

Using isotopic tracers to decode concentration-discharge relationships

MARK A. TORRES¹, J. JOTAUTAS BARONAS², A. JOSHUA WEST³, R. BASTIAN GEORG⁴

¹Rice University, mt61@rice.edu

²University of Cambridge, jjb92@cam.ac.uk

³University of Southern California, joshwest@usc.edu

⁴Trent University Water Quality Center, rgeorg@trentu.ca

Variations in solute concentrations with river discharge may capture the climatic sensitivity of chemical weathering, its mechanism(s), and its relationship to other environmental variables (e.g., erosion and lithology). Existing challenges with interpreting concentration-discharge (C-Q) relationships, however, include the fact that multiple processes are capable of producing observed patterns and that environmental heterogeneity can add C-Q variability unrelated to weathering. Here, we explore isotopic tracers and hydrologic models as a means to improve C-Q interpretations using the Peruvian Andes to Amazon transition as a case study.

Across catchments of various size, we find that spatial heterogeneity in the timing of runoff peaks and solute generation leads to significant C-Q variability that obscures information about chemical weathering processes for many solutes. However, in our study region, the behavior of Si is relatively uniform in space and thus may be useful as a tracer for isolating the effects of weathering processes in otherwise heterogeneous systems. Based on this assessment, we couple hydrologic data, solute concentrations, water isotopic ratios, and stable Si isotopic ratios to elucidate how the balance between primary mineral dissolution and secondary mineral formation varies with discharge within a model framework that explicitly accounts for time-variable fluid transit time distributions.