High-resolution integrated stratigraphy of the Hauterivian in Umbria-Marche (Central Italy)

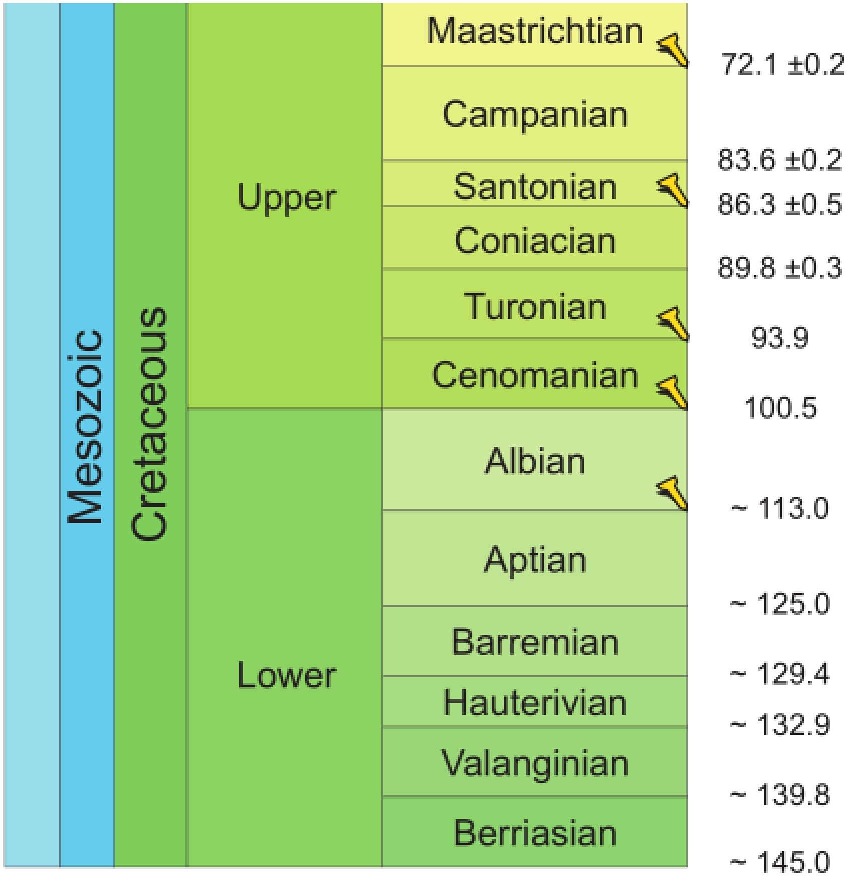
Sébastien Wouters, Sara Satolli, Mathieu Martinez, Johann Schnyder, Frédéric Boulvain, Thomas Goovaerts, Bruno Meyvis & Xavier Devleeschouwer

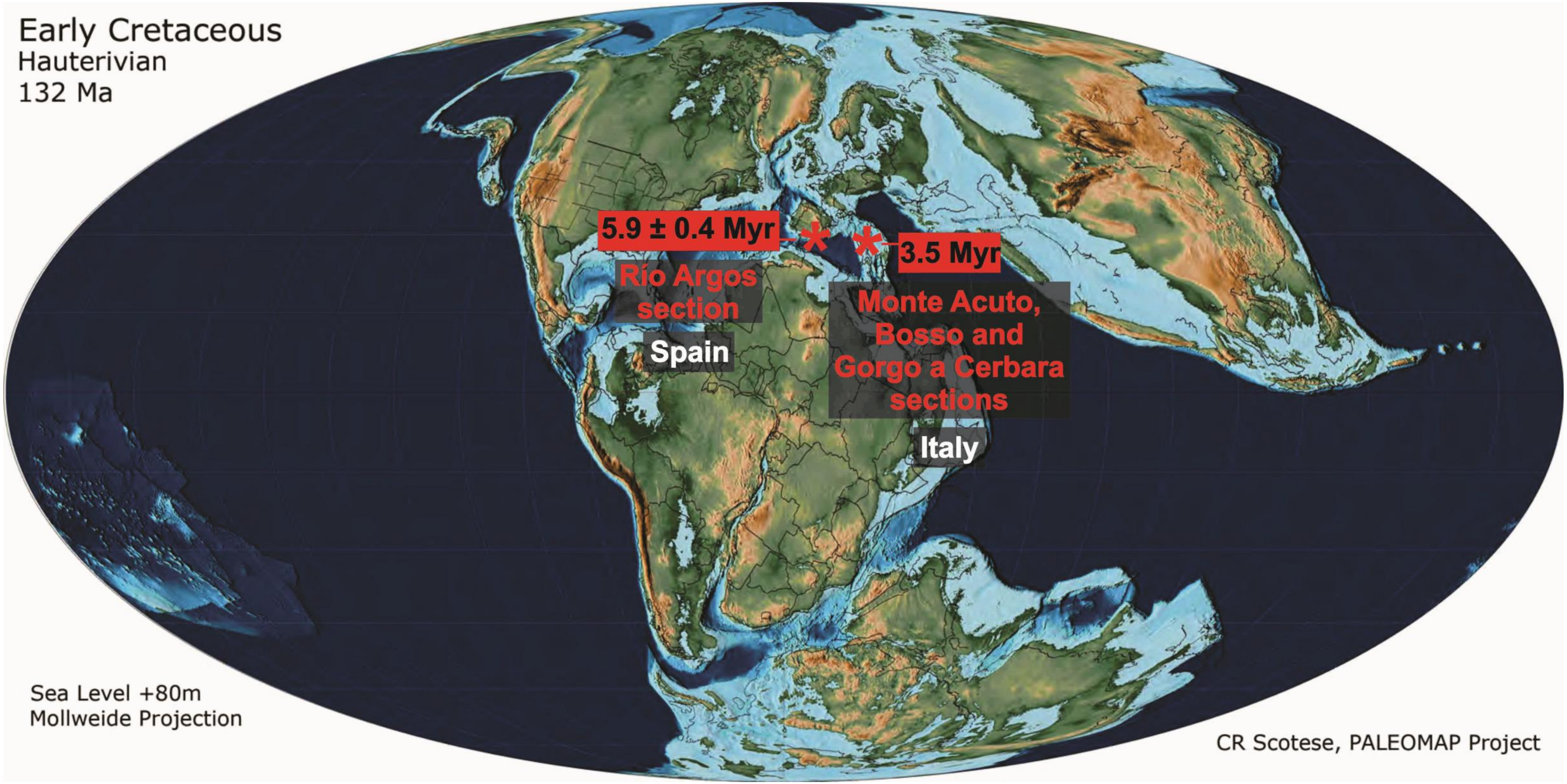
STRATI 2019 2nd -5th July

Introduction

- The **CRASH** project:

Checking the **R**eproducibility of **As**trochronology in the **H**auterivian




Early Cretaceous
Hauterivian
132 Ma
5.9 ± 0.4 Myr
Río Argos section
Spain
3.5 Myr
Monte Acuto, Bosso and Gorgo a Cerbara sections
Italy
Sea Level +80m
Mollweide Projection
CR Scotese, PALEOMAP Project

Introduction

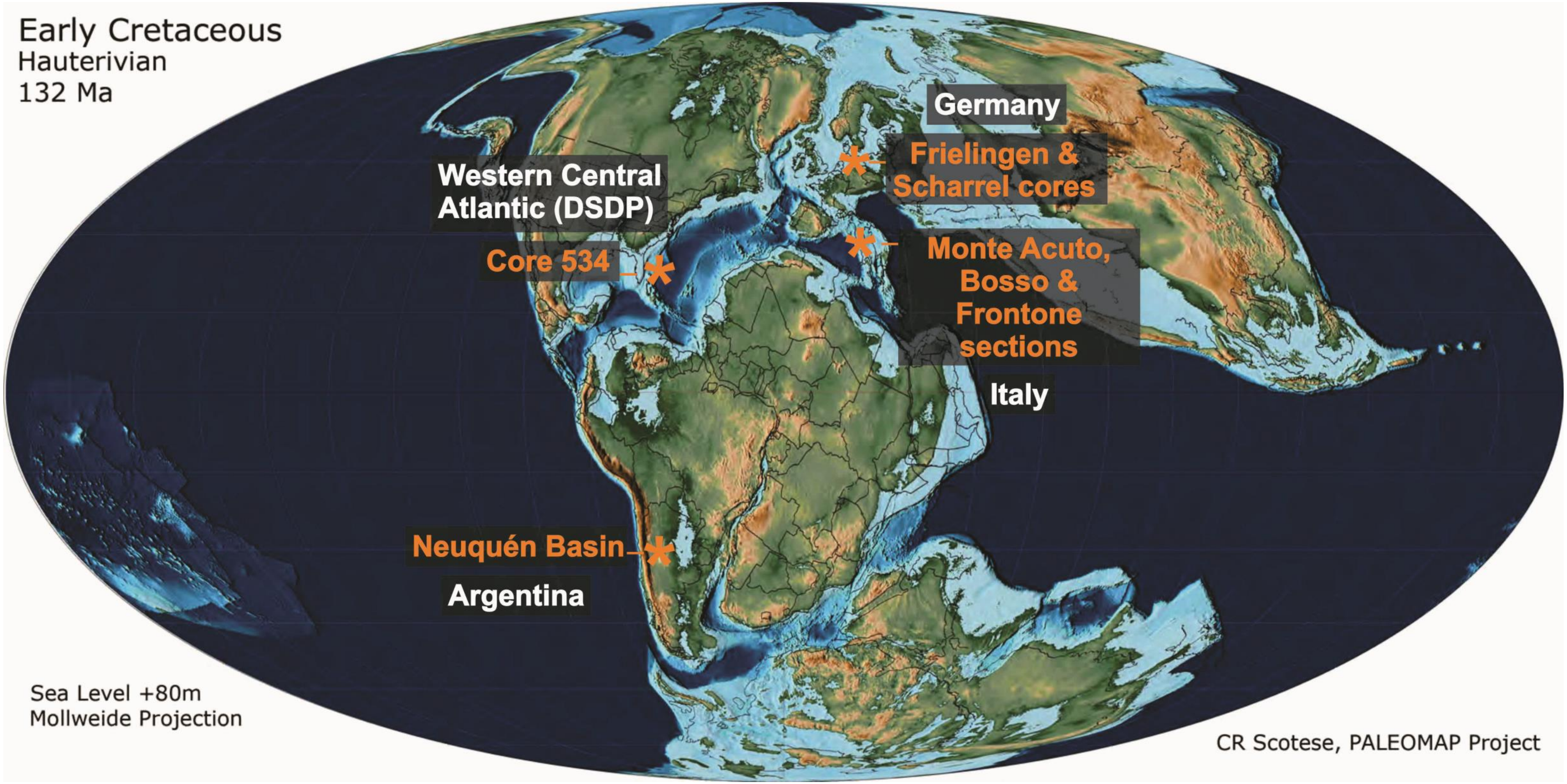
- The **CRASH** project:

Checking the **R**eproducibility of **As**trochronology in the **H**auterivian

- Discrepancy of astrochronological duration of the Stage:

  - **5.9 ± 0.4 Myr** in Río Argos (Spain)

  - **3.5 Myr** in Italian sections (Bosso and Monte Acuto)



Early Cretaceous
Hauterivian
132 Ma
Germany
Frielingen & Scharrel cores
Western Central Atlantic (DSDP)
Core 534
Monte Acuto, Bosso & Frontone sections
Italy
Neuquén Basin
Argentina
Sea Level +80m
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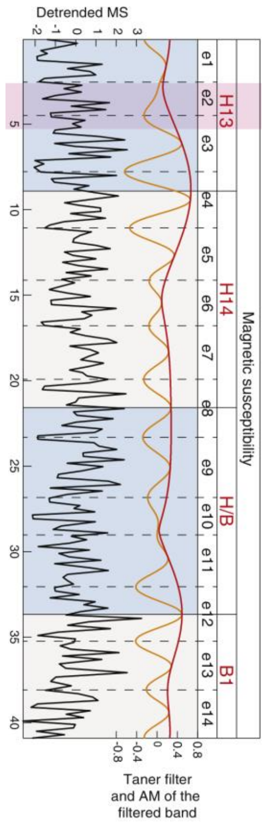
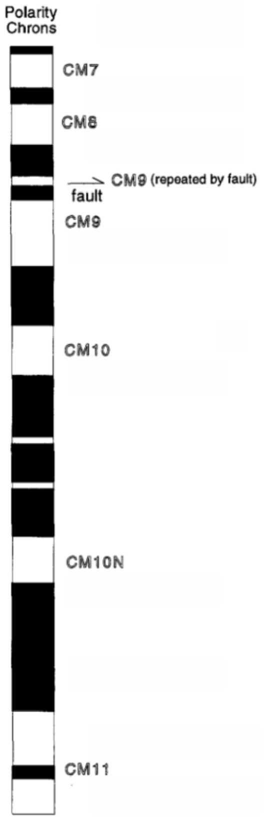


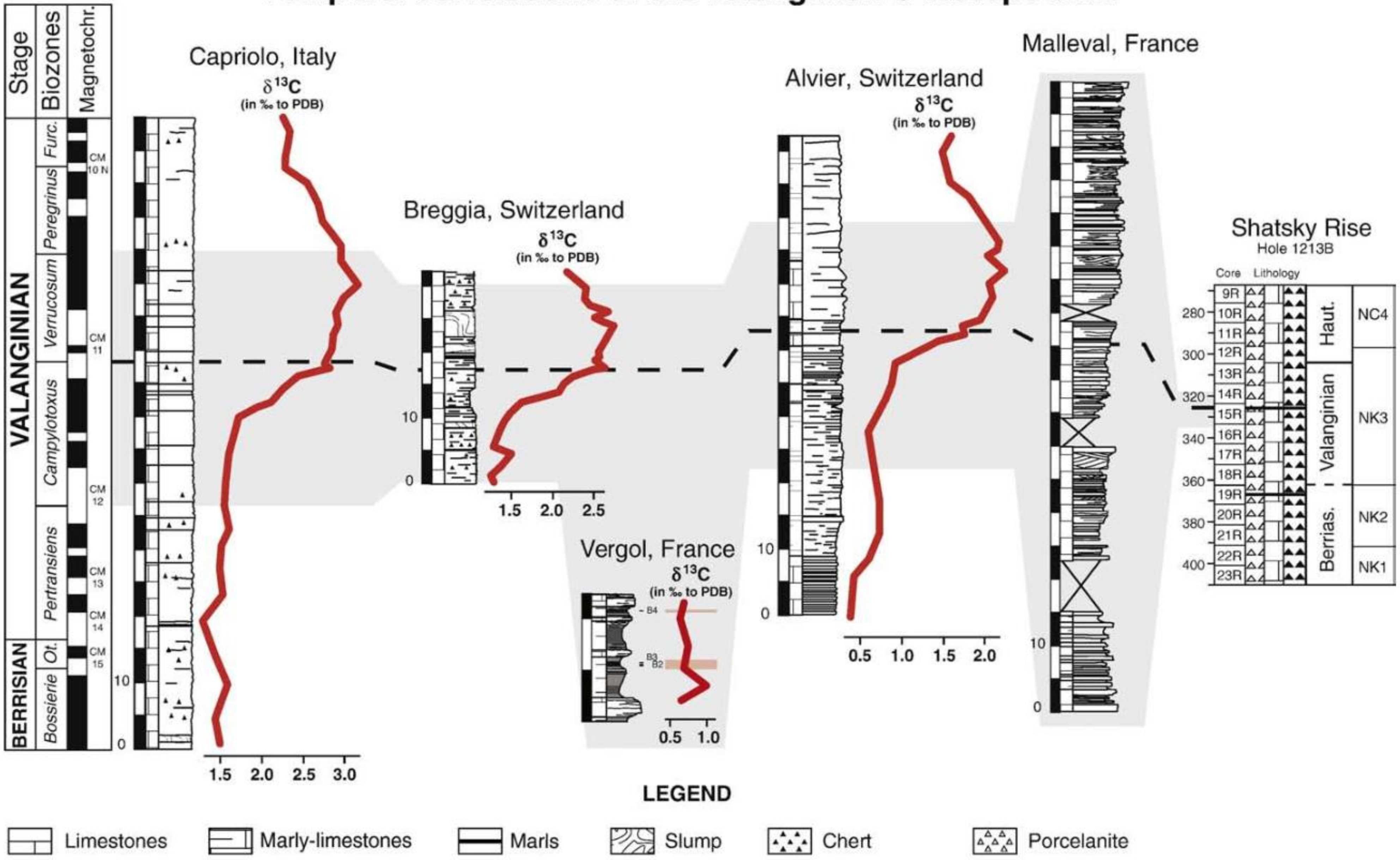
Spain

Examples of cyclo- and magnetostratigraphy in the Hauterivian (Channell et al., 1995, Martinez et al., 2015)



Italy

Temporal correlations of the Valanginian C-isotope shift



(Westermann et al., 2010)

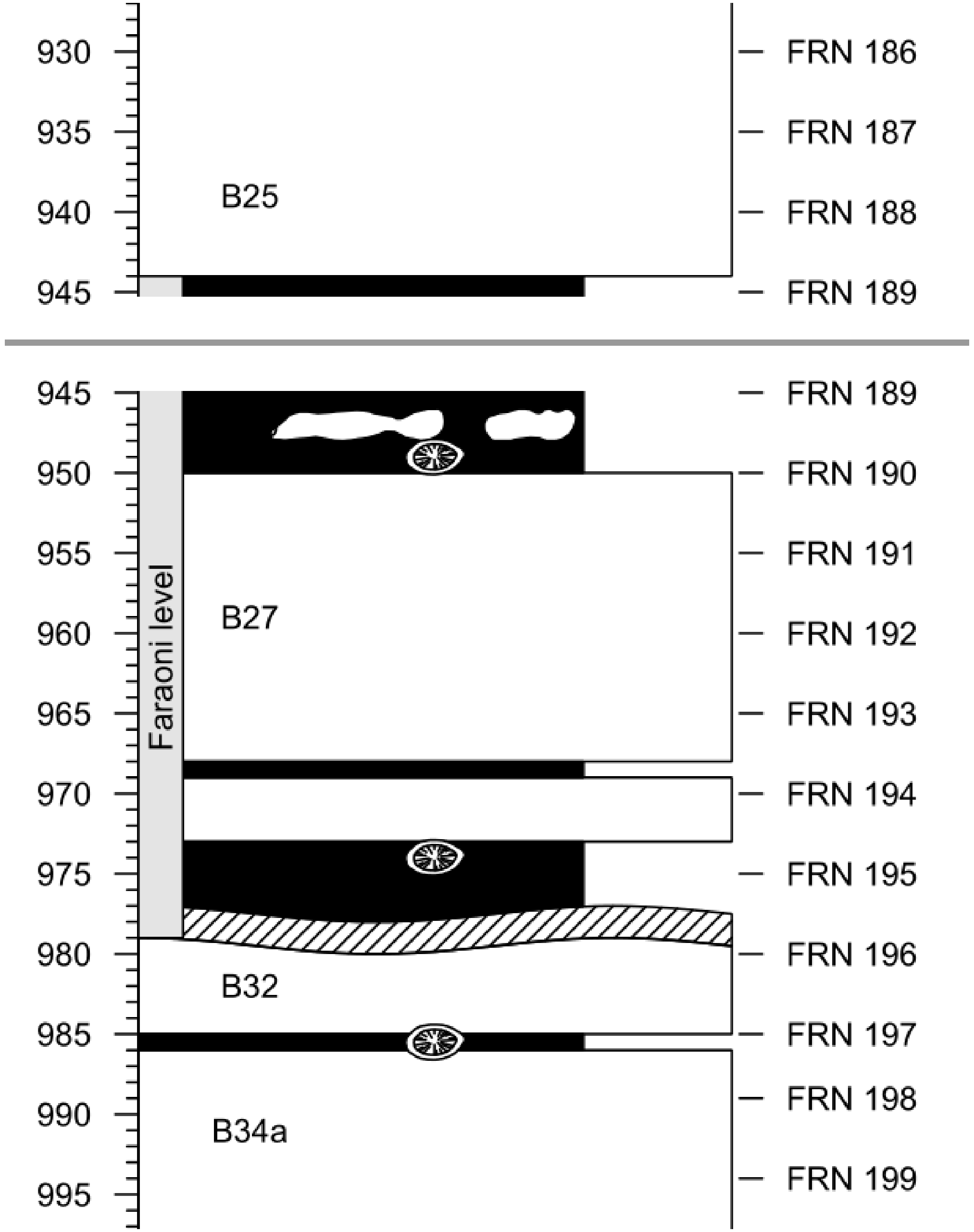
StratigrapheR

StratigrapheR: Integrated Stratigraphy

Version:	0.0.6
Depends:	R (≥ 3.5.0)

https://CRAN.R-project.org/package=StratigrapheR

- R package available on the Comprehensive R Archive Network (**CRAN**)
- Entirely **open source**
- Implements R functions for integrated stratigraphy, to be used in **combination of base R functions**



