Source rock deposition in Morocco from Late Cenomanian to Early Turonian

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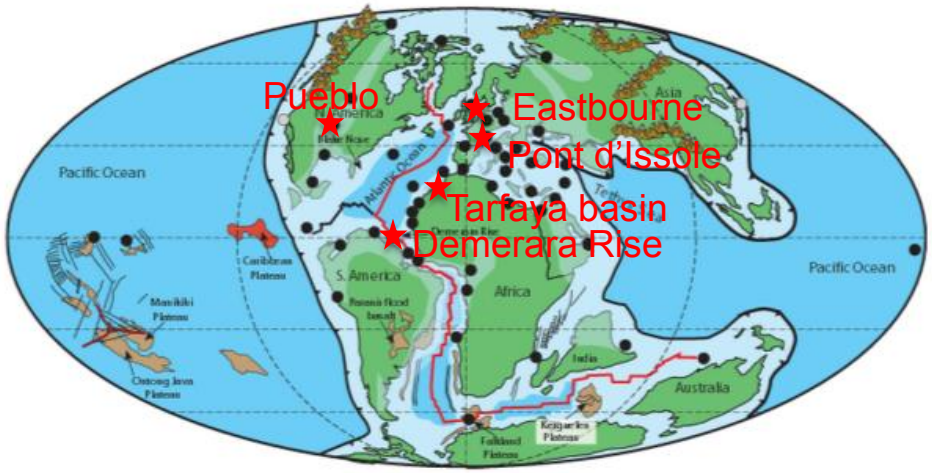
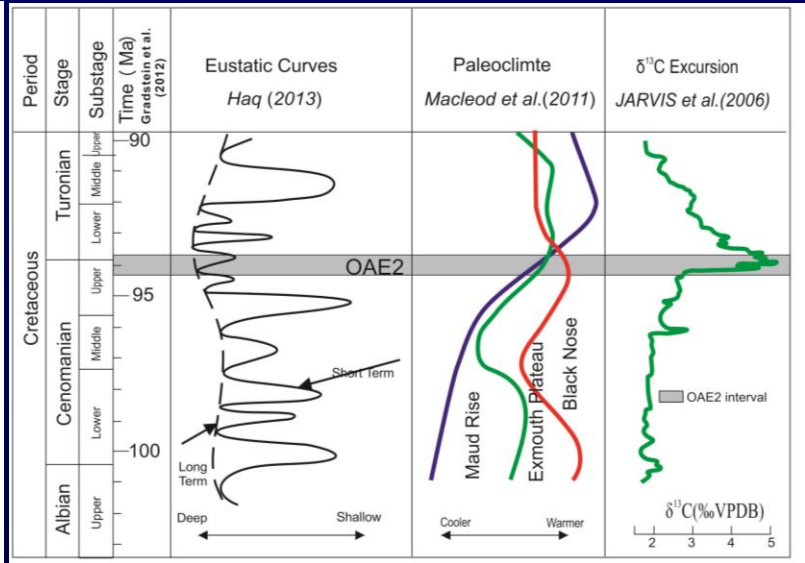
Introduction

OAE2

Source rock was widely deposited during Oceanic Anoxic Event (OAE2), an interval with increased organic carbon storage globally



Distribution of black shales during OAE2



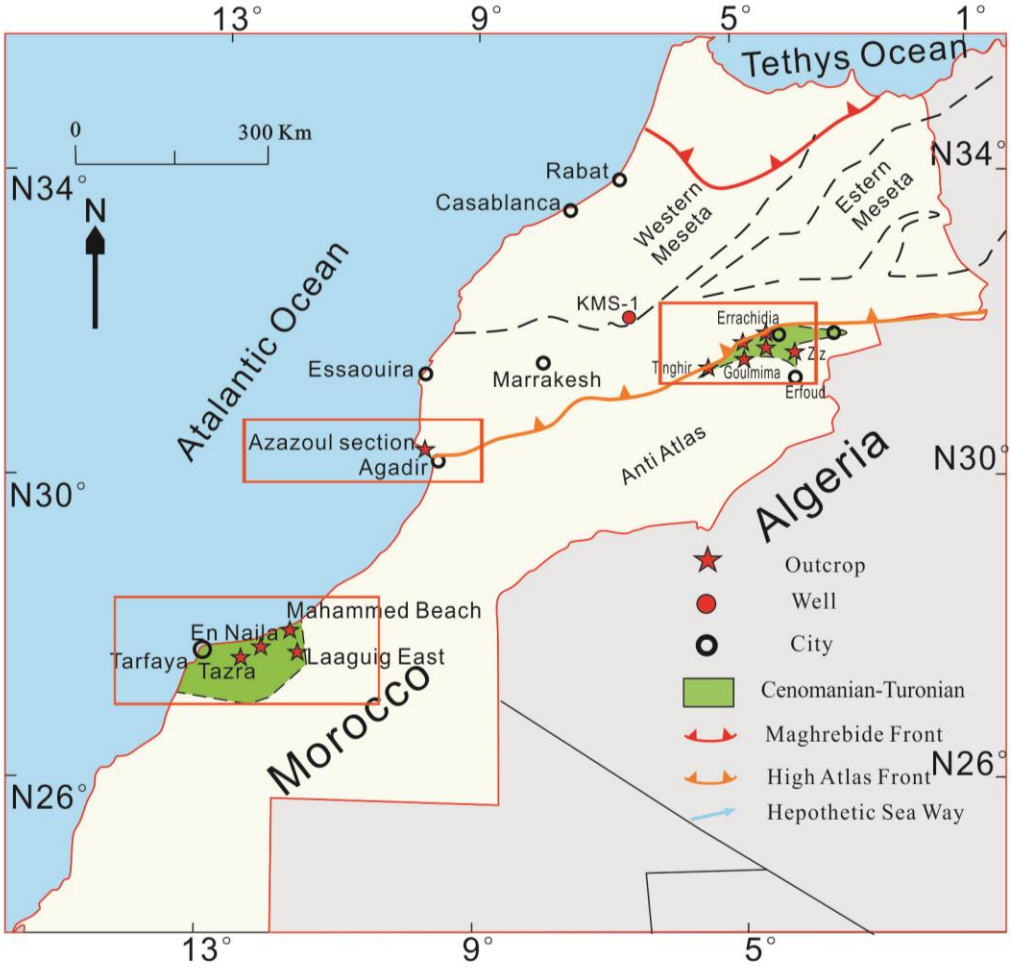
The characteristics of OAE2

Age: Late Cenomanian to Early Turonian Duration: < 1 Ma

Paleoclimate: Extremely warm climate and high sea level

Characteristics: OM-rich mudstones deposition and positive $\delta^{13}C$ excursion

Introduction



Location of studied Moroccan basins

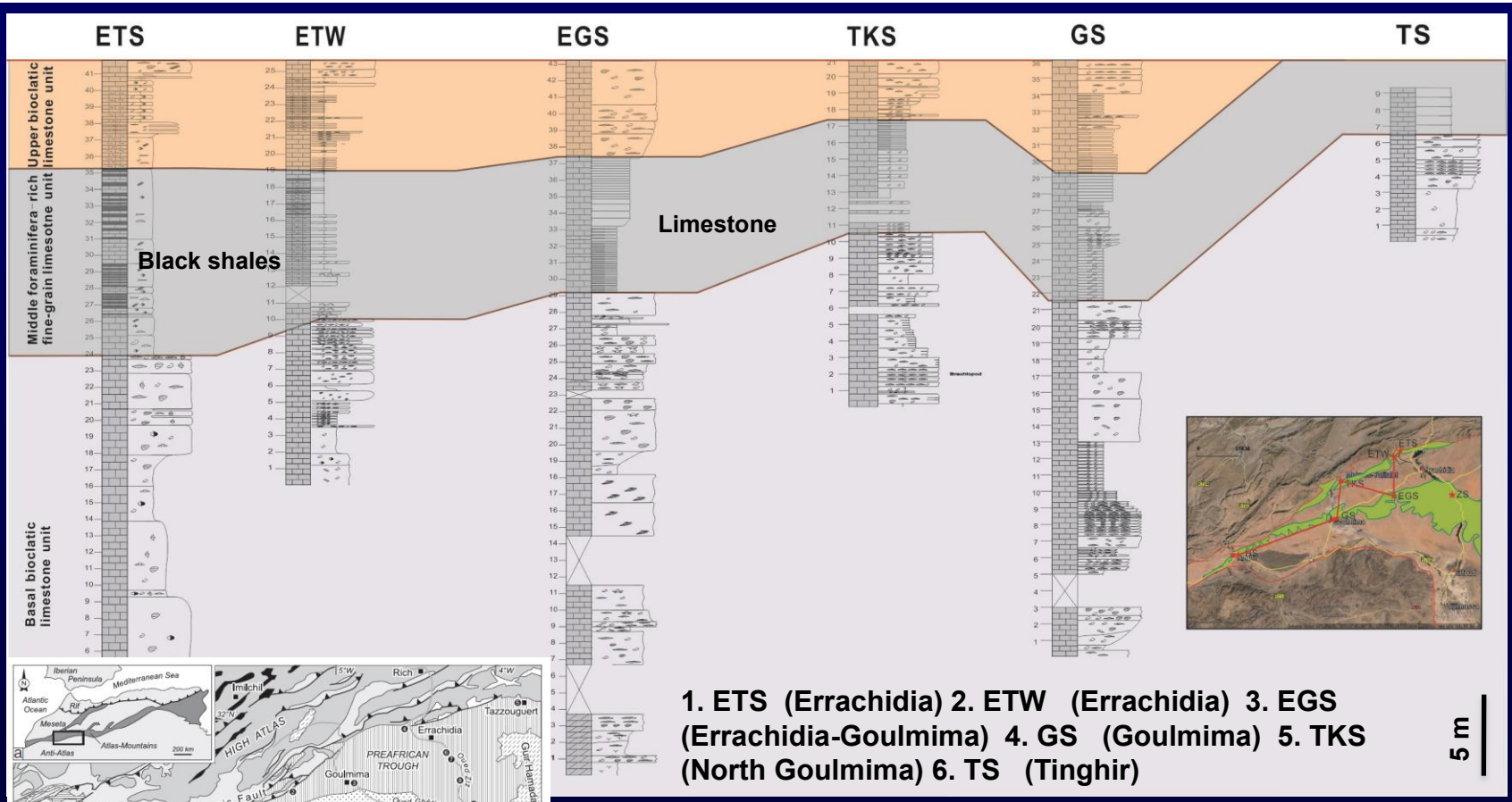
Aims:

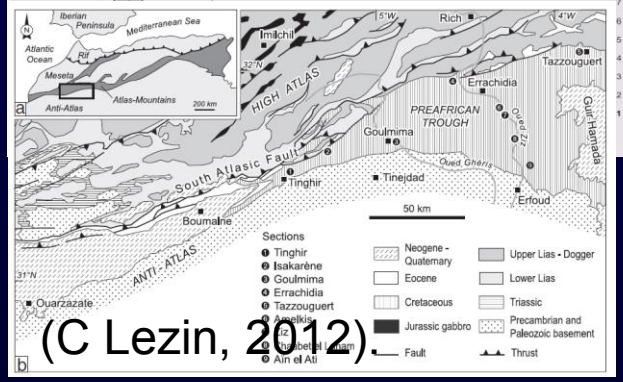
- Identify the distribution and quality of C-T source rock in Moroccan basins
- Source rock timing
- Controls on the source rock
- Analogue for offshore basins

Studied basins:

- Errchidia-Goulmima basins
- Agadir-Tarfaya basins

1. Errachidia-Goulmima Basins



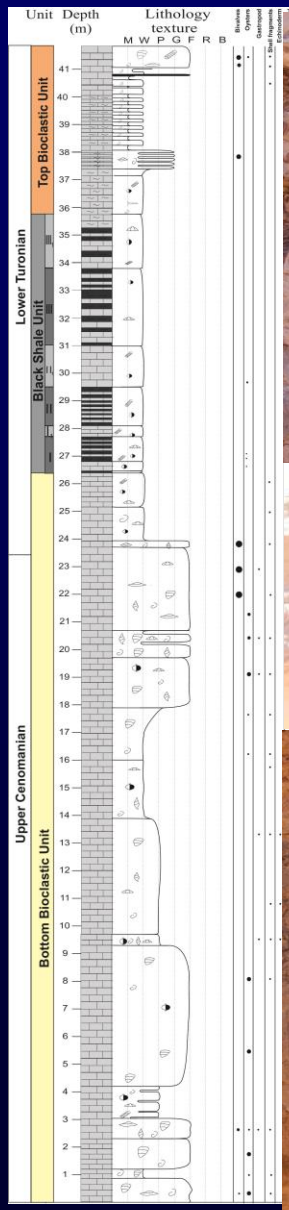


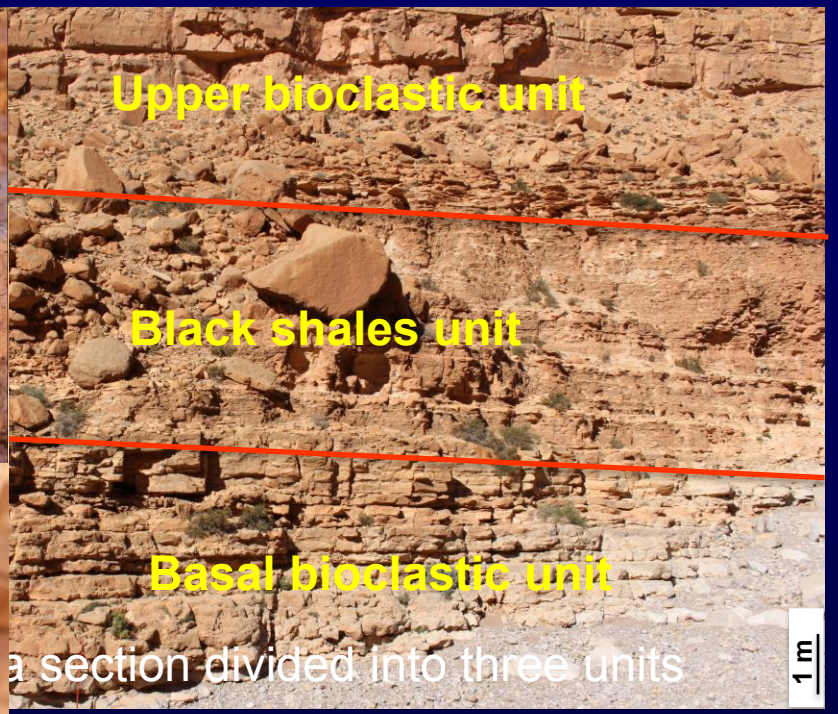
(C Lezin, 2012)

Shallow carbonate platform deposition during C/T interval
Black shales developed in Errachidia basin

1. Errachidia-Goulmima Basins

Errachidia Basin





r Post-OAE2 interval: Macrofossil-rich
tone

r Post-OAE2 interval: Black shales

. interval: Macrofossil-rich limestone

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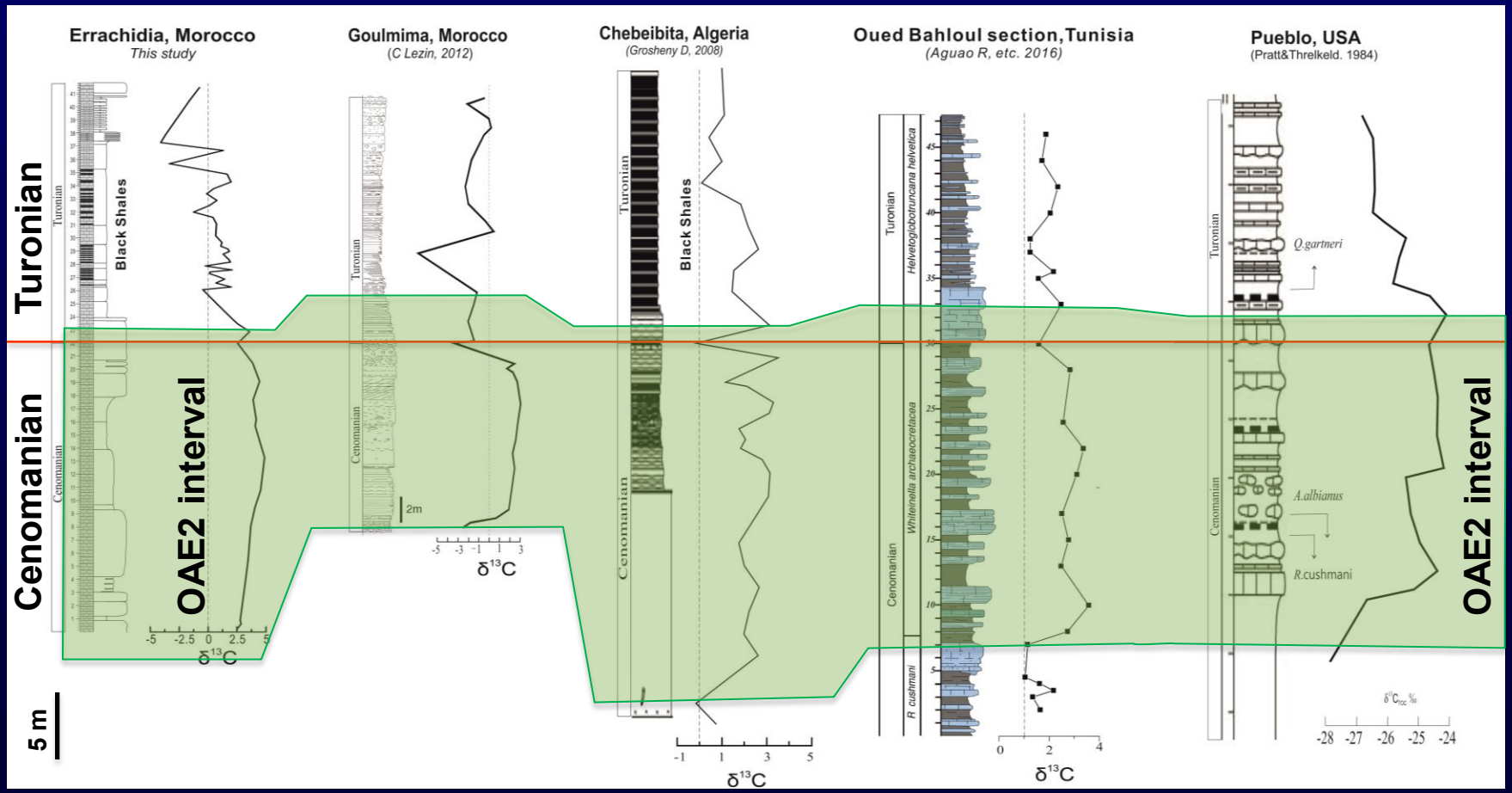
1. Errachidia-Goulmima Basins

