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Material, Magnetic, and Microbial Features of a Submarine Inflow ZoneTraversed by SUSTAIN Drill Cores, Surtsey Volcano, Iceland

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A series of basaltic eruptions from 1963 to 1967 off the southern coast of Iceland produced the oceanic island of Surtsey. Investigations of this volcanic system provide a time-lapse window into the real-time alteration of basaltic tephra through interactions with meteoric water in a subaerial tuff cone and with seawater in submarine deposits. In 1979, a 181 m core was recovered from a borehole (SE-01) on the eastern flank of the Surtur vent. In 2017, the ICDP-supported SUSTAIN drilling project drilled two vertical cored boreholes (SE-02a, SE-02b) to 151 and 187 m below surface (m b.s.) parallel to the 1979 borehole, and an additional angled cored borehole (SE-03) to 354 measured depth. These newly recovered cores, in comparison with the 1979 core, have promoted research into alteration processes within the volcano over the half century since its eruption. The scientific drilling undertaken in both 1979 and 2017 provides data critical to investigating mechanisms and rates of mineralogical change in basalt, evolving material and magnetic properties, and the characterization of basalt-hosted microbial communities.

Previous research, including mineralogical analyses and geophysical downhole logging, reveals a weakly altered region at ~143-155 m b.s. that corresponds with a submarine zone of cool seawater inflow. The purpose of this study is to better understand processes in this zone by examining SE-02b drill core samples taken at 141.6 m b.s. (83-86 °C) with mineralogical analyses and at 148 m b.s. (83-84 °C) with magnetic analyses and microbial community analyses. Mapping of the weakly-consolidated basaltic tuff at micrometer-scale using synchrotron X-ray micro-diffraction and micro-fluorescence studies shows that the basalt is primarily composed of fresh sideromelane glass, volcanic crystals, and open voids. Olivine and labradorite are the principal volcanic minerals; they have begun to alter to lizardite and aluminous tobermorite, respectively. The basaltic glass has begun to alter to nanocrystalline clinochlore and smectitic clay mineral, mainly nontronite and montmorillonite. The abundance of fresh glass, however, confirms a weakly altered region of the volcano. Uniaxial and cubic single domain titanomagnetite is the principal magnetic remanence carrier in the glass, whereas the magnetic minerals in more highly altered zones of lapilli tuff, only a few meters distant, are more oxidized and exhibit different magnetic

anisotropies, consistent with the growth of secondary titanomaghemite. The properties of magnetic remanence remained relatively stable in the cool seawater inflow zone but changed very rapidly during fluid-rock interactions at higher hydrothermal temperatures. The microbial community detected in the drill core sample at 148 m b.s. from SE-02b is dominated by taxa generally found in seawater such as Psychromonas, Glaciecola, Marinomonas and suggests a possible infiltration of microbial taxa from the seawater to the submarine deposit. This anomalously permeable, poorly-consolidated horizon provides a strong contrast to the characteristics of the well-lithified lapilli tuff deposits and demonstrates the potential for substantial variability in mineralogical, magnetic and microbial submarine processes in other Surtseyan volcanoes and seamount structures.