Aerobic microbial lithotrophic oxidation of pyrite at neutral pH

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Pyrite is the most common sulfide mineral in Earth's crust. The mechanism and occurrence of pyrite oxidation under acidic conditions such as acid mine drainage systems are well established; however, much less is known about microbially accelerated pyrite oxidation at circumneutral pH where solubility of Fe(III) is limited and oxygen is likely the dominant oxidant. Our recent work has demonstrated the ability of microorganisms from a variety of habitats to accelerate the oxidation of pyrite at circumneutral pH, suggesting that this poorly documented phenomenon may be ubiquitous in nature. Geochemical and metagenomic evidence suggest that in addition to sulfur-based metabolic processes, chemolithotrophic iron oxidizing bacteria (FeOB) may directly accelerate the oxidation of pyrite via surface-associated Fe-redox reactions involving extracellular electron transfer (EET) [1]. This study investigated the role of FeOB in neutral pH subsurface oxidative weathering of shale hosted pyrite at Susquehanna-Shale Hills Critical Zone Observatory in Central Pennsylvania. *In situ* mineral incubation experiments were conducted at the inferred depth of the pyrite reaction front (c.a. 26 m and 6 m depth for wells DC0 and CZMW6, respectively) using ground country rock with or without additional ground specimen pyrite (<106 µm). After ca. 4 months *in situ* incubation, the minerals were collected and used as inocula to establish lithotrophic pyrite oxidizing enrichment cultures with O_2 as an electron accepter. Sulfate generation in biotic reactors was ca. 2.5-fold higher relative to abiotic controls over the first 35 days: the experiment remains ongoing. Parallel microcosms were used for DNA extraction and forthcoming metagenomic analysis whereby the genomic potential of microorganisms *in situ* and in enrichment culture will be evaluated, with particular interest in Fe-EET-based metabolic pathways.

[1] Percak-Dennett *et al.* (2017) *Geobiology* **5** 690-703.