Geophysical Research Abstracts
Vol. 21, EGU2019-18812, 2019
EGU General Assembly 2019

Design and implementation of a submarine borehole observatory at Surtsey Volcano, Iceland

Andreas Türke (1), Marie D. Jackson (2), Wolfgang Bach (1), Wolf-Achim Kahl (1), Steffen Leth Jørgensen (3), and Magnús T. Gudmundsson (4)

(1) Department of Geosciences and MARUM, University of Bremen, Bremen, 28357, Germany, (2) Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah, 84102-0102, USA, (3) K.G. Jebsen Centre for Deep Sea Research, Department of Earth Science, University of Bergen, Bergen 5007, Norway, (4) Nordvulk, Institute of Earth Sciences, University of Iceland, Reykjavík, Iceland

The exploration of very young submarine tephra deposits produced by 1963–1967 explosive basaltic eruptions off the southern coast of Iceland at Surtsey volcano is expected to provide the first glimpse of microbial life in the very young, "zero-age" basaltic tuff of the oceanic crust. One of the cored boreholes acquired through the International Continental Scientific Drilling Program SUSTAIN Expedition in summer 2017 has been equipped with a subsurface observatory dedicated to in situ experiments. These will monitor water-rock interactions and the role of microbes in basaltic glass and olivine alteration processes at 25–141 °C in the subaerial and submarine hydrothermal system. Optimized design, implementation and monitoring technologies were undertaken to minimize contamination of the borehole, stabilize the free-hanging casing to ensure long term functionality, precisely monitor borehole temperatures, and maximize fluid-glass-olivine interactions in incubation experiments. To minimize contamination of circulating fluids and the host basalt, the SE-02b vertical borehole was cored with filtered seawater passed through two UV-sterilization devices. An anodized T-6061 extruded aluminium tubing product $2\frac{3}{4}$ inch in diameter (NQ, outer diameter 66.9 mm) with 0.25" in wall thickness ($2\frac{1}{4}$ inch inner diameter, or 57.15 mm) was hung freely in the borehole to a landing depth of 181.2 m, and stabilized by Polytetrafluoroethylene spacers at the custom wellhead. Polyvinyl chloride (PVC) centralizer tubes are installed between the aluminium casing and the steel HWT conductor casing to further minimize corrosion. There are fifty threaded aluminium pipes, of which five are perforated with $\frac{1}{4}$ inch diameter (6.35 mm diameter) holes spaced equally on 72° angular increments that extend over four feet (1.21 m), centred in the mid-section of the pipe to encourage hydrothermal fluid flow. The threaded casing joints were wrapped with Teflon tape, to minimize contamination as compared with paste lubricants, and wrenched together by hand. A custom shoe designed with a conical shape prevented infill of residual tephra and drilling debris during installation. The Vectran rope hung from the custom well head is currently equipped with 40 perforated incubation polyether ether ketone chambers (PEEKins) designed to investigate alteration of initially sterile basaltic glass and olivine (Fo90) over an expected two-year period, September 2017–2019. A HOBO temperature logger monitors in situ temperature every 30 minutes at the depth of each perforated section: 34.01–38.63, 62.74–63.96, 106.11–107.33, 135.03–136.25, and 160.48–161.70 m below surface. The steep temperature gradients in the young hydrothermal system, including a section that in 1979 exceeded the known temperature limit of life, offer a unique opportunity to monitor the temperature dependency of biomediated processes immersed in diverse hydrothermal fluid compositions within Earth's deep biosphere hosted by oceanic basalt.