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A Spatiotemporal Reconstruction of Hydrothermal Fluxes in the Eastern Pacific Ocean

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Hydrothermal vent fluids are a significant source of many metals to the deep ocean, including iron and manganese. These fluids impact ocean chemistry and primary productivity, thereby influencing the carbon cycle and global climate. Currently, there exist gaps in knowledge regarding the spatial extent to which hydrothermally sourced metals persist in the water column and how hydrothermal metal fluxes have varied through time. In order to constrain the role of vent fluids in elemental cycling, it is necessary to resolve the spatiotemporal patterns of hydrothermally sourced metals. In this project, we leverage two sediment-based tracers – lead (Pb) isotopes and multi-elemental statistical modeling – to explore where hydrothermal metals travel along four Pacific transects and how hydrothermal fluxes have varied in the eastern Pacific over the Cenozoic. Our multi-tracer approach allows us to gain a nuanced understanding of how/where different elements are transported and affected by hydrothermal processes.

The Pb isotope composition of hydrothermal vent fluids reflects that of local basaltic seafloor, which is distinct from seawater and average continental Pb. Therefore, the Pb isotope composition of sediment may be used to distinguish hydrothermally sourced deposits. Multi-elemental statistical modeling leverages characteristic metal ratios in end-member sources to identify the contributions of hydrothermal, hydrogenous, dust, ash, and other inputs to sediment sample composition. Here, we measure the Pb isotopic composition of 50 coretop sediment samples collected along four GEOTRACES transects that span the Pacific (i.e., GP15, GP16, GP17, and SO245) and 54 downcore sediment samples collected at three Deep Sea Drilling Project Sites in the eastern Pacific (i.e., Sites 38, 319, and 598). Additionally, we measure the major, trace, and rare earth element concentrations of these sediment samples, then use multivariate statistical techniques (i.e., Q-mode factor analysis and constrained least squares multiple linear regressions) to quantify the contributions of various sources. The results of this study allow us to trace where and how far hydrothermally sourced material travels through the water column of the Pacific before being deposited on the seafloor, and to reconstruct how hydrothermal metal fluxes have varied through the Cenozoic.