Deciphering local from global signals in Portimão Bank sedimentary dynamics

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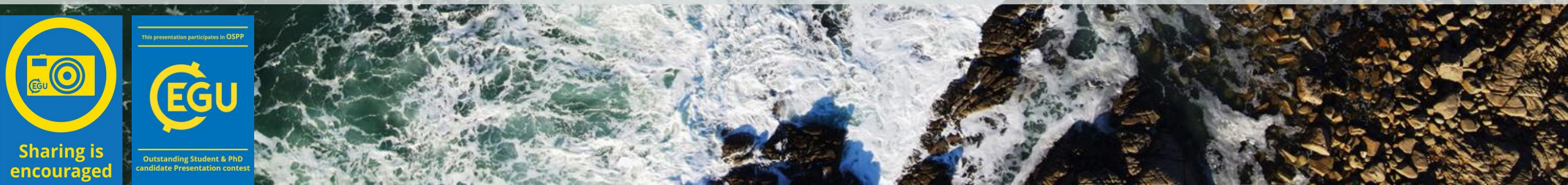
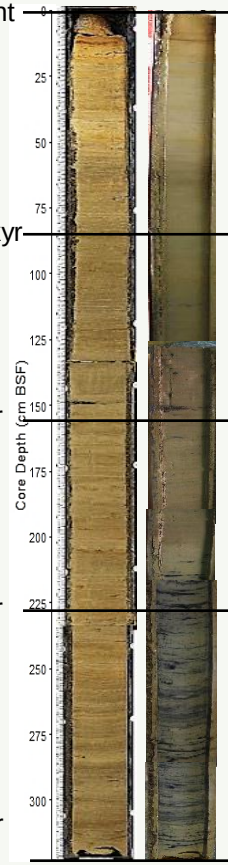
Instituto Português do Mar e da Atmosfera (IPMA)

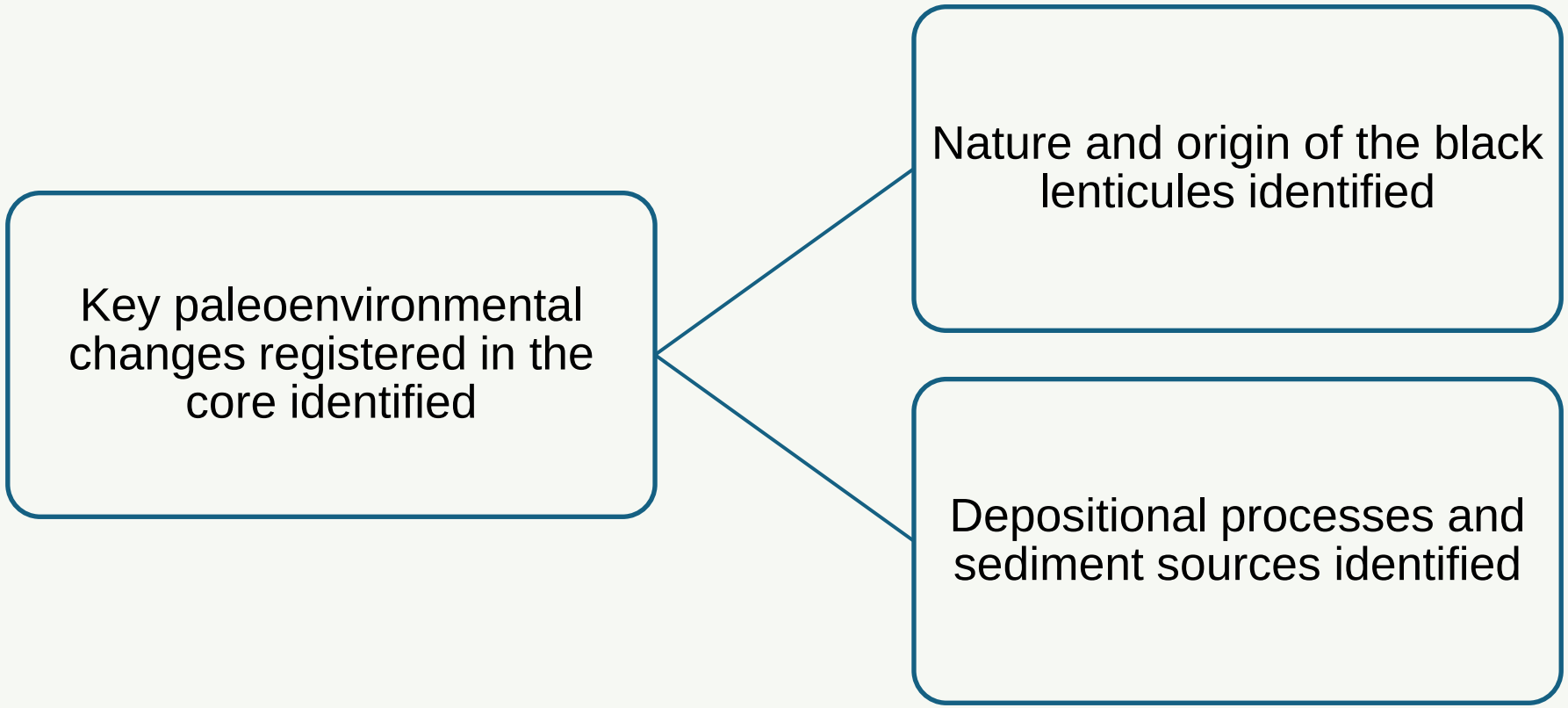


Unveiling Sedimentary Patterns



UNITS	STRUCTURES	MEAN GRAIN SIZE	TEXTURES	CARBONATES	MINERALOGY	INTERPRETATION	
D	Low bioturbation	3-4 µm	Very slightly sandy silty clay (up to 56% clay)	High (up to 40%)	**B: Planktonic foraminifera (>50%)**, and nannofossils (>40%)	**Microfossil-rich mud**	**B**
C	Rare bioturbation, **rare black lenticules**	5-6 µm	Very slightly sandy clayey silt (up to 59% silt)	Moderate (up to 25%)	**T-A: Clay minerals (>30%),** and pyrite (up to 25%), as well as OM (up to 25%)	**Clay-rich mud**	**T**
B	Rare bioturbation, **several black lenticules**	From 3 to 4.5 µm	Clayey silt (up to 57% silt)	Moderate (<30%)	**OM** (>20%), and **A**: pyrite (>20%)	**Pyritic organic-rich mud**	
A	Rare bioturbation, **dominated by black lenticules**	Up to 6,3 µm	Very slightly sandy clayey silt (up to 64% silt)	Low to moderate (down to 17%)	**T-B-A**: Clay minerals (25%), nannofossils (30%), and **pyrite (up to 40%)**	**Pyritic mud**	

