Continental carbonates growth pathways, fabrics and diagenesis Share#EGU

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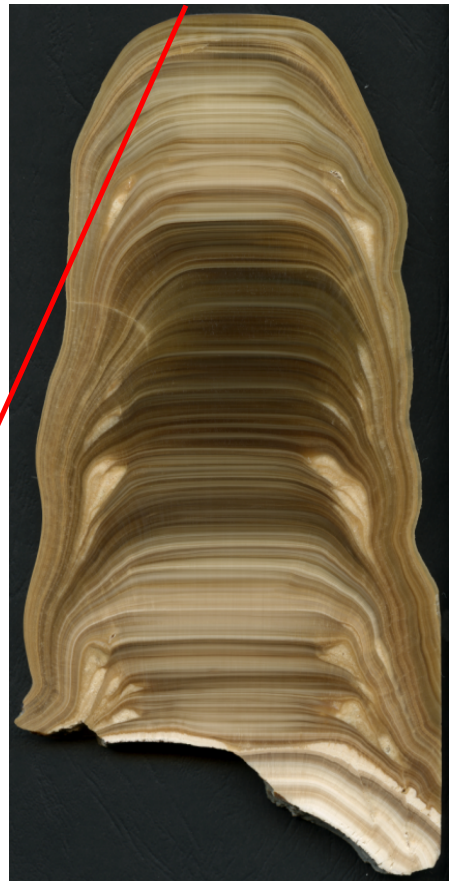
Focus point of the Presentation

- fabric and chemical properties of continental carbonates used in climate research *largely depend on crystallization pathways.*
- nanoscale investigation, through High Resolution Transmission Electron microscopy of cave, lake and spring deposits suggest *particle attachment is a common growth pathway.*
- *peloidal micrite consists of calcite nanocrystals,* which in lake and spring deposits is associated with organic filaments.
- trace elements may be incorporated both intra lattice and extra-lattice (between nanocrystals, in nanophases). This has implications for the use of partition coefficients in climate research.
- organic matter compounds help preserving *original climate data,* when they preserve nano-crystals from ripening.

Speleothem fabrics

Consist of rigid and relatively fragile arrangement of calcium-carbonate crystals in successive layers.

Crystals commonly grow with the c-axis perpendicular to the growth surface.
They usually form from low to moderate supersaturated water (SIcc = 0.2 – 1) and are largely controlled by inorganic processes.

