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The Eastern Australian Volcanic Province, its primitive melts, constraints on melt sources and the influence of mantle metasomatism

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The Eastern Australian Volcanic Province (EAVP) is a ~ 3,800 km discontinuous belt of Cenozoic mafic intraplate volcanoes along the eastern seaboard of Australia (Fig 1). EAVP volcanic centres contain mantle-derived melts that show minor fractionation but have large ranges in major element concentrations. Primitive melts cannot be explained by partial melting of mantle peridotites alone, and foundational work by [1] showed sources for EVAP melts must be metasomatised.

Based on a collated database of 3971 samples with chemical and spatial data across the EAVP, we show all primitive melt compositions can be produced by melting mantle source assemblages consisting of various proportions of three *'end-members'*: (1) a mixed anhydrous peridotite-pyroxenite, (2) a hydrous (phlogopite- and/or amphibole-bearing) pyroxenite, and (3) a hydrous pyroxenite + accessory Ti-oxides ± apatite. Primitive melts were identified with a filter on whole rock oxides, based on experimental melt compositions from realistic source compositions and *P*-*T* conditions. We suggest that the majority of, if not all, mantle source assemblages that gave rise to the EAVP underwent some degree of mantle metasomatism; this produced the three source end members introduced above. The metasomatic agents were probably silicate and carbonatite melts related to past subduction events during the accretion of eastern Australia while attached to eastern Gondwana between the mid-Cambrian to the late Triassic. Basaltic and leucitite centres can be clearly separated by TiO_2 and K_2O concentrations. Basaltic centres represent melts from the least metasomatised mantle sources on younger and thinner lithosphere to the east, whereas leucitites on older and thicker lithosphere to the west are sourced from pervasively metasomatised mantle assemblages at greater depths (120-160 km).

Melts within the EAVP were generated at temperatures below those required to melt peridotite, as the solidi for metasomatised mantle assemblages are depressed by ~ 300°C compared to anhydrous peridotites. At these cooler temperatures melting can begin with slight increases above the ambient upper mantle temperature (~ 1350 °C); this is compatible with shear-driven upwelling and edge-driven convection rather than mantle plume activity as the melting mechanism for intraplate volcanism in eastern Australia.

[1] Frey et al., 1978. JPetrol

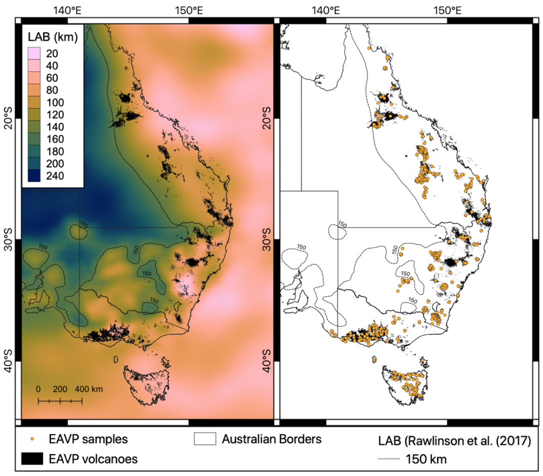

Figure 1. Maps with the discontinuous intraplate volcanic centres of the EAVP. The map on the left shows the LAB depth in relation to EAVP volcanic centres, and a 150 km LAB contour (Rawlinson et al., 2017). The map on the right includes all sample locations in the collated dataset.