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Using Dissolved ($^{234}U/^{238}U$) Ratios as a Watershed Tracer for Climate, Lithology, and Land Use: a Combined Geochemical, Geological, and Geographic Approach in Texas Rivers

LIN MA[1], NURIA ANDREU[2], LOURDES MOREU[2], GRACE GOLDRICH-MIDDAUGH[3], PAOLA SOTO-MONTERO[2], JASON RICKETTS[2] AND PAMELA L SULLIVAN[3]

[1]University of Texas et El Paso
[2]University of Texas at El Paso
[3]Oregon State University
Presenting Author: lma@utep.edu

Riverine ($^{234}U/^{238}U$) ratios have great potentials to improve understandings of watershed functions, flow paths/residence times, and surface-groundwater interactions. However, their wide applications to solve many of these critical geochemical and hydrological issues have been hindered by the inability to decipher the multitude of mechanisms that control dissolved ($^{234}U/^{238}U$) ratios across climate, lithology, and land use gradients. Our project aims at testing 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.

To test this hypothesis, we leverage the strong environmental and geologic gradients across two Texas river basins (Colorado and Pecos) with sizes ranging from 10s-100s of km^2 that will fill a gap existing in current watershed studies at the critical regional scale. We used a combined watershed-scale, geochemical, geological, and geographic information system (GIS) approach to study the controls on the dissolved ($^{234}U/^{238}U$) ratios. Here, in our first field study, we identified a total of 22 river sample sites for both rivers to investigate the controls of precipitation, lithology, and land uses. Seasonal variations of river chemistry, $^{87}Sr/^{86}Sr$ and ($^{234}U/^{238}U$) ratios were investigated in the collected July and December 2021 samples along the Colorado and Pecos river. The preliminary results highlight that the dissolved ($^{234}U/^{238}U$) ratios are a great tracer for climate and human impact parameters while $^{87}Sr/^{86}Sr$ ratios are a great tracer for lithology and surface-groundwater interactions. Our current investigation is focused on testing U isotope fractionation models in the existing literature across this matrix of drivers.

Our study also analyzed historical river flow and major chemistry trends, as well as spatial data of lithology, land-use, and water availability in the Colorado river watershed. We will develop and test a predictive model for assessing how these variables affect river major chemistry by comparing calculated chemistry values to historical stream gauge data and our recently collected river samples.