

Combining molecular-scale characterization with field flow fractionation: a pilot study based on probing colloids in floodplain sediments.

SOHEYL TADJIKI¹, ELIZABETH L PAULUS², BRANDY STEWART³, KRISTIN BOYE³ AND VINCENT NOËL³

¹Postnova Analytics

²Stanford University

³SLAC National Accelerator Laboratory

Owing to their high specific surface area and density of reactive surface functional groups, colloids are important carriers of critical substances, including organics, nutrients, heavy metals, and pollutants. Therefore, colloids have crucial impacts across a large spectrum of important processes from environmental to nanomedicine/pharmaceutical applications. The variability of chemical compositions of colloids undoubtedly influences their physical and chemical properties, reactivity, and toxic/remediation effects. However, the variability of colloids found in complex systems requires probing the molecular-scale composition of different concomitant colloid groups to predict their distinct stability/reactivity and transport responses. To resolve this knowledge gap, we developed an approach combining molecular-scale characterization (*e.g.*, X-ray spectroscopy (XAS) and microscopy (STXM)) with asymmetric flow field flow fractionation (AF4). Using AF4 coupled with ICP-MS, UV-, MALS-, and zetasizer-DLS detectors allow us to separate and categorize particles according to their physico-chemical compositions. Distinct colloid groups can then be subsampled for deeper molecular-scale characterization.

Through the example of natural cycling of colloids in redox-affected floodplain sediments in a mountainous watershed (CO, U.S.A.), we show promising results for our intended Stanford Synchrotron Radiation Lightsource (SSRL) users' facility, aiming to provide quantitative speciation-resolved characterization of nanoparticles by in-line coupling of AF4 with XAS. Due to preliminary results revealing that oxic conditions during AF4 analyses impact colloid size and composition, we developed a system preserving redox integrity while separating colloids. Further, we show that AF4-STXM and AF4-XAS can successfully separate/concentrate and characterize different carbon- and Fe-associated colloid, respectively. Our workflows are amenable (with slight modifications) to multiple areas of study, including nano-medicine, water treatment, mining, and agriculture.