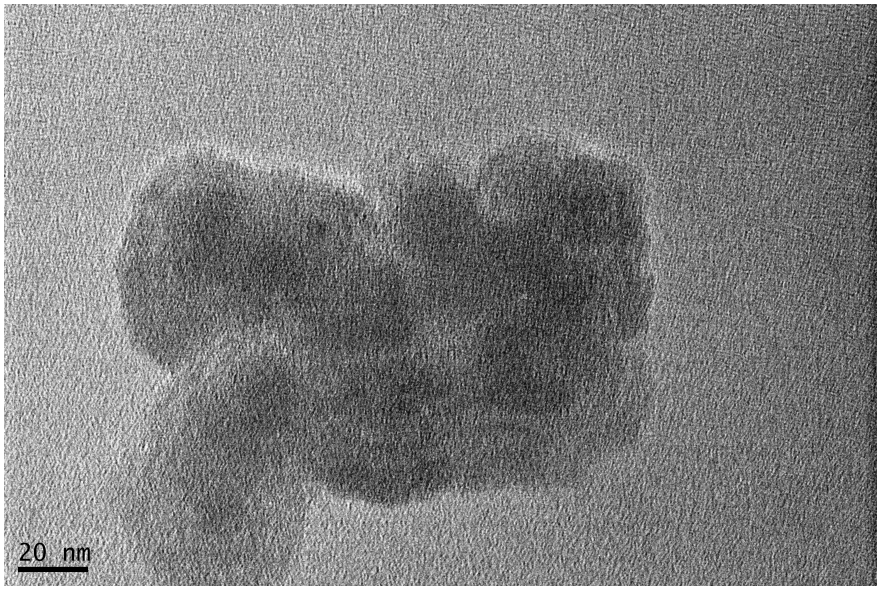


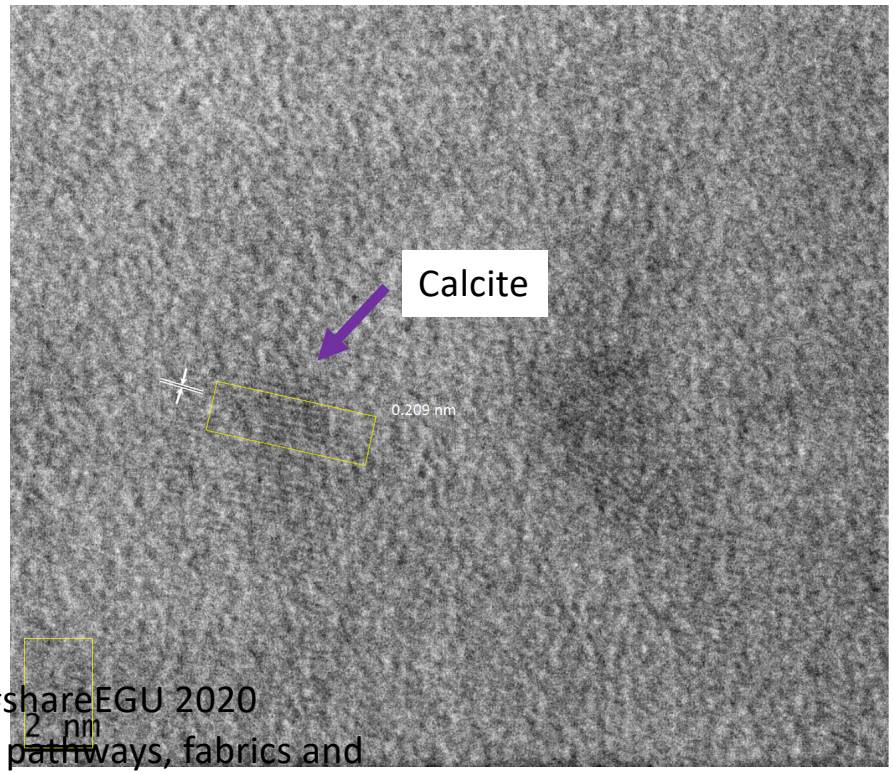
Most common fabric is Columnar, with flat faces at the crystal/water interface and rough, stepped faces on the “flanks”.

Pits in flat surfaces suggest that inner layers are also rough

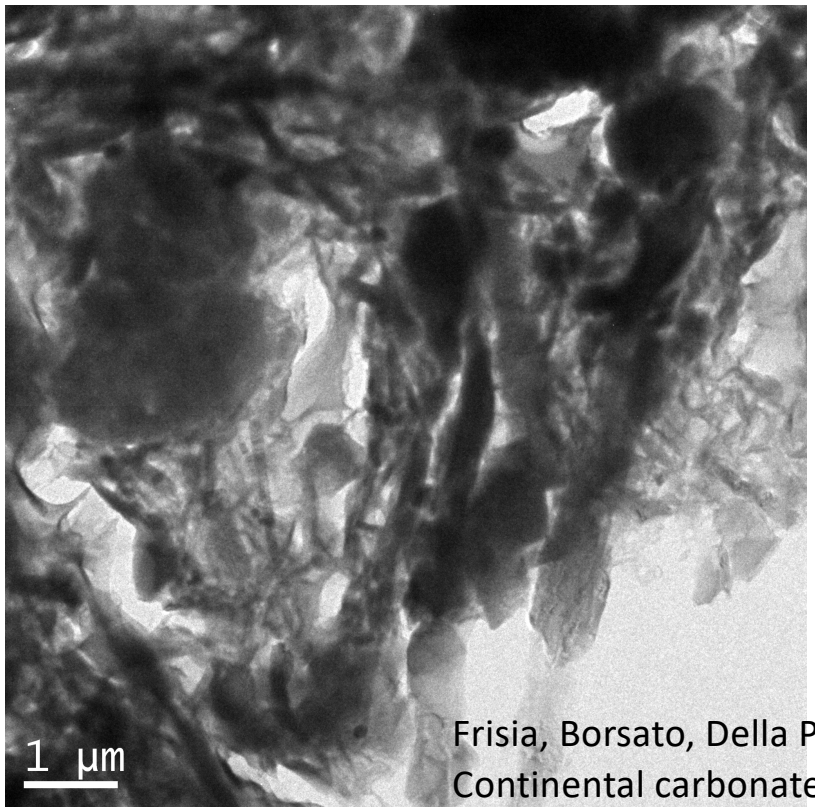
Frisia et al. (2018) demonstrated that even this fabric can form by particle attachment…

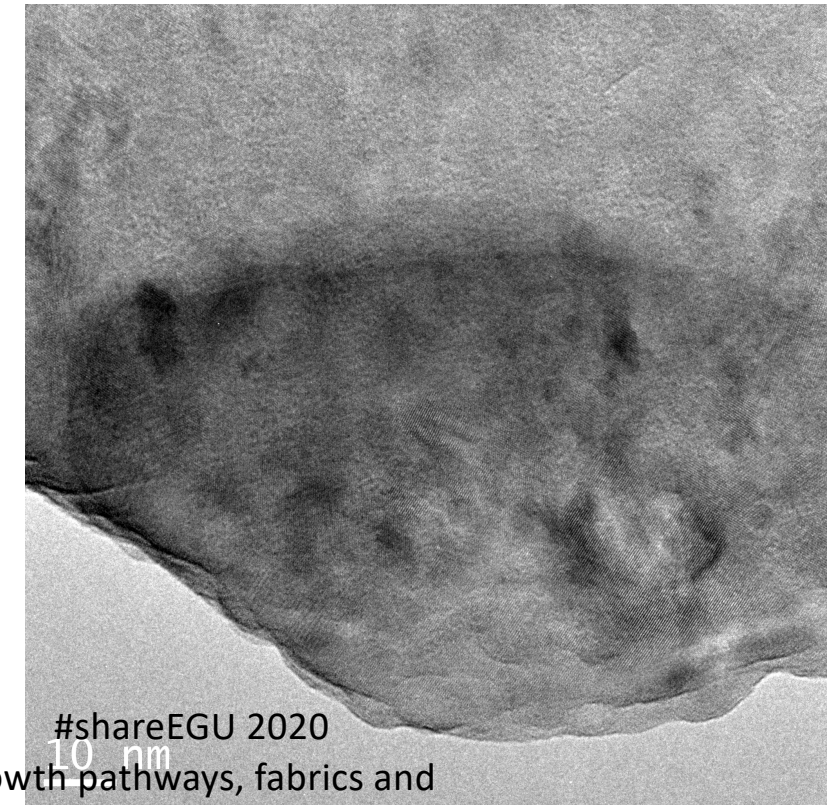
Speleothems: most fabric grow by nanocrystals attachment. Aggregation seems catalyzed by inorganic particulate



