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Institutional Report

National Institute of Ocean Technology

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Introduction

The National Institute of Ocean Technology (NIOT) under the aegis of Ministry of Earth Sciences started in November 1993 and celebrating Silver Jubilee during 2018-19 is the nodal agency in executing R&D activities to develop technologies and their application for sustainable utilization of ocean resources, to provide competitive, value-added technical services and solutions to organizations working in the ocean and to develop a knowledge base and institutional capabilities in India for management of ocean resources and environment.

India, with a long coastline with vast Exclusive Economic Zone, warranted extensive studies related to the ocean, not only to oceanographic parameters but also on technology development. It was imperative to build an understanding of issues related to coastal and deep waters to harness resources in an environment-friendly manner (Jalihal, 2019).

Broad Areas of Activities of NIOT

The activities of NIOT presently organized under i) Renewable energy and Freshwater by desalination ii) Ocean structures iii) Coastal and Environmental Engineering iv) Deep-sea technology development for non-renewable resource exploration v) Ocean observation network including Tsunami early warning

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systems vi) Ocean electronics, Ocean Acoustics and Marine sensor systems vii) Ocean science and technology for islands and Viii) Vessel Management.

Renewable Energy and Freshwater

Institute is involved in developing technologies for harnessing wave energy through floating wave-powered devices, a platform for offshore windmills, devices for extracting energy from ocean currents and ocean thermal energy. Wave powered navigational buoy has been developed and is in use since 2017 at the navigational channel of Kamarajar Port at Ennore, Chennai (Fig. 1). Prototype hydrokinetic device is demonstrated to produce power from ocean currents at Andaman in 2016 and being scaled up for 5 kW for usage in off-grid units in the Andaman Islands. Design and Development of Ocean Thermal Energy Conversion plant with desalinated water are in progress during 2018-19 to give power to the island community of Kavaratti of LakshadweepIsland using the temperature gradient on the ocean.

In continuation of the freshwater generation by Low-Temperature Thermal Desalination Technology (LTTD) of NIOT at Kavaratti during 2005, two more plants were erected at Minicoy and Agatti during 2011-12 (Fig. 2). As the drinking water quality improved, the health scenario of Island community Government of India entrusted NIOT to install the similar technology at six more islands in Lakshadweep and the activities are in progress to commission the first plant by 2019.

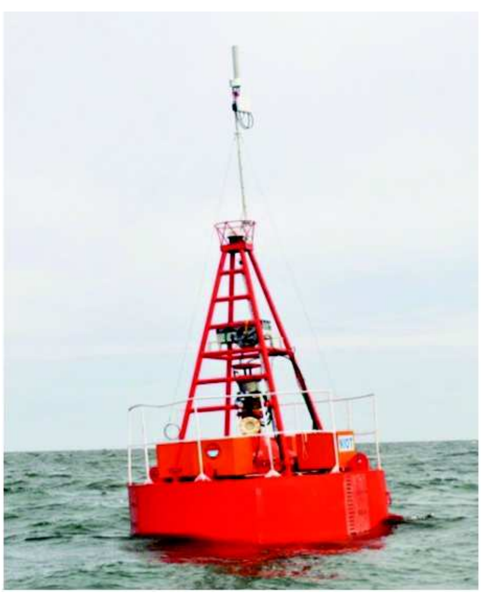

Fig. 1: Wave powered navigational buoy

Fig. 2: Low-Temperature Thermal Desalination (LTTD) plant at Kavaratti Island

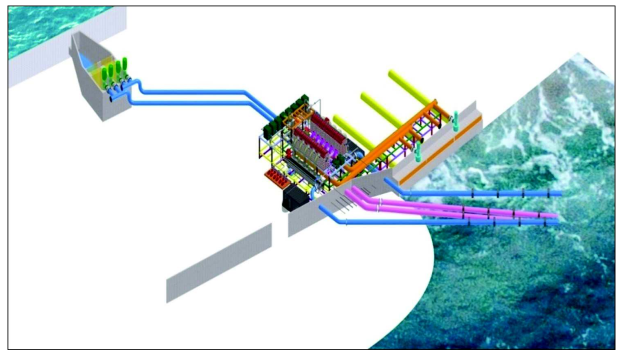

Fig. 3: 3D view of LTTD plant at Tuticorin Thermal Power station

Using the waste heat from a thermal power plant, using the LTTD principle, activities are in progress to install the plant at the TuticorinPower plant for 2 MLD (Fig. 3) (Venkatesan *et al*., 2019).

