Combining U-series and Sr isotopes to trace water flow through the Critical Zone

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In remote headwater catchments of the Jemez River Basin Critical Zone Observatory (JRB-CZO) in New Mexico, USA, water isotopes and solute chemistry have shown that snowmelt infiltrates and is stored before later discharging into springs and streams via subsurface flowpaths that change with season. Therefore, water-rock interactions controlling stream chemistry are expected to also change seasonally as hydrologic flowpaths vary. Uranium-series isotopes have recently been shown to be a novel tracer of water-rock reactions and of source water contributions to surface water, while radiogenic strontium isotopes are commonly used as indicators of chemical weathering. This study combines U-series and Sr isotopes to explore their applicability as tracers of water flow through the CZ, groundwater-surface water connectivity, and matrix versus fracture flow in several catchments within the JRB-CZO.

Water samples across multiple water years from streams draining three neighboring catchments were analyzed for ($^{234}U/^{238}U$) and $^{87}Sr/^{86}Sr$ to establish the hydrologic controls on water's isotopic composition. Preliminary results show that ($^{234}U/^{238}U$) of streams within each catchment increase just after peak streamflow suggesting increased groundwater contributions to streams following snowmelt. $^{87}Sr/^{86}Sr$ ratios also vary with stream discharge signifying that water from different weathering environments transmits to streams during different hydrologic regimes. Relationships between U-series activity ratios and U concentrations vary over space (differences between catchments) and time likely indicating shifts in residence time of water contributing to streams with season. Time series of ($^{234}U/^{238}U$) and $^{87}Sr/^{86}Sr$ of groundwater samples from multiple depths below ground surface are part of ongoing analysis to identify groundwater-surface water connectivity. Finally, several springs across the three geologically complex volcanic catchments were also analyzed to identify differences in isotope composition in matrix flow dominated by alpha recoil or fracture flow dominated by chemical weathering.