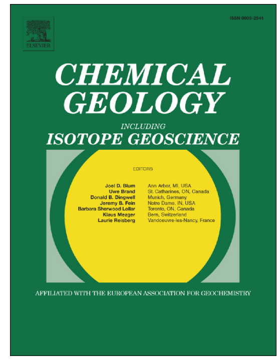
Accepted Manuscript



Distinguishing slow cooling versus multiphase cooling and heating in zircon and apatite (U-Th)/He datasets: The case of the McClure Mountain syenite standard

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PII: S0009-2541(18)30157-8
DOI: doi:10.1016/j.chemgeo.2018.03.038
Reference: CHEMGE 18718

To appear in: *Chemical Geology*

Received date: 15 December 2017
Revised date: 23 March 2018
Accepted date: 26 March 2018

Please cite this article as: Wesley R. Weisberg, James R. Metcalf, Rebecca M. Flowers , Distinguishing slow cooling versus multiphase cooling and heating in zircon and apatite (U-Th)/He datasets: The case of the McClure Mountain syenite standard. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Chemge(2017), doi:10.1016/j.chemgeo.2018.03.038

Distinguishing slow cooling versus multiphase cooling and heating in zircon and apatite (U-Th)/He datasets: the case of the McClure Mountain syenite standard

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Revised version submitted to *Chemical Geology*

Abstract

New zircon, titanite, and apatite (U-Th)/He (ZHe, THe, AHe) data for four samples of the 524 Ma McClure Mountain syenite (MMS) in the Wet Mountains of Colorado constrain the <200°C thermal history of this $^{40}Ar/^{39}Ar$ geochronology standard. ZHe dates vary from 420 to 567 Ma, do not correlate with their limited eU range (66-388 ppm), have dispersion attributable to eU zonation, and show no systematic variation between samples. THe dates are 488 to 515 Ma. AHe dates range from 70 to 211 Ma, with some inter-sample variability that could be due to modest post-70 Ma displacements along faults. Our dataset is consistent with recently published (U-Th)/He data for the MMS, although the published ZHe results extend to higher eU and define a negative date-eU correlation not captured by our lower eU zircons. Existing U-Pb and $^{40}Ar/^{39}Ar$ thermochronologic data, together with the THe and ZHe results, document rapid post-emplacement cooling of the MMS to ≤200°C by ~500 Ma. A recent (U-Th)/He study inferred that the MMS subsequently underwent simple slow monotonic cooling until present-day. However, geologic relationships are incompatible with such a history, instead requiring that rocks in the vicinity of the MMS were at the surface at ~480 Ma, ~180 Ma, and ~60 Ma, with possible phases of burial and erosion of varying magnitude between these times. Inverse thermal history modeling can simultaneously satisfy the new and previously published ZHe and AHe