NATIONAL INSTITUTE OF OCEAN TECHNOLOGY'S SAMUDRAYAAN

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A prototype of the MATSYA 6000, a submersible made by Chennai-based National Institute of Ocean Technology. File | Photo Credit: R. Ravindran

The influence of James Cameron, the Canadian-American filmmaker, whose cinema has frequently explored the mysteries of the deep ocean, looms large on scientists at the National Institute of Ocean Technology (NIOT) in Chennai.

"Have you seen the film [Deepsea Challenge]," Ananda Ramadass asks this correspondent. The documentary charts Cameron's solitary, 10,000-metre journey down the Marianna Trench — the deepest point in earth's seabed — in 2012 aboard the Deep Sea Challenger, a submersible. "It is incredible."

Dr. Ramadass and his colleagues aspire to capture some of the aura of the ocean depths when India's indigenous submersible, MATSYA-6000, plunges into the bowels of the Indian Ocean, with a three-person crew onboard. At 6,000 metres, this will be shallower than Cameron's excursion but the deepest dive yet by Indians into the ocean.

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If India's mission – expected to take place in late 2024 or in 2025 – were to be successful, it would make it only one among six countries to have piloted a crewed under-sea expedition beyond 5,000 metres **.**

The hull (sphere) can house three people and such a crew is expected to undertake a journey to a depth of 6,000 metres in the Indian Ocean by 2025. | Photo Credit: R. Ravindran

Much like the early days of India's space programme, which prioritised public utility over Cold War spurred Sputnik-Apollo Space Races, India's motivations are guided by pragmatism – explore the potential of the seabed for precious metals and scoping marine biodiversity. "India's seabed and the relevant zones with economic potential aren't deeper than 6,000 metres. Our technology and vehicles are designed and developed for our needs," said Dr. Ramadass.

Samudrayaan, or the journey into the sea, and NIOT mission can be conceptualised as the reverse of the forthcoming Gaganyaan mission – The Indian Space Research Organisation's (ISRO) attempt at a crewed mission into space – also expected in late 2024 or 2025.

However, the journey to the ocean depths will likely be "far more comfortable" than a sojourn into space, said a key scientist of the Samudrayaan mission. Space flights are characterised by astronauts strapped into a jangling hulk of metal propelled upwards by fiery booster engines at speeds touching 40,000 kmph (to escape Earth's pull).

This would be the first such under-sea mission by India. | Photo Credit: R. Ravindran

A dive into the ocean, by contrast, will be a cruise. Ballast tanks on the submersible pull in water from the ocean and the weight gradually sinks the watercraft aided by 'trim' tanks allow more precise manoeuvring. The submersible, equipped with life-support and oxygenated, is capable of floating underwater and collected soil and rock samples from the seabed with attached robotic arms.

"Except for the turbulence of surface waves, the journey down is expected to be much smoother," said D. Sathianarayanan, a scientist who manages multiple components of Samudrayaan. Ensconced in a spherical, titanium hull, three navigators, over a fortnight and about 1,500 km away from Kanyakumari will undertake multiple trips – each lasting about 12 hours.

"Descent and ascent will be eight hours, with four hours of exploration, surveying and scientific activity," said Dr. Sathianarayanan. "It will be cold inside but regular warm apparel will suffice. You can eat during descent and ascent but because you'll be in a 2.1 metre sphere with two others, it may feel claustrophobic and cramped."

At a depth of 6,000 metres, the weight of water would be nearly 600 times that at sea level which make the pressurised hull the most important component of the submersible.

At present, NIOT has made multiple, prototype steel hulls into which personnel can climb into, one at a time, and test the necessary instruments to steer the vehicle. While strong, steel is heavy and the corrosion from marine environments means unsuitable for long-term research and hence the material of choice for submersibles globally is titanium alloy.

At present, NIOT has made multiple, prototype steel hulls into which personnel can climb into. | Photo Credit: R. Ravindran

However, no commercial fabricators in India were capable of fashioning such a titanium hull, until the NIOT found an ally in ISRO.

Two hemispheres of titanium alloy have to be fused to create a single hull becoming thus the only barrier between the inhabitants of the submersible and the crushing water columns, but at the same time be no more than 80 millimetre thick – to be relatively light, manoeuvrable and eke out a few more precious inches of space for the crew.

"Only ISRO here can make this. We will have two such hulls manufactured and that we hope will be sufficient for our research and exploratory programmes for many decades," said Dr. Ramadass. By early 2024, NIOT is expected to undertake a 500-metre exploratory dive in the titanium sphere and a few more at greater depths prior to the main mission.

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About 60% of the submersible, said Dr. Sathianarayanan, was manufactured in India. These mainly comprise the external frame, ballasts and pressurised casing. Components such as cameras, sensors, communication systems were bought from international vendors. “The software that details the submersible’s position, movement is developing in-house at NIOT,” he added.

Over the years, NIOT has consulted with crewed-submersible experts from several countries – Japan, Russia, France – and pieced together the knowhow necessary to ensure a safe ascent and descent.

Much like Cameron — who descended solo — MATSYA’s entire journey will be filmed by 12 cameras, fitted along the submersible to capture a 360-degree view of the descent. The crew will also be able to film their surrounds through glass portholes.

“The Mir 1 and 2 submersibles filmed the descent and exploration of the *Titanic,* as the movie showed,” said Dr. Sathianarayanan, in yet another allusion to a Cameron classic. The chambers are oxygenated and, in the case of an emergency, has enough air for the crew for 96 hours. There’s a ‘drop weight’ system that can haul the 25-tonne MATSYA out in case of an emergency.

In contrast to space flights, where the risk of explosion is omniscient thanks to extremely combustible fuel, gravity, water and lithium-ion batteries are the only fuel that MATSYA needs. To date, since the Trieste submersible descended the Mariana Trench in 1960 with Jacques Picard and Don Walsh on board, there have been no fatal or injurious accidents involving submersible dives.

However, the depth reckoned and water resistance means that only a very basic system of acoustic communication – a live-streaming feed for instance is ruled out – between the launch-ship and the submersible would be possible, due to a 20-second lag to transmit from the seabed to surface, said Dr. Sathianarayanan.

India’s energy needs and increasing competition to harness ocean resources are the key thrust for the Samudrayaan mission, said Dr. Ramadass.

The International Seabed Authority has allocated about 75,0000 square kilometres in the Central Indian Ocean Basin (CIOB) to conduct exploratory mining. This will mean scouting polymetallic nodules that lie on the seabed. Preliminary estimates indicate that 380 million tonnes of such nodules comprising copper, nickel, cobalt and manganese are available here.

The Union Cabinet in 2022 approved a [4,000 crore ‘Deep Ocean Mission’] to be piloted by the Ministry of Earth Sciences, the parent organisation of the NIOT, that lists among its objectives, developing vehicles and technology that can scan and mine the ocean.

Just this month the United Nations passed a treaty – India too has committed to this – that seeks to protect 30% of the world’s ocean by 2030. The High Seas treaty, as it is known seeks to conserve marine environments and regulate mining and commercial prospecting in the high seas, or parts of the ocean that are beyond the zone where a country has exclusive operating rights. CIOB is also part of the high seas, which encompass about two-thirds of the earth’s oceans.

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