Alphachron™

APPLICATION NOTES FROM asi > JUNE 2009

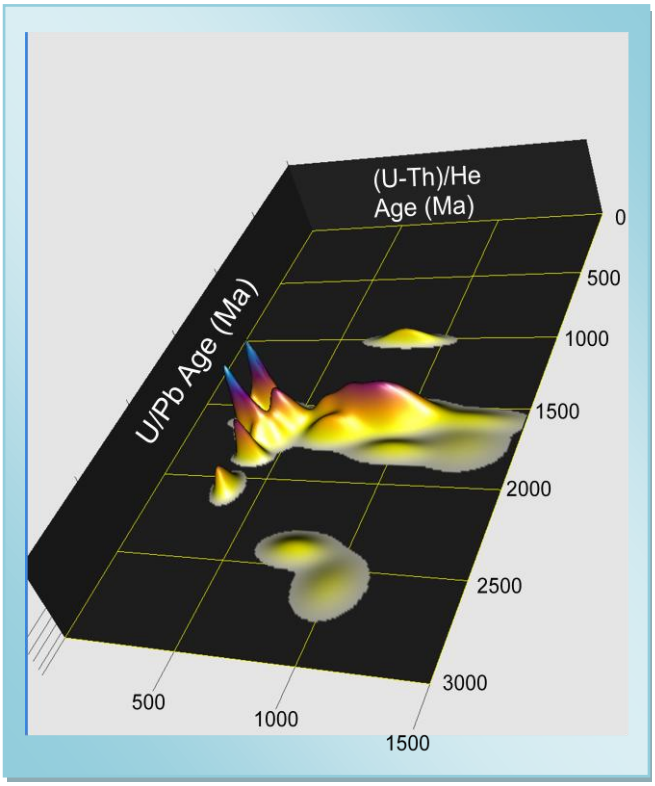
Automated, Turn-key Thermochronology

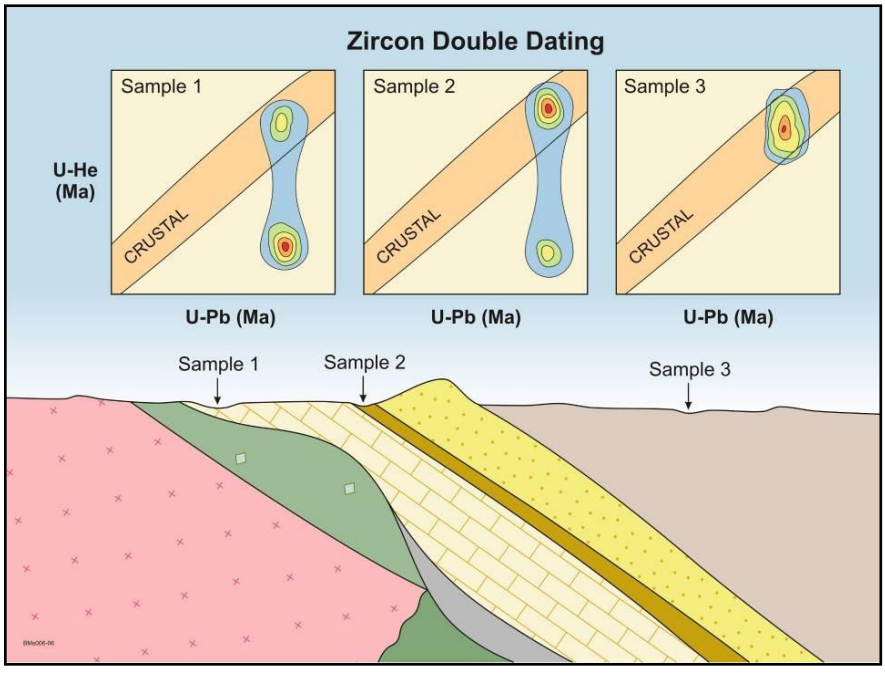
HOT ZIRCONS: An Indicator for Diamond Exploration

Diamond exploration can be extremely difficult. In Australia's tropical conditions, kimberlite indicator minerals (e.g., G10 garnet, Cr-diopside, chromite, ilmenite) are destroyed by chemical weathering. Elsewhere glacial till or vegetation can obscure targets. However, zircons, like diamonds, are "forever," and their analysis provides both timing and provenance information.

