

# MORPHOLOGIES MINERALES (HEMATITE, PYRITE, DOLOMITE) ATTRIBUABLES A L'ACTION MICROBIENNE

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MAMET B & PREAT A (2004) Morphologies minérales (hématite, pyrite, dolomite) attribuables à l'action microbienne. *Microbialite and microbial communities in sedimentary systems, Workshop, Paris, 6-9 September.*  
*Eds. Camoin 1 Gautret, Public. ASF, Paris, n°46, 71*

## THREE EXAMPLES

- 1. The iron bacteria and associated fungi**
- 2. The pyrite et the pyritospheres**
- 3. The ‘filamentous’ chains of dolomite**

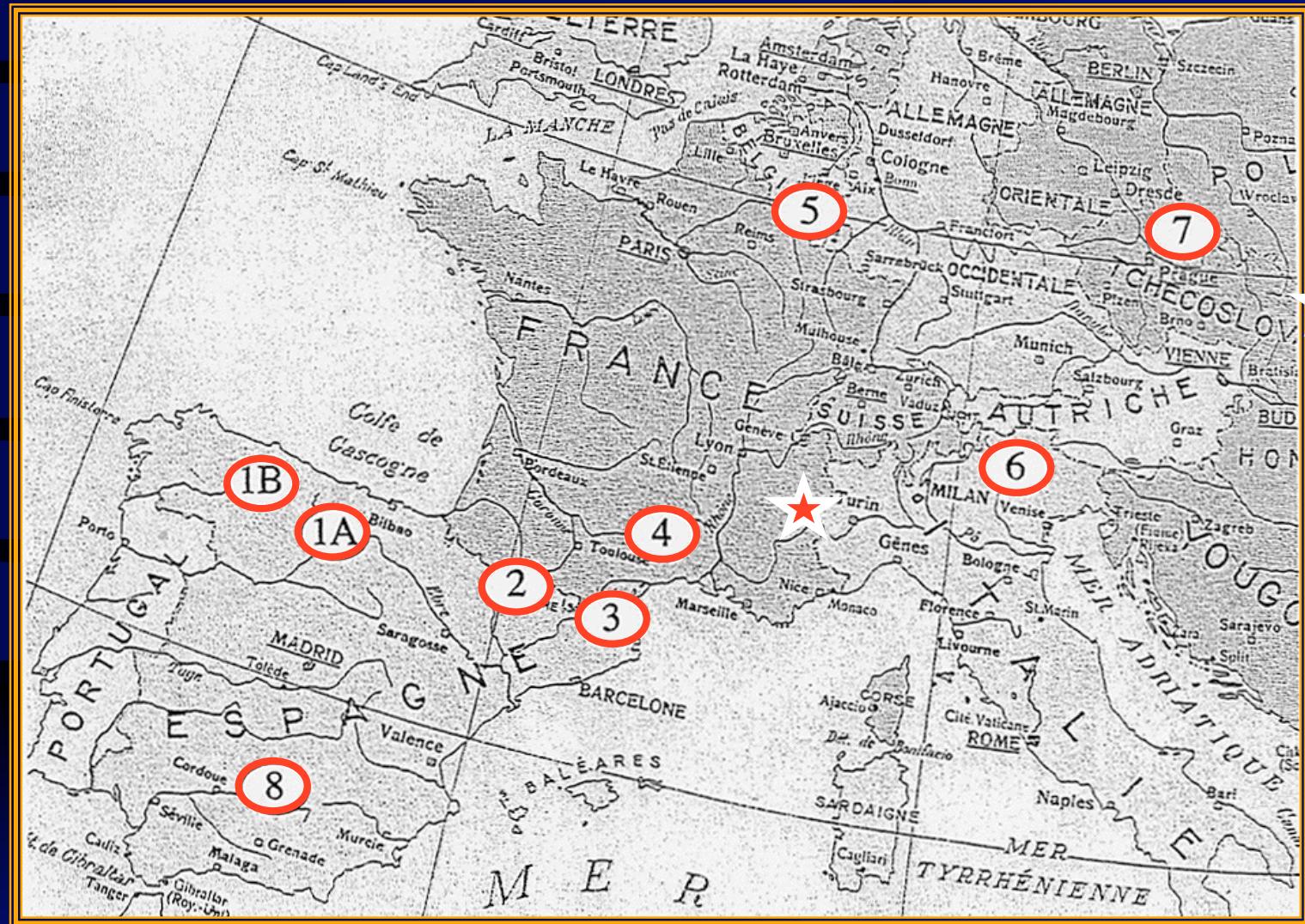
## 1. The IRON BACTERIA and FUNGI

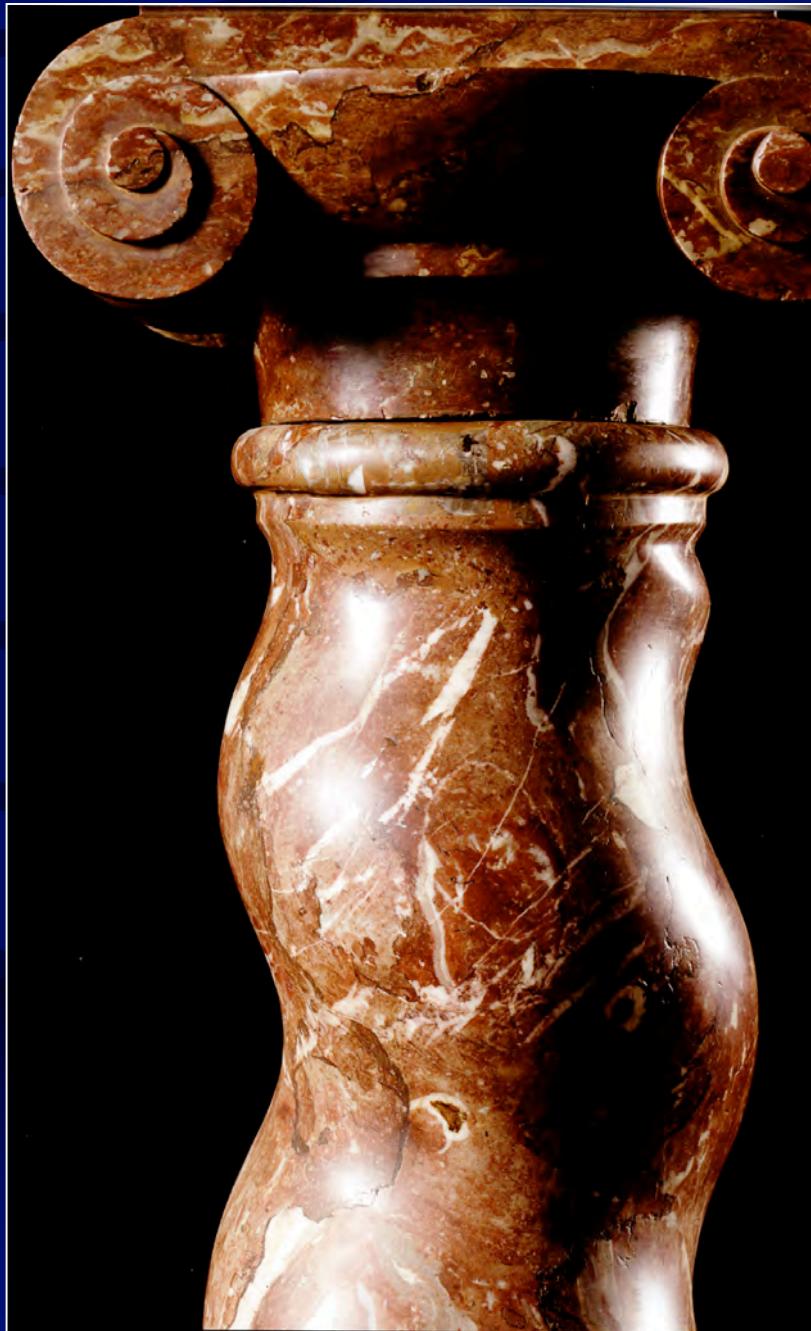
European red marbles are rare  
but precious ...

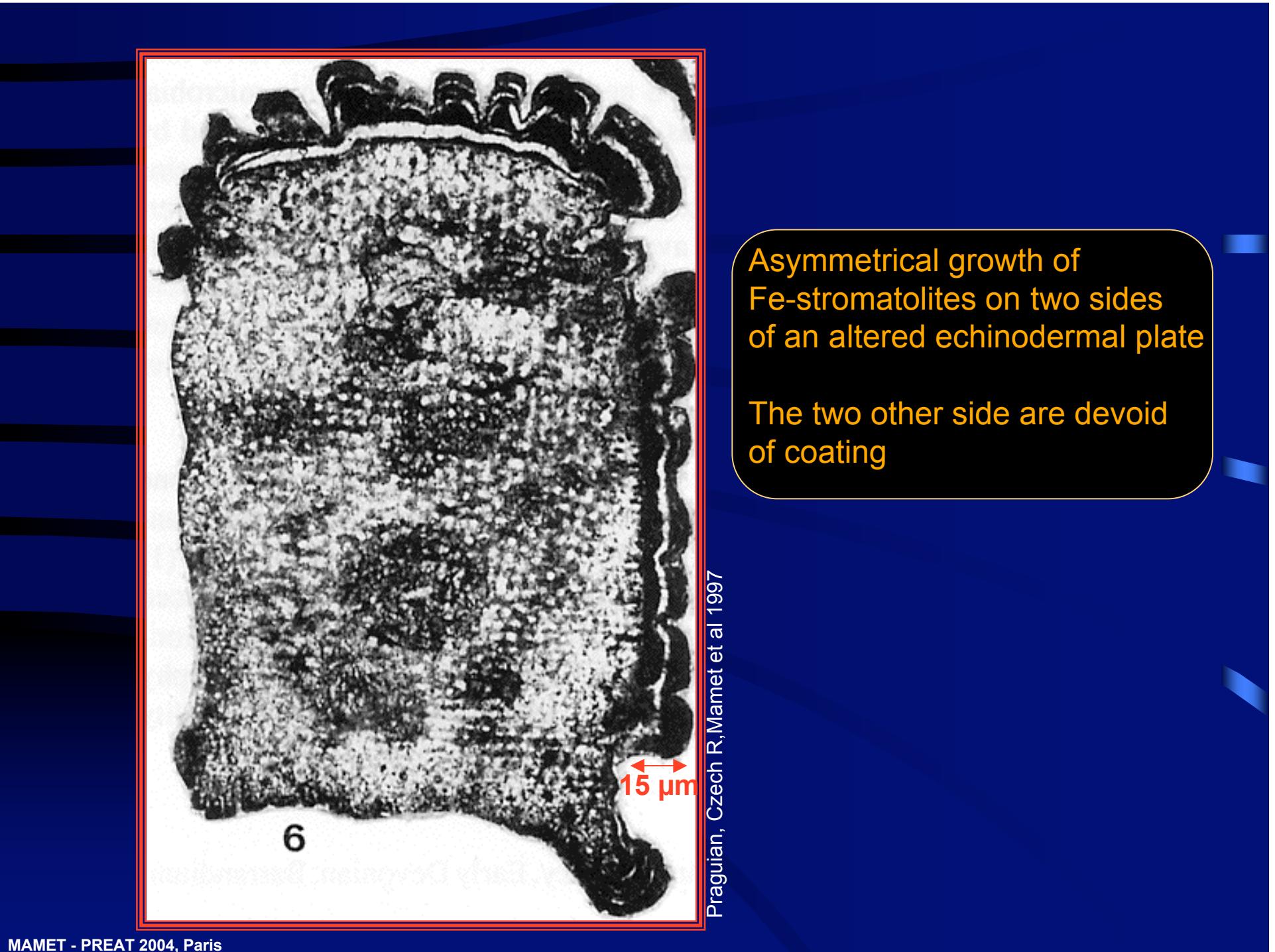
- griottes Devonian France, Viséan Spain
- ‘red marbles’ Devonian (Frasnian), France, Belgium
- Ammonitico Rosso Jurassic, Italy, Spain, *Bulgaria, Guillestre*
- ‘red marble’ Devonian, Slivenec (Prag)
- ‘red lenses’ Carboniferous, Spain
- ‘Oolite ferrugineuse de Bayeux’ mid-Jurassic, Normandy

