# On modeling H$^+$ and U transport behavior in an acidic plume

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A nearly 1 km long acidic plume has developed under the F-Area at the U.S. Department of Energy Savannah River Site, South Carolina, from the disposal of low-level acidic radioactive waste solutions into seepage basins overlying relatively permeable, mostly sandy sediments. The disposal operations lasted for about 35 years until 1990, when the seepage basins were solidified and capped. Since then, the groundwater pH in the plume has remained mostly in the 3–3.5 range despite the end of disposal operations and fast groundwater velocities, although U concentration adjacent to the basins has been decreasing exponentially.

Here, we report on exploratory geochemical and reactive transport modeling investigations conducted to assess the relative roles of surface protonation and mineral precipitation in slowing down the rebound of pH at this site, as well as U transport behavior downgradient of the disposal basins. The modeling work is integrated with investigations of 'reactive facies', which aim at identifying specific types of sediments with unique properties affecting reactive transport, then correlating these sediment types with lithologic facies and their associated geophysical signatures for estimation of reactive properties over plume scales.

One- and two-dimensional reactive transport simulations were conducted considering Al and Fe mineral dissolution and precipitation, as well as H$^+$ and U surface complexation models from the literature. Simulations indicate that H$^+$ sorption reactions on goethite and kaolinite (primary minerals at the site besides quartz) could buffer pH at the site for long periods of time. The precipitation of Al silicates, hydroxides, and/or hydroxy sulfates could also strongly impede pH rebound at the site. Although the pH is computed to rebound quite slowly, U concentrations could potentially decrease at comparatively much faster rates from dilution with clean recharge water. Simulations results are most sensitive to reactive surface areas, to relative rates of reaction versus acidic discharge, to relative rates of mineral precipitation and dissolution, and to the type of implemented sorption models and parameters. The model sensitivity to heterogeneous fields of permeability and reactive surface areas derived from the reactive facies investigations is also investigated.

# Biomineralization and growth mechanism of morphologically controlled strontium carbonate

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Biomineralization is a growing discipline in modern earthscience and is attracting much attention as it helps us (i) to synthesis marine carbonates with required morphology, composition and structure and (ii) to understand and quantify the controlling factors which affects the microbial mineralization in deep marine environments.[1, 2] The biological systems are very effective at controlling crystal growth, especially polymers have been successfully developed to control crystallization of inorganic particles in aqueous solutions. In this work we report the synthesis of araganite type strontium carbonate super structures using Gum acacia and also discussed the growth mechanism of the carbonates.

Gum acacia is a branched polysaccharide containing carbohydrates, amino acids, gulcuronic acid and a glycoprotein complex. The functional groups (-OH) present in arabinose and rhamnose and (-COOH) of glucuronic acids play a crucial role in the growth and formation of metal carbonates whereas the proteinaceous core with amino acids (-NH$_2$) stabilize the formed metal carbonates and play a key role in mimicking the biomineralization process. The crystallization involves the formation of different hierarchical structures like rice grain, doughnut shaped, flower shaped, hexagonal rods and cross shaped which have never been seen before in natural biominerals. Proteins and polysaccharides with complicated patterns of various functional groups in GA selectively adsorb on to the metal ion thereby hindering the crystal growth, followed by the mesoscale self-assembly of nanometer-scale building block into hierarchical superstructures. The key reaction of CO$_2$ with Sr$^{2+}$ ions entrapped within GA polymer leads to the growth of beautiful structures of strontianite. Structural characterization of the synthesized materials was investigated by XRD, SEM, EDAX, TEM, TGA-MS and FT-IR.

[1] Porter SM. (2007) *Science* **316**, 1302. [2] Sanchez-Roman. M. *et al*. (2011) *Chemical Geology* **281**, 143.