Zircon in lithosphere evolution studies: Exploring the weak link

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The combined U-Pb and Hf-isotope systematics of zircon provide a powerful tool for studying processes of crust and mantle evolution. New technologies and large-volume zircon datasets make it possible to study lithosphere evolution on a global scale and have boosted the number of emerging crustal growth models [1, 2]. It is generally accepted now that 65-70% of continental crust was originally generated in Archean time and the prominent peaks in the age distribution of zircon-bearing rocks do not reflect net crustal growth, but simply record periods of increased crustal reworking linked to collisional tectonics. However, available datasets are likely to be representative mainly of the upper crust, and in particular the more felsic (hence zircon-rich) parts of it. This already introduces a bias in the modelling by underestimating the proportions of more mafic lithologies that dominate the lower crust and upper mantle. This issue is clearly reflected in the deep trough on the distribution curves of zircon crystallisation age, including a globally recognised minimum at 2.4-2.2 Ga [2, 3]. These intervals correspond to breakup of supercontinents and could be related to magma-plume rifting processes that are missing in the zircon record.

Bridging this weak link in the zircon record, is a significant series of mantle-derived zircons from alkaline mafic and ultramafic rocks. They are distinguished from grains of crustal origin by distinct crystal morphology, trace-element contents, and Hf- and O-isotope composition. Recent studies also suggest large differences in zircon saturation between intermediate-felsic magmas and mafic magmas [4]. This group of zircons provides insights into the evolution of the lowest levels of crust, and of cratonic lithosphere. One of the outstanding examples is the evidence for a long-lived (ca 2.7 Ga) lithosphere-scale magmatic system under the Siberian Craton [5]. Clear recognition of mantle- versus crustal-derived zircons is thus essential for understanding of the dynamics of crust-mantle interactions, recognition of crustal recycling, and lithosphere processes.

[1] Hawkesworth *et al*. (2019) *Geoscience Frontiers* **10**, 165-173. [2] Belousova *et al*. (2010) *Lithos* **119**, 457-466. [3] Condie *et al*. (2009) *EPSL* **282**, 294-298. [4] Shao *et al*. (2018) *Solid Earth Sciences* **in press**, 1-16. [5] Tretiakova *et al*. (2017) *Gondwana Research* **42**, 126-132.