

## MoHole to Mantle: Project M2M

Susumu Umino<sup>1\*</sup>, Scientific Party M2M<sup>2</sup>

<sup>1</sup>Department of Earth Sciences, Kanazawa University, <sup>2</sup>International MoHole Science Group

Sampling a complete section of crust and shallow mantle was the original motivation for scientific ocean drilling, since "Project Mohole (1958-1966)". With development of the Japanese riser-drilling vessel Chikyu, the aspirations of generations of Earth scientists to drill completely through the oceanic crust, and through the Moho into the upper mantle, have moved into the realm of technical feasibility.

Although only 20% of modern mid-ocean ridges are fast-spreading (>80 mm/yr), more than 50% of the present day seafloor (~30% of Earth's surface), and the great majority of crust subducted into the mantle during the past 200 M.yr was produced at fast spreading ridges. As a plate moves away from the ridge, seawater entering through fractures deep into the crust and the uppermost mantle is heated to become reactive hydrothermal fluid that hydrates and exchanges materials with the rocks and returns to the ocean. While being altered by hydrothermal fluids, the crust and mantle become extensive habitats for microorganisms. Water recycled into the mantle by the subduction of hydrated plate reduces the mantle viscosity and melting temperature, allowing continuous mantle convection and plate tectonics, providing the key reason why Earth is different from the other terrestrial planets in the solar system (e.g. Venus), and is a key ingredient for the formation of arcs and continents.

Because of the relatively uniform architecture of fast-spreading plates, understanding of mantle and crust genesis and evolution at one site can be extrapolated to a significant portion of Earth's surface with some confidence. Importantly, we have well developed theoretical models of contrasting styles of magmatic accretion at intermediate to fast-spreading ridges, which can be tested using samples recovered from cored sections of ocean basement. Therefore, the goal of the currently proposed project "MoHole to Mantle (M2M)" is to sample, as continuously as feasible, the entire crust, Moho and shallow mantle peridotites, in oceanic crust and mantle formed at a fast-spreading rate. Drilled cores will be used to test models of crustal accretion and melt movement, to resolve the geometry and intensity of hydrothermal circulation, and to document the limits and activity of the deep microbial biosphere. After completion of drilling, coring, and logging, the MoHole will be used for experiments, including vertical seismic profiles, and long-term geophysical and microbiological monitoring. Instrumenting the MoHole will eventually be a key, last-stage goal. Hence, the sub-sea equipment and borehole should be constructed to accommodate observatory science (e.g., fluid monitoring, and microbiology incubation experiments).

Based on the scientific requirements and technological constraints, three regions have been identified as potential MoHole project areas: 1) Cocos Plate; 2) Off Southern and Baja California (including the original site of project Mohole); and, 3) North of Hawaii.

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