

**Government of India**  
**Ministry of Earth Sciences**

**Call for Proposals for collaborative research under Deep Ocean Mission (DOM)**

Ministry of Earth Sciences provides services for weather, climate, ocean and coastal state, hydrology, seismology and natural hazards. It undertakes survey to explore and harness marine living and non-living resources in a sustainable manner and explores the three poles of the Earth (Arctic, Antarctic and Himalayas). It has been undertaking various Research & Development activities in Ocean Science & Technology. Considering the importance of Ocean sciences for sustainable development of the country, the Ministry has recently launched Deep Ocean Mission which aimed at developing technologies to explore deep ocean for resources and their sustainable use, growing the country's marine and maritime economy, tackle climate change and pollution. The major components of Deep Ocean Mission consist of; i) Development of Technologies for Deep Sea Mining, and Manned Submersible, ii) Development of Ocean Climate Change Advisory Services, iii) Technological innovations for exploration and conservation of deep-sea biodiversity, iv) Deep Ocean Survey and Exploration, v) Energy and freshwater from the Ocean, vi) Advanced Marine Station for Ocean Biology. A detailed background of the Deep Ocean Mission can be found at [www.moes.gov.in](http://www.moes.gov.in)

**Proposals are solicited from scientists/academicians working in relevant areas at different Institutions and Universities in the country which fit in one of the following thrust areas and sub-themes of the Deep Ocean Mission program of the Ministry:**

- 1. Development of Technologies for exploration and harnessing ocean resources such as Manned submersible and deep-Sea mining.**
  - **Deep Sea Mining:** Sediment plume monitoring in water column, Slurry transportation through rigid and flexible risers, Slurry flow dynamics and dewatering, Low temperature hydraulics, Floating platform dynamics etc.
  - **Manned Submersible:** Floating and submerged body hydrodynamics, Thermal comfort, Human psychology, metabolism and safety systems, Emergency feedback, Underwater communication, Low cycle fatigue, Low density syntactic foam, Acrylic windows, Titanium alloy Metallurgy, welding techniques etc.
  - **Underwater Robotics:** Underwater vehicle guidance and autonomy, Subsea brushless DC motor, Seawater hydraulics, Carbon fiber frames & structures, Sensors and systems, Robotic arms /force feedback, Artificial intelligence and Machine learning for vehicle navigation, Autonomous vehicles, Power sources, batteries etc.
- 2. Ocean Climate change advisories**
  - Regional Indian Ocean model development based on MOM6
  - Development of AI/ML schemes for climate assessment research
  - Storm surge-wave coupling and inundation modelling
  - Deep ocean physical and biogeochemical processes.
- 3. Exploration of Deep Sea biological resources and inventorisation**
  - **Bio-processing and Bio-transformation of marine microbial enzymes:** Development of processes for using microbial enzymes as industrial intermediates; Technology for transformation of marine microbial enzyme intermediates.

- **Screening of Deep- Sea Metagenomic libraries:** Construction of large scale deep- sea metagenome clone libraries; Development of process to screen large scale metagenome libraries; Downstream processing of biomolecules screened from metagenome libraries.
- **High- throughput screening of microbial metabolites:** Development of microbial metabolite library; Screening of microbial metabolites against potential targets.
- **Development of high pressure retainable sediment sampler:** Development of high pressure sampling system to collect deep- sea sediments at in- situ conditions; Validation and testing of the sampling system.
- **Development of automated characterization and species identification system:** Biodiversity of various taxa and their assemblage patterns of deep seamount ecosystems based on digital inventory; Automated characterization of underwater video and identification of biological organisms using artificial intelligence and machine learning.
- **Development of cell line from deep sea organisms:** development of long term storage and preservation methods.

#### 4. Deep Ocean survey and exploration

- Mapping of the mid-ocean ridge systems in Indian Ocean and exploration of hydrothermal mineral deposits in the parts of Central and Southwest Indian Ridges.
- Multibeam bathymetry mapping of the Exclusive Economic Zone (EEZ)
- Mapping of Sea bed using geophysical surveys viz. single channel seismic, Magnetic and Gravity etc.

