

Vertical movement, source-to-sink and Triassic and Ordovician hydrocarbon plays in N Africa: *The Morocco-Tunisia connection*

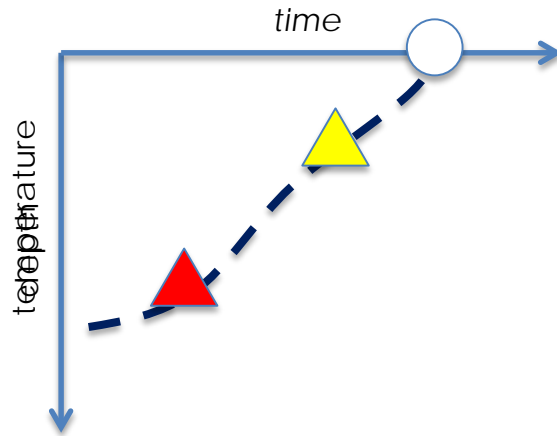
Giovanni Bertotti, Jonathan Redfern and





AFTA: Tracks from U particles decay are annealed when apatite at $T > 120^\circ$ (**annealing temperature**)

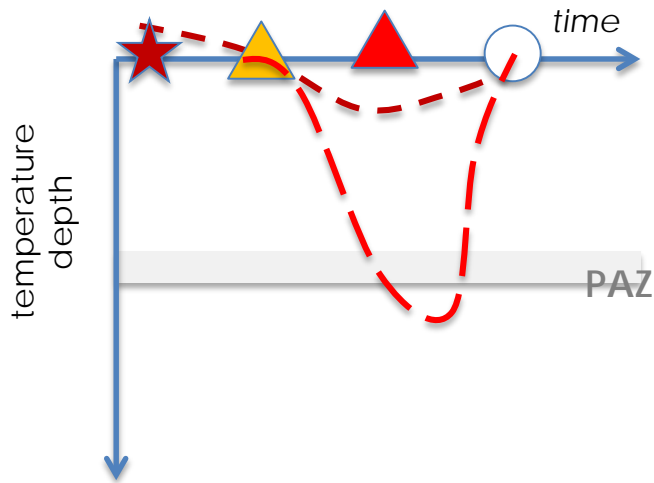
(U-Th)He ratio, changes when apatite at $T < 60^\circ$ (**closure temperature**)



a cooling time-temperature path for that specific sample

Assuming a (time-dependant) gradient, the curve is **interpreted** as exhumation (distance between sample and Earth surface)

Things become more interesting when geological constraints are introduced, first of all **sedimentation**