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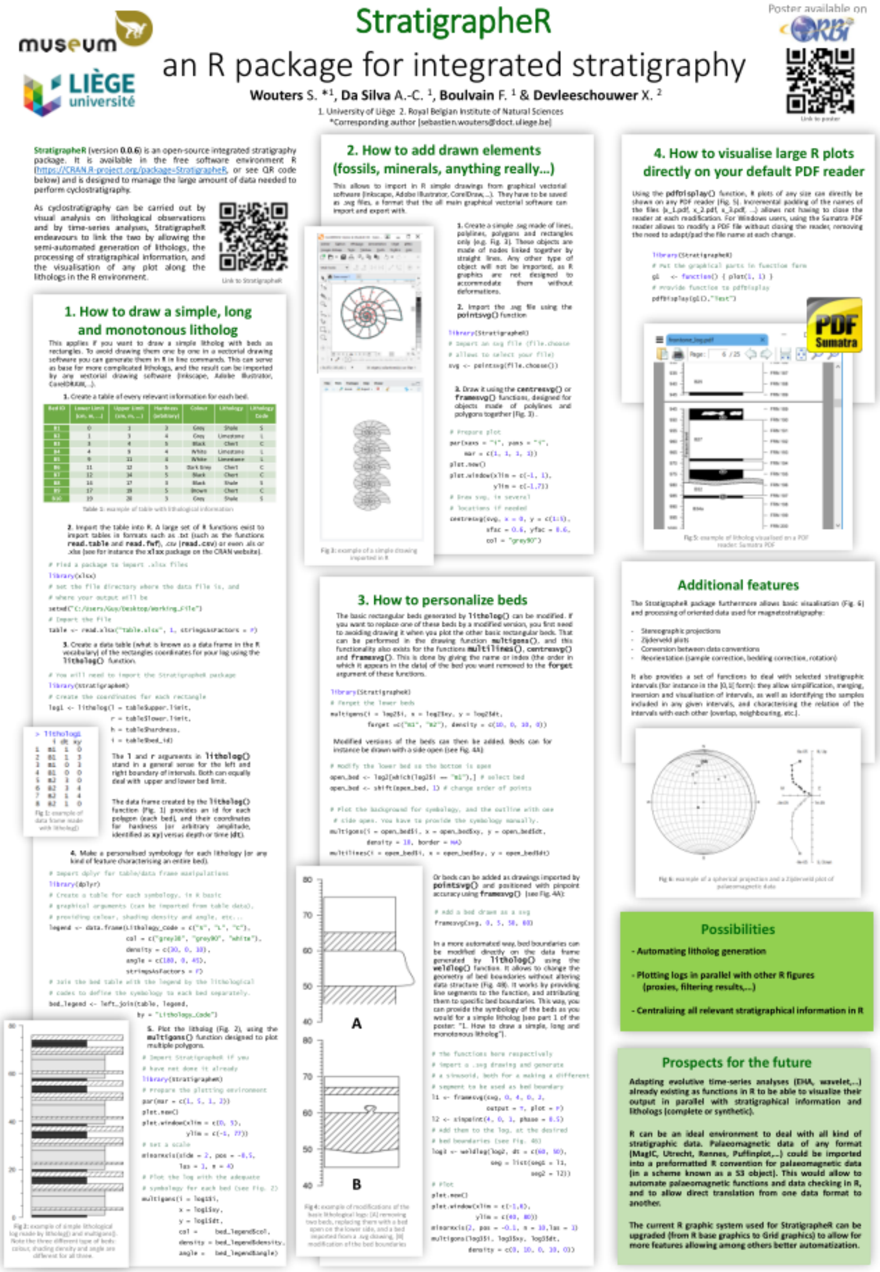
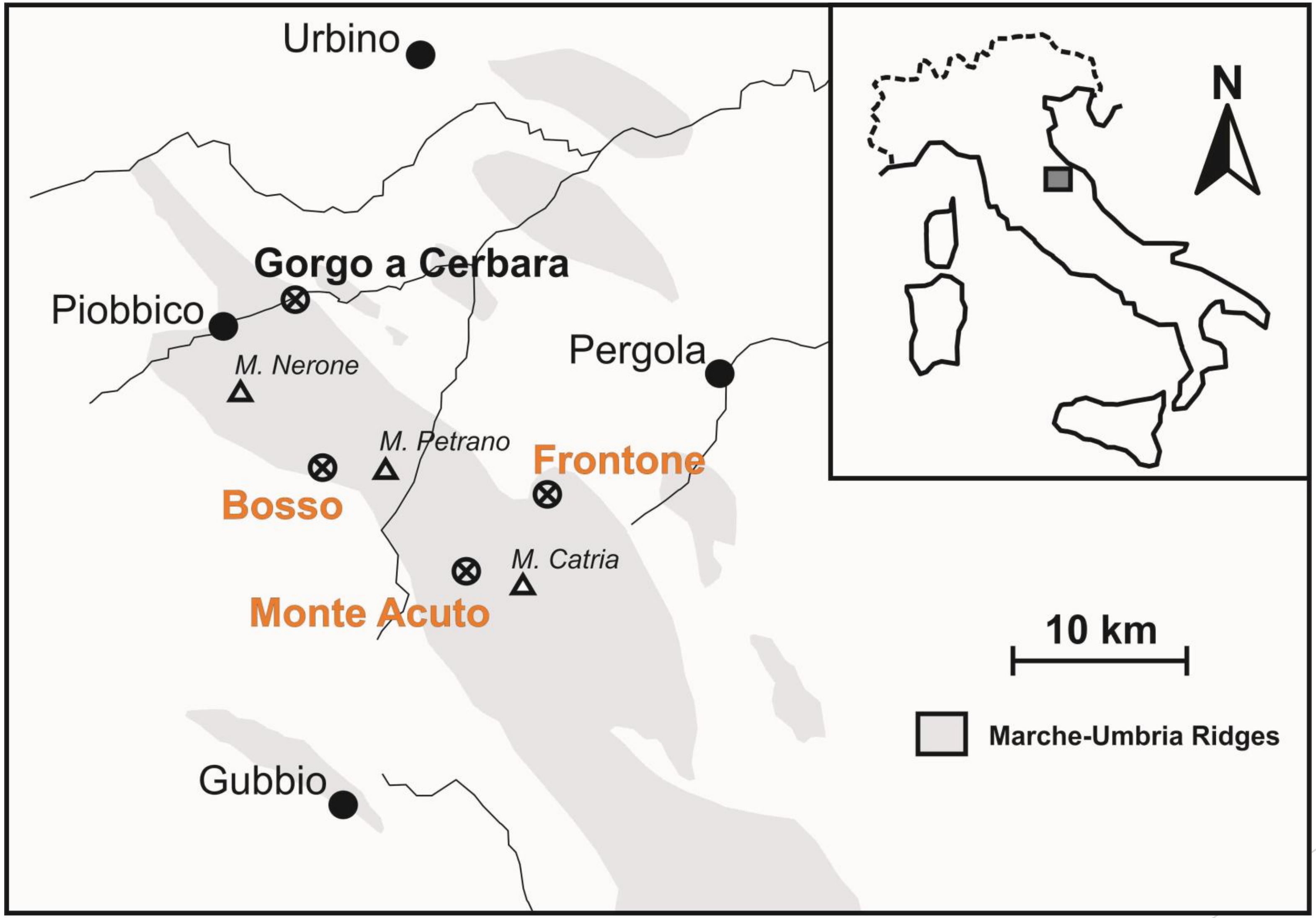
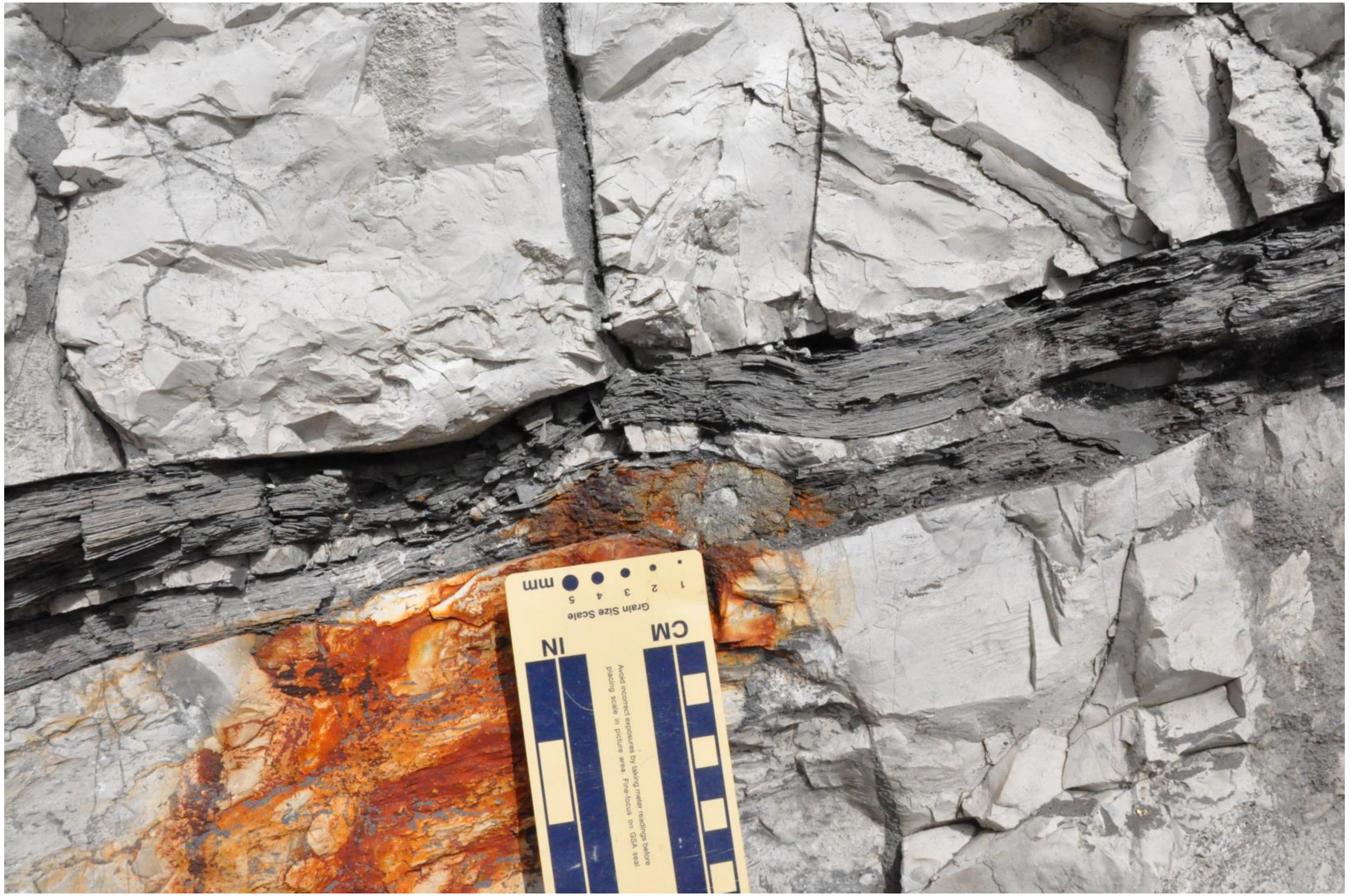
Poster: panel n°17 on Thursday and Friday

ST2.3-12



Geological setting




mm
Grain Size Scale
CM
IN

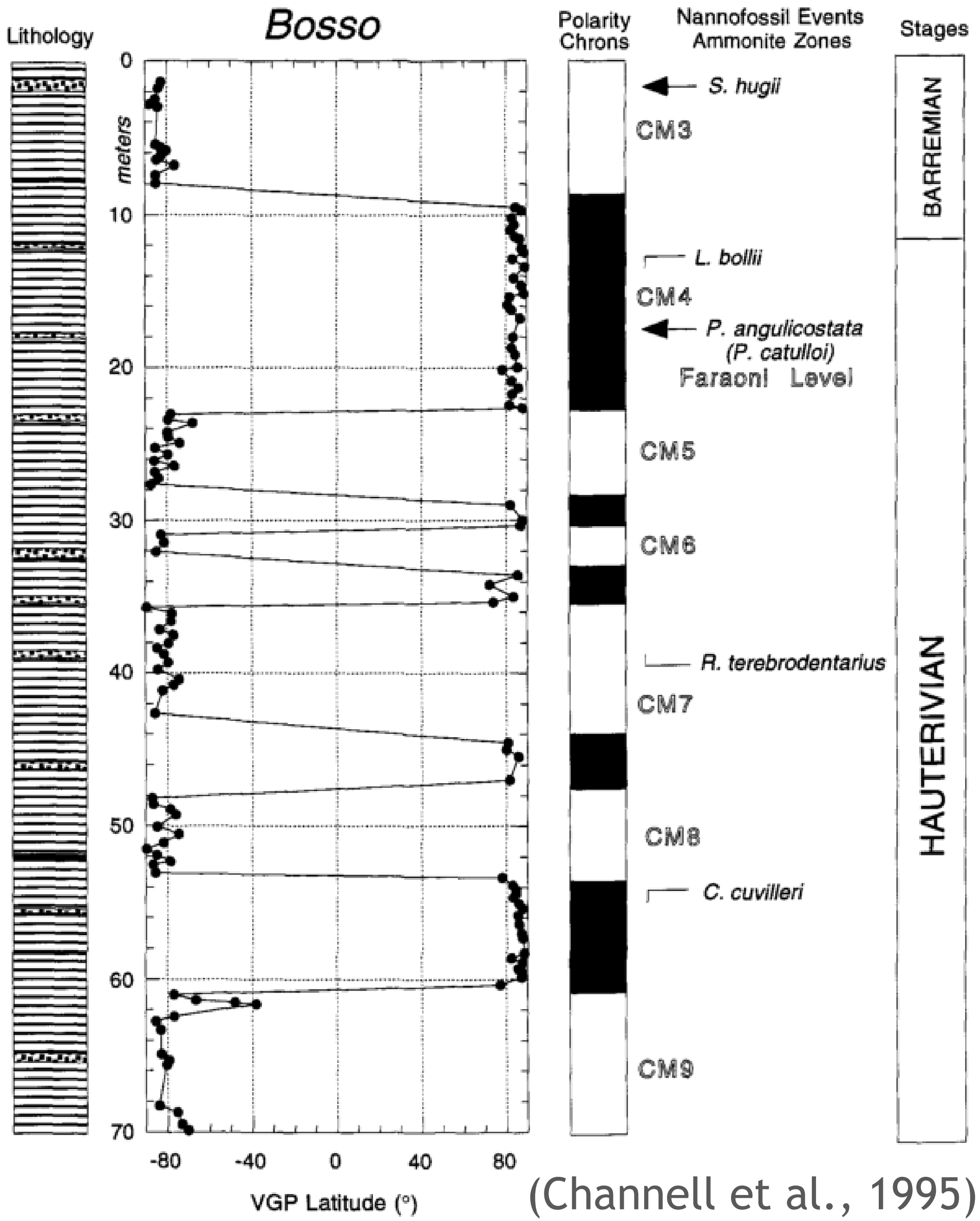

Nikon

New magnetostratigraphic framework

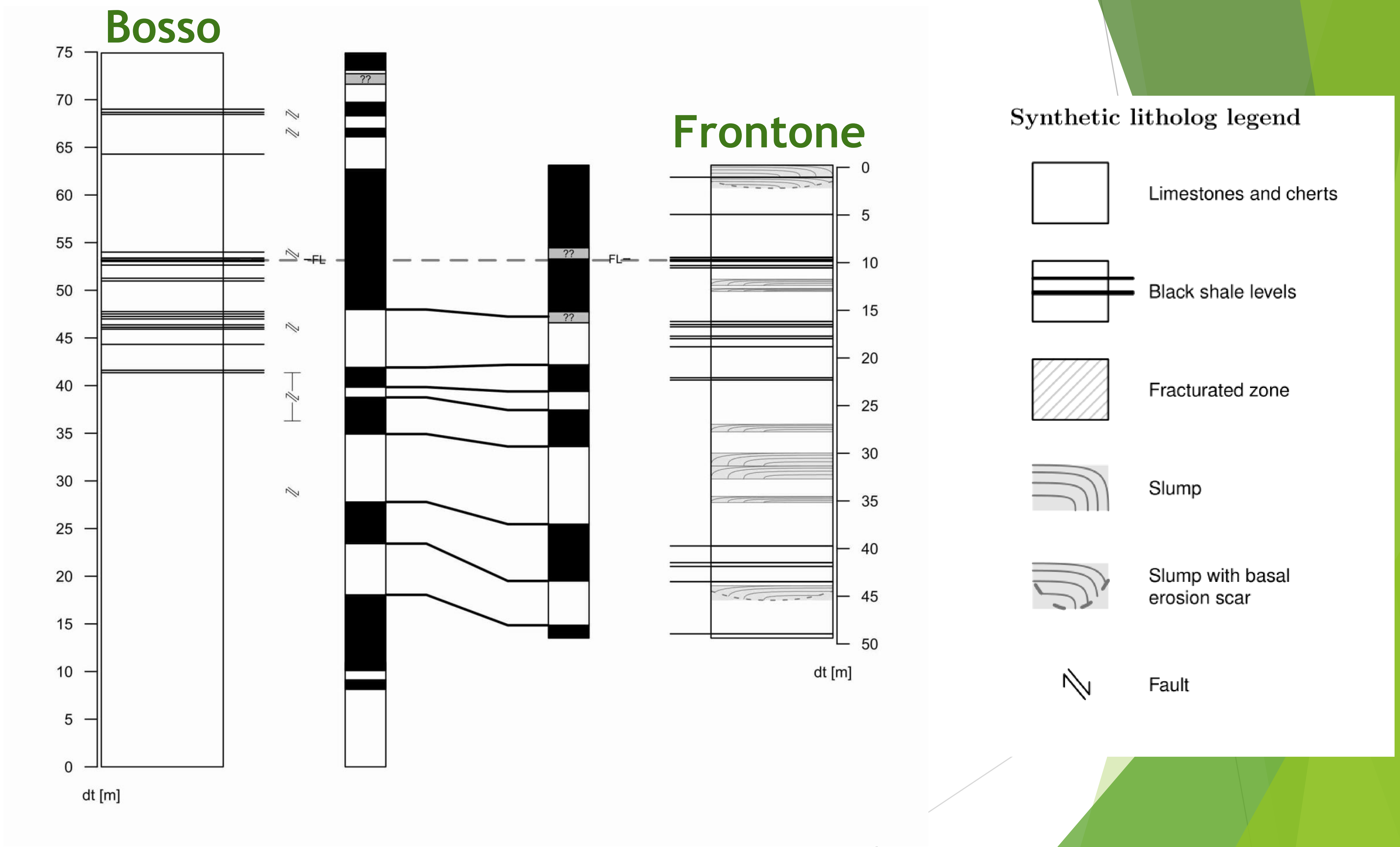
- We refined the magnetostratigraphic framework:

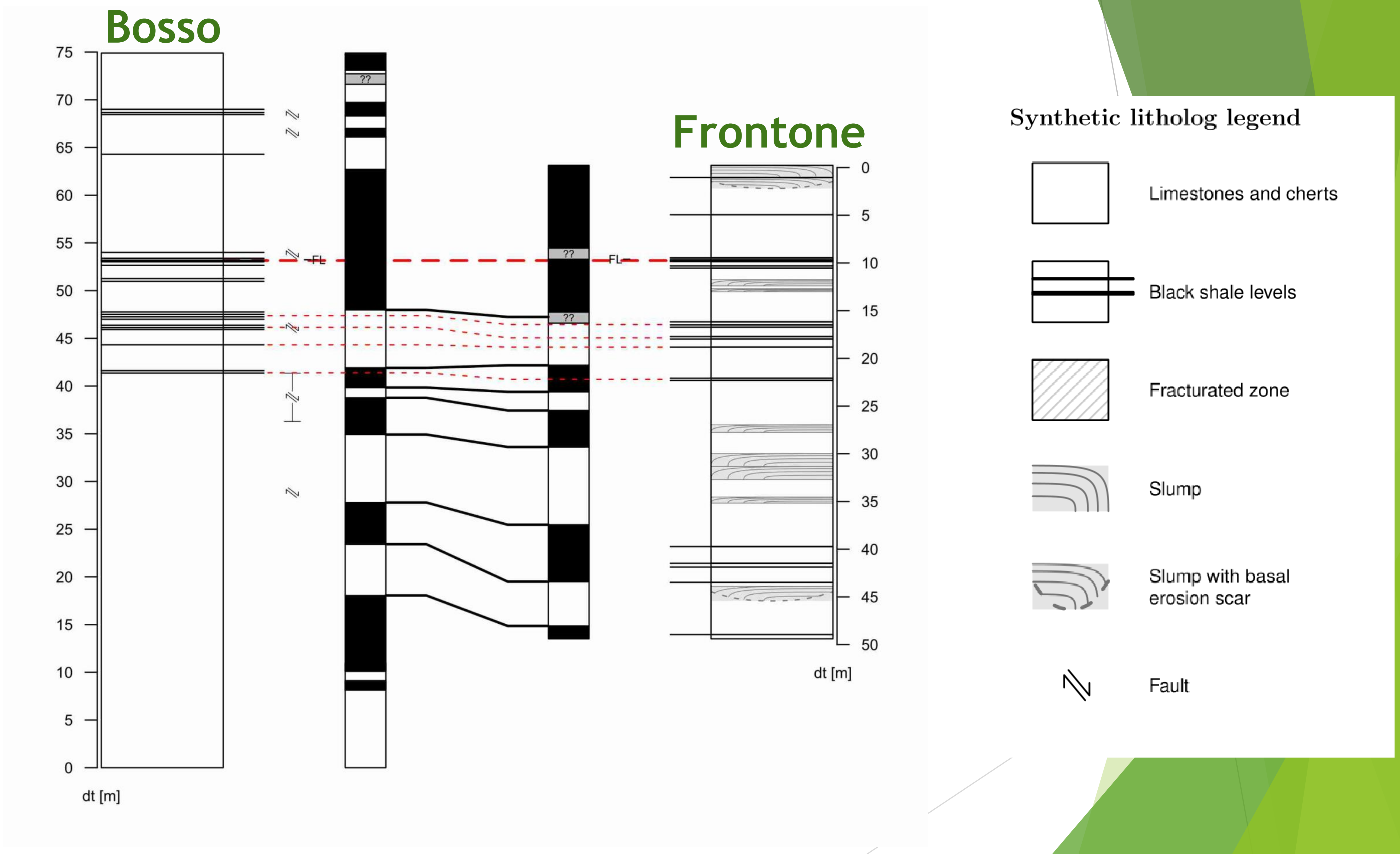
Increased resolution at the magnetic inversions (in progress)

Palaeomagnetic samples well positioned against high resolution litholog and cyclostratigraphic samples



(Channell et al., 1995)


Bosso
Frontone
dt [m]
FL
??
Synthetic litholog legend
Limestones and cherts
Black shale levels
Fracturated zone
Slump
Slump with basal erosion scar
Fault



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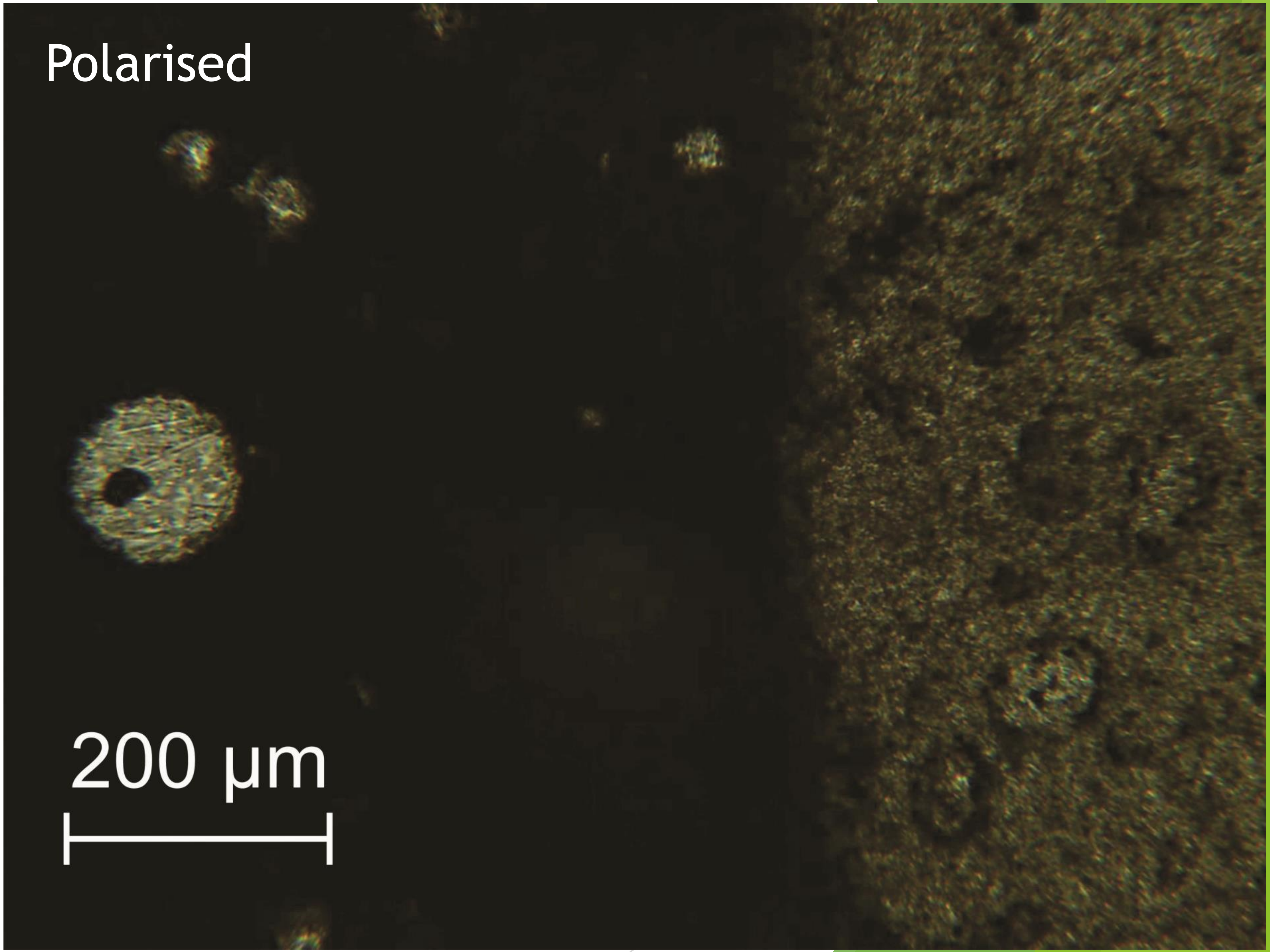
??

Chert and limestone in thin sections

Differentiating quartz and calcite

- Limestone:
- Fine micrite

- Cherts:
- microquartz (< 20 μm)



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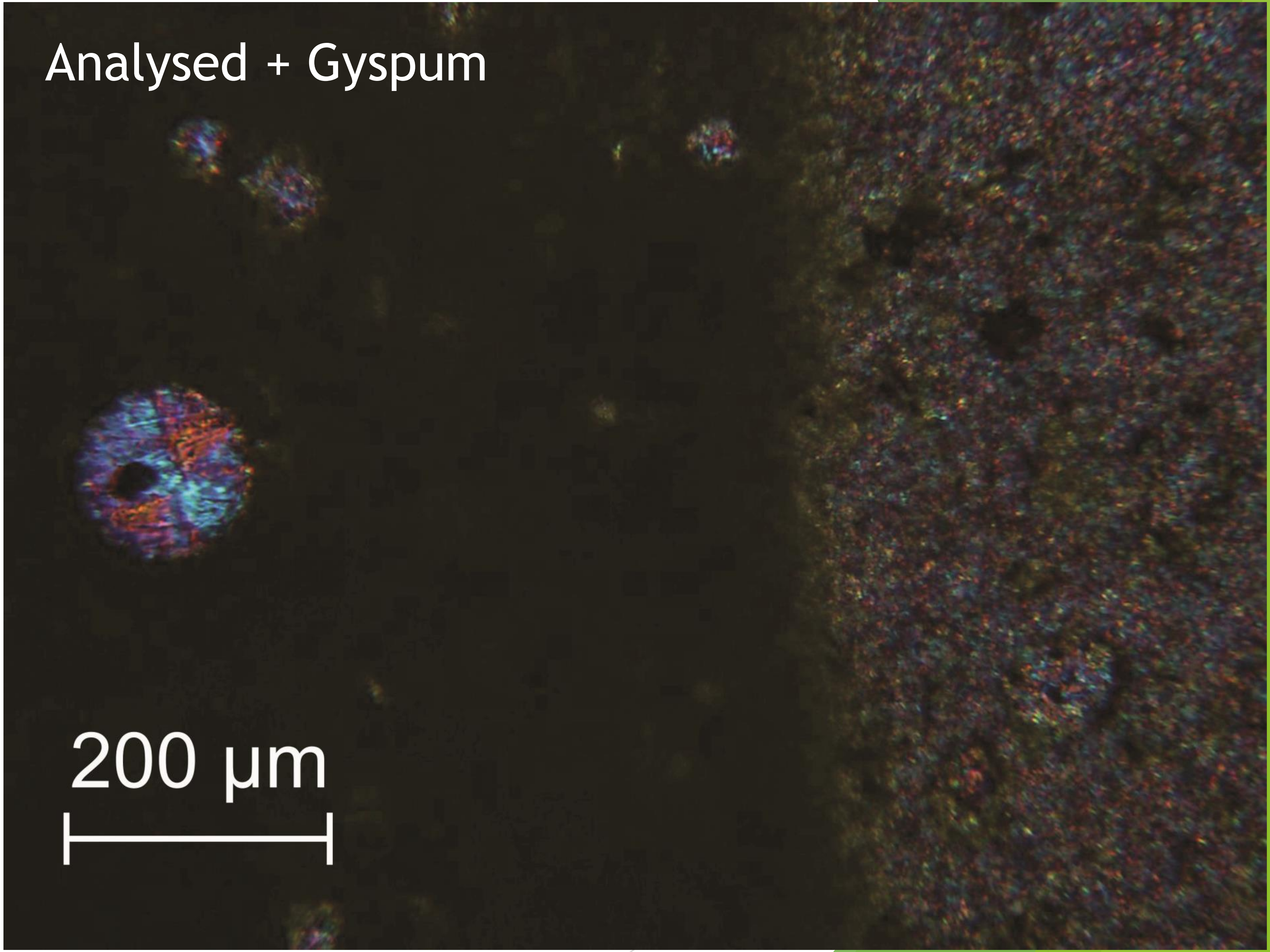
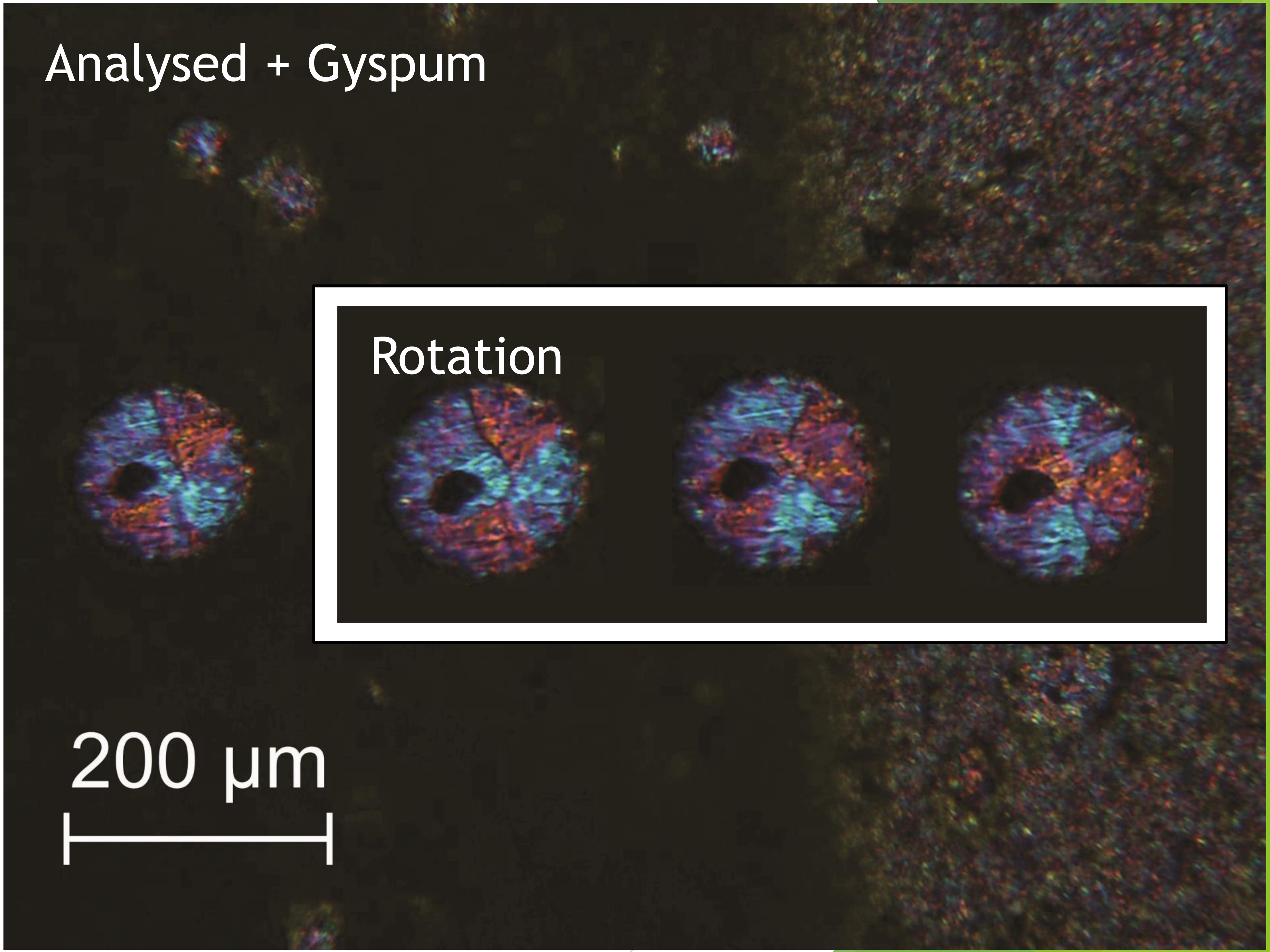


- Limestone:
  - Fine micrite
- Cherts:
  - microquartz (< 20 µm)
- Radiolaria:
  - Silicified or calcified



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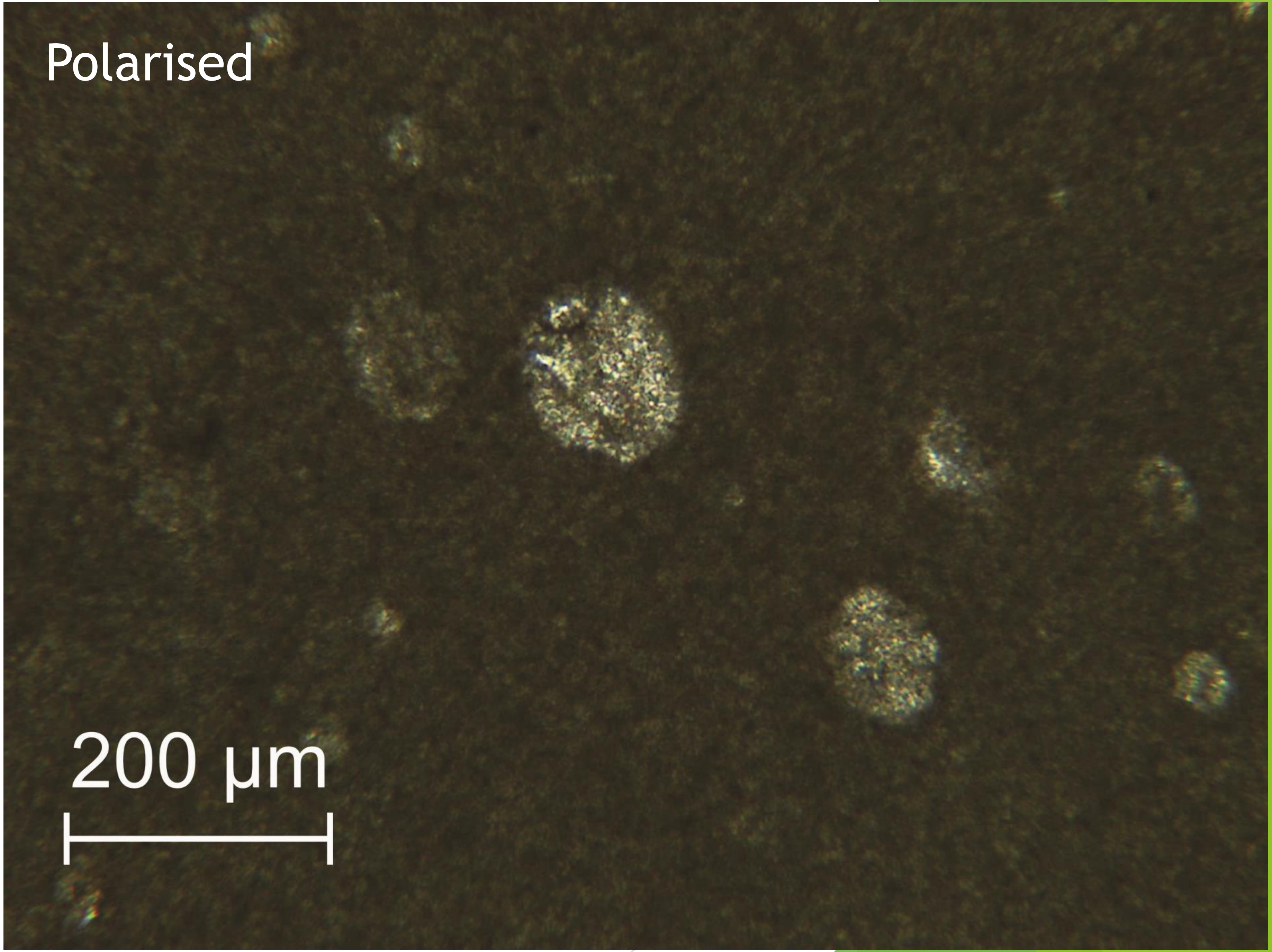