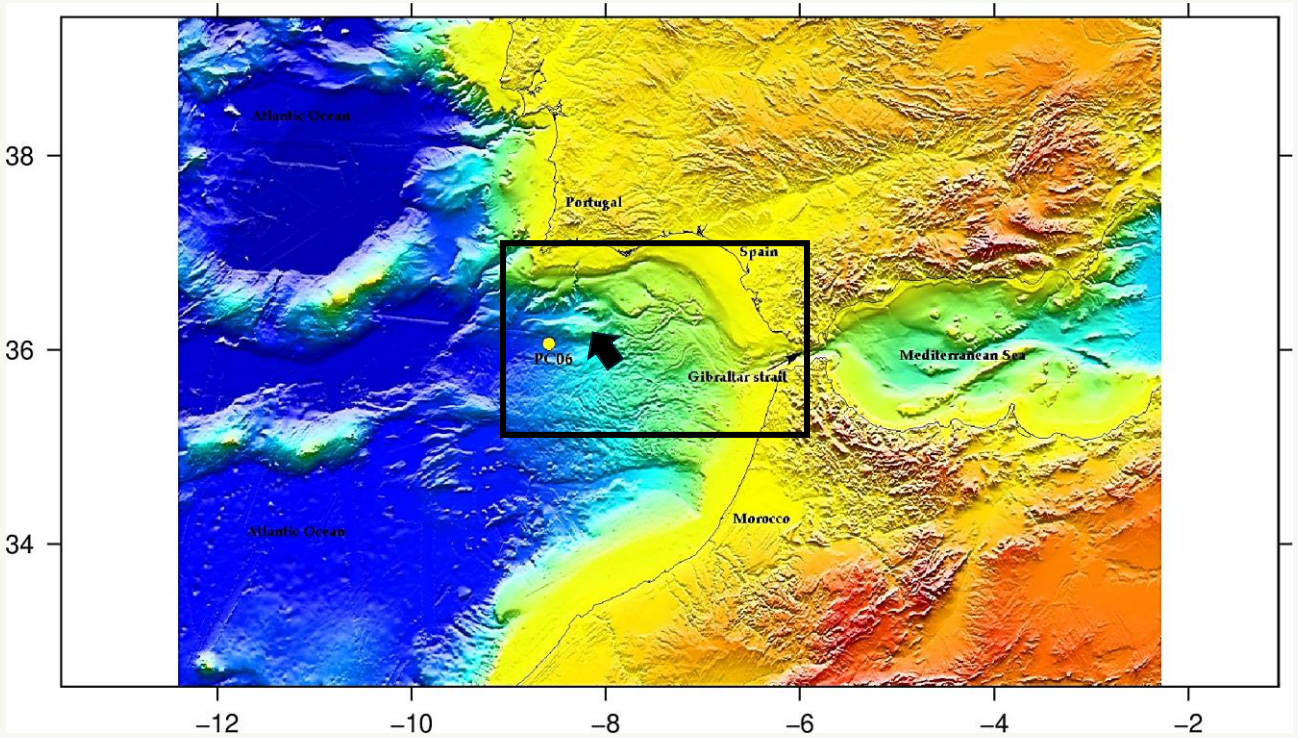
Objectives and Future Directions



NEW QUESTIONS

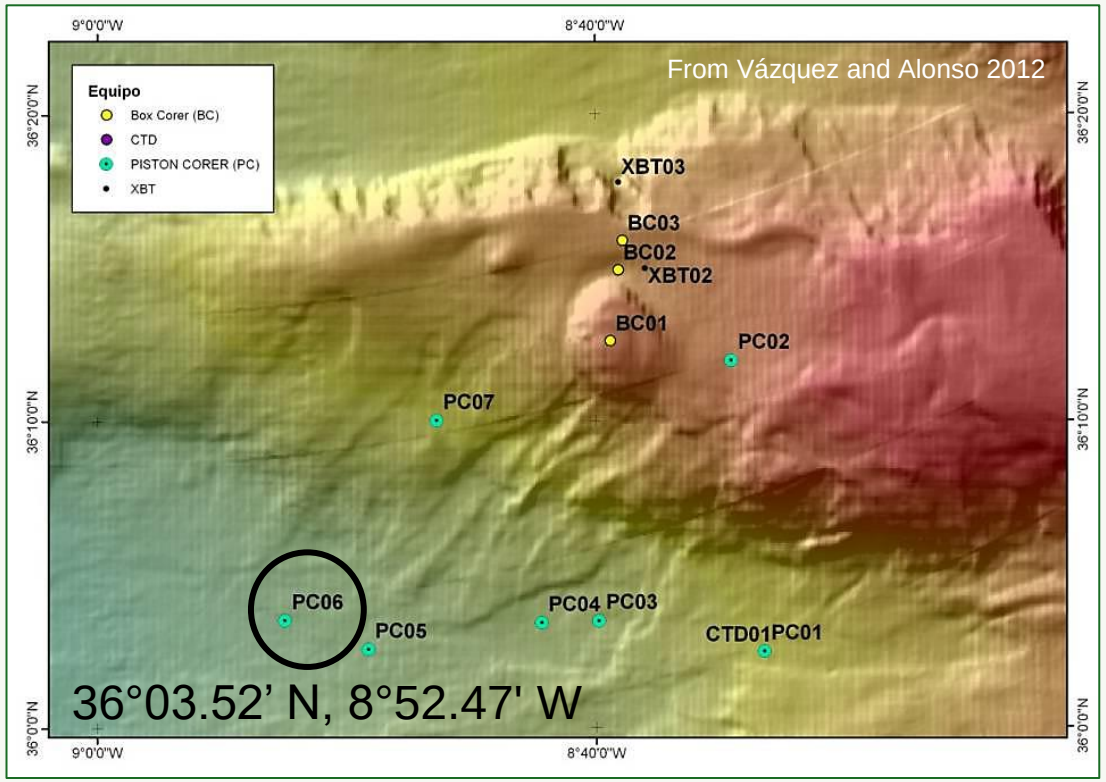
Study Area

Gulf of Cadiz



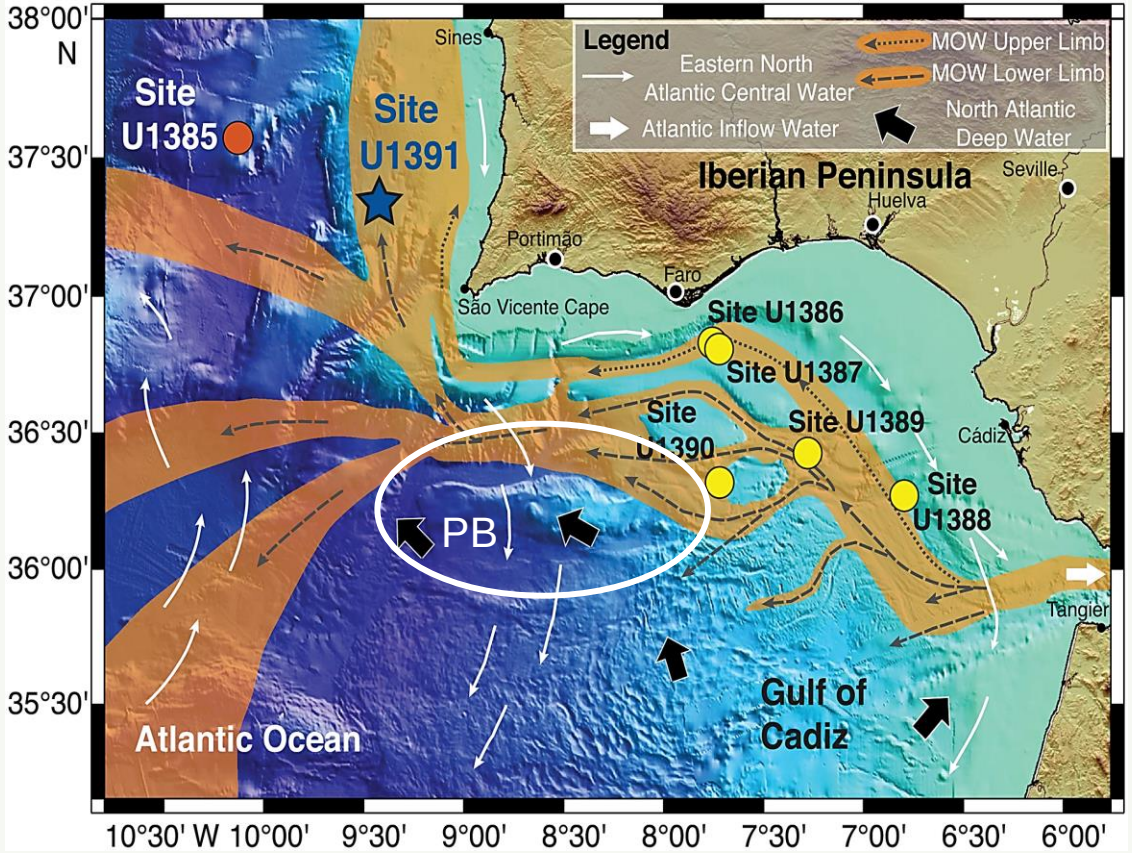
Dynamic region, hub for paleoenvironmental research.

MONTERA (CTM 2009-14157-C02 CSIC) Spanish project



Portimão Bank (PB)

