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Clinopyroxenite dikes crosscutting banded peridotites just above the metamorphic sole in the Oman ophiolite: early cumulates from the primary V3 lava

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Oman ophiolite is one of the well-known ophiolites for excellent exposures not only of the mantle section but also of the crustal section including effusive rocks and the underlying metamorphic rocks. In the Oman ophiolite, three types of effusive rocks (V1, V2 and V3 from the lower sequences) are recognized: i.e. V1, MORB-like magma, V2, island-arc type lava, and V3, intra-plate lava (Godard et al., 2003 and references there in). V1 and V2 lavas are dominant (> 95 %) as effusive rocks and have been observed in almost all the blocks of northern part of the Oman ophiolite (Godard et al., 2003), but V3 lava has been reported only from Salahi area (Alabaster et al., 1982). It is clear that there was a time gap of lava eruption between V1-2 and V3 based on the presence of pelagic sediments in between (Godard et al., 2003). In addition, V3 lavas are fed by a series of doleritic dikes crosscutting V2 lava (Alley unit) (Alabaster et al., 1982).
We found clinopyroxenite (CPXITE) dikes crosscutting deformation structure of basal peridotites just above the metamorphic sole in Wadi Ash Shiyah. The sole metamorphic rock is garnet amphibolite, which overlies the banded and deformed harzburgite and dunite. The CPXITE is composed of coarse clinopyroxene (CPX) with minor amount of chlorite, garnet (hydrous/anhydrous grossular-andradite) with inclusions of titanite, and serpentine formed at a later low-temperature stage. The width of the CPXITE dikes is 2-5 cm (10 cm at maximum) and the dikes contain small blocks of wall harzburgite. Almost all the silicates are serpentinized in the harzburgite blocks except for some CPX. The Mg# (= Mg/(Mg + Fe) atomic ratio) of the CPX is almost constant (= 0.94-0.95) in the serpentinite blocks but varies within the dikes, highest at the contact with the block (0.94) and decreasing with the distance from the contact to 0.81 (0.85 on average). The contents of $Al2O_3$, $Cr2O_3$, and TiO_2 in the CPX of the dikes are 0.5-2.0, 0.2-0.6, and 0.2-0.7, respectively. Garnets, both andradite and glossular, contain high amounts of TiO_2 (up to 18 wt%). The TiO_2 content should be higher in the primary CPX if we consider the formation of secondary Ti-rich garnet and titanite. The La/Yb ratio, normalized to C1 chondrite (subscript CN) (McDonough and Sun, 1995), of CPX in the dikes is high (1.1-2.0) and (La/Yb)CN of calculated melt in equilibrium with the CPX is 6.0-9.6. The REE patterns differ completely from those of diopsidite dikes, (La/Yb)CN < 1, related with hydrothermal fluid (Python et al., 2007), but are similar to those of V3 lava, (La/Yb)CN ≈ 5, (Godard et al., 2003). We can judge the CPXITE dikes are cumulates from alkaline basalt based on the mineral assemblages and mineral chemistry of the dikes. Based on the similarity of the REE pattern between this CPXITE dike and V3 lava, the CPXITE dike thought to be cumulates from the primary or closely related V3 lava, filling its conduit. These dikes are the clear evidence for that the V3 magma came from outside of the Oman ophiolite after its obduction.