Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.25630

What causes variation in apatite (U-Th-Sm)/He data?

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Apatite (U-Th-Sm)/He (AHe) analysis dates the cooling of rocks through the 40–75 °C temperature window. It is therefore the method of choice for analyzing processes close to the Earth's surface, e.g., uplift and erosion in mountain belts, unroofing along normal faults, or sedimentary burial and basin inversion. A major problem in AHe analysis is intra-sample age dispersion (ISAD) – variation in single-grain ages within a sample exceeding analytical uncertainties. As ISAD complicates or prevents the interpretation of AHe data in terms of a sample's thermal history, understanding its main sources is crucial for improving the capabilities of apatite thermochronology. The current state of knowledge assumes that ISAD results from the interplay of apatite-grain properties, e.g., grain size, mineral chemistry, and radiation damage, and the thermal history. There are two major obstacles to trace ISAD back to its causes by conventional whole-grain AHe analysis: the small number of grains routinely measured, and the necessary digestion of the grains in acid inhibiting the analysis of other parameters after dating. The novel laser-ablation-based AHe (LA-AHe) analysis is an alternative, less destructive technique that allows fast acquisition of large datasets. We present LA-AHe ages from bedrock samples with different thermal histories together with additional grain-size, major and trace-element, and Raman spectroscopic data. For each sample we evaluate the effect of the grain properties on the AHe age and relate the differences across sample ages and cooling rates.