



Micritization and Microbial-related Diagenetic Features in Modern Shallow Marine Carbonates (Red Sea, Arabian Gulf)

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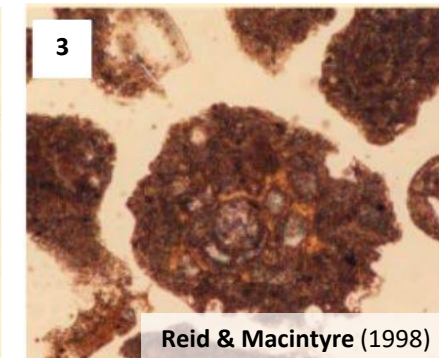
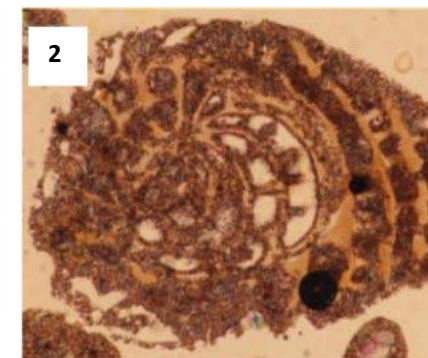
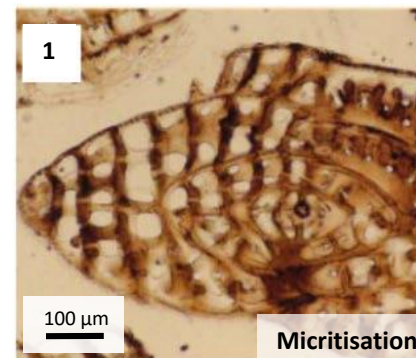


Introduction :

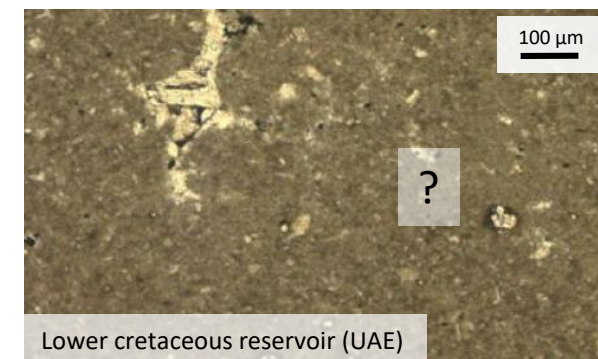
- Microbes are actively involved in the generation and accumulation of carbonate sediment.
- Nucleation of carbonate... Formation of structures... Mediate bio-erosion...
- Early bio-erosion and **micritization** : destruction of the initial grain microstructure.

Questions :

- Which are the favorable conditions for micritization ? and where ?
- Which microbes are the primary agent of micritization ? Processes ?
- Driver for the development of microporosity ? Mud production ?
- Micritize sediment in laboratory ?



▲ **Micritization** – process by which original fabrics of carbonate grains are altered to cryptocrystalline texture by repeated algal coring and filling of the bores holes with micritic precipitates. (Bathurst, 1966)





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Objectives : fundamental understanding of the syn-sedimentary micritization process in shallow marine settings. Where micritisation occurred ? Intensity ? Microbes involved ?

