



Chloride-bearing liquids and partial melting of mantle eclogites: experimental study and application to the diamond-forming processes.

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Recent studies prove that the partial melting in some eclogite xenoliths in kimberlites is closely related to formation of diamonds in these rocks at 4–6 GPa and 1150–1250⁰C [e.g. 1, 2]. Along with specific mineral assemblages, the products of the eclogite partial melting commonly include relics of potassium-rich silicic melts (45–65 wt. % of SiO₂, 4–14 wt. % of K₂O and K₂O/Na₂O > 1.0) [1, 2]. Available experimental data, however, demonstrate that such melts can not be produced by “dry” or hydrous melting of a common eclogite. It implies that partial melting and conjugate diamond formation in mantle eclogites was triggered by infiltration of potassic fluids/melts. Assemblages of Cl-bearing phases and carbonates in eclogite xenoliths [1], and eclogitic diamonds [3–6] suggest that these agents were chloride-carbonate-H₂O melts or/and chloride-H₂O-CO₂ fluids. In order to characterize interaction of both types of liquids with eclogites and their minerals, experiments in the eclogite-related systems with participation of CaCO₃-Na₂CO₃-KCl-H₂O or H₂O-CO₂-KCl are reviewed.

Melting relations in the system eclogite-CaCO₃-Na₂CO₃-KCl-H₂O follow the general scheme proposed earlier for chloride-carbonate-silicate systems [7]. Below 1200⁰C, Grt, Cpx and phlogopite (Phl) coexist with L_{CC} only. Formation of Phl and Ca-rich Grt after Cpx indicate active reactions of Cpx with L_{CC} accompanied by CO₂ degassing and depletion of the clinopyroxene in jadeite. Subsequent dissolution of silicates in L_{CC} at >1200⁰C results in formation of potassic silica-undersaturated carbonate and Cl-bearing melt (L_{CS}) (37–40 wt. % of SiO₂, 10–12 wt. % of K₂O, ~3.5 wt. % of Cl) immiscible with the L_{CC}. Compositional feature of this melt is very comparable to those of low-Mg carbonate-silicate melt inclusions in diamonds [6]. However, it is not relevant to the melt relics preserved in the partially molten eclogite xenoliths.

Melting of eclogites with participation of the H₂O-CO₂-KCl fluid at 5 GPa at 1200–1300⁰C [8] produces CO₂-depleted aluminosilicate melts with up to 46 wt. % of SiO₂, 9–10 wt. % of K₂O, 2–5 wt. % of Cl, whose SiO₂ and K₂O contents resemble the silica-poor varieties of melt relics in the eclogite xenoliths [1, 2]. Presence of KCl in the fluid intensifies melting, that is related both to high Cl content in the melt and its enrichment in K₂O via K-Na exchange reactions with the immiscible chloride melt. The ratio K₂O/Cl in the melts increases with the increase of the KCl content in the system and reaches 2.5–3.5 in the melts coexisting with immiscible chloride liquids.

No additional crystalline phases, except Grt, Cpx, and Phl, were observed in the above experiments. However, experiments in the model system jadeite-diopside-KCl(±H₂O) at 4–5 GPa shows, that KCl liquids provoke formation of ultrapotassic Cl-bearing silica-rich (i.e. 63–65 wt. % of SiO₂) melt, which is able to produce sanidine and Al-celadonite-phlogopite mica, which are observed in partially molten eclogites [2]. Dissolution of pyrope in KCl-rich liquids results in formation of spinel and olivine, which are also common products of garnet breakdown within the zones of partial melting in eclogite xenoliths [1, 2].

Thus, the reviewed experiments imply that the KCl-bearing liquids could serve as triggers for formation of the wide varieties of K-rich aluminosilicate and carbonate-silicate melts during the eclogite melting in the mantle. Nevertheless, compositional variability of the produced melts, as well as formation of some crystalline phases (sanidine, mica, spinel, olivine) during this process could be a result of highly localized action of these liquids.

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