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Origin of olivine-rich gabbroic rocks from the Atlantis Massif (MAR 30˚N, IODP Hole U1309D) : petrostructural and geochemical study

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IODP Hole U1309D sampled the Atlantis Massif (western flank of MAR 30˚N; IODP Expeditions 304 and 305), an oceanic core complex, through an exposed detachment fault. Core U1309D is mostly made of gabbroic rocks where olivine-rich troctolites (ol $>$70%) represent 5.4% of the recovered rocks. These troctolites are the most primitive gabbroic rocks ever drilled at mid-ocean ridges. We present a petrostructural (EBSD) and geochemical (EPMA, LA-ICPMS) study of olivine-rich troctolites and associated gabbros coming from four olivine-rich zones in Core U1309D.

Olivine-rich troctolites display poikilitic textures; olivine ranges from coarse-grained subhedral crystals to medium-grained rounded crystals, included in large clinopyroxene and plagioclase poikiloblasts. Clinopyroxene has primitive compositions (Mg# = 85-89.5). Both clinopyroxene and plagioclase are not deformed, depleted in trace element (e.g., Yb $<$17.3 and $<$0.15 x chondrites, respectively), and are in equilibrium with MORB melts.

Olivine-rich troctolites show weak to moderate olivine crystallographic preferred orientations, indicating deformation by dislocation creep with activation of the high-temperature, (010) [100] and (001) [100] slip systems. Analysis of misorientation angle distribution in olivine reveals well-developed (100) subgrain boundaries in some crystals. Olivine is characterized by highly variable compositions (Mg# from 82 to 88 and Ni from 1479 to 2294 ppm) displaying a linear correlation, atypical of cumulate trends.

These observations suggest a complex crystallization history in an open system with

percolation of MORB-type melts in a previously deformed olivine matrix. It probably occurs in a zone with large magmatic transfer and accumulation in which the impregnation by plagioclase and clinopyroxene occurred during the last stages of olivine-rich troctolite formation. Prior to melt impregnation, Hole U1309D olivine-rich troctolites could have been either (i) ultrabasic cumulates with a very primitive character suggesting very magnesian source melts, so far unknown at mid-ocean ridges, or (ii) mantle peridotites. We favour an inherited mantle origin, the mantle composition being strongly modified by interaction with and impregnation by large volumes by MORB-type melt.