#### 5. Ocean Energy

- Thermal processes and turbo machinery for thermal desalination and OTEC
- Offshore platform designs
- Moorings and risers
- Hydrogen generation

#### 6. Ocean Biology

- Cell and developmental biology of marine organisms
- Physiological, neurological and behavioral biology of marine organisms
- Biochemistry and microbiology
- Computational and systems biology
- Biotechnology
- Biodiversity and ecology
- Climate change impacts and evolutionary ecology of marine organisms

**Proposals should include details on methodology, work plan, financial implications, facilities available with the institute, requirements to execute the proposed study as well as detailed bio-data of the PI/Co-PI etc. Prescribed Format for submission of proposal is at Annexure-I.**

**Maximum duration of project will be two years only.**

**Important Instruction for submission of project proposal:**

- a. The proposal should be forwarded by the Head of the Institution / Organization.
- b. Manpower requirement should be properly justified in terms of number and designation, and should be recruited as per DST guidelines.
- c. Inter-institutional programmes are highly appreciated.
- d. The Advanced Instrumentation Facilities available within and outside the organization should be preferred and the charges are permitted on payment basis.
- e. Number of MoES projects with the PI should not exceed two. Additional research proposals can be considered only when the ongoing research proposals are about to conclude.
- f. The PI should provide the names of 5 Area Experts (complete postal address, telephone numbers and e-mail addresses)
- g. Publication of results/presentation of papers should clearly acknowledge the funding from the Ministry of Earth Sciences.
- h. The proposal shall be submitted along with the requisite documents. Incomplete proposal shall not be entertained.
- i. Format for required documents like Certificate & Undertaking, UC & SoE, and Annual Progress Report etc. may be downloaded from MoES Website [www.moes.gov.in](http://www.moes.gov.in)

**The proposal (soft copy and hard copies) may be submitted to the Ministry latest by 30<sup>th</sup> November, 2022 and may be sent to the following addresses:**

**1. Dr. M.V. RAMANA MURTHY**  
Advisor & Mission Director (Deep Ocean Mission)  
Ministry of Earth Sciences, Govt. of India  
Prithvi Bhawan, Lodhi Road, New Delhi 110003  
Tel: 011-24669517

and

**2. Dr. MITHILA VERMA**  
Scientist-E & Prog. Officer (DOM)  
Ministry of Earth Sciences, Govt. of India  
Room No. 218, Prithvi Bhawan,  
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## BACKGROUND

The oceans are one of the three unique features of planet Earth, along with plate tectonics and the protective atmosphere covering the planet. The oceans remain a key part of our life and have excited the human mind for as long as we can remember. India particularly has a very interesting location on the Globe surrounded on three sides by the ocean. Our country's coastline is also very long with around 30% of the country's population living in coastal areas. The delicate balance of nature, ecology, environmental perspectives and climate change has resulted in the necessity for better development of the oceans. Oceans are a storehouse of living and non-living resources, and have features at the seabed that have hitherto not been explored or very rudimentary examination at best has been carried out. Only 5% of Deep Ocean has been explored and the rest remains to be explored. The global security issues involved with oceans dictate exploration of deep sea that needs specialized modern technology, which is not commercially available. The modern oceanography started in India with the establishment of National Institute of Oceanography in 1966 by Government of India in Goa. Since then, the expansions in ocean related activities including the necessity to study the polar ocean and continents and the mapping of sea bed for the assessment of poly-metallic deposits in the Central Indian Ocean basin demanded the establishment of Department of Ocean Development (DoD) in 1982. Later, DOD was elevated as a ministry and then as Ministry of Earth Sciences (MoES) in 2006 integrating the activities in atmospheric research, weather services and geosciences. All these developments, accelerated the development of Indian expertise in ocean science and technology, marine geosciences, operational oceanography, exploration of marine living resources, etc. and also lead to the establishment of National Institute of Ocean Technology (NIOT), National Centre for Polar and Ocean Research (NCPOR), Indian National Centre for Ocean Information and Services (INCOIS), etc.

Today, India is capable of providing forecasts on various facets of ocean including the early warnings on tsunami and storm surges, building desalination plants to solve the drinking water problems in Lakshadweep Islands, building remotely operable underwater vehicles, exploring the Southern Oceans, management of marine living resources, etc. With these capabilities, India is well posed to take the next step to channel these developments in the areas of ocean science and technology to craft out socially, strategically and economically useful products and knowledge. Several countries around the world are fast recognizing the growing importance of the seas and the need to take a strategic approach for managing their marine interests. Considering the importance of oceans on the life and sustenance of the current as well as the future generations of the humanity on the Earth, the UN has already taken steps to declare the decade during 2021-2030 as Decade of Ocean Science for Sustainable Development. Further, the Sustainable Development Goal 14 (SDG14) proposed by United Nations (UN), which deals with the life below the water emphasizes the importance of ocean in modulating and sustaining the life and environment on the planet Earth. Though some of our national goals are overlapping with the goals set by UN, we have to prioritize our efforts in ocean science and technology to achieve the national goal of transforming the 6th largest economy in the world (2.6 Trillion Dollar) to 3rd largest (a 10 Trillion Dollar economy) by 2030. In addition, the developments in ocean science and technology also need to be tuned to facilitate the informed decision-making capability of the Government and in making policies and regulatory laws to deal with the varied interests in the oceans and coasts. Especially, the developments in ocean science and technology need to be further channelled to support and fuel the marine and allied industries that will