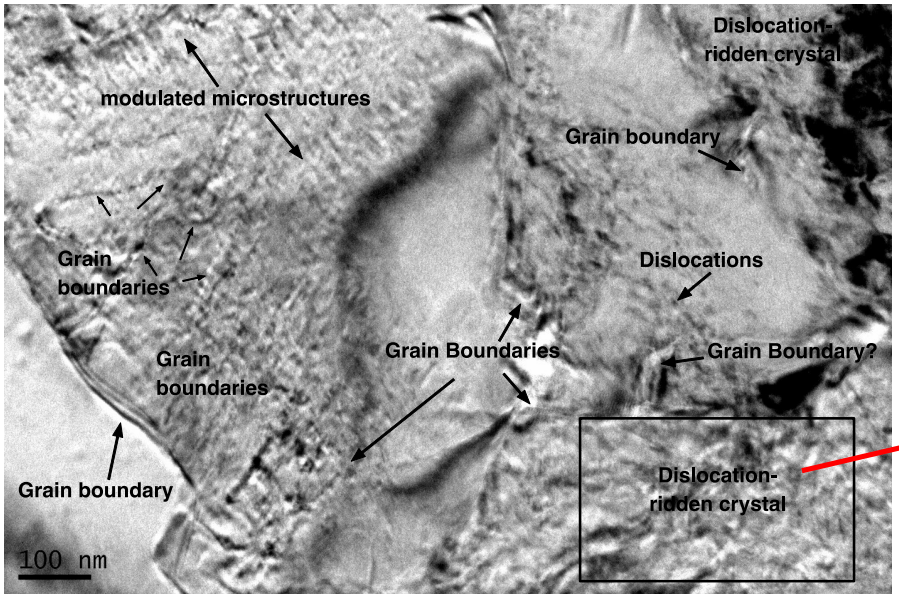


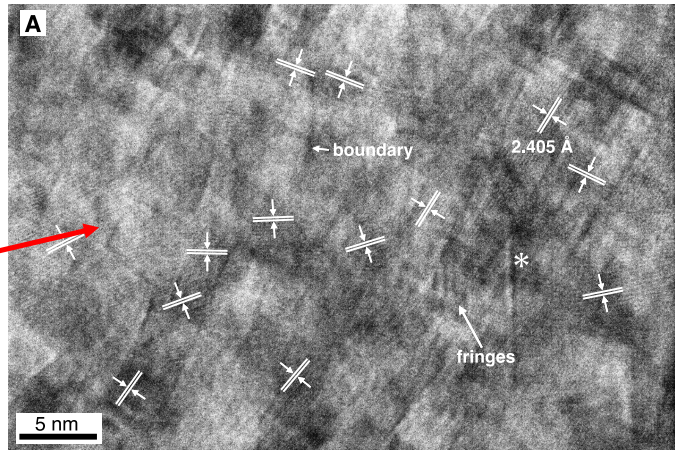
In Holocene lake and spring deposit, peloidal micrite consists of nanocrystal aggregates. Here calcite is associated with aragonite. Organic filaments seem to catalyse aggregation, and possibly preserve the fabric





Meister & Frisia (2019) actually observed nanocrystals in a dolomite micritic peloid 220 million year old…still there!





TEM image of a Triassic dolomite peloid. The box highlights a zone very rich in dislocations, which gives a "salt and pepper" contrast

(From Meister & Frisia, 2019)

High Resolution TEM image of the "salt and pepper" contrast area shows an aggregate of nanocrystals with slight lattice orientation mismatch. This mismatch is what gives the salt and pepper contrast.

- We analysed speleothems and other layered carbonates by synchrotron radiation micro-XRF fluorescence, and found that elements such as Sr and Mg are concentrated where “organic compounds” or particulate are negligible, that is in the carbonate crystals. Other elements, such as Y (and, in analogy, REE) go extra lattice (associated with particulate). This pattern is maintained through diagenesis.

- Nanoscale investigation of crystallization pathways provides understanding of how climate/environmental proxy data are incorporated in diverse fabrics. Then, we can apply the results to the many cases of “non-equilibrium” partitioning to reconstruct past temperatures or water composition.