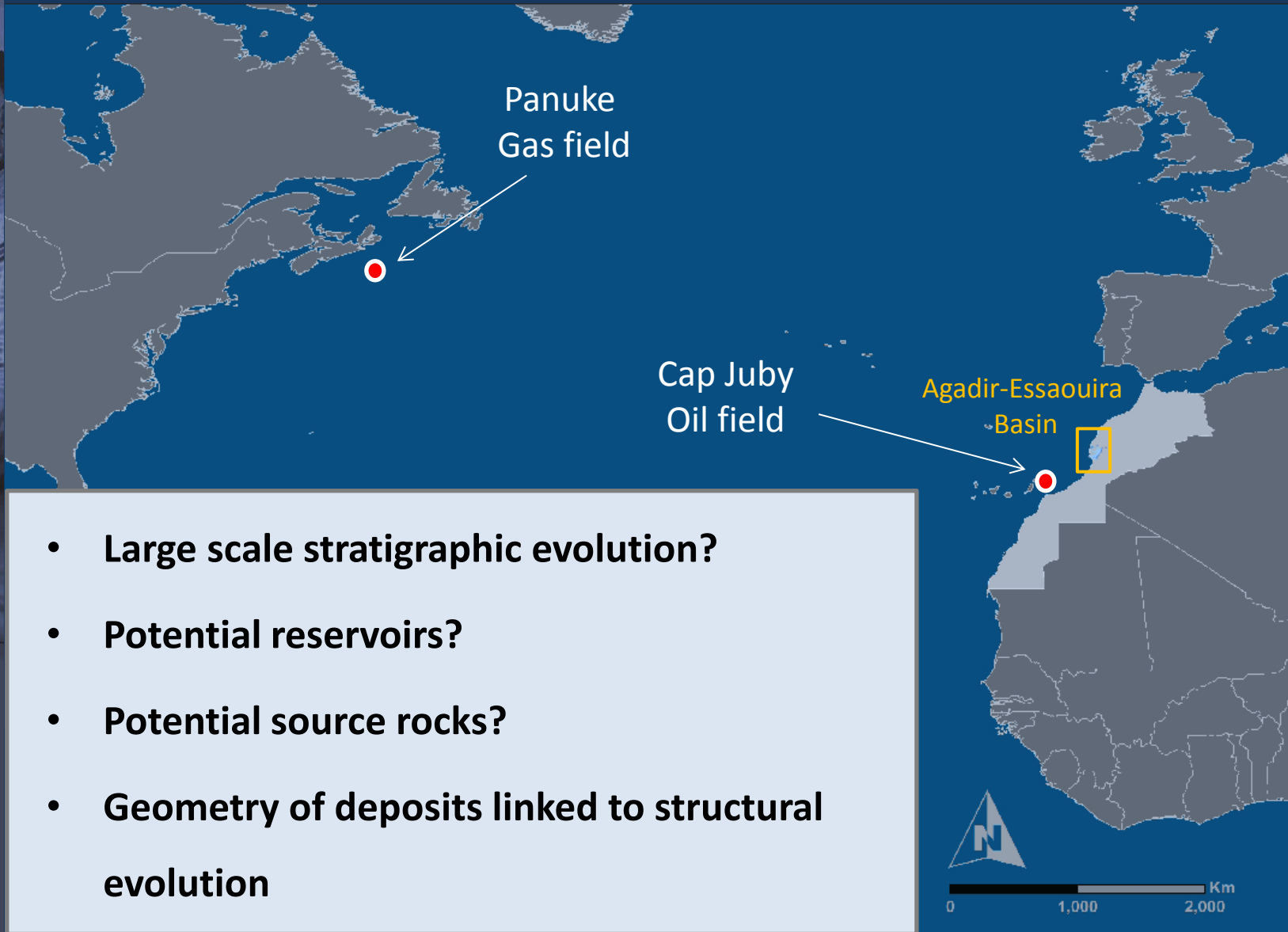


# Stratigraphic evolution of Jurassic shelf margin carbonates in the Agadir-Essaouira Basin

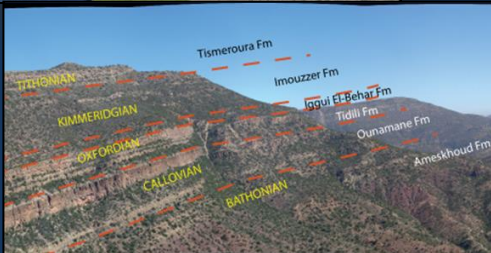
## Atlantic margin - Western Morocco

A. Duval-Arnould ; S. Schroeder ; J. Redfern

# AIMS OF THE STUDY



# AGENDA



1. INTRODUCTION

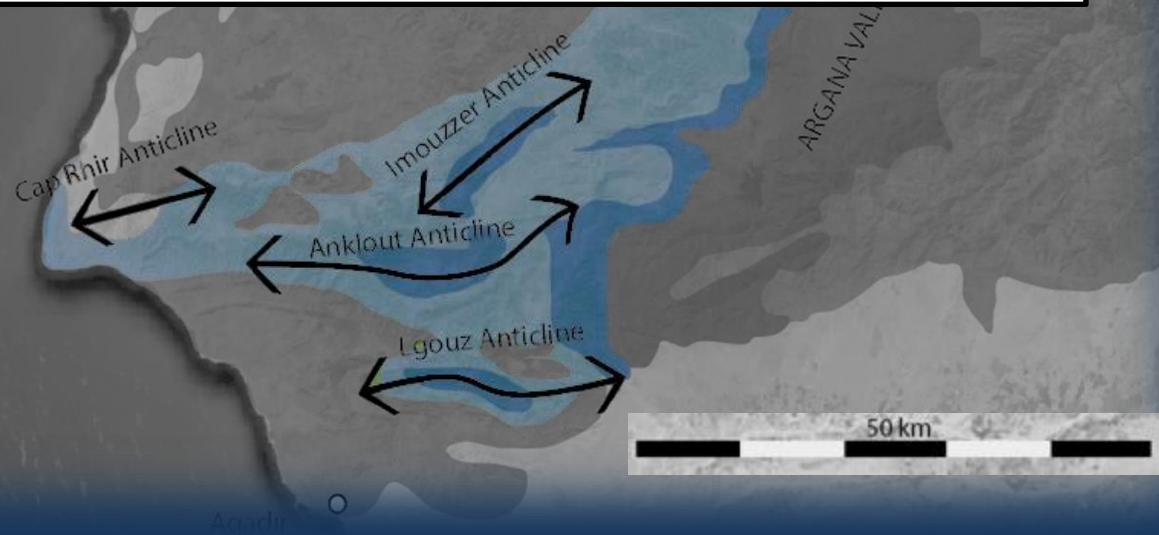
2. GENERAL STRATIGRAPHY

3. POST-RIFT PLATFORM

4. PLATFORM AND REEFS

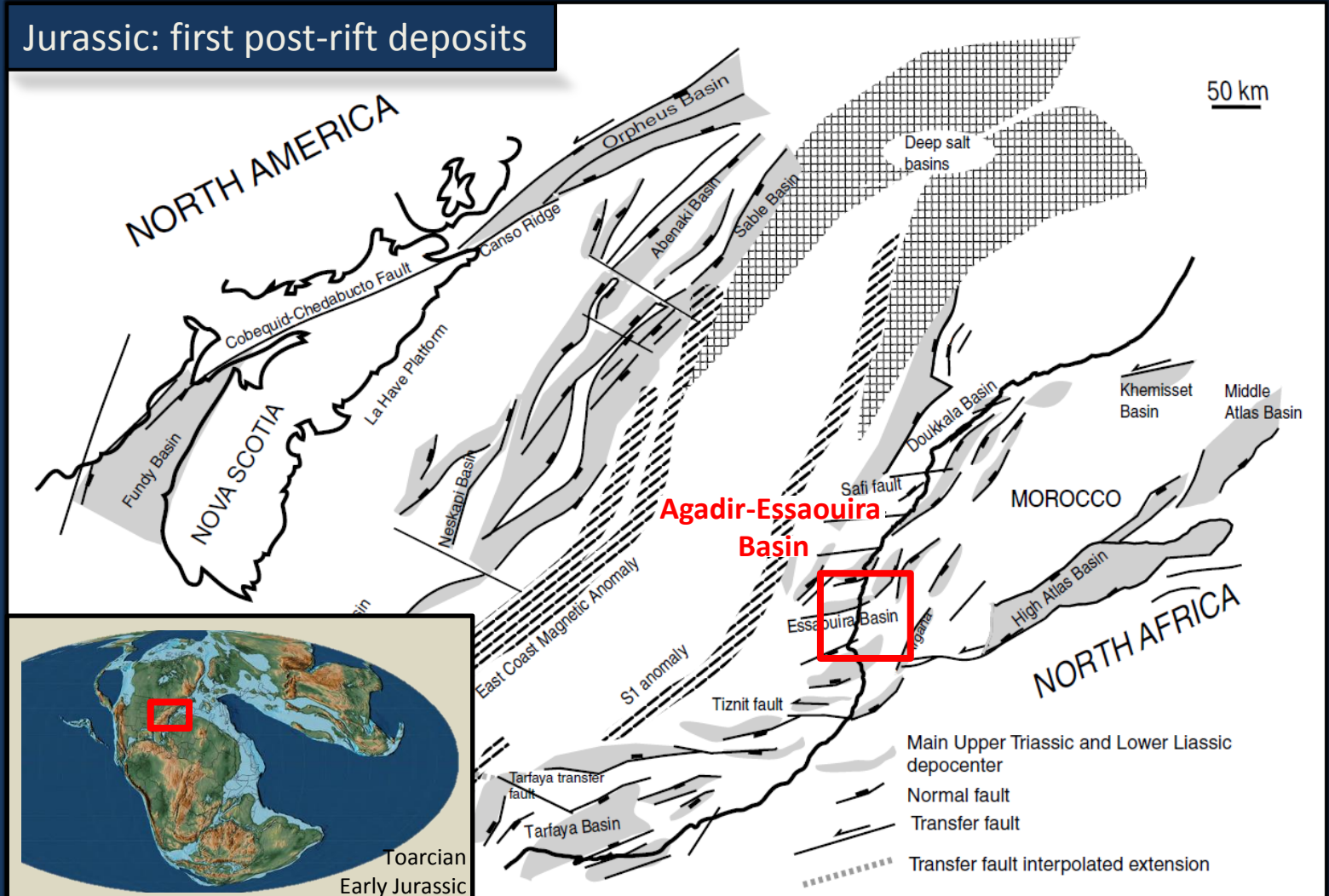
5. CONCLUSIONS

# INTRODUCTION



# PRESENTATION

Jurassic: first post-rift deposits



Structural framework of the Central Atlantic intracontinental Triassic–Liassic rift.

