

**A long-term drilling program for understanding of tectono-climatic evolution of northern Indian Ocean**

Dhananjai Pandey\*, S. Rajan and Rasik Ravindra

[pandey@ncaor.org](mailto:pandey@ncaor.org)

National Centre for Antarctic and Ocean Research,  
(Ministry of Earth Sciences, Government of India)

Goa, INDIA 403804

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**Abstract:**

Compared to the exhaustive deep-sea drilling carried out through the world oceans, the northern Indian Ocean sector is marked by very few DSDP/ODP locations (Fig. 1). The lack of critical deep ocean sampling has been a major constraint in scientific endeavours towards unravelling the history of the geological and climatic evolution of ocean basins in this part. Availability of sub-seabed cores buried underneath water column of up to 4km deep would certainly enhance our understanding of key geological processes. Under these circumstances, as an associate member of the Integrated Ocean Drilling Program (IODP), India would like to draw attention of the international scientific community towards making appropriate steps for IODP boreholes in this region.

Since the northern Indian Ocean covers a vast area and is largely under-sampled region in terms of ocean drilling activities, a long-term, multi-leg project is favoured. Considering that the INVEST meeting would provide an ideal opportunity to discuss the scientific aspects of this sector, it is felt that the next science plan could be guided to cover the already active (#552, 595, 605, 618, 704, 744 etc.)/future IODP proposals in the northern Indian Ocean. It is also perceived that the wide-range of geological and climatic processes over the extensive zone justify our attempts to prioritize this region.

## **1. Introduction:**

Much of the geo-scientific issues about northern Indian Ocean (NIO) were learnt after the International Indian Ocean Expedition program (IIOE-1960-65). Since then, integrated geophysical and geological studies have considerably improved our understanding of geological evolution of the NIO through time. Results from previous studies in association with the ODP/DSDP boreholes in the Indian Ocean have further enhanced our knowledge. However, several key questions pertaining to the tectono-climatic evolution of this region, having global relevance, still remain unanswered. This is due to the lack of adequate marine geophysical and geological data and their validation by direct sub-surface sampling using ocean drilling program in this sector.

The advent of technology has brought us to the stage of multi-parameter deep ocean floor and sub-seafloor sampling through Integrated Ocean Drilling Program (IODP). Therefore, it is highly desirable to commence a long term, multi-leg project focussed on the NIO to fill the gap in knowledge.

## **2. Potential geological-climatic processes**

The evolution of the global oceanic and atmospheric circulations systems has been affected by several geodynamic processes. In general, the orbital variations play the dominant part over shorter periods of time and tectonic components (such as dynamics of ocean basins, hot spots, growth and erosion of orogenic belts etc.) contribute over longer periods of time. This means one would need to look at both of these components in order to build a complete tectonic and climatic evolutionary history [1].

The NIO has several key geological features that make it an ideal zone to investigate the solid-Earth-climatic interactions. The climatic signal is strong, especially with regard to the Monsoon, and the rate of sedimentation is often high, allowing detailed palaeo-oceanographic reconstructions. The NIO contains ideal sites to study both a volcanic continental margin as well as subduction zone at its ends and hence their climatic implications.

Much work remains to be done in terms of understanding of tectonic and climatic evolution of this part of the Indian Ocean [2, 3]. Past decade has witnessed several efforts made to understand the temporal variations in climate, erosion and tectonism of this region. However, such efforts would be incomplete without having a benchmark knowledge recorded in the oceanic sediments. To unravel the story completely, additional marine geophysical data and deep scientific drilling are required in the Arabian Sea and the Bay of Bengal sectors. This would help construct the detailed records required to quantify the nature of solid-Earth climatic coupling.

Keeping the evolutionary history in mind, some of the key questions which require urgent attention through IODP can be enlisted as:

- 1) Indus fan sedimentation and its climatic implications,
- 2) Conjugate margin studies in Bay of Bengal and Arabian Sea,

- 3) Role of hot spots in the evolution of Indian continental margin,
- 4) Bengal fan sedimentation and its link with Himalayan orogeny,
- 5) Structural evolution of 85° east ridge,
- 6) Kinematics of the Andaman subduction zone,
- 7) Gas hydrates related studies, and
- 8) Hydrothermal circulations.

Over the past few years, a number of scientific cruises over this vast region have led to the discoveries of several ground-breaking facts. Multiple international collaborative cruises to the northern Indian Ocean have contributed significant marine data and sediment cores required to construct the evolutionary history of this region. Besides, the Ministry of Earth Sciences (Government of India) took an initiative to acquire large scale (> 30K line km) marine geophysical data comprising seismic reflection, refraction, gravity, magnetic and bathymetric data covering almost entire Arabian Sea and the Bay of Bengal (Fig. 2).

