Next-generation Technology for Ocean Resources Exploration

Zipangu in the Ocean Program

Zipangu in the Ocean Program–Seeking the Wealth of Mineral Resources in Our Seas

In the 13th century, the Italian explorer/merchant Marco Polo described Japan as Zipangu, that is, the island of gold in the Travels of Marco Polo. In fact, Japan once was the world-leading producer of gold, silver, and copper, but now it imports almost all its needed metal resources from abroad. Although these resources on land have been mined out, the seabed around the Japanese archipelago is still believed to hold a wealth of mineral resources. The goal of the Next-generation Technology for Ocean Resources Exploration (Zipangu in the Ocean) Project is to develop ocean resource survey technologies to launch our nation forward in creating a world-leading ocean resource survey industry.

Program Director

Tetsuro Urabe

The University of Tokyo
Professor Emeritus
Japan Mining Engineering & Training Center (JMEC)
Executive Adviser

Profile

Tetsuro Urabe graduated from the University of Tokyo in 1971 and received a Ph.D. in geology at the University of Tokyo in 1976. His professional career includes assistant professor, Geological Institute, University of Tokyo (1976–1985), chief geologist, Geological Survey of Japan (1996–2000), and professor, Department of Earth and Planetary Science, University of Tokyo (2000–2014). He was also a member of the United Nations Commission on the Limits of the Continental Shelf (CLCS) (2011–2017). Dr. Urabe is currently executive adviser at the Japan Mining Engineering & Training Center (JMEC) and professor emeritus at the University of Tokyo.

Research and Development Topics

1. Development of area selection method based on scientific research on the genesis of the mineral deposits

Develop science-based methodology to narrow down potential areas for seafloor exploration to identify mineral resources. Such techniques will be developed through understanding the mechanisms by which mineral resources are formed, as well as identifying distinctive indicators of mineral resources. Develop these techniques into a survey protocol for use by private enterprises, helping them to reduce exploration time and costs significantly.

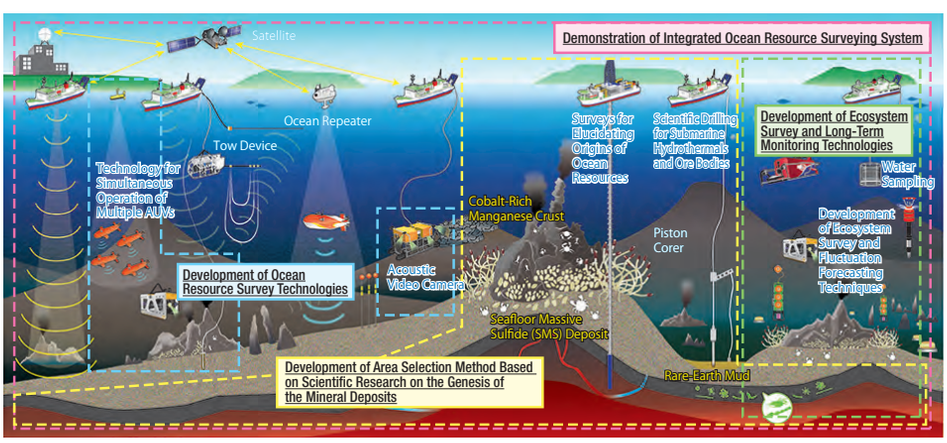
2. Development of ocean resource survey technologies

There have been no systems to date that enable us to detect seafloor massive sulfide (SMS) deposits concealed in a deep-sea environment. Accordingly, we will develop the world's first survey system enabling us to efficiently discover resources below the seabed, by combining the operation of multiple autonomous underwater vehicles (AUV) capable of wide-ranging surveys with the high-efficiency survey systems of remotely operated underwater vehicles (ROV). With these advancements, we will create new markets of ocean resource survey and development business.

3. Development of ecosystem survey and long-term monitoring technologies

Consideration for ecosystems and the environment is essential for ocean resources development. Examine risk assessment categories to ensure a balance between the development of ocean resources and the protection of the environment. Establish international standards for environmental impact assessment and environmental management, and aim to export these technologies to other countries and win contracts for overseas surveys.