*Le Roy and Piqué, 2001*

# STUDY AREA

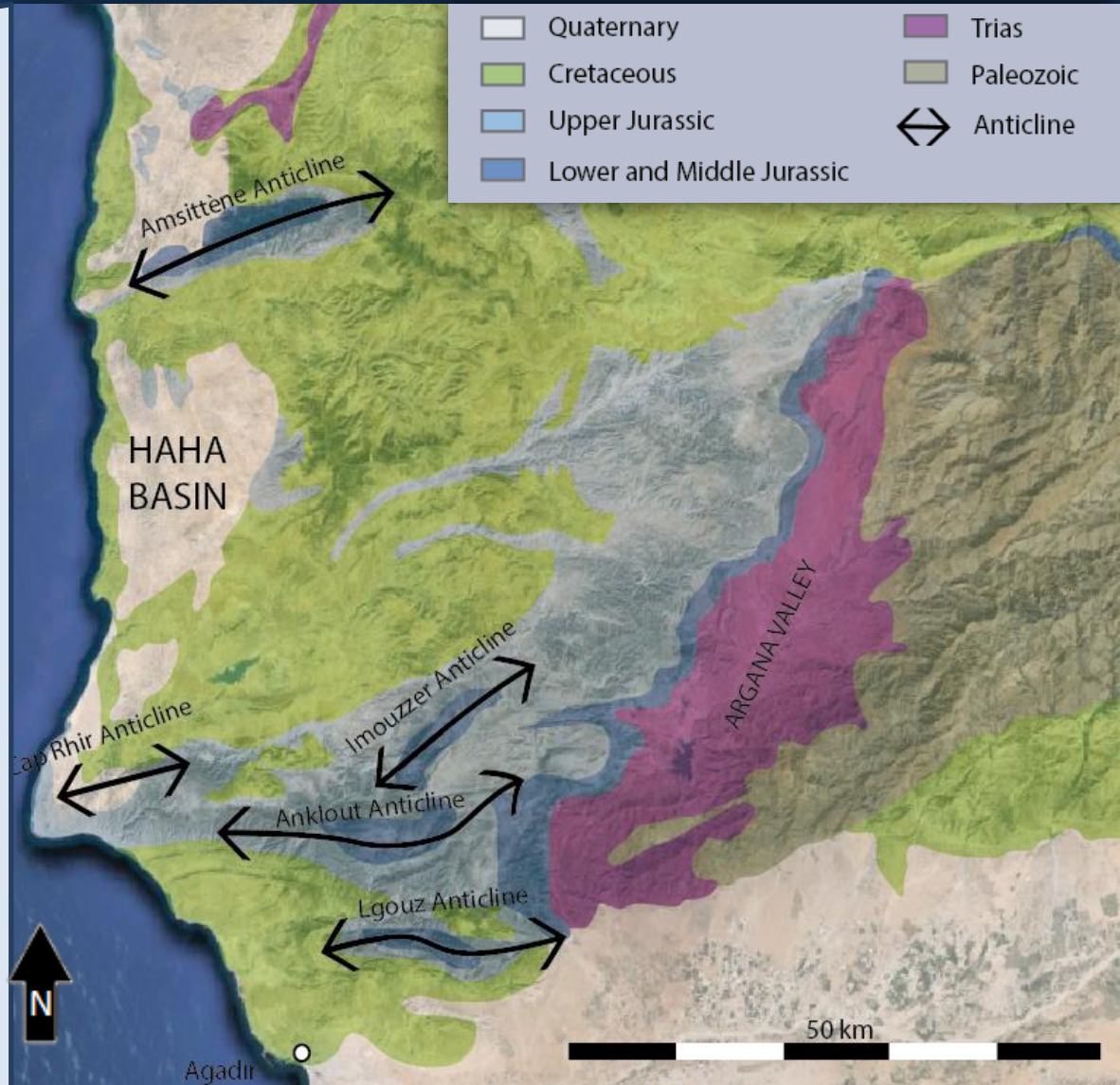
## OUTCROPS

### East-West Anticlines

- Access to complete succession
- Controls on carbonate deposition (?)