Study Area



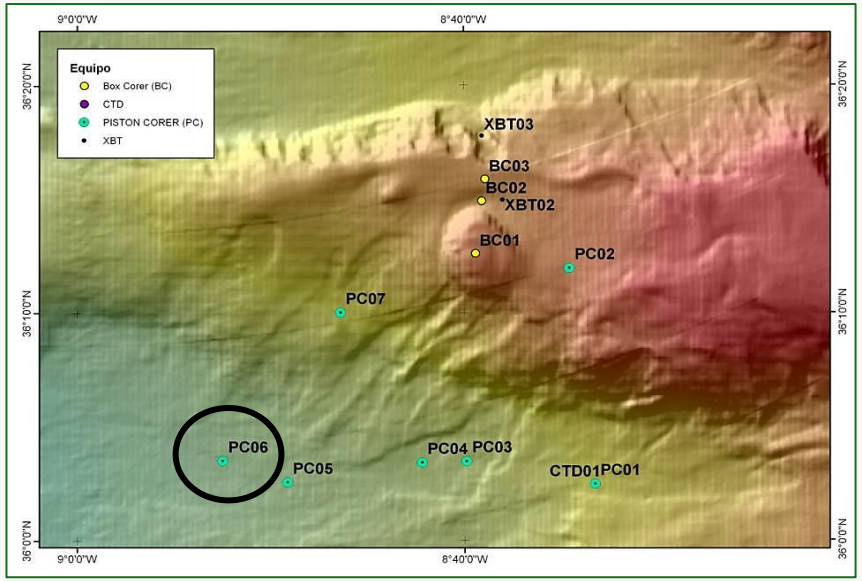
From Nichols et al. 2020

From Vázquez and Alonso 2012

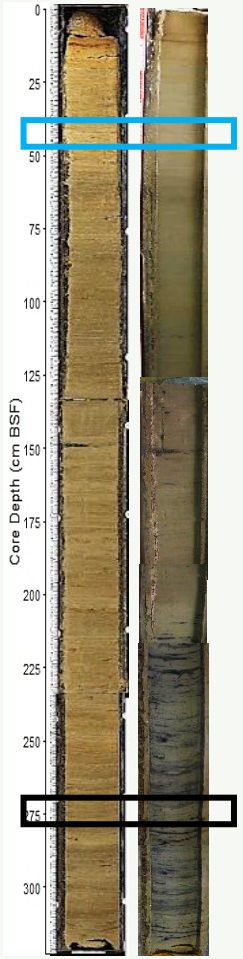
- Atlantic Ocean / Mediterranean Sea
- Current oceanographic pathways :
  - 1- Eastern North Atlantic Central Water (ENACW)
  - 2- Mediterranean Outflow Water (MOW)
  - 3- North Atlantic Deep Water (NADW)

PC06 Deep-Sea Core

- MONTERA-0412 scientific cruise
- B/O SARMIENTO DE GAMBOA
- Retrieved at 3520 m water depth

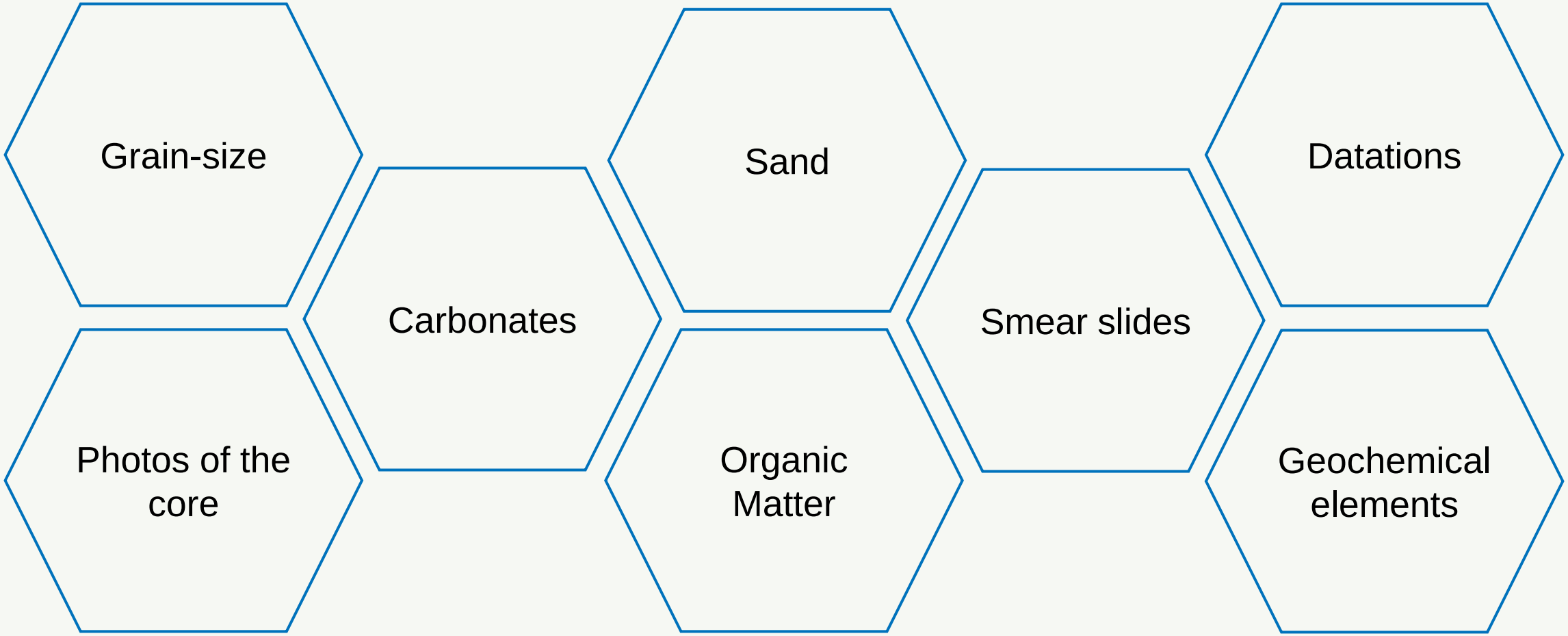


- Spans the last 49,000 years
- 324,5 cm long
- Many parts with very intense black lenticules that had not previously been studied



What's Core For ?

Multidisciplinary Approach



Sedimentological Analyses

DATA	METHOD	SAMPLING RESOLUTION	LOCATIONS	TEAM IN CHARGE	PRESENT WORK
Grain-size	Laser diffraction	55 samples	Institut de Ciències del Mar (ICM) Barcelona, Spain	MONTERA research team members	Statistical analysis, and interpretation
Carbonates	Volumetric method of Scheibler	55 samples	Instituto Português do Mar e da Atmosfera (IPMA) Tavira, Portugal	IPMA	Interpretation
Organic matter	Loss on ignition	55 samples			
Smear slides	Sampled by hand	42 samples			Grains counting, statistical analysis, and interpretation (20 samples)
Sand	Sampled by hand	16 samples		Present work	Grains counting, statistical analysis, and interpretation

Sedimentological Analyses

Malvern Mastersizer 3000

Calcimeter-Eijekelkamp

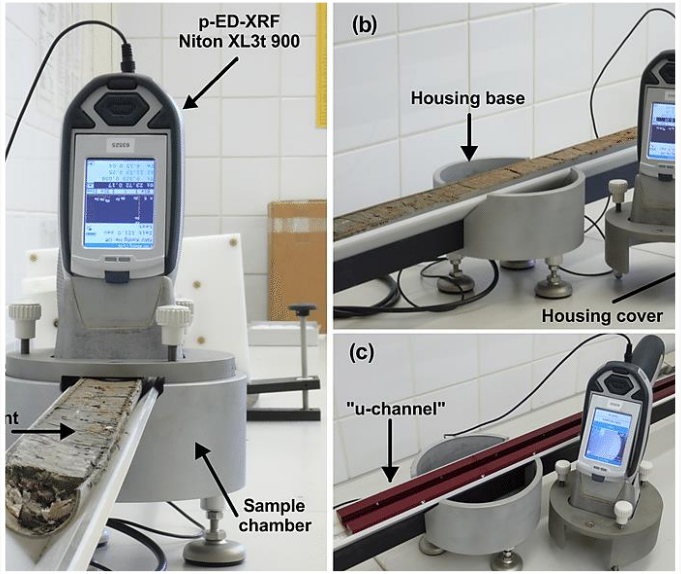
Binocular Microscope

Geochemical & Other Analyses

DATA	METHOD	SAMPLING RESOLUTION	LOCATIONS	TEAM IN CHARGE	PRESENT WORK
Photos	MSCL	High-resolution photographs	On board B/O SARMIENTO DE GAMBOA	MONTERA research team members	Imagery analysis, and interpretation
Geochemical contents	XRF	4890 measurements	CORELAB Barcelona University, Spain		Interpretation
Datations	From ^{14}C	5 samples	Barcelona's Poznań Radiocarbon Laboratory	Age-depth model realised at IPMA Algés	Interpretation

