INTERNATIONAL CONTINENTAL SCIENTIFIC DRILLING PROGRAM

ICDP Operational Report

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Operational Report for the 2017 Surtsey Underwater volcanic System for Thermophiles, Alteration processes and INnovative concretes (SUSTAIN) drilling project at Surtsey Volcano, Iceland

Tobias Björn Weisenberger, Magnús Tumi Gudmundsson, Marie Dolores Jackson, Carolyn F. Gorny, Andreas Türke, Barbara Irene Kleine, Beau Marshall, Steffen Leth Jørgensen, Viggó Thór Marteinsson, Andri Stefánsson, James D.L. White, Amel Barich, Pauline Bergsten, Julie Bryce, Samantha Couper, Florencia Fahnestock, Hjalti Franzson, Carla Grimaldi, Marco Groh, Ágúst Gudmundsson, Ágúst Thór Gunnlaugsson, Cedric Hamelin, Thórdís Högnadóttir, Kristján Jónasson, Sigurdur Sveinn Jónsson, Alexandra Klonowski, Jochem Kück, Rögnvaldur Líndal Magnússon, Erica Massey, Jocelyn McPhie, Einar Sindri Ólafsson, Solveig Lie Onstad, Simon Prause, Velveth Perez, J. Michael Rhodes, Snorri P. Snorrason

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Operational Report for the 2017 **S**urtsey **U**nderwater volcanic **S**ystem for **T**hermophiles, **A**lteration processes and **IN**novative concretes (SUSTAIN) drilling project at Surtsey Volcano, Iceland

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Abstract

In summer 2017, the ICDP SUSTAIN project (Surtsey Underwater volcanic System for Thermophiles, Alteration processes and INnovative concretes), drilled three cored boreholes (Table 1) through Surtsey at sites ≤10 m from a cored hole obtained in 1979. Drilling through the still hot volcano was carried out with an Atlas Copco CS1000 drill rig, whose components were transported by helicopter to Surtsey and re-assembled on site. The first vertical borehole, SE-02a, was cored in HQ diameter to 152 meters below surface (m b.s.) during August 7-16. It was terminated due to borehole collapse. A second vertical (SE-02b) cored borehole was then drilled in HQ diameter to 192 m during August 19-26. Wireline borehole logging in SE-02b was performed August 26. The anodized NQ-sized aluminum tubing of the Surtsey Subsurface Observatory was installed in SE-02b to 181 m depth on August 27. A third borehole, SE-03, angled 35° from vertical and directed 264°, was drilled from August 28 to September 4 and reached a measured depth of 354 m (~290 m vertical depth) under the eastern crater. The core is HQ diameter to a measured depth of 213 m and NQ diameter from 213-354 m measured depth. The core traverses the deep conduit and

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intrusions of the volcano to a total vertical depth of 290 m b.s. Seawater drilling fluid for boreholes SE-02a and SE-02b was filtered and doubly UV-sterilized at the drill site. No mud products were employed while coring SE-02a, while small amounts of attapulgite mud were used in SE-02b and SE-03. Core samples for geochemical analyses of pore water and microbiological investigations were collected on site from all three boreholes. About 650 m of core was transported by helicopter to Heimaey, 18 km northeast of Surtsey, to a processing laboratory where the core was scanned, documented, and described. Additional core processing has taken place at the Náttúrufraedistofnun Íslands, the Icelandic Institute of Natural History in Gardabaer, where both the 1979 and 2017 cores are stored.

Referencing Article

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Supplementary Data

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Coordinates of main spot: 63.3016, -20.59977 (WGS 84)

Table 1. *Boreholes drilled in Surtsey in 1979 (SE-01) and 2017 (SE-02a, SE-02b, SE-03).*

Bore-hole name	Hole ID	Coordinates (WGS84)	Flange height (m a.s.l.)*	Reference level during drilling (m a.s.l.)*	East** North** (m)	Horizontal Distance from SE-01 (m)	Depth** * (m)
SE-01	73552	63° 18.09749'N	58.40	-	419756.79	-	180.6
		20° 35.98221'W			311669.86		
SE-02a	73553	63° 18.09659'N	58.01	57.57	419749.70	7.08	152.01
		20° 35.99063'W			311668.38		
SE-02b	73554	63 18.09739'N	57.86	57.65	419750.11	6.86	191.85
		20° 35.99020'W			311669.85		
SE-03	73555	63° 18.09649'N	58.13	57.65	419748.81	9.92	354.64
		20° 35.99170'W			311668.22		

* a.s.l.: above sea level; ** Reference coordinate system: ÍSN93 UTM Zone 27N; *** SE-03 is inclined 35° from vertical; depth is along hole axis.

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*IceSUSTAIN consortium, The IceSUSTAIN team includes individuals from the University of Iceland, Institute of Earth Sciences; ÍSOR, Iceland GeoSurvey; Matís, Food Safety, Environment and Genetics, Iceland, and the Icelandic Institute of Natural History, Iceland.

Appendix A provides information on personnel for the drilling operations and the core processing at the Heimaey Laboratory and the Icelandic Institute of Natural History (IINH).

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1 Introduction

In late summer 2017, the **S**urtsey **U**nderwater volcanic **S**ystem for **T**hermophiles, **A**lteration processes and **IN**novative concretes (**SUSTAIN)** drilling project (Jackson et al., 2015), drilled three cored boreholes through Surtsey Volcano (Table 1), a very young oceanic island (Figure 1, Figure 2), nature preserve and UNESCO World Heritage site (https://whc.unesco.org/en/list/1267). The goal of creating a drill core record of basaltic deposits at Surtsey fifty years after eruption was first conceived in late 2013. Four years of advance planning and preparation resulted in the successful acquisition of nearly 650 m of drill core from the still hot volcano, through a project sponsored by the International Continental Scientific Drilling Program (ICDP) (http://surtsey.icdp-online.org). The 2017 cores will be compared with a 181 m vertical core through the volcano, acquired in 1979 (Jakobsson and Moore, 1982; 1986); the three 2017 wellheads are situated within 10 m of the 1979 cored borehole. Fluid compositions and temperatures in the 1979 borehole have been monitored continuously by scientists and by members of the Surtsey Research Society since 1980. The 1979 and 2017 time-lapse drilling projects therefore provide a record of global significance for studying the early progression of processes and properties in the young oceanic crust.

The rationale and scientific framework for acquiring new drill cores through Surtsey were developed in October 2014, at a workshop sponsored by ICDP on Heimaey, located in the Vestmannaeyjar Islands about 18 km northwest of Surtsey. A great deal of attention was given to creating a zero-impact drilling operation that would fully preserve the sensitive surface and subsurface environments on Surtsey, and that would follow all guidelines set by the Iceland Environment Agency and the Surtsey Research Society to avoid any risk to the vegetation, birds and sea life that inhabit the island and the marine preserve that surrounds it. An emphasis has also been placed on positively engaging the interest of individuals around the world in the drilling operation and its eventual scientific discoveries, since the island is a designated UNESCO site of outstanding value to humanity.

The purpose of this report is to describe the drilling operation that took place on Surtsey from July 23-September 12. The project activities began with the development of comprehensive planning and drilling strategies, presented in an April 2016 application to the Iceland Environment Agency. Project preparations then took place mainly in Reykjavík, at the Institute for Earth Sciences at the University of Iceland, and in Salt Lake City, Utah, USA, with collaborations between the drilling contractor, DOSECC Exploration Services, and the principal investigator of the project at University of Utah. Details of mobilization of equipment on Surtsey, rigging up, drilling operations, rigging down, borehole monitoring, and demobilization of equipment and site restoration are recorded in this report. These descriptions are designed to preserve all relevant information to aid in possible future drilling expeditions on Surtsey and other drilling projects emphasizing zero-impact drilling strategies.

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Figure 1. *Surtsey aerial view from the north, June 10, 2017 (photo: Walther Erhat).*

Figure 2. *Surtsey aerial photograph, July 26, 2016 (courtesy of Loftmyndir ehf).*

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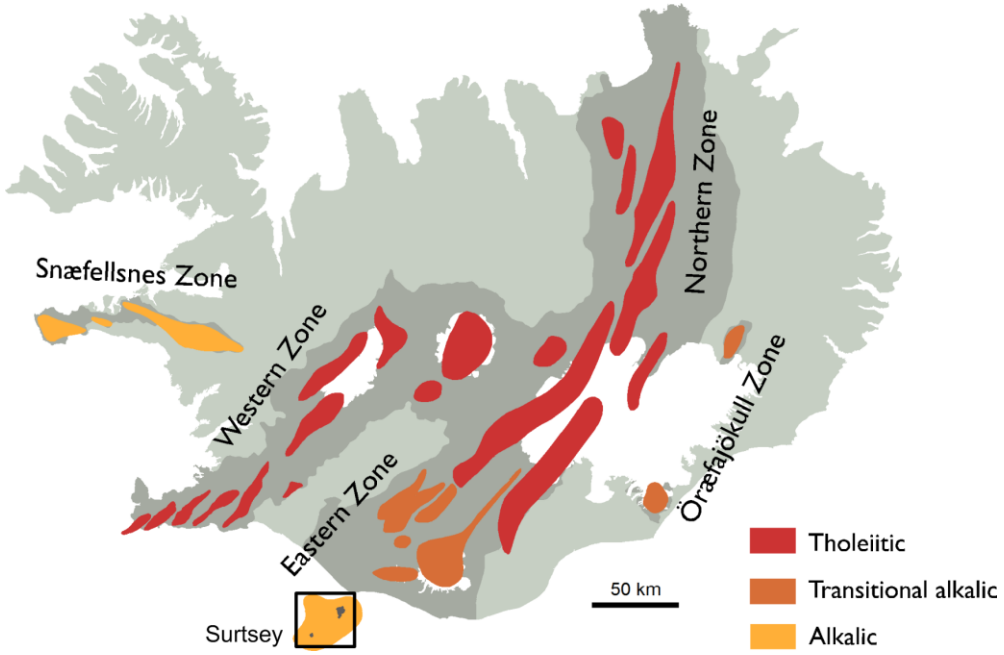

Figure 3. *Map of active volcanic systems in Iceland, colors refer to compositional trends in basaltic rocks. Surtsey is located at the southern tip of the Eastern Volcanic Zone. The square indicates the map shown in Figure 4. Map compiled by Sveinn P. Jakobsson; modified from Baldursson and Ingadóttir (2007).*

The report begins with a description of Surtsey, and its young, active hydrothermal system. It then provides descriptive records of the logistical procedures for drilling on the small oceanic island, the drilling operations, wireline logging, and the installation of the Surtsey Subsurface Observatory, and brief summaries of hydrothermal fluid and core sampling procedures. The report concludes with brief outlines of the processing and initial logging of the drill cores and preliminary assessments of the principal components of the SUSTAIN research objectives. Detailed information is contained in appendices, including reference datasets from the ICDP Drilling Information System (DIS).

1.1 Funding

Funding for this project was provided by the International Continental Scientific Drilling Program (ICDP) through a grant to the SUSTAIN project (led by Marie D. Jackson), including extra funds allocated to the project in June 2018 to cover unforeseen overruns, the Icelandic Science Fund, ICF-RANNÍS, and the IceSUSTAIN consortium (led by Magnús T. Gudmundsson), the Bergen Research Foundation and K.G. Jebsen Centre for Deep Sea Research through the Centre for GeoBiology at University of Bergen, Norway (led by Steffen Leth Jørgensen), the German Research Foundation (DFG) (led by Wolfgang Bach and Bernd Zimanowski), and DiSTAR, Federico II, University of Naples, Federico II, Italy (led by Piergiulio Cappelletti). The total cost of the Surtsey drilling operation in July-September 2017, was about 1.5 million U.S. dollars. The University of Utah, USA (Marie D. Jackson), and the two Icelandic power companies Reykjavík Energy and Landsvirkjun contributed additional funds to the SUSTAIN project. Remaining financial issues were in process at the time of the writing of this report (November 2018).

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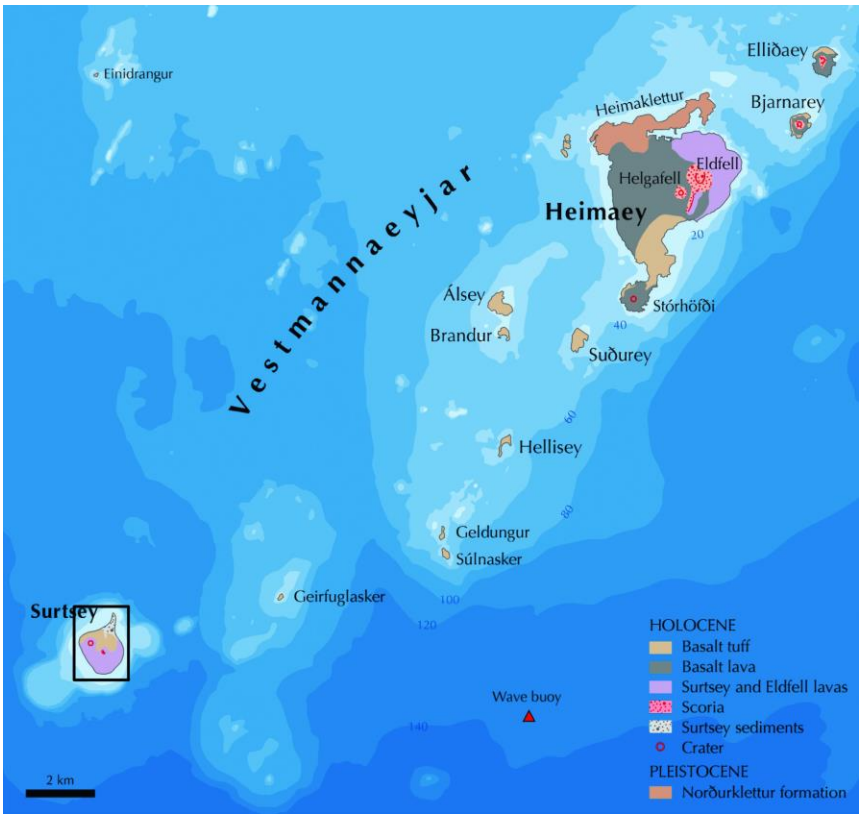

Figure 4. *Map of the Vestmannaeyjar archipelago with Surtsey at its southwest tip. The islands are formed through eruptions similar to those of Surtsey (after Baldursson and Ingadóttir, 2007). The square indicates the map shown in Figure 5.*

2 Surtsey Volcano, a very young hydrothermal laboratory in basalt

Surtsey is an isolated volcanic island created by basaltic eruptions over three and a half years from 1963 to 1967 in the insular shelf 32 km from the south coast of Iceland (Thórarinsson et al., 1964; Thórarinsson, 1967). Surtsey forms part of the Vestmannaeyjar archipelago, a young volcanic system that marks the southern offshore tip of Iceland's SE rift zone (Figure 3, Figure 4). The island was constructed from an original seawater depth of 130 m, and eventually attained a height of 150 m above sea level (a.s.l.). At the termination of activity in June 1967 the total erupted volume was about 1 km^3. Explosive eruptions followed by basaltic lava flows were exceptionally well documented (Thórarinsson, 1967). Surtsey provides an unusually well-constrained eruptive record of world-wide significance. It "has been protected since its birth, providing the world with a pristine natural laboratory" and a unique scientific record of colonization of new land by plants, animals and marine organisms through long term studies of primary biological succession (Baldursson and Ingadóttir, 2007). Surtsey and its surroundings comprise a World Heritage Site of the United Nations Educational, Scientific and Cultural Organization (UNESCO).

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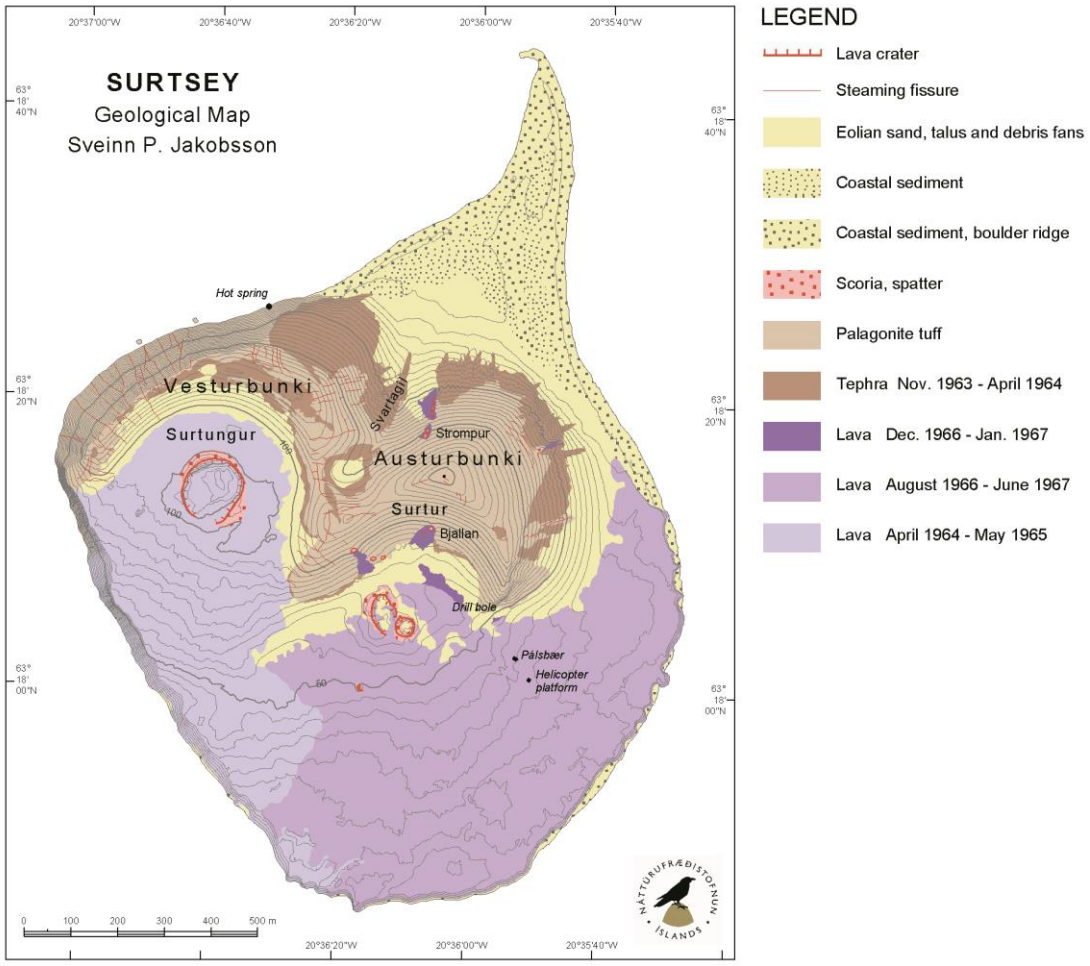

Figure 5. *Geological map of Surtsey compiled by Sveinn Jakobsson (Baldursson and Ingadóttir, 2007).*

Subsurface processes were first explored in 1979 by a 181 m deep cored drill hole through the rim of the eastern tephra cone (Figure 5), the top of the core is situated at about 58 m a.s.l. (Jakobsson and Moore, 1982). Investigations of the core described volcanic structures above and below sea level (b.s.l.), the thermal system, and the composition and alteration of basaltic tuff-the rock formed of lithified volcanic ash or tephra composed of glass, crystals, and authigenic mineral cements (Jakobsson and Moore, 1982; 1986).

Subsurface microbiota of bacteria and archaea have recently been observed in fluids extracted from the deeper zones of the 1979 drill hole below a 120-140 °C thermal barrier at about 100 m b.s. (Marteinsson et al., 2015) (Figure 6). Below this horizon, microbial life could be derived from the seafloor and, therefore, be potentially indigenous to the oceanic environment. Microbial habitats in the young basalt could potentially have formed in the subsurface equivalent of the surficial colonization of Surtsey deposits that have been studied over the past 50 years (Magnússon et al., 2014).

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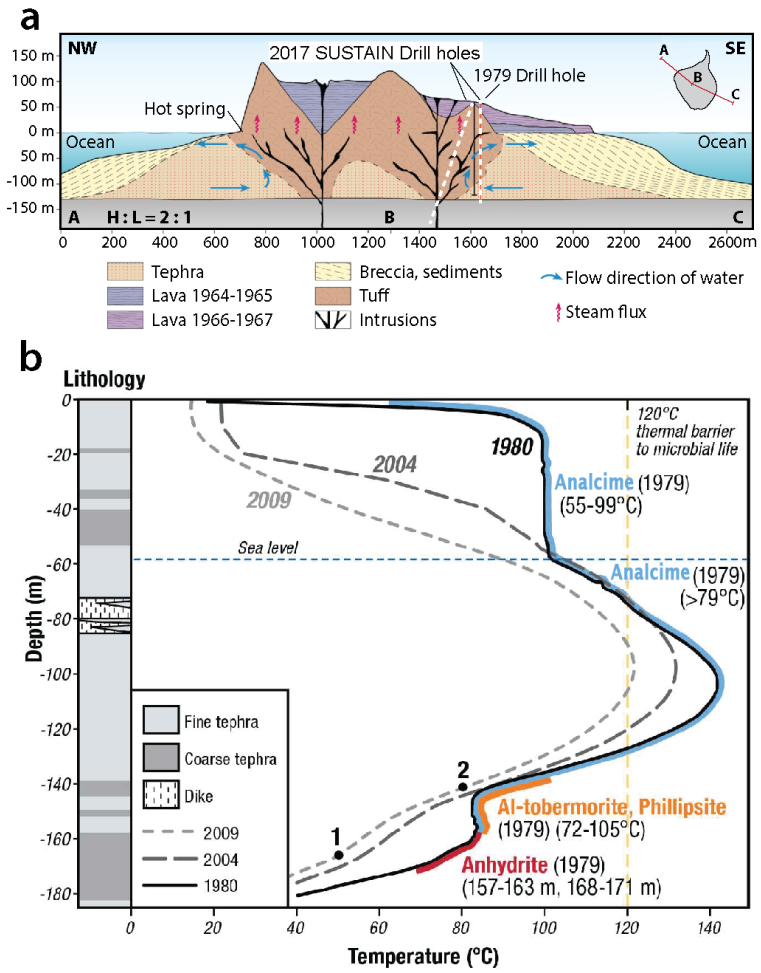

Figure 6. *Hydrothermal alteration of Surtsey deposits (after Jackson et al., 2015). a) Schematic cross-section (Jakobsson et al., 2009) shows inferred feeder dikes, lavas flows, palagonitization of basaltic tuff in 2004, the 1979 drill hole, and the two original planned drill holes. b) Temperatures in the 1979 hole. Lines adjacent to the 1980 curve show greatest abundance of authigenic minerals: analcite (blue), Al-tobermorite and phillipsite (orange), and anhydrite (red). Downhole water sampling in 2009 and microbiological analyses reveal diverse subterrestrial bacterial sequences and Methanobacteria and archaeal sequences at 172 m (54 °C) (site 1) and an archaeal community dominated by Archaeoglobus-like 16S rRNA sequences at 145 m (80 °C) (site 2) (Jakobsson and Moore, 1986; Ólafsson and Jakobsson, 2009; Marteinsson et al., 2015).*

2.1 Time-lapse changes at Surtsey Volcano 50 years after eruption

The SUSTAIN drilling project opens a new window into the active hydrothermal system at Surtsey volcano, 50 years after eruptions terminated. It provides the basis for interdisciplinary, longitudinal studies that investigate how biological and mineralogical processes initiate, evolve, and interact in freshly erupted basalt — the most abundant volcanic rock on earth and the substrate in which microbial life began about 4 billion years ago (Furnes et al., 2004; Bengsten et al., 2017). Time-lapse processes of basaltic glass alteration and authigenic mineral growth recorded in two new vertical drill

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cores (SE-02a, SE-02b) are now being compared with the parallel drill core obtained in 1979 (SE-01) in deposits above sea level, in the zone of tidal flux, in the maximal temperatures of the hydrothermal system, and in the lower edifice above the sea floor (Jakobsson and Moore, 1982; 1986; Jakobsson et al., 2013) (Figure 6).