### Argana Valley

- More proximal deposits
- Lower part of the succession



Amsittène Anticline

# General stratigraphy

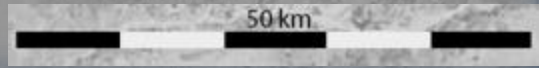
Cap Rhir Anticline

Imouzer Anticline

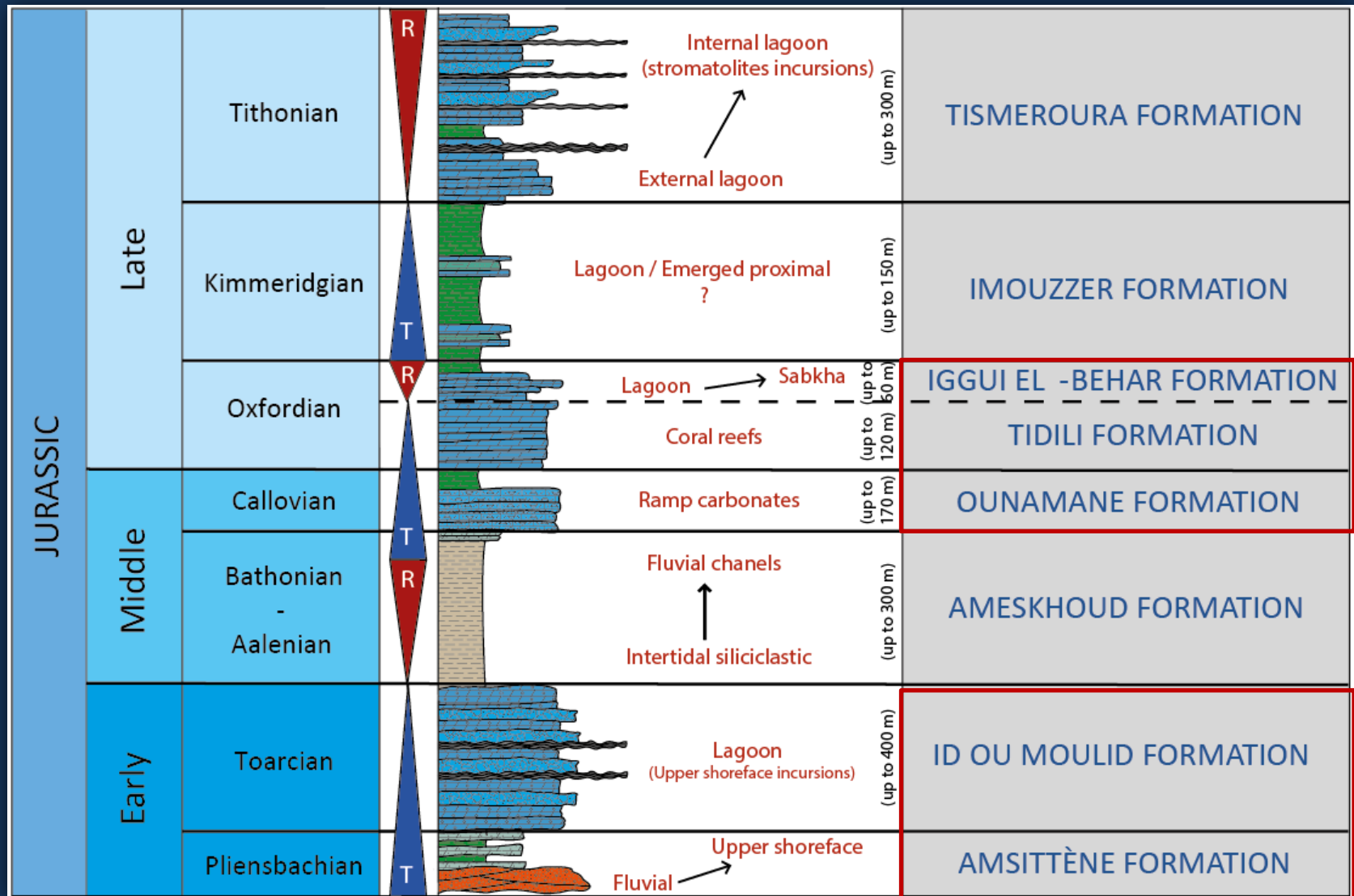
Anklout Anticline

Igouz Anticline

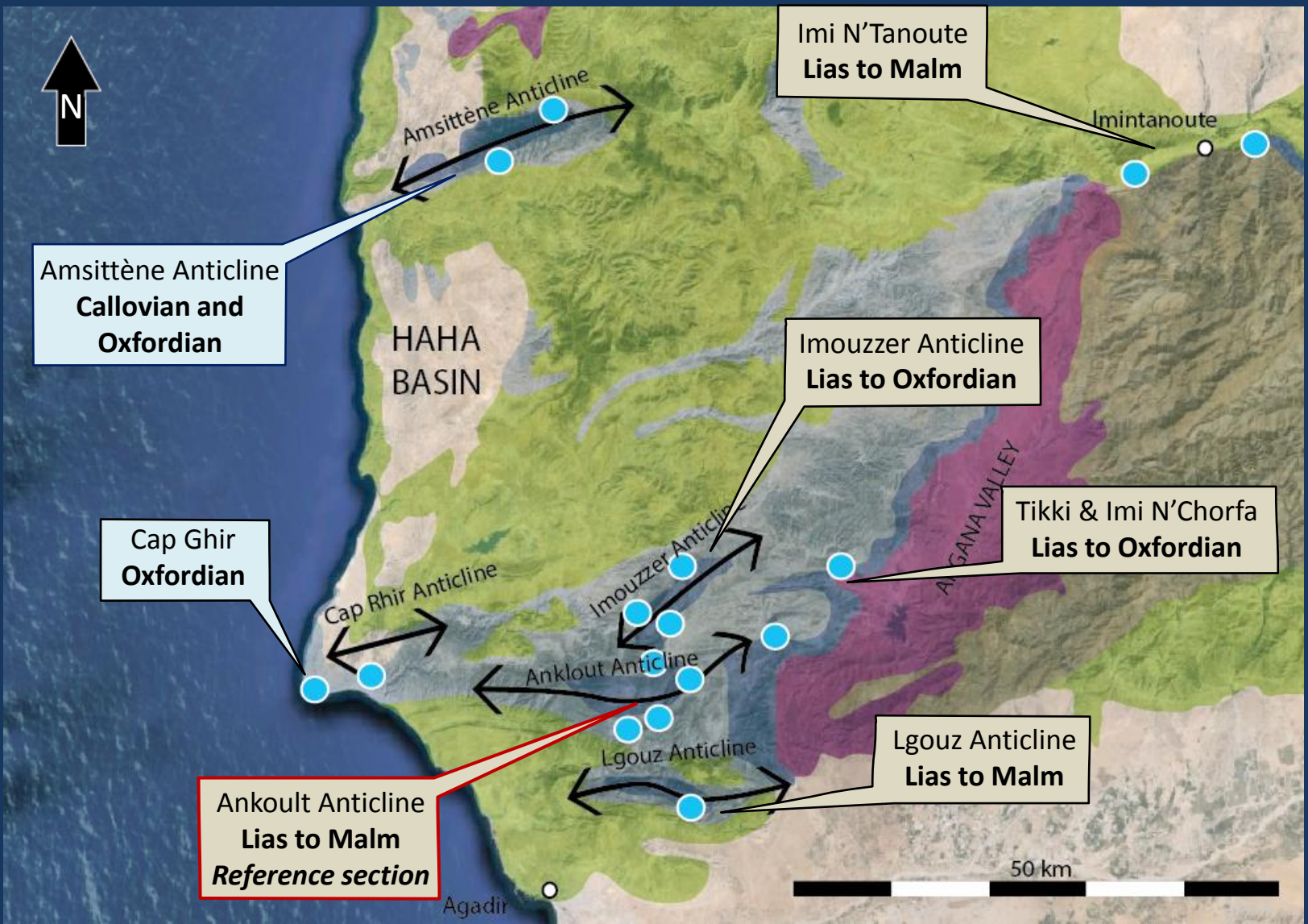
ARGANA VALLEY

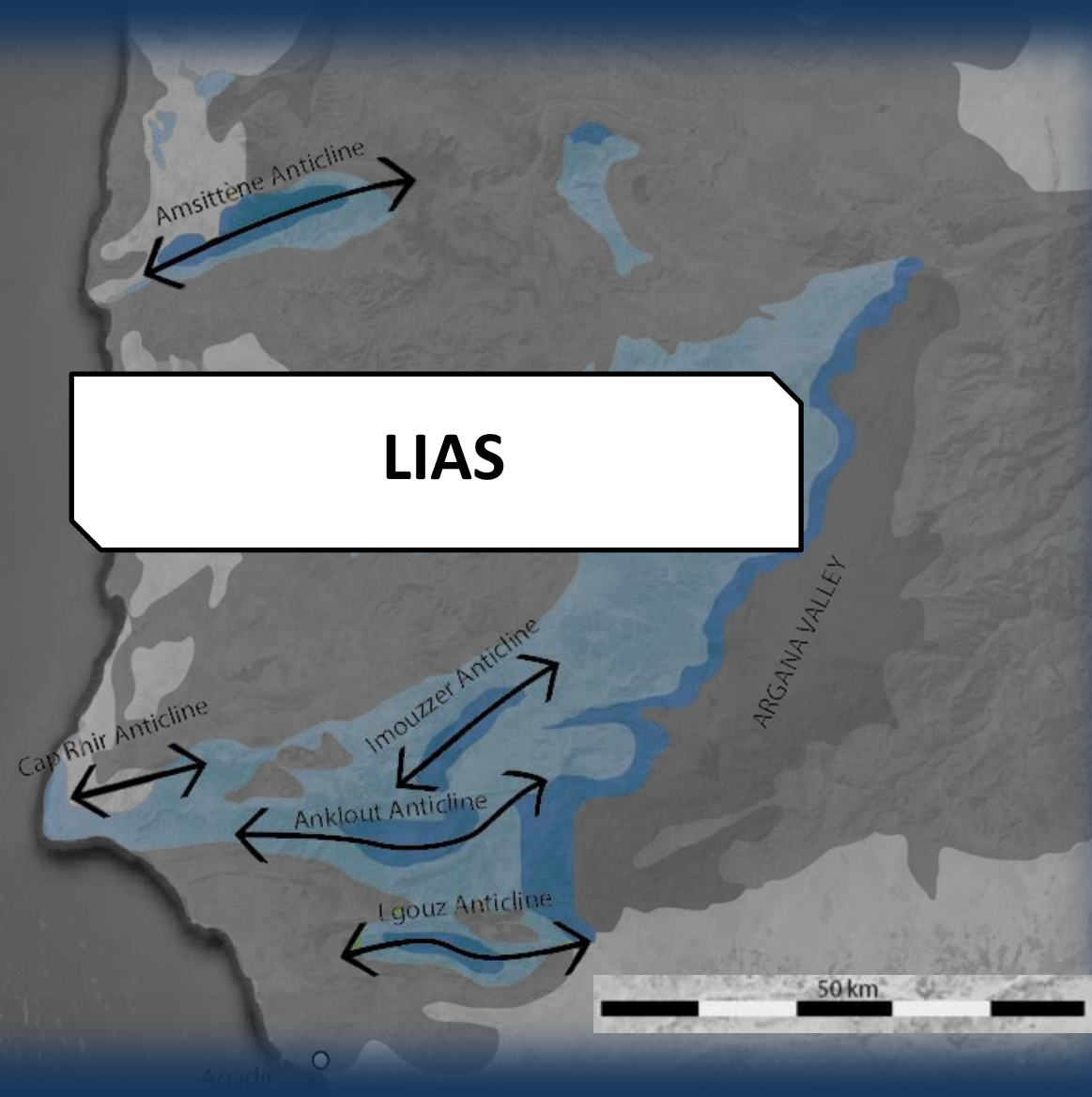


# STRATIGRAPHIC EVOLUTION



# OUTCROPS STUDIED





# AMSITTENE FORMATION

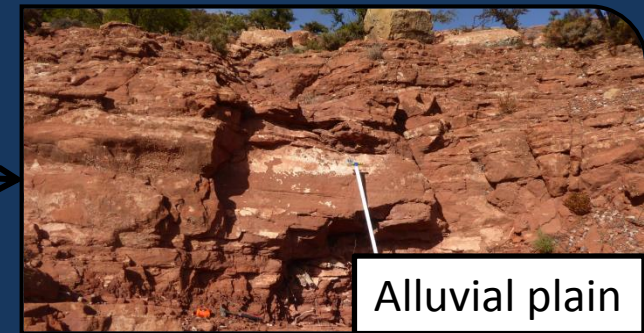
Tikki section : complete Lias succession



Sebkha



Braided rivers



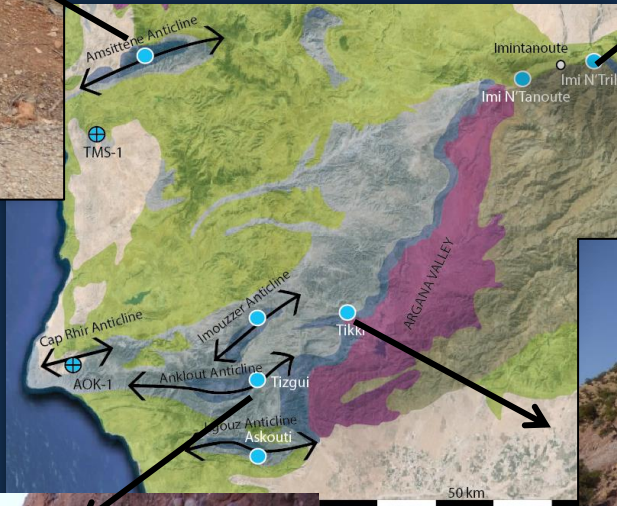
Alluvial plain

# AMSITTENE FORMATION

Base fluvial, then MST and evaporites



Fluvial - braided river and alluvial plain



Fluvial - braided river and coastal plain



Fluvial - stacked braided rivers then red clay and evaporites

# ID OU MOULID FORMATION

## TIKKI SECTION



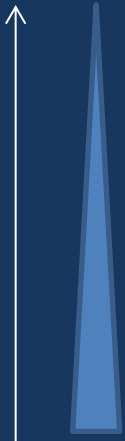
Settlement of a carbonate platform across the basin

# ID OU MOULID FORMATION



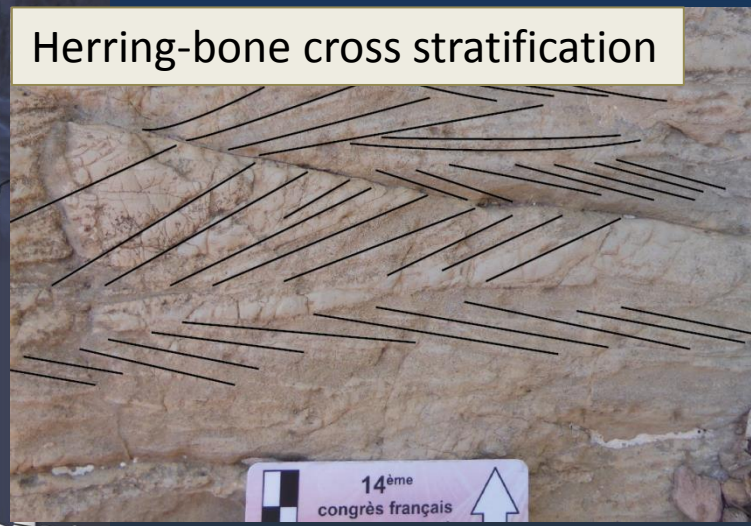
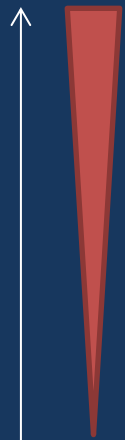
Oolitic PST/GST

