Understanding the Behavior of Sulfidic Colloids in the Presence of Metals

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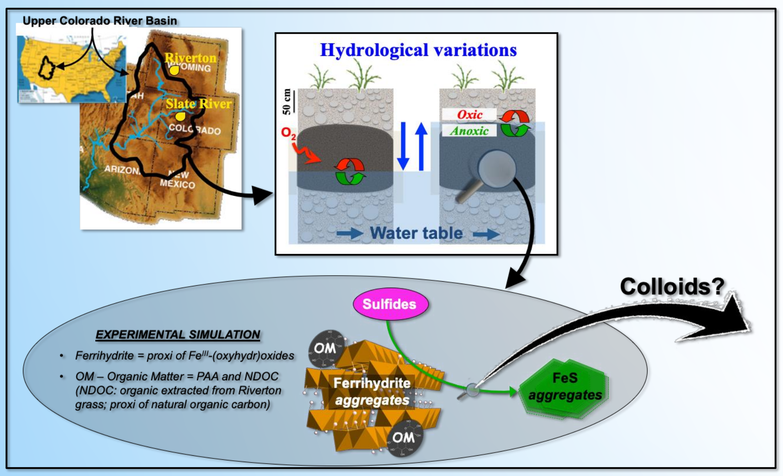
Background:

A high concentration of metals accumulated in the groundwater of the floodplains can be toxic to living organisms of these ecosystems as well as provide undrinkable water. Understanding the mobility of these metals is critical to management and remediation of these sites.

- **Motivation:** colloids (suspended <µm mineral particles or organic matter) are suspected of bound and transport these metals in floodplain sediments from porewater to groundwater, and subsequently impact the groundwater quality
- **Knowledge:** groundwater fluctuations due to seasonal cycling promotes mineral transformations at sediment-water interfaces, generating colloid release in the porewaters
- **Knowledge gaps:** Anoxic environment, developing during the saturation seasonal phase, has been proposed to generate sulfide colloids, however direct evidence for their formation is still lacking
- **Hypothesis:** Fe^{III}-(oxyhydr)oxide sulfidation, happening in anoxic environment, generate colloids that can bind and mobilize metal(loid)s, such as uranium (U), molybdenum (Mo), zinc (Zn), cupper (Cu), and nickel (Ni). These are important alluvial contaminants at Riverton, WY DOE legacy uranium ore processing site, and Slate River.

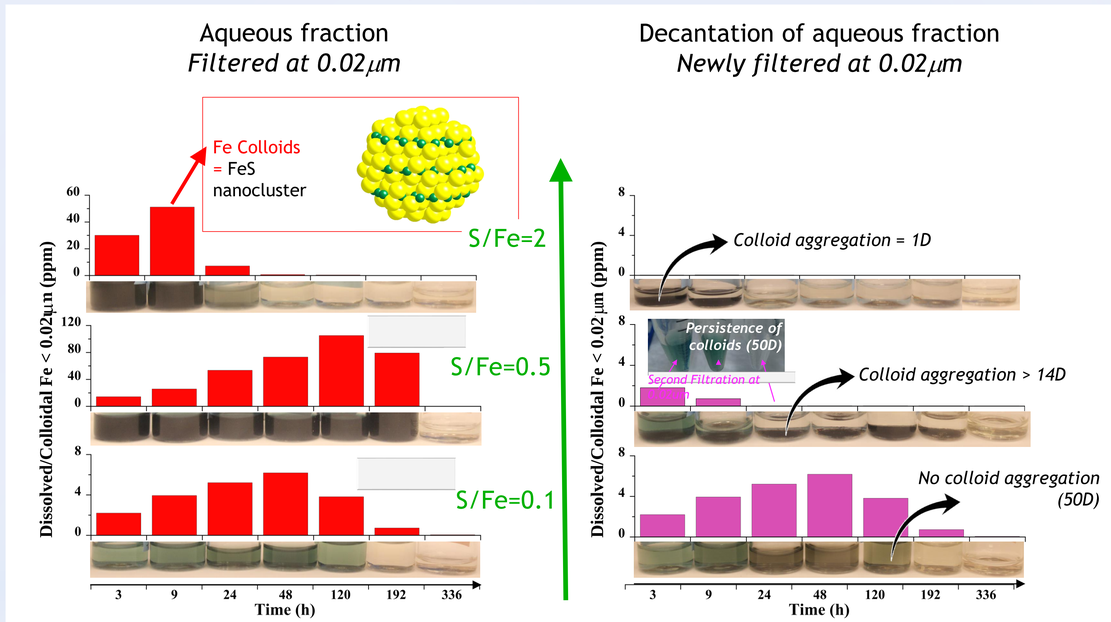
Objective:

The objective is to improve our knowledge of the nature of colloids in anoxic environments and influence of metals themselves on the generation of these colloids.
These results are critically needed to improve our understanding of water quality in responses to hydrological changes.



Formation and stability of FeS colloids

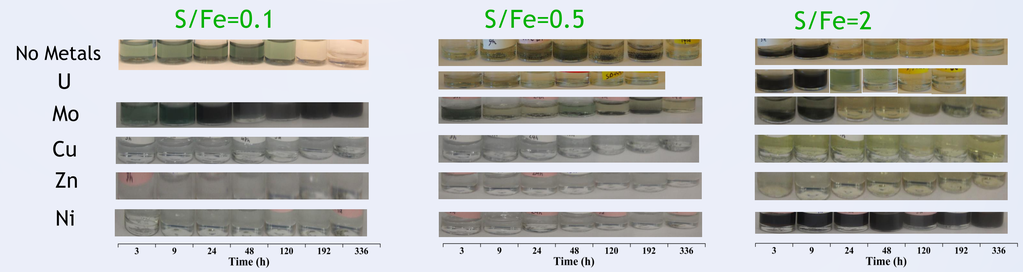
Artificial Slate River Groundwater



- Reductive dissolution of OM-ferrihydrite generated Fe colloids => FeS nanocluster
- Their residence time in suspension is correlated to S/Fe ratio:
  => Low sulfidation (S/Fe ≤0.5): FeS remain stable in groundwater for at least 14 days
  => High sulfidation (S/Fe >0.5): promotes aggregation of FeS colloids

Impact of metals on FeS colloid generation

Artificial Slate River Groundwater



- U and Mo doesn't influence the generation and stability of FeS colloids
- In the presence of Cu and Zn, no FeS colloids are generated for at least 14 days
- For Nickel, the generation of colloids appears to be dependent on the ratio of S/Fe;
  => Low sulfidation (S/Fe ≤0.5): no FeS colloids
  => High sulfidation (S/Fe >0.5): promotes the generation and stability of FeS colloids

Conclusions

1/ Sulfidation of OM-ferrihydrite aggregates can generate sulfidic colloids depending on the S/Fe ratio:

- At low sulfidation (S/Fe ≤0.5): there is production of stable FeS colloids, promoting the mobility of FeS-associated contaminants

2/ The type of dissolved metal impurities also impacts the generation and stability of FeS colloids in groundwater

Future works:

- Study of FeS colloid stability in a wide range of groundwater compositions to define controlling chemical parameters
- Study of molecular form of Cu, Zn and Ni at low sulfidation in order to determine why FeS colloids are not stable in presence of these metals.
- Understand if the presence of Zn, Cu and Ni could control the inhibition of colloids and thus paradoxically their impact on the water quality

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