Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28587

Spatio-temporal variations of dissolved ($^{234}U/^{238}U$) ratios in Texas watersheds: insights for controls by global principles of climate, lithology, and land use

LIN MA[1], JENNIFER HERERRA[1], ANGIE CANO[1], JASON RICKETTS[1] AND PAMELA L SULLIVAN[2]

[1]University of Texas at El Paso
[2]Oregon State University

Dissolved ($^{234}U/^{238}U$) ratios in rivers have great potentials to improve our understandings of many watershed and critical zone processes, especially for those increasingly threatened by both natural and anthropogenic stresses, such as flow paths, residence times, chemical weathering, and surface-groundwater interactions. It is crucial to understand the complex dynamics governing these natural systems. Variability of dissolved ($^{234}U/^{238}U$) ratios in rivers reflects geochemical responses of catchments to local and global conditions such as climate, lithology, and land use parameters. Here, we leverage the strong and well-defined environmental and geologic gradients across three Texas river basins (Brazos, Colorado, and Pecos) at the important regional scale with watershed sizes ranging from 10s-100s of square kilometers. We used a combined geochemical, geological, and geographic information system (GIS) approach to investigate the controls on the dissolved ($^{234}U/^{238}U$) ratios in Brazos, Colorado and Pecos rivers. We investigated 37 river sample sites under different impacts of precipitation, lithology, and land uses. Seasonal variations of river chemistry and ($^{234}U/^{238}U$) ratios were observed along these three rivers due to the different climate and human impact parameters. Both uranium isotope ratios and concentrations were simulated with existing U isotope fractionation models across this matrix of drivers. Both U parameters reflect closely water residence time and flow paths from water-rock interactions in these watersheds despite challenges due to the heterogeneity of landscape features. Our project tested the umbrella hypothesis that riverine ($^{234}U/^{238}U$) ratios can be predicted by quantifying factors of alpha recoil and chemical dissolution at the weathering interfaces with 1) climate parameters of the watershed; 2) lithological parameters of the weathering bedrock; and 3) water residence times; while 4) land uses (such as agriculture and urban development) can overprint these natural signatures. Our new investigation explores the spatio-temporal variability of dissolved ($^{234}U/^{238}U$) ratios in river water and the new developments highlight that the dissolved ($^{234}U/^{238}U$) ratios are a great tracer for climate, lithology, and land use in watersheds.