Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11290

Not yet on everyone's LIPs? Tasting the potassic flavours of Karoo volcanism

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Both lithospheric and sublithospheric mantle sources contribute to the vast volumes of primitive magmas in continental flood basalt provinces. Several large igneous provinces (LIPs) on cratons have been directly associated with rapid climatic and biotic change on a global scale. The outgassed volcanic CO_2 and SO_2 (and other volatiles) responsible for the observed environmental impact have been suggested to be sourced from either recycled crustal components in deep-seated mantle plumes or from volatile-rich components within ancient continental lithospheric mantle. These scenarios compete with models in which greenhouse and other gases are primarily released from sedimentary rock units intruded by LIPs. Distinguishing between these options has implications for modeling potential links between deep volatile cycles, volcanic activity, and environmental change.

Many basalt and picrite units of the ca. 180 Ma Karoo LIP in Africa–Antarctica show trace element and isotopic features that are best explained by melt contributions from incompatible element enriched components within the lithospheric mantle of former Gondwanaland. This implies that thick continental roots took actively part in magma formation. However, the exact nature of these strongly incompatible element enriched components remains elusive.

We identified a ca. 180 Ma old lamproite magmatic event in south-central Africa, sourced from within the diamond stability field. The ultrapotassic lavas provide first constraints on the origin and evolution of 'pure' K-rich components within the mantle source regions of a continental flood basalt province. Non-traditional stable isotope data do not support an origin of the K-rich component by subduction recycling of continental or oceanic crust. Rather, radiogenic isotope systematics suggest that such ultrapotassic components accumulated within a cratonic mantle root during episodic percolation of low-degree alkaline silicate melts since ca. 1 Ga. Such K-rich metasomes have relatively low melting points and, thus, are readily remobilized as the dominant enriched component of continental LIPs, which are sourced mainly from below the lithosphere. The most enriched Karoo picrites may contain up to 10% mass fraction from such K-rich cratonic mantle components. The carbon and sulfur budgets of these metasomes are, however, too small to cause significant environmental impact.