boost the Blue Economy of the country in the days to come. In this scenario, the time has come for India to take forward the ocean related research and development with a goal-oriented approach with societal impact as the prerogative. A focused approach in some of the areas, that have already well progressed, can make India a global leader and serve her national goals. For this, a mission mode approach will pay the best dividends if the developmental efforts are restructured with adequate resources towards large scale result-oriented projects rather than dealing them as open ended locally distributed research at individual levels. The mission mode will harness the already available expertise in the country, supplement their gaps, resolve the shortcomings and lead them to achieve larger goals on an accelerated pace. The projects under this mission will be inter-institutional, inter-ministerial and will need policy makers, industry, academia, and research organizations, all contributing their individual strengths towards meaningful larger deliverable goals. The sea remains a key part of lives in the coastal states. It supports tourism, livelihoods and trade. Oceans are the storehouse of energy, controller of weather and climate and underpin life on Earth. However, that relationship is ever-changing. Autonomous vessels and other emerging technologies like marine bio-technology are creating a new generation of economic activity. The marine environment is under threat from climate change, pollution and mindless fishing. It is vital that, as a nation, we are able to proactively respond to these changes, and be prepared to meet the new challenges and take advantage of new opportunities.

With a view to explore deep ocean for resources and develop deep sea technologies for sustainable use of ocean resources, Cabinet Committee on Economic Affairs (CCEA) approved the proposal of Ministry of Earth Sciences (MoES) on “Deep Ocean Mission” at an estimated cost of Rs. 4077.0 crore for a period of five years to be implemented in a phase-wise manner. The estimated cost for the first phase for the three years (2021-2024) would be Rs.2823.4 crore. Deep Ocean Mission will be a mission mode project to support the Blue Economy Initiatives of the Government of India.

The six major areas are:

- (i) Development of Technologies for Deep Sea Mining and Manned Submersible
- (ii) Development of Ocean Climate Change Advisory Services
- (iii) Technological innovation for exploration and conservation of deep-sea biodiversity
- (iv) Deep Ocean Survey and Exploration
- (v) Energy and freshwater from the Ocean
- (vi) Advanced marine station for Ocean Biology

The technology development aims at developing technologies to harness minerals in the deep waters, development of, as well as the development of a manned submersible. To harness the deep-water resources like polymetallic nodules, the development of submersibles like manned and unmanned underwater vehicles, mining systems, autonomous vehicles are necessary. Some technological advances have taken place in those technologies during the past years, but they need to be scaled up for operations in the Deep Ocean.

The global temperature rise due to global warming has direct and indirect consequences on sea level rise, inundation of low-lying coastal areas, extreme events and flooding thereby and the like. Climate change can have far reaching implications on the biogeochemistry of the sea and the life in the sea. Thus, it is important to assess and project

the future changes in the ecological and physical properties of the Indian Ocean. Thus, the development of ocean climate change advisory service on mission mode assumes importance. As part of this, long term predictions on increasing intensities of cyclones, storm surges, fishery, stocks, sea level rise, etc. are proposed to be developed. To monitor the changes occurring in the ocean, the deep ocean observations need to be taken up in a bigger way involving autonomous observing systems.

The deep sea holds the highest biodiversity on earth that has hardly been explored. Also, technology for culture of deep sea symbionts, piezotolerant and piezophilic microbes is required. Hence the marine bio resources and their exploration and sustainable utilization are proposed as a major theme of this mission.

Deep Sea mineral resources, including hydrothermal sulphides, have attained immense attraction as being considered as the future alternative of land resources and source for future global metal supply. Exploration of hydrothermal sulphide deposits on the deep-ocean realm has kindled a lot of interest primarily because of the high concentration of base metals and many noble metals in them. Deep Ocean Survey and Exploration component of the DOM entrusts to undertake advanced survey and exploration activities to locate and confirm hydrothermal mineral deposits in parts of Central and South West Indian ridges. A new dedicated research vessel having all requisite and advanced gadgets for undertaking deep ocean survey activities is also proposed under this mission.

