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Serpentinization, carbonation and H_2 production at Atlantis Massif (MAR 30°N): Preliminary geochemical results from IODP Expedition 399

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IODP Expedition 399 has allowed drilling into the feeding system of the Lost City Hydrothermal Field (LCHF) on the Mid-Atlantic Ridge (Site U1601, Atlantis Massif 30°N MAR). The LCHF is an exceptional site producing hydrogen-rich alkaline fluids that harbor unique chemolithoautotrophic microorganisms. These fluids are interpreted as derivatives of the serpentinization of underlying mantle peridotites.

Hole U1601C is the deepest hole ever drilled into mantle rocks (1268 m deep) with an exceptional recovery rate (up to 100% at certain levels). The recovered cores are primarily composed of variably serpentinized harzburgites interspersed with gabbros, especially below 950 m [1]. These rocks are locally fractured, forming serpentine-rich zones ± carbonates. During Expedition 399, 260 rock samples were collected at Site 1601 for mineralogical characterization and bulk rock geochemical analyses. 61 samples were selected as representative of the background lithology, and 199 samples were recovered from fractured and reacted areas for combined geochemical and microbiological studies. The fluids from the cores and along the borehole were also collected for analyses.

We present here preliminary results of the bulk rock geochemical study of Site U1601 variously altered mantle rocks and gabbros. Harzburgites and dunites have refractory and depleted compositions, overlapping that of the peridotites previously drilled along the Mid-Atlantic Ridge (ODP Leg 153 and 209). Gabbros have the same composition as previously drilled Atlantis Massif gabbros (IODP Site U1309). Downhole spikes in U (depths < 200 m) and C (whole hole) compositions of mantle rocks suggest localized fluid fluxes and variable reaction pathways, although serpentinization appears to be pervasive, and systematic correlation to faults and/or gabbroic bodies remains challenging. We will discuss the new insights these data provide about the conditions and mechanisms driving serpentinization and associated reactions (redox, carbon mineralization, ...) in the plumbing system of hydrogen-rich hydrothermal vents.

[1] Lissenberg C.J. et al., 2024. A long section of serpentinized depleted mantle peridotite. Science 385,623-629, doi:10.1126/science.adp1058