Coastal Protection

The coastal environment plays a major role in the nation's economy through its resources. The coast is under threat in the form of erosion and accretion by increasing population, urbanization and accelerated developmental activities in the coastal region. Institute had demonstrated the usage of soft measures to control erosion by detail understanding of coastal processes which includes studies on coastal geomorphology, sediment transport, wave forces, tide and current role apart from the longshore sediment transport. In the form of non-structured soft measures energy from incoming waves gets dissipated by mirroring the natural forces and maintaining the natural topography of the coast. Through pilot project at Tamilnadu with submerged dyke concept and Pondicherry with, NIOT had demonstrated the soft and hard solutions in combination pertinent the processes involved in the site condition and could able to restore the lost beaches over last few years 2016 to 2019 as shown in the Figs. 4 and 5 (Ramanamurthy *et al*., 2019)

Fig. 4: Puducherry Beach After Submerged Dyke Construction

Fig. 5: Beach restoration at Periyakuppam beachbefore and after dyke construction

Deep Ocean Exploration

As a pioneer investor, a status awarded by United Nations in 1987, India has been allotted 75,000 sq km area at Central Indian Ocean Basin (CIOB) by the International Seabed Authority (ISA) under UN to explore the poly-metallic manganese nodule rich in cobalt, nickel, manganese, iron, etc. (Ramadass *et al*., 2019). NIOT has developed 6000 m depth rated Remotely Operated Vehicle (ROSUB 6000) and

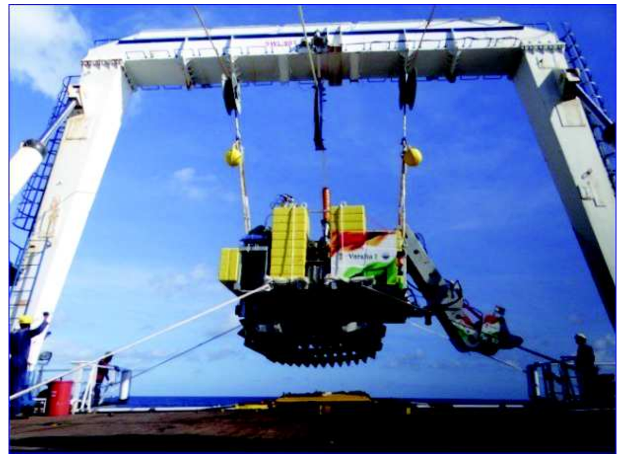

Fig. 6: Integrated deep-sea mining machine

Fig. 7: Deep-sea soil tester at 5462m in CIOB

tested at 5289 m water depth and In-situ Soil Tester to understand seabed geotechnical properties and tested at 5462 m water depth (Fig. 7). To have pilot-scale mining of deep-sea manganese nodule institute has demonstrated a crawler-based Integrated Mining System at 1000 m water depth during 2018 (Fig. 6) and is in the process of performing first demonstrative sea trial at CIOB during 2020. Deepwater ROV – ROSUB-6000 is being utilized for deep-ocean mineral exploration such as polymetallic manganese nodule at 5289 m water depth, hydrothermal sulfides at 2832 m water depth and gas hydrates at 1019 m water depth (Fig. 8) (Atmanand *et al*., 2015; Ramadass *et al*., 2019).

Shallow Water and Polar Exploration

With the expertise developed in unmanned underwater vehicle development, the institute had developed and demonstrated shallow water cum polar remotely operated vehicle (PROVe-500). Vehicle had explored the Priyadarshini Lake near Maitri base station of Antarctica and ice shelf studies near the new Indian barrier during 2015. Studies carried out with PROVe

