



Model of the carbonatite-kimberlite connections in the chloride-carbonate-silicate systems

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Kimberlitic melts are usually considered as products of gradual transition from Mg-rich carbonatitic melts formed via partial melting of carbonatized mantle peridotites [1, 2]. On the other hand, recent discoveries show significant contribution of alkali chlorides in the formation of kimberlites. These are (*i*) melt/fluid inclusions in the kimberlitic diamonds and olivines worldwide [3-5] and (*ii*) chloride-rich kimberlites of the Udachnaya-East pipe [4]. Both of them may indicate not only active role of alkalic chloride-rich liquids in incipience of chloride-rich carbonatitic melts but also in their transformation into kimberlitic magmas. Our experimental studies [6, 7] showed that the saturation of chloride-carbonate liquids with silicates resulted in the formation of two immiscible melts: Cl-bearing carbonate-silicate (CS) and chloride-carbonate (CC). This could suggest immiscible separation of the kimberlitic melts during interaction of mantle peridotites with the chloride-carbonate liquids. Purposeful experimental study of the chloride-carbonate liquid interaction with peridotitic minerals and kimberlite were carried out in order to test this suggestion.

In the system olivine-(Ca, Na₂)CO₃-(K, Na)Cl at 5.4 GPa exchange reactions of olivine with the CaCO₃ component of the chloride-carbonate melt results in the formation of clinopyroxene and chloride-rich “dolomitic” melt. The higher CaCO₃ content in the melt the more intensive reactions of olivine and the larger amount of newly formed clinopyroxene. Chlorides do not participate in “dissolution” of olivine. No CC-CS immiscibility was observed in the run products up to temperatures 1650°C. Thus, olivine, as the only Si-bearing component, cannot effectively saturate the chloride-carbonate liquid with silica. In contrast, the dissolution of orthopyroxenes and/or garnets could lead to the silica saturation of the chloride-carbonate melt and further CC-CS immiscibility [7]. Redistribution of carbonate and Ca from CS melt to coexisting CC results in increase of the Si content and the Mg/Ca ratio in the carbonate-silicate melt shifting toward kimberlite composition.

Additional experiments in the system kimberlite-(Ca, Na₂)CO₃-KCl at 4.8 GPa revealed that the kimberlite-like CS melt can coexist with immiscible CC liquid at 1400-1600°C. Generally, compositional characteristics of this melt are very similar to those in Cl-rich kimberlites of the Udachanaya pipe [4]. However, in contrast to “classic” kimberlite, it is enriched in alkalis and chlorine. With cooling, the compositions of coexisting melts become closer to each other, while the miscibility gap disappears and the only single Cl-rich carbonatitic melt is stable. This process is controlled by crystallization of olivine and spinel.

The above experimental data were applied to alkalic chlorine-rich carbonatitic inclusions in diamonds [3] and chlorine-rich kimberlites of the Udachnaya-East pipe [4].

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