Geochemical & Other Analyses

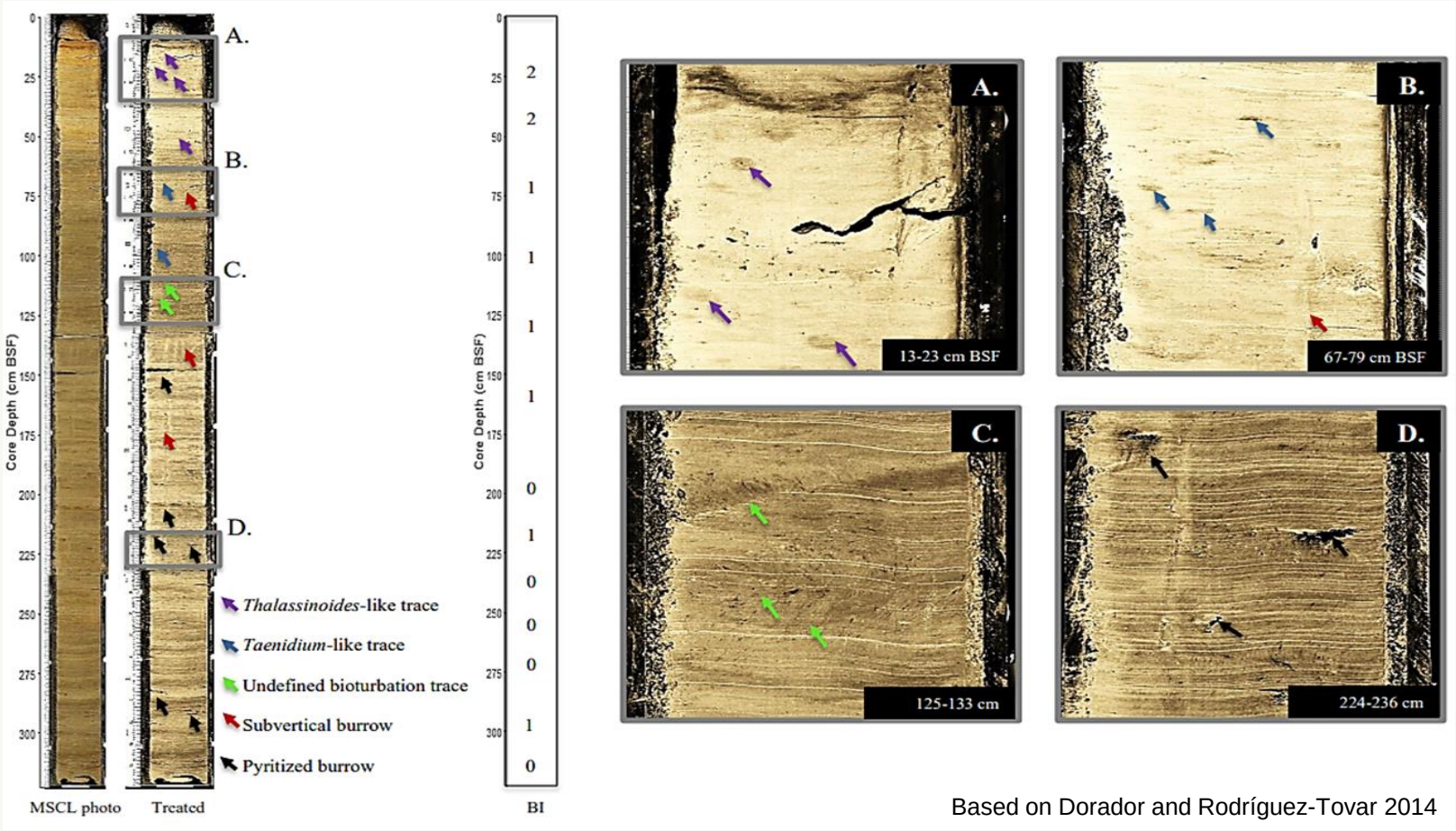
Geotek MSCL



XRF

From Hoelzmann et al. 2017

Key Findings



Based on Dorador and Rodríguez-Tovar 2014

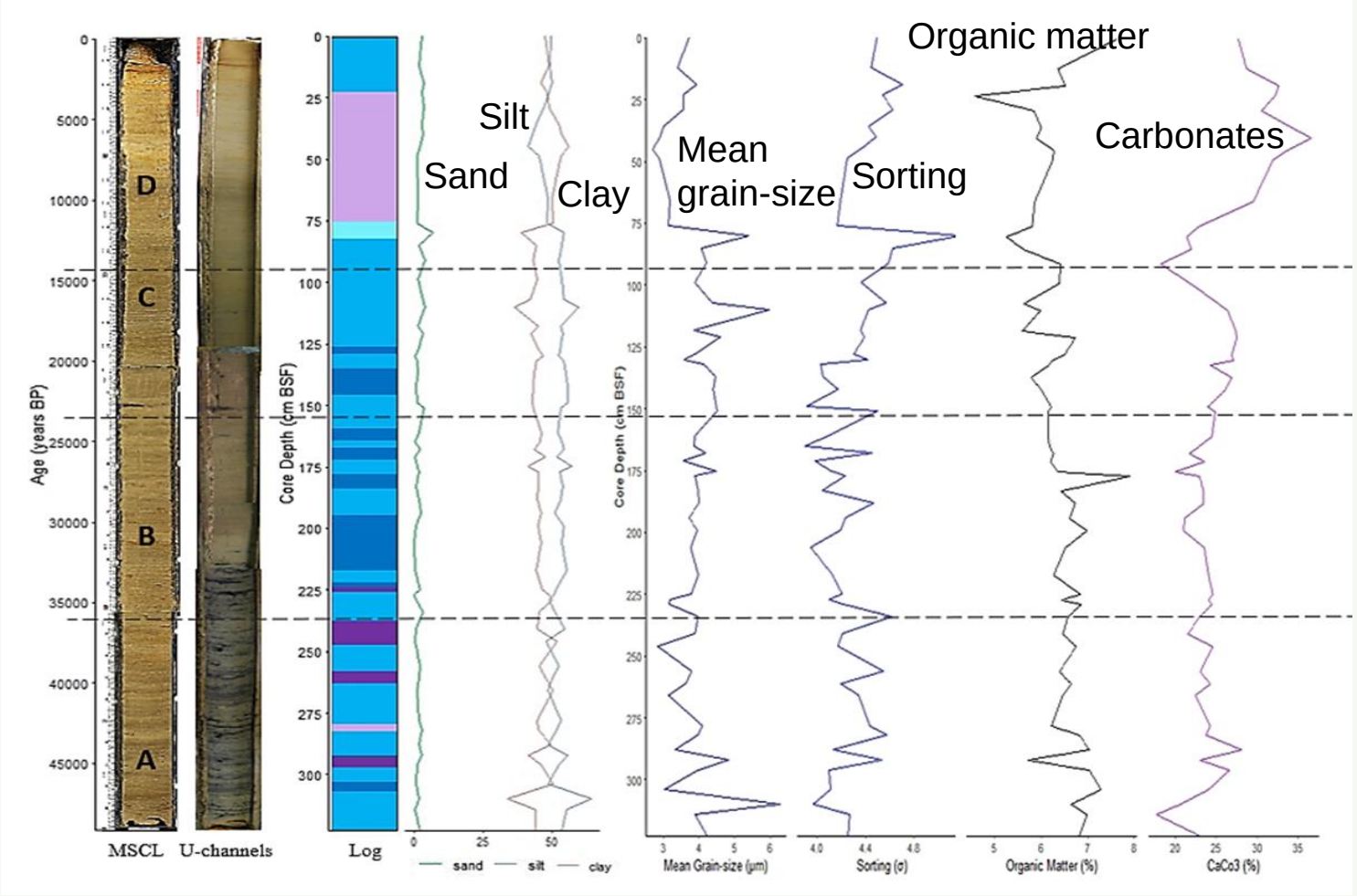
Trace fossils

Bioturbation index (BI) card

Bioturbated sediment	BI	Description	Sectional view
0%	0	Bioturbation absent	
1%–5%	1	Rare bioturbation, bedding boundaries distinct, very few discrete traces	
6%–30%	2	Low bioturbation, bedding boundaries distinct, low trace density	
31%–60%	3	Moderate bioturbation, bedding boundaries mostly intact, traces disctrete, overlap uncommon	
61%–90%	4	High bioturbation, bedding boundaries mostly destroyed, high trace density, overlap common	
91%-99%	5	Intense bioturbation, bedding completely disturbed (barely visible)	
100%	6	Complete bioturbation, traces hard to identify due to repeated reburrowing, very few discrete traces	

From Gani 2020

Key Findings

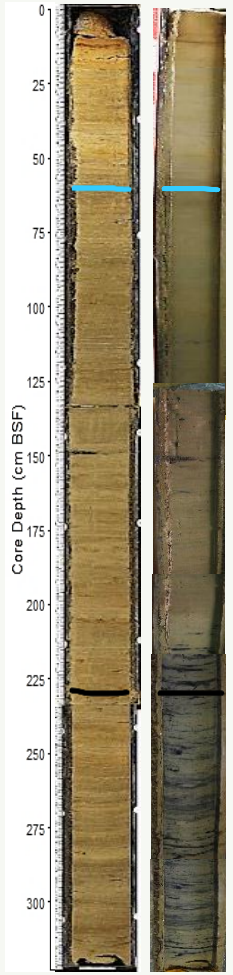


Sedimentological characteristics

- Average of the mean grain-size : 3,99 µm (clay size)
- Made up of mud, 52% silt and 46% clay

