



Kimberlite genesis and mantle metasomatism: Insights from in situ U-Pb dating of single garnet xenocrysts

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Garnet xenocrysts from kimberlites provide unique insights into the composition, structure and evolution of the subcontinental lithospheric mantle (SCLM). For example, different metasomatic events in the SCLM are reflected in compositional differences between garnet xenocrysts. As mantle metasomatism largely controls the physical and chemical properties of the SCLM, it exerts first order control over the genesis of kimberlitic magmas and diamond formation. However, dating mantle lithologies and processes is complicated by high ambient temperatures that allow the equilibration of most isotopic systems up to the time of kimberlite eruption. As a consequence, the temporal connection between metasomatic events in the mantle and kimberlite genesis is commonly ambiguous.

In this study, we applied LA-ICPMS U-Pb dating to 43 harzburgitic, lherzolitic and megacrystic garnet xenocrysts from the ~376 Ma diamondiferous V. Grib kimberlite, Russia, in order to investigate the link between different types of mantle metasomatism and kimberlite genesis.

Our results indicate that, with two possible exceptions, only harzburgitic garnet overlaps in age with the kimberlite eruption, whereas lherzolitic and megacrystic garnet crystals are ~20 to 130 million years older. Furthermore, garnet U-Pb ages and Ni-in-garnet temperatures of ~820 to 1200 °C do not correlate. This, and the high closure temperature of U-Pb in garnet (≥ 900 °C) suggests that the garnet U-Pb ages indeed reflect metasomatic events in the SCLM. However, the U-Pb ages could also reflect cooling ages. In this case, the metasomatic events recorded in the garnet crystals must still have occurred up to ~130 million years prior to the eruption of the V. Grib kimberlite.

These findings have far-reaching implications for the genesis of (diamondiferous) kimberlites, as they clearly show that the time lag between metasomatic events in the SCLM, as recorded in kimberlitic garnet xenocrysts, and kimberlite eruption may extend to tens of millions of years.