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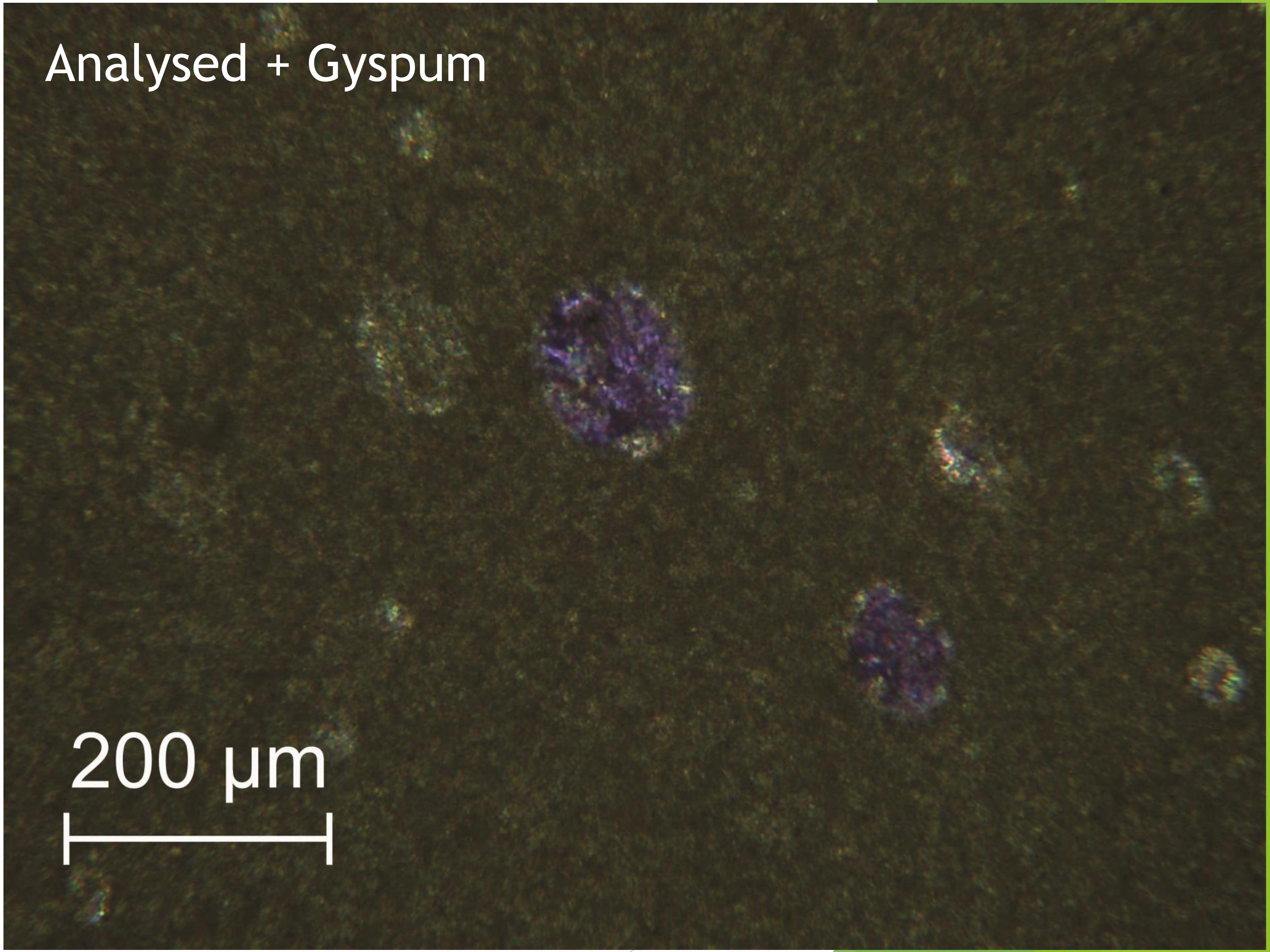
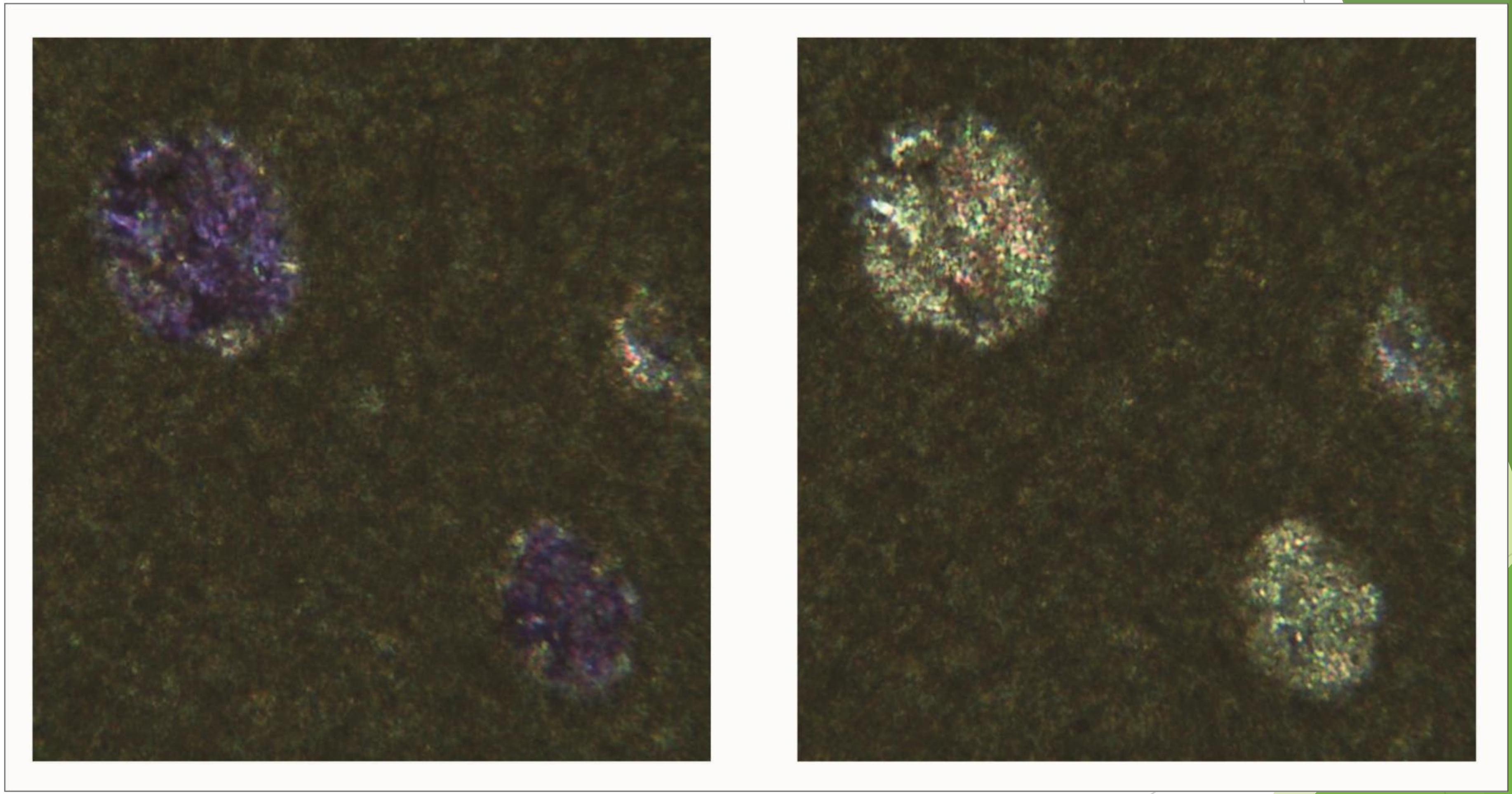


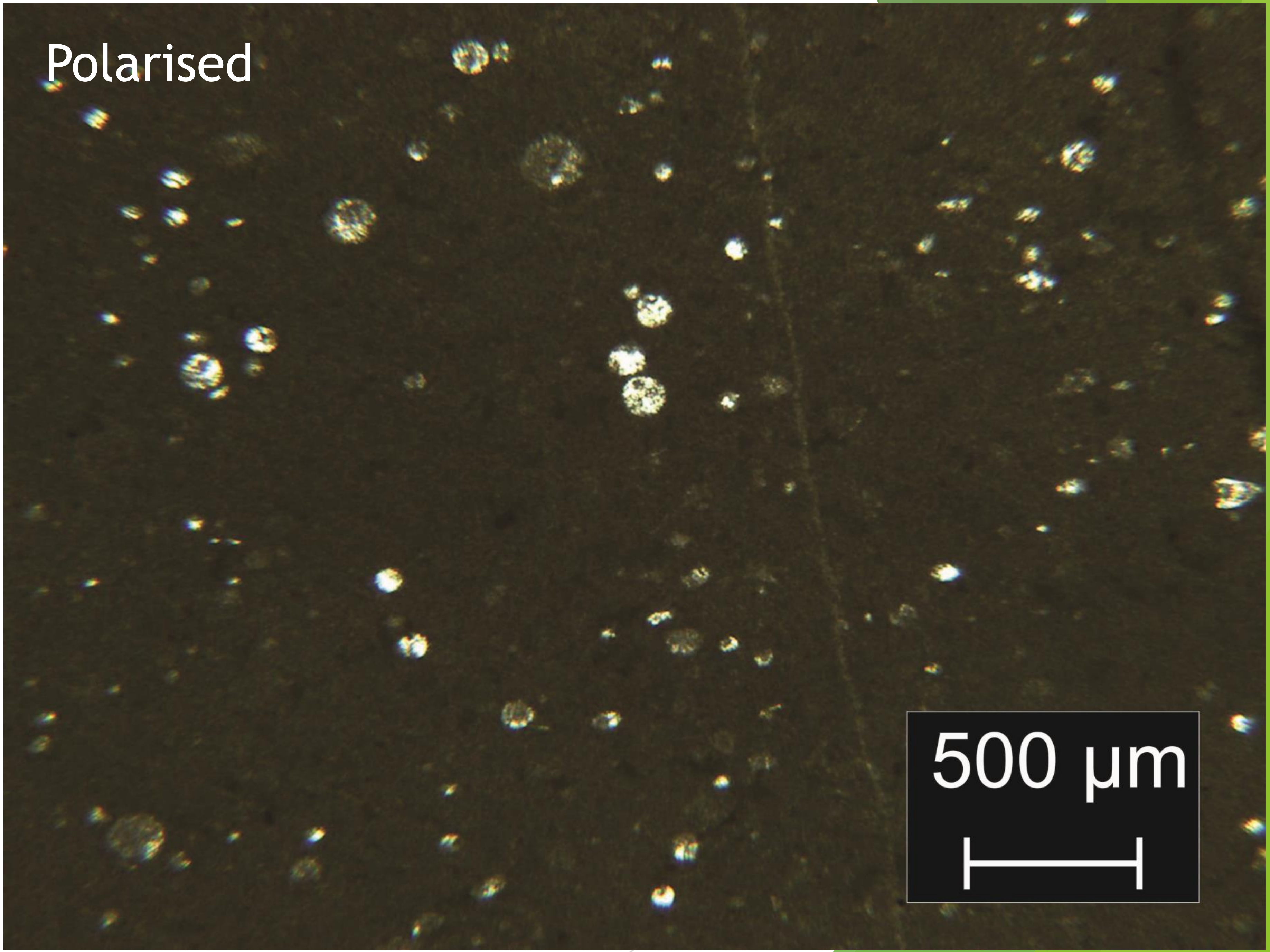
Analysed + Gyspum Rotation



Chert and limestone in thin sections

Characterization

- Limestone:
- Fine micrite
- Calcified radiolaria, badly preserved, visual estimation 5-10%
- Common stylolites



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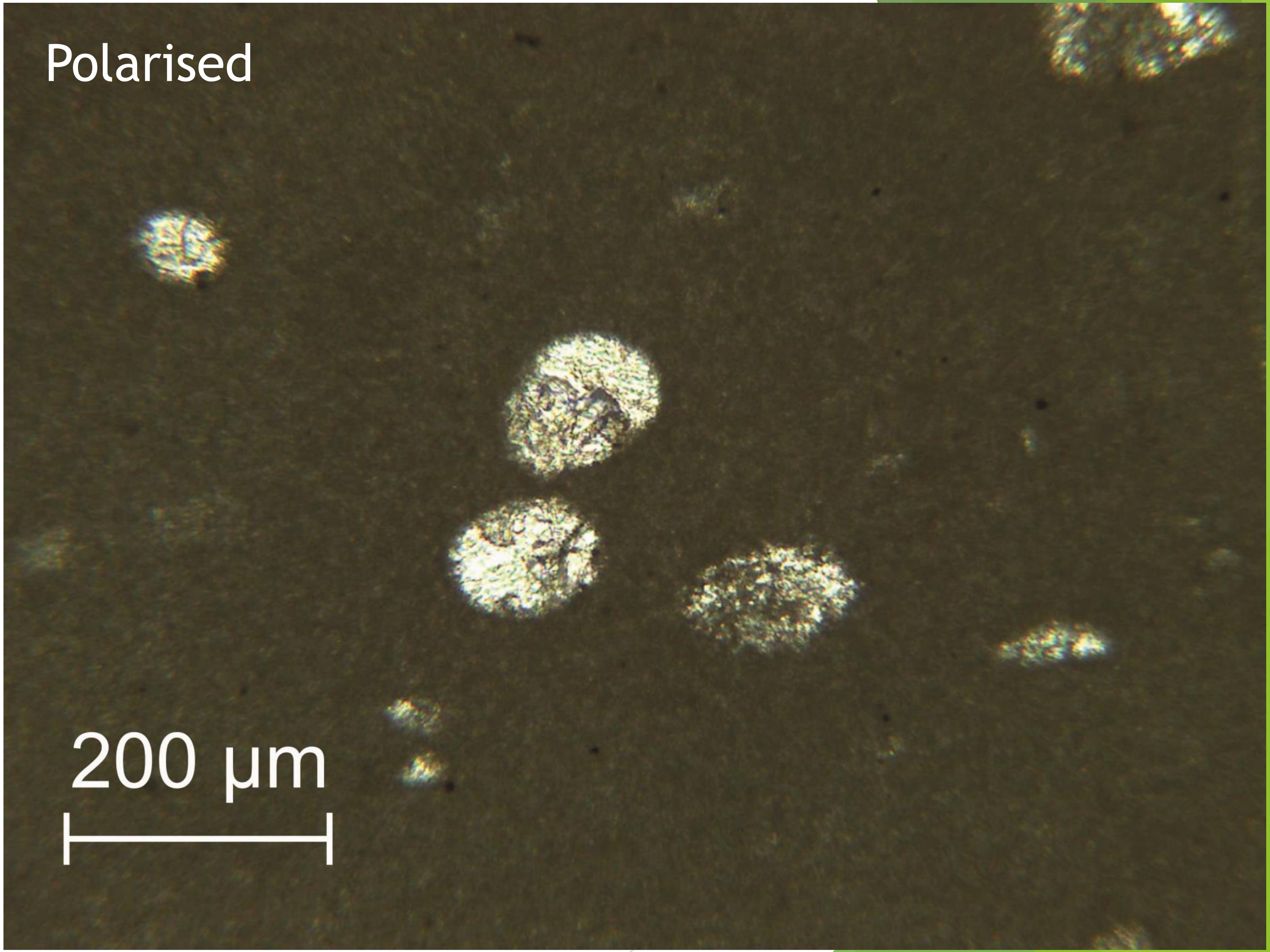

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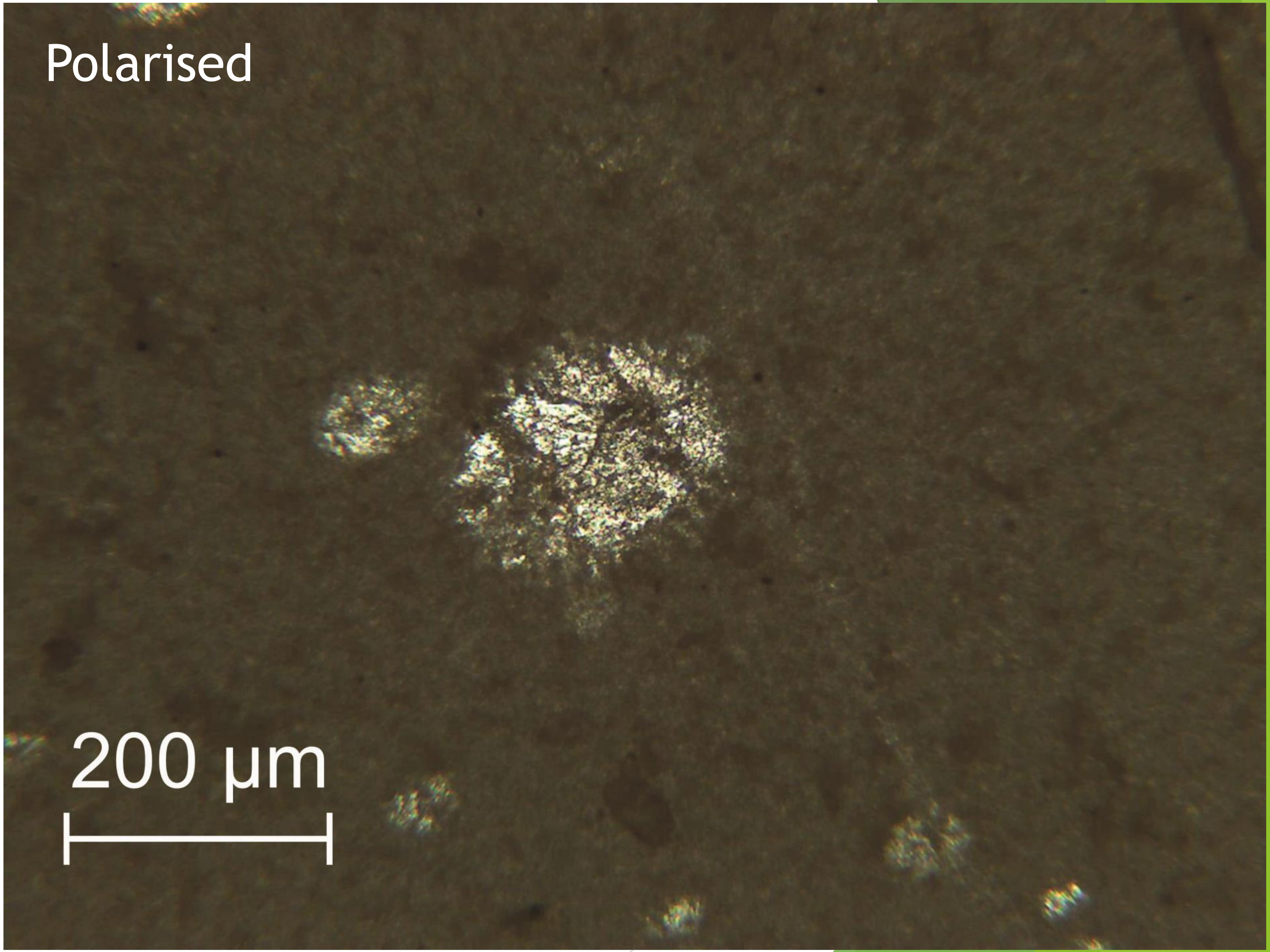

