Geophysical Research Abstracts
Vol. 12, EGU2010-9796, 2010
EGU General Assembly 2010

Perovskite inclusions in deep mantle diamonds and the fate of subducted lithosphere

Michael Walter and Lora Armstrong
Department of Earth Sciences, University of Bristol, UK (m.j.walter@bristol.ac.uk)

Sublithospheric diamonds are typically Type II, frequently exhibit complex zoning, and sometimes contain mineral inclusions that can potentially reveal deep mantle lithologies and petrologic processes. A considerable number of these diamonds contain inclusions with elemental stoichiometries consistent with transition zone (e.g. majoritic garnet, Ca-perovskite) and lower mantle phases (e.g. Mg-perovskite, Ca-perovskite, (Mg,Fe)-periclase) [1]. Ca-rich perovskites, some containing considerable $CaTiO_3$ component, almost invariably have very low Mg contents, unlike what would be expected in solid lower mantle peridotitic or basaltic lithologies, but have elevated incompatible elements abundances that almost certainly indicate crystallization from a low-degree Ca-rich partial melt [2,3]. High-Ca majoritic garnets also have both major and trace element characteristics indicating the role of low-degree, Ca-rich partial melts [3,4], and in some cases calculated melts likely formed in subducted oceanic crust or lithosphere [3]. Given that diamond crystallized syngenetically with the inclusions, crystallization from carbonated melts is implicated. The reducing conditions expected in the ambient transition zone and lower mantle [5] could promote reduction of the carbonate component in slab-derived, carbonated (oxidized), partial melts. Reduction can lead to diamond and perovskite crystallization from the melt, possibly with H_2O as a by-product through a reaction such as:

$$CaCO_{3\,(melt)} + SiO_{2(melt/solid)} + CH_{4(fluid/melt)} = CaSiO_{3(melt/solid))} + 2H_2O_{(melt)} + 2C_{diamond}$$

Mg-perovskite could crystallize via a similar reaction involving the $MgCO_3$ component of the melt. We speculate that when subducted slabs stall at the base of the transition zone, they may heat up and release low-degree carbonated melts [6]. Such melts may migrate, crystallize and metasomatize the ambient mantle. Trace element abundances in some kimberlites are remarkably similar to liquids that could have coexisted with majoritic garnet and Ca—perovskite inclusions in diamonds [2,4,7]. This implies a link between carbonated melts released from subducted materials in the deep mantle or transition zone and protokimberlite melt generation.

1. Harte, B., et al., In Mantle Petrology: Field observations and high pressure experimentation. Geochemical Society Special Publications, 1999: 125-153.

2. Wang, W., T. Gasparik, and R. Rapp, Earth Planet. Sci. Lett., 2000. 181: 291-300.

3. Walter, M., et al., Nature, 2008. 454: 622-625.

4. Keshav, S., G. Gudfinnsson, and D. Presnall, 11th EMPG Abstracts, 2006: 36.

5. Frost, D.J. and C.A. McCammon, Ann. Rev. Earth Planet. Sci., 2008. 36: 389-420.

6. Dasgupta, R., M.M. Hirschmann, and A.C. Withers, Earth Planet. Sci. Lett., 2006. 227: 73-85.

7. Moore, R.O., E. J. Mineral., 1991. 3.