SUBTIDAL



Stromatolites

SUPRATIDAL



Herring-bone cross stratification

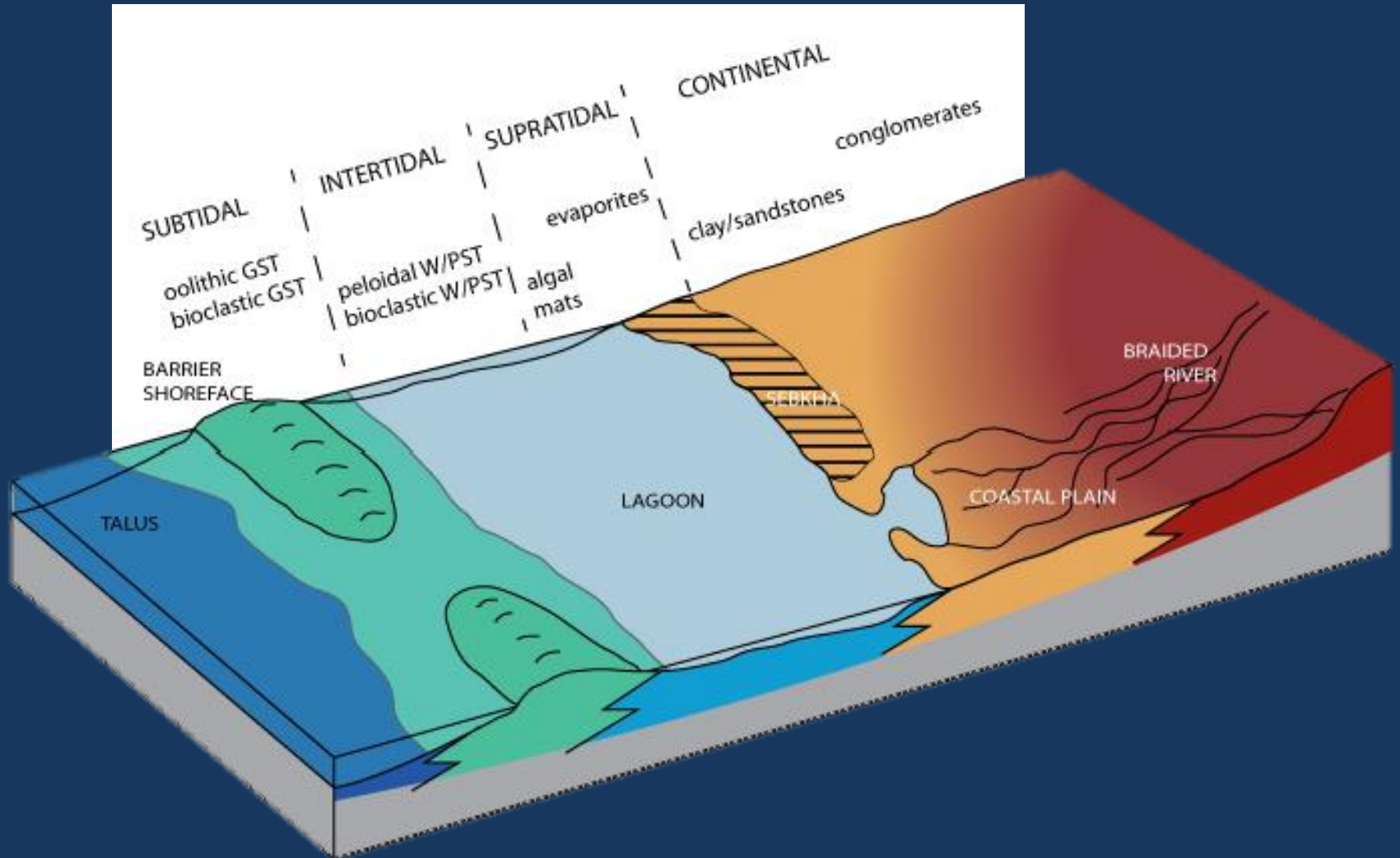


Dissolution breccias

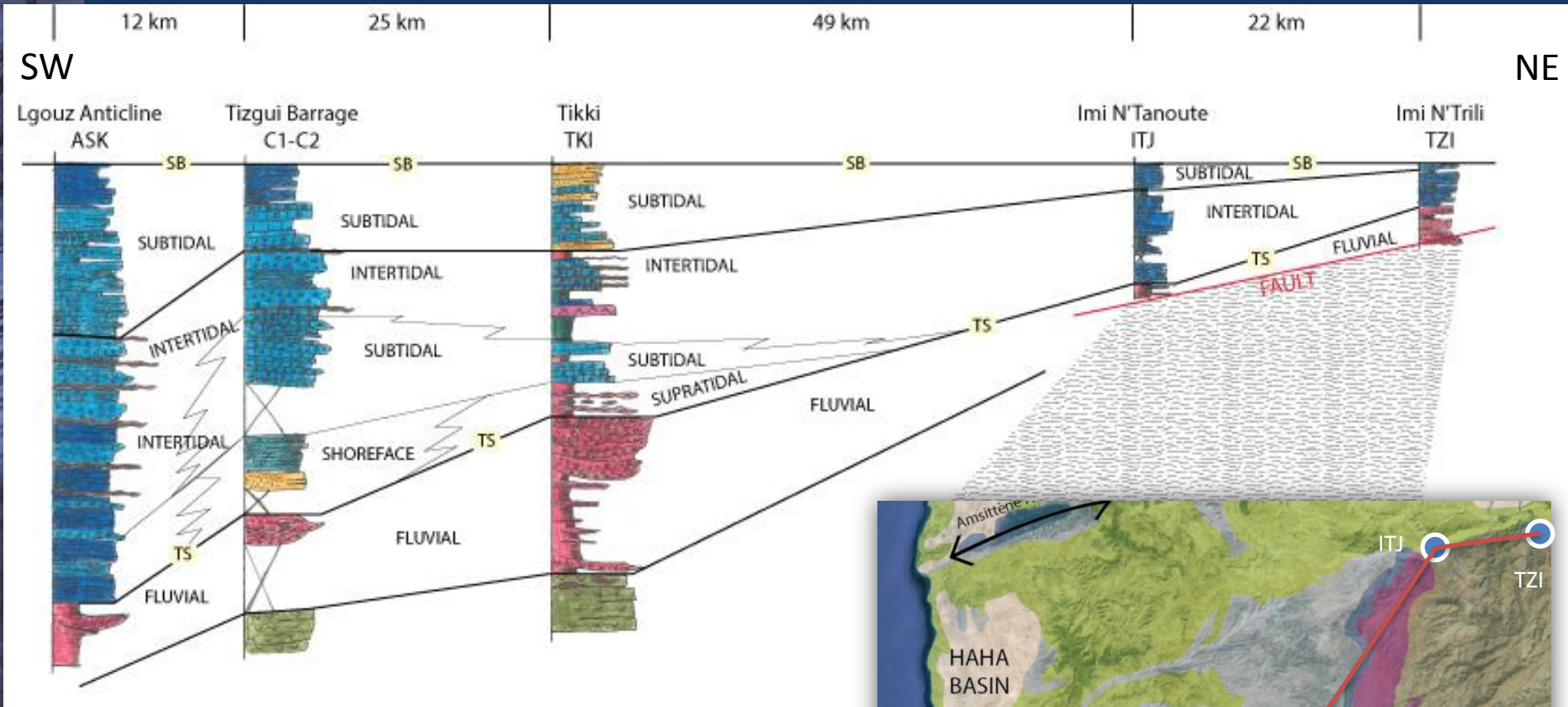
INTERTIDAL

General evolution of the Formation in the South of the Basin

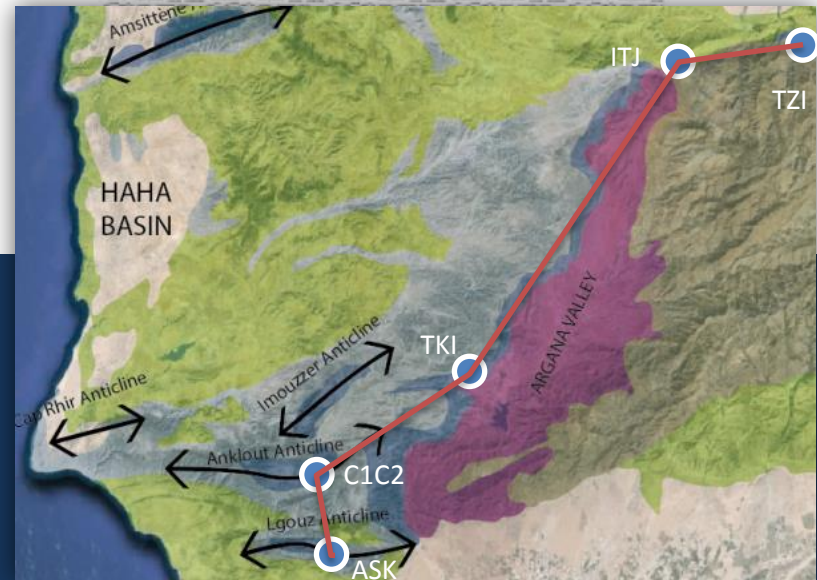
# DEPOSITIONAL ENVIRONMENT MODEL



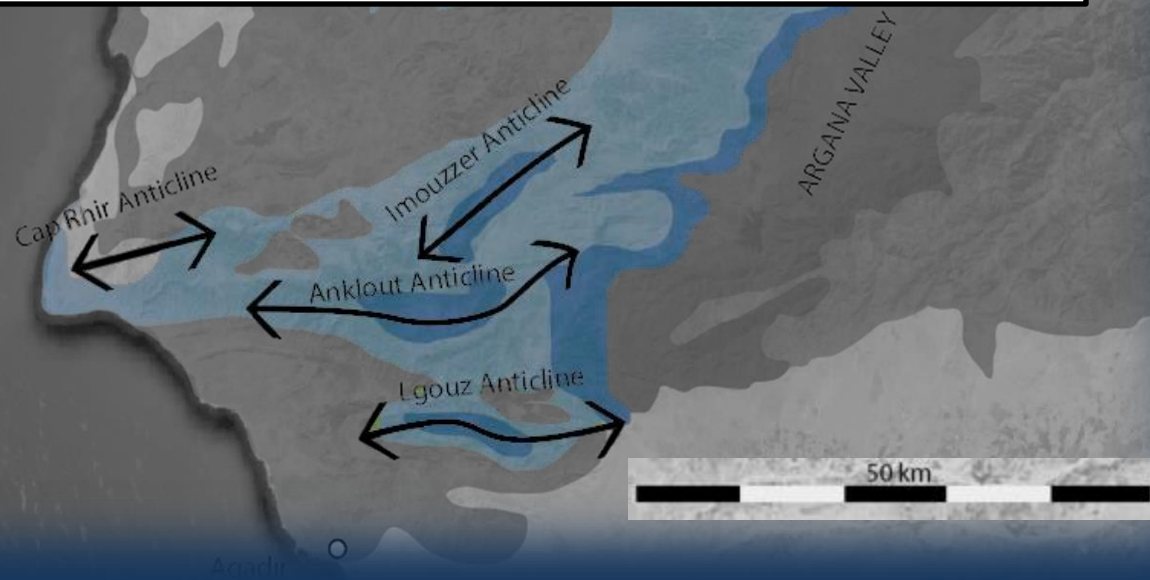
# CORRELATIONS



Draft correlation panel for the Ameskhoud and Id Ou Mouldid formations

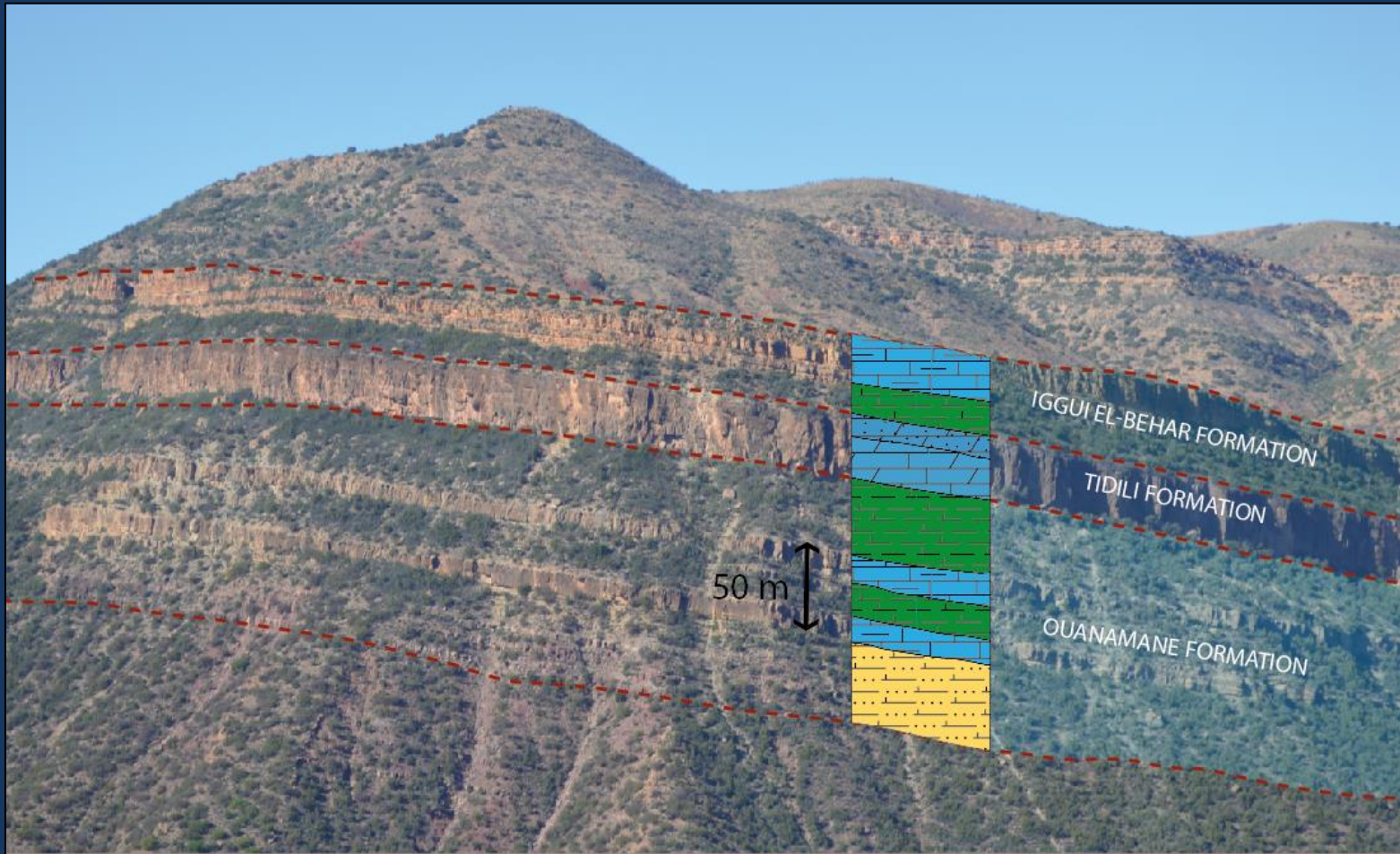
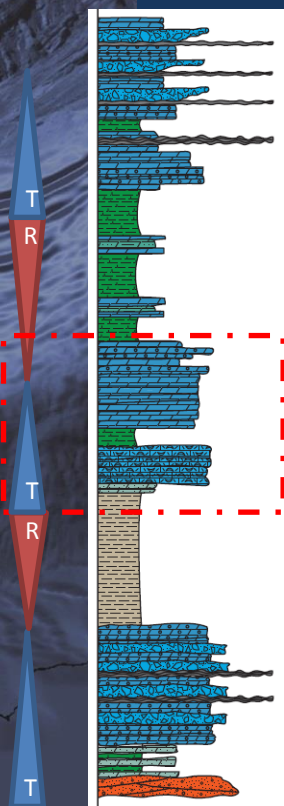


