Microstructures, bulk and mineral chemistry of the gabbro cores of Holes GT1A and GT2A drilled in the Oman Drilling Project –Melt distribution in the subaxial lower crust

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The lower crustal section of the Oman Ophiolite was drilled in the Oman Drilling Project in 2016 to 2017 and recovered 400 m long cores each from Hole GT1A and GT2A in Wadi Gideah, north of Ibra. The purpose of this research is to correlate the microstructures and the amount of trapped melt of the gabbro samples and to understand the conditions of magmatic and hypersolidus deformation that operated in the lower crust beneath the Oman paleoridge axis.

Cored samples are predominantly olivine gabbros consisting of anhedral olivine, anhedral to subhedral clinopyroxene and subhedral to euhedral plagioclase. Deformed olivine aggregates and clinopyroxene with quarter structures are embedded in plagioclase with equilibrium granoblastic textures and large euhedral plagioclases with resorbed turbid cores. Considering these textures combined with the mechanical strength of the three constituent minerals, these gabbros suffered deformation under the presence of melt, which assisted complete recovery of strain through recrystallization of fine-grained plagioclase and overgrowth of euhedral rims around magmatic plagioclase cores. Poikilitic and ophitic clinopyroxene occur sporadically throughout the holes, which are commonly present in the upper gabbros. Hypersolidus deformation structures are present irrespective to depth.

The whole-rock Mg#s of gabbro core samples from stratigraphically lower and higher sections (Hole GT1A and GT2A) range in 72-83 and 68-79, respectively. The lowest Mg#s of 72-74 overlap those of the spreading-stage sheeted dikes. The whole-rock Al_2O_3 versus MgO plots indicate the whole-rock compositions are mainly controlled by accumulated plagioclase, olivine, clinopyroxene associated with a small amount of primitive melts. The whole-rock Mg# and incompatible elements (REEs and HFSEs) are lower and higher in GT2A, suggesting larger amounts of trapped melt at higher levels in the lower crust. Clinopyroxene preserve cores with higher Mg# than the rims and surrounding smaller clinopyroxenes. Lower Ti in the core and jumps in Ti concentration define the core-rim boundary of clinopyroxenes, through which Mg# gradually changes. In addition to this, olivine grains are almost homogeneous and consistently lower in Mg# than the clinopyroxenes with reversed rims in contact with olivines, indicating diffusive Fe-Mg exchange between olivine and clinopyroxene during cooling.

The amounts of trapped melt between cumulus phases were estimated by two ways. First one is to determine La and Ce concentrations in the core of clinopyroxenes with LA-ICP-MS. Second one assumes La and Ce concentrations of trapped melts to be equivalent to those of the sheeted dikes, and estimates the sheeted dike compositions by using an Fe-Mg partition coefficient of 0.275 (Putirka, 2003) between clinopyroxene and the melt. Mass balance calculations yield the amount of trapped melt in gabbros to be 5 to 10 mass% in general and 25 mass% at most.

Poorly developed modal layering, evidence of common hypersolidus deformation, ubiquitous presence of zoned cumulus minerals and common ophitic clinopyroxenes as well as the amount of trapped melt >5 mass% are all characteristics of foliated gabbros. In addition to this, field observations of the gabbros

along Wadi Gideah, including the Site GT1A and GT2A show that the gabbroic rocks poorly develop modal layering but foliation defined by shape-preferred orientation of clinopyroxenes in the most stratigraphic levels, including both GT1A and GT2A holes. Layered gabbros with well-developed modal layering are only present in the lowermost levels in the crust just above the Moho Transition Zone.

We concluded that both GT1A and GT2A sampled the thick foliated gabbros in Wadi Gideah section, which crystallized on the axial melt lens floor and were transported downward in the lower crust.

Keywords: Oman ICDP, GT1A, GT2A, Lower oceanic crust, Gabbro glacier, Foliated gabbro

