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Role of alkali carbonates in the mantle magmatism, metasomatism, and diamond formation

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There are much direct and indirect evidences of carbonatitic and hydrous melt/fluid segregation in the deep mantle in the past Earth's history. One particular example is the source regions of carbonatites, kimberlites, and lamproites some of which originate from more than 250 km depth. On the basis of experimental studies they appear to represent opposite ends of the volatile spectrum; carbonatites and kimberlites clearly require abundant CO₂ in the source, whereas lamproites require H₂O rich sources.

Another example is the natural diamond forming medium. Experimental data suggest that water-bearing alkali carbonates and CO₂-H₂O fluid are only species which are capable to initiate diamond crystallization at pressures and temperatures that correspond to those of natural diamond formation. Analysis of data on micro-inclusions in "fibrous" diamonds from different localities indicates that the diamond-forming media at the stage of inclusion entrapment constituted of super-critical fluid or melt with different ratios of carbonates and water. These integrated results strongly support the concept of diamond crystallization from either hydrous fluid or alkali carbonate melt.

In accordance with the current geotherms for the upper surfaces of subducted slabs and the phase equilibria computed for an oceanic metabasalt and subducted marine sediments the local abundance of water and carbonates in the mantle can be attributed to the subduction. However, for much of geological time (>500 m.y.) subduction geotherms have been too hot to allow carbonate and water subduction. This means that water-bearing silicates and carbonates rather underwent decomposition and melting at shallow depth leading arc magmatism than were transported into the deep mantle. In accordance with this and since the average mantle concentrations of carbon and hydrogen do not exceed 100 and 120 wt ppm respectively, the volatile segregation in a broad mantle region should be involved to explain the local abundance of CO₂ and/or H₂O. Enrichment of these fluids in incompatible trace elements (specifically, K, Rb, Sr, Ba, light REE, Ti, Nb, Zr, P, U, and Th) also implies their long infiltration history through the large volumes of mantle rocks. However, mechanisms and forces driving fluid transport and segregation in the deep mantle are poorly understood.

In this talk we would like to highlight following subjects.

- 1.PT conditions of carbonatite magma formation. Mantle solidus.
- 2.Mechanism of carbonate melts segregation.
- 3.Migration rate of carbonatite melt through solid no-porous silicate mantle.
- 4.Proto-kimberlite magma composition. Experimental constrain.
- 5.P-T conditions of natural diamond formation in presence of carbonatite melt.
- 6.Effect of carbonate-silicate ratio on kinetics of diamond formation.

Keywords: carbonatite melt, kimberlite, metasomatism, diamond, mantle