Evidence of polygenic CO_2 trapping in the Oman ophiolite peridotites

J. NOËL[*1], M. GODARD[1], I. MARTINEZ[2] E. OLIOT[1], F. BOUDIER[1], P. GOUZE[1], C. CHADUTEAU[2], O. RODRIGUEZ[3]

[1] Géosciences Montpellier, CNRS, Univ. Montpellier, 34095 Montpellier, France (*Julie.Noel@gm.univ-montp2.fr)
[2] IPGP, Université Paris Diderot, 75005 Paris, France
[3] Voxaya SAS, 34090 Montpellier, France

CO_2 mineralization in peridotites contributes to carbon exchanges between solid Earth and its outer enveloppes. Understanding the mechanisms driving carbon trapping is critical to quantify the impact of seafloor hydrothermal alteration versus continental weathering on the global carbon budget. To investigate these processes, we performed petro-structural (EPMA, EBSD, microtomography) and geochemical (LA-ICP-MS, stable isotope) studies of harzburgites cored in the Oman ophiolite (Wadi Dima area).

Studied harzburgites are highly serpentinized (> 90 %) and crosscut by carbonate veins (vol. > 20 %). Carbonates have compositions ranging from calcite to dolomite (Mg/Ca = 0 to 0.6). They were classified based on their morphology and their structural relationships. Type 1 carbonates comprise fine discontinuous penetrating veinlets and carbonate cores replacing serpentine in the mesh texture. They have low REE (e.g., Yb = 0.08-0.23 x C1-chondrite) and Ba (5-20 ppm) and high Ni (120-1000 ppm) contents. Calcite end-members have $\delta^{18}O_{SMOW}$ = 27-32‰, and dolomite $\delta^{18}O_{SMOW}$ = 17-30‰ suggesting precipitation temperatures up to 110°C (for dolomite). Type 2 carbonates are pluri-mm carbonate veins. Locally they display evidence of two-stage serpentinization at vein walls. Dynamic recrystallization is commonly observed, indicating a polygenetic formation in veins : well-developed calcite crystals with REE and Ba contents overlapping that of Type 1 carbonates, are locally replaced by small grains of dolomite and calcite, with higher REE (e.g., Yb = 0.35-1 x C1-chondrite) and Ba (15-80 ppm) and low Ni (10-250 ppm). Calcite end-members have $\delta^{18}O_{SMOW}$ = 29-32‰ and dolomite $\delta^{18}O_{SMOW}$ = 27-33‰, suggesting precipitation at T < 30°C.

These results indicate an evolution of the compositions of fluids forming carbonates from seawater and/or sediment derived fluids to subsurface waters. Carbonate formation started as a penetrative process, partly at the expense of serpentine, at T > 100°C. It probably relates to lithospheric cooling (off axis and/or obduction). This first stage was followed, after ophiolite emplacement, by the formation of a suite of low T carbonate veins acting as main flow paths for fluids interacting with peridotites. We speculate that this process is still on-going today.