



Integrated source to sink
analysis of NW Africa :

*Provenance of the Barremian to Aptian
coarse sandstones of the EAB*

Emmanuel **Roquette**, 2nd year PhD student



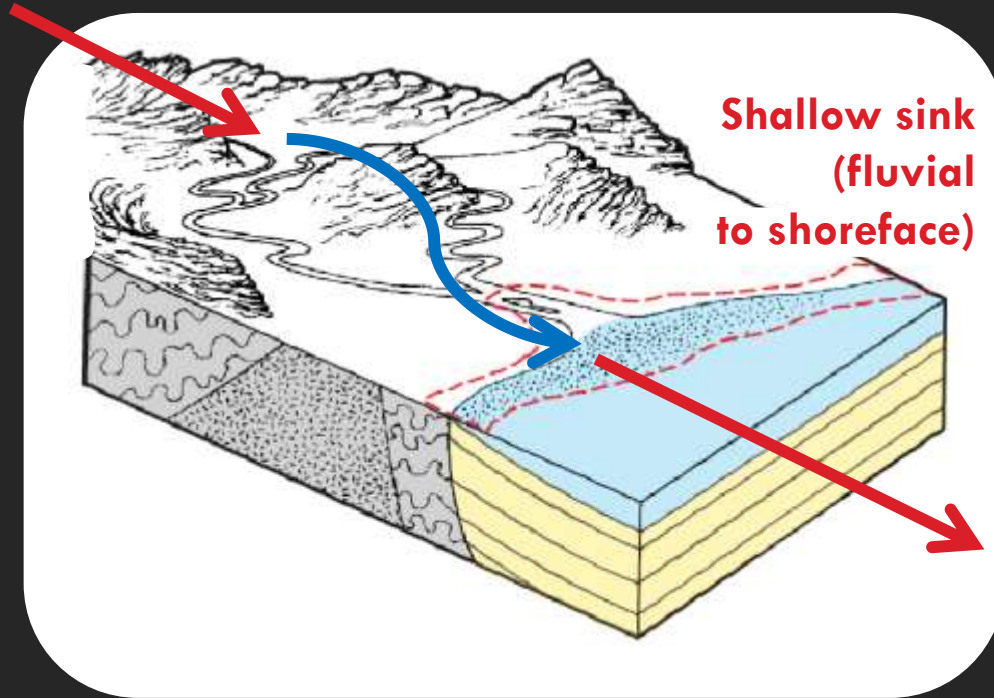
Introduction

SOURCES

Quantity,
timing and nature of
the sediments

TRANSPORT

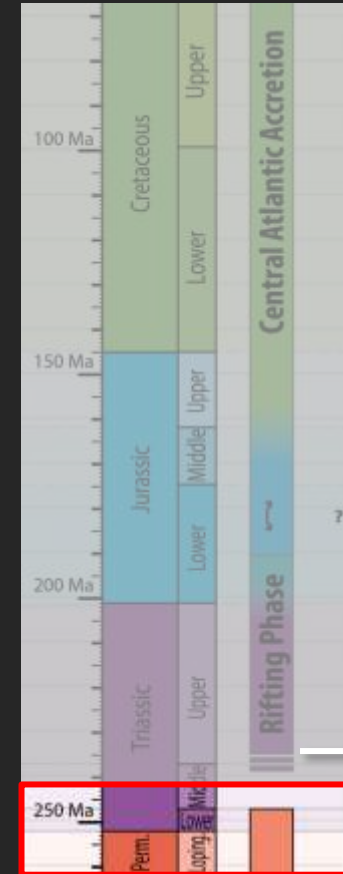
Textural
maturation,
storage, mixing



BASIN

Deposition
processes,
compaction,
diagenesis

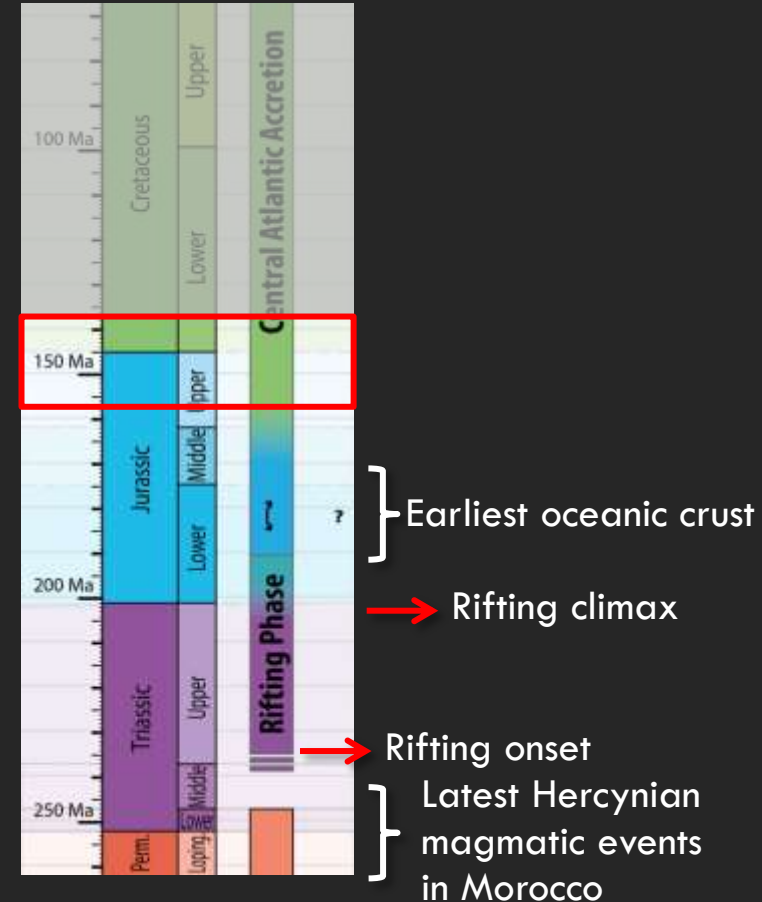
Tectonostratigraphic framework



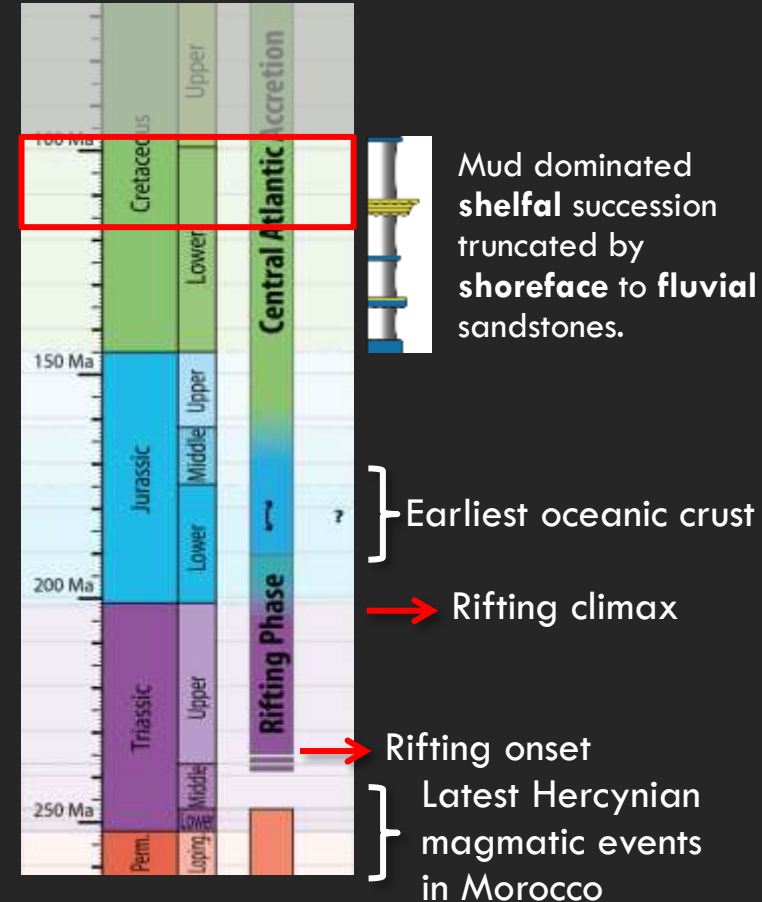
→ Rifting onset

} Latest Hercynian magmatic events in Morocco

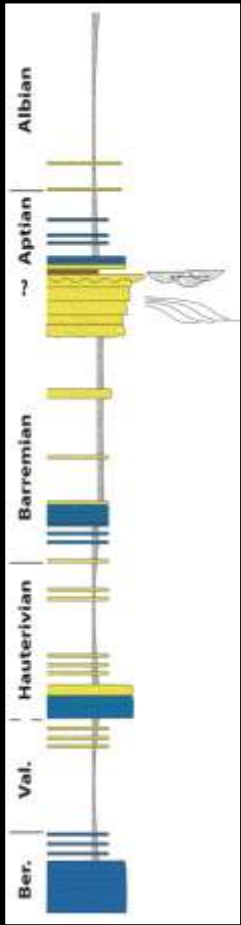
Tectonostratigraphic framework



Tectonostratigraphic framework



Tectonostratigraphic framework



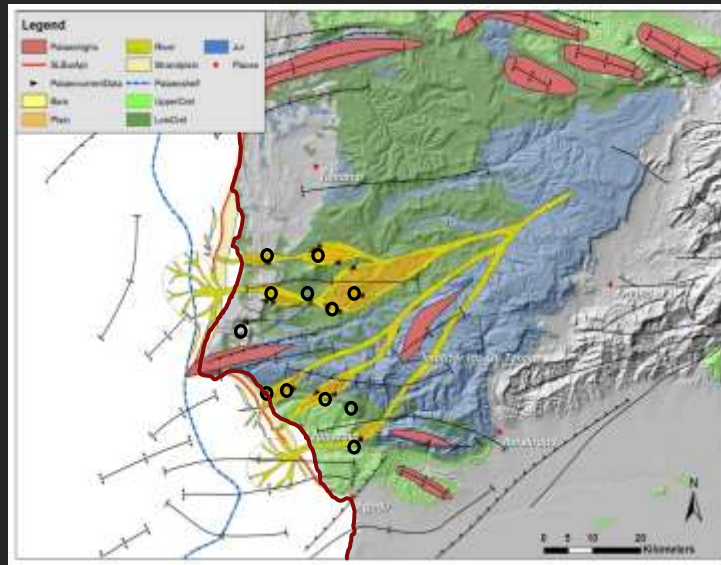
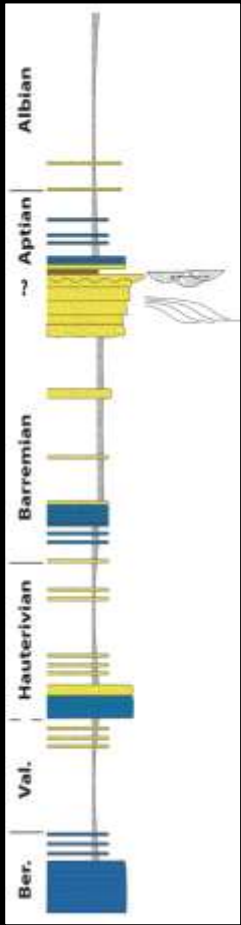
Lower Cretaceous :

Mud dominated **shelfal** succession truncated by **shoreface** to **fluvial** sandstones.



