Depth-dependent geochemical and microbiological gradients in acid mine drainage-derived Fe(III) deposits

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In the Appalachian coal mining regions of the U.S., several sites have been identified in which emergent coal mine-derived acid mine drainage (AMD) flows as a sheet (0.5-1 cm deep) over the terrestrial surface. Microbiological oxidation of AMD-associated Fe(II) gives rise to thick iron(III)-hydroxide deposits that are referred to as iron mounds. We characterized depth-dependent geochemical and microbiological gradients within the an iron mound that had accumulated to 10 cm. While organic carbon diminished with depth, total cell abundances were uniform throughout the iron mound sediments. Similarly, abundances of culturable aerobic Fe(II) oxidizing bacteria were uniform throughout the sediments despite depletion of O_2 at a depth of approximately 3 cm. Culturable Fe(III) reducing bacteria (FeRB) were most abundant in the top 2 cm of the iron mound sediments, coincident with the highest Fe(II) concentrations, despite the presence of abundant O_2. Fe(II) concentrations decreased at depths below approximately 2.5 cm, though it is unclear how Fe(II) may have been oxidized in the anoxic regions of the sediments. Nucleic acid based characterization of microbial communities at discrete depth intervals within the iron mound sediments revealed an abundance of phylotypes attributable to aerobic FeOB *"Ferrovum"* spp. and photosynthetic microeukaroytes in the upper 3 cm of iron mound sediments, and the relative abundances of these phylotypes were low in deeper portions of the iron mound. However, phylotypes attributable to acidophilic Gammaproteobacterial lineages capable of Fe(II) oxidation and Fe(III) reduction comprised at least 20% of sequence libraries recovered from all depths within the iron mound. Our results indicate that while Fe(II) oxidizing and Fe(III) reducing bacterial activities in iron mound sediments occur in close proximity to each other in oxic regions of the sediments, microbial activities, including Fe(II) oxidation, may be sustained in anoxic regions of the iron mound sediments.