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Isotopic Composition of the Earth's Lower Mantle from Ca-Silicate Inclusions in Diamonds

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The last few years have seen significant advances in our understanding of the dynamics and composition the Earth's mantle. Seismic tomography has revealed subducted slabs penetrating below the 660 km discontinuity (van der Hilst et al., 1997) and recycled crustal components have clearly been identified in ocean island basalts (OIB; Lassiter & Hauri, 1998; Blichert-Toft et al., 1999; Sobolev et al., 2000). In contrast, He and Ne isotopes from OIB still strongly argue for "primitive", primordial reservoirs within the deeper mantle (Trieloff et al., 2000). Models of mantle evolution demonstrate that phase and viscosity changes in the mantle cannot preserve large scale heterogeneities over Gy timescales (van Keken & Ballentine, 1999). Hence, it remains enigmatic how reservoirs of "primitive" composition have been preserved until today.

Rare Ca-silicate inclusions preserved in diamonds from Kankan (Guinea) and Sao Luiz (Brasil) provide a unique opportunity to study lower mantle processes directly. On the basis of their particular phase assemblages, some have been shown to be derived from the uppermost lower mantle from ~700 km depth (Joswig et al., 1999). Apart from other trace elements, both Sr and Nd are highly enriched in some of those inclusions (Stachel et al., 2000), hence enabling isotopic tracer studies to be performed.

Here we present preliminary isotopic data of such deep-seated mantle inclusions. So far, only one inclusion composed of $CaSiO_3$ (KK66a; coexisting with ferropericlase in the same diamond) with an average diameter of ~150 microns has been analyzed by ID-TIMS. SIMS analyses showed high Sr and Nd concentrations of 6800 and 277 ppm, respectively, indicating the possibility of obtaining relatively precise isotopic compositions despite small sample sizes (= 10 micrograms). The Sr isotopic analysis of KK66a, however, only yielded a concentration of 26.0 ppm Sr (total Sr of ~220 pg; procedure blanks of ~7 pg Sr), which resulted in a rather imprecise present-day $^{87}Sr/^{86}Sr$ ratio of 0.70406 ±52 (95% c.l.) and a $^{87}Rb/^{86}Sr$ ratio of 0.0044. One way to reconcile the significantly different Sr concentrations from SIMS and TIMS of KK66a is to envisage dilution of a surface layer of high Sr-Nd $CaSiO_3$ (analyzed by SIMS) by stishovite, hence lowering the bulk trace elemental budget of KK66a. In view of the expected, similarly lowered Nd concentrations, no Nd isotopic composition is available so far. Because of the low $^{87}Rb/^{86}Sr$ ratio of 0.0044, limited radiogenic ingrowth of ^{87}Sr took place for KK66a. It is unclear, how long the Ca-inclusions resided in the mantle before they were erupted during the Cretaceous. A conservative estimate of 1 Gy lowers the $^{87}Sr/^{86}Sr$ ratio to 0.7040, which is both in line with derivation from altered oceanic crust (Stachel et al., this vol.) but it could also reflect a primitive mantle composition.

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