

Direct sampling and measurement at deep crust through scientific ocean drilling

*Shin'ichi Kuramoto¹

1. Japan Agency for Marine-Earth Science and Technology

The Kola superdeep borehole is well known as the deepest scientific drilled hole on our planet located at Kola peninsula, Russia. It took about 20 years and reached approximately 12km deep in the crust. High temperature and pressure refused the drilling operation. KTB drilling project reached about 9km deep in Germany in 1994. Both projects have set a monumental milestone in scientific onshore drilling, and also showed the limitation of drilling technology at the same time. The technological difficulties are caused by borehole instability and high temperature even using drilling fluid circulation. However, ocean drilling is much difficult than onshore drilling. Because ocean drilling is conducting unstable conditions using a floating platform/vessel. Therefore, vertical drilling depth may have some limitations around 10km deep and temperature may lower than 300°C in general.

The scientific ocean drilling vessel Chikyu has been started scientific ocean drilling operation since 2005 and reached about 3.3km below the seafloor in 2019. It is the current world record of the deepest borehole as scientific ocean drilling conducted at the Nankai accretionary wedge. Achieving mantle drilling by “Chikyu” that has never reached humanity is her next challenge. In addition, a mantle observation and experiment system using boreholes will be planned. The Mantle drilling will provide a fundamental understanding of the Earth system, such as the compositional distribution from the oceanic crust to the upper mantle, rheology, life and chemical evolution processes, and the behavior of thermal and environmental variables. Deepwater and deep penetration technology are under development. We are discussing the first target of Mantle drill at off Hawaii where relatively low temperature and reachable depth to the upper-most mantle by ocean drilling. Scientific drilling cut core samples and measure and/or monitor physical/chemical properties in the borehole. That is the only way to do material science and in-situ high-resolution measurements and monitoring, and it is the uniqueness of ocean drilling. Chikyu has been completed relatively shallow depth drilling campaigns to understand the mechanism of large earthquakes and Tsunamis, the deep life under extreme conditions and the marine mineral resources so far. The scientific results will be presented in addition to future technology developments for the deep drilling into our planet.

Keywords: Ocean Drilling, Chikyu, Mantle Drilling, Borehole Monitoring, Borehole Experiment