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In-situ U-Th/Pb geochronology of (urano)thorite

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ABSTRACT

A laser-ablation multi-collector inductively coupled plasma mass spectrometry (LA-MC-ICPMS) study of seven thorite and uranothorite [$(Th,U)SiO_4$] samples ranging in age from ~13 to ~500 Ma provides new insights into the U-Th/Pb isotope systematics of these geologically significant, high-Th mineral species. Despite extreme actinide enrichment and complex intra-crystal zonation in actinides and rare earth elements, this study demonstrates that radiogenic-lead loss and/or metamictization is minimal and restricted to domains that have undergone significant hydration. Dating of four igneous uranothorites yields ages that are concordant in U/Pb and Th/Pb space, consistent with other high-temperature chronometers, and are inferred to accurately reflect the timing of crystallization of each rock. Similarly, Th/Pb ages of three thorite and/or huttonite-bearing samples yield geologically plausible dates consistent with other mineral chronometers. No evidence of isotopic inheritance was observed in any of the samples. Data presented here demonstrate for the first time the feasibility of extracting accurate and precise U/Pb and Th/Pb ages from Phanerozoic thorite, uranothorite and huttonite using LA-MC-ICPMS at the 5 μm spatial resolution. These phases have the potential to be robust chronometers in igneous and metamorphic rocks as well as to provide important provenance information complementary to more widely used minerals such as detrital zircon.

Keywords: Thorite, uranothorite, huttonite, laser ablation, geochronology