Chromium isotope systematics in the Mobile Bay estuary, Northern Gulf of Mexico

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The stable chromium isotope system ($\delta^{53/52}$Cr) is an emerging paleoredox proxy that has been used to track Earth's redox evolution over a range of timescales. Understanding the global Cr isotope mass balance is important for this application. River and seawater $\delta^{53/52}$Cr data have grown significantly in the past few years. However, the Cr isotope behavior in estuaries is poorly understood. Estuaries are the transition zones before riverine Cr flux enters the open ocean. Therefore, Cr geochemical cycles in estuary environments can potentially change the riverine Cr flux and isotope compositions determined previously.

To better constrain the effect of estuary processes on Cr isotope systematics, we collected water, suspended particulate, and sediment samples along a salinity gradient in the Mobile River estuary located in the Northern Gulf of Mexico. Our Cr concentration and isotope data show weak but statistically significant linear correlation with salinity, suggesting conservative mixing between freshwater and seawater in this estuary system. This contrasts with a previous study in the Connecticut River estuary system, which advocates for more Cr isotope studies in other estury systems.

Both dissolved Cr and particulate Cr concentrations decreased as salinity increased. The decrease of particulate Cr concentration indicates desorptive loss of Cr from particulate matter in high-salinity waters. The $\delta^{53/52}$Cr of particulate matter decreases as salinity increases, despite that dissolved $\delta^{53/52}$Cr increased, conssitent with desorptive loss of isotopically heavy Cr (likely Cr(VI)) from particulates to high-salinity water. There is a positive correlation between sediment $\delta^{53/52}$Cr and Cr concentration, indicating authigenic enrichment of Cr in sediments from water in high salinity areas.