

# Advances in geochemistry: past, present and future


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AESC 2010  
AuScope symposium



something we want to understand  
from both scientific and public perspective



A photograph of a volcanic landscape. In the foreground, a blue and white helicopter is parked on a dark, rocky, and ash-covered ground. Several people are standing around the helicopter, some wearing yellow safety vests. The background shows a steep, dark volcanic slope on the left and a large, billowing plume of white smoke or ash rising from the right side of the frame. The sky is dark and overcast. The text "ore deposits & climate change" is overlaid on the right side of the image.

ore deposits &  
climate change

Geochemistry has been a major contributor to transforming our subject into a quantitative science

- planetary science
- geochronology
- igneous petrology
- metamorphic petrology
- sediment provenance
- hydrosphere and atmosphere
- environmental
- carbonates
- ore deposits
- archaeology

and much of it has been led by Australia

[www.goldschmidt2006.org](http://www.goldschmidt2006.org)

The image features a promotional banner for the 16th Annual V.M. Goldschmidt Conference. The top left corner contains a logo with a stylized, flame-like shape in a wood-grain texture, with the year '2006' in a large, white, italicized font. Below this, the word 'goldschmidt' is written in a bold, lowercase font, with 'geochemistry & petrology' in a smaller font underneath. The background of the banner is a photograph of a beach with several large, golden-brown rock formations (sea stacks) in the ocean under a blue sky with scattered white clouds. At the bottom of the banner, a grey semi-transparent box contains the text: '16th Annual V.M. Goldschmidt Conference', '27 August - 1 September 2006', and 'Melbourne, Australia'. A large, faint, grey watermark of the word 'goldschmidt' is visible across the bottom half of the banner.

Goldschmidt meetings have grown from ~400 attendees in 1997 to over 3000. Next meeting is in Prague in 2011.