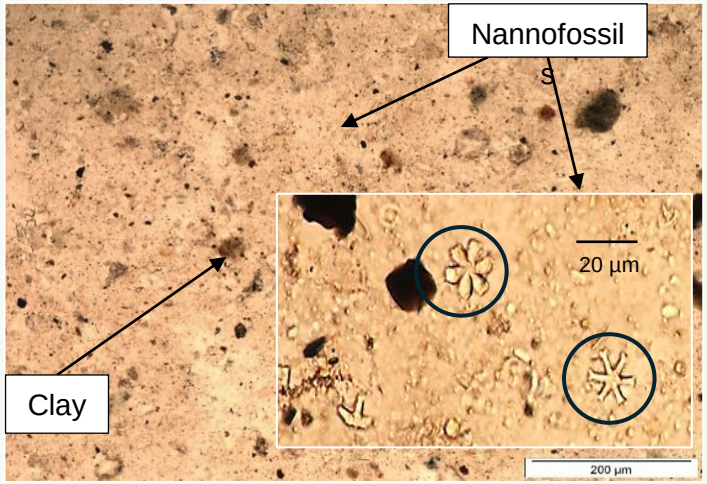
e.g., “geometric method of moments” (in µm) and Blott and Pye (2012) particle size classification

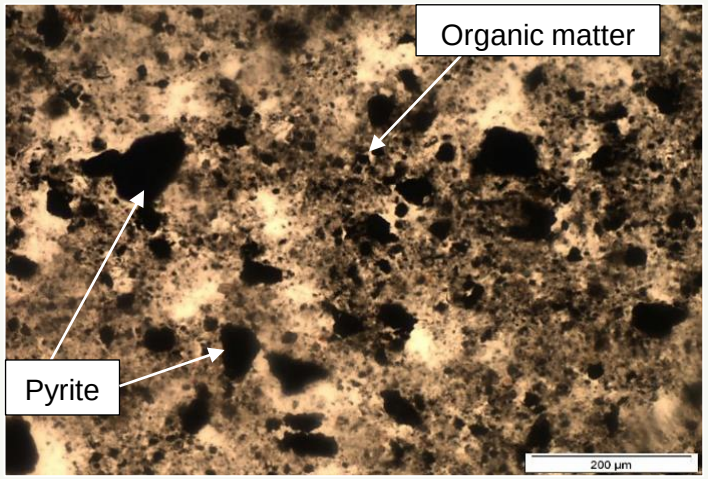
Key Findings



64,6 cm

228,5 cm

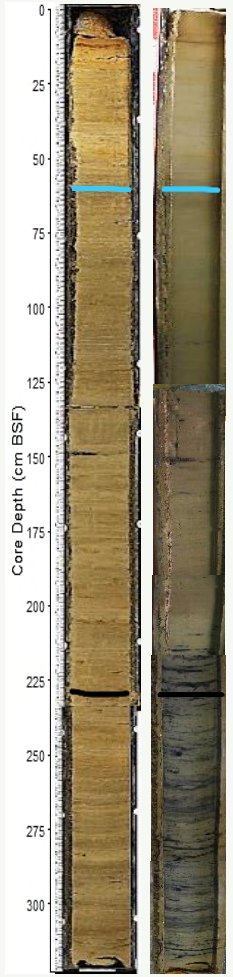




Mineralogy - Smear slides

Components (smear slides)			Average (%)			
			Background sediments		**Black lenticules**	
Terrigenous	**Clay**	Biotite	29	**48**	13	**32**
		Chlorite				
	Quartz		10		7	
	Feldspar		4		3	
	Opaque grains		5		0	
	Heavy minerals		0		9	
Biogenic	**Nannofossils**		44	**46**	10	15
	Foraminifera		2		5	
	Sponge spicule		0		0	
Authigenic	**Pyrite**		1	1	26	**34**
	Fe oxides		0		6	
	Glauconite		0		2	
Organic matter			5		19	

Key Findings



64,6 cm

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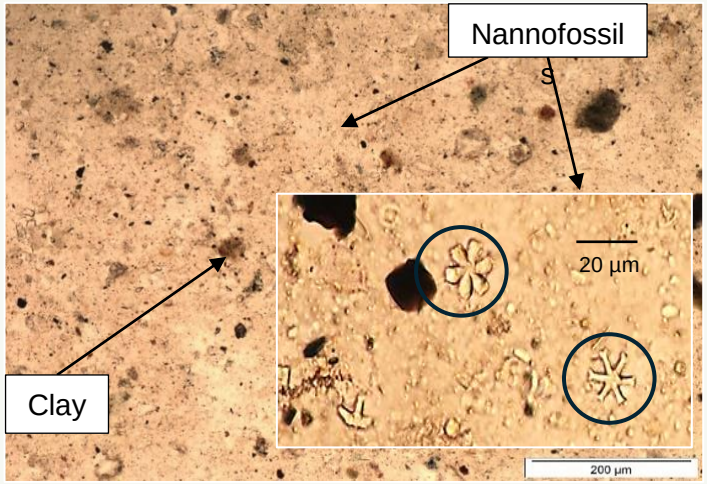
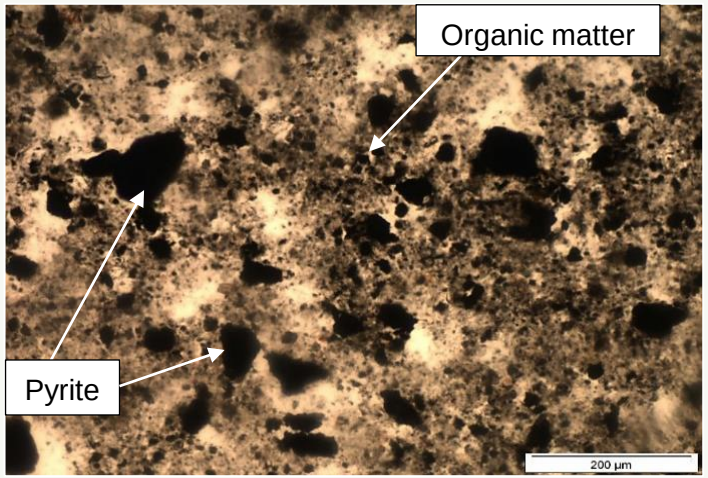
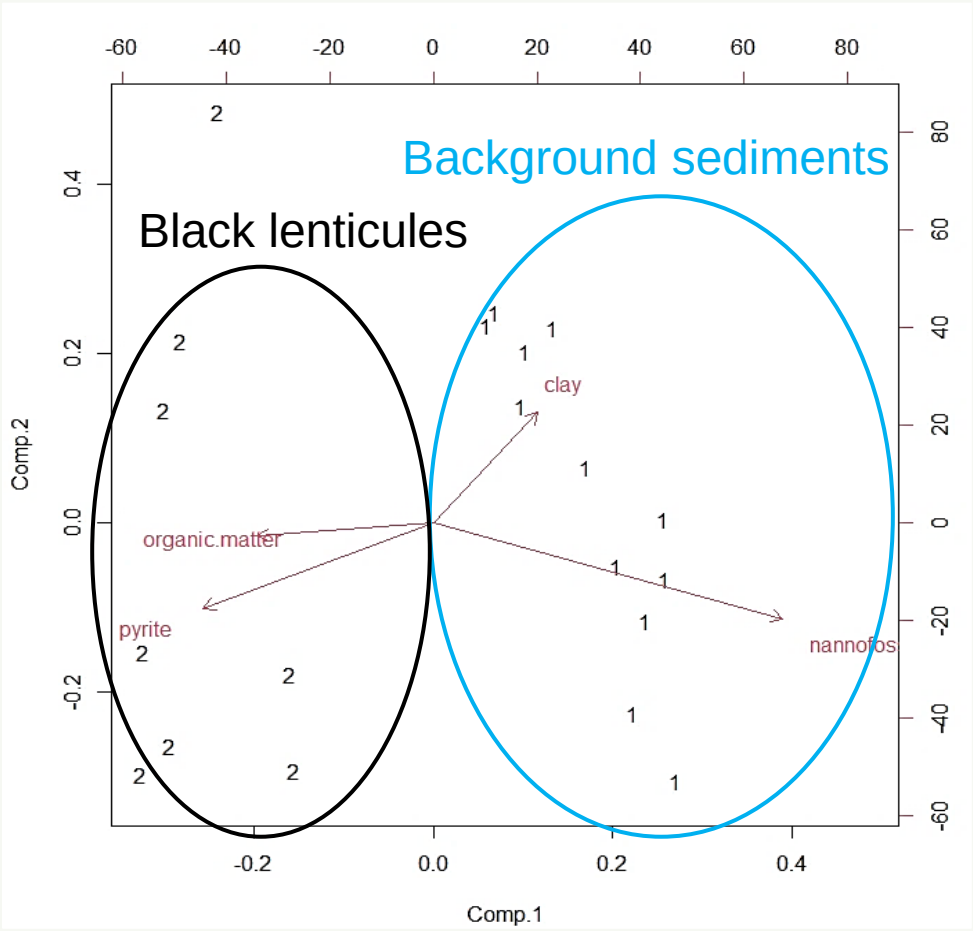