•Overview of Research and Development Topics



Exit Strategies

Create an ocean resource survey industry

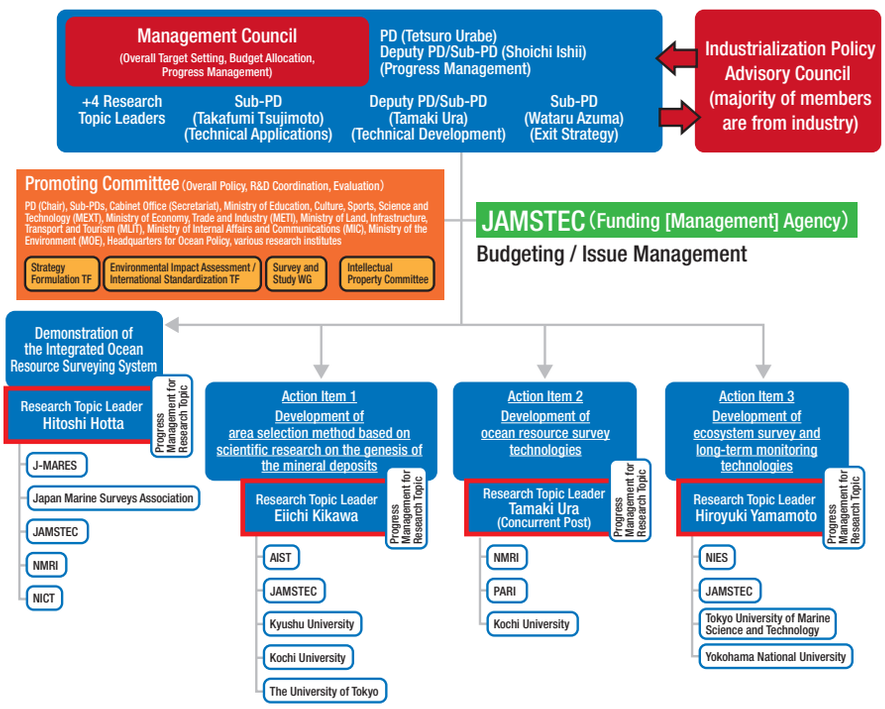
Develop competitive ocean resource survey technologies (low-cost, high-efficiency, rapid and safe) through industry-academia-government cooperation. Use policy to transfer new survey technologies and expertise to the private sector. Create a new ocean resource survey industry by meeting the needs of resource industries and organizations, such as the Japan Oil, Gas and Metals National Corporation (JOGMEC), which explore and develop ocean mineral deposits.

Establish global standards

Lead the world in the field of efficient survey and environmental monitoring technologies and work for the international standardization of Japan's technologies and methods. Export Japanese survey systems and perform survey projects on contract with overseas entities.

Implementation Structure

The project's Management Council consists of the Program Director (PD), Sub-PDs (from private enterprise, universities and research institutes of several government ministries and agencies), and Research Topic Leaders. The Council manages progress of the project with a view to the exit strategies, guiding the project to solid results. With an aim of creating an ocean resource survey venture, the Council has gathered industry, academia and government together into an agile and strategic research framework. In a close partnership with JOGMEC, the Council promotes efforts from development of technologies to their tests under actual ocean conditions. Moreover, the Council is responsible for promoting the transfer of technology to private enterprise. The Promoting Committee consists of the PD serving as Chair, the Cabinet Office serving as Secretariat, as well as other experts and representatives from various ministries and agencies. The Committee utilizes operating expense grants provided to the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), making maximum use of the knowledge and expertise developed.



Progress to Date

From Demonstration Testing of Technology, to Building an Integrated Ocean Resource Surveying System

In this program, we successfully surveyed a submarine hydrothermal area off the coast near Izu Oshima using two fully automated cruising-type AUVs and one hovering-type AUV, simultaneously operated and controlled by way of an ocean repeater. Using acoustics and optical imaging, the survey revealed distinct signs of hydrothermal activity. It was the first time in the world for a seafloor survey to be conducted through the simultaneous operation of multiple AUV controlled by way of an unmanned ocean repeater. The results demonstrate that since other work can be undertaken by the mother ship while the AUVs are in operation, there is potential to dramatically improve the efficiency of surveys compared to conventional methods. Also, rather than using dedicated support vessels owned by the research institute, this survey was performed using ordinary workboats owned by a private company. We achieved it in a short period of training.

