M190: Geochemistry of fluids from hydrothermal systems at the Mid-Atlantic Ridge 29-38°N

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Objectives

- Investigation of **dissolved metals and their isotopes** from hydrothermal systems and their distribution along the **rising and non-buoyant plume** above the Mid-Atlantic-Ridge (MAR) between 29°10'N and 37°50'N.
- Decipher the variability of those fluids between km-separated vents and investigate if we can distinguish **different controls on this variability** such as host-rock geochemistry, temperature, pressure, volcanism and faulting
- Transformation or complexation of dissolved metals within the rising and non-buoyant plume has been of major interest, with a focus on **understanding the fate of metals** and how it is affected by metal/sulfide and metal/carbon ratios.

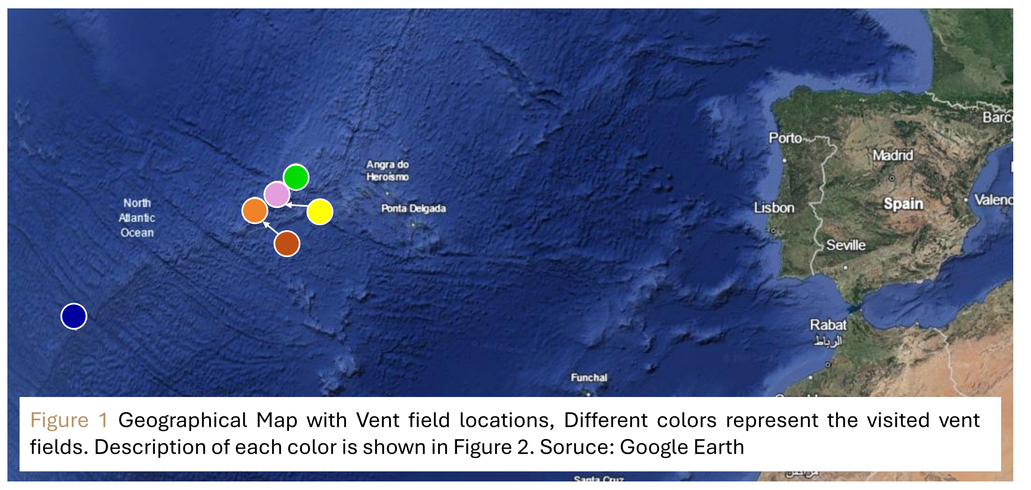
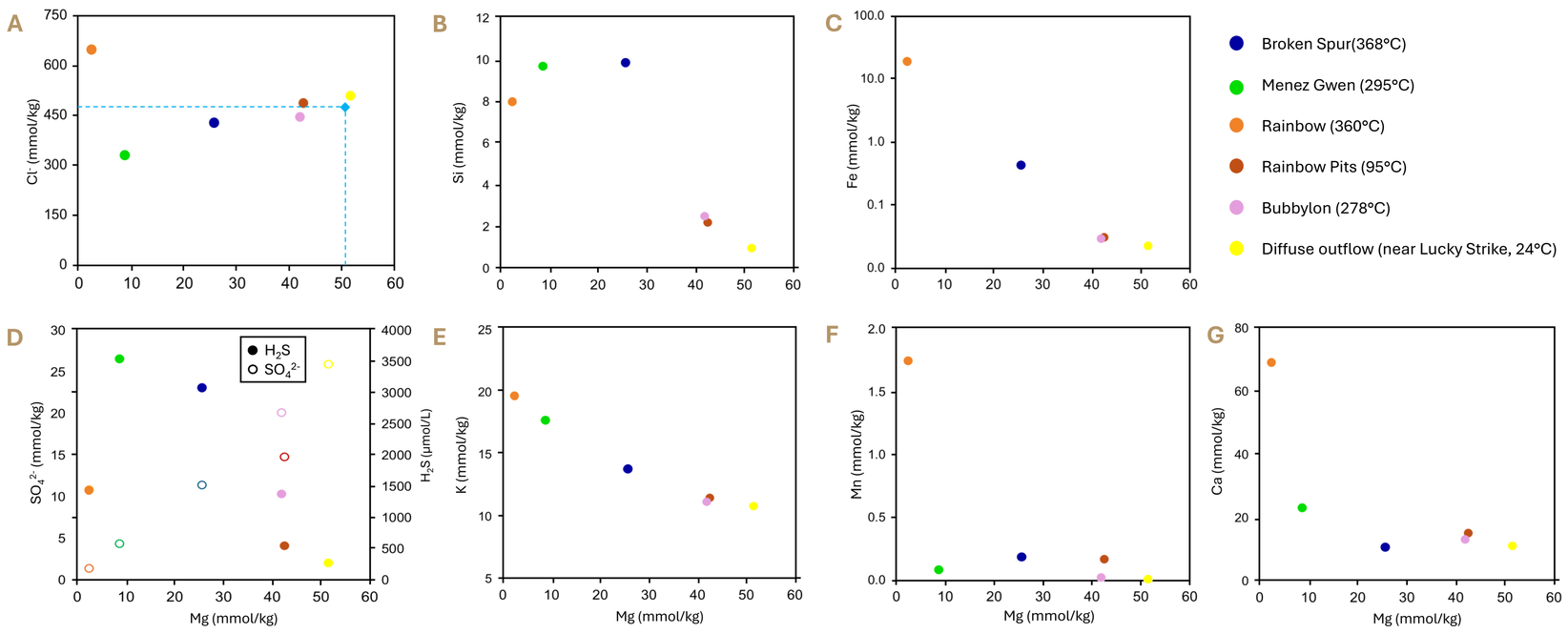


Figure 1 Geographical Map with Vent field locations, Different colors represent the visited vent fields. Description of each color is shown in Figure 2. Soruce: Google Earth

Geochemistry of Fluid samples



- A Phase-separation of fluids in brine- and vapor-phase. Dashed blue lines represent chlorinity and magnesium concentration of seawater. Rainbow as brine-phase with a higher chlorinity than seawater, compared to Broken Spur and Menez Gwen as vapor-phases with lower chlorinity than seawater.
- C, F, G Significant high Fe, Mn and Ca concentrations at Rainbow hydrothermal vent system in contrast to other MAR vent fields, in alignment with (Douville et al., 2002), logarithmic scale for C
- D Notably low sulfide and sulphate concentrations at Rainbow, compared to Broken Spur and Menez Gwen
- E Conservative behaviour due to mixing with seawater, while sampling

Figure 2 ICP-OES Analyses of high-temperature fluids from visited vent sites. Samples were filtered on board through 0.2 µm PES-Filter and acidified for further analyses on land. Each element is plotted against the magnesium concentration.

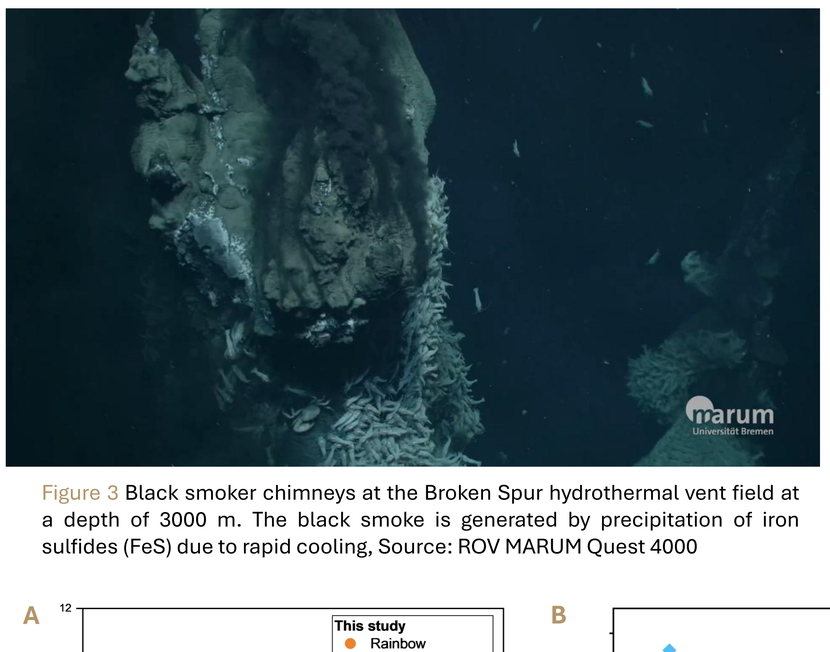


Figure 3 Black smoker chimneys at the Broken Spur hydrothermal vent field at a depth of 3000 m. The black smoke is generated by precipitation of iron sulfides (FeS) due to rapid cooling, Source: ROV MARUM Quest 4000

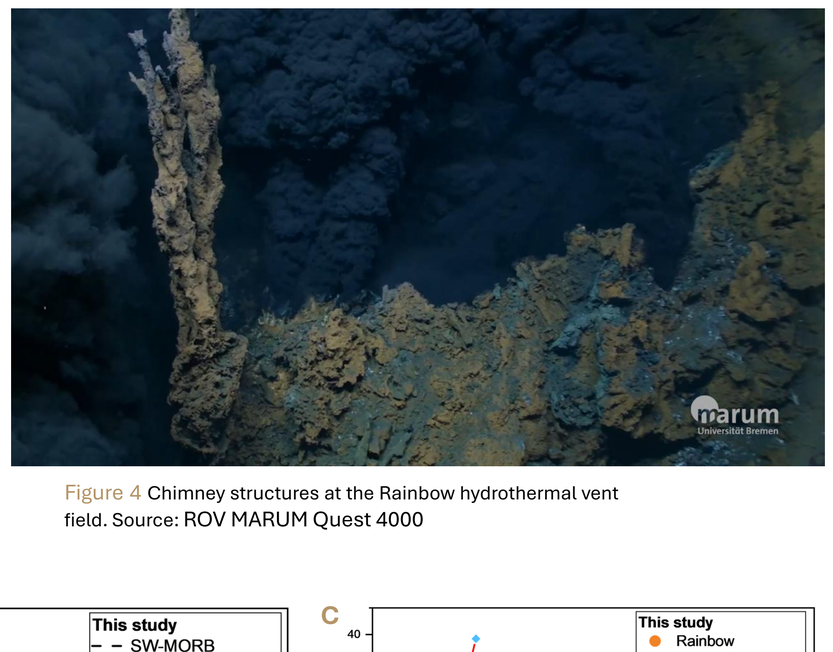


Figure 4 Chimney structures at the Rainbow hydrothermal vent field. Source: ROV MARUM Quest 4000

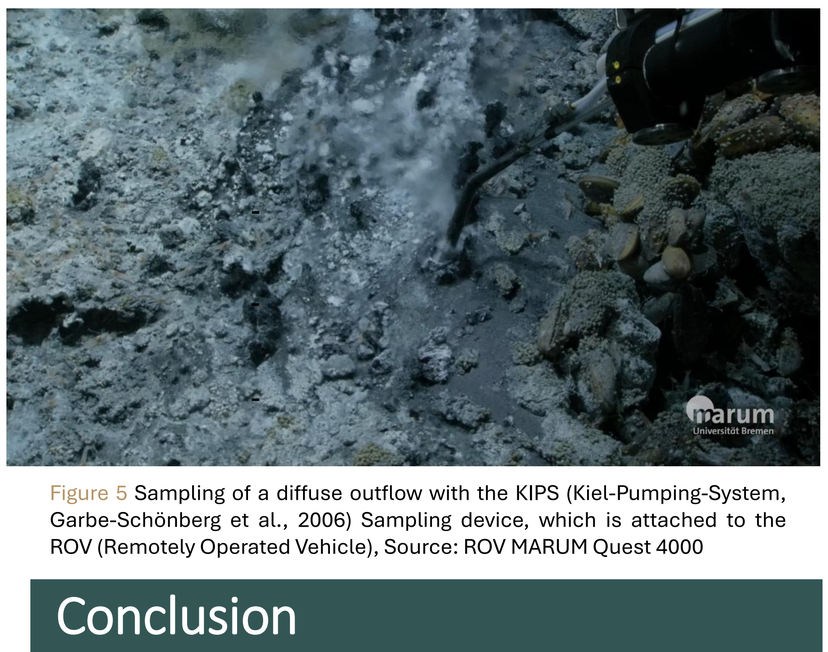


Figure 5 Sampling of a diffuse outflow with the KIPS (Kiel-Pumping-System, Garbe-Schönberg et al., 2006) Sampling device, which is attached to the ROV (Remotely Operated Vehicle), Source: ROV MARUM Quest 4000

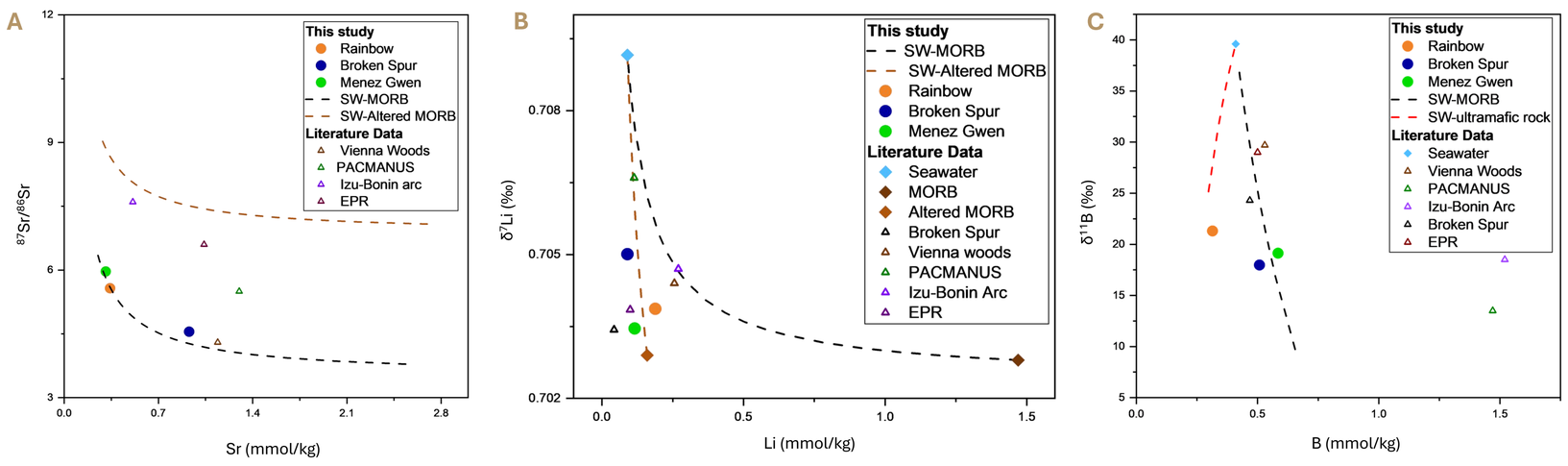


Figure 6 (A): represents the isotopic profile of strontium plotted against the Sr concentration. The black dashed represents an interaction between two end-members seawater and MORB and the brown line represents an interaction between seawater and altered MORB. (B): shows the isotopic profile of lithium plotted against the Li concentration. Li isotopic ratio is independent of host rock lithology, rather dependent on w/r (Water to Rock) ratio. The lines predict the fluid Li and δ7Li variation for the reaction of seawater with MORB and altered MORB at different w/r ratios. (C): represents the isotopic profile of Boron plotted against the B concentration. Boron isotopic ratio depend on the host rock lithology. The lines predict the fluid B and δ11B variation for the reaction of seawater with MORB (black) and ultramafic rock (red) at different w/r ratios. Literature is listed below e.g. Araoka et al., 2016 and Yamaoka et al., 2015.

Conclusion

- Collected fluid samples along the Mid-Atlantic-Ridge show a high variability in their composition: Broken Spur and Menez Gwen are vapor-phase separated fluids with low metal concentrations and higher H_2S concentrations, in contrast to Rainbow as a metal-rich brine-phase.
- Chloride and sulfide are important metal-complexing ligands, this will have implications for metal transport within the plume
- Li, B and Sr indicate variations in the geological environment and water/ rock ratio.
- Leaching of Sr at high-temperature, reflecting a rock-dominated signal and interaction with altered MORB
- Isotopic ratios in Rainbow vent fluids are influenced by ultramafic host rocks.

Outlook

- Further characterisation of the molecular composition of dissolved organic matter (DOM) in the fluids, as well as rising and non-buoyant plumes, aiming to measure metal-organic complexes at the FT-ICR-MS to **understand the role of metal-DOM interactions during the transport of hydrothermally derived metals** into the water column.
- We will use the isotopic signatures of Li, Sr, B and S, to identify the parameters which influence the partitioning of metals **between precipitated and dissolved phases** from different hydrothermal sources.

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