Low-T geochr. ages > strat. ages

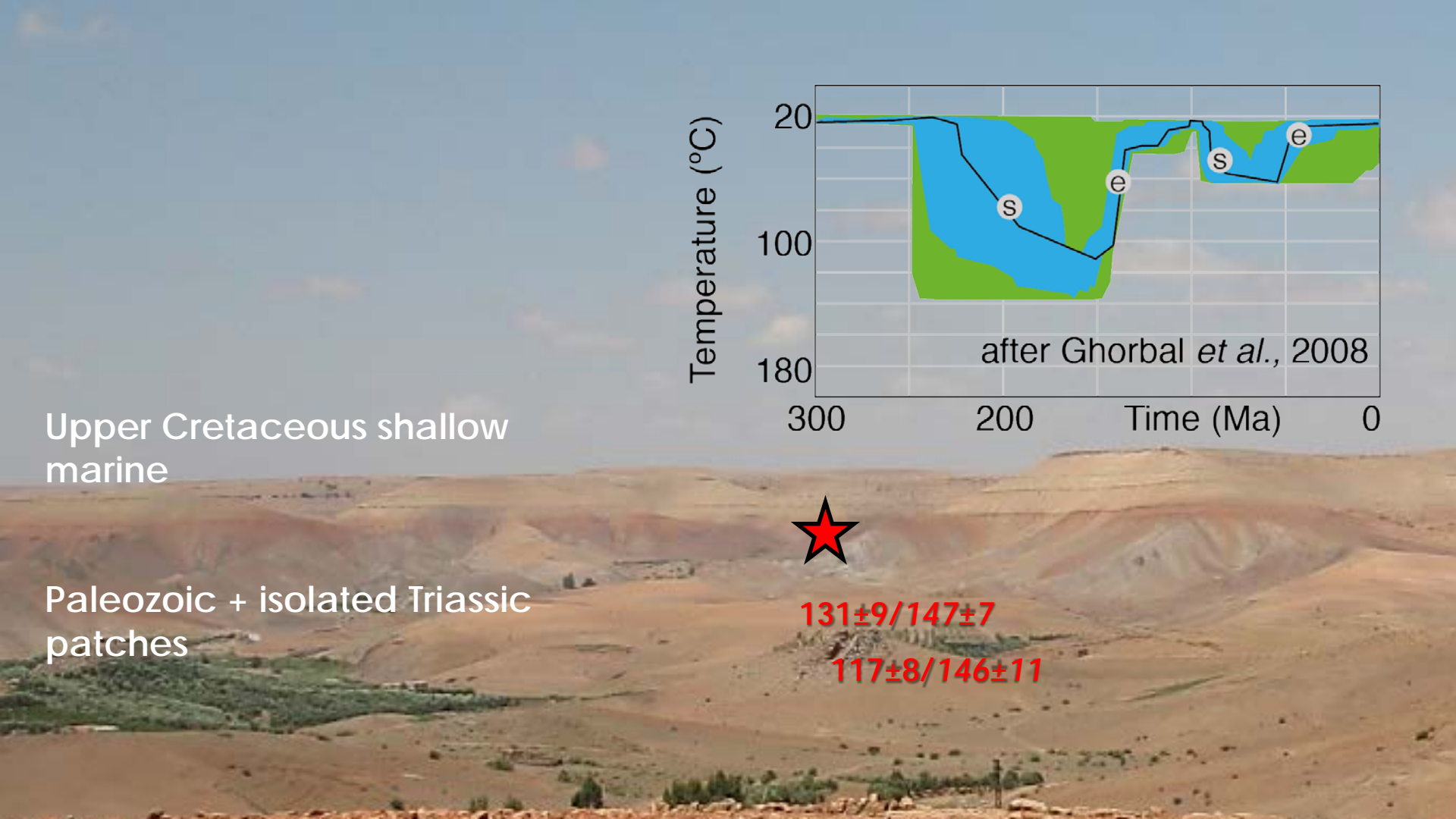


information on **source area**
Domain remains stable after deposition

If geochr. ages < strat ages



information on exhumation and
subsidence is obtained



Upper Cretaceous shallow marine

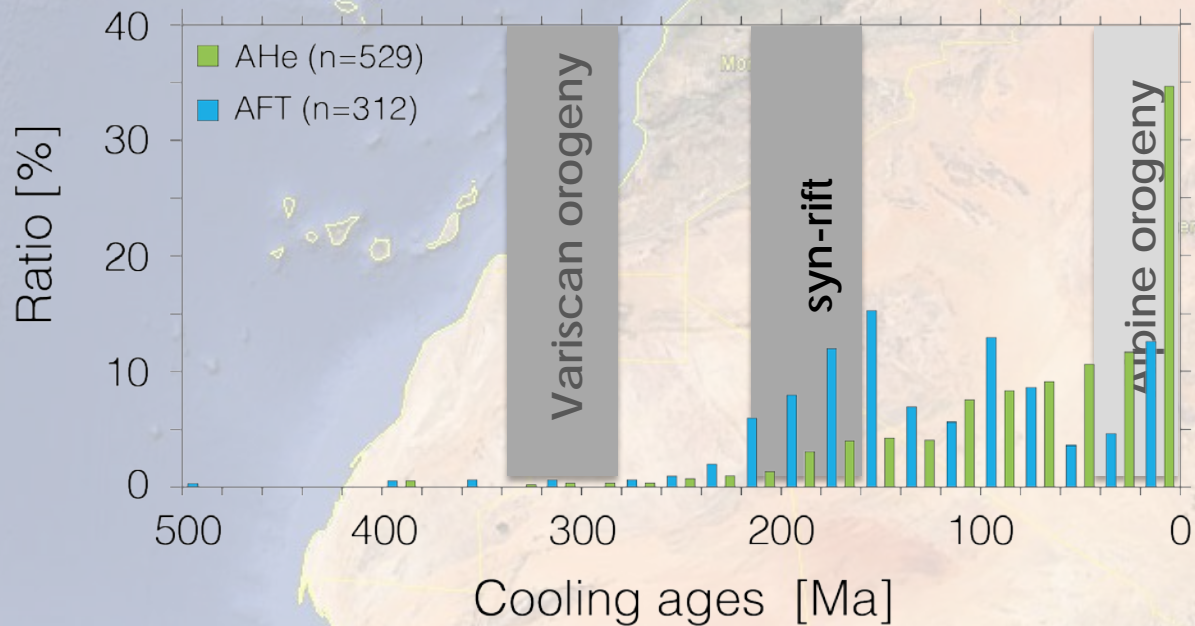
Paleozoic + isolated Triassic patches



$131 \pm 9 / 147 \pm 7$

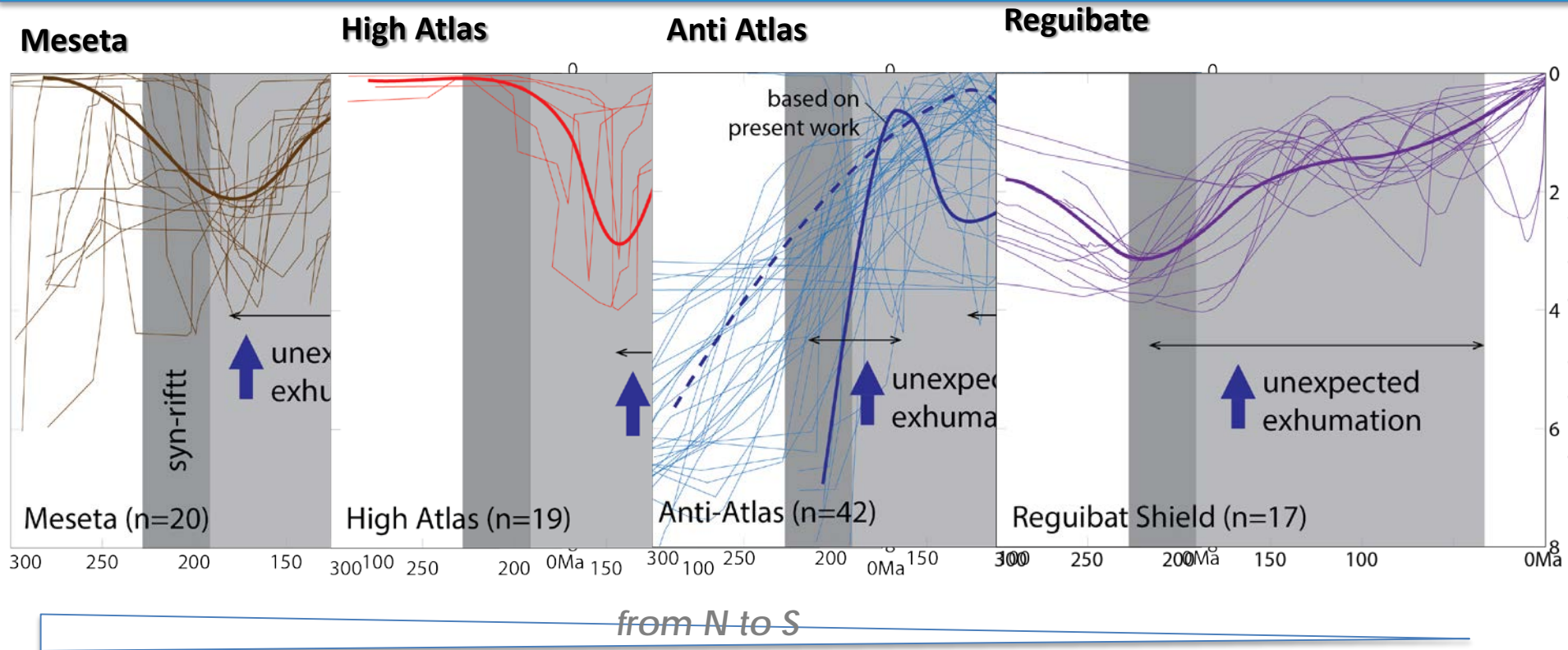
$117 \pm 8 / 146 \pm 11$

The margin of NW Africa



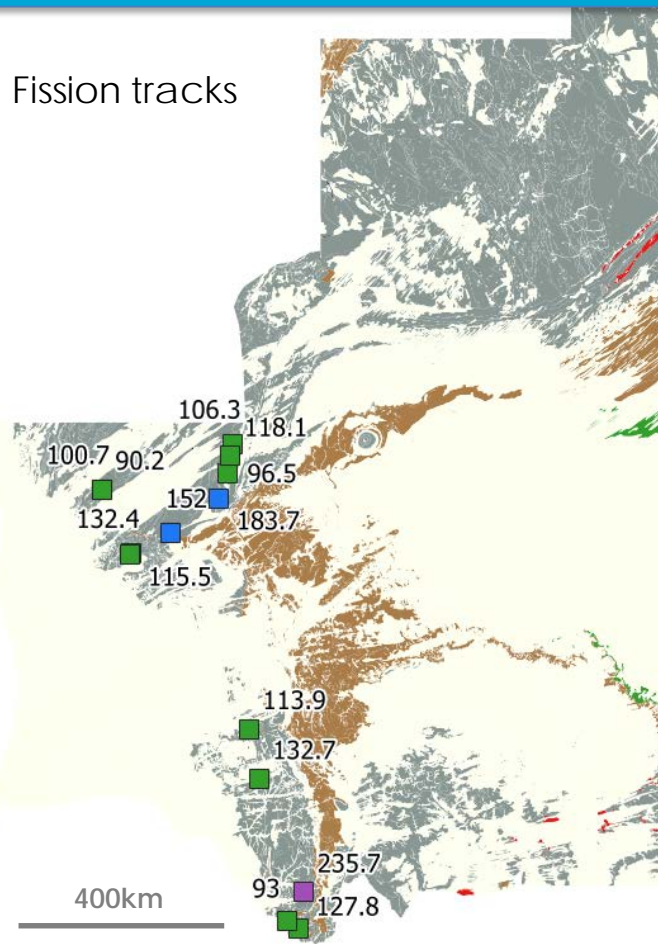
**A lot of action during post-rift
Coeval with arrival of siliciclastic in the offshore**

Vertical movements

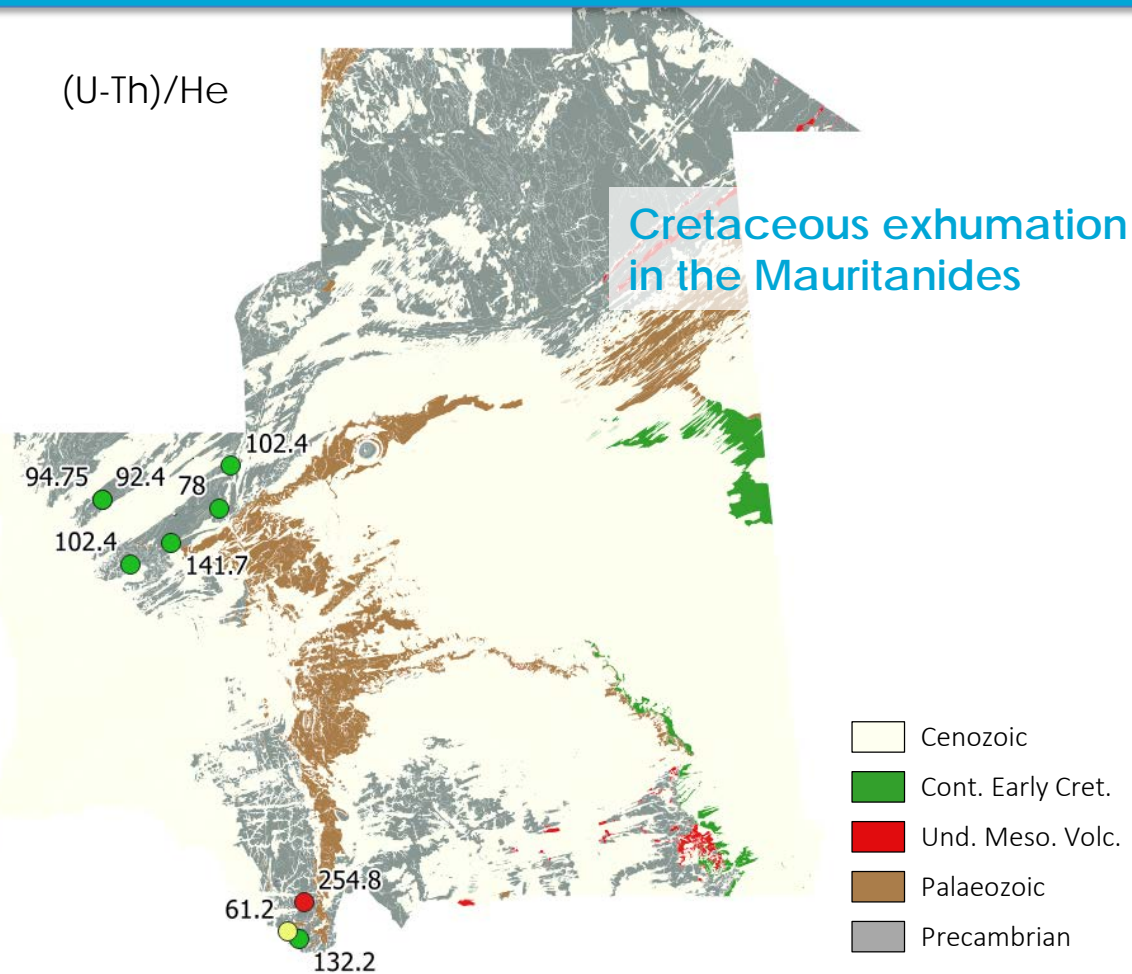


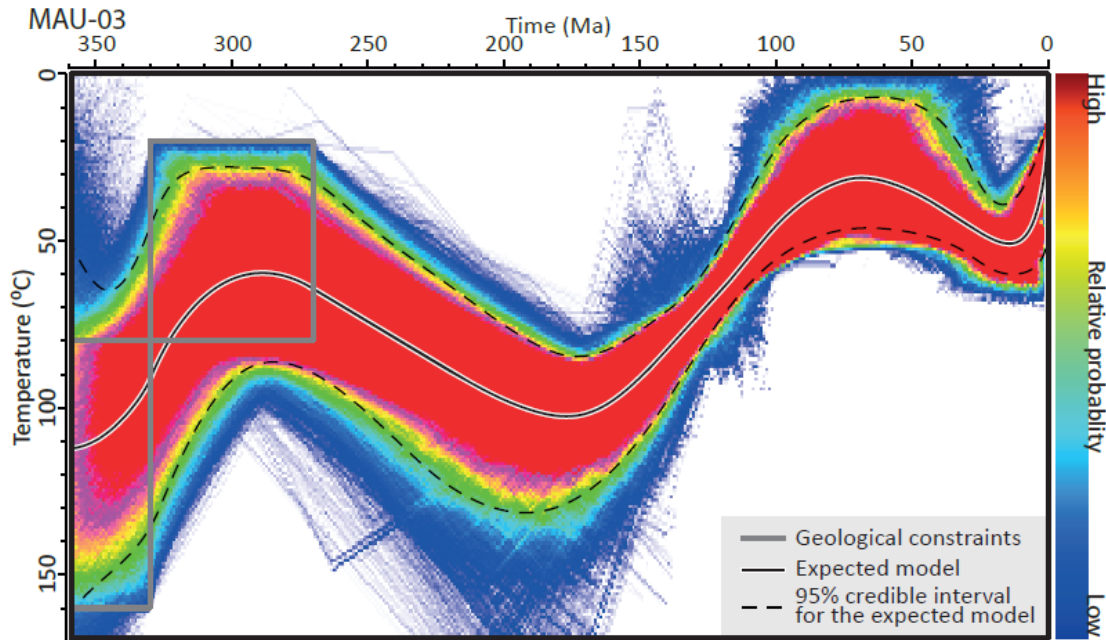
Mauritania: the first data set!

