Anomalous apatite (U-Th)/He ages vs fictional track annealing

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An increasing body of evidence shows that in samples with apatite fission track (AFT) ages older than ~100 Ma, apatite (U-Th)/He ages are commonly much older than expected on the basis of the thermal history derived from the AFT data. While originally considered as representing problems with the (U-Th)/He system (e,g, [1,2]), Hendricks and Redfield [3] recently suggested that incompatible apatite (U-Th)/He and FT ages from Fennoscandia could be explained by "radiation enhanced" fission track annealing at low temperatures. In this interpretation, AFT ages from the region are regarded as anomalously young, not providing a reliable measure of the thermal history of the sampled rock.

A compilation of AFTA data and (U-Th)/He ages in apatites from a varied suite of samples illustrates the disparity between the two systems, and show that the degree of inconsistency becomes increasingly pronounced as the product of the uranium content and the measured FT or He ages increases. Significantly, in low uranium apatites the two techniques give much more consistent results.

In order to identify the source of this disparity, we analysed apatites from a setting where AFTA and (U-Th)/He data in high and low uranium apatites having shared a common history can be directly compared, within a setting constrained by independent evidence. Measured (U-Th/He ages in high uranium apatites are clearly anomalous, these apatites retaining He at temperatures where accepted diffusion systematics suggest all He should be lost. We conclude that inconsistencies between AFTA and apatite (U-Th)/He dating arise because of a change in the helium retentivity of apatite as the accumulated radiation dose within the crystal lattice increases, and suggest that apatite (U-Th)/He studies should routinely incorporate AFT data in order to monitor the (U-Th)/He system response and to guard against the anomalous behaviour described here.

We see no reason to regard published fission track ages from Fennoscandia in terms of non-thermal age reduction. Data from other cratonic regions shows evidence for repeated cycles of burial and exhumation, and we suggest a similar history (supported by geological evidence) can readily explain the AFT data from Fennoscandia.

References

[1] Crowhurst, P.V., Green, P.F., Farley, K.A., Jacobs, J. and Griffin. B. (2004) (Abstract). 10th Int. Conference on fission track dating and thermochronology, Amsterdam

[2] Lorencak, M., Kohn, B.P., Osadetz, K.G. and Gleadow, A.J.W. (2004) *EPSL* 227, 87-104.

[3] Hendriks, B.W.H. and Redfield T.F. (2005) *EPSL* 236, 443-458.