RCAS| 香港亞洲研究中心
Hong Kong Research Center for Asian Studies

RCAS Report

India's Deep-sea Mining: Progress and Challenges

Debashis Nandy&Jayanath Colombage&Sujit Kumar Datta

Hong Kong Research Center for Asian Studies (RCAS), Hong Kong

January 27, 2026

Address: 1507B, EASTCORE1, No.398, Kwun Tong, Kooloon, Hong Kong
Ph: 00852 2397 7886|Email: hkrcas@163.com|Web: www.rcas.top

About RCAS

香港亞洲研究中心| The Hong Kong Research Center for Asian Studies (RCAS) is a nonprofit research organization focusing on Asian affairs. It is a newly established institution founded in February 2022 by Dr. Nian Peng in Haikou and subsequently moved to Hong Kong in September 2023. We currently have an international research team with nearly 100 resident/nonresident researchers from China and other countries.

RCAS aims to become a leading research institute and think tank on Asian affairs in the Indo-Pacific region. To date, RCAS has conducted research programs on maritime disputes in the South China Sea (SCS), China's relations with the Indo-Pacific states, the Belt and Road Initiative (BRI), terrorism/counterterrorism in the Afg-Pak region, and so on. It is committed to promoting maritime cooperation, regional integration, and regional peace in the Indo-Pacific region at large.

RCAS has published nearly ten books in Chinese and English and more than 20 papers in SSCI/SCOPUS/CSSCI-indexed journals. Recent English publications include *Populism, Nationalism and South China Sea Dispute: Chinese and Southeast Asian Perspectives* (Singapore: Springer Nature, 2022); *Pakistan's Foreign Policy: Contemporary Developments and Dynamics* (London: Routledge, 2022); *Crossing the Himalayas: Buddhist Ties, Regional Integration and Great-Power Rivalry* (Singapore: Springer Nature, 2021); *The Reshaping of China-Southeast Asia Relations in Light of the COVID-19 Pandemic* (Singapore: Springer Nature, 2021); *Territorial Disputes, The Role of Leaders and The Impact of Quad: A Triangular Explanation of China-India Border Escalations* (2023); *Managing the South China Sea Dispute: Multilateral and Bilateral Approaches* (2022); *China-Pakistan Cooperation on Afghanistan: Assessing Key Interests and Implementing Strategies* (2022); *Hedging Against the Dragon: Myanmar's Tangled Relations with China since 1988* (2021); and *China-Pakistan Conventional Arms Trade: An Appraisal of Supplier's and Recipient's Motives* (2020).

RCAS has also published hundreds of articles, and its researchers have been interviewed in various local and international media outlets, such as *The Diplomat* in the United States, *East Asian Forum (EAF)* in Australia, *Bangkok Post* in Thailand, *Jakarta Post* in Indonesia, *Lian He Zao Bao*, *Think China* in Singapore, *South China Morning Post (SCMP)*, *China-US Focus* in Hong Kong, *CGTN, Global Times, World Affairs* in China. RCAS researchers have actively participated in international conferences or study visits in the United States, India, Pakistan, Sri Lanka, Nepal, Myanmar, Cambodia, and other places.

Welcome to visit our website: http://www.rcas.top.

Address: 1507B, EASTCORE1, No.398, Kwun Tong, Kooloon, Hong Kong
Ph: 00852 2397 7886|Email: hkrcas@163.com|Web: www.rcas.top

India's Deep-sea Mining: Progress and Challenges

India's advancements in deep-sea mining, propelled by the Deep Ocean Mission, focus on the development of homegrown technology such as the Matsya-6000 submersible. This initiative has reached significant milestones in the exploration of polymetallic nodules and sulphides, while also obtaining international contracts for essential minerals including cobalt, nickel, copper, and manganese. These resources are critical for the nation's blue economy and energy transition, highlighted by achievements in deep-sea trials and resource mapping.

India's efforts in exploration are directed towards securing crucial minerals and diversifying its economy, prompted by the diminishing terrestrial reserves of metals such as nickel and cobalt, which are essential for renewable energy technologies and electronics. This exploration enhances self-sufficiency in line with the "Atmanirbhar Bharat" initiative, thereby decreasing reliance on imports. The "Deep Ocean Mission," associated with India's Blue Economy policy, aims to sustainably utilize ocean resources to enhance GDP through marine industries. Potential energy resources like gas hydrates found on the seabed provide a long-term solution for India's growing energy needs.

