Impact of "Flow Tubes" within Structured Media on Groundwater Transport and Surface/Groundwater Interactions

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Recent studies at the ORIFRC site indicate that groundwater transport in structured media may behave as a system of parallel flow tubes. ORIFRC studies suggest that several dominant types of groundwater flow paths exist with the primary driver being the solid phase encountered (e.g., clays, carbonates, clastics) as contaminants migrate along the pathway. We have begun conducting preliminary geophysical, spectrographic, geochemical and microbiological studies to help determine if processes (solid phase reactions, recharge, diffusion, microbial interactions) that occur along the groundwater flow tubes have a significant impact on the reactions that occur when groundwater discharges and interacts with surface water. Groundwater geochemistry and contaminant concentrations reaching the Bear Creek tributaries can vary depending on the "tube" groundwater flows through and the solid phase encountered. For example, if a tube is rich in carbonate, the pH of the groundwater will increase and the U concentration will decrease but high nitrate concentrations are maintained. Low pH and high U conditions are likely to be more persistent in pathways with lower carbonate present in the solid phase.

As expected, preliminary studies show that surface/ground water interactions are dynamic; changing rapidly in time and space due to precipitation events. Under some flow conditions we have observed extreme contaminant stratification with depth in some deeper pools (2-3 feet deep). For example on 11/3/11 at NT1+250 the Specific Electrical Conductivity (SEC) at the creek bottom was 11,320 μS/cm and the pH was 4.4. Close to the surface SEC and pH were 732 μS/cm and 6.9, respectively. This suggests contaminated groundwater is entering at the bottom of these pools and remains temporarily trapped at the bottom due to density effects. As highly contaminated low pH and DO water at the bottom of the pool migrates upwards and interacts with surficial waters containing high pH and DO, mixing and contaminant transformation will occur. In this zone of mixing, kinetically controlled reactions are likely to occur that produce U, Al, Mn, Fe and other precipitates. Microbial sampling and DNA analysis of sediment and surface water samples collected from Bear Creek and tributaries are underway to help elucidate changes in microbial processes under different flow conditions.

Preliminary data shows that how and where surface water samples are collected can significantly impact the results, interpretation and estimation of surface water fluxes. The amount of mixing and reaction kinetics after discharge depends on the proportion of surface water and groundwater that enters the creek along the mixing zone. These processes are presently poorly understood and warrant further in-depth study to better understand and predict long-term contaminant fate, transport and discharge through the surface water exit pathway.