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Oxide gabbro intrusions of the dike-gabbro transition, Hole GT3A, Oman Drilling Project

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Hole GT3A of the Oman Drilling Project located near Aswad in the Samail block, intersected the dike-gabbro transition of the Samail Ophiolite. It crossed 301.6 m of the sheeted dike complex (diabase, basalt), 87.14 m of high-level gabbros and 14.82 m of evolved lithologies (diorite, tonalite, trondjhemite). Igneous contacts mostly consist of dikes cutting gabbro, felsic lithologies crosscutting other rock types and are variable in diorites. The logged units were grouped into an Upper (<111.02 m) and Lower (127.89-233.84 m) Sheeted Dike Sequence, and two Gabbro Sequences whose main distinctive feature is the predominance of olivine (bearing) gabbro in the Upper (111.02-127.89 m) and of oxide (disseminated) gabbro in the Lower (233.84-398.21 m). We report preliminary data on five 5 to 13 m thick, disseminated/oxide gabbro intrusions of the Lower Gabbro Sequence (stratigraphic tops i-249.2, ii-259.1, iii-317.9, iv-348.6, v-366.4 m) to assess fractionation processes and the influence of oxide saturation in the evolution of MORB evolved magmas. Greenschist facies mineral assemblages replace 35 to 100% of the primary mineralogy, the lowermost intrusion being the most affected. Intrusion (v) is topped by amphibole bearing oxide gabbro that grades into a 1 m thick oxide bearing leucodiorite; diorite also occurs at the top of intrusion (i) rooting dikelet offshoots.

There is no systematic mineralogical variation between different intrusions, however there are noteworthy intra-intrusion variations. The oxide/disseminated gabbros are fine- to medium-grained and have mostly granular textures at the base of the intrusions, that develop into poikilitic (rarely ophitic) or varitextured to the top. Plagioclase modal contents roughly increase from 55 to 75%vol towards the top of the intrusions, along with a striking variation in the oxide-apatite association: at the base, oxides form interstitial single grains of ilmenite-magnetite, crystalized after plagioclase and clinopyroxene; upwards, the oxides form predominantly skeletal mixed aggregates included in plagioclase and clinopyroxene, suggesting oxides were liquidus phases, in agreement with experimental observations for evolved MORB (Koepke et al., 2018, Lithos V23); apatite (<2%vol) joins the assemblage in the uppermost domains. This crystallization sequence is correlative of compositional variations in the silicates, with median plagioclase cores becoming less anorthitic (An) and clinopyroxene less magnesian (#Mg) upwards (i-An_{55-43}#Mg_{77}, ii-An_{63-89}#Mg_{66-89}, iii-An_{55-35}#Mg_{70}, iv-An_{59-60}#Mg_{77-73}, v-#Mg_{72-71}) and oxides (decreasing MgO in ilmenite, increasing V_2O_3, TiO_2 in magnetite). Intrusion (ii) reversed compositions are associated to fine-grained, amphibole bearing (edenite, hastingsite-pargasite) primitive granular gabbro with plagioclase (An_{86-57}) and clinopyroxene megacrysts (#Mg_{89-87}, Cr=3671-818 ppm), and to a fine granular phase (An_{88-55}#Mg_{90-88}, Cr=3479-2648 ppm) in sharp contact with more evolved, poikilitic, coarser gabbro (An_{64-46}#Mg_{82-51}, Cr=346-311 ppm). These fine-grained primitive compositions coupled with higher V_2O_3 in interstitial magnetite suggest intrusion (ii) marks a primitive magma replenishment that permeated a more evolved crystal mush. Otherwise, textural and compositional data support within-intrusion, upward fractionation. The diorites evolved composition ($An_{<28}$, magnesio-horneblende, apatite) and gradational transition from the oxide gabbros suggest they represent extreme fractionation products following extensive periods of oxide fractionation (Toplis & Carrol, 1995, J. Petrology V36), leading to the onset of V depletion as attested by the V-poor nature of magnetite.