Tectonostratigraphic framework

Interval of interest: Fluvial to shoreface sandstones of the **Late Barremian** to **Earliest Aptian** regressive succession

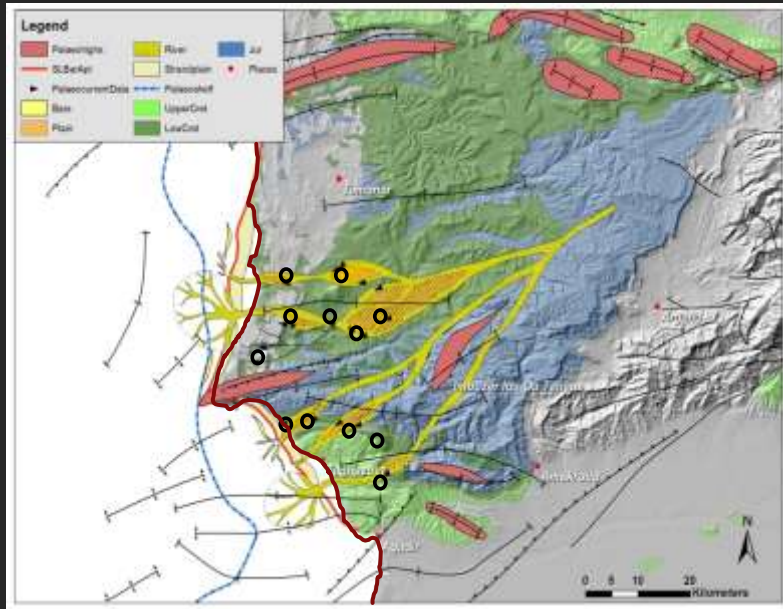


EAB = Essaouira-Agadir Basin

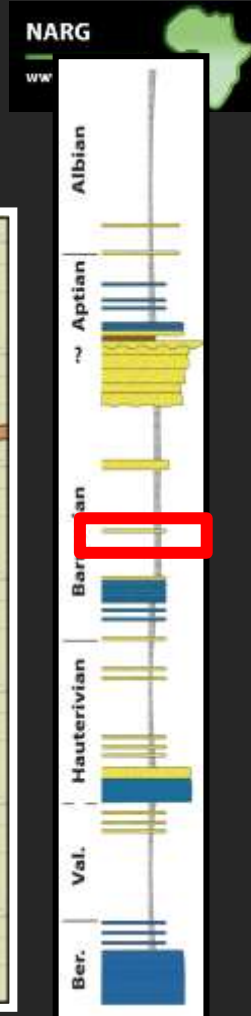
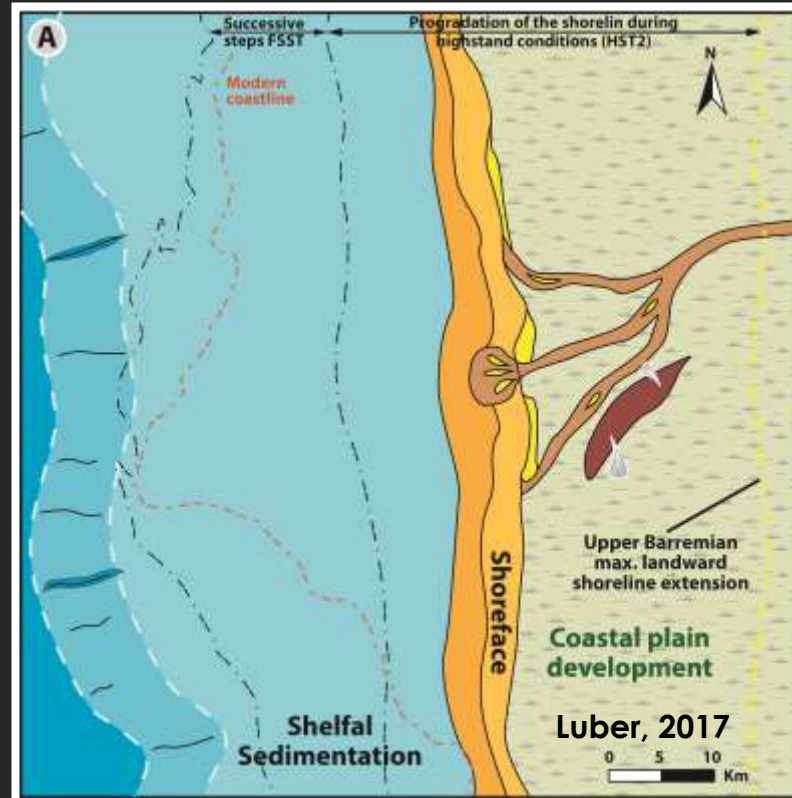


Tectonostratigraphic framework

Barremian to lowermost Aptian evolution



Pre-Regression - HST

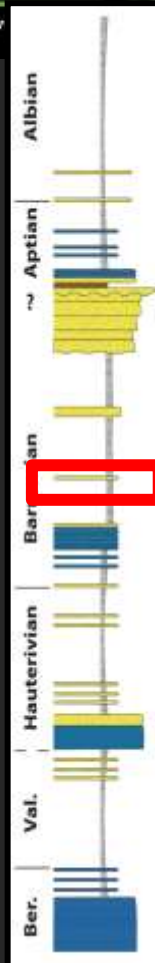
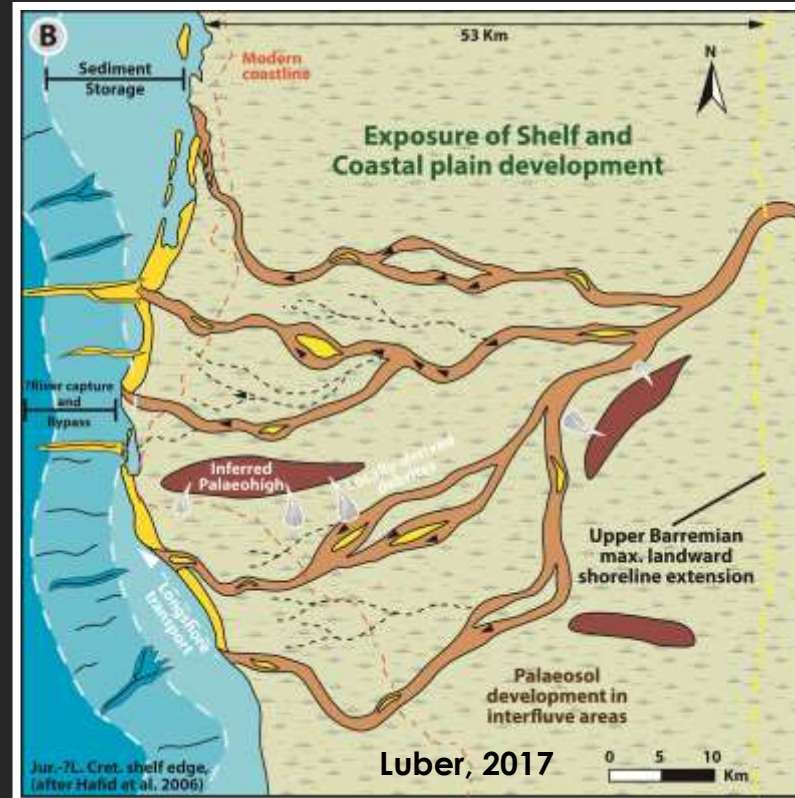
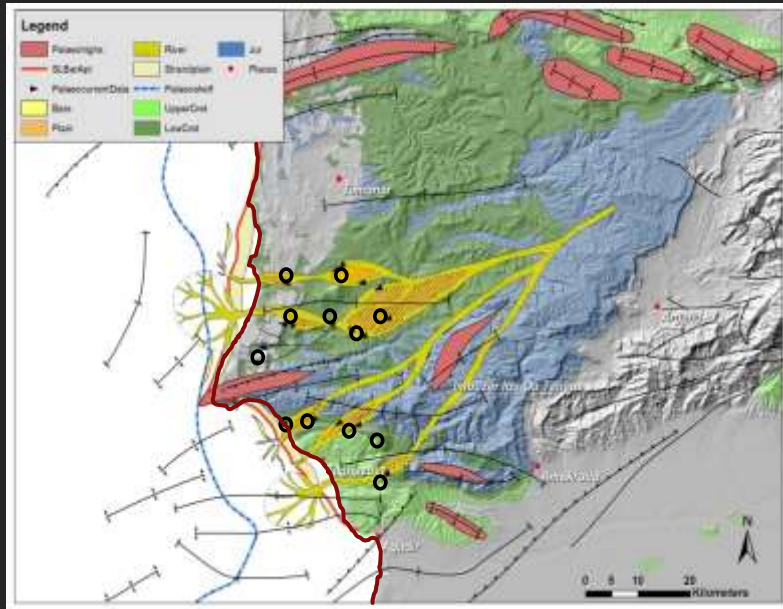