Fission tracks



(U-Th)/He

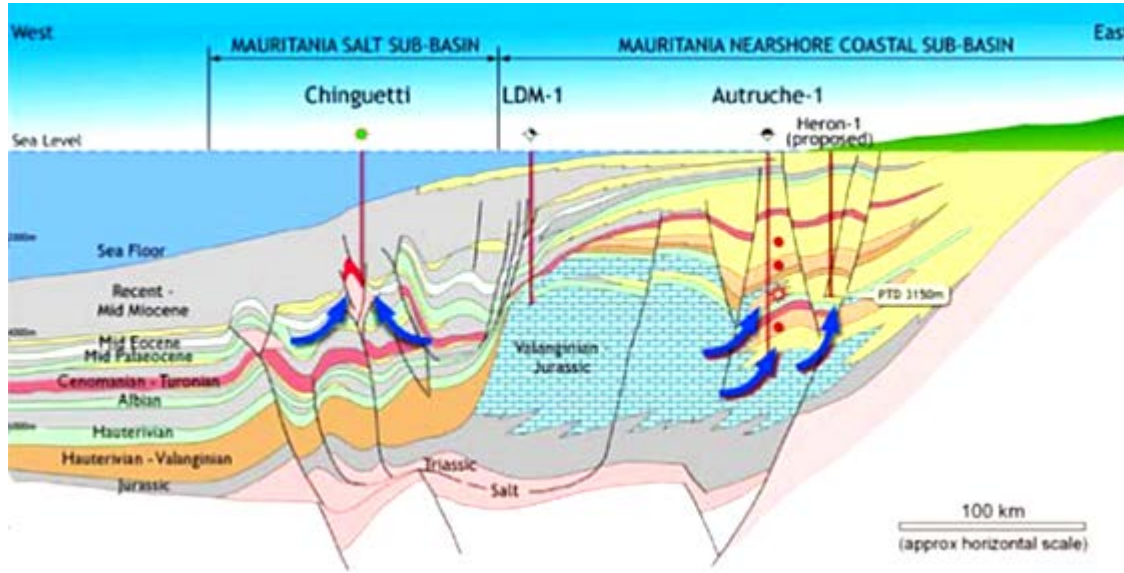




Subsidence 300-200Ma

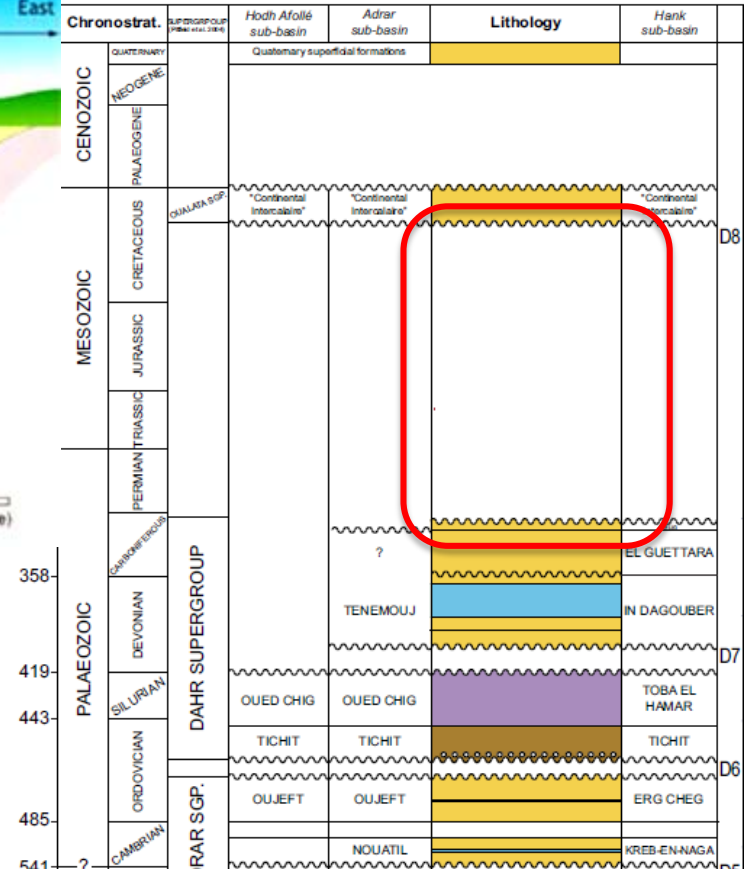
Mesozoic exhumation

Gouiza et al in prep.

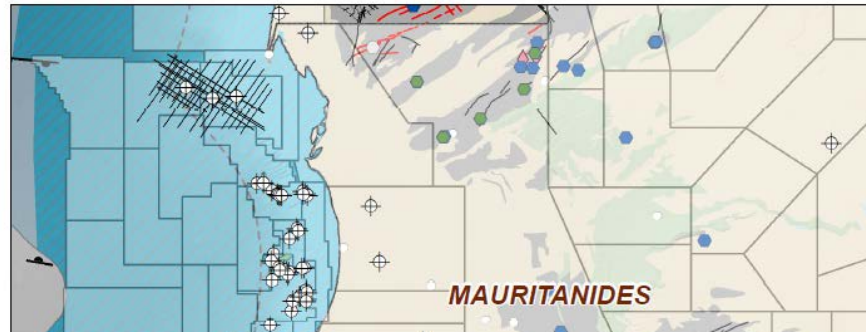


Factors controlling punctuated delivery of terrigenous sediments from a continuously exhuming region

