Hydrologic and environmental controls on uranium-series isotopes in a natural volcanic weathering environment

ALISSA WHITE,[1] LIN MA,[2] BRYAN MORAVEC,[3] JENNIFER MCINTOSH[1], JON CHOROVER[3]

[1]Department of Hydrology and Atmospheric Sciences, Univeristy of Arizona, Tucson, AZ, USA
[2]Department of Geological Sciences, University of Texas at El Paso, El Paso, TX, USA
[3]Department of Soil, Water, and Environmental Sciences, University of Arizona, Tucson, AZ, USA

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 transit times (WTT) and 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 source water contributions to surface water; therefore, this study seeks to understand how U isotope signatures evolve along changing water flowpaths as they intersect variable mineralogy, lithology, and redox conditions. More specifically, this work examines the relationship between seasonality, WTT, critical zone (CZ) structure and U-series isotopes in several catchments within the JRB-CZO.

To determine the effect of WTT on the U isotopic composition of natural waters within the Valles Caldera, samples from ten springs, for which WTT were previously determined, were analyzed for $^{234}U/^{238}U$ and $^{87}Sr/^{86}Sr$ ratios. Preliminary results suggest that WTT cannot fully explain the variability of $^{234}U/^{238}U$ and $^{87}Sr/^{86}Sr$ in springs throughout the JRB-CZO, and additional controlling mechanisms play an important role. Water samples were also collected from streams within three catchments across multiple water years to establish how seasonality controls water's isotopic composition. $^{234}U/^{238}U$ and $^{87}Sr/^{86}Sr$ indeed vary across seasons; however, those seasonal changes are not consistent among catchments, suggesting that differences in the mineralogy and structure of the deep CZ likely also control isotopic variability. Ongoing work is investigating the distribution of U-series isotopes in solid phase core samples with depth (down to ~45m) beneath the surface and shows distinct weathering depth profiles that can be vital for the characterization of hydrogeologic and redox controls on isotopic composition in this complex lithologic terrain.