Tectonostratigraphic framework

Barremian to lowermost Aptian evolution

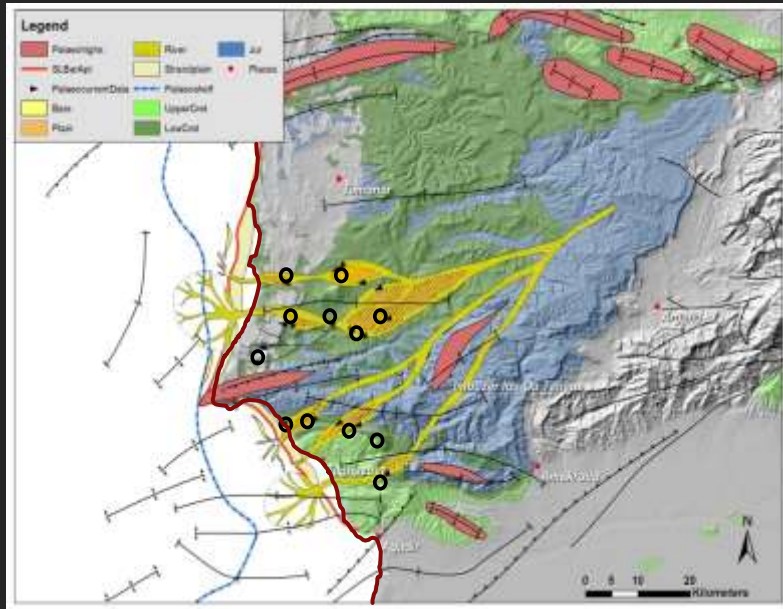


Pre-Regression - HST

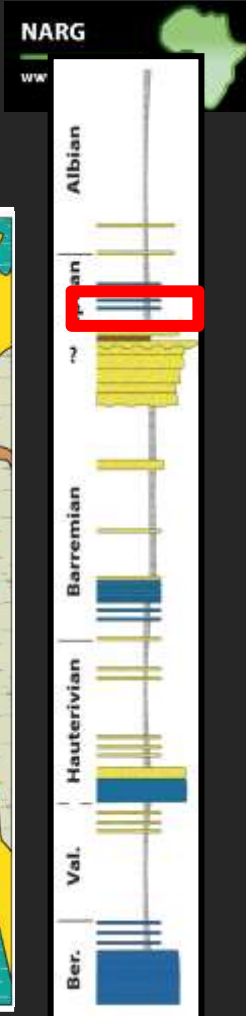
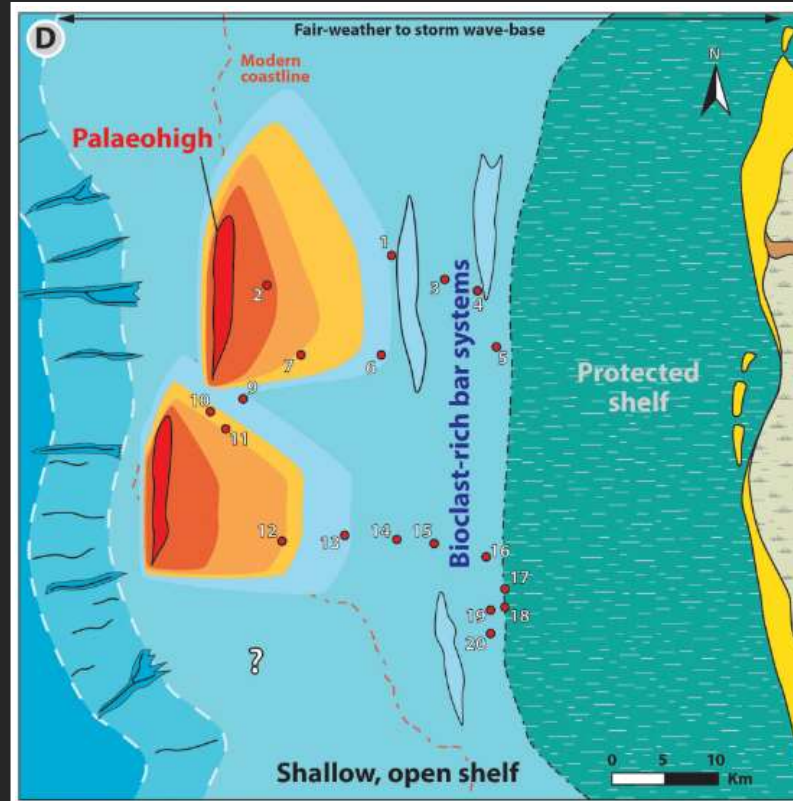


Tectonostratigraphic framework

Barremian to lowermost Aptian evolution

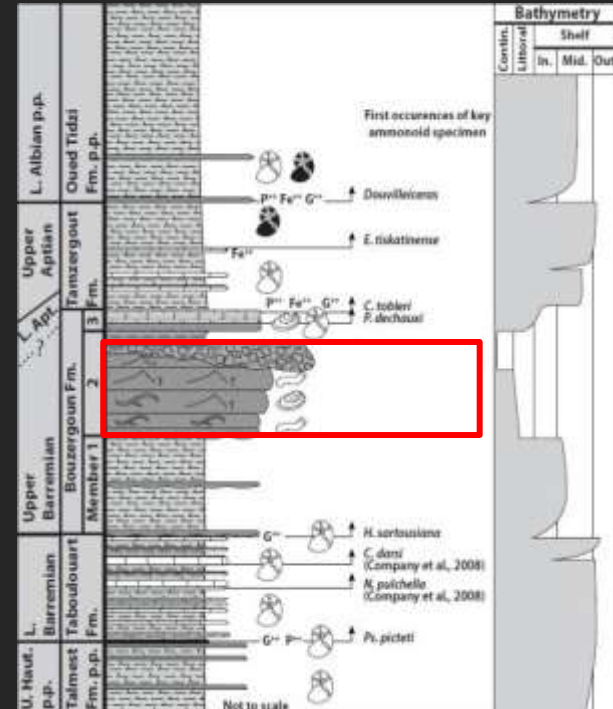


Pre-Regression - HST



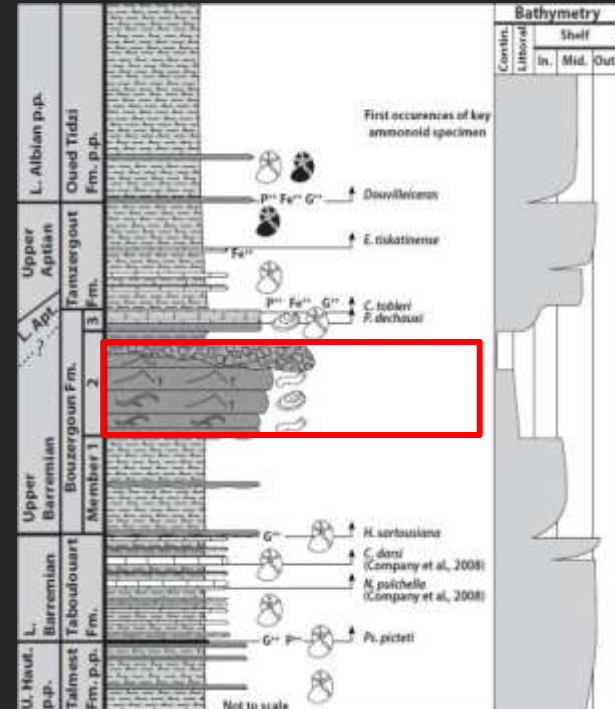
Objectives:

- Constrain the **provenance** of the **Barremian Aptian regressive interval**
- Identify shifts in the **sources** of the Lower Cretaceous **clastics** across NW Africa
- Constrain the importance of **transport** and **mixing as a control on character** of the sediment brought to the shelf margin and delivered to deep basin

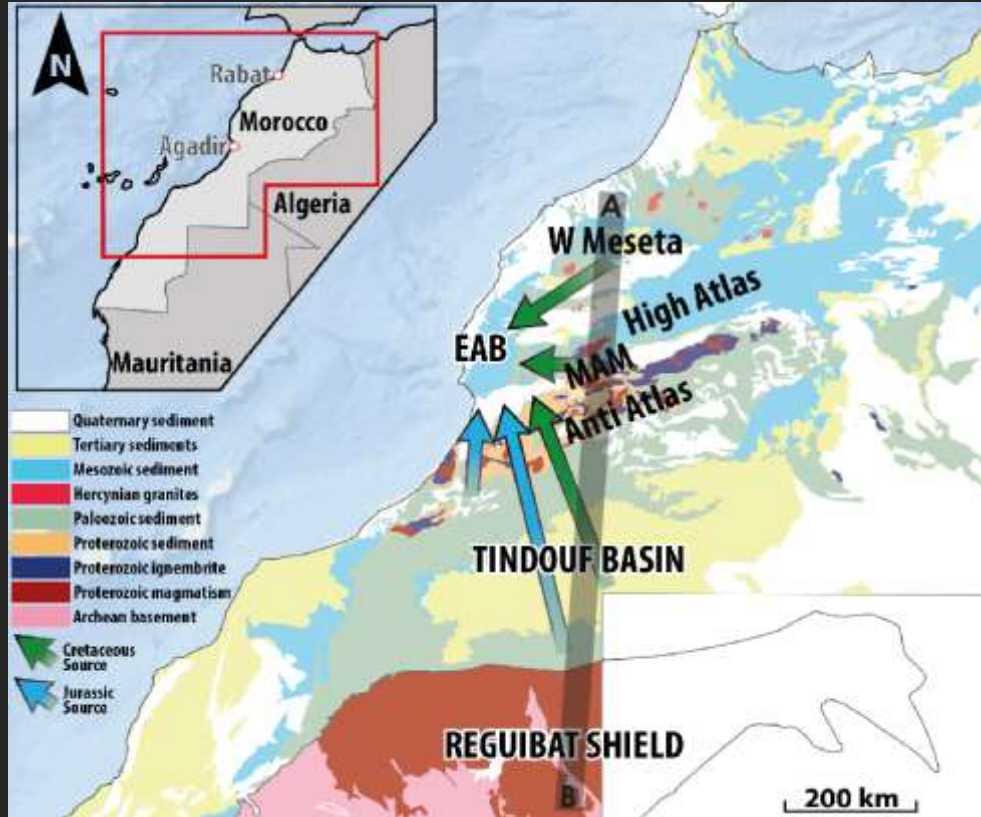
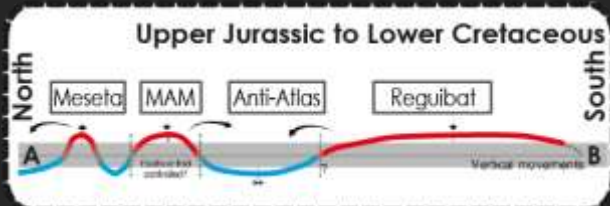
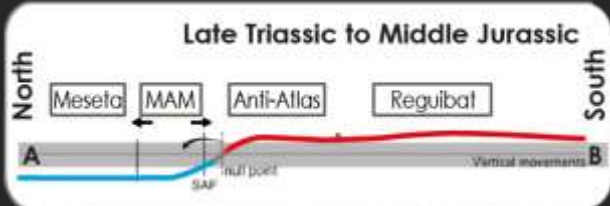


Methods:

- **Thermochronology:** assessment of the main vertical movements affecting the post rift evolution of the margin.
- **Petrography** and mineral populations supported by SEM/QEMSCAN
- **Geochemistry**, Zircon (U/Pb) and feldspars (Pb isotopes) to correlate the basin fill to the source
- **Heavy mineral analysis**



