

Soil colloid mobilization and metal transport

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Crop and Soil Sciences Seminar

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Following construction of the Department of Energy's Savannah River Site (SRS) near Aiken, SC in 1954, over 44,000 kg of depleted uranium (U), a similar amount of nickel (Ni), and other metal contaminants were released into the Tims Branch-Steed Pond (TBSP) system. Failure of the Steed Pond dam in the 1990s facilitated significant transfer of U to downstream ecosystems largely in association with particulates suspended during rainfall events. Since that time Steed Pond has become much more densely vegetated and the effect of this landcover shift on U and Ni mobilization is currently unknown. Preliminary monitoring efforts below Steed Pond suggest that during base flow, mobilized Ni predominately occurs in soluble or nanoparticulate ($<0.2 \mu\text{m}$) form, while significant portions of U are mobilized as filterable particulates ($>0.2 \mu\text{m}$). To evaluate the current impact of rainfall events more systematically, we will install an automated stream monitoring system below the outlet of Steed Pond. This monitoring system will be triggered by turbidity measurements to capture peaks in suspended particulates during episodic rain events. We are also investigating the mechanisms responsible for generating the suspended particles. Erosive mobilization of wetland sediment is likely responsible for the largest suspended particles, but other mechanisms may drive mobilization of particles in the colloid or nanoparticle size range (1 nm to $1 \mu\text{m}$). Changes in pH are well known to affect the dispersion of colloidal particles. In addition, reduction of ferric oxides under anoxic conditions can promote colloid dispersion by dissolving the connective cement that holds aggregates together. This reduction of Fe-oxides also results in increases in solution pH through hydroxide production, which can indirectly influence colloid dispersion through development of negative charge on the particles. Thus, we will be conducting laboratory studies that probe the influence of pH, ionic strength, and redox status on the remobilization of colloid-bound U within the TBSP system. To refine our laboratory methods, we have examined colloidal carbon release from soils across the Hawaiian archipelago, which are commonly assumed to contain an abundance of dispersible nanoscale organo-mineral phases. We measured colloidal and nanoparticulate carbon release in three size fractions after equilibrating the soils across a range of pH values and following 21 days of anoxic incubation. Our results indicate that in comparison to anoxic sediments, pH shifted sediments release similar amounts of dissolved (1.3 nm) and nanoparticulate (1.3 nm – 35 nm) carbon. However the largest particles measured, (35 nm – 260 nm) were only dispersed after anoxic incubation, suggesting they are associated with Fe-oxide cements.

References

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