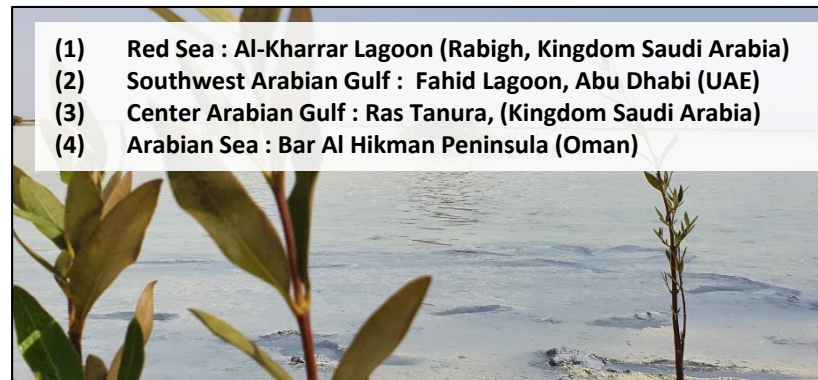
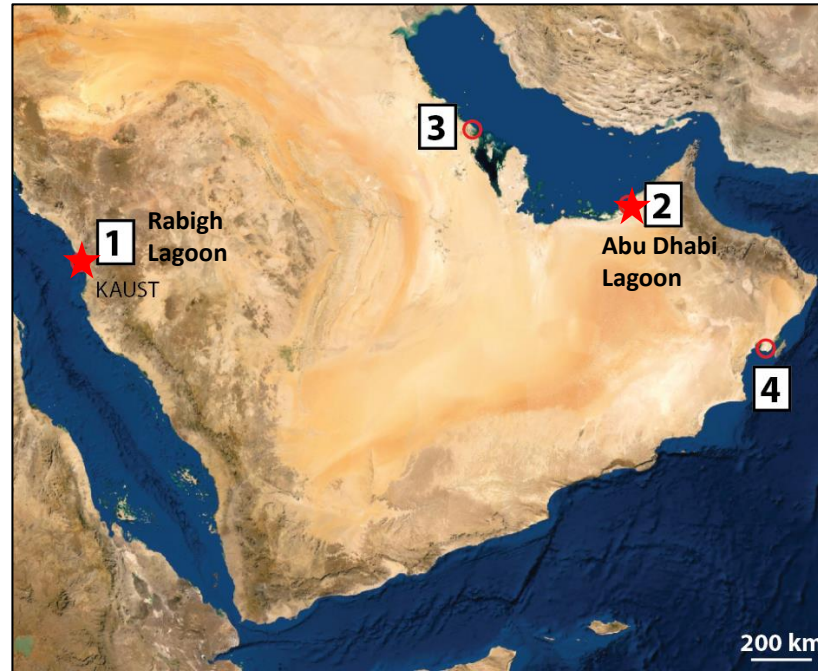
Approach :

Sedimentology, microbiology, diagenesis, geomicrobiology, geochemistry, rock imaging...

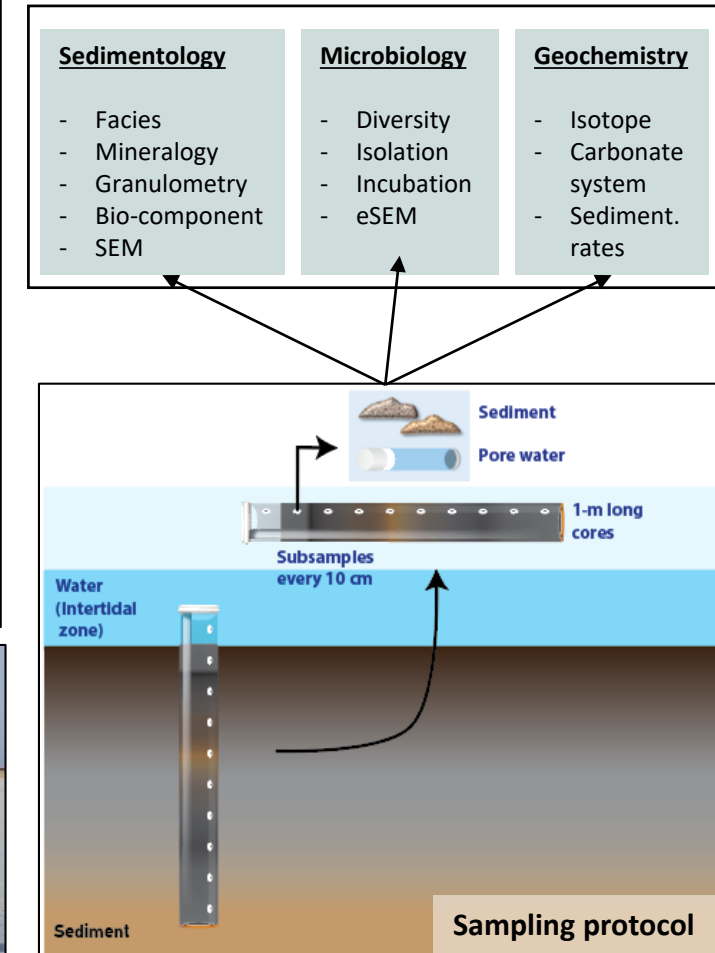
Methods :

- **Field** : Sampling cores of sediment in various shallow marine lagoons around the Arabian plate
- **Laboratory**: identification of sedimentological features and microbial diversity. Document and compare between locations
- **Experiments**: long term laboratory and in-situ incubation in order to reproduce the micritisation processes in constrained conditions.

