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Mineralogical and Geochemical controls on intracellular amorphous calcium carbonate (ACC) formed by magnetotactic bacteria in Lake Pavin, France

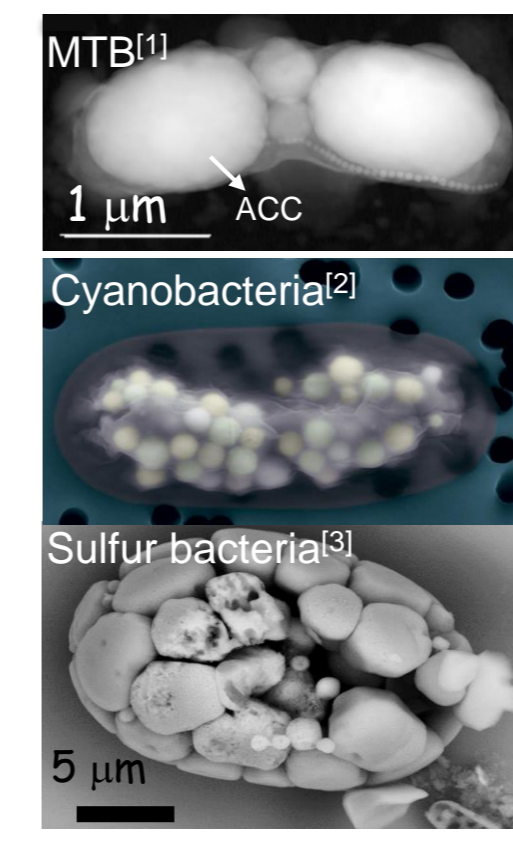


Neha Mehta, Postdoctoral Researcher, Sorbonne University, France email: neha.mehta@upmc.fr
 Co-authors: E Viollier¹, D Jézéquel², N Menguy³, E Duprat³, C Mangin⁴, C Travert³, CT Lefèvre⁴, CL Monteil⁴, K Benzerara³



Background

Recently, phylogenetically diverse magnetotactic bacteria (MTB) from Lake Pavin sediments (France) were shown to form intracellular amorphous calcium carbonate (ACC), thereby expanding the taxonomical diversity of iACC-forming bacteria^[1]. The ACC found in MTB (and other bacteria^[4]) remains relatively stable intracellularly, which is surprising as pure abiogenic ACC is highly unstable. The mechanisms underlying such stability are unclear. Moreover, the ACC-forming MTB are proposed as an overlooked player in the geochemical cycle of Ca given their high abundance (>10⁴ cells mL⁻¹) and ability to sequester large quantities of Ca as ACC.



Objective

What **biogeochemical factors** control the abundance and population structure of ACC forming MTB in the sediments?

