Geophysical Research Abstracts,
Vol. 11, EGU2009-10247-1, 2009
EGU General Assembly 2009

Reproducibility of old apatite (U-Th)/He ages: an example from East Greenland

C. Persano (1), D.A. Swift (2), F.M. Stuart (3), and V. Olive (3)

(1) Department of Geographical & Earth Sciences, East Quadrangle, University of Glasgow; Glasgow, G12 8QQ, UK (Cristina.Persano@ges.gla.ac.uk), (2) Department of Geography, University of Sheffield, Winter Street, Sheffield, S10 2TN, UK (d.a.swift@sheffield.ac.uk) , (3) Scottish Universities Environmental Research Centre, Rankine Avenue, East Kilbride; G75 0QF, UK (f.stuart@suerc.gla.ac.uk; v.olive@suerc.gla.ac.uk)

In the last decade or so the apatite (U-Th)/He thermochronometer has proved increasingly useful as a tool for quantifying rates of denudation and hence the timing and mechanisms of landscape evolution. This has required advances in analytical procedures, a better understanding of the effects of alpha-recoil and parent element distribution on He diffusivity gradients, and the introduction of new software that enables users to combine (U-Th)/He data with apatite fission track information to better constrain thermal histories. However, several recent studies have shown that AHe ages in excess of 50-100 Ma are often older than expected based on the fission track ages of apatite from the same rock, implying that the apatite (U-Th)/He thermochronometer can be applied only to much 'younger' landscapes.

Here we present a statistically large number of replicate single-grain apatite (U-Th)/He age measurements from eighteen samples collected in the East Greenland fjord region in order to test the extent to which anomalously old AHe ages may reflect differences in crystal size and diffusion behaviour (as a result of radiation damage related to high [eU]). The samples constitute four topographic profiles, spanning elevations from sea-level to $\sim$1100 m, collected in Devonian sandstone (1 profile) and Caledonian basement (3 profiles). Up to 20 transparent, euhedral crystals were analysed for each sample, resulting in a total of 214 (U-Th)/He determinations. Only one sample (He age: 31 ± 3 Ma; n = 6) reproduces within the 10% uncertainty that approaches the reproducibility (1 sigma) of the laboratory internal standard. Generally, reproducibility decreases with AHe age and samples with average ages older than $\sim$ 50 Ma show particularly poor reproducibility, with standard deviations calculated over the arithmetic mean of the single-crystal corrected AHe ages of up to 40%.

To explore the reasons for such poor reproducibility, we focus here on three samples from a single profile in Caledonian basement that should therefore have experienced the same thermal history. Importantly, the probability distribution of all the replicates for each sample is normal, indicating that poor age reproducibility cannot be ascribed to 'excess He' due to the presence of undetected fluid and/or mineral inclusions. Replicates with low parent concentration (i.e. [eU] $<$10 ppm) show some correlation between crystal size and AHe ages. We interpret this as indicating that for the time spanned by these AHe ages, radiation damage resulting from a parent concentration of $<$ 10 ppm is insufficient to affect the He diffusivity. Higher parent concentrations should cause sufficient radiation damage, but not all replicates characterised by high U and Th are characterised by consistently old AHe ages. It is therefore possible that other factors, such as a complicated thermal history, play a role in determining the AHe age variability of these samples.

These preliminary results indicate that in samples with a high U and Th concentration and/or old AHe age ($> \sim$50 Ma), radiation damage may be an important factor in controlling He diffusion. Diffusion is time-dependent and the AHe ages need to be modelled and interpreted taking into account the effect of radiation damage. Without correction, the AHe ages should be considered as maximum ages, even in the case of the youngest replicates. This study shows that non-reproducible samples should not be simply discounted on the basis of an inferred poor quality of the picking procedure, as they many provide fundamental information about 4He diffusion and in general how AHe ages should be interpreted and used to constrain the rocks thermal histories.