Exploring Biogeochemical Interactions at Serpentinizing Vent Systems

Urja Zaveri[1*], Martina Preiner[3], Peter Kraal[2], Oliver Plümper[1]

Introduction

- Hydrothermal vents (Fig 1.) are one of the earliest types of environments to have existed on Earth [1]
- The thermal gradients could have facilitated synthesis of the first organic molecules on Earth
- Serpentinite rock have been shown to form complex organics due to their nanoscale porosity and the presence of nanoparticles that act as solid catalysts [2]
- Vent fields are found to be abundant in iron nanoparticles that may control deep ocean iron cycle and facilitate organic formation [3]

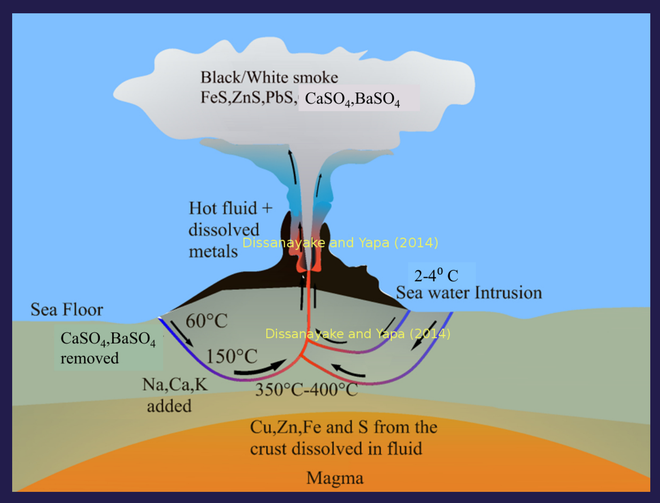


Fig 1. Structure of a hydrothermal vent [4]

Research Problem

Despite the abundance of nanoparticles and organics in hydrothermal vent systems. we do not know the fate of these components as they reside in seawater

Aim of the study

Age Rainbow Hydrothermal vent particles and efficiently track the evolution of biogeochemical interactions at serpentinizing vent systems.

Experimental Procedure

- Collected hydrothermal vent fluids and particles from serpentinite-hosted Rainbow Vent Field in Mid Atlantic Ridge.

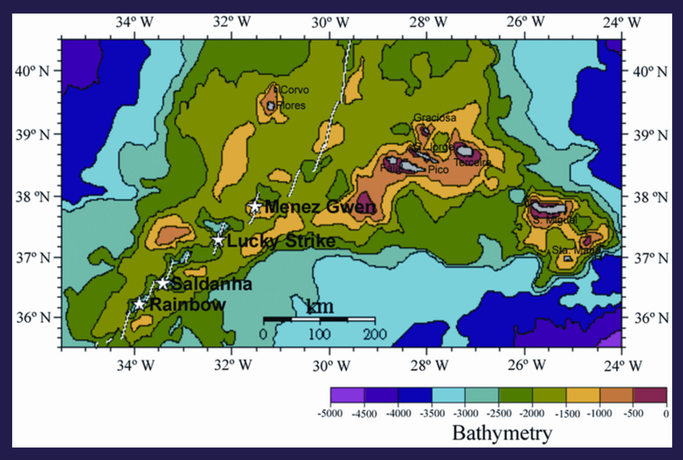


Fig 2. Bathymetry map of Rainbow Vent Field [5]

- Aged the collected filter pieces in artificial and natural seawater for 1, 5, and 15 days.

