Chromium isotope systematics and diagenesis in marine carbonates

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Stable chromium (Cr) isotopes have emerged as a new tool for tracking broad-scale changes in Earth's surface oxygen levels. Carbonates are one proposed sedimentary Cr isotope archive. In order to provide a more robust framework for interpreting carbonate Cr isotopic compositions and evaluating their ability to record the global redox state, we explored Cr isotope systematics of modern and Archean carbonate successions. We studied carbonate platform sediments from the Great Bahama Bank with variable diagenetic histories to better understand the effects of diagenetic alteration on carbonate-bound Cr and its isotopic composition in a modern well-oxygenated ocean-atmosphere system. More specifically, we investigated the effects of dolomitization and aragonite-to-calcite neomorphism in marine and meteoric fluids. We additionally present δ^{53}Cr values from three carbonate successions, the ~3.0 Ga Chobeni, ~2.8 Ga Mosher Carbonate, and ~2.65 Ga Cheshire formations, that were deposited under an anoxic atmosphere. We find that modern Bahamian carbonates have a large range of almost exclusively positive δ^{53}Cr values that appear to be reset during both meteoric and marine diagenesis. Moreover, we find that Archean carbonate successions—like the mid-Proterozoic successions—contain both positively fractionated and crustal δ^{53}Cr values. The Cr isotope fractionation observed in the Archean could be linked to either non-redox dependent Cr isotope fractionations, local Cr redox cycling, late-stage diagenetic alteration, or some combination thereof. Given these effects, we suggest that Cr isotope values from ancient carbonate sediments should be interpreted with extreme caution and should not be linked to periods of atmospheric oxygenation.