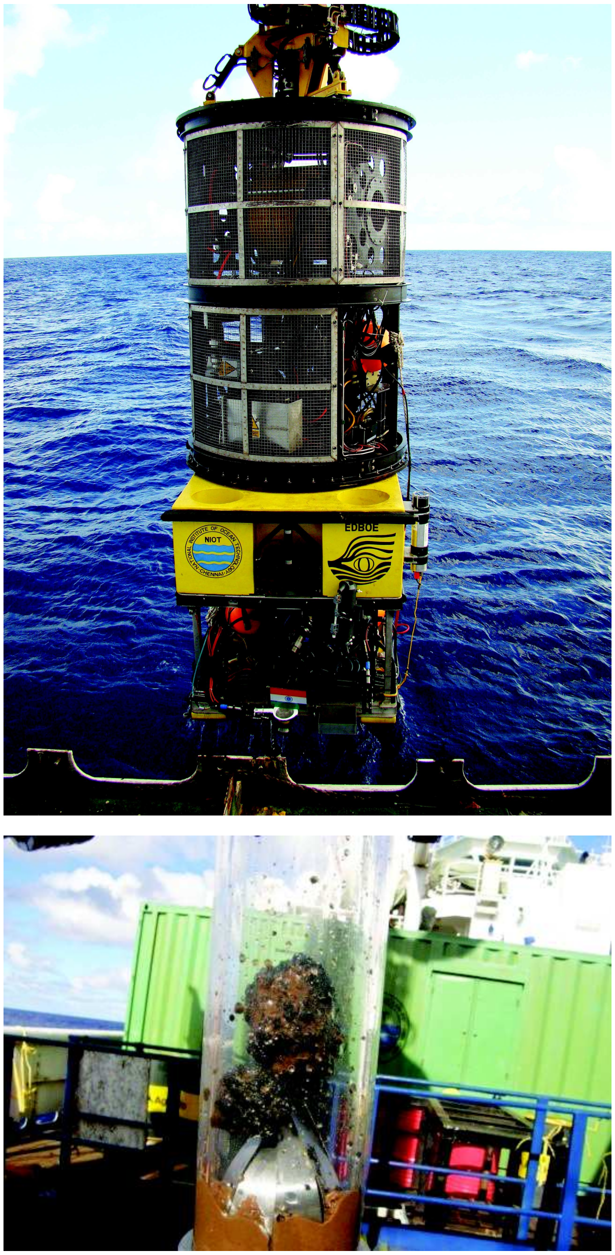

Fig. 8: Remotely Operable Vehicle (ROSUB-6000) based exploration at central Indian ocean basin with manganese nodule sample

for biodiversity assessment at Andaman coral region has brought out modern science to the Indian community for simultaneous observation of high-density underwater visuals with positional details, Spatio-temporal mapping of the sea bed, in-situ Physico-chemical measurement along with light penetration intensity measurements using Spectral irradiance sensor (Fig. 9) (Ramesh *et al.*, 2016 and 2017).

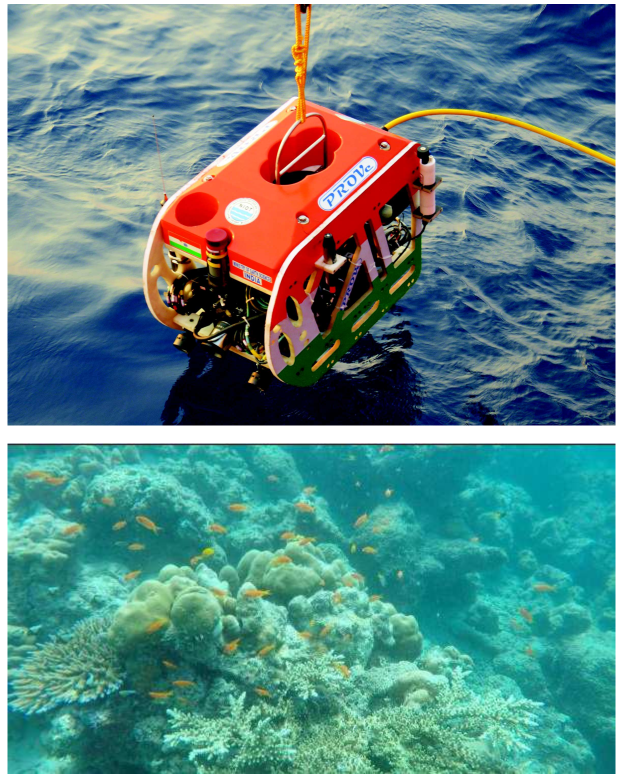

Fig. 9: Shallow water ROV and Coral reefs at the Andaman Islands

Technology for Gas Hydrates

NIOT is involved in the development of exploration tools and extraction feasibility studies of gas hydrate with reference marine gas hydrate reservoir settings of India. A deep water work class ROV with necessary payloads and the visual system was deployed at the gas hydrate site of Krishna Godavari

