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FOCAL POINT ON DEEP-SEA RESOURCES

PRODUCED IN PARTNERSHIP WITH THE CROSS-MINISTERIAL STRATEGIC INNOVATION PROMOTION PROGRAM

THE RICH RESOURCES IN JAPAN'S DEEP-SEA MUDS

Vital to many expanding technologies, RARE-EARTH DEPOSITS WERE IDENTIFIED IN JAPAN'S DEEP-SEA CLAYS in 2013. Scientists have been contemplating the technical and environmental challenge this presents.

Despite their name, rare-earth elements, a group of 17chemical elements, are not so much rare as difficult and expensive to extract. Demand for these elements is growing due to their use in technologies ranging from hybrid cars and rechargeable batteries to LED bulbs and wind turbines.

Australia's Lynas Corporation has a more than 10% global market share, but it is China that commands more than 70% of the market. And after Japan faced disruptions in rare-earth element supplies from China in 2010, it has looked to diversify its sources.

In 2011, a Japanese report first surfaced of rare-earth element-rich deep-sea clays in the Pacific Ocean. Later expeditions identified rich deposits in muds and fossilized fish bones near Minamitorishima Island, Japan's easternmost territory. In 2018, researchers estimated rare-earth oxides of yttrium, europium, terbium, and dysprosium for a promising area in Japan's exclusive economic zone could account for 62, 47, 32, and 56 years of annual global demand, respectively, and Japan decided to dip a toe into its deep sea.

Entirely new prospecting and mining technologies will be needed. Even the deepest oil rigs reach to only about 3,500m depths, while the valuable sediments and mud-entombed fish-bone fossils are found at depths of more than 5,000m.

The Japanese government launched a project known as the Development of Innovative Technologies for Exploration of Deep Sea Resources, under its Cross-ministerial Strategic Innovation Promotion Program, to come up with high-efficiency, low-cost deep-ocean resource surveying and extraction systems. New deep-water acoustic mapping technologies, exploratory autonomous vehicles and mud pumping machinery are in early testing.

MINERALS IN MUD
Yttrium is among the most commonly commercialized rare-earth elements, used to produce phosphors for cell phones, display screens and LEDs.

Left: © Bjoern Wylezich/Shutterstock; Right: © Grant Faint/The Image Bank/Getty Images; © JAMSTEC; © SIP: Cross-ministerial Strategic Innovation Promotion Program

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Rare-earth elements, such as terbium, europium and dysprosium are used in **SOLAR PANELS**, **ELECTRIC CAR TECHNOLOGY** and **WIND TURBINES.**

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Because of the difficulty in doing research hundreds or thousands of metres below the ocean's surface, no-one has established the full range for known **DEEP-SEA SPECIES**.

Wataru Azuma is one of the executives leading the effort through the research hub the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). Azuma says the projects are all well advanced, although commercial viability is yet to be established. Despite this, environmental monitoring remains the challenge.

Terrestrial sources of rare-earth elements are fraught with significant health and pollution issues. Prices for the minerals may be artificially low by not factoring in environmental clean-up of mining operations. Since Japan's rare-earth element-rich ocean mud appears to densely cover specific areas and have fewer radioactive elements than terrestrial sources, deep-sea minerals may have less waste and tailings issues than terrestrial mining.

Meanwhile, Azuma says profound gaps exist in our basic knowledge about deep-sea ecosystems and resilience to mining disturbance. "We need enough time to build up a consensus on these issues, because nobody really knows anything about the deep-sea environment," he says.

Even initial sampling and simulation work in relation to shallower massive-sulphide mining of vent fields in the western Pacific Ocean suggest substantial variation in ecosystem recovery time, adds Hiroyuki Yamamoto, a principal researcher at JAMSTEC. The effect of noise pollution and sediment plumes on midwater ecosystems and fisheries will also need to be considered, he says. Data should be collected before and after sediments are disturbed, he adds.

Affordable monitoring technology developed in Japan should help. "Deep-sea observatories are usually heavy and huge," explains Yamamoto. "Commercial crews would like to use smaller vessels, and that's why we developed a new system that is very compact." Their Edokko Mark I type 365, a small rig of nine glass spheres with simple recording, testing and battery equipment, can withstand pressures at 8,000m. It has already survived the mandatory one-year baseline required by international authorities for monitoring. It could also be used for fisheries in shallower waters, adds Yamamoto, which will increase its commercial appeal. Seven smaller Pacific Islands nations have already sent representatives to learn about the technology. Japan has also been involved in developing internationally recognized water quality, invertebrate community assessment and genomic analysis technology for the deep sea.

However even with the best possible monitoring, seabed-mining impacts are unlikely to be fully understood until full-scale mining has been monitored for years. Professor of Oceanography at the University of Hawai'i, Craig Smith, led a group of researchers from marine science departments in North America, Europe and Russia, who in a 2020 paper, flagged a long-term precautionary approach. Smith says, "for example, allowing only one mining operation to proceed until the environmental impacts of mining seabed minerals are well documented."

The ship may have already sailed. The International Seabed Authority, the organization created by the United Nations to manage seabed mining beyond national jurisdictions, has already granted roughly 30 exploration contracts covering more than 1.3 million square kilometres. In 2021, it will also finalize mineral exploitation regulations that will enable active seabed mining, and from January 2020, a working group on marine technology for the International Organization for Standardization has been developing standards that will contribute to environmental marine impact assessments. So while environmental concerns remain in the spotlight, it's not impossible that rare-earth elements from the deep sea could one-day see Japan become a global resource provider. ■

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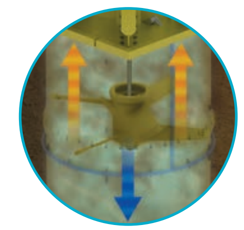
MACHINERY IS IN TESTING THAT HELPS MIX DEEP-SEA MUD so that it forms a consistency able to be pumped thousands of metres to the surface.



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