



Trace elements mineral-melt partitioning in diamond-forming peridotite-carbonatite system (experimental study at 8.5 GPa)

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The upper mantle peridotite-carbonatite system of the model composition $[(\text{Ol}_{36-60}\text{Opx}_{16}\text{Cpx}_{12-24}\text{Grt}_{12-24})_{30}\text{Carb}_{70}]_{99}\text{TE}_{01}$ represents ultra-basic parental medium for diamond and paragenetic mineral inclusions therein. This experimental study is focused onto geochemical behavior of trace elements (TE) during formation of diamond in heterogeneous parental medium consisting of completely miscible carbonate-silicate melt and peridotitic minerals which are paragenetic to diamond (olivine Ol, orthopyroxene Opx, clinopyroxene Cpx and garnet Grt). The TE mixture consists of Li, Rb, Cs, Ba, Th, U, Ta, Nb, La, Ce, Pb, Pr, Sr, Nd, Zr, Hf, Sm, Eu, Gd, Tb, Dy, Y, Ho, Er, Tm, Yb, Lu, Sc, and Zn. The trace elements were mainly introduced into the system as oxides.

In experiments at 8.5 GPa and 1510°C , quite large (more than $100 \mu\text{m}$) garnet, clinopyroxenes, and olivine crystals were formed in completely miscible carbonate-silicate (carbonatite) melts. Orthopyrohene was not formed. After quenching, the melt phase was presented as cryptocrystalline aggregate which was analyzed over areas of $10 \times 10 - 100 \times 100 \mu\text{m}$ size with the use of microprobe and LA-ICP-MS methods. The methods were used in analyzing TE content in single crystalline olivine, clinopyroxene and garnet submerged into the quenched melt.

Coefficients of inter-phase TE partitioning K_d for the coupled phases olivine-melt, clinopyroxene-melt, garnet-melt, and olivine-garnet were calculated, based on the results of LA-ICP-MS determination of the TE contents. Spydergram characterizing clearly the inter-phase TE partitions is plotted.

By the spydergram, garnet and olivine are the major phases in TE inter-phase mineral-melt partitioning for the diamond-forming peridotite-carbonatite system. The feature is that light REE elements (La, Ce, Pr) are mainly distributed into the melt phase where as the medium and heavy elements (Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu) – into garnet ($K_d = 1 - 6$).

Such heavy elements as Zr, Hf, Y, and Sc are also accumulated in garnet ($K_d = 1 - 5$) where as the other elements concentrated in the completely miscible carbonate-silicate melt. Highest $K_d = 5-6$ for the garnet-melt couple is in Sc and Lu cases. Olivine accumulates intensely light TE - Li, Rb, Cs, Ba ($K_d = 2.5 - 5$) as well as Th, U, Pb, and Zn ($K_d = 1.5 - 4.5$). It was found that clinopyroxene is practically not participated in TE partitioning for the peridotite-carbonatite system.

The new experimental data are applicable to interpretation of TE contents in paragenetic inclusions of peridotite paragenesis in natural diamond. Support: The RF President's grant MK-913.2011.5, RFBR grants 10-05-00654 and 11-05-00401.