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The East Australian Potassic Suite – Petrology, Geochemistry, and Origin

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The Eastern Australian Potassic Suite (EAPS) is an alkaline volcanic province made up of over 20 widely dispersed outcrops that extend almost 700 km, forming the southern portion of the Cosgrove track. These localities are usually on lithosphere greater than 120 km, suggesting that the lithosphere-asthenosphere boundary has a strong influence on their depth of generation. In contrast to larger basaltic volcanic complexes on thinner lithosphere, the EAPS is entirely mafic and characterised by potassium-rich occurrences with low-volume eruptions on the order of hundreds of metres to a few kilometres. We undertake a systematic re-evaluation of these occurrences to understand their source enrichment processes and melting conditions. Newly acquired major, trace, and volatile element, whole-rock data show that the EAPS is chemically variable, but exceptionally enriched in potassium, with high K_2O/Na_2O and MgO. We report the only complete volatile element data for the EAPS which show the lavas are similarly enriched in nitrogen to lamproites, while being more CO_2-rich despite being partially degassed. Trace element patterns most closely resemble orogenic lamproites, and the mineralogy, major element and trace element concentrations closely match the classification criteria for lamproites. Trace element ratios identify these melts as near-primary mantle melts with a primitive signature generated from a highly enriched source that has previously undergone mixed silicate-carbonatite metasomatism. The most likely source for these rocks is a phlogopite-bearing and olivine-poor assemblage that originates in the garnet stability field (i.e. phlogopite-garnet-pyroxenite). The relatively high Ti and P contents of these magmas are likely inherited from the source suggesting that apatite and oxide minerals were present during melting. These new data helps inform regional variations in melt generation and mantle source mineralogy in the highly heterogeneous metasomatised mantle beneath eastern Australia. We suggest that the mechanisms that generated the EAPS likely include a combination of edge-driven convection and shear-driven upwelling which contributed to metasomatic depletion and refertilisation cycles.