Provenance model

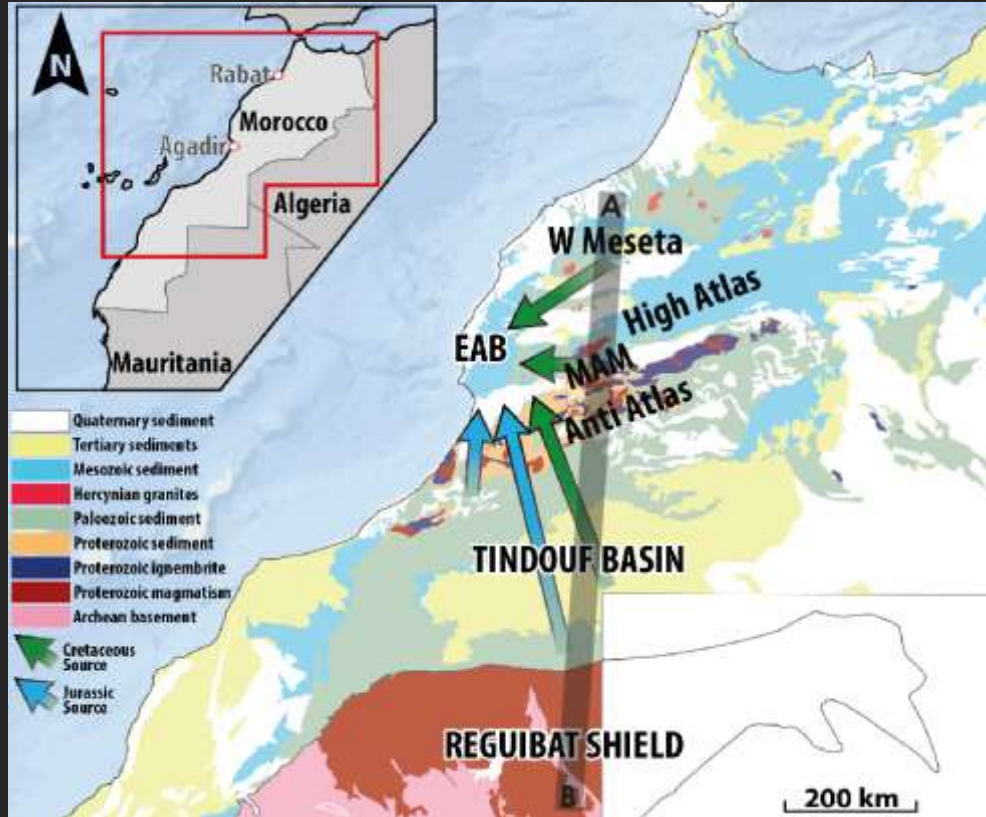


Uplifting Subsiding

NARG
www.narg.org.uk

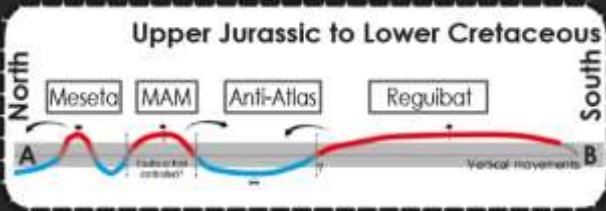
compiled by Remi Charton

Provenance model



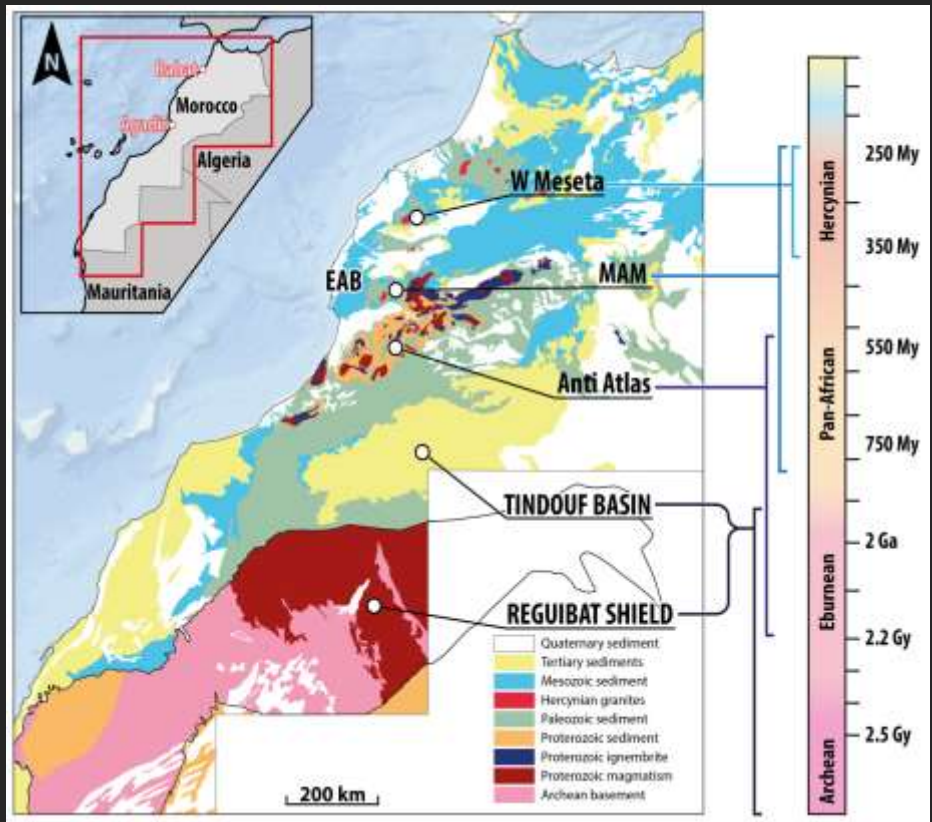
Uplifting
Subsiding

NARG
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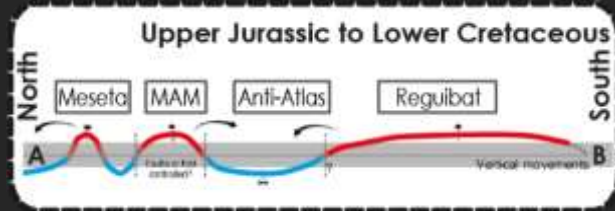
compiled by Remi Charton

Provenance model



Uplifting
Subsiding

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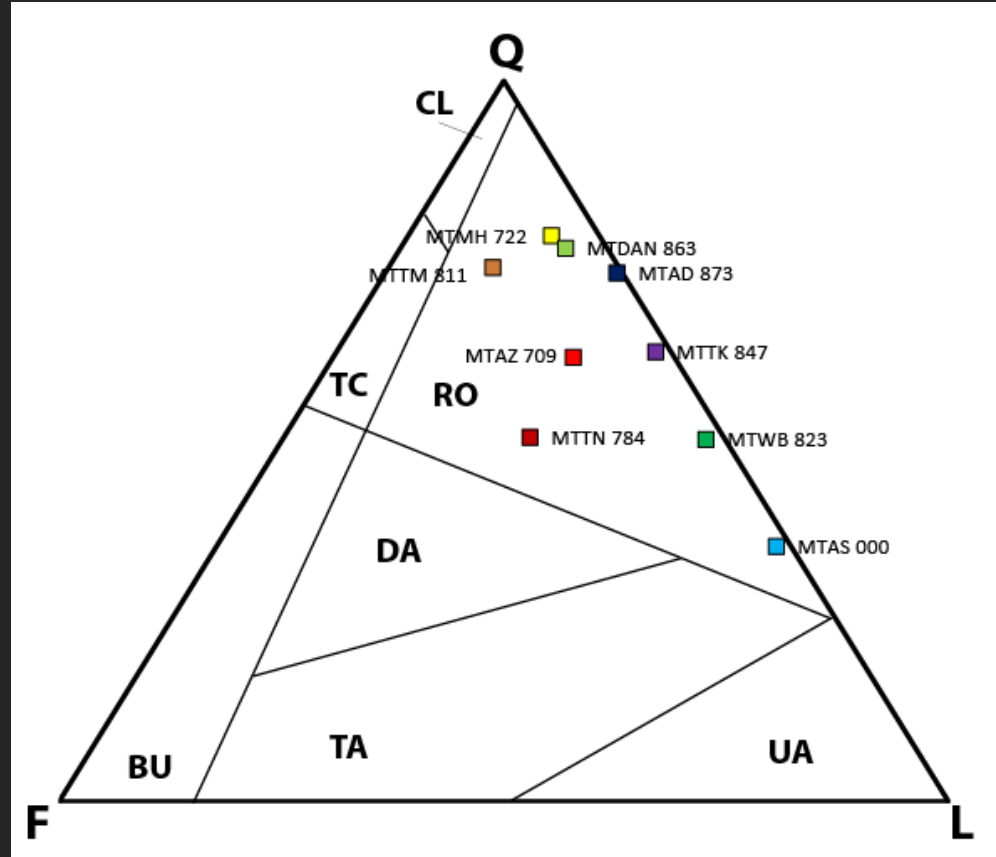
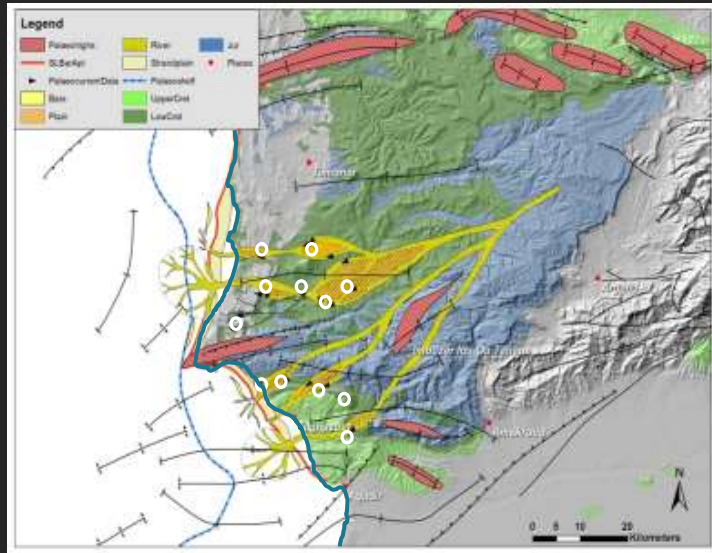
compiled by Remi Charton