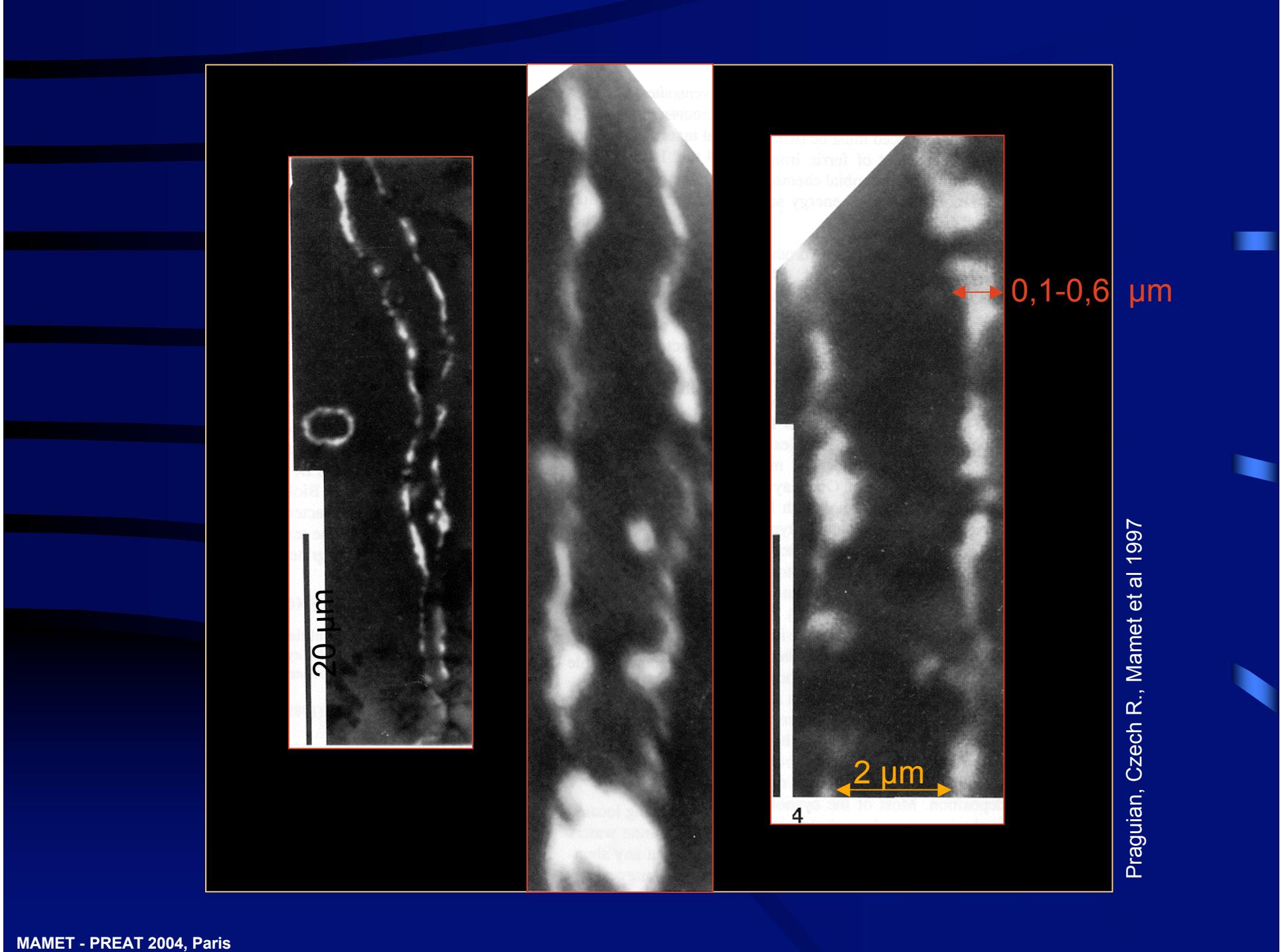
*cathedrals, castles, Versailles, Trianon...*

# 1. The IRON BACTERIA and FUNGI





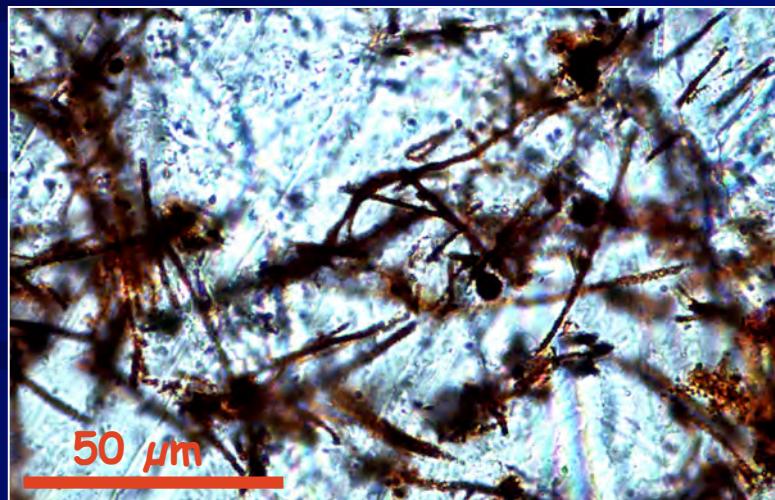




Pragian, Czech R., Mamet et al 1997

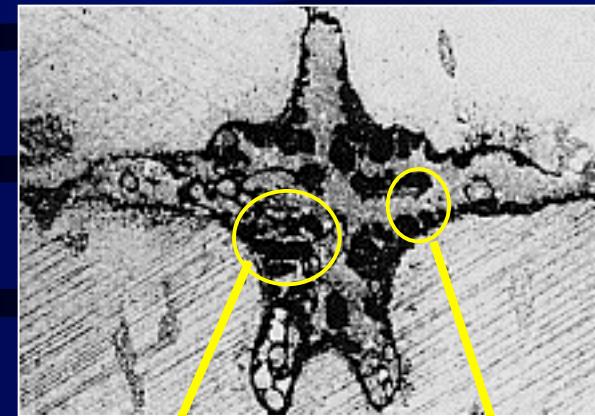
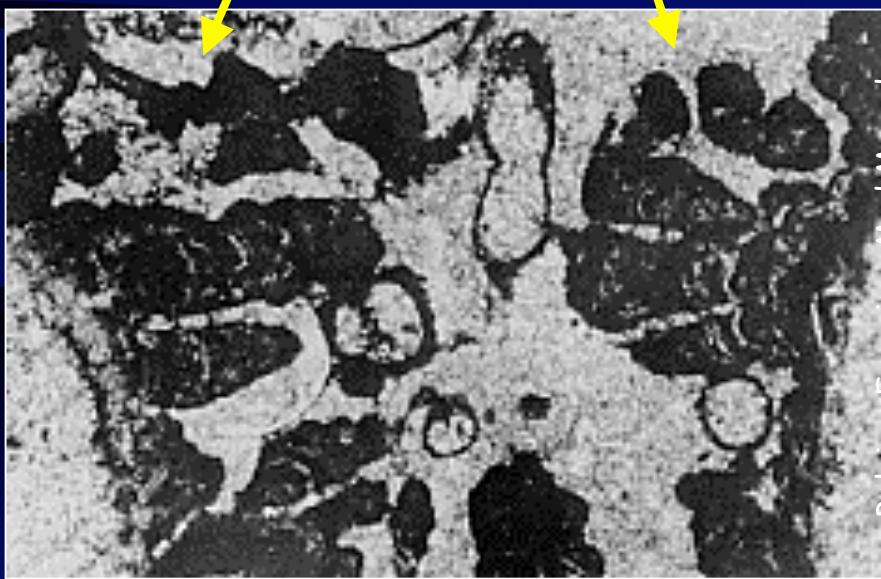


## 'F2j' mud mounds or 'bioherms'

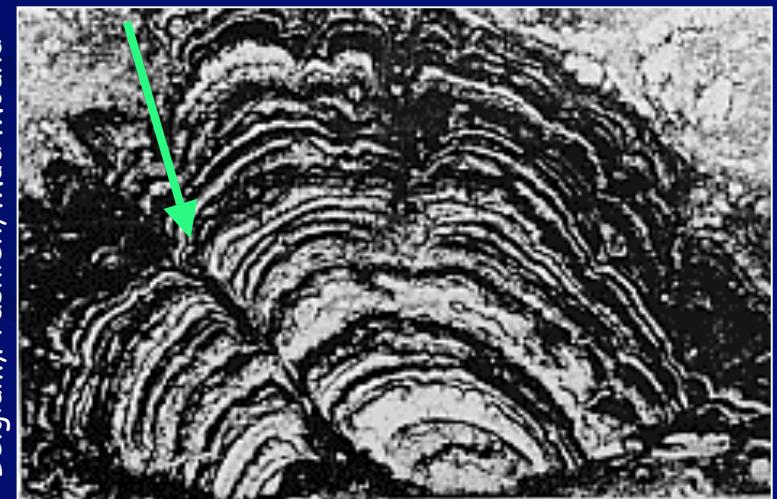


Iron-bacteria  
(*Siderocapsa*-like, *Sphaerotilus-Leptothrix*-like  
in the internal sediments of *Receptaculites*  
Rochefontaine quarry, Franchimont, Philippeville  
Massif (Boulvain et al. 2001)

