IODP-INDIA

STATUS REPORT OF ACTIVITIES RELATED TO THE INTEGRATED OCEAN DRILLING PROGRAM

National Centre for Antarctic and Ocean Research Goa, India
1. BACKGROUND

The Integrated Ocean Drilling Program (IODP) began in 2003, envisaged as an ambitious expansion of exploration beneath the oceans. The IODP is an international marine research endeavour that explores Earth's structure and history recorded in oceanic sediments and rocks and monitors sub-sea floor environments. IODP builds upon the earlier success of DSDP (1968-1983) and ODP (1985-2003) and augments the reach of these programs using multiple drilling platforms. The first phase of IODP campaigns is scheduled for completion by October 2013 which would mark the beginning of new phase of IODP (2013-2023).

The centrepiece of IODP’s deep-water efforts during the first phase has been a brand new riser-equipped, dynamically positioned drillship, operated by JAMSTEC (Japan Marine Science and Technology Center). This riser vessel “CHIYKU” is partnered with a modern, non-riser, dynamically positioned drillship, a successor to the Ocean Drilling Program’s JOIDES Resolution, supplied and operated by the US National Science Foundation. In addition, the European and circum-Pacific nations have taken the initiative to provide “mission-specific platforms (MSP)” for small-scale ocean drilling.

IODP’s scientific objectives are organized into three major themes: The Deep Biosphere and the Sub-seafloor Ocean; Environmental Change, Processes and Effects; and Solid Earth Cycles and Geodynamics. Within these three themes, the following eight initiatives have been identified that are ready to be addressed within the first decade of IODP drilling:

Deep Biosphere; Extreme Climates; Rapid Climate Change; Continental Breakup and Sedimentary Basin Formation; Large Igneous Provinces; Gas Hydrates; 21st Century Mohole; Seismogenic Zone

2. IODP-India @ National Centre for Antarctic & Ocean Research

Against the above background of IODP operations and science plan and in the context of the front-ranking scientific endeavours being planned/being undertaken by India in the ocean domain, the Ministry of Earth Sciences (MoES), Government of India took an initiative during 2008-09 towards India joining the IODP fraternity as an Associate Member. A formal MoU in this regard was also signed between MoES and NSF/MEXT- the two lead Agencies for IODP Operations. India joined IODP as an Associate Member. On behalf of MoES, the National Centre for Antarctic and Ocean Research, Goa has been designated as the nodal agency to deal with various facets of the IODP program in India. Since joining this consortium, NCAOR has been involved significantly in this international endeavour. India is member of Science Advisory Structure (SAS) as well as Science Planning Committee (SPC) of this multi-national mission.

Under the MoU with NSF/MEXT, provisions were made for the Indian scientists and researchers to participate in the regular IODP expeditions around the world and get involved in the active research pertaining to the deep sea drilling. A complete list of Indian scientists participated so far in various IODP expeditions are appended later in this document.
Looking beyond the participation of Indian scientists in the IODP activities elsewhere in the world, there was an imperative need for the country to develop a concrete Science Plan of its own, addressing the scientific issues pertaining to the seas around Indian Ocean which calls for deep-drilling. Taking cognizance of this need, the Ministry constituted an Expert Group to co-ordinate India’s initiatives in this regard and to help develop a Science Plan for deep sea drilling in the Arabian Sea, Bay of Bengal and adjoining regions of Indian Ocean.

The first meeting of this Expert Group was held at the National Centre for Antarctic and Ocean Research (NCAOR) on the 28th November 2008 under the chairmanship of Director, NCAOR. The meeting followed very close interactions among Indian geo-scientific community whereby inputs were received from scientists across the country to finalise the Indian Science Plan for Deep Sea Drilling in the Indian Ocean. The first phase of IODP is about complete its 10 years and set to enter its new phase by 2013. The Science Plan highlights priority areas around Indian Ocean that require deep-sea drilling and therefore will form the basis for our involvement in the program. The Indian Science Plan includes following major themes:

1. **Crustal Evolution** –
   
   **Western Continental margin**
   - Continent Ocean Boundary
   - Characterization of crust at selected locations (Laxmi Basin, Chagos-Laccadive Ridge, etc)
   - Mesozoics under the traps
   - SW coast of India and Gulf of Mannar

   **Eastern Continental margin**
   - Continent Ocean Boundary – Transect drilling
   - Mesozoic crust
   - Sampling of 85E ridge
   - Afanasy Nikitin Sea mount
   - Distal Bengal for KT superchron

   **Andaman Sea**
   - Spreading centre
   - Barren Island – Heat flux from the crust,
   - Earthquake swarms

   **Mid Ocean Ridges**
   - Carlsberg Ridge (RTI zone, core complexes, hydrothermal vent fields)
   - Triple junctions

2. **Gas Hydrates** -
   - Sediment characteristics, BSR characteristics and GH occurrence (West coast – Off Mangalore and Cape Comorin)
3. Climate Change-
- Timing of the SW monsoon and NE monsoon and their later evolution
- Sediment fluxes in BOB through time and linkages with Himalayan Orogeny

Based on our Science Plan, we have submitted a scientific proposal to the IODP consortium for drilling in the Arabian Sea to recover records from the sea-floor and beneath to understand past climate change. This information is crucial to learn about the climate change in future.

