Origin of a diamondiferous spinel harzburgite

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Spinel forms a significant proportion of silicate inclusions found in diamonds worldwide. To date, however, the genesis of the spinel peridotites assumed to be the host of these diamonds is poorly constrained. We report on the occurrence of an extremely well preserved diamondiferous chromite harzburgite from Kimberley, S.A. (LOI= 4%). This mildy foliated xenolith (opx aspect ratio of 1.25:1) is 40x30x25cm and has diamonds exposed at two positions on the surface (> 1 ct exposed). The larger diamond occurrence comprises 3 intergrown octahedra with pronounced {111} stepped faces. Diamonds are transparent and colourless. The harzburgite comprises 69.5% olivine, 27% opx, and 3.5% chromite and no cpx. Three irregular 1-3 mm thick phlogopite dunite veins cut the sample.

The bulk rock composition (excluding the phlogopite dunite veins) is highly depleted in basaltic components; FeO, CaO and Al_2O_3, 4, 0.08 and 0.2 wt % respectively. The major rock forming phases are highly magnesian and depleted in TiO_2 and Al_2O_3 and remarkably homogeneous; olivine Fo 95.44 ± 1 (1 SD); opx Mg# 96.04 ± 8, Al_2O_3 0.66 wt %; chromite Cr# 0.83, TiO_2 < 0.1 wt %.

Despite the highly melt depleted nature and an extremely high Mg0 content (50%) the sample has a low MgO/SiO_2 ratio of 1.09. Relative to predicted residual peridotites, this composition is among the most marked SiO_2 enriched yet recorded. A comprehensive mineralogical, major, trace element and C-Sr-Nd-Hf-Os isotope study is nearing completion. HREE abundance and fractionation constrain the extent and depth of melting. Incompatible elements and isotope ratios record the timing of melt depletion and subsequent metasomatic enrichment associated with SiO_2 and opx enrichment. CL, FTIR and in situ SIMS C isotope data will be used to establish the growth history of the diamonds and relate diamond growth to the initial melt depletion and opx enrichment events.