Soain, Frasnien



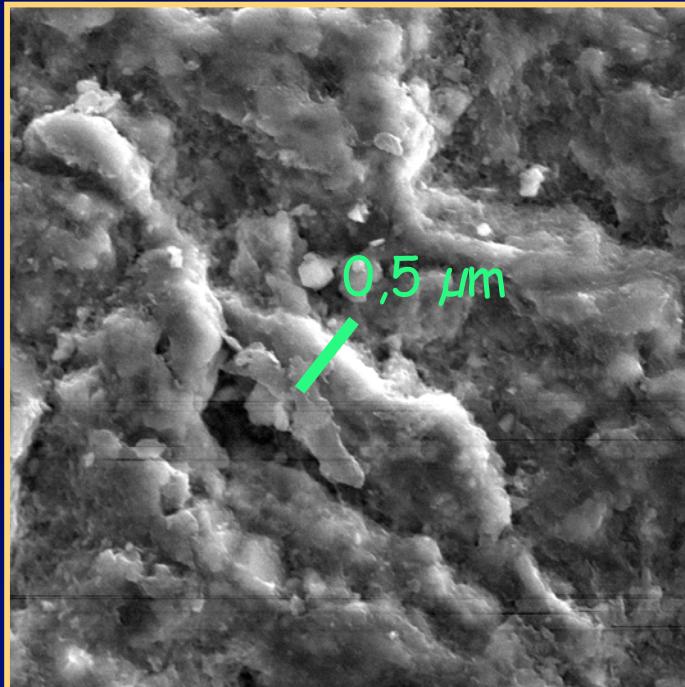
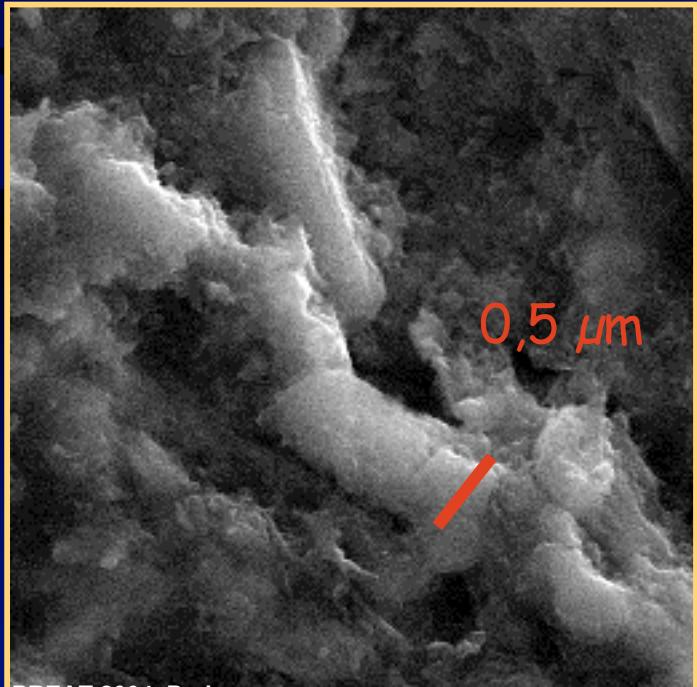
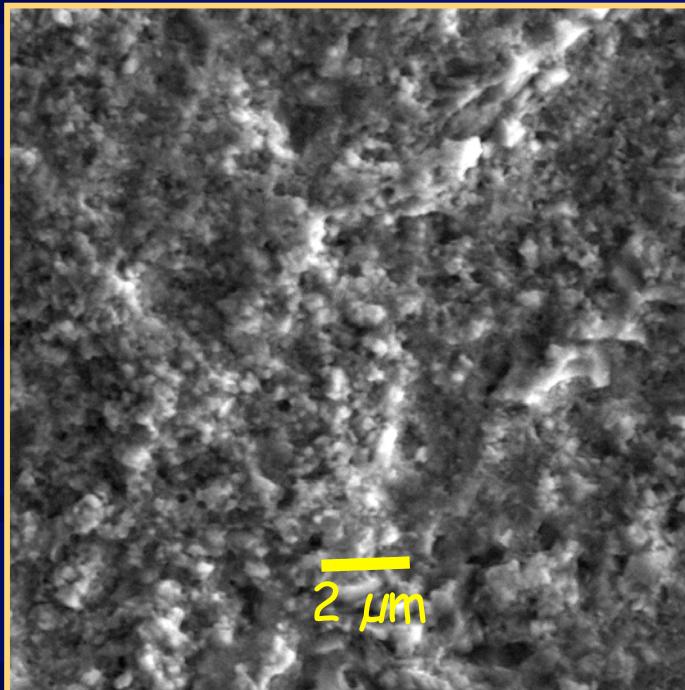
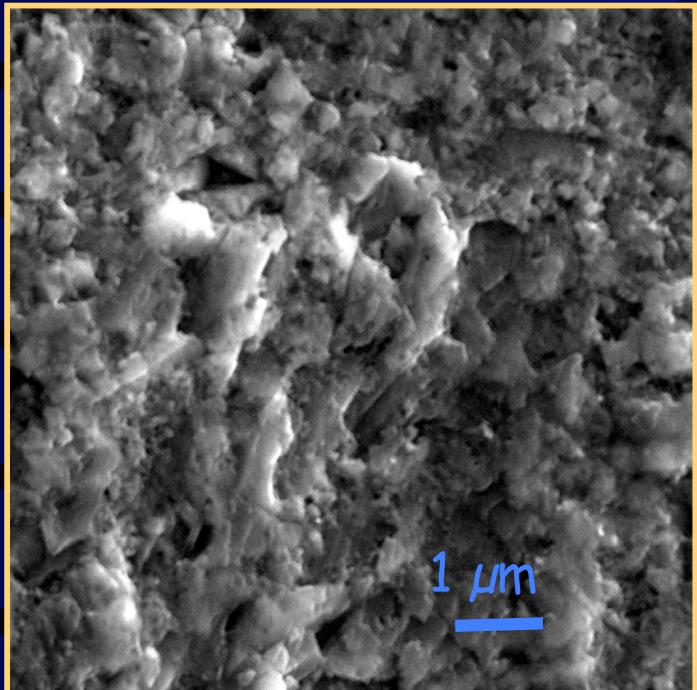
Belgium, Frasnien, Mud Mound

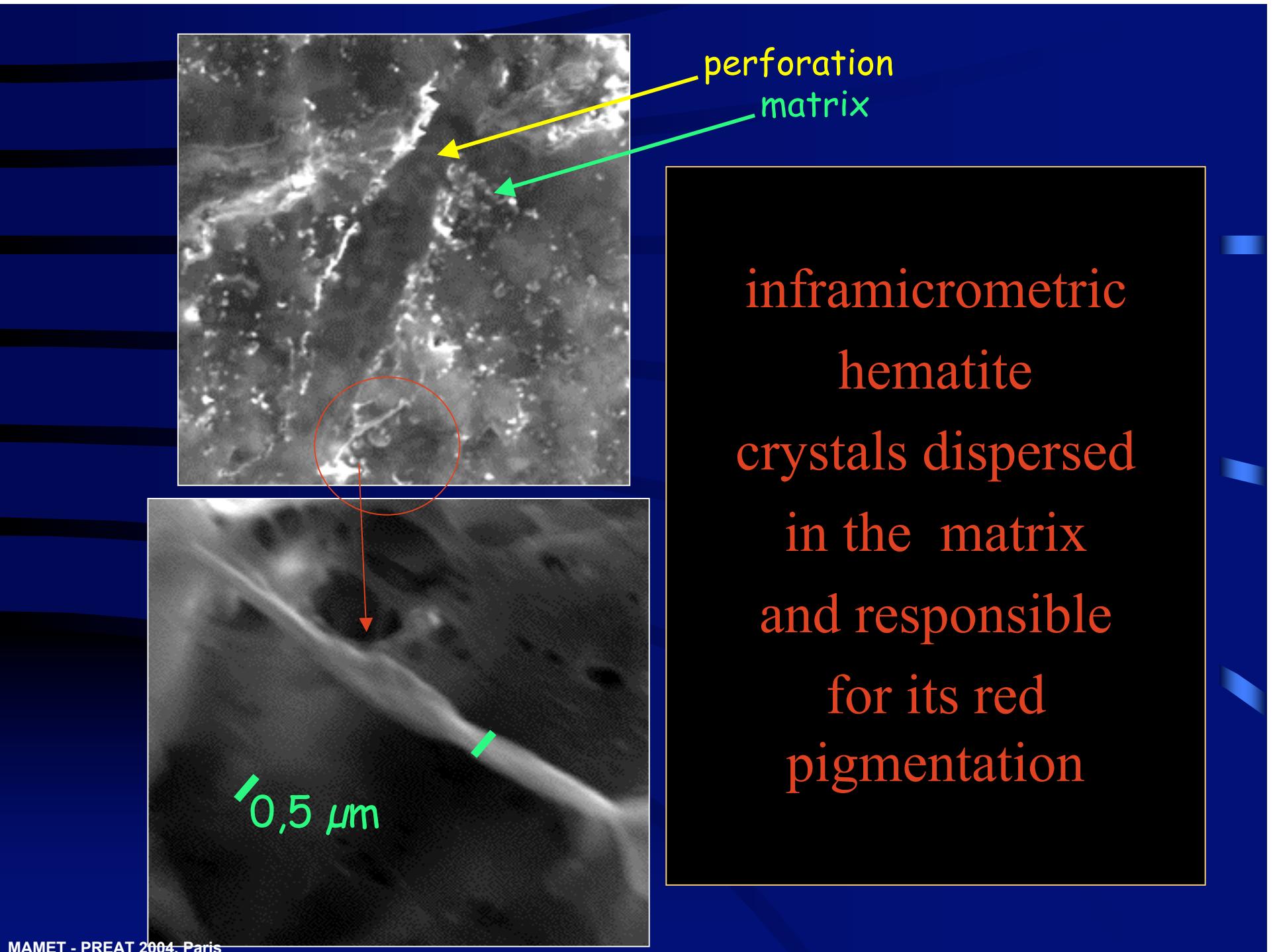


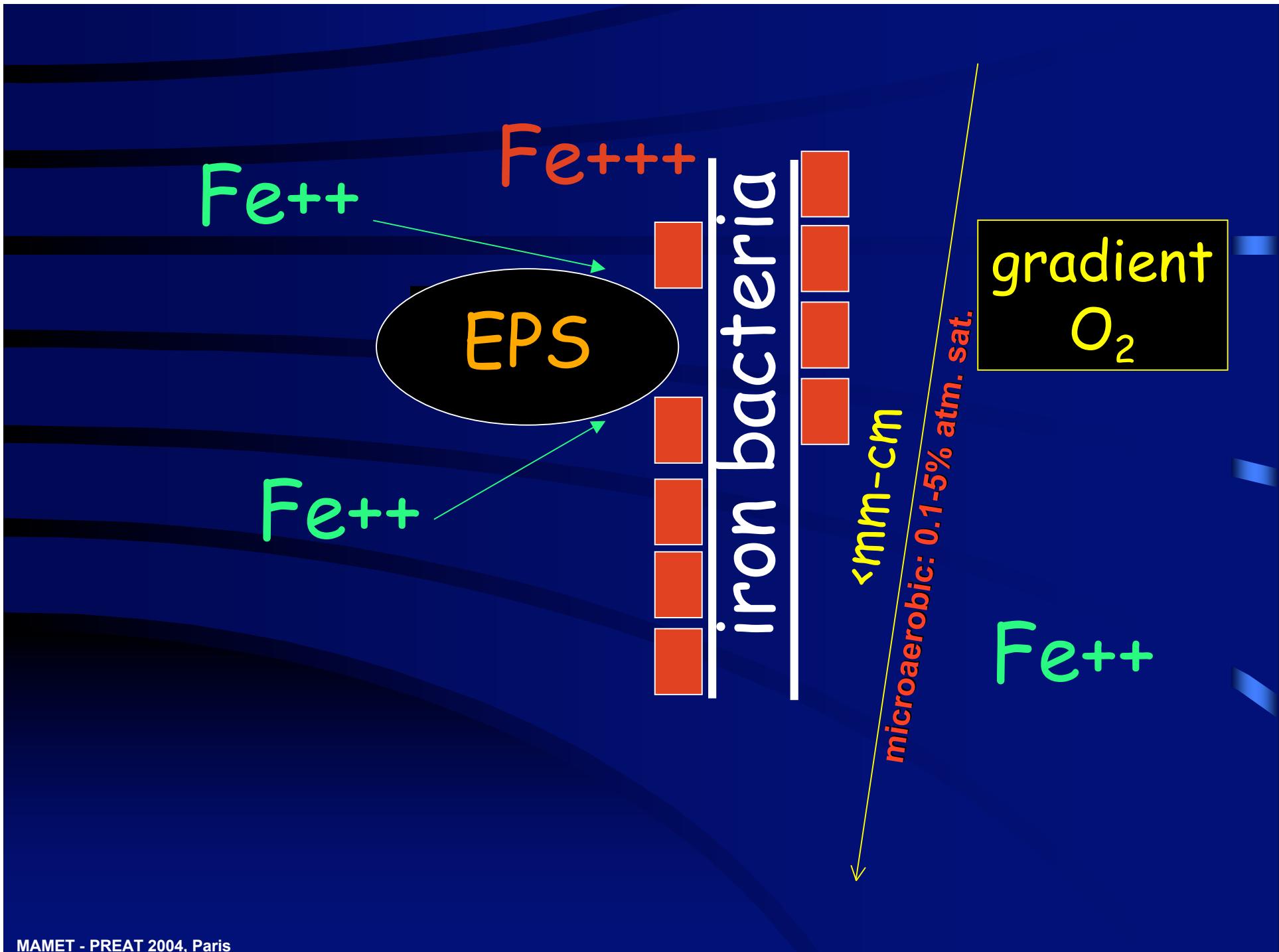
*with Fe-endostromatolites and Fe-microstromatolites*

