A cross section of oxygen isotopes in the deep mantle

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Sublithospheric diamonds inclusions are a unique window to processes occurring within the deep mantle [1-4]. Here we present oxygen isotope data for majoritic garnets and retrogressed bridgmanite from Kankan, Guinea. While nearly all majoritic garnet inclusions are eclogitic or pyroxenitic, based on their Cr_2O_3 and CaO contents, charge-balance for $Si^{[VI]}$ is achieved differently in majorites from Jagersfontein [1], Kankan [2], and Juina [3], ranging from eclogitic $Na^{[VIII]}Si^{[VI]}$ to peridotitic $Mg^{[VI]}Si^{[VI]}$ substitutions schemes [5]. When coupled with oxygen isotopes [3-4, this study], this information suggests that Juina majorites crystallized in discrete pockets of heterogeneous $\delta^{18}O$ melt in the descending slab, whereas Kankan and Jagersfontein majorites crystallized from the reaction of larger degrees of melt with variable amounts of peridotite. The larger mobility of melts in the Kankan and Jagersfontein eclogitic sources homogenized the $\delta^{18}O$ to ~9‰, implying that melting only occurred in the uppermost, altered basaltic section of slabs. Subsequent infiltration and reaction of slab-derived melts with adjacent pyrolitic mantle increases Mg# and Cr_2O_3, while only slightly reducing $\delta^{18}O$. This process is in agreement with recent experiments that indicate the precipitation of majorites and diamonds from a reaction of slab-derived carbonatite with reduced pyrolite at asthenosphere to transition zone depth [6].

Four inclusions of former bridgmanite provide the first-measured $\delta^{18}O$ values for lower mantle material. These values are within error of primitive mantle, suggesting derivation either from primitive lower mantle, or subducted oceanic lithospheric mantle that was not previously altered.

Oxygen isotopes of Kankan super-deep diamond inclusions thus, highlight the role of slab-pyrolite reactions in the asthenosphere to transition zone, while the new $MgSiO_3$ data conform with a primitive lower mantle composition.

[1] Tappert et al. (2005), Geology, 33, 565-568 [2] Stachel (2000), Cont. Min. Pet., 140, 1-15 [3] Burnham et al. (2016), Lithos, 265, 199-213 [4] Ickert et al. (2016), Geochim Cosmo Acta, 174, 345-359 [5] Kisseva et al. (2013) Geology, 41, 883-886 [6] Thomson et al. (2016), Nature, 529, 76-79