Constraints from U and Sr isotopes on the hydrology of a alluvial aquifer at Rifle, Colorado

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The Rifle Site consists of a floodplain along the Colorado River that was remediated through the removal of surface material underlying former U-V mill tailings. The Rifle Site provides an excellent field laboratory for the study of the fluxes of water and carbon from the vadose zone to groundwater (LBNL SFA2.0). A network of monitoring wells, particularly a series of holes instrumented in the vadose zone, provide the opportunity to closely sample groundwater and vadose zone porewater both in space and time. In order to better understand the spatial and temporal variation of vadose zone interaction with groundwater within the Rifle floodplain and provide constraints for a Rifle hydrological model, we have analyzed the Sr isotopic compositions and $^{234}U/^{238}U$ activity ratios (AR) of groundwater, vadose zone porewater (sampled through depth-distributed lysimeters) and surface water including the Colorado River. Significant contrasts in $^{87}Sr/^{86}Sr$ and $^{234}U/^{238}U$ allow the identification of different sources contributing to Rifle groundwater.

Contour maps of groundwater $^{87}Sr/^{86}Sr$ show a general increase in $^{87}Sr/^{86}Sr$ across the floodplain towards the Colorado river, with two localized highs. Similarly, $^{234}U/^{238}U$ AR show a decrease across the floodplain, but with a much steeper gradient than $^{87}Sr/^{86}Sr$. Vadose zone porewater is characterized by high $^{87}Sr/^{86}Sr$ and Sr concentrations and falls at one end of a mixing line with Rifle groundwater suggesting that a significant portion (up to 20%) is contributed through vertical recharge on the floodplain compared to the upgradient watershed. An irrigation-return ditch cuts the site toward the eastern edge. Sr and U isotopic and concentration analyses of water from the ditch and from nearby monitoring wells indicate a significant hydrologic connection between the ditch and groundwater, constraining the nature of the boundary conditions for the Rifle hydrologic model.

Results so far suggest that Rifle groundwater Sr is strongly influenced by vadose zone porewater, while high U concentrations and low (near 1) $^{234}U/^{238}U$ AR are due to local U sources associated with aquifer sediments consistent with previous observations.