

India's Deep Ocean Mission and Leadership in PMS Exploration

Introduction

In September 2025, India became the first country in the world to hold two contracts with the International Seabed Authority (ISA) for the exploration of Polymetallic Sulphides (PMS).

With exclusive rights over 10,000 sq km of the Carlsberg Ridge in the Indian Ocean, alongside its earlier allocation in the Central and Southwest Indian Ridge, India now holds the largest exploration area globally for PMS. This development is not merely a scientific milestone but a strategic advancement that consolidates India's maritime presence, aligns with its Deep Ocean Mission, and strengthens the foundations of its Blue Economy. For a country heavily dependent on imported minerals and seeking leadership in global governance of the commons, this achievement has far-reaching implications.



Background – Polymetallic Sulphides and the International Seabed Authority

Polymetallic Sulphides (PMS) – Found near hydrothermal vents on ocean ridges. Contain iron, copper, zinc, silver, gold, and platinum. Considered vital for industries ranging from electronics and renewable energy to aerospace.

International Seabed Authority (ISA) – Established under the UN Convention on the Law of the Sea (UNCLOS) in 1994. Governs mineral resources of the international seabed, considered the “common heritage of humankind.” Allocates exploration areas to countries and ensures protection of marine ecosystems. India has had a long association with the ISA. In 1987, it became the first country to receive a pioneer area for polymetallic nodule exploration and was designated as a Pioneer Investor. The second PMS contract reaffirms India's status as a leader in deep-sea exploration.

India's Deep Ocean Mission

Launched in 2021, the Deep Ocean Mission (DOM) represents India's vision to harness resources from the oceans while advancing marine science and technology. Its six major components include –

1. Development of technologies for deep-sea mining and manned submersibles.
2. Exploration of polymetallic nodules and sulphides.
3. Study of deep-sea biodiversity and conservation.
4. Development of ocean climate change advisory services.
5. Research on deep-sea ecosystems for bioprospecting.
6. Establishment of advanced marine stations.

The PMS contract at Carlsberg Ridge directly strengthens Component 2, while enhancing India's technological and scientific leadership.

Significance of the Achievement

1. Strategic and Geopolitical Significance – The Indian Ocean is becoming a theatre of global competition, with China investing heavily in seabed exploration. India's dual contracts not only secure mineral rights but also enhance its maritime strategic depth. Hosting the 8th ISA Annual Contractors Meeting in Goa (2025) projects India as a responsible leader in global ocean governance.

2. Economic Significance – India's manufacturing sector, especially renewable energy, electric vehicles, and electronics, requires critical minerals like copper, zinc, and rare metals. Domestic reserves are limited; dependence on imports exposes India to price volatility and supply chain risks. PMS exploration can secure resource independence and reduce reliance on external markets.

3. Scientific and Technological Significance – Developing indigenous mining technologies, remotely operated vehicles, and manned submersibles places India among the select nations with

advanced marine capabilities. Enhances research on hydrothermal vent ecosystems, contributing to global knowledge.

- 4. Blue Economy and Sustainable Development** – India's Blue Economy contributes nearly 4% to GDP but remains underdeveloped compared to its potential. PMS exploration aligns with India's vision of using marine resources for sustainable growth, employment, and energy security.

Challenges and Concerns

While the achievement is remarkable, it comes with serious challenges that aspirants must critically examine –

- 1. Environmental Concerns** – Hydrothermal vents are biodiversity hotspots, home to unique species adapted to extreme conditions. Mining could destroy fragile ecosystems, disrupt marine food chains, and release toxic substances. Over 99% of the deep ocean floor remains unexplored, raising ethical questions about exploitation without full understanding.
- 2. Technological Barriers** – Deep-sea mining at depths exceeding 3,000–6,000 metres require advanced robotics, pressure-resistant equipment, and sustainable extraction technologies. High costs and risks of accidents remain major hurdles.
- 3. Governance and Regulation** – ISA regulations on deep-sea mining are still evolving. Balancing resource utilisation with environmental protection will be contentious. India must navigate diplomatic challenges as global consensus on seabed mining is fragile, with some countries demanding a moratorium.
- 4. Economic Viability** – Extraction, processing, and transport of PMS are extremely expensive. Unless global demand and prices for metals remain high, projects may struggle to be commercially sustainable.