Alongside severe threats such as irreversible damage to fragile ecosystems, loss of biodiversity, noise and light pollution that interferes with marine organisms, the discharge of toxic metals, the disturbance of carbon sinks, and potential governance conflicts, India's deep-sea mining initiatives encounter considerable technological, financial, and regulatory challenges. Detractors raise concerns regarding the sustainability and ethical implications of extracting deep-sea resources prior to fully comprehending the consequences.

A comprehensive approach is needed to advance sustainable deep-sea mining in the Indian Ocean. This includes developing cutting-edge, eco-friendly technologies, implementing strict international regulations through the ISA, conducting thorough Environmental Impact Assessments and biodiversity studies, strengthening marine science capacity building, aligning with the Blue Economy, and participating in international collaboration for unified standards and technology exchange.——**Debashis Nandy, Kazi Nazrul Islam University, India.**

About Author

Debashis Nandy is an Associate Professor in the Department of Political Science, Kazi Nazrul University, Asansol, West Bengal, India. He is the Coordinator of the Centre for Studies of South and South-East Asian Societies at the same university. He was the Visiting Faculty Member in the Department of Foreign Area Studies, Tajik National University, Dushanbe (Tajikistan) and Indian Cultural Ambassador to Tajikistan. A position awarded by the Tajik Society of Friendship with Foreign Countries, the Republic of Tajikistan in 2019. In 2022, Dr. Nandy has served the Department of Japanese Studies at the University of Dhaka, Bangladesh as the Visiting Faculty. Dr. Nandy was the Visiting Faculty at Frankfurt University of Applied Sciences, Frankfurt, Germany in 2023. In 2024, he was the Visiting Fellow at Osaka School of International Public Policy, Osaka University, Japan. Dr. Nandy was the Visiting Faculty in the Department of World Economy , Saint Petersburg State University, Russia in May 2025. He is the Senior Research Fellow at Pan-Asia Research Institute (PARI), Tokyo, Japan. He was the Adjunct Faculty at National Institute of Technology (NIT), Durgapur in 2023. His research interests include India's Foreign Policy, South Asian Politics, and South-East Asian Affairs, Energy Security, Global Economic Affairs, Human Security, Refugees and Migration Studies Email: debasishnandy.kc@gmail.com.

India continues to develop capabilities and aspirations for deep-sea mining to the year 2026 too. India wishes to be a world leader in deep-sea mining. India's aspirations to be the third largest economy in the world by 2030 coincide with exploration into the deep-ocean as well. India has secured sea-bed mining rights from the International Sea bed Authority and embarked on technical trials and advances in blue-bio technology for scientific explorations at sea and exploitation of commercially viable mineral deposits. In September 2025, India became the first nation to hold two active contracts from the International Seabed Authority (ISA) for exploring Polymetallic Sulphides (PMS) in the Indian Ocean.

- **Carlsberg Ridge Rights**: India recently secured exclusive rights to explore a 10,000 sq km area in the Carlsberg Ridge, a geologically significant zone rich in copper, zinc, gold, and silver.
- **Extended Nodule Rights**: India holds a long-standing contract for polymetallic nodules (PMN) over a 75,000 sq km area in the Central Indian Ocean Basin, estimated to contain 380 million metric tonnes of manganese nodules.

India's first manned deep-sea submersible, (Samudrayaan Mission) MATSYA 6000, is undergoing phased trials. Successful wet tests and integrated functionality demonstrations with three human crew members were completed in early 2025. Some of these achievements are as follows:

- **Deepest System Test**: India became the first country to successfully test a deep-sea mining system at a record depth of 5,270 meters in the Central Indian Ocean.
- **Mineral Collection**: In 2024–2025, India demonstrated the collection of over 100 kg of cobalt-rich polymetallic nodules from depths of approximately 1,173 meters in the Andaman Sea.
- **Varaha Mining Machine**: The self-propelled seabed mining system, Varaha, has completed initial mobility and power trials at extreme depths, paving the way for future commercial extraction of manganese, nickel, and copper.
- **New Species Discovery**: Biodiversity surveys conducted by India have already discovered 23 new deep-sea species and identified active hydrothermal vent fields.
- **Blue Economy Goals**: India's is planning to achieve a ₹100 billion Blue Economy, targeting self-reliance in critical minerals essential for green energy and electric vehicles.
- **Underwater Research Lab**: India is planning a 6,000-meter-deep underwater research laboratory, often called the "underwater ISS," with a pilot module expected to host scientists for 24-hour stays.

