Craton-scale variations in crustal evolution: new insights from Scottish Highland detrital zircon

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Recent work on the evolution of the Earth's continental crust has focussed on the ability of refractory minerals, such as zircon, to preserve information about crustal units long since lost from the rock record. Techniques used in these studies include U-Pb ages of crystallisation, $\delta^{18}O$ to track crustal contamination, and Hf model ages of source rock extraction from the mantle. Such analyses, either alone or in combination, can provide insight into questions on a range of scales, from identifying early recycled material in younger crust, to locating similar (possibly related) source rocks now separated by great distances and investigating whether early crustal production were regional or global in extent.

Work on detrital zircons from key areas of Hadean and Early Archaean crust - the Jack Hills (eastern Australia), Acasta Gneiss and Slave Province (Canada) and the Limpopo Belt (southern Africa) - has suggested crustal generation was episodic, with distinct peaks every 0.3-0.6 Ga from 4.5-1.2Ga. Younger sediments from other areas of the world could record many of the same events, and/or identify new ones. One such area is north-west Scotland, which comprises various unconformable Proterozoic and Palaeozoic (meta)sedimentary units that have sampled the underlying basement, and potentially basement from further afield within Laurentia and possibly Baltica. While many studies in other localities have presented combined U-Pb and Hf data to identify episodes of crustal production, the addition of $\delta^{18}O$ analyses can distinguish between production of juvenile crust and reworking of pre-existing (sedimentary) material. We present the first correlated in situ U-Pb, $\delta^{18}O$ and εHf data from detrital zircons sampled throughout the region, including the Meso- to Neoproterozoic Torridonian and Moine Supergroup and Cambro-Ordovician sediments. These data identify significant juvenile extraction events at c.1.6, c.2.2 and c.3.3Ga, without regard to stratigraphic level. In addition, three zircon crystallisation episodes correspond with the onset of supercontinent stabilisation - Superia, Nuna and Rodinia. The extraction events identified in this study fall between those recognised from older sediments in previous work, suggesting possible differences in the records of crust generation preserved in different terrains. Such differences may be of assistance when tracking continental cratons through the formation and destruction of supercontinents such as Rodinia.

These samples also contribute to our understanding of Scottish regional geology, and our ability to correlate these detrital repositories with those in other parts of the world. Previous U-Pb provenance work indicates these Scottish rocks correlate with similar sequences in Greenland and Labrador, Canada, all derived from now-absent units on greater Laurentia. The Scottish data represent the first crustal evolution work of this kind to be undertaken on this significant craton.