Errachidia Basin

$\delta^{13}C$ isotope stratigraphy

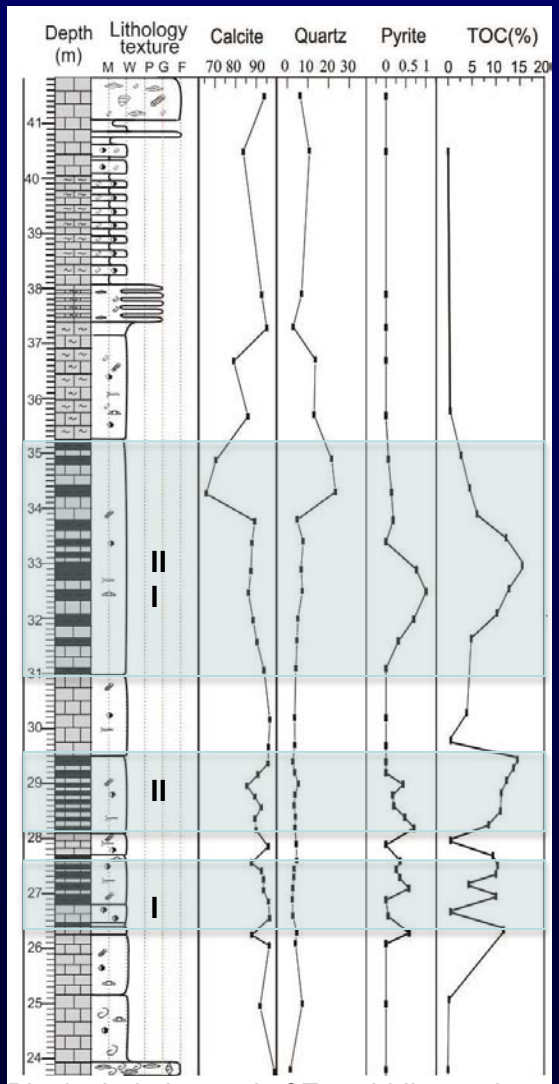


Black shales deposited during Early Turonian, Post OAE2 interval

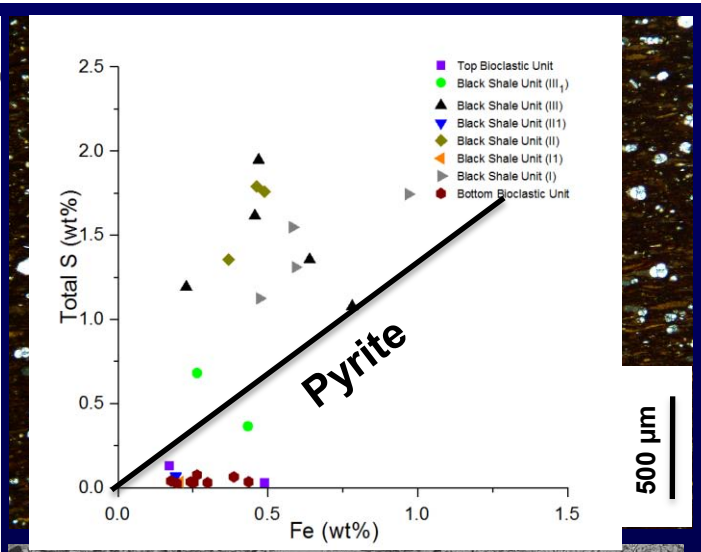
Fossil-rich limestone deposited during OAE2 interval

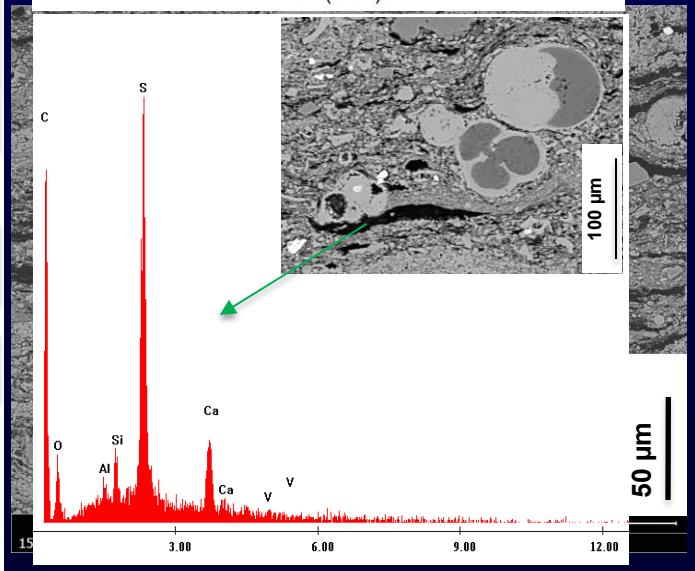
1. Errachidia-Goulmima Basins

Errachidia Basin



Black shale interval of Errachidia section





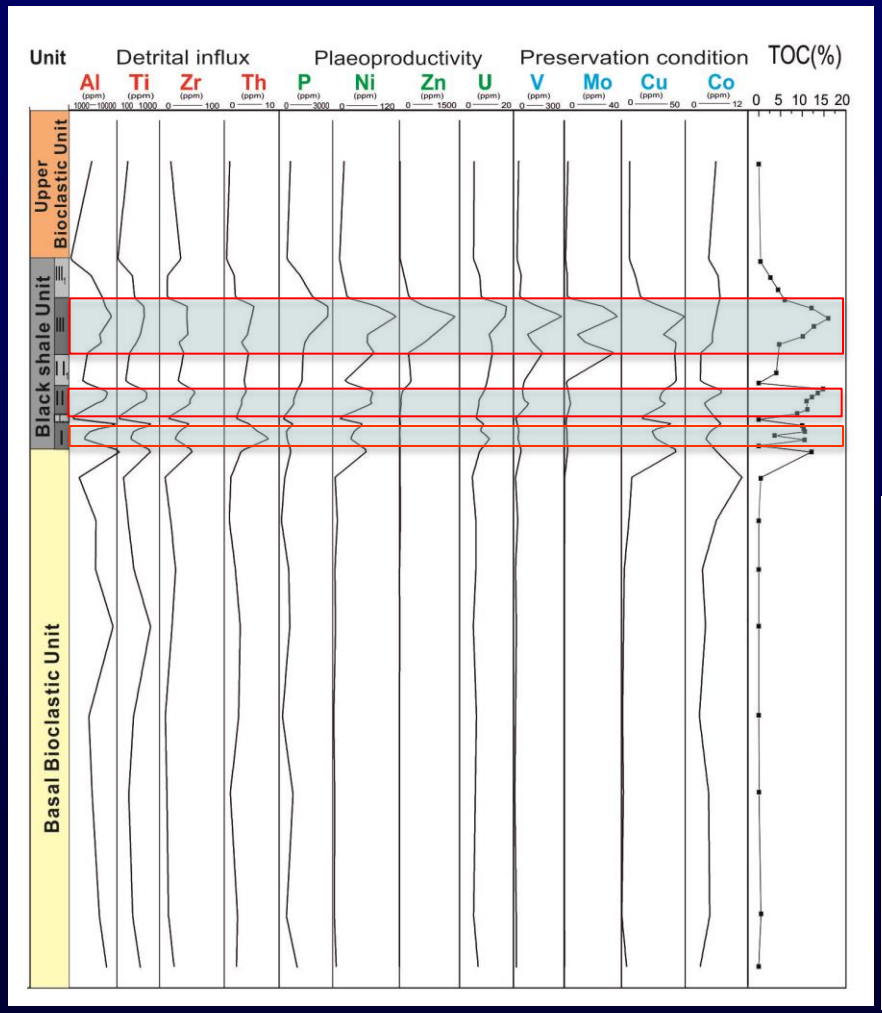
- Alternated with fine-grain limestone
- Laminated
- Planktonic foraminifer rich
- Average TOC values 9.6%, Maximum16%
- High calcite content
- Type I kerogen

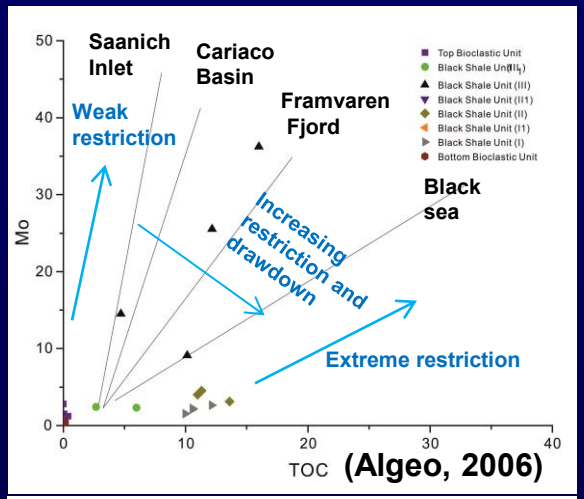
- Low pyrite content
- Sulfur in organic matter

