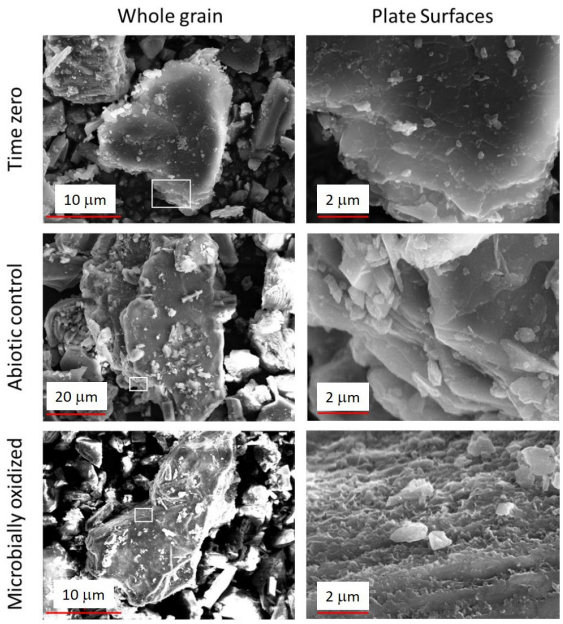
Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37356

Let them eat rock: aerobic chemolithotrophic oxidation of insoluble Fe(II)-bearing minerals at circumneutral pH

ERIC E RODEN

University of Wisconsin-Madison

Aerobic chemolithotrophic oxidation of Fe(II) at circumneutral pH is typically thought of in connection with oxidation of soluble Fe(II) delivered to solution via solute transport or mineral dissolution. However, insoluble Fe(II)-bearing minerals such as Fe(II)-silicates (e.g. biotite, hornblende) and pyrite (FeS_2), which are common in igneous/metamorphic and sedimentary rocks, also contain a large amount of free energy that could be available to microorganisms capable of directly extracting electrons from the mineral surface. Such microbial metabolism would presumably require the activity of an extracellular electron transfer (EET) process akin to that known to be involved in the reduction of insoluble Fe(III) oxides as well as the oxidation of soluble Fe(II) at circumneutral pH. This presentation will summarize recent studies (Napieralski et al., 2019; Napieralski and Roden, 2020; Napieralski et al., 2022; Haas et al., 2024) that demonstrate the ability of aerobic microbial consortia to accelerate the oxidation Fe(II)-silicates and pyrite in natural rock materials. Genomic sequencing of organisms in the cultures provides evidence for previously unrecognized pathways whereby microbial EET may accelerate oxidative weathering of insoluble Fe(II)-bearing minerals in soils and sediments. The ability of microbes to accelerate the reaction of oxygen with such phases has significant implications for major and trace element biogeochemical cycling across a variety of time scales.



Field emission SEM images of granodiorite-hosted biotite at the whole grain scale (left) and basal plane (right). The approximate area of the basal plane presented is outlined in white on the grain scale images. Note the ragged appearance of the basal plane observed after microbial alteration. From Napieralski et al. (2019).

Haas, L., M. Ginder-Vogel, J. J. Zambito, D. Hart, and E. E. Roden. 2024. Microbially-mediated aerobic oxidation of trace element-bearing pyrite in neutral-pH sandstone aquifer sediments. Environ. Sci.: Advances Article d3va00399j.

Napieralski, S. A., and E. E. Roden. 2020. The weathering microbiome of an outcropping granodiorite. Front. Microbiol. 11:601907.

Napieralski, S. A., H. L. Buss, S. L. Brantley, S. Lee, H. Xu, and E. E. Roden. 2019. Microbial chemolithotrophy mediates oxidative weathering of granitic bedrock. Proc. Nat. Acad. Sci. USA 116:26394-26401.

Napieralski, S. A., Y. H. Fang, V. Marcon, B. Forsythe, S. L. Brantley, H. F. Xu, and E. E. Roden. 2022. Microbial chemolithotrophic oxidation of pyrite in a subsurface shale weathering environment: Geologic considerations and potential mechanisms. Geobiology 20:271-291.