Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.13216

The Surtsey subsurface observatory: Surface mineral reactions in natural hydrothermal environments

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Understanding the alteration of minerals and rocks is one of the key problems to comprehend material fluxes on earth. While many authors examined the influence of pH and temperature, the impact of microorganisms on crystal surfaces is not yet well understood. Throughout the last decades, mineral dissolution rates have mainly been gathered through laboratory experiments[1]. However, mineral surface alteration changes significantly when it is measured in natural systems. Thus, designing laboratories for field studies is a valuable method to gain information about solid-fluid interactions.

In 2017, during the ICDP SUSTAIN Expedition 5059 a subsurface observatory has been constructed at the Surtsey volcano[2], which is part of an oceanic archipelago near the southwest coast of Iceland. Polyether ether ketone (PEEK) chambers containing volcanic tephra and olivine(Fa_{90}) crystals were mounted on a robe and hung into a borehole of a depth of 197m b.s. This design provides the possibility of performing a mineral dissolution experiment with samples in an environment of natural basaltic tuff and a constant fluid flow through the borehole. Afterwards laboratory dissolution experiments are performed in seawater to compare surface alteration of natural- and sterile systems.

With the help of surface analysis techniques including Raman-VSI and AFM measurements, surface alteration of all samples can be observed in the high nm to µm scale. Furthermore, chemical analyses of attached material are conducted by RAMAN spectroscopy. These methods allow us to gain new insights into the interaction of fluids and mineral surfaces during the presence of microorganisms.

[1] Lamerand et. al (2019), *GCA*, 268: 123-141

[2] Türke, A., et al. (2019). "Design of the subsurface observatory at Surtsey volcano, Iceland." Sci. Dril. 25: 57-62.