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Comparison of three hydrothermal Vent Sites at the Mid-Atlantic Ridge: which Parameters control the Differences in Fluid Chemistry?

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Three hydrothermal vent fields at the Mid-Atlantic Ridge (MAR), which are located at 3000 m water depth (close to the critical point of seawater), were sampled during several research cruises as part of the German SPP 1144 project. The Logatchev field is located at 14˚45'N in an ultramafic setting and comprises a variety of hot (up to 360˚C) and diffuse vents. The other two vent fields are the first fields sampled on the MAR south of the equator, both at 4˚49'S. The Turtle Pits field consists of two sulfide mounds and the vents are characterized by boiling and the highest temperatures measured so far along the MAR (400˚C). The Red Lion vent field is located at a distance of only 2 km from the Turtle Pits field and consists of four smokers with very different appearances. The temperatures are significantly cooler than at Turtle Pits and also the fluid chemistry differs clearly, with no indications for boiling and phase separation. The higher concentrations of Fe, Cu, Co, Ag, and REE at Turtle Pits can be related to the extremely high temperature, which controls the solubility of these elements. However, most other metals are higher enriched in the cooler Red Lion fluids. The fluids we sampled at Turtle Pits represent the vapor phase of the phase-separated fluid and are therefore depleted in most metals compared to the non-separated fluids at Red Lion. Despite their spatial proximity and the identical basaltic host rock in which they are situated, the two vent fields show a clearly different fluid chemistry. We identify the temperature in conjunction with phase separation as the dominating parameter.

Although the Logatchev field is located in an ultramafic setting and Turtle Pits is a basaltic system, we find several similarities such as a Fe/Mn ratio of about 7. However, in general the gas concentrations are significantly higher at Logatchev, due to the serpentinization reactions producing high amounts of hydrogen and methane. Significant differences between these two sites were also observed for Ca, Sr, Cs, Cu, Zn, and Co. Although the Logatchev fluids are slightly depleted in chlorinity compared to seawater, evidence for phase separation is much less clear than for Turtle Pits. While the Logatchev fluids have shown a rather constant fluid composition for about 10 years, we expect significant compositional changes within the next years in the young post-eruptive system of Turtle Pits. Revisiting these vent sites in consecutive years within the SPP 1144 program offers the unique opportunity for a detailed study of the temporal variability of the fluid geochemistry at the selected vent sites.