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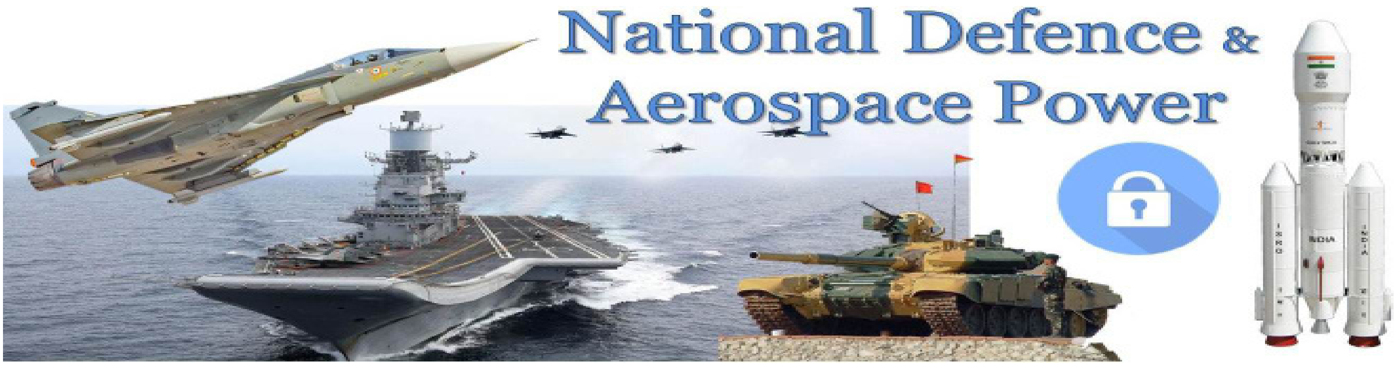

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INDIAN EXPLORATION OF RARE EARTH ELEMENTS IN INDIAN OCEAN REGION: MOVING TOWARDS NON-CONVENTIONAL SOURCES?

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The ocean resources are assumed to have a significant potential to contribute towards sustainable development and economic growth. With the emphasis on the same, India's recent 'Deep Ocean Mission' launch is the initiative to take its blue economy goal forward, developing deep-sea technologies and exploring ocean resources, thus securing its economic and energy needs. Besides the geographical reserves, India is surrounded by oceans on three sides that involve abundant mineral deposits suitable for commercial exploitation. India's Exclusive Economic Zone (EEZ) extends to 2.02 million sq km and 0.18 million sq km on the continental shelf area.[1] India's recently launched Deep-Sea mission seeks to develop a manned submersible that can potentially carry three people to a depth of 6,000 meters in the ocean to create an integrated mining system.[2]

India's recently launched Deep-Sea mission seeks to develop a manned submersible that can potentially carry three people to a depth of 6,000 meters in the ocean to create an integrated mining system.

Out of all minerals/resources available in deep-sea bed, Rare Earth Elements (REEs) are significantly required for India's commitment to shift towards clean energy technologies and reduce GHG and CO_2 emission, considering its potential for low-cost technology production. It is noteworthy that the processing of rare elements available in the ocean works for and against the climate at the same time. The ocean REEs processing generates no thorium and uranium, which is a major problem involved in land REE-processing. However, the ocean REEs exploration process can affect the marine life adversely. In addition, the deep-sea exploration techniques are minimal in comparison to land geochemical prospection.[3]

Resources in the Ocean

The growing need for technological advancement has set the world in a race to secure the required resources or minerals, for which most countries recourse to the geographical reserves such as rocks, soil, ores and so on. However, the other resource sources have been overlooked, considering the limited knowledge and high-cost technology required for the extraction. It is undeniable that the geographical sources are not abundantly available for most countries, that makes necessitates the shift towards exploitation of other sources or reducing dependence on the geographic reserves. The non-conventional sources involve solar, hydro, wind, nuclear and ocean resources, but the countries realize the significance of these resources at a sluggish pace. Out of all the non-conventional sources, the ocean could be seen as the significant alternative considering its potential to contribute to all aspects of life.