# CALLOVIAN AND OXFORDIAN

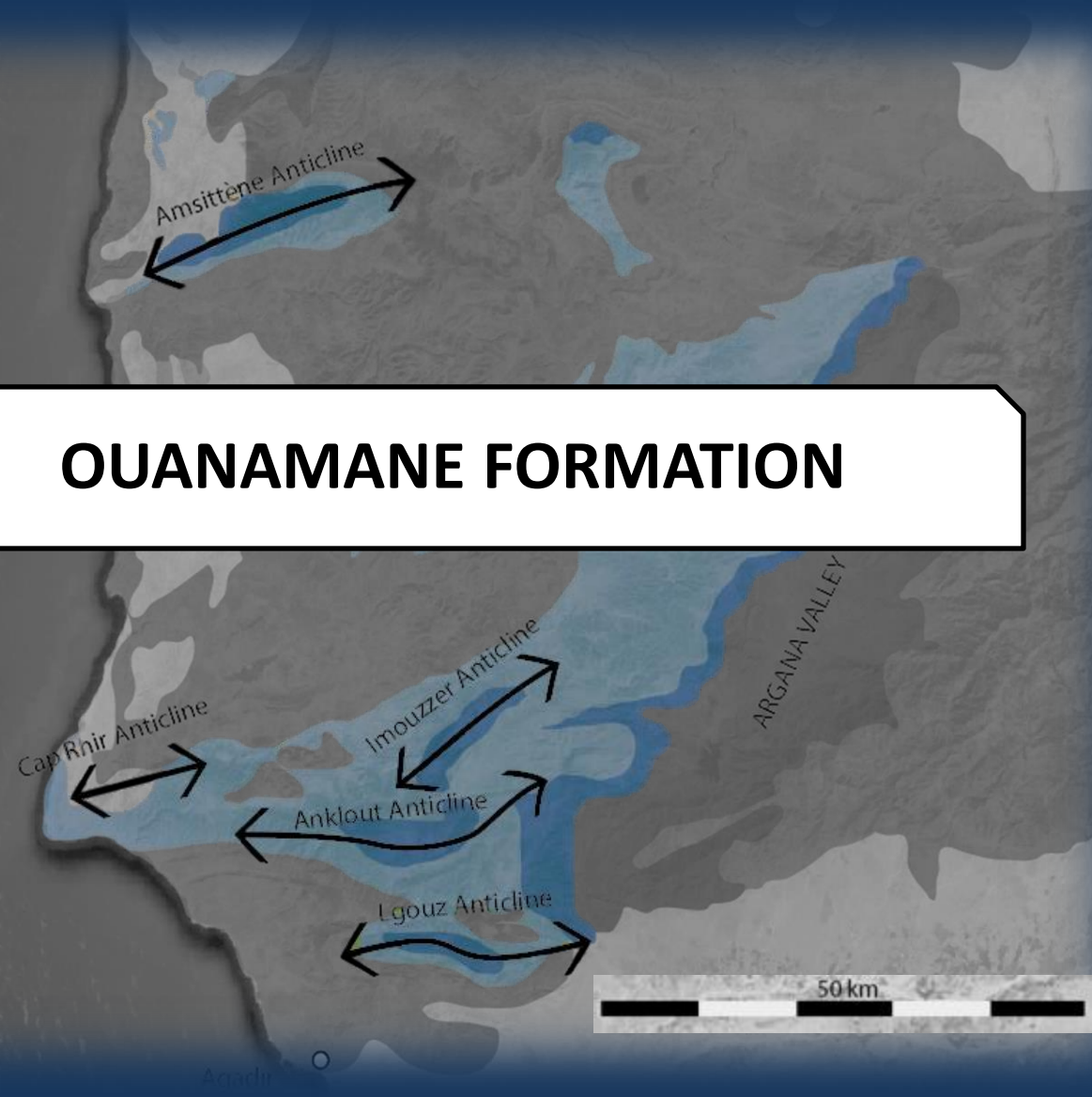


# Second Jurassic platform

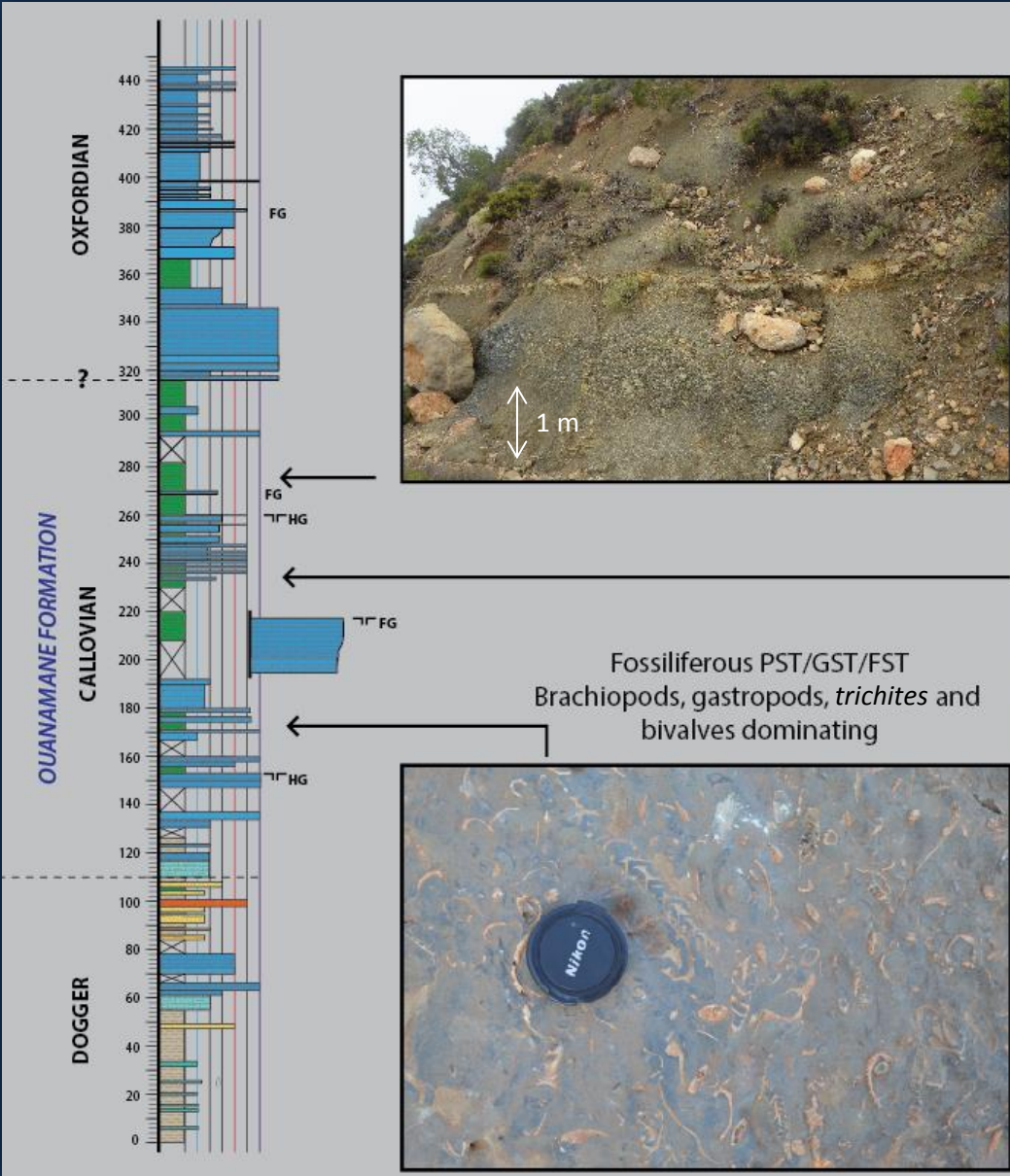
Overview of the Ouanamane to Iggui El Behar formations in the proximal part of the basin. Tizgui N'Chorfa section



# OUANAMANE FORMATION

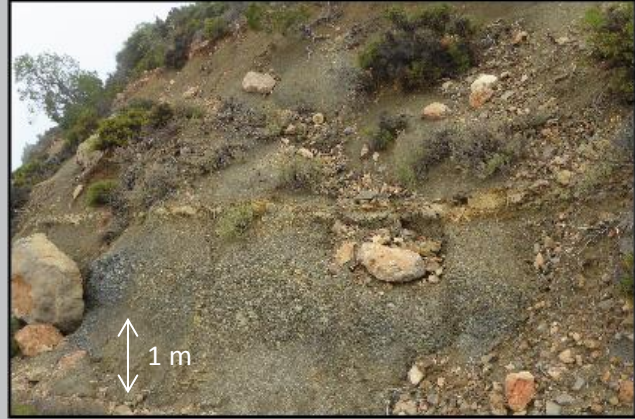


# OUANAMANE FORMATION



Marls with MST/WST levels  
Some brachiopods and belemnites  
*Pholadomya sp.*

Marly fossiliferous FST/RST  
Brachiopods and bivalves dominating




Fossiliferous PST/GST/FST  
Brachiopods, gastropods, *trichites* and bivalves dominating

Evolution from silty limestone to fossiliferous PST alternating with marls and FST/RST, capped by hardground. Marly upper part



# BIOSTRATIGRAPHY

- Collection of **Brachiopods** over the basin
- **Ammonites** : Pinpoint age constraints
- **Bivalves** : Environmental indications



TZG P10B

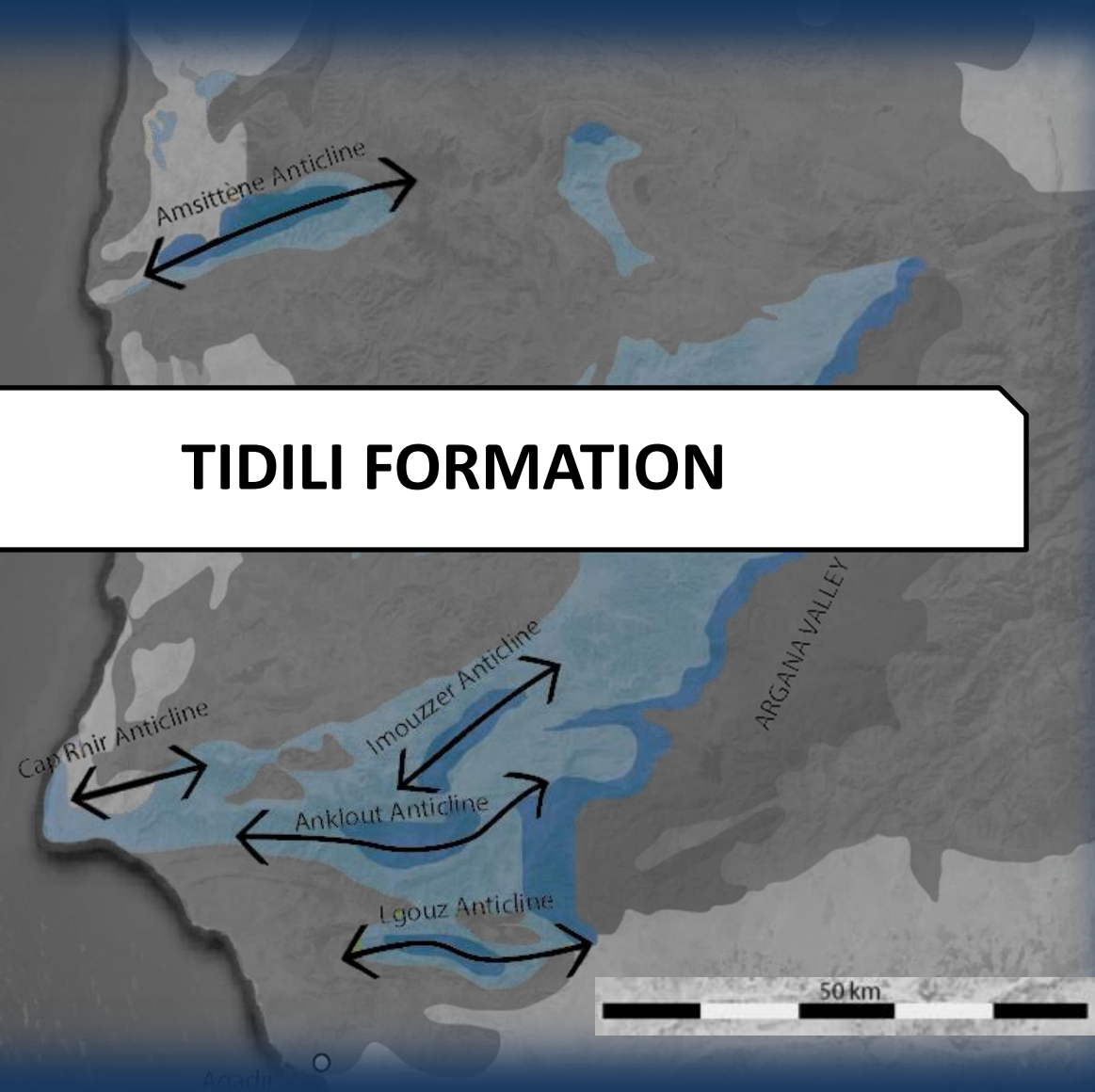
TZG P29 late early to early middle Callovian  
(Gracilis and Anceps zones)

late middle to early late Callovian  
(Coronatum and Athleta zones)