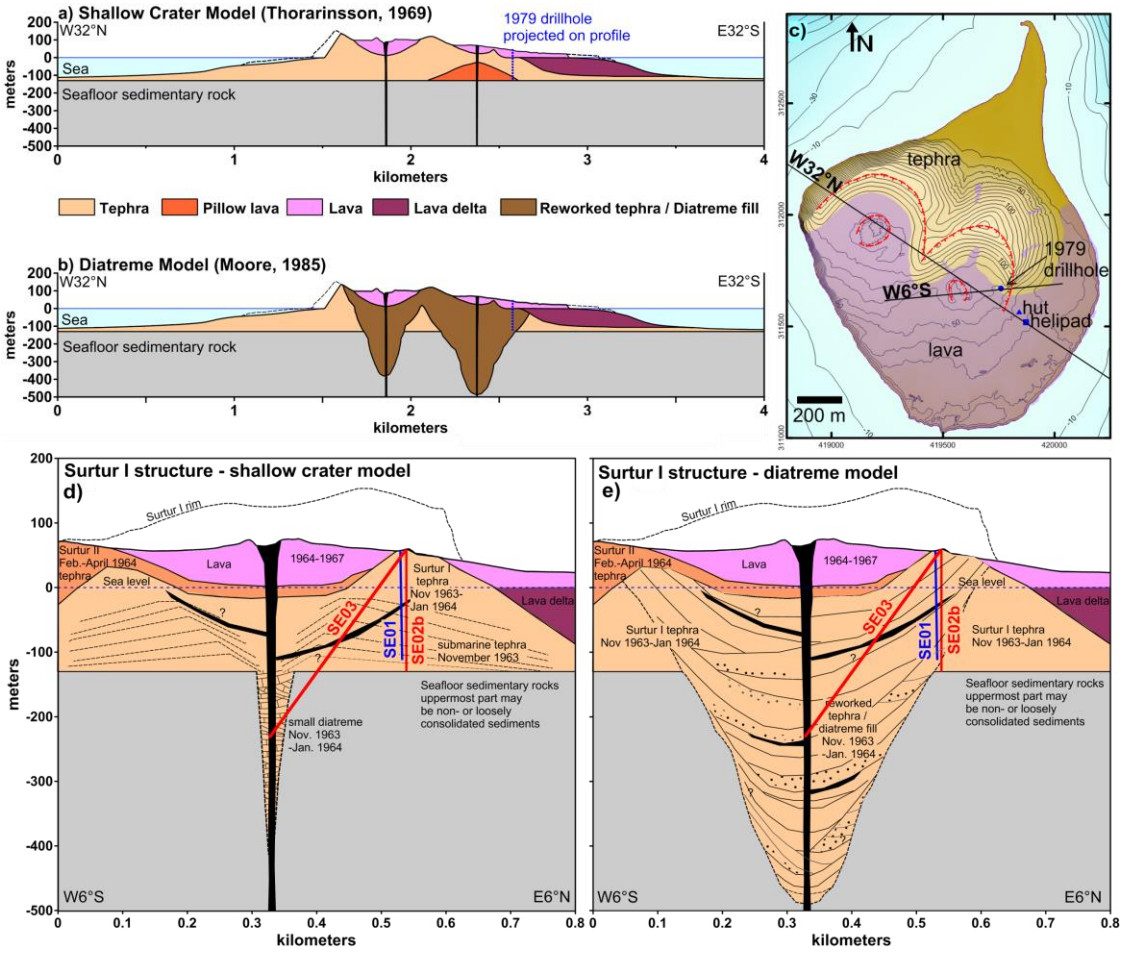

Figure 7. *Structural models of Surtsey. (a and d) showing the shallow crater hypothesis (Thórarinsson, 1969). (b and e) show the diatreme hypothesis (Moore, 1985) (adapted from Jackson et al., 2015). Red lines (d,e) show the planned drill holes. Although the occurrence of a layer of pillow lava at the bottom of the formation cannot be ruled out (model shown in a) no pillow mound is included in (d). This was detected neither in the 1979 drill hole nor in gravity modeling (Thórsteinsson and Gudmundsson, 1999). The geological map of Surtsey (c) shows the helipad, Pálsbaer II hut and 1979 drill site.*

The inclined cored hole (SE-03) has now sampled the central conduit of the eastern crater of the volcano (Figure 7). Investigations of this core will further clarify the internal structure and facies architecture of the type locality of Surtseyan volcanism (Thórarinsson, 1967), and the nature of the hydrothermal system below the seafloor. Studies of volcanic fabrics in all three cores provide a reference for thermal granulation experiments to refine models for explosive magmatic and phreatomagmatic fragmentation and production of airborne ash clouds (Wohletz et al., 2013).

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Microbial succession has been recognized as one of the primary drivers of alteration in ridge crest seafloor basalts and has important implications for global element budgets in seafloor and seawater exchange, and geo-biological cycles (Thorseth et al., 2001; 2003; Furnes et al., 2007; Santelli et al., 2008; Staudigel et al., 2009). The temperature range recorded within the Surtsey edifice below about 40 m below sea level (b.s.l.) in the 1979 drill hole (Figure 6) provides an ideal situation for studying the extreme temperature conditions of microbial ecosystems that use chemosynthetic energy provided by the surrounding rocks and water. A temperature maximum of 141 °C at 100-106 m b.s. in 1980, has now decreased to 125 °C, within the possible range of microbial function and growth (Cragg and Parkes, 1994; Prieur and Marteinsson, 1998; Ivarsson et al., 2009) (Figure 6). The SUSTAIN drilling project has now sampled tephra together with its associated pore water at successive depths from the tuff cone to the deepest levels of the erupted deposits, with all precautions taken to avoid contamination from the surroundings.

Basaltic tuffs produced through explosive hydromagmatic eruptions occur worldwide at oceanic crust and continental deposits, yet the mechanisms through which they alter and grow mineral cements remain poorly understood (Wohletz et al., 2013; Stroncik and Schminke, 2001; Walton, 2008; Pauly et al., 2011). The systematic, longitudinal monitoring of the hydrothermal system through the 1979 SE-01 borehole, the new comparisons of the 1979 and 2017 drill cores, and the present record of fluid geochemistry, permeability and microbial activity 50 years after eruption provide fresh interdisciplinary perspectives on the development of cementitious microstructures and macroscopic rock physics properties of lithified tuffs.

3 Scientific objectives

The principal research foci of the SUSTAIN drilling project involve interdisciplinary studies in volcanology, hydrothermal processes, mineralogy and microbiology. These integrate scientific investigations by international researchers with a broad range of research expertise to answer three principal questions: How do explosive eruptions of oceanic volcanoes produce hazardous ash fall clouds? How do incipient oceanic volcanic islands develop hydrothermal systems, lithify, and stabilize themselves over time to resist incessant marine erosion? How does life in its many forms colonize very young subsurface basaltic deposits?

The principal global scientific and societal benefits of the research project are directed towards:

i. investigating explosive fragmentation processes of basaltic tephra as a means to refine predictions of hazards associated with sub-aerial explosive eruptions and rapid edifice growth of seafloor volcanoes,
ii. describing the chemical, mineralogical, and mechanical changes in the Surtsey tephra through hydrothermal rock-water interactions as a means to refine geophysical monitoring of thermal and chemical stimulation of hydrothermal reservoirs in pyroclastic rocks and fluid/waste disposal or storage sites, and
iii. determining the role of geochemical and biochemical processes in the development of zeolite-Al-tobermorite cementing mineral assemblages in Surtsey deposits and transferring this information to applied laboratory studies to reproduce these cementitious fabrics in

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innovative pyroclastic rock concretes and, potentially, cementitious barriers and waste forms using basaltic tephra.

Analytic investigations are currently underway, and preliminary results were reported at a post-operational workshop held May 1-4 2018 at Náttúrufraedistofnun Íslands (the Icelandic Institute for Natural History) in Gardabaer, Iceland. Initial reporting also took place at the European Geophysical Union (Bergsten et al., 2018; Jackson et al., 2018a; Gudmundsson et al., 2018). Collaborative investigations within the SUSTAIN scientific team will include studies of volcanic fabrics in the tuff and tephra deposits and basaltic intrusions, whole rock geochemistry, fluid geochemistry, glass stability and alteration, authigenic mineral assemblages, temperature dependence of various processes, the thermal history and evolution of the island, and the extent, function and diversity of microorganisms in the tephra, tuffs and intrusions. Chapter 16 presents a brief summary of the present outlook for the scientific findings.

4 Previous drilling

4.1 Drilling of SE-01 in 1979

Initial coring of Surtsey took place between June and August 1979, as described by Jakobsson and Moore (1982). The hole was collared at an elevation of 58.4 m and drilled to a total depth of 180.6 m. The hole was cored in NQ diameter (75.7 mm outside diameter, 47.6 mm core diameter) until the bit became stuck at 176.5 m. It was then completed in BQ diameter (60 mm outside diameter, 36.5 core diameter) to the total depth. Core recovery was very good (97.9%) to 138 m. Below that point, drilling was more difficult and core recovery was lower due mainly to unconsolidated tephra. The horizons at 140.0-143.8 m, 148.5-150.6 m, 157.4-168.7 m, 170.5-180.1 m b.s. had poor recovery and slow drilling progress (Jakobsson and Moore, 1982). The steel drill casing remains in the hole. Seawater pumped from the coast, about 1.4 km to the northeast of the drill site was the circulating medium, and the return fluids were flushed back to the ocean. No drilling mud was employed.

4.2 Site selection

The 1979 drilling program on Surtsey provided exceptionally well-constrained information about the structure, stratigraphy, temperature, and hydrothermal system of a 181 m vertical section through the SE sector of the eastern crater (Jakobsson and Moore, 1982; 1986). The opportunity to determine in situ rates of alteration and other changes over the last 38 years strongly influenced the decision to locate the new drill holes within 10 m of the 1979 SE-01 hole (Figure 7). The SUSTAIN project proposed to extract approximately 500 m of drill core, through a vertical cored hole parallel to the 1979 hole and an inclined hole directed across the eastern crater. In actuality, nearly 650 m of core was recovered. Figure 8 shows the layout of the logistical components of the drilling operation. Seawater was used for circulation, pumped over a distance of 1.4 km from a sheltered location on the western side of the northern peninsula.

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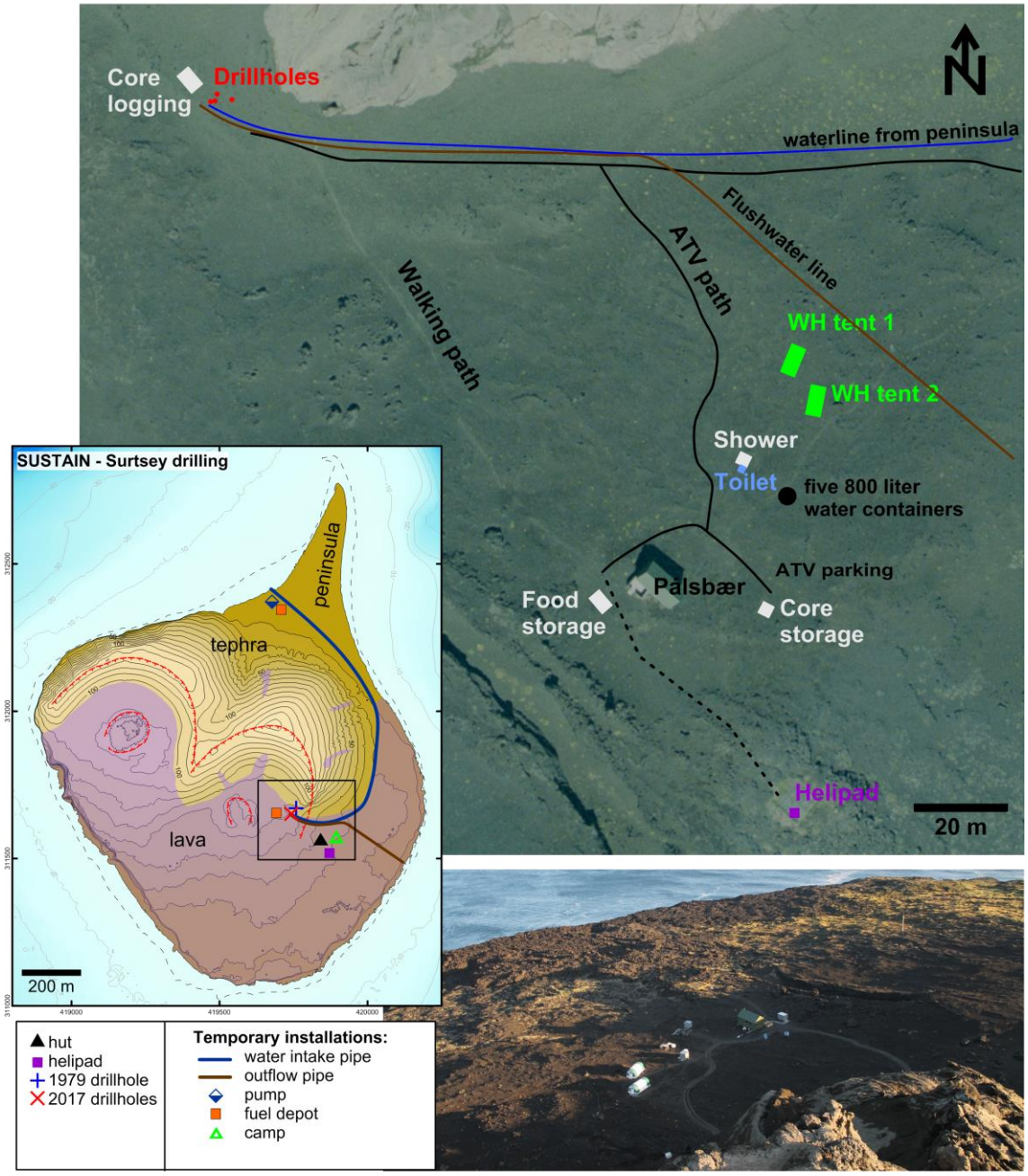

Figure 8. *Map of the SUSTAIN Surtsey camp set up at end of July and taken down in September. WH: Weather Heaven tents, ATV: All-terrain vehicle parking. [Air photo, courtesy of Loftmyndir ehf, photo: Magnús Tumi Gudmundsson (MTG)].*

5 Logistics of drilling on Surtsey

The strict terms of the protection of the Surtsey Natural Reserve required that the drilling operation be carried out with no impact to the island, its flora, fauna and geology. To obtain permission for the drilling operation, an application was submitted in April 2016 to the Iceland Environment Agency (Umhverfisstofnun). SUSTAIN team leaders worked closely with representatives of the Agency to develop best practices for every aspect of the drilling operation. To overcome the logistical

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challenges, we sought assistance and cooperation with institutions and companies with the necessary expertise and experience to operate effectively in the Surtsey Natural Reserve. This included the drilling contractor DOSECC Exploration Services (DOSECC), which has extensive experience with scientific drilling in environmentally sensitive and remote locations. Comprehensive planning and preparation of equipment for shipment to Iceland was critical to ensuring a functional operation in Surtsey's remote and protected environment. The absence of a harbor on the island required that all transport of materials and provisions take place via helicopter or landings via dinghy from a larger boat offshore. The logistics of delivering the equipment, personnel and facilities to keep the operation running effectively was one of the more challenging aspects of the drilling project.

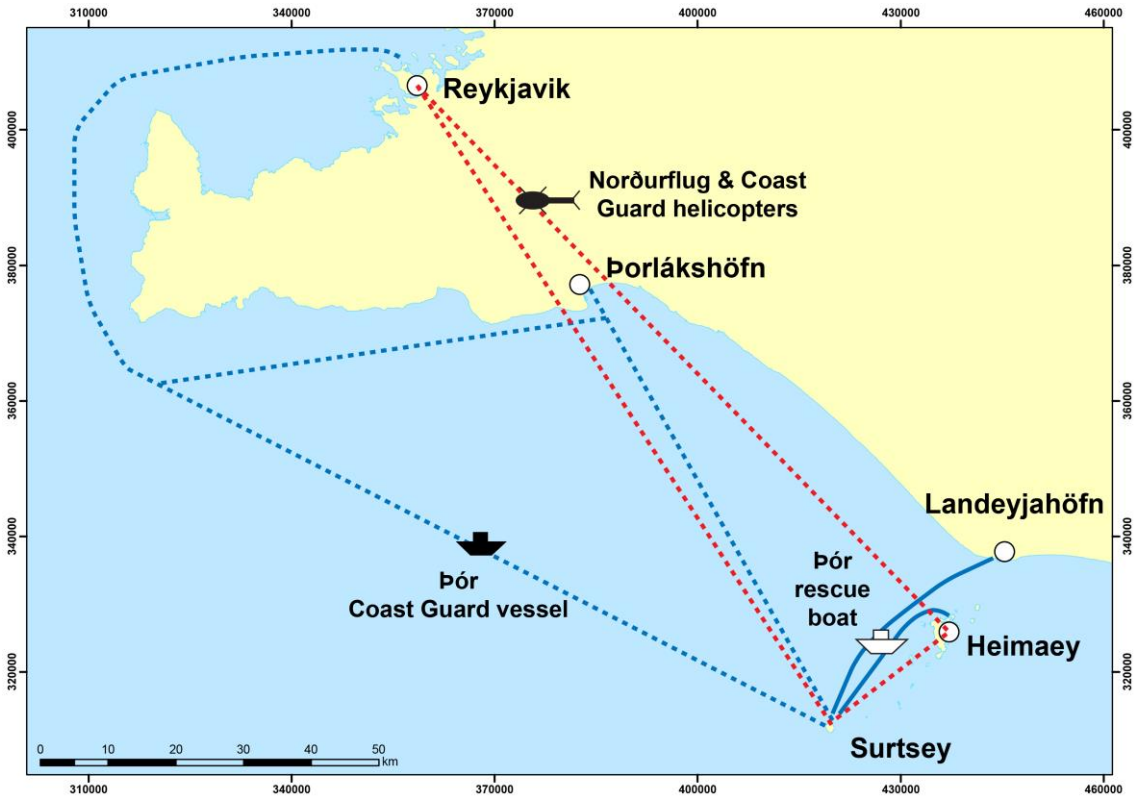

Figure 9. *Map of transport modes and routes during the 2017 Surtsey drilling operation.*

Given the remote location of Surtsey with its lack of a harbor, transport of all materials and provisions had to take place with helicopter or boat. As a result, the logistics of bringing the necessary equipment, providing facilities and keeping the operation running was a highly challenging part of this drilling project.

For transport of the expected 60-65 metric tons of equipment, fuel, provisions and camp materials from Thorlákshöfn to Surtsey and then to Reykjavík, after demobilization (Figure 9) we sought the assistance of the Icelandic Coast Guard. The Coast Guard was the only operator in Iceland with the organizational and technical capabilities needed to carry out the maritime helicopter sling-lift equipment transport for the expedition. For helicopter transport of personnel and general servicing during the operation, we secured the services of the Nordurflug helicopter company, which has a twin-engine Dauphin and highly experienced pilots. Finally, for occasional boat transport and the needed on-sea support we sought the assistance of the rescue group in Heimaey (Björgunarfélag

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Vestmannaeyja) which has a high-speed rescue boat and well-trained crews for sea rescue and transport operations. The cooperation with all parties worked well with everybody involved doing their best, at the time needed and sometimes at short notice. This positive attitude towards the project was of major importance and contributed greatly to the success of the expedition. Transport routes during the SUSTAIN drilling operations are shown Figure 9. Appendix B gives an overview of helicopter and boat trips to Surtsey for materials and personnel transport. Appendix C gives an overview of the transport of the drill rig, fuel, provisions and camp provided by the Icelandic Coast Guard.

5.1 Scientific and logistical work effort

The scientific and logistical work on Surtsey, and the logging operations on Heimaey and the Icelandic Institute of Natural History were carried out by scientists and volunteers from participating institutions. The total work carried out on Surtsey itself amounted to about 3 person-years. About one third of this was carried out by DOSECC drillers; about 2 person-years were scientific and logistical tasks. The majority of the individuals taking part in the work on Surtsey came from the IceSUSTAIN team. For the Heimaey core-logging and support operation, the work amounted to nearly one person-year, carried out by individuals from twelve SUSTAIN partner institutions. The core-processing work in October-December 2017 at the Icelandic Institute for Natural History was carried out by the IceSUSTAIN group and amounted to nearly one-half person-year. The complete logistical and scientific on-site and core-logging work put in by the SUSTAIN partners from the start of mobilization in July and the end of core logging in December therefore amounts to about 3.5 person-years. The substantial pre-drilling planning and preparation work that occurred over several months in Utah and Iceland is not counted here. The final core processing and preparation for storage in April-May 2018 at the Iceland Institute for Natural History carried out by the IceSUSTAIN and University of Utah groups amounted to two-person months of work.

In addition, a pre-drilling kick-off meeting took place at the University of Iceland in June 2017. A post-operation workshop was held at the Icelandic Institute of Natural History in Gardabaer, near Reykjavík in May 2018. Scientist and student members of the SUSTAIN science team contributed initial results and participated in collaborative discussions and research planning.

5.2 Permits and official inspections

All travel to Surtsey requires a permit from the Environment Agency of Iceland (https://www.ust.is/). This special protection has been in place since 1965, with amendments made in 2006 and 2011. The purpose of the protection is to ensure that the island, its geological formations, flora and fauna evolve without human intervention. Four official letters and permits were needed be able to proceed with the drilling in Surtsey:

i. A decision from the Planning Agency (Skipulagsstofnun) on whether drilling on Surtsey called for an assessment based on laws concerning environmental impact. This request was sent on August 15, 2015. The verdict of the Planning Agency (November 9, 2015) was that SUSTAIN drilling did not require this type of assessment (Appendix D).

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ii. A project permit from the Environment Agency (Umhverfisstofnun). An application was sent on May 2016, followed by consultation later that month and in winter 2016-17. The permit, outlining the requirements and conditions to be met by the project was issued on July 14, 2017 (the full permit can be found in Appendix D).

iii. A permit from the South Iceland Health Inspectorate (Heilbrigdiseftirlit Sudurlands) for running a camp with living quarters and provision of food, fulfilling requirements for hygiene and space for staff during drilling in Surtsey was issued on July 18, 2017 (Appendix D).

iv. A permit to carry out a drilling operation within the municipality of Vestmannaeyjar, was issued on July 31, 2017 (Appendix D).

The project permit from the Environment Agency (Appendix D) sets out the conditions under which the drilling operation was to be conducted. The main conditions were:

- The operation was approved, with the license for drilling and temporal facilities designated for the period July 22-September 10. Travel permits for individual staff members were issued separately and approved for each individual over specific time periods.
- All changes from the plan as described in the application (and summarized in the permit) would require advance approval before implementation.
- All equipment was to be thoroughly cleaned before transportation to Surtsey, ensuring that no seeds or organisms would be brought to the island.
- After completion of the operation, all traces of the operation except the wellheads would be removed. This included all waste, including human waste, and stipulated that water for washing, showers etc. would not be discarded on the island.
- It was not permitted to enter the bird nesting areas before August 15 and entering the peninsula on the north side was to be prohibited except under supervision of the Environment Agency after September 1.
- Oil barrels brought to the island were to be stored on a four layers of reinforced plastic sheeting and while in use stored in sturdy, plastic thick fish tub.
- All-terrain vehicle (ATV) use was to be confined to designated tracks between the drill site, the Pálsbaer II hut and the closest passable point on the hiking path to the pumps on the northern peninsula. The three permissible parking areas should be covered with a four layers of reinforced plastic sheeting.

To fully implement these guidelines during the drilling operation, the following mitigation efforts were undertaken. To minimize any possible introduction of plant or animal life, all zippers were inspected for seeds and all shoes were scrubbed with a brush before entering helicopter or boat transport, so that no organisms would be inadvertently brought to the island. All food preparation and consumption took place in designated areas of the Pálsbaer II hut so that no food scraps or trash (tomato, cucumber or melon seeds, for example) would be dispersed on the Surtsey substrate. All wastewater from washing was flushed to the sea through the pipe that discharged seawater from drilling, after removal of sediment, into the ocean. Two portable toilets were installed, one at the drill site and the other at the Pálsbaer II hut, to capture human waste. However, to reduce transport,

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urine was collected and disposed into the sea. The waste was collected in a small plastic liner, placed in a designated receptacle, compacted, and then transported by helicopter to Vestmannaeyjar and delivered to the waste treatment facility on Heimaey on a weekly basis. All trash was collected in robust plastic garbage bags, packed in receptacles, and transported off island by helicopter. No waste of any kind was left on the island or within the boundaries of the Surtsey Nature Reserve.

The principal potential source of pollution to the Surtsey environment was considered to be an accidental fuel spill. About 75 barrels of diesel fuel were transported to Surtsey via the Coast Guard helicopter mobilization. About ¾ of these were sling-dropped at the drill site onto a secure plastic base and then surrounded by berms of volcanic ash. About ¼ of the barrels were sling-dropped at a depot at the site of the temporary sheds for operating the generator at the Pálsbaer II hut, or at a depot on the shoreline of the northern peninsula for operating the seawater pumps (Figure 8). The barrels were bound together with straps; placed on a triple layer of 6 ml, reinforced Visquene plastic sheeting, which was covered with a layer of volcanic tephra; and surrounded with thick berms of tephra. Although a heavy-duty absorbent diesel fuel spill kit was kept on reserve at the drill site to manage any spill or leakage, this was not needed during the operation. The volcanic tephra were flown off island with the emptied fuel containers.

All drilling material reserves were stored in the container shed near the Pálsbaer II hut or in plastic totes with tightly fastened lids at the drill site. The attapulgite drilling product was wrapped in plastic and tightly fastened on wooden pallets near the drill rig. Attapulgite has a non-swelling, needle-like morphology and high mechanical and thermal stability. It is easily recognized in the drill core specimens and does not interfere with the material properties of the Surtsey deposits. After completion, each borehole was circulated with fresh seawater to flush out drilling fluid. Fluid and rock cuttings were then run into a settling tank. The clear fluid was discharged from the outlet pipe on the eastern shoreline. The residual rock cuttings and mud product in the settling tank were transported off island by helicopter.

All personnel were given a briefing and written information on their duties and how to follow the regulations for protection of Surtsey environment (Appendix E). A representative of the Environment Agency was present on Surtsey July 26-30, August 13, and September 6-10. An inspection by the Environment Agency representative took place on August 13. Comments outlining minor improvements were issued August 14. These involved storage of wastewater, storage of solid waste, leakage from the wastewater line to the ocean and other adjustments. The recommendations were implemented in the following days.

All travel and personnel changes were sent to the Environment Agency, with notification usually a day or so in advance. Lists of people arriving and people leaving were sent to the Environment Agency where they were approved with an official letter.

