



Sediment as a source of iron and the role of Fe in preservation of soft-bodied organisms

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Many Cambrian soft-bodied fossils are preserved as kerogenous or aluminosilicate films with diffuse pyrite in various iron-rich sediments. Given the frequent presence of iron both in fossils and sediments, its role in soft-bodied fossils formation has been discussed. One idea is that iron binds to recalcitrant exopolymers, thus protecting the organic molecules from bacterial degradation. Another possibility is that the pyrite produced via bacterial sulfate reduction precipitate on buried carcasses and spread centripetally. Both hypotheses presume that Fe is the agent that prevents decay.

To test this idea, we carried out long-term experiments (1 and 5 years). We buried nauplii of *Artemia salina* (Crustacea) in Mg-rich and Fe-rich chlorites (clinochlore and chamosite respectively, duration 1 year) in marine water anticipating better preservation in the chamosite. Besides, *A. salina* in montmorillonite (Fe: 7 wt%) was kept for 5 years in fresh water. Upon completion of the experiments, we estimated the degree of preservation of exhumed nauplii and the changes in elemental content of the carcasses. Mineralogy of the experimental sediments was tested via STA; the detected changes in them were then compared with the elemental composition of the carcasses.

The experiments revealed interesting patterns of decay. In the chlorites, light spots formed around every carcass on day 8-10; by the 4-5th month, a specific layer (light green in the clinochlore and black in the chamosite) appeared on the water-sediment interface, then this layer began to spread downward. In the chamosite, this layer became orange after 8 months. In the gel-like montmorillonite thickened with depth, a bright red layer formed in the middle of sediment after 5-6 months. This red layer maintained the same color for the following 4.5 years.

In both chlorites, the degree of preservation of nauplii was similar and low compared with those from montmorillonite (even after 5 years of burying) and other sediments (in the parallel experiments with kaolinite, amorphous artificial silica, and kaolinite + Ca-carbonate). In the "clinochlore" carcasses, Mg and Ca dominated, while in the "chamosite" carcasses, Fe appeared in significant amount instead of Mg and Ca. Mineralogical analyses revealed leaching of Mg in the former and Fe in the latter, and corresponding degradation of mineral structures.

The montmorillonite "red layer" contained considerable amount of ferrihydrite with its characteristic red color and, as it usually happens in soils, stabilized by Si-ions. Fe- and Si-ions were produced via degradation of the clay. The carcasses from this "red layer" were covered by small "Fe-, S-" spheres.

The patterns in the sediments reflected complex chemical processes fueled by the presence of decaying organic matter. Due to these processes, eroding minerals of the sediments became a source of Fe and other elements. Fe did not contribute to better preservation of the carcasses. Thus, Fe-induced halting of decay seems to be inconsistent with the experimental results. Meanwhile, Fe in sediments or medium would bind to organic substance to form coating or shapes and crystals on the surface or in deeper tissues.