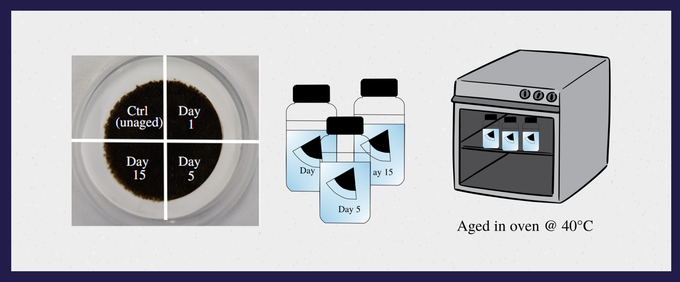
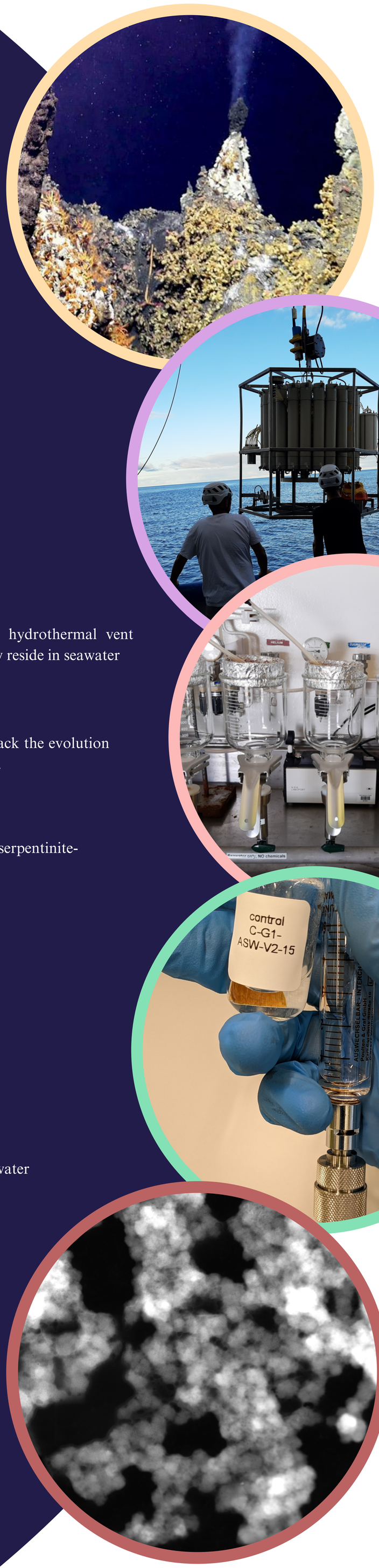


Fig 3. Set-up of the aging experiment

- We then seperated the aged components of respective time points at day 1, 5, and 15 since beginning of the experiment.
- Next step was to analyze the aged supernatant, seawater, and (nano)particles
- ICP-MS and NMR was used for the fluids, Raman Analysis for the filter pieces, and SEM and TEM for the nanoparticles.



To find out more about the I-nano project, scan the QR code.

Experimental Results

ICP-MS results indicate an increase in the concentration of phosphorus and silicon with time.
The artificial sea water time point always shows a higher concentration than the natural counterpart.