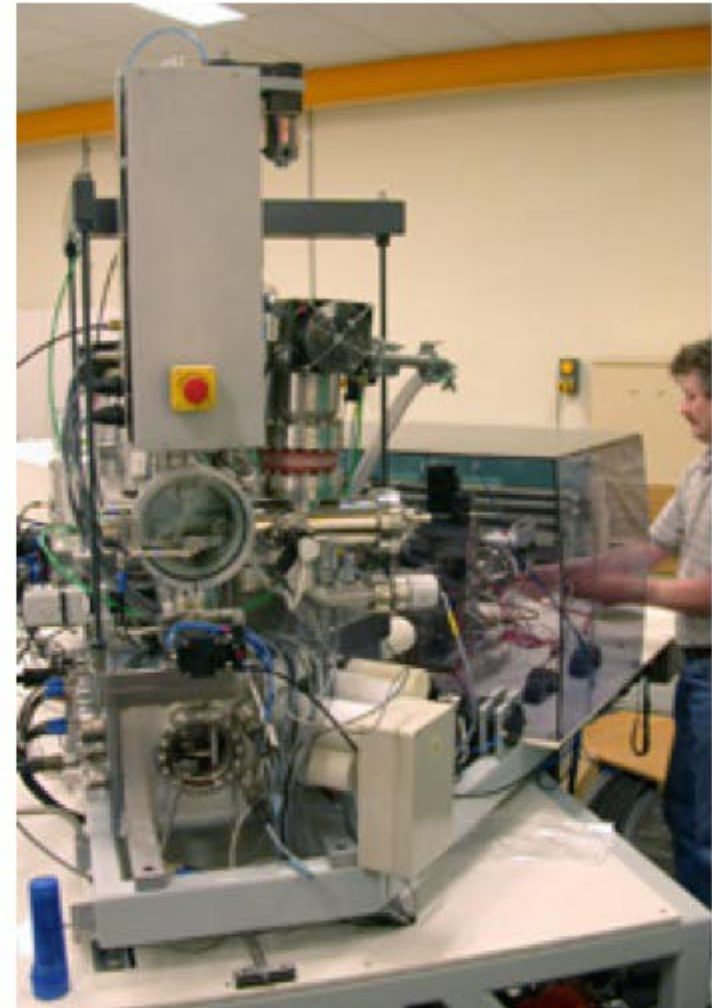
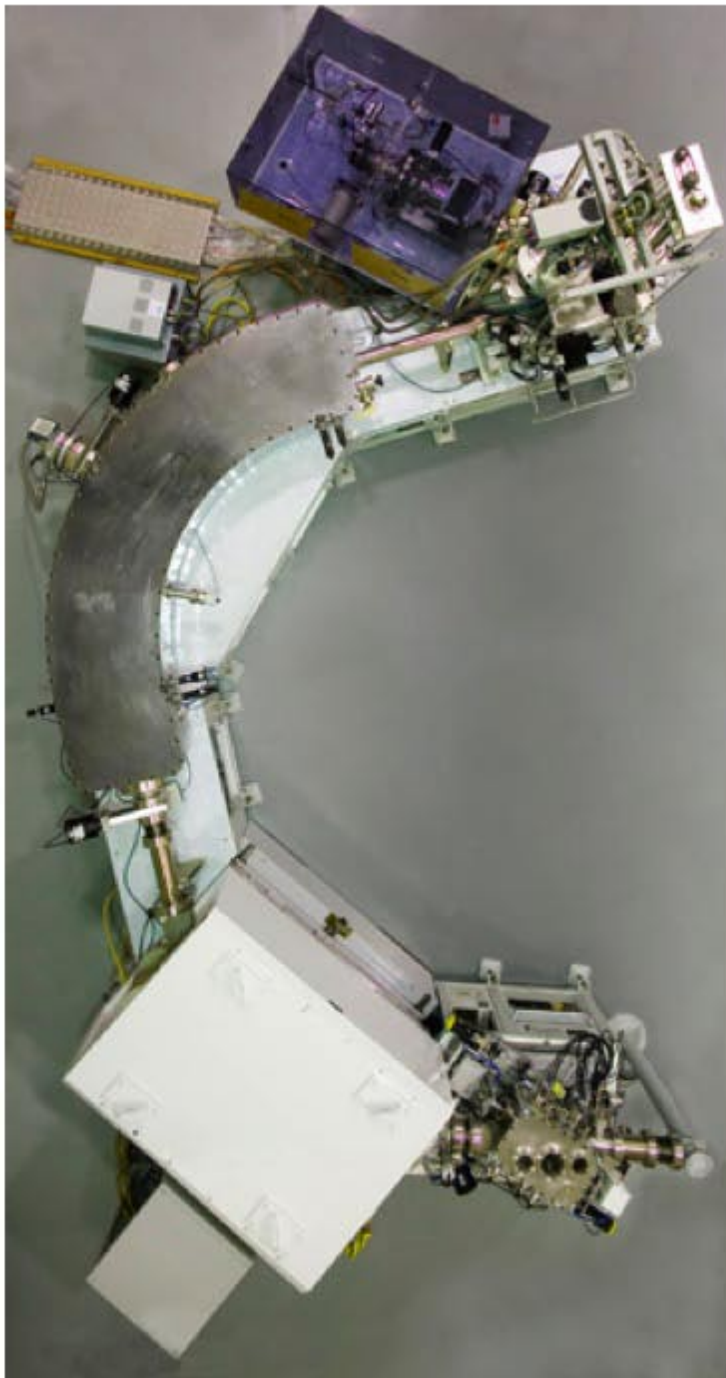
Once upon a time - wet chemistry....

... to XRF - changing igneous petrology for ever



# ... mass spectrometry (cold war)





SHRIMP - revolutionized  
U-Pb chronology & more  
(smaller sample sizes)

