



## Melting Relations in Ultrapotassic High-Pressure Systems

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### Introduction

Compositions of ultrapotassic (UP) liquids trapped in kimberlitic diamonds vary between aluminosilicate melt (Bulanova et al., 1988; Novgorodov et al., 1990), carbonate-silicate melt (Navon et al., 1988; Schrauder, Navon, 1994), and chloride-carbonate brine (Izraeli et al., 2001). Immiscibility between the silicate-rich melt and the brine, probably, manages compositions of the UP liquids under the mantle conditions (Perchuk et al., 2002; Navon et al., 2003). The UP liquids coexist with both peridotite and eclogite minerals, the later being predominant (Izraeli et al., 2004). Potassium-bearing clinopyroxene (KCPx) and sanidine are indicative minerals for the UP environments.

We present results of experiments on phase relations in the silicate, carbonate-silicate, and chloride-silicate systems at 3.5-7 GPa in order to model mineral assemblages in equilibrium with the UP mantle liquids.

### UP silicate systems

1. KCPx appears at liquidus of the UP silicate melts.  $K_2O$  content in the Na-free KCPx reaches 5.6 wt. % at 7 GPa, while 0.5-1.5 wt. % can be produced at 5-6 GPa. Jadeite dramatically limits the  $K_2O$  content in KCPx. The Ca-Ts and Ca-Esk contents of KCPx in the UP systems are close to those of natural KCPx.

2. The UP silicate melts produce eclogite-like assemblages, where KCPx coexists with Grt, Opx, and San. Because of high K and Si, the UP melts coexist with these minerals down to  $\sim 1100^\circ C$ . These data allow substantiation of a magmatic origin for mantle

KCpx or San bearing parageneses at  $T < 1200^{\circ}\text{C}$ .

3. San is unstable in the Cpx-rich melts at  $P > 4$  GPa being replaced by the  $\text{KCpx} \pm \text{Opx} + \text{Grt}$  assemblage. This explains a scarcity of San in the mantle assemblages. Crystallization of San as a liquidus phase or the assemblage  $\text{KCpx} + \text{Grt} + \text{San}$  at the UHP results from the evolution of the K-Si-Al-rich melts. Similar relationships have been reported from kimberlitic diamonds (Bulanova et al., 1988; Novgorodov et al., 1990).

UP carbonate-silicate systems

1. KCpx is the liquidus phase of the UP carbonate-silicate melts. In the Na-free carbonate-silicate systems, the  $\text{K}_2\text{O}$  content of KCpx is close to that of KCpx from silicate systems.

2. At  $P > 4$  GPa, the UP carbonate and silicate melts are miscible, whereas immiscibility appears at lower  $P$ .

UP chloride-silicate systems

1. Experiments show that the Cl-bearing silicate and chloride UP melts are immiscible, at least, up to 7 GPa. The silicate melt in equilibrium with the KCl melt contains 6-20 wt. % of  $\text{K}_2\text{O}$ . The maximal Cl content in the melt is recorded at  $(\text{Ca} + \text{Mg} + \text{Na}) / (\text{Al} + \text{Si}) \sim 0.4$  in the silicate melt and decreases to both Al-rich and Al-poor compositions at given  $T$  and  $P$ . At constant  $P$ , the Cl content in the melt increases with  $T$  in the Si-Al-rich melts and decreases in the Si-Al-poor melts. Pressure produces an opposite effect.

2. Solubility of the alumino-silicate component in the chloride melt is  $< 1$  wt. %.  $K_D = (C_K^{sil} * C_{Na}^{chl}) / (C_{Na}^{sil} * C_K^{chl})$  increases with the Na content in the system, thus Na-rich chloride melt coexists with UP silicate melt.

3. In Na-poor chloride-bearing melts Cpx is unstable and Fo appears at liquidus. In the Na-rich chloride-bearing systems Cpx becomes stable at liquidus. The  $\text{K}_2\text{O}$  content in Cpx of the chloride-bearing UP systems is extremely low.

4. In presence of  $\text{H}_2\text{O}$ , Cl-bearing phengite-rich phlogopite appears near the solidus of the KCl-bearing systems. This unique phase is associated with the brine inclusions in diamonds (Izraeli et al., 2004).

Conclusion

Our experimental data suggest that the UP liquids can be active participants of the mantle magmatism. They change dramatically thermodynamic conditions of the formation of “ordinary” deep-seated assemblages.

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