Diving to Newer Depths

India's S&T Missions
NATIONAL TECHNOLOGY DAY SPECIAL 2022

India's Deep Ocean Mission Set To Create New Landmarks

Dr M. Ravichandran
Secretary, Ministry of Earth Sciences (MoES)

Dr Vijay Kumar
Scientist G-Adviser & Programme Head, Deep Ocean Mission, MoES Hq

Dr G.A. Ramadass
Scientist G-Adviser and Director, National Institute of Ocean Technology (NIOT), Chennai

Dr Gopal Iyengar
Scientist G-Adviser, MoES Hq

Dr S. Ramesh
Scientist G-Adviser, NIOT

Dr M. Ashokan
Scientist D, MoES Hq

Dr Bhavya Khanna
Scientist D, MoES Hq

THE Deep Ocean Mission — India's flagship programme to explore the deep oceans – was approved by the Cabinet in June 2021 with a budget outlay of Rs 4,077 crores over five years. To be chiefly coordinated and implemented by the Ministry of Earth Sciences, the Deep Ocean Mission aims to expand India's deep-sea scientific research, activities, and expertise.

Aligned with the vision of the Hon'ble Prime Minister, Shri Narendra Modi, the Deep Ocean Mission will provide a big boost to India's blue economy by aiding the development of infrastructure, trade, tourism, revenue, and opportunities. The Deep Ocean Mission is identified amongst the nine missions under the PM-STIAC (Science, Technology and Innovation Advisory Council) aimed to develop a futuristic roadmap for the holistic progress of our country.

In October 2021, with the launch of *Samudryaan* under the Deep Ocean Mission by the Hon'ble Union Minister, Dr Jitrendra Singh, there is now more mettle to India's strong commitment to making the Deep Ocean Mission highly successful.

Samudryaan ('Samudra' meaning Ocean and 'yaan' meaning vehicle) is India's first manned mission to reach the ocean bed at 6,000 meters below the water surface. It aims to onboard a three-membered crew and scientific equipment in Matsya 6000, which is an indigenously developed underwater vehicle for deep-sea mining and exploration in the Central Indian Ocean. 'Matsya' is the Sanskrit word meaning Fish, which signifies that the indigenously-developed Indian underwater vehicle will exhibit significant endurance and resilience.

The Deep Ocean Mission encompasses a set of six ambitious focus areas with an overarching aim to explore the deep oceans and sustainably harness marine resources for advances in science, technology, and engineering for societal benefit. Almost 90 per cent of the world's oceans remain unexplored to date. The Deep Ocean Mission, which will enhance exploration and harnessing resources, is envisaged to be a source of new knowledge, valuable materials including chemicals, drugs, and minerals, several undiscovered species, and much more. Moreover, the wisdom emanating from the Deep Ocean Mission activities would also feed into ocean-related issues of national and international importance, such as improving marine and maritime economy, addressing climate change and pollution, and enhancing sustainable use of ocean resources.

The Ministry of Earth Sciences (MoES), erstwhile Department of Ocean Development established in 1982, is the nodal Ministry to implement the Deep Ocean Mission. MoES is a network of ten institutions (three attached offices, five autonomous institutes, and two sub-ordinate offices) spread across the country, with headquarters in New Delhi. Deep Ocean Mission is in accord

with the mandate of MoES to provide services of weather, climate, Ocean and coastal state, hydrology, seismology, and natural hazards; explore and harness marine living and non-living resources sustainably; explore the three poles of the Earth (the Arctic, Antarctic and Himalayas); and develop ocean technology for exploration of oceanic resources and societal applications.

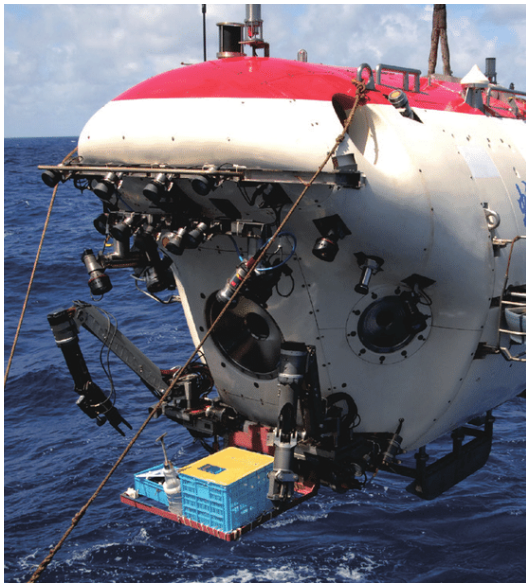
Focus Areas

The six focus areas of activities planned under the Deep Ocean Mission are as follows.

