Mapping the 4D lithospheric architecture of Zealandia using zircon O and Hf isotopes in plutonic rocks

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A comprehensive multi-isotopic study of zircon from over 170 plutonic rocks has been completed for the recently discovered continent of Zealandia. The analysed plutonic rocks are from Zealandia's Western Province, and represent a c. 400 Ma period of plutonism along the active continental margin of Gondwana from the Cambrian to the Early Cretaceous. This new dataset includes >1500 O-isotope analyses, and >3500 Lu-Hf and U-Pb analyses, making Zealandia's Western Province one of the most well characterized segments of Phanerozoic continental lithosphere in the world.

Multi-isotopic contour maps have been produced that effectively 'image' the cryptic nature of Zealandia's deep lithosperic architecture and its evolution through time. For the first time, these maps reveal marked differences in both $\delta^{18}O_{zircon}$ and $\varepsilon_{Hf}(t)$ that highlight distinct lithospheric 'domains' requiring diverse sources and/or processes in the petrogenesis of the emplaced magmas. Significantly, a pervasive domain of plutons with light-$\delta^{18}O_{zircon}$ values (<< +4.7 ‰) and primitive $\varepsilon_{Hf}(t)$ is recognised along the eastern margin of Zealandia's Western Province. This light-$\delta^{18}O$ domain appears unique in a global context, and especially for magmas generated and emplaced along a continental arc margin. This light-$\delta^{18}O$ domain is long-lived (>400 Ma), spatially extensive, and relatively isotopically homogeneous, and is interpreted to indicate the presence of a primitive mafic lithospheric keel beneath Zealandia that was hydrothermally altered prior to Phanerozoic melting. Calculated crustal residence ages suggest that this keel is Precambrian in age, and was formed in response to Rodianian assembly and eventual supercontinental rifting. This result significantly enhances our understanding of the age and character of Zealandia's lithosphere, especially since no Precambrian crust has been found at the surface.