In the Taoudeni basin



The Mauritanides in Senegal



Samples shipped, separation started, results expected before the end of the year

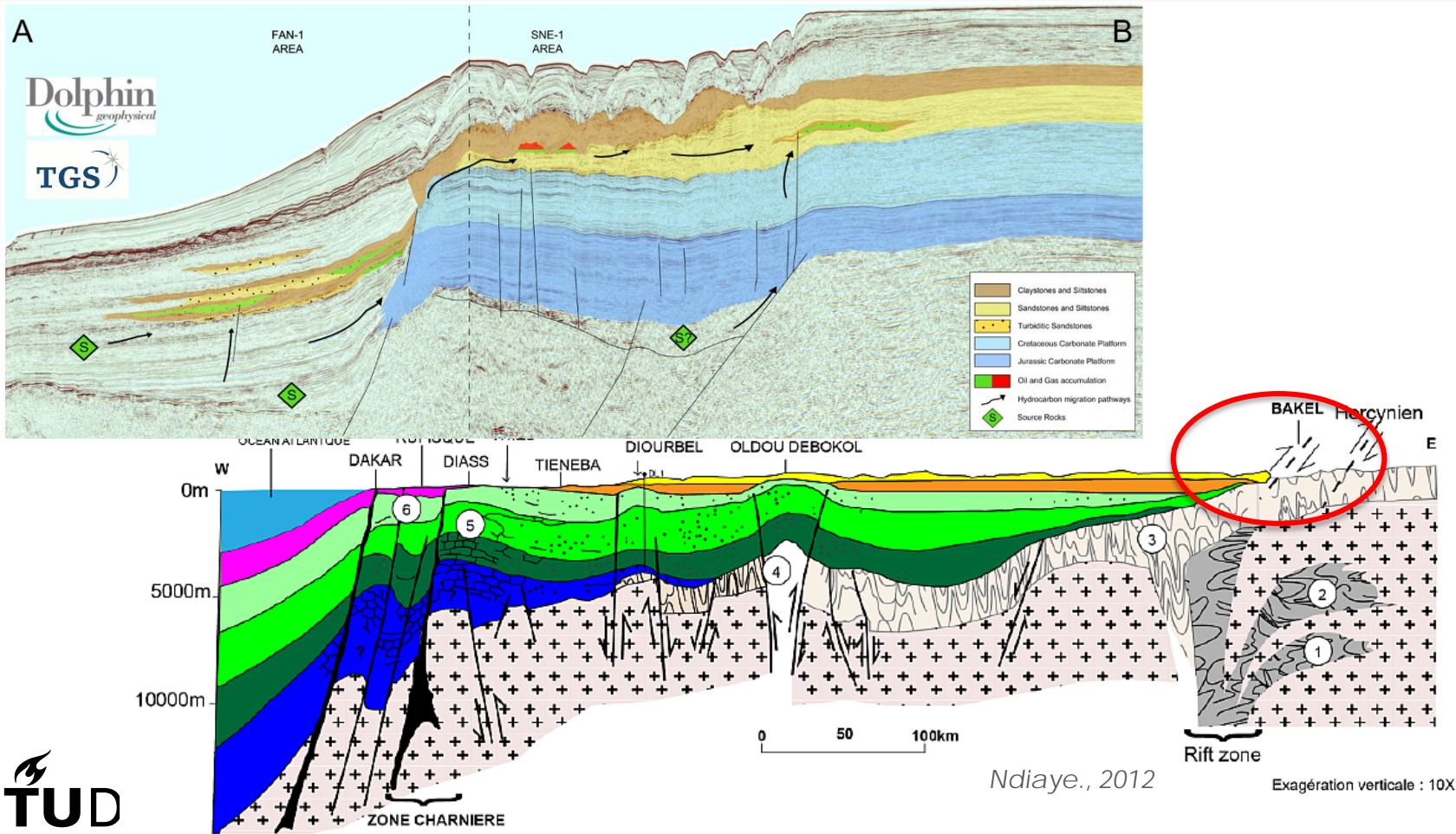


0 55 110 220 330 440 Kilometers

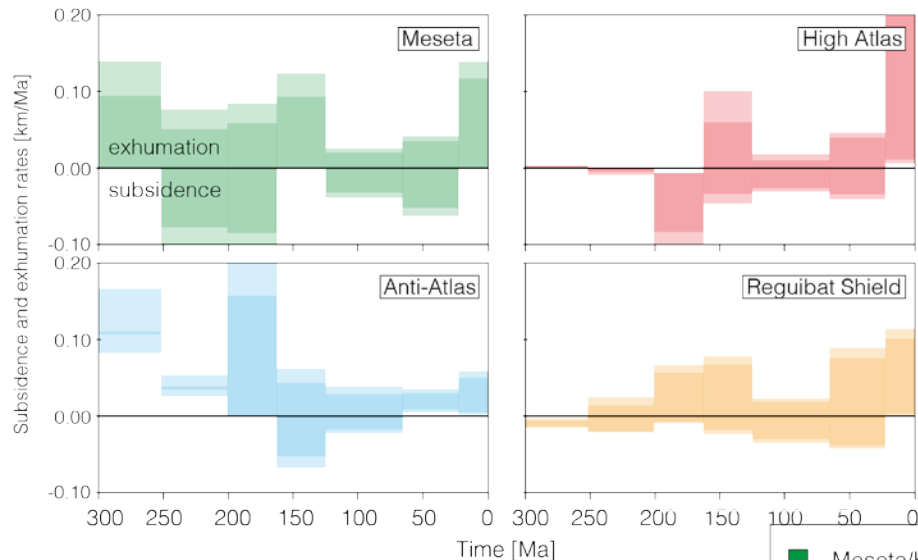


The NARG GIS data base

The Mauritanides in Senegal

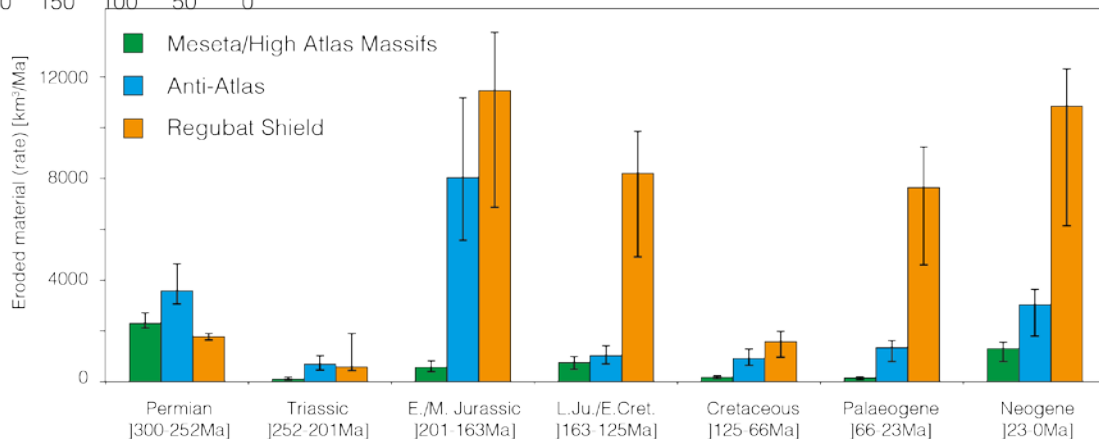


Erosion and vertical movement



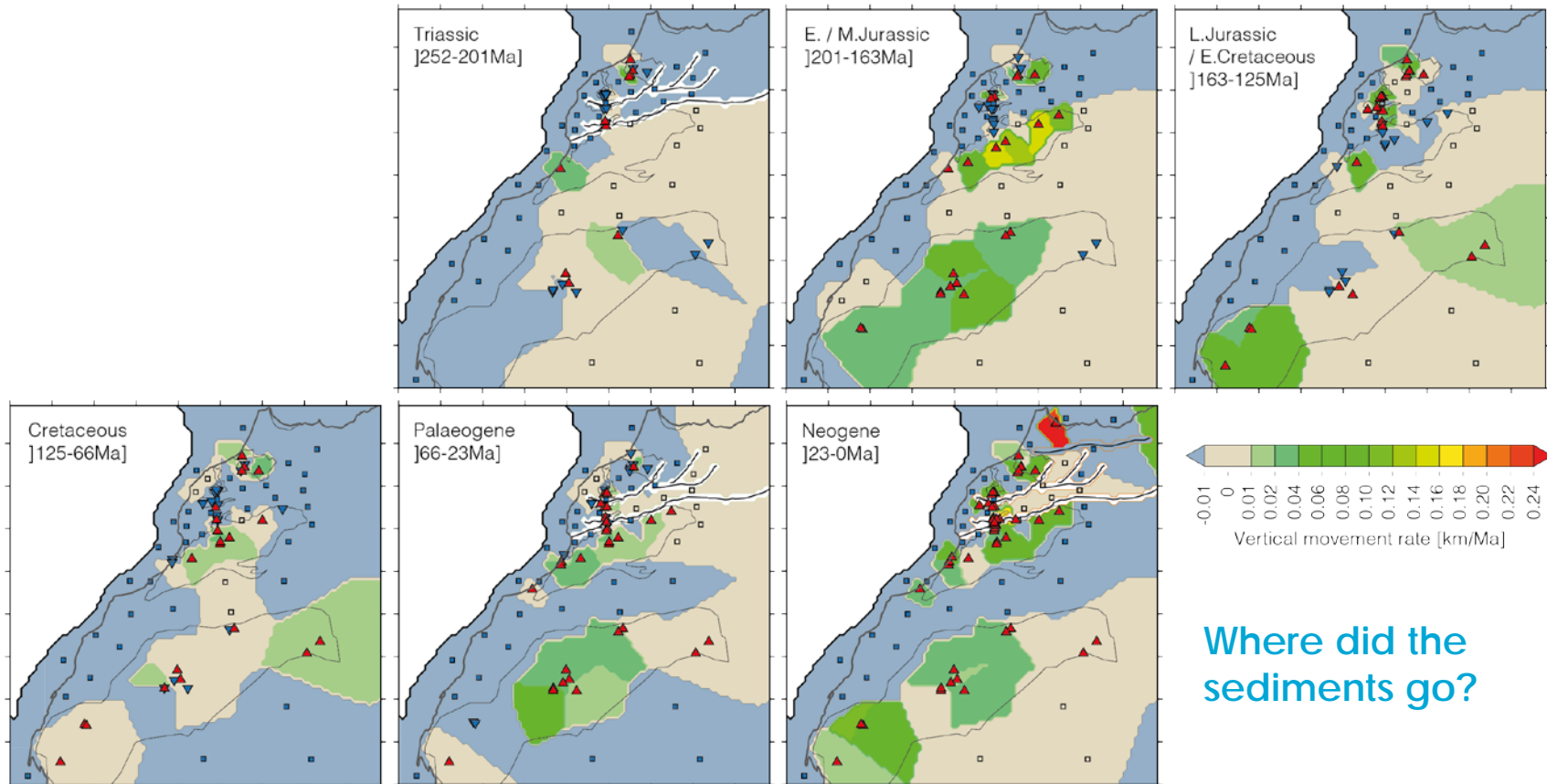
Major erosion in the post-rift
The Reguibate shield being the most
important source

Not always a
correspondence
between eroded
material and thickness



Vertical movements

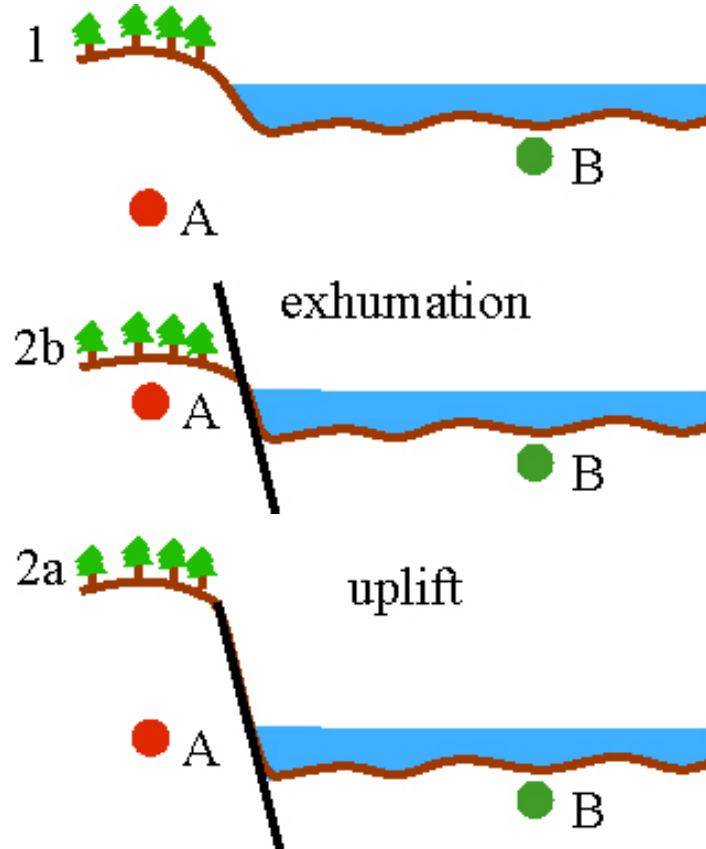
Making assumptions on the thermal gradient, this can be translated in thickness of the **eroded column** in time intervals of choice