3. IODP SESSION AT ASIA OCEANIA GEOSCIENCES (AOGS) MEETING, HYDERABAD (5-9TH JULY 2010)

Following development of a long-term Indian Science plan for the Deep Sea Drilling in the Indian Ocean, a dedicated scientific session was organised during AOGS meeting during July 5-9, 2010 at Hyderabad, India. The main objective of this session was to facilitate ample discussions among Indian scientific fraternity and concretize a fully fledged Indian drilling proposal. The meeting was chaired by the Secretary, MoES and attended by delegates from numerous institutes/organisations across the country such as PRL, NIO, NGRI, IITM, NCAOR, IIT, having varied expertise. The meeting was open to all the participants of the AOGS meeting to receive possible feedback for developing a comprehensive drilling proposal for the northern Indian Ocean. The meeting was highly significant in terms of collecting valuable suggestions related to this program at one such forum.

In addition to the above meeting, a parallel poster session was also organised during AOGS meeting in association with the IODP-MI to promote overall awareness about the benefits of deep sea scientific drilling and their role in resolving various scientific problems. In this connection a combined booth was displayed with participants from NCAOR, Goa as well as IODP-MI, Japan.
4. **Indian Proposal for Deep Sea Drilling in the Arabian Sea:**

Following the meeting of National Expert Committee on IODP on 27th January 2010 and the discussion meeting held at AOGS (05-09 July 2010), Hyderabad, wherein a resolution to submit a scientific drilling proposal in the Arabian Sea was taken, a comprehensive proposal for the scientific drilling in the Arabian Sea was prepared involving proponents from various scientific and academic institutes in India and was submitted to the IODP on October 1, 2010.

The scientific proposal entitled “Deep sea drilling in the Arabian Sea: Discovering the tectono-climatic unknowns (IODP-776_FULL)” is primarily aimed at recovering deep sea cores from five different sites (shown as red stars in the figure above) from the Arabian Sea to:

i. Obtain high-resolution climate records from regions of high pelagic sedimentation in the Arabian Sea (vs. records of Himalayan erosion in the Indus Fan).

ii. Reconstruct the erosion response of the western Himalaya to proposed monsoon strengthening at 8 Ma.

iii. Recover Paleogene sediments from Arabian Sea to understand significant issues pertaining to the evolutionary history of this region such as offshore extension of Deccan Traps and the Mesozoic sediments beneath them and the nature of crust in the Laxmi basin area of the Arabian Sea.

**Present Status:** After its submission, the proposal was reviewed independently by the IODP through their Proposal Evaluation Panel (PEP) and Site Survey Panel (SSP). Based on the comments of the PEP watchdogs, proposal was modified and re-submitted under the category of Complementary Project Proposal (CPP) in April 2012 (IODP_793CPP). The CPP proposal is also reviewed by the PEP panel and the revised version has been submitted to IODP (IODP_793CPP2) which is currently under External Review. The external review process is supposed to be completed by March 2013 and recommendations shall be placed before next PEP meeting (June 2013). One of the key constraints of the proposal suggested by the PEP
panel is to have a site survey data around the proposed drill sites for which NCAOR is currently in touch with MoES.

5. INDIAN PARTICIPATION ONBOARD VARIOUS IODP EXPEDITIONS:

Consequent upon India’s joining the IODP consortium, Indian scientists have been participating on various IODP expeditions around the world. Nominations of these scientists are invited from across the country and selected based on their field of expertise in tandem with the scientific objectives of each expedition. The Indian scientific participation onboard IODP platforms has been one of the most significant aspects of the IODP membership as scientists from various disciplines and expertise have been able to get hands-on experience of scientific drilling in the ocean. So far, all the Indian scientists participated in the IODP expeditions have been very young who with their first hand experience would be a great potential for the capacity building in the years to come. All of the scientists participated so far have initiated research programs based on the exclusive sediment cores obtained through respective IODP expeditions. Total fourteen scientists (including two onshore science party) have participated in IODP expeditions and about three scientists are in the processes before 2013. A list of Indian IODP participation so far is provided below:

Figure (above): Map of IODP expeditions before 2013. Rectangles in red represent IODP expeditions for which Indian scientists have participated.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Expedition</th>
<th>Name of Scientist</th>
<th>Organization</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>IODP-345 (Hess Deep)</td>
<td>Dr. Abhishek Saha</td>
<td>Calcutta University</td>
<td>Dec 12 – Feb, 2013</td>
</tr>
<tr>
<td>3.</td>
<td>IODP-343 (JFAST, Japan)</td>
<td>Dr. Santanu Bose</td>
<td>Calcutta University</td>
<td>April-May, 2012</td>
</tr>
<tr>
<td>4.</td>
<td>IODP-342 (Newfoundland sediment drifts)</td>
<td>Dr. Amit Kumar Ghosh</td>
<td>BSIP, Lucknow</td>
<td>June-August, 2012</td>
</tr>
<tr>
<td>7.</td>
<td>IODP-336 Mid-Atlantic Microbiology</td>
<td>Dr. Mamatha S.S.</td>
<td>NIO, Goa</td>
<td>Sept- Nov, 2011</td>
</tr>
<tr>
<td>8.</td>
<td>IODP-335 Superfast spreading ridge</td>
<td>Dr. Parijat Roy</td>
<td>NGRI, Hyderabad</td>
<td>April – May, 2011</td>
</tr>
<tr>
<td>9.</td>
<td>IODP-334 CRISP</td>
<td>Dr. Yatheesh V.</td>
<td>NIO, Goa</td>
<td>March – April 2011</td>
</tr>
<tr>
<td>10.</td>
<td>IODP-325 Great Barrier Reef</td>
<td>Dr. Manish Tiwari</td>
<td>NCAOR, Goa</td>
<td>July, 2010</td>
</tr>
<tr>
<td>11.</td>
<td>IODP-323 Bering Sea</td>
<td>Dr. Maheshwar Ojha</td>
<td>NGRI, Hyderabad</td>
<td>July – Sep 2009</td>
</tr>
<tr>
<td>13.</td>
<td>IODP-321 PEAT</td>
<td>Dr. Pawan Devangan</td>
<td>NIO, Goa</td>
<td>May – June, 2009</td>
</tr>
<tr>
<td>14.</td>
<td>IODP-318 Wilkes Land</td>
<td>Mr. Prakash Srivastava</td>
<td>GSI, Faridabad</td>
<td>Jan – March, 2010</td>
</tr>
</tbody>
</table>
6. **Indian Representation on Various IODP Forums/Panels:**
India being an associate member has been actively participating in meetings of the various scientific and administrative panels of the IODP. This includes Science Advisory Structure (SAS), International Working Group plus (IWG+), Science Planning and Implementation Committee (SIPCom – Shri R K Sharma, MoES) and the Proposal Evaluation Panel (PEP – Prof. A K Singhvi, PRL), Site Characterisation Panel (SCP- Dr. D K Pandey, NCAOR) and Technology Panel (TP – Dr. Sathianarayanan - NIOT).

7. **Extramural Research Support:**
In order to support the advance science based on the sediment samples obtained by Indian scientists, like other Program Member Offices (PMOs), India has also supported several Indian scientists with extramural grants. The support was provided based on their scientific proposals submitted to IODP-India which went through a peer review process. A list of them is provided below:

<table>
<thead>
<tr>
<th>SN</th>
<th>Name of Scientist (s) &amp; organisation</th>
<th>Expedition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dr. N. C. Pant, <strong>Delhi University</strong> &amp; Mr. Prakash Srivastava, <strong>GSI, Faridabad</strong></td>
<td>(IODP expedition 318: Wilkes land Expedition)</td>
</tr>
<tr>
<td>2</td>
<td>Dr. Manish Tiwari, <strong>NCAOR Goa</strong></td>
<td>IODP expedition 325 (Great Barrier Reef)</td>
</tr>
<tr>
<td>3</td>
<td>Dr. Pavan Govil, <strong>BSIP Lucknow</strong> and NCAOR Goa</td>
<td>IODP Expedition 322 (Nankai Trough expedition)</td>
</tr>
<tr>
<td>4</td>
<td>Dr. Yatheesh Vadakkyakath, <strong>NIO, Goa</strong> and NCAOR Goa</td>
<td>IODP expedition 334 (Costa Rica Seismogenic zone – CRISP)</td>
</tr>
<tr>
<td>5</td>
<td>Dr. Parijat Roy, <strong>NGRI, Hyderabad</strong></td>
<td>IODP expedition 335: Superfast Spreading Rate Crust 4</td>
</tr>
<tr>
<td>6</td>
<td>Prof. A D Singh, <strong>BHU, Varanasi</strong></td>
<td>IODP Expedition 339: Mediterranean Outflow</td>
</tr>
</tbody>
</table>
8. INDIAN IODP PARTICIPANTS MEET, GOA (14-15 JAN 2013):

Indian IODP Participants meet was organised by IODP-India on 14-15 January 2013 at NCAOR, Goa to facilitate interaction among the Indian IODP participants. The meet was focussed on evolving future strategy to involve Indian participants in the IODP proposal on Arabian Sea submitted by India. The two days programme was inaugurated by Prof V K Gaur, Emeritus Scientist, CMMACS, Bangalore in the presence of Dr S Rajan, Director NCAOR, Shri R K Sharma, Advisor, MoES, Prof A K Singhvi, outstanding Scientist, PRL and expert invitees besides the participants. About 30 delegates from various parts of the country attended the programme and presented the scientific work carried out by them based on their IODP expedition.

