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New constraints on the origin of the eastern Australian potassic suite based on whole rock and mineral analyses

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The eastern Australian potassic suite (EAPS) makes up the 700 km-long southern portion of the world's longest continental hotspot track, the Cosgrove track [1]. In contrast to the large basaltic volcanic complexes to the east and north [2], the EAPS occurs exclusively as mafic potassium-rich occurrences with inferred low-volume expressions on the order of hundreds of metres to a few kilometres. These localities are usually on lithosphere thicker than 120 km [1] suggesting that the lithosphere-asthenosphere boundary may have a strong influence on the generation of these enriched melt compositions.

Texturally, these rocks comprise olivine, phlogopite, and oxide minerals with variable amounts of clinopyroxene and K-richterite. The primary felsic mineral in these rocks is the feldspathoid leucite, which sees them termed leucitites in constantly evolving classifications of exotic but potentially economically significant alkaline rocks [3]. However, this classification does not reflect their chemical or genetic affinity. In this study, we undertake a systematic re-evaluation with the aim of understanding their melting and source enrichment processes.

We present results of newly acquired major and trace element data for whole-rock (WR) and mineral analyses. Our WR data shows the EAPS is chemically variable, but exceptionally enriched in potassium, with high K_2O/Na_2O and MgO (K_2O 1.2 – 7.4 wt%; K_2O/Na_2O 0.3 -7.8; MgO 7 – 16 wt%). High K_2O concentrations are reflected in the abundance of leucite in the aphanitic groundmass and of phenocrystic phlogopite and K-richterite which varies significantly between eruptive centres. Phlogopites show significant enrichment in Ti and variable, but high F contents. Phlogopite is likely the primary contributor to the high TiO_2contents (3.3 – 5.3 wt%) and to volatile WR contents up to 4.8 wt%.

WR trace element patterns most closely resemble lamproites with similar mineralogy and these rocks bear many of the chemical hallmarks of lamproites. This new data helps inform interpretations of regional variations in melt generation and mantle source mineralogy in the highly heterogeneous metasomatised mantle beneath eastern Australia [2].

[1] Davies et al. (2015) Nature 525, 511-514
[2] Shea and Foley (2019) Minerals 9, 546
[3] Mitchell (2021) Encyclopedia of Geology, 215-239