

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 the island of gold in the Travels of Marco Polo. In fact, Japan once was the world-leading producer of gold, silver, and copper. Although these resources on land have been mined out, the seabed around the Japanese archipelago may still hold the 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.

Next-Generation
Technology for Ocean
Resources Exploration

Zipangu in the Ocean Program

Program Director

Tetsuro Urabe

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University of Tokyo
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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 experience 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 is currently executive adviser at the Mining Engineering & Training Center, professor emeritus at the University of Tokyo, and a member of Commission on the Limit of the Continental Shelf of UNCLOS.

Tetsuro Urabe

The Zipangu in the Ocean is Twelve Times Larger than the Japanese Archipelago

Fifteen million years ago, the Japanese archipelago was mostly under the ocean. Volcanic activity on the seabed pushed magma into the ocean crust, dissolving and concentrating minerals. This process is called as hydrothermal activity, and this activity produces vast amounts of mineral resources, called Kuroko deposits, on the ocean floor. This natural phenomenon has repeated several times during the long history of Japan, leaving mineral deposits within the formations of rocks we now see on land.

Japan has a more than 1000-year history of mining gold, silver, and copper. In the 8th century, Japan used gold for trade, resulting in the transfer to Japan of Buddhism and other continental cultures. Silver was the resource Japan used as a means to adopt the European cultures during the Edo period. During the Meiji Restoration, copper exports contributed to modernize Japan. However, most of Japan's gold, silver, and copper mines today have been exhausted; Japan imports nearly 100 percent of its metal from overseas. But, turning our eyes to the oceans surrounding Japan, scientists indicate the high potential of mineral resources in the continental shelf that represent more than 12 times the mass of Japan's land mass. We still don't know the total amount of resources due to the vast areas to explore. What we do know is there are many hydrothermal ore deposits and cobalt-rich manganese crusts in locations that we have already started to look at in detail.

Says Tetsuro Urabe, director of the Next-Generation Technology for Ocean Resources Exploration Program, "The Kuroko deposits for which Japan is famous—including zinc, copper, lead, gold, and silver—were all formed when most parts of the Japanese archipelago was submerged 15 million years ago. Even today, this same mechanism is creating new hydrothermal deposits in the ocean around Okinawa and Izu-Ogasawara. The ocean floor in these areas is still producing minerals today."

Creating World-Leading Survey Technologies from Japan

In high school, Dr. Urabe read a newspaper article featuring the exploitation of the manganese nodules from the deep-sea bed. That article influenced him to become a geologist, convinced of the potential of developing enormous resources for a resource-poor Japan. He selected resource geology as his major course of study at university, researching the origins of the Kuroko deposits located in northern Japan. One of the major turning points of Urabe's career was the opportunity in 1985 to join an expedition to the hydrothermal deposits discovered for the first time in the world near the island of Galapagos. He was fortunate enough to go along in the DSV Alvin deep-sea submersible to see the deposits for himself.

The hydrothermal deposits are formed on the ocean floor from venting hot water (~300°C) containing dissolved metals. The hot water, called a hydrothermal solution, precipitates minerals upon cooling that result in ore deposits. The oceans off Japan's coast are rich in these hydrothermal

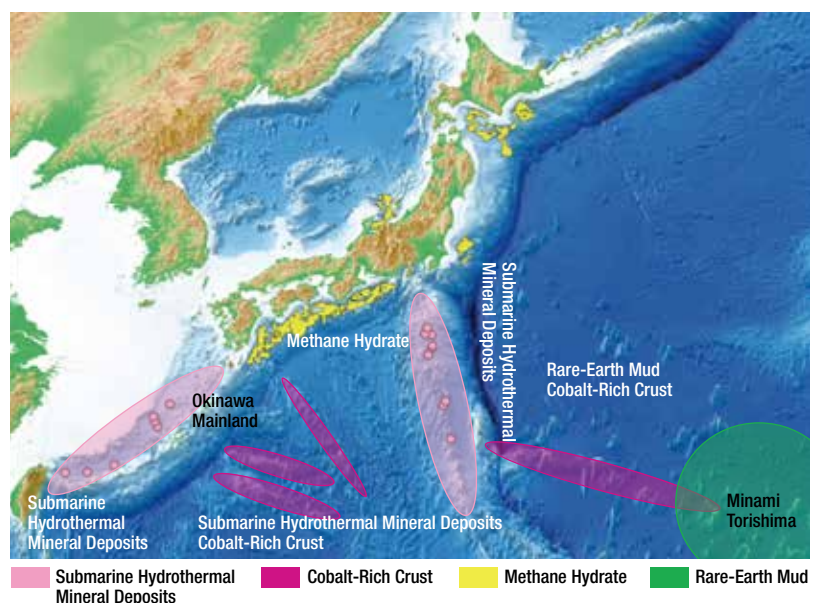
ore deposits, about thirty of which have been discovered to date. Universities and national institutes such as the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) have spent 30 years engaged in the investigative research. Cobalt-rich manganese crusts and methane hydrates (natural gas resources in which methane has combined/crystallized with water molecules) exist in abundance all over the seabed, offering an attractive target for ocean resource development.