- Zircon (U+Th/He) dating techniques can be used to determine kimberlite ages, and to determine whether detrital zircon grains were derived from a kimberlite source.
- Detrital zircons near kimberlites should have two dominant end-member populations.
- Upper crustal zircons are "cold zircons".
- Low to mid-crust zircons are "hot zircons".

(U+Th)/He analysis of zircon from stream sediment samples adjacent to the Merlin kimberlite pipes, found a high concentration of hot zircons in similar proportion to microdiamonds and other kimberlite indicator minerals. Led by Dr Brent McInnes, the team concluded that hot zircons return (U+Th)/He ages that are the same as the kimberlite eruption [for diamonds], and in general are much younger than the cold zircons that have been near the Earth's surface for thousands of millions of years. In turn, this shows that zircons can be used as an indicator mineral for diamond exploration, which is of particular value where kimberlite pipes are overlain by sediment.





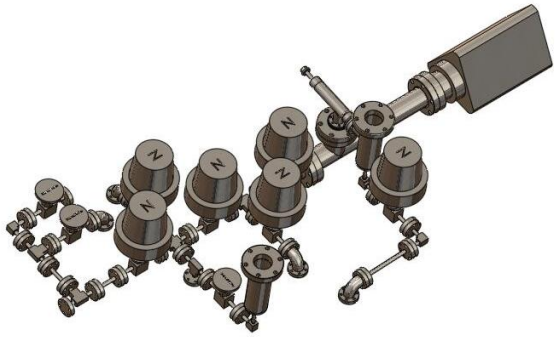
McInnes et al., 2009. Zircon U-Th-Pb-He Double Dating of the Merlin Kimberlite Field, Northern Territory, Australia. *Lithos* (http://dx.doi.org/10.1016/j.lithos.2009.05.006).

Australian Scientific Instruments Pty Ltd

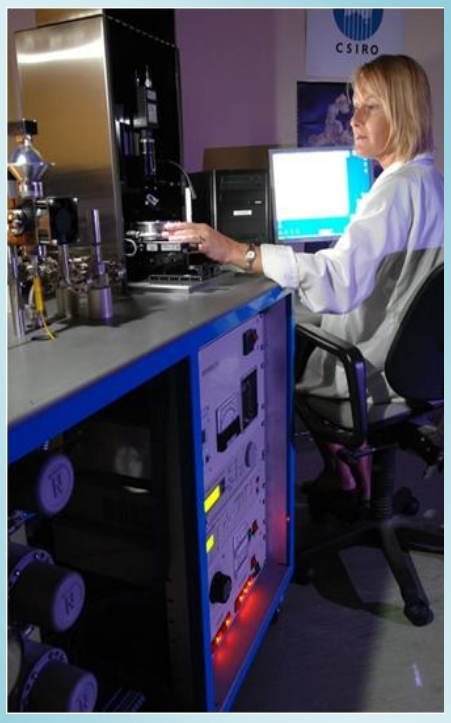
Alphachron™

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 ^{3}He and analysed by isotope dilution using a mass spectrometer.



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

Performance Specifications

- Gas analysis reproducibility < 0.35% at 1 sigma
- Background level of 4He < 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: < 2×10-11 mbar; sensitivity to Ar: > 5×10^{-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 ^{3}He spike, an analytical ^{4}He standard, and a ^{4}He 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 double-dating methodology. For further information please contact:

CSIRO

Australian Scientific Instruments
Dr Ed Roberts
CEO
ed.roberts@asi.anutech.com.au

CSIRO Exploration and Mining
Dr Brent McInnes
Chief Research Scientist
brent.mcinnes@csiro.au

North America
Patterson Instruments Ltd
Dr Des Patterson, Director
des@helium-labs.com