Increasing ages southward

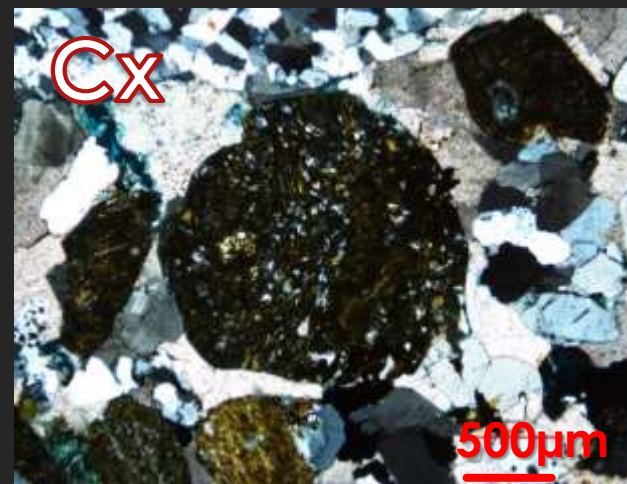
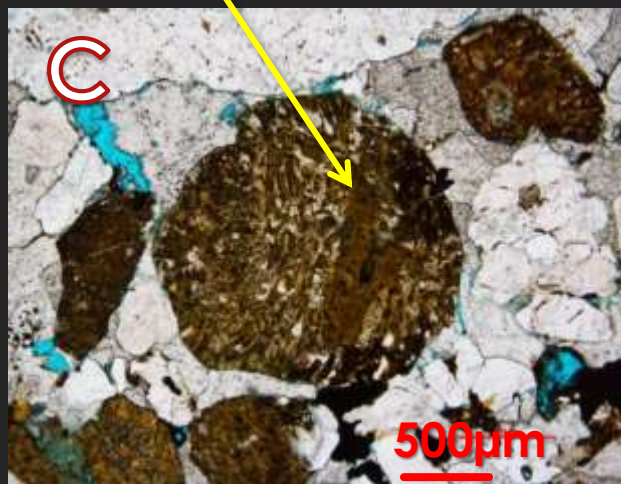
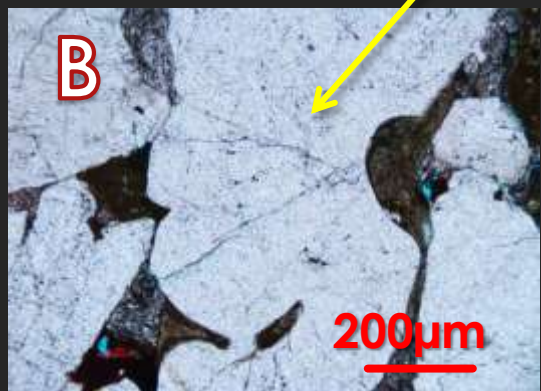
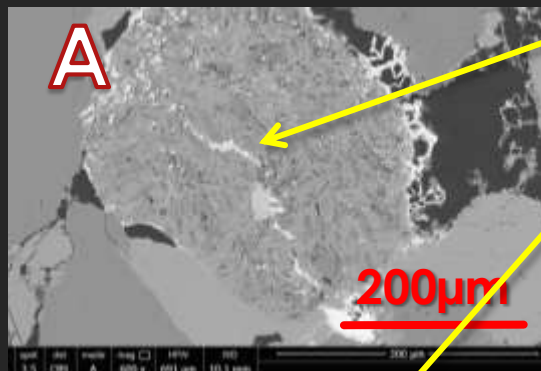
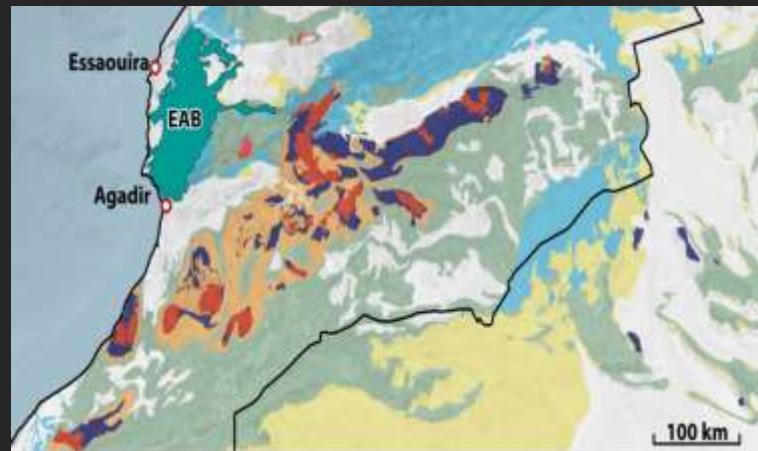
Petrography:

QFL

- Recycled orogen,
- No visible trend north and south of the paleo-high



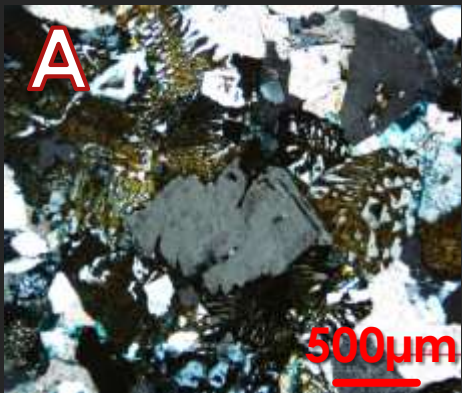
Petrography: Volcanic products



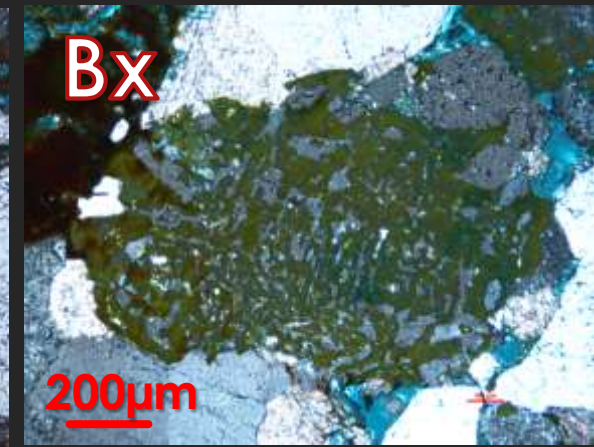
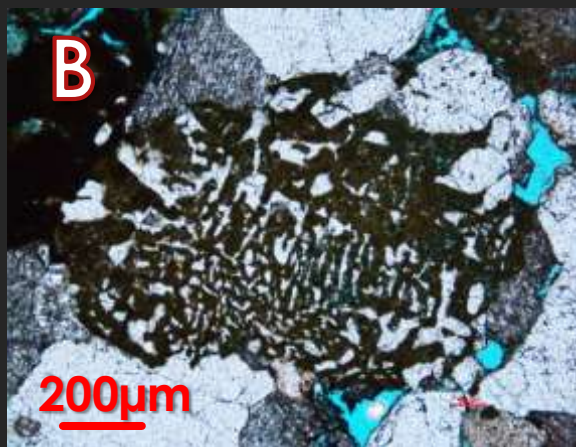
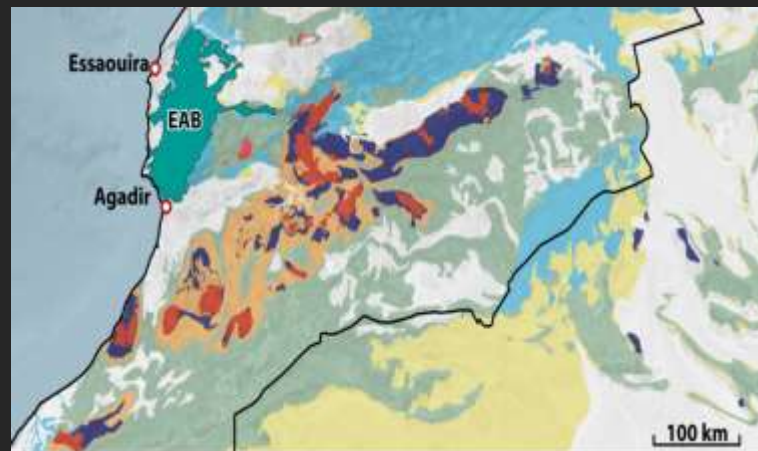
Rhyolite
Embayed Quartz
(pyroclasts)
Pumice

Petrography:

Volcanic products

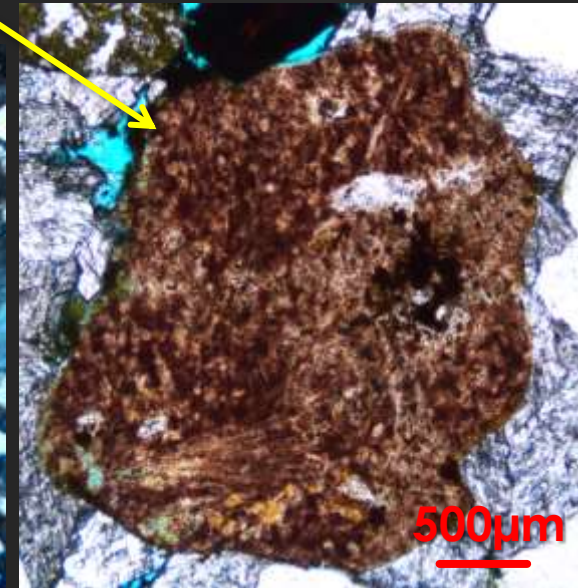
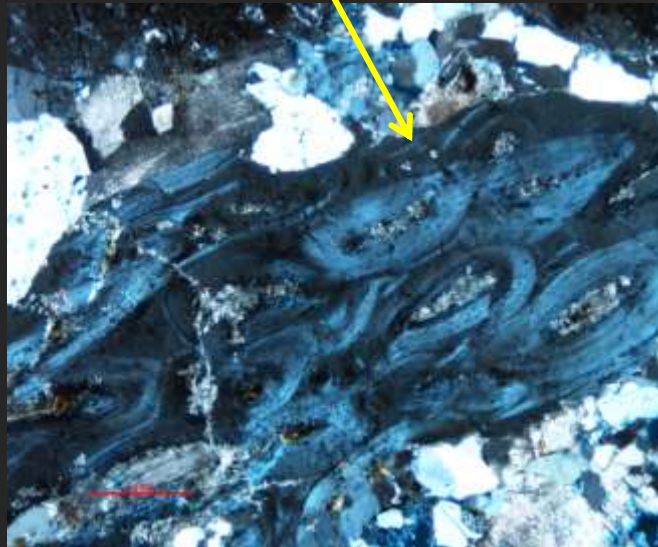
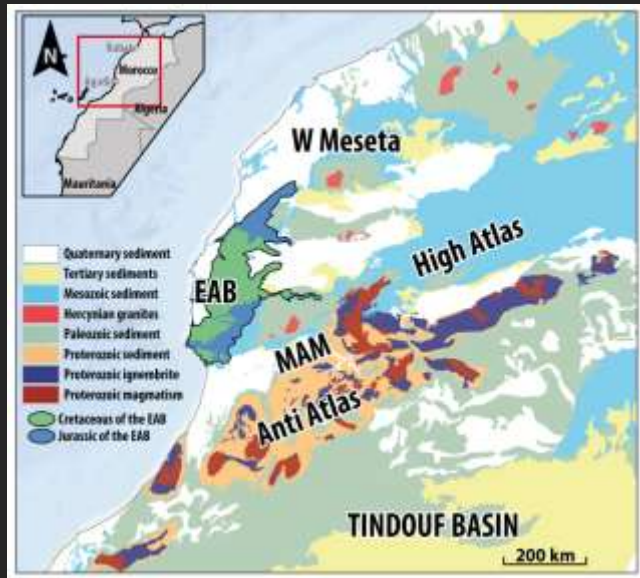