During the meeting, comprehensive presentation was made on the Indian IODP proposal in the Arabian Sea to decipher tectono-climatic linkages. Possible roles of Indian IODP participants in the Arabian Sea drilling proposal was explored through discussions. It was unanimously agreed that a core competence should be developed to deal with post-cruise science plan of the Indian IODP proposal in the Arabian Sea. Scientists attending the meet expressed their excitement towards the Indian IODP activities and requested IODP-India for continued association in future in this international endeavour. Further, participants suggested to form few theme based sub groups to chalk out prospective scientific drilling proposals emanating from Indian Ocean sector.

9. INTERNATIONAL WORKSHOP ON INDIAN OCEAN, GOA (OCT 17-18, 2011):

The Indian Ocean has experienced one of the most complicated tectonic histories. Right from the disintegration of Gondwanaland to collision of the Indian plate with Asia to subduction of the Indian plate in one of the most prominent subduction zones, the region has a diversity of key tectonic features. Despite these remarkable efforts, several key questions in the Indian Ocean with significant global relevance are still unanswered. Decades of geo-scientific work
focussed on this sector has produced compelling hypotheses on various fronts. Our present understanding vis-a-vis these propositions requires corroboration from direct measurements such as deep ocean cores. The need for scientific drilling in the Indian Ocean sector is highly evident by several active proposals with the IODP-MI at various stages (e.g. proposal # 549, 552, 595, 667, 701, 702, 704, 717, 724, 727, 760, 776, 778, 780 and 783).

Considering that the IODP is entering into a new phase from 2013 and drilling in the Indian Ocean has been most desired by the scientists, IODP-India proposed a workshop in India to discuss the relevant scientific themes in an emerging scenario. The proposal, supported by the MoES, was approved by the Executive Council of IODP Science Advisory Structure. This international workshop would be organised during October 17-18, 2011 on scientific drilling in the Indian Ocean sector in association with Australia and New Zealand IODP Consortium (ANZIC) and IODP-MI. The workshop aims to provide a unique platform for about 100 scientists (60 Indians and 40 international) to interact and prioritize existing ideas as well as explore new research frontiers having larger societal relevance such as climate change, earthquake hazards, biotechnology and natural resource potential etc.

Because there has been no drilling in the Indian Ocean for nearly a decade, this workshop is vital in building the international scientific alliances that can lead to further strong proposals. Also, India itself has only joined IODP recently and such a workshop would provide wide exposure to the Indian science community of IODP science and IODP capability, leading to better understanding and new IODP proposals.

The Indian Ocean has often been considered as the most complex of the world’s major oceans. The tectonic evolution of this region (such as large igneous provinces and Himalayan orogeny) is believed to have had and to still have remarkable control on the global climate. Furthermore, the region hosts two of the world’s thickest accumulation of sediment (Indus and Bengal Fans). The build up of these fans is attributed to the growth and denudational history of the Himalayas. Understanding the controls on regional climate, especially monsoon strength, is important not only to science but also to society, given the large number of people - nearly half of Earth’s population - who live within the influence of the modern monsoon and the economic importance of monsoonal regions to the global economy.

The first international Indian Ocean IODP workshop had four primary themes:

1. Cenozoic oceanography, climate change, gateways and reef development.
2. The history of the monsoons.
3. Tectonics and volcanism.
4. The deep biosphere.
IODP-India hosted the first meeting of the newly constituted Science Implementation and Policy Committee (SIPCom) of IODP in Goa during January 18-20, 2012. The meeting was attended by more than 40 international delegates from various IODP program member countries including USA, Japan, China, Australia, UK, France, Spain, Korea etc. to discuss the existing proposals for the scientific drilling as well as future course of actions pertaining to the new framework of the IODP program. The SIPCom meeting was preceded by International Working Group Plus (IWG+) meeting to discuss various administrative and management aspects of the new IODP program to be started from 2013. In the meeting IODP-India was encouraged to submit a revised proposal under CPP scheme – Complementary Project Proposal (wherein a third party commitment of at least 70% of the science operation costs of the proposal is mandatory) with more international participation as per the recommendations of IODP-SAS panel which has been complied with.
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