Early diagenesis of foraminiferal calcite under anoxic conditions: A case study from the Landsort Deep, Baltic Sea (IODP Site M0063)

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Foraminiferal coatings and their trace element compositions

Authigenic carbonates precipitated in/on foraminiferal shells significantly alter the bulk foraminiferal geochemistry and impede the application of foraminifera-based proxies.

Foraminiferal coatings with high Mn, Mg, Fe, and Ba concentrations found in the deepest basin in the Baltic Sea indicate the authigenic minerals were formed under "extreme" environmental conditions often with anoxia and low salinity.

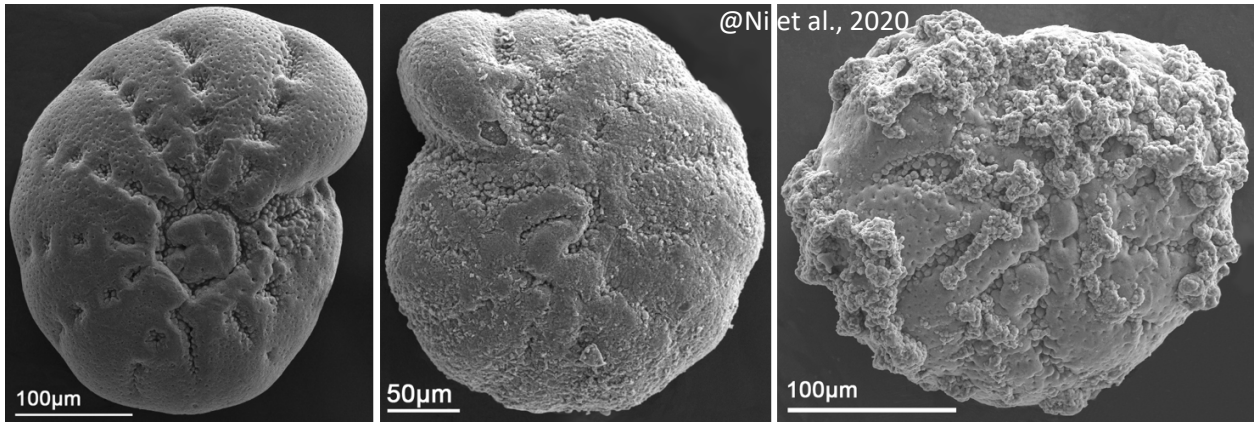


Figure. Three typical example SEM images of foraminifera with different degrees of diagenesis from the Landsort Deep Site M0063. The degree of diagenesis on the outer surface of the foraminifera increases from left to right.