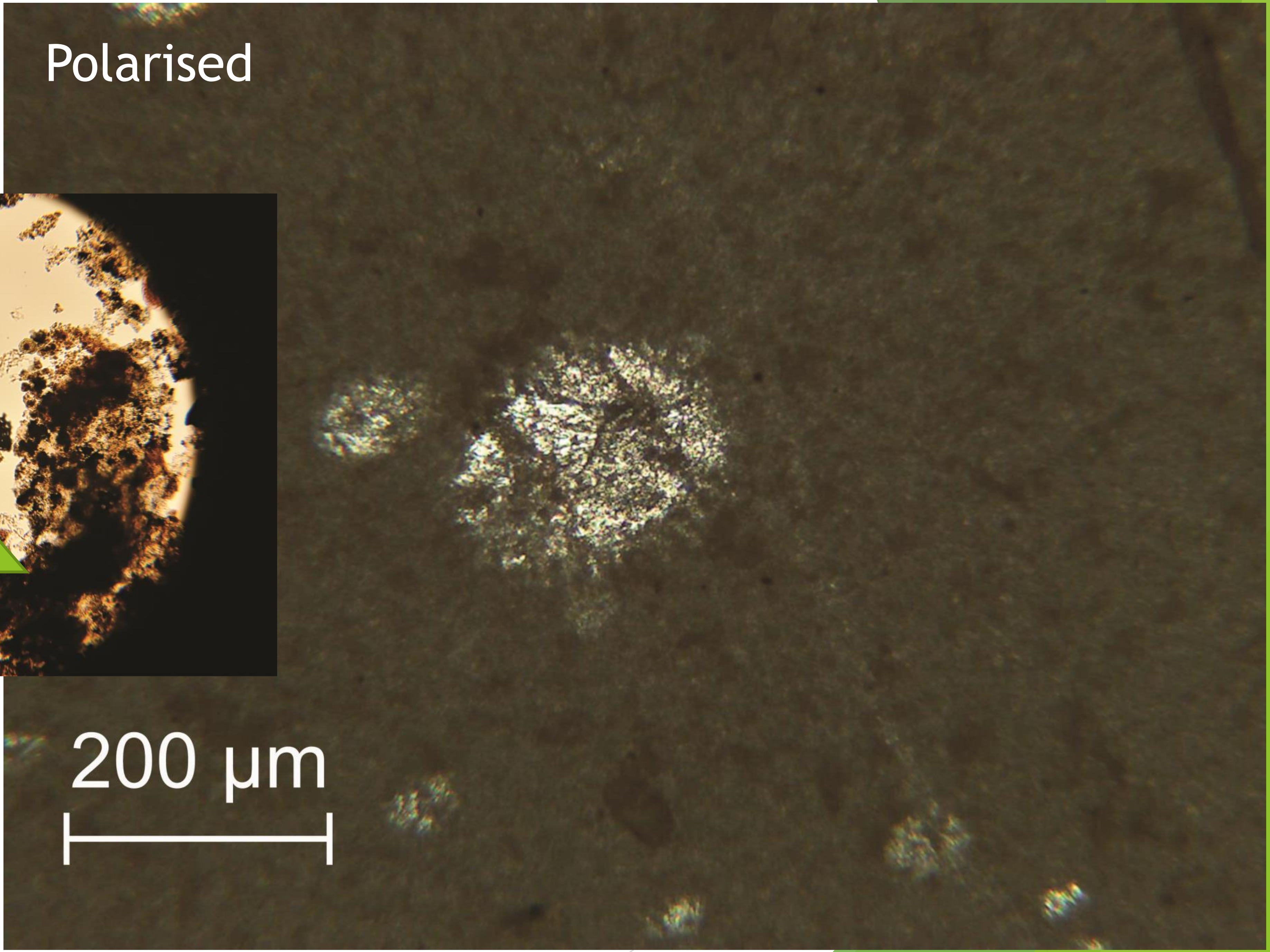

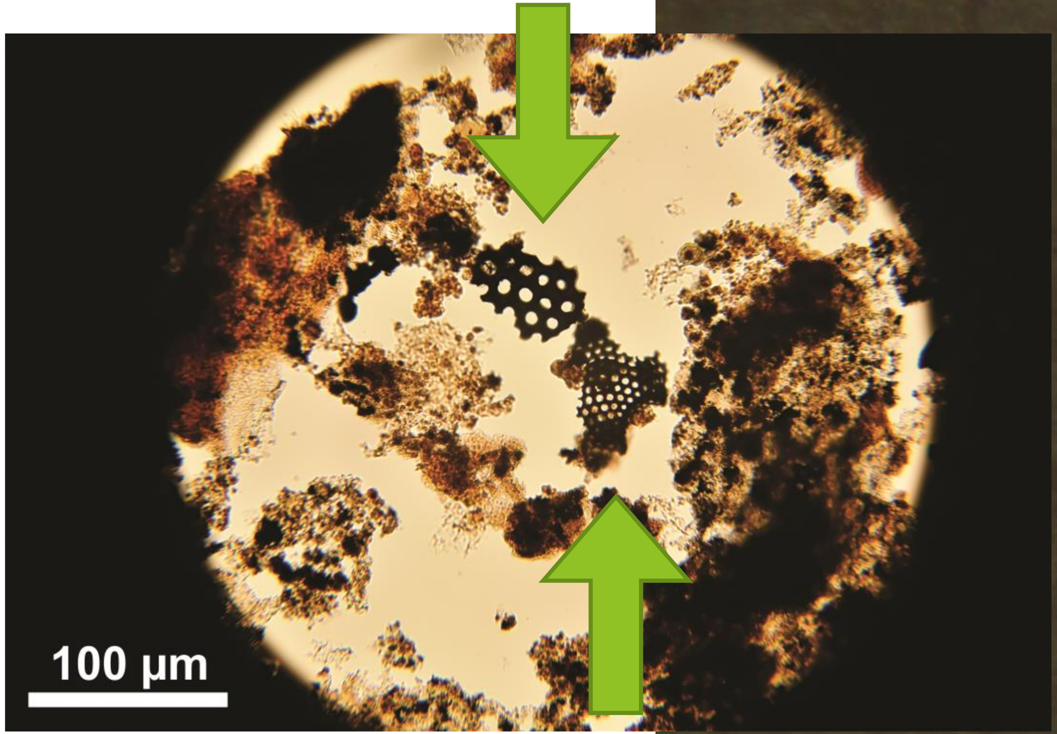

Well preserved (pyritized) radiolaria parts in palynogical thin sections of black shale for reference

- Limestone:
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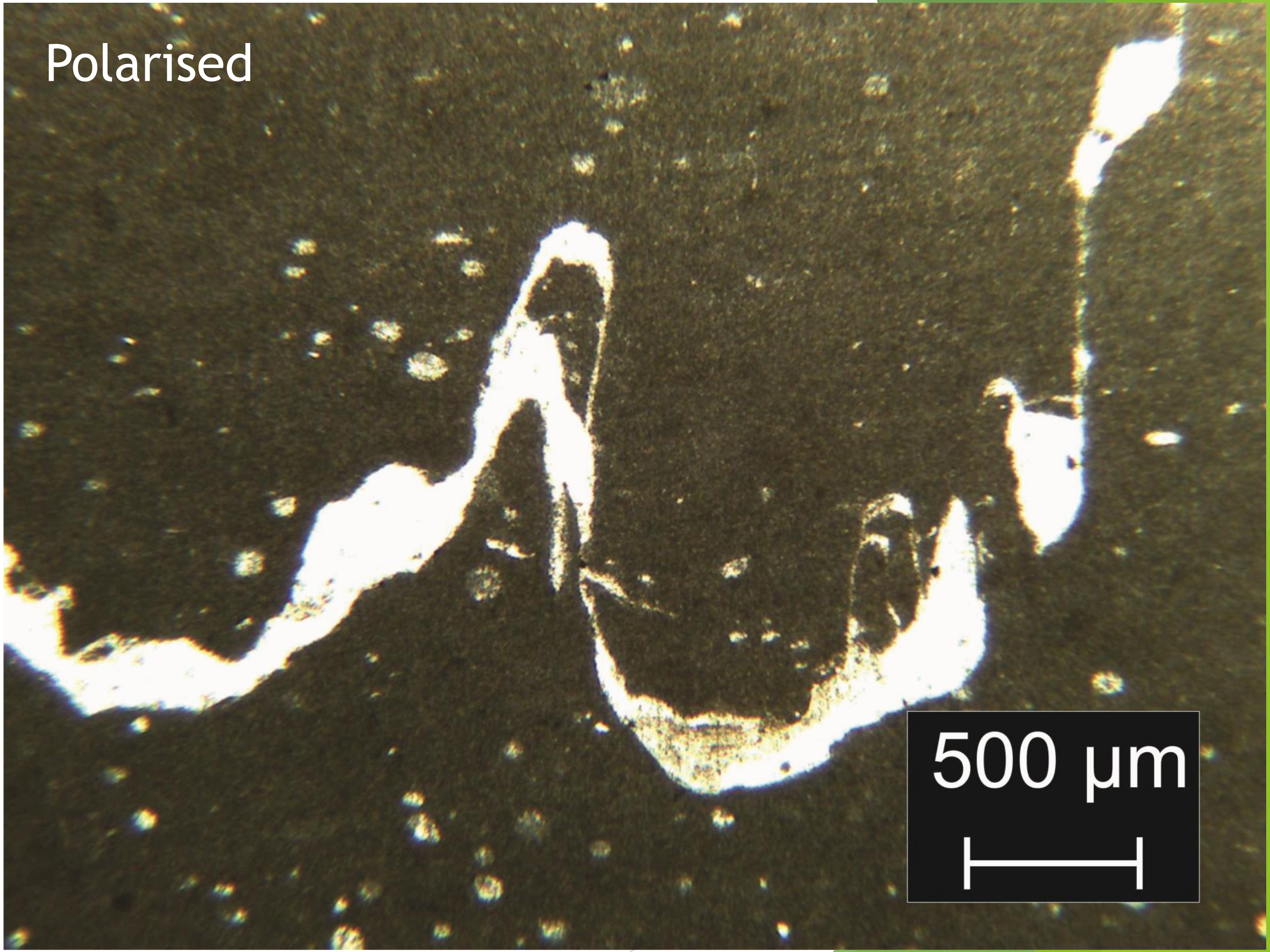

Limestone

- Fine micrite
- Calcified radiolaria, badly preserved, visual estimation 5-10%
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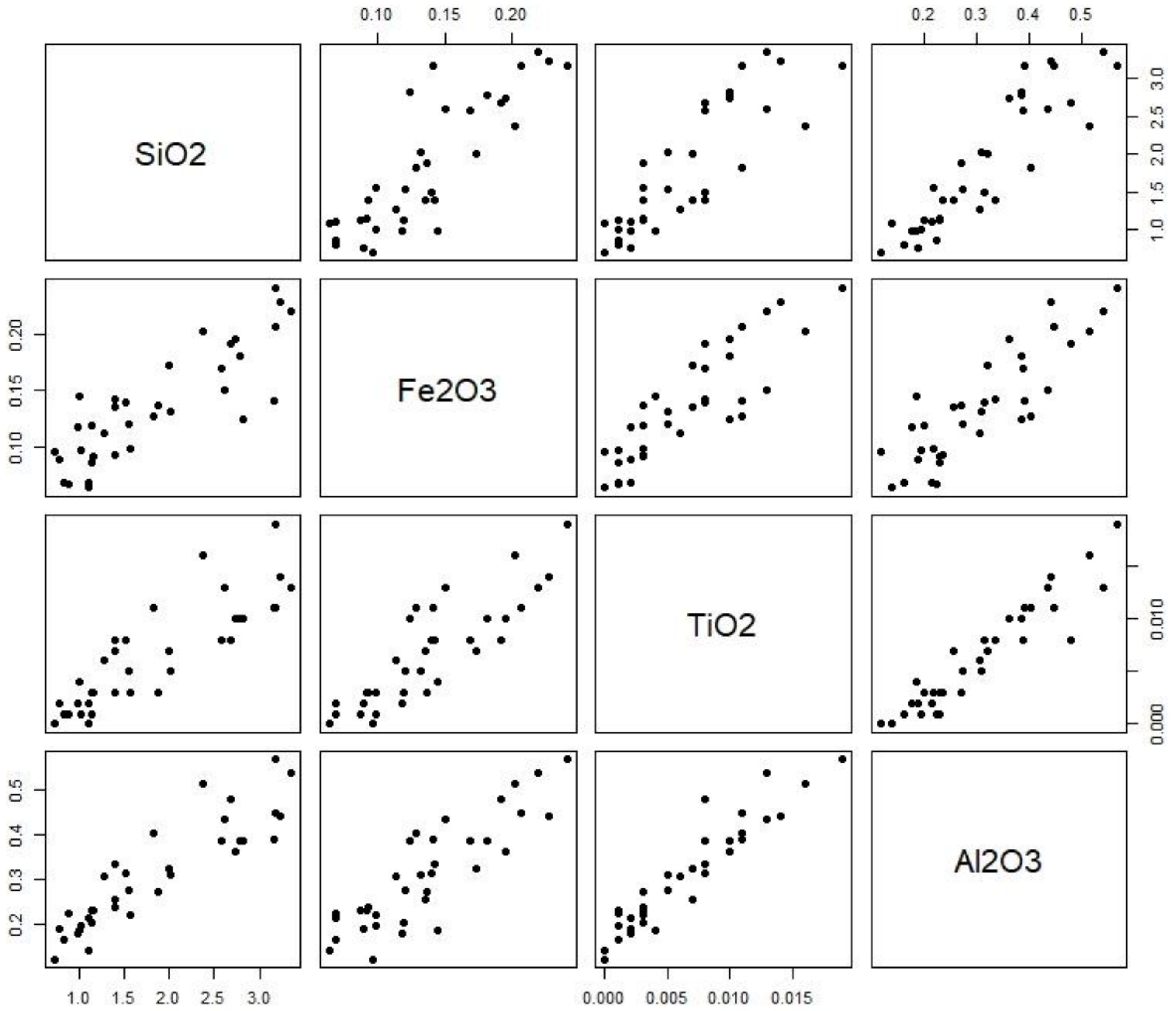
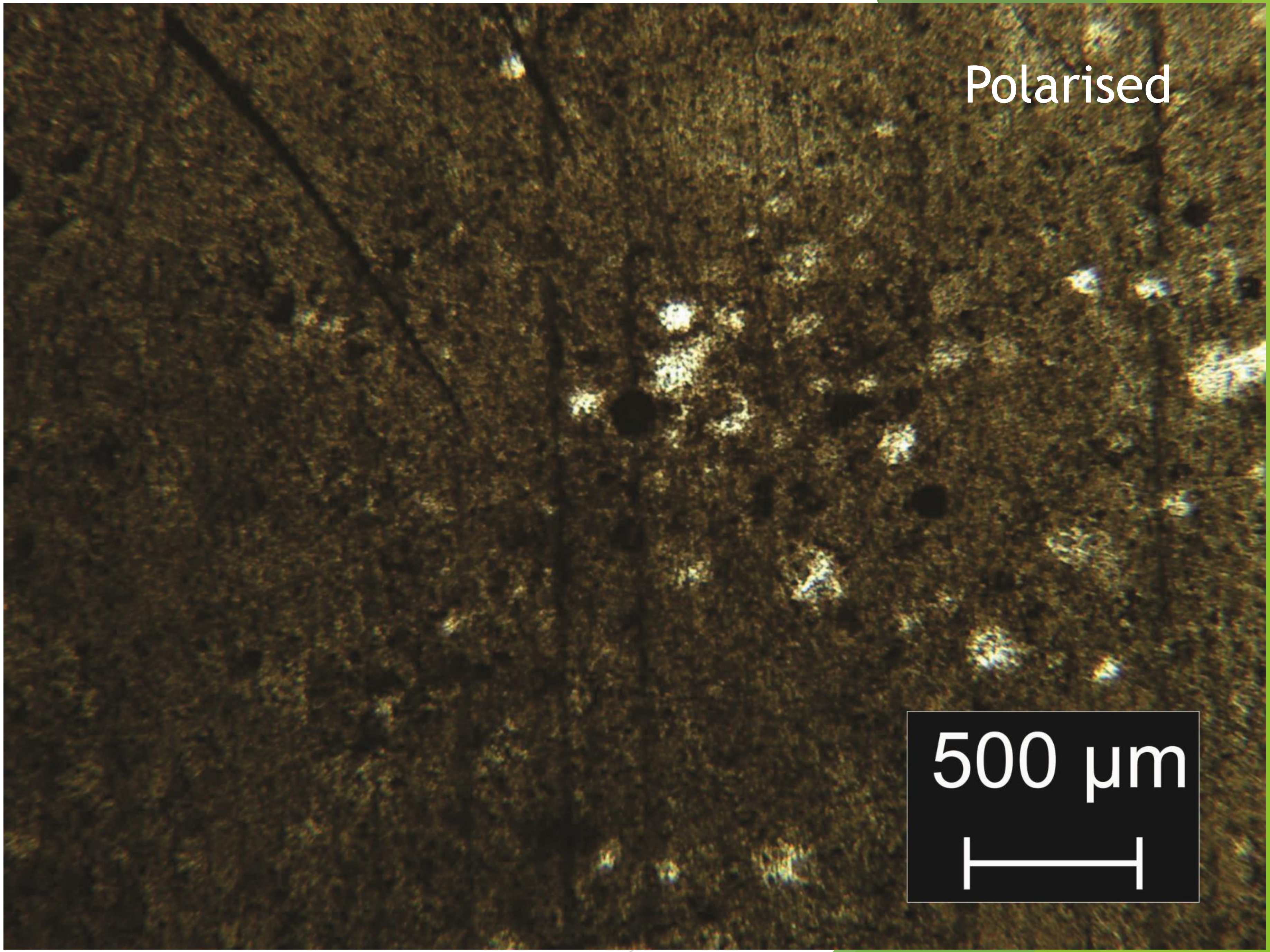
- **0.7 to 3.3% SiO_2**, well correlated to:
- Fe_2O_3 (R = 0,84)
- TiO_2 (R = 0,85)
- Al_2O_3 (R = 0,90)



- Cherts:
- Microquartz (< 20 µm)
- Silicified radiolaria in cherts or neighbouring limestones, well preserved, visual estimation 5-10%
- Limestone/chert interface sometimes sharp, sometimes transitional



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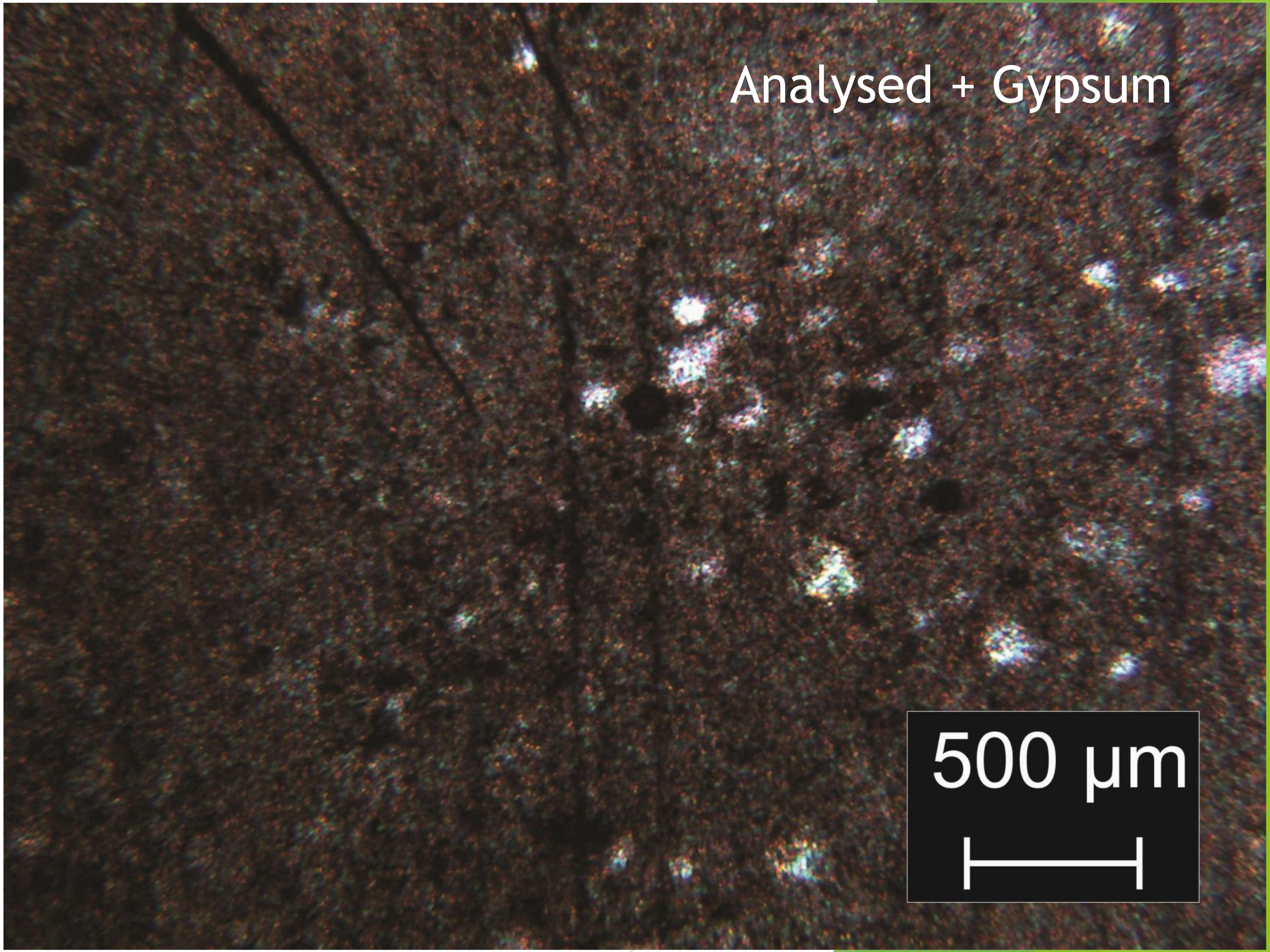

