

Drilling at Atlantis Massif oceanic core complex: IODP Expeditions 304/305

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Atlantis Massif was drilled during the Integrated Ocean Drilling Program (IODP) Expeditions 304 and 305 to investigate the formation mechanism of oceanic core complex as well as the nature and evolution of oceanic lithosphere at slow-spreading environment. The massif is a 0.5-2 myr old oceanic core complex on the inside-corner high at the intersection of Atlantis fracture zone and Mid-Atlantic Ridge at 30 degrees north. The domal, corrugated surface of the massif is interpreted to be 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 interpreted to be a hangingwall block. Most of our operation was devoted to a footwall site within the central dome of Atlantis Massif.

Two drill holes at the footwall site (Holes U1309B and U1309D) penetrated a long gabbroic section, providing core that documents the tectono-magmatic history of footwall emplacement associated with detachment faulting. We deepened Hole U1309D throughout the two expeditions to ~ 1400 meters below seafloor (mbsf). The cored lithology was mostly various type of gabbroic suites, ranging from troctolite to gabbro to gabbro norite to oxide gabbro, the composition of these rocks is amongst the most primitive known along the Mid-Atlantic Ridge. The boundaries of the lithologic zones for each suite often coincide with structurally-defined boundaries. Several meter-scale intervals of serpentinitized peridotite were also recovered, comprising only less than 1 % of the total recovery. A few of these ultramafic intervals may represent residual mantle harzburgite but many are interpreted to be cumulates. Diabase and basalt occur rarely and most are of tholeiitic composition. Alteration mineral assemblages in cores recovered from Hole U1309D record cooling of mafic plutonic suites from magmatic conditions to less than 100 degrees Celsius (zeolite facies). The lack of widespread deformation documented at Hole U1309D suggests that strain is localized on a small number of very localized zones. A monotonic decrease in deformation intensity and/or systematic rotation of the footwall, such as predicted by the rolling hinge model for exhumation of core complex, is not recorded in the recovered core.

The main result from the limited recovery at hanging wall sites (Sites U1310 and U1311) is that relatively fresh basalt occurs near the boundary of the central dome and adjacent volcanic block. The composition of these basalts is primitive tholeiite.