1. Advanced technologies for deep-sea mining, manned submersible, and underwater robotics

India has been allotted an area of almost 75,000 square kilometres in the Central Indian Ocean Basin and another 10,000 square kilometres in the Mid-Ocean ridge (around 25° S in the Indian Ocean) by the International Seabed Authority, where most of the activities as part of the Deep Ocean Mission will be executed. These areas are rich sources of polymetallic nodules and sulphides. Polymetallic nodules and sulphides deliver metals such as Copper, Nickel, Cobalt, Molybdenum, Vanadium, Titanium, Platinum, and Rhodium, etc. that are extremely valuable and industrially useful. It is estimated that the value of extracted polymetallic nodules from the Central Indian Ocean basin as part of the Deep Ocean Mission will be to the tune of about 100 billion dollars, which would be a big boost to the Indian economy.

Launch of the *Samudryaan*, India's first manned deep-sea mission, under the Deep Ocean Mission, by the Hon'ble Union Minister, Dr Jitendra Singh, in October 2021, with Dr M. Ravichandran, Secretary, MoES (second from left). (Courtesy: Press Information Bureau)



Manned submersibles Alvin of USA (up left), Jiaolong of China (up centre), and MIR 6000 of Russia (up right), Nautile of France (below left) and Shinkai of Japan (below right). *Picture courtesy: Google Images.*

Coastal research vessels (CRVs) named Sagar Tara (up left) and Sagar Anveshika (up right), Autonomous Underwater Vehicle (below left), Remotely Operated Vehicle (below centre), and Shallow water Remotely Operated Vehicle (below right), developed and deployed by the National Institute of Ocean Technology (NIOT), Chennai, under MoES for ocean research. ***(Picture courtesy: NIOT)***

To achieve these objectives, India will expand its capacity to build, maintain, and operate more autonomous underwater vehicles, remotely operated vehicles, oceanographic research vessels, deep-sea crawlers, subsea drills, and similar deep-sea instruments.

Most importantly, India will develop a manned submersible that can carry up to three crew members to a depth of about six kilometres below the sea surface. The six-kilometre depth is set to execute mining at the Central Indian Ocean Basin location allocated to India by the United Nations (UN).

The indigenously developed manned submersible (named Matsya 6000) will combine the properties of both an autonomous underwater vehicle and a remotely operated vehicle. It will be a titanium alloy personnel sphere of about 2.1 metres in diameter with an endurance of 12 hours and an additional 96 hours during emergency.

The metal with which Matsya is made, Titanium, is an industrially valuable, low density, high strength, and corrosion-resistant metal that will impart desirable properties to Matsya. The 6,000 meters depth would be a significant achievement, considering that the most advanced submarines reach a depth of only about 500 meters. With such advancement of technology, India will join the league of countries like France, Japan, China, Korea, Russia, and Germany. Matsya 6000 will be ready for qualification trials by December 2024.

The National Institute of Ocean Technology (NIOT), Chennai, an autonomous institute under the MoES, is entrusted with developing deep-sea technologies for India, such as for deep-sea mining, manned submersible, and underwater robotics, and ensuring that they become operational and industrially viable.

2. Energy and freshwater from the Ocean

The upper layers of ocean water are warmer than the deep sea. This vertical thermal or heat gradient in oceans can be a renewable and green energy source and can be utilised for several purposes, including converting salty seawater to potable and clean water. Many remote locations in India are either not connected to the grid or experience frequent power cuts. For instance, the islands of Lakshadweep and Andaman are primarily powered by diesel generators, which is polluting and highly inefficient. For such issues, energy from oceans can be a big game-

Low-Temperature Thermal Desalination (LTTD) plants in Kavaratti (above) and Agati (below) islands in Lakshadweep generate nearly one lakh litres of fresh water from seawater per day.

changer. In addition to the thermal gradient in ocean waters, waves, winds, tides, and currents can also be used to harness energy.

A technology known as OTEC (Ocean Thermal Energy Conversion) helps generate power using the thermal gradient in ocean water. OTEC energy is entirely green, renewable, and sustainable. Under the Deep Ocean Mission, the Ministry of Earth Sciences, through the National Institute of Ocean Technology, Chennai, will carry out studies and detailed engineering design for offshore OTEC-powered desalination plant.

When integrated with another technology called LTTD (Low-Temperature Thermal Desalination), OTEC helps generate fresh potable water from ocean water. Three LTTD plants were set up by the Ministry of Earth Sciences, one each in three islands of Lakshadweep (Kavaratti, Agati, and Minicoy) since 2011. Each of these plants generates nearly one lakh litres of freshwater per day. This regular supply of clean water has helped improve the quality of life of the islanders.