1. Errachidia-Goulmima Basins

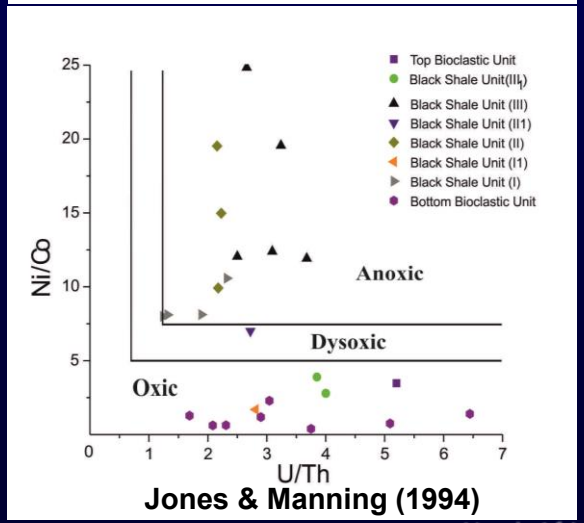
Errachidia Basin

Redox condition and productivity





(Algeo, 2006)



Jones & Manning (1994)

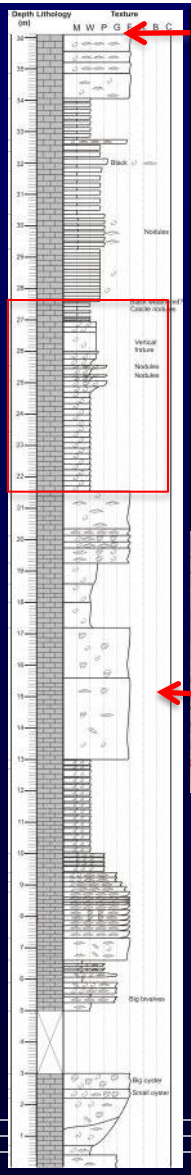
Restrict marine environment

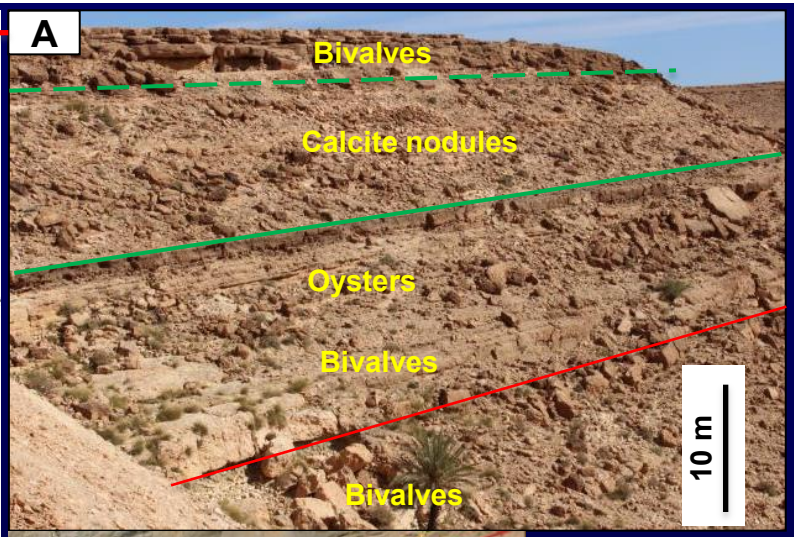
Extremely low detrital influx

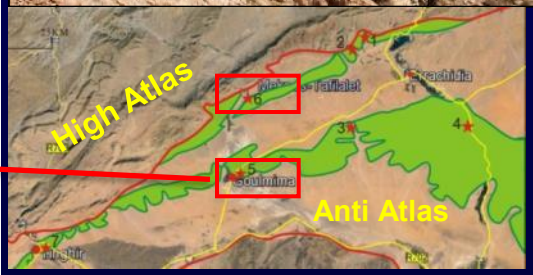
Enhanced primary producvtivity and Anoxic condition facilitated the OM-rich black shale deposition

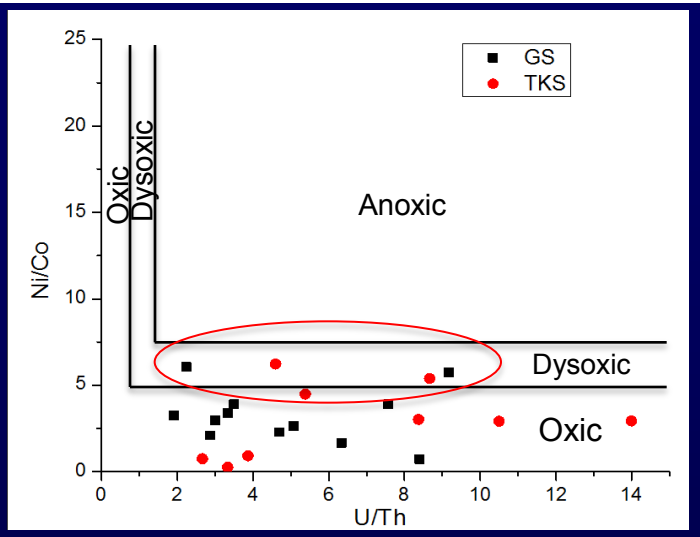
1. Errachidia-Goulmima Basins

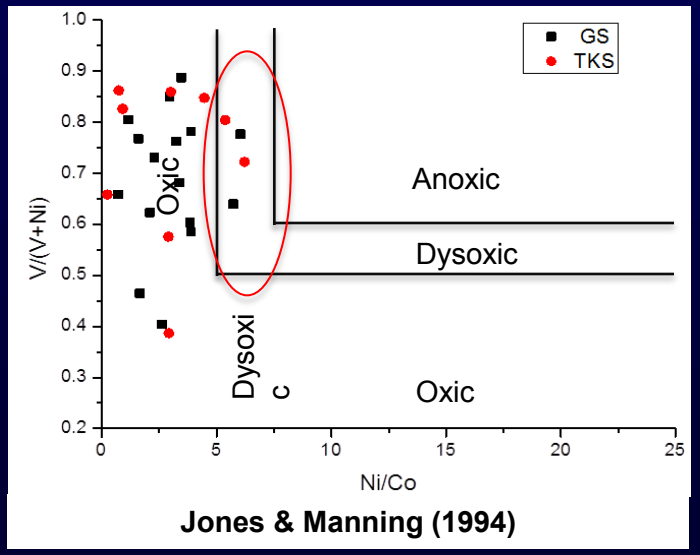
Goulmima











Jones & Manning (1994)

Shallow platform deposition
Inner ramp to middle ramp

Dysoxic-Oxic water condition

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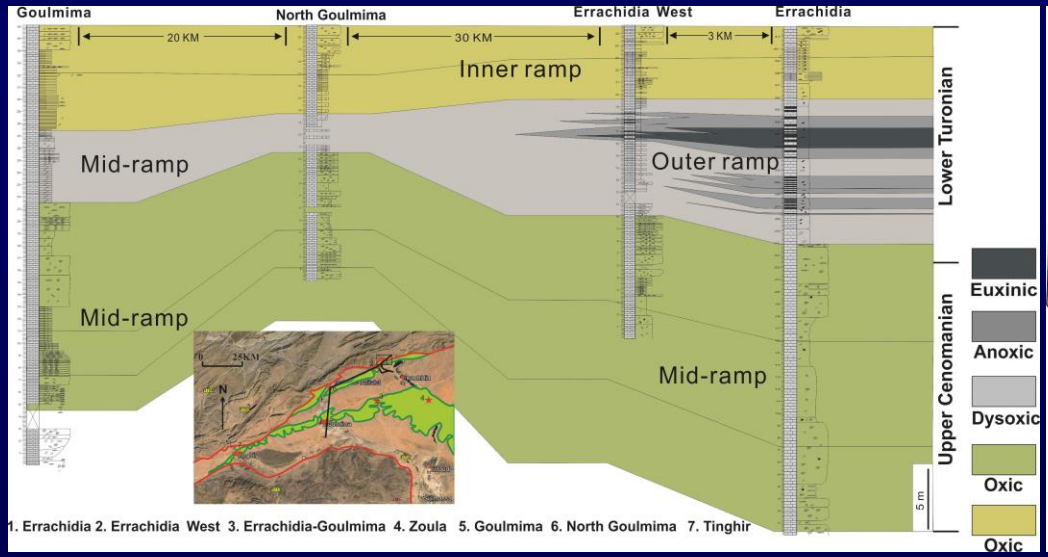
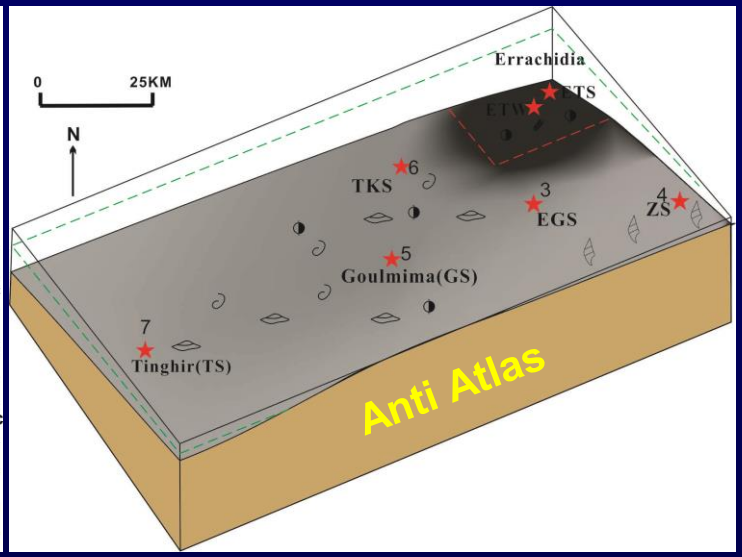
1. Errachidia-Goulmima Basins