# Elements

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## Early Earth

The Origin of the Earth

Impact Processes on the Early Earth

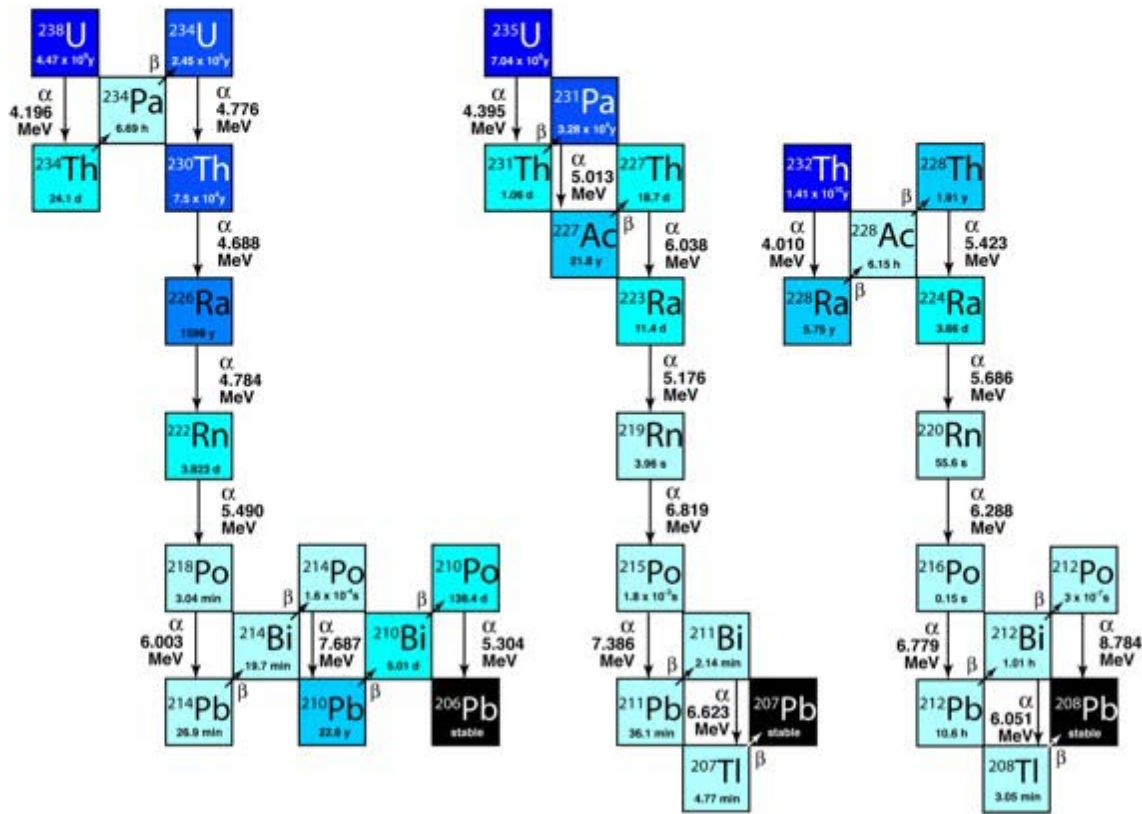
Earth's Earliest Atmosphere

Antiquity of the Oceans and Continents

The First Billion Years: When Did Life Emerge?

# U-series isotopes

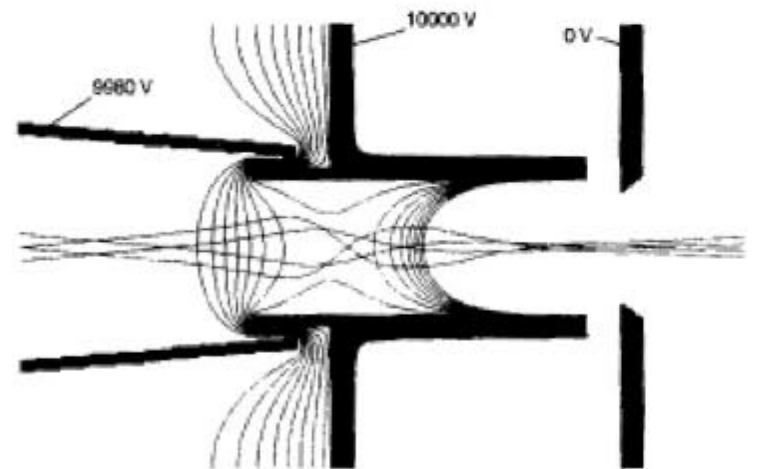
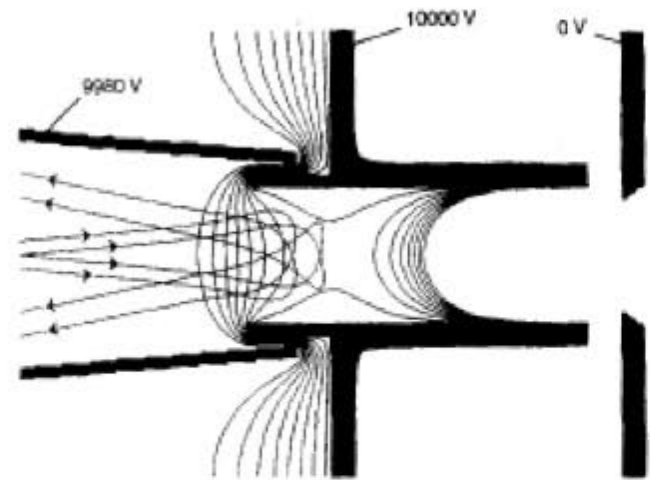
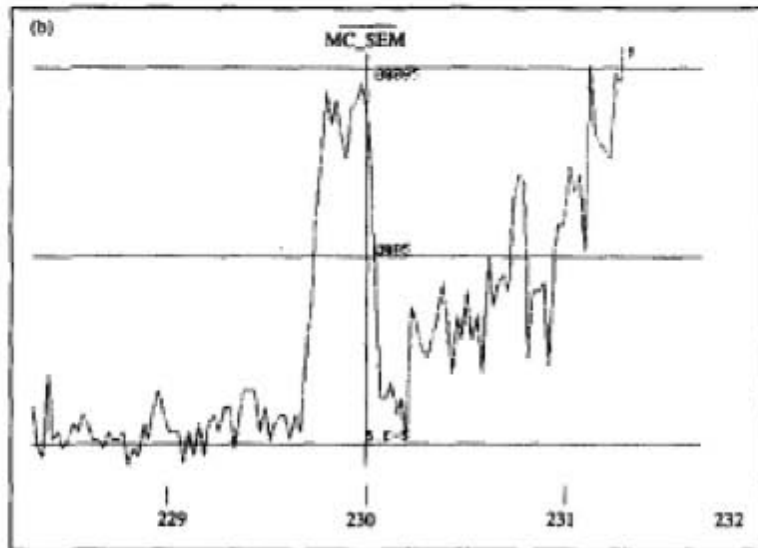
“Our ability to investigate natural processes depends on how well we can determine time”  
 T.H. van Andel (1994), *New visions on an old Planet*. Cambridge University Press.