*benthic  
bacterial  
mats  
(up to  
20%!)*

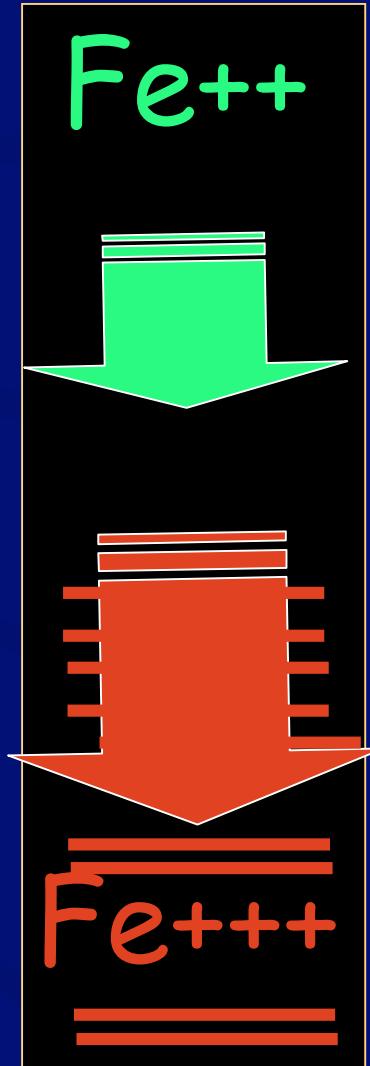
Italy, Jurassic, AR







in the past,  
coccoid and bacillar bacteria  
associated with other micro-  
fossils formed mineralized  
biofilms



# ORIGIN OF PIGMENTATION

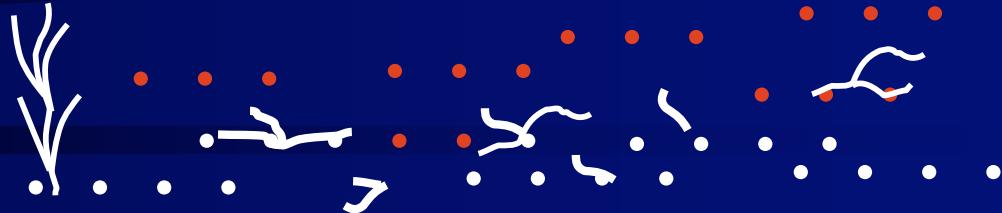


Bacterial and fungal filaments, tufts and/or mats grow at the sediment-water interface.

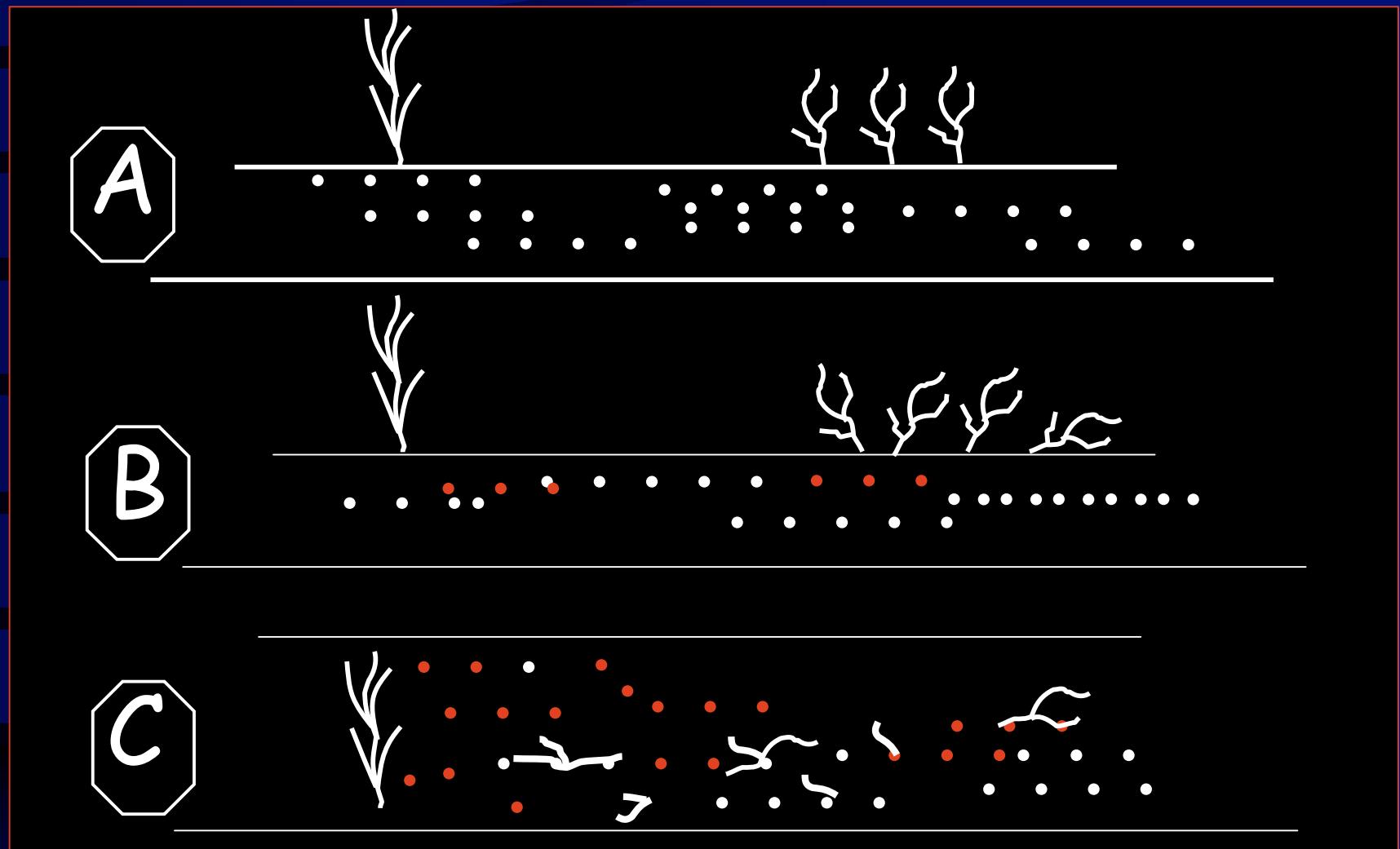
B



Tufts decay, iron rich sheaths disintegrate and liberate iron hydroxides in the sediment. Some filaments are fortunately preserved.



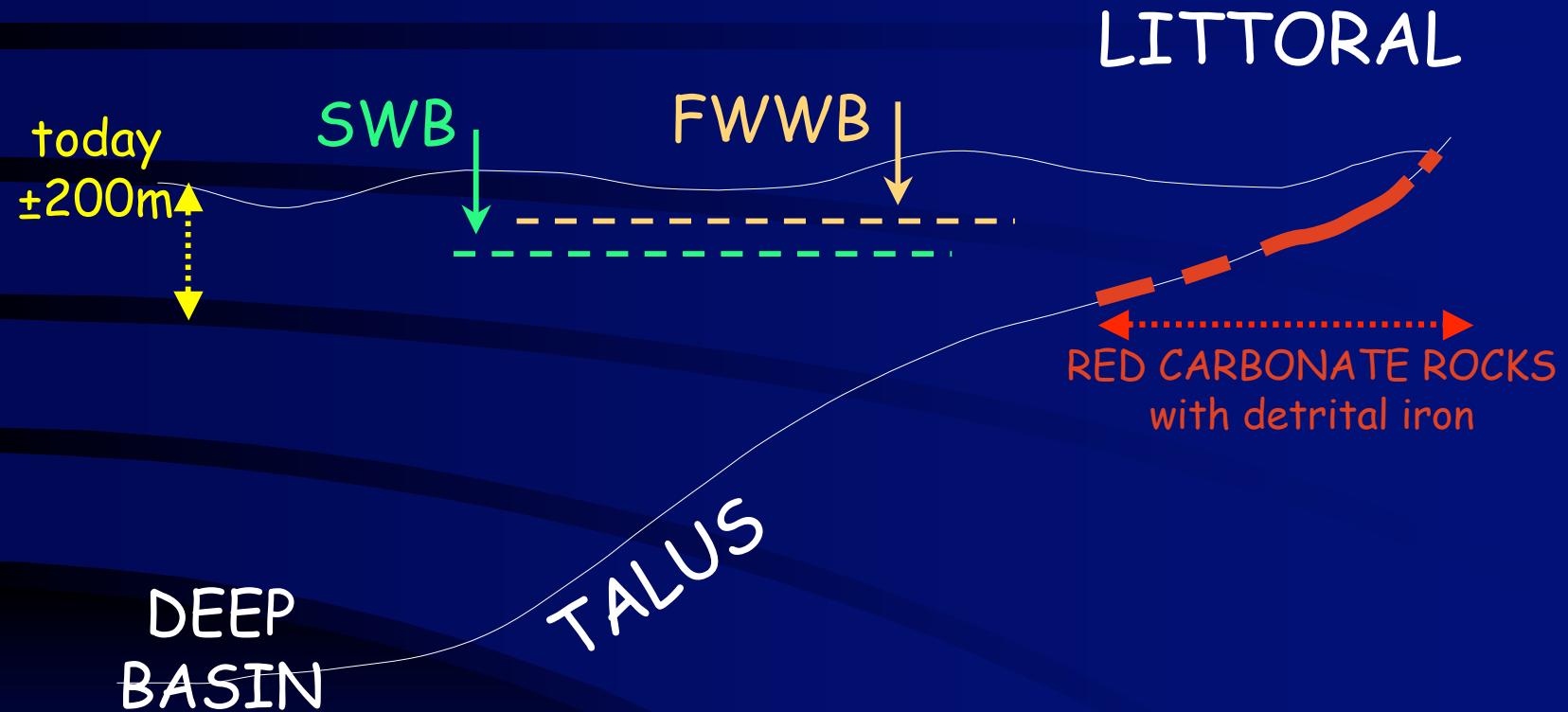
The sediment recrystallized and is now rubefied. Rare fossilized microfossils point to the original bacterial horizon.



