

India's Samudrayaan Mission: Human Deep-Sea Exploration by 2027

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Samudrayaan Mission Latest News

- Two Indian aquanauts, Cdr (Retd) Jatinder Pal Singh and R Ramesh, undertook training dives aboard the French vessel *Nautilus*, reaching depths of 5,002 and 4,025 metres in the Atlantic Ocean earlier this month.
- These preparatory missions are crucial for India's ambitious **Samudrayaan project**, which aims to send three humans 6,000 metres deep into the ocean by 2027.
- The experience, much like how Axiom-4 supports Gaganyaan, will provide vital insights for advancing India's deep-sea exploration capabilities.

Samudrayaan Mission: India's Deep Ocean Exploration Plan

- The **Samudrayaan Mission**, part of India's **Deep Ocean Mission** approved in 2021 with an outlay of ₹4,077 crore over five years, aims to explore and sustainably utilise deep ocean resources.

- Its objectives include developing technologies for **deep-sea mining, underwater vehicles, robotics, and a crewed submersible** to carry three humans up to 6,000 metres below sea level.
- Other components involve creating:
 - An ocean climate change advisory service,
 - exploring and conserving deep-sea biodiversity,
 - conducting surveys for mineral deposits, and
 - innovating technologies for deriving energy and freshwater from the ocean.
- Additionally, the mission will **establish an advanced marine station** to boost research-to-industry applications in ocean biology and engineering, thereby supporting India's **blue economy**.
- The **National Institute of Ocean Technology (NIOT)** is the coordinating agency leading the development of the human-carrying submersible.

Matsya-6000: India's Crewed Deep-Sea Submersible

- **Matsya-6000** is the specialised vehicle being developed under India's **Samudrayaan Mission** to carry three aquanauts to a depth of **6,000 metres** in the ocean.
- Shaped like a large fish, it houses a **2.1-metre diameter personal sphere** designed to safely accommodate the crew.
- The submersible will support human life for **12-hour missions**, with backup systems ensuring survival for up to **96 hours in emergencies**.
- For the initial human trials at **500 metres depth**, a **steel sphere** will be used, though this material cannot withstand the extreme pressures at 6,000 metres (around **600 times atmospheric pressure at sea level**).
- For the full-scale mission planned for **2027**, the personal sphere will be constructed from a **titanium alloy with 80 mm thickness**, offering the required strength and durability for deep-sea exploration.

Challenges of India's Crewed Deep-Sea Mission under Samudrayaan

- India's **Samudrayaan Mission**, which aims to send three aquanauts to a depth of **6,000 metres**, faces multiple scientific, engineering, and human challenges.

Developing a Pressure-Resistant Vessel

- The foremost challenge is building a submersible strong enough to withstand extreme ocean pressure — nearly 600 times atmospheric pressure at 6,000 metres.
- A titanium alloy personal sphere (2.1 m diameter, 80 mm thick) is being developed by ISRO.
- The challenge lies in **sourcing titanium** (a rare and strategically controlled material) and achieving precise electron beam welding, as even a 0.2 mm deviation in thickness could cause catastrophic collapse.

Maintaining a Livable Environment

- Inside the confined personal sphere, aquanauts will require a controlled atmosphere with 20% oxygen levels and regulated carbon dioxide scrubbing.

- Emergency backup systems include packed re-breather oxygen units that recycle exhaled air, similar to diving systems.

Ensuring Aquanaut Health and Safety

- Aquanauts must be in peak physical condition to endure long hours under extreme pressure and respond effectively to emergencies.
- With no access to washrooms, food and water intake is minimised before and during the mission.
 - For instance, during a nine-hour test dive to 5,002 metres, Cdr (Retd) Jatinder Pal Singh consumed only a few dry fruits.

Overcoming Communication Barriers

- **Radio waves cannot penetrate deep waters**, making conventional communication impossible.
- Instead, India has developed its own acoustic telephone, which transmits sound waves to receivers near the surface.
- Early harbour tests failed due to factors like temperature and salinity, but the system later worked successfully in open sea trials.

India's Push for Deep Sea Exploration under the Blue Economy Vision

- India, with its 7,517 km-long coastline, is investing in deep-sea missions as part of its Blue Economy strategy to drive future growth and sustainable resource use.
- The deep ocean remains largely unexplored but holds vast reserves of minerals, fuels, and biodiversity, which can boost economic and scientific development.
- Exploring under-explored domains like the deep sea and outer space will play a crucial role in achieving the government's vision of "Viksit Bharat".
- With the Samudrayaan Mission, India aims to send humans to 6,000 metres below sea level by 2027, **placing it among the few nations** — including the United States, Russia, China, Japan, and France — with advanced deep-sea exploration capability.

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