Geophysical Research Abstracts
Vol. 12, EGU2010-1436-1, 2010
EGU General Assembly 2010

Detecting of the processes of the diamond formation using the monomineral thermobarometry .

Igor Ashchepkov (1), Valentin Afanasiev (1), Lyudmila Pokhilenko (1), Alla Logvinova (1), and Nikolai Vladykin (2)

(1) Institute of Geology and Mineralogy, SD RASc, Academician V.A. Koptyug avenue 3, 63090 Novosibirsk, Russia (igor.ashchepkov@uiggm.nsc.ru, +7 83832 332792), (2) Institute of Geochemistry SD RAS, Favorsky str. 1a, Irkutsk, 66403, Russia

The methods of the monomineral thermobarometry used for the reconstruction of the mantle sections beneath the kimberlite pipes (Ashchepkov et al., 2009) allow to determined PT range for the diamond inclusions (DI) and diamond bearing associations. They show various conditions for the crystallization of diamond for in mantle lithosphere beneath the Yakutia, Africa, and North America.

In Yakutia most DI (Sobolev ea 1997, 2004; Logvinova ea., 2005 and ref their in) (Cr-pyropes, Mg -opx) form Mir and Udachnaya pipes are referred to the cold geotherms 35 (partly 33 mvm-2) at the pressure range from 35 to 80 kbar. Cr- pyropes (Ti-bearing) partly drops the on the heated area near convective branches 40-45 mvm-2 convective geotherms. Most Cr- rich pyroxenes refer to the coldest or heated (metasomatic type) at the deeper parts of the mantle columns while mildly Cr-rich varieties refer to the conditions of the crystallization from the melts related to the protokimberlites and associated carbonatites near the Graphite-Diamond boundary (G-D). They are more widely distributed in mantle beneath the Mir pipe where the essential part of mantle column from 50 to 35kbar was subjected to the refertilization. But chromite PT estimates mostly refer the heated conditions of the convective branch at the lithosphere base (∼70-60kbar). They are most typical for the Alakite pipes. Diamond bearing eclogites show the some separate levels of crystallization with the high T-range reflecting conditions 35 to 45 mvm-2 mostly in the 60-50 kbar interval. They coincide with the levels of the intensive heating in the mantle columns.

For the South Africa in the Mesozoic pipes beneath Lesotho - Jagersfontein (Viljoen ea. 2005), Finsch (Appleyard ea., 2004; Gurney, Switzer, 1973; She ea., 1983), Koffiefontein (Rickard ea., 1986), diamond bearing associations refer to three geotherm branches. The coldest (Cr-pyropes and Mg-Opx) is related to ancient subduction with the heating at 60 and 75 kbars. The 40 mvm-2 is related to the Diam-eclogites (To according to Krogh, 1988), Fe- Opx and chromites. And hottest (45mvm-2) refers to the magmatic type eclogites (cumulates) and some HT chromites (restites). In mantle columns beneath the Proterozoic pipes like Roberts Victor (Souter, Harte, 1988; Jacob ea, 2004), Premier (Gurney ea., 1985; Viljoin ea, 2009) the eclogitic DI trace mostly 40 mvm-2 geotherm but large amount of PT point drops onto advective hottest branch. Mostly eclogites are separated to several branches according to Mg#. The Fe- rich (ancient trondjemitic cumulates) are commonly low-To (LT). Conditions for the mantle beneath Tanzania (Stachel ea, 1998) and Ghana (Stachel ea, 1997) are close to 40mvm-2 geotherm from the deepest∼80 kbar level to 35 kbar. The PT estimates for DI from Guinea (Denies, Harris, 2004), those from Angola kimberlites refer to colder geotherm branch.

Similar but hotter conditions are detected for the V-Cm kimberlites from Botswana – Venetia (Viljoen ea 2009; Hin et al., 2009) which in mantle columns reveals subadiabatic branch from 1450oC (45mvm-2) but the Late Mesozoic pipes in this region like Letlhakane (Achtenbergh ea, 2001; Stienfenhofer ea, 1997; Deines, Harris, 2004), Orapa (Denies ea., 2009; Stachel ea., 2004) reveal conditions close to 42 mvm-2. PT for mantle xenoliths from the "of craton" Namibian pipes (Louwrensia, Hanous) (Mitchel, 1984; Boyd ea., 2004) trace the G-D boundary or are plotted above it and only relic associations are correspondent to the levels ∼65-70 kbar. The PT for OPx and some Cpx in diamonds (Harris ea, 2004) from placers are close to this boundary but those for hot (1400oC) eclogites (magmatic type) are correspondent to the lower levels of mantle columns or coincides with the hottest PT conditions for peridotites. The location of the PT estimate for DI above the Diam –Graph boundary is probably due to metastable crystallization or mantle diapirism.

In North America kimberlites the conditions for the DI are mostly LT. Garnet DI from the Diavic mine (Schultze ea, 2008) locate from 50 to 70 kbar near 36 mvm-2 geotherm. Hi-Mg eclogites demonstrate more LT conditions, while the conditions for Hi-Fe eclogite are close to convective 40 mvm-2 branch similar to those for Chromite DI and several points are lose to 45 mvm-2or locate slightly above Diam-Graph. DI from Panda (Tomlinson ea, 2006; Greighton ea, 2009) kimberlites from the same region reveals close PT but are slightly LT. The PT conditions for diamondiferous eclogites from Jericho (Lac De Gras) (Heaman ea, 2004) are most LT in Slave craton (33 -36 mvm-2) at 50-65 kbar range. The eclogitic Cpx and peridotitic pyrope DI (Aulbach et al., 2004) from Buffalo Heard (Banas ea., 2006) at the west of region also trace 36 heating to 40 mvm-2 geotherm at 70 kbar and some more hot PT points trace D–G line. In Wayoming craton the Cr-pyrope DI from low Paleozoic KL-1 pipe (Coopersmith ea ., 2004; Schultze ea 2008) reflect the range 35-40 mvm-2 of heating at lithosphere base 75-65 kbar and more Fe-rich Opx demonstrate HT conditions probably refer to cumulates.

Thus the mantle inclusion in different part of the Earth mantle in general repeats the conditions of the whole mantle column. They reflect higher PT gradients in ancient time. In Africa they are hotter in general and often trace advective branches. While in the thicker and colder lithosphere beneath the Slave craton DI reveal colder and deeper in general conditions. In Siberia many of DI especially Chr as well as Diam- eclogites reflect the conditions of the heating and the influence of the protokimberlite melts.