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The role of chloride-carbonate fluid in kimberlite magmatism: experimental study

Nadezda Chertkova[1*], Oleg G. Safonov[2]

[1]ISEI, Okayama University, [2]IEM, Russian Academy of Sciences

Close relationship between partial melting of diamond-bearing eclogites and deep alkalic fluids was clearly demonstrated by recent find of chloride-carbonate inclusions in diamonds from eclogite xenolith (Udachnaya pipe, Yakutia) [1]. This eclogite xenolith and the mix of $CaCO_3$, Na_2CO_3, KCl in proportions, imitating the composition of chloride-carbonate inclusions in diamonds, were used as starting materials in a series of experiments. Experiments were conducted using "anvil-with-hole" (Bridgman-type) apparatus in the temperature range 1110 - 1510 degree C, at 5.5 gigapascals.
According to the results of experiments, at temperatures below 1200 degree C garnet-clinopyroxene-phlogopite assemblage is stable with highly potassic chloride-carbonate melt. Crystallization of phlogopite and neogenic Ca-enriched garnet indicates decarbonation reactions between eclogite and chloride-carbonate melt.
At temperatures 1200 - 1400 degree C two immiscible melts (almost pure chloride and carbonate-silicate) are coexisting with crystalline phases (mainly garnet and clinopyroxene). Quenched products of carbonate-silicate melt contain about 34 weight percent (wt%) $SiO_2$and 12 wt% Al_2O_3, have high concentrations of K_2O (up to 13 wt%) and Cl (up to 4 wt%). Spectroscopic methods detect graphite flakes in bubbles in silicate glass, allowing making an assumption, that silicate melt contained considerable amounts of CO_2.
Following increase of temperature above 1400 degree C leads to continuation of decarbonation reactions and disappearance of garnet. Accordingly, in this temperature interval liquidus clinopyroxene is coexisting with chloride and carbonate-silicate melts. The composition of carbonate-silicate melt is different from the low-temperature one: while it has the same concentrations of $SiO_2$and Al_2O_3, it is depleted in K_2O (about 7 wt%) and enriched in MgO (12.5 wt %) and CaO (16.5 wt%).
Experiments demonstrated that in the process of interaction of mantle eclogite with alkalic chloride-carbonate melt two factors play an important role: (1) degassing and (2) formation of two immiscible melts. Melt compositions, obtained in present experiments, fall into the compositional range of melts inclusions in diamonds from various world kimberlitic provinces and supplement compositions, obtained by Litasov and Ohtari [2] in the system peridotite-chloride-carbonate. Thus, the model of liquid immiscibility in silicate-chloride-carbonate systems at high pressures [3] can be applied to complex natural kimberlite associations.

References
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3. Safonov O.G., Chertkova N.V., Perchuk L.L., Litvin Yu.A. (2009) Experimental model for alkalic chloride-rich liquids in the upper mantle. Lithos, V. 112, P. 260-273.