Residual Peridotites from the Oceanic Core Complex: IODP Exp.304/305 at the Atlantis Massif, MAR 30N

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The Atlantis Massif is a 1.5 - 2 Myr old oceanic core complex forming on the inside-corner high at the intersection of the Atlantis Fracture Zone and Mid-Atlantic Ridge (MAR) 30N (Blackman et al., 2006). The domal, corrugated surface of the massif is interpreted as a long-lived, low-angle normal or detachment fault exposed at the seafloor. High density mantle rocks invoked to explain observed gravity anomalies and high seismic velocities inferred from seismic analysis were expected to occur less than 1 km below the seafloor (e.g., Cann et al., 1997). Integrated Ocean Drilling Program (IODP) Expeditions (Exp.) 304/305 successfully penetrated and recovered long mafic-ultramafic rock sections from two holes, Holes U1309B and U1309D, at and below the detachment fault (Site 304/305-U1309). Hole U1309B was deepened to 101.8 m below the sea floor (mbsf) with an average recovery rate of 46%. The Hole U1309D was deepened to 1415.5 mbsf with an average recovery rate of 74.8%. Cores from both holes dominantly consist of gabbroic rocks, such as 49% for Hole U1309B and 85% for Hole U1309D. Serpentinized peridotites were rarely recovered from both Holes U1309B (3%) and U1309D (0.3%) (Blackman et al., 2006). We report petrological and geochemical features of the peridotites from the Atlantis Massif, and discuss their origin.

A single interval composed of spinel harzburgite was collected at 58 mbsf in Hole U1309B. The harzburgites exhibit protogranular texture with deformed olivine and orthopyroxene. The interval is in direct contact with the coarse-grained gabbro interval above, but the lower boundary was not recovered. Based on the modal composition and mineral chemistry, the harzburgites probably correspond to residual materials of upper mantle origin. However, REE compositions of clinopyroxene, which are systematically changed within the harzburgite interval, suggest that original features of the residual peridotite were modified by injected melt forming the upper gabbro. In the harzburgite far from the contact with the gabbro, clinopyroxenes almost avoid effects of the melt and have a low MREE/HREE ratio with low HREE abundances and slight enrichment of LREE (e.g., $(Gd/Yb)_N$ = 0.14, $(Ce/Yb)_N$ = 0.45, Yb_N = 2). The clinopyroxene compositions are similar to those of the most depleted abyssal peridotites (e.g., Hellebrand et al., 2002). The LREE/HREE ratio of clinopyroxene increases toward the contact, and the REE abundances are higher (e.g., Yb_N = 5, Ce_N = 1.6) near the contact. Several short peridotite intervals surrounded by gabbros occur at different depths of a limited zone (61 - 224 mbsf) in Hole U1309D. The intervals consist of lherzolite, wehrlite and dunite. The peridotites contain various amounts of interstitial plagioclase indicating melt impregnation. The mineralogical data imply that the peridotites primarily have various origins, such as magmatic (cumulate) or residual (restite). The genetic variations of the peridotites recovered from the Atlantis Massif suggest that both the lower crust and mantle were intruded and fragmented by the melt forming the gabbro beneath the segment end of the MAR.

References: Blackman et al. (2006) IODP304/305 Exp. Rep.; Cann et al. (1997) Nature 385, 329; Hellebrand et al. (2002) J. Petrol. 43, 2305.