LTTD plants in six more islands (Amini, Androth, Chetlat, Kadamat, Kalpeni and Kiltan) are now on the anvil. In the future, MoES will establish additional OTEC-LTTD plants in several offshore locations and islands. This would be a boon for locals and coastal dwellers who constitute a significant workforce of our country.

3. Ocean climate change advisory services

The UN has declared 2021-2030 the Decade of Ocean Science for Sustainable Development. This emphasises the importance of oceans for Earth's sustenance and modulating processes to maintain life. Reports suggest that the Earth is already facing the brunt of climate change with irreversible effects. It is known that sea levels may rise, followed by the inundation of low-lying areas, increased flooding due to extreme weather events (like storm surges, cyclones, tsunamis, etc.) and erosion of beaches deltas and islands.

Under the Deep Ocean Mission, several activities and research projects will be executed to measure multiple ocean-related parameters like temperature, salinity and currents at various depths, wave, biogeochemical variables, etc., to understand and document changes in sea level, waves, cyclone intensity and frequency, and associated storm surges. Deep Ocean observations proposed under the mission will provide more insights into the role of Oceans in regulating global warming and climate change.

In collaboration with institutes and Universities, the Ministry of Earth Sciences will develop models to accurately simulate and forecast extreme weather and ocean events such as cyclones, storm surges, wind waves, and changes in sea level in a timely and user-friendly manner to stakeholders and the public to enable them with a better decision-making process.

4. Exploring and conserving deep-sea biodiversity

It is estimated that marine biodiversity far exceeds the diversity of life forms on land. Such expansive biodiversity brings avenues for harnessing novel biomolecules having environmental, industrial, and biomedical applications.

The Deep Ocean Mission aims to explore, decipher, and discover the vast deep-sea fauna (animal diversity) and flora (plant diversity) in seamounts in the Indian Ocean. This programme can potentially lead to several innovations in both products and processes.

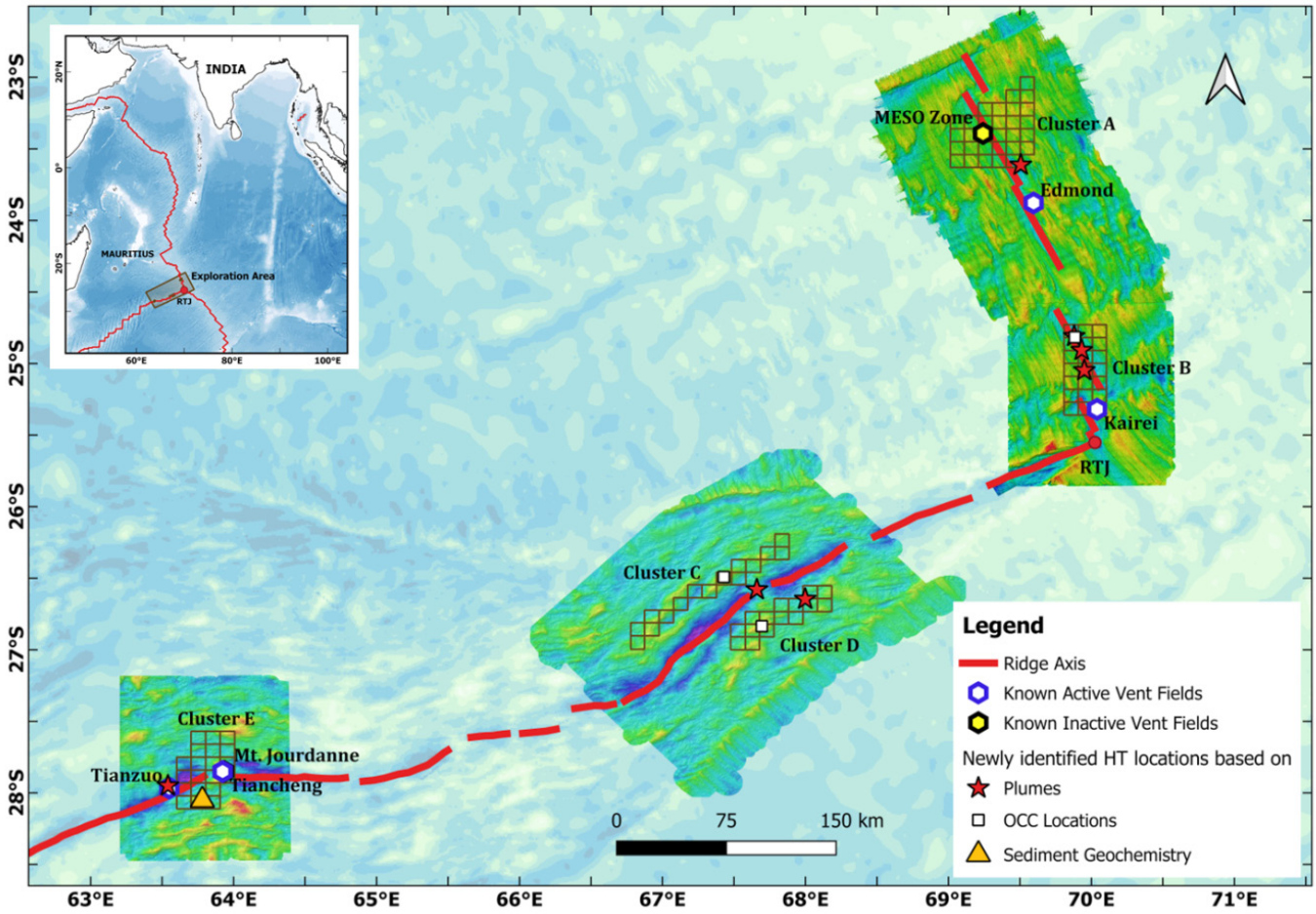
It is planned to execute this programme in close collaboration with the Department of Biotechnology, under the Ministry of Science and Technology, especially for advanced genome-related studies. Under this focus area, a DNA bank of deep-sea organisms will be established that will help enhance knowledge in marine biotechnology, taxonomy, genomics, etc. It would also fuel innovations and entrepreneurship.