Fig. 10: Autonomous Coring System on board R/V Sagarnidhi

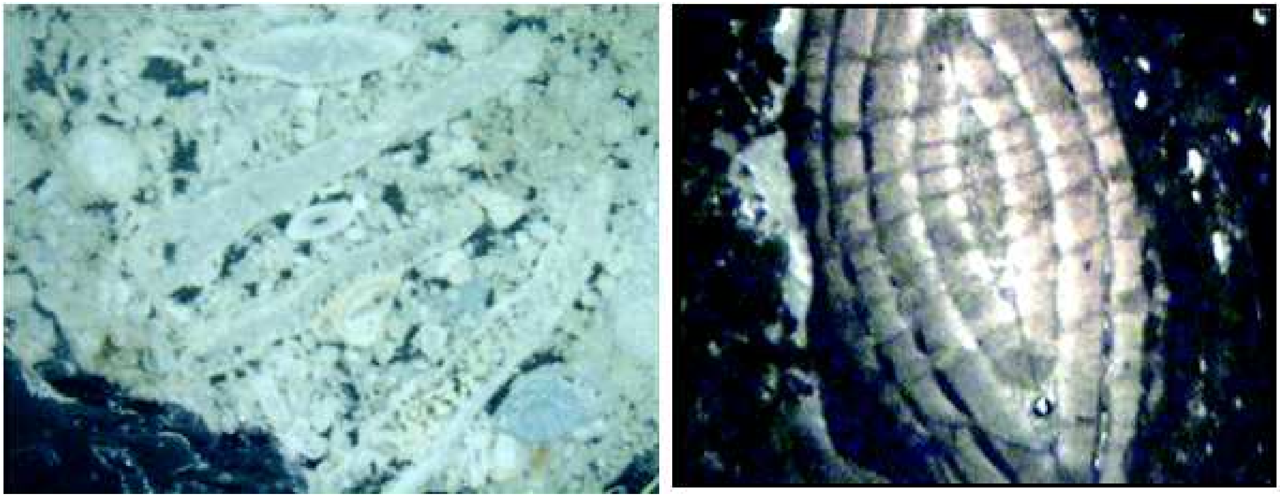

Fig. 11: Nummulite Sp with associated

basin and brought out chemosynthetic habitats abundance at the seafloor for the first time in India (Ramadass *et al*., 2010; Dilsha *et al*., 2009).

As a ground truth validation of gas hydrate occurrence below the seafloor, NIOT has developed a deep-sea wire-line Autonomous Coring System (ACS) in collaboration with M/s. Williamson & Associates, USA (Fig. 10). The system can collect core sampling by wireline mechanism upto a depth of 3000 m water depth. The system is qualified for its operational capability at 3000 m during 2016 and drilled below the seafloor upto 40 m at a selected site of 900m water depth. Long core sampling using at a depth of 850 m revealed the first time report of Nummulitic coralline limestone occurrencefrom 18 to 38 mbsf indicating the presence of Lower Eocene formation in Palar Basin offshore in East coast of India (Fig. 11). Based on the drilling operation and sample collected, the observed larger foraminifera Nummulitessp without distorted shape along with coralline filaments signifies in situ occurrence of the fauna at 850 m water depth even-though with its paleoecology of < 20 m depth indicates pulling down of the shallow shelf region (Ramesh *et al*., 2019).

Fauna Collected from Palar Offshore

Towards the extraction feasibility of gas hydrates, NIOT has developed Spatio-temporal depressurization simulation software namely IndHyd01. Depressurization and thermal concept applicable to Indian reservoir conditions pertinent to Krishna-Godavari, Mahanadi and Andaman basin were worked out to derive the energy efficiency of saturation parameters (Vedachalam *et al*., 2016, 2018).

Ocean Observation Network

Towards sustainable utilization of ocean resources and conservation, an observational platform plays a critical role in understanding the dynamics of the ocean interms of air-sea interaction and at seabed level variation. The observational program will focus on operational forecast for cyclones, storm surges and extreme events like Tsunami. To get a global climate change linkages observational platforms are also erected at Arctic region during 2016 for long term continuous measurement near India's Arctic station Himadri at Kongsfjorden fjord (Fig. 13).