India is aiming to conduct full-depth crewed missions to 6000 meters depth by 2027, making India a rare country to have this capability. In August 2025, Indian aquanauts

completed preparatory training dives to 5,002 meters in the Atlantic Ocean in collaboration with France's IFREMER.

The main driving forces behind India's deep-sea mining exploration in the Indian Ocean are a combination of economic needs for critical minerals, the pursuit of technological self-reliance, and strategic geopolitical positioning in the Indo-Pacific region.

The land-based mineral resources needed especially for high-tech industries such as Electric Vehicles are depleting fast. India wishes to be self-reliant in minerals such as rare-earth ones. Large number of rivers flowing from Himalayas have been depositing sediments in the Indian Ocean for thousands of years. It is believed that these deposits contain exploitable and commercially valuable hydrocarbons and minerals. The Indian Ocean seabed contains vast deposits of polymetallic nodules and sulphides rich in: Nickel, Cobalt, Copper, Manganese, Rare earth elements.

India is heavily import-dependent for many of these strategic minerals. Access to its own deep-sea reserves in the Central Indian Ocean Basin (an area of 75,000 sq km allotted by the International Seabed Authority) could significantly enhance its resource security and meet future energy requirements. Hence the ocean has become the new and next frontier for exploitation of minerals for India.

"Blue Economy" Growth: The exploration is a core component of the Indian government's "Blue Economy" vision, which aims to sustainably harness ocean resources for national economic growth, job creation, and the development of related marine industries.

Countering China's Dominance: China has a significant head start in deep-sea exploration and controls a large portion of the world's mineral processing capacity. India's deep-sea mission is partly driven by the need to counter China's influence in the Indian Ocean Region (IOR) and break its monopoly over critical mineral supply chains.

Assertion of Maritime Strength: By developing advanced deep-sea capabilities (like the manned submersible "MATSYA 6000" as part of the Samudrayaan project), India positions itself as a major player in ocean governance and marine science, joining an elite group of nations with this niche technology.

Global Ocean Governance: Active participation in exploration and adherence to international frameworks like the UN Convention on the Law of the Sea (UNCLOS) and the International Seabed Authority (ISA) allows India to influence the development of future deep-sea mining regulations and secure its exploration rights.

National Security: Deep-sea infrastructure, such as undersea data cables, is critical for the digital economy and national security. Developing indigenous deep-sea capabilities includes the capacity for monitoring and protecting this infrastructure.

Advancing Indigenous Technology: The mission fosters the development of cutting-edge, indigenous marine technology and expertise in areas like robotics, underwater vehicles, and high-pressure resistant materials.

Scientific Research: Beyond mining, the Deep Ocean Mission supports broader scientific objectives, including climate change research, marine biodiversity assessment, and the development of offshore renewable energy and desalination techniques.

Some of the negative impacts of India's deep-sea mining activities on the Indian Ocean could include:

Habitat Destruction: Direct contact by mining equipment, such as the Varaha seabed system, can crush organisms and destroy habitats for endemic species that may not exist elsewhere.

Sediment Plumes: Digging stirs up fine particles, creating plumes that can travel for kilometers. These smother seafloor life, clog the feeding apparatus of filter-feeders, and disrupt food webs in mid-water zones.

Pollution: Noise and artificial light in naturally dark, silent environments disrupt the communication, navigation, and feeding of marine mammals (like whales) and fish.

Carbon Sink Disruption: Disturbance of the seafloor may interfere with the ocean's "biological pump," potentially releasing stored carbon and reducing its ability to mitigate climate change.

Extreme Pressure: At these depths, pressure exceeds 380 atmospheres, requiring specialized materials like titanium alloys. High-profile incidents, such as the 2023 Titan implosion, underscore the risks of structural failure.

Complex Logistics: Maintaining a 6,000m flexible riser pipe to pump mineral slurry to the surface requires immense power (approx. 1 MW/hour) and faces significant friction and potential leakage.

Equipment Durability: Saltwater is highly corrosive, and the soft, muddy ocean floor makes it difficult for heavy tracked vehicles like Varaha to maneuver.