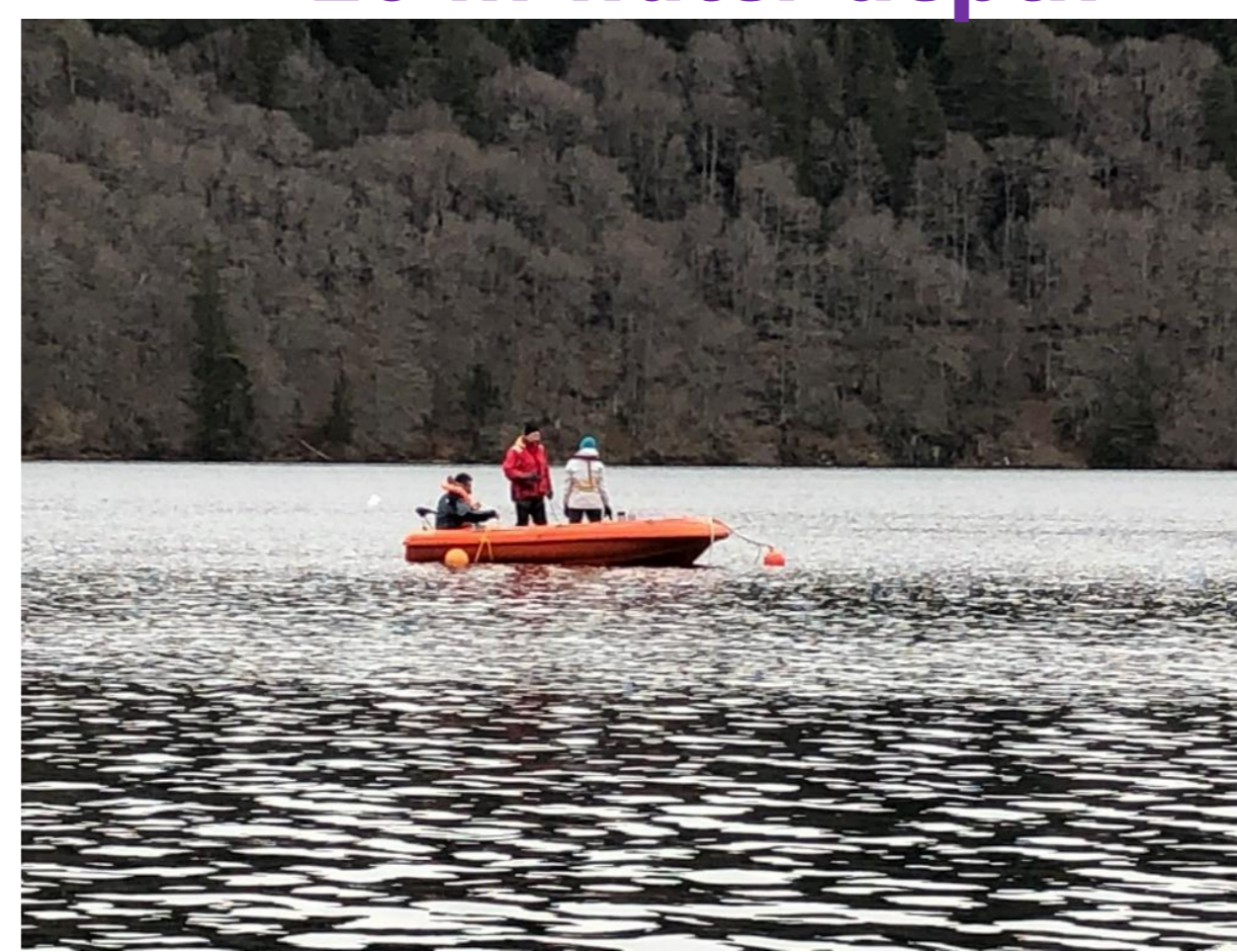
What is the **fate of intracellular ACC** in the sediments and its overall impact on sedimentary geochemical cycle of calcium?

