc basin, a spreading ridge, cratered volcanic seamounts and apparently active faults are identified. The north-south trending 80 km long spreading ridge is active in the south. The axial valley and the seamount crater seems to contain broken parts of a chimney structure, along with disseminated and vein type metal sulphides. The Nicobar rift valley, the deepest in the region, is studied recently in detail. Late release of stress through this faulted rift valley seems to have adjusted the basement, which is overburdened with huge pile of sediment in the form of hour-glass structure, oriented normal to the principal strain axis. The present configuration of the basin seems to be the result of a continuous dilational stress, with younger tensional structures reorienting the geomorphic regime. Studies on peropod assemblage in the surrounding area successfully drew the boundary between the top warmer Holocene and cooler Pleistocene at a depth between 90-110 cm.

Outstanding problems in the Indian Ocean

Indian researchers have been visiting the IORS sporadically. The studies undertaken so far were mostly individual driven. Although the advances made, in the face of all logistic constraints, are appreciable, such programmes tend to be governed by the subject expertise of the concerned scientist(s), than a part of the integrated and well thought of plan. It is time that we see the MOR as an integrated entity.

Indian ridge research community during the early years of the new Century should focus on some of the following outstanding problems.

- How a triple junction is created and how it propagates, like the nascent one suspected between 6°S and 10°S latitudes along the CIR, where the Indo-Arabian, Australian and African plates meet?
- Why hydrothermal activities are reported to be infrequent along IORS, in contrast to other slow-intermediate spreading centres?
- Why melt beneath the IORS occurs in distinct provinces?
- How the kinematics of heat and mass flux transfer from mantle to the hydrosphere work in a well segmented IOR system?

Additionally, generation and growth of new faults, their episodicity, and effect of mantle temperature on formation, migration, budget, upwelling of magma, and on the rate of crustal accretion may constitute interesting studies. Moreover, exploring the nature of mixing of ridge and hotspot melts; and the formation, eruption style and conduit geometry of near-axis seamount would be of immense significance. Another aspect we need to look into is the biology of the ridges

under a hostile condition. This aspect holds tremendous promise from astrobiology point of view. Field studies, coupled with modelling should be India's research prerogative.

The Future

Only 25% of the 4200 km long CR+CIR stretch has been studied so far by Indian and International agencies. Hence, a vast tract is still waiting to be discovered. A small effort has been initiated in 1997 with the formation of **InRidge**. The Indian scientific community having interest in this fascinating world of ridge research should come together to develop this embryonic initiative into an effective scientific body to set plan, give directions, coordinate and monitor high quality multi-disciplinary integrated scientific research. Such an initiative could be a major research priority of DST or DOD.

Interested scientists may initiate the process of coming together by contacting by post or email: ranadhir@csnio.ren.nic.in; iyer@csnio.ren.nic.in; kamesh@csnio.ren.nic.in; abhay@csnio.ren.nic.in before December 15th, 1999. The details could be discussed by the interested researchers during the Annual convention of the Indian Geophysical Union to be held in Pondicherry between December 21st and 23rd, 1999.

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LAKSHMESHVAR RAMARAO BIRTH CENTENARY RESEARCH GRANTS: 1999-2000

A sum of Rs.10,000 will be available under the above head during 1999-2000 for helping young research scholars. Grants will be available to graduate students engaged in research in the fields of Palaeontology and Stratigraphy for carrying out laboratory and field work.

Those interested in seeking assistance are requested to make an application to the Society, furnishing full particulars of their academic qualifications, details of the project they are engaged in and the extent and nature of assistance required by them. The application should be supported by their guide and the head of the Institution and should reach the Secretary, Geological Society of India, P.B. No.1922, Gavipuram P.O., Bangalore-560 019 on or before 10th January 2000.