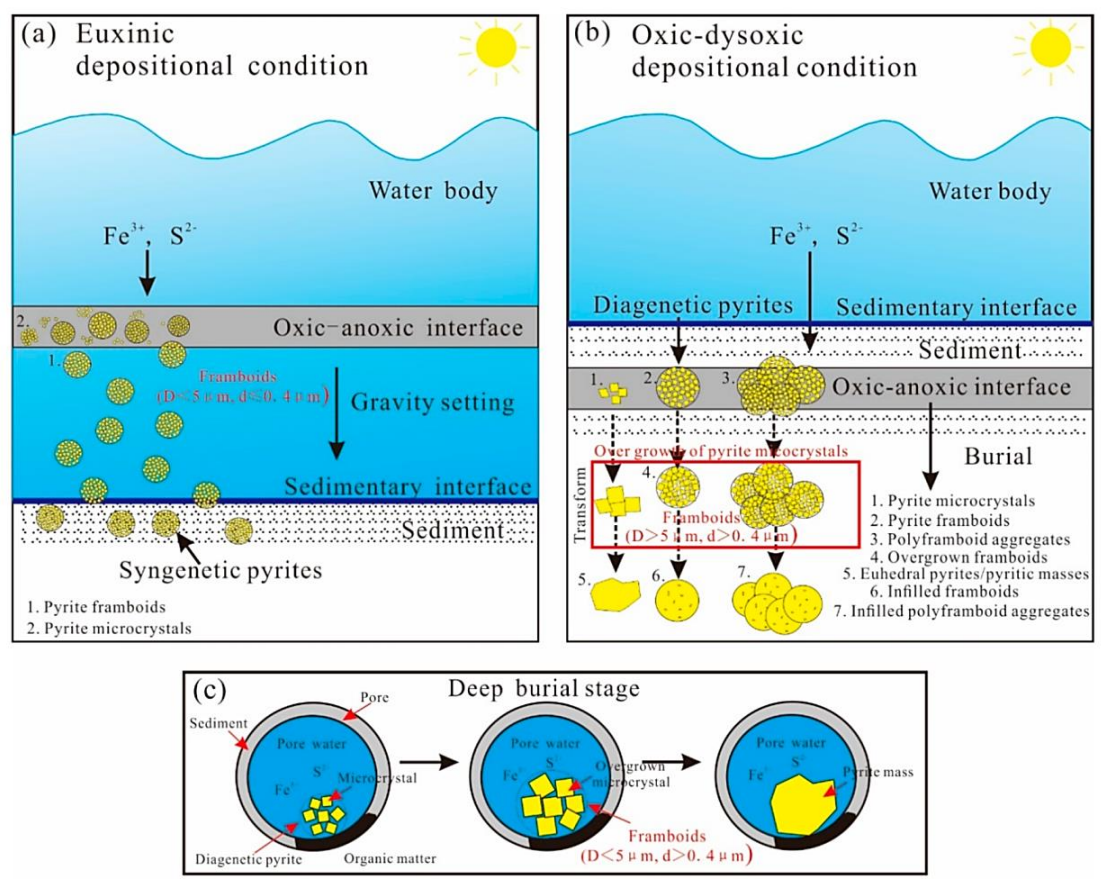




Mineralogy - Smear slides

Clustering analysis – k mean

Key Findings



From Liu et al. 2019

Presence of Euhedral Pyrite

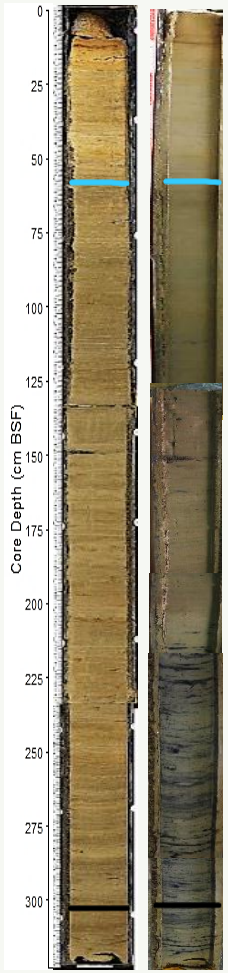
1- Decomposition of organic matter

2- Generation of hydrogen sulphide

3- Pyrite precipitation

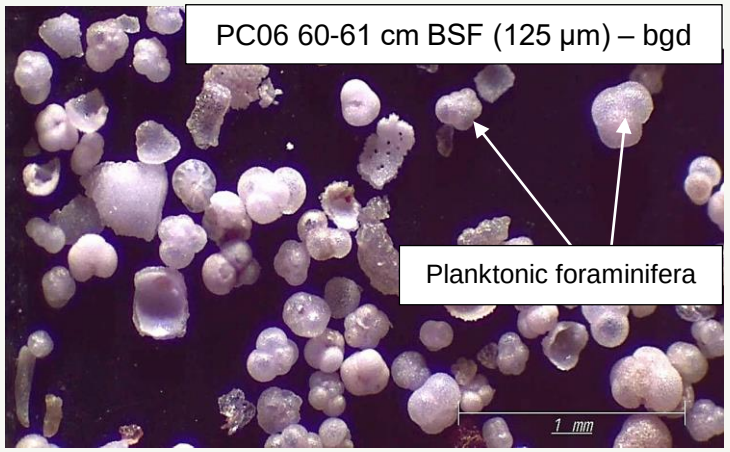
Low oxygen conditions

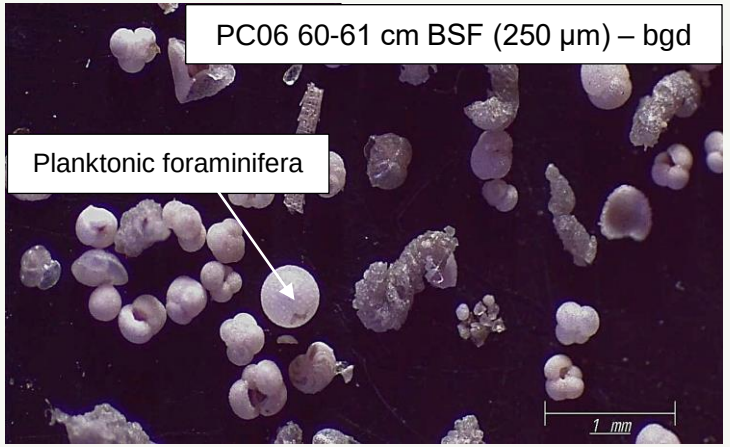
Key Findings

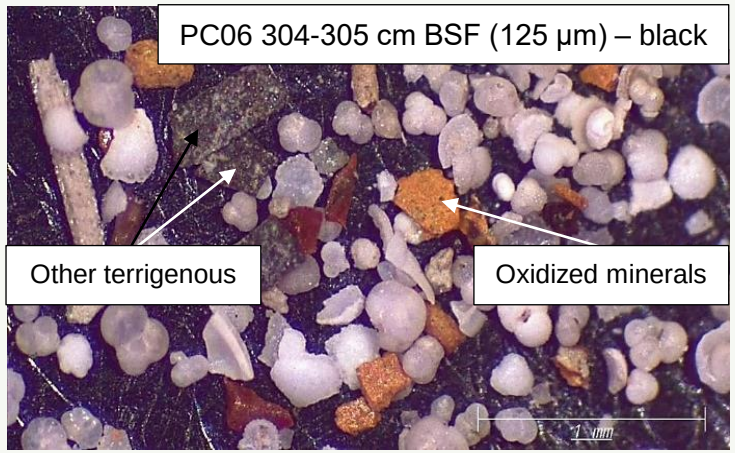


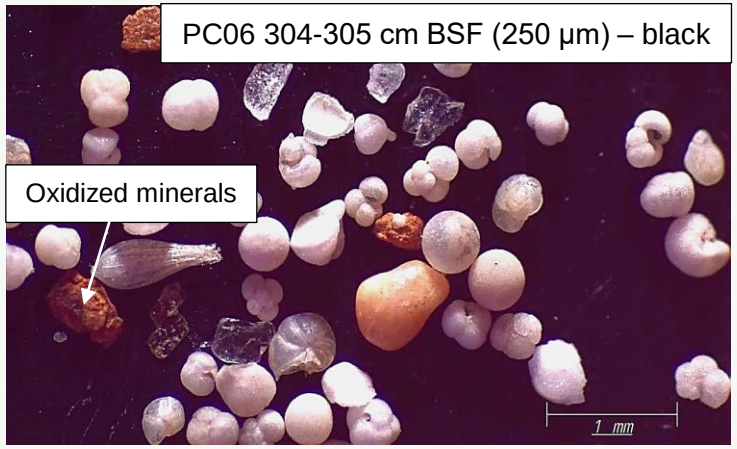
60-61 cm

304-305 cm



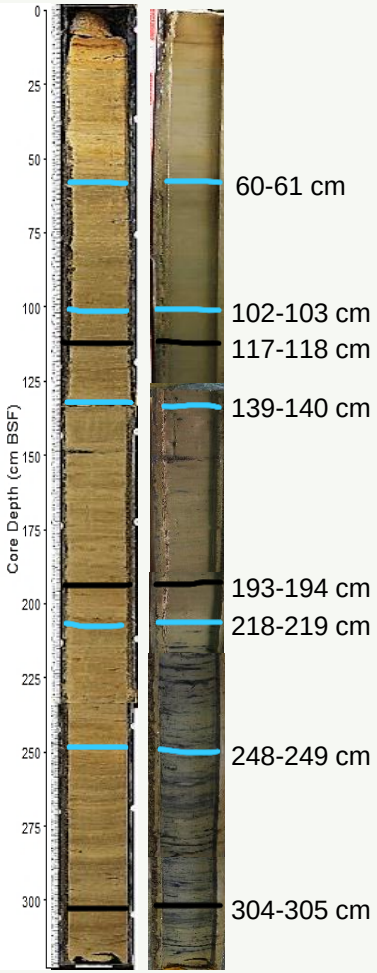




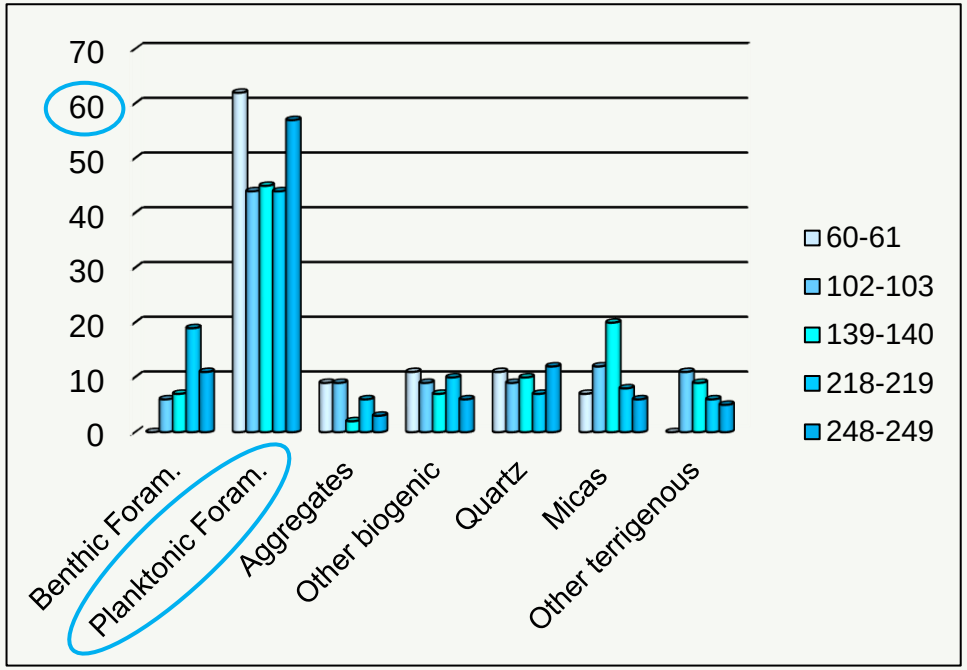


Mineralogy Sand

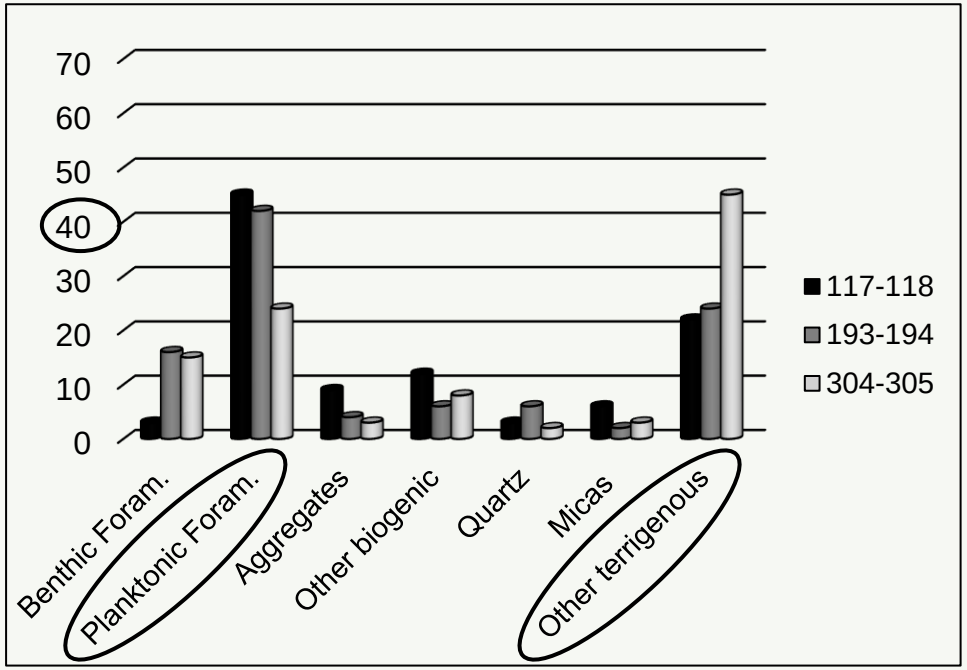
Key Findings



Mineralogy - Sand

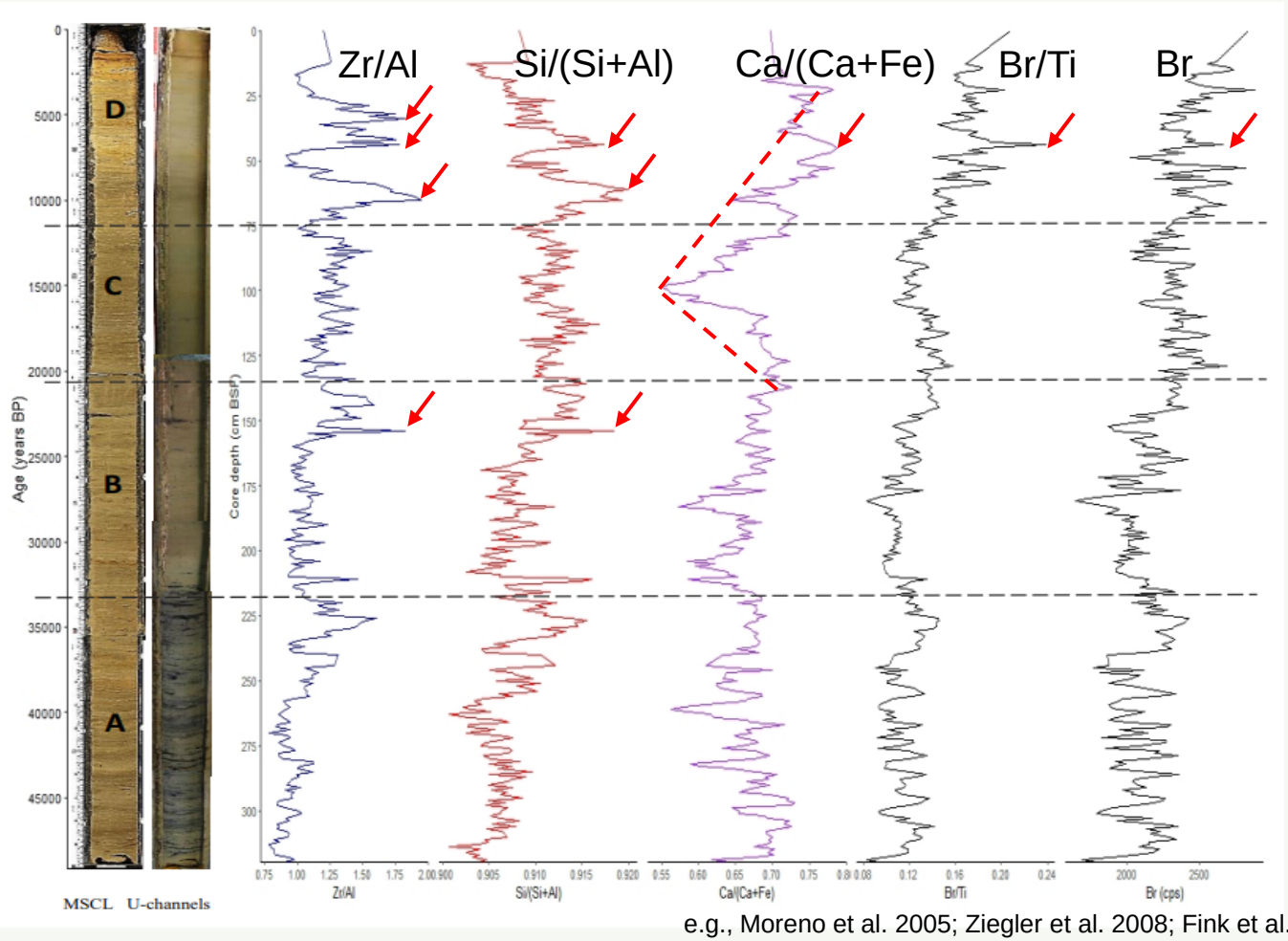


