The trace-element content of zircon as a fingerprint of Hadean magmas

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Zircon is an important accessory minerals because of its durability, use as a geochronometer, and ability to record geochemical signatures that are related to the temperature, oxygen fugacity, or composition of the melt from which it crystallised. Detrital zircons may be all that survive of earlier igneous rocks and crystals of zircon in the Jack Hills metasediments are the oldest known samples of the Earth.

To assess how the trace element composition of zircon relates to the composition of a magma, the concentrations of 26 elements in 75 zircons from 13 I-type and 70 zircons from 10 S-type granites of the Lachlan Fold Belt, the type locality where these end-members were first defined, were determined. The results were compared to published data for the Jack Hills zircons (JHZ).

The zircons from the I- and S-type granites exhibit clear differences in the abundances of various elements. In particular, the P content and P:(REE+Y) ratio can be used to distinguish between I- and S-type sources. There is a strong 1:1 correlation between P and (REE+Y) in zircon from S-type granites, but not for those from the I-types.

There are strong similarities between the trace element signatures of zircon from I-type granites and the JHZ. These indicate that the JHZ crystallised predominantly from I-type magmas formed by melting of a reduced, garnet-bearing lower crust. There is no apparent change in the composition of the source of the JHZ despite an age range of over 700 Ma. The melts that produced the JHZ may have formed in a similar environment to Archaean tonalite-trondhjemite-granodiorites. The Ce and Eu anomalies in the JHZ suggest that the crustal source was about an order of magnitude more reduced than the sources of Phanerozoic I-type granites.

The low P contents of the JHZ are inconsistent with the strongly peraluminous compositions that would normally be required for the observed inclusions of muscovite to be primary. There is no clear evidence that sediment melting played a significant role in the formation of the melts from which the JHZ crystallised.

[1] Burnham & Berry (2017) Nature Geoscience (in press).