In this way, advances have been made in the technical development of survey technologies and methods, and the project has moved into a phase of demonstrating these in open waters. Project outcomes thus far have been utilized in the integrated ocean resource surveying system, which narrows the scope of promising areas systematically in conjunction with aerial surveys, semi-localized surveys and localized surveys, and technologies are being steadily transferred to the private sector. We will continue to validate the system in the Okinawa Trough, another location of seafloor massive sulfide (SMS) deposits, establishing technology for detecting unexposed hydrothermal mineral deposits in the uppermost 30 meters beneath the seafloor. We are also validating a proposed environmental impact assessment protocol.

●Multi-AUV operating technology enabling low-cost surveying

Program Director **Tetsuro Urabe** Interview

Demonstration Tests for an Integrated Ocean Resource Surveying System Ahead of Schedule

The Next-generation Technology for Ocean Resources Exploration (Zipangu in the Ocean) Project is advancing the high-efficiency, low-cost ocean resource surveying system toward an exit strategy ahead of schedule. As part of this process, we now plan to begin field tests in the third year of this program. Tests were originally scheduled to begin in the fourth year.

Prospects for Mineral Deposit Identification 2,000m below the Surface of the Ocean and up to 30m below the Sea Floor

The Japanese archipelago is situated above the subduction zone of two oceanic plates under the continental plate. From ancient times, Japan produced rich mineral resources, including gold, silver, and copper, the blessings of submarine volcanic activity. Today, most of Japan's mines have been exhausted, and Japan imports nearly 100 percent of its major metal resources from overseas. However, if we turn our eyes to the sea surrounding the archipelago, we find rich mineral resources including seafloor massive sulfide (SMS) deposits and cobalt-rich manganese crusts.

While terrestrial exploration techniques, such as satellite remote sensing and drilling, are well established, using these techniques for seafloor resources is still a tremendous technical challenge, particularly since sunlight and radio waves do not penetrate down to the deep seafloor. Cost is another issue. Drilling surveys, for example, can be dozens of times costlier underwater than on land. In response to these circumstances, Japanese research institutes related to marine science and technology have jointly pursued the development of high-efficiency, low-cost surveying technologies in last two years.

One specific approach is to develop a technology to operate multiple AUVs simultaneously. Artificial seismic source waves (i.e., acoustic waves) are transmitted from a ship to receive reflected waves from sub-seafloor formations to examine the presence of mineral deposits. An artificial electric current passing through sub-seafloor domains is measured to detect anomalies in electric resistance related to mineral deposits. Other techniques measure the anomaly of rock magnetism. Rock magnetism can reveal the existence of submarine mineral deposits, since hydrothermal activity modifies the magnetic properties of rock.

These techniques are being combined to create an integrated ocean resource surveying system capable of searching mineral deposits up to 30 meters below the seafloor at a depth of 2,000 meters.

Field Tests Begin in Year Three

Based on these outcomes, PD Urabe declares, "From the third year of this program, we will set clear targets for achieving our exit strategies and concentrate our efforts."

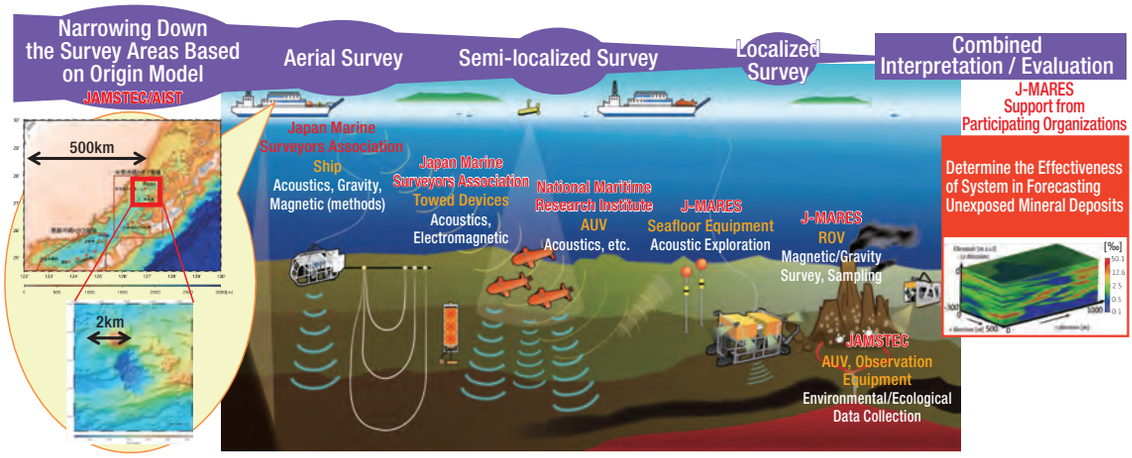
"Research on the origins of ocean resources" focuses on seafloor massive sulfide (SMS) deposits. This research seeks to develop technologies to narrow the scope of promising areas from among a vast choice of survey areas.