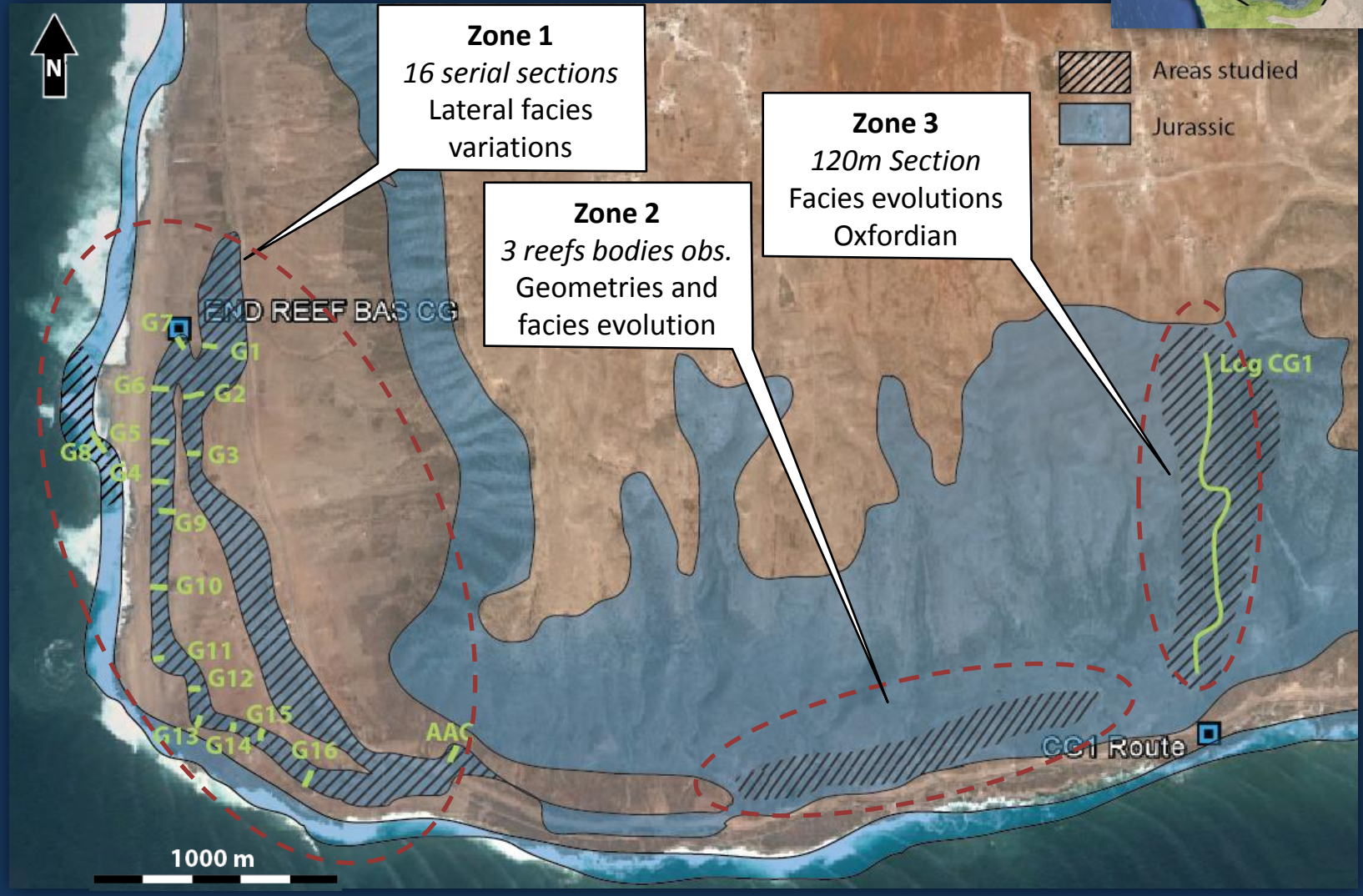
TZG P50

TZG P29

# TIDILI FORMATION



# CAP GHIR OUTCROPS LOCATION



Modified from Geological Map of Morocco: TAGHAZOUT 1 / 100 000

# CAP GHIR - ZONE 1



Molluscs and coral fragment-rich Gst



Large oncoidal Gst



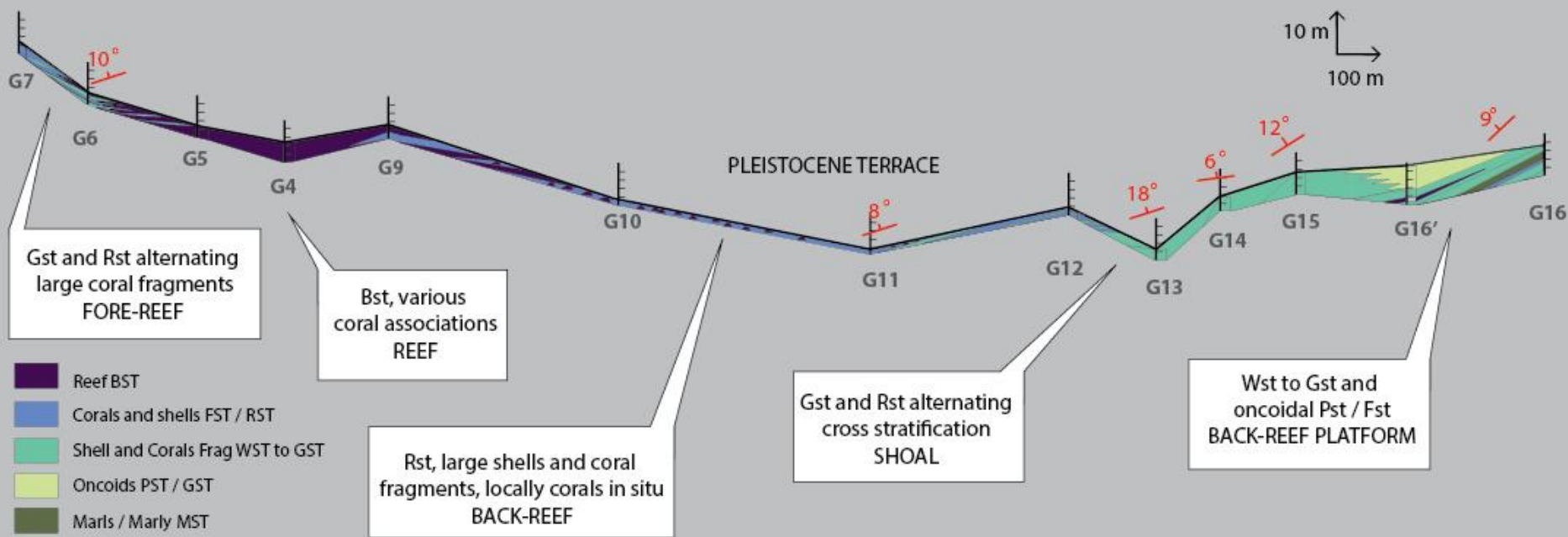
Large shells, coral fragments and isolated corals



