Incidental iron oxide nanoparticle characteristics and stability during remediation of a mining-impacted stream

LOGAN N. RAND[1], JAMES F. RANVILLE[1*]

[1]Chemistry Department, Colorado School of Mines, Golden, CO 80401, USA (*correspondence: jranvill@ mines.edu)

Acid mine drainage (AMD), which poses a significant water quality threat to streams, causes the precipitation of Fe (hydr)oxides to which heavy metals sorb. Given that this process is a result of mining activities, we can classify the resulting precipitates as incidental nanoparticles (INPs) and their colloidal aggregates. We examined the characteristics, abundance, surface properties, and aggregation of INPs, as well as a model iron oxide, during remediation of the AMD inputs to the North Fork of Clear Creek, Colorado.

Particle sizes and concentrations were measured concurrent with water chemistry monitoring during the first six months of lime water treatment plant operation. Single particle ICP-MS (spICP-MS) analyses showed Fe and Cu INP number concentrations in impacted stream water decrease from 10^7 to 10^5 particles mL^{-1}, before and after treatment respectively. Additionally, the number-weighted, most frequent Fe INP size was 182 ± 7 nm during treatment versus 45 ± 3 nm without treatment. Laser scattering (suitable for particles > 500 nm) demonstrated a similar reduction in colloidal particle concentration following treatment.

We also studied the importance of changes in surface chemistry during the treatment period on INP stability. We measured the aggregation of hematite, a model Fe oxide INP, that was suspended in filtered water samples. Changes in zeta potential and INP size, measured by dynamic light scattering, support that the pre-treatment stream chemistry promoted rapid aggregation and sedimentation while improved water quality inhibited aggregation.

This work provides new insight into AMD-generated INP behavior before and during stream remediation. We highlight the utility of spICP-MS for observing INPs in complex, natural systems while advocating caution in its data treatment to minimize artifacts.