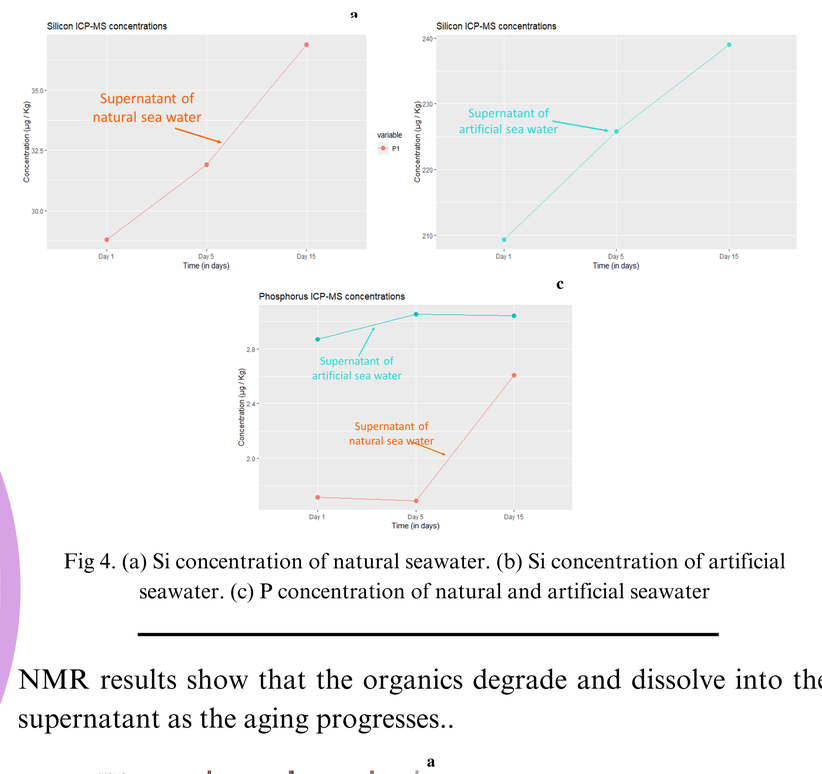


Fig 4. (a) Si concentration of natural seawater. (b) Si concentration of artificial seawater. (c) P concentration of natural and artificial seawater

NMR results show that the organics degrade and dissolve into the supernatant as the aging progresses..

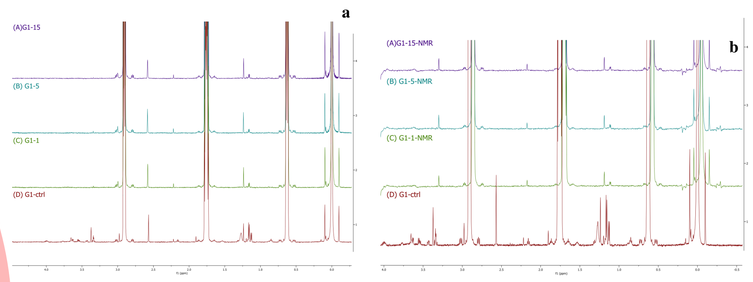


Fig 5. (a) NMR spectra of filter pieces. (b) NMR spectra of supernatant of same sample

Diffraction pattern of nanoparticles obtained by TEM analysis show an increase in nanocrystallinity as aging progresses.

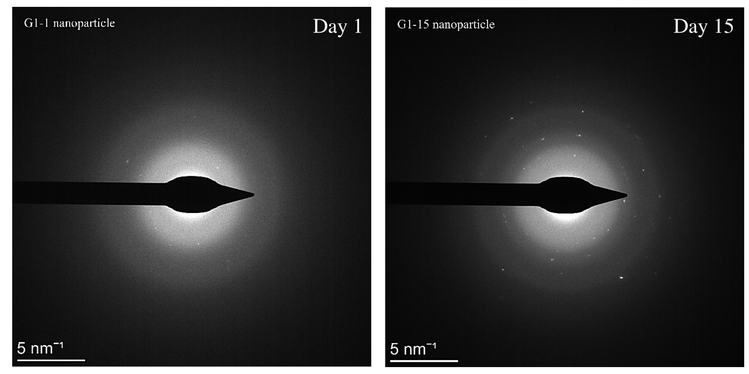


Fig 6. Diffraction pattern. Day 1 aged nanoparticle (left). Day 15 aged nanoparticle (right)

Conclusion and future scope

- The reactions occurring at vent systems can play a role in the metal availability in deep ocean and in facilitating abiotic formation of organics.
- The biogeochemical changes within different components at serpentinizing vent systems haven't been well determined.
- In this study, we successfully set up an aging experiment to track the changes in vent particles and organics collected from **Rainbow hydrothermal vent field**.
- Future studies can repeat the aging experiments at different kind of vent fields. Further scope also includes using higher resolution techniques (such as synchrotron) to understand the iron speciation in these nanoparticles

References

[1] Kelley D.S. et al. Annual Review of Earth and Planetary Sciences 30.1 (2002): 385-491.
[2] Nan, Jingbo et al. Geology 49.3 (2021): 330-334.
[3] Yücel, M. et al., Nature Geoscience, 4(6), 367–371.
[4] www.webspace.clarkson.edu
[5]Santos, R. S. et al. . Proceedings of the workshop: Horta (2003). University of the Azores.

*u.p.zaveri@students.uu.nl
[1] Utrecht University, Netherlands
[2] Royal Netherlands Institute for Sea Research, the Netherlands
[3] Max Planck Institute for Terrestrial Microbiology, Germany