Topography:

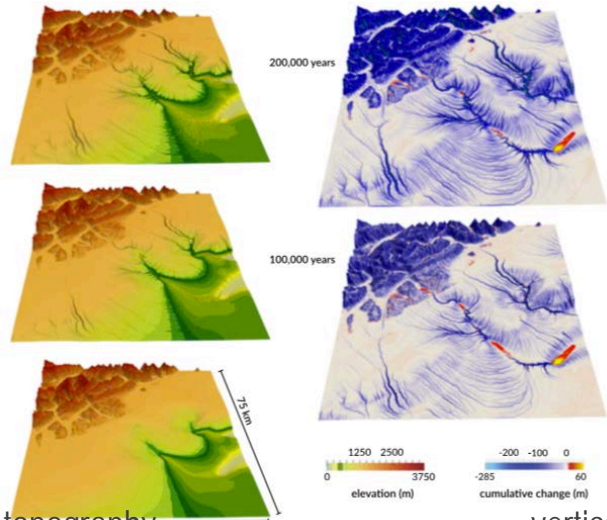
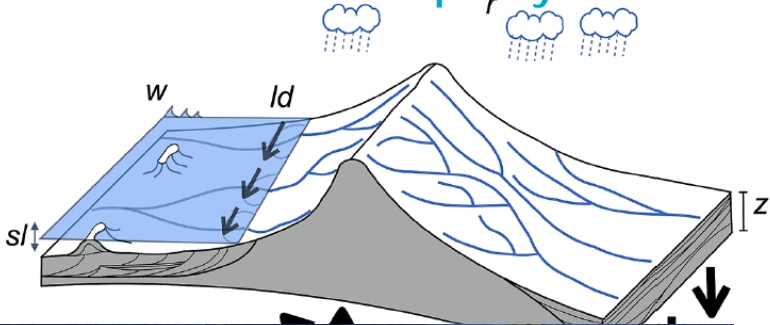
Important for river pattern and for topography in buried areas

Exhumation \neq uplift



Modelling topography: badlands

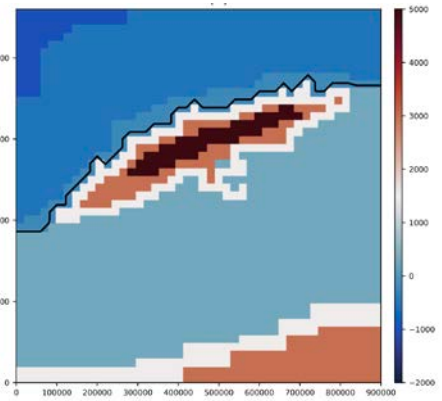
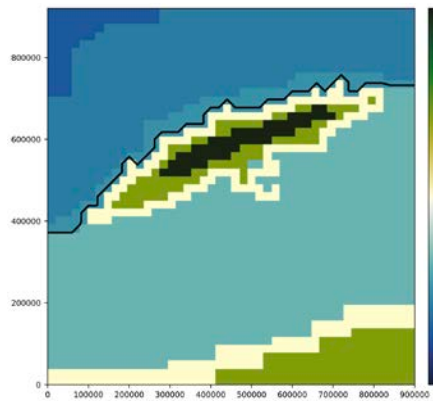
Basin and Landscape Dynamics



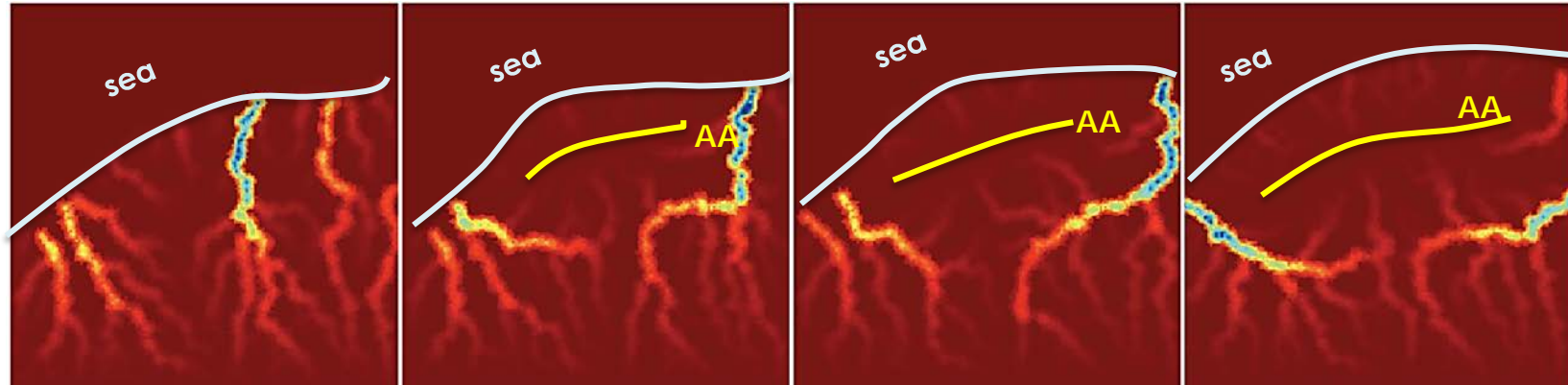
initial topography

initial setting

vertical movement



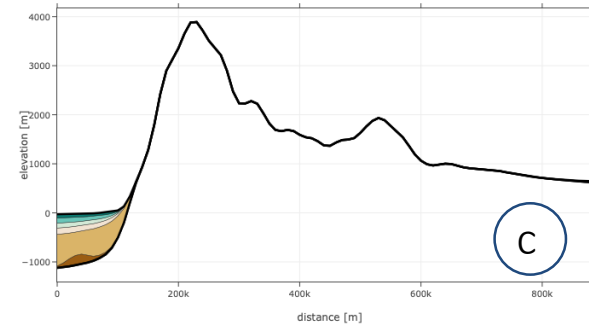
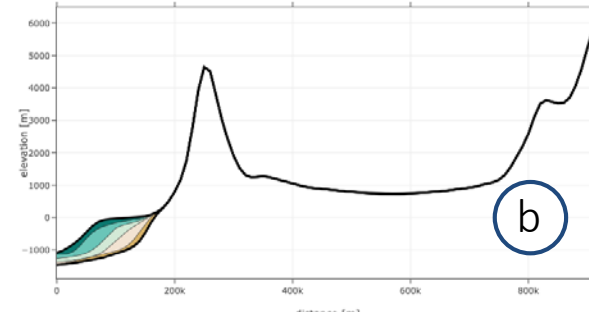
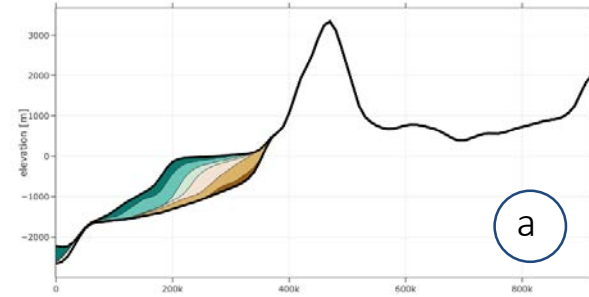
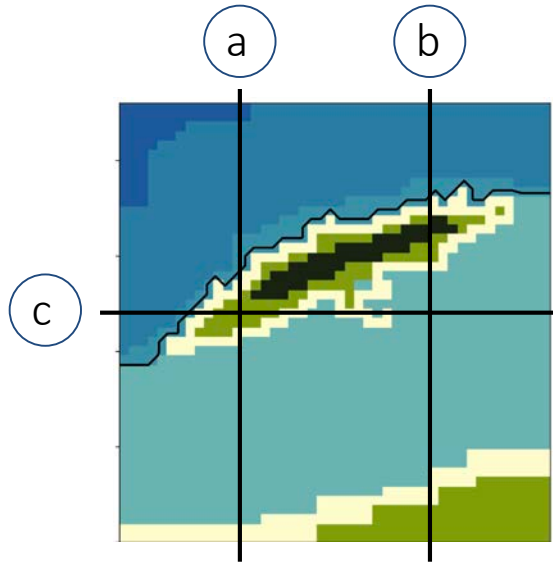
No initial AA topography