*Further diagenesis will transform the micrite into a porous microspar. Iron hydroxides are now hematite.*

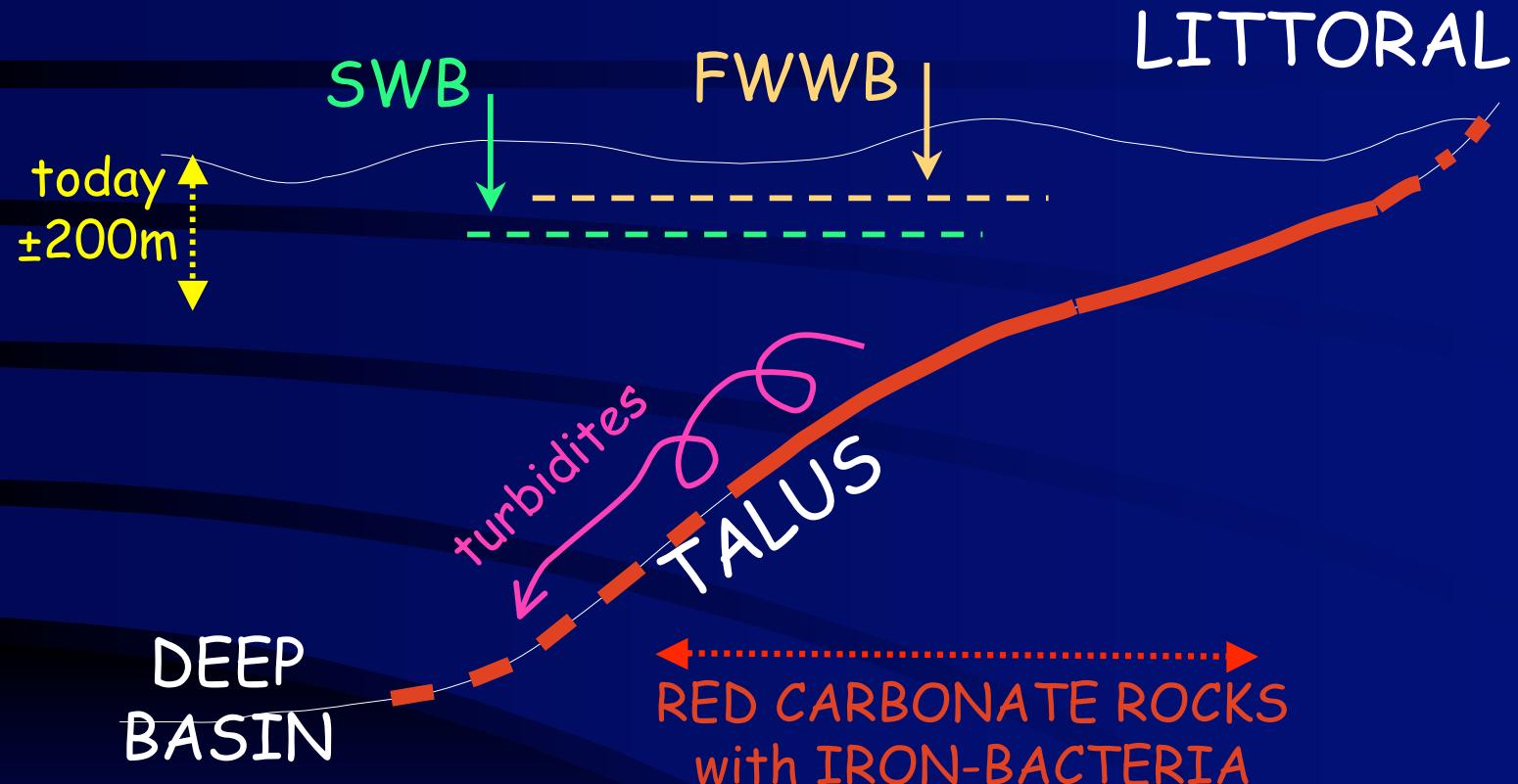
... What about palaeogeography ?

# DETrital ORIGIN



*... if the iron is detrital, it will be concentrated  
in very shallow agitated waters,  
near the continent associated with high O<sub>2</sub> levels*

# BIOLOGICAL ORIGIN



*... if iron bacteria are present, iron hydroxides are linked to an oxic/anoxic gradients in poorly oxygenated waters and independent of light*

## 2. The PYRITE and the PYRITOSPHERES

D-C boundary stratotype of *La Serre*, Montagne Noire

D-C boundary strata in the Dinant and Avesnes basins

*Chaxhe,*

*Rivage,*

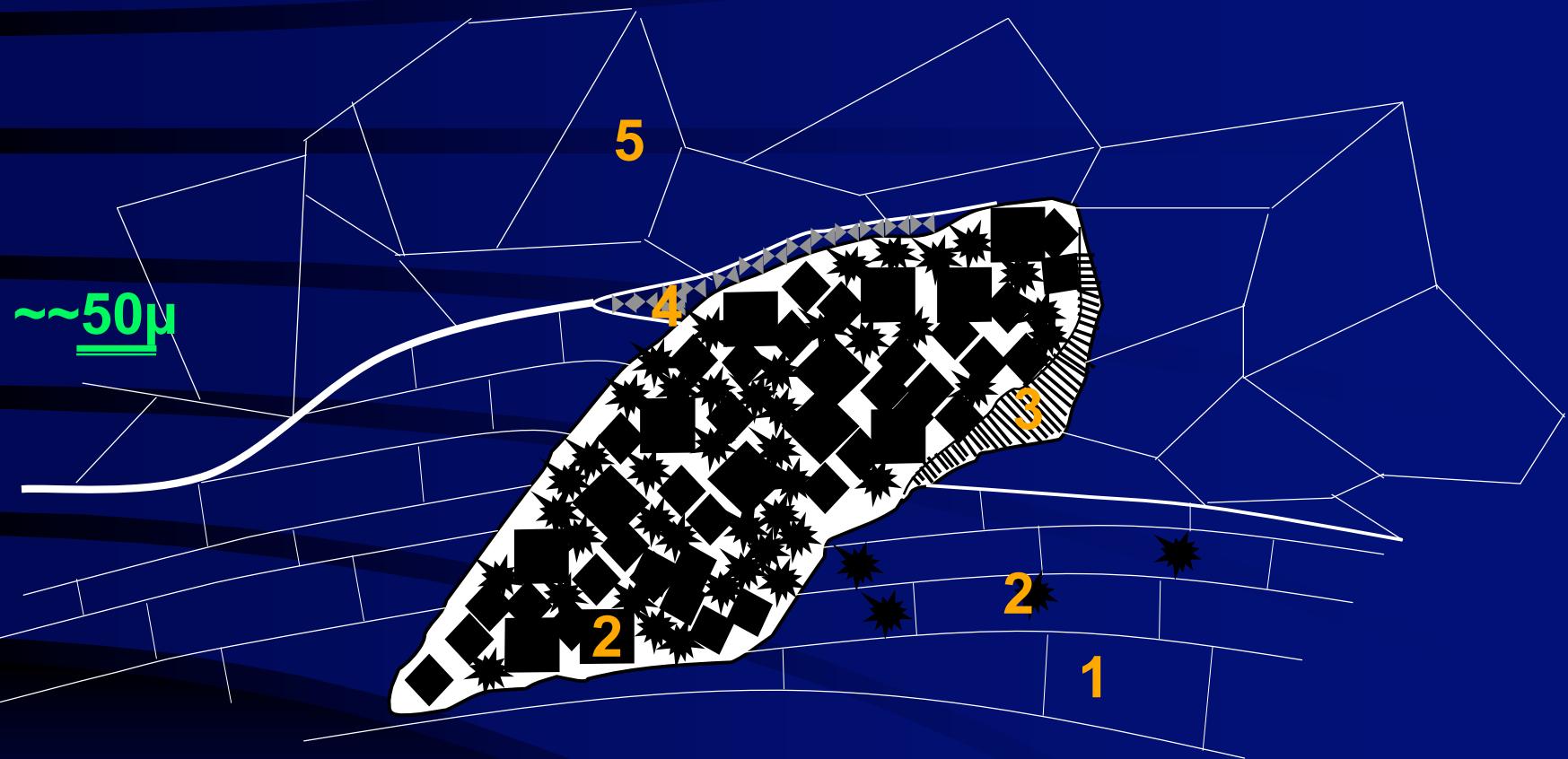
*Anseremme,*

*Avesnes-sur-Helpe*

F-F boundary strata

*Cinquefoil, Roche Miette (Canada)*

## Schematic parasequence



- 1 porous or soft substrate (stromatopore...)
- 2 blisters of pyrite and pyritosphere crystals
- 3 early marine palissadic calcite cement (rare)
- 4 'sheath' of microspar
- 5 coarse clear sparite crystals

