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Microstructures of olivine gabbros from the Atlantis Bank OCC (57°E Southwest Indian Ridge) reveal compaction-driven melts extraction and accumulation in ultraslow-spread oceanic crust.

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Slow- to ultraslow- spreading oceanic crust is constructed by a complex magma injections history that requires at least partial extraction of melts to ultimately form the gabbroic sequences. The processes aiding melt migration and melt collection and extraction remain poorly documented. At the Atlantis Bank Oceanic Core Complex (OCC) along the Southwest Indian Ridge, the exposed gabbroic sequence records protracted magmatism during continuous uplift and crystal-plastic deformation. We couple geochemical composition of mineral phases with microstructures and plagioclase Crystallographic Preferred Orientations (CPO) of olivine gabbros lacking evidence for exhumation-related crystal-plastic deformation, to gain insights on the relationship between compaction, melt migration and melt accumulation during the early magmatic history of the section of lower oceanic crust recovered from IODP Hole U1473A.

U1473A olivine gabbros display grain size variability throughout the Hole from fine- (FG) to coarse-grained (CG) intervals with commonly irregular contacts. CG minerals are deformed and Ol and Pl show resorbed grain boundaries against Cpx. FG are undeformed and show granular textures. Mineral compositions record a progressive chemical evolution, correlated with significant enrichments in the most incompatible elements, from more primitive cores of CG minerals to more evolved compositions of their relative rims, the latter being similar to the unzoned FG minerals. Bended CG Pl associated with the weak foliation and lack of lineation in CPO of CG Pl suggest that CG intervals were deformed during compaction of the crystal mush. In contrast, CPO of undeformed FG Pl show weak lineations, likely indicative of non-coaxial strain.

Mineral compositions, microstructures and Pl CPO suggest that during the early stages of magma differentiation in the crystal mush, reactive melt migration occurred at all depths. Compaction of CG, ongoing from the stage of Ol+Pl±Cpx crystal mush to the melt-poor stage, likely aided extraction of residual melt and accumulation in discrete melt-rich zones where crystals orientated in the direction of magmatic flow. Crystallization of melts in the melt-rich zones ultimately formed the FG-intervals. Our study show that compaction can lead to local chemical and grain-size heterogeneities in a lower crustal section.