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Isotopic constraints on seawater-rock interaction and redox conditions of the gabbroic-dominated IODP Hole 1309D, Atlantis Massif (30N, MAR)

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Drilling of the Atlantis Massif, an oceanic core complex (OCC) located at 30˚N along the Mid-Atlantic Ridge, during the two consecutive Integrated Ocean Drilling Program (IODP) Expeditions 304 and 305, provided a unique opportunity to study lateral and vertical variations in composition, fluid fluxes, serpentinization and alteration conditions within the massif. The main hole (Hole 1309D) was drilled to 1415 mbsf and consists predominantly of various types of gabbroic rocks (92%, from troctolites to oxide gabbros) intercalated with minor ultramafic rocks (5.7%, serpentinized peridotites and olivine-rich troctolites). A combination of radiogenic (Sr and Nd) and stable (S and C) isotope analyses have been performed on a set of ultramafic and gabbroic rocks selected at regular intervals along Hole 1309D in order to monitor the downhole variations in fluid fluxes and redox conditions. At the top of the hole, low to moderate water-rock ratios (2 to 39) are indicated by Sr-isotope compositions close to seawater values related to the serpentinization of the ultramafic rocks. Downhole, relatively homogeneous mantle-like Sr- and Nd-isotope compositions of gabbroic rocks and olivine-rich troctolites attest to limited seawater-rock interaction. The gabbroic-dominated oceanic crust at the central dome is characterized by Ni-rich and low-sulfur sulfide assemblages reflecting reducing conditions and limited seawater-rock interac-

tion. The high total sulfide contents, high $\delta^{34}S_{sulfide}$ values, and low $\delta^{34}S_{sulfate}$ values of the serpentinites at the top of the hole reflect the addition of sulfur by thermochemical sulfate reduction and minor sulfide oxidation. Downhole, local variations from mantle-like sulfur isotope compositions in the gabbroic section are related either to magmatic variability or to interaction with fluids channeled in fault zones. The occurrence of an anhydrite vein and Fe-Ni sulfides in the olivine-rich troctolites provide temperature constraints ($>$150-200°C) of the late circulating fluids at depth. Limited seawater circulation at the central dome is also indicated by the presence of low amount of organic compounds, mainly present as isoprenoids (pristane, phytane) and n-alkanes (up to C_{40}), reflecting a marine organic input likely through cracks and vein networks.