Charton in progress

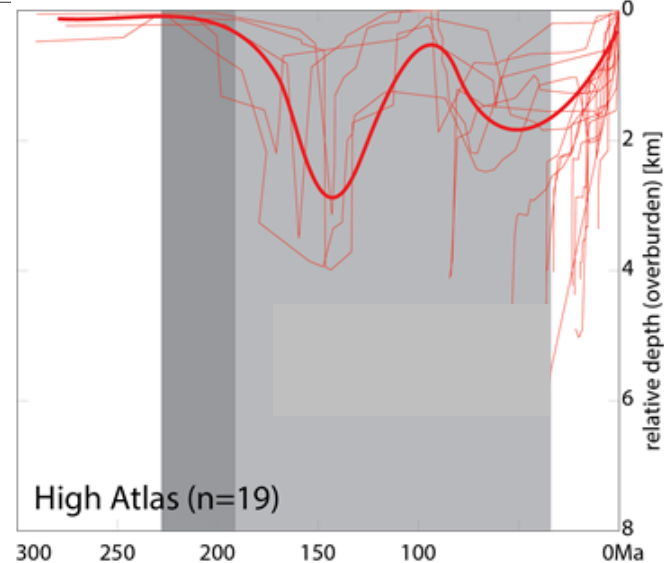
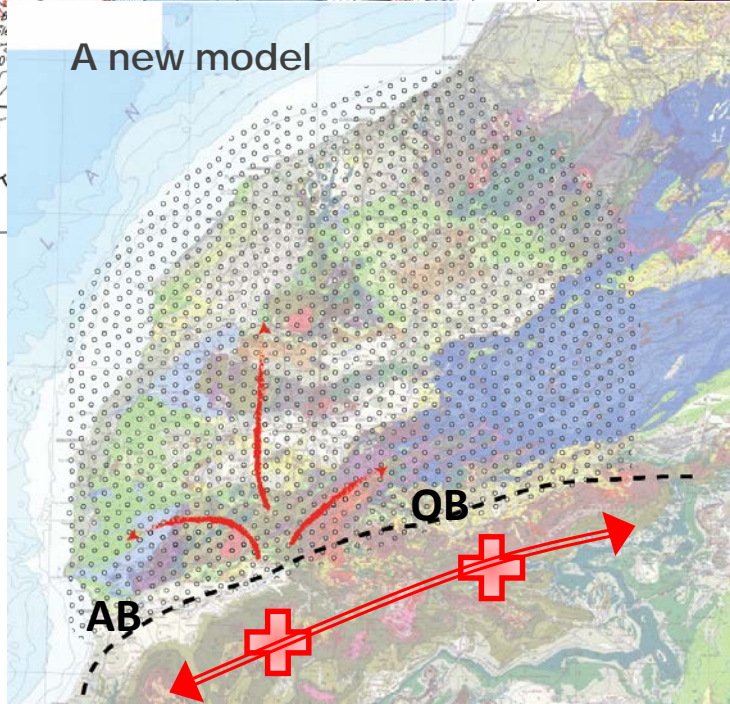
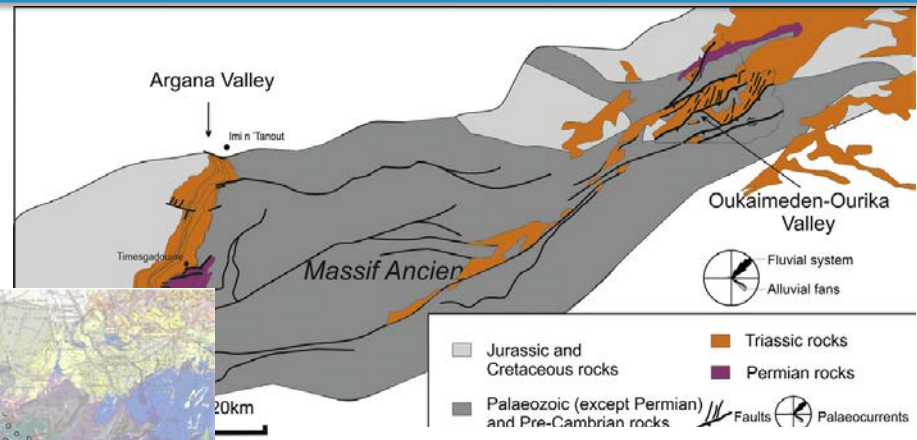
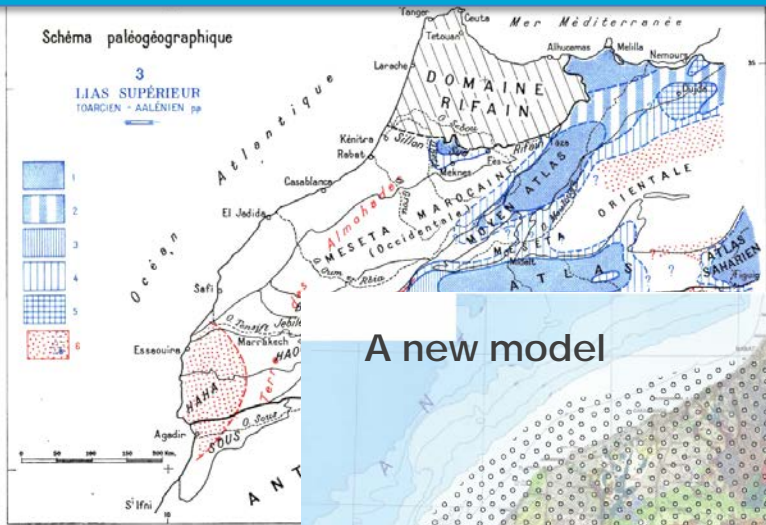
increasing AA uplift

Sediment deposition

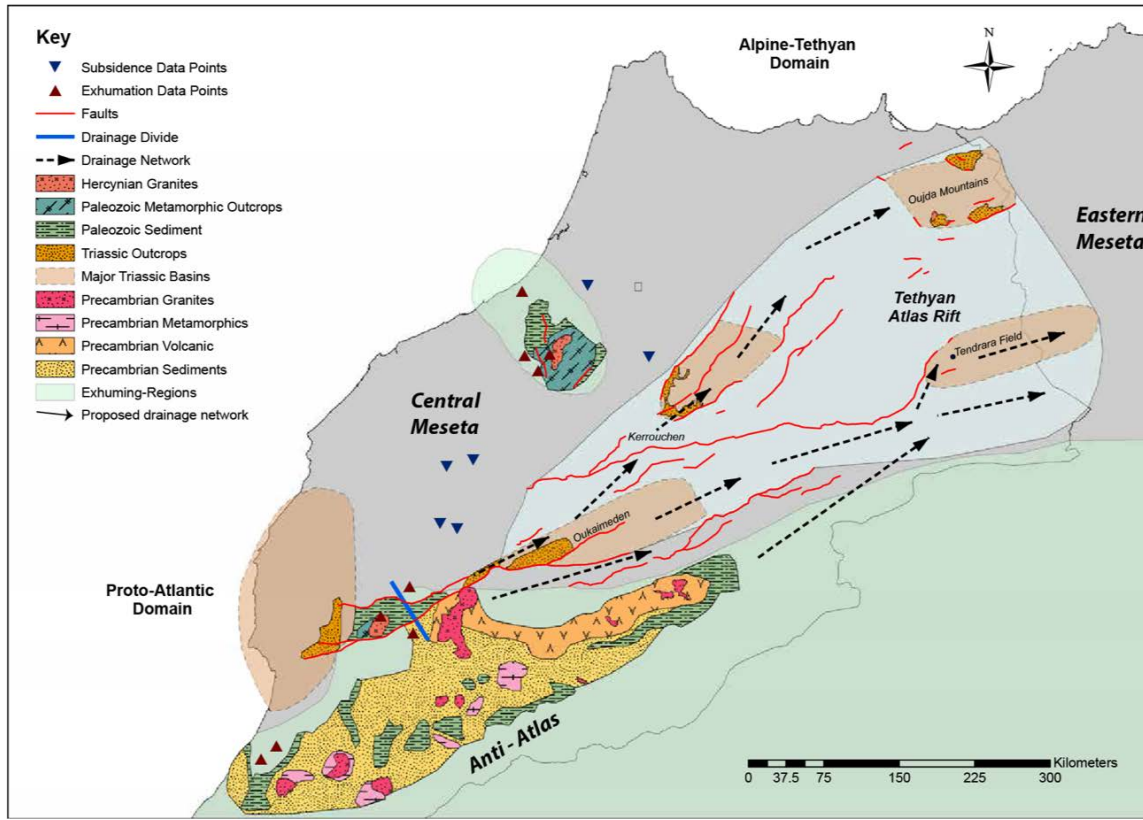


- The passive margin is not so passive (major changes in our understanding of the evolution of PCMs)
- Some (present) topographic highs cannot be the source of Jurassic-Cretaceous clastics (too small at that time, or even **subsiding!**) (it is misleading to use the present topography as an inspiration)
- We need to re-think the paleogeography and the source area

Massif Ancien de Marrakech



Following the Triassic trail to the East

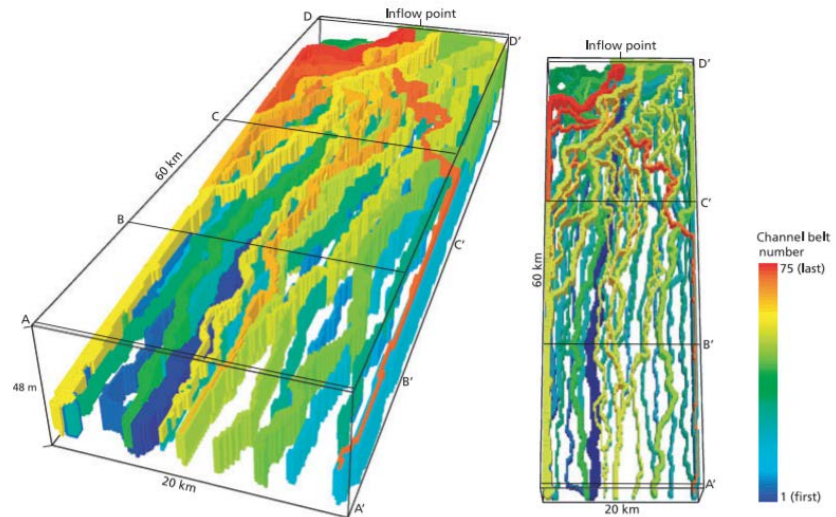


The Kerrouchen basin
Anti-Atlas the main source
Sediments routed from the Atlas
domain through Kerrouchen basin
to the High Plateau
Increasing proportion of mafic
heavy minerals associated with
increasing unroofing