Way Forward for India

- 1. Strengthening Research and Development** – Enhance collaboration between MoES, NCPOR, ISRO, and IITs for indigenous mining technology. Invest in AI, robotics, and remote sensing for sustainable extraction.
- 2. Environmental Safeguards** – Adopt a "precautionary principle" in exploration. Commit to biodiversity mapping, impact assessments, and eco-friendly mining techniques.
- 3. Diplomatic Leadership** – Lead global negotiations in ISA to frame fair, transparent, and sustainable regulations. Push for an equitable sharing of resources under the principle of "common heritage of humankind."
- 4. Integrating with Blue Economy Policy** – Link PMS exploration with India's fisheries, renewable energy, and port-led development. Develop coastal infrastructure for mineral processing and logistics.
- 5. Public-Private Partnerships** – Encourage participation of Indian industries in deep-sea technology development. Model partnerships similar to the space sector's private integration under ISRO.

Conclusion

India's dual PMS contracts with the ISA mark a historic milestone in the country's quest to harness ocean resources. It consolidates India's strategic presence in the Indian Ocean, aligns with the Deep Ocean Mission, and strengthens its claim as a leader in global ocean governance. Yet, the achievement must be tempered with caution. Exploiting seabed resources poses serious environmental, technological, and governance challenges. For India, the challenge lies in balancing its economic aspirations with its environmental responsibilities. If pursued with vision and responsibility, PMS exploration can become a pillar of India's Blue Economy, contributing to resource independence, global leadership, and sustainable growth. The oceans hold immense promise, but the future will depend on how wisely humanity – and India – navigates this uncharted frontier.

Main Practice Question (15 Marks, 250 words)

1. "India has become the first country to hold two exploration contracts with the International Seabed Authority for Polymetallic Sulphides". Critically examine the significance of this achievement for India's economy, strategic interests, and environmental responsibilities under the Deep Ocean Mission."

Answering Guidelines

1. Introduction (30–40 words)

Briefly introduce Polymetallic Sulphides (PMS) and mention India's milestone of holding two ISA contracts. State how this aligns with India's Deep Ocean Mission and broader Blue Economy vision.

2. Body

1. Significance for India (Economic, Strategic, Scientific) (80–100 words)

Economic – Access to copper, zinc, gold, platinum – critical for EVs, electronics, renewable energy; reduces import dependency.

Strategic – Enhances maritime depth in Indian Ocean; positions India as a leader vis-à-vis China.

Scientific – Advances in deep-sea mining technology, robotics, biodiversity studies.

Diplomatic – Strengthens India's role in ISA and global commons governance.

2. Challenges and Concerns (60–70 words)

Environmental risks – Fragile hydrothermal ecosystems, biodiversity loss, toxic releases.

Technological barriers – High costs, deep-sea mining at 3000–6000m depth.

Governance gaps – ISA regulations evolving; risk of disputes.

Economic viability – High extraction costs, uncertain demand-supply balance.

3. Way Forward (40–50 words)

1. Strengthen R&D in sustainable mining technologies.
2. Adopt precautionary principle for ecosystem protection.
3. Lead ISA negotiations on fair and sustainable seabed governance.
4. Integrate PMS exploration with Blue Economy & Atmanirbhar Bharat.

3. Conclusion (30–40 words)

India's leadership in PMS exploration is a historic step that strengthens economic security and global standing. However, success will depend on balancing development with environmental stewardship, ensuring that the oceans remain a shared heritage for humankind.