"Development of ocean resource survey technologies" aims to develop high-efficiency, low-cost exploration technologies and transfer them to private enterprise. These efforts also focus on commercialization of these technologies.

"Research on environmental impact assessment technology" focuses on establishing a survey protocol and observation technologies capable of assessing environmental impact from the surface to the deep seafloor of the ocean. Efforts are made to make these technologies international standard.

To accelerate the development, the program has brought

•Integrated Ocean Resource Surveying System



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forward field testing of the "integrated ocean resource surveying system" into the third year of the program. These tests were originally planned to be conducted in Year Four.

Stage 1 of the field tests will be conducted at a selected location where intensive seafloor drillings have already revealed the topography and geology of the seafloor as well as the presence of a concealed SMS deposit. The "integrated ocean resource surveying system" will be applied to validate its effectiveness. If these tests are proven to be successful, Stage 2 will be extended to field tests at areas with no previous surveys. This is part of a comprehensive validation of the efficiency, cost, and environmental impact of this technology, in an effort to establish the world's first system capable of detecting unexposed SMS deposits.

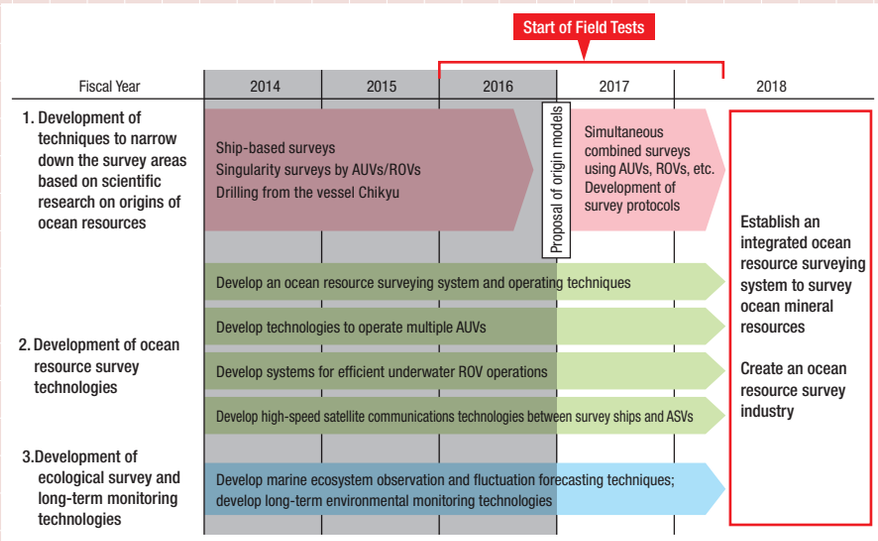
Toward Reliable, Eco-friendly Resources Development and International Cooperation

Looking to the future, PD Urabe says, "One of our exit strategies for next-generation technology for ocean resources exploration is to create an ocean resource survey industry. Taking the bigger view, however, we believe our initiatives will contribute to Japan's national security and resource stability. These technologies can be used to examine bedrocks on the seafloor for anchoring floating oil rigs. They could also be used to choose best locations suited for laying underwater cables.

We have particularly high expectations to use our technology to develop ocean resources around small island countries. Island countries in the Pacific Ocean are limited in their land territories, but have an extensive continental shelf around them. Contributing to these island countries by providing not only resource development technology but also environmental protection technologies for them to protect their pristine environment for tourism could also create new industries and jobs. It would also lead to more diverse suppliers of resources for Japan. These are the future goals we want to accomplish."

Future Plans

The goal of the program is to establish an integrated ocean resource surveying system that is capable of high-efficiency and low-cost surveying unexposed SMS deposits up to 30 meters below the seafloor at a depth of up to 2,000 meters. The program focuses on those SMS deposits that are most plausible for commercial development, and aims to be centered around private enterprise. To accomplish this goal, field testing of the integrated ocean resource surveying system will be conducted from the third year of the program.



We will accelerate development of the integrated ocean resource surveying system, commercializing the system for use in private enterprise, securing a stable resources supply, and contributing to international cooperation.