"However," says Urabe, "at the bottom of the sea, where no sunlight or electric waves can reach, we're literally working in the dark—like using a flashlight at night to search for lost car keys. Progress has been painstakingly slow." The elemental technologies needed for ocean surveys have been developed only relatively recently. These developments include autonomous ocean survey robots equipped with new types of sensors to search the ocean floor in detail and remote-controlled robots designed to efficiently take samples from the bottom of the sea.

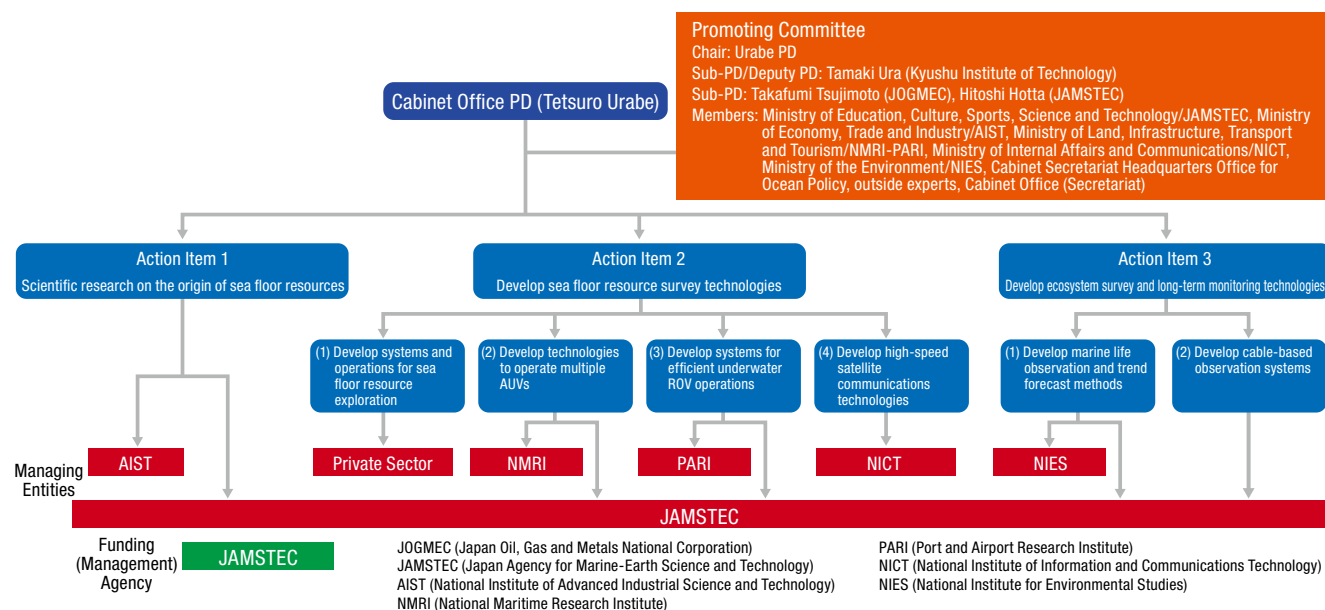
Says Urabe, "Japan is behind foreign oil companies in terms of using large ships for off-shore oil exploration, but we lead the world in ocean floor mineral exploration. This program is a quest to establish world-leading exploration technologies, bringing together an all-Japanese team of ocean research and development experts to produce comprehensive ocean resource survey technologies. From there, part of our target plan calls for transferring the results of our work to the private sector for commercialization."

