

Formation of iron sulfides in a co-culture of sulfate- and sulfur-reducing bacteria

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Iron sulfides are mostly formed in the sediments of temperate ecosystems through microbial sulfide production. Among these minerals, pyrite (FeS₂) is the geologically most stable one, thus it plays a crucial role in regulating the oxidation state of the atmosphere and is often used as an isotope archive for reconstructing past environments. However, our understanding of how microorganisms together with burial diagenesis affect pyrite formation is still incomplete. While incubations of pure sulfate-reducing cultures with ferrous salts generated less stable iron sulfides, pyrite rapidly appeared in the presence of a sulfate/sulfur reducing consortium enriched from a ferruginous lake [1]. We hypothesize that the cyclic production of sulfide by these two microbes in reaction with ferric iron continuously forms intermediate S compounds, which are now widely regarded as necessary for pyrite precipitation [2]. Thus, the aim of this study was to determine the type and morphology of iron sulfides formed in the (co)-culture of a sulfate- (*Desulfovibrio desulfuricans*) and sulfur-reducing (*Sulfurospirillum deleyianum*) bacterium grown with different ferric compounds before and after simulated diagenesis. After a month of bacterial activity iron sulfides of irregular shape and size formed, with differential reactivity of the starting iron minerals. After diagenesis, iron sulfides were often present as sheets, euhedra and spherules in both pure culture setups and abiotic controls, potentially reflecting local (super)saturation states of the minerals. However, in the presence of both bacteria iron sulfides appeared to have less defined shapes compared to their pure-culture counterparts. This indicates how microbial consortia and burial can ‘homogenize’ the morphology of iron sulfides and thus hinder the search for biosignatures in the rock record. As opposed to previous work focusing on pure cultures, this and further studies will enhance our general knowledge of how mixed S-reducing communities subjected to diagenesis affect the type and S isotopic composition of iron sulfides commonly found in nature.

[1] Berg, J. S. et al. (2020), Sci Rep 10, 8264.

[2] Mansor, M. et al. (2025), Geo-Bio Interfaces 2, e6, 1-31.