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Utilization of Lead Isotopes as a Tracer of Lead and Freshwater Inputs to Galveston Bay, Texas

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Lead (Pb) is a valuable geochemical tracer of anthropogenic influence in aquatic systems, as much of modern dissolved Pb results from anthropogenic emissions. Pb distributions in coastal bays arise from riverine discharge and atmospheric deposition, both influenced by anthropogenic activities. The particle-reactive nature of Pb removes significant Pb to the sediments, but the remaining dissolved Pb may serve as a useful tracer of Pb source. Pb isotope compositions, which vary depending on their geologic sources, can be used to distinguish between natural and anthropogenic Pb. Here, we explore Pb and Pb isotopes in Galveston Bay, Texas, one of the largest and most anthropogenically-influenced coastal bays along the Gulf Coast. Two main rivers feed Galveston Bay: the relatively pristine Trinity River and the anthropogenically-influenced San Jacinto River. Each river has distinct Pb isotope compositions, and we aimed to track the influence of various freshwater inputs into the bay by measuring Pb isotope ratios in bay samples. We collected Galveston Bay seawater samples quarterly from June 2017 to June 2019 and river water samples in June 2019. Three distinct endmembers are observed, which can explain the majority of the data through their mixing: Trinity River with low dissolved Pb concentration and high 206Pb/207Pb ratio, San Jacinto River with high dissolved Pb concentration and low 206Pb/207Pb, and Gulf of Mexico seawater which has a range of concentrations but the highest 206Pb/207Pb ratio. The variation of the Pb isotope ratio within the mixing diagram is driven by the Trinity River, whose discharge contributes the majority of freshwater to Galveston Bay. Bay samples whose Pb isotopes cannot be explained by conservative mixing of endmembers could instead be explained by local anthropogenic Pb inputs and events. Seasonal variability does not seem to control the bay's Pb isotope compositions, which are more spatially variable. In September 2017, after the massive precipitation event associated with Hurricane Harvey, the entire bay showed relatively constant Pb isotope ratios suggesting homogenization of the system. This study shows the value of Pb isotope ratios in constraining contaminant sources to coastal ecosystems rich in economic services.