The chemistry of diffuse-flow vent fluids on the Galapagos Rift (86°W): Temporal variability and subseafloor phase equilibria controls

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Recent (2002, 2005) expeditions to the Galapagos Rift, 86°W have conducted integrated experiments to assess temporal/spatial changes in both the chemistry and associated biology of diffuse-flow hydrothermal vents. The chemical data adds significantly to time series observations of hydrothermal processes at the Galapagos Spreading Center (GSC), where seafloor venting was first discovered in 1977. Assuming quartz-fluid equilibria (0.55 NaCl solution), end-member values for dissolved silica in 2002/2005 indicate temperatures ~50-100°C lower than in 1977. The higher predicted temperature in 1977 is consistent with observed chloride depletion in fluids issuing from Oyster Beds vent, indicating fluid phase separation, whereas all fluid samples from 2002/2005 are at or above seawater concentration. Respective values of dissolved Mn further suggest a lower temperature hydrothermal reaction zone at 86°W relative to three decades ago. The slope of Li-Si data from 1977, however, does not depart significantly from the 2002/2005 data, suggesting temperature change has little effect on dissolved Li in the hydrothermal endmember. At some point between 1990 and 2002 a volcanic eruption covered the historical Rose Garden vent-field, ending years of biological observations. Although the precise age of the lava flow is uncertain, the lack of chloride depletion and low H_2S/heat ratios of the 2002/2005 vent fluids suggest the 2002 expedition arrived well after the eruption based on observations from other diffuse-flow systems perturbed by volcanic activity. Lower dissolved silica, Mn and H_2S in the 2005 vent fluids relative to 2002, however, may indicate continued cooling in the aftermath of the recent eruption. Results of geochemical modeling for evolved seawater in equilibrium with a moderately oxidizing mineral assemblage are consistent with chemistry of recent GSC fluid samples, predicting $H_2S/Fe > 1$, with little Fe in fluids diluted to the extent typical of 86°W vents. Results from in-situ chemical sensor measurements reveal non-conservative behavior of dissolved H_2S, especially at temperatures below 10°C, which may be due to microbial metabolism.

Quantification of sulphur cycling at the Mid-Atlantic Ridge

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Mid-ocean ridges and associated hydrothermal vent systems represent a unique scenario in which the interaction of hydrosphere, lithosphere and biosphere and the related element cycling can be studied. Here, we present concentration and isotope data (S, O, H, C) for hydrothermal fluids and their dissolved constituents as well as from mineral precipitates collected at the Logatchev hydrothermal field (14°45'N) and different sites at the southern MAR (4° – 11°S).

$\delta^{34}S$ values for dissolved sulphide and metal sulphides from the emanating hot fluid itself or pieces from black smokers between +1,9 and +8,8‰ (V-CDT) suggest that sulfur represents a mixture between mantle sulfur and reduced seawater sulphate. More detailed quantifications are based on the rare sulfur isotopes (^{33}S and ^{36}S) suggesting a contribution from recycled seawater sulphate between 20 and 30%.

Dissolved inorganic carbon in hydrothermal fluids from both hydrothermal areas show characteristic $\delta^{13}C$ values around -3.9‰ (V-PDB, end member corrected).

Isotope values of $\Delta^{18}O = 2.2‰$ and $\Delta^{2}H = 6.6‰$ for the hydrothermal fluids at Logatchev and southern MAR sites clearly point to intense interaction between fluid and host rock. Very high sulphide concentrations up to 8.2mmol/L (calculated end member) measured for fluids from the Turtle Pits site (5°S) indicate an early stage of hydrothermal activity and are consistent with young volcanism. This indication is supported by very high fluid temperatures up to 407°C for the black smoker "Two Boats".

Strongly negative sulphur isotope values as low as -24.0‰ for sulphidic sediments at the Logatchev HF are clear indicators for bacterial activity and, thus, point to the participation of microbial communities in sulfur cycling at the Mid-Atlantic Ridge.

The results, so far, provide a deeper insight into element cycling at the Mid-Atlantic Ridge, including apparent differences to fast-spreading ridge systems, such as the East-Pacific Rise (EPR).

Acknowledgements

This is a contribution to DFG-SPP 1144. Financial support by the DFG (Str 281/26-1) is gratefully acknowledged.