Use of *in situ* Hf–isotope analyses of zircon to interpret granitoid magma genesis

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In situ analysis of zircon is revealing wide ranges in Hf–isotope composition within single granitoid bodies, that may suggest mixing of crustal– and mantle–derived magmas or mixing of magmas from different crustal sources. In this study, *in situ* LAM–ICPMS U–Pb and Hf–isotope analyses of zircon have been used to constrain models of granitoid magma genesis in the Australian craton, and the adjacent Palaeozoic Tasman Fold Belt, north Queensland.

Zircon rims and unzoned grains of Siluro–Devonian age in I–type granitoids from the cratonic Georgetown Inlier have a wide range in $^{176}Hf/^{177}Hf$ (from 0.28167 to 0.28228) almost identical to that defined by their resorbed Mesoproterozoic cores and grains. The observed ε_{Hf} values in the granitoids can be explained by remelting of ca 1550 Ma old crust that was already heterogeneous, and no juvenile mantle input is required, although underplating by mantle–derived basaltic magmas may have provided heat for crustal melting. The range in ε_{Hf} values of core–rim pairs and/or inherited zircon cores in granites from the Hodgkinson Province, in the Tasman Fold Belt, also is consistent with remelting of heterogeneous Proterozoic crust. Rare inherited Proterozoic zircons with radiogenic Hf–isotope compositions in the Siluro–Devonian and Permian granitoids require juvenile mantle input, whereas other Proterozoic zircons require crustal source rocks, suggesting that the heterogeneity of the Proterozoic crust reflects an assembly of magmatic rocks derived from Archean crustal rocks, and some juvenile mantle–derived magmas.

Some Carboniferous granitoids in the Georgetown Inlier, and some Permian granites in the Hodgkinson Province, have a narrow range in ε_{Hf} values, and show no evidence for juvenile mantle input. The observed ε_{Hf} values may reflect crustal remelting, in which inherited zircons completely dissolved, followed by magma homogenisation before zircon crystallised. Although similar in age, the individual Carboniferous granitoids within each Supersuite have a range of Hf–isotope compositions that cannot be produced by fractional crystallisation. Some of these granitoids are host–rocks to mineralisation, and mixing of magmas from different crustal sources may be a significant process in producing metallogenic fertility in such granitoid magmas.