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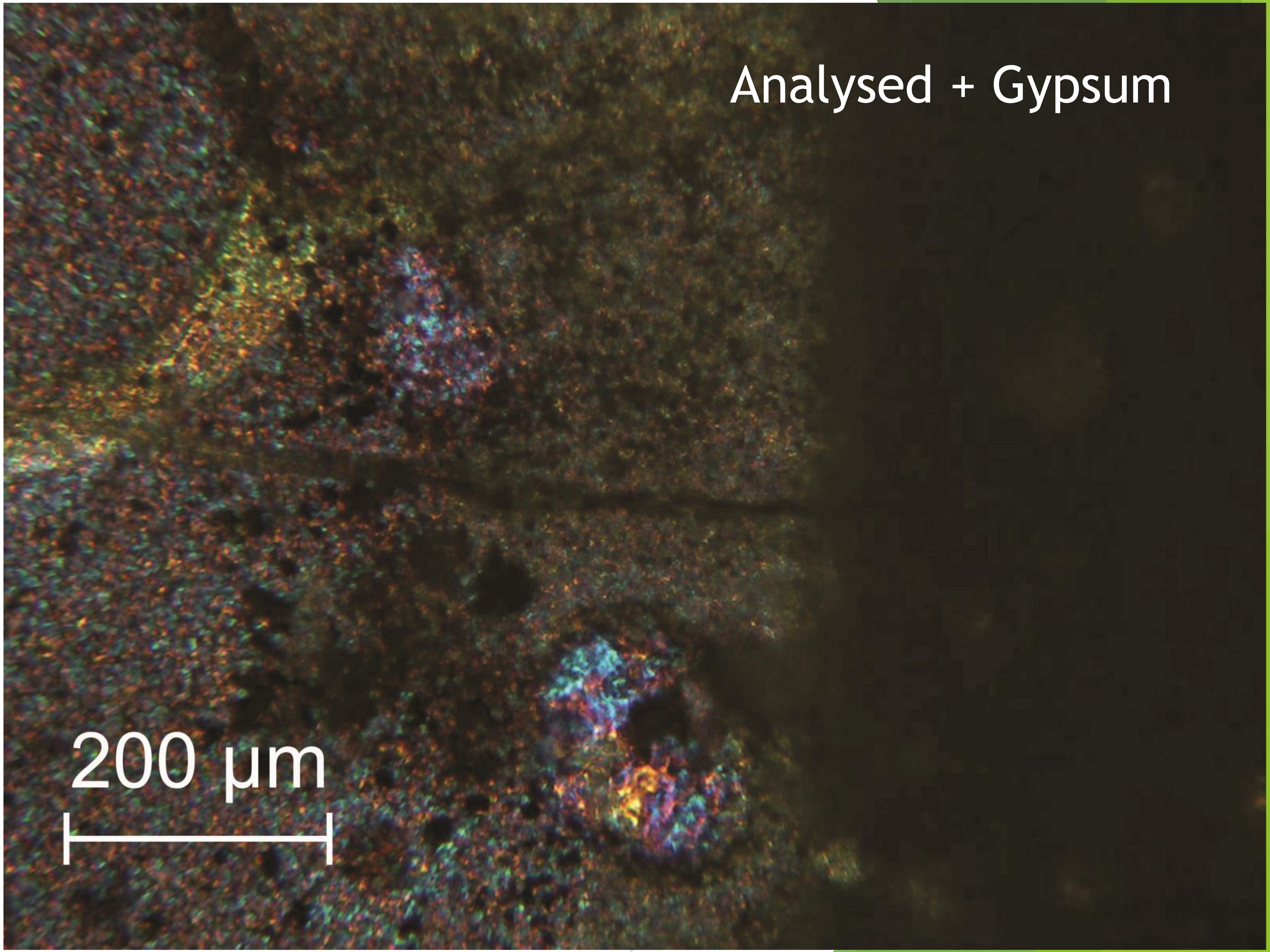

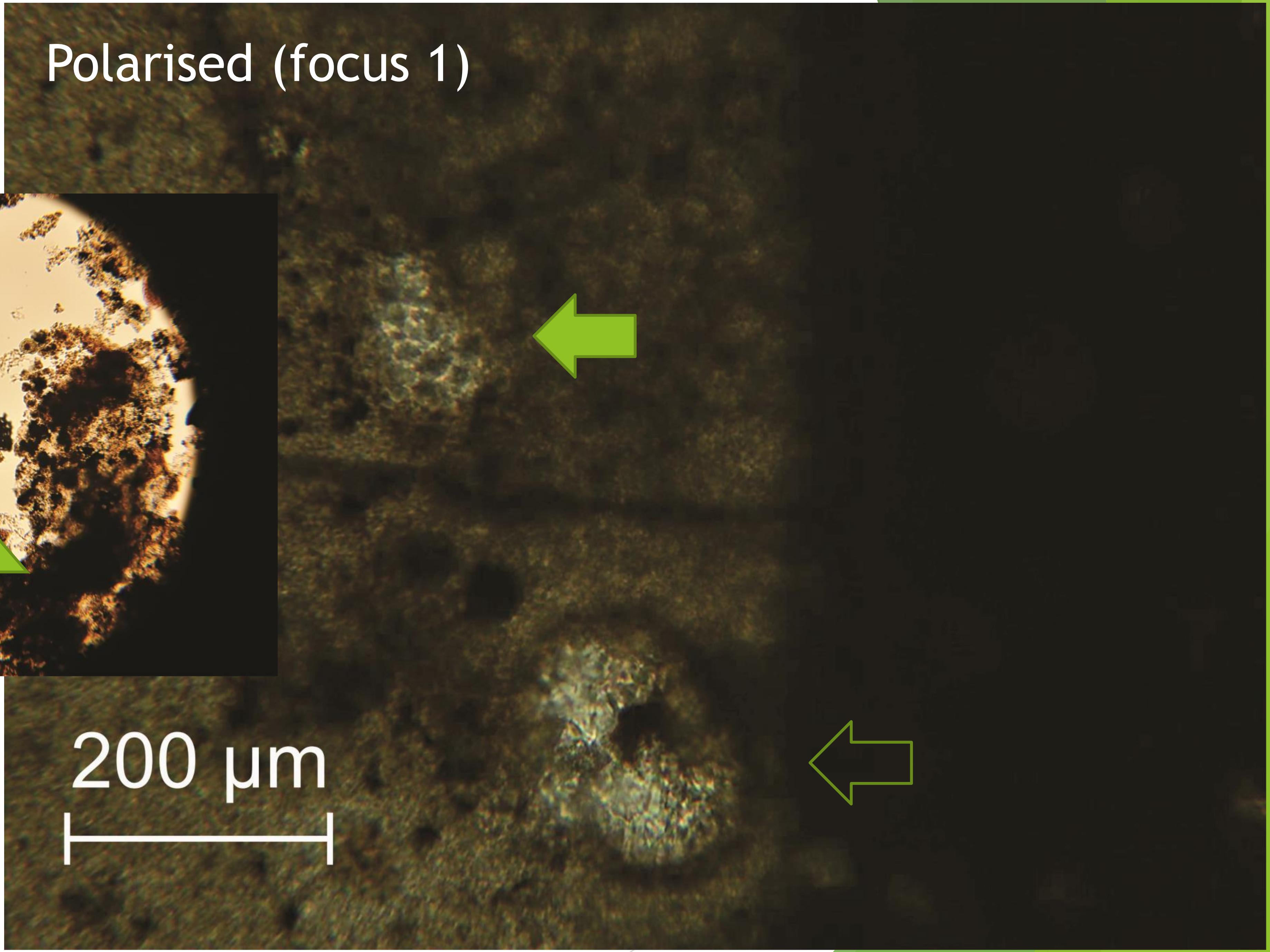

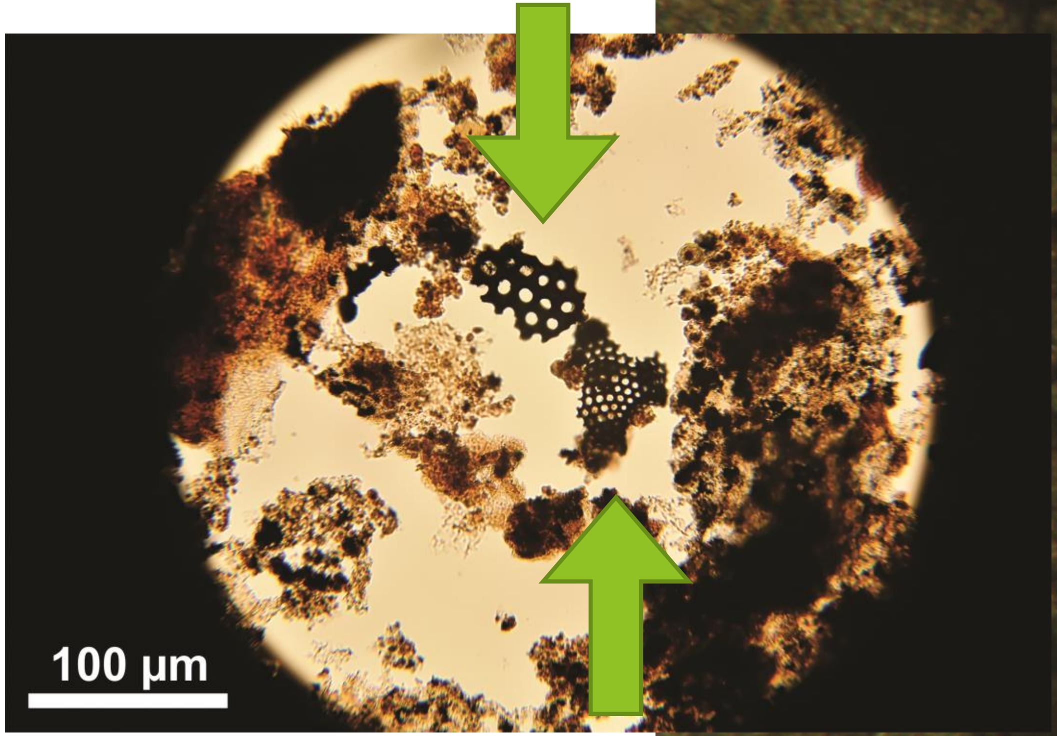

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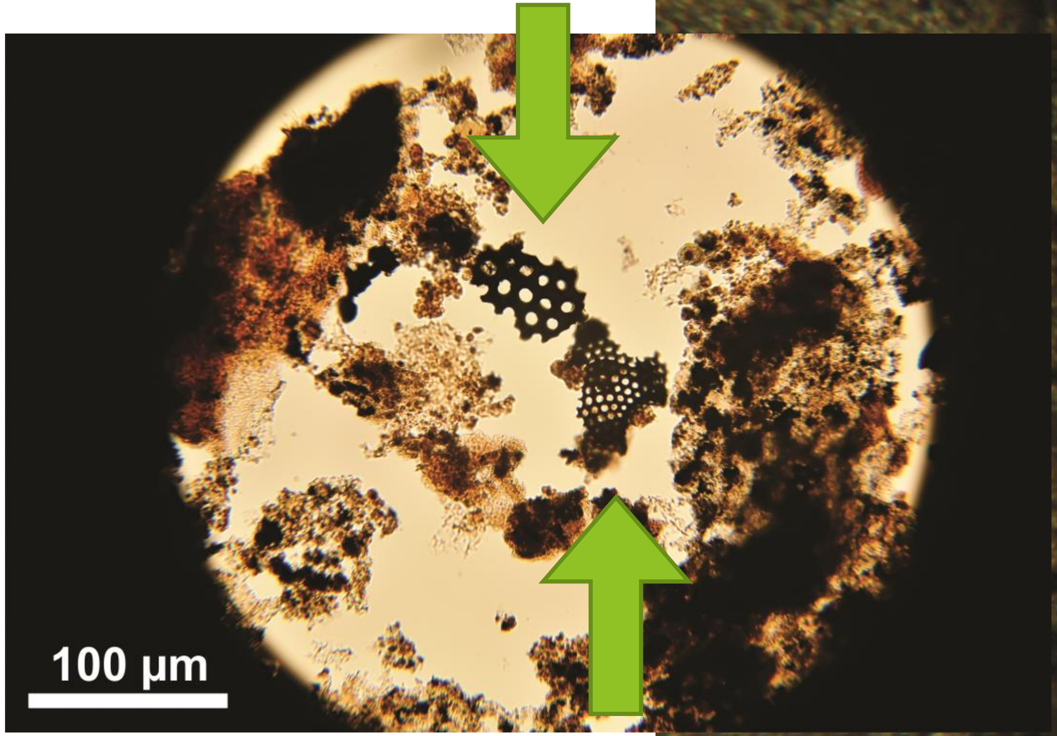

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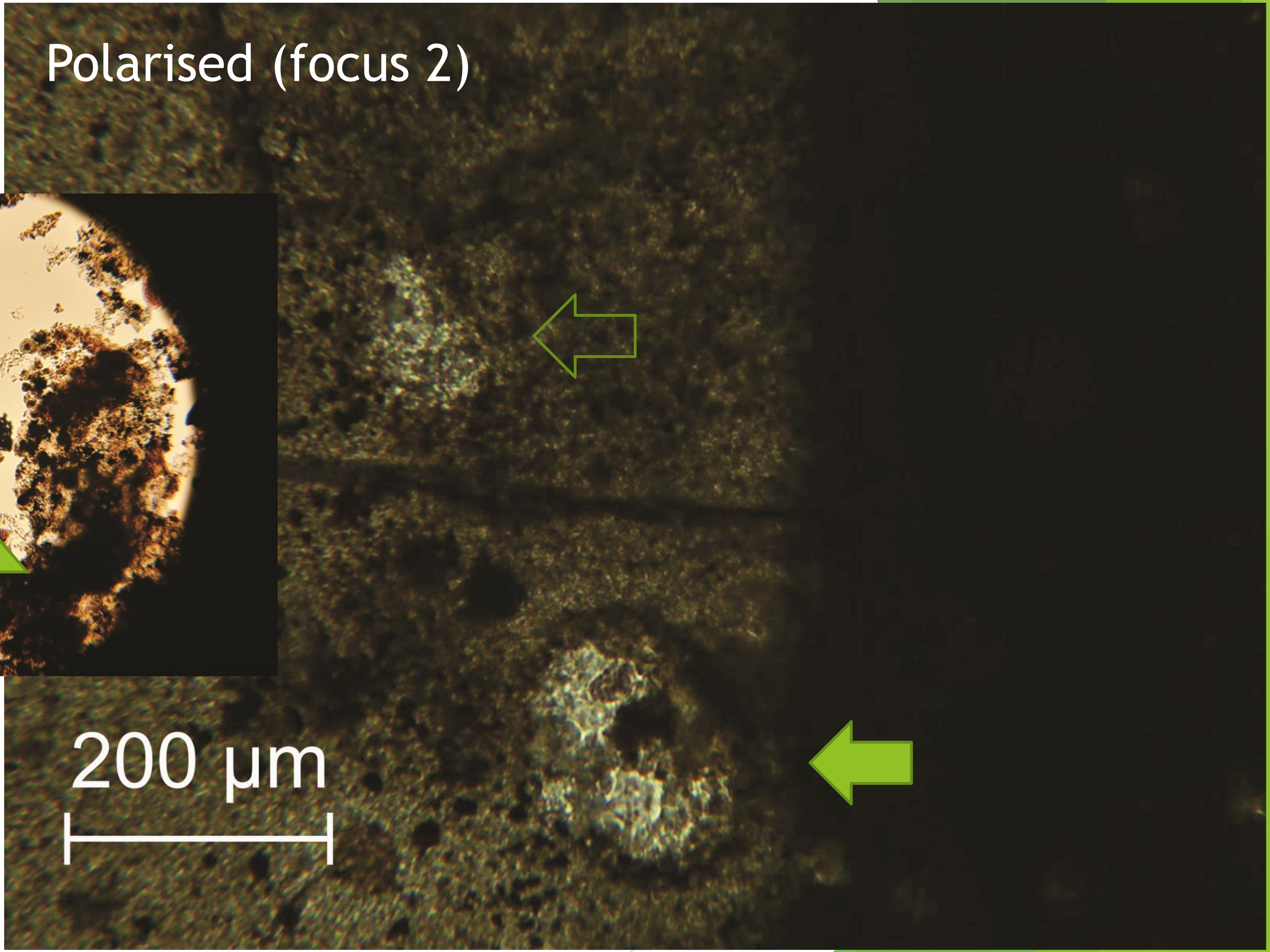