Lake Pavin, France



3 Field campaigns:
 October '21
 April '22;
 June '22

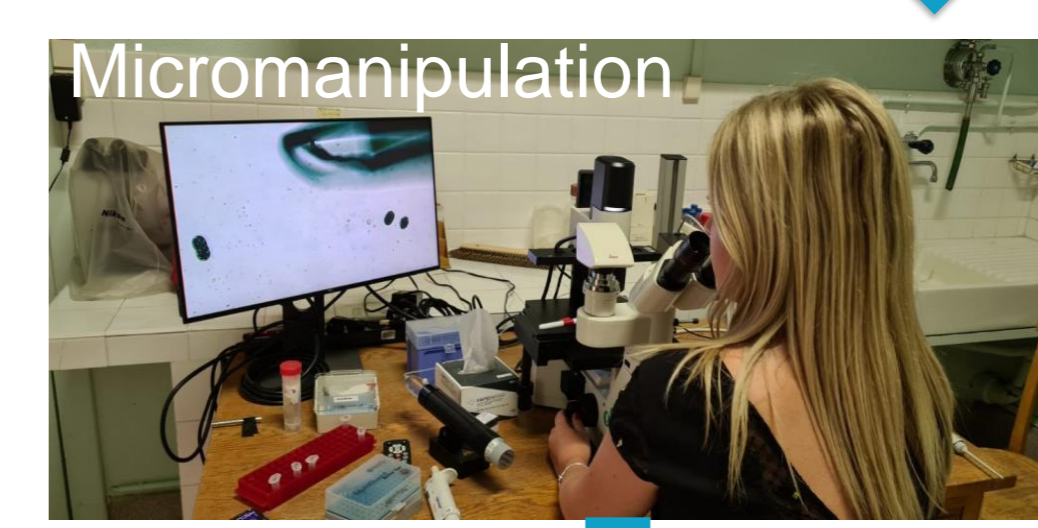
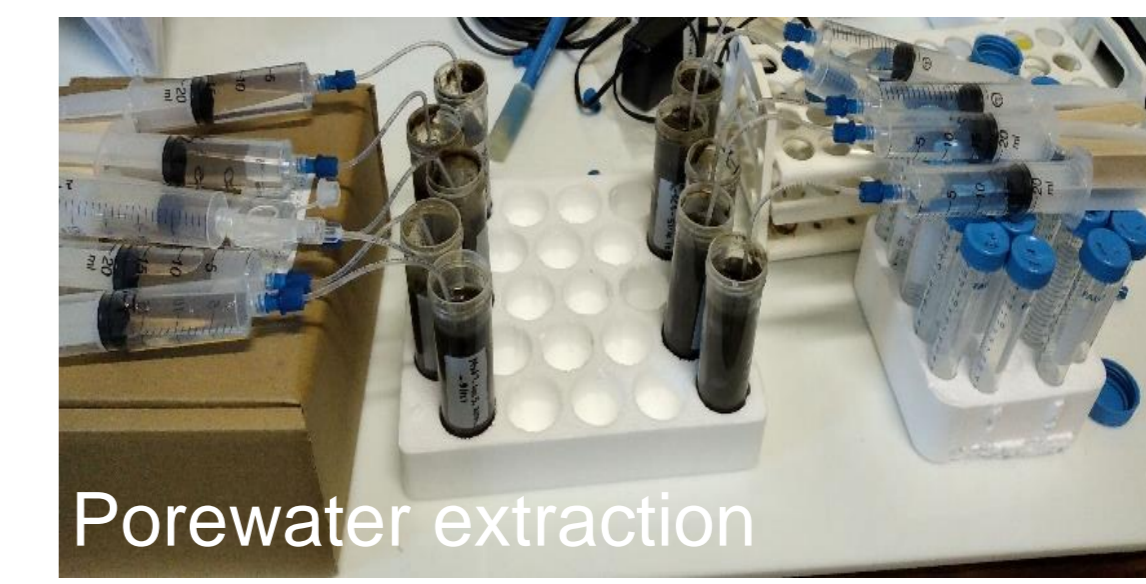
