Crust-mantle interactions in a hot subduction zone: geochemical and stable isotope evidence

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Multiphase solid inclusions (MSI) trapped in garnet in (ultra)mafic rocks at peak conditions ~ 1100°C and 4.5 GPa provide evidence for element recycling in a hot subduction zone. Detailed examination of mineral assemblages, textures, mineral and bulk composition of the MSI and stable isotope (C,O) composition allows tracing the source of the metasomatizing fluid and evolution of the melts. The MSI consist of Mg-rich silicates (hornblende, barian mica) and carbonates (dolomite, magnesite), and a variety of minor and accessory phases. They are enriched in volatiles (H_2O, CO_2, Cl), LILE (Ba, K, Sr), Th, U, LREE and W, and impoverished in HFSE. The mineral assemblage of MSI in lherzolite and harzburgite evolves from hornblende-dominated inclusions to MSI rich Ba-silicates (e.g. barian feldspar, barian micas) and Ba-carbonates, devoid of hornblende but with pyroxene and second garnet generation, with a distance from garnet pyroxenite veinlets. Spinel is common in pyroxenite and adjacent ultramafic rocks along with apatite as a predominant LREE-bearing phase in MSI, giving way to monazite with increasing distance. These trends correspond to decrease in SiO_2,TiO_2, Al_2O_3, Na_2O and P_2O_5 and increase of BaO, K_2O and CO_2, as well as Cr_2O_3 in bulk MSI. Textures of MSI reveal early crystallization of spinel and apatite, commonly enclosed in other phases, followed by hydrous minerals occurring at the MSI-garnet interface, and carbonate present in the core. Both bulk composition trends and derived crystallization sequence of the MSI correspond to differenciation of kimberlite-like silicate-carbonate melt evolving to highly mobile low-viscosity CO_2-rich compositions. The melt was produced by mantle metasomatism by fluids rich in volatiles and LILE, derived from the garnet pyroxenite enriched in these crustal components within the subduction context. Oxygen isotope composition of dolomite in the MSI ($\delta^{18}O$ ~ 17 - 22 ‰ VSMOW) reflects crustal, sedimentary source, whereas $\delta^{13}C$ carbon isotope values (~ -3 to - 10 PDB) straddle the typical mantle values. Our data demonstrate a complex nature of crust-mantle interaction at UHP-UHT conditions, with final products involving contribution from several sources and processes.