

A Geobiological Investigation of Mazon Creek fossils



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The exceptionally preserved fossil remains of the Mazon Creek biota - a diverse assemblage of marine, brackish, freshwater and terrestrial fauna and flora - are hosted within siderite-cemented mudstone concretions from the Francis Creek Shale Member (mid-Pennsylvanian Carbondale Formation) of northeastern Illinois. The mud-dominated Francis Creek succession records deposition in a subequatorial, estuarine setting characterized by episodic influxes of sediment from upstream areas during floods. Analyses of concretions containing soft-bodied organisms and of brine shrimp carcasses from laboratory diagenesis experiments were used to further understand the mechanisms of soft-tissue preservation.

To determine the presence or absence of microbial textures and associated or potential organic remains in concretions, polished 2 mm thick sections from a jellyfish, holothurian and polychaete worm were screened at The Western Nanofabrication Facility using the LEO (Zeiss) 1540XB focused ion beam/scanning electron microscope (FIB/SEM) equipped

with an Oxford Instruments INCAx-sight energy dispersive spectrophotometer (EDS). Areas with spongy texture (A) and high atomic carbon (B) were further analysed using time of flight-secondary ion mass spectrometry (ToF-SIMS) to confirm that the carbon is organic in nature.

Brine shrimp were buried in 60 cc. syringes containing a sediment-slurry inoculated with a microbial consortium (i.e., Fe-reducers, sulfate reducing bacteria, methanogens) set-up to model the initial stages of decay and preservation in an iron-rich, estuarine environment. Decayed shrimp carcasses were analysed using the LEO 1540. Cuticular remains (C) were retrieved, but soft tissues were not widely mineralised. SEM, EDS and geochemical analyses suggest that siderite (D), iron sulfides and calcium phosphate are involved in early diagenesis. These products are comparable with the minerals observed in the Mazon Creek concretions

Preliminary analysis of pyritised soft-tissue fossils suggests microbial remains may also be present in Mazon Creek concretions. In burial experiments, the total decay of soft-tissue and extensive cuticular degradation of brine shrimp carcasses suggest that increasing burial depth, compaction and syneresis are essential for concretion formation and soft-body preservation. Further taphonomic studies will better our understanding of the conditions required for exceptional soft-body preservation.

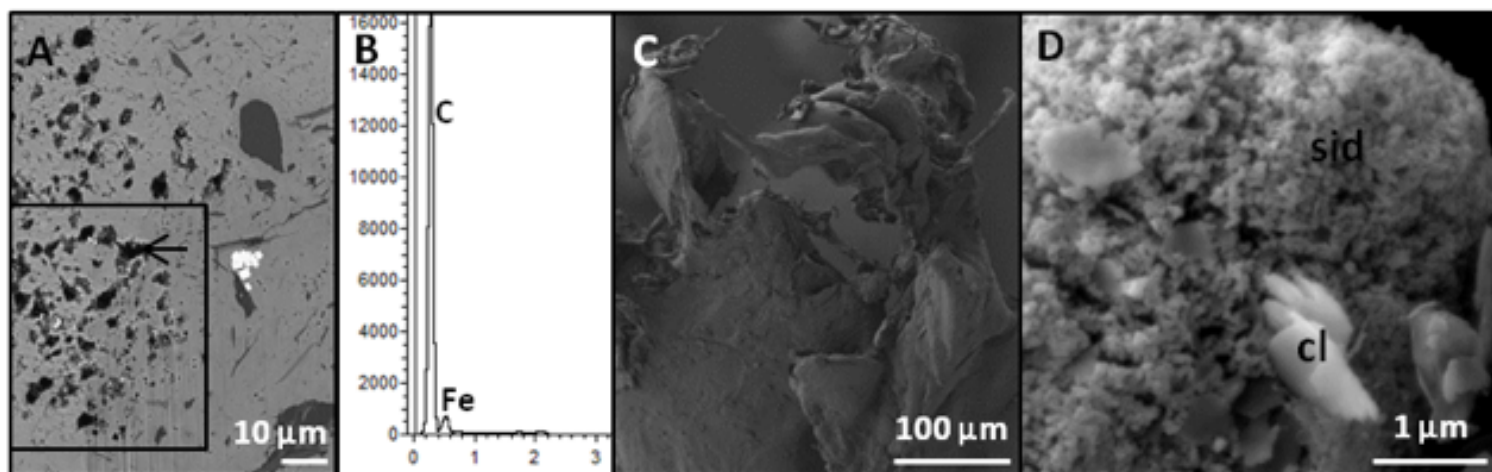


Figure: SEM images of FIB machined 5 μm diameter Zr-2.5%Nb (transverse normal) micro-pillars (a) before compression, (b) after compression testing (non-irradiated condition), (c) after compression testing (Zr⁺ irradiated condition). Figure: A) Backscattered electron micrograph of a jellyfish concretion showing spongy texture (boxed region). B) EDS spectrum (x-axis = keV, y-axis = counts) of spot indicated by arrow in A. Secondary electron micrographs showing: C) the dorsal surface of a uropod located at the abdominal posterior of a brine shrimp carcass at 9 months; and D) An aggregate of colloidal siderite forming around clay particles within syringes at 2.5 months.