Characterization of bioturbation and biota and in a modern inner ramp setting, Abu Dhabi, United Arab Emirates

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Summary

This study examines sediment and x-ray tomography scans of surface cores taken in Abu Dhabi in 2017 (Figure 1). We will compile a database of biological components from inter-tidal sediments immediately downdip of the sabkha in a modern inner ramp setting, and assess the overall impact and sequence of early diagenesis in these environments. The coast of Abu Dhabi remains one of few modern carbonate ramp analogues that may help us to understand processes that affected numerous ancient examples, including Alberta's Stettler Formation in the Wabamun Group, which represents a large carbonate ramp and sabkha that covered much of central and southern Alberta. Invertebrate soft-bodied fauna is able to inhabit these intermittently restricted and meso- to hypersaline environments, but the preserved record of this biota is affected by their limited preservation potential. Diagenesis has helped to preserve bioturbation in some ancient examples, including in the Stettler Formation, however the same processes that help to preserve bioturbation commonly distort or overprint the original burrow through dolomitization or recrystallization. The goals of this study are to catalogue the burrows and biota in modern sabkha sediments, and assess the effects of early diagenesis on preservation potential of these components. Initial findings of this modern study have revealed three different types of burrows, and sediments that are dominantly composed of peloids, benthic foraminifera, gastropods, ostracods and small bivalves.

Methods

Several short (<1 m) sedimentary cores were taken in Abu Dhabi in 2017 as part of a larger project focused on the biogeochemistry of the inner ramp and hardground formation. Porewater chemistry profiles were collected and pH, Eh and electrical conductivity recorded and compared with those of overlying seawaters. Three of these cores were scanned at Bristol University using a Nikon XTH x-ray tomography scanner (XTM). The scans were processed and segmented using freeware called 3D Slicer, to visualize burrows preserved in the core (Figure 1). One of the cores was subsequently sliced into two halves and the sediments from one half of the core were dissected into 1 cm^3 samples that would be analyzed for trace elements using the iCAP Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) at MacEwan University. Sediments remaining after dissection for ICP-OES were rinsed and sieved for analysis using a Hitachi TM3000 scanning electron microscope (SEM) at MacEwan University. The other half of the sediment core was impregnated with epoxy and sliced into 12 polished thin sections that were half stained with Alizarin red for differentiation of calcite/aragonite phases from dolomite.

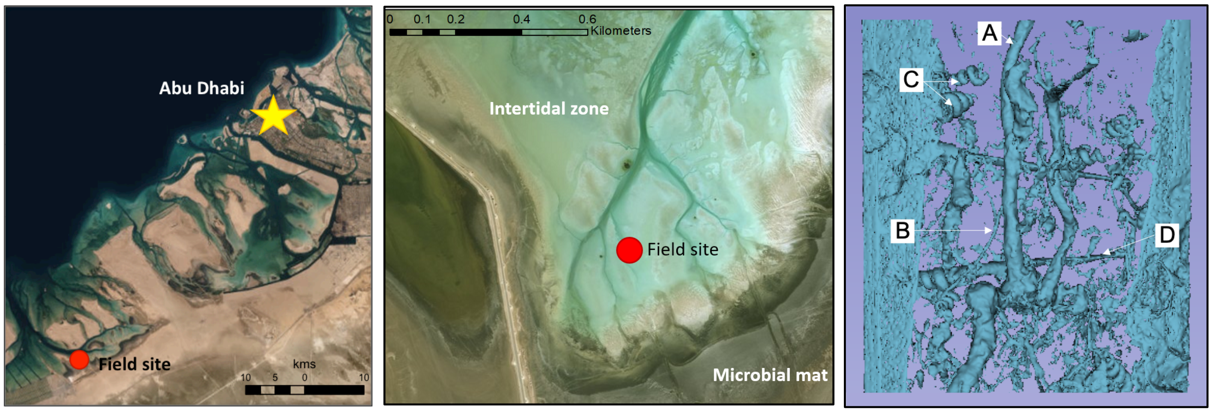

Figure 1: Field site in Abu Dabhi (left – Google Earth); sample site location (middle); and segmented XTM scan of upper 4.2 cm of the sedimentary core (right): A) *Thalassinoides* burrow, B) polychaete burrow, C) gastropods, and D) rhizome (for pore water analysis).

Results

Semidiurnal, mesotidal exposure results in large variations in the composition of seawater overlying the sediment, with salinity measured in November and January ranging from 48.7-76.4 ppt and pH from 8.4-7.8. The most alkaline and highest salinity waters are recorded after low tide and result from drainage from the sabkha and microbial mats situated landward of the sampling site. The sediment column profile is affected by upward leakage of brines (>100 ppt, pH 7.0) from beneath a thick hardground upon which the sediments were deposited. The porewater composition reflects a combination of mixing of these end-member fluids and reactions with the sediment, with anoxic conditions established within 10 cm of the sediment surface. Whilst mottling was apparent within the sediment suggesting sharp redox gradients associated with burrows, we were not able to measure these effects with the 5 cm long rhizomes used for porewater sampling from the core (Figure 1 – left image D).

XTM scans of one sediment core revealed at least three different types of burrows (Figure 1) including: *Thalassinoides, Arenicolites,* and unclassified polychaete burrows. Thin section and SEM analyses document several genera of benthic foraminfera, gastropods, and small bivalves. The burrowed sediment is dominated by abundant peloids, ranging in size and composition, with some preferentially containing siliciclastics. Several grains (~25%) appear to be micritized and the thick internal aragonite portion of some gastropod shells are not stained with the Alizarin red, suggesting possibly alteration. Future analysis will explore high resolution (1 cm^2 grid) trace element content of the sediment core to assess early diagenesis and redox of sediments within the first 40 cm of the sediment-water interface.

Acknowledgements

Steven Lokier is thanked for his assistance in the field during sample collection. Benjamin Moon is thanked for his assistance with the XTM scans performed at the University of Bristol. Funding for associated travel to the University of Bristol was provided by the Benjamin Meaker Visiting Professorship program.