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Sedimented Hydrothermal Vent Fields as Analogs for Deep Subsurface Carbon Alteration

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Deep in the subsurface, organic compounds found in sediments break down and rearrange into new organic products. This process, which produces petroleum and other organic compounds, is a major control on the long-term preservation of organic carbon in the carbon cycle. This alteration of organic compounds has long been attributed to exposure to rising heat and pressure during burial. While it is not possible to fully recreate these exact conditions in a laboratory setting, particularly while accounting for the complexities of interactions with surrounding minerals and fluids, more recent lab experiments have suggested that pressure exerts a minimal influence on the alteration of organic matter compared to temperature. If pressure can be reasonably ignored, then hydrothermal vent fields, occurring in organic-rich sediments, with reducing vent and pore fluids, match many of the same characteristics as organic-rich sediments heated in the subsurface and can serve as suitable analogs.

We investigated organic matter alteration occurring at sedimented hydrothermal vent fields in the Gulf of California and matched our findings to the range of alteration found in the subsurface. Vent fluids from four active vents and sediment samples from one drill core at the Auka vent field were collected by the ROV Hercules and the EV Nautilus in November 2017 at the southern edge of the Gulf of California. Additionally, data from previously published pore fluids and sediment samples at Guaymas vent field in the center of the Gulf of California was also analyzed.

We found that both vent fields produced similar compounds, including n-alkanes and PAHS, in the sediments. Production of mid-to long-chain *n*-alkanes and PAHs increased at depths exposed to elevated temperatures. At the Auka vent field, organic matter alteration increased rapidly over a short distance of 15 cm depth as result of nearby vent activity. Overall, our results suggest that sedimented hydrothermal vent fields serve as excellent analogs of subsurface organic alteration and may answer future questions about chemical interactions and timing.