Aillikite and Kimberlite Dike Emplacement as a Climax of Long-lived Magmatism in West Greenland

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Eruption of CO_2-rich ultramafic magma involves rapid ascent of mantle-derived magmas loaded with mantle xenoliths and xenocrysts (>30 vol%). The dynamics and duration of such eruptions are increasingly well constrained; the causes are nevertheless largely unclear. To address this issue, we performed a petrological and speedometric analysis of well-preserved crustal xenoliths from aillikite dikes at Sisimiut and Sarfartôq alkaline provinces, W Greenland.

The xenoliths represent mafic granulites, scavenged from c. 25-36 km depth within the mid-to-lower crust. The rocks are infiltrated by various types of melt in grain boundaries, cracks and veins. Zirconium-in rutile thermometry and Fe-in-rutile speedometry indicate melt temperature of c. 1,015 °C and melt exposure time of c. 4 hours for the host aillikite, implying an average ascent rate of c. 2 m s^{-1}. This is slower than average ascent rates of mantle cargo (4-40 m s^{-1} [1]), suggesting a slowing-down of transport at shallow levels.

Local diffusive zoning in garnet indicates up to 6,000 years of melt-assisted mass transport. This demonstrates a two-stage magmatic process of rapid melt ascent preceded by a previously unrecognized long magmatic episode. Melt infiltration at Sismiut lasted 10 times longer than at Sarfartôq, and unlike at Sarfartôq was initially associated with carbonate- and sulfide-rich melt. This contrast reflects a fundamental difference in the devolatilization efficiency of parental carbonatite magma. The rapid development of the Sarfartôq system is ascribed to the local lithospheric mantle being highly depleted and rich in the decarbonation reactant orthopyroxene [2]. A link is also proposed between this feature, and the occurrence of REE-carbonatite and diamond-bearing mantle cargo at that particular location.

References:

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