Re-evaluating low temperature apatite thermochronology in slowly cooled terranes

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Crossover of the predicted apatite fission track (AFT)>(U-Th)/He (AHe) age relationship recently reported for the eastern Fennoscandian shield has been interpreted in terms of failure of the AFT system to properly record long-term stability due to postulated radiation-enhanced annealing at low temperatures [1]. We report large data sets from slowly cooled terranes in the shields of Western Australia, southern Canada and northeastern Brazil to further evaluate this claim. Plots of U content versus AFT age, single grain AFT age or mean track length using AFT data selection criteria adopted by [1] do not show the pronounced negative correlation reported from the eastern Fennoscandian shield, but more closely conform to those in the western part of that shield. The most consistent and reproducible AHe results, which also honour the AFT>AHe age relationship, are from apatites hosted by the low U and Th environment of mafic to ultramafic rock types. This suggests that existing modelling protocols are applicable to derive thermal histories for such samples and most likely record a realistic cooling and denudation history. AHe measurements from the more extensive 'silicic' lithologies mostly yield non-reproducible and seemingly anomalously old AHe ages compared to their coexisting AFT ages.

We find no systematic radiation-enhanced annealing effects on the cratons investigated, but note that in samples where apatite U content exceeds ~80 ppm, there is a clear crossover effect. However, the AHe data, although reproducible, is too old when other geological factors are taken into account, making the use of conventional apatite kinetic annealing models inappropriate for such samples, as suggested by [1]. In another case reproducible AHe analyses from younger terranes exceed the crystallisation ages of their host plutons. We suggest that the interpretation of AHe data from slowly cooled terranes can not always be taken at face value without accompanying AFT data and where possible other geological evidence.

References

[1] Hendriks BWH and Redfield TF (2005) *Earth and Planetary Science Letters* **236**, 443-458.