Peridotite carbonation at the leading edge of the mantle wedge: OmDP Site BT1

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Hole BT1B sampled 3 layers of carbonated peridotite (listvenite, 0-80, 100-180, 185-197 m) separated by 2 layers of carbonate-bearing serpentinite (80-100, 180-185 m), underlain by 100 m metasediment and metabasalt. Listvenites (magnesite and/or dolomite + quartz + Fe–oxyhydroxides + chromian spinel ± fuchsite rocks) replacing mantle peridotite at and near the base of the Samail ophiolite (Stanger 85, Wilde ea 02, Nasir ea 07, Falk & Kelemen 15: FK15) reveal processes of carbon transfer into the mantle wedge (Kelemen & Manning 15) and suggest methods for CO2 capture and storage (Kelemen ea 11). Near BT1, 10 to 200 m thick tabular listvenites interlayered with partly serpentinized harzburgite have contacts parallel to the basal thrust. Imprecise Rb/Sr and 40Ar/39Ar ages indicate listvenite formed during obduction (FK15). Listvenite-peridotite contacts are gradational over 1-2 m. The listvenite matrix is microcrystalline quartz + magnesite. Quartz recrystallized from opal as in listvenites worldwide (Akbulut ea 06, Boschi ea 09, Jurkovic ea 12, Aftabi & Zarrinkoub 13, Posukhova ea 13, Ulrich ea 14) consistent with 80-120˚C from clumped isotopes and phase equilibria (FK15). Thus listvenite formed –and deformed ductilely –at low T. The depth is unconstrained; this temperature range occurs in subdution zones at 6 to 60 km. Ubiquitous carbonate-rich veins locally comprise >10% of core sections; many have antitaxial textures consistent with expansion due to crystallization pressure. Carbonate-rich veins cut serpentinite and listvenite; veins formed a mesh, followed by replacement of mesh cores. Despite variability in and around veins, average Mg/Si, Fe/Si, Al/Si, Fe/Mg, and Cr/Al in listvenite (75 whole rocks, 7712 XRF scanner points) are indistinguishable from average Samail peridotite. CaO (average 5wt%, range 0-40), and strongly correlated Sr were added to peridotite, most likely from subducting sediment. Rare core with >10vol% dolomite has higher Fe/Mg than peridotite, but the same Mg/Si. Thus Mg, Si, Al and Cr, plus Fe in most rocks, were largely immobile on a 1-10 m scale during introduction of C, O, lesser Ca, minor Fe, and fluid mobile trace elements (Godard ea AGU 17) during transformation of Mg-silicates to carbonate + quartz. With prior and coeval serpentinization, this implies 80% solid volume expansion compared to unaltered peridotite, in a zone >200 m thick at the leading edge of the mantle wedge. EQ3/6 modeling of phase proportions requires a fluid with 3000 to 30,000 ppm CO2, in equilibrium with calcite in subducted sediments between 1-2 GPa. Observed paragenesis suggest unmixing into CO2- and H2O-rich fluids during decompression.

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