Measuring actinide partitioning to improve the ^{230}Th correction

A. N. COCCIADIFERRO[1]*, N. M. MCLEAN[1], M. J. KRAWCZYNSKI[2], J. P. TOURAN[2]

[1]Univ. of Kansas, Lawrence, KS 66045, USA
(*correspondence: ashleycocc@ku.edu
[2]Washington Univ., St. Louis, MO 63130, USA

The element Th, including its isotope ^{230}Th, an intermediate daughter isotope in the ^{238}U decay series, is excluded relative to U from the mineral zircon during crystallization. Zircon is geochronologically important due to its ability to incorporate U, but when Th is excluded a deviation from secular equilibrium occurs. The return to secular equilibrium after crystallization results in a deficit of daughter ^{206}Pb, meaning measured zircon ^{206}Pb/^{238}U dates are up to ~100 ka too young. The ^{230}Th deficit can be corrected for by comparing estimated Th/U_{zircon} to Th/U_{melt} and calculating a fractionation factor. This fractionation factor is a major source of uncertainty for Cenozoic zircon because existing Th-U partitioning studies on experiments and natural samples are imprecise [1, 2, 3].

A series of experiments across realistic zircon crystallization conditions (pressure, temperature, volatiles, oxygen fugacity, composition) will explore the effects of zircon-melt partitioning of Th and U. Improving the accuracy and precision of U-Pb zircon dates ultimately requires measurements of Th/U fractionation with 1-5% uncertainties. This will be accomplished by calibrating a new Th-U isotopic tracer, spiking individual zircon crystals and glass fragments, and utilizing an ICP-MS. Interpolating among these measurements, we hope to define a model of Th-U behavior that will be made widely available in U-Pb data reduction software [e.g., 4] to calculate better ^{230}Th corrections.

The CA-ID-TIMS method [5] can determine zircon ages to better than 0.05% [6], but for Cenozoic zircon, the ^{230}Th correction dominates the analytical and systematic uncertainty budget. With a precise and accurate ^{230}Th correction, young zircon can better resolve rapid geologic processes such as incremental pluton assembly [e.g., 7] and provide better age constraints on extinction and biotic recovery events [e.g., 8].

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