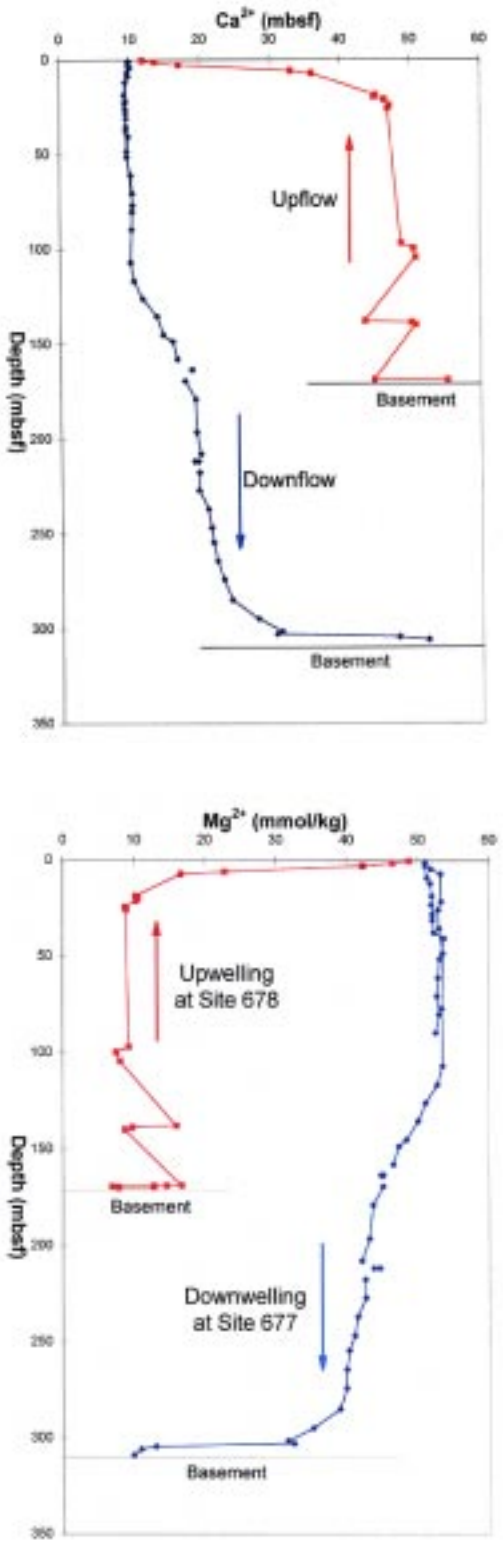
Massive hydrothermal circulation of seawater through mid-ocean ridge flanks: Insights from ocean drilling

Michael J. Mottl, Dept. of Oceanography, University of Hawaii

While the spectacular hot springs along the mid-ocean ridge axis have received a lot of attention, it is likely that a much larger flux of heated seawater occurs through mid-ocean ridge flanks [*Mottl and Wheat,* 1994]. The flanks are a diverse environment that covers about a third of the ocean floor, between the ridge axis and the abyssal plains. The most voluminous hydrothermal circulation takes place through basaltic basement, beneath a cover of less permeable sediment. This flux of warmed seawater accounts for about 20% of the total rate of heat loss from the solid Earth. The accompanying chemical fluxes are probably large, but they are poorly known because of the wide range of crustal conditions encountered that control the composition of the altered seawater in basement and the path for fluid circulation through basement. The key variable that controls the chemical composition is basement temperature, which varies with crustal age, basement topography, and sediment thickness and type.

One of the best ways to study such systems is by sampling pore water from throughout the sediment column: the shape of composition-depth profiles allows us to determine whether water is flowing through the sediment, and the composition of pore water immediately above basement is typically similar to that in the basement itself. Generally the only way to do this is by drilling. Several sites drilled on Leg 111 within 2 km of one another on 6 million-year-old crust on the southern flank of the Costa Rica Rift indicated that seawater is downwelling through 310 m of sediment over a basement trough and upwelling through 170 m of sediment over a basement ridge (Mottl, [1989]; see figure). On Leg 168 an 80-km transect was drilled on the eastern flank of the Juan de Fuca Ridge into crust spanning 0.6 to 3.6 million years old. Profiles of pore water composition suggest that seawater enters basement where it outcrops near the ridge axis and flows steadily eastward for 50 km or more, becoming warmer and more altered as it goes. Data from both legs provide a beginning for understanding hydrothermal processes on mid-ocean ridge flanks, but only by examining a range of crustal conditions will we be able to accurately determine thermal, mass, and chemical fluxes from mid-ocean ridge flanks.



References:

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