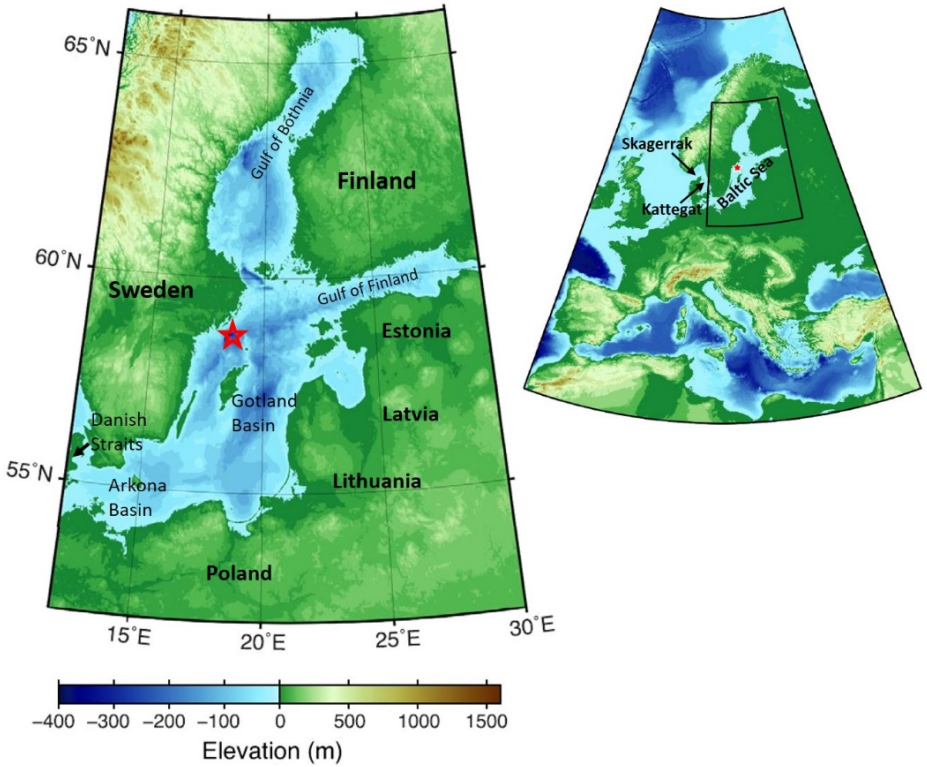
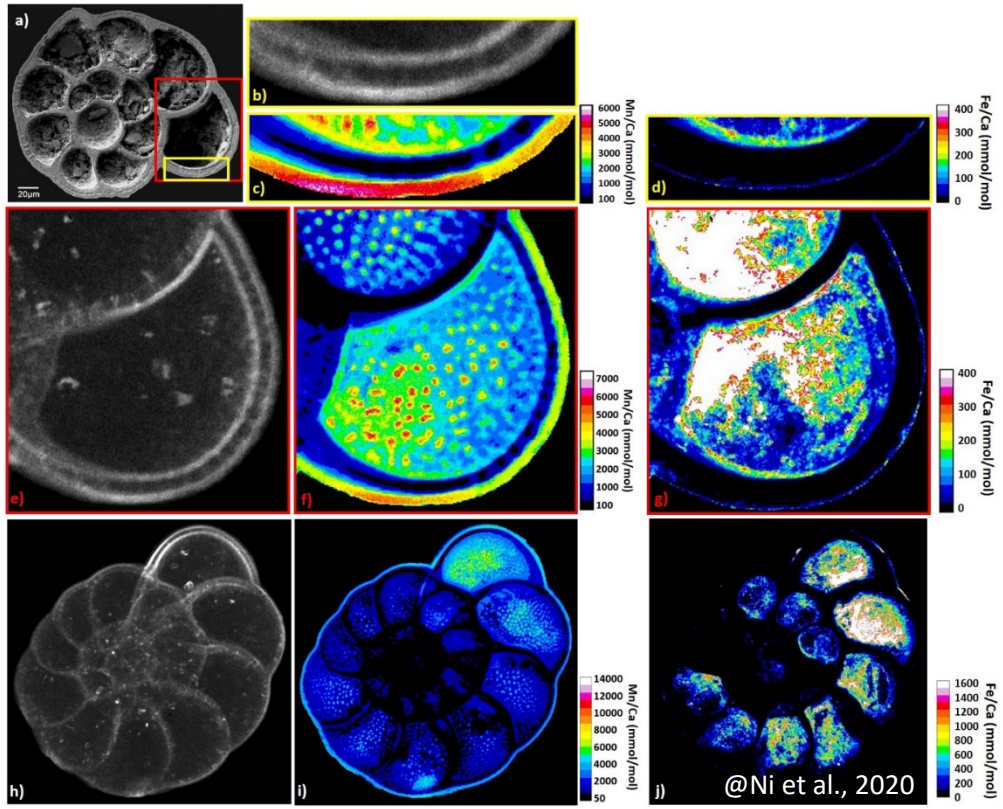


Figure. Map of the Baltic Sea and the position of IODP Site M0063 (437 m water depth, 58°37.35'N, 18°15.26'E), Map is modified from Obrochta et al. (2017).

Figure. a) SEM overview of the cross-section of the specimen, showing two sub-areas we measured µXRF in the yellow boxes and red boxes; b, e, h) density indicator image of a part of the wall of the last chamber, a cross-section of the last chamber, and a cross-section of one foraminiferal specimen, respectively. In the Density indicator images, brighter grayscale indicates higher density of the material, where the original foraminiferal calcite has the lowest density, the pore fillings have an intermediate density, and the authigenic coatings have the highest density. c, f, i) Mn/Ca (mmol/mol) µXRF mapping; d, g, j) Fe/Ca (mmol/mol) µXRF mapping. In the trace element (TE) maps, warm colors indicate higher TE/Ca values.



Authigenic mineral types and formation sequence

The Mn-rich carbonates either completely plugged or only covered the pores. Subsequently, the inner surfaces of the chamber calcite were initially covered by Mn-rich authigenic carbonates. These high-Mn overgrowths initially "avoided" the top of the pores first but eventually also covered the pore areas. The crystal shapes of these overgrowths were rhombohedral or acicular. The Mn-rich carbonates continued to grow on top of the former layer, and occasionally the former layer could be covered by authigenic calcium carbonate which was flat and patchy. In some cases, Fe-rich carbonates and non-carbonate accessory minerals occasionally appear on top of the Mn-rich carbonates inside the foraminifera.