# pyrites + pyritospheres

ch44

stromatopore

1

5

20  $\mu\text{m}$

diameter 3  $\mu\text{m}$

1

2

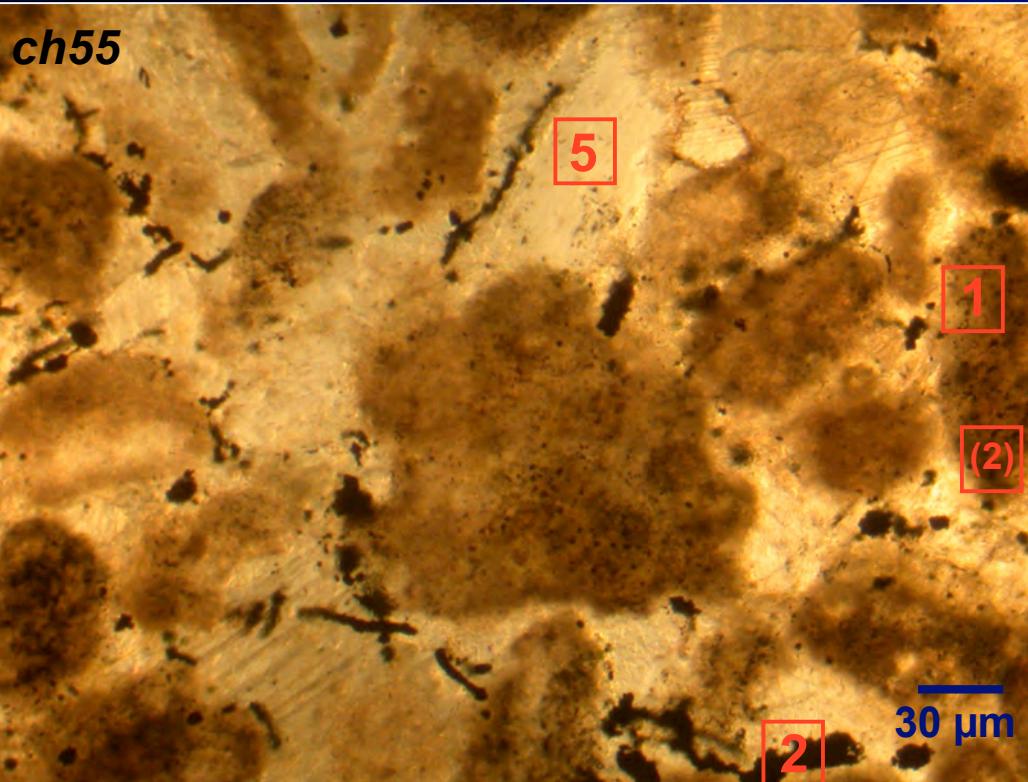
diameter 5  $\mu\text{m}$

2

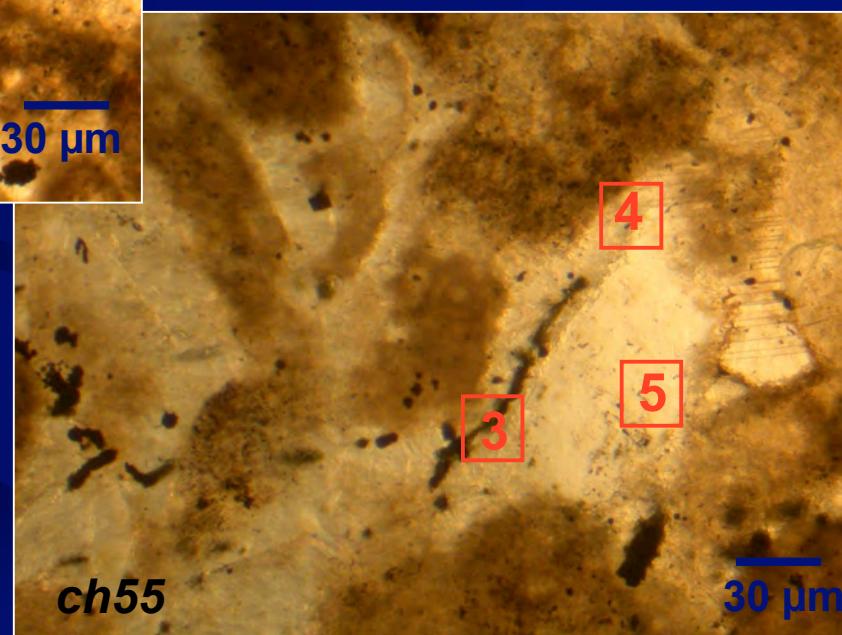
ch44

ch44

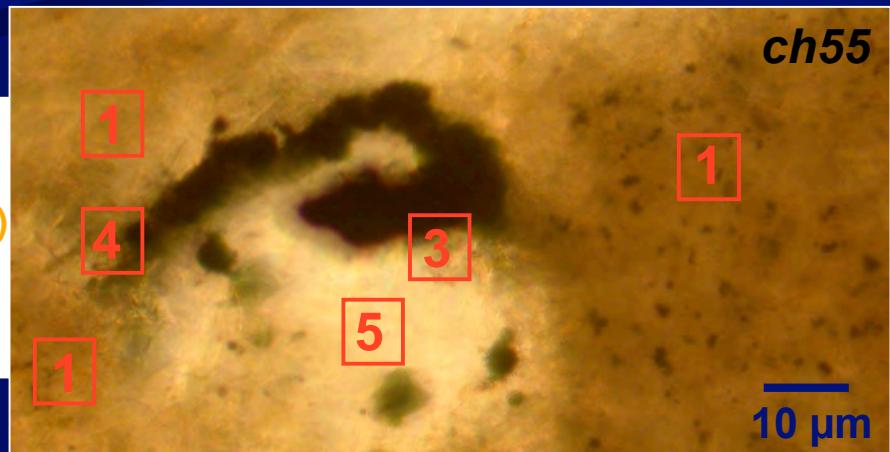
# pyrites + pyritospheres



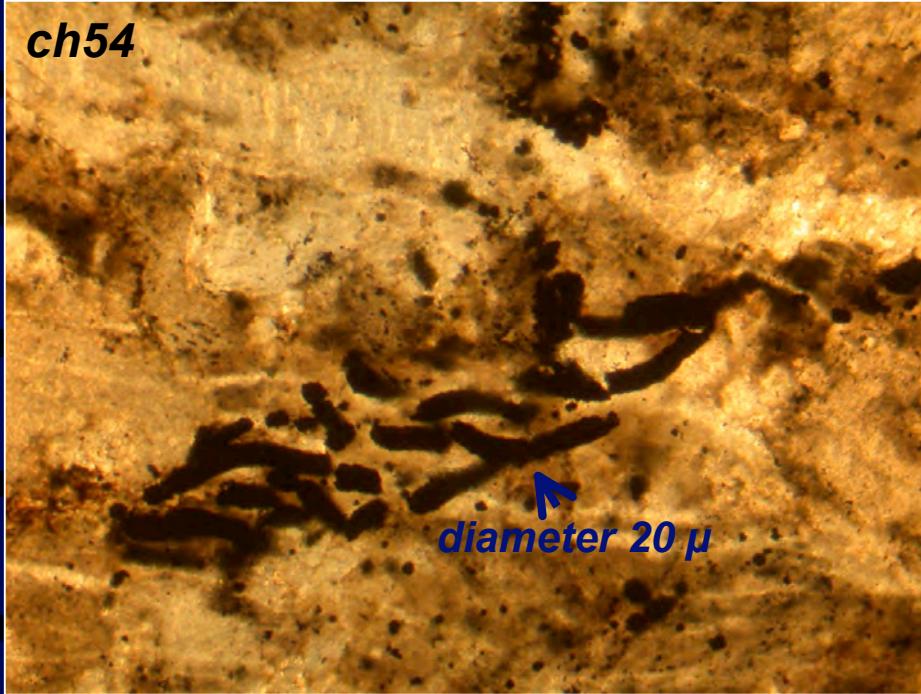
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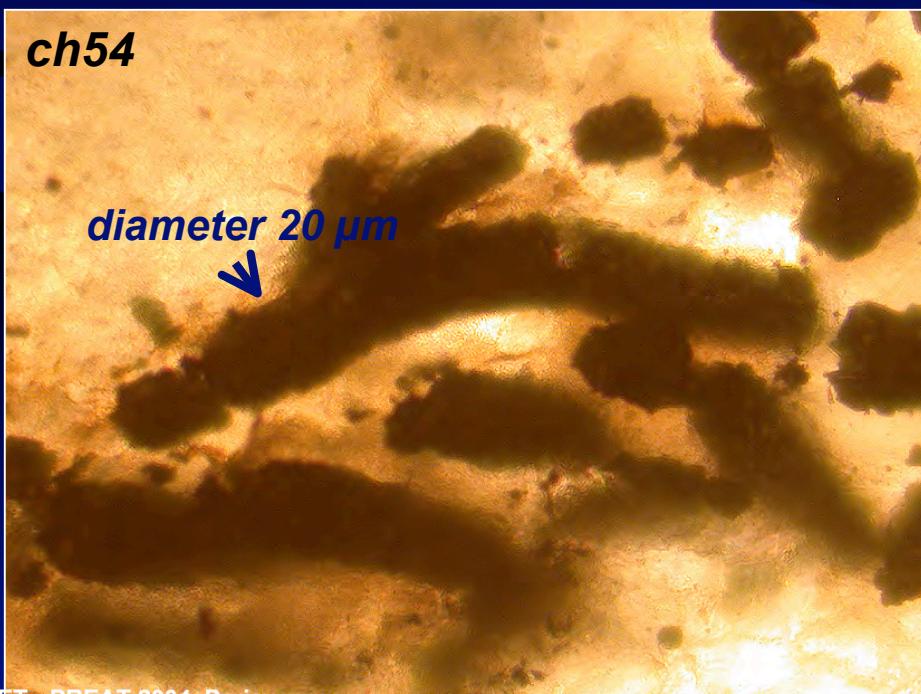


*ch54*

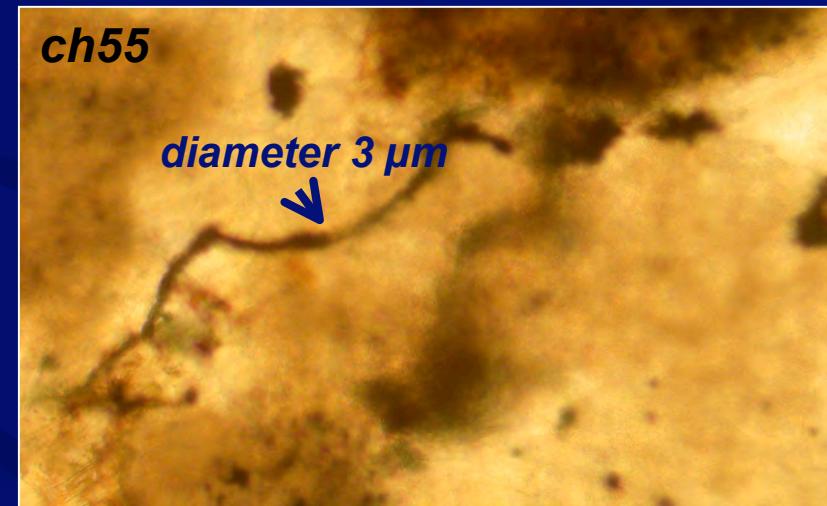


**pyrites + pyritospheres  
+ FILAMENTS**

*ch54*



*ch55*

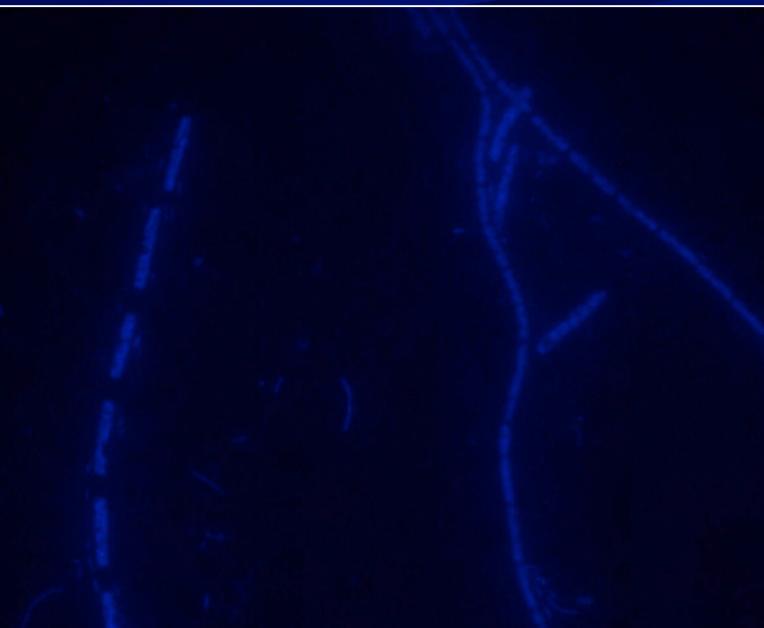


De Ridder & Gomes 2003

*Desulfonema* (formation of H<sub>2</sub>S)  
in the intestinal caecum  
of *Echinocardium cordatum*  
[Recent sea urchin]

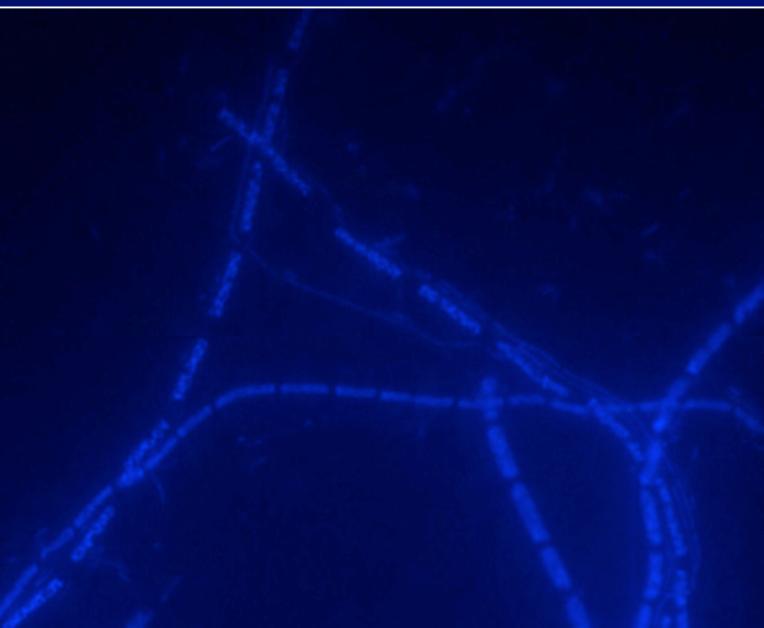
MAMET - PREAT 2004, Paris

Diam: 2 µm



CQF      Upper Devonian  
pyrite      2      5  
pyrite      2      2  
Cinquefoil, Canadian Rocky Mtns

Diam: 3 µm



### 3. The FILAMENTOUS CHAINS of DOLOMITE

Middle Viséan at Avesnes-sur Helpe (North of France)

