

Promotion of international scientific ocean drilling research for understanding the Earth system

Request documents

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Kochi University



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【Summary】

Japan is subject to frequent and severe geological and meteorological disasters. The Japan Drilling Earth Science Consortium (J-DESC) will contribute to reducing the damages from disasters, such as large earthquakes and volcanic eruptions, by effectively utilizing the knowledge gained from scientific ocean drilling. J-DESC is poised to lead the world in scientific ocean drilling and advance the state of geoscience. In particular, ocean drilling is essential for understanding the world climate system and addressing modern and future climatic change, which is an urgent issue in the Anthropocene world.

The scientific goals of J-DESC are consistent with the international long-term vision of the “2050 Science Framework: Exploring Earth by Scientific Ocean Drilling”. Given Japan's international responsibilities as a maritime nation, J-DESC will take the leadership role in the international scientific ocean drilling program. In furtherance of that endeavor, we stress the importance of the continuous operation of the deep-sea drilling vessel *Chikyu* and the Kochi Core Center.

【Body of Letter】

International scientific ocean drilling programs have accumulated valuable scientific results for more than half a century. For example, after the 2011 Great East Japan Earthquake, considered to be a thousand-year event, frictional heat associated with the large and sudden movement of the Earth's crust was directly observed by drilling in the Japan Trench under the International Ocean Discovery Program (IODP). Scientific ocean drilling programs have achieved many groundbreaking scientific discoveries, including deep understanding of long-term climate change, presence of life at great depths beneath the seafloor, and the discovery and assessment of large-scale energy and mineral resources. These have been closely linked to vital issues identified by the Japanese government: earthquake/volcanic disaster, national land conservation, environmental change, and resource security.

In 2020, the long-term vision “2050 Science Framework” was formulated in collaboration with more than 650 researchers around the world. The framework includes strategies that open up new frontiers in association with technological innovation. In their contributions to the framework, Japanese researchers have noted the importance of urgent issues for humankind, such as huge earthquakes, catastrophic eruptions, and runaway climate change due to the greenhouse effect.

Since the IODP started in 2003 and the deep-sea scientific drilling vessel *Chikyu* joined the program in 2005, Japan has made indispensable contributions to the world's scientific ocean drilling program. These contributions have relied on the development of innovations in riser drilling, advanced ship maneuvering technology, excavation and logging technology, installation of long-term observation equipment in boreholes, high-quality core sampling, and support for the storage and analysis of cores. As Japan is a maritime nation located in Asia, the Japanese scientific ocean drilling community has become aware of its special role in supporting the international deep-sea scientific drilling program.

There will be many important and urgent issues in our future. The scientific evidence suggests that there is a 70-80% probability of a great (magnitude 8+) earthquake occurring within 30 years in the Nankai Trough. Disasters like this can be effectively mitigated by monitoring the condition of the Earth's crust, using the holes drilled by *Chikyu*, in collaboration with related scientific, engineering, and social communities, can provide information to help mitigation of damage from such disasters. Also menacing in the Japanese islands are many active volcanoes, including several submarine volcanoes, that may be capable of catastrophic giant eruptions. “Carbon Neutral 2050” states that another urgent issue for modern society is understanding the quantitative mechanisms of climate change on the scale of less than a century. Sediment samples from previous major geological events recovered by ocean drilling will provide empirical support for the recommendations that science

must offer for human society to adapt and thrive in response to climatic change. Furthermore, we would like to promote “dream-goals” at the frontier of science, for example, exploring the ultradeep biosphere and reaching the mantle of the Earth.

The world at present exists in a new period of time in Earth history when human activity has a significant impact on the planet’s climate and ecosystems, a time widely known as the Anthropocene epoch. Japan, in addition, faces the certain prospect of severe geological disasters that have occurred repeatedly in historic times. Under these circumstances, we believe that scientific ocean drilling is extremely important for the sustainable development of civilization and the resilience of our country. And as a major maritime nation, Japan accepts a special obligation to contribute in this way to the development of valuable knowledge and intellectual property for the benefit of all humankind.

Specific important items for future scientific drilling

(Background, achievements, and future prospects)

(1) Research on subduction zones (prevention and mitigation of earthquake and tsunami disasters)

The occurrence of great Nankai Trough earthquakes can be estimated from historical documents and data from geological observations. Drilling by *Chikyu* provided the first evidence that high-speed slip during subduction-zone earthquakes can extend all the way up to the trench. The Japanese government's Central Disaster Prevention Council, recognizing this important evidence, has announced that the maximum magnitude of the next major earthquake may reach magnitude 9, many times more powerful than previously thought. By detecting “slow slip earthquakes”, under study as precursors of huge earthquakes, and understanding the state of sticking on the surfaces of earthquake faults, we can contribute to preventing or mitigating disasters through increased observations by instruments installed in drill holes.

(2) Research on volcanic eruptions (mitigation of volcanic super-eruption disasters)

Great eruptions that cause sizable damage to Japanese society have a 1% probability of occurring in the next 100 years. In order to reduce the expected damage from such an event, we will elucidate the mechanism of these eruptions by improved understanding of the underground structure of volcanoes and by more intensive monitoring and prediction of the status of threatening volcanoes. One important target is the Kikai submarine caldera, where a supergiant eruption occurred about 7300 years ago.

(3) Climate change research (contributions to a decarbonized society)

Climate and environmental change in the Anthropocene will be comparable to previous significant events in geological history. The speed of change in the modern state of global climate is 10-100 times faster than natural rates of environmental change. At the time boundary of the Paleocene and Eocene geological epochs, approximately 55 million years ago, a great release of carbon dioxide by decomposition of methane hydrate led to severe ocean acidification and resulted in the extinction of half of the species of deep-sea calcareous foraminifera. By deepening our understanding of this and other geological events through scientific drilling, we can better evaluate countermeasures for the future in the Anthropocene.

4) Research on life and material science under the seafloor

There is great scientific value in drilling still deeper. *Chikyu* has recovered evidence of active life in sediment 2,500 m below the seafloor. Also, penetrating the oceanic crust to the underlying mantle has been a dream target since the dawn of scientific drilling. By comprehensively understanding the limits of life and the Earth's material cycles of water and carbon on the surface and in the interior, we can contribute to the creation of a human society that is fundamentally compatible with the long-term processes that maintain the Earth.

(5) Advancement of vessel operation and drilling-related technologies (disaster prevention through borehole monitoring)

Chikyu has demonstrated the world's most advanced drilling technology and has produced many scientific results, including probing the limits of the existence of life. *Chikyu* has successfully operated in water depths of 7,000 m at the Japan Trench and accomplished the world's deepest penetration (3,200 m) at the Nankai Trough while maintaining a fixed position even in strong currents of 5 knots (2.6 m/s). *Chikyu* is well equipped to expand and improve the long-term borehole monitoring system and thus contribute to the mitigation of large earthquakes in the near future.