Observational platforms recorded all the cyclones during the last four years' time period, namely Phailin, HudHud, Lehar, Madi, Vardha, Okchi etc. Indian Tsunami buoys are placed at the Andaman arc region at a depth of around 4000 m water depth with the Bottom Pressure Recorded system. First Indian Tsunami Buoy system Sagar Bhoomi was successfully demonstrated at the site with an endurance of two years (Venkatesan et al., 2019). Met ocean buoy and Tsunami buoy system is shown in Fig. 12.

NIOT is also involved in the development of drifter buoys, Autonomous Profiler drifters, and buried object detection sonar and ocean acoustic sensors. These series of systems measure various parameters of ocean basins at the surface and as profiling,

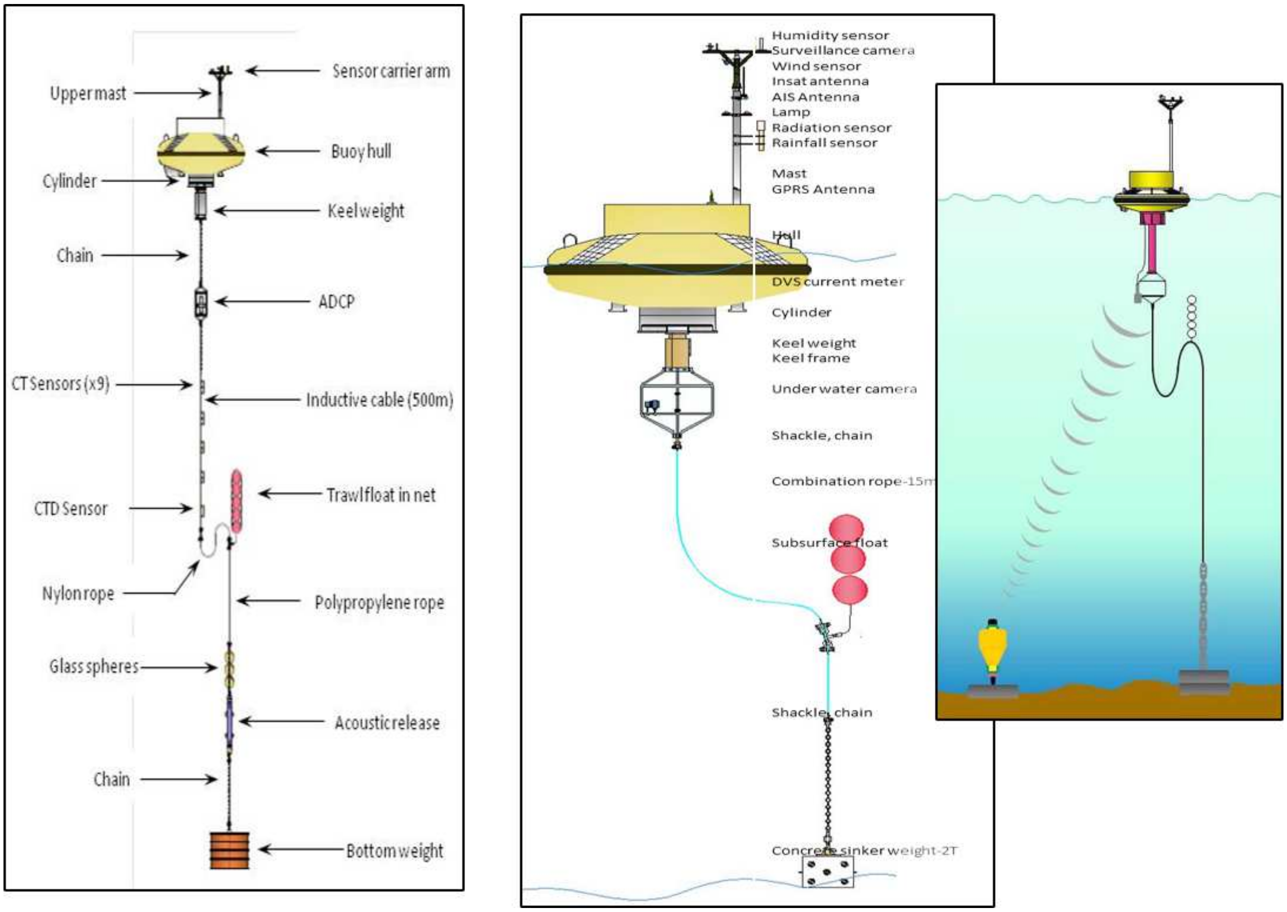

Fig. 12: Met-ocean and Tsunami buoy

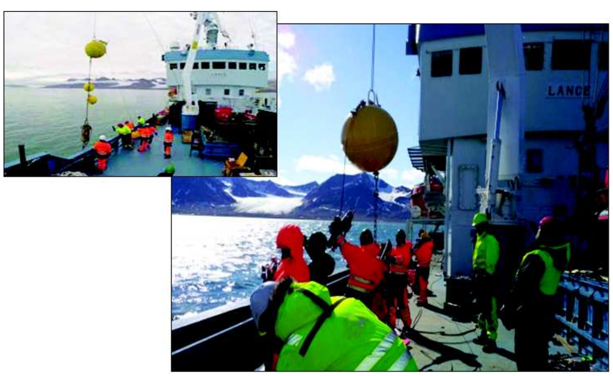

Fig.13: Ocean mooring system deployment in Arctic ocean

measurement to understand the ocean phenomena for forecasting and surveillance (Thirunavukkarasu *et al*., 2017, Dhilsha *et al*., 2019).

Ocean Science and Technology for Islands

