Observations and assessment of iron oxide and green rust nanoparticles in metal-polluted mine drainage within a steep redox gradient

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In this study of iron- and silica-bearing nanoparticle and colloid aggregates in slightly acidic mine drainage, we combined bulk scale geochemistry techniques with detailed nanoscale analyses using high-resolution transmission electron microscopy (HR-TEM) to demonstrate the complexity of iron oxide formation and transformation at a steep redox gradient (groundwater outflow into a stream), and the resulting role in metal(loid) uptake. We also identified pseudohexagonal nanosheets of Zn-bearing green rust in outflowing groundwater using HR-TEM. This is only the second study where green rust was identified in groundwater, and the second to examine naturally occurring green rust with analytical TEM. In aerated downstream waters, we found aggregates of poorly crystalline iron oxide particles (20-200nm in diameter). Inductively coupled plasma-mass spectrometry (ICP-MS) analysis of water fractions shows that most elements such as Ni and Zn were found almost exclusively in the dissolved-nanopa