Deep-Sea Mining Explained: India's Race for Critical Minerals and the Cost to the Ocean

UPSC GS-I, II, III | HPAS: Geography, S&T, Environment | Updated: September 2026

Introduction

Every electric scooter, solar inverter and smartphone depends on metals such as cobalt, nickel and copper. Large amounts of these metals lie on the ocean floor, thousands of metres below the surface. The question facing India and the world is simple to ask and hard to answer: can we collect these minerals without destroying one of the least understood ecosystems on Earth?

1. What Is Deep-Sea Mining?

Deep-sea mining means extracting mineral deposits from the ocean floor, usually below **200 metres**. Most deposits of commercial interest, however, lie **4,000–6,000 metres** deep, in complete darkness and under crushing pressure.

Three Types of Seabed Deposits

Deposit	Where It Is Found	Key Metals
Polymetallic nodules	Potato-sized lumps lying loose on flat abyssal plains	Manganese, nickel, cobalt, copper
Polymetallic sulphides	Around hydrothermal vents on mid-ocean ridges	Copper, zinc, gold, silver
Cobalt-rich crusts	Hard layers on the slopes of underwater mountains (seamounts)	Cobalt, manganese

Concept Box: Exploration vs Exploitation

Exploration means studying a deposit: mapping it, taking samples and testing equipment. **Exploitation** means recovering minerals for sale. An exploration contract does **not** give permission for commercial mining. Today, the world has many exploration contracts but no approved commercial mining in international waters.

2. Why Does India Care?

- **Critical mineral security:** India imports most of its cobalt and nickel. Supply chains for these metals are concentrated in a few countries, which makes prices and access vulnerable to geopolitics.
- **Energy transition:** Copper carries electricity through every grid and motor; nickel and cobalt are used in many lithium-ion batteries. Targets for renewable energy and electric mobility raise demand for all three.
- **Technological self-reliance:** Working at 6,000 metres needs robotics, pressure-proof materials and underwater sensors. Building these at home strengthens India's marine

engineering base.

- **Scientific knowledge:** Exploration reveals new species, ocean currents and seabed geology, which helps climate and biodiversity research.

Important Qualification

Finding minerals is not the same as mining them profitably. Extraction cost, processing, metal prices, environmental risk and changing battery technology all decide whether a deposit is worth mining.

3. Who Governs the Ocean Floor?

UNCLOS (1982)

The **United Nations Convention on the Law of the Sea** is the constitution of the oceans. It defines maritime zones and rights. The seabed beyond national jurisdiction is called **"the Area"**, and its minerals are declared the **common heritage of mankind**. No country can claim them; they must be managed for the benefit of all humanity.

International Seabed Authority (ISA)

- Set up under UNCLOS; headquarters in **Kingston, Jamaica**.
- Controls all mineral activity in the Area and must protect the marine environment from its harmful effects.
- Its rulebook is called the **Mining Code**. Rules for exploration already exist; rules for commercial exploitation are still being negotiated.

Concept Box: EEZ, High Seas and the Area

EEZ: Up to 200 nautical miles from the coast. The coastal country controls its resources.
High Seas: The *water column* beyond national jurisdiction.
The Area: The *seabed and subsoil* beyond national jurisdiction.
Common trap: The Area does not always begin at 200 nautical miles, because a country's continental shelf can extend further under UNCLOS rules.

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4. India's Deep-Sea Initiatives

Initiative	What It Is
Deep Ocean Mission (2021)	Approved with an outlay of **₹4,077 crore** over five years; nodal ministry **MoES**. Six components: mining technology and submersibles, ocean-climate advisory, deep-sea biodiversity, ocean survey, energy and freshwater from the ocean, and a marine biology station.
Samudrayaan / MATSYA-6000	India's first crewed deep-ocean mission. MATSYA-6000, built by **NIOT Chennai**, is designed to take **three people to 6,000 metres**. It is a research vehicle, not a mining machine. The crewed deep dive is still pending.
Seabed mining trials	NIOT tested a seabed mining system at **5,270 metres** in the Central Indian Ocean. This shows engineering progress, not the start of commercial mining.
ISA exploration contracts	Three regions: **Central Indian Ocean Basin** (nodules), **Central and South-West Indian Ridge** (sulphides) and **Carlsberg Ridge** (sulphides; 10,000 sq km; 15-year contract signed September 2025).
Domestic law	**Offshore Areas Mineral (Development and Regulation) Act, 2002**, amended in 2023, governs minerals in India's own maritime zones. It is separate from ISA rules for the Area.