Communication Gaps: Standard radio waves do not work underwater; India must rely on costly, specialized acoustic technologies (VLF/ELF) which are still being developed.

Legal and Geopolitical Risks. Regulatory Uncertainty: India currently lacks a comprehensive national deep-sea mining policy. Internationally, the International Seabed Authority (ISA) has yet to finalize a commercial "Mining Code," leading to legal ambiguities for future exploitation. Now there is Biodiversity Beyond National Jurisdiction (BBNJ) which will come into force in the near future and India need to abide by this convention and the ISA guidelines too.

Sovereignty Disputes: India's interest in cobalt-rich sites has sparked tensions with neighbors, particularly Sri Lanka, over overlapping maritime claims, especially when the outer limit of the continental margin is agreed upon by the United Nations.

Strategic Competition: A "race to the bottom" is intensifying with China, which possesses advanced deep-sea capabilities. This rivalry extends beyond resources to include concerns over the security of undersea internet cables.

Key Criticism. A growing coalition of scientists and over 30 countries have called for a moratorium (precautionary pause) on Deep Sea Mining until its full environmental impacts are understood. Critics argue that the potential for "unforeseen ecological nightmares" and permanent biodiversity loss outweighs the short-term economic gains.

Promoting sustainable deep-sea mining in the Indian Ocean requires a strong, science-based approach focusing on rigorous environmental assessments, implementing advanced mitigation technologies (like sediment containment), establishing 'Marine Protected Areas (MPAs)', strengthening the International Seabed Authority (ISA) regulations, fostering international collaboration, and investing in research and monitoring to balance economic goals with marine conservation. This includes strict adherence to the evolving ISA Mining Code, BBJN Convention, continuous real-time monitoring, and developing national frameworks for ecological safeguards.

- **Robust Environmental Governance:** Comprehensive EIAs: Conduct thorough

baseline studies to understand sensitive habitats before any mining begins.

- **Adaptive Management**: Implement strategies that adjust mining practices based on real-time monitoring data.
- **MPAs:** Designate no-mining zones to protect biodiversity hotspots.
- **Sediment Control:** Use advanced systems to contain sediment plumes and reduce their spread.
- **Noise Reduction:** Minimize underwater noise pollution that harms marine life.
- **Renewable Energy**: Power operations with clean energy sources to reduce the carbon footprint.
- **Baseline Data:** Use ROVs and sonar for detailed surveys of species and habitats.
- **Impact Modeling**: Predict long-term effects of plumes, noise, and contamination.
- **Capacity Building**: Train local experts and decision-makers in marine stewardship.
- **Strengthen ISA Regulations:** Ensure mining codes align with strong environmental protections.
- **International Cooperation**: Facilitate dialogue between governments, scientists, and the ISA.
- **National Frameworks:** Indian Ocean nations should develop domestic regulations aligned with global standards.
- **Resource Efficiency:** Promote recycling and reuse of metals to decrease demand for seabed minerals.
- **Eco-friendly Tech:** Invest in R&D for greener mining methods.

By integrating these strategies, stakeholders can work towards responsible deep-sea exploration that benefits from mineral resources while safeguarding the unique ecosystems of the Indian Ocean.——**Jayanath Colombage, Sri Lanka Navy, Sri Lanka.**

About Author

Jayanath Colombage is an Non-resident Senior Fellow at the Hong Kong Research Center for Asian Studies (RCAS), Hong Kong. He has served the Sri Lanka Navy for a period of 36 years and retired as the Commander of the Navy on 01 July 2014. He is the 18th Commander of the Sri Lanka Navy and was decorated for gallantry and commended for exceptional service to the Navy. He held the portfolio of Additional Secretary to the President for Foreign Relations, and the Secretary to the Foreign Ministry from August 2020 to May 2022. He is a visiting lecturer at the University of Colombo, Defence Services Command and Staff College (Sri Lanka), Kotelawala Defence University and Bandaranaike International Diplomatic Training Institute. He is also a Fellow of Nautical Institute, London UK, and Guest Professor at Sichuan University and Leshan Normal University in China and an adjunct professor at National Institute of South China Sea Studies, Haikou, China. He has also been an editor and reviewer of a number of internationally renowned academic journals. In addition, he has served as the Director General of the Institute of National Security Studies Sri Lanka as well. He is currently a PhD examiner for University of Colombo. Email: jayanathskc@yahoo.com.

