

Can primitive kimberlite melts have an alkali-carbonate composition?

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Kimberlites are very important rocks because they provide unique insights into the deep Earth and are a primary source of diamonds. Despite decades of research, the original compositions of kimberlite melts, which are derived from depths >150 km, remain highly debatable due to significant modifications of these melts during ascent and emplacement. Snapshots of mantle melts represented by secondary melt inclusions were found in healed cracks in rock-forming olivine from sheared peridotite xenoliths from the Udachnaya-East kimberlite pipe (Siberian craton, Russia). These xenoliths were derived from 180-230 km depth and are amongst the deepest mantle samples. Various Na-K-Ca-, Na-Mg-, Ca-Mg- and Ca-carbonates, alkali sulphates and halides are predominant among the daughter minerals in crystallized melt inclusions, whereas silicates are subordinate. Raman-mapping of unexposed inclusions show that the carbonate content is ≥ 63.4 vol.%, whereas the silicate content is ≤ 14.7 vol.%. The presence of aragonite, a high-pressure polymorph of CaCO_3 , among the daughter minerals suggests a mantle origin for these melt inclusions. This entrapped melt is characterised by very high contents of alkalis (with bulk molar $(\text{Na}+\text{K})/\text{Ca} \sim 3.4$), carbon dioxide, chlorine, sulphur and extremely low silica and water [1-3]. Thereby these inclusions can be considered as Cl-S-rich alkali-carbonate melts that existed near the base of the cratonic lithosphere (≥ 230 km). We interpret these melts entrapped xenolith minerals to represent snapshots of the primitive kimberlite liquids, which subsequently formed the Udachnaya pipe. This finding is in contrast with the generally accepted ultramafic silicate water-rich nature of kimberlite melts. Such alkali-carbonate melts also are a very suitable diamond-forming medium and may support the idea of a relationship between some diamonds and kimberlite magmatism.

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[1] Golovin *et al.* (2017) *Chem. Geol.* **455**, 357-375. [2] Golovin *et al.* (2018) *Chem. Geol.* **483**, 261-274. [3] Golovin *et al.* (2019) *J. Raman Spectrosc.* in press.