Table 2. *Operational time line.*

Time	Type of activity	Place
07.06-08.06.2017	Kick-off meeting	Reykjavík
23.07-30.07.2017	Pre-operational preparation	Reykjavík/Mosfellsbaer
23.07-30.07.2017	Advance team preparations on Surtsey	Surtsey
28.07-30.07.2017	All equipment lifted by helicopter to Surtsey	Surtsey
07.08.2017	Drilling on Surtsey begins	Surtsey

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Time	Type of activity	Place
08.08.2017	Core processing on Heimaey starts operation	Heimaey
04.09.2017	Drilling on Surtsey completed	Surtsey
10.09-12.09.2017	All equipment lifted by helicopter from Surtsey	Surtsey
12.09.2017	Removal of all material from Surtsey completed	Surtsey
18.09.2017	Cleaning, sorting and packing of equipment completed	Reykjavík/Mosfellsbaer
26.09.2017	Core processing on Heimaey terminated	Heimaey
29.09.2017	Core processing facility cleaned and shut down	Heimaey
30.10-19.12.2017	Core processing at IINH	Gardabaer/Reykjavík
01.05-04.05.2018	Post-operational workshop	Gardabaer/Reykjavík

5.3 Camp at Surtsey

The camp at Surtsey (Figure 8, Table 2) was mainly set up during July 28-30. It provided sleeping quarters for up to 16 people in two Weather Haven insulated tents designed for challenging weather conditions. The tents were erected on wooden platforms constructed in Reykjavík and securely fastened to the ground with either anchors or bolts into the underlying lava outcrops. The Pálsbaer II hut was designated as accessible 24 hours a day and generally not used as sleeping area, although it has berths for seven people. Lights and a four-plate gas cooker were installed in the hut, and connected to a 220 V generator. With these additions and the exclusive use of the Weather Haven tents for sleeping, full access to social, eating and working conditions for drillers, scientists and support personnel were ensured.

Toilet and shower facilities conformed to the specifications set forth in the Environment Agency permit. Two portable toilets, one at the camp site, the other at the drill site, were anchored to the Surtsey substrate. All human waste was collected in plastic bags, and then placed in sealed 60-liter barrels that were flown off the island to Heimaey for disposal. A shower was installed in a 2 by 2 meter aluminum container, and all shower water was collected, settled, and run through a discharge line to the east coast of the island. A separate 2 by 3 meter container held two refrigerators, a freezer and pantry for food storage (Figure 8, Figure 10, Figure 11).

5.4 Steering of the drilling operation

The foundations of the SUSTAIN project were established at an ICDP-sponsored workshop in Vestmannaeyjar in October 2014 (Jackson et al., 2015) and the objectives and design of the project were outlined in the SUSTAIN project application to ICDP, led by Marie D. Jackson (MDJ) in January 2015. Extensive preparatory work for the operational aspects took place in 2015-2017, both in Utah and Iceland. MDJ led the work in Utah in collaboration with DOSECC, including project planning with Beau Marshall (BM), the DOSECC drilling supervisor, who oversaw equipment organization, packing specifications for helicopter transport, and design of borehole components. Magnús Tumi Gudmundsson (MTG) led the work in Iceland, including logistical planning, contacts and negotiations with helicopter and boat operators, the Icelandic Coast Guard, Vestmannaeyjar municipality, contacts regarding the various permits required including the Environmental Agency and other local aspects of the operation. The Environment Agency application was based on the preparatory work in Utah and Iceland. It was written by MDJ in collaboration with MTG. A large part of the logistical work in Iceland in 2017 was carried out by Ágúst Thór Gunnlaugsson, the operational facilitator.

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Table 3. *Scientists in charge on Surtsey.*

Phase	Time	Scientist in charge	Affiliation
Pre-operational sourcing	2016 & 2017	Ágúst Thór Gunnlaugsson	IES-UI
Mobilization	23.07-30.07.2017	Magnús Tumi Gudmundsson	IES-UI
Drilling SE-02a	30.07-18.08.2017	Marie D. Jackson	University of Utah
Drilling SE-02b	18.08-28.08.2017	Tobias Björn Weisenberger	ÍSOR
Drilling SE-03	28.08-05.09.2017	Magnús Tumi Gudmundsson	IES-UI
Fluid sampling	05.09-06.09.2017	Tobias Björn Weisenberger	ÍSOR
Demobilization	06.09-12.09.2017	Ágúst Thór Gunnlaugsson	IES-UI

Figure 10. *Photographs of mobilization logistics and transport: a) Rescue boat, Thór, with advance party, equipment and materials for preparations on July 23; b) Coast Guard helicopter, TF-LÍf, carrying loads from Icelandic Coast Guard vessel, VS-Thór, on July 28; c) Fuel barrels wrapped in double plastic sheeting to prevent leakage during transport to Surtsey; d) Nordurflug Dauhpin helicopter TF-HDU on helipad (photo: MTG).*

Operational decisions at the site were taken by the scientist in charge (Table 3). Overall strategy and major decisions were managed by a drilling steering committee (MDJ, MTG, J. Michael Rhodes (JMR), Tobias Björn Weisenberger (TBW) and Viggó Thór Marteinsson). Surtsey is covered by internet and cell phone service and the meetings took place through phone conferences.

5.5 Personnel plan

The Surtsey on-site team, was comprised of the DOSECC drilling crew, consisting of the drilling supervisor, two drillers and two helpers, one or two camp managers, a cook, and up to six scientists, including geologists, geochemist and microbiologists who contributed to the primary visual core inspection, sampling, downhole logging and operational documentation. After coring began on August 10, work was conducted in 12 hours shifts (08:00-20:00/day shift and 20:00-08:00/night shift), with two drillers and two scientists/loggers on each. The camp manager and the cook worked

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mainly during the day shift. The original plan required only one camp manager on Surtsey. Due to problems encountered with the onshore water supply and storage systems an additional camp manager was present from August 15-18 and again from August 21 onwards. Personnel changes occurred every 3-8 days, with the scientists/loggers, camp managers and cooks usually staying 5-7 consecutive days (Appendix A). Figure 12 provides an overview of the personal record on Surtsey. In total 47 individuals came to Surtsey to work on the SUSTAIN operation. Written permits with details of names, dates of arrival and departure for each flight and/or boat trip were issued by the Environment Agency.

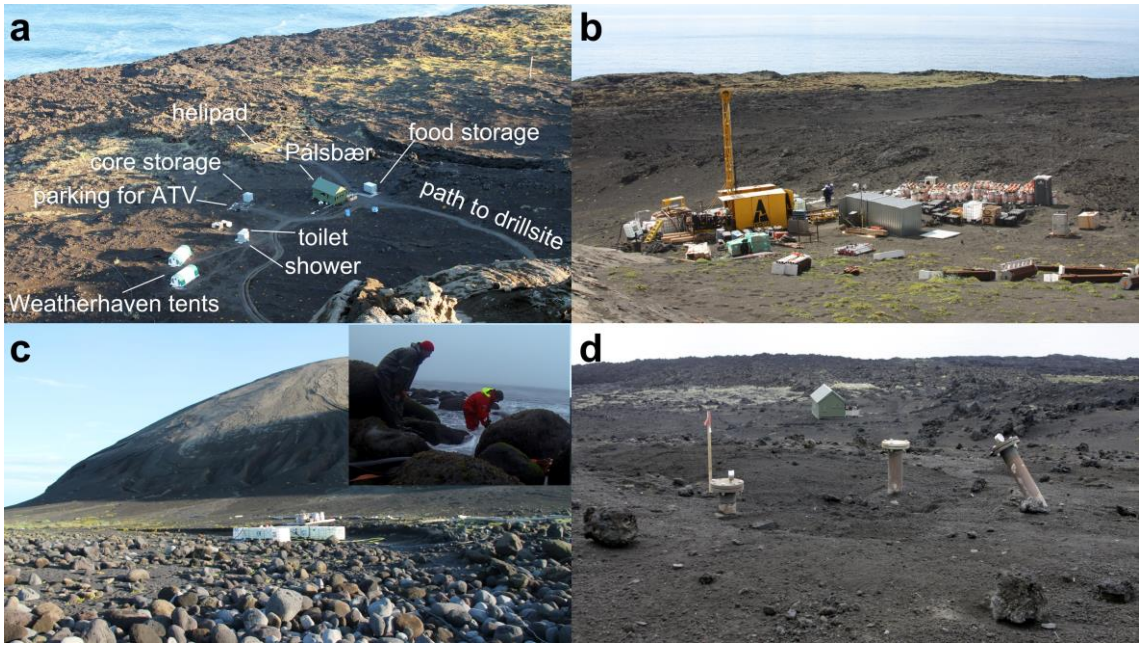

Figure 11. *Photographs of temporary installations on Surtsey: a) Layout of camp; b) Drill site; c) water reservoir and pump installation at northern peninsula; d) Wellheads of the three 2017 new drill holes SE-02b, SE-02a and SE-03, September 12, 2017 (photo: MTG).*

5.6 Local supply chain

Equipment and provisions were regularly sourced from Reykjavík and Heimaey via helicopter. This included generators, pumps and other necessities. Food for stocking the camp came either from Reykjavík or from Heimaey. A support team was at hand at IES-UI sourcing the materials and provisions needed, communicating with the Environment Agency, the Coast Guard, Nordurflug Helicopters, the rescue group in Vestmannaeyjar and any other entities supporting the operations. Helicopter trips were planned several days ahead, with the final timing usually decided a day or two in advance. All commercial helicopters operated out of Reykjavík and therefore called for at least 1.5 hours´ round trip flying time at a cost of about 1 million ISK (10,000 U.S. dollars).

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5.7 Camp operation

Before coming to the island, all participants received written guidelines and requirements for preserving the sensitive environments on Surtsey and for safety practices. They also received additional briefing upon arrival (Appendix E) and guidelines were displayed in the Pálsbaer II hut.

Camp managers ensured that all requirements of the Environment Agency permit were met regarding waste, water usage, and camp cleanliness. They also managed the generators that provided electricity for the camp, the drill site and the seawater pump at the northern peninsula.

Installation of the 16,000-liter seawater reservoir at the northern peninsula on August 13-15 required two individuals to manage the new seawater pumping system. This involved frequent inspection and changes in pump locations to ensure delivery of seawater to the drill site during low tide. As a consequence, after August 15 the camp manager and an additional helper were occupied predominantly in running the water supply operation. Tidal ranges played a major role in the operation of the pumps. This was considerably easier during neap-tide (August 30 –September 3) than during spring tide (August 24-28), when the pumps had to be moved further offshore due to the larger tidal range.

The meal schedule was designed around shift changes in the drilling crew. Cooks prepared breakfast before the start of the morning shift, at 08:00, with the day shift served first and the night shift after the shift change. An evening meal was served in the same way, before and after the shift change at 20:00. Food was stored inside a 2 by 3 meter aluminum container next to the Pálsbaer II hut, in a freezer and two refrigerators. The camp was provisioned by helicopter transport, so that it could remain self-sufficient for at least 8-10 days.

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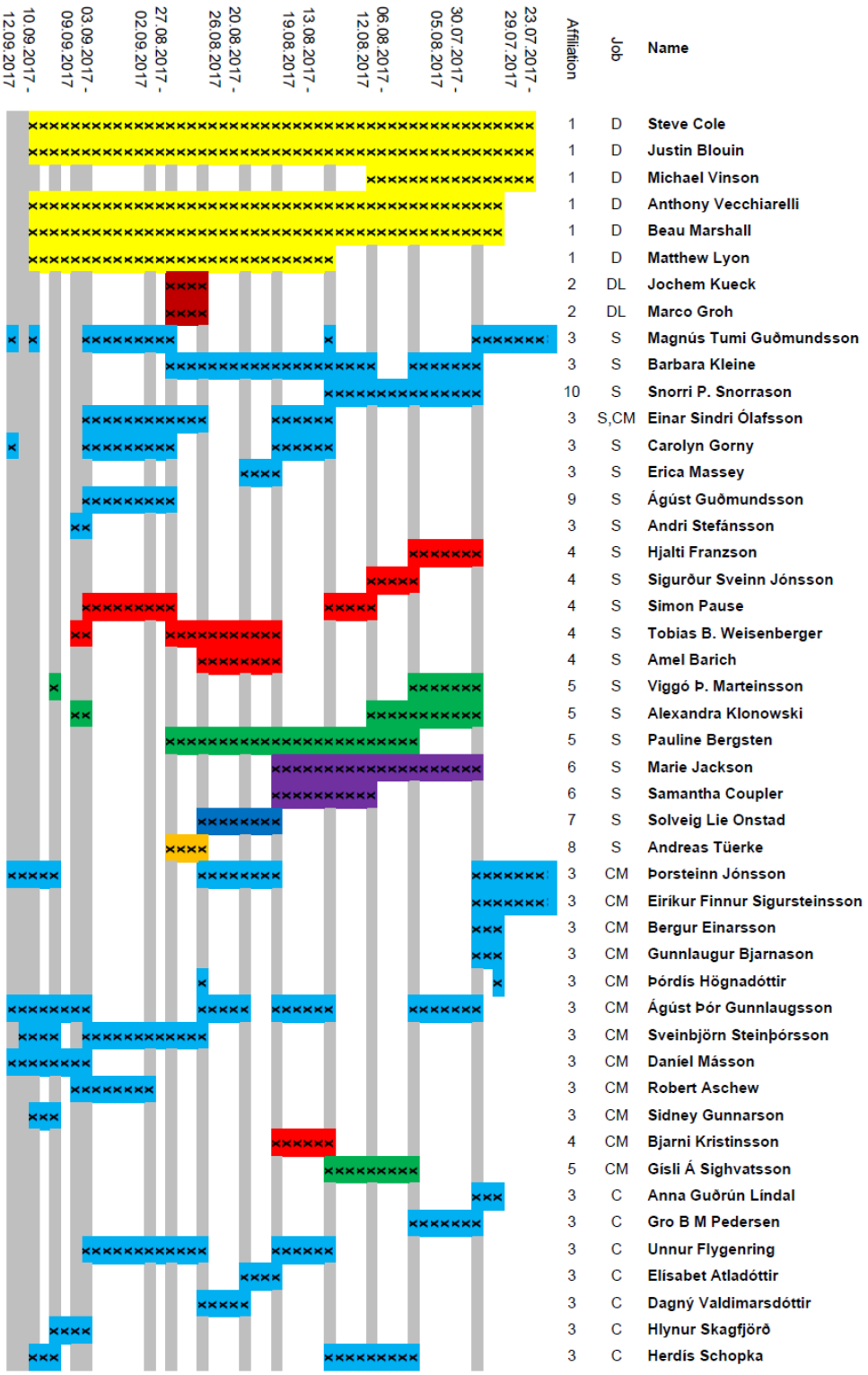

Figure 12. *Personnel schedule on Surtsey. Grey horizontal lines indicate days of helicopter and/or boat transport. Abbreviations of positions: C: cook; CM: camp manager, D: driller, DL: downhole logging; S: scientist. Abbreviations of affiliation: 1: DOSECC; 2: OSG-ICDP; 3: IES-UI, 4: ÍSOR, 5: Matís; 6: Utah, 7: Bergen; 8: Bremen; 9: Jarddtaeknistofan; 10: VERKÍS. The colors correspond to affiliations except that 9 and 10 are grouped together with IES-UI (blue).*

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5.8 Core transport

Core was transported in one-meter-long plastic, HQ core trays via helicopter from Surtsey to Heimaey. A full core tray contained four meters of core, and weighed about 25 kg, in the case of the HQ3 diameter core. The core trays were loaded one by one into the helicopter cabin and then strapped and secured together. The first delivery occurred on August 13. Subsequent deliveries took place on August 18, 25, and 28. On September 5 all core from borehole SE-03 was flown to Heimaey in three trips.

5.9 Incidents

A large generator brought to Surtsey with the drill rig during mobilization was non-functional and could not be repaired. The diesel generators that provided electricity for the Pálsbaer II hut failed and had to be replaced with petrol-driven generators. Some of these also failed, and new ones had to be rented. As a consequence of these generator problems, petrol was consumed more quickly than planned and a 200-liter barrel was carried on a sling by the helicopter from Heimaey to Surtsey on September 5.

On September 6, during removal of all equipment from the northern peninsula, a water tank fell into the ocean while being sling-transported towards the camp. The Vestmannaeyjar Rescue Group quickly sent out their boat and retrieved the tank near Geirfuglasker island.

A driller with an infection produced by volcanic glass packed into the outer ear departed Surtsey August 9, to return to the United States for medical treatment. His replacement arrived on Surtsey August 13.

5.10 Daily reports from Surtsey

The distribution of daily drilling reports from the Surtsey operations, written by the scientists-in-charge, was initiated during drilling of SE-02b (Appendix I). The daily reports were sent out to a wider group and summarized the drilling and operational activity on Surtsey, contained digitalized lists of conducted core runs, sections classification and on-site samples.

6 Drilling operation overview

6.1 Drill rig and drilling technique

Drilling was carried out by DOSECC Exploration Service (DES) of Salt Lake City, Utah, USA, using a helicopter-transportable Atlas Copco CS1000 drill rig (Figure 13). Predrilling for all three boreholes (SE-02a, SE-02b, SE-03) involved rotary drilling with a 6⅛" (15.56 cm) tricone rotary drill-bit (Figure 14). The pilot hole was drilled to install and cement in place a 4½" (11.43 cm) HWT conductor casing. Individual HWT casing pipes were 3.05 m in length. The conductor casing had an HWT casing shoe of 16 cm in length affixed.

After cementing the conductor casing, coring and drilling operations were performed using a standard wire-line coring technique. The cored rock was captured and collected in an inner tube assembly, and then retrieved and brought to the surface by an overshot device attached to a wireline

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cable. The maximum length of a core run was 3.05 m. The core was recovered by using plastic liners inside the inner tubes similar to practices that use aluminum splits. Boreholes SE-02a and SE-02b were cored solely with a HQ3 size drilling bit (96 mm hole diameter) (Table 4, Figure 14). Borehole SE-03 was cored initially with an HQ3 size bit, but then reduced at about 213 m to NQ3 (75.7 mm hole diameter) when the supply of HQ rods was fully consumed. Table 4 shows the specifications of the used core bits.

In boreholes SE-02b and SE-03, attapulgite drilling mud (Florigel High-Yield Salt Water Stable Drilling Clay) was occasionally employed to stabilize the borehole and improve lifting of rock fragments within the circulating seawater fluid. The use of this product was approved by the Environment Agency. Sixteen pallets, each holding twenty-five 50 lb bags of the attapulgite mud, were transported to Surtsey; ten pallets of unused product were flown off the island during the demobilization. About 7500 lbs (3,410 kg) of mud was therefore employed in boreholes SE-02b and SE-03. A discharge line attached to the mud diverter on top of the HW casing ran from the drill site to a plastic catchment basin near the camp. Cuttings settled out, and a line at the top of the basin discharged clear fluid to the ocean on the eastern shore of the island.

Drilling was conducted 24 hours per day, seven days a week through a two-shift system. Each shift consisted of one driller and one helper. In addition, the drilling supervisor was on site for the entire drilling operation.

Table 4. *Used coring bits used during the drilling activity in 2017 on Surtsey.*

Well	Bit Type
SE-02a	Atlas Copco Excore HQTT series 8-9, 3830 x 2.400, PN 3760918727
SE-02b	Atlas Copco Excore HQTT series 8-9, 3830 x 2.400, PN 3760918727
SE-03	Atlas Copco Excore HQTT series 10 3830 x 2.400, PN 3760918729
SE-03	Atlas Copco Excore HQ3 bit series 10 2.985x 1.775, PN 20420561

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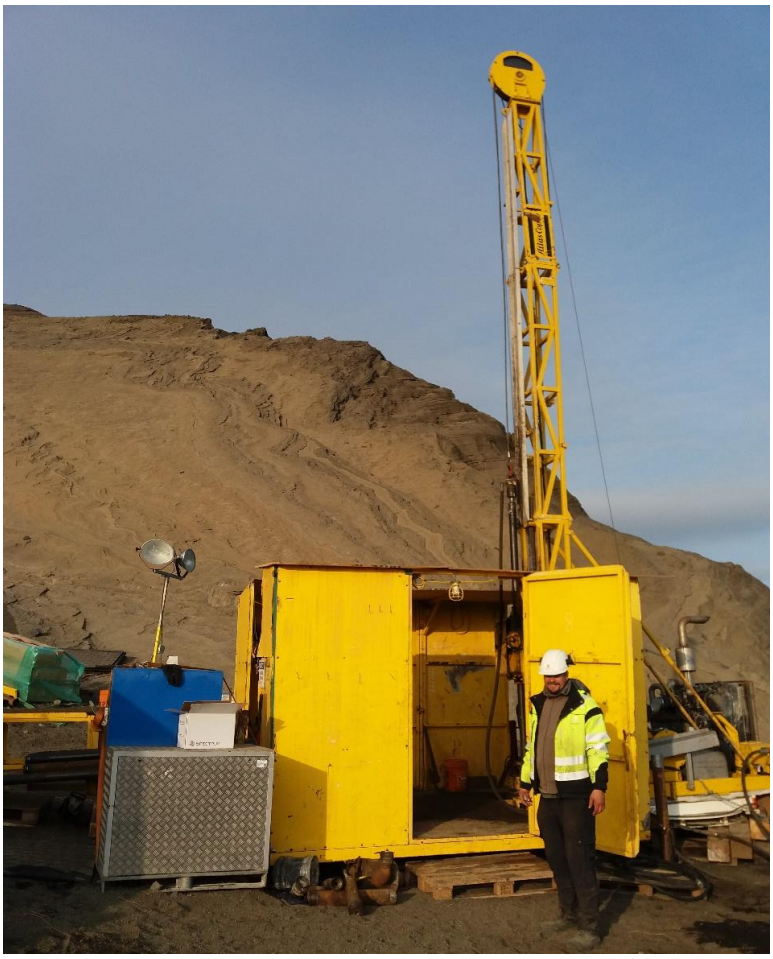

Figure 13. *Photograph of the CS1000 drill rig on Surtsey (photo source: Amel Barich (AB)).*

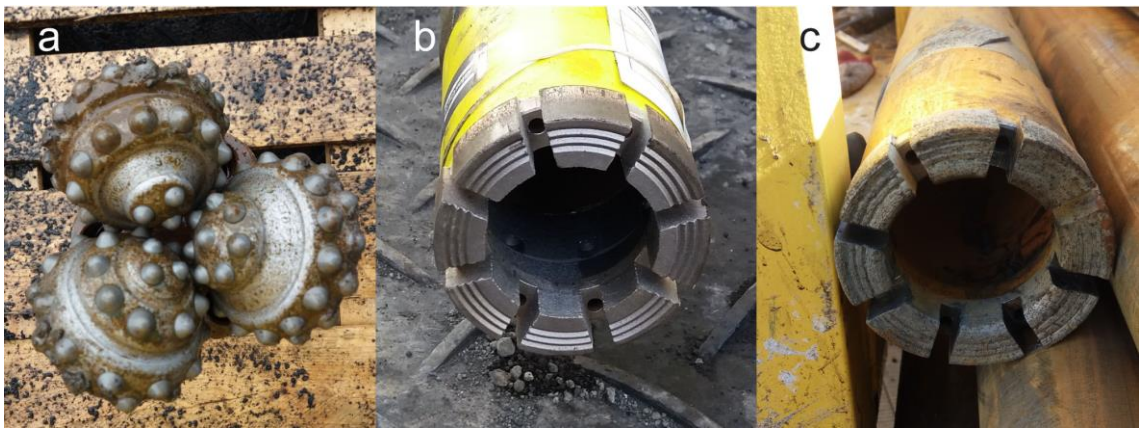

Figure 14. *Photographs of drill bits used during 2017 drilling on Surtsey. a) Tricone rotary drill bit 6⅛"(15.56 cm) used for the SE-03 conductor hole. b) A new core bit is shown for comparison. c) HQ3 core bit after 28 core runs, SE-02b, after the drill string was pulled out of hole August 23. (photos: TBW).*

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6.2 Water Supply line

The water line was designed to transport seawater drilling fluid from the western shore of the northern peninsula to the drill site (Figure 8). This is a location relatively sheltered from wave action, which is most intense on the eastern and southern coast of the island. The water system consisted of a submerged electric pump, a generator to run the pump, and a 1.4 km long water pipe to the drill site.

6.2.1 Water line pumping through August 14, 2017

A submersible pump was placed about 15 m offshore on August 1 via helicopter, at 2-3 m depth. It was surrounded by a steel frame welded at both ends to prevent impact with the seafloor by wave action and to reduce the risk of sea weed or seafloor sediments being sucked into the pump. The pipe that led from the submerged pump to onshore pumping station (Figure 8) was placed inside a 10 cm diameter HDPE hose that also shielded the 230 V electric cable for powering the pump. The system lost functionality on August 8 and 9, delaying drilling progress of borehole SE-02a. The submerged pump was lifted from the ocean with helicopter support, and a new pumping system placed in tide pools at the bouldered shoreline of the peninsula on August 10. The seawater storage system at the drill site could not, however, supply sufficient circulating fluid for continuous drilling during periods of low tide. It was decided to construct a seawater storage supply and pumping system on the northern peninsula that could be modified and operated onshore, and which would not depend on helicopter assistance for repairs.

6.2.2 Water line pumping August 15 to September 5, 2017

Portable water pumps for shallow wells (Pentair Drenox 350/12) were used to pump water from the ocean to a ~16,000-liter reservoir that was constructed on the peninsula, 150 m inland from the beach, from sixteen connected 1,000-liter, sturdy, plastic tote containers. The submersible pump was removed from the offshore cage, and placed in one of connected totes to lift the stored seawater 58 m to the drill site. Two individuals then managed the movement of the pumps within the bouldered shoreline, and maintained them below the sea level at low tide. After the onshore storage system was implemented, very few delays occurred due to seawater storages.