Sediment core collection at 20 m water depth



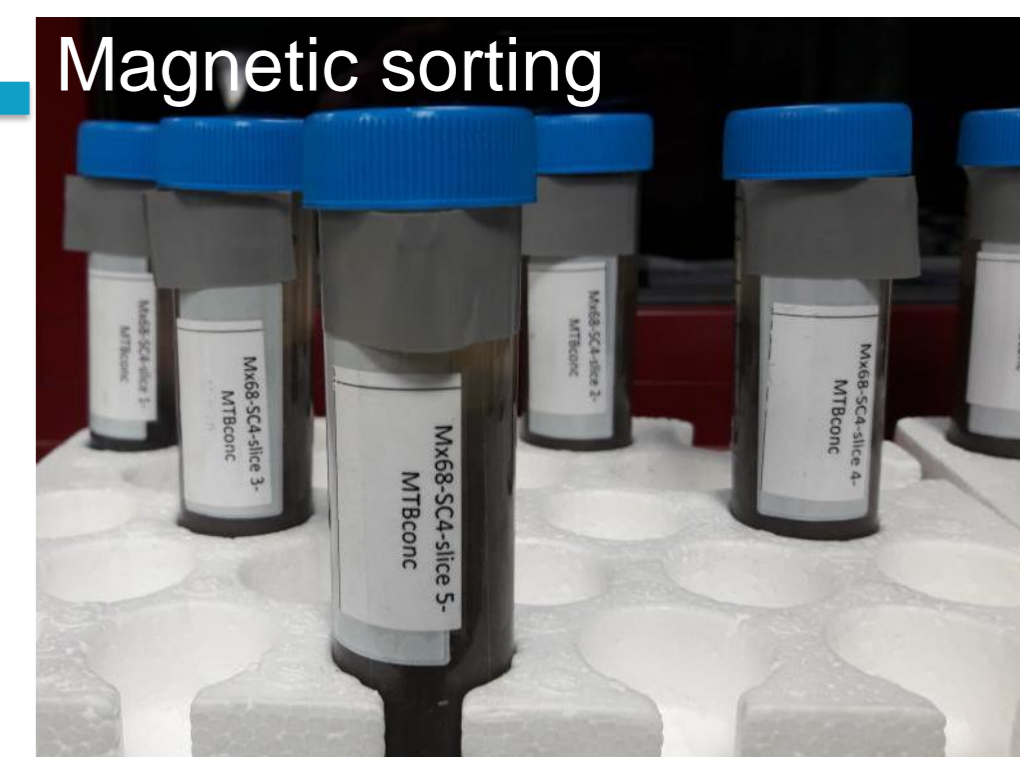
Anoxic sectioning of sediment core (1 cm section)



