Stepwise chemical abrasion ID-TIMS-TEA of Hadean Jack Hills Zircon microfragments

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The Hadean Jack Hills Zircons represent the oldest known terrestrial material, providing a direct record of Hadean Earth history. This unique zircon population has been extensively studied via high spatial resolution, high throughput in situ isotopic and elemental analysis techniques such as SIMS. However, the Jack Hills zircons have never been previously been subjected to high-precision CA-ID-TIMS geochronology. Higher temporal precision has the potential to, for instance, more accurately assess concordance in Hadean zircon populations to constrain lead loss and alteration history.

In order better understand the lead loss history of terrestrial Hadean zircons and to explore the analytical space bridging the complementary capabilities of traditional TIMS and SIMS geochronology, we conduct multiple step leaching CA-ID-TIMS-TEA on manually microfractured Jack Hills zircon fragments that were previously dated by SIMS and shown to be Hadean. We conducted three successive HF leaching steps on each individual zircon fragments, followed by column chromatography to isolate U-Pb and trace element fractions. Following isotopic and elemental analysis, the result is an independent age and trace element composition for each leachate of each zircon fragment.

The results provide insight into Hadean zircon formation and subsequent lead loss history, as well as new insight into the mechanism of chemical abrasion. We document a protracted history of Hadean zircon growth, with multiple Hadean zircon formation events over more than 100 million years. Meanwhile, step-wise leachate trace element chemistry reveal enrichments of LREE, U, Th, and Pb* in early leached domains relative to the zircon residue, suggestive of the removal of metamict domains that have been subject to partial open-system behavior.