Record of segregated magma modified by reactive porous flow in ultraslow-spreading oceanic crust

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Oceanic Core Complexes (OCCs) at slow- to ultraslow-spreading ridges provide a unique access to lower sections of the modern oceanic crust. *In situ* sampling of OCC reveal that the slow-spreading oceanic crust is constructed by a complex history of multiple and successive magma injections. In order to better quantify the processes that contribute to the building of ultraslow-spreading oceanic crust, we investigate olivine gabbro recovered during IODP Expedition 360 in the 810 m deep Hole U1473A at the Atlantis Bank (SWIR, 57°E).

U1473A olivine gabbros display intense grain size variability throughout the Hole from fine- to coarse-grained with sharp (rare) to irregular contacts (common). At irregular contacts, the grain boundaries of coarser grained plagioclase [Plg] and clinopyroxene [Cpx] are resorbed against the finer grained olivine gabbros, suggesting partial dissolution by a melt that crystallized the fine-grained material. Relicts of partially dissolved coarse-grained Plg are also embayed in fine-grained domains. Minerals chemical composition vary away from contacts between different grain sizes. Coarser grained minerals have more primitive composition ($Mg\#_{Olivine[Ol]}$ = 72-74 mol%; $Mg\#_{Cpx}$ = 80-86 mol%) compared to the finer grained ($Mg\#_{Ol}$ = 71-72 mol%; $Mg\#_{Cpx}$ = 78-80 mol%). Coarse-grained Cpx have primitive cores and more evolved rims, which are in chemical equilibrium with fine-grained. Cpx display significant enrichments in the most incompatible elements (from Zr = 10 ppm and Ce/Y = 0.2 in coarse-crystal cores, to Zr = 100 ppm and Ce/Y = 0.5 in fine-grained), associated to reactive porous flow. Fine-grained Cpx show the most significant enrichments in LREE, suggesting crystallization of segregated reacted melt.

Structural, microstructural and chemical constraints point to a multi-process origin of these grain size variations: (i) crystallization of primitive coarse-grained olivine gabbro mush, (ii) reactive porous flow driven by a MORB-type melt migrating and partially assimilating the pre-existing coarse-grained matrix, (iii) segregation of the reacted melt, which crystallizes the fine-grained olivine gabbro. The widespread occurrence of grain size variations in olivine gabbro from IODP Hole U1473A indicates that melt migration and reactive porous flow are primary and fundamental processes in the formation of the ultraslow-spreading oceanic crust.