Zircon trace element compositions as a proxy for continental crust evolution

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Continents modulate Earth's habitability, ocean chemistry and biogeochemical cycles, therefore understanding how they formed is critical to understand Earth system evolution. While whole rock geochemical data compilations have provided important information on crustal evolution, they are limited by "petrogenetic gaps" — key age intervals that are underrepresented. Conversely, zircon is resistant to chemical and physical weathering and thus presents as a tool to fill-in these petrogenetic gaps in the crustal chemistry record. Global detrital zircon U-Th-Pb, Hf, and O isotopic datasets have been extensively used to investigate continental growth history, while zircon trace element (TE) concentrations have received comparatively little attention. Using Laser Ablation Split Stream analysis, we have generated a comprehensive global detrital zircon U-Pb and TE dataset, spanning seven continents and ~4 Ga. Combined with existing data, we used Monte Carlo Bootstrap resampling to generate a temporal record of zircon TE chemistry over geological time. This dataset reveals many similarities with published whole-rock records as well as a number of novel features. LREE/HREE and Eu/Eu* trends are consistent with stabilization of thick crust during the Archean, after which the crustal thickness progressively decreases. Most incompatible elements increase progressively corresponding with modeled decreases in mantle potential temperature. After 800 Ma, total Hf decreases whereas P, Th, and HREE markedly increase. This may be related to lower proportions of continental detritus in subducted sediments, which have greater concentrations of Hf compared to abyssal clays. Similarly, compiled εHf data shows more positive averaged values after 800 Ma, which further indicates a broad decrease in continental reworking and an increase in juvenile magmatism. Thus, combined detrital zircon εHf and trace element data may potentially indicate enhanced lateral continental growth during following the Neoproterozoic.