A model for the formation of carbonatite-phoscorite assemblages

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Carbonatites are mantle-derived igneous rocks (≥30 vol.% magmatic carbonates) often associated with a range of silicate rocks [1] and occasionally associated with phoscorites, which exclusively occur in combination with carbonatites [2]. However, individual emplacement processes and relations are not properly understood.

New phlogopite data from the Palabora complex [3] suggest that liquid immiscibility plays an important role during phoscorite petrogenesis [2]. We suggest that carbonatitic melts generated in the upper mantle were enriched in Fe and P due to the preferred partitioning of these elements into a carbonatitic melt [3, and references therein]. These carbonate-phosphate/iron-oxide-rich melts (CPIO melts) may represent parental melts for carbonatites and phoscorites. With an increasing enrichment of Fe and P, CPIO melts become denser and lose their state of buoyancy within a voluminous silicate melt accumulation, by which they may be dragged into an ascending channel. Due to decreasing temperature and pressure an ascending CPIO melt separates into a phoscoritic and carbonatitic magma. This segregation induces a large density contrast between carbonatite (low density) and phoscorite (high density) melts, which may cause descending phoscorite accumulation at the outer zones of the magma channel and a jet-like ascent of the carbonatite magma through the intruding silicate magma front to higher crustal levels.

Our work predicts the ratio between carbonatites and different associated rock types according to the source-emplacement-distance (ΔS-E) model, and explains the origin of phoscorite magmas.

[1] Mitchell (2005) *The Canadian Mineralogist* **43**, 2049-2068. [2] Krasnova et al. (2004) in Wall & Zaitsev (eds.) *The Mineralogical Society of Great Britain and Ireland*, 45-74. [3] Giebel et al. (2019) *Lithos* **324-325**, 89-104.