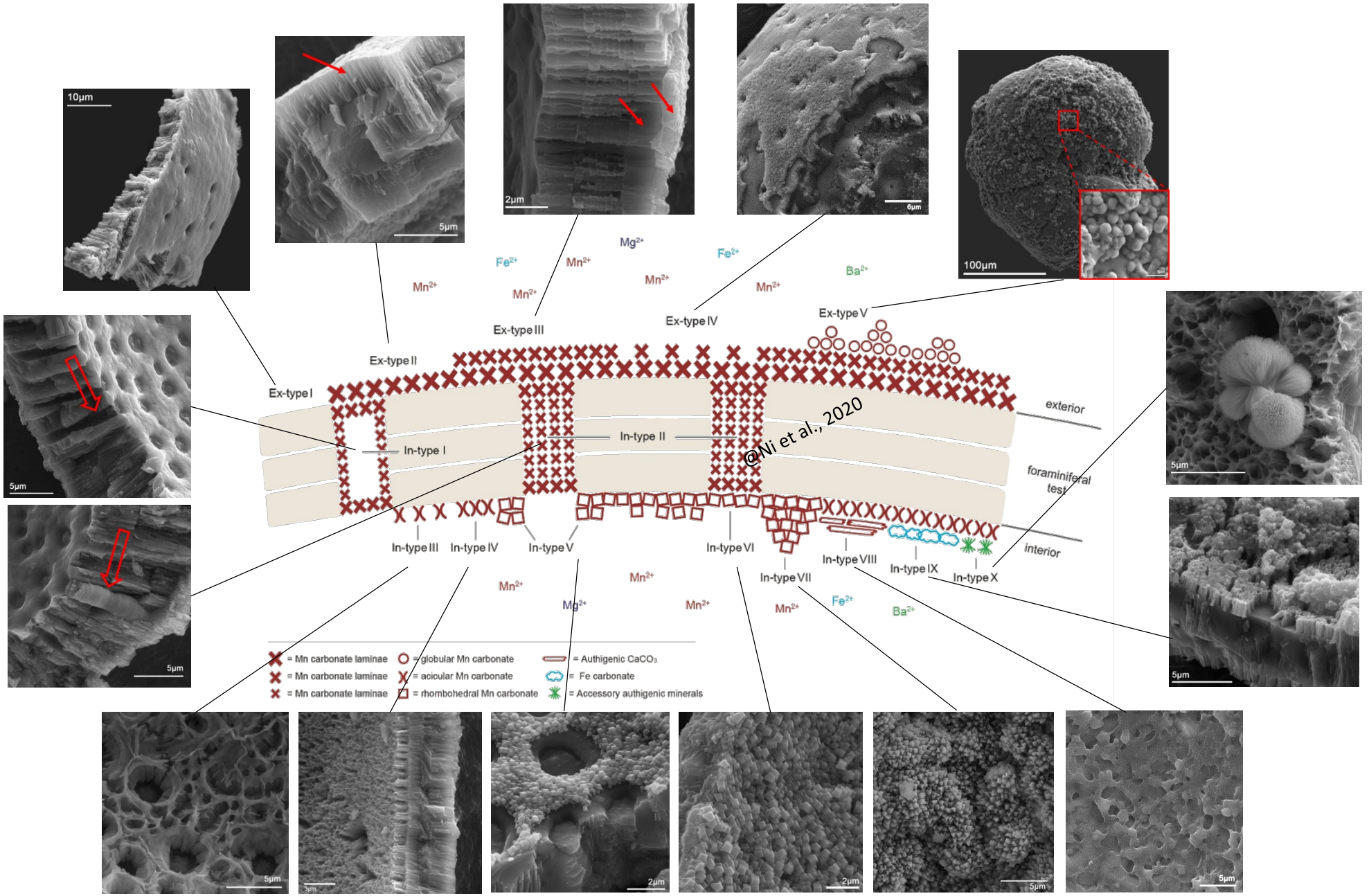


Figure. Scheme and SEM images of authigenic mineral types and their formation on the interior and exterior of the foraminiferal test. Elements ions inside and outside the foraminiferal chamber indicate the free ions in the ambient porewater that could be used for authigenic minerals formation. Increasing degrees of early diagenesis of foraminifera-coating authigenic minerals are indicated by going from the left to the right side of the scheme.