NIOT is involved in developing technologies in the areas of cage culture, deep-sea microbial biotechnology, fish cage culture etc and having a branch at Chennai and Port Blair. Group is also involved in developing a complete technological package for nutraceutical production coupled with biodiesel production from marine microalgae in pilot-scale mass culture facility (Dharani *et al*., 2019).

Vessel Management

Fig: 14: Coastal Research Vessel Sagar Tara

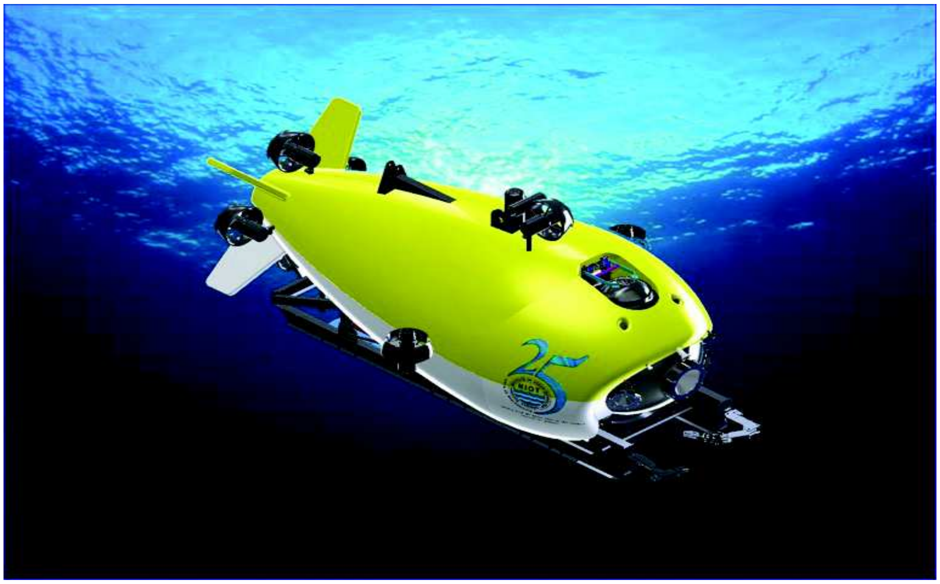

Fig. 15: Conceptual model of Deep-sea Manned-submersible-Matsya 6000

NIOT has a fleet of vessels such as Sagar Nidhi, Sagar Manjusha and Sagar Pachmi for exploration and observation of ocean basins. To add further understanding of the ocean need two more new coastal vessels are added namely Sagar Tara and SagarAnveshika during 2019 which has been built in India (Fig. 14).

Future Outlook

By considering the importance of the understanding necessity of deep ocean basin, India is commencing a mission mode program namely Deep Ocean Mission encompassing to realize the deep ocean exploration tools to explore and exploit renewable and non-renewable resources including 6000 m depth rated manned underwater mission for deepwaterexploration (Fig. 15).

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