Why are Udachnaya-East pipe kimberlites enriched in Cl and alkalis, but poor in H_2O?

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Kimberlite magmas, as the deepest probe into the Earth's mantle, can supply unique information about volatile components in the source mantle. The compositions of kimberlite parental magmas remain largely unknown because of syn-eruptive contamination and degassing, and post-magmatic alteration. We attempt to overcome the problems related to disturbance of magmatic volatile and alkali abundances by the study of uniquely fresh kimberlites from the Udachnaya-East pipe, Siberia [1,2]. These Ol-phyric rocks are essentially anhydrous (<0.5 wt% H_2O), but exceptionally enriched (in wt%) in Cl (2.3-3.2), Na (2.6-3.7) and K (1.6-2.0). Such unusual chemical features are reflected in the groundmass assemblage, which lacks serpentine, but contains alkali-, and Cl-bearing phases (Na-K-Ca carbonates, Na-K chlorides, K-Cl-Fe sulphides, and sodalite). Similar minerals are recorded among the alteration products of kimberlitic macrocrysts (pyroxenes, garnet, ilmenite), olivine-hosted melt inclusions, and nodule-like chloride-carbonate aggregates in the kimberlite. The nodules often demonstrate liquid immiscibility textures that are similar to those observed in the chloride-carbonate melt inclusions at ~600°C [1]. The similarity of O and C isotope compositions of carbonates from the groundmass and nodules ($\delta^{18}O$ 12.5 to 13.9 ‰ SMOW; $\delta^{13}C$ -3.7 to -2.7 ‰ PDB) points to their common origin at similar temperatures. Thus, the nodules are interpreted as crystallized pools of residual kimberlite magmas.

The high abundances of Na, K and Cl, depletion in H_2O, and preservation of water-soluble minerals and chloride-carbonate melt pockets in the Udachnaya-East kimberlite cannot be coincidental. We present evidence against possible contamination of ascending kimberlite magmas by crustal sediments. We argue that essentially anhydrous and carbonate- and chloride-rich compositions can be attributed to the parental magma of the Udachnaya-East kimberlite. Oxidation of reduced hydrogen species at the upper levels of kimberlite bodies can explain common serpentinisation of kimberlites.

References

[1] Kamenetsky M.B. et al. (2004) *Geology* **32,** 845-848.
[2] Maas R. et al. (2005) *Geology* **33,** 549-552.