Summary

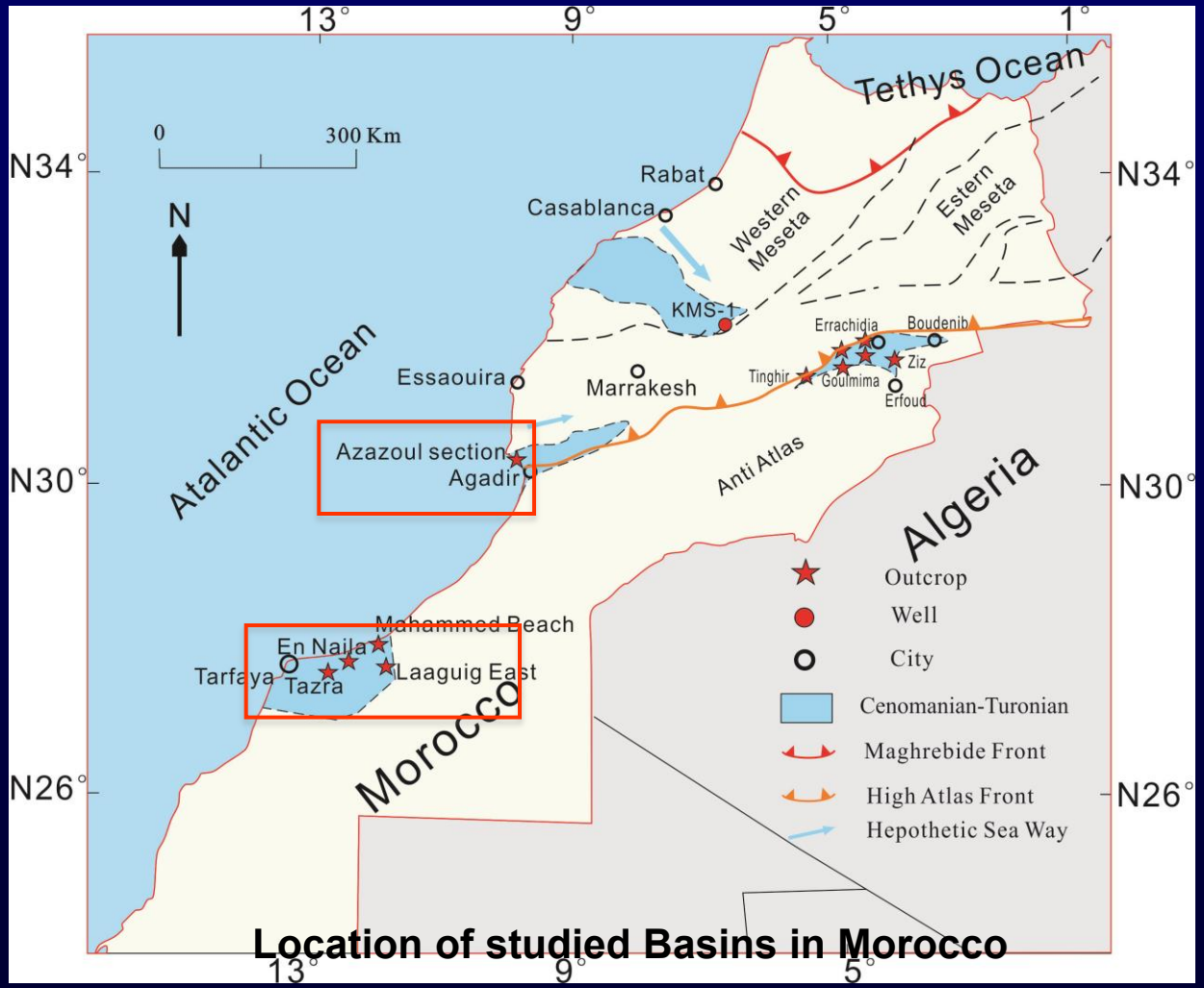




The black shales in Errachidia summary:

- The OM-rich black shales were developed during post-OAE2 interval in Early Turonian.
- There is positive excursion $\delta^{13}C$ isotope, which indicates OAE2 interval, recorded within fossil-rich limestone deposition shallower marine environment, but with no black shale deposited.
- OM-rich black shales were deposited in a strongly restricted marine environment with extremely low detrital influx. The high productivity and anoxic/euxinic water conditions facilitated organic-rich black shales deposition.

2.Tarfaya and Agadir basin



Location of studied Basins in Morocco

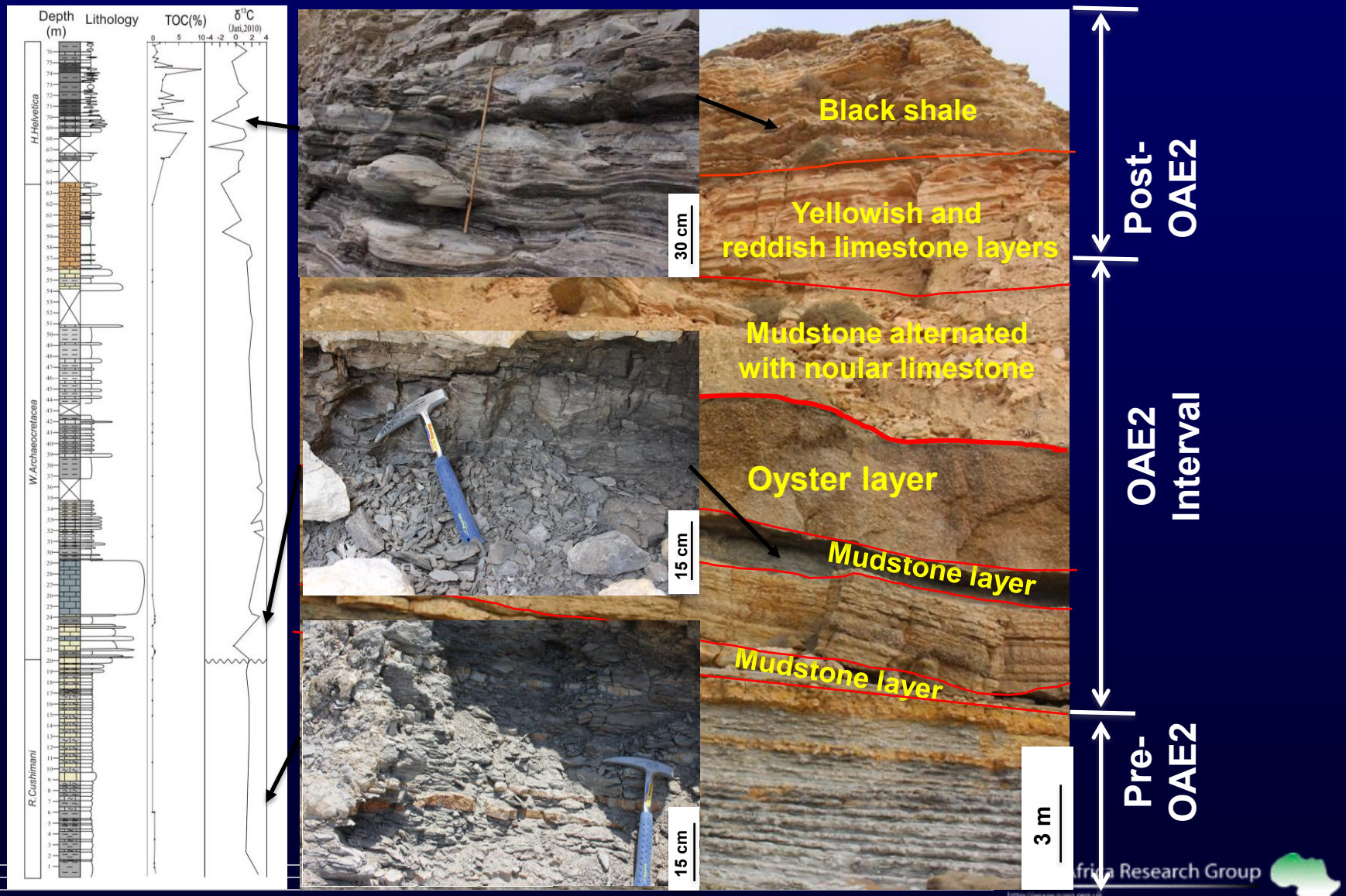
Atlantic ocean controlled basins:

Agadir basins:
Azazoul section

Tarfaya basins:
Laaguig East section
Tazra section
En Naila section

2.Tarfaya and Agadir basin

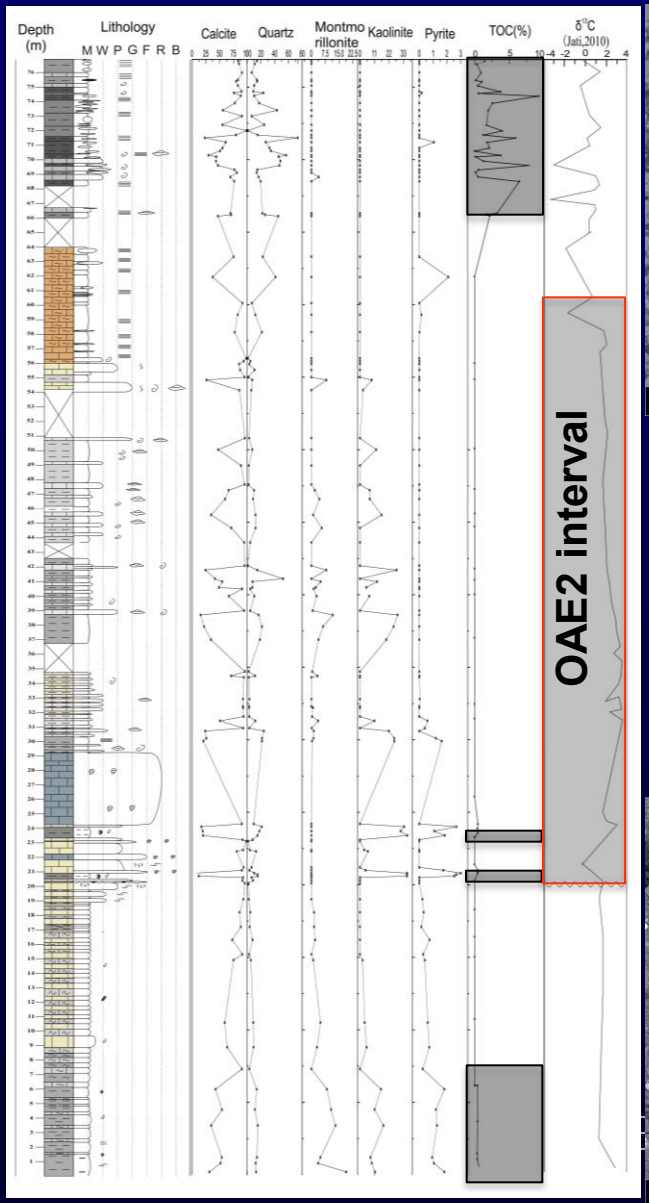
Agadir Basin

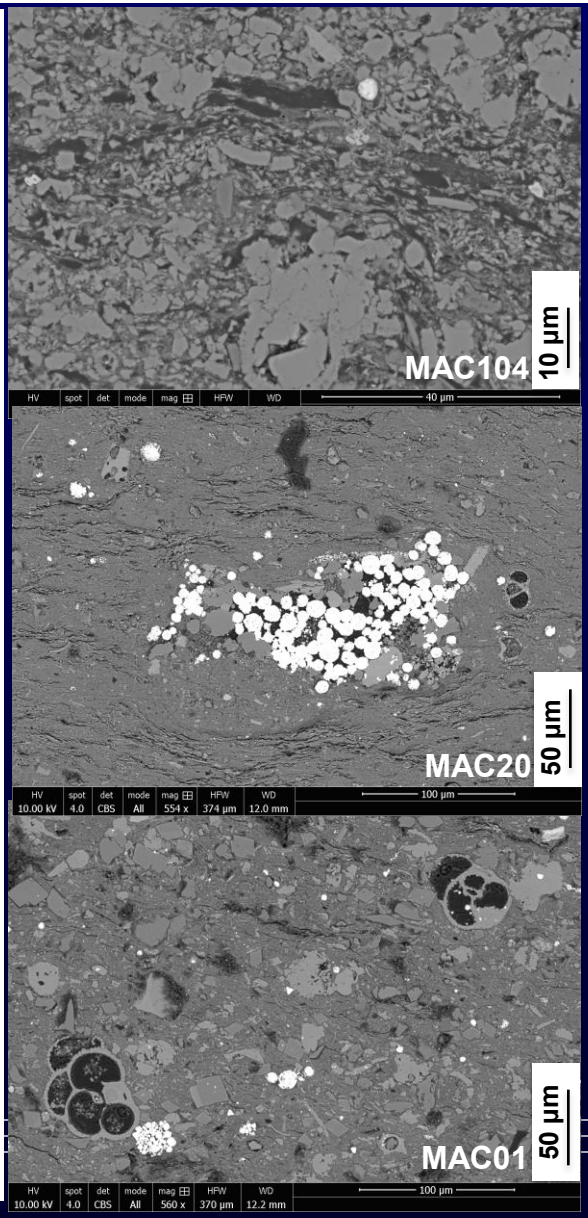


Cenomanian-Turonian of Azazoul Beach section

2.Tarfaya and Agadir basin

Agadir Basin





Post-OAE2 interval:

TOC values up to 9.2%, with average values 2.5%.
Calcite-rich and Quartz-rich.
Low pyrite content
Type II kerogen
Sulfur content in OM

OAE2 interval:

TOC values less than 1%
Clay mineral-rich.
High Pyrite content
Type III kerogen

Pre-OAE2 interval:

TOC values less than 1%
Clay mineral-rich.
Relative high pyrite content
Type III kerogen

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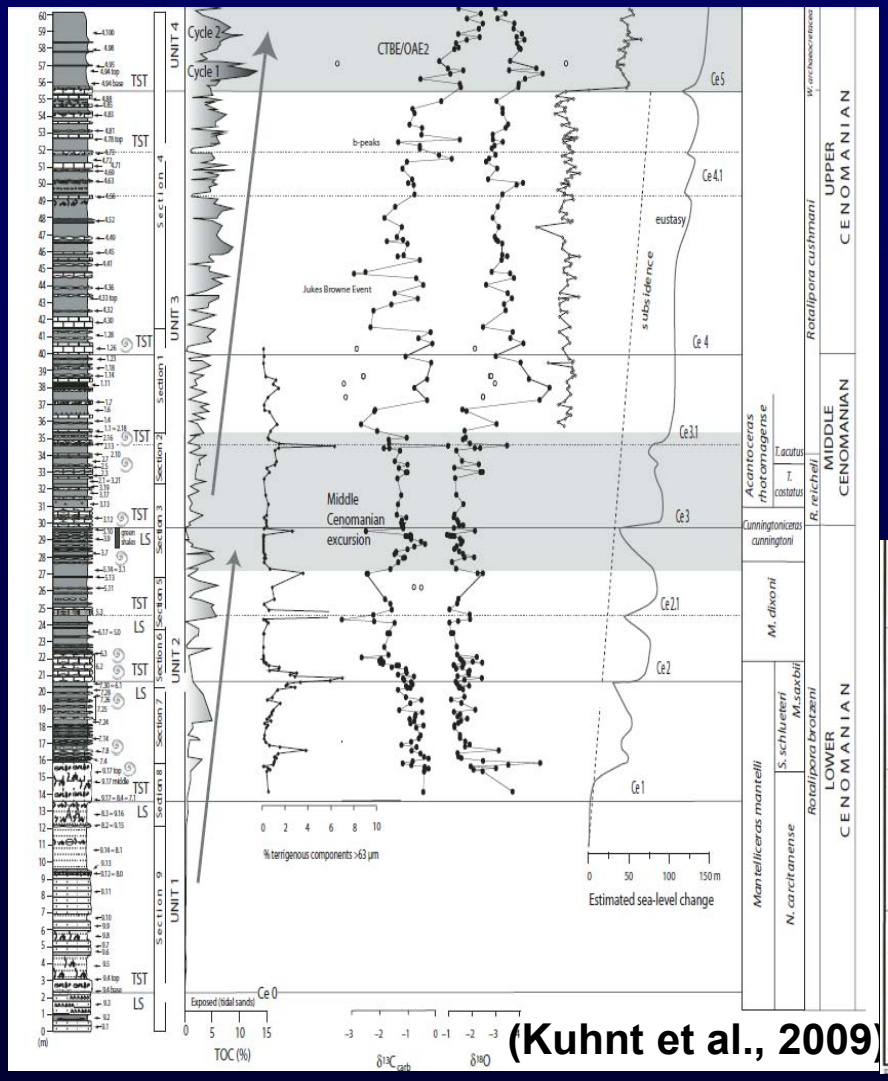
2.Tarfaya and Agadir basin

Tarfaya Basin



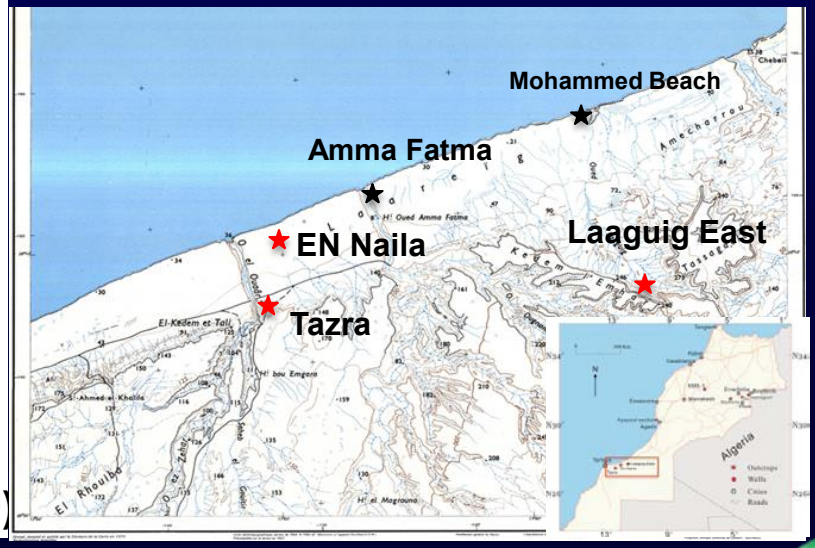
(Kuhnt et al., 2009)