Granophyric
texture in
Ignimbrite clasts
Likely sourced
from the MAM

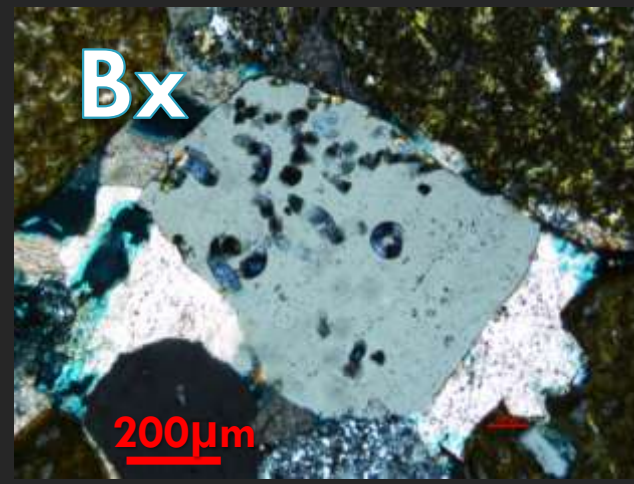
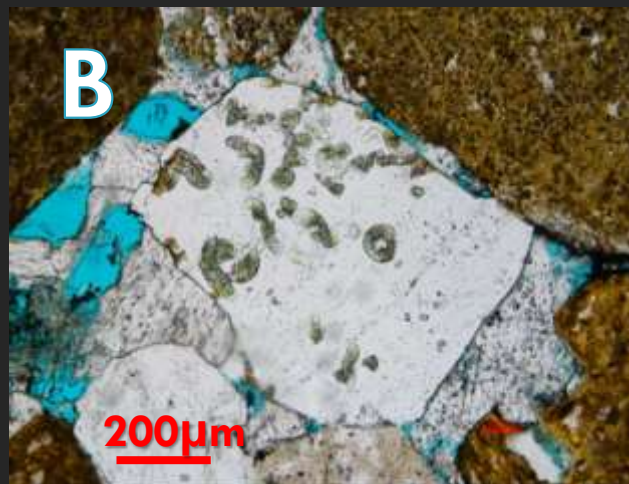
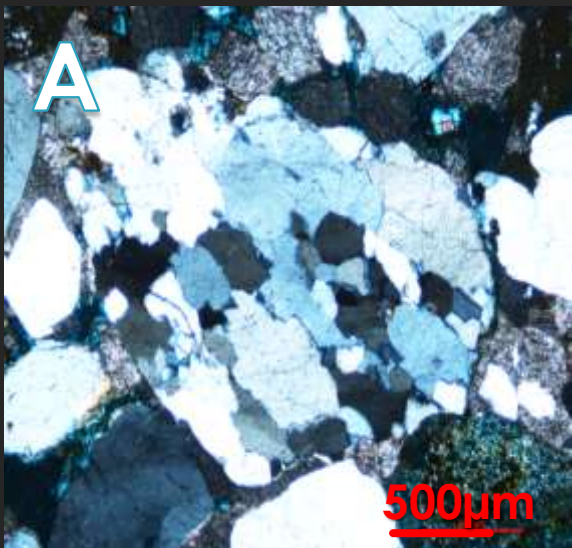
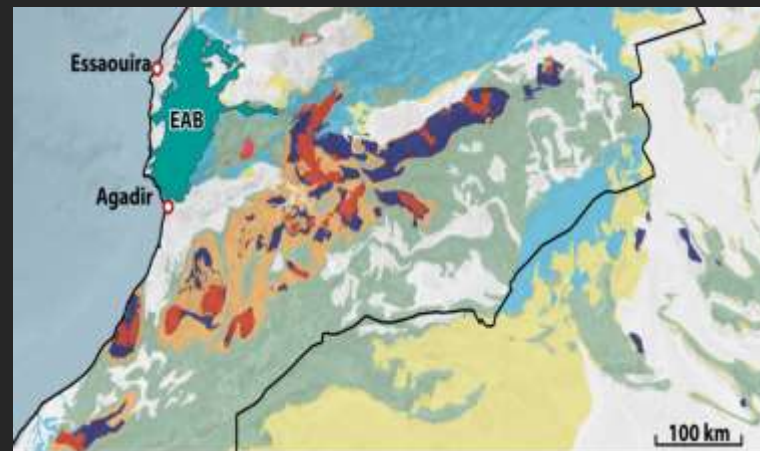


Petrography: Intrabasinal

Carbonate clasts



Petrography: Granitic and metamorphic clasts



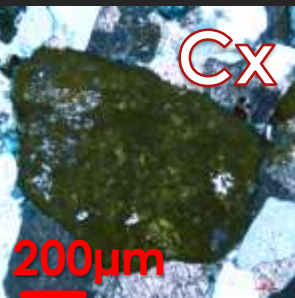
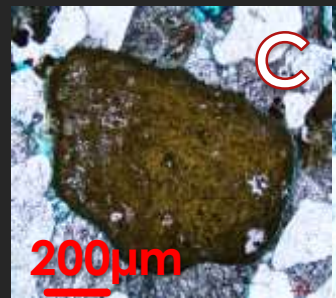
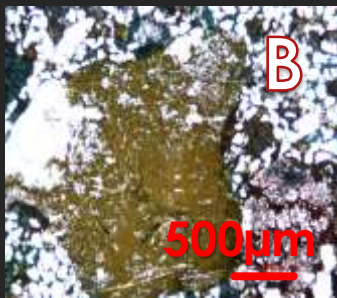
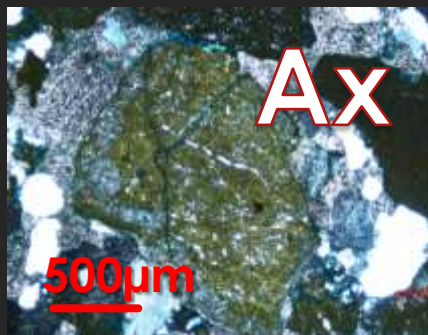
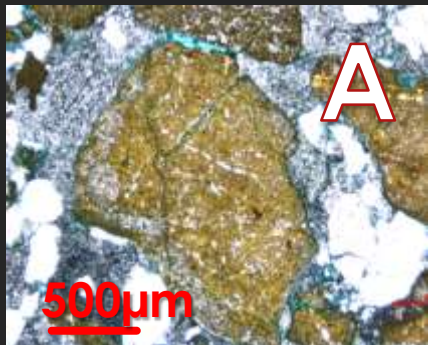
Petrography: recycling of sediments

1st or 2nd cycle origin ?

Feldspars contributions :

- **1st origin indicator** (unlikely to survive recycling)
- **Provenance tool** (Pb isotopes)

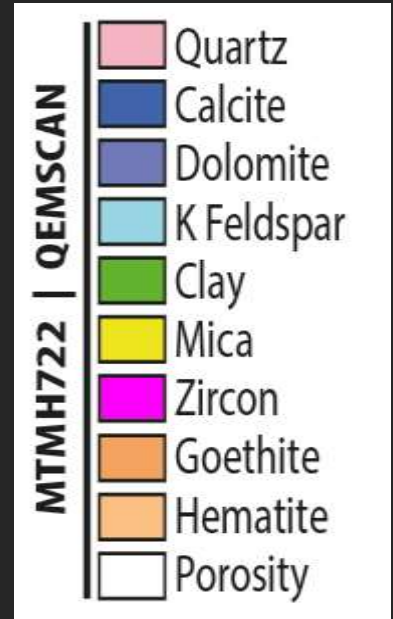
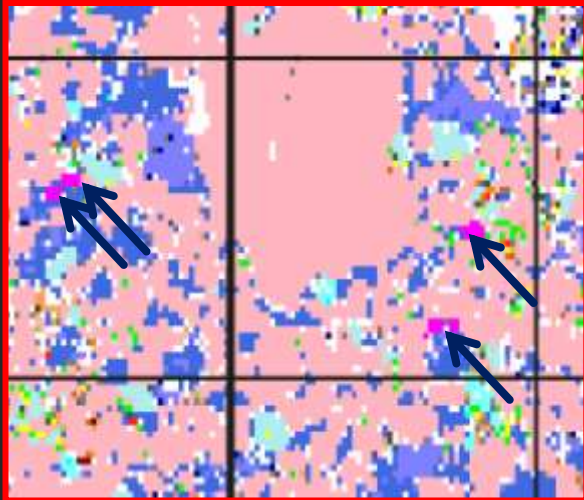
→ Approach challenged



Petrography:

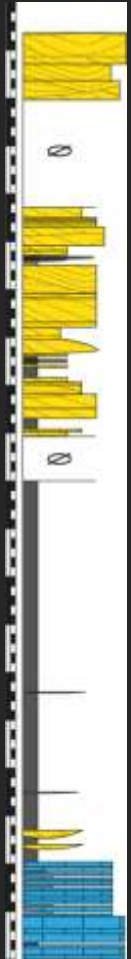
→ **Apatite :**
Good substitute
for the feldspar
approach

1st or 2nd cycle origin ?



State of the study

- **Provenance model** built and source candidates isolated.
- Beginning of the HM analysis delayed by the setting up of the lab but **lab now operational**.
- Latest **field season** just completed to :
 - sample and log **additional sections** in the EAB
 - **sample sources** in the MAM and Cambrian of the Anti Atlas
- Partnership with NERC to conduct the **isotopic work at the NIGL**

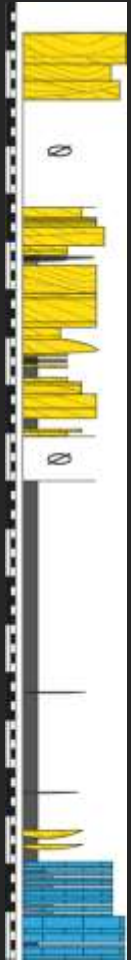


Tamzergout log
(additional section)



State of the study

- Which contribution from the south ?
- Existence or not of a drainage divide between the Northern and Southern part of the basin
- Efficiency of apatite as a recycling tracer



Tamzergout log
(additional section)



New in house facilities

Crushing of samples (1-2 kg)



sieving (30 μ m and 250 μ m)



*Cryogenic separation of Heavy
Minerals (\approx 10g)*



New in house facilities

Crushing of samples (1-2 kg)



sieving (30µm and 250µm)



Cryogenic separation of Heavy Minerals (≈10g)



Mounts for isotopic dating

Source rock density

$$SRD = \frac{[\Delta_{HM}(1 - \%opaque) + 5.00 \times \%opaque]HMC + 2.65(100 - HMC)}{100}$$