5. What Changed in 2026?

- **Rules still unfinished:** The ISA's July 2026 session continued negotiations on exploitation rules but set no adoption deadline. Environmental protection, monitoring and benefit-sharing remain unresolved.
- **Growing call for a pause:** About **46 countries** now support a moratorium or precautionary pause on deep-sea mining.
- **Challenge to the system:** A US subsidiary of The Metals Company applied for mining licences under US national law instead of through the ISA. The ISA has opened an inquiry into contractor compliance. This dispute tests whether the "common heritage" principle can hold.

6. Environmental Concerns

- **Habitat destruction:** Collector machines scrape the seabed. Nodules themselves are homes for attached organisms and take millions of years to form, so they cannot regrow on any human timescale.
- **Sediment plumes:** Mining stirs up clouds of fine sediment that can bury animals and spread with currents over large distances.
- **Noise, light and pollution:** Species adapted to total darkness and silence may be disturbed; released metals may affect water quality.
- **Carbon storage:** Seabed sediments store carbon. How much disturbance would release, and whether it matters for the climate, is still uncertain.

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- **Missing baseline:** Most deep-sea species are undescribed. Without knowing what exists today, damage cannot be measured tomorrow.

7. Governance and Economic Challenges

- **Precaution vs commercial pressure:** Mineral demand is urgent, but ecological loss may be permanent.
- **Monitoring:** Inspecting activity at 5,000 metres in remote oceans is costly and hard to verify independently.
- **Liability:** Money cannot bring back an extinct species or a destroyed habitat.
- **Uncertain returns:** Metal prices and battery chemistry can change faster than a mining project pays off.
- **Fair sharing:** Benefits from the Area must reach developing countries and future generations, not only technologically advanced ones.

8. Way Forward for India

- **Keep science and commerce separate:** Continue exploration, but require a distinct, evidence-based decision before supporting any commercial mining.
- **Build environmental baselines:** Map species, currents and sediments, with long-term monitoring and public data.
- **Assess cumulative impact:** Judge mining, shipping and waste discharge together, not project by project.
- **Protect sensitive zones:** Identify no-mining areas and reference sites that stay untouched for comparison.
- **Reduce demand:** Promote battery recycling and urban mining. **LFP (lithium iron phosphate) batteries use no nickel or cobalt**, showing how technology can shrink the need for seabed metals.
- **Back strong global rules:** Support measurable environmental limits, independent oversight and enforcement before exploitation begins.

9. Himachal Pradesh Angle

- **Clean mobility:** HRTC's electric buses and the state's push for electric vehicles depend on the same battery metals found on the seabed.
- **A familiar dilemma:** Himachal already debates development versus fragile ecology in hydropower, road building and river-bed mining. Deep-sea mining raises the same question on a global scale: when damage may be irreversible, how much precaution is enough?
- **Circular economy:** E-waste and battery recycling offer a way to meet mineral demand without new extraction, on land or at sea.

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Key Terms Box

Term	Meaning
Polymetallic Nodules	Mineral lumps on the deep seabed containing manganese, nickel, cobalt and copper
The Area	Seabed and subsoil beyond national jurisdiction
Common Heritage of Mankind	Principle that the Area's resources belong to all humanity
ISA	UNCLOS body regulating mineral activity in the Area (Kingston, Jamaica)
Mining Code	ISA rules for prospecting, exploration and exploitation
Sediment Plume	Cloud of disturbed seabed particles carried by currents
Moratorium	Temporary stop on an activity until conditions are met
Urban Mining	Recovering metals from e-waste and used batteries

Exam Angle

Prelims: traps to avoid

- High seas = water column; the Area = seabed. They are not the same.
- An exploration contract is not a mining licence.
- MATSYA-6000 carries **three** people to a designed depth of **6,000 m**; it is a research submersible.
- Deep Ocean Mission: 2021, ₹4,077 crore, Ministry of Earth Sciences.
- ISA headquarters: Kingston, Jamaica.

Mains: GS Paper III

- *"Deep-sea mining presents a dilemma between critical mineral security and marine ecosystem conservation." Discuss with reference to India's initiatives and the international regulatory framework. (250 words)*

HPAS Mains

Useful for questions on resource security, environmental impact assessment and the precautionary principle, with the Himalayan development debate as a comparison.

Conclusion

The ocean floor holds minerals the world needs for a cleaner future, yet mining it could cause damage that no future can repair. India's best path is to lead in ocean science and technology, invest in recycling and alternative battery chemistries, and support mining only when credible evidence and strong international rules are in place.

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