

Automated, Turn-key Thermochronology

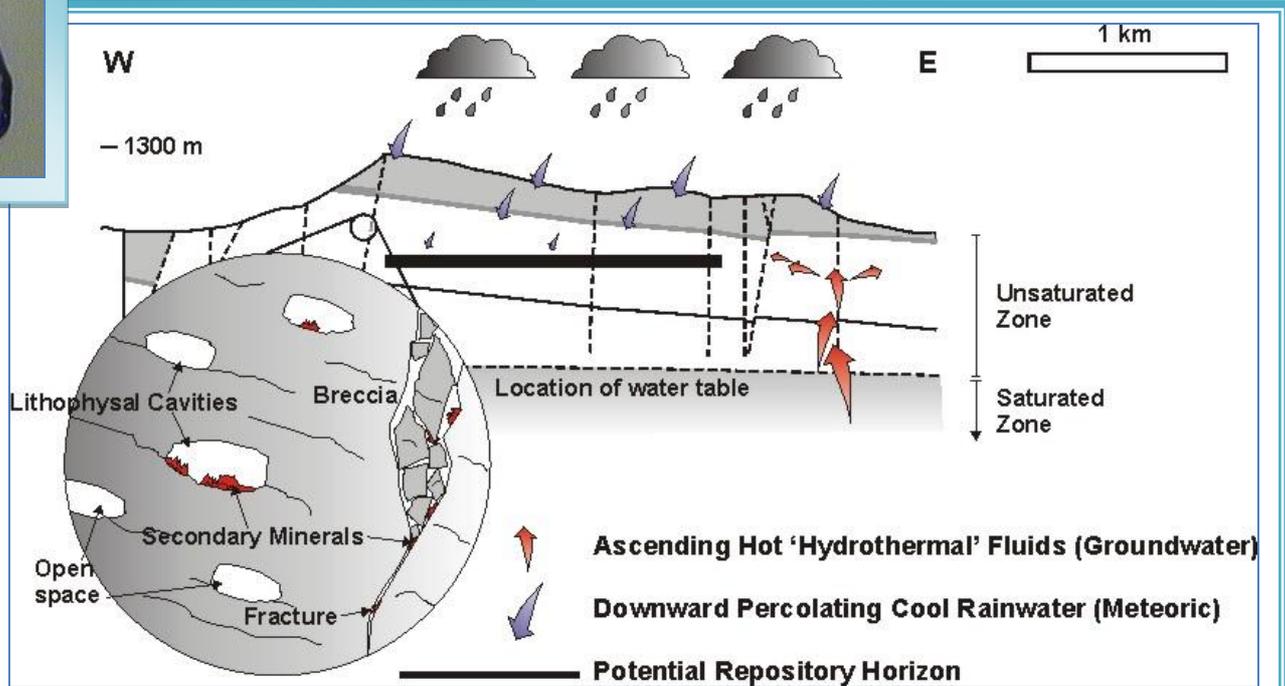
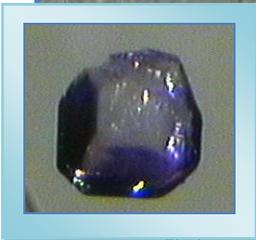
Analysis of Nuclear Repositories – Case Study: Yucca Mountain Nuclear Repository (Nevada)



Investigating the long term geological stability and geothermal history is critical to selecting sites suitable for use as long term nuclear waste repositories. Alphachron helium data provide a unique tool to investigate the timing of the most recent thermal event.

Case Study Results

- Fluorite (CaF_2) is a thermochronometer with a closure T of $\sim 90^\circ\text{C}$.
- Topopah Spring Tuff deposited at 12 Ma (sanidine Ar-Ar).
- Fluorite formed 9.7 Ma during cooling of host volcanic tuff.
- No evidence for geothermal fluids since that time.

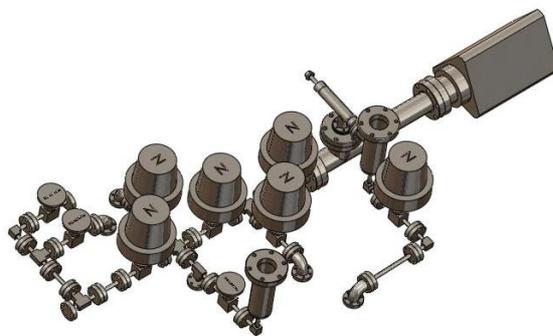


Evans, NJ et al., 2005. (U-Th)/He thermochronology of fluorite and the low temperature history of Yucca Mountain, Nevada, *Applied Geochem.* 20, 1099-1105.

Alphachron™

Alphachron MKII He Extraction Instrument

The Alphachron can be used to track temperature changes in a rock formation as it deforms and cools over millions of years. Geologists can use this tool to determine uplift and erosion rates during mountain belt formation, the timing of hydrocarbon charge in a petroleum basin, the heat flow regime around a geothermal energy source, and the probability of preservation of ore deposits containing gold, base metals or diamonds. Alphachron thermochronology can tell geologists when magmas intruded near to the rock formation, even if there is no other evidence of intrusion. It can also tell whether these magmas came from deep in the Earth or from closer to the crust.



The Alphachron can automatically analyse up to 25 samples, heating each sample sequentially under vacuum with a 970 nm diode laser. The extracted gas is spiked with ^3He and analysed by isotope dilution using a mass spectrometer.



The CSIRO Alphachron. The Alphachron Instrument is an integral element of CSIRO's double-dating program.

Performance Specifications

- Gas analysis reproducibility $< 0.35\%$ at 1 sigma
- Background level of $^4\text{He} < 0.02$ ncc
- Resolution 0.5 AMU (10% level)

Instrument Features

- Quadrupole mass spectrometer (QMS); range of mass magnitude: 1-100 amu; detector: Faraday/passage multiplier; detection limit: $< 2 \times 10^{-11}$ mbar; sensitivity to Ar: $> 5 \times 10^{-4} / 200$ A/mbar
- High vacuum system with getter pumps, ion pump and turbo pump
- Stainless steel high-vacuum line with automatic and manual valves
- Automated x-y laser stage with alignment via stepper motors and CCD vision system
- 970 nm diode laser co-aligned with CCD camera and interlocked safety shield
- 25-sample capacity laser chamber with sapphire window
- Three stainless steel gas pipettes with automated valves that deliver ^3He spike, an analytical ^4He standard, and a ^4He reference standard
- Control computer and Alphachron system software and drivers for sample location and alignment, laser automation, gas handling and measurement of radiogenic helium
- Installation and training
- Data reduction /alpha correction software routines and spreadsheets
- Instrument manuals
- Option: Helium diffusion cell (Max. operating temperature 600°C)
- Option: Isotope dilution standards, supplied by CSIRO
- Option: Extended 2 years support agreement

Australian Scientific Instruments is pleased to partner with CSIRO in the development of this innovative methodology. For further information please contact:



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