Background sediments



Black lenticules

Key Findings



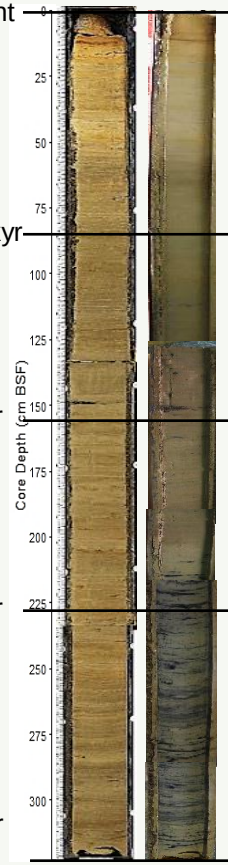
Geochemical proxies

- Zr/Al ratio : bottom current indicator
- Si/(Si+Al) ratio : dry/wet conditions
- Ca/(Ca+Fe) ratio : paleoproductivity indicator
- Br/Ti ratio : marine organic matter accumulation indicator
- Br : marine organic carbon contents indicator

N.B. Al : Aluminium, Br : Bromine, Ca : Calcium, Fe : Iron, Ti: Titanium and Zr : Zirconium.

e.g., Moreno et al. 2005; Ziegler et al. 2008; Fink et al. 2013; López-González et al. 2013; Bahr et al. 2014; Rothwell and Croudace 2015; Stow et al. 2018

Unveiling Sedimentary Patterns



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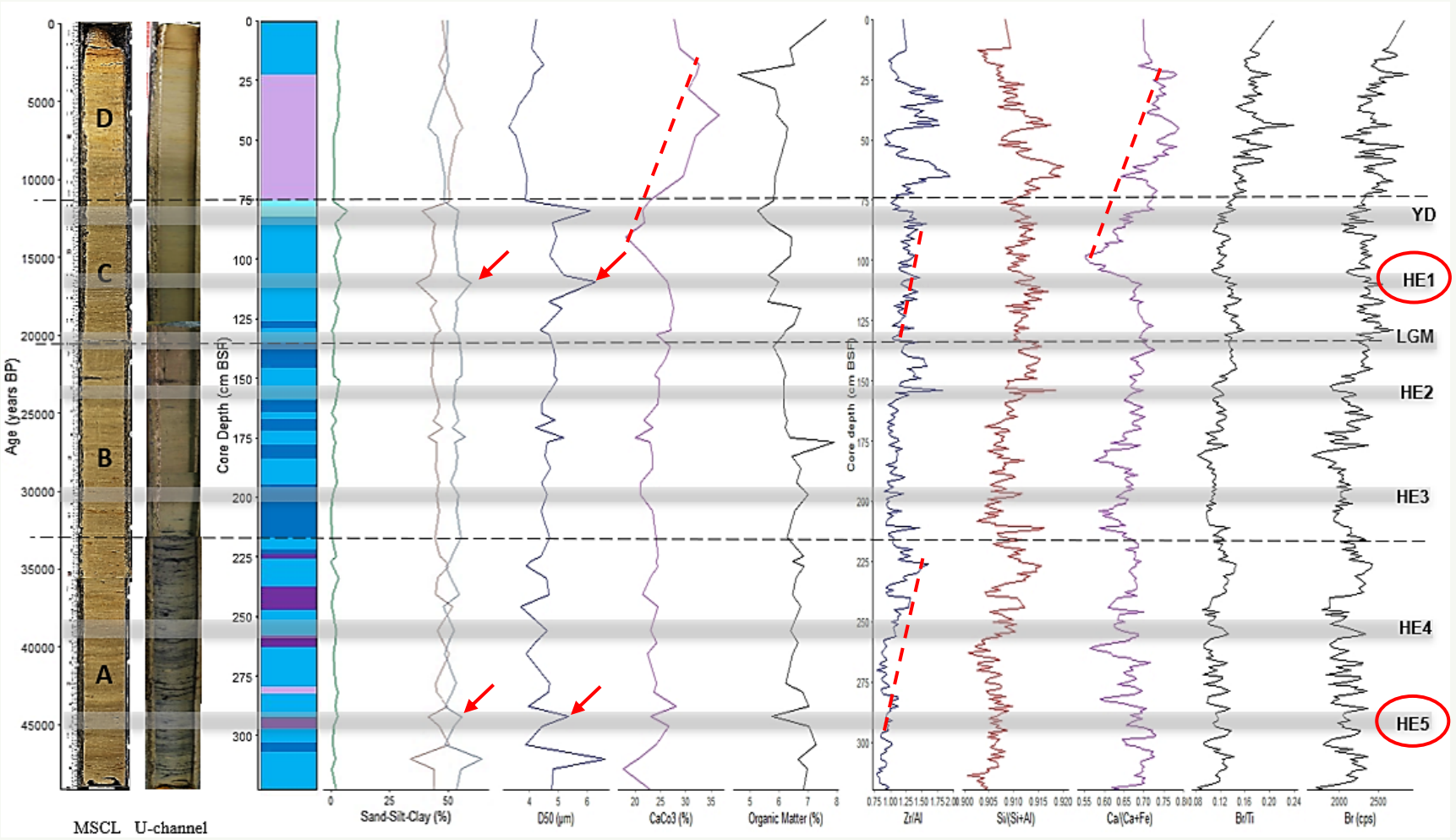