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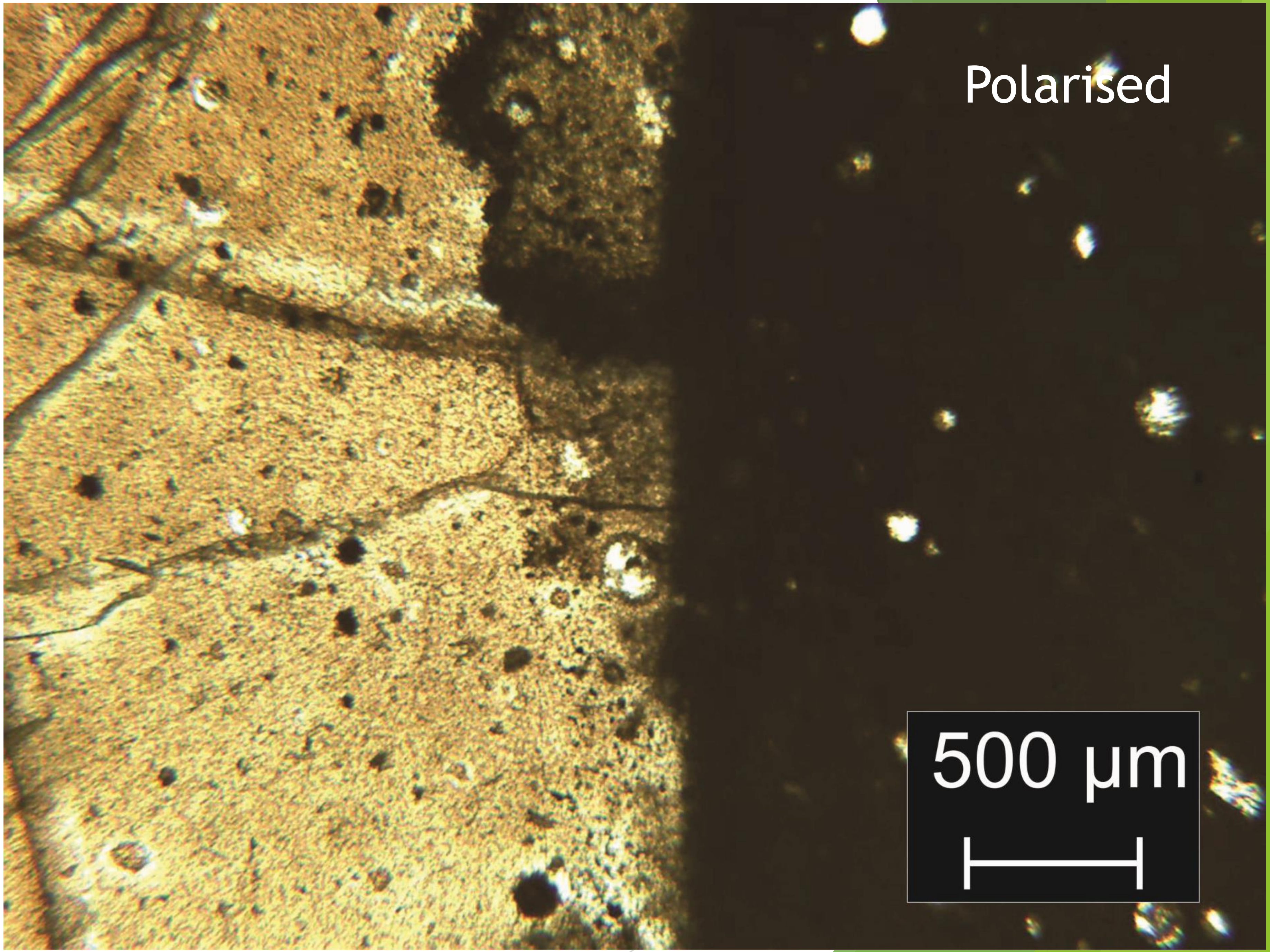

Chert

- Microquartz (< 20 µm)
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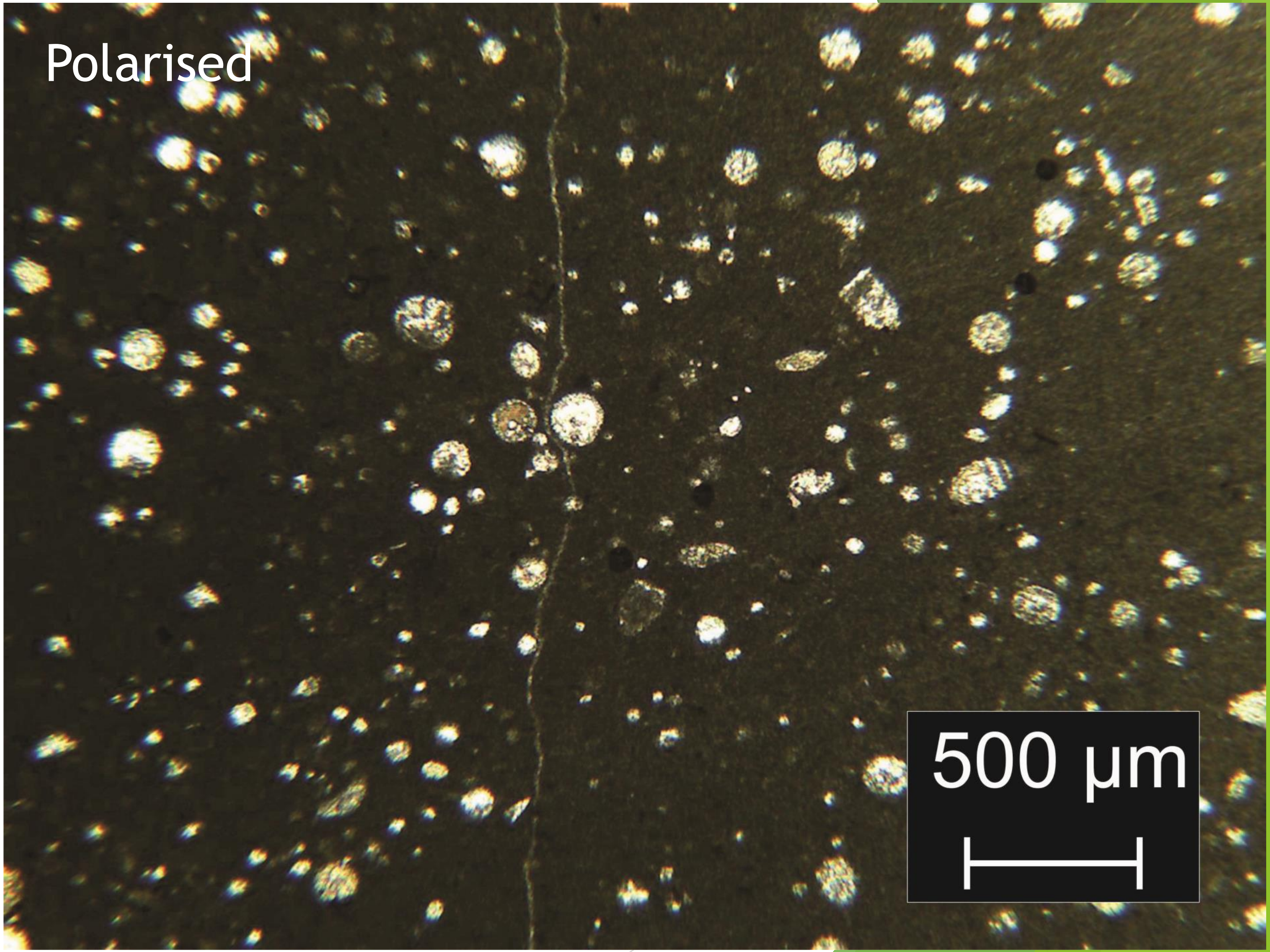
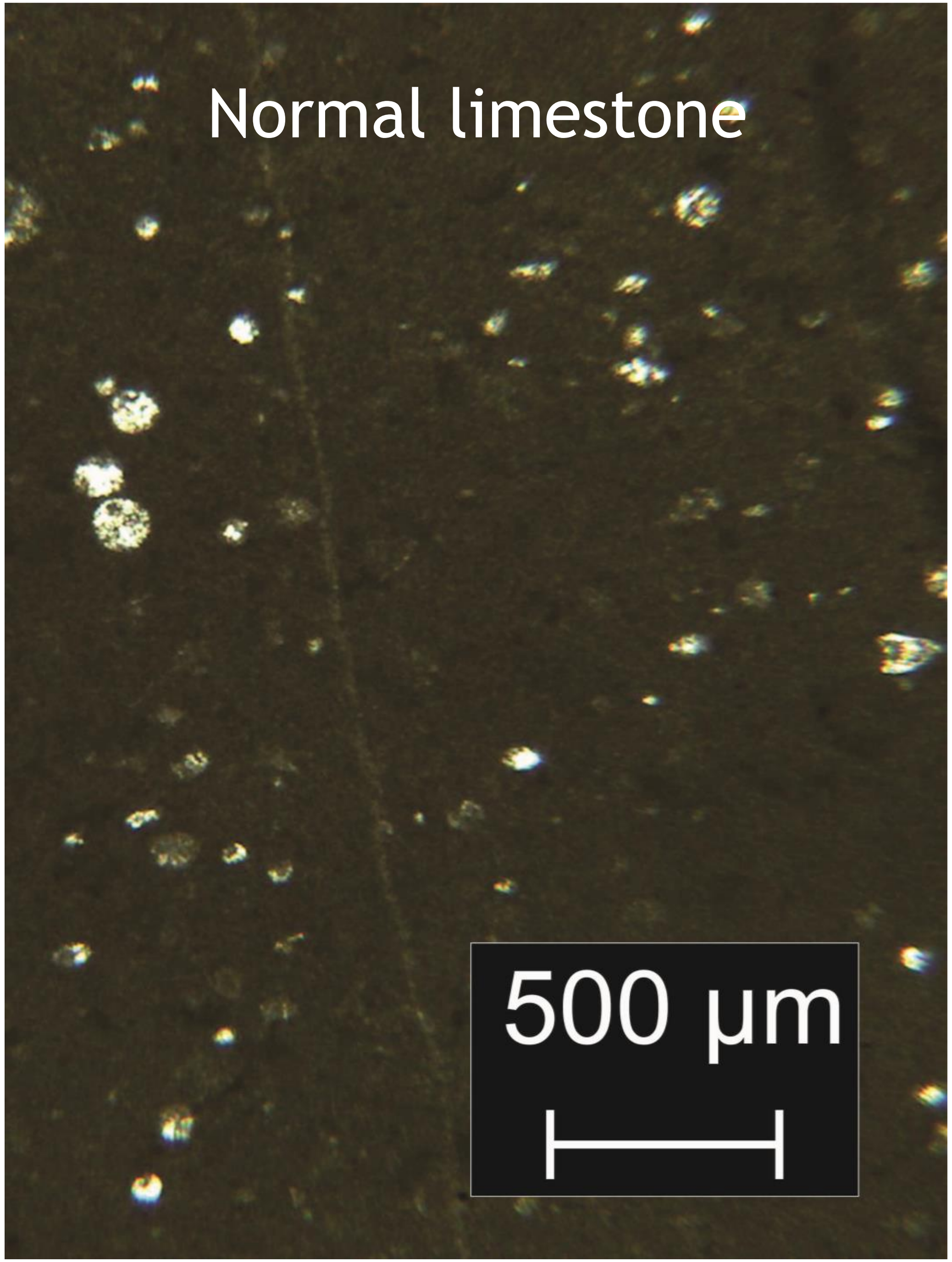
- Purest samples:

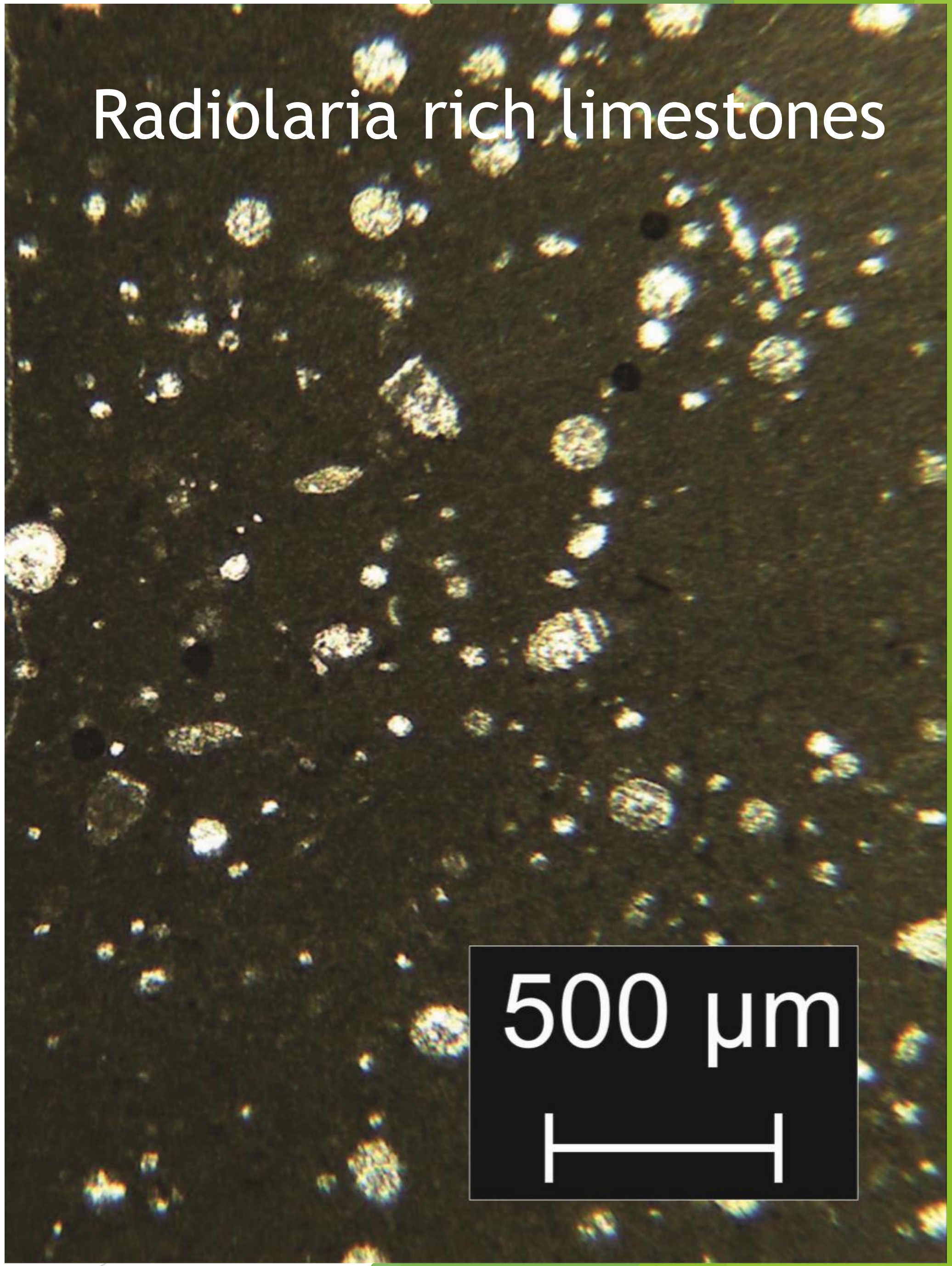
  (less than 1% CaO, assumed without contamination, 7 samples on 11)

- 96 to 98% SiO_2
- TiO_2 and Al_2O_3 mean values similar to the ones of limestones (but correlations between detrital elements are weak)
- Fe_2O_3 mean values 40% of that of the limestones, magnetic susceptibility systematically lower than in limestones

- Radiolaria rich limestones (3 samples):
  - Higher than average radiolaria density (15-20 %)
  - Associated with cherts nodules
  - Well preserved silicified radiolaria in limestone
  - 15% SiO_2 (1 sample), probably from small nodules, highest Fe content of limestones




Normal limestone
500 µm


Radiolaria rich limestones
500 µm

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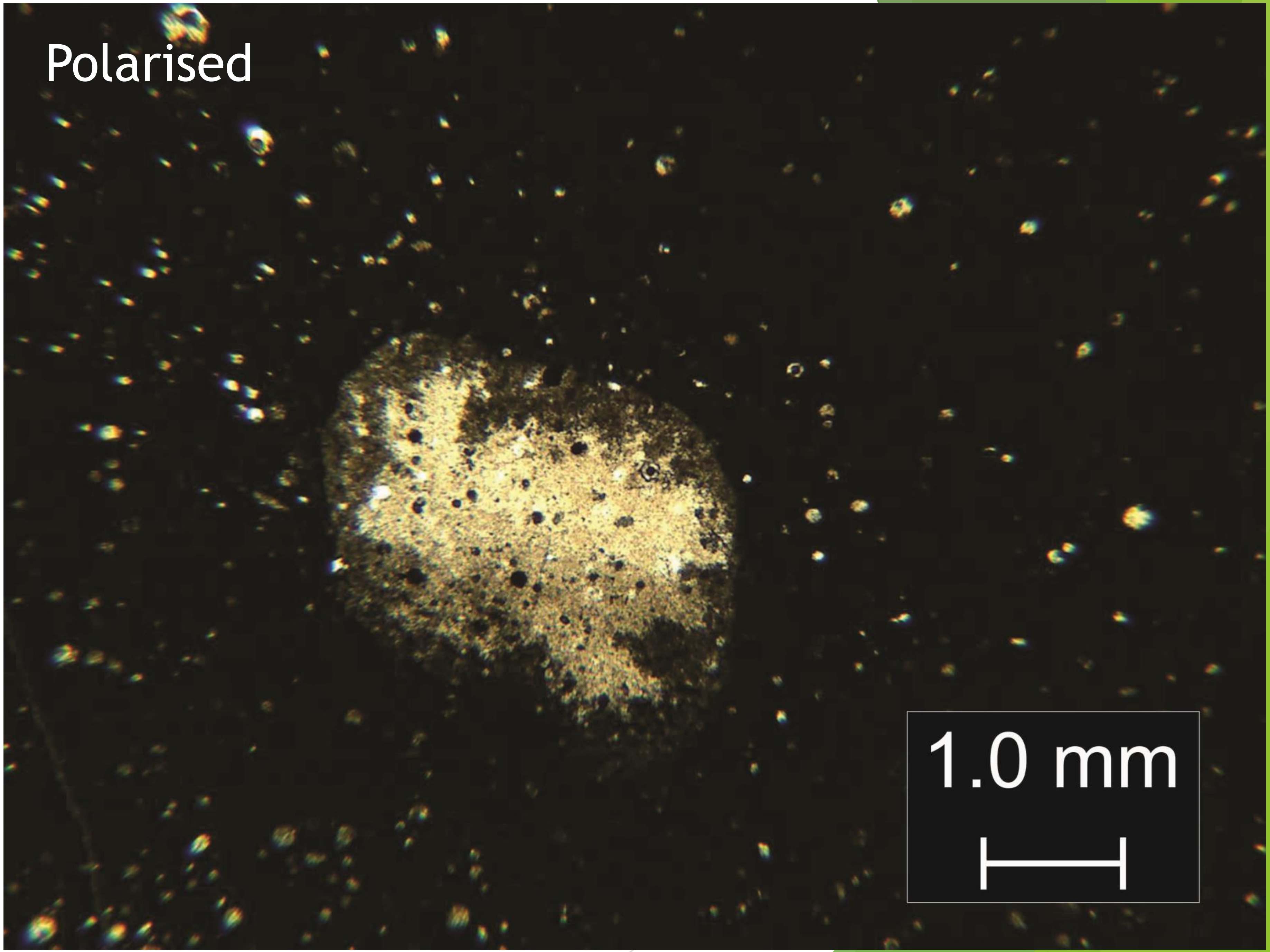