India has also made great progress in the exploration of deep-sea mining in the Indian Ocean compared to some countries in the world that are well developed in the seabed. The most notable achievement is the exploration of the success of the polymetallic nodules in the Central Indian Ocean Basin (CIOB), which is assigned to India by the International Seabed Authority (ISA). These nodules are manganese-rich, nickel-rich, cobalt-rich, and copper-rich, which are strategic to the industry and clean-energy technologies.

India has developed local deep-sea technologies as small projects under its Deep Ocean Mission, including the design and trial of the man-in-the-deep-water submersible Matsya 6000, which can dive to a depth of 6,000 meters.

In addition, the National Institute of Ocean Technology (NIOT) has also proceeded to come up with seabed mining systems, underwater crawler technology, and environmental impact assessment tools, which will be utilized to ensure that exploration is carried out responsibly. India has conducted a few research cruises to map the seabed resources, study the marine biodiversity, and assess the environmental hazards of mining.

All of these processes attest to a technological self-sufficiency of India, the enhancement of scientific understanding of the Indian Ocean seabed, and aim to become significant in the establishment of future international guidelines in terms of exploration of deep-sea resources and sustainable ocean management.

The primary causes, which have necessitated the deep-sea mining exploration process in the Indian Ocean, are strategic resource security, technological ambition, and geopolitics.

Since demand for the essential minerals, such as polymetallic nodules, a source of substantial amounts of cobalt, nickel, copper, and manganese, is increasing, India wants to reduce its dependence on external supply chains that supply clean power and advanced production.

Deep-sea exploration is also congruent with the vision of the Blue Economy and enhances the native Indian scientific and technological expertise. Increased Indian Ocean operations also enhance the Indian sea power and strategic independence in the emerging great-power rivalry in the region.

India has been facing several environmental, technical, and governance-related issues regarding the Indian Ocean deep-sea mining exploration. Polymetallic nodules mining poses environmental hazards to the fragile deep-sea ecosystems, which are poorly comprehended and recover slowly. The resulting sediment plumes may cover the benthic organisms and disrupt the higher marine food webs.

On a technical level, operating at 4,000-6,000 meters would be a nightmare for the engineering profession, with equipment collapsing due to the pressure of being deep, the high cost of operation, and the low reliability of the remotely operated equipment. Critics also have scientific uncertainty, and this is because the baseline ecological data are insufficient to enable making accurate judgments of long-term effects.

In addition, the regulatory and geopolitical concerns, in particular, the compliance with the regulations of the International Seabed Authority, and the potential strategic competition in the Indian Ocean, still persist. The environmentalists and civil society organizations argue that the quest to ensure security in India regarding the resources may be overrunning precautionary protection, casting uncertainty on the sustainability, transparency, and balancing of the economic ambition and ocean protection.

The exploration of sustainable deep-sea mining in the Indian Ocean should be enabled with a prudent precaution strategy that would develop a balance between demands on resources and the environment. It involves a great deal of research based on open environmental analysis and strict regulation in the international system, such as the International Seabed Authority.

The integration of the Indian Ocean states at the regional level, the utilization of low-impact technologies, the informational exchange, and the continuous control may lead to the fact that the process of exploration will have the least ecological effects and will ensure the long-term sustainability of oceans. —— **Sujit Kumar Datta, University of Chittagong, Bangladesh.**

About Author

Sujit Kumar Datta is Deputy Director, Hong Kong Research Center for Asian Studies (RCAS), Hong Kong, and Director, The Hong Kong Research Center for Asian Studies Bangladesh Center. He is also the former Chairman and Professor in the International Relations Department at the University of Chittagong, Bangladesh. Dr. Datta graduated with a BA (Honors) and MA degree in International Relations from the Jahangiragar University and completed his PhD in International Politics from the School of Political Science and Public Administration, Shandong University, China. After that, he had worked at the BRAC Training Division (BTD) as a faculty member. He had joined in the department of International Relations, University of Chittagong, Bangladesh as a Lecturer in January, 2010. Dr. Datta has authored several articles and book chapters in renowned national and international peer-reviewed journals (Web of Science, Scopus indexed). Email:datta.ir@cu.ac.bd.