Upper Cenomanian:

Mohammed plague section

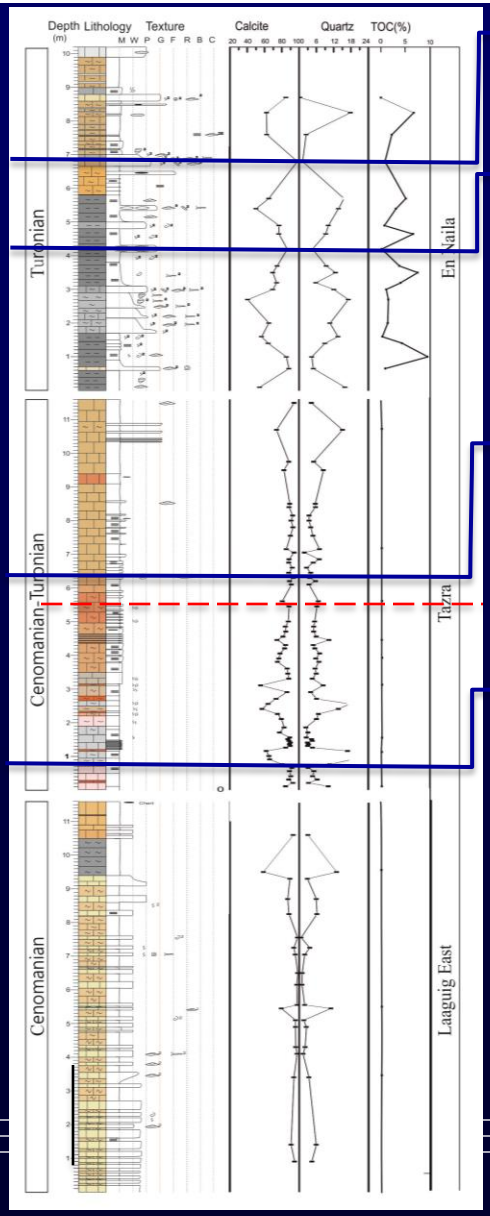
Relative high TOC values (up to 10%)

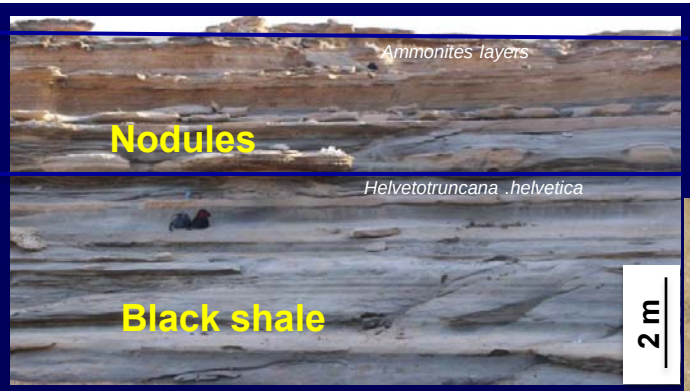
Deep marine environment

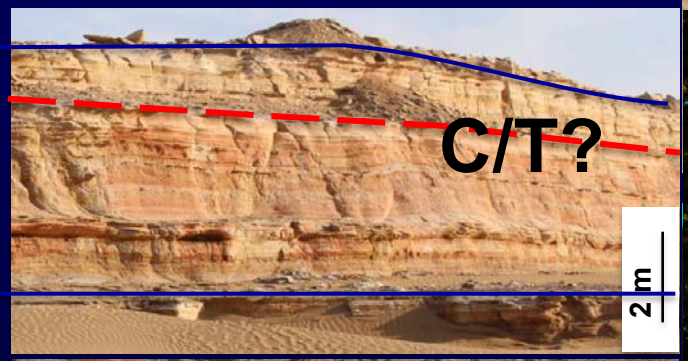


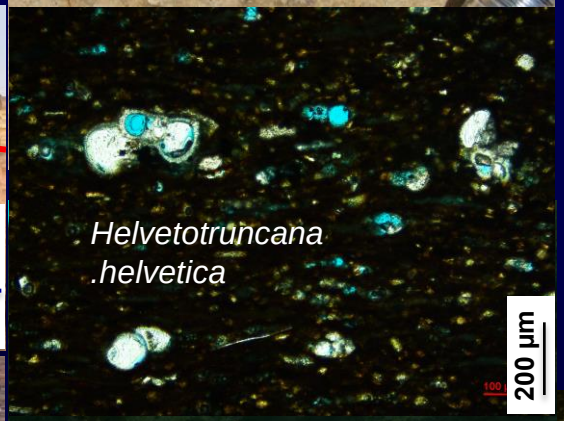
2.Tarfaya and Agadir basin

Tarfaya Basin



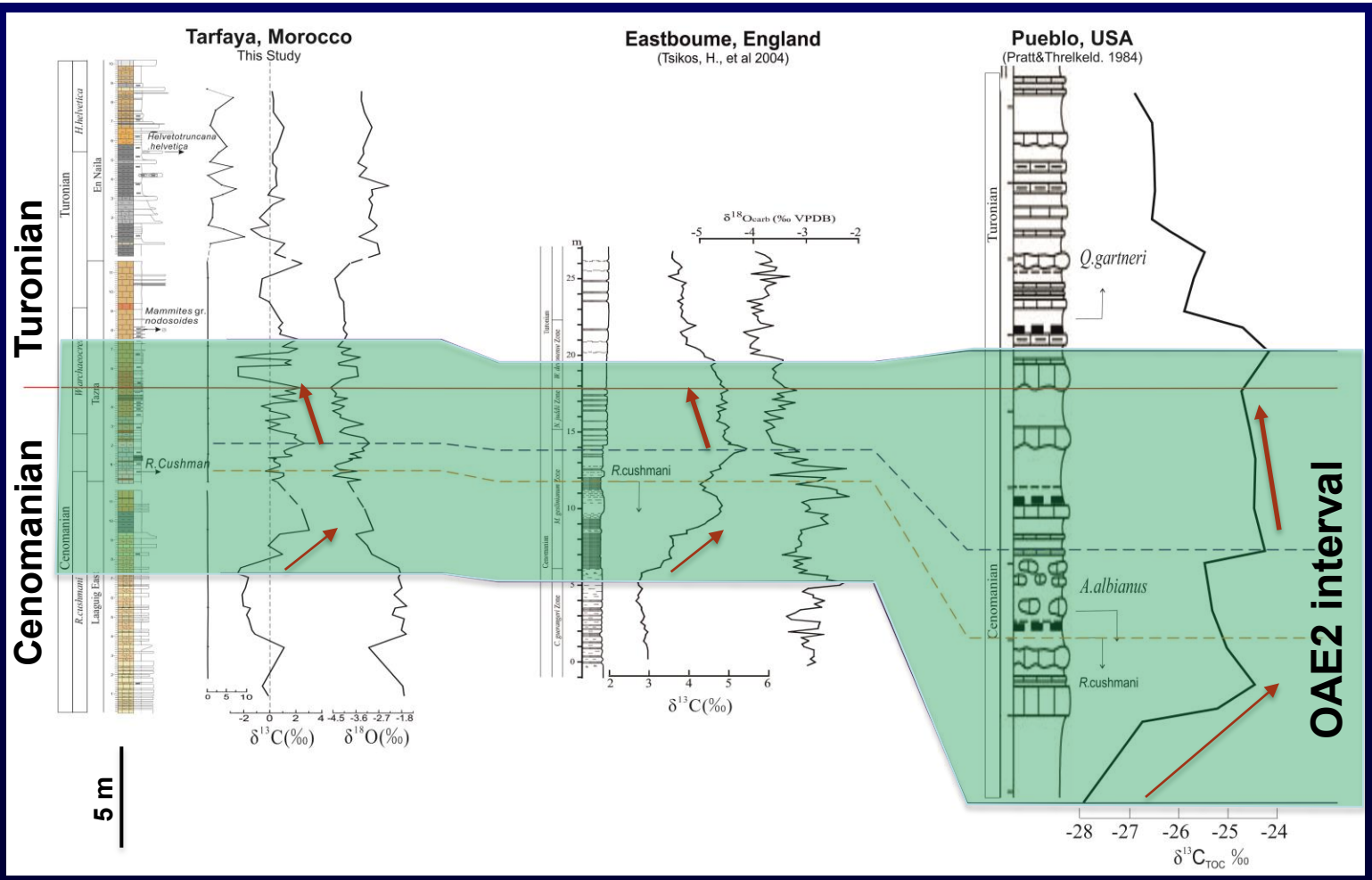






2.Tarfaya and Agadir basin

Tarfaya Basin



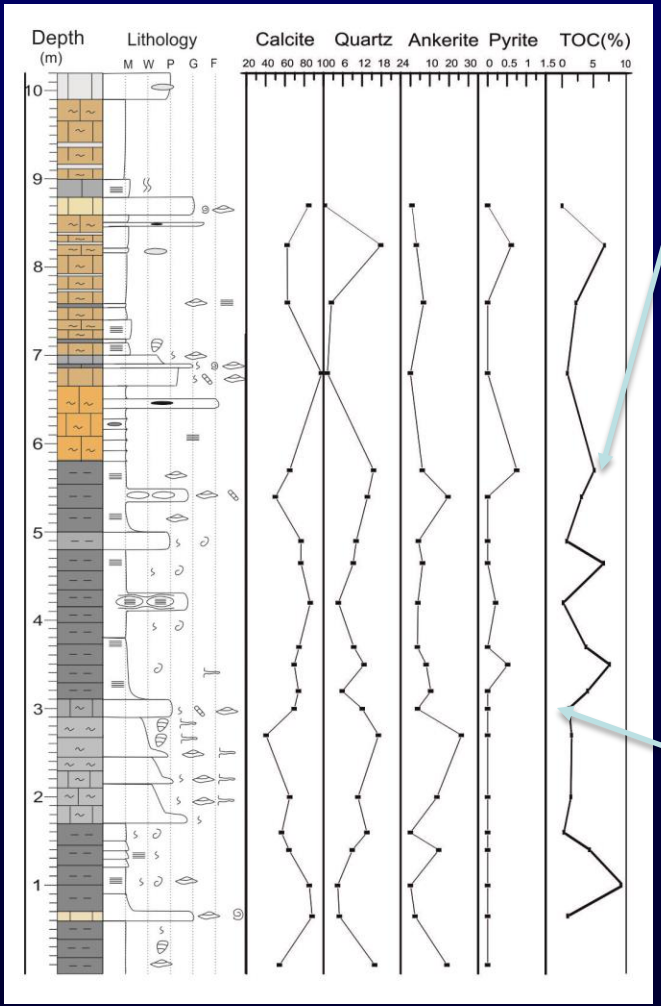
C/T Boundary was identified in Tazra section

