Laser ablation *in situ* (U-Th-Sm)/He and U-Pb double dating of apatite

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Combined *in situ* (U-Th-Sm)/He thermochronology and U-Pb geochronology utilizing ablation excimer lasers is a promising new approach for dating accessory minerals [1-7], that provides advantages over traditional solution-based methods in terms of sample requirements, throughput, spatial resolution, avoidance of alpha-ejection correction, and analytical safety. The efficacy of the *in situ* approach has been demonstrated on zircon and monazite [1-7], which, owing to their high U and/or Th content, yield sufficient quantities of radiogenic He for measurement from the small sample volume. Here, we explore the potential of *in situ* apatite double dating. The major analytical challenges for apatite include the low U, Th and He contents relative to zircon and its elevated non-radiogenic Pb content. On the other hand, the typically less extreme and less complex zoning of parent isotopes (U and Th) are an advantage.

We have developed analytical protocols for apatite *in situ* dating utilizing an integrated range of instruments (i.e., 193 nm excimer laser, ultra-high vacuum system with a noble gas mass-spectrometer, and a quadrupole ICP-MS - the system commercially known as the RESOchron^{TM}), and applied these to a gem quality Durango apatite and to high U (~900 ppm) apatite crystals from the Black Forest [8]. The *in situ* U-Pb and (U-Th-Sm)/He ages obtained are in good agreement with those determined by conventional U-Pb TIMS and (U-Th-Sm)/He dating methods [8], providing a solid base for further experiments that will target more 'common' apatite crystals with lower U and Th concentrations.

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