Scientific Research; Development of Survey Technologies; and Environmental Protection projects

The Next-Generation Technology for Ocean Resources Exploration Program has been charged with three major projects: Scientific research related to the origins of mineral deposits; development of ocean resource exploration technologies; and development of environmental and long-term monitoring technologies. All of these tasks are being performed under the auspices of cross-ministerial coordination.



• Submarine Mineral Deposits surrounding Japan



Implementation Structure

Researching the Origins of Mineral Deposits

This research project plans to investigate the origins of mineral deposits, creating models and validating them at the bottom of the sea. This work will include collecting and analyzing sea floor mineral deposits samples such as hydrothermal ore deposits, cobalt-rich manganese crusts, and deep-sea mud, a potential future source of rare earth elements. A goal of this research is not only to create the geological model of the mechanism of mineral formation, but to also narrow down areas of promising sea floor resources.

Several geophysical, seismic, and geochemical exploration tools will be tested at the sites of known mineral deposits as a collaborative effort among several companies and research institutes. As part of the work to develop exploration technologies and methods for sea floor resources, the program intends to develop highly efficient underwater platform systems. To achieve this goal, research teams are working on both system development and mounting them to different types of autonomous underwater vehicles (AUV) and/or Remotely Operated Underwater Vehicles (ROV). The exploration technologies include 3D acoustic radar, efficient sample retrieval technologies mounted on ROVs, and, high-speed satellite communications network technologies for transmitting large volumes of survey data from AUV and ROV through floating relays or ships to land-based research hubs.



Measuring heat flow in sediment

It is crucial to develop methods and technologies to protect precious biodiversity and marine environment from the surface to the bottom of the sea before we start sea floor mining anywhere in the

world. In this program, research teams are working to model relevant ecosystems and to develop a long-term monitoring network as the third project of the program. We will develop methods to observe the microbiology and macrobiology of the ocean to develop a model that enables us to investigate inter-connectivity among ecosystems around and above the target site. This work will be done in collaboration with another national program that aims to mitigate the environmental impact of sea floor mining. A cable-based observation system will be developed for efficient and continuous monitoring of underwater work sites.

Japan to Contribute to Global Standards

A major feature of this program is the focus on reducing the environmental impact and protecting biodiversity as part of the overall development scheme—factors often postponed in the pursuit of resource development. Dr. Urabe states, “The hydrothermal sites and surrounding deep sea bed are homes to a variety of unique life forms, including microorganisms that live on chemosynthesis, surviving without oxygen near hydrothermal vents spouting water at more than 300°C. We need more investigation to know the complex interaction existing between hydrothermal ecosystems and surrounding deep sea ecosystems in order to model the environmental impacts caused by development on these ecosystems in the deep sea bed.”

Urabe continues, “The globe is connected through its oceans, and impact in the deep sea are certain to have an impact on the surface. We believe that the number one consideration in our R&D work is, in collaboration with other researchers in the world, to establish methods that incorporate ways to protect marine life and the environment. Further, the goals of this program are to create a comprehensive ocean resource survey technology package and to establish a model and protocol for environmental protection that serves as a global standard.” The Zipangu in the Ocean Program has embarked on a journey looking forward 100 years into the future.

Research and Development Topics

1. Conduct scientific research related to the origins of oceanic phenomena

Collect and analyze ocean resource samples to explain the origins of ocean floor minerals and ore deposits; narrow down potential regions with likely stores of resources.

2. Develop ocean resource survey technologies

Develop efficient ocean resource survey technologies; develop systems to make a several-fold leap ahead in seabed mineral and other information collection efficiency.

3. Develop biological survey and long-term monitoring technologies

Develop methods to forecast ecological changes based on the impact of ocean resource development; develop technologies for long-term, uninterrupted monitoring of the environment and ecology.

Exit Strategies

✓ Create ocean resource survey industries

Develop competitive ocean resource survey technologies (low cost, high efficiency, speed, safety) through industry-academy-government cooperation; transfer new survey technologies and expertise to the private sector to create new ocean resource survey industries.

✓ Establish global standards

Lead the world in efficient survey and environmental monitoring technologies. Leverage this lead to promote internationalization based on Japanese technologies and methods. Export Japanese survey systems and perform survey projects on contract with overseas entities.

We are engaged in an all-Japanese ocean resource development program to benefit future generations.

Creating a world-leading ocean resource survey industry