Mineralogical analysis
 Synchrotron XAS



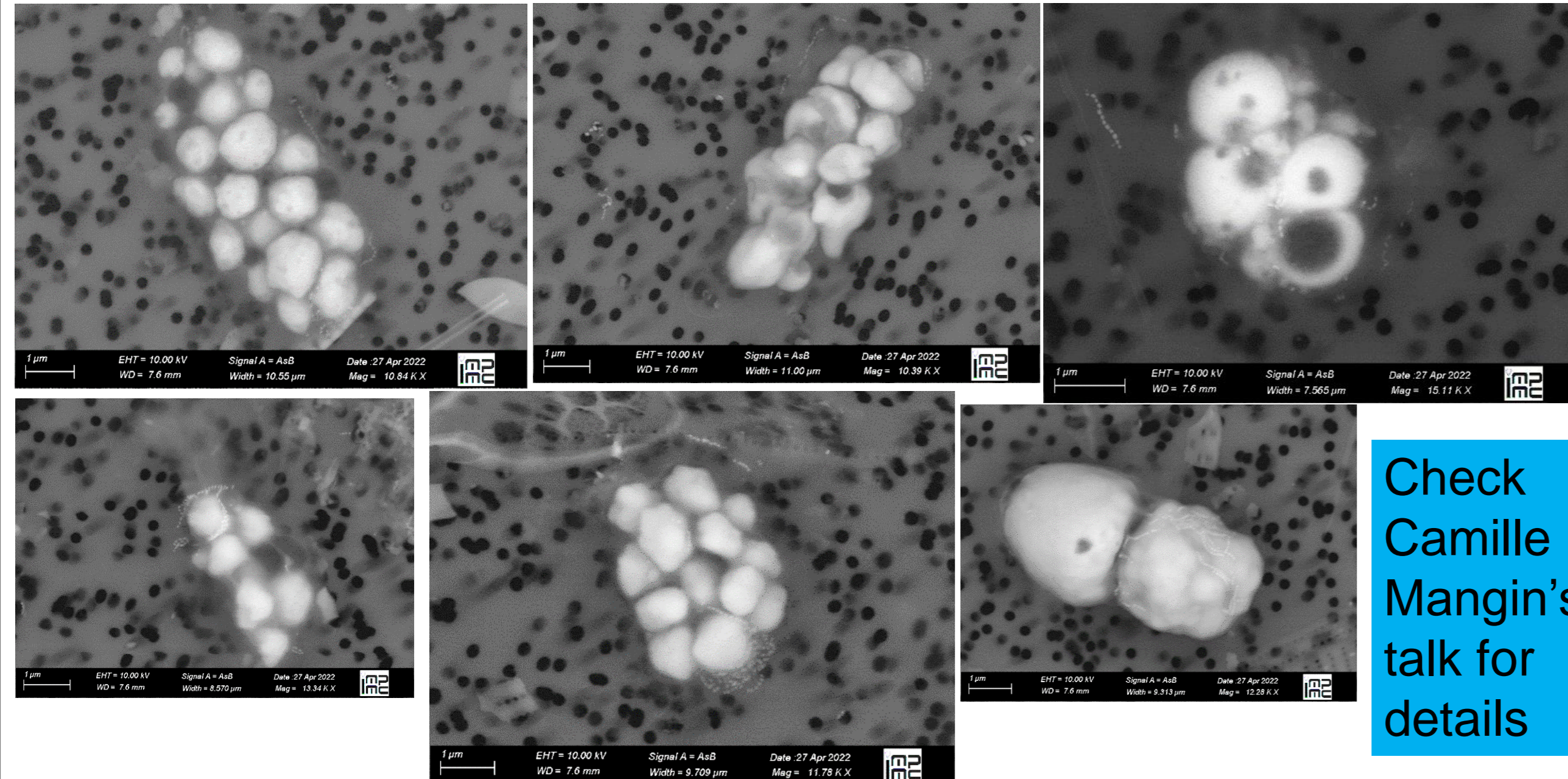
Single cell
 Synchrotron IR



Electron microscopy

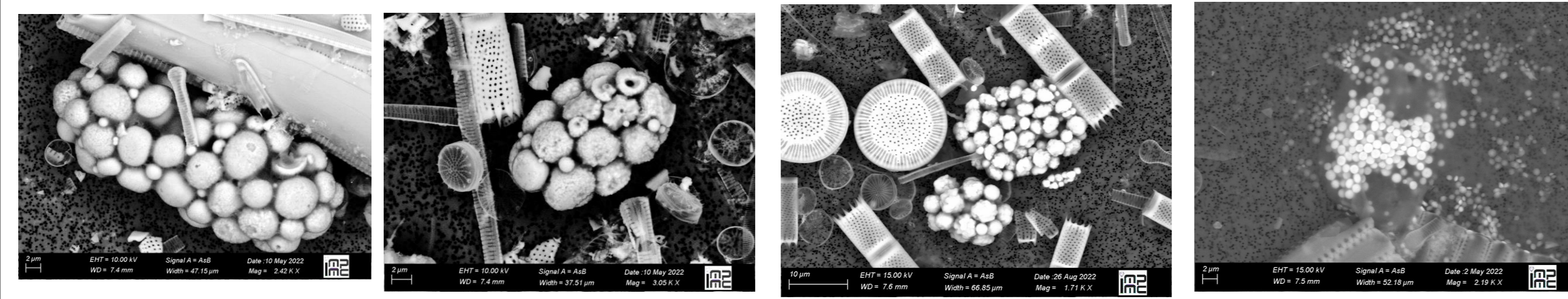
Geochemical analysis

Diversity of ACC forming MTB in the sediments cores



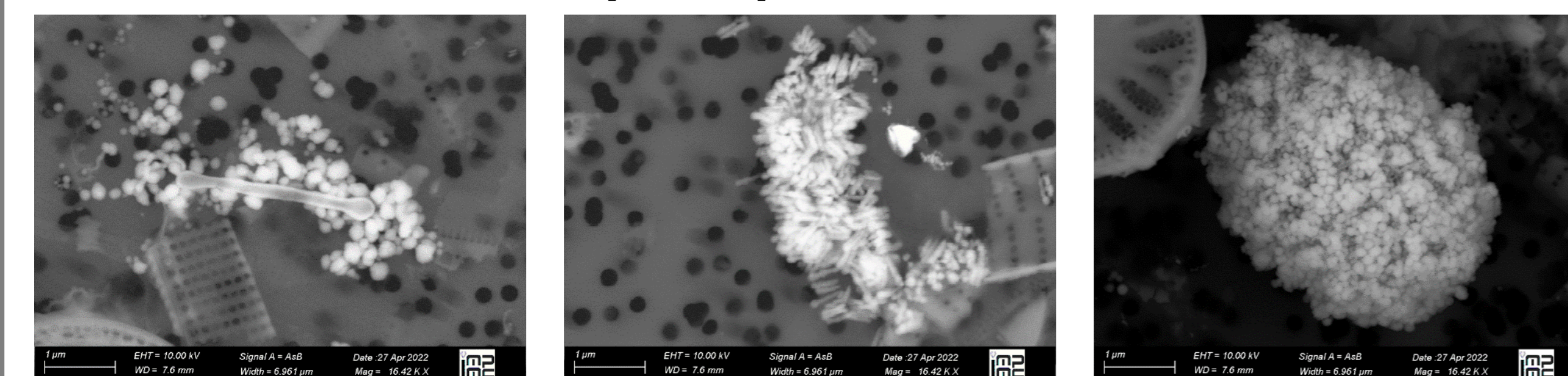
Check Camille Mangin's talk for details

Other ACC forming bacteria found in sediments

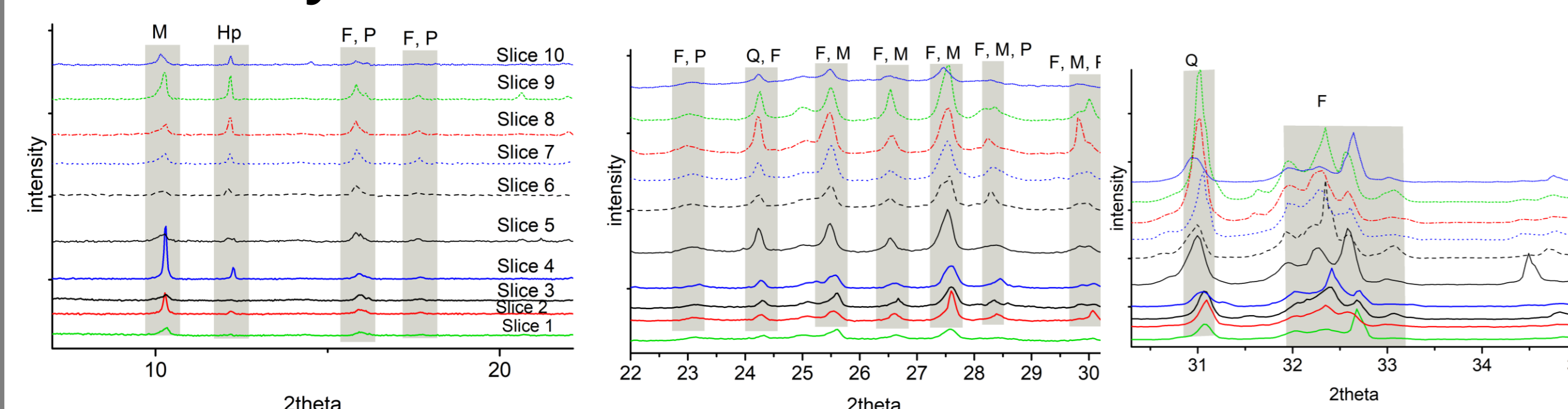


Sediment mineralogy

Different Fe-P rich precipitates in the sediments