Heavy Mineral Concentrations

$$HMC = \frac{HM\%}{(1 - d/t)} \times 100$$

Factor of recycling and transport

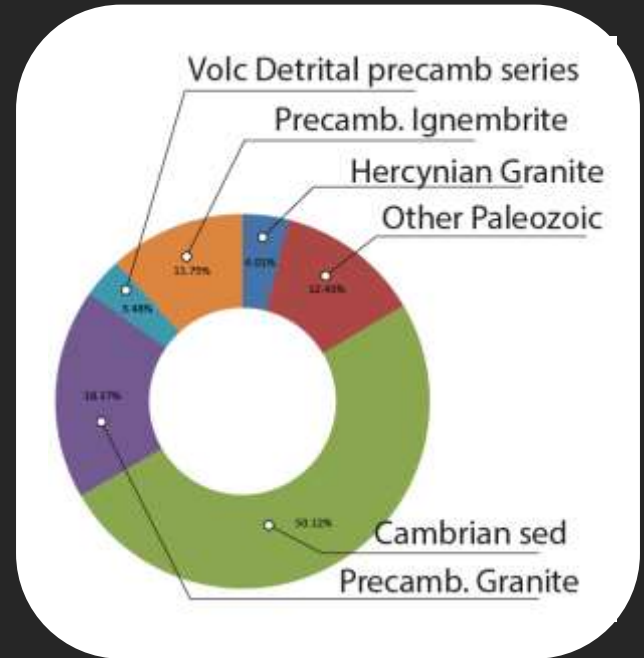
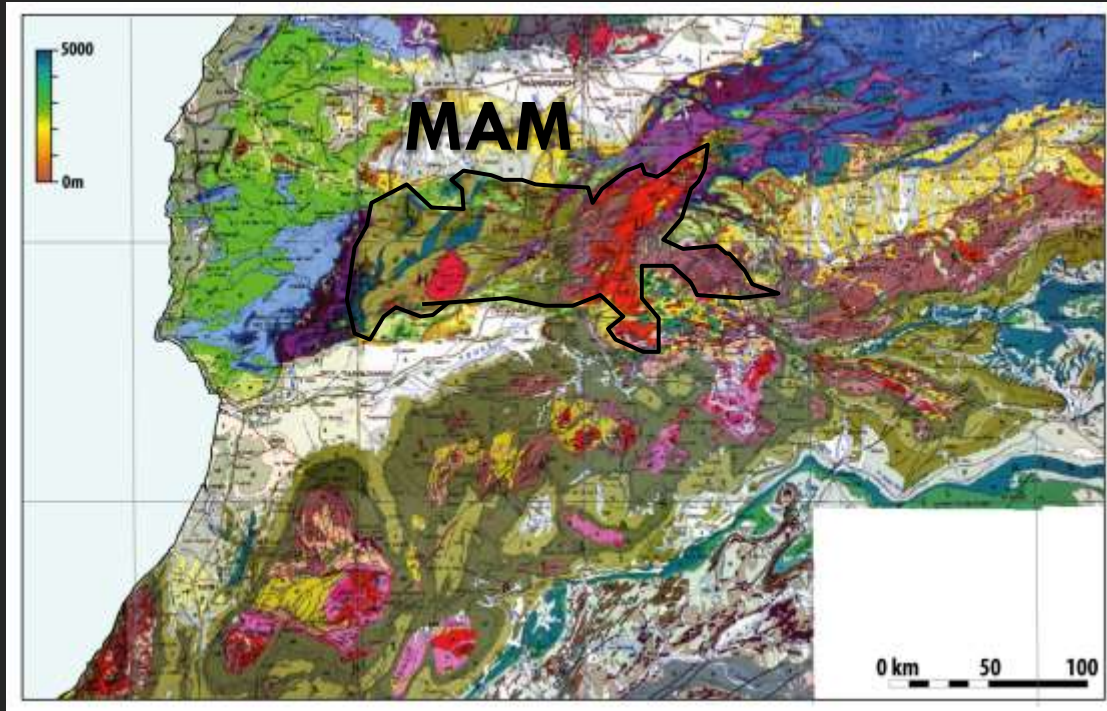
Mirror the composition of parent rock

(Garzanti & Ando 2007)

HM analysis : direct links between the nature of the HM and the source rocks

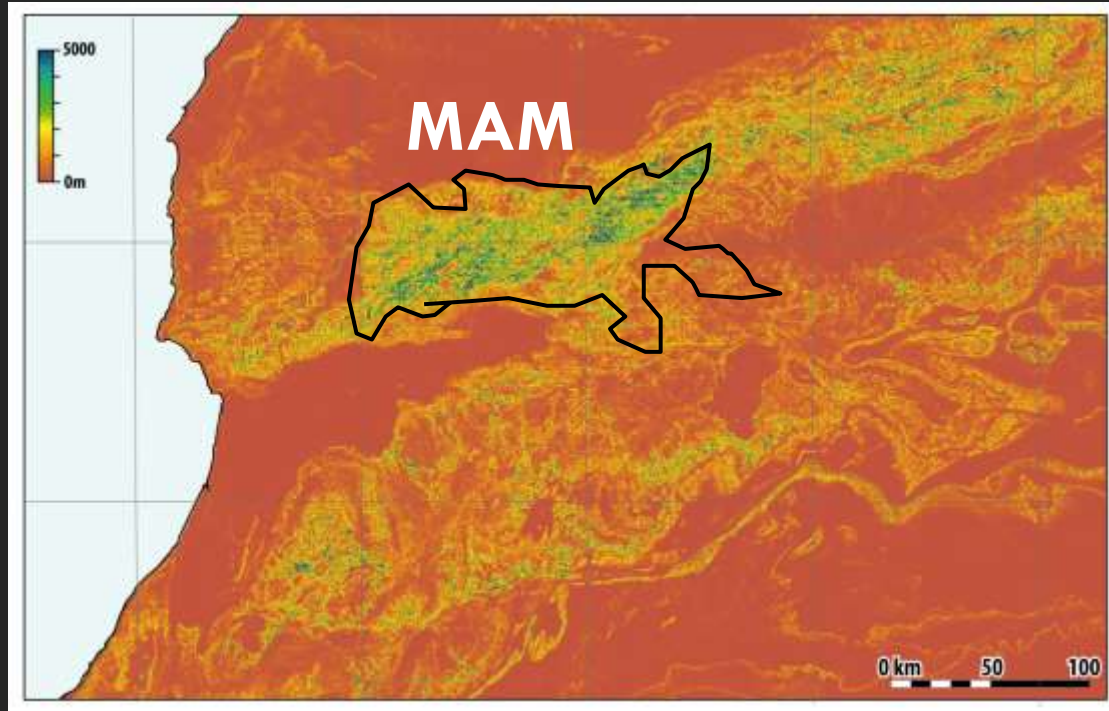


Reservoir prediction : sediment nature



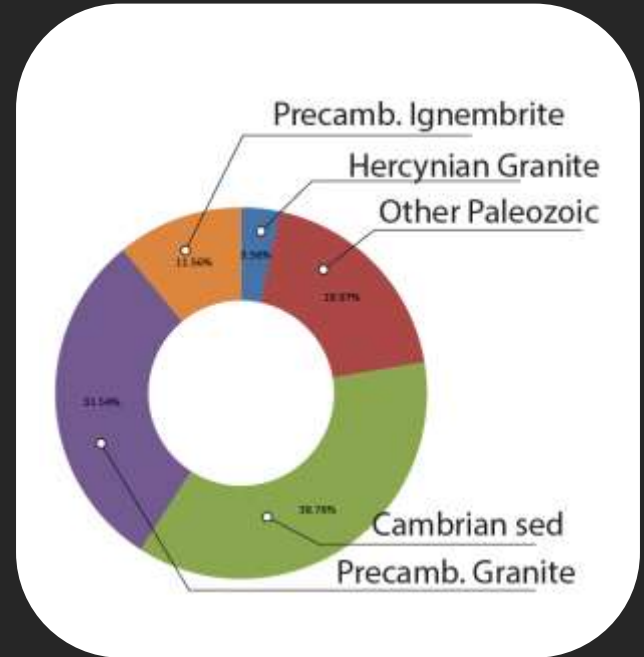
Lithologies cropping out in
the MAM today

Reservoir prediction : sediment nature



Gross erosion since Late Albian

Erosion model :



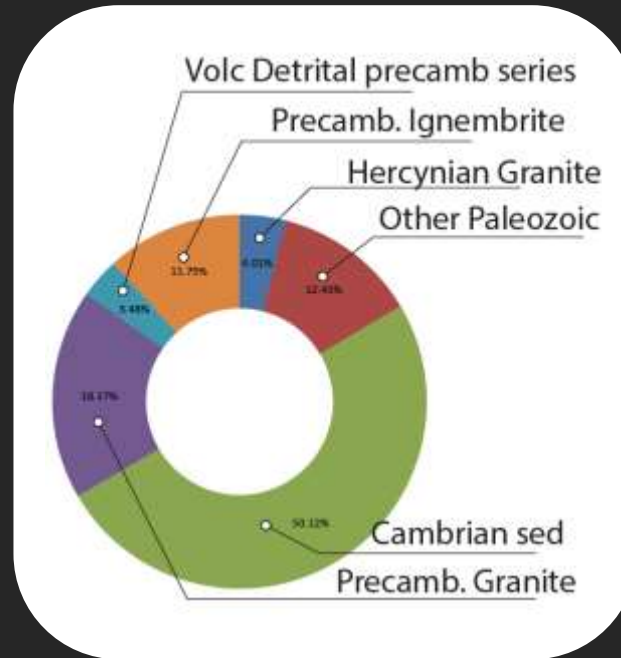
Reservoir prediction : sediment nature

Erosion model :

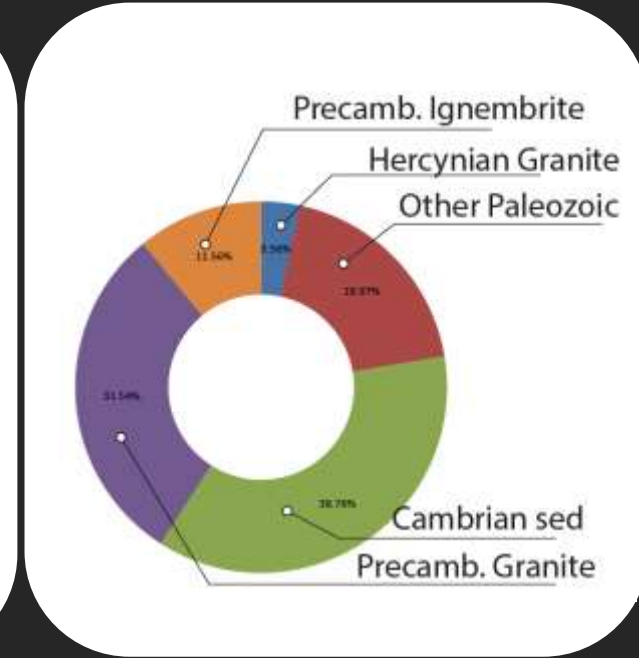
Limits :

Many assumptions :

- Constant uplift
- Thermochronology data repartition
- Climate reconstruction based on Cross sections, unable to reconstruct any unit entirely eroded away.



