



Drilling at Atlantis massif oceanic core complex. IODP expeditions 304 and 305

IODP 304/305 Shipboard Scientific Party

dblackman@ucsd.edu, benoit.ildefonse@dstu.univ-montp2.fr, bjohn@uwyo.edu,
macleod@cf.ac.uk, miller@iodp.tamu.edu, ohara@jodc.go.jp

Seafloor drilling on Expeditions 304 and 305 of the Integrated Ocean Drilling Program (IODP) was designed to investigate the processes that control formation of oceanic core complexes as well as the exposure of ultramafic rocks in very young oceanic lithosphere. Atlantis Massif is part of a 0.5-2 Myr old oceanic core complex on the western rift flank of the Mid-Atlantic Ridge, 30°N. The domal, corrugated surface of the massif is interpreted as a detachment fault exposed at the seafloor. The domal core forms the footwall to the detachment fault system, the adjacent volcanic block to the east is inferred to be a hangingwall block. IODP drilling and logging was mainly focused on a footwall site within the central dome of Atlantis Massif. Recovery rates in Hole U1309D to date are very good, average recovery for the hole is 64% but below the top few tens of meters rates are almost 70%. In the 400 m penetrated during Expedition 304 (Nov-Dec 2004), a sequence of gabbroic intrusions were distinguished based on variation in olivine abundance, the presence of intercumulus phases, the extent of late magmatic diking, the occurrence of oxide gabbro, and cross-cutting relations. The boundaries between these lithologic zones often coincide with structurally-defined boundaries, based on recovered fault rock and logging data. Overall, the composition of the gabbroic rocks is amongst the most primitive known along the Mid-Atlantic Ridge. Several meter-scale intervals of serpentinized peridotite were recovered, comprising <5% of the total recovery at Hole U1309D. A few of these ultramafic intervals may represent residual mantle harzburgite but many have low Mg number (88.9-89.6) and cumulate textures. Subhorizontal diabase sheets cut through the upper 130 m of the footwall; none are found below this depth in Hole U1309D.

Alteration mineral assemblages in core recovered from Hole U1309D record cooling of mafic plutonic rocks from magmatic conditions (>1000°C) to less than 100°C (ze-

olite facies). Most of the upper 400 m displays a range of superposed metamorphic conditions, but no single interval has undergone the entire cooling history of the site. Much of the core recovered from 350-400 meters below seafloor (mbsf) displays little or no alteration. The most extensive metamorphic event recorded is static hydration at and below greenschist facies. Localized fluid flow led to intense alteration associated with thin (less than tens of centimeters thick) zones of brecciation above 60 mbsf, and with late felsic intrusions below about 160 mbsf. This alteration episode occurred under conditions similar to the static alteration but generally appears to postdate it. In ultramafic rocks this later alteration episode produced talc-tremolite veins.

Shallow penetration holes through the sediment carapace on the footwall and into basement provided fossiliferous ooze, hyaloclasite, and fragments of fault rock and metabasalt. These samples provide initial confirmation that the corrugated dome represents an exposed detachment fault.

Deformation is localized on a small number of narrow, low-temperature fault zones. Several aspects of the recovered rock change across these faulted zones: the nature of the intrusive sequence and its alteration history, the intensity of deformation and veining, and the average paleomagnetic inclination angle. The rocks do not display widespread, high-temperature shear zones. Systematic rotation of the footwall, such as predicted by the rolling hinge model, is not recorded in core recovered from the upper 400 m.

Expedition 305, Jan-Feb 2005, aims to deepen Hole U1309D with the goal of obtaining fresh peridotite that would correspond to previously measured seismic velocities of ~ 8 km/s. Combined seismic reflection and refraction data suggest that this transition in rock type/alteration properties should be intersected by drilling 500-700 meters below seafloor. These depths are well within expected drilling capabilities for Expedition 305 so we intend to report on initial findings from this interval at the meeting.