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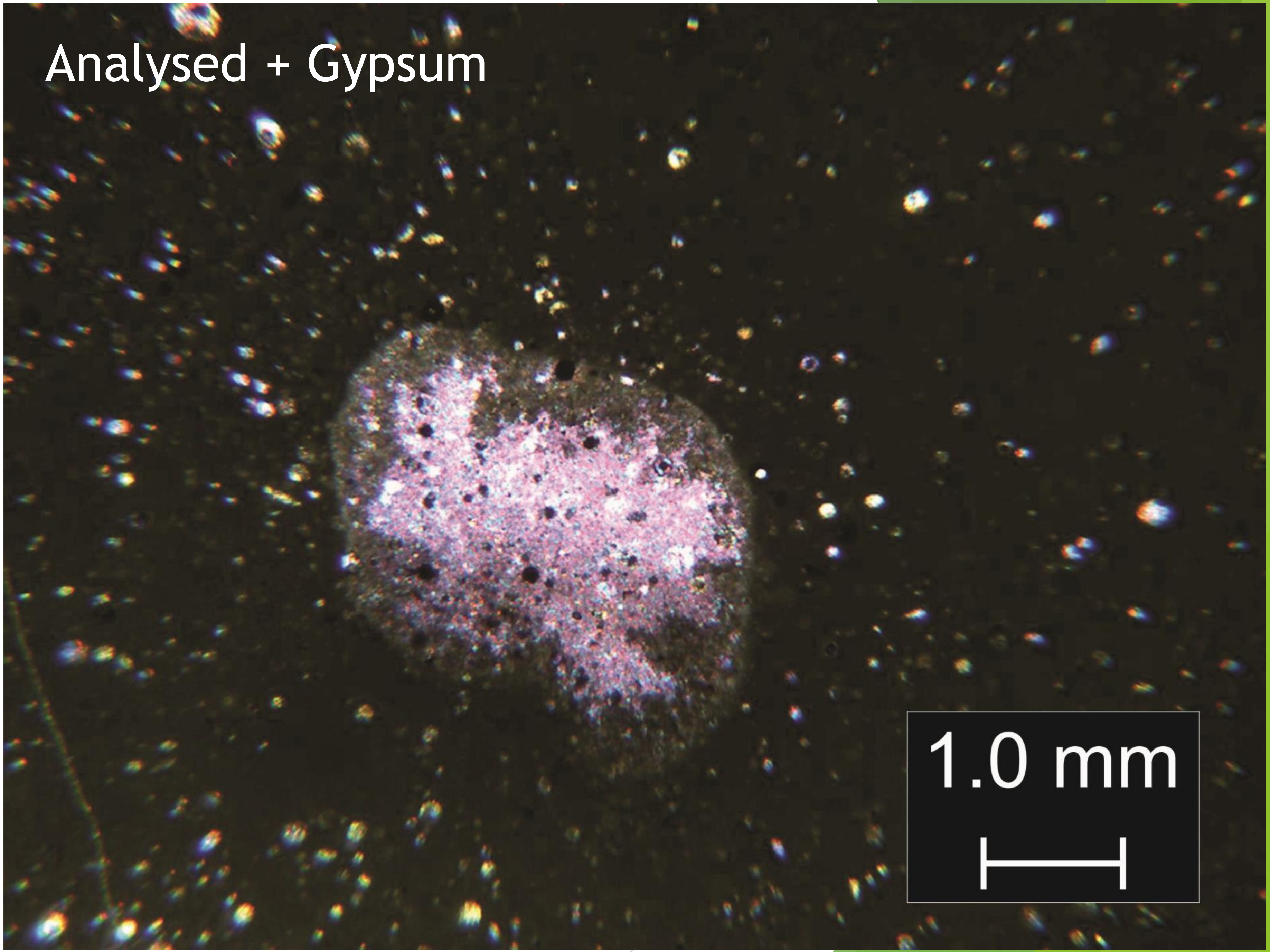

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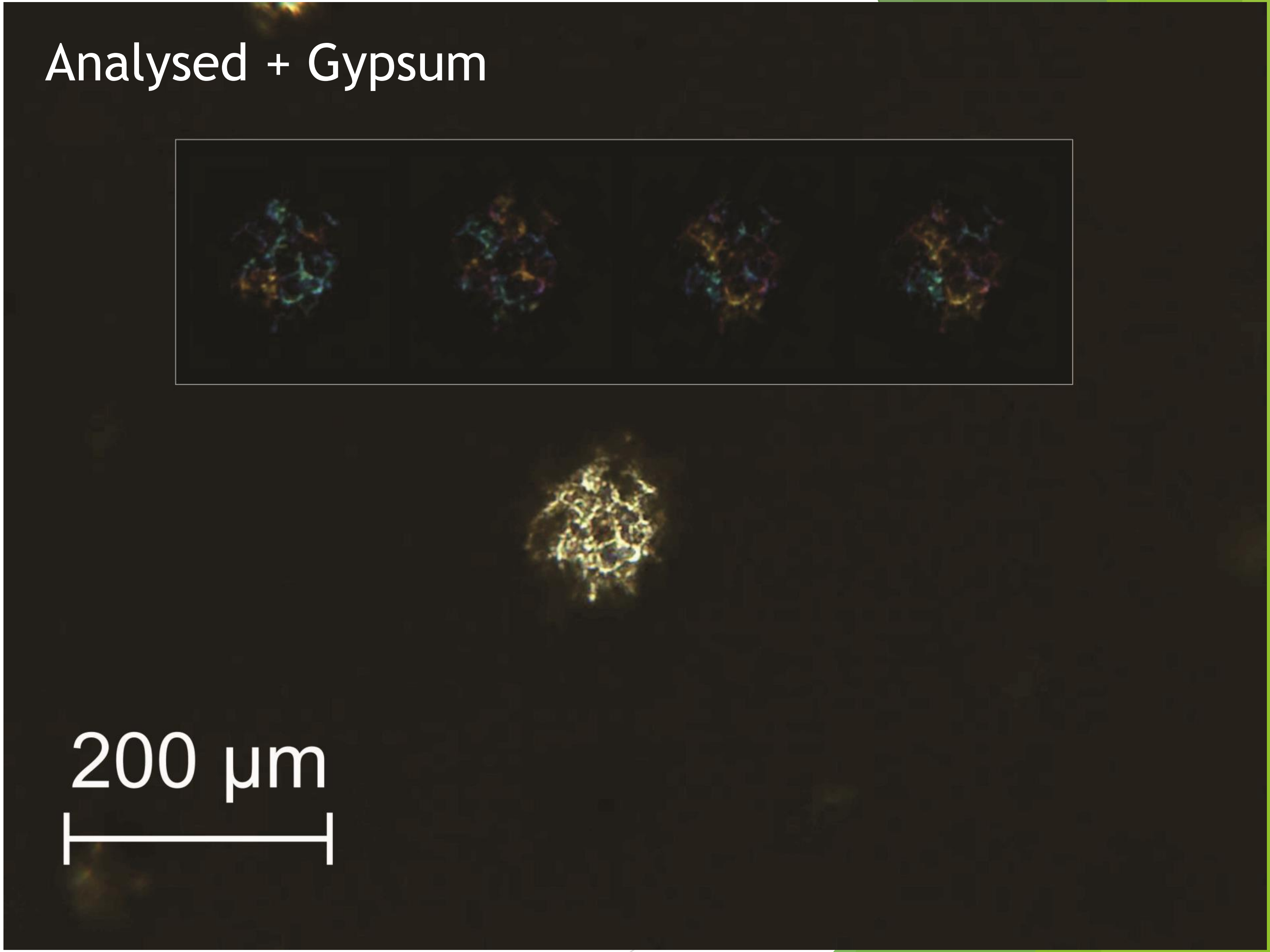


Diagenetic effect

- Thorough **segregation** of mobile **Si** and **Ca** between cherts and limestones
- Similar concentrations of **radiolaria**, **Ti** and **Al** in cherts and limestones
- The abundance of cherts in the section (estimated from **5 to 12%** based on lithological observation) is coherent with the visual abundance of radiolaria observed in most thin sections (**5 to 10%** cherts and limestones alike)

- Relatively low **Fe** concentrations and low magnetic susceptibility in cherts: iron oxides dissolution ?

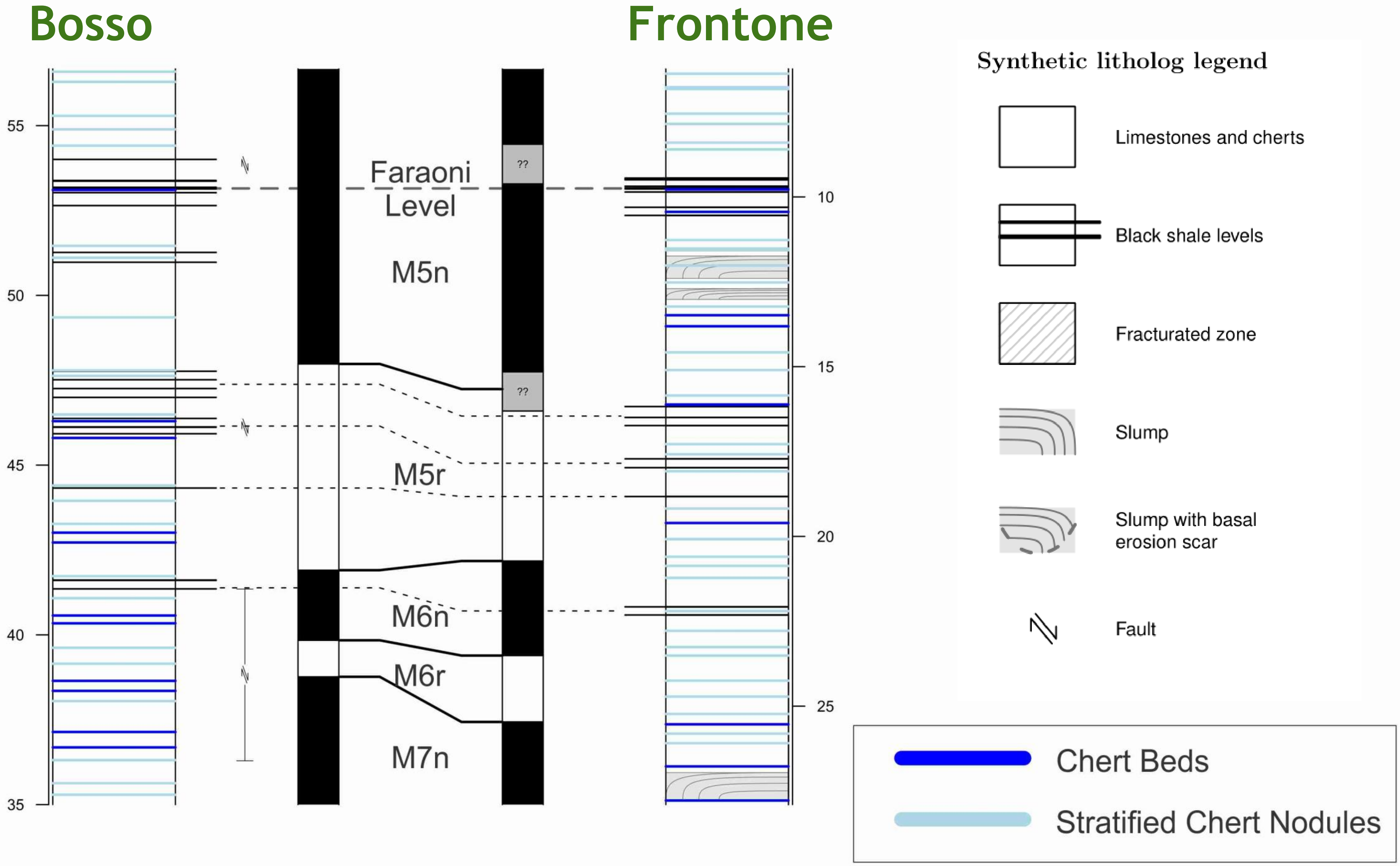
- Intermediary samples of limestone with high radiolaria density and chert nodules

Discussion

- Is there a primary signal preserved in the limestone/chert alternation ?
- Is the diagenetic effect reinforcing the alternations or creating them entirely ?

"…opal-CT nucleation during chertification is largely heterogeneous on pre-existing opal-CT crystals…" (Maliva and Siever, 1989)

Mechanisms explaining chert formation allow for both possibilities



Bosso
Frontone
Synthetic litholog legend
Limestones and cherts
Black shale levels
Fracturated zone
Slump
Slump with basal erosion scar
Fault
Chert Beds
Stratified Chert Nodules
Faraoni Level
M5n
M5r
M6n
M6r
M7n
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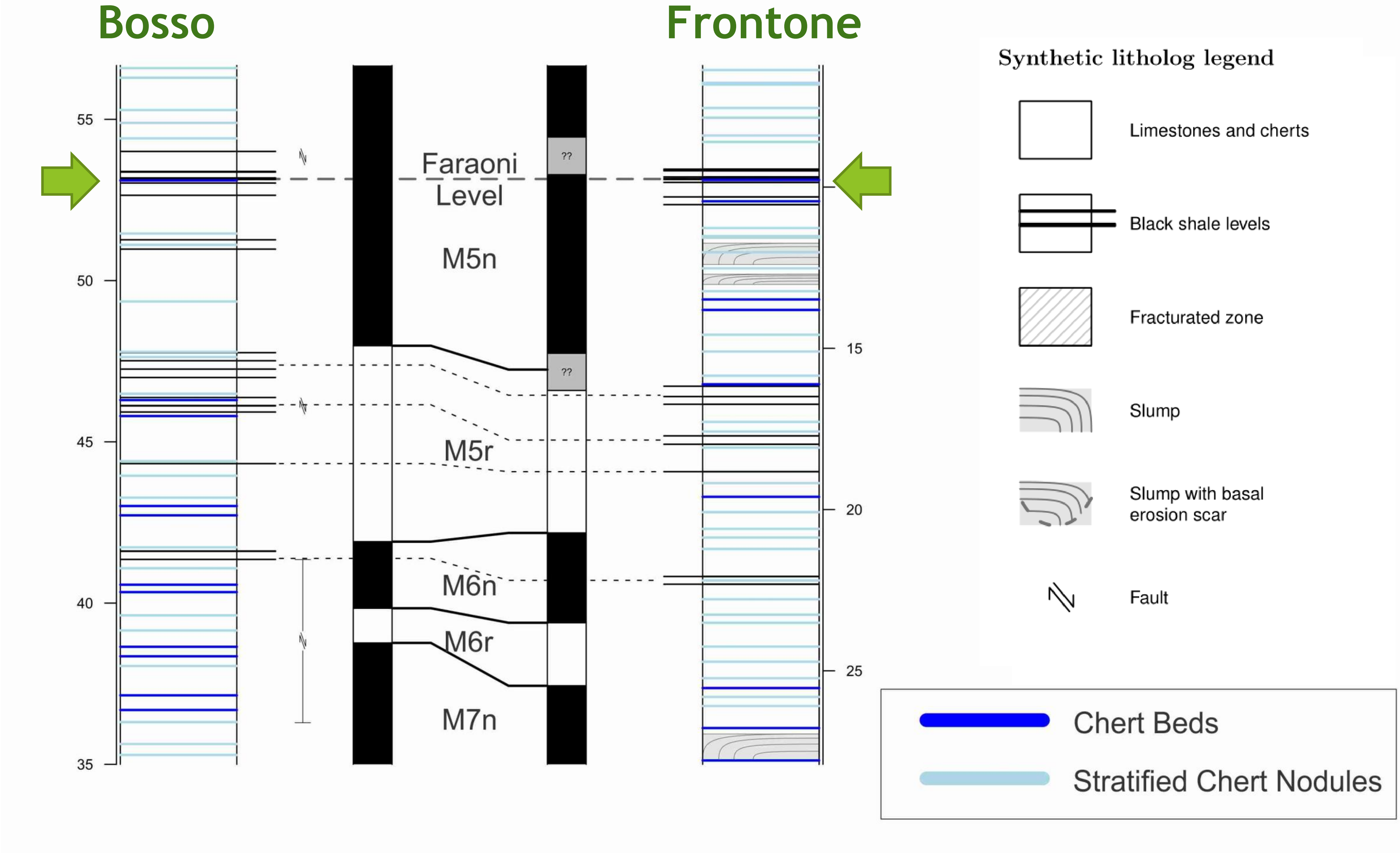

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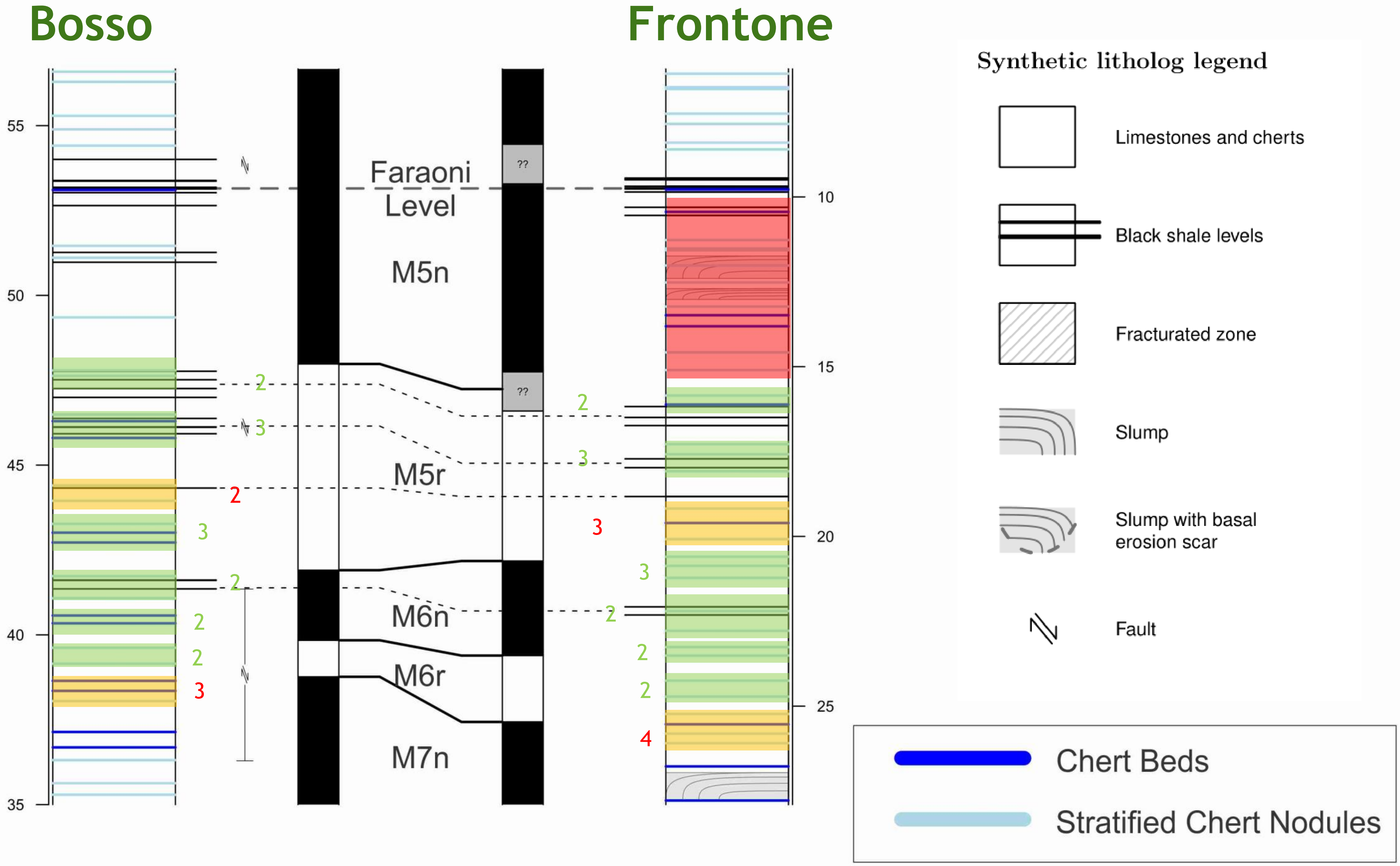

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Fault
Chert Beds
Stratified Chert Nodules

Using stratigraphy to study diagenesis

- Chert **beds** and **stratified nodules** can be correlated as bundles in some parts of the sections, with some only small offsets in relation with black shales and a few differences in number of cherts

- Beds can be correlated to nodules and vice-versa

- Some parts of the sections are not correlatable (extending beyond the slump-affected parts in Frontone)

Conclusion

- Strong **diagenetic segregation** of **Si** and **Ca** at the source of **nearly pure chert and limestones**

- Chert beds and stratified nodules still record a reproducible pattern at a regional scale

- **On part strongly inconsistent:**

  - Lack of cherts in Bosso

  - Slumps in Frontone, and abundant chert levels outside neighbouring slump intervals

Conclusion

- High-resolution stratigraphy at a regional scale is a powerful tool to study diagenesis

- **Even with signs of strong diagenesis, diagenetic alternations can still be correlated at a regional scale**

  => Reinforcement of primary alternations ?

- **However heterogenous processes seem to be equally capable of creating alternations from nothing**

The ubiquity and regularity of chert layering make it generally difficult to identify any specific pattern without independent high-resolution stratigraphy

How do we characterise/quantify discrepancies in pattern matching ?


Thank you for your attention

References

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