Coral Boundstone, reef



# CAP GHIR - ZONE 1



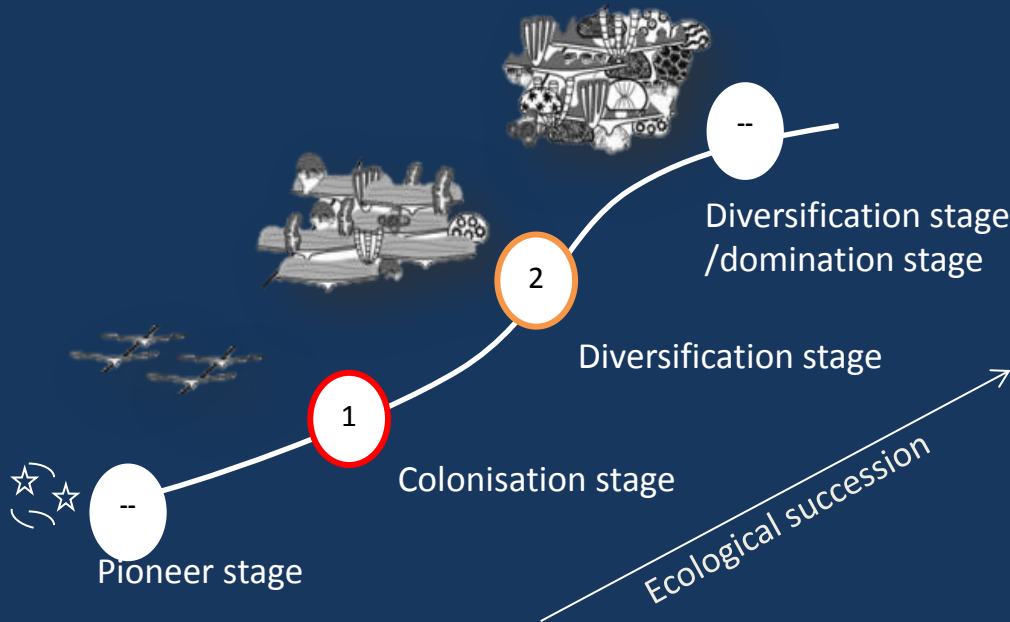
# TIDILI FORMATION



**Dolomitic Bst, locally W/Pst**  
corals (platy, branching), serpulids, brachiopods...

**Dolomitic F/Rst (W/Pst)**  
coral fragments, crinoids, shells...

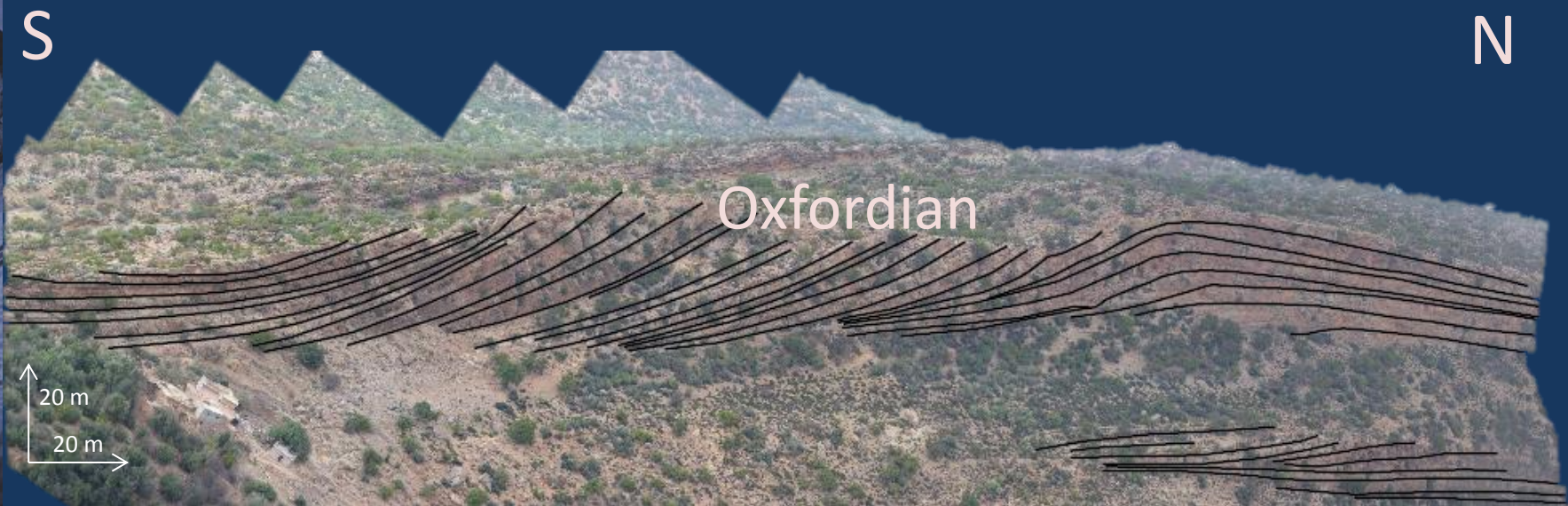
## OXFORDIAN REEF ECOLOGICAL SUCCESSION



**Dolomitic fine P/Gst** : shelly fragments, brachiopods, gastropods ...

Modified after Olivier et al., 2012

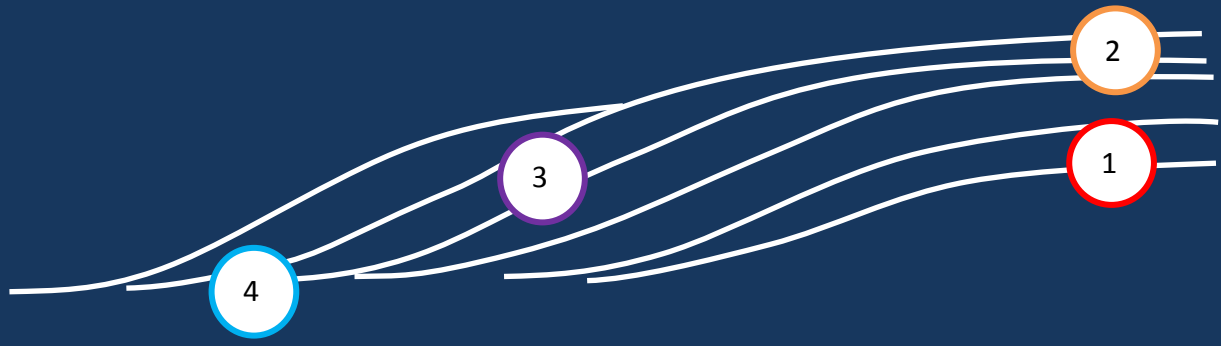
# TIDILI FORMATION



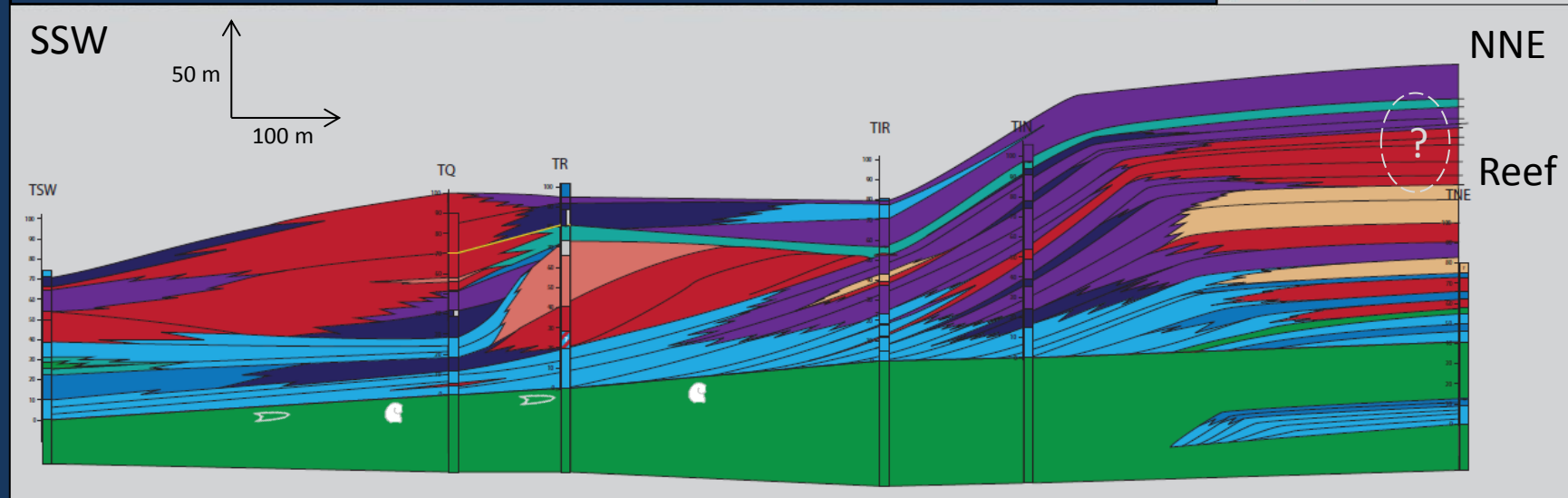
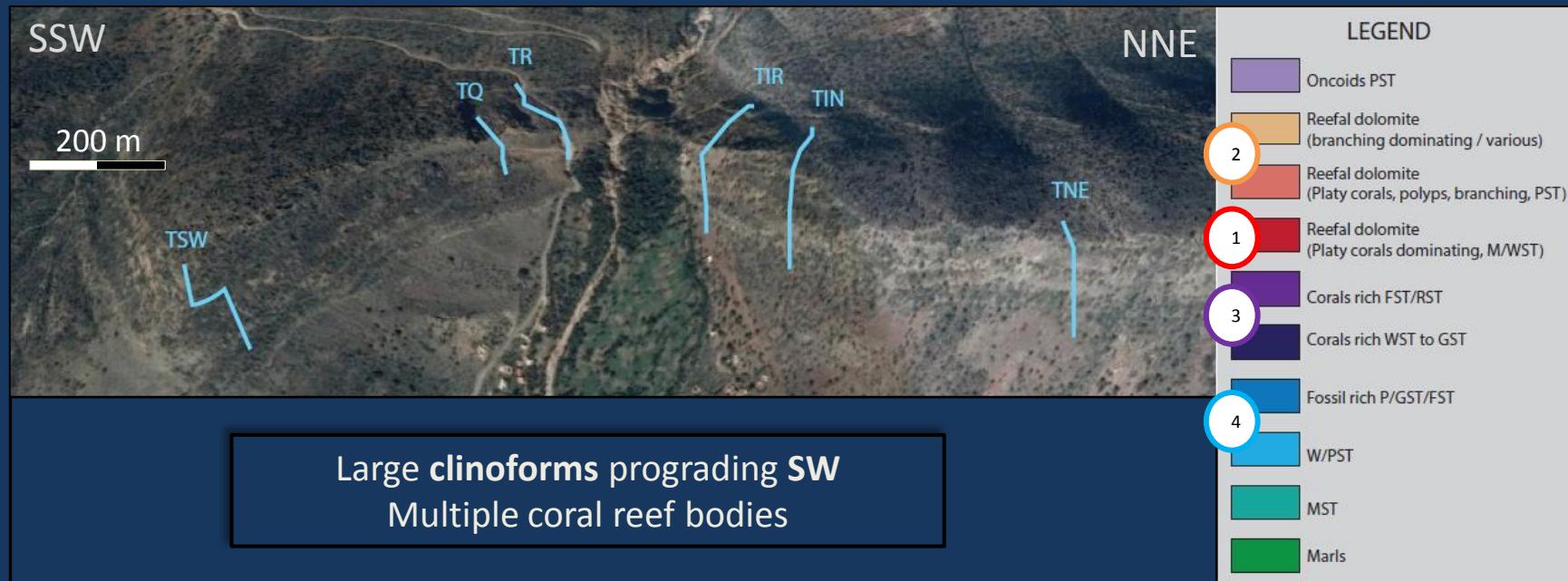
Large clinoforms offlapping the reef structure



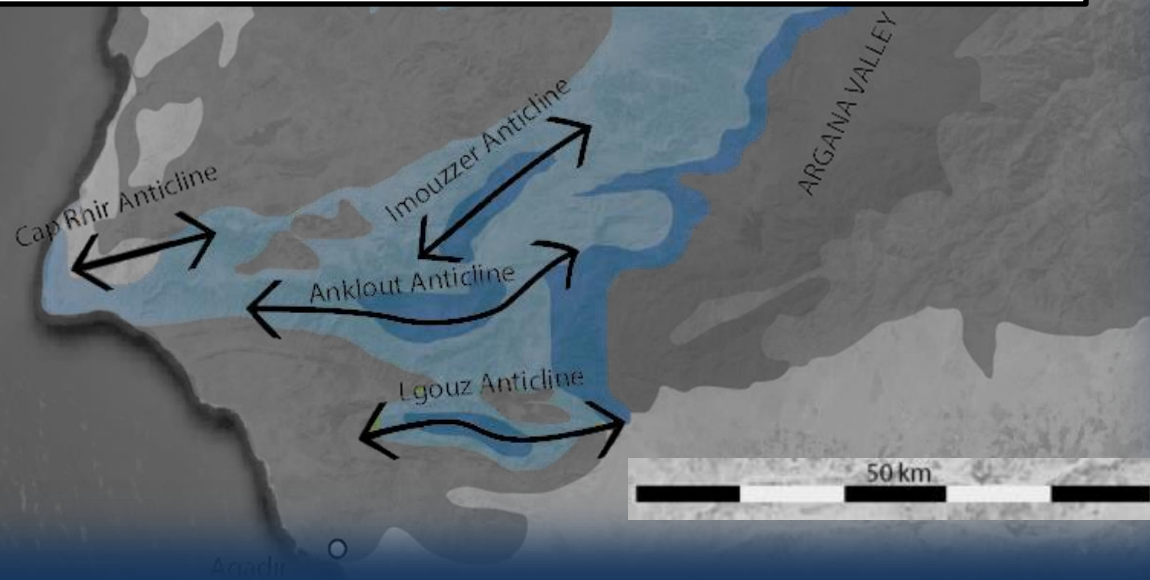
REEF EDGE / CLINOFORMS



# TIDILI FORMATION



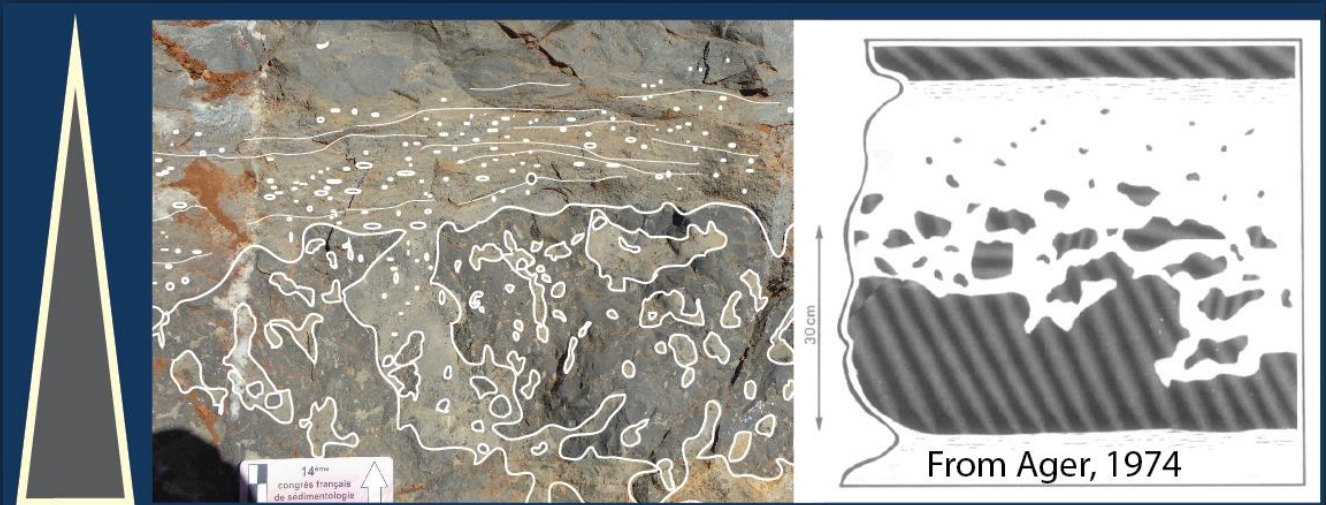
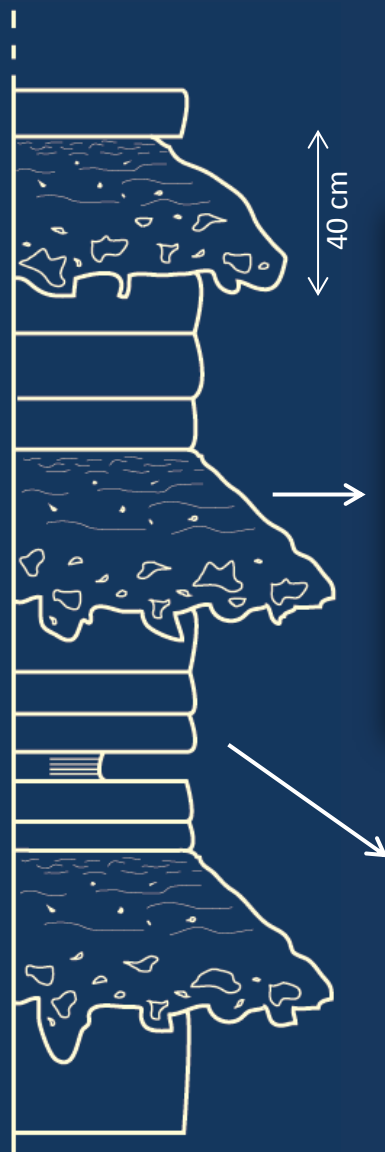
# IGGUI EL BEHAR FORMATION



# IGGUI EL-BEHAR FORMATION

Cyclic alternations between:

- MST to PST rich in benthic foraminifers and gastropods
- Storm deposits (*Ager, 1974*)



# IGGUI EL-BEHAR FORMATION

## UPPER PART OF THE IGGUI EL-BEHAR FORMATION

Cyclic alternations between:

- MST with gypsum crystals
- Storm deposits

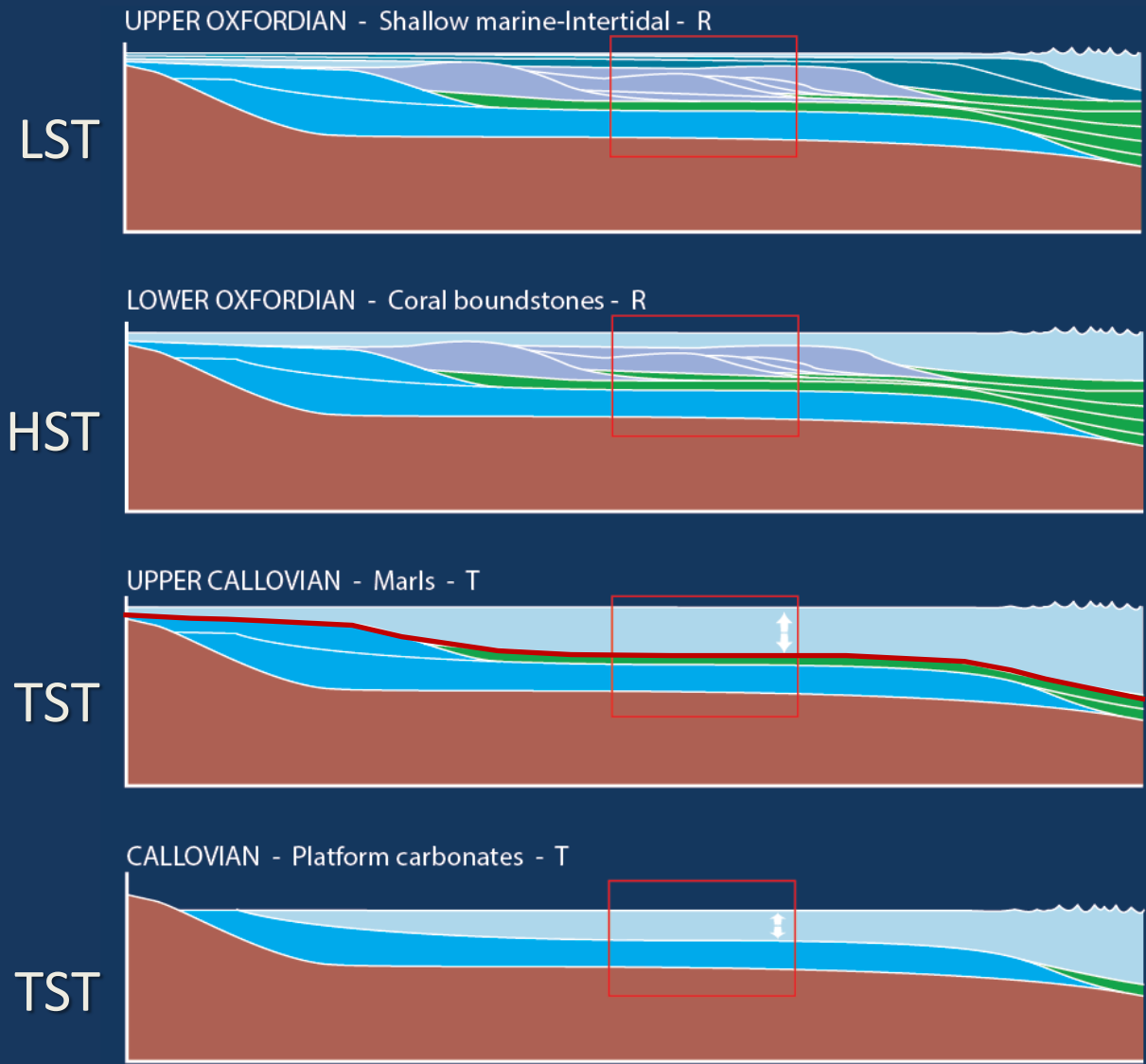


**GYPSUM** deposited in intertidal / higher salinity environment ?

**SHALLOWING-UPWARD / formation of a RESTRICTED ENVIRONMENT**

# LOCAL CONCLUSIONS

10 km 



**IGGUI EL-BEHAR Formation:**  
Shallowing upward  
Recurrent **storm deposits**

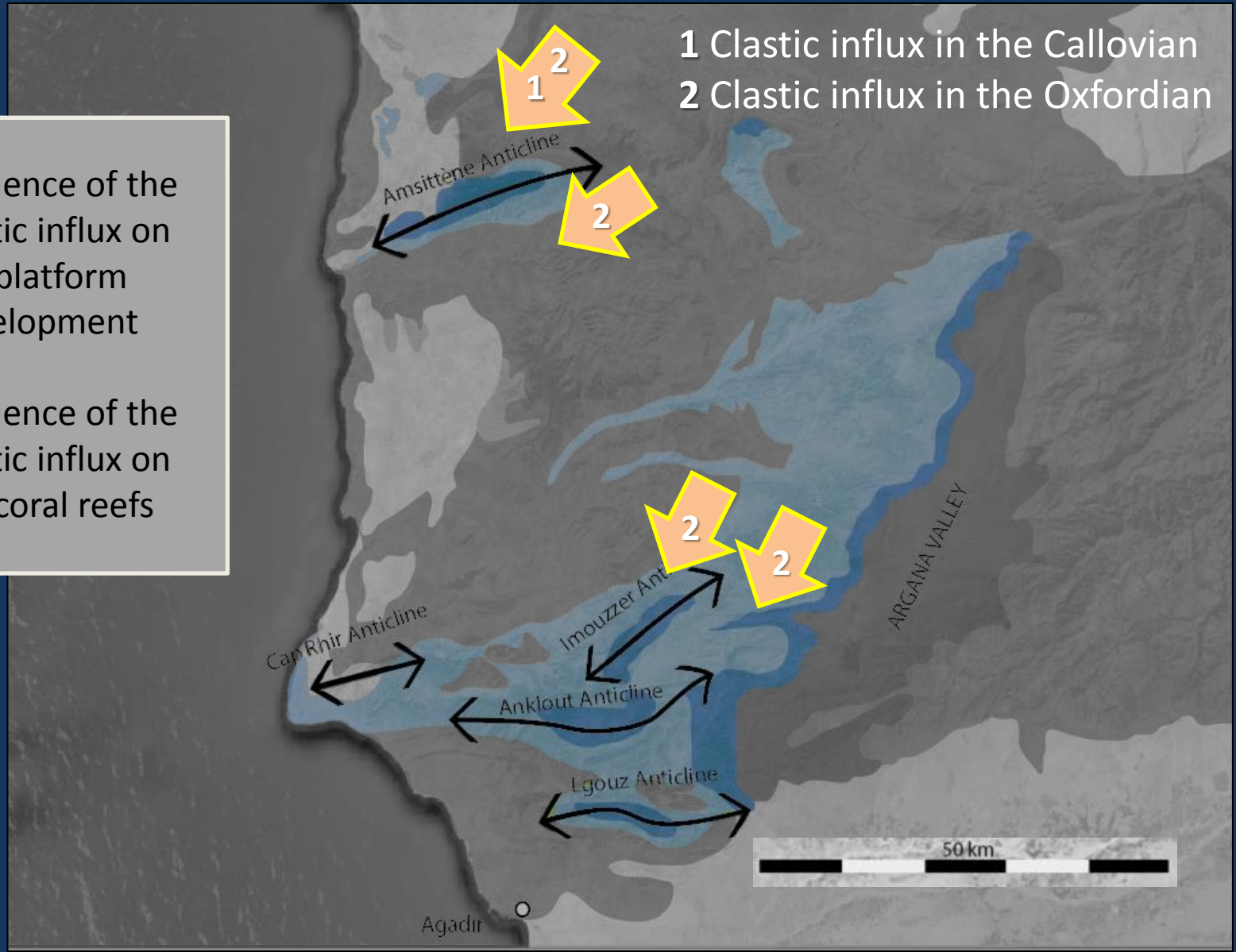
**TIDILI Formation:**  
≠ **types** of builds-up  
≠ build-ups **generations**  
**Dolomitisation** →  $\Phi$   $\rho$

Marls  
**MFS**

**OUANAMANE Formation:**  
Laterally **homogeneous**  
Stratigraphic markers : **HG**

# SILICI-CLASTIC INFLUX

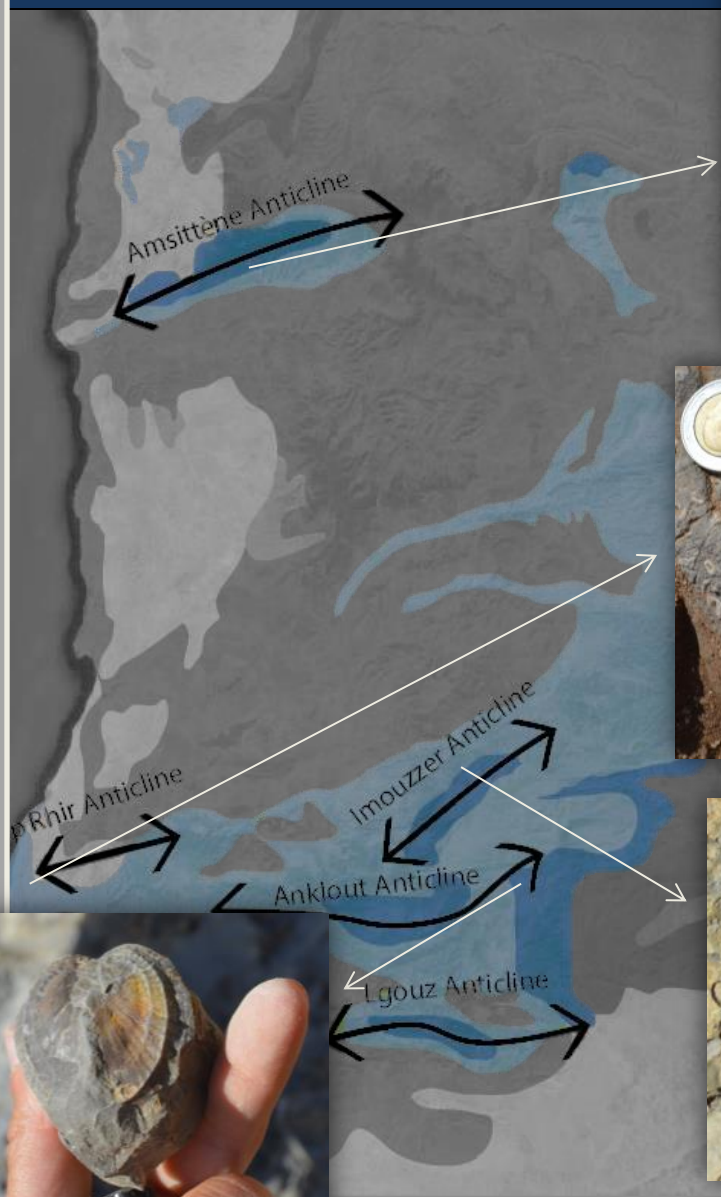
- Influence of the clastic influx on the platform development
- Influence of the clastic influx on the coral reefs





# BIOSTRATIGRAPHY

- Brachiopods collection in the Ouanamane and Tidili formations
- Echinoderrms collection
- Ammonites collection
- Gastropods collection when no others available
- Bivalves collection to constrain the environmental conditions



# Conclusions & Outlook

- Field work : Refine the Lower Jurassic **stratigraphic evolution**
- New sections and thin sections
- Potential Lower Jurassic **siliciclastic** play
- **Geographic evolution** of the platform and reef system is better constrained
- The **extent of reef units** has been quantified in different areas
- Main reef growth phase with establishment of **large scale coral reefs**
- Second phase of establishment of small **patch-reefs**

## *Ongoing work:*

- **Microfacies analysis** to get a better understanding of the depositional environments and the system evolution
- **High resolution models** will be used to understand the **general evolution** of the platform and reefs towards the basin
- Strong focus on **high resolution biostratigraphy** to determine paleowater depth and timing of the different units all over the basin

# Thanks to our sponsors:



Special thanks :



A person in dark clothing is bent over on a rocky ledge, cooking with a small stove. The background features a vast, hazy mountain range under a clear sky. A large, leafy tree is on the right side of the frame.

**Thank you for your attention**

Contact:

[aude.duval-arnould@manchester.ac.uk](mailto:aude.duval-arnould@manchester.ac.uk)