Can Apatite (U-Th)/He Dating Provide Useful Thermal History Information in Sedimentary Basins?

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Numerous studies have illustrated the potential of apatite (U-Th)/He dating for refining thermal history solutions derived from AFTA (apatite fission track analysis) and VR (vitrinite reflectance) data in hydrocarbon exploration settings, particularly at lower temperatures.

Initial studies showed a high degree of consistency between AFTA and apatite (U-Th)/He dating, but increasing evidence contradicts this simple picture, revealing apatite (U-Th)/He ages which are often much older than expected on the basis of AFTA. Use of thermochronologic data in hydrocarbon exploration demands accuracy in the systematics of the processes involved, and therefore it is vital that the cause of any inconsistencies between different techniques should be identified and eliminated.

This inconsistency between AFTA and (U-Th)/He becomes particularly pronounced in samples giving Mesozoic or Paleozoic ages, although low uranium apatites provide more consistent data. Results from a setting where AFTA and (U-Th)/He data in high and low uranium apatites can be compared reveal that (U-Th)/He ages in high uranium apatites are clearly anomalous, retaining He at temperatures where accepted diffusion systematics suggest all He should be lost.

We conclude that the 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. We find that published He diffusion systematics apply only to “low-dose” apatites, and their use in extracting thermal history information from apatites giving fission track ages are older than ~50 Ma can be justified only if the uranium content is < ~2 ppm.