In the future, activities under exploring and conserving deep-sea biodiversity of the Deep Ocean Mission will mark India as a trans-national and regional hub for marine biology and biotechnological know-how and advances.

5. Deep ocean survey and exploration

In the 1980s, India had conducted a deep ocean survey of about 1.5 lakh square kilometres in the Indian Ocean and submitted detailed and meticulous scientific reports to the international community. As a result, the UN allotted a vast, nearly 75,000 sq km of area in the Central Indian Ocean Basin to India in 2002 for deep ocean survey and exploration for polymetallic nodules. Under the Deep Ocean Mission, India plans to run and expand deep ocean survey and exploration in full swing.

In 2016, India signed a 15-year contract with the International Seabed Authority for exploring hydrothermal mineral deposits in the Indian Ocean ridges. It will help our country establish a solid footing in international waters and yield new knowledge of valuable minerals and resources that can be extracted as future alternatives



Area allocated to India by International Seabed Authority for exploration of polymetallic sulphides.
(Courtesy: National Centre for Polar and Ocean Research)

to land resources for global metal supply. It would also contribute to national revenue to expand India's blue economy.

The prime task is to explore and identify potential sites of multi-metal Hydrothermal sulphides mineralisation along the Indian Ocean mid-oceanic regions, hunting a few square meter vent areas in the vast Ocean at a depth of 3-4 km!

Deep ocean survey and exploration will require India to acquire new research vessels to launch advanced underwater robotics such as Autonomous Underwater Vehicles, Remotely Operated Vehicles, and deep-sea crawlers. These advanced new research vessels will be used for undertaking physical, chemical, geological, and geophysical ocean observations and exploration, apart from scientific investigations in the Ocean. The research vessels would be built in an Indian shipyard under the 'Atmanirbhar Bharat' vision and would create employment opportunities.

6. Advanced Marine Station for Ocean Biology in India

Under the Deep Ocean Mission it is also planned to set up an Advanced Marine Station for Ocean Biology in India. It is envisaged as a hub-and-spokes model and will help the Deep Ocean Mission to strengthen its networking with various organisations across research institutes for marine sciences within India and globally.

The Station will harbour a comprehensive set of technological platforms and know-how, which can be used as reference and training instruments, as well as establishing a commercial incubator/ accelerator. The translation of applied research into marketable products will be strongly encouraged through interactions with industries as well as through the hosting of incubator facilities for ocean science entrepreneurs. There will be a focus on capacity building which can be accomplished by developing education programmes at the masters and graduate levels.

At the international level, collaborative activities in research and teaching will be established with leading marine stations in France through an exchange of experts in research and education, shared use of knowledge, resources, expertise, equipment and technology. Several international scientific conferences and exchange programmes will be hosted. The Pacific Ocean-Indian Ocean-Arabian Sea rim countries (Japan, Fiji, Seychelles, Mauritius, Maldives and Tanzania) and other nations will partner with India in various capacities.

The Advanced Marine Station for Ocean Biology would make India a world leader of knowledge and innovations in ocean sciences.

For further correspondence:
Dr Vijay Kumar, Program Head, Deep Ocean Mission (vijay.kumar66@nic.in, 011-24669518).