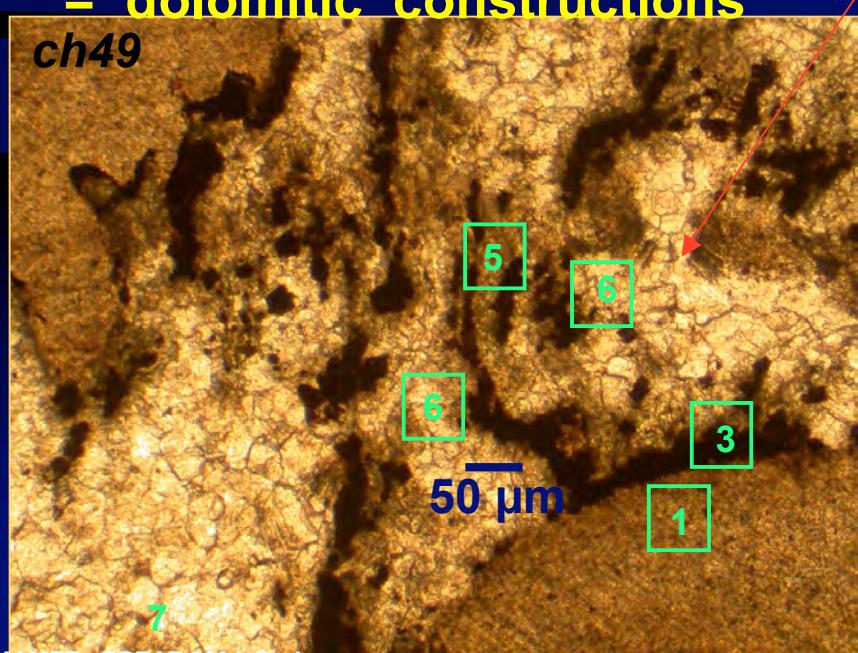
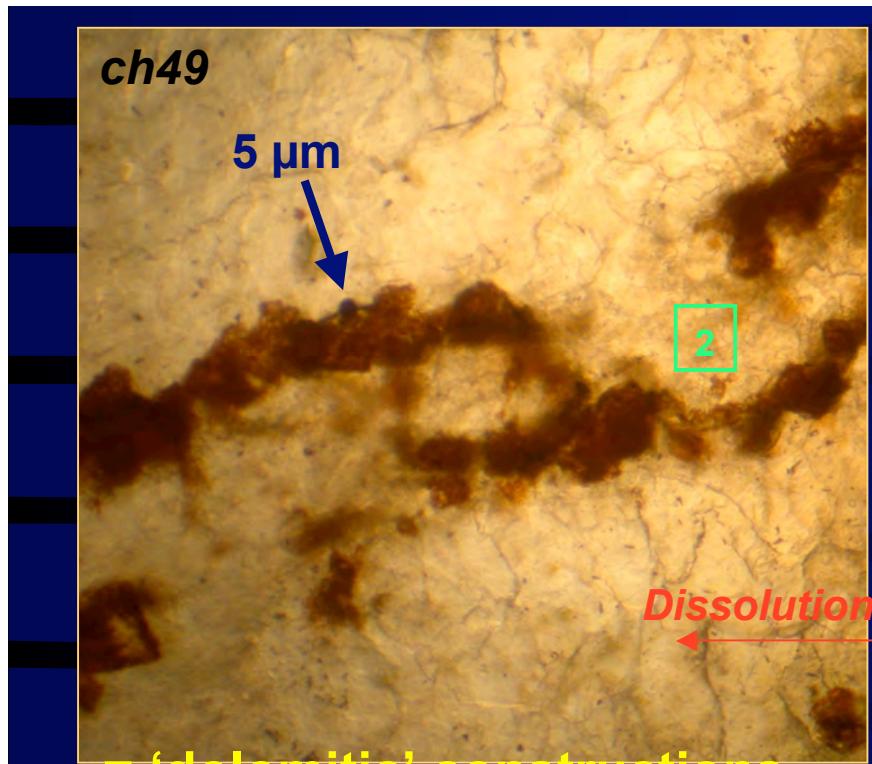
- *Calcretes and sebkhas infested by fungi*

Upper Famennian along the Ourthe Valley (Belgium)

- *Reflux of hypersaline brines on bioclastic porous shoals*

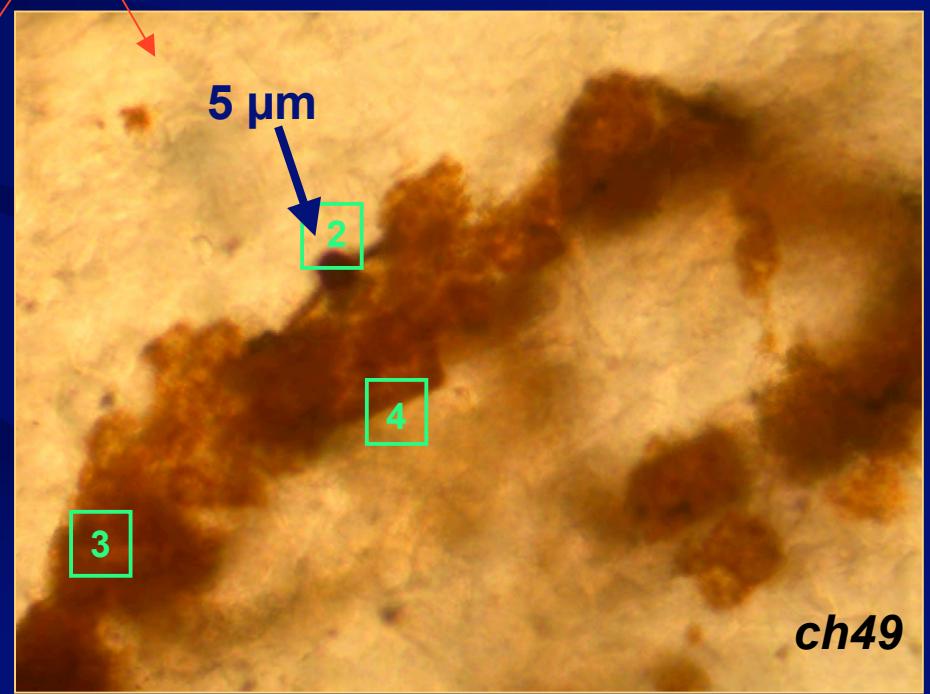
Experimental work of K. KOLO (Belgium, VUB-ULB)

- *Dolomitic substrates from the Viséan of Avesnes-sur-Helpe*

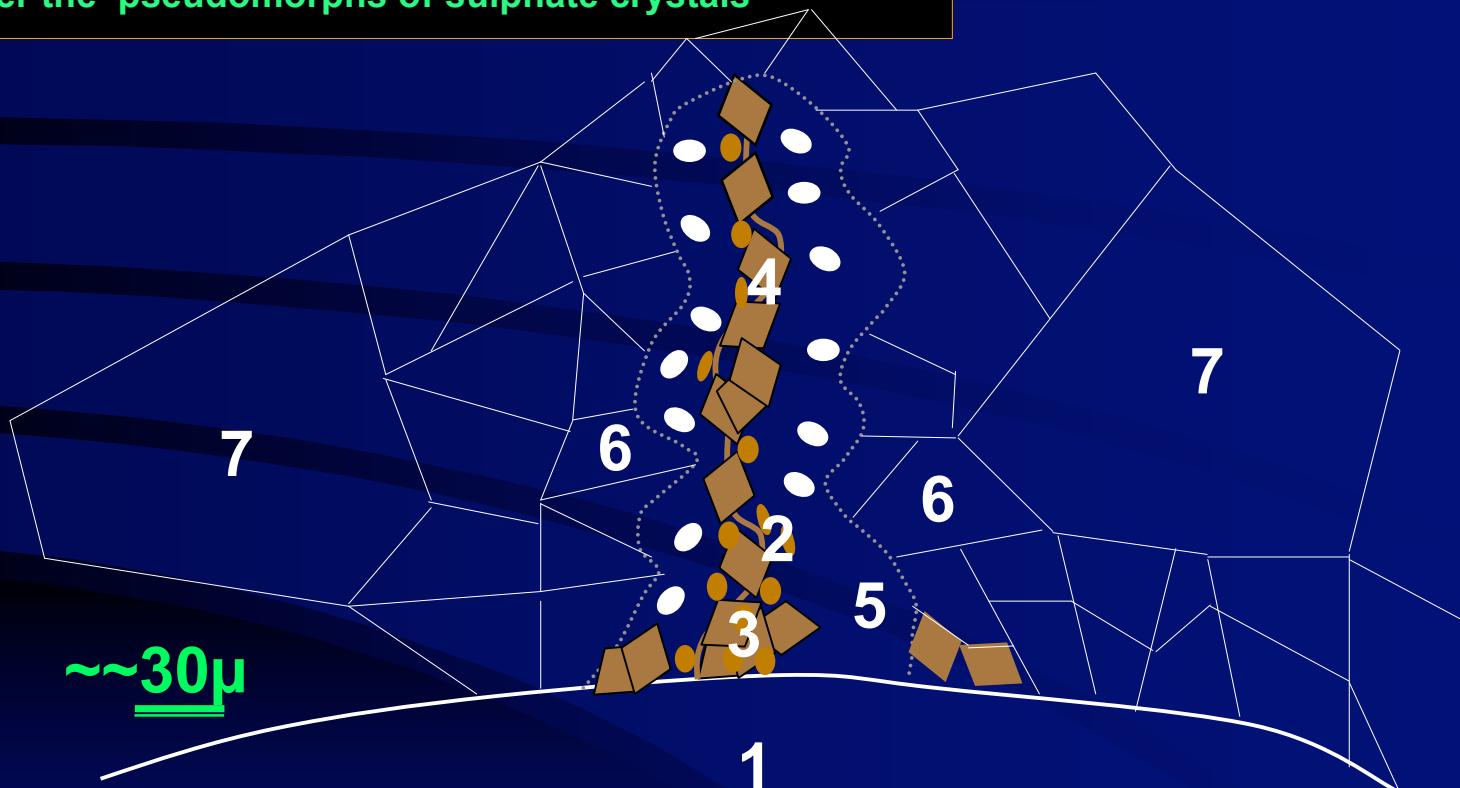


## Dolomite (Fe) on FILAMENTOUS CHAINS

- 1 Substrate
- 2 Fungal chains and ?coccoids
- 3 Poorly ordered dolomite crystals
- 4 Idiotopic dolomite crystals
- 5 Irregular sheath of microspar moulding the chains
- 6 NL equigranular sparitic cement
- 7 NL clear sparitic cement NL in large crystals  
after the pseudomorphs of sulphate crystals