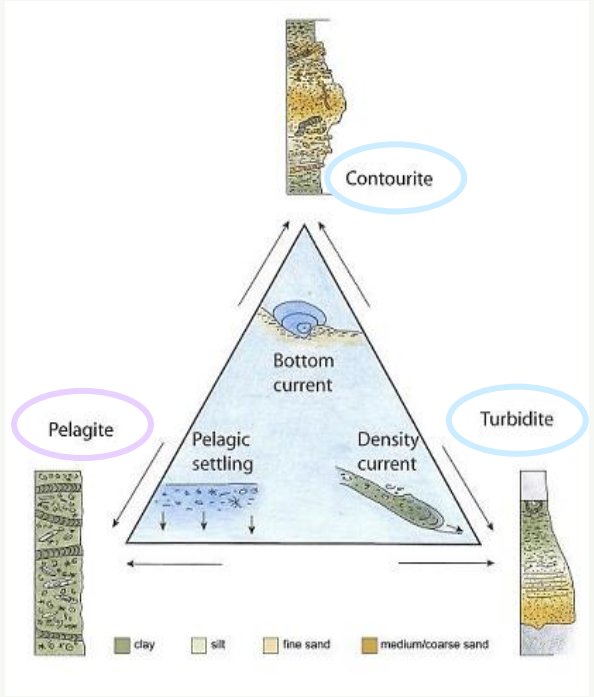


B

T



From Rogerson et al. 2014

Final Remarks

Variations in the environmental changes at two different temporal scales:

i. from the glacial (A to C) to interglacial (D) periods;

ii. a short-scale local variations during the A to C unit sedimentation related to the presence of pyrite.

NEW QUESTIONS !!

Limits ?

Time

Resolution

Acknowledgements

To my supervisors, Prof[a]. Dr. Cristina Veiga-Pires, Dr. Gemma Ercilla and Dr. Teresa Drago;

To all the scientists involved in this work, especially, Prof. Dr. Paulo Fernandes, Dr. Filipa Naughton and Dr. Cristina Roque;

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To the University of Algarve (UAlg);

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