Mission Moho: Drilling Through the Oceanic Crust to the Mantle

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Beyond our view, but no longer beyond our dreams, the Mohorovičić discontinuity (Moho) is a seismic boundary assumed to represent the frontier between Earth's crust and mantle. The goal of Mission Moho is to drill to and beyond this frontier for the very first time and to determine its nature using *in situ* sampling and downhole data collection. Deep drilling improves our understanding of the creation of ocean crust and how it repaves the ocean's basins every 100 to 200 million years. Using new technologies, Mission Moho will finally realize the very goal that inspired the start of scientific ocean drilling over 45 years ago.

A full workshop report is available at: www.iodp.org

The Mission Moho workshop, co-sponsored by IODP-MI, JOI, Ridge 2000, and InterRidge, was held September 7-9, 2006 in Portland, Oregon. Its purpose was to prioritize research objectives relating to formation and evolution of the ocean lithosphere that could be addressed by ocean drilling.

A clear consensus emerged at the workshop. Drilling a single deep, full-crustal-penetration hole in fast-spreading crust—through the Moho into the uppermost mantle—is the first priority and Mission Moho expeditions should pursue this goal as soon as feasible. With upper mantle samples in hand, we can define (in at least one place) the geological meaning of the Moho and address fundamental questions about mantle melt migration, mantle composition and deformation, and lithosphere cooling rates. Ocean crust produced at fast-spreading ridges appears to be relatively homogeneous. In contrast, crust created at slow-spreading ridges is spatially heterogeneous. The majority of crust subducted back into the mantle during the last 200 million years formed at fast-spreading ridges. Thus, understanding accretion processes at one fast-spread site might be extrapolated to describe a significant portion of Earth's surface.

The workshop participants also recognized that the primary Mission Moho objective of full crustal penetration must be supplemented by studies of spatial and temporal variability, especially at slower spreading rates, to fully understand ocean lithosphere formation. For example, slow-spread crust often includes fault-emplaced, serpentinized mantle rocks. Drilling through serpentinized crust down to fresh peridotite will help test competing hypotheses on the nature of the Moho and the behavior of seismic waves in the crust. A vital goal of deep-drilling through the peridotite-serpentinite transition is to understand the role of serpentinization in modifying the seismic signature of the crust and the transition to typical mantle velocities.

In a special panel, several drilling engineers joined experienced scientists to discuss technological requirements for achieving Mission Moho objectives. In addition to deeper drilling, desired developments include improved core recovery (balanced against maintaining satisfactory penetration rates), drilling and logging tools able to withstand temperatures greater than 200°C, and the ability to obtain oriented cores. Penetrating the entire ocean crust will require the *Chikyu*'s riser drilling technology. However, all potential deep-penetration sites are in deep water (reflecting relatively thin crust) and require a technically challenging modification of the riser, identified as a priority by the Japanese government, to extend its present 2500-meter maximum depth capability to 4000-4500 meters. Even with enhanced deep-water access, there are only a limited number of potential deep drilling sites that are old (and cooled) enough to be viable drilling targets but shallow enough to reach with riser capability.

Site 1256 in the eastern Equatorial Pacific was identified as the currently best-known potential location for deep penetration into fast-spreading crust. However, alternative sites must be identified and thoroughly evaluated before a final "Moho" site is identified. In the near term, riserless drilling should be used to deepen Hole 1256D as far as reasonably possible, to investigate one or more alternate sites, and then to prepare a cased hole for subsequent riser drilling at the selected deep-penetration site.

Because of the number of holes required for multi-hole transects, important issues such as crustal aging and evolution cannot be included as essential elements of a reasonably "sized" Mission Moho. However, workshop participants recognized that drilling strategies designed to increase understanding of the evolution of the oceanic crust remain fundamental scientific goals for IODP as a whole.

The Authors

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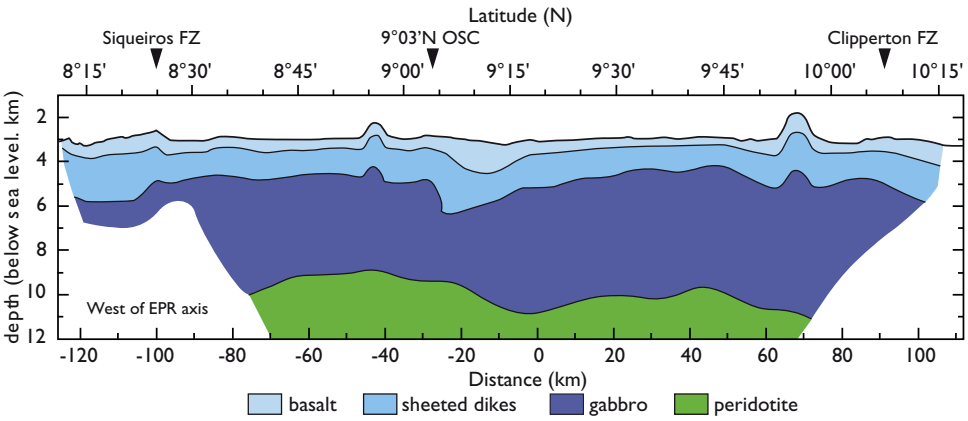

Lithostratigraphy of the fast-spreading East Pacific Rise crust, interpreted from a ridge-parallel wide-angle seismic refraction profile between 8°N and 10°N, immediately west of the ridge axis. (After Canales et al., 2003, Geophysical Journal International, *152(3):766-794)*