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# Surtsey after 50 years: Time lapse palagonitization within a young seawater-dominated hydrothermal system

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The volcanic island of Surtsey situated off the south coast of Iceland is the youngest and southernmost member of the Vestmannaeyjar Islands, having formed between 1963 to 1967. In 1968, one year after the end of the eruptions, the first signs of incipient hydrothermal activity were observed in the form of visible steam rising from the tephra pile as well as a zone of anomalous heat exchange [1]. In 1979, a drilling expedition was dispatched, which recovered a 181 m long drill core for the purpose of investigating the island‘s subsurface lithology and its emerging hydrothermal system [2]. Detailed studies of this drill core contributed to an improved understanding of the effect of temperature on alteration rates of basaltic glass and associated secondary mineral assemblages in a young seawater dominated low-temperature hydrothermal system.
In 2017, the ICDP-supported SUSTAIN drilling project drilled two new 152 and 192 m deep vertical holes (SE-02a and SE-02b) on the island at a distance of about 7 m to the 1979 drill hole (SE-01). Another borehole (SE-03) was drilled at an angle of 35°, reaching a measured depth of 354 m. The newly recovered drill core of the SUSTAIN project represent an unprecedented opportunity for a comparative study of drill core material collected during both the 1979 and 2017 Surtsey expeditions. The data gained from this study provides new insights into the history of Surtsey‘s young seawater dominated low-temperature hydrothermal system.
Results of our research will allow to constrain reaction rates of sideromelane to palagonite in a seawater dominated hydrothermal system and changes in alteration mineralogy as a function of time, depth, temperature and pressure. Petrographic and mineralogical analysis of hydrothermally altered tephra samples from SE-01 and SE-02b shows, that alteration has progressed within the Surtsey tephra over the past four decades. Our findings on SE-01 generally reproduce and confirm previously established data on alteration features presented by Jakobsson and Moore (1968). Palagonitization and alteration of primary minerals, such as olivine, have continued over the past 38 years. A comparison of SE-01 to SE-02b demonstrates, that over time alteration has progressed into previously unaltered or lightly altered zones both above and below sea level. A comparatively lower degree of overall alteration is observed in both SE-01 and SE-02b at a depth of about 140-150 m, which may indicate a recharge zone at this depth – a hypothesis independently supported by both mineralogical analyses as well as geophysical downhole logging. Furthermore, reaction rates were found to be positively correlated to temperature. As such, alteration progress with time has declined over the last few decades as the system underwent cooling.

[1] Friedman, J. D., and Williams, R.S. (1970), Changing Patterns of Thermal Emission from Surtsey, Iceland, between 1966 and 1969, U.S. Geol. Survey Prof. Paper 700-D, 116-124
[2] Jakobsson, S.P., and Moore, J.G. (1986), Hydrothermal Minerals and Alteration Rates at Surtsey Volcano, Iceland, GSA Bulletin, 97, 648–659.