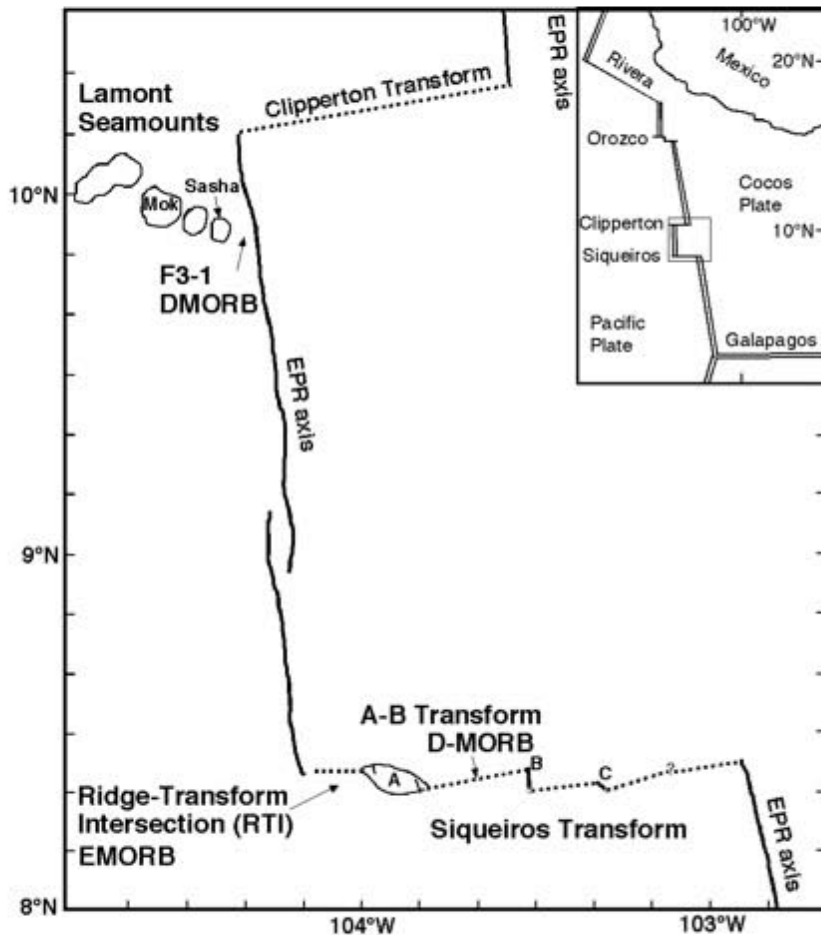
- melting processes
- melt extraction
- differentiation
- degassing
- erosion
- speleothem growth
- palaeoclimate
- archaeology
- ocean circulation

$^{230}\text{Th}/^{232}\text{Th} \sim 6 \times 10^{-6}$

2 SE  $\sim 0.5\%$



# Geochemistry complements Geophysics



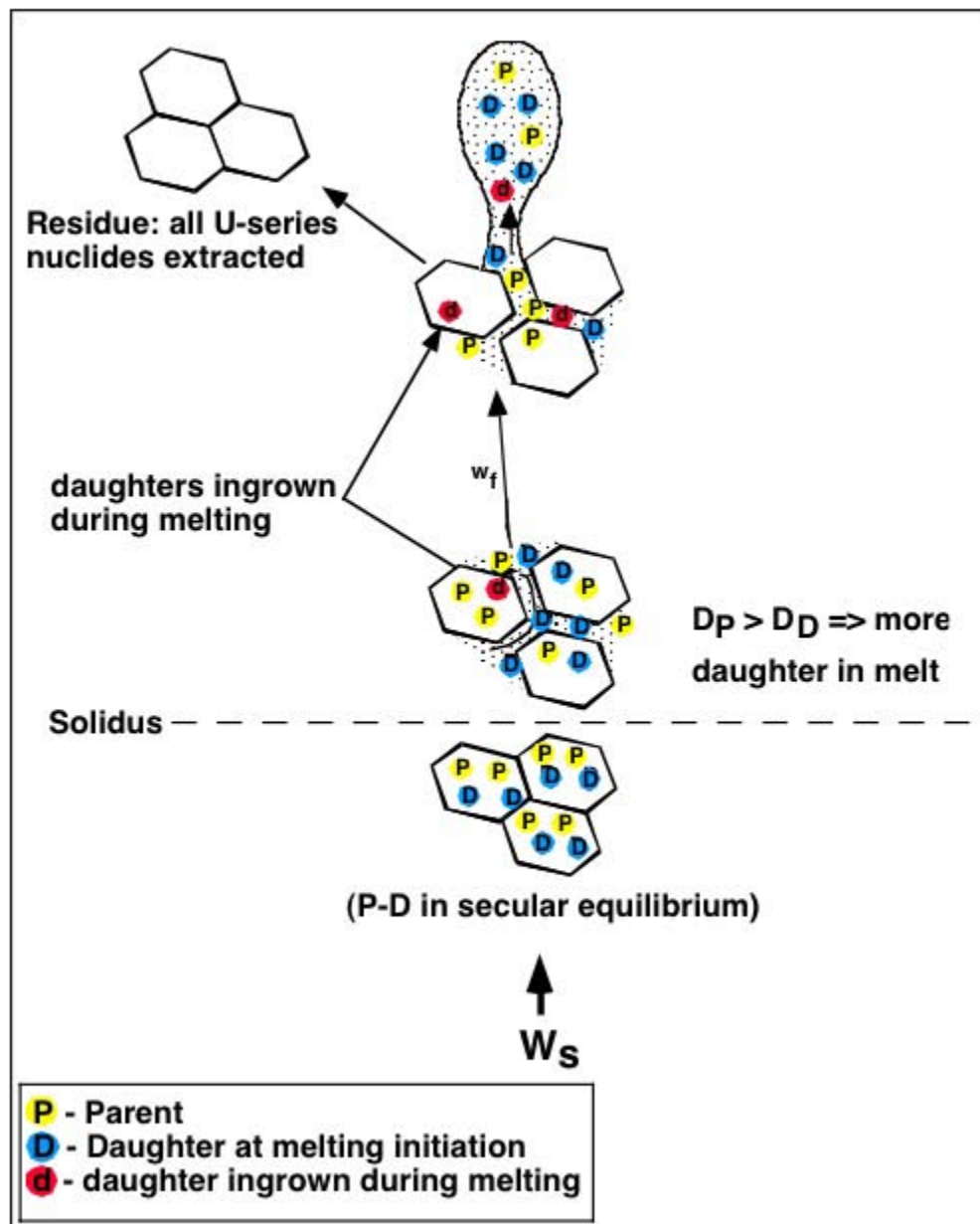
MELT experiment at the east pacific rise revealed low velocity beneath the ridge but cannot determine if this is melt or whether melt is interconnected (can escape) or not.



U-series element partition coefficients are too small and similar for batch or fractional melting to generate significant disequilibria at reasonable  $F$ .

Therefore, melting must involve in-growth or so called dynamic melting.

Can constrain melting rate and porosity.

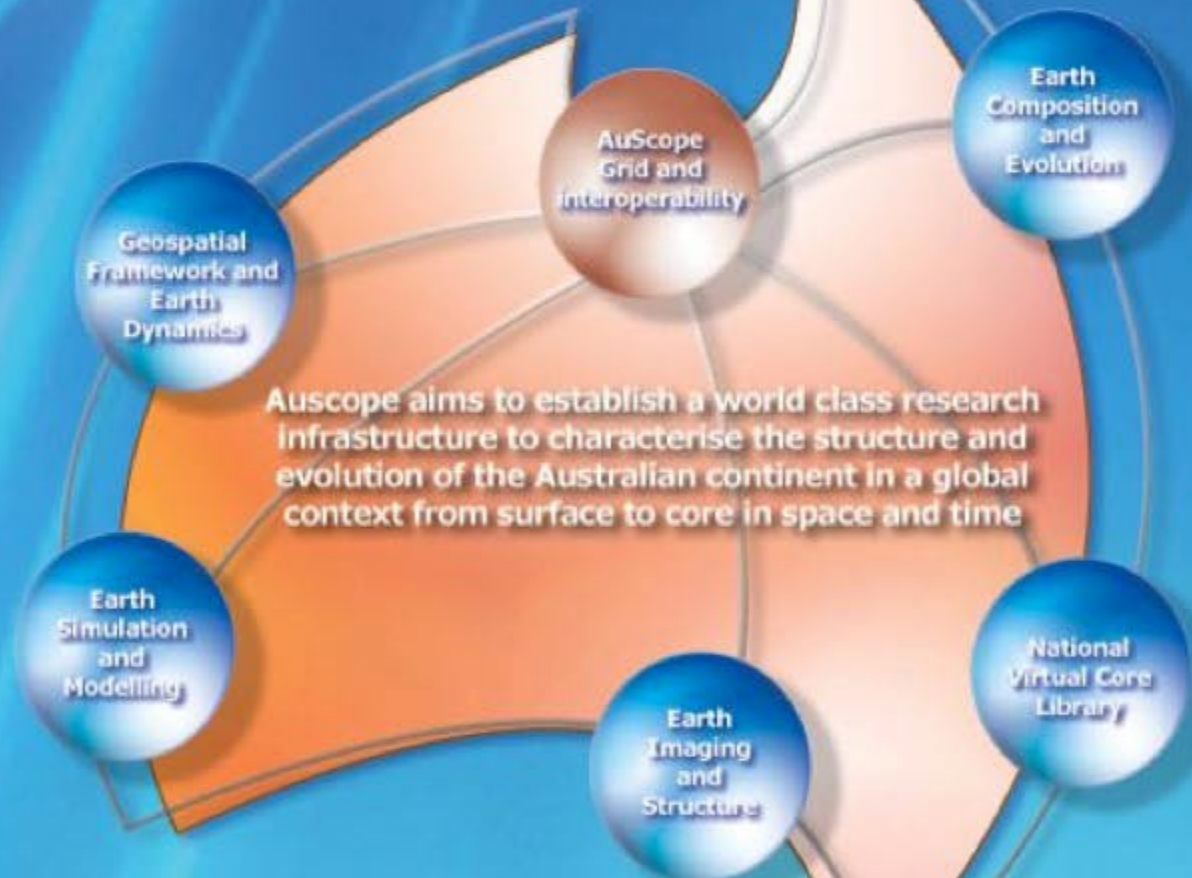


MC-ICP-MS has opened the field of transition metal isotopes in planetary materials  
e.g. W-Hf and the age of the core (40-60 Myr)



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# AuScope 2007-2011



**AN ORGANISATION FOR A NATIONAL EARTH SCIENCE INFRASTRUCTURE PROGRAM**

- Cameca 1280i SIMS, CMCA, UWA
  - Single upfront contribution to instrument acquisition (\$1M)
- Thermochronology, Melbourne University
- Terranechron, Macquarie University
- JdL Centre, Curtin University

SIMS ~ all projects are geological (O, Li and B isotopes)

Thermochronology and Terranechron both show significant (up to 100%) increase in publications since 2006

What do  
geochemists  
envisage for  
the future?



Broad, collaborative networks with multiple nodes involved in cutting edge research (incl. analytical developments) and research training for the next generation

but also maintenance of existing facilities

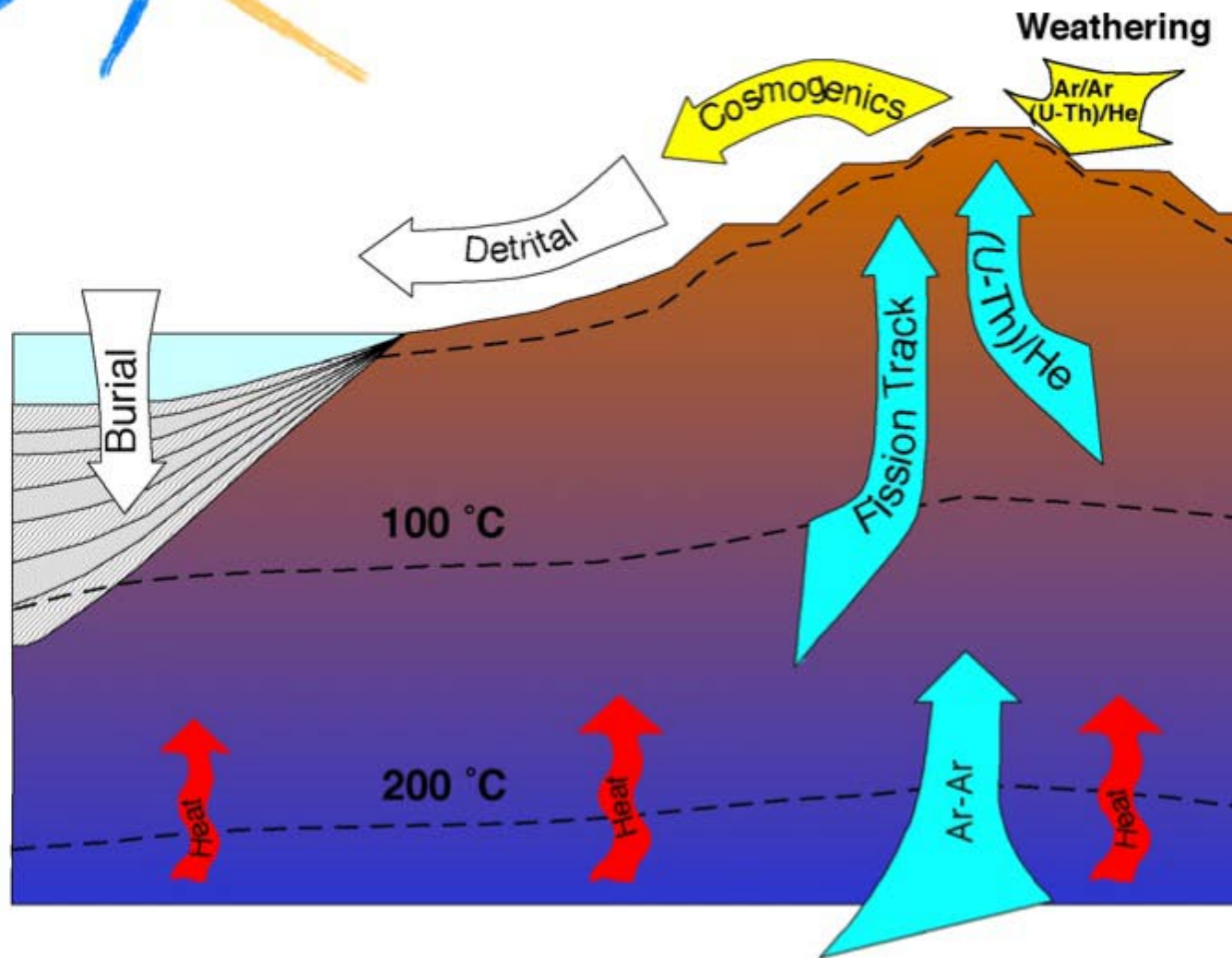
# Linkage Project LE0989067



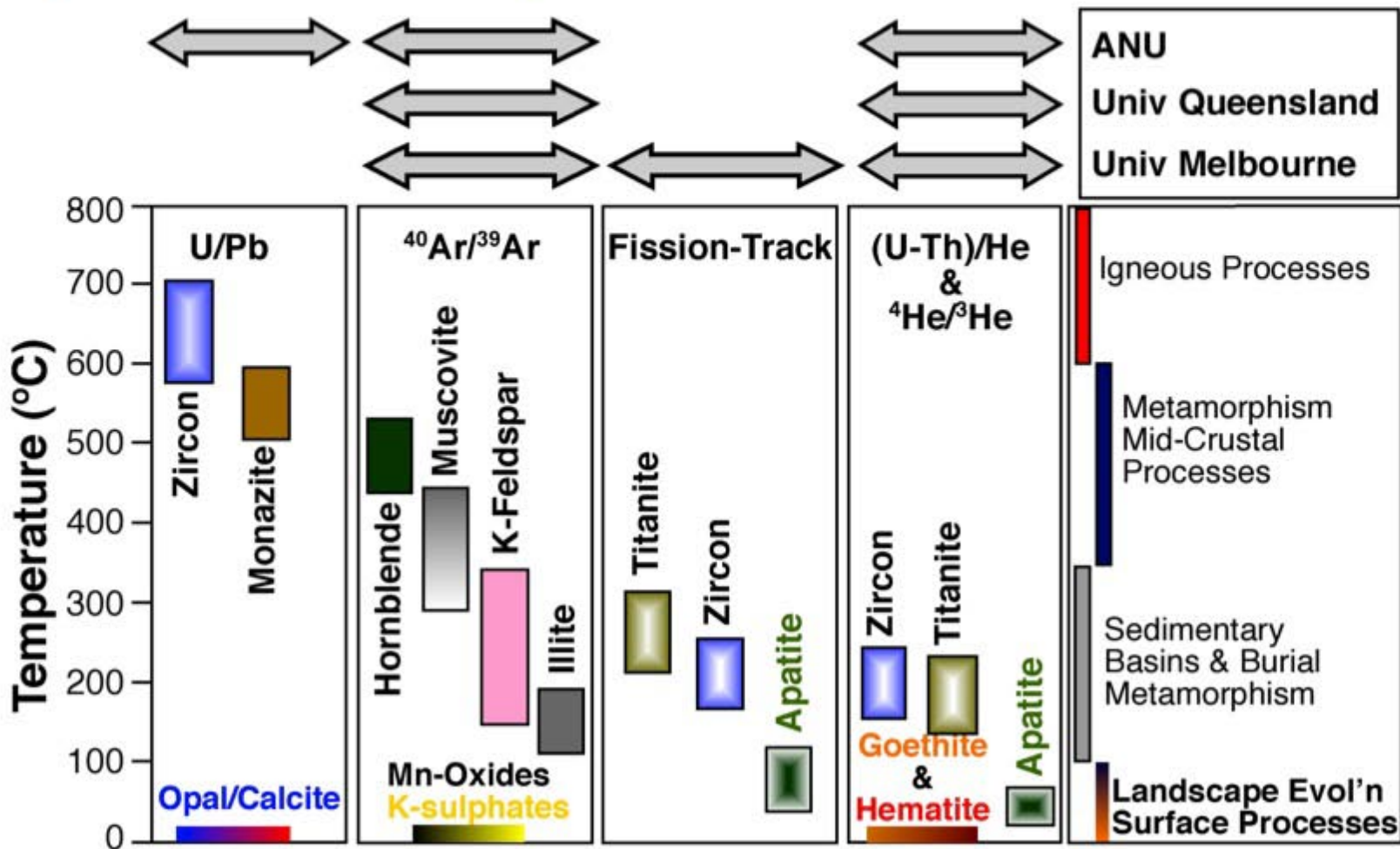
**“The future of palaeoclimate and archaeological research in Australia: next generation instrumentation for chronology and environmental reconstruction”**

- an unprecedented collaboration between 8 Institutions (UQ, Melb, Wollongong, ANSTO, UNSW, Newcastle, QUT, Southern Cross, Flinders) and involving 53 CI's
- funded 2 x \$ 1 million instruments, situated in Brisbane & Melbourne, servicing a significant proportion of the palaeoclimate and archaeometry community on Australia with U-Th and U-Pb analyses
- a different emphasis for each instrument, with establishment of sample preparation facilities at several nodes (knowledge transfer)

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## Challenges for the future

- climate change ( $\text{CO}_2$  sequestration)
  - public health (F in volcanic gas)
- energy (uranium) and other commodities
- geological hazards (e.g. volcanic eruptions,  $^{210}\text{Pb}$ )
- ability to analyze smaller materials (e.g. cosmic dust)
  - biological processes
  - education