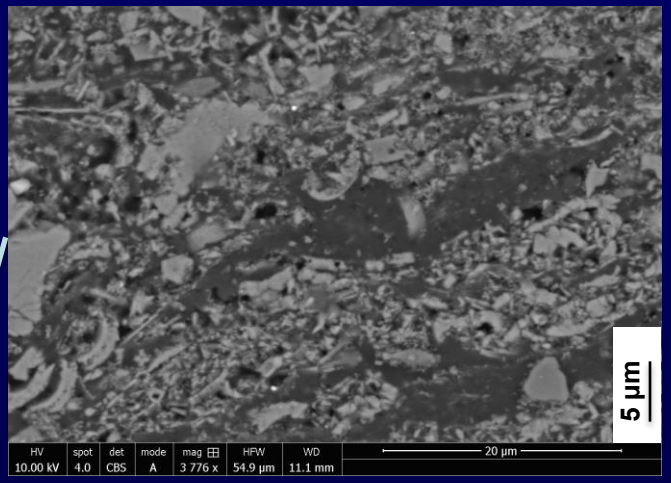
Black shales deposited during Early Turonian, Post OAE2 interval

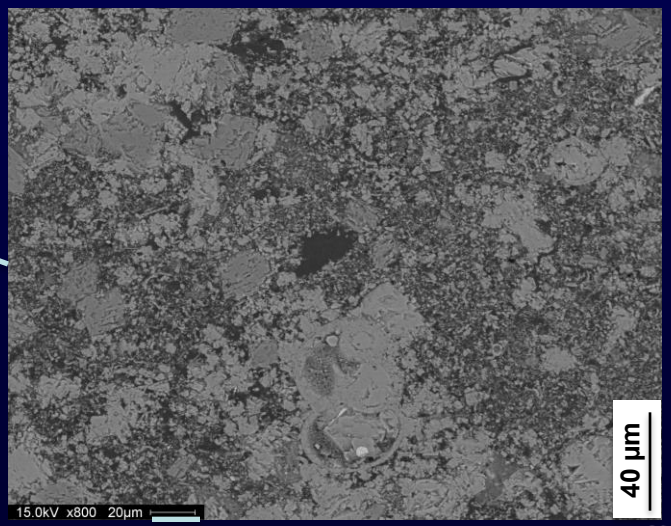
2.Tarfaya and Agadir basin

Tarfaya Basin

En-Naila: Early Turonian







Intercalated with calcite nodules

Carbonate-rich

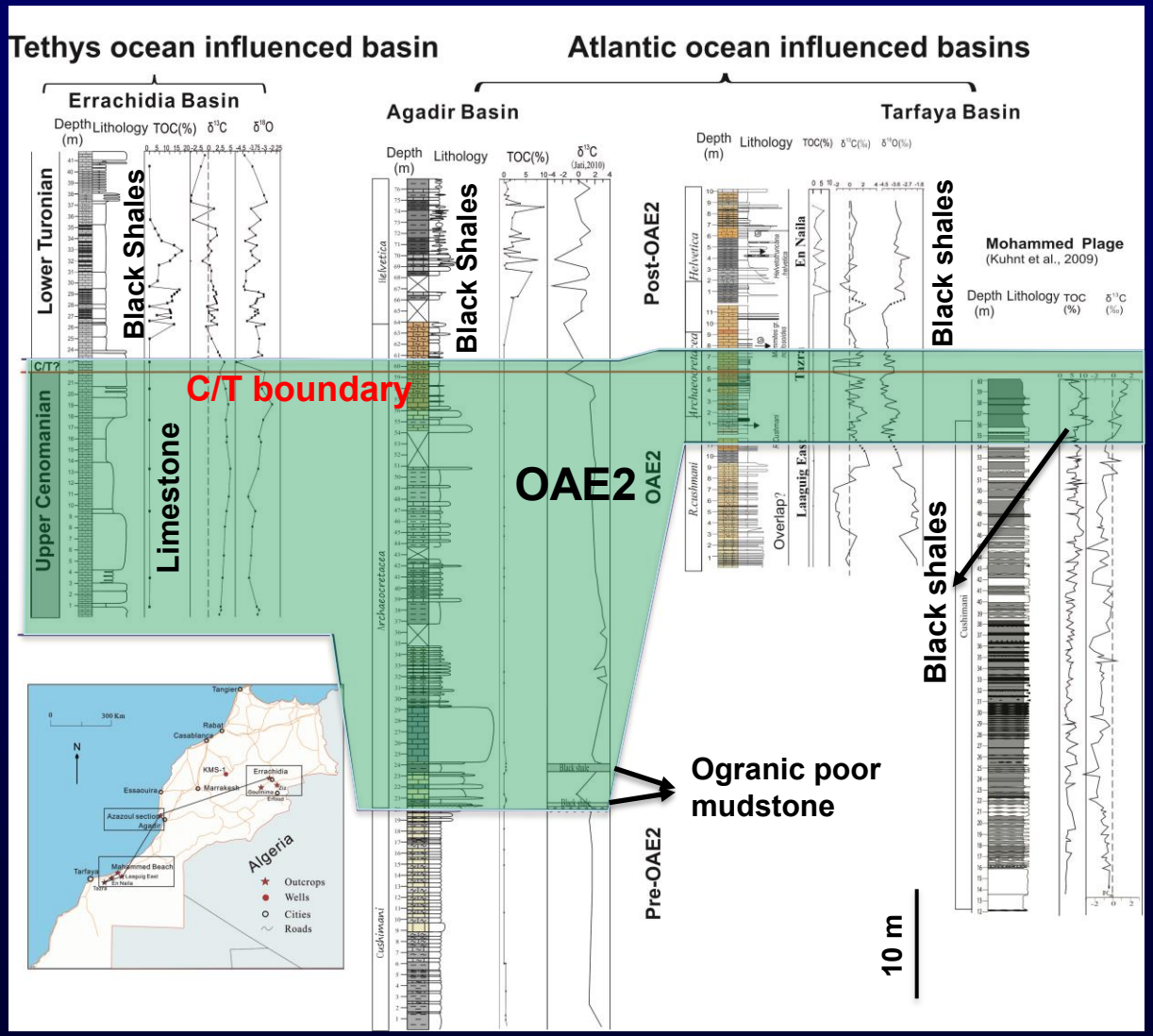
Average TOC values 3.4%, Maximum9.8%

Low pyrite content

Type II kerogen

Sulfur content in OM

Moroccan basins



Tethys Ocean influenced basin:

OM-rich black shale developed during post-OAE2 interval in Early Turonian, recording the Early Turonian rapid sea level transgression

Anoxic/euxinic water conditions and high productivity facilitated the OM-rich black shale deposition.

High TOC values, type I kerogen.

Atlantic Ocean-inflenced basins:

OAE2 interval:

Black shales can be correlated with the positive δ^{13} C excursion (OAE2), but the OM richness varies, poor in Agadir basin while rich in Tarfaya basin

Post-OAE2 interval:

OM-rich black shales developed in both basins, with high TOC values and type II kerogen

Conclusion

- Biostratigraphy and carbon isotope analysis suggests source rock developed in both Upper Cenomanian(OAE2) and Lower Turonian (post-OAE2) interval.
- During Late Cenomanian (OAE2 interval), Organic-rich source rock was only confined in relative deep marine environment, such as Tarfaya basin, while mudstone or limestone deposited in shallow marine environment was with low OM content, such as Agadir and Errachidia basin. The result suggests the deeper marine basins could have potentially hydrocarbon source rock in Upper Cenomanian
- OM-rich source rock was widely deposited in both Atlantic and Tethyan influenced Moroccan basins during Early-Turonian interval. The type II kerogen in Atlantic influenced basins and Type I kerogen in Tethyan influenced basins indicate Lower Turonian is a potential oil sources interval.

Questions and Answers:

Thank you for your support:

Special Thanks:

ONHYM

المكتب الوطني للهيدروكاربورات و المعادن

OFFICE NATIONAL DES HYDROCARBURES ET DES MINES

Azazoul section, Morocco 23/05/2015