Lithospheric Removal: The Cause of Widespread Cenozoic Intraplate Volcanism on Zealandia?

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Diffuse intraplate volcanism spanning the Cenozoic on Zealandia (the New Zealand micro-continent) has produced quartz tholeiitic to nephelinitic (including their differentiates) fields of monogenetic eruptive centers and large composite shield volcanoes. An extensive new $^{40}Ar/^{39}Ar$ age data set from the submarine (~90%) and subaerial (~10%) parts of Zealandia does not show any correlations between age, location or composition of the volcanism. The lack of age progressions of the volcanism and of seismic tomographic anomalies in the upper mantle beneath the volcanic fields [1] are not consistent with a plume origin for the intraplate volcanism. Although localized extension took place during some episodes of volcanic activity, the degree of extension does not correlate with erupted volumes or compositions. Major and trace element data suggest that the alkali basalts/tholeiites were derived through larger degrees of melting at shallower depths than the basanites/nephelinites and that all melts were produced from ocean island (OIB) type sources, containing garnet pyroxenite/eclogite. The Sr-Nd-Pb isotope data indicate that the basanites/nephelinites were derived from high time-integrated U/Pb (HIMU)-type sources and the alkali basalts/tholeiites from more enriched mantle (EM)-type sources, reflecting interaction with or derivation from lithosphere modified by subduction while Zealandia was attached to the Gondwana margin. The first-order cause of melting is inferred to be decompression melting of upwelling asthenosphere, triggered by piecemeal (sometimes incremental) removal (detachment) of different parts of the subcontinental lithospheric keel throughout the Cenozoic. Different volcanic styles in part reflect the mode of removal, and size and shape of detached parts of the lithospheric keel. Removal of continental lithospheric mantle could be an important processes for explaining the origin of Diffuse Igneous Provinces globally.

References

[1] Finn C.A., Mueller R.D., Panter K.S. (2005) G^3, 6 Q02005, doi:02010.01029/02004GC000723.