Modeling of ultramafic-hosted hydrothermal systems using CAST3M

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Along the Mid-Atlantic Ridge, ultramafic-hosted active hydrothermal sites such as Rainbow and Ashaze release unusual high fluxes of methane and hydrogen relatively to the hydrothermal sites in basaltic environments [1, 2]. This has been interpretated as the result of serpentinization processes. The purpose of this ongoing work is to simulate the hydrothermal circulation and fluid-rock interactions in such ultramafic environments with a thermo-hydraulic model in order to investigate hydrogen fluxes. We thus developed a two-dimensional numerical model of the ridge using a Finite Volume method to simulate heat driven fluid flows in the framework of the CAST3M code [3]. This thermo-hydrogeological model was then coupled with a geochemistry module to simulate the serpentinization reaction. The latter was built thanks to laboratory experiments [4, 5] and speciation calculations performed with the EQ3/6 code.

Preliminary results for the Rainbow site show that the model produces realistic temperatures for the exiting fluids (Fig. 1).

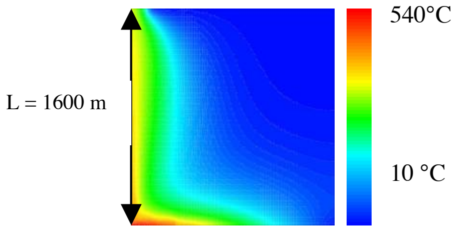

Figure 1: Simulated temperature field.

The next step will be to simulate hydrogen production and to compare it to available field data [1, 2] to gain further insight into the ongoing serpentinization process at Rainbow.

[1] Charlou *et al.* 2010 AGU Monograph series. [2] Seyfried *et al.* (2011) *Geochim. Cosmochim. Acta* **75**, 1574–1593. [3] http://www-cast3m.cea.fr. [4] Martin & Fyfe(1970) *Chem. Geol.* **6**, 185-202. [5] Marcaillou *et al.* (2011) *Earth & Planet. Sci. Lett.* **303**, 281-290.

Controls on microbes in an actively venting chimney and in low-temperature hydrothermal fluids

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Two types of venting are recognised in hydrothermal habitats: hot and low-temperature emissions. Hot venting is commonly accompanied by formation of chimneys, which precipitate when ascending hot, reduced liquids come into contact with cold, oxygenated, ambient seawater. Alternatively, low-temperature emissions exist. These areas are often covered by microbial mats or symbiotic mussels. Besides the possibility of the type of host rock contributing to the chemical signature, the degree of seawater admixed to endmembers defines temperature and fluid chemistry in these liquids/habitats.

To understand the feedbacks of temperature and chemistry on the indigenous microbial community of hydrothermal biotopes, we collected a flank from an actively venting chimney and low-temperature hydrothermal emissions from two basalt-hosted sites on the southern Mid-Atlantic Ridge. As anticipated, measured sulfide (~6 mM), and hydrogen (~50 μM) is considerably higher in the hot chimney fluids (375°C) than in the low-temperature (9°C) emissions (47 μM, and 0, 9 μM, respectively). Oxygen was below detection limit in the former and around 71 μM in the latter fluids. The metagenomes of the chimney and the diffuse fluids clearly reflect the thermal and anoxic/oxic conditions of the two environments. From the metagenomic data, the importance of different pathways and enzymes for sulfur, nitrogen and carbon cycling can be deduced for the two biotopes. However, while microbial hydrogen and sulfide consumption rates were similar for both sites, hydrogen and sulfide only stimulated microbial CO_2 fixation considerably in the low-temperature fluids. Besides chemical controls, alternative factors may govern the microbial community structure. For example, more divergent transposases were in the chimney, but a higher divergence and abundance of phages, plasmid-related-functions as well as virulence, defense and disease strategies were found in the low-temperature liquids. Since conditions in the hot chimney are already highly selective for specific lifestyles, these type of defense/transfer strategies may be of profound importance for survival in low-temeprature venting habitats.