The first oceanography voyage was conducted to access deep ocean was conducted in 1873, by the His Majesty's Ship (HMS) challenger ship that discovered the deep-sea resources. According to deep-sea mining proponents, the seabed nodules could provide most of the world's minerals. The International Seabed Authority (ISA) considered Clarion-Clipperton Zone (CCZ) the most attractive seabed mining site. However, the deep-sea exploration techniques are limited and mainly involve sampling using drilling or sediment grabber.[4]

Rare Earth Elements in the Ocean

The deep ocean involves all those rare earth elements used to produce rechargeable batteries, electronics touchscreens, etc. The oceans have abundant metals like copper, nickel, cobalt, iron manganese, and rare earth elements. Gerard Barron, the Australian CEO of the seabed-mining company- 'The Metals Company', called ocean minerals 'a battery in a rock' and 'easiest way to solve climate change.[5]

According to Eastern south and Central North Pacific studies, the deep-sea surface contains over 1,051 ug/g concentration of REE. The ocean has 1,000 times larger REE reserves than land reserves, mostly high concentrations of Lutetium and Gadolinium. The positive factor about the ocean REE reserves is no generation of Thorium and Uranium in their processing, whose radioactive generation is the environmental problem during land extraction of REE.[6] In 1964, the US launched its first deep-sea submersible vehicle, 'Trieste II' and 'DSV-2 Alvin'[7] marking as the first successful deep-sea exploration attempt. Then, Japan attempted to develop submersible technology by launching 'Shinkai.'[8] in 1970, which was followed by France launching 'Nautile' submersible[9] in 1984, that could operate at a depth of up to

6km. Then, in 1986, Russia began the operation of the Prize class deep-sea submergence vehicle[10], and launched a deep-diving nuclear-powered submarine called 'Losharik.'[11] in 2003. After all the countries attempting to develop deep-sea submersible, China's attempt was the most successful by exploring the deepest ocean in the world with Jiaolong deep-sea submersible in 2010.

In 2011, the International Seabed Authority (ISA) gave China the exclusive right to explore the valuable ocean minerals under a contract, furthering China's stake in the Indian Ocean Region (IOR).

In 2010, the rare earth embargo by China against Japan, following the Senkaku-Island dispute, made it essential for Japan to secure its supply. As part of its effort to assure the rare earth supply, Japanese researchers found large quantities of REE in 2011 in the Pacific ocean depths of more than 3,500 to 6,000 meters. Japanese scientists outlined the availability of some 80-100 billion tonnes of rare earth deposits underwater, but their harvesting was not precise.[12]

China's Capacity for Ocean Mineral Exploration

Being the world's leading manufacturer of solar panels, EV batteries, and other electronics, China needs a stable supply of resources to sustain its technological leadership. In 2011, the International Seabed Authority (ISA) gave China the exclusive right to explore the valuable ocean minerals under a contract, furthering China's stake in the Indian Ocean Region (IOR). Besides IOR, China achieved two other exploration contracts in the Atlantic and Pacific oceans. In 2017, China developed its first under-sea submersible called Jiaolong, which carried out a 118-day stay on the Indian ocean floor. The Jiaolong gathered 700 samples during its survey and discovered an 'active chimney vent', which included gold, silver, copper, and zinc deposits.[13] In 2009, the Jiaolong began the deep-diving operation from the South China Sea, followed by the Western Pacific ocean in 2012 and Indian Ocean Region in 2014. Finally, with a final diving operation in the northwestern Pacific Ocean and reaching a depth of 6,579 meters, China completed its first successful seabed submersible and headed towards the deepest Mariana trench for the next stage.[14]

China is a world leader in submersible technology, withholding three exploration permits in the Clarion-Clipperton Fracture Zone (CCZ) and advanced deep-sea mining machinery.[15] From 2017 onwards, China has increasingly turned towards the ocean to secure its resource supplies for the high-tech electronics industry. Terrence Haverluk, a Professor of Geopolitics at the US Air Force Academy, explained the primary motivation for China to develop deep-sea mining was to establish sovereignty over the South China Sea.