Lithologies cropping out
Today In MAM



Lithologies cropping out
In the late Albian in MAM

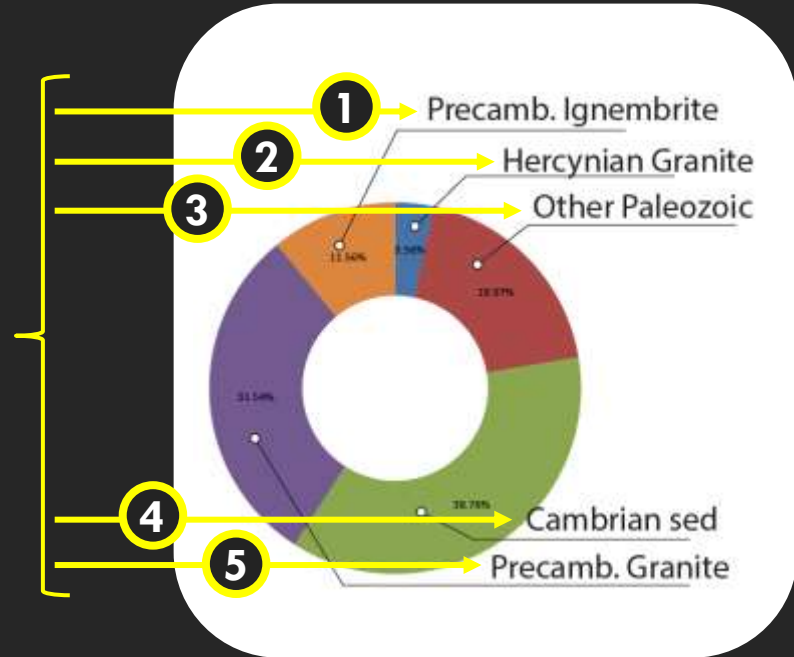


Reservoir prediction



Sampled during the
last field season

Erosion model :

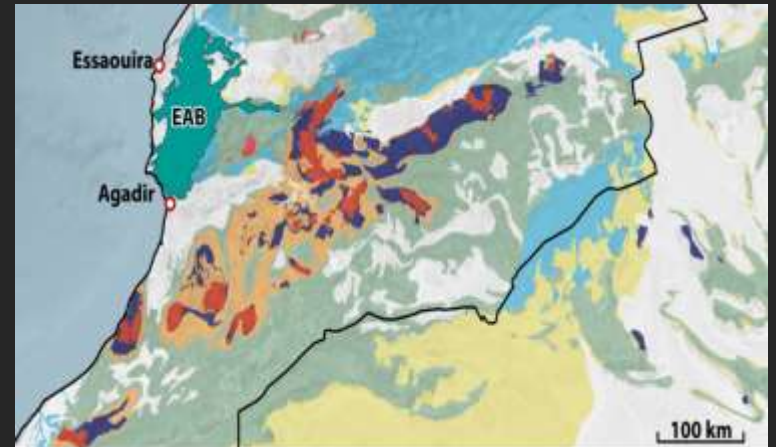


Lithologies cropping out
In the late Albian in MAM



Erosion model :

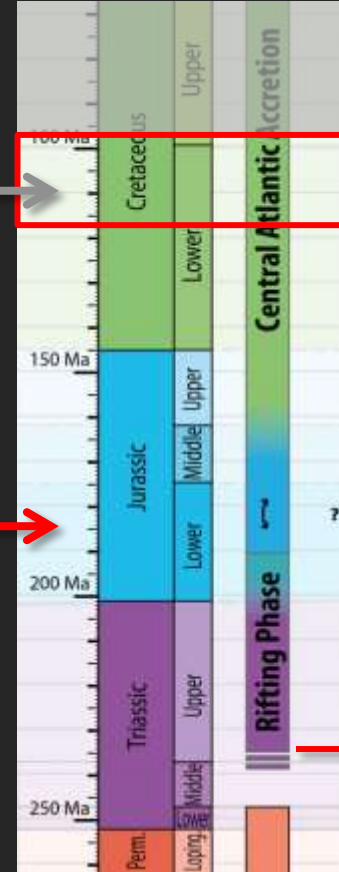
- How much sand brought to the deepwater basin ?
- Regional consistency of the Cambrian
- Feasibility of a regional erosion map



Additional sampling for HM analysis



Pliensbachian Fluvial sandstones



Mud dominated shelfal succession truncated by shoreface to fluvial sandstones.

Earliest oceanic crust

Rifting climax

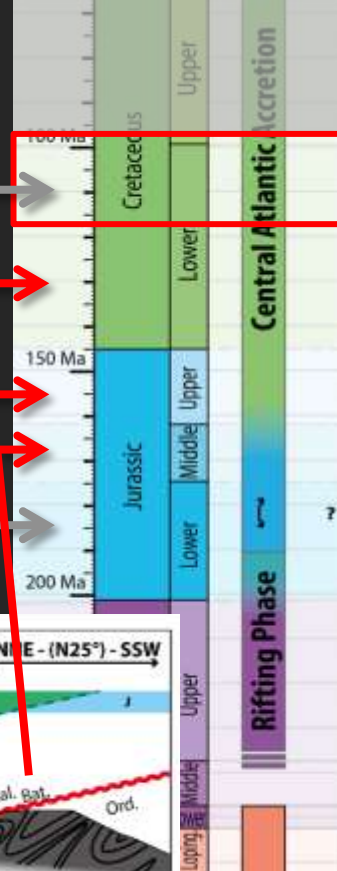
Rifting onset

Latest Hercynian magmatic events in Morocco

Additional sampling for HM analysis

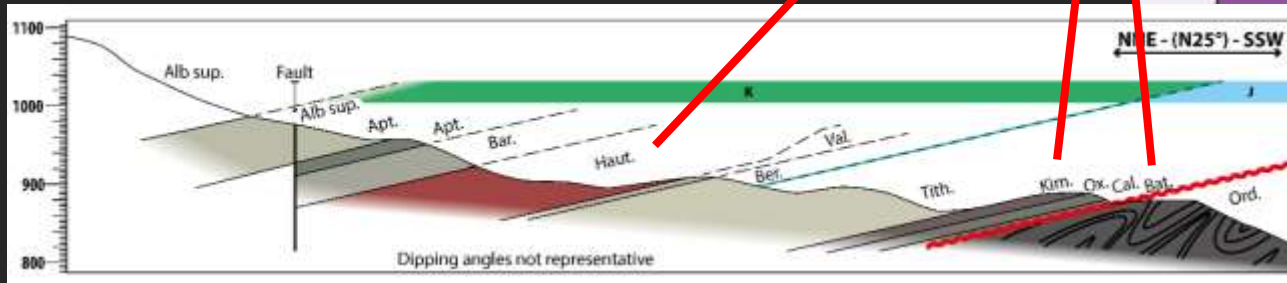


Imi N Tanout :
Bathonian
Kimmeridgian
and **Hauterivian** Fluvial
sandstones



Mud dominated
shelfal succession
truncated by
shoreface to fluvial
sandstones.

Earliest oceanic crust
Rifting climax

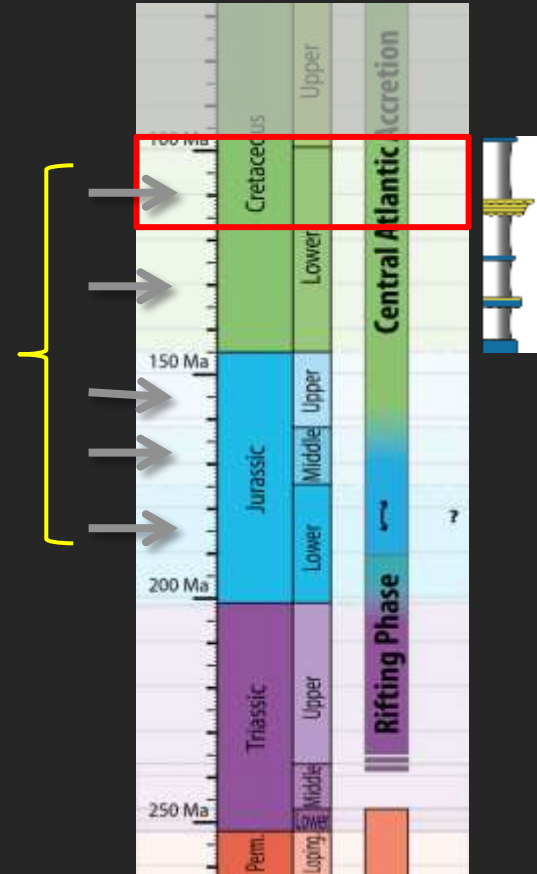


Additional sampling for HM analysis



Basin scale availability
of fluvial sections,
sampled to trace the
evolution of the
provenance systems

One or several systems ?



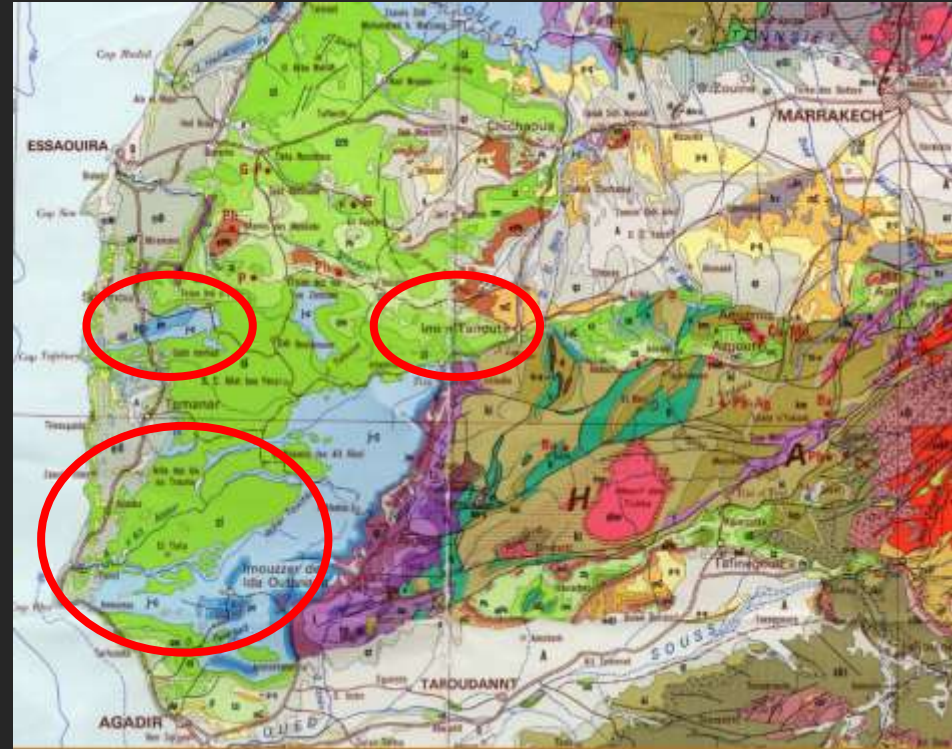
Mud dominated
shelfal succession
truncated by
shoreface to fluvial
sandstones.

Additional sampling for HM analysis



Basin scale availability
of fluvial sections,
sampled to trace the
evolution of the
provenance systems

One or several systems ?



Conclusion

-
- Selection of the **main source candidates** based on the **thermal history** of the margin
 - **Identification of the ages** of the potential sources prior to the isotopic work
 - Petrographic evidence of **source mixing** and highly probable contribution of the **Massif Ancien de Marrakech (MAM)**
 - Good yield of heavy mineral (>1% of the 64-125 μm fraction) suggesting an important input of 1st cycle sediments

Thank you for your Support :

Special thanks to :



Research partners :

