Untangling detrital and authigenic signals of redox-sensitive proxies

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The trace metal fraction of shale is comprised of detrital and authigenic components. Untangling the influence of these constituents for redox-sensitive trace metal proxies (Cr, V, U) is vital for interpretations of redox-driven enrichments, depletions, and isotopic signals in the rock record (e.g. 1, 2). Traditionally, a single crustal average is used as a cutoff for detrital input, and enrichments or depletions above or below this value are interpreted as authigenic. Authigenic isotopic signals are then often based off an assumed detrital contribution. However, we find that due to large variation in detrital flux, use of a single crustal average may not provide the resolvability necessary to quantify the authigenic fraction. This is especially true with smaller levels of authigenic enrichment frequently observed through the Proterozoic, where the marine reservoir of metals such as Cr, U, and V is already depleted due to widespread anoxic waters [3]. Using soil data from across the continental United States [4], we find large variation from accepted crustal averages in redox-sensitive metals (Cr, U, V) compared to typical detrital tracers (Al, Ti, Sc, Th). This variability is present over large catchment-size areas comparable to major rivers like the Brahmaputra, the Columbia, and the Danube. This disparity in detrital flux highlights the utility of isotopic systems such as Cr to distinguish authigenic enrichments and provide higher resolution constrains on local marine redox. For example, samples from the Burgess shale are enriched in Cr but lack Mo and U enrichments. The preservation of a fractionated Cr isotope signal in this environment suggests an authigenic enrichment that has captured the effects of terrestrial oxidative weathering, rather than an enhanced detrital flux.

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