

Fluid-mineral equilibria in subseafloor reaction zones beneath Eastern Manus Basin vent fields

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Seawater-derived hydrothermal fluids at the SuSu Knolls and PACMANUS vent fields in the back-arc spreading centers of the Eastern Manus Basin (EMB), Papua New Guinea are highly acidic, metal-rich, Mg- and SO₄-depleted, and variably enriched in magmatic volatiles. Although there is significant overlap with fluids from basalt-hosted mid-ocean ridge environments, the majority of EMB fluids are significantly more acidic with measured pH (25°C) values from 2.3 to 2.9. The lower pH may reflect the influence of primary rock composition, magmatic volatile input, and/or the presence of secondary mineral assemblages that buffer pH to low values. Geochemical reaction path modeling was used to evaluate these possibilities and constrain factors that regulate the generation of acididity and the ability of fluids to transport metals in solution.

Results of these efforts indicate that fluid-rock reaction involving seawater-derived fluids with andesitic and dacitic crust that is abundantly present in the EMB produces fluids with pH values that are not significantly different than values predicted for interaction with basaltic crust in MOR environments. Addition of SO₂-bearing magmatic fluids to convecting seawater-derived fluids can result in extremely acidic solutions, but is accompanied by elevated SO₄ concentrations unless sufficient Ca is available to remove SO₄ by anhydrite precipitation. Although fluid-rock interaction subsequent to magmatic volatile input represents an abundant source of requisite Ca for anhydrite precipitation, it effectively titrates acidity to pH values higher than those observed for EMB vent fluids. Models involving reaction of seawater-derived vent fluids with fresh crustal rocks followed by equilibration with rocks previously altered to argillic and advanced argillic mineral assemblages produce vent fluid compositions that are strikingly similar to those observed in the EMB. We postulate that previous degassing of acidic magmatic volatiles may extensively alter the oceanic crust in upflow zones above shallow magma chambers to mineral assemblages that buffer the pH of convective vent fluids to highly acidic values during the temporal evolution of the hydrothermal system, the absence of magmatic degassing, notwithstanding.

Terminal metabolism in coastal, freshwater sediments: Seasonal and temperature-controlled fluctuations in rates and pathways

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The persistent increase in atmospheric methane levels has contributed to modern climate change. Methane, along with carbon dioxide, are the two final products of terminal metabolism of organic matter in anoxic, freshwater sediments. As global temperatures rise, a potential positive feedback exists between global warming and the production of these greenhouse gases in sediments. This study explored the influence of temperature on the dominant pathways of terminal metabolism in coastal, freshwater sediments from three distinct biogeographic provinces. Geochemical profiles and radiotracer rate assays of sulfate reduction, acetoclastic and hydrogenotrophic methanogenesis, acetogenesis, anaerobic methane oxidation, and acetate oxidation revealed seasonal variations in carbon flow at the three study sites. Laboratory manipulations with and without specific inhibitors were conducted and the formation of methane and its metabolic intermediates, including carbon dioxide, hydrogen, and volatile fatty acids, over a range of temperatures (3-35°C) was determined. This detailed investigation of trace-gas dynamics, microbial activities, and sediment porewater geochemistry highlights the important role of temperature in microbial-mediated carbon mineralization in freshwater sediments. Seasonal and temperature-related shifts anaerobic metabolism are then compared across a latitudinal gradient.