In situ monitoring and modelling of near seafloor hydrothermal dynamics and formation of diffuse vents at the Lucky Strike hydrothermal field, mid-Atlantic ridge.

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Km-scale convection cells at the origin of focused, black smoker vents have been the focus of most previous studies of hydrothermal circulations in the oceanic lithosphere at mid-oceanic ridges. These hot hydrothermal fluids are modified in the highly permeable domain that lies just below the seafloor. Mixing with secondary seawater circulations and chemical reactions lead to the formation of diffuse effluents that vent mid to low temperature fluids. These diffuse vents release larger heat and chemical fluxes than the high temperature black smokers, and host most of the chemiosynthetic biological activity at mid-ocean ridges vents but remain poorly studied.

In situ studies of the characteristics of diffuse mid-ocean ridge hydrothermal fluids over long time period are scarce. We use data generated at the multidisciplinary EMSO-Azores observatory for the 1 km^2 Lucky Strike basalt-hosted hydrothermal field (Mid-Atlantic Ridge 37°17'N). We use these data to constrain physical models of fluids circulation in the shallow seafloor. Our in-situ observations and monitoring data focus on two vent sites showing typical characteristics of hydrothermal mounds: a massive sulphide deposit structure, up to 20 meters in diameter, with several black smokers, set in a semi-elliptical domain of diffuse venting up to 20 to 70 m in diameter.

In our modelling approach, we focus on the upper 100 m of the basement with a physical model using heat conduction and Darcy's porous flow laws, with a central pipe of hot fluid (modelled as hot seawater). The pipe size and fluid speed at the base of the model are among the model's unknowns. We test plausible values for these parameters which we constrain by running larger scale models of the black smoker hydrothermal circulation. We find that secondary seawater circulations generated in our small scale models prevent the high temperature (>300°C) fluids to reach the seafloor and to form black smokers. In order to form these focused vents, we need to introduce minerals precipitation leading to local permeability variations that insulate part of the hot fluids all the way to the seafloor.