Energy and freshwater are two such non-living resources that can be harnessed. Today the need for clean, green and renewable energy is very well recognized and efforts for harnessing all forms of renewable is really essential. Ocean Thermal Energy Conversion (OTEC) using the temperature difference in the ocean is an important form that needs to be harnessed. Since the OTEC will have intakes from cooler water from the deep and warmer surface water, the technology can also be augmented with a Low Temperature Thermal Desalination (LTTD) plant to generate freshwater for the consumption of coastal population. The energy produced from the offshore OTEC plant will be used to power the desalination plant on the same platform. If implemented, this would be the first offshore OTEC together with LTTD desalination in the world. For this purpose, proof of concept for OTEC is necessary and therefore proposed as initial experiment.

Advanced Marine Station for Ocean Biology is aimed as development of human capacity and enterprise in ocean biology and engineering. This component will translate research into industrial application and product development through on-site business incubator facilities. This component will support the Blue Economy priority area of Marine Biology, Blue trade and Blue manufacturing.

The mission mode will harness the already available expertise in the country, supplement their gaps, resolve the shortcomings and lead them to achieve larger goals on an accelerated pace. The projects under this mission will be inter-institutional, inter-ministerial and will need policy makers, industry, academia, and research organizations, all contributing their individual strengths towards meaningful larger deliverable goals.

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## FORMAT FOR SUBMISSION OF PROJECT

(Prescribed font: Calibri 11, 1.5 spacing)

### **Section 1: Project title**

Title of the Project (not exceeding 150 characters)

### **Section 2: Subject**

Thrust area and Sub-theme

### **Section 3: Principal Investigator and Co - Investigators:**

- a. Name (surname first)
- b. Date of Birth (dd/mm/yyyy)
- c. Affiliation(s)
- d. Address for correspondence
- e. Email address
- f. Mobile No. / telephone / fax number
- g. Specialization in key words (not more than 4 relevant disciplines)

### **Section 4: Principal Implementing Institution**

- a. Status (University/Institute/Govt./autonomous/private, etc.)
- b. In case of Institute/University, provide AICTE Registration No. or UGC Notification No.
- c. In case of private or registered society or NGO, a copy of SIRO Certificate is to be submitted. In such cases a bond has to be executed between the PI's institution and MoES for proper use and the management of the funds (subsequent to the approval of the proposal). Copies of the annual report and audited annual accounts for the last two years are to be enclosed.
- d. In case of NGO, provide Unique ID generated by NITI Aayog.

### **Section 5: Collaborating Investigators/Institutions**

In case a project is to be executed by more than one Institutions (which MoES encourages) and/or requires regular inputs from other scientists, the names of collaborating institutions and Scientists are to be recorded.

The Project should also explicitly indicate the nature of contributions by the individual Investigators (who will do what) in terms of scientific/technological contributions.

### **Section 6: Project: Salient features on the following:**

#### **6.1. Intellectual merit:**

State briefly why this work is important in the national and international context and what new science is to be explored or new hypotheses are to be examined.

#### **6.2. Data Collection and Analysis:**

Detail the primary data to be collected and state what novel methodology or computational aspects will be employed.

### **6.3. Broader impacts:**

A statement each on the following: Include statements on the following aspects.

- a. Training and support to (a) scientists, (b) students (M. S./ Ph. D.)
- b. Fostering of new interdisciplinary collaborations between scientists.
- c. Development or Calibration or lab facilities.
- d. Dissemination of results by students and collaborators at professional meetings and in peer-reviewed journals.
- e. Activities that reach out to the society or general public such as exhibitions, school-education, etc.
- f. A brief about the technical expertise of PI & Co-PI to execute the Proposed Project supported by Publications in the cited journals having Impact Factor.
- g. A statement about sharing of data and knowledge to the scientific communities of India.

### **Project Summary:**

The project title, PI name and name of the Institution involved should precede the summary.

The summary (in telegraphic language) should be a self-contained description of the research activity including (a) subject (b) research objectives (c) methodology to be adopted (d) expected outcome and deliverables of the project and (e) brief budget.

### **Section 7: Project Description (not to exceed 10 pages including figures, tables and references:**

#### **(a) Objectives**

The objectives may be given point by point in telegraphic language keeping in view of the problem (< 200 words).