Rare Earth Elements in the Indian Ocean Region

> **As part of India's Deep-Sea or Samudrayaan mission that got approved in 2019 and in order from June 2021, the first successful deep-sea manned submersible 'Matsya 6000' is planned to launch.**

The Food and Agriculture Organization (FAO) assessment of ocean resources suggested their increasing depletion, but the Indian ocean resources are still unexplored thus have great exploration potential. There is abundant availability of polymetallic nodules and sulphides mineral resources in the IOR.[16] The entire landmass and rocks around Indian Ocean Region (IOR) contain the REEs as the coastline is enriched with 'Mineral Sands', an easily recognizable black colour sand used as alloy, paint, filtration, and sandblasting. These mineral sands contain rare earth elements, whose production is cheaper in comparison to industrial mineral mining. Several countries are interested in conducting exploration projects in the IOR, but for now Australia, Indonesia, Thailand, Myanmar, India, Kenya, Tanzania, Seychelles and Madagascar, are in advantageous location to use these mineral sands.[17]

India's Deep- Sea Mission

In 1977, India declared its Exclusive Economic Zone (EEZ) to explore rich ocean resources. This marked the beginning of its 'Blue Economy Mission' as part of which India created a Department of Ocean Development (currently Ministry of Earth Sciences) tasked with managing Indian ocean resources.[18] . However, despite certain initiatives, India's capacity to explore and exploit the IOR resources remained limited over the years. In 2017, India got the first exploration contract in IOR from ISA and started developing its under-sea submersible, contributing to its blue economy mission.[19] In 2018, Gidugu Ananda Ramadass, head of India's deep-sea mining project at the National Institute of Ocean Technology (NIOT), said, "We are exploring Mars, we are exploring the moon; why don't we explore our oceans?". India's deep-sea exploration goals started decades ago but gained momentum with Chinese expansion in the IOR and its resources.[20]

As per the study of a Jamaica-based Intergovernmental agency, China has access to 4 of 29 total licenses awarded by the International Seabed Authority (ISA), thus getting control on the world's almost high-sea exploration. In comparison, India just got permission from ISA to explore around 75,000 sq. km. in Indian Ocean Region (IOR).[21] On 16 June 2021, the Deep sea mission was launched as part of India's 'Blue Economy Initiatives' and focused on six primary goals- a) develop technologies and manned submersible for deep-sea mining;

b) development of ocean advisory services to promote coastal tourism; c) exploration and conservation of deep-sea biodiversity; d) deep ocean survey and exploration; e) energy development from off-shore ocean freshwater; f) Advancement of marine station for Ocean biology.[22] As part of India's Deep-Sea or Samudrayaan mission that got approved in 2019 and in order from June 2021, the first successful deep-sea manned submersible 'Matsya 6000' is planned to launch.[23]

Rare Earth Minerals in the Coastal States of India

The large Monazite deposits in India are primarily found in the coastal tracts of Orissa on the east coast and Kerala on the west coast. Bastnaesite – a source of cerium- is located in the state of West Bengal. Monazite in Carbonatites is found in the Meghalaya, Tamil Nadu, Assam. Xenomite containing REE dysprosium is found in the states of Chhattisgarh and Jharkhand.[24] . India has a 35% deposit of beach sand minerals deposits. The Beach Minerals Producers Association experts estimated that the Indian rare earth mineral downstream industry could generate 121 thousand crores, including Rs 50,000 crore worth of foreign exchange. The significant rare earth minerals found in India include- Ilmenite, Sillimanite, Garnet, Zircon, Monazite, Rutile- collectively called Beach Sand Minerals.

Way Ahead and Implications for India

Ocean exploration would further not only the blue economy goal of India but also its clean energy goals, whose infrastructure development requires rare earth elements. Moreover, China is increasing its access to land and ocean resources, furthering its geo-economic engagement with the resource-rich countries. The Samudrayaan or Deep-Sea mission will add India to the category of elite nations, having deep-sea submersible, after China, the US, Japan, France and Russia. In addition, India's access to deep-sea submarines can set the common ground of cooperation among the QUAD members to counter the monopoly of China in the rare earth industry.

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