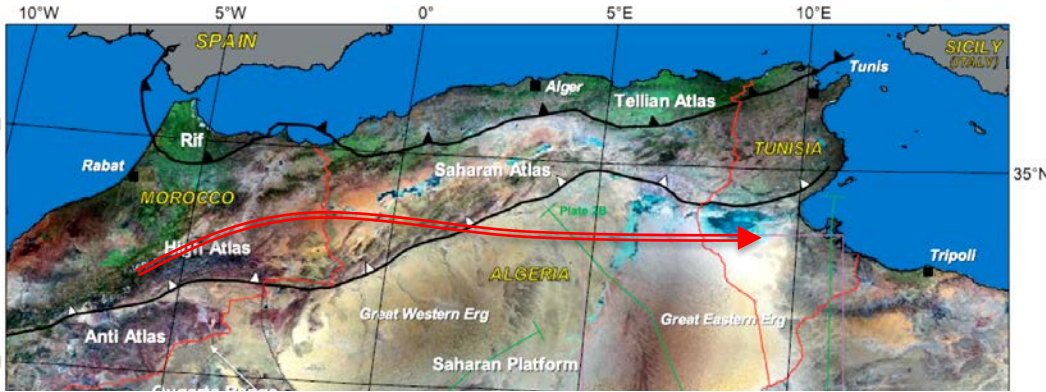
Kerrouchen basin



Integrated with process-based
sedimentary models



Towards Unisia

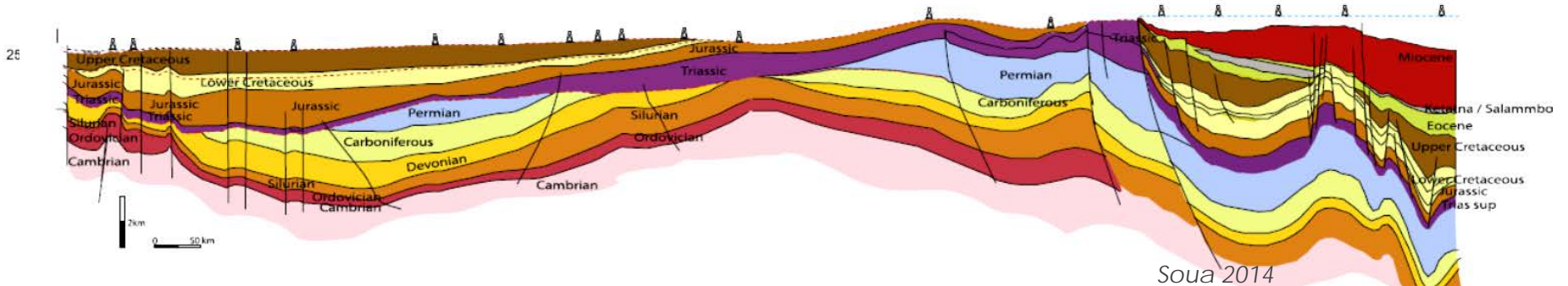


Widespread Triassic
A base Triassic unconformity
(Variscan s.l.)
Folded and deformed
Paleozoic

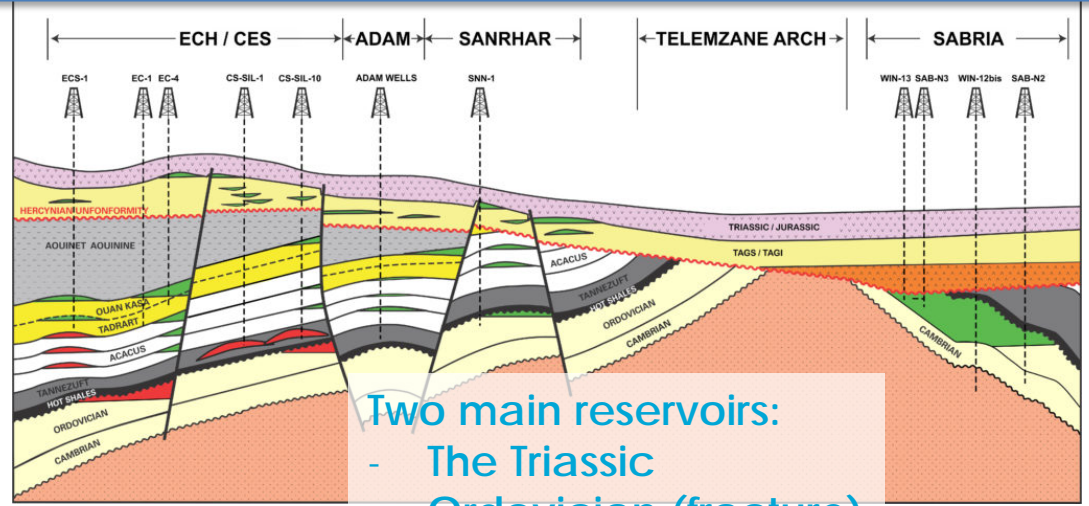
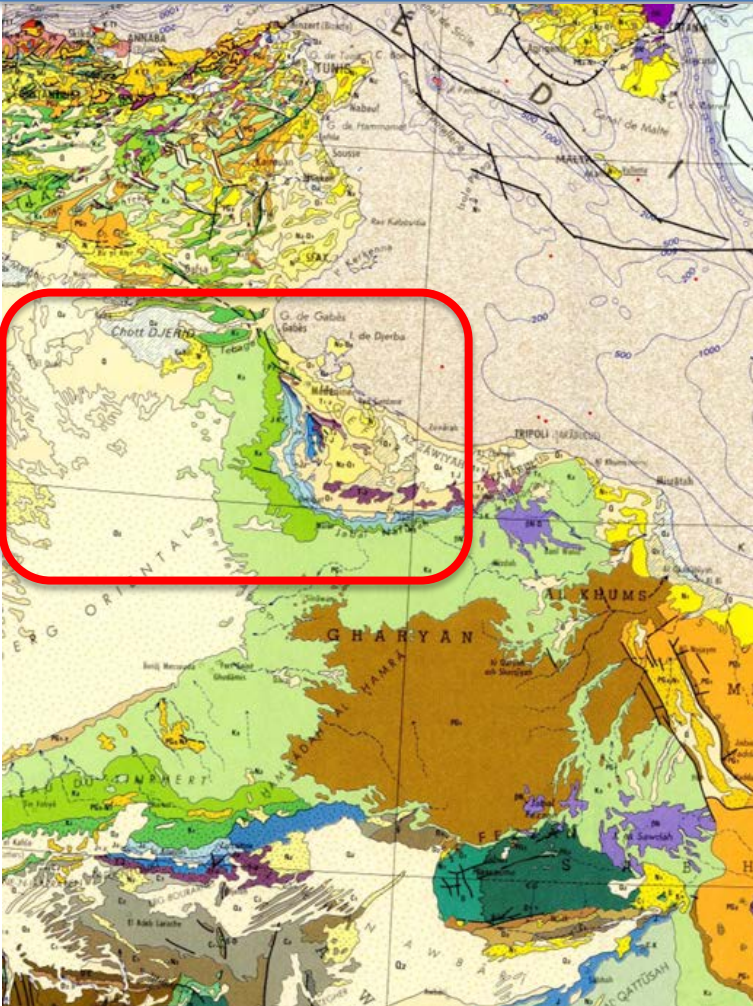
ALGERIA

TUNISIA

JEFFARA




Tunisia



Two main reservoirs:
- The Triassic
- Ordovician (fracture)

Back from the past: NARG in Tunisia




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Research in Tunisia

Fieldwork undertaken across Tunisia, examining the Cretaceous stratigraphy and depositional systems. Also our Source Rock Hunter project completed a detailed study of the Eocene Bou Dabbous source rock.

Completed projects

- Third order sequence stratigraphic framework for the Palaeozoic reservoirs of North Africa.
- Nummidian Flysch depositional system and provenance.

Lead researchers

Manchester:

- Prof Jonathan Redfern
- Dr David Hodgetts
- Dr Cathy Hollis
- Dr Stefan Schroeder
- Dr Mads Huuse
- Prof Kevin Taylor

Heriot-Watt:

- Prof Dorrik Stow
- Prof Patrick Corbett
- Dr Andrew Gardiner

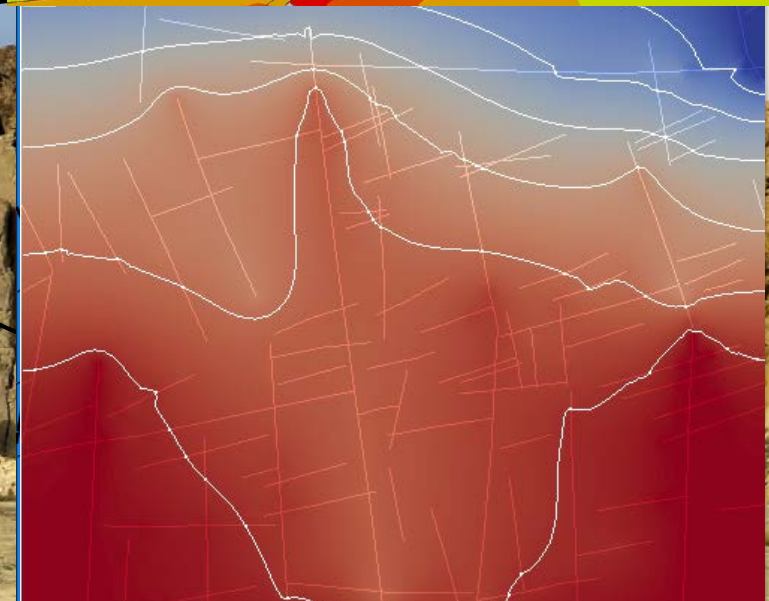
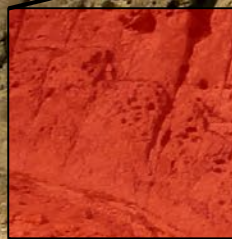
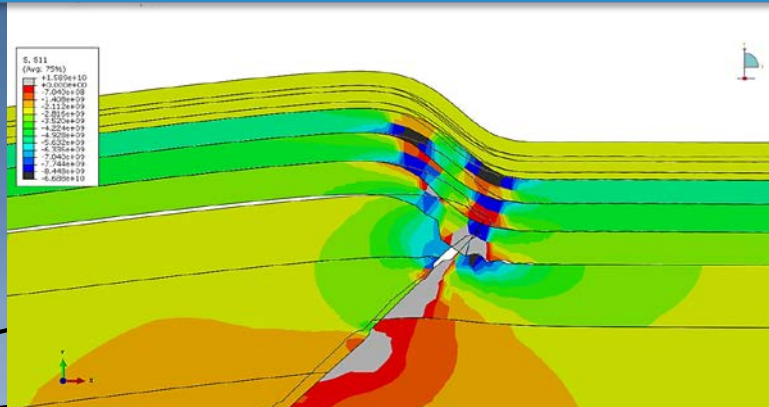
TU Delft:

