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Multiple mechanisms of carbonatite melt formation in alkaline igneous complexes

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Melt and fluid inclusions were investigated in minerals from two alkaline igneous complexes: Dunkeldyk, eastern Pamirs and Gardiner, East Greenland. Diopside from the alkaline basaltoids of the former complex contains cogenetic carbonate, silicate, and combined melt inclusions. During heating droplets of carbonate liquid in silicate melts were formed at 1040-1100^{o}C and gas dissolution was observed in the carbonate and silicate fractions at 1180^{o}C. The silicate glass of quenched inclusions contains $\sim$46 wt % SiO_2, 12–18 wt % Al_2O_3, 8.5 wt % FeO, up to 3 wt % MgO, up to 4 wt % Na_2O, up to 12 wt % Ê$_2$Î, up to 1.5 wt % ÂàO, 0.6 wt % SrO, 2 wt % H_2O, 1.2 wt % F, 0.7 wt % Cl, and 0.3 wt % S. The composition of the carbonatite melt was estimated using the experimental values of carbonate melt/silicate melt partition coefficients as 10 wt % SiO_2, $<$3 wt % Al_2O_3, 3 wt % MgO, 5 wt % FeO, 16 wt % CaO, and up to 20 wt % K_2O + Na_2O. The origin of the carbonatite melt was related to silicate-carbonate liquid immiscibility of an initial silicate magma enriched in CO_2, alkalis, ÑàÎ and incompatible trace elements. The presence of magmatic carbonates and hydrous minerals in inclusions suggests that the melts crystallized in a crustal magma chamber at about 0.7 GPa and were not affected by degassing.

The earliest melt inclusions in melilites from the Gardiner melilitolites show silicate-carbonate compositions and contain daughter shortite, $Na_2Ca_2(CO_3)_3$. They coexist with cogenetic gas-dominated and salt inclusions. It is supposed that an alkali-rich fluid was released at 1030-970^{o}C. During decompression and cooling, the fluid unmixed to a concentrated brine (salt melt) and a low-density gas phase. This resulted in the formation of an alkali-rich carbonate melt (up to 28 wt % Na_2O and 20 wt %

CaO), whose composition was similar to the Na-carbonatite lavas of Oldoinyo Lengai, Tanzania. The presence of water is supported by the occurrence in the inclusions of hydrous daughter phases, pectolite, phlogopite, and kankrinite. The two complexes addressed in this report illustrate two mechanisms of carbonatite melt formation: (i) liquid immiscibility of a silicate melt in a magma chamber and (ii) release of fluid and its subsequent dehydration with the formation of alkali-rich carbonate brine (melt).