Carbon transport and transformation from vadose zone to groundwater

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The dynamics of carbon in the vadose zone, the interface between land surface and groundwater, are poorly understood yet important for predicting C cycling and responses to climate change. As a component within the LBNL Science Focus Area 2.0, this effort is designed to determine concentrations and speciation of C in vadose zone pore waters, how these characteristics differ from overlying soil and the underlying groundwater, and how transport and transformation rates for C in the vadose zone respond to changes in climate, vegetation, and microbial communities. Our initial investigations are at the Rifle Site along the Colorado River. Within this floodplain, boreholes were drilled (down to 7 m depth) at three sites for sediment sampling, and instrumented with pore water and gas samplers at 0.5 to 1 m intervals in the vadose zone and aquifer, and with thermistors at generally wider intervals. Vadose zone pore waters, groundwaters, and vadose zone gas samples have now been collected periodically for ~1 year. Analyses include DOC, DIC, major and trace elements, and $\delta^{13}C$ of the DOC and CO_2 gas samples. Different collection methods and analyses are enabling seasonally and vertically resolved geochemical profiles of the vadose zone pore-waters. We found that DOC concentrations are many times higher in the vadose zone than in groundwater, and vary seasonally in the vadose zone and capillary fringe, but the groundwater. The decreased aromaticity of DOC in the pore waters with greater depth, the identified DOC speciations, and $\delta^{13}C$ isotope data all suggest complex biogeochemical transformations during transport through dynamic vadose zone gradients of moisture and temperature. Quantitative understanding of C, O, N, and potentially microorganisms cyclically transported from the vadose zone into groundwater are important for understanding the system response to climate and hydrologic changes, and the Rifle site studies will provide key data that will help us unravel those responses.