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Surface reaction kinetics of volcanic materials at hydrothermal conditions – an in-situ experiment at the Surtsey volcano

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The diversity and functioning of microbial life is a key research topic in the field of marine geochemistry and geobiology. For understanding biological processes at the temperature limit of functional life, it is necessary to gain insights about microbe-rock-fluid interactions under natural hydrothermal conditions within the basaltic ocean crust. Although there has been research in the field of biological interactions on olivine and tephra surface in laboratories and samples from volcanos ([1], [2]), the kinetics of microbe-rock-fluid interactions has not been systematically evaluated by in-situ experiment in a natural reservoir.

During the ICDP SUSTAIN Expedition 5059 at the Surtsey volcano off the southern coast of Iceland in 2017, a borehole was endowed with a subsurface observatory to analyze the evolution of olivine (Fo_{90}) and volcanic glass surfaces embedded in PEEK containers at fixed temperatures ranging from 25°C to 125°C for two years ([3]). This incubation experiment delivers novel data of surface reaction kinetics under defined conditions in a natural setting.

In-depth analysis of the sample surface with vertical scanning interferometry, atomic force microscopy as well as Raman spectrometry provides insights into solid-fluid reactions of volcanic minerals. On the one hand, this analysis delivers a quantitative and qualitative breakdown of the chemical and physical alteration of natural matter below the oceanic crust. On the other hand, the in situ experiment facilitates a validation of a range of experiments that have been performed in laboratories under similar conditions. The possibility to gain knowledge about dissolution and precipitation on the interface of common seafloor materials within a natural hydrothermal system is critical step towards understanding submarine microbial life.

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