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Polymagmatic activity and complex magma evolution at the monogenetic Mt Gambier Volcanic Complex in the Newer Volcanics Province, SE Australia

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Monogenetic volcanism can produce eruptive suites showing considerable complexity in compositional features and pre-eruptive magma evolution. The ∼5 ka Mt Gambier Volcanic Complex (MGVC), a monogenetic volcanic centre in the Newer Volcanics Province (NVP), SE Australia, is a good example. It displays a complex stratigraphy of interbedded deposits related to different eruption styles from a multi-vent system. Formation of the MGVC proceeded through simultaneous eruption of two alkali basaltic magma batches: a more alkaline and light rare earth element enriched basanite batch (Mg# 58-62) in the west and a trachybasalt batch (Mg# 58-64) enriched in SiO_2 and CaO in the east. Trace element modelling suggests an origin of both magma batches from a single parental melt formed by 4-5% partial melting of a metasomatised lherzolite source in the asthenospheric mantle (2.2 GPa; ∼80 km). At the base of the lithosphere, part of this parental melt interacted with a deep-seated pyroxenite contaminant to form the trachybasaltic suite. Further modification of either magma batch at crustal levels appears to have been negligible. Isotope and trace element signatures are consistent with the inferred asthenospheric magma source; Pb isotopes in particular suggest a source with mixed Indian mid-ocean ridge basalt (MORB)-Enriched Mantle 2 (EM2) affinities, the latter perhaps related to metasomatic overprinting. It is argued that Cainozoic NVP volcanism in SE Australia is not necessarily related to a mantle plume but can be explained by other models involving asthenospheric upwelling. Fast magma ascent rates in the lithosphere evidenced by the presence of mantle xenoliths may reflect reactivation of lithospheric structures that provide magma pathways to the surface.