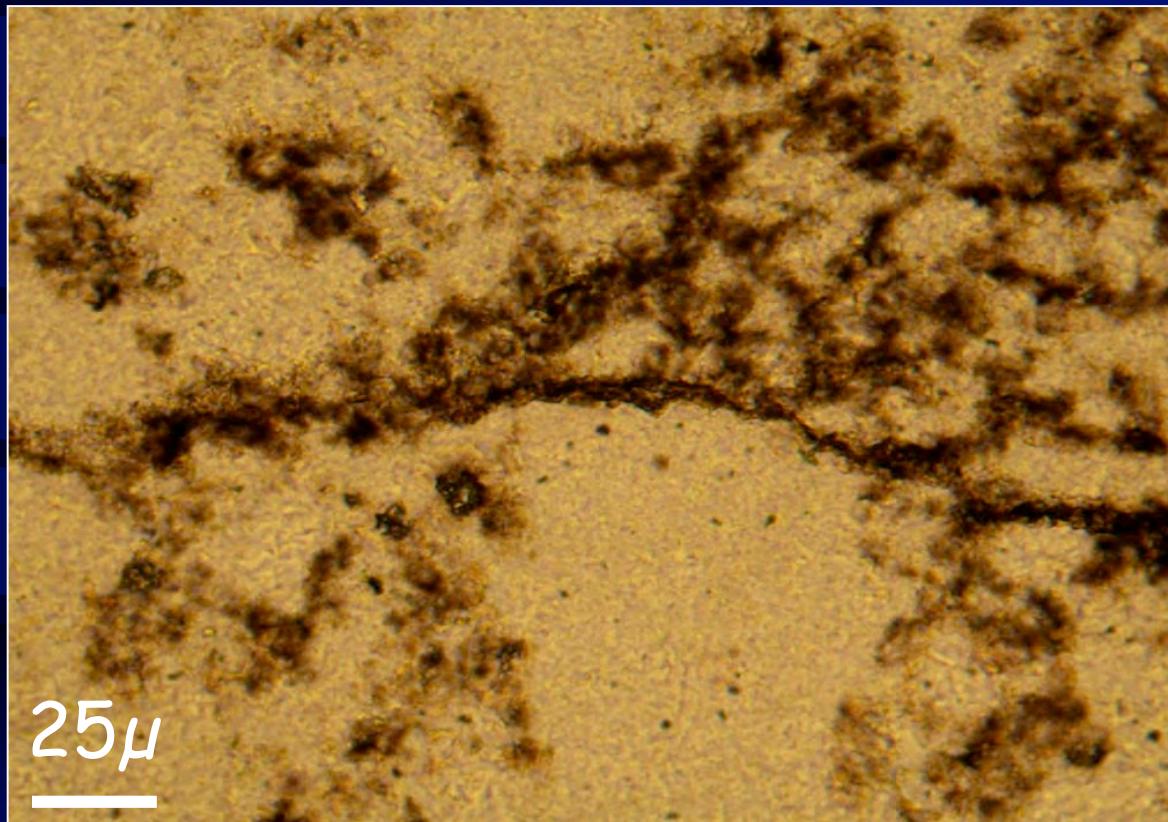


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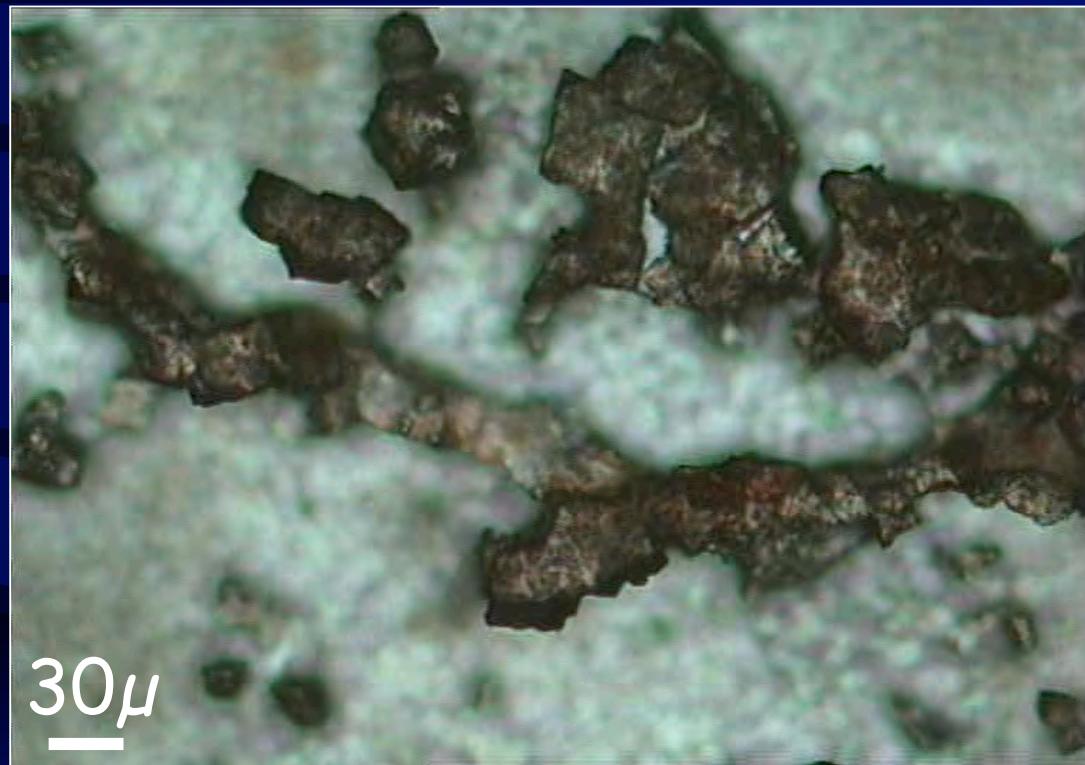
## PARASEQUENCE OF THE DOLOMITE 'CONSTRUCTIONS'

# EXTRACTED FILAMENTOUS OM (Viséan, Avesnes-sur-Helpe)



# Etched thin section

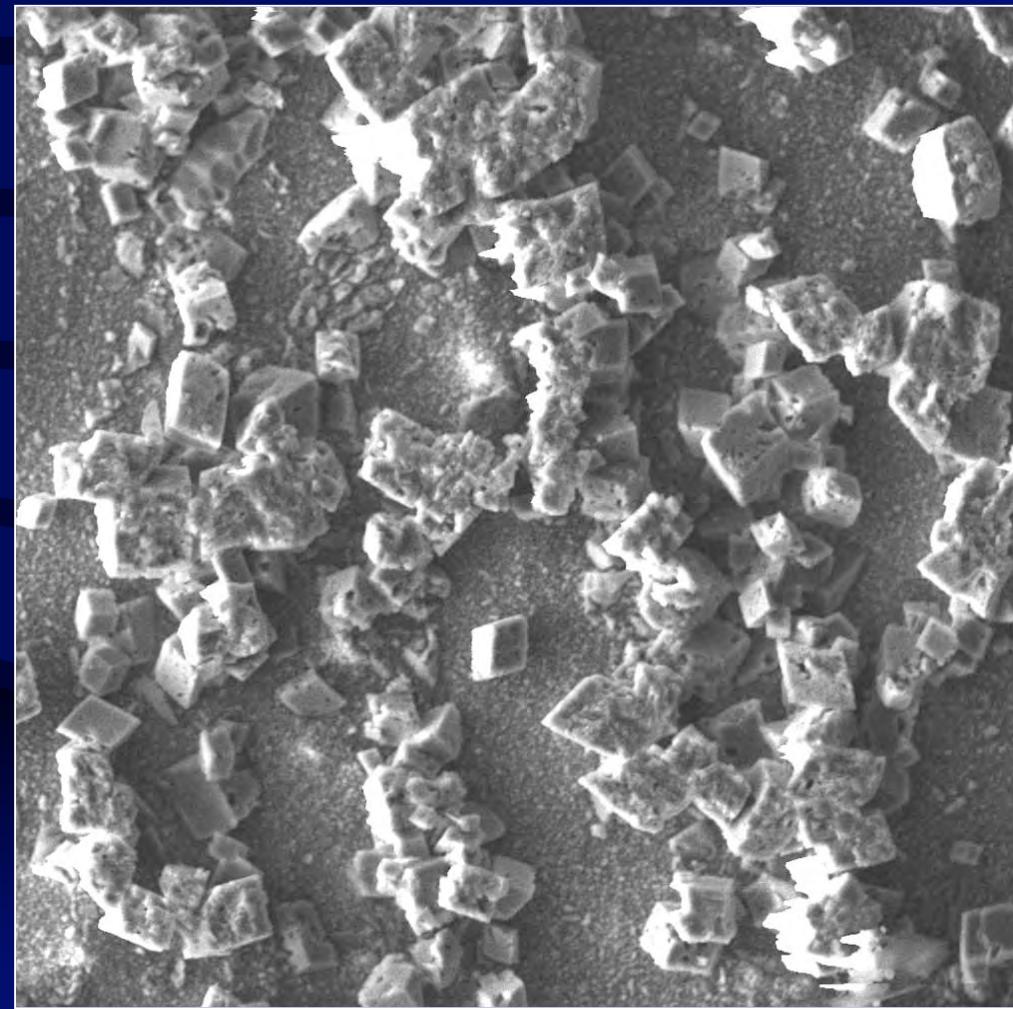
## Filamentous-dichotomous dolomite crystals (Viséan, Avesnes-sur-Helpe)



# SEM micrograph

## Filamentous-dichotomous dolomite crystals

### Viséan, Avesnes-sur-Helpe

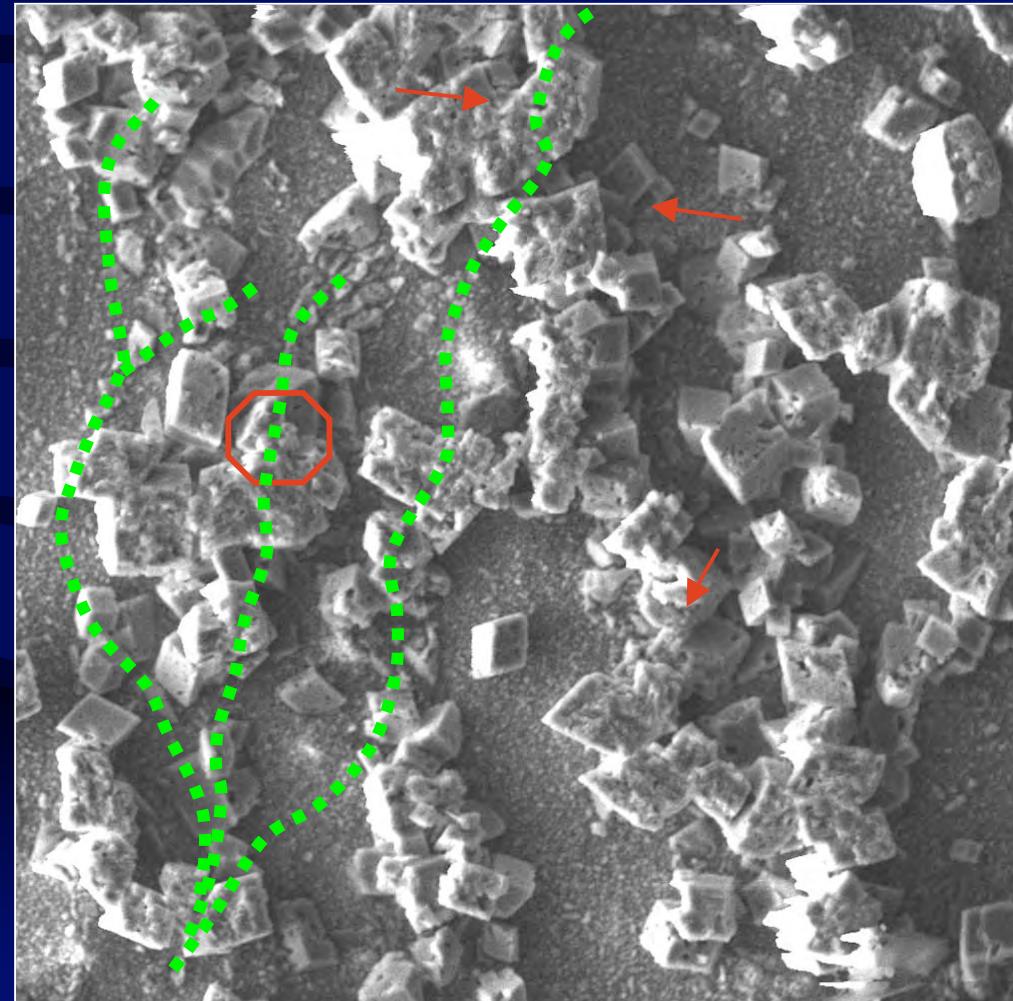


40  $\mu$

# SEM micrograph

## Filamentous-dichotomous dolomite crystals

### Viséan, Avesnes-sur-Helpe



40  $\mu$

## THREE EXAMPLES

1. The iron bacteria and associated fungi
2. The pyrite et the pyritospheres
3. The 'filamentous' chains of dolomite

HOW TO SUMMARIZE?