- Prof Giovanni Bertotti
- Prof Joep Storms

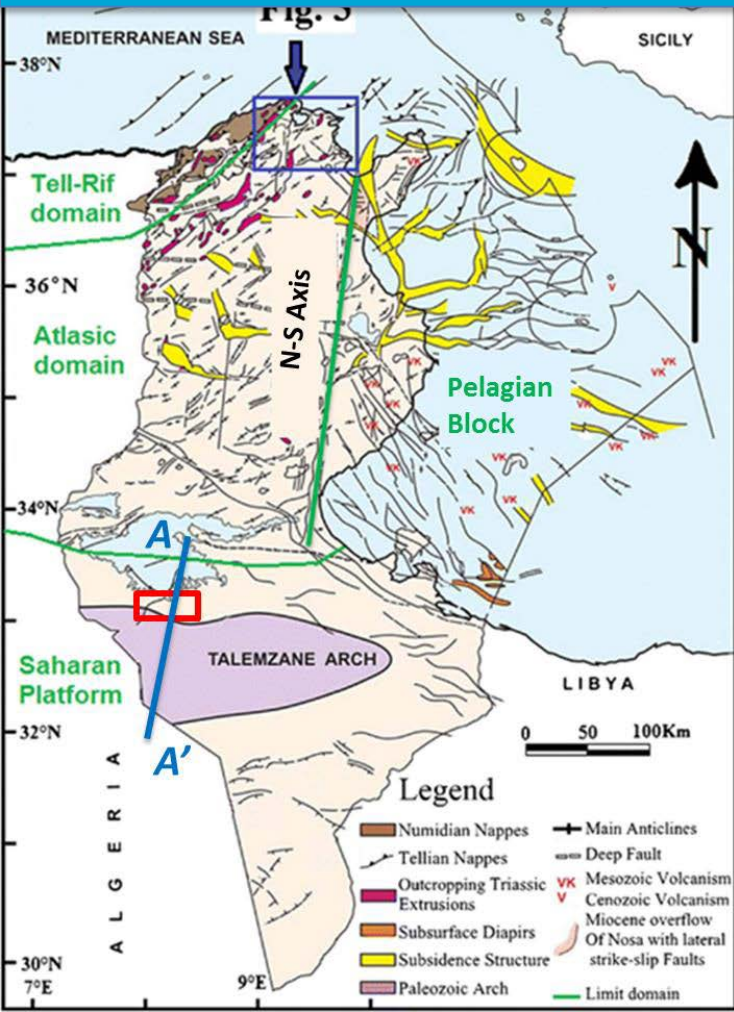
Collaborating Institution

Tunisian National Oil Company (ETAP)

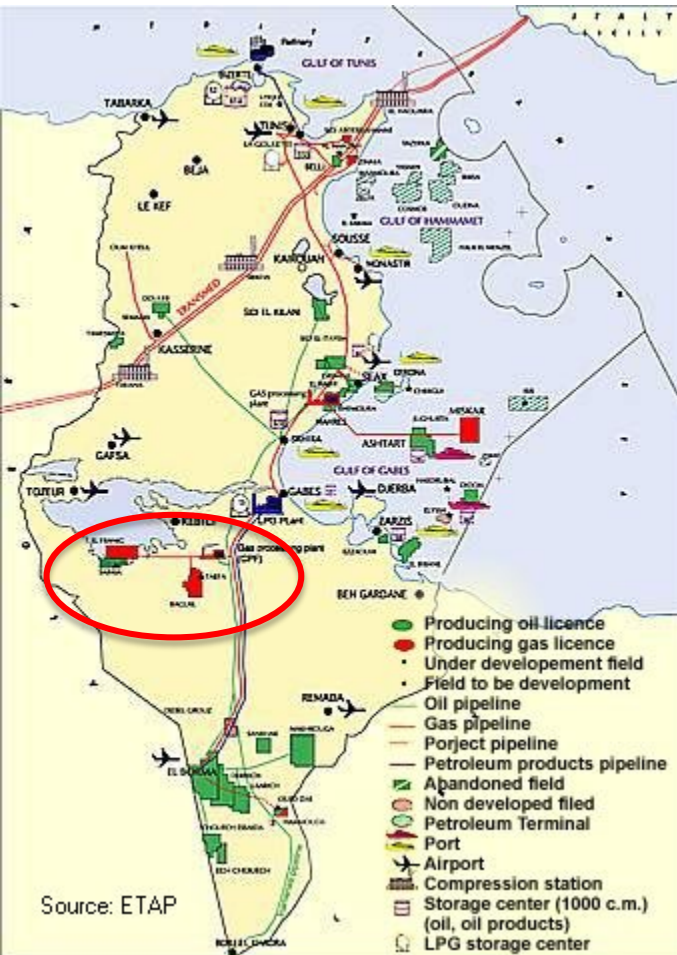
Tunisia: fractured reservoirs



Fracture modelling in the Sabria field

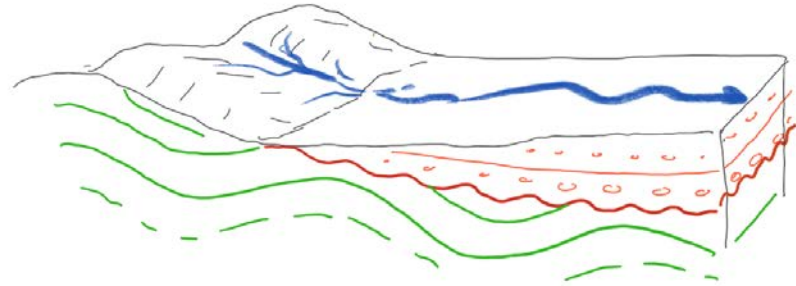


Tunisia: a new potential partner



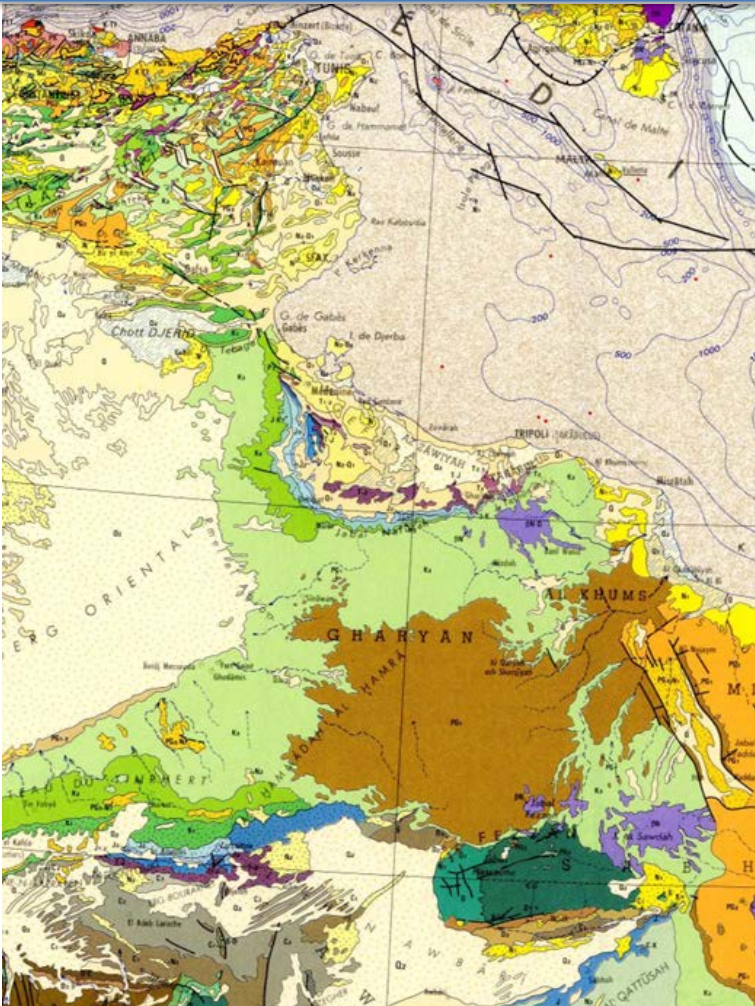
Interest in the Triassic and (fractured) Ordovician

Permo-Triassic tectono-sedimentary system in Central Tunisia



Variscan deformations control fracturing in Ordovician **fractured reservoirs** and **Triassic sedimentary system**

- Vertical movements from seismics and wells (geochronology)
- Regional and reservoir-scale sedimentary system
- Provenance analysis



Thank you

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