Development of Innovative Technologies for Exploration of Deep-sea Resources

Challenge for exploration and production of deep-sea resources for future industrialization

The deep seafloor around Japan is known to contain a large amount of mineral resources. Recent studies have identified the existence of marine mineral resources, including **rare-earth elements** that are essential to economic and social development. They have been found at the sea bottom approximately 2,000 m to 6,000 m below the sea surface, which accounts for two-thirds of the seabed of Japan's exclusive economic zone (EEZ). The program to be pursued through the collaboration of nine ministries aims to take a step-by-step approach to establish and verify innovative technologies for exploration of deep-sea resources, including mineral resources, such as rare earth deposits existing in the deep seafloor. The objectives are to be a global pioneer, to promote social implementation of the technologies, such as technology transfer to private corporations, and to pave the way toward the future establishment of a business model.

Program Director

ISHII Shoichi

Corporate Advisor of Japan CSS Co., Ltd.

Profile

Held numerous key positions in resource development companies, including Vice President & Representative Director of JAPEX, President of Japan CSS Co., Ltd. and Japan Methane Hydrate Operating Co., Ltd. Currently corporate advisor of Japan CSS Co., Ltd.
Served as a member of Coordination Subcommittee, Committee on Oceanic Resources, Keidanren from 2009 to 2018.
Deputy PD of "Next-generation technology for ocean resources exploration" SIP by the Cabinet Office.

Research and Development Topics

1. Exploration and analysis of the abundance of marine mineral resources including rare earth deposits

It has been reported that large deposits of rare earth minerals with a high concentration of rare earth elements (rare earth deposits) occur in the seafloor surrounding Minamitorishima Island in the Japanese EEZ. We will narrow down sites with the greatest potential for development and make a rough estimate of the amount of rare earth minerals.

2-1. Development of technologies for exploration of deep-sea resources (operation of multiple Autonomous Underwater Vehicles (AUVs) and a terminal system with a battery charger in the deep sea)

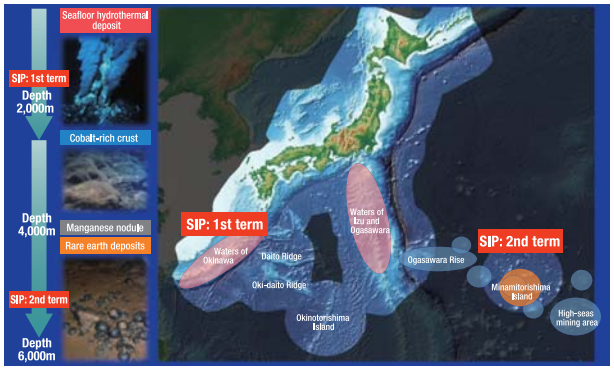
In order to estimate the accurate potential of various deep-sea resources existing at depths between 2,000 m and 6,000 m, we need to establish technologies to efficiently explore precise bathymetric features and sub-seafloor structures. For this purpose, we will attempt to build a system capable of exploring deep-sea resources with high efficiency by developing the technology for simultaneous operation of multiple deep-sea AUVs and technology concerning deep-sea terminals with a battery charger, which would enable AUVs to cruise for longer periods.

2-2. Development of technologies for production of deep-sea resources (cracking, sampling and lifting technology of rare earth deposits)

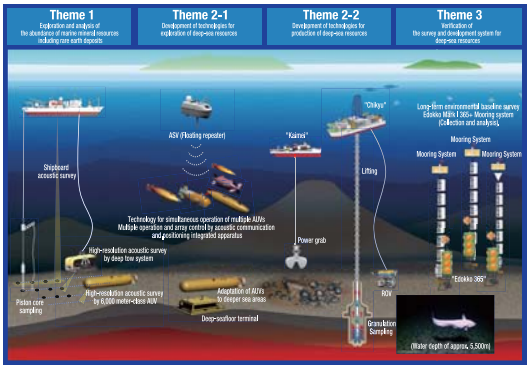
A system for continuous retrieval of rare earth deposits from the bottom of the deep sea does not exist. Thus, it is necessary to establish technologies for cracking solidified rare earth deposits and for lifting the cracked deposits to the ship by fluid circulation through the drill pipes of the deep-sea drilling vessel *Chikyu*. We will verify the technologies for granulation, sampling and lifting through field experiments in the actual sea and establish this engineering system as a global pioneer.

