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Improving accuracy and precision of zircon (U–Th)/He dates by rectifying parent nuclide zonation with time-of-flight secondary ion mass spectrometry (ToF-SIMS)

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Distribution of parent isotopes (i.e., U, Th, ±Sm) in minerals used for (U-Th)/He dating can significantly affect the accuracy and precision of (U-Th)/He data (e.g., [1]). However, currently, distribution of parent nuclides is not routinely examined in (U-Th)/He dating workflows but instead homogeneity of parent nuclides is assumed, despite the fact that commonly dated minerals, such as zircon, often show zonation in uranium and thorium. In this paper, we present a novel approach utilizing time-of-flight secondary ion mass spectrometry (ToF-SIMS) to quantify isotopic variations in zircon for (U-Th)/He dating. ToF-SIMS is essentially a non-destructive, surface analysis technique that is capable of generating 2D isotopic maps with ≤50 nm lateral resolution in a relatively short time (tens of minutes per crystal). We demonstrate how our new, ToF-SIMS-based protocol for high-spatial resolution 2D mapping of uranium and thorium in minerals, can be used for improved alpha ejection correction of (U-Th)/He dates, ultimately resulting in more accurate, more precise and less dispersed (U-Th)/He data, and also benefit (U-Th)/He based thermal history models through improved parametrization of input data.

[1] Meesters & Dunai (2002): *Chemical Geology* 186(3-4), 333-344.