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Testing geochemical proxy development from fundamental sedimentology 101

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Over the last several decades, our understanding of deep time and Earth's paleoclimatic evolution has grown significantly. Studies that examine stratigraphic geochemistry are central to new insights. Given the incomplete and uneven nature of Earth's sedimentary rock record, many such studies have focused on limited samples (and few sections) to describe global conditions. While often necessary, this extrapolation can lead to interpretations that are either biased or overly generalized. To confidently use singular geochemical records to tell global histories, researchers must validate basic assumptions about the homogeneity of various geochemical proxies and their variation (or lack thereof) across time and space.

In this presentation, we utilize a large, detailed dataset from a single basin, which formed during the Paleozoic (i.e., Devonian to Mississippian), to examine several geochemical and sedimentological metrics and their expression across the depositional center. Specifically, we quantify how proxies describing weathering (Chemical Index of Alteration, or CIA), salinity (Sr/Ba), detrital fluxes (K/Al, Zr/Al, Rb/Zr), and redox (Mo/Al, V/Al) are dependent on both location in the basin and physical properties of the containing sediment (e.g., lithology). Through this quantification, we illustrate the challenges of using individual sections as global indicators and propose that heterogeneity, not homogeneity, should be the first assumption for geochemical expression in sediments. We further link our observations of geochemical variability to sedimentary processes that were operating during basin formation (e.g., rivers delivering sediment). We highlight the specific records—interpreted using fundamental knowledge drawn from present-day processes—that enable us to make such connections. Finally, we urge further development of such validation tests by the Earth history community.