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Magma chamber to micro-habitats: near seafloor dynamics of mid-ocean ridge hydrothermal systems

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Hydrothermal circulations at mid-ocean ridges transfer most of the magmatic heat associated with the accretion of new oceanic crust and are one of the main carriers for chemical transfers between the solid Earth and the Ocean. They also host unique ecosystems that use the reduced chemical compounds in the hydrothermal fluids as a source of energy. Focused high temperature vents (black smokers) create sulfide chimneys and result directly from the km-scale fluid convection cells that mine heat and chemical elements from hot rocks next to axial magma chambers. Diffuse, intermediate to low temperature vents extend over larger surfaces, overall releasing larger heat and chemical fluxes than the black smokers and providing most of the gradient domains that host biological communities. These diffuse vents result from complex, and still poorly understood near surface processes that involve mixing with secondary seawater circulation(s), chemical and biochemical reactions. In this poster we use monitoring data acquired at the EMSO-Azores observatory to better constrain these complex processes.

We focus on two instrumented vent sites set in the 1 km2 Lucky Strike basalt-hosted hydrothermal field. Both sites comprise a central sulfide mount, with several black smokers, set in a wider, semi-elliptical domain of diffuse venting, 20 to 50m in diameter. Permeable basalts and volcaniclastic deposits in this domain are commonly capped by a thin (<1 m) indurated and impermeable hydrothermal/pyroclastic formation called “the slab”. Diffuse venting occurs through fractures of this slab, or, where the slab is absent, in sandy areas made of degraded volcaniclastic deposit. We use geological observations, seafloor mapping, fluid chemistry and long time series of fluid temperature, current, and seafloor pressure to address the near surface dynamics of hydrothermal fluids leading to the formation of such diffuse vents. In our approach of the temperature time series, we focus on their response to tidal forcing. Our observations lead us to propose scenarios for the mechanisms of diffuse fluids formation at the Lucky Strike vent field. We plan to test these scenarios in physical models, and also using data from new seafloor experiments that have been developed at the EMSO-Azores observatory (with funding from ANR project LuckyScales).