#### **(b) State of knowledge**

This should be based on literature survey with key references and relevance of the knowledge both at National and International level. Also, identify gaps in the area vis-à-vis their relevance in line with our national priorities and how the work proposed would help in addressing the gap areas. Indicate important references and cite fully at the end of the proposal under reference section.

- National Scenario
- International scenario

#### **(c) Importance of the proposed project**

#### **(d) Justification for support:**

Highlight the new and challenging scientific issues being raised in the subject / sub-theme areas.

#### **(e) Patent details (domestic and International), if anticipated.**



**(f) Methodology (should explicitly mention the hypotheses being tested)**

**(g) Work schedule and detailed plan of implementation with year wise time lines and targets time**

**(h) Utilisation of research results**

- Specific deliverables-digital statements.
- Impacts of the proposed work on the broader scientific community in terms of training, and publication of results, collaborations and benefits to society.

## **Section 8: Budget**

**(a) Overall Budget (Rs. in lakhs)**

S. No.	Items	2022-23	2023-24	Total
	<b>A. Non - Recurring</b>			
1	Design / Development /DataAnalysis			
2	Minor Equipments & Materials			
3	Contingency			
	<b>A. Total Non - Recurring</b>			
	<b>B. Recurring</b>			
1	Manpower			
2	Travel (Local)			
3	Consumables etc.			
4	Contractual Services and Field Trials			
5	Contingency			
	<b>B. Total - Recurring</b>			
	<b>Grand Total (A +B)</b>			

**(b) Budget for Research Manpower & Justification**

Designation	No. of Positions	2022- 23	2023- 24	Total
Post Doctoral Fellow				
Senior Research Fellow				
Junior Research Fellow				
Total				

\*Fellowship as per MoES/DST guidelines

**(c) Justification for the consumables:**

Item Name	Justification

**(d) Justification for travel requirement within India:**

**(e) Justification for other costs involved, if any:**

Some projects may have special requirements not covered under sections 8(a) to (c). Costs for such requirements are to be indicated, based on realistic estimates and due justifications.

**(f) Budget for permanent equipment and justification.**

Apart from other minor items, list all items of permanent equipment costing *Rs.50,000/-* or above, or requiring import. Include provisions for installation charge, inland transport, insurance etc. in the estimated cost.

- Detailed Specifications of the equipment proposed
- Details of such equipment in the country and the need for additional facility
- statement on the capabilities of the PI in using these
- cost estimate (notional quotations)
- For major equipment of cost > 50 lacs, please indicate as to how the instrument will be maintained after the project completion. This should be a formal statement by the head host institution on its letter head indicating how much financial and infrastructural support will be available.

**(g) Budget for minor equipment (< 5 lakhs only) with justification.**

- Detailed specifications of the equipment proposed with quotations from the manufacturer.
- The total cost of minor equipments should not exceed 30% of the grant value excluding the manpower budget.

S.No.	Equipment Name	Estimated cost	Justification	Availability in within and other institutes

**Section 9: Existing facilities**

Basic infrastructural facilities, equipment and other resources available that would be extended by the institute to the project should be recorded as given below:

- a. Equipment within the research group of PI/Co-PIs.
- b. Equipment in the Department/University/Institution
- c. Equipment in other Departments or Centers of the institution in the region including Regional Sophisticated instrumentation centers

S.No.	Name of the Instrument	Working status

**Section 10 : CURRICULUM VITAE (Max 2 pages )**

Two page Biodata with only **5 relevant publications** of the Principal Investigator and other Investigators who are in employment and will contribute to the project. Publication record

should include publication during only the last 5 years in peer reviewed journals with h-index and citation details.

**Section 11: Other research projects with investigators (one page)**

List of Projects with the PI/Co-PI along with name of funding agency, project funding amount, and date of completion and summary details of the projects (completed / on-going or proposed) with all investigators may be given. A summary of results from these projects and publication is to be enclosed.

S. No.	Name of the Project	Name of Funding Agency	Date of Commencement	Date of Completion

**Section 12: Any other information (in direct relevance to the project).**

**Section 13: References**

**Section 14: Project Summary:**

A summary of the proposal should be submitted at the end including (a). Title of the proposal, (b). Subject, (c) Keywords up to 5, (d). Objectives (in bullet form), (e). PI name, (f). Name of the Institution, (g). State-of-the-art involved, (h). Methodology to be adopted, (i). Relevance to MoES activities, (j). Expected outcome and deliverables of the proposal and (k). Brief budget details.

**INCOMPLETE APPLICATIONS IN ANY RESPECT WILL BE REJECTED.**