XRD analysis of sediments

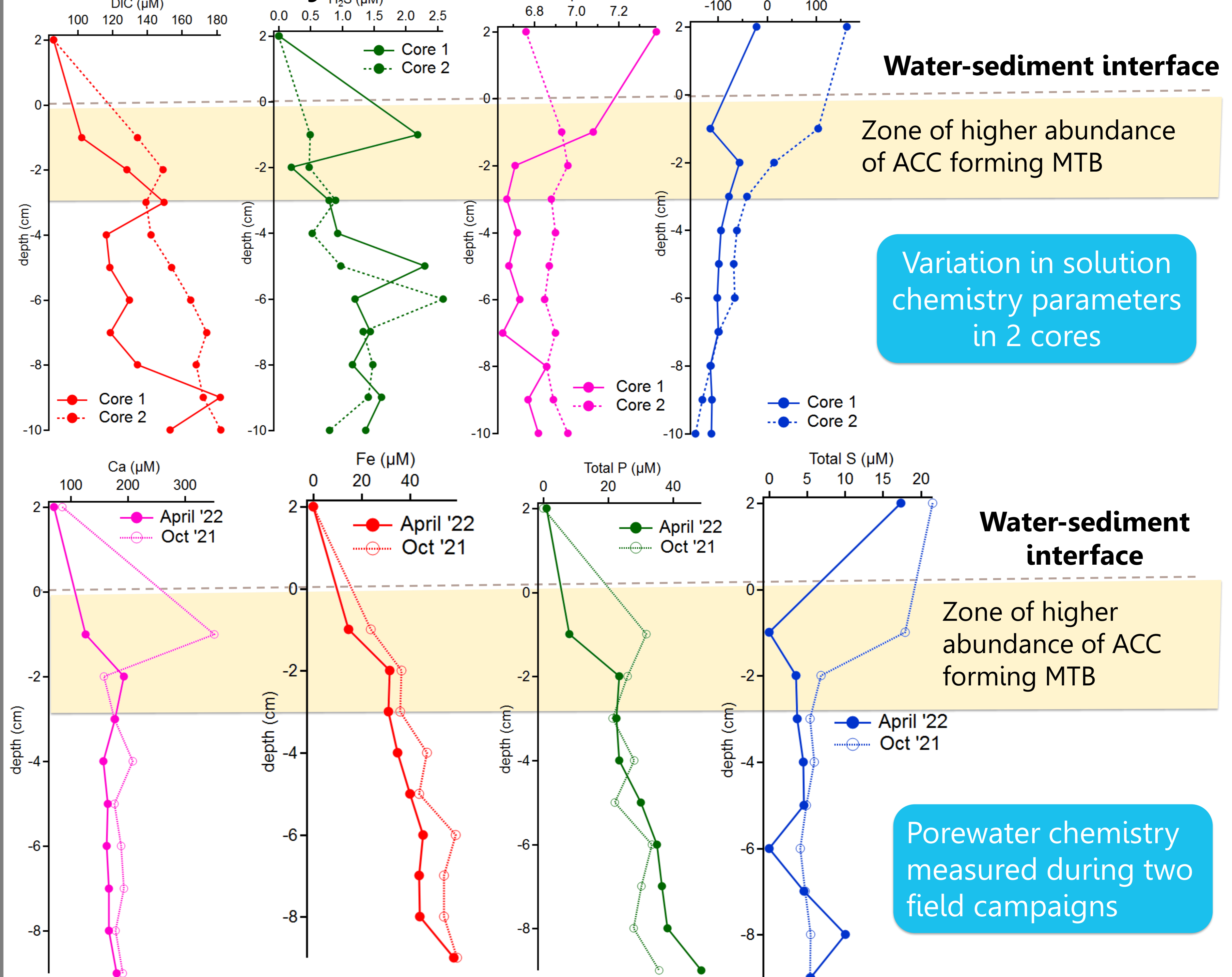


Major phases identified in sediments:

Mica (M), Ca-hydroxyapatite (Hp), Feldspar (F), Pyroxenes (P), Quartz (Q)

- **Nature of major host matrix of Ca** in the sediments remain unclear → Future work will utilize XAS to better constrain sedimentary Ca speciation

Geochemistry



Ongoing work

- Sedimentary microbial diversity assessment using **metabarcoding**
- Mineralogical analysis of sediments using **SEM-EDX** and **multivariate statistics**
- MTB-ACC characterization using **synchrotron nano IR spectroscopy**
- Ca K-edge XAS analysis to quantify impact of ACC forming MTB on Ca cycle

References

- [1] Monteil et al., 2021, ISME, 10.1038/s41396-020-00747-3
- [2] Couradeau et al, 2012, Science, 10.1126/science.1216171
- [3] Benzerara et al, 2020, Geobiology, 10.1111/gbi.12424
- [4] Benzerara et al. 2022, Genome Biology and Evolution, 10.1093/gbe/evac026



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