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Carbonatite formation in continental settings via high pressure – high temperature liquid immiscibility

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The goal of this study is to compare compositions of high temperature silicate-carbonatite immiscible melts, known from melt inclusions and experiments, to compositions of silica-undersaturated volcanic rocks from continental settings, in order to improve understanding of the formation of calcite carbonatite rocks worldwide. Melt inclusions in this study are hosted in perovskites from magnetite-perovskite cumulates collected at the Kerimasi volcano in the East African Rift. The temperature of complete dissolution of daughter minerals in the melt inclusions and the high CO_2−content of the silicate melt (5.4-9.8 wt%) support early formation of the rock and entrapment of melts at high temperatures (~1100 ºC) and pressures (≥1GPa). Heated-quenched melt inclusions indicate the presence of immiscible mafic-melilitite and Ca-Na-K-carbonatite melts together with a fluid phase at entrapment. We compared our melilitite melts with a global dataset of 146 continental melilitite and 640 nephelinite compositions (GEOROC database). Our results show that studied calcite-saturated melilitite melts formed in a continental rift setting and were able to exsolve carbonatite melts that crystallized voluminous calcite carbonatite rocks during their evolution. In contrast, MgO-rich melilitite and nephelinite volcanic rocks from intracontinental settings are compositionally far away from any immiscibility field at reasonable pressures and were only able to unmix carbonatite melts during late-stage evolution, leaving small chance for calcite crystallization. CaO- and alkali-rich, but extremely silica-undersaturated melilitite melts play a key role in early silicate-carbonatite immiscibility, can only be preserved in melt inclusions and cannot be represented by volcanic rocks.