Planning the Drilling of the Samail Ophiolite in Oman

Workshop on Scientific Drilling in the Samail Ophiolite; Palisades, New York, 13–17 September 2012

PAGE 32

For more than a decade, plans have been afoot for scientific drilling in the Samail ophiolite in Oman. The ophiolite is a thrust sheet of oceanic crust and shallow mantle, emplaced on the Arabian continental margin 95 to 70 million years ago, which has tilted and eroded so that one can now observe sections extending from 0 to more than 15 kilometers below the paleo-seafloor. Plans to study formation and evolution of the ophiolite have been spurred by recent interest in ongoing alteration and weathering, the associated sub-surface biosphere, and the possibility of carbon storage via accelerated mineral carbonation.

A preliminary proposal led to the Workshop on Scientific Drilling in the Samail ophiolite, supported by the International Continental Drilling Program (ICDP), the Sloan Foundation's Deep Carbon Observatory, and the U.S. National Science Foundation. There were 77 attendees from 11 countries, including 20 early-career scientists.

Keynote speakers outlined hypotheses and areas of frontier exploration to be addressed via drilling. These include mantle upwelling (passive vs. buoyancy-driven); mantle melt transport (diffuse, porous conduits, fracture flow); lower crustal accretion and cooling (gabbro glaciers vs. sheeted sills, active hydrothermal convection in dikes and lavas vs. the entire crust); microseismicity during weathering; rate of ongoing alteration; and density and habitat of subsurface microbial communities. Additional keynotes covered geological logging of core, geophysical logging in boreholes, and data management.

Breakout groups discussed science themes, designed ideal projects to address these themes and then considered practical constraints. It was agreed that the project would focus on studies relevant to global processes. Core must be logged to the Integrated Ocean Drilling Program (IODP) standard by dedicated science teams, with extensive geophysical logging and experiments in boreholes. Individual holes will be limited to 600 meters in depth, using local drilling expertise. After diamond drilling with continuous coring, some holes will be widened or paralleled by rotary-drilled holes for geophysical logging.

Given an estimate of US$250/meter for continuous coring, and about half that for rotary drilling, the three final breakout groups were charged with designing a "Phase I" program costing US$2 million. All recommended similar plans. Despite interest in the more complex northern ophiolite massifs, all focused on drilling the simpler southern massifs in Phase I. To investigate active peridotite weathering, all favored multiple holes of moderate length in a peridotite catchment hosting alkaline springs, to locate reaction zones where magnesium bicarbonate ($MgHCO_3$) groundwater is transformed to alkaline water rich in calcium hydroxide (CaOH). A few holes would later be deepened and widened. All groups prioritized 600-meter holes through the dike-gabbro transition, crust-mantle transition, and basal thrust, and within selected parts of more homogeneous lower crustal gabbro and mantle sections, with some to be widened for logging. Several could be supplemented by shorter holes to investigate lateral heterogeneity.

The high level of participation, consensus, and enthusiasm at the workshop will facilitate preparation of a full proposal, to be submitted to the ICDP in mid-January 2013. In turn, ICDP funding (partial funding of drilling costs) will encourage other agencies and foundations to support the balance of drilling costs plus scientific operations.

More information can be found at http://www.icdp-online.org and http://www.ldeo.columbia.edu/gpg/projects/icdp-workshop-oman-drilling-project.

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