Progress and Problems with Apatite (U-Th)/He Dating

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It has been about a decade since the first apatite (U-Th)/He ages demonstrated the potential of the method for uniquely low-temperature thermochronometry. In that period much has been learned about the mechanism of helium diffusion, how to interpret and model ages associated with cooling through such low temperatures, and a wealth of applications have been pursued ranging from fault-associated uplift to river incision histories to regional erosion to paleotopography.

Despite numerous successes, there has been a growing recognition that in some cases apatite (U-Th)/He ages are irreproducible, or inconsistent with expectations derived from apatite fission track data. Based on analyses of a very large number of multiply-replicated samples at Caltech, it now seems clear that individual apatite grains from a single rock typically reproduce at ~7% (1σ), far worse than analytical precision. A subset of samples yield far more discrepant ages. This variability is independent of cooling rate, and contrary to expectations the scatter is not preferentially toward older ages as expected, e.g., from inclusions or α implantation. Some of this variability, especially as occurs in rocks which have been subjected to reheating (e.g., detrital apatites), can be attributed to radiation-damage induced changes in He retentivity, as discussed by Shuster et al. and Flowers et al., this volume. In other cases additional and as yet only poorly understood processes must be involved. In this talk I will summarize our observations and offer possible explanations for these results and suggest under what circumstances apatite (U-Th)/He ages seem most reliable, and in what circumstances they may be invalid.