To minimise the ambiguities with interpretations made based on indirect geological and geophysical datasets, a ground validation would be highly desirable. Such validations could only be made through the direct sampling using IODP. This would facilitate bringing together an international team of scientists from various disciplines to analyse and exchange the multitude of scientific information in order to improve evolutionary process of this region.

### **3. Justification for a long-term project:**

The NIO remains sparsely covered by the ocean drilling program whereas it contains some of the major thrust areas falling in line with the IODP science objectives (e.g. The Deep Biosphere and the Sub-seafloor Ocean; Environmental Change, Processes and Effects; and Solid Earth Cycles and Geodynamics). Scientists have unanimously felt that the lack of critical sub-seafloor data in this region has been major constraint for future endeavours. Taking stock of what we know about the ocean basins around us and what remains to be studied, a thematic drilling plan for NIO could be considered as a way forward. Bearing the expected key outcomes, their multi-disciplinary nature and global implications in mind, a long-term plan is fully justified over several specific ones to deal with the problems.

### **4. References:**

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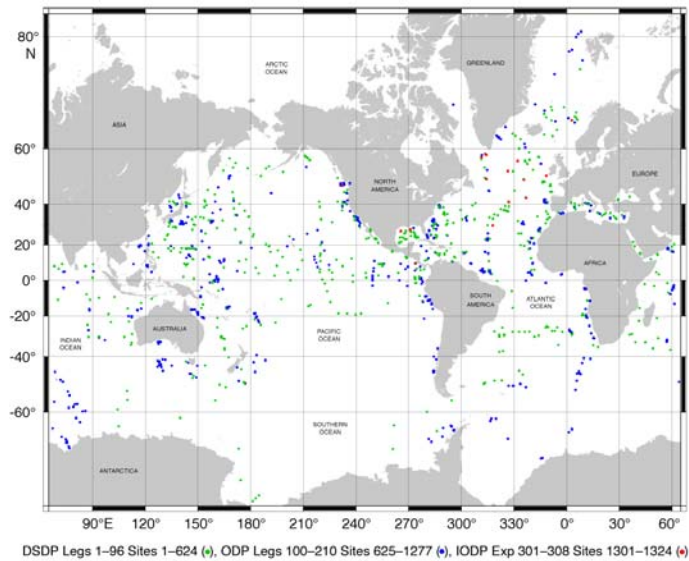


Figure 1: ODP/DSDP/IODP expeditions throughout the world (source: IODP website)

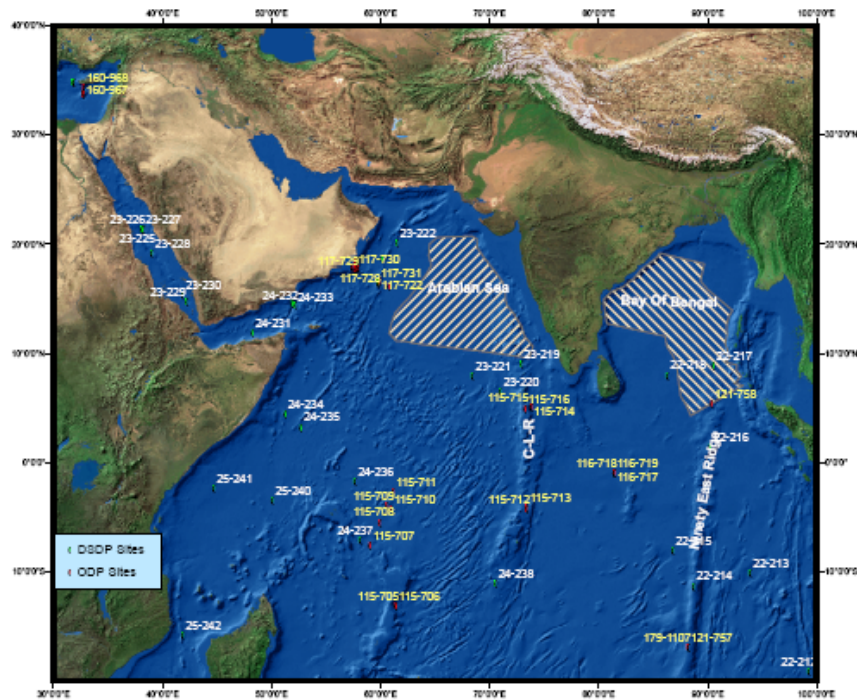


Figure 2: The map showing northern Indian Ocean with DSDP/ODP locations. The shaded area shows the region covered by closely spaced multi-channel seismic reflection, refraction, gravity, magnetic and bathymetric profiles stretched over more than 30K line km. The high quality marine geophysical data would help in the site characterization for the future IODP locations.