Study area : shallow marine carbonate environment, lagoon, intertidal area.



A multidisciplinary approach



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1) Environmental conditions :

Al-Kharrar Lagoon (Rabigh, KSA, Kingdom Saudi Arabia)

- Central Red Sea coast
- 20 km long, 5 km large
- One narrow shallow inlet (North)
- Salinity : 38.9‰ to 45.4‰
- Water Temp. : 25°C to 30.6 °C (Al Dubai et al., 2017)
- Low mangrove cover intertidal area
- Tide : 0,20 – 0,30 m

Khawr as Sadiyat, Abu Dhabi (UAE)

- South west part of Arabian/Persian Gulf
- Barrier island, lagoons, tidal channels
- Highly restricted lagoon
- Abundant mangrove coverage
- Salinity : 35‰ to 39‰
- Water Temp. : 19.3–26.9 C (Perderson et al. 2021)
- Tide 1-2 m





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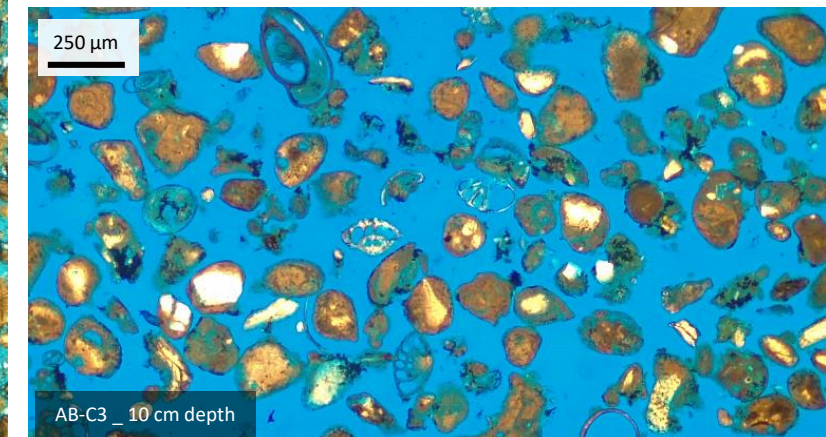
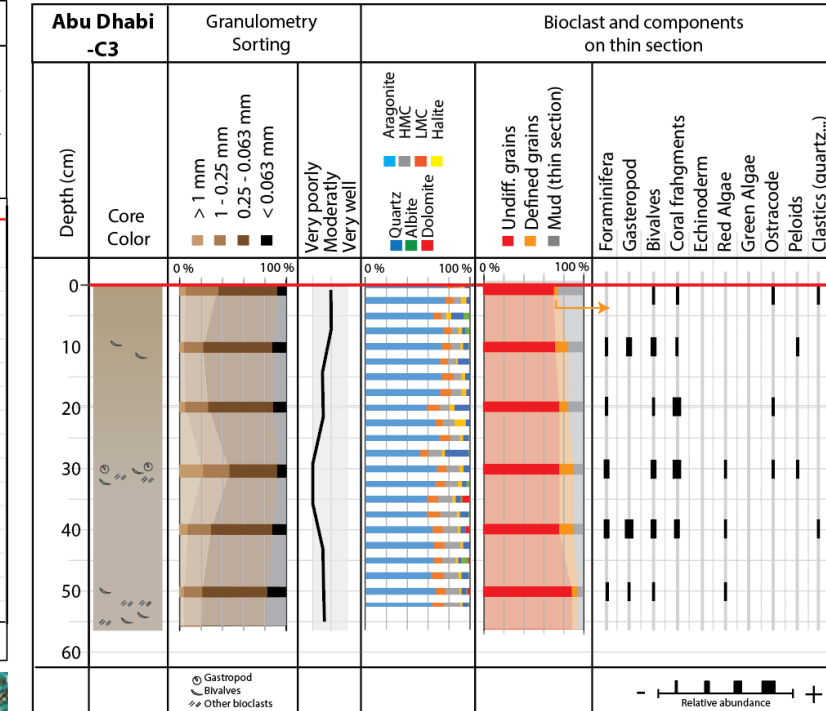
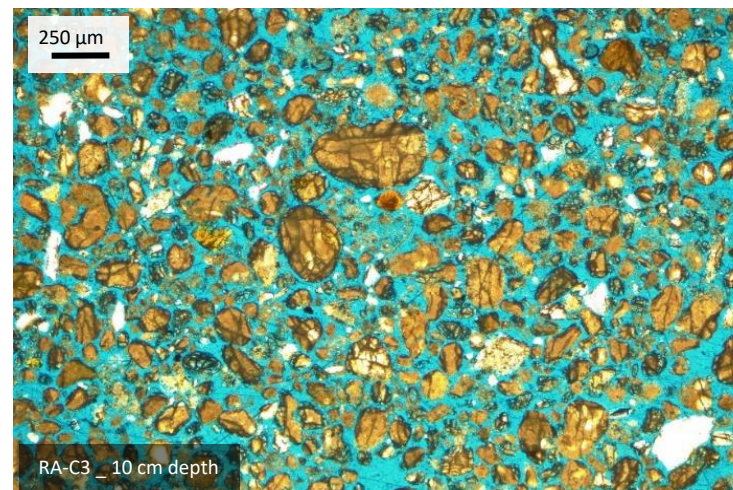
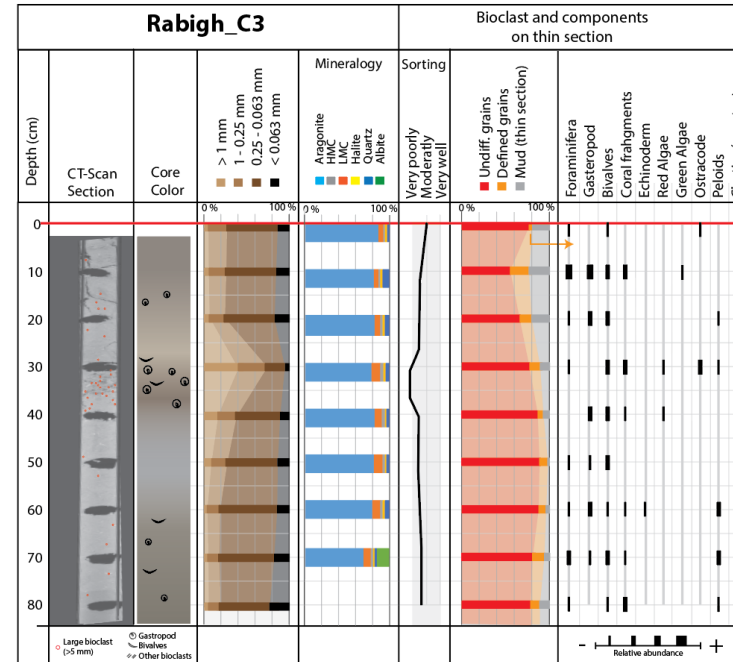
2) Sedimentary facies :

