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Organic matter degradation influence on dolomite formation in the sabkhas of Qatar

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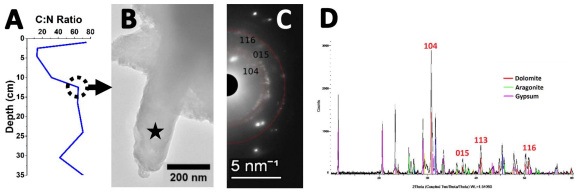

The Qatar peninsula is host to diverse biogeochemical environments; from coastal and inland salt flats (termed "sabkhas") to evaporite ponds and tide-stream mangroves. These unique regions, some protected in national parks, offer hot and hyper-saline conditions, promoting formation of various calcium-carbonate and -sulfate minerals such as aragonite, dolomite and gypsum in the sediment. Despite these extreme conditions, these regions are favorable for surface and sub-surface microbial activity. Microbial colonies are present as "mats": organic-rich layers on the sediment surface covered by mere millimeters of upwelled or coastal seawater. The combination of microbial mats' carbon sequestration and upwelled seawater promotes the formation of minerals near sedimentary organic matter (OM) and microbial productivity. Previous studies suggest that dolomitization of calcium carbonate proceeds under high OM degradation due to high alkalinity and pH levels. However, the interactions between OM and minerals at the nanoscale, and mineral speciation in these degradative sediments require study.

We aimed to elucidate the effect of OM degradation (positively correlated to the C:N ratio of the sediment) on dolomitization in the sabkha sediments, and to uncover OM & mineral nano-structural interactions in the microbial mat. We performed total carbon, organic carbon and nitrogen analyses on sedimentary core layers of the sabkhas to determine OM degradation rate. X-ray diffractometry (XRD) was used to determine mineral speciation and abundance. High-resolution transmission electron microscopy (TEM) crystal diffraction and synchrotron scanning transmission X-ray microscopy (STXM) chemical mapping showed localization and identity of minerals within the OM matrix of the mat. The mechanisms behind organo-mineralization in sabkhas inform future studies of using microbial mats as templates for mineralization & bioremediation experiments.

References

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Figure 1: Dolomite in a highly degradative microbial mat at Dohat Faishakh sabkha, Qatar. A) C:N ratio profile of the sedimentary column. OM degradation increases at the mat layer. B) TEM micrograph of polycrystalline Ca-carbonate within the OM matrix of this layer. C) Electron diffraction at ★ region in B produces diffraction rings corresponding to dolomite 104, 015 and 116 crystal lattice planes. D) XRD of the layer shows abundance of dolomite in the layer.