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Yakutian diamond-forming fluids - the evolution of carbonatitic high density fluids

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We explored the composition of micro-inclusions in twenty four diamonds, including fibrous cubes and coated diamonds, from Udachnaya, Ubilenaya, Aikal, Zarniza and Komsamolskaya mines. FTIR and EPMA analysis have shown that fifteen of the diamonds carry carbonatitic high-density fluids (HDFs) rich in Ca, Mg, K and carbonate while nine carry HDFs that are intermediate between the carbonatitic end-member and a silicic end-member rich in Si, Al, K and H_2O.

Combining EPMA and FTIR data, we constrained the major element composition of the two end-members. The carbonatitic end-member caries 77.8 wt% carbonates, 8.9 wt% silicates, 6.0 wt% water, 5.0 wt% apatite and 2.3 wt% halides. On a CO_2 and water-free basis, the composition of this end-member is SiO_2=8.4, TiO_2=0.7, Al_2O_3=0.7, FeO=6.7, MgO=28.7 CaO=23.2, BaO=0.7, Na_2O=9.1, K_2O=16.4, P_2O_5=2.6, Cl=2.1 and Cr_2O_3=0.4 wt%. Fluids that show enrichment in the silicic-HDF vary in composition between $\sim$10 and $\sim$70 wt% SiO_2 (on a CO_2 and water-free basis). The end member composition is: SiO_2=69.2; TiO_2=0.6, Al2O3=13.6; FeO=0.7, MgO=0.3, CaO=1.1, Na_2O=1.7, K_2O=10.4, P_2O_5=0.9, Cl=0.2, Cr_2O_3=0.2 wt% and when volatile are included it amounts to 89.2 wt% silicates, 4.1 wt% carbonates, 4.1 wt% water and 2.6 wt% apatite.

The large number of diamonds carrying carbonatitic HDFs enables a detailed analysis

of the early evolution of the diamond-forming fluids. As MgO decreases from 28 to 17.5 wt%, Ca-Mg-(Fe) carbonates precipitate along with a minor amount of silicates. While MgO decreases from 17.5 to 12 wt% the CaO and FeO content increases, suggesting the precipitation of an Mg rich carbonate and/or an Mg-silicate. Saline HDF (rich in K, Na and Cl) also exsolves at this stage. The decrease in the K_2O concentration, that starts at relatively high MgO content (21.5 wt%), may be related to the precipitation a mica or an alkali-carbonate. Alternatively, such decease may be linked to loss of water and potassium as a result of metasomatic interaction with the country rock. At MgO$<$12 wt% carbonates, apatite, a Ti-bearing phase and possibly a mafic silicate phase precipitate from the evolving fluid, accompanied with the separation of additional saline-HDF or the precipitation of halides.