Al-Kharrar Lagoon (Rabigh, Saudi Arabia)

- Mainly very fine sand (<250 μ m)
- No vertical facies changes
- Low mud (< 20%)
- Component : mainly undifferentiated (80-90%), bivalves, gastropods and coral/reef fragment
- Mineralogy : Aragonite, calcite (10%; XRD)

Khawr as Sadiyat (Abu Dhabi, UAE)

- Very fine to fine carbonate sand
- No vertical facies changes
- Low mud (< 20%)
- Component : mainly undifferentiated (80-90%), bivalves, gastropods and coral/reef fragment
- Mineralogy : Aragonite, calcite (up to 20%; XRD)





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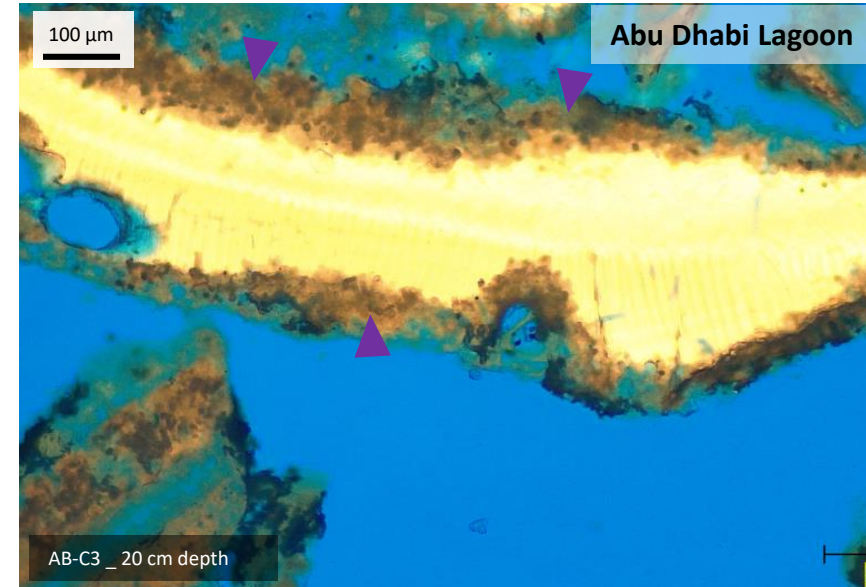
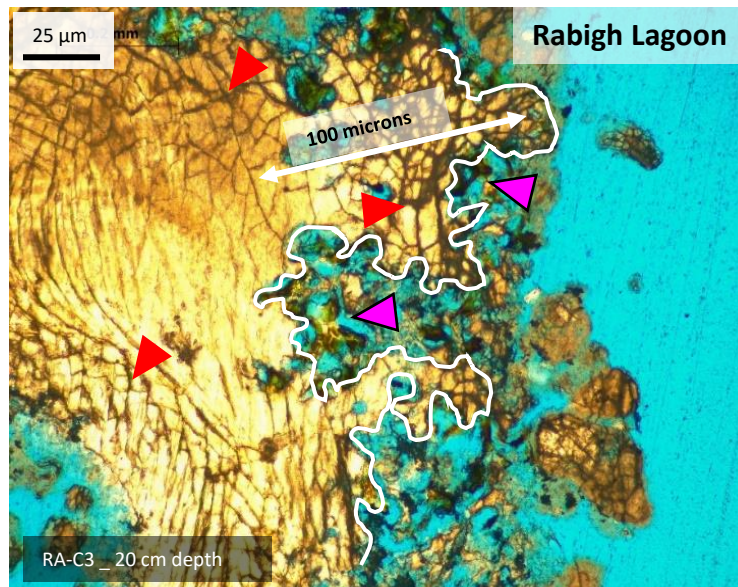
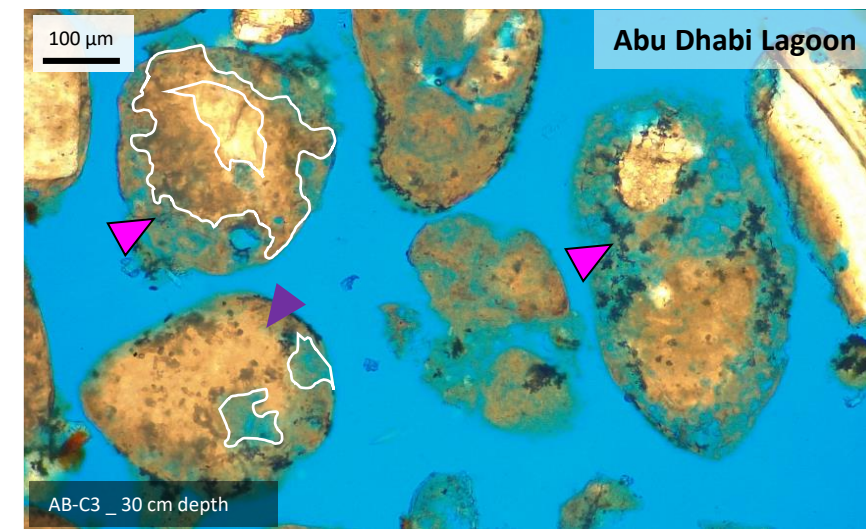
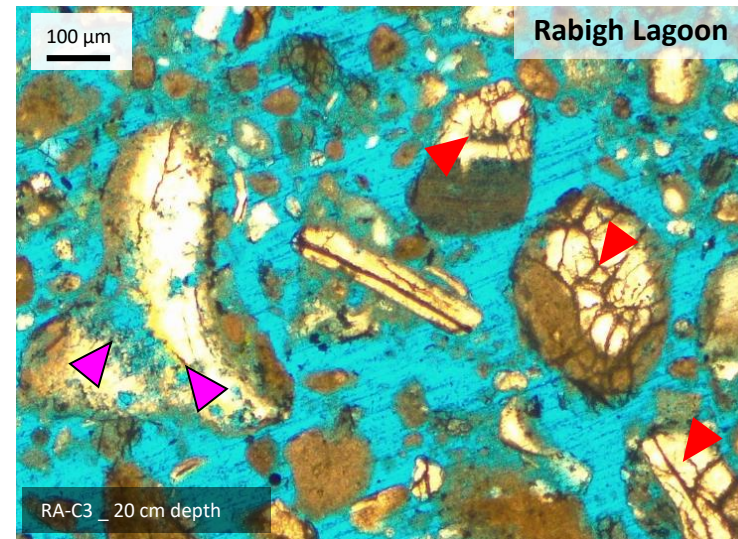
3) Early diagenesis and micritisation :

Al-Kharrar Lagoon (Rabigh, Saudi Arabia)

- High breakage intensity (abrasion and fracturing ▶)
- 60 % of grains show microborings ▶
- Mainly empty microborings
- low occurrence of micritic rims ▶

Khawr as Sadiyat, Abu Dhabi (UAE)

- Subrounded to Rounded grains
- low breakage intensity
- 93 % of the grains show microborings ▶
- Very common micritic envelope ▶
- Early cements common

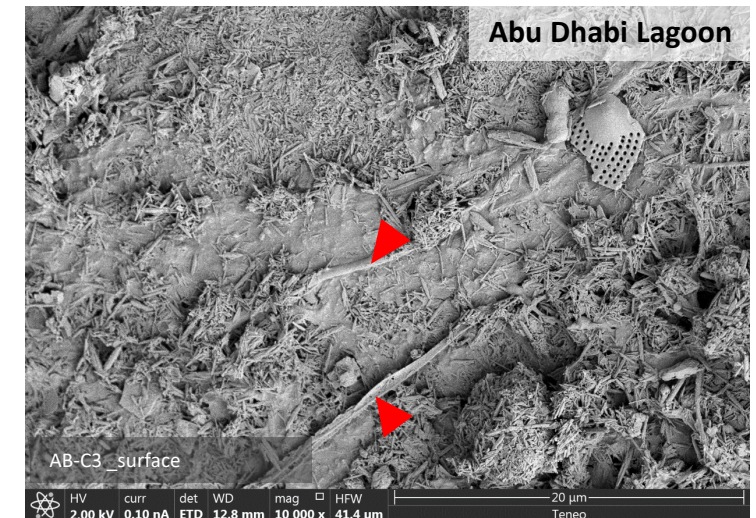
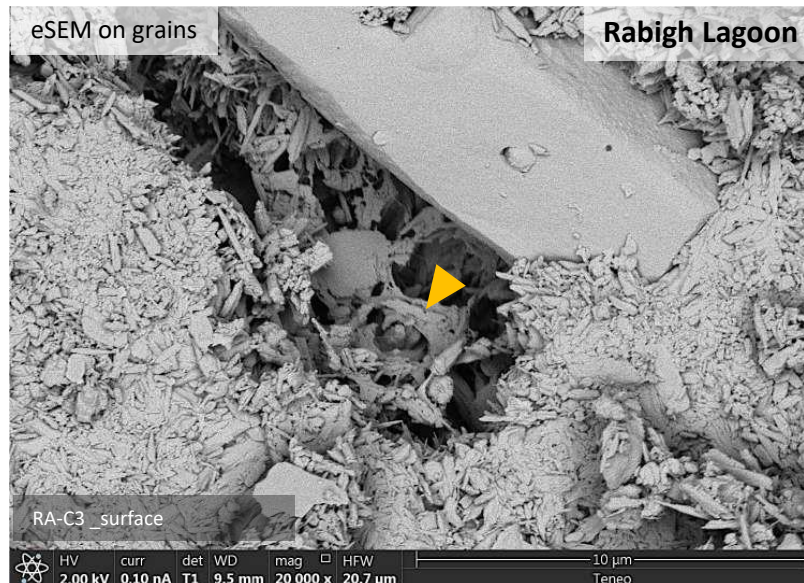
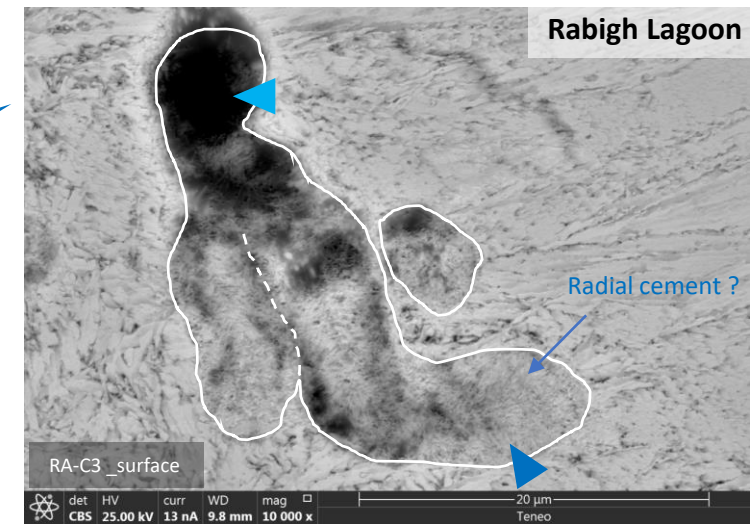
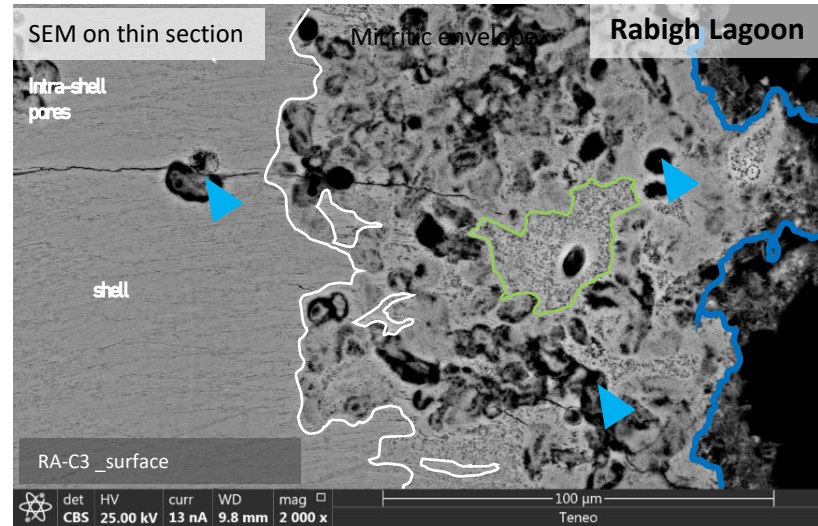




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3) Early diagenesis and micritisation (SEM):

- Most of the grains in Abu Dhabi show microborings and micritic envelopes
- Complex interplay between empty ► and filled ► (cement ?) microborings
- In both locations, the surface samples (0-10 cm) showed the presence of biological materials (web-like membranes ►, cyanobacteria or fungal, tubular structures ►)
- In Abu Dhabi, the biological materials are more abundant
- Only biological residue in Rabigh...





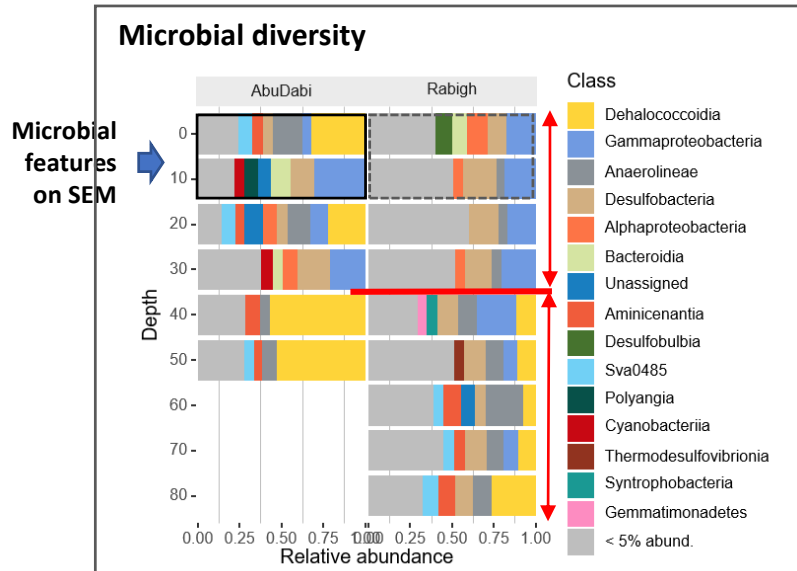
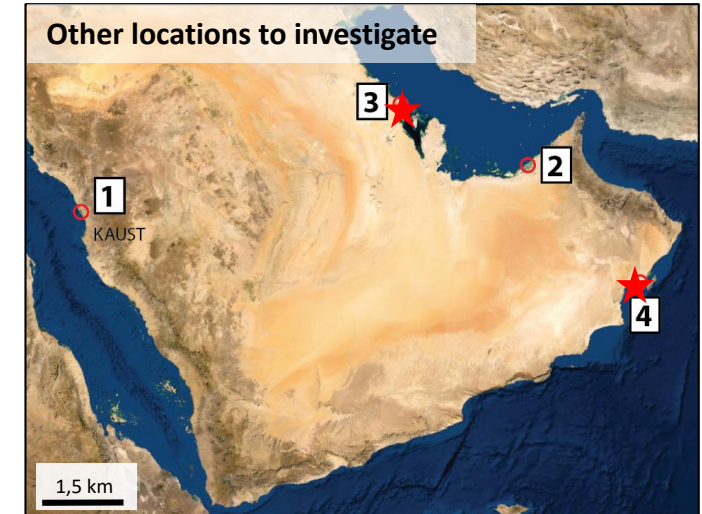
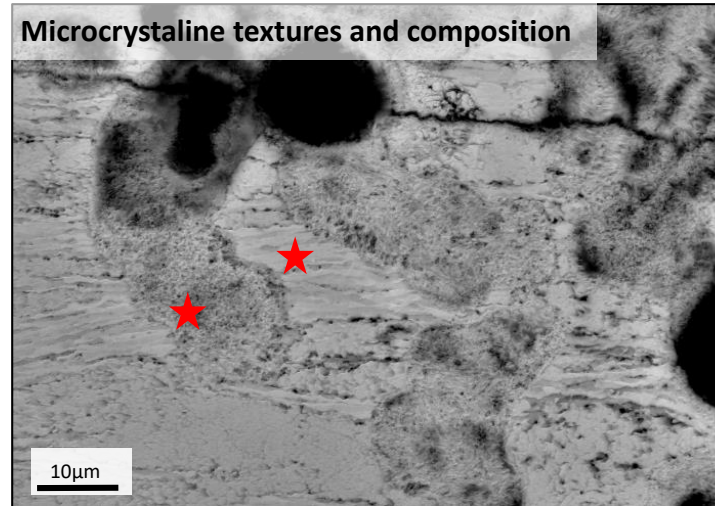
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First conclusions:

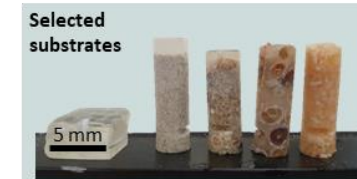
- Microbial grain alterations in both locations (microborings, micritic rim) but more common in Abu Dhabi.
- Biological features mainly observed in the first cm of depth (0-10 cm depth)
- Balance between abrasion and bio-erosion could be explained by environmental conditions (organic reactions) and by surface energy (remobilization, traps).

Work in progress...

- Deepen the observations of micro-textures (SEM-EDS, NMR...)
- Mechanics involved in the Red Sea? *Bathurst 1966 ? Reid and Macintyre, 1998 ? Ge et al 2020 ?*
- Investigate the other locations (transects)
- Link to microbial diversity (and processes)
- Produce micritized grains in controlled conditions (lab, in-situ...?)



Experiments to reproduce micritisation



- (1) Calcite crystal
- (2) Ooids sand
- (3) Cerithids
- (4) Mix bioclastic sand
- (5) Foraminifera

T0 : BEFORE incubation



T1 : AFTER incubation



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Thank you