3. Verification of the survey and development system for deep-sea resources

For the purpose of paving the way toward the establishment of a business model to develop deep-sea resources, we will apply the environmental impact assessment method and comprehensively verify the engineering system developed through the research activities of Themes 1, 2-1 and 2-2. Through such verification, we will take a step-by-step approach toward future industrialization in relation to the development of deep-sea resources by gaining opportunities for deep-sea surveys in response to various needs.



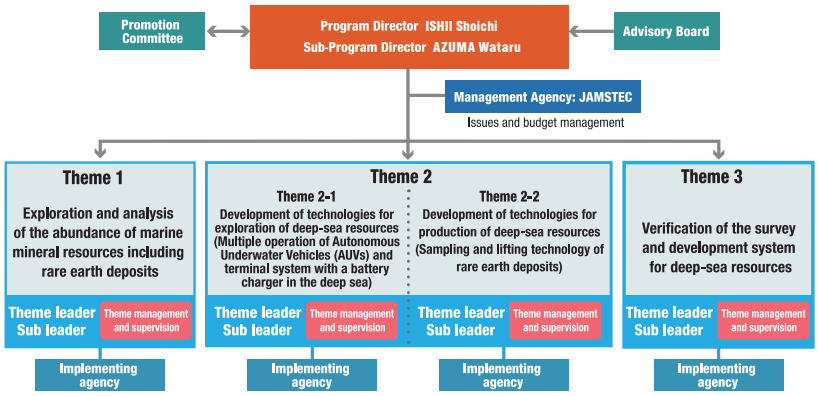
● Distribution of seabed resources around Japan



● Outline of each theme

Implementation Structure

The Program Director (PD) is responsible for general management of the whole project. The PD will establish appropriate vertical and horizontal linkages with theme leaders and the Management Agency and build a management scheme in cooperation with such persons. In addition, an Advisory Board, which provides advice from technical and academic points of view, is established. Furthermore, coordination scheme based on the collaboration among ministries is built in the Promotion Committee so that steady progress can be made toward the establishment of technologies for exploration of marine resources, which is important for the future of Japan.



Promotion Committee

Leader: Cabinet Office (Council for Science, Technology and Innovation), Sub-leader: National Ocean Policy Secretariat (Cabinet Office), National Space Policy Secretariat (Cabinet Office), the Ministry of Internal Affairs and Communications, the Ministry of Foreign Affairs, the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Agriculture, Forestry and Fisheries, Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure and Transport, the Ministry of Environment, the Ministry of Defense, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan Oil, Gas and Metals National Corporation (JOGMEC), and National Institute of Maritime, Port and Aviation Technology (MPAT)

Exit Strategies

Establishment of a model for industrialization of deep-sea resources

Survey and retrieval technologies developed through this program will be strategically transferred to industry after verification of their practicality and effectiveness so that they may be commercially utilized. Private companies, which receive technology transfers, will win contracts for deep-sea surveys in response to various needs, thereby further activating the marine survey industry in a close industry-academia-government collaboration. In the process of technology transfer, we will define challenges to be overcome, examine methods to reduce the impact on the environment, and formulate a business model for the future development of deep-sea resources.

Past Milestones and Anticipated Outcomes

- **Marine sediment samples were gathered and analyzed to understand the rare-earth deposits in the waters off Minamitorishima Island, and three concentration patterns were recognized. By clarifying the approximate amount of rare-earth resources on the basis on these analysis results, it is expected that prospective development sites in the waters will be identified.**
- **Acoustic communication and integrated positioning systems, AUV line-controlling algorithms, ASV relay devices at sea, deep seafloor terminal system and AUVs capable of working at great depths are under development. Integration of these element technologies will lead us to dramatically improve survey capabilities for deep sea resources.**
- **Design and fabrication of a system to collect rare-earth deposits, based on various element tests and simulation results is under progress. It is expected that the development technology to collect (crack, sample, and lift) deep sea rare-earth resources, which have not been verified so far, will be established for the first time in the world.**
- **Sediment samples including rare-earth elements deposited in the subseafloor in the waters off Minamitorishima Island were examined/refined, and rare-earth elements have been extracted. As a result, it was shown that the deposits were rich in very useful elements, such as neodymium and dysprosium.**
- **One-year environmental monitoring in deep sea areas deeper than 5,000m was successfully conducted with the "Edokko Mark 1" and a moored observation device off Minamitorishima Island. A vast amount of monitoring data was accumulated, including video image data. In addition, it is also expected that these efforts will contribute to new applications for deep seafloors for other fields including provision of a platform for degradation tests for biodegradable plastic, and dissemination of these technologies and methods around the world.**