Surprises from the microbial world: Bacterial Mn-oxidation at low pH

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Mn oxides are ubiquitous in natural environments, ranging in pH from acidic to alkaline conditions, and their formation in neutral environments is typically attributed to biological activity. Many microorganisms, including bacteria and fungi are known to readily oxidize Mn(II) and precipitate Mn oxides at pH ~7 under oxic conditions. However, little is know about the ability of Mn(II)-oxidizing bacteria (MOB) to precipitate Mn oxides under acidic conditions. We isolated 3 novel MOB isolates at pH 5.5 from an acidic, metalliferous uranium mine, where natural attenuation of heavy metals is associated with Mn oxide rich soils. Our isolates, *Duganella* spp. strain AB_14 and *Albidiferax ferrireducens* strain TB-2 were only able to oxdize Mn at acidic pH, whereas, our isolate *Mesorhizobium australicum* strain T-G1, was able to oxidize Mn at both acidic and neutral pH. *M. australicum* strain T-G1 utilizes different pathways for Mn oxidization depending on the pH, with multicopper oxidase expression and reactive oxygen species (ROS) associated with acidic and neutral pH oxidation, respectively. AB_14 and TB-2 produced Mn oxides with similarities to todorokite and birnessite, whereas, at acidic pH, T-G1 produced bixbyite-like Mn oxides. We demonstrate that MOB can be involved in the formation of biogenic Mn oxides in both moderately acidic and neutral pH environments and utilized different Mn oxidation pathways depending on the environmental conditions. This suggests that biological processes have an even larger influence on Mn biogeochemical cycling than previously identified.