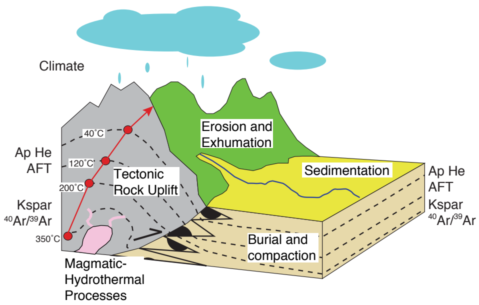
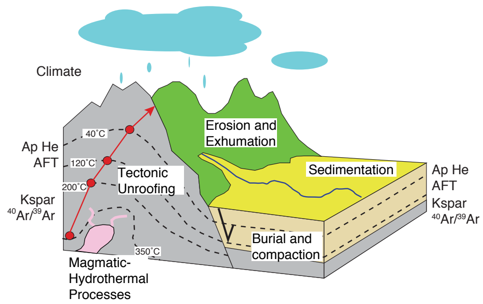
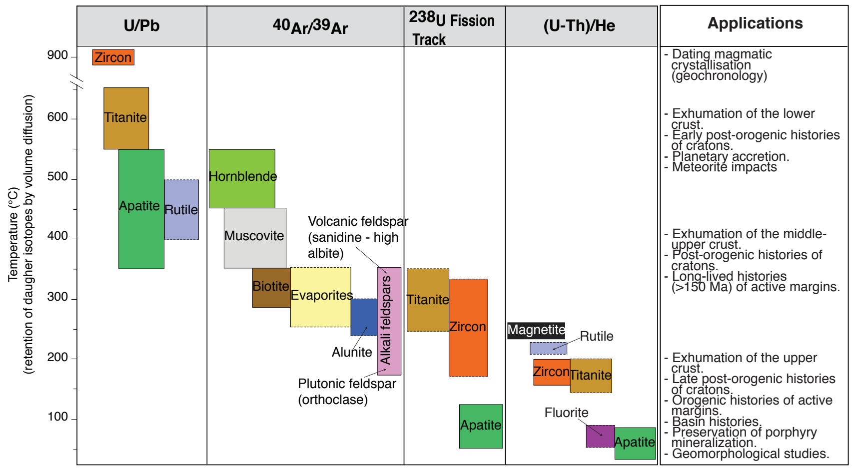
Do you need geochronology and thermochronology ?



Compressional setting



Extensional setting



Geochronology
- Magma crystallization.
- Dating volcanic deposits.
- Detrital zircon studies.

Ore deposits
- Dating mineral growth events.
- Dating fluid alteration zones.
- Dating orebodies.
- Dating deformation .

Basin analysis
- Thermal histories (t-T) of basement rocks and sedimentary infill.
- Timing of formation of structural traps and the measurement of maximum paleo-temperatures.
- Quantifying burial and exhumation (temperatures).
- Applications to hydrocarbon maturation.
- Identification of source regions, and their exhumation histories.

Exhumation studies
- Estimates of exhumation, rock uplift and surface uplift.
- Timing and magnitude of vertical fault displacement.
- General applications to tectonics.
- Ore preservation.

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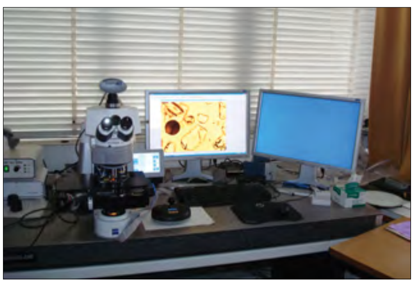
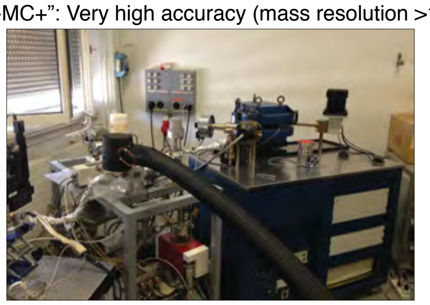
U–Pb analysis: Geochronology for early magmatic (>900°C) to hydrothermal zircons (>300°C) .
Thermochronology of apatite (550 – 350°C) for in-situ (e.g. igneous) crystals: continuous t-T of the deep/hot crust.

Fission track analysis: thermochronology of zircon (300 – 200°C) and apatite (120 – 60°C).
In-situ (e.g. igneous) crystals: continuous t-T of the upper crust.
Detrital crystals: thermal and exhumation histories of source regions.



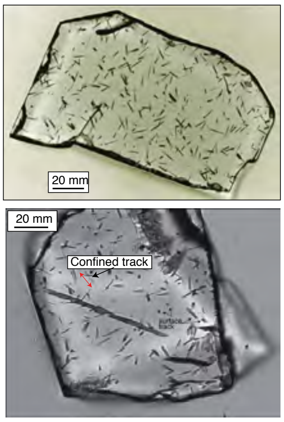
$^{40}Ar/^{39}Ar$ analysis: thermochronology of muscovite (440 – 380°C) and alkali feldspar (350 – 150°C). 2 mass spectrometers -
"ARGUS VI": Very high precision (uncertainty on date <0.1%).
"HELIX-MC+": Very high accuracy (mass resolution >1500).



(U–Th)/He analysis: thermochronology of zircon (180 – 140°C) and apatite (90 – 40°C).
In-situ (e.g. igneous) crystals: continuous t-T of the upper crust.
Detrital crystals: thermal and exhumation histories of source regions.

Apatite Fission Track Thermochronology

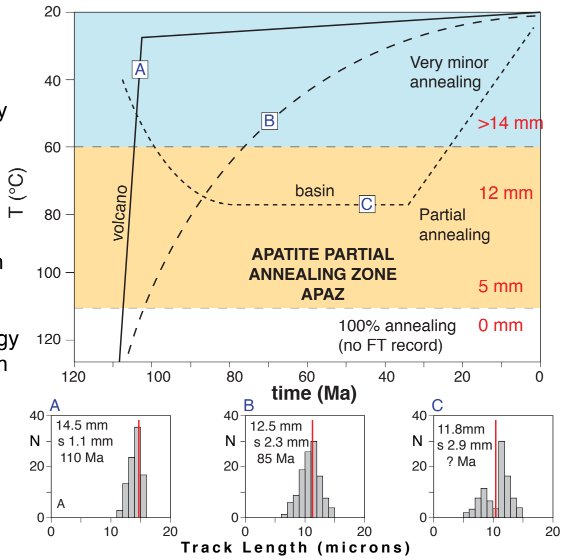
Fission Track Analysis (FT)



Fission tracks form by spontaneous fission of ^{238}U. The surface density of tracks is proportional to the fission track date.

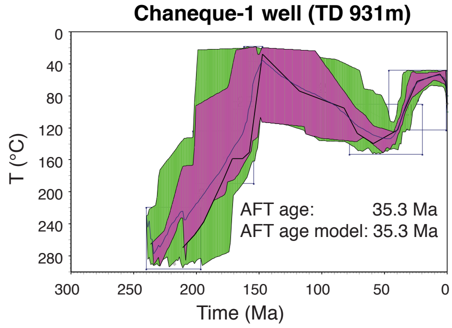
The distribution of fission track (confined) lengths provides quantitative information of the topology of the t-T history between 120 - 60°C.

Track Length Distributions and t-T



Numerical modelling of t-T (Monte Carlo; HeFTy)

Chaneque-1 well (TD 931m)



Basement core in the Gulf of Mexico (Bottom Hole Temperature = 56°C)

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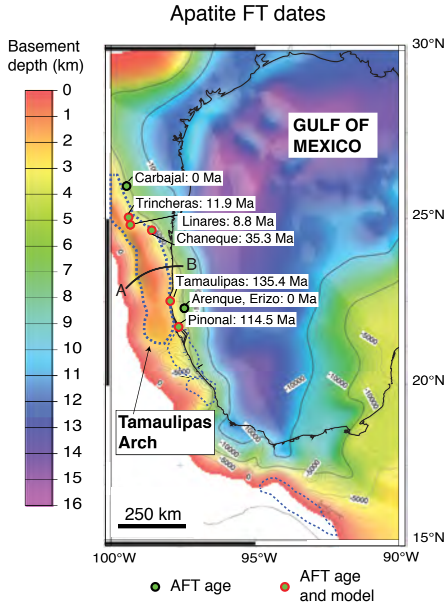
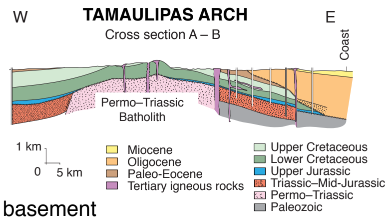
Applications of Low-Temperature (<300°C) Thermochronology

Example from borehole rocks in the hydrocarbon-rich Gulf of Mexico



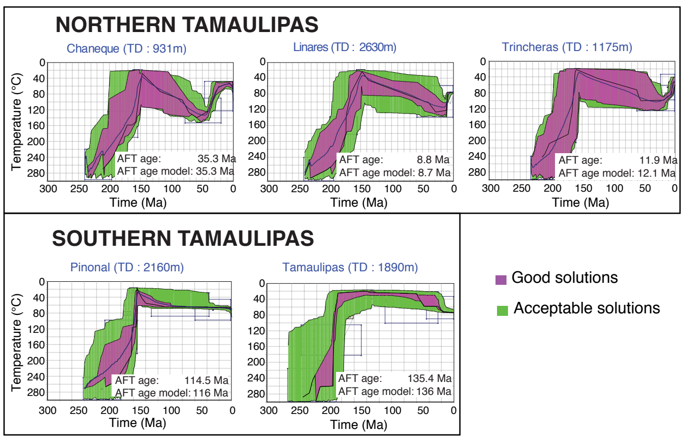
From Villagomez, Pindell & Spikings (GSA, in press)



The buried basement is composed of Permo–Triassic granitoids. Crystalline rocks recovered from drill cores were analysed using Apatite Fission Track (AFT) analysis (using LA–ICP–MS to measure the U content).

The aim of the study was to reconstruct the Cretaceous to Cenozoic burial and rock uplift history of the hydrocarbon-rich SW Gulf of Mexico.

The AFT data showed that during the Cenozoic, basement rocks from the northern Tamaulipas Arch were buried to temperatures where fission tracks (apatite) were almost completely reset (temperatures close to 120°C). Samples from the southern Tamaulipas Arch were only partially reset. (temperatures <80°C).



Thermal history solutions to the AFT data reveal along-strike variations within the Tamaulipas Arch, which were interpreted to reflect variable amounts of rock uplift and erosion.

Variations in exhumation have important implications for hydrocarbon generation and preservation, and it is necessary to identify those zones where the Jurassic–Cretaceous section remained within the oil window for significant amounts of time.