6.2.3 Water line from pumping site to drill site

The 1,400 m long water hose was composed of 200 m long segments of 50 mm diameter HDPE plastic hose. Wastewater circulated up the drill hole or as overflow from reservoirs at the drill site was flushed down a 75 mm diameter plastic hose into a 1,000 liter. Sturdy plastic fish tank located just east of the camp site. The tank acted as a sediment trap for drill cuttings and mud, which were flown off island by the Icelandic Coast Guard during the demobilization operation. A 450 m long, 75 mm diameter plastic hose flushed clear drilling fluid downslope to the eastern coast, where it drained from a 20 m cliff into the ocean.

6.3 Water filtering system

Seawater pumped from the northern peninsula was used as the circulating drilling fluid. At the drill site, the seawater was stored 1000-liter reservoir tanks (Figure 15), and then pumped to the drill head. The two vertical boreholes, SE-02a and SE-02b, were cored using filtered seawater passed

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through two UV light sterilization units. Borehole SE-02b used occasional attapulgite mud, Florigel High-Yield Salt Water Stable Drilling Clay. The inclined drill hole, SE-03, was cored with untreated seawater and occasional attapulgite mud.

Before entering the final storage reservoir, the seawater used in boreholes SE-02a and SE-02b was passed through a PENTEK Big Blue filtration unit, with a 30 µm cartridge filter that removed fine debris (Figure 15). The seawater was then passed through a UV light AQUA4ALT system from WEDECO (Aquaculture systems, Xylem Water Solutions Herford GmbH, Germany) with maximum flow rate of 1.58 L/s or 5.7 m^3/h, and stored in three 1000-liter reservoir tanks for subsequent use. During pumping to the drill head, the treated seawater was then passed through another UV light WEDECO AQUA4ALT system. Despite these measures to reduce live microbial contamination, the drilling fluids were not considered to be sterile, and water samples were collected throughout the drilling operation to track microbial contaminants introduced into the boreholes during the drilling process.

Figure 15. *Photograph showing seawater storage at the drill site. a) Barbara Kleine, managing the water sterilization system. b) Used water filter (photo: AB).*

6.4 Time line

Table 5 provides a chronological summary of the drilling activity on Surtsey in 2017. Figure 16 shows the drilling operation and entire drilling progress. On July 18, the DOSECC drilling crew arrived in Reykjavík. On July 19, unpacking of drilling equipment and preparation of equipment took place at the Landsvirkjun warehouse in Mosfellsbaer, to finalize and secure helicopter loads for transport to Surtsey.

An advance team arrived on July 23, transported by the Vestmannaeyjar rescue boat Thór, to prepare the drilling platform, camp, and other sites before the mobilization operation. Meanwhile, other team members continued equipment preparations in Reykjavík. On July 26 the drilling equipment was transported by truck from the warehouse to Thorlákshöfn harbor. About one-half of this was then loaded on the Icelandic Coast Guard vessel VS Thór. After sailing to Surtsey, the Icelandic Coast Guard Super Puma helicopter TF-LÍF lifted equipment from the VS Thór to Surtsey. The vessel returned to Thorlákshöfn harbor, was loaded a second time, and returned to Surtsey. The

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Icelandic Coast Guard TF-LÍF helicopter delivered 50 loads on July 28, 29 loads on July 29, and 28 loads on July 30.

Table 5. *Chronological overview of drilling activity.*

Date	Operation	Individuals on site	Scientist in charge
18.07.2017	**DOSECC drillers arrive in Reykjavík.**		
19.07.2017	Preparation of equipment for transport to Thorlákshöfn.		
20.07.2017	Preparation of equipment for transport to Thorlákshöfn.		
21.07.2017	Preparation of equipment for transport to Thorlákshöfn.		
22.07.2017	Preparation of equipment for transport to Thorlákshöfn.		
23.07.2017	**Advance party transported to Surtsey** by boat from Heimaey. Preparation of equipment for transport to Thorlákshöfn.	3	MTG
24.07.2017	Preparation of equipment for transport to Thorlákshöfn.	3	MTG
25.07.2017	Three DOSECC drillers transported to Surtsey with Nordurflug helicopter Dauphin, TF-HDU. Dauphin slings loads from the peninsula to drill site.	6	MTG
26.07.2017	Drilling equipment (60-65 tons) trucked to Thorlákshöfn harbor.	6	MTG
27.07.2017	Icelandic Coast Guard vessel VS Thór loaded in Thorlákshöfn harbor. Overnight transport to the east coast of Surtsey.	6	MTG
28.07.2017	Drilling equipment sling-lifted from VS Thór to Surtsey by Icelandic Coast Guard Super Puma helicopter (TF-LÍF).	12	MTG
29.07.2017	TF-LÍF lifting from VS Thór to Surtsey continues. Camp is set up on Surtsey.	11	MTG
30.07.2017	TF-LÍF lifting from VS Thór to Surtsey completed. Camp set up continues on Surtsey. Nordurflug helicopter, Astar, TF-HDA, precision lifting to assemble the components of CS1000 drill rig. Rigging-up operations begin.	13	MTG
31.07.2017	Rigging up and waterline assembly continue. Temperature measurements in SE-01.	13	MDJ
01.08.2017	Astar, TF-HDA helicopter places submersible water pump system in ocean on west coast of north peninsula.	13	MDJ
02.08.2017	Rescue boat, Thór, transports driller with ear infection to Heimaey for medical treatment.	13	MDJ
03.08.2017	Rigging up and waterline assembly continue.	13	MDJ
04.08.2017	Rescue boat, Thór, transports driller to Surtsey after initial medical treatment.	13	MDJ
05.08.2017	Dauphin, TF-HDU flight, transport of food and personnel.	12	MDJ
06.08.2017	Rigging up and waterline assembly continue.	12	MDJ
07.08.2017	Rigging up and waterline assembly continue. **Spud of borehole SE-02 (later renamed to SE-02a). PQ conductor casing to 9.54 m b.s.**	12	MDJ
08.08.2017	Work on drill rig continuous. Temperature measurements in SE-01.	12	MDJ
09.08.2017	Thyrlu Thjónustan helicopter, Bell 407, TF-HHH, lifts submersible water pump from ocean and replaces it, after repairs. Transport of personnel.	12	MDJ
10.08.2017	Coring begins with HQ3, using filtered, ultraviolet-treated seawater. SE-02a at 31 m measured depth at 20:00.	12	MDJ
11.08.2017	Coring continues, with intermittent disruptions due to waterline issues.	12	MDJ
12.08.2017	SE-02a at 63 m measured depth at 03:00. Submersible water pump failure. Backup pump installed in shoreline tide pool; pumping not possible at low tide.	12	MDJ

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Date	Operation	Individuals on site	Scientist in charge
13.08.2017	SE-02a at 93 m measured depth at 20:00. TF-HDU flight, transport of personnel and food. First core transport to Heimaey. Inspection by Environment Agency. Continuing problems with seawater supply to the drill site. Rescue group boat Thór brings 16 water tanks (1100 liters each) for onshore water reservoir on northern peninsula.	15	MDJ
14.08.2017	Team on Surtsey carries water tanks from shore onto designated site on north peninsula. Little drilling progress due to lack of water at drill site. SE-02a at 108 m measured depth.	14	MDJ
15.08.2017	Seawater storage system, submersible water pump, and waterline are assembled and activated. Two individuals are designated to manage seawater pumping, waterline, filtering and sterilization. SE-02a at 141 m measured depth at 23:00.	14	MDJ
16.08.2017	SE-02a at 151 m measured depth in morning, when drill becomes lodged and stuck.	14	MDJ
17.08.2017	**SE-02a eventually collapses** high in the borehole, removal of rods is not successful. Insertion of aluminum tubing will not be possible.	14	MDJ
18.08.2017	Dauphin, TF-HDU flight, transport of personnel and food. Core transported to Heimaey.	13	MDJ
19.08.2017	**Spud of borehole, SE-02b,** 1.6 m from abandoned SE-02a hole. PQ conductor casing to 14.40 m measured depth. Cored with HQ3. Rescue boat, Thór, brings sand grout from Heimaey. A cable with one pressure-temperature sensor and three temperatures sensors is placed in SE-01.	13	TBW
20.08.2017	SE-02b coring starts in the evening, first HQ3 core surfaces before 22:00. Drilling is carried out with filtered, ultraviolet-treated seawater.	13	TBW
21.08.2017	Documentary film crew from Talesmith Ltd., Smithsonian “Life on Earth from Space” arrives by inflatable boat from Heimaey for one day visit. SUSTAIN personnel transport.	13	TBW
22.08.2017	SE-02b at 42 m measured depth at 20:00.	13	TBW
23.08.2017	SE-02b at 80 m measured depth .Problems with conductor casing stabilization are resolved over the day. Drilling recommences in the evening.	13	TBW
24.08.2017	SE-02b at 139 m measured depth.	13	TBW
25.08.2017	SE-02b at 182 m measured depth at 22:00. Dauphin, TF-HDU flight, transport of personnel, food and core. ICDP downhole logging team arrives on Surtsey.	14	TBW
26.08.2017	**SE-02b at total depth, 192 m measured depth.** Drilling terminates at 01:00 with complete loss of core recovery at depth close to presumed pre-eruption sea floor. **Downhole logging** of SE-02b carried out down to 180 m measured depth.	13	TBW
27.08.2017	**Anodized aluminum casing installed in SE-02b** during the night shift.	13	TBW
28.08.2017	**Spud of borehole, SE-03**, inclined 35° from vertical. PQ conductor casing to 11.91 m measured depth. Dauphin, TF-HDU flight, transport of personnel, food and core.	12	TBW
29.08.2017	SE-03 coring starts using HQ3, untreated seawater. Borehole at 26.4 m at midnight.	12	MTG
30.08.2017	SE-03 at 90.4 m measured depth (74 m vertical) at midnight. Rescue boat, Thór, brings one additional scientist to Surtsey.	13	MTG
31.08.2017	SE-03 at 166.6 m measured depth (136.6 m vertical) at midnight.	13	MTG
01.09.2017	SE-03 at 213.9 m measured depth (174 m vertical) at midnight. All HQ3 rods are in use, and drilling continues with NQ.	13	MTG
02.09.2017	SE-03 at 242.7 m measured depth (199 m vertical) at midnight.	13	MTG
03.09.2017	SE-03 at 328.2 m measured depth (269 m vertical) at midnight. Hole reaches basaltic intrusion(s) in the central Surtur I conduit.	13	MTG

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Date	Operation	Individuals on site	Scientist in charge
04.09.2017	**SE-03 at total depth, 354** m measured depth (290 m vertical) at 10:30. Last core retrieved is lapilli tuff after several m of basalt intrusion(s). NQ rods are left as casing. HQ3 rods are stuck, cannot be retrieved and therefore left in place. Helicopter transport planned for afternoon abandoned due to high winds.	13	MTG
05.09.2017	Dauphin, TF-HDU flight. Transport of personnel, food and core. Temperature measurements and water sampling in drill holes.	11	MTG
06.09.2017	**Incubation experiments installed in the SE-02b subsurface observatory.** Astar, TF-HDA flight. Drill rig disassembled, sling-transport of waterline materials from north peninsula to drill site, transport of personnel. Rescue boat, Thór, retrieves water tank that fell into ocean and drifted away from Surtsey.	8	TBW
07.09.2017	Equipment packed for helicopter sling transports from Surtsey. Restoration and cleanup on Surtsey.	8	ÁTHG
08.09.2017	Dauphin, TF-HDU flight. Transport of personnel, food and samples. Equipment packed for sling transports, restoration and cleanup continues.	12	ÁTHG
09.09.2017	Camp disassembly and packing. Restoration of island, removal of all tracks and materials continues.	11	ÁTHG
10.09.2017	Icelandic Coast Guard TF-LÍF arrives, sling-transports from Surtsey to the Icelandic Coast Guard vessel, VS Thór. Temperature logging of SE-03 and SE-02a. Sling operation from drill site is not possible due to high winds. DOSECC drillers leave Surtsey and arrive in Reykjavík.	6	ÁTHG
11.09.2017	TF-LÍF commences sling-transport to ICG vessel, VS Thór in late afternoon after wind speeds have dropped.	5	ÁTHG
12.09.2017	TF-LÍF, completes about one hour of sling-transport from Surtsey to the VS Thór. Pálsbaer II hut cleaned. VS Thór arrives in Reykjavík in the evening and is unloaded. **Removal of all material and personnel from Surtsey is complete.**	6	ÁTHG
13.09.2017	Washing, packing of drilling equipment for transfer to USA, Reykjavík.		
14.09.2017	Washing, packing of drilling equipment for transfer to USA, Reykjavík.		
15.09.2017	Packing of drilling equipment to transfer to USA. SUSTAIN dinner held at University of Iceland.		
16.09.2017	Packing of drilling equipment for transfer to USA.		
17.09.2017	Packing of drilling equipment for transfer to USA.		
18.09.2017	Packing of drilling equipment for transfer to USA.		
19.09.2017	DOSECC drillers leave Iceland		

* Abbreviations for scientist in charge: ÁTHG: Ágúst Thór Gunnlaugsson, MDJ: Marie Jackson, MTG: Magnús Tumi Gudmundsson; TBW: Tobias Björn Weisenberger

Installation of the camp and rigging up activities continued for several days. On August 7, the drillers spud in borehole SE-02 (later named SE-02a) and drilling was officially underway. Major problems soon developed with the water pumping system, however, which required additional helicopter operations to remove and repair the submersible pump and reset it into the ocean. On August 13, the Rescue boat Thór brought additional equipment to Surtsey from Heimaey to repair and improve the water supply system. In the morning of August 16, the drilling string became stuck at about 151 m b.s., due to hole collapse. Attempts to free the rods were partially successful. On August 17, no further progress was achieved in freeing the stuck rods, and it was decided to terminate borehole SE-02a, without the planned installation of the Surtsey Subsurface Observatory.

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The pilot hole for a second vertical hole, SE-02b, began on August 19. There were initial problems with seawater supply, but this was resolved with the addition of a second camp manager so that the seawater pumping system was maintained over both 12-hour shifts. Coring reached a total depth of about 192 m on August 26. Borehole logging operations were carried out by the ICDP Operational Support Group on August 27. This was followed by installation of the anodized aluminum tubing for the Surtsey Subsurface Observatory on August 27.

The pilot hole for the inclined SE-03 borehole was drilled on August 28, and core drilling operations began on August 29. These operations proceeded efficiently, since cementing of the conductor casing and water supply problems had been effectively resolved. On September 4, the angled hole reached total measured depth at about 354 m, and rigging down activities began.

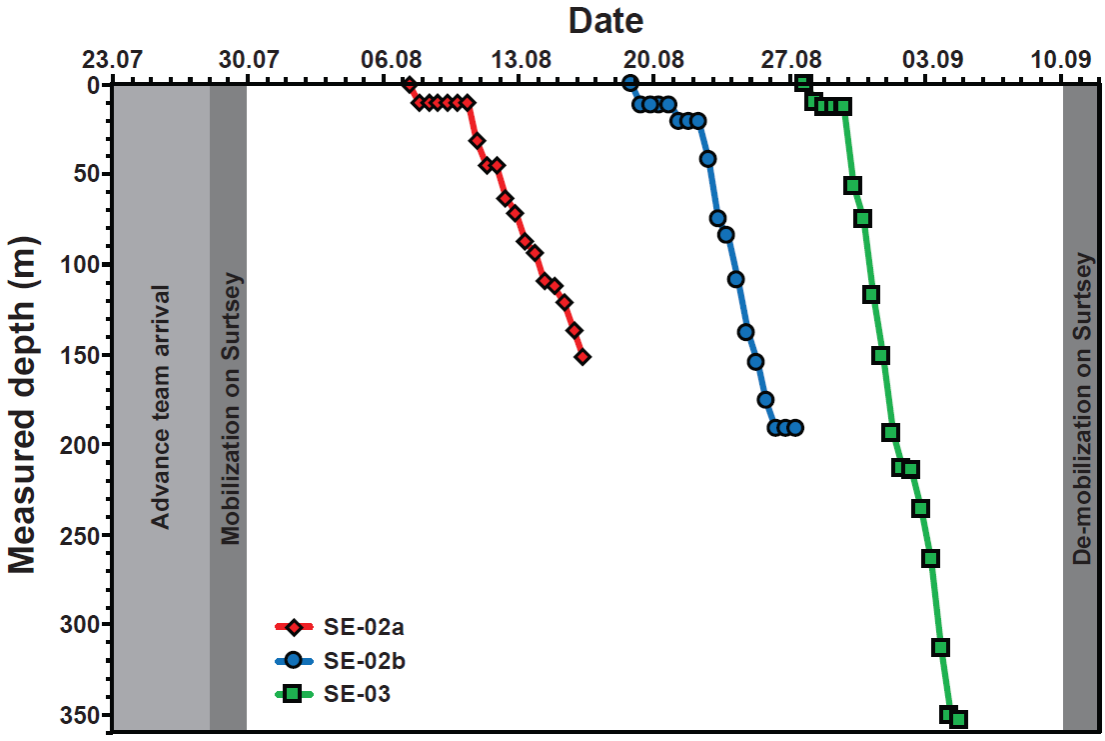

Figure 16. *Timeline for activities on Surtsey in 2017 and drilling progress of the three boreholes.*

On September 5, a SUSTAIN team of geochemist and microbiologists arrived on Surtsey to collect fluid samples in the boreholes. This was completed on September 6 and, that day, the incubation chambers hung on Vectran rope were placed in the Surtsey Subsurface Observatory in borehole SE-02b. The science team departed on September 6. Rigging down and clean-up of all traces of the drilling continued to September 9. Lifting and removal of equipment from Surtsey by the Icelandic Coast Guard Super Puma helicopter, TF-LÍF, to the Icelandic Coast Guard vessel, VS Thór, began on September 10. By September 12, all equipment had been removed from Surtsey. The island was left in pristine condition, and verified on site by the Environment Agency representative.

The Icelandic Coast Guard vessel VS Thór arrived in Reykjavík harbor the evening of September 12. All equipment was unloaded and transported to the Landsvirkjun warehouse in Mosfellsbaer, and subsequently sorted, cleaned, packed for container shipment to the United States. The

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demobilization efforts were completed September 18. On September 19, the DOSECC drilling crew departed Iceland.

6.5 Drilling progress

Drilling progress for the 2017 boreholes are given in Table 6, Table 7, Table 8. Although the rate of penetration (ROP, in m/hour) that appears constant at about 3 m/hour, the true progress varied substantially, however, mainly due to problems with the supply of seawater drilling fluid. The relative daily drilling progress for the three 2017 boreholes (Figure 16, Figure 17) is compared with daily progress of the 1979 borehole (Figure 18) (Jakobsson and Moore, 1982).

Table 6. *Drilling progress for the 2017 borehole, SE-02a.*

Date and time of shift change	Drilling time (hours)	Drilled section (m)	ROP (m/hour)	Total depth at shift change
07.08.2017 08:00				0
07.08.2017 20:00	2.25	10	4.4	10
08.08.2017 08:00				10
08.08.2017 20:00				10
09.08.2017 08:00				10
09.08.2017 20:00				10
10.08.2017 08:00				10
10.08.2017 20:00	7.50	21.91	2.9	31.1
11.08.2017 08:00	6.00	13.72	2.3	44.82
11.08.2017 20:00				44.82
12.08.2017 08:00	4.00	18.3	4.6	63.12
12.08.2017 20:00	5.00	8.5	1.7	71.62
13.08.2017 08:00	6.50	15.9	2.4	87.52
13.08.2017 20:00	3.00	6.1	2.0	93.62
14.08.2017 08:00	2.50	15.25	6.1	108.87
14.08.2017 20:00	1.00	3.1	3.1	111.97
15.08.2017 08:00	3.50	9.1	2.6	121.07
15.08.2017 20:00	6.00	15.25	2.5	136.32
16.08.2017 08:00	5.50	15.2	2.8	151.52

Table 7. *Drilling progress for the 2017 borehole, SE-02b.*

Date and time of shift change	Drilling time (hours)	Drilled section (m)	ROP (m/hour)	Total depth at shift change (m)
18.08.2017 20:00				0
19.08.2017 08:00	4.00	12	3.0	12
19.08.2017 20:00				12
20.08.2017 08:00				12
20.08.2017 20:00				12
21.08.2017 08:00	4.00	8.84	2.2	20.84
21.08.2017 20:00				20.84
22.08.2017 08:00				20.84
22.08.2017 20:00	8.50	21.35	2.5	42.19
23.08.2017 08:00	12.00	33.55	2.8	75.74
23.08.2017 20:00	3.00	9.15	3.1	84.89

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Date and time of shift change	Drilling time (hours)	Drilled section (m)	ROP (m/hour)	Total depth at shift change (m)
24.08.2017 08:00	7.00	24.4	3.5	109.29
24.08.2017 20:00	11.00	28.8	2.6	138.09
25.08.2017 08:00	5.50	16.95	3.1	155.04
25.08.2017 20:00	10.50	21.35	2.0	176.39
26.08.2017 08:00	3.50	15.25	4.4	191.64
26.08.2017 20:00				191.64
27.08.2017 08:00				191.64

Table 8. *Drilling progress for the 2017 borehole, SE-03.*

Date and time of shift change	Drilling time (hours)	Drilled section (m)	ROP (m/hour)	Total depth at shift change (m)
27.08.2017 20:00				0
28.08.2017 08:00	3.50	10	2.9	10
28.08.2017 20:00	2.00	2.6	1.3	12.6
29.08.2017 08:00				12.6
29.08.2017 20:00				12.6
30.08.2017 08:00	12.00	44.34	3.7	56.94
30.08.2017 20:00	8.00	18.2	2.3	75.14
31.08.2017 08:00	12.00	42.7	3.6	117.84
31.08.2017 20:00	12.00	33.55	2.8	151.39
01.09.2017 08:00	12.00	42.8	3.6	194.19
01.09.2017 20:00	5.50	19.7	3.6	213.89
02.09.2017 08:00	1.00	0.21	0.2	214.1
02.09.2017 20:00	12.00	22.15	1.8	236.25
03.09.2017 08:00	12.00	27.86	2.3	264.11
03.09.2017 20:00	12.00	48.8	4.1	312.91
04.09.2017 08:00	12.00	37.59	3.1	350.5
04.09.2017 20:00	2.50	3.55	1.4	354.05

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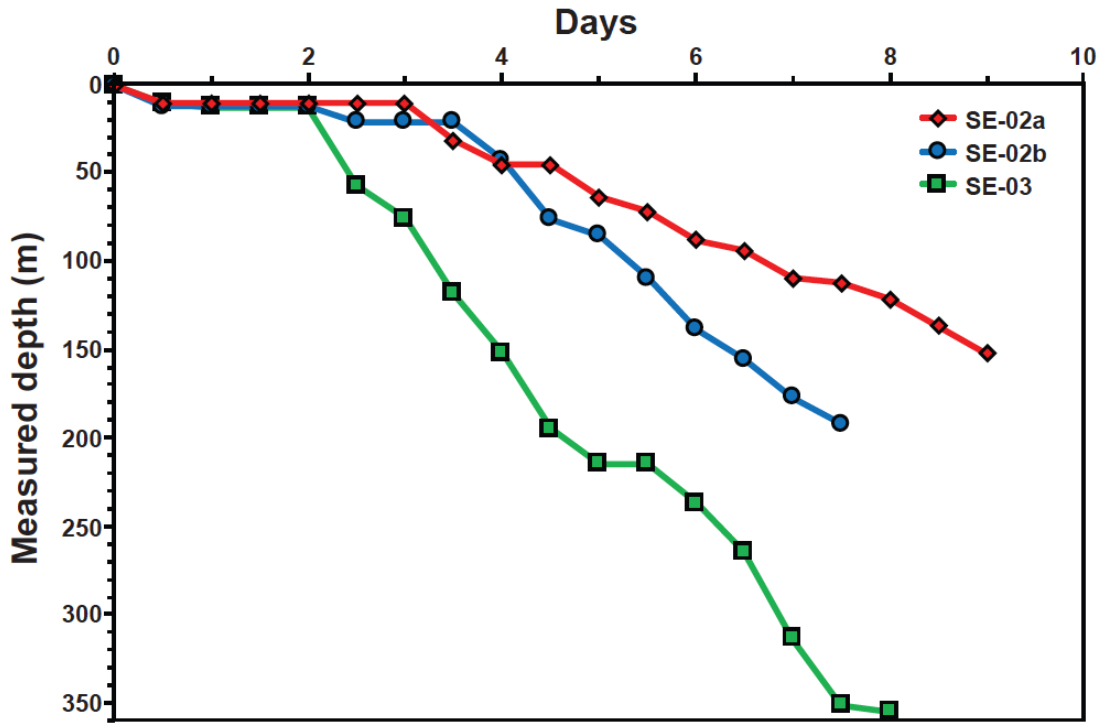

Figure 17. *Graph comparing relative drilling progress for the 2017 boreholes.*

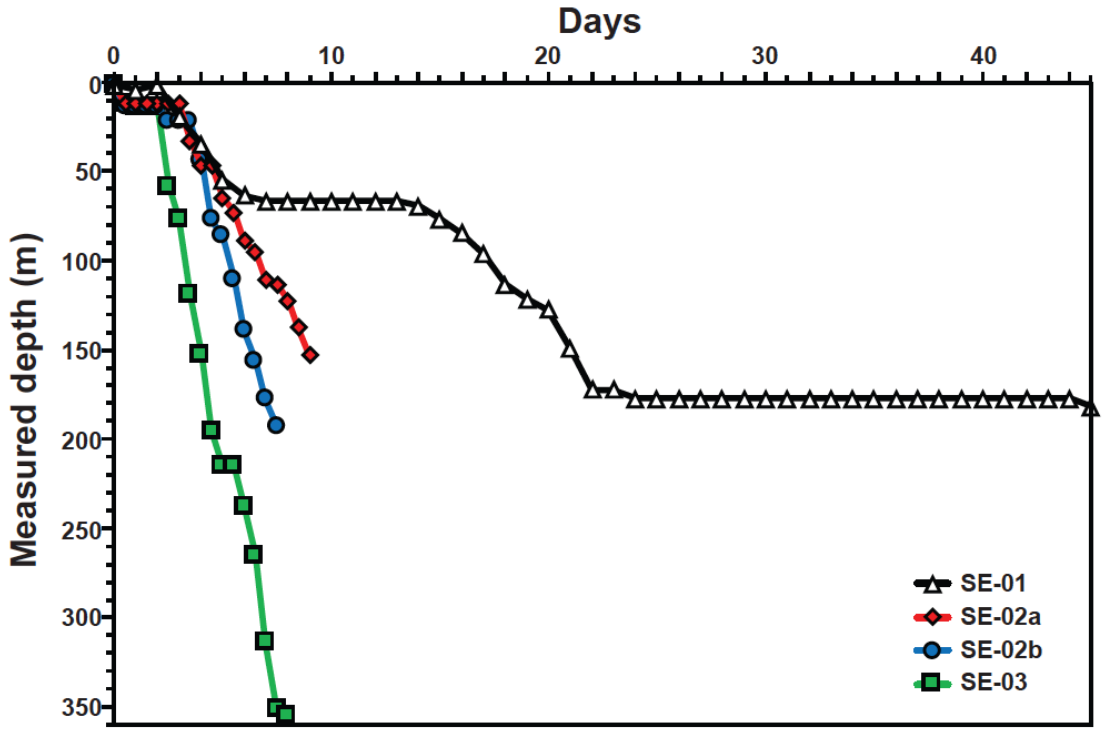

Figure 18. *Graph comparing relative drilling progress for the 2017 boreholes and with the 1979 borehole (after Jakobsson and Moore, 1982).*

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7 Borehole information

7.1 Borehole locations

Boreholes drilled in 2017 (SE-02a, SE-02b, SE-03) are drilled close to the cored borehole drilled in 1979 (SE-01) (Figure 19, Table 1). The wellhead of the vertical SE-02a borehole lies 7.08 m WSW of SE-01 and the wellhead of the vertical SE-02b borehole lies 6.86 m WNW of SE-01. The wellhead of the inclined SE-03 cored borehole lies about 10 m WSW from SE-01. The azimuth is directed to the west (264°), and the horizontal displacement at the bottom of the well is about 203 m from the wellhead. The heights of the wellhead flanges were measured on September 11, 2017. Wellhead heights relative to sea level are given in Table 1.

Figure 20 shows the wellhead and drilling platform after completion of the drilling activity for reference and scale. The ground surface is loose unconsolidated tephra, and it is expected to change with time.

7.2 Borehole design

Drilled depths, casing lengths, and borehole design are shown in Figure 20 and Table 9. The reference level during drilling was the local ground surface. However, due to the unconsolidated nature of the surficial tephra, the reference level differs among the individual boreholes. The three 2017 boreholes have been equipped with a wellhead flange and cap (Figure 20, Figure 21). A short description of each cored borehole is given to illustrate the drilling history and well design.

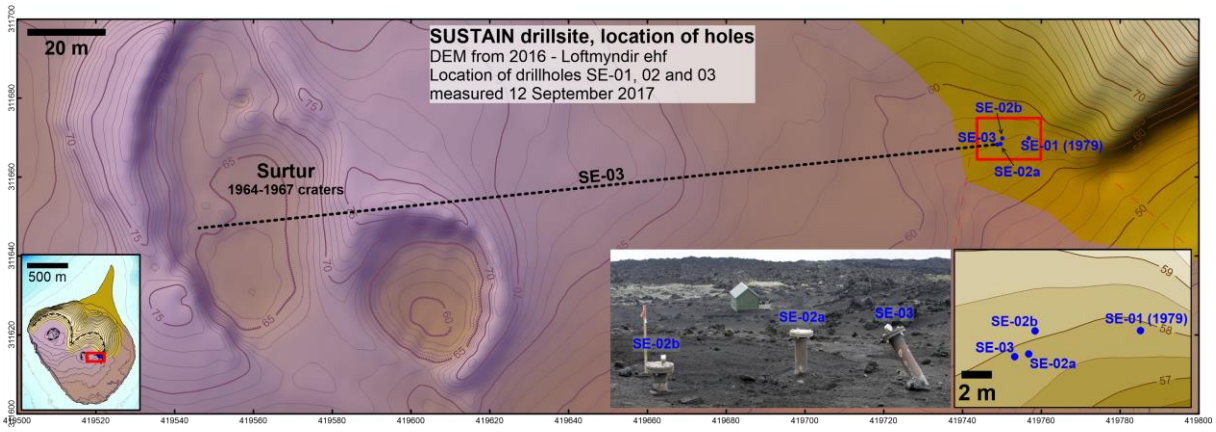

Figure 19. *Topographic map showing 1979 and 2017 boreholes on Surtsey and the horizontal projection of the 2017 inclined borehole.*

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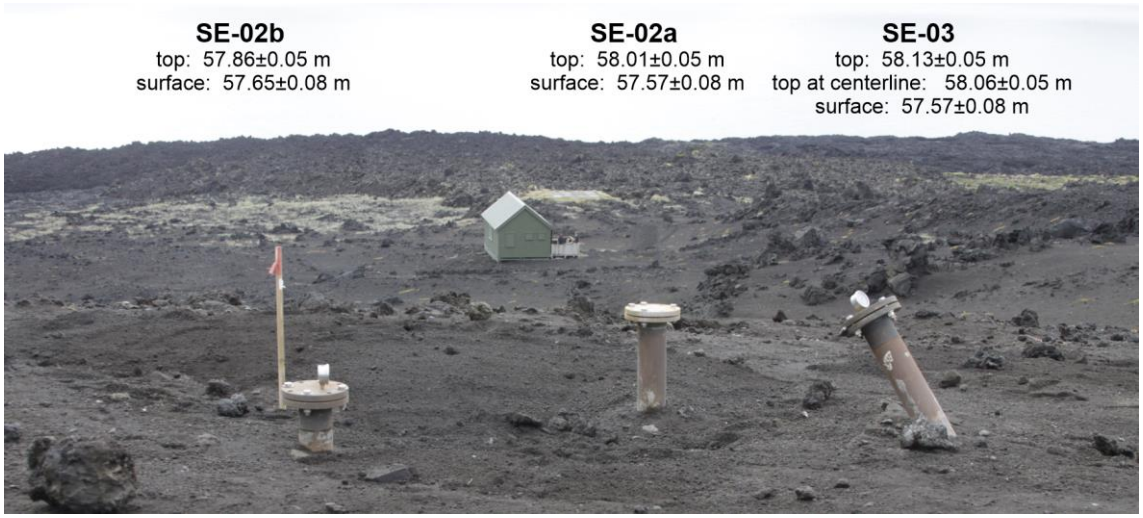

Figure 20. *Photograph showing the wellheads of the three 2017 boreholes and their measured heights above the local ground surface on September 11, 2017 (photo: MTG).*

7.2.1 Borehole SE-02a

The SE-02a cored borehole was vertically pre-drilled with a 6⅛" tricone rotary drill-bit to a measured depth of 9.55 m. A 4½" HWT conductor casing (outer diameter: 114.3 mm, inner diameter: 101.6 mm) was lowered to a casing shoe depth of 9.54 m and cemented, but infill of host tephra apparently prevented satisfactory cement displacement. The conductor casing was then removed and successfully re-cemented. After waiting on cement, coring with a HQ3 (outer diameter: 88.9 mm, inner diameter: 77.8 mm) bit reached a total depth of 151.57 m. Here, the string became stuck. The drill crew pulled the string free in three attempts, and raised the string by 6 rods. The string then became stuck again with the coring bit at 133.27 m measured depth, leaving an 18 m uncased section at depth. Five cuts were made at progressive depths to retrieve the HRQ rods at 122 m measured depth and at rods 37, 34, 18, and 15. The string could not be pulled from the uppermost cut at 46 m depth, however, and 43 HRQ drill rods and the bottom-hole assembly (4.14 m) remained in the borehole. Work on the borehole was terminated on August 17, 2017. An extension of the HWT conductor casing and a flange were installed 0.44 m above the reference ground level.

7.2.2 Borehole SE-02b

The SE-02b borehole was rotary drilled from the surface to about 13 m with a 6⅛" tricone bit. A 4½" HWT conductor casing was lowered into the hole and cemented in place with the casing shoe at 12.74 m measured depth. After waiting on cement, coring with a HQ3 began. At 20.84 m measured depth the conductor casing lifted up. This was pulled from the borehole and another cement job carried out. After waiting on cement, coring continued to 81.84 m measured depth when the conductor casing displaced downwards about one meter. An attempt to fish the HWT casing resulted in the recovery of only two casing segments. Two 10-foot HWT new segments were inserted, and a 5-foot segment added; the joints were welded together. Thus, twenty-five feet of new casing were threaded into the two remaining HWT casing segments.

This extension resulted in a new casing shoe depth of 14.40 m. Coring then continued to a total depth of 191.64 m.

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Wireline logging was conducted after pulling the coring string out of hole to a depth of about 40 m. The 2¾" T-6061 anodized aluminum tubing for the Surtsey Subsurface Observatory was then run into the borehole to a landing depth of 181.25 m. This consists of fifty casing tubes in which five perforated segments were placed at 38, 63, 106, 136, and 161 m measured depth from the flange. The perforated tubes have 29 rows of five ¼-inch punched perforations that extend over four feet, centered in the mid-section of the 12-foot long pipe. The flush joints of the tubes were wrapped with Teflon tape and wrenched together by hand. Teflon tape concentrates organic compounds at the joint, as compared with paste lubricants that could have been smeared along tubing surfaces, potentially contaminating the observatory. The aluminum tubing occurs in three lengths, due to sourcing constraints encountered by the provider, Arconic Energy Systems, 7211 Spring Cypress Road Spring, Texas, 77379, USA, in spring 2017. The casing tally is provided in Table 10. At the top of the borehole, PVC centralizer tubes were installed between the aluminum tubing and the steel HWT conductor casing to minimize corrosion over time. A flange was installed 0.21 m above the reference ground level. A custom wellhead cap and cover holds the Vectran rope of five incubator experiments that were hung in the center of the perforated segments on September 6.

7.2.3 Borehole SE-03

The SE-03 cored borehole was pre-drilled at 35° from vertical with a 6⅛" tricone rotary drill bit to a measured depth of 12.6 m. After lowering the 4½" HWT conductor casing to a casing shoe depth of 11.91 m, the conductor casing was cemented in place. After waiting on cement, coring with a HQ3 bit tagged cement at 11.39 m. Coring continued to 213.89 m measured depth, when the supply of HRQ drilling rods was fully consumed. The HQ rods remain in the borehole to a measured depth of 213.62 m and coring continued with an NRQ string (outer diameter: 69.9 mm, inner diameter: 60.3 mm). Coring with a NQ3 bit reached a total measured depth of 354.05 m. This corresponds 290 m vertical depth below the ground surface and a horizontal displacement of about 203 m (Figure 19). The NRQ coring string was left in the hole as permanent casing, including the NQ3 bottom-hole assembly. An extension of the HWT conductor casing was added and a flange was installed, at 0.48 m above the reference ground level. This corresponds to an additional well length of 0.59 cm.

Table 9. *Borehole specifications.*

Well name	SE-02a	SE-02b	SE-03
Well ID	73553	73554	73555
Comment	Collapsed		
Orientation	Vertical	Vertical Slightly inclined (1°)	Angled (35° from vertical) Direction 264°
Drilling Information (drilling reference level)			
Total measured depth (m)*	151.57	191.64	354.05
Well-head flange height above drilling reference level (m)	0.44	0.21	0.59 (0.48 vertical height)
Total measured depth (m)**	152.01	191.85	354.64
Total vertical depth (m)*	-	-	290.0
6⅛" tricone rotary drilling (m)*	0-9.55	0-13	0-12.6

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HQ drilling (m)* coring	9.19-151.57	12.86-191.64	11.39-213.89
NQ drilling (m)* coring	-	-	213.89-354.05
Casing information			
HWT conductor casing shoe depth (m)* (OD: 114.3 mm, ID: 101.6 mm)	9.54	14.40	11.91
HRQ drill rods left in hole (m)* (OD: 88.9 mm, ID: 77.8 mm)	133.27		213.62
NRQ drill rods left in hole (m)* (OD: 69.9 mm, ID: 60.3 mm)			354.05
2¾" T-6061 anodized aluminum tubing depth (m)* (OD: 69.85 mm, ID: 57.15 mm) (perforated at 38, 63, 106, 136, and 161 m)		181.25	
PVC centralizer tubes at top of casing**		14.63	

*Drilling reference level, **Reference level: flange, Abbreviations: OD: Outer Diameter, ID: Inner Diameter

Table 10. *Casing tally for the 2¾" aluminum tubing in borehole SE-02b.*

Number of installation	Number top to bottom	Length (m)	Perforated section (m)*	Top depth (m)	Bottom depth (m)	Joint offset (m)
50	1	3.60		0.00	3.60	
49	2	3.60		3.62	7.22	0.015
48	3	3.60		7.23	10.83	0.015
47	4	3.60		10.85	14.45	0.015
46	5	3.60		14.46	18.06	0.015
45	6	3.60		18.08	21.68	0.015
44	7	3.60		21.69	25.29	0.015
43	8	3.60		25.31	28.91	0.015
42	9	3.60		28.92	32.52	0.015
41	10	3.60		32.54	36.14	0.015
40	11	3.75	X (37.42-38.64)	36.15	39.90	0.015
39	12	3.60		39.92	43.52	0.015
38	13	3.60		43.53	47.13	0.015
37	14	3.60		47.15	50.75	0.015
36	15	3.60		50.76	54.36	0.015
35	16	3.60		54.38	57.98	0.015
34	17	3.45		57.99	61.44	0.015
33	18	3.75	X (62.72-63.94)	61.46	65.21	0.015
32	19	3.45		65.22	68.67	0.015
31	20	3.60		68.69	72.29	0.015
30	21	3.60		72.30	75.90	0.015
29	22	3.60		75.92	79.52	0.015
28	23	3.60		79.53	83.13	0.015
27	24	3.75		83.15	86.90	0.015
26	25	3.45		86.91	90.36	0.015
25	26	3.60		90.38	93.98	0.015
24	27	3.60		93.99	97.59	0.015
23	28	3.60		97.61	101.21	0.015

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Number of installation	Number top to bottom	Length (m)	Perforated section (m)*	Top depth (m)	Bottom depth (m)	Joint offset (m)
22	29	3.60		101.22	104.82	0.015
21	30	3.75	X (106.10-107.32)	104.84	108.59	0.015
20	31	3.45		108.60	112.05	0.015
19	32	3.75		112.07	115.82	0.015
18	33	3.45		115.83	119.28	0.015
17	34	3.60		119.30	122.90	0.015
16	35	3.60		122.91	126.51	0.015
15	36	3.60		126.53	130.13	0.015
14	37	3.60		130.14	133.74	0.015
13	38	3.75	X (135.01-136.26)	133.76	137.51	0.015
12	39	3.60		137.52	141.12	0.015
11	40	3.60		141.14	144.74	0.015
10	41	3.60		144.75	148.35	0.015
9	42	3.60		148.37	151.97	0.015
8	43	3.60		151.98	155.58	0.015
7	44	3.60		155.60	159.20	0.015
6	45	3.75	X (160.46-161.71)	159.21	162.96	0.015
5	46	3.60		162.98	166.58	0.015
4	47	3.60		166.59	170.19	0.015
3	48	3.60		170.21	173.81	0.015
2	49	3.60		173.82	177.42	0.015
1	50	3.60		177.44	181.04	0.015
Casing shoe	Casing shoe	0.20		181.05	181.25	0.015

* The five perforated sections have a pattern of 1/4" (6.35 mm) holes that extends over four feet (122 cm), centered in the mid-section of each pipe.

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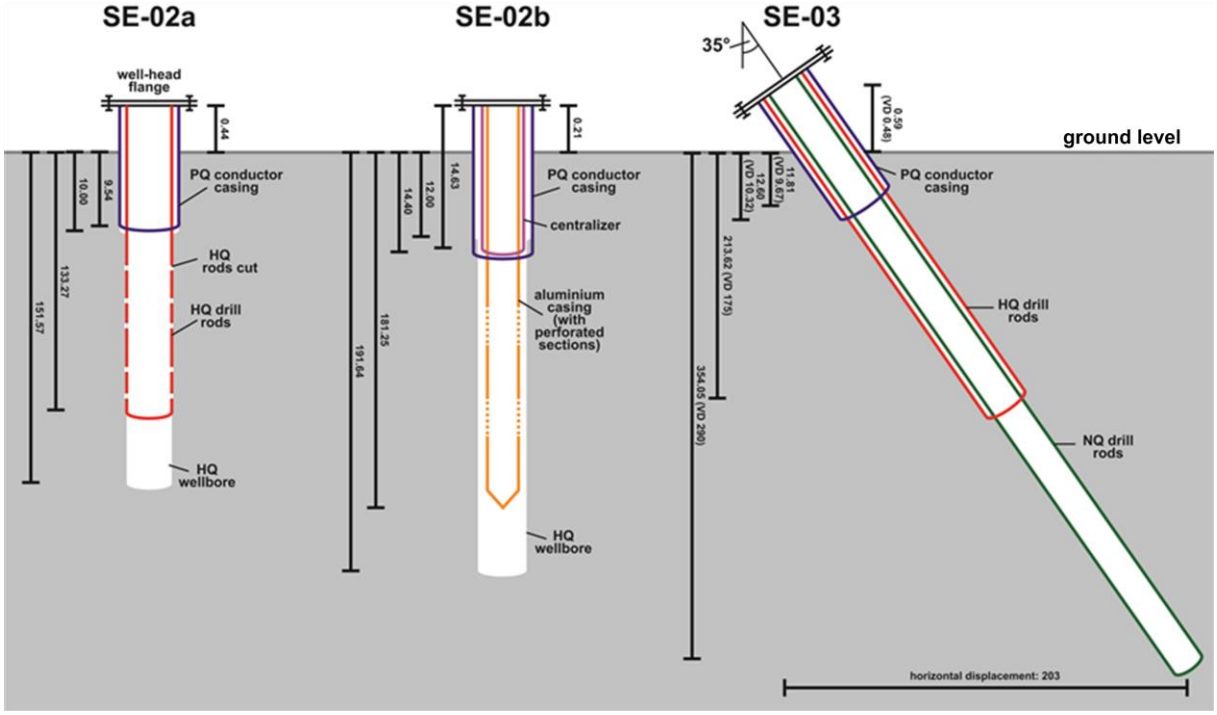

Figure 21. *Schematic drawing of boreholes drilled on Surtsey in 2017. Although the ground surface is shown as a horizontal surface, variations exist in ground level. Measurements are recorded relative to the local ground level at each site at the time of drilling.*

8 Drilling history

8.1 Pre-operation sourcing and preparations, until July 25, 2017

Preparation of the equipment for the drilling operation began in winter 2017, at the DOSECC offices and yard in Salt Lake City, Utah. Extensive lists were made and all possible equipment, tools and support materials that would be needed on Surtsey were gathered together, often in duplicate. The equipment was trucked in four containers from Salt Lake City to Portland, Oregon in early June. A fifth container holding the rental Atlas Copco CS1000 drill rig was trucked to Portland from Rig Source in Chicago, Illinois. The containers arrived in Reykjavík in early July.

The extensive work required to package the drilling equipment and provisions, including several tons of water for showering and washing and two tons of drinking water. Into helicopter lift took place July 15-26 at the Landsvirkjun Warehouse at Völuteigur in Mosfellsbaer, 10 km from central Reykjavík. The DOSECC team led these preparations, along IceSUSTAIN participants, including about 10 staff members of IES-UI and ÍSOR who packed fuel drums into double layered plastic to minimize the risk of leakage during transport and storage on the island (Figure 10).

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8.2 Advance party and Surtsey preparations, 23 to 30 July 2017

On July 23 a three-person advance team was transported by the Vestmannaeyjar Rescue Group (Björgunafélag Vestmannaeyja) rescue boat, Thór, from Heimaey to Surtsey, which carried 3.5 tons of equipment and materials for the drilling platform construction and the preparations for the drilling operations (Figure 10). Three DOSECC drillers arrived by helicopter on July 25. The initial plan to construct a drilling platform was abandoned. This was firstly because the depth to basaltic lava substrate was much greater than expected, making anchoring as planned, with shallow rods, impossible. The drillers had prepared for this possibility and employed an alternative platform, using a broad spinner base and burning five HQ anchor rods into the lava underlying the drill site to secure the CS1000 rig in place. The advance team prepared the ground surface using shovels and rakes at the drill site and near the Pálsbaer II hut. A fuel storage area was lined with four layers of reinforced Visquene plastic sheeting. Similar procedures were employed at parking sites for the ATV, and the other fuel depot on the northern peninsula. At the drill site, areas were prepared for the seawater drilling fluid storage reservoir and mud staging area. The Pálsbaer II hut was equipped with electric lighting.

8.3 Transport of equipment and provisions to Surtsey, July 26 to 30, 2017

Equipment and provisions were trucked to Thorlákshöfn July 26-27, and then loaded onto the Icelandic Coast Guard vessel, VS Thór. Following safety regulations, fuel drums (14,400 liters) were transported empty to Thorlákshöfn, and filling with fuel took place at the harbor. About one-half of the lifts were taken in the first voyage to Surtsey. The VS Thór returned to Thorlákshöfn during the evening of July 28, and the remainder of the equipment and provisions were loaded and then transported in a second voyage to Surtsey on July 29.

The Coast Guard mobilization began on July 28. After a safety meeting, the Aerospatiale Super Puma AS-332L1 helicopter TF-LÍF (Figure 22) slung about 50 loads from the Icelandic Coast Guard vessel VS Thór, located just off the eastern shore of the island. Beginning at 17:00, the Coast Guard helicopter delivered 29 loads, including drinking water, water for showers, fuel, drill pipe and other equipment. Preparations continued at the drill site and on the west coast of the peninsula. At the peninsula the focus was on the seawater intake location, generator location, fuel storage area, taking into account installation issues, and recommendations by Thórdís Bragadóttir, the Iceland Environment Agency representative. On July 30, the Icelandic Coast Guard helicopter arrived at 13:45, and delivered the remaining 28 loads of equipment, including fuel, plastic core liners, plastic rig mats, hoses, drilling mud, core boxes, etc. Lifts were completed at about 19:15. The drill shack base was set into place, welding of the water intake cage for the submersible offshore pump was completed, and the fuel stations were fully set up. Table 11 shows the weights of equipment and material delivered during the July 28-30 mobilization to Surtsey.

The Nordurflug helicopter arrived at 19:30 on July 30, and did 11 lifts, with 8 precision lifts to set the drill rig components, finishing at about 22:30. By the end of the day, the shower and toilets at the camp were installed, the tents and bunks set up, and some of the crew moved from the Pálsbaer II hut to the tent accommodations.

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Figure 22. *Photographs of the Icelandic Coast Guard helicopter crew, Magnus Tumi Gudmundsson, and the Icelandic Coast Guard Super Puma helicopter (TF-LÍF) after completion of the first day of mobilization, July 28, 2017 (photo: Thórdís Högnadóttir (THH)).*

Table 11. *Equipment, fuel and materials lifted by Icelandic Coast Guard helicopter (TF-LÍF).*

Item	Weight (kg)
Drill rig and rig-related equipment	16,700
Drill rods (HQ -366 m, NQ - 366 m, PQ conductor casing - 36 m)	9,100
Core liners (HQ and NQ)	300
Logging equipment	1,000
Drill mud (attapulgite)	5,900
Electric generators	900
Diesel fuel for drill rig and generators (10,800 liters, 54 200 liter drums)	10,000
Petrol for generators (3,400 liters, 18 200 liter drums)	2,900
Water line pipes (1900 m)	1,700
Tents, containers and other camp-related equipment	4,700
Food	1,800
Shower and washing water	5,000
Drinking water	2,100
Total	**62,100**

8.4 Rigging-up operations

Rigging-up began on July 31, and on August 1, the drilling crew finished connecting the hydraulic lines on the CS1000 rig, installed and filled the fuel tank, and filled the hydraulic oil. They also ran the water line from the drill site to western shore of the peninsula, and installed the submersible pump inside the offshore water intake cage. At 18:30 the Nordurflug helicopter arrived to place the intake pump/cage into the ocean.

On August 2, the drilling crew leveled out the drill rig, adjusted the planks and timbers of the drill platform, adjusted the jack legs, installed the main line, towered up the rig, installed the drill head, installed the foot clamp, and tested all functions of the rig. The water intake pump was deployed in the sea and seawater was pumped through the line.

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The drilling crew then focused on water line work. Water moved through about 7/8 of the required distance, almost to the drill site, but two connections failed. There were, in fact, two types of fittings delivered to the island. The fitting with a barbed brass inner seal, or crimp ring, best gripped the hose and the seal remained intact. By contrast, the seal with a thin plastic crimp ring consistently failed along the line, over time. The crew replaced the two plastic connections with the brass fittings and finally delivered seawater to the drill site. A flow test indicated a good flow rate, 45-49 L/min. The drilling crew continued, however, to be preoccupied with resolving water line issues. There was no water pressure during the day of August 4. By evening, however, issues with seals were resolved and seawater was again flowing to the drill site. It required about 19 minutes to fill a single 1000-liter tote.

On August 6, the drilling crew rolled out and connected the last segment of the discharge line across the lava flow and over the eastern sea cliff of the island. They then burned five HQ anchor rods into the basalt underlying the drill site to secure the Atlas Copco CS1000 rig in place. They levelled out and cribbed up the rig, placed non-flammable plastic sheeting under it, and dug the catchment sump. They then re-set drill shack, fixed the discharge line, and set up PQ handling on the drill, hand and tricone bits. The spinner base worked extraordinarily well. Scientists performed the first filtering and UV sterilization processing on the seawater drilling fluid from the reservoir at the drill site.

8.5 Drilling of SE-02a

The drilling crew torched holes in the anchor rods and secured the rig to the basaltic substrate on August 7. They then rotary drilled with a 6⅛” tricone bit from the surface to about 10 m. There were returns initially but lost circulation occurred from 1.5-10 m. During this period the supply of sterilized seawater drilling fluid ran out twice. They then tripped out, removed the tricone bit, tripped in with the conductor casing, mixed a grout cement, and attempted to displace. The displacement method did not work well, since there had evidently been caving of loose tephra in the hole. This apparently collared or bridged off in the annulus, prohibiting a satisfactory amount of displacement. The crew tripped out and pumped the plug through the casing and abandoned the cement job.

On August 8, after tripping out, taking off the tricone bit, and tripping back in with the HWT conductor casing, a cement slurry, including coarse tephra was injected to cement the casing into place. A cement sample was taken to monitor setting time. Late in afternoon, it was discovered that water was not pumping to the drill site. When walking along the water line, no leaks were observed. It appeared that the connection between the offshore pump and HDPE pipe had pulled apart.

At midday on August 9, the cement had set for 24 hours, but no seawater was available for drilling. The submerged water intake cage and pump were then pulled by helicopter from the ocean. The HDPE pipe had slipped or blew out of the connection, which had a plastic crimp ring. This was replaced by the barbed and crimped brass ring. The pipe and electrical cable were reconnected, and the pump and cage set back into ocean.

Core drilling operations began with the August 10 day shift, and the first core was recovered at 09:30. Coring continued until 19:00. There was a serious vibration during the last drill run. It was decided to trip out and check the bit and rods; these looked fully functional. The crew drained the gear oil in the head, took off the front plate, and checked inside the head. Metal shavings were

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present, but visual inspections did not indicate anything seriously amiss. Eight core runs (1-8) were obtained during the day shift, from 9.19-31.10 m measured depth, with 98% recovery (Figure 23). The night shift finished reassembling the drill head, refilled the gear oil, tripped back in the hole, and resumed drilling, acquiring 13.72 m with 100% recovery.

The last two hours of the night shift on August 11 were spent hiking to the peninsula and working on the water supply pump. No seawater was arriving at the drill site and the offshore pump was not operational.

Figure 23. *Photograph of the first drill core recovered, borehole SE-02a, August 10, 2017. Beau Marshall, Steve Cole, Marie Jackson, Justin Blouin, and Simon Prause (left to right) (photo: Samantha Couper (SC)).*

The day shift of August 11 began with the drill shut down, due to lack of water. Two members of the drill crew, then isolated and traced the water supply issue to a mechanical failure of the submerged water pump. The spare submersible pump was subsequently installed in a near shore tide pool and tightly fastened to a large basalt boulder. At 17:45, when the tide was high enough to cover the intake, the pump immediately turned on, and water was once again being pumped to the drill site. It took about 30 minutes for seawater to pump from the peninsula to the site and each valve along the way was opened to let the air bleed out of the line. The rest of the day focused on filling totes and sterilizing water, and the night shift began with full water storage and sterilized water ready to drill. The seawater supply was then at the mercy of the tides and delivery to the drill site involved a pumping schedule and a great deal of hiking to and from the peninsula.

The day shift of August 12 cored 8.5 m with 98% recovery, core runs 20-24 from 63.13-71.62 m measured depth, but a team member had to hike to the peninsula twice during the shift to start and stop the submersible pump. The plastic liner appeared intermittently caught and bunched. The night

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shift cored 15.99 m with 100% recovery, core runs 25-30, drilling from 71.62-87.52 m measured depth. The night crew was then shut down for six hours waiting for the tide to rise in order to pump seawater to the drill site.

The day shift of August 13 began on standby, waiting for the seawater storage totes to fill at the drill. After hiking to the peninsula to fix and adjust the newly installed intake pump, the drilling crew discovered that the pump had slipped farther down the suction screen, affecting the hose and connection fittings. After putting rocks in the bottom of the suction screen, setting the pump back inside the screen on top of the rocks, and securing it more deeply into the tide pool, seawater began pumping to the drill site again.

Figure 24. *Photograph of the rescue boat, Thór, in Landeyjahöfn, loaded with water supply equipment, August 13, 2017 (photo: TBW).*

Work also began on an onshore storage reservoir on the peninsula with materials delivered by boat from Heimaey (Figure 24). Sixteen 1000-liter storage totes and a generator were hauled from the shoreline, up the boulder ridge, and onto the top of the spit. The intent was to create a water delivery system that was more manageable and reliable than the fixed pump in the ocean that was dependent on tidal flux, thereby making drilling independent from the tides.

The day shift crew cored 6.10 m with 100% recovery, from 87.52-93.62 m, over two core runs, 31-32. The night shift began with the onsite water storage full, and were able to core 15.25 m with 100% recovery, from 93.62-108.87 m, before running out of water at 03:00 after five core runs, 33-37. A sulfurous smell began with first core run, at 93.62 m. By 07:00 the tide was high and the night shift could once again begin pumping water.

The day shift of August 14 began with waiting for the water storage totes at the drill site to fill. During this period a run with the DES temperature tool gave a bottom hole temperature of 103.5 °C,

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after 30 minutes at 108.87 m measured depth and no sterilized seawater pumped into the hole for six hours. This is about 20 °C less than the 124 °C temperature measured the previous week in the 1979 SE-01 hole at the same depth. The cores were arriving warm, but both the inner tubes as well as the water coming up out of the rods were cool when the tube was pulled. Drilling operations were suspended to set up the water storage at the shoreline. All colleagues went down to the peninsula to carry the 16 totes from the tip of the spit to the lowland near the fuel depot. This activity took all day, 10:00-19:00, and was labor intensive, accomplished in heavy rain. One drill run, 38, was cored 3.05 m with 100% recovery, from 108.87-111.92 m. The night shift drilled three core runs, 39-41, from 111.92-121.07 m, giving 9.15 m with 100% recovery before running out of water at 01:00.

On August 15, water delays occurred at the beginning and end of the day shift but 15.25 m were drilled with 100% recovery. These are core runs 42-46, from 121.07-136.32 m. There was also a throttle cable break on the rig, but a makeshift solution was produced. Meanwhile, the on-site team installed and connected the sixteen water storage tanks on the peninsula. Seawater was pumped from the ocean into the totes, and the submersible pump placed into another tote to deliver the stored seawater to the drill site. By 19:00 seawater was pumping from the shore storage tanks to the drill site. The night shift also had two standby water delays at the start and at the end of the shift but managed to drill 15.25 m and recover 10.16 m. These are core runs 47-53 from 136.32-151.57 m. The last three runs struggled to get good recovery of core. Steaming of the core decreased through the core runs. The rods were also sticking, so a trouble spot in the hole had been reached, which the team expected based on the 1979 drill logs.

The day shift of August 15 began with a delay waiting for totes to finish filling with seawater, since full functionality of the peninsula storage system had not yet been achieved. There was about 1-1.5 m of fill or cave when the rods were set back on the bottom of the hole. It was decided to put on a core lifter basket combination, in order to core and collect the caved in material, since the intention was to drill this hole without using mud products. As soon as the tube hit bottom, however, the rods stuck. The crew managed to work them free and found a small spot where they could get rotation back but, instead, got stuck again trying to back ream out. It was then decided to mix mud, but the rods remained stuck. The night shift inherited the stuck rods and after a small battle of tug-o-war, they pulled the rods free. They immediately began to trip out, making sure the bit was still attached, and after pulling out six stands (18 m), the hole grabbed. The night shift continued working the rods with little progress, all night. The collapse appeared to be high in the hole, just below the HWT casing, since there was little rod stretch or rotation.

Attempts to free the rods on August 17 produced no movement. In discussions with the PIs, it was decided to terminate hole SE-02a and begin cutting operations to recover the HQ rods. By the end of day shift the first cut had been made at 122 m measured depth and the NQ rods tripped out. The cutter lug snapped and needed to be replaced. The night shift pulled on the HQ rods to determine whether the cut that the day shift made had freed the HQ string, but they were still stuck. The night crew replaced the lug twice and made four more cuts but the rods were still stuck. The last cut was made at 46 m measured depth. It was then decided to begin rigging down and initiate a new borehole (Figure 25) as decided by the Drilling Steering Committee.

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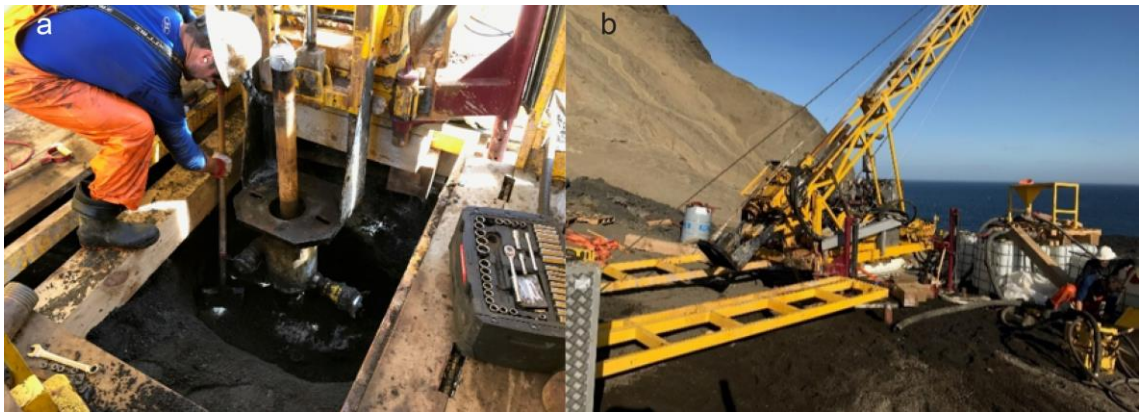

Figure 25. *Photographs showing preparations for borehole SE-02b. a) Top of SE-02a mud diverter flush with ground level. HRQ rods are sticking up, and were cut off at ground level after removing diverter. b) Top of HWT casing sticking up about 8" from the ground surface. The drill rig was rotated on the spinner base in preparation for drilling borehole SE-02b (photo: Beau Marshall (BM)).*

8.6 Drilling of SE-02b

On August 18 the rig was partially dismantled and rotated on the spinner base to begin drilling a second vertical cored borehole, SE-02b. A new delivery of cement was requested by the drilling crew in the afternoon of August 18, as the cement that was originally taken to Surtsey was running out.

Damage to one of the pipes from the ocean pumps to the water reservoir was observed on the evening on August 18. The damage was repaired by the camp manager in the morning of August 19 during low tide.

Pre-drilling with a 6⅛" rotary tricone drill-bit (Figure 14) to 12 m was carried out from 0:30 to 4:30 on August 19. A total loss of circulation occurred and no cutting samples were retrieved. According to the drillers, the lowermost section indicated a relatively stable formation. Four HWT conductor casing segments were lowered and cemented in place, using four 30 kg bags of cement. It was not clear how much cement reached the casing shoe as an unknown volume of the cement was not useable due to fact that the cement bags got wet, and an unknown volume had partially hardened during storage on site. While waiting for cement, the rig crew continued to install the rig site after the rig rotation. During the day of August 19, 300 kg (12 bags, each 25 kg) of cement (sand grout) were sourced on Heimaey and transported by rescue boat, Thór, to Surtsey (Figure 26). The boat arrived at 18:30 at the eastern shore of the peninsula; the sourced material was unloaded onshore and transported to the drill site. Four bags were employed before the shift change at 19:30.

Meanwhile, a monitoring string was lowered into the SE-01 borehole at 15:00 on August 19 (Figure 27). This was constructed in Reykjavík by a team from the Institute of Earth Sciences of the University of Iceland and the Iceland GeoSurvey to measure temperature and tidal flux during drilling of the new boreholes, and transported to Surtsey with the helicopter on August 18. The arrangement of the monitoring string is provided in Table 12.

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Table 12. *Arrangement of monitoring string for SE-01.*

Mark on slick line (m)	Depth (m), referenced to top of the well.	Sensor
0	175	HOBO temperature memory tool
40	135	HOBO temperature memory tool
75	100	HOBO temperature memory tool
110	65	MadgeTech PT memory tool
175	0	

Figure 26. *Photographs showing the Surtsey team receiving 300 kg cement (sand grout) delivered by the rescue boats, Thór, from Heimaey on August 19, 2017 (photo: AB).*

Waiting on cement continued on August 20. During the early morning hours, it was observed that water storage at the drill site was low and that problems with the seawater pumps on the northern peninsula had occurred. The submersible pump was unable to draw water from the ocean; it was discovered that a large amount of seaweed was stuck in the pumping mechanism. Using a portable pump (trash pump) placed on the boulders close to the shoreline and attaching all remaining suction hoses, water was drawn up to the storage totes at the northern peninsula, and then to the totes at the drill site. Filling the water storage at the drill site was completed about 17:00.

After some further preparations at the drill site, including digging out a cellar for borehole SE-02b, coring began at 22:00 on August 21. Three core runs were executed to a total measured depth of 20.84 m. Yet in the last run, the inner tube became stuck inside the rods as it was being retrieved. Either the rods became stuck in the casing or the bit caught the bottom of the casing shoe and pulled the HWT conductor casing up slightly to the foot clamp. The casing was reset on the bottom of the hole and another plug of cement slurry was sent down to tack the shoe and hole. It was discovered

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that the cement product delivered on August 19 was a stucco-sand finishing product rather than actual Portland cement.

Waiting on cement continued until 10:00 on August 22. After removal of a 2 ft segment of HWT casing, the PQ system was switched for HQ coring, which drilled out cement. Coring began again at 11:30. Minor delays occurred when the flow rate of the filtering and UV-sterilization system could not satisfy drilling demands. At the 20:00 shift change, 12 core runs were completed to 42.19 m measured depth. Full water storage on site and at the shore was established and, at midnight, 16 core runs had been completed to 54 m measured depth.

Figure 27. *Photograph showing Tobias Björn Weisenberger (left) and Erica Massey (right) installing a temperature and pressure monitor string in SE-01, August 18, 2017 (photo: AB).*

Coring continued on August 23 and at the shift change at 08:00, 26 core runs were completed, to 75.74 m measured depth. During coring of the night shift minimum two attapulgite mud sweeps were used to circulate the well (core run 15 and 20). The coring activity was stopped at about 10:30, after core run 28, when a spike in the torque was observed. Inspections indicated that the surface casing dropped and most likely caused the torque spiking. The HWT casing drop was most likely related to a washout around the casing shoe. The HQ drill string was pulled out of hole and subsequently, the drill crew tripped in with a PQ Bowen Spear, stabbed into the casing, pulled it up, only to discover that two HWT segments were recovered, not four. The lower two segments were securely planted and would not budge. Two straps were then welded onto two segments of HWT casing, tripped in, and then stabbed into the top of the original casing string. The other two HWT casing segments were threaded in with a pipe wrench and all four segments torqued together with the drill head. A 5 ft (1.525 m) segment was added. After tripping in with the HQ rods, a core run was achieved with fluid returns coming from the top of the casing. Coring began again at 19:00, and core run 29 was retrieved at 20:00 at 84.89 m. At midnight, the measured depth was 92.09 m.

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After midnight on August 24, a decision was made to use untreated seawater to reduce delays associated with filtering and UV-sterilization, since the slow processing rates could not meet drilling demands. Coring was paused after core run 37, at 106.24 m depth at 03:00, while issues were resolved with water storage on the peninsula. Coring then resumed at 06:00 with filtered seawater, and at the 08:00 shift change the borehole reached 109.29 m measured depth.

Seawater was not sterilized during core run 40 and mud was used in core run 43. During coring, problems occurred, due to thermally induced deformation of the plastic. Drilling continued for the entire day and at 20:00, the borehole reached a depth of 138.09 m. At this point, however, the inner tube could not be freed from the core barrel. Tripping pipe revealed that the shoe of the tube had unthreaded slightly and wedged itself inside the core barrel.

After tripping back in, and conditioning the hole with attapulgite mud after midnight on August 25, coring began at 01:45. At the 08:00 shift change, the measured depth was 155.04 m. Attapulgite mud was used in core runs 49, 50, and 51. It remains unclear whether or not only non-sterilized seawater was employed. Drilling continued during the entire day shift. At the 20:00 shift change in total 63 core runs had been completed, to a measured depth of 176.39 m. Non-sterilized seawater was employed in core runs 56 and 58.

Coring into the formation continued with the night shift. After core run 65, at 181 m, the on-site scientists observed that the consolidated tuff transitioned to poorly-consolidated tuff. The driller also reported on a change in drilling behavior during core run 65. In core run 66 only one section, 98 cm in length, was recovered (32% core recovery). The core retrieved was similar to the poorly-consolidated tuff of core run 65.

After observation and evaluation of the recovered rock it was decided to carry out another core run. During core run 67, only 38 cm of core were recovered (12 % core recovery). Primary core observations indicated the penetration of a fine-grained rock formation. The driller and the scientist in charge evaluated the situation, and it was decided to carry out another core run (68). Coring conditions were difficult during core run 68, and the driller reported possible washouts of certain sections. As in the previous two core runs, the drill string was immediately pulled up by a few rods to limit the risk of getting stuck and it was circulated with attapulgite mud. The unconsolidated nature of the drilled rock formation was confirmed by retrieval of an empty tube (0 % core recovery). Both the driller and scientist in charge agreed that further drilling would be highly risky and after further consultation the borehole SE-02b was completed after 68 core runs at a total measured depth of 191.64 m. Figure 16 to Figure 18 and Table 7 provide information on drilling progress.

Borehole SE-02b accomplished several objectives:

i. it exceeds the total vertical depth of the 1979 cored borehole (SE-01, 181 m measured depth).
ii. it acquired consolidated tuff at a depth greater than that of the 1979 core (SE-01, 171 m b.s.).
iii. it provides a suitable vertical space for the Surtsey Subsurface Observatory.

Shortly after midnight on August 26 the drill crew began pulling out the coring string by about 50 m and circulated the well while waiting for the wireline logging. The ICDP-OSG downhole logging team

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then began preparations at 8:30, while the drill rig crew continued pulling up the coring string to a depth of 39 m. To limit the risk of collapse within the upper section of the poorly consolidated tephra, it was decided to leave 10 drill rods and the bottom-hole assembly in the uppermost borehole. A steering committee meeting defined the downhole logging strategies. Wireline logging began at midday with a temperature, pressure, natural gamma and mud resistivity log. This was followed by logs measuring magnetic susceptibility, inclination, resistivity and spontaneous potential. These were carried out to a maximum depth of 180 m, in order not to risk hole collapse in the poorly-consolidated tephra in the lowermost borehole. Subsequently, the drilling steering committee had another meeting and decided not to continue the logging activity to the bottom of the hole. A sonic log was considered too risky overall. An addition temperature log below 180 m using a slick line and HOBO memory tools was also rejected in order to limit any borehole damage that could risk the installation of the Surtsey Subsurface Observatory. Logging was completed at 20:00 and the remaining string was pulled from the borehole.

At about 22:00 a briefing was held at the drill site to review the delicate process of installing aluminum tubing of the Surtsey Subsurface Observatory. Running in began about 23:00 to place the 50 casing tubes, including 5 perforated sections (Figure 28). Installation of the approximately 12-feet long pipes proceeded smoothly and the ID number for each pipe was recorded, continuing into August 27 (Figure 28). The flush joints of the tubes were wrapped with Teflon tape and wrenched together by hand. After 16 pipes were run into the borehole, it was observed that in contrast to the provided information, the pipes had different lengths (Figure 28); these were then inventoried and the ID numbers linked to the length of each pipe. Running in began again after about 1.5 hours. The final 5 pipes were run into the borehole with attached PVC centralizers to ensure that the aluminum tubing would not be corroded through contact with the steel HWT conductor casing. Installation of the wellhead and the casing hanger for the aluminum tubing was completed at 06:00 on August 27. The top of the casing was cemented and the wellhead flange installed (Figure 29).

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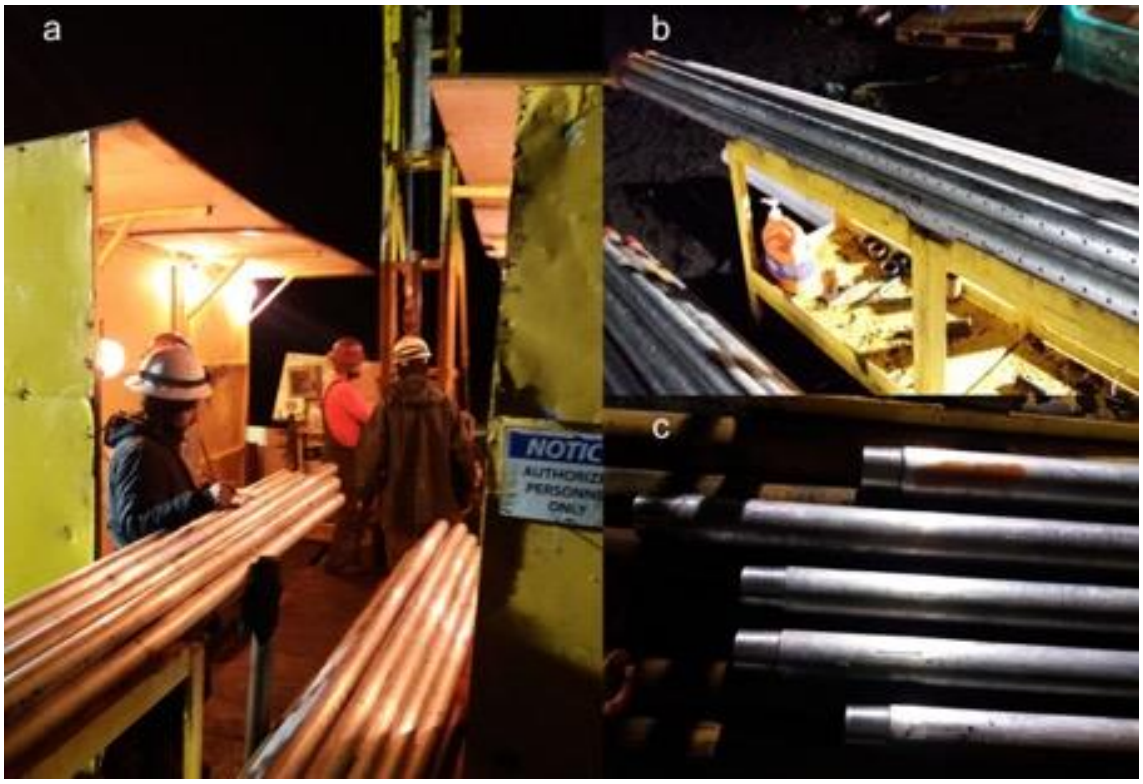

Figure 28. *Photographs showing installation of the anodized aluminum tubing for the Surtsey Subsurface Observatory in borehole SE-02b. a) Drill crew runs in the tubing. b) Perforated section. c) Variable casing lengths (photo: TBW).*

Figure 29. *Photograph of the well-head of borehole SE-02b (photo: BM).*

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8.7 Drilling of SE-03

After completion of borehole SE-02b rigging down, rigging up of angled borehole SE-03 began on August 27. The rig was rotated on the spinner base to an azimuth of 264° and then inclined of 35° from vertical. Rigging up continued into August 28, and SE-03 was spudded at 02:30 through pre-drilling of a pilot hole for the conductor casing using a 6⅛" tricone rotary drill-bit. Pre-drilling was completed at 11:00 at a measured depth of 12.6 m. A 12 m long HWT conductor casing was lowered into the hole at 12:30. The casing was cemented in place.

While waiting on cement, water reservoirs were filled and pumps were ensured as fully operational. Increasing the efficiency of the onshore seawater storage reservoir on the peninsula was considered a priority. The tidal range had decreased over the previous few days and was expected to stay within 1 m until September 3, as compared to a 3 m tidal range four days earlier. This indicated favorable seawater pumping conditions over the next days, since it reduced the work of moving pumps around the bouldered shoreline and cleaning them of sea weed at very low tide.

Coring of SE-03 began just after 20:00 on August 29. At the 08:00 shift change on August 29 16 core runs had been completed. Coring first utilized only unfiltered, non-sterilized seawater, yet attapulgite mud was used from core run 8 onwards. No delays due to water problems occurred, until pumping from the peninsula stopped at 01:00 on August 30. A generator had stopped, resulting in no power to the pumps. This was quickly repaired and no further delay at the drill site occurred. The measured depth at the 08:00 shift change was 56.8 m, corresponding to a total vertical depth of 46.6 m b.s. The day shift continued drilling without incident until 12:00, when the drill became stuck. It was quickly freed, but the drill string was pulled up since the core barrel could not be retrieved. Coring continued after 16:00. Seven core runs were retrieved during the day shift, resulting in a 75.5 m measured depth and 61.9 m vertical depth at 20:00. An additional camp manager arrived with the rescue boat, Thór, to fill a vacant position, work on water line maintenance, and assist with the drill cores.

Twenty-four core runs were carried out from 20:00 on August 30 to 20:00 on August 31. Drilling continued without incident. Pumping of water from the peninsula paused occasionally, but resumed quickly as the waterline team restarted generators. Some core runs employed only seawater, while others also employed attapulgite mud. The measured depth at the 20:00 shift change on August 31 was 151.4 m, corresponding to 124.1 m vertical depth.

Twenty-one core runs were carried out over 17.5 hours from 20:00 on August 31 to 13:30 on September 1. The measured depth, 213.9 m, corresponds to 175 m vertical depth. Drilling progressed at a steady rate and without incident until the supply of HQ rods was fully consumed at core run 69. About 140 m of HQ rods remained in borehole SE-02a after it collapsed. The HQ string was pulled out of hole and the bottom-hole assembly was removed before running in again with in total 70 HRQ rods, with the casing shoe located at a depth of 213.62 m. A temperature sensor was inserted at the bottom where it recorded 85 °C.

The change to the NQ string was completed at the end of the day shift on September 1. Rust inside the NQ pipes caused problems by clogging up water flow resulting in pulling the NQ string out of the hole to retrieve the core barrel. Near the end of the night shift these problems had been resolved by using mud to flush the hole, and drilling could commence. A total of 9 core runs were made over the 6.5 hours of drilling time between 20:00 on September 1 until 20:00 on September 2 by using a NQ

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coring bottom-hole assembly and string. The measured depth at the 20:00 shift change on September 2 was 236.3 m, corresponding to a vertical depth of 194 m.

The drilling progressed without interruption for 24 hours as 27 core runs were achieved from 20:00 on September 2 and 20:00 on September 3, reaching a measured depth of 312.9 m, or 256 m vertical depth. This is about 65-70 m below the sea floor before the eruptions began in 1963 (Thórarinsson et al., 1964). The strong team spirit at Surtsey was very much on display, with all excited about the drilling progress. It was decided to continue drilling until 10:30 Monday morning, September 4. Eighteen additional core runs were made, and core recovery was close to 100% when drilling through lapilli tuff. At a measured depth of 343 m the drill entered crystalline basalt. Core recovery (40-90%) was variable in the basalt intrusions. At a measured depth of 352-353 m the lithology changed to greenish-gray lapilli tuff, nearly identical to the tuff overlying the intrusion. The intrusion is approximately 5-7 m thick and occurs below the Surtur I crater, where effusive activity occurred between August 19, 1966 and June 5, 1967 (Jakobsson and Moore, 1992). It may therefore be considered as a feeder dike to the 1966-1967 effusive eruptions.

Figure 30. *Photograph of the drilling crew with the last core segments retrieved from SE-03 at the end of a remarkable series of shifts. Steve Cole, Justin Blouin, Anthony Vecchiarelli, Beau Marshall and Matthew Lyon (left to right) (photo: MTG).*

Drilling of borehole SE-03 was completed after 123 core runs at a total measured depth of 354.05 m, or a vertical depth of 290 m. Figure 30 shows the drilling team after retrieval of the final core. Figure 16 to Figure 18 and Table 7 provide information on the drilling progress.

The NQ rods are left in the hole as casing. Since the HQ rods remain, the borehole has a double casing through the upper 213.62 m. This should not affect future use of the hole for temperature monitoring and fluid sampling.

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8.8 Rigging down, de-mobilization and fluid sampling

Rigging down and preparations for demobilization began Monday, September 4. A helicopter transport planned for September 4 was postponed due to unfavorable weather conditions. On September 5, the Nordurflug helicopter brought three SUSTAIN team scientists from Reykjavík, to collect fluids the boreholes. During rigging down the on-site scientists collected fluids from SE-01 and SE-02b on September 5, by using a sampling bailer. The fluid sampling was completed on September 6 by sampling SE-03. The Vectran rope holding the five Surtsey Subsurface Observatory in situ incubation experiments was lowered into borehole SE-02b in the afternoon of September 6.

TF-HAD helicopter flights on September 6 transported equipment from the onshore water reservoir on the northern peninsula to the rig site, and dismantled the drill rig components in seven lifts.

Packing of the disassembled drill rig components and other equipment, and restoration and cleaning operations took place during September 6-9. ATV tracks were removed using rakes and shovels. On September 8, cement was mixed to continue a top job on the SE-02a and SE-03 boreholes. Well flanges were welded on SE-02b and SE-03. Personnel, food and samples were transported off Surtsey via helicopter. Intensive rigging down and packing continued.

Demobilization began September 10, through sling transports with the Icelandic Coast Guard TF-LÍF helicopter from Surtsey to the Icelandic Coast Guard vessel, VS Thór, but ceased after about 10 lifts due to strong wind conditions. The entire DOSECC drilling crew left Surtsey for Reykjavík. Temperature logs were conducted in boreholes SE-02a and SE-03.

Lifting of equipment resumed in the late afternoon of September 11. Two DOSECC drillers returned to Surtsey on the TF-LÍF helicopter and assisted with transport of about 50 lifts. Transports were stopped due to low visibility in the increased evening darkness. The 5 remaining loads were lifted off Surtsey in the morning of September 12. The Pálsbaer II hut was cleaned and all traces of drilling activity, except the three new wellheads, were fully removed. All personnel departed Surtsey.

The Icelandic Coast Guard vessel, VS Thór, arrived in Reykjavík in the evening of September 12. All equipment was then transported the Landsvirkjun warehouse in Mosfellsbaer, where it was sorted, cleaned, packed and prepared for shipping. On September 15, a project celebration party took place at the Institute of Earth Sciences at the University of Iceland (Figure 31). Packing and preparation of shipping continued during the next days, and was completed on September 18. The rig and drilling equipment was shipped in four containers to the United States.

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Figure 31. *Photograph of the SUSTAIN drilling team at the celebration party, Institute of Earth Sciences, Reykjavík, September 15, 2017 (photo: THH).*

9 Downhole logging

Logging activities carried out during the drilling campaign on Surtsey included temperature logs on all boreholes (Table 13) and a pressure-temperature monitoring string that was installed in borehole SE-01 while drilling hole SE-02b. These were carried out principally by the science team. A wireline downhole logging program (Table 14) in borehole SE-02b was carried out by the Operational Support Group of ICDP (ICDP-OSG) (Figure 32) on August 26, under the supervision of the scientist in charge, Tobias Björn Weisenberger. The Surtsey Subsurface Observatory was the installed in borehole SE-02b.

Temperature logs were initially planned with a handheld wireline logging tool. However, due to the corrosive nature of the saline hydrothermal fluids in the boreholes, the wireline connection malfunctioned. A HOBO temperature memory tool was then employed. The temperature memory tool was attached to logging string and lowered into the borehole, and the exact time recorded when the tool reached discrete depths. Upon retrieval, the HOBO data was downloaded from the memory tool and the recorded temperature-time data was compared with the time at which the logging tool passed the discrete depth interval. The monitoring string in borehole SE-01 consisted of three HOBO temperature memory tools and a pressure/temperature (MadgeTech) memory tool (Table 12). The string was installed on August 19 (Figure 33) and retrieved on September 4, 2017. The lowermost tool was, however, lost in hole because the aluminum clamps that attached the tool corroded and detached from the string.

The wireline downhole logging was carried out by the ICDP-OSG, used a 600 m logging winch and several logging sondes (Table 14, Figure 34) to measure following logs: total natural gamma, temperature, pressure, mud resistivity, magnetic susceptibility, hole inclination, total magnetic field amplitude, electrical resistivity and spontaneous potential. Because of the known risk of wall collapse, the drill string remained in the borehole to 39 m to provide protective guidance for the logging tools. The water table was detected at about 55 m.

A handheld temperature sensor measured the temperature of the SE-03 core as it was handed from the drillers to the on-site scientists. These temperature measurements are plotted together with the

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borehole temperature curves (Figure 35, Figure 36). The temperature logs for all four boreholes show a similar trend with a temperature maximum at about 100 m vertical depth.

Figure 32. *Photograph showing the ICDP-OSG team (left: Marco Groh, right Jochem Kück) carrying out wireline downhole logging of SE-02b (photo: TBW).*

Figure 33. *Photograph showing installation of the pressure and temperature monitoring string in SE-01 (Table 12) (photos: AB).*

Two temperature logs where carried out in borehole SE-03, one immediately after reaching the total depth on September 5 and another five days later, on September 10. These suggest a rapid temperature recovery, with a 20 °C increase in the maximal temperatures of the hydrothermal zone at about 120 m b.s. The September 10 log shows a linear trend through the lapilli tuff below about 250 m measured depth, corresponding to a depth of about 200 m b.s. This depth corresponds to the

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depth of the former sea floor before the eruption (Figure 7). The temperature logs of vertical boreholes SE-01, SE-02a, and SE-02b show a distinct temperature minimum at about 145 m b.s., possibly related to the recharge zone of the hydrothermal system.

The temperature and pressure monitoring in borehole SE-01 during drilling of borehole SE-02b (Figure 37, Figure 38) shows only small variations, 1-3 °C, indicating that any influence of the circulating seawater drilling fluid was very limited. The pressure fluctuations correspond to tidal cycles, although the response in SE-01 is slightly shifted in time, with a delay of about an hour from calculated values for Surtsey (tidal model on the webpage of Vegagerdin: http://www.vegagerdin.is/vs/ArealDetails.aspx?type=tides). On August 26-27 the monitoring string was removed from the SE-01 borehole but inserted again for the drilling of SE-03. Temperature monitoring then continued at 100 m measured depth and 135 m measured depth in borehole SE-01 until September 4 (Figure 38).

The results of the wireline downhole logging (Figure 34) in borehole SE-02b from temperature, mud resistivity and resistivity logs support the hypothesis of a recharge zone at about 145 m b.s.

Table 13. *Temperature logs carried out during drilling in 2017.*

Well	Date	Measurement	Analyst	Comment
SE-01	31.07.2017	Temperature	Viggó Th. Marteinsson	Downlog & uplog, problems with wireline connection
SE-01	08.08.2017	Temperature	Viggó Th. Marteinsson, Sigurdur Sveinn Jónsson	HOBO sensor
SE-02a	10.09.2017	Temperature	Magnús Tumi Gudmundsson	HOBO sensor
SE-02b	26.08.2017	Temperature	Marco Groh, Jochem Kück, Tobias Björn Weisenberger	ICDP-OSG wireline tool
SE-03	05.09.2017	Temperature	Magnús Tumi Gudmundsson	HOPO sensor, logged to 220 m
SE-03	10.09.2017	Temperature	Magnús Tumi Gudmundsson	HOBO sensor

Table 14. *Borehole logging carried out in borehole SE-02b, August 26, 2017.*

Sonde	Parameters	Logged depth range (m)	Remarks
TS2-MP-TEMP	Temperature, pressure, Mud resistivity, natural gamma	0-180	Water level @ 55 m (= elevation of drill pad), max. TEMP = 85 °C @ 113 m, local Temp minimum (51 °C) @ 143 m with indication also in MRES (higher), GR < 30 gAPI, poor variations
TS2-SGR-MS	Magnetic susceptibility, natural gamma	38-180	Good variations, many spikes; CS @ 39; GR too weak to log SGR, GR from MS run is Master-GR
TS2-DLL	Dual laterolog resistivity, natural gamma	55-180	MRES and DLL resistivity show similar trend
TS2-DIP	Dipmeter, total magnetic field, hole orientation, natural gamma	39-180	DEVI ≈ 1 deg, sonde movement is slightly wobbly -> DEVI varies ± 0.5 deg
SP	Self (spontaneous) potential	55-180	Good variations, first time use of this new ICDP-OSG sonde

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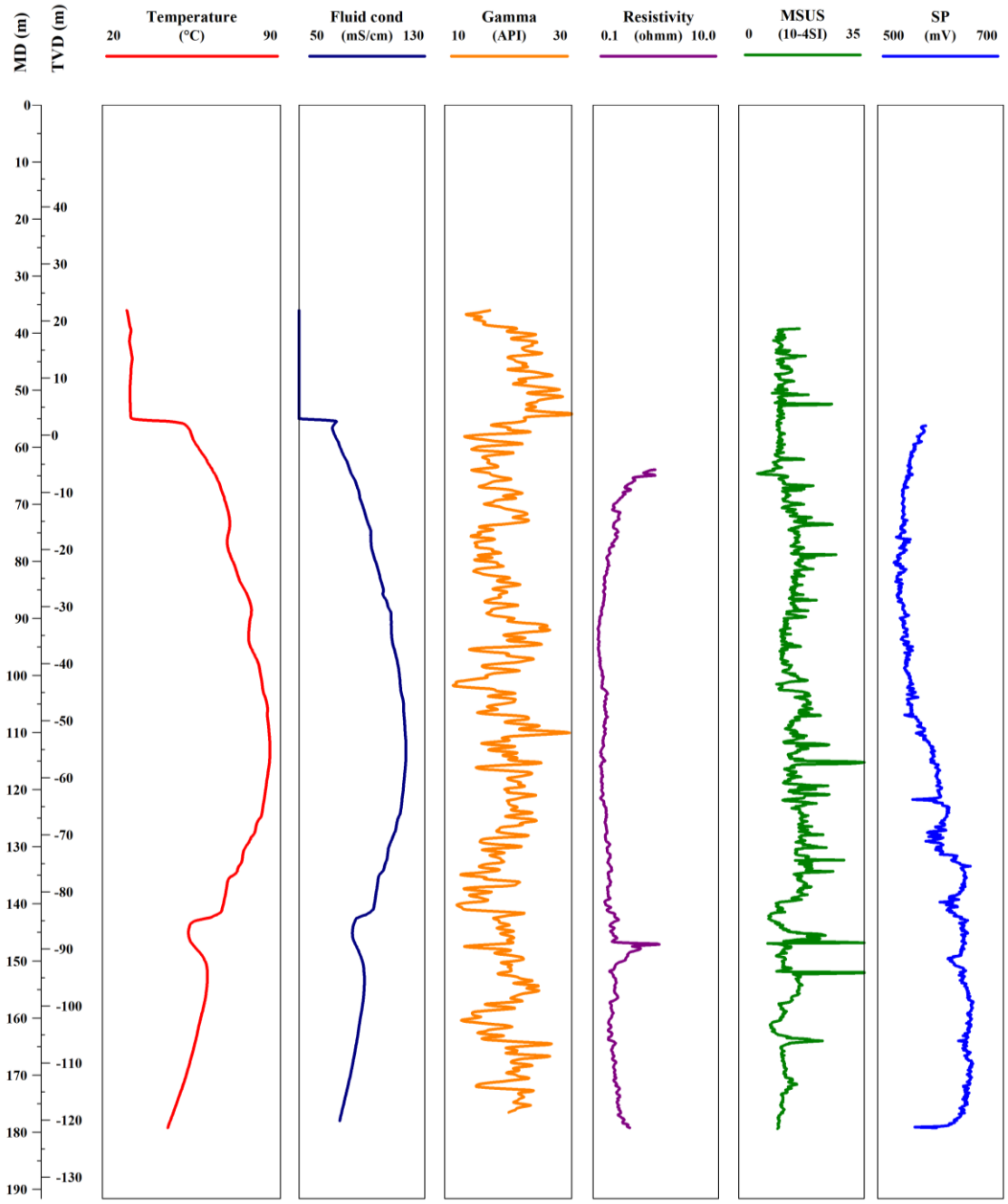

Figure 34. *Results of downhole logging in borehole SE-02b carried out August 26, 2017. All scales linear except resistivity which is logarithmic. To avoid the risk of collapse a 39 m long segment of the drill string was left in the hole, through which the logging tools were run up and down into the open hole. To reduce the risk of damage and potential collapse, logging tools were not introduced into the lowermost 10 m of the borehole.*

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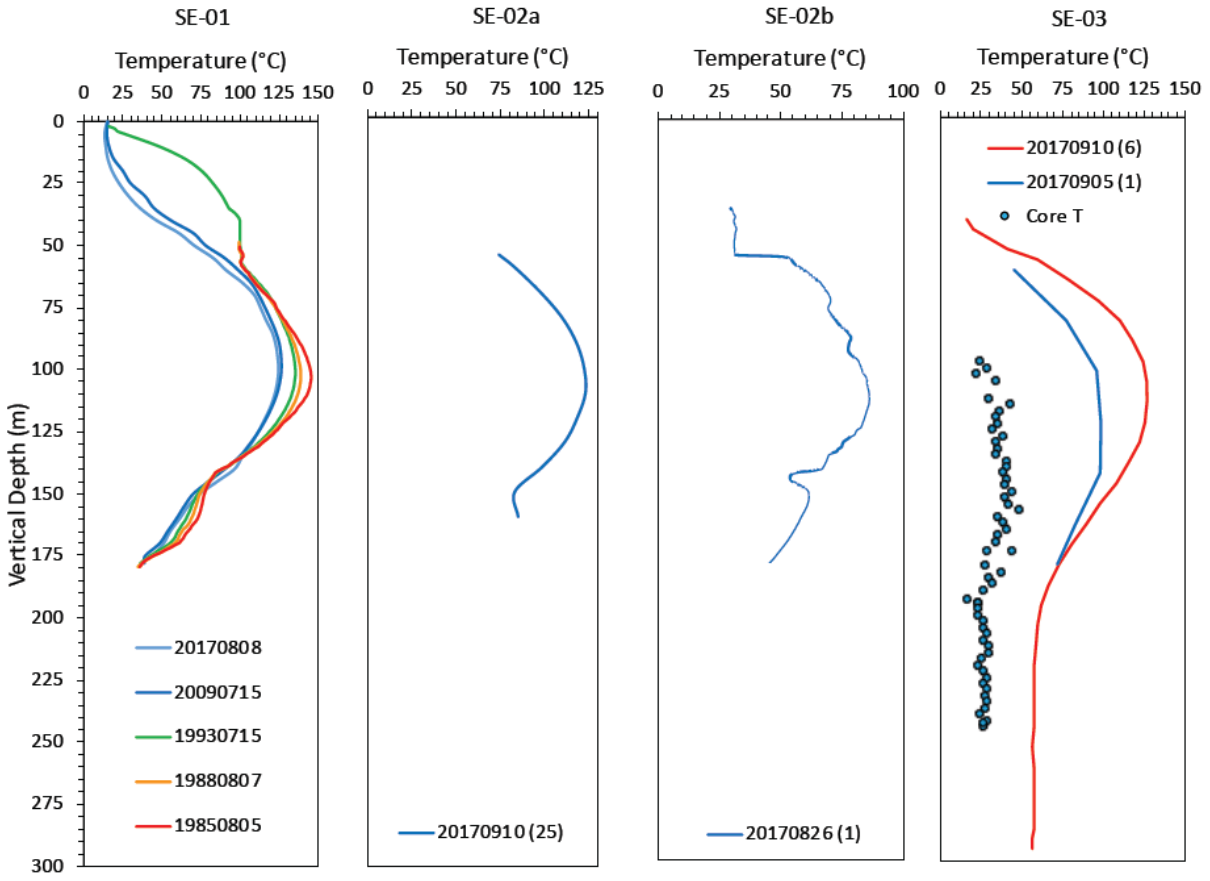

Figure 35. *Temperature logs for Surtsey boreholes. Selected temperature logs of borehole SE-01 (ÍSOR database). Temperatures in borehole SE-02a measured 25 days after completion, and SE-02b one (1) day after completion. Circles show temperatures of the SE-03 core measured at drill site retrieval. For SE-03, downhole temperatures were measured one (1) and six (6) days after borehole completion.*

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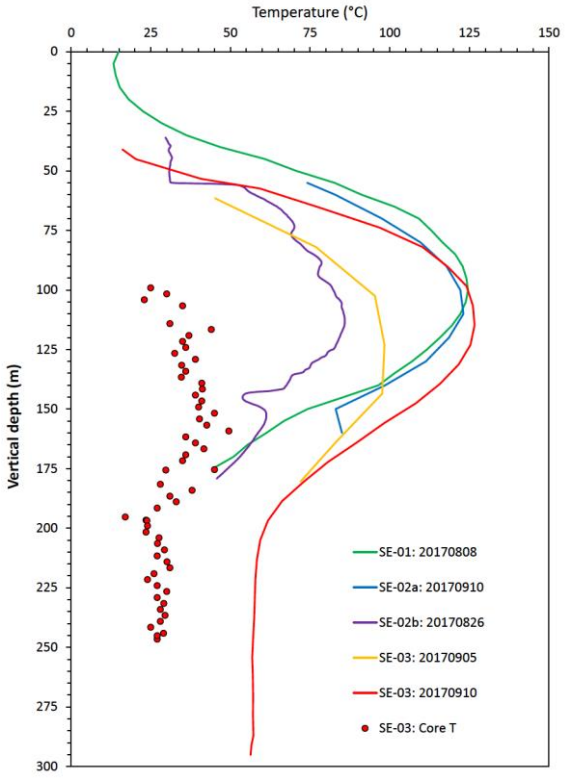

Figure 36. *Compilation of temperature logs obtained in 2017. Circles show temperatures of the SE-03 core measured at drill site retrieval.*

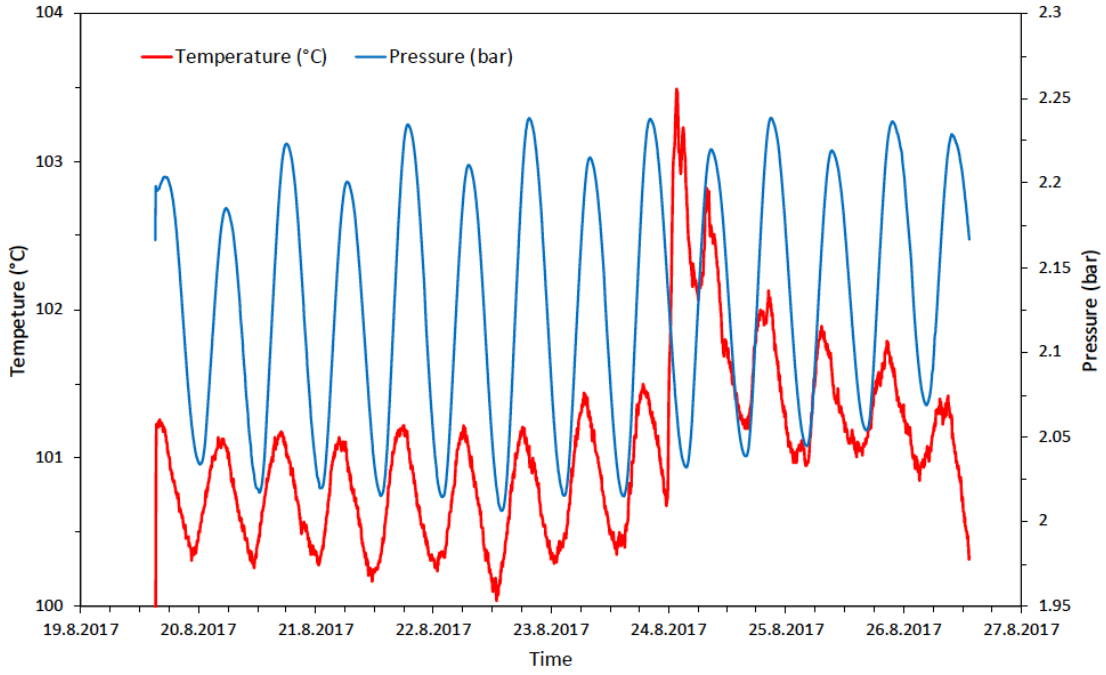

Figure 37. *Temperatures and pressures measured in borehole SE-01 at 65 m depth, August 19-26, 2017, during the drilling of borehole SE-02b.*

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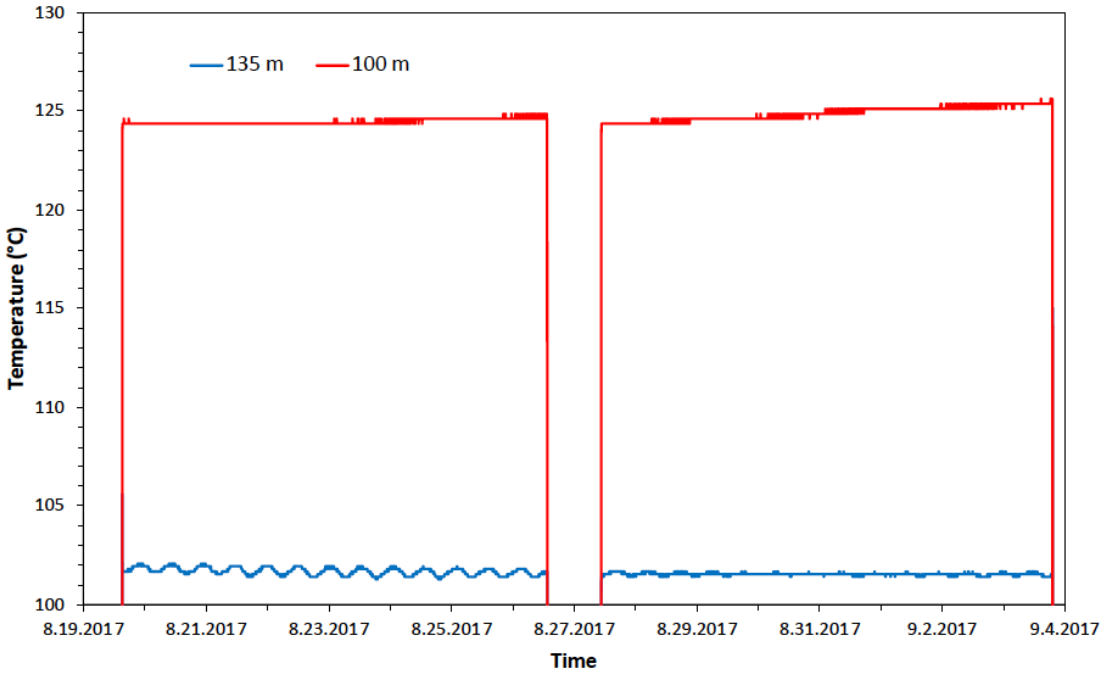

Figure 38. *Temperature data measured in borehole SE-01 at 100 m measured depth and 135 m measured depth during drilling of SE-02b, August 19-September 4, 2017. The data gap on August 26-27 occurred when the monitoring string was temporarily removed from the borehole.*

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10 Core handling and sampling on Surtsey

10.1 Core handling

Core processing took place in an aluminum container constructed at the rig site (Figure 39). The driller handed the core in its plastic liner to the on-site scientists. If present, the core catcher segment was carefully removed and packed directly into a separate plastic liner. Plastic gloves were worn throughout to minimize contamination.

Figure 39. *Photographs from the core shed at the drill site. a) Barbara Kleine (left) and Amel Barich (right) wait for the start of SE-02b coring, August 22, 2017. b) Core in plastic liner is cut with a pipe cutter. c) Carolyn F. Gorny observes a core fragment. d) Alteration minerals in the SE-03 core at about 200 m depth (photos: MTG, TBW).*

The core-in-liner from a 10 ft (3 m) core run was placed on a long steel holder (Figure 39) and immediately marked with the standard ICDP red and black two-line convention. Subsequently, the empty plastic liner was sawed off by using a conventional hack saw, followed by measurement of the length of the core and splitting it into several sections by using a pipe cutter (Figure 39). The core was then measured into sections of one meter or less that would fit in the one-meter-long storage trays. Longer sections were preserved in the uppermost core of borehole SE-02a, however, and cut into

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one meter lengths in the Heimaey laboratory. A pipe cutter was employed to cut through the liner and core; the segment was capped (blue on top, white below) and fastened with duct-tape; and the core liner labelled according to ICDP conventions for core tray and section number in a four panel portrait orientation (Figure 40).

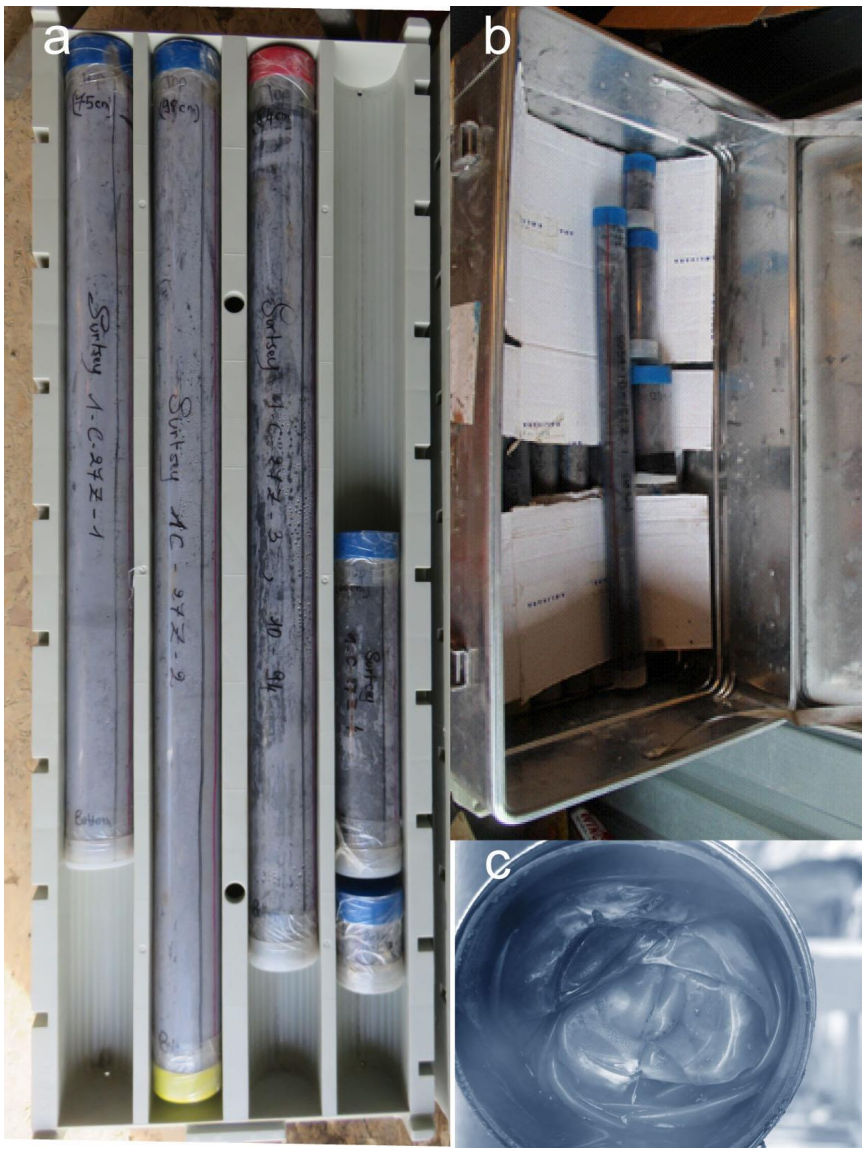

Figure 40. *Cores in plastic liners on Surtsey: a) Core run 27 (5059-1-C-27-Z), borehole SE-02b, cut into four sections, and placed in portrait format in the core tray. Microbiological and geochemical samples have been taken from the top of section 3, indicated by the yellow cap at the top of section 2 and the red cap at the bottom of section 3. b) Temporary storage of SE-03 core, awaiting additional core tray delivery. c) Deformed plastic liner in the coring tube (photos: AB, MTG, TBW).*

In principle, a single core run was to be stored in each core tray. These were stacked in the core shack, while awaiting helicopter transport to Heimaey. For borehole SE-02a, the core-in-liner sections longer than one meter were stored on the floor of the core shack. The supply of core trays ran out during coring of borehole SE-03, and the core-in-liner sections were stored in large aluminum boxes

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(Figure 40). On-site geologists made lithological descriptions from observations of the ends of the cut core sections or the core catcher (Figure 39). In core derived from the higher temperature zones of the hydrothermal system, the plastic liners thermally deformed (Figure 40). The rig crew had difficulties retrieving the core in the plastic liner from the metal core tube.

Collection of samples for microbiological studies and fluid geochemistry analysis followed a pre-determined protocol. An approximately 30 cm segment was identified in every third core run and further processed by the on-site microbiologists and geochemist (see details below). The resulting gap in the core was marked with a yellow plastic cap on its upper contact and a red plastic cap on its lower contact (Figure 39). The fact that the samples were taken from the core before the 1-m long sections had been defined, did occasionally cause difficulty in the later core processing as the combined length of the sample and the remaining core segment was sometimes more than the maximum 1 m section length.

10.2 Sampling on Surtsey

10.2.1 Microbiology

Fifty-six core samples were collected for microbial detection and analysis from the three boreholes from August 10 to September 4. In total, 17 core samples were collected from SE-02a, 17 core samples from SE-02b, and 22 core samples from SE-03. A 30 cm core section was cut from the lower end of the upper two meter of every third core run and divided into three sub-sections on the drill site: 10 cm for use in molecular analyses, 8 cm for cultivation, and 2 cm for microscopic investigation (Figure 41). Downhole water samples were also collected at successive depths from the SE-01 borehole and the SE-02a, SE-02b, and SE-03 borehole.

Molecular analyses sections were kept in the plastic core liner, taped at both ends, wrapped in a plastic bag and kept in liquid nitrogen (-196 °C) until delivery into long term laboratory storage at -80 °C. Cultivation sections were immediately removed from the liner, put into a sterile plastic bag, the oxygen removed by gas-pack; and stored at 4 °C. Microscopic investigation sections were incubated in a PBS 1X and 2% formaldehyde solution, washed twice with PBS 1X, transferred into a solution of PBS 1X and ethanol 96%, and stored at -80 °C. Sample preparation took place in a temporary laboratory in the Pálsbaer II hut.

10.2.2 Geochemistry

From the 30 cm long core segment, 10 cm has been stored for pore-water and whole rock chemistry analyses. These 10 cm segments were cut off from the sampling core using a conventional pipe cutter and/or saw; kept within the plastic liner; and capped and labelled following standard ICDP convention. The segment was then wrapped twice into plastic sample bags and sealed with conventional duct tape to limit any exchange between the core with the atmosphere. The sealed segment was stored in a refrigerator at 4 °C to avoid inducing chemical reaction prior to pore-water extraction and chemical analyses.

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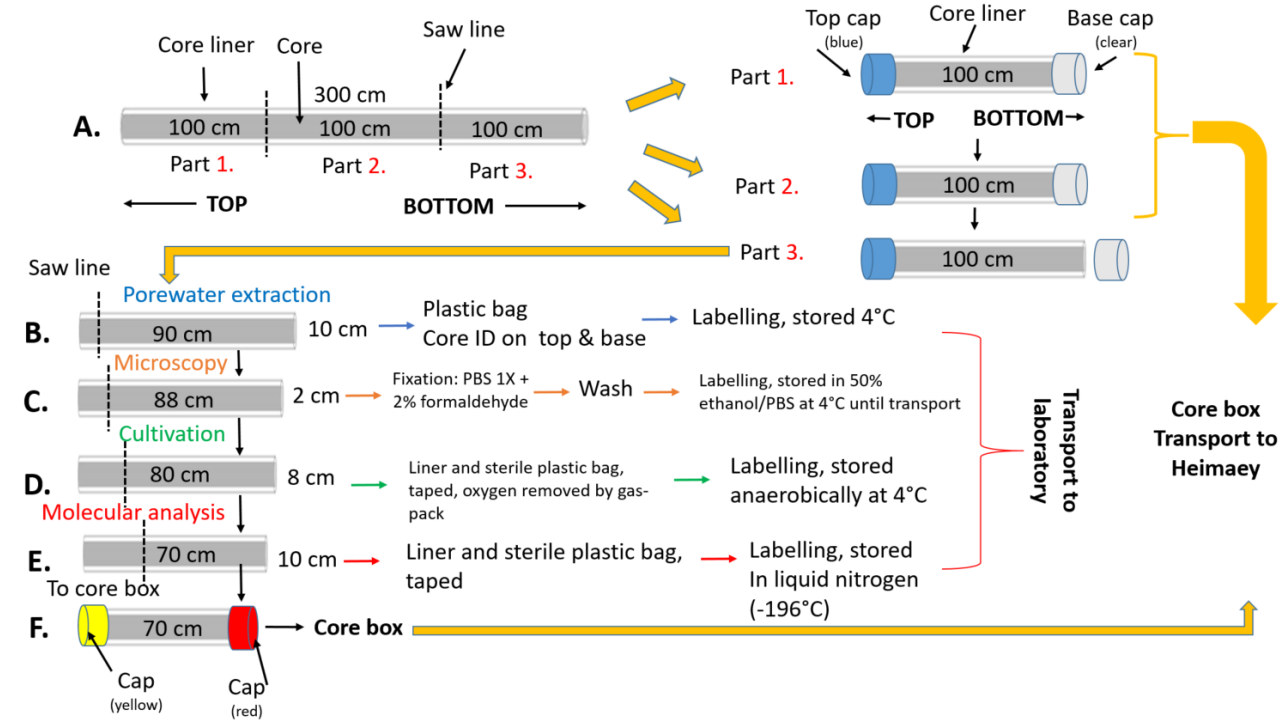

Figure 41. *Core processing protocols for microbiological sampling and pore-water extraction.*

11 Fluid sampling on Surtsey

During and after the drilling expedition, fluids were sampled within borehole SE-01, SE-02b and SE-03 for geochemical and microbiological investigations (Table 15, Table 16). The fluid sampling used an ÍSOR fluid sampling bailer with about one liter sampling volume (Figure 42), which was lowered into the borehole on a slick line to the sampling depth. A messenger was then sent down along the slick line in order to open the fluid bailer mechanically. After a short time, 10-20 seconds, had elapsed for the bailer to fill, it was closed, and then pulled out of the borehole. After retrieval the fluid was further processed and stored.

On September 5-6, 2017, it was observed that the fluids sampled from SE-02b were mud-rich, whereas fluids from SE-03 had very limited visible mud content.

The seawater circulation fluid was not considered to be sterile, despite the UV-sterilization processing, and water samples were collected during drilling to trace possible microbial contaminants introduced into the boreholes. At each depth that the core was sampled microbial investigations, one liter of drilling fluid was collected and filtrated through Sterivex filters to capture the microbial fraction. These samples were stored in liquid nitrogen at -196 °C on site and then transferred at -80 °C to the laboratory for future molecular analyses. During drilling, regular control samples were also collected from the decontaminated drilling fluid. Table 17 provides a list of all samples collected.

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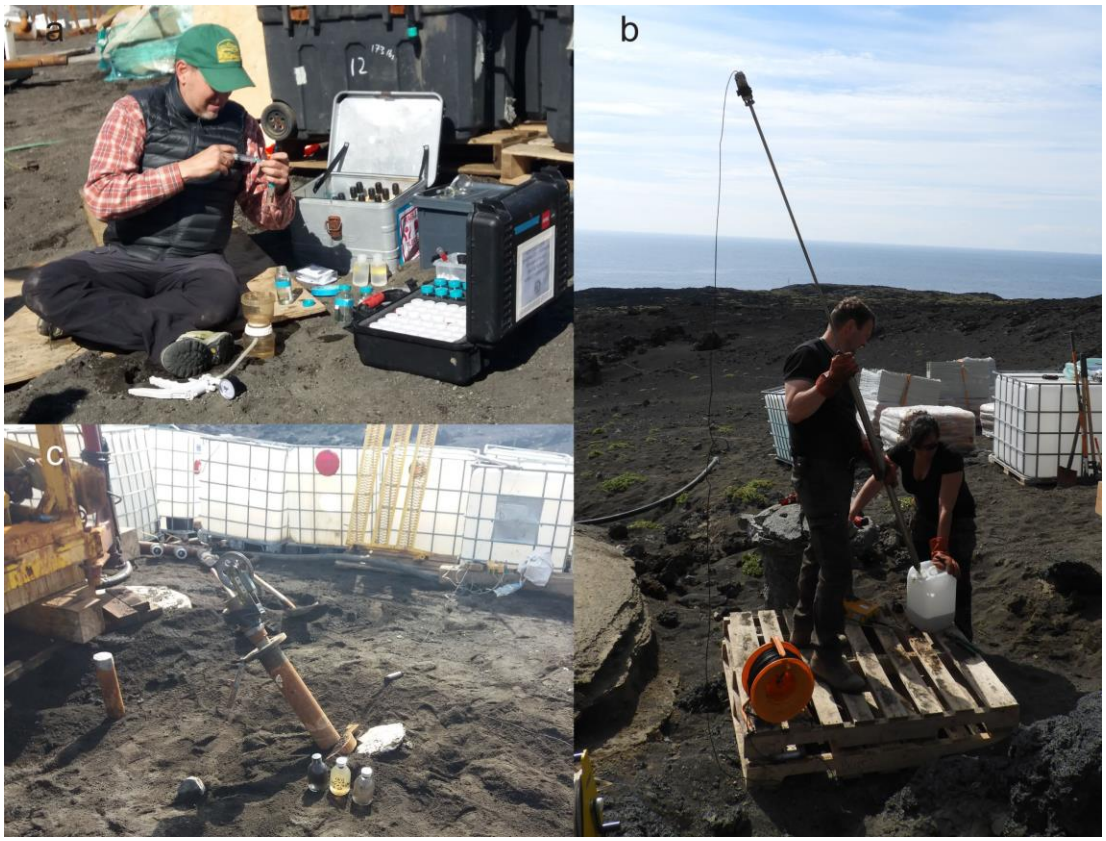

Figure 42. *Sampling of borehole fluids. a) Andri Stefánsson filters fluid samples, September 5-6, 2017. b) Well-head wheel on top of the angled borehole, SE-03. c) Viggó* Thór *Marteinsson and Alexandra Klonowski sample fluids from SE-01 using a fluid bailer, August 3, 2017 (photos: Barbara Kleine (BK), TBW).*

Table 15. *Fluid samples collected in 2017 with a fluid bailer from Surtsey boreholes for geochemical studies.*

Well	Sample no.	Sampling date	Depth (m)
SE-01	17-SURT-1	05.09.2017	60
SE-01	17-SURT-2	05.09.2017	80
SE-01	17-SURT-3	05.09.2017	90
SE-01	17-SURT-4	05.09.2017	100
SE-01	17-SURT-5	05.09.2017	110
SE-01	17-SURT-6	05.09.2017	120
SE-01	17-SURT-7	05.09.2017	130
SE-01	17-SURT-8	05.09.2017	140
SE-01	17-SURT-9	05.09.2017	150
SE-01	17-SURT-10	05.09.2017	165
SE-02b	17-SURT-11	05.09.2017	80
SE-02b	17-SURT-12	05.09.2017	90
SE-02b	17-SURT-13	05.09.2017	100
SE-02b	17-SURT-14	05.09.2017	140
SE-02b	17-SURT-15	05.09.2017	160
SE-02b	17-SURT-16	05.09.2017	170
SE-02b	17-SURT-17	05.09.2017	60
SE-03	17-SURT-18	06.09.2017	140

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Well	Sample no.	Sampling date	Depth (m)
SE-03	17-SURT-19	06.09.2017	200
SE-03	17-SURT-20	06.09.2017	280
SE-03	17-SURT-21	06.09.2017	75

Table 16. *Fluid samples taken in 2017 with a fluid bailer from Surtsey boreholes for microbiological studies (DNA isolation and cultivation).*

Well	Sampling date	Time	Depth (m)	Sampled by*	Volume (L)
SE-01	02.08.2017	16:08-18:00	160	AMK/VTHM	5
SE-01	03.08.2017	10:30-12:08	150	AMK/VTHM	5
SE-01	03.08.2017	15:45-17:00	56 to 58	AMK/VTHM	5
SE-01	04.08.2017	16:36-16:55	mix (120)	AMK/VTHM	1.5
SE-01	04.08.2017	17:57-18:47	120	AMK/VTHM	2
SE-01	08.08.2017	12:00-13:00	mix (165)	PB/AMK	0.85
SE-01	08.08.2017	12:00-13:00	165	PB/AMK	1
SE-01	05.09.2017	16:00-19:00	0-170	AMK	0.5
SE-02b	05.09.2017	16:00-19:00	80	AMK	0.5
SE-02b	05.09.2017	16:00-19:00	90	AMK	0.5
SE-02b	05.09.2017	16:00-19:00	100	AMK	0.5
SE-02b	05.09.2017	16:00-19:00	140	AMK	0.5
SE-02b	05.09.2017	16:00-19:00	160	AMK	0.5
SE-02b	05.09.2017	16:00-19:00	170	AMK	0.5
SE-02b	05.09.2017	16:00-19:00	60	AMK	0.5
SE-02b	05.09.2017	16:00-19:00	0-160	AMK	0.5
SE-03	06.09.2017	11:30-13:00	140 +/- 10	AMK	0.5
SE-03	06.09.2017	11:30-13:00	200 +/- 10	AMK	0.5
SE-03	06.09.2017	11:30-13:00	280 +/- 10	AMK	0.5
SE-03	06.09.2017	11:30-13:00	75 +/- 10	AMK	0.5
SE-03	06.09.2017	11:30-13:00	mix	AMK	0.5
SE-03	06.09.2017	11:30-13:00	mix	AMK	0.5

* AMK: Alexandra M. Klonowski, VTHM: Viggó Th. Marteinsson

Table 17. *Fluid control samples collected during drilling from the drilling fluid.*

Labeled	Core run no.	Date	Sampled by*	Volume (L)	Storing conditions	Others comments/ Observations
B-0Z-0, 0-0, C1	0	07.08.2017	PB	1	Liquid nitrogen	filter saturated at 1L
B-0Z-0, 0-0, C2	0	07.08.2017	PB	1	Liquid nitrogen	filter saturated at 1L
B-0Z-0, 0-0, C3	0	07.08.2017	PB	1	Liquid nitrogen	filter saturated at 1L
B-3Z-1, C	3	10.08.2017	PB	1	Liquid nitrogen	
B-9Z-2, C	9	10.08.2017	BK	1	Liquid nitrogen	
B-12Z-2, C	12	11.08.2017	PB	1	Liquid nitrogen	
B-15Z-3, C	15	11.08.2017	PB	1	Liquid nitrogen	
B-18Z-3, C	18	12.08.2017	PB	1	Liquid nitrogen	
B-25Z-3, C	25	12.08.2017	PB	1	Liquid nitrogen	
B-28Z-3, C	28	13.08.2017	PB	1	Liquid nitrogen	
B-31Z-3, C	31	13.08.2017	BK	1	Liquid nitrogen	
B-33Z-4, C	33	14.08.2017	PB	1	Liquid nitrogen	
B-42Z-3, C	42	15.08.2017	BK	1	Liquid nitrogen	
B-49Z-4, C	49	16.08.2017	PB	1	Liquid nitrogen	

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Labeled	Core run no.	Date	Sampled by*	Volume (L)	Storing conditions	Others comments/ Observations
B-52Z-4, C	52	16.08.2017	PB	1	Liquid nitrogen	
C-13Z-3-C	13	22.08.2017	PB	1	Liquid nitrogen	
C-17Z-3-C	17	23.08.2017	PB	1	Liquid nitrogen	
C-22Z-3-C	22	23.08.2017	PB	1	Liquid nitrogen	
C-27Z-3-C	27	23.08.2017	PB	1	Liquid nitrogen	
C-33Z-3-C	33	24.08.2017	PB	1	Liquid nitrogen	
C-36Z-3-C	36	24.08.2017	PB	1	Liquid nitrogen	
C-39Z-3-C	39	24.08.2017	BK	1	Liquid nitrogen	
C-42Z-3-C	42	24.08.2017	BK	1	Liquid nitrogen	
C-45Z-1-C	45	24.08.2017	BK	1	Liquid nitrogen	
C-51Z-C1	51	25.08.2017	PB	1	Liquid nitrogen	Start to use non sterile water or/and mud
C-51Z-C2	51	25.08.2017	PB	0.05	4 °C	Mud in falcon tube
C-53Z-C	53	25.08.2017	PB	0.05	4 °C	Mud in falcon tube
C-55Z-C	55	25.08.2017	BK	1	Liquid nitrogen	NS seawater
C-59Z-C	59	25.08.2017	BK	1	Liquid nitrogen	NS seawater
C-62Z-C	62	25.08.2017	BK	1	Liquid nitrogen	NS seawater

* BK: Barbara I. Kleine, PB: Pauline Bergsten

12 Surtsey Subsurface Observatory

A 2¾" aluminum alloy (T-6061) tubing (outer diameter: 69.85 mm, inner diameter: 57.15 mm) provides a 181.25 m long cylinder for in situ incubation experiments in borehole SE-02b (Figure 43). The tubing consists of 50 individual pipes, in which five have a perforated mid-section that allows fluids to enter at specific intervals: 38, 63, 106, 136, and 161 m b.s. (Figure 28 and Table 10). The tubing is attached to the wellhead, and is designed to hang freely within the borehole. The Surtsey Subsurface Observatory is comprised of a Vectran rope hung from the wellhead within this casing, on which experimental equipment and monitoring tools are mounted at desired intervals (Figure 43). These can be designed to measure a range of geochemical processes and physical properties over time. The observatory string is easy to retrieve and deploy. It is expected that it will form a template for future generations of oceanic observatories that can be modified for specific research objectives.

The first iteration of deployments consists of 40 incubation chambers (PEEKins) for basaltic glass and olivine mineral alteration studies. These are constructed from PEEK, and are similar in design to those used by Orcutt et al. (2010). They are perforated to allow fluid percolation. Eight packages (4x2) at the depths of the perforated casing sections were deployed on September 6, 2017. Fluids extracted from the borehole at that point had muddy appearance. Each package of PEEKins is equipped with a HOBO temperature memory tool. In addition, a pressure logging memory tool is located at 38 m b.s. Pressure and temperatures are measured at 30 minute intervals.

Artificial, sterile tephra, melted and quenched from Surtsey lava by Bernd Zimanowski, as well as olivine (Fo90) were placed in the incubation chambers. Each package contains 4 olivine and 4 tephra chambers. It is anticipated that the samples and data will be collected from the observatory in two years, in 2019, following guidelines for access to Surtsey. The samples will be investigated with microbial genomics studies including 1) community profiling with high throughput sequencing of

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prokaryotic 16S ribosomal gene libraries, 2) shot-gun sequencing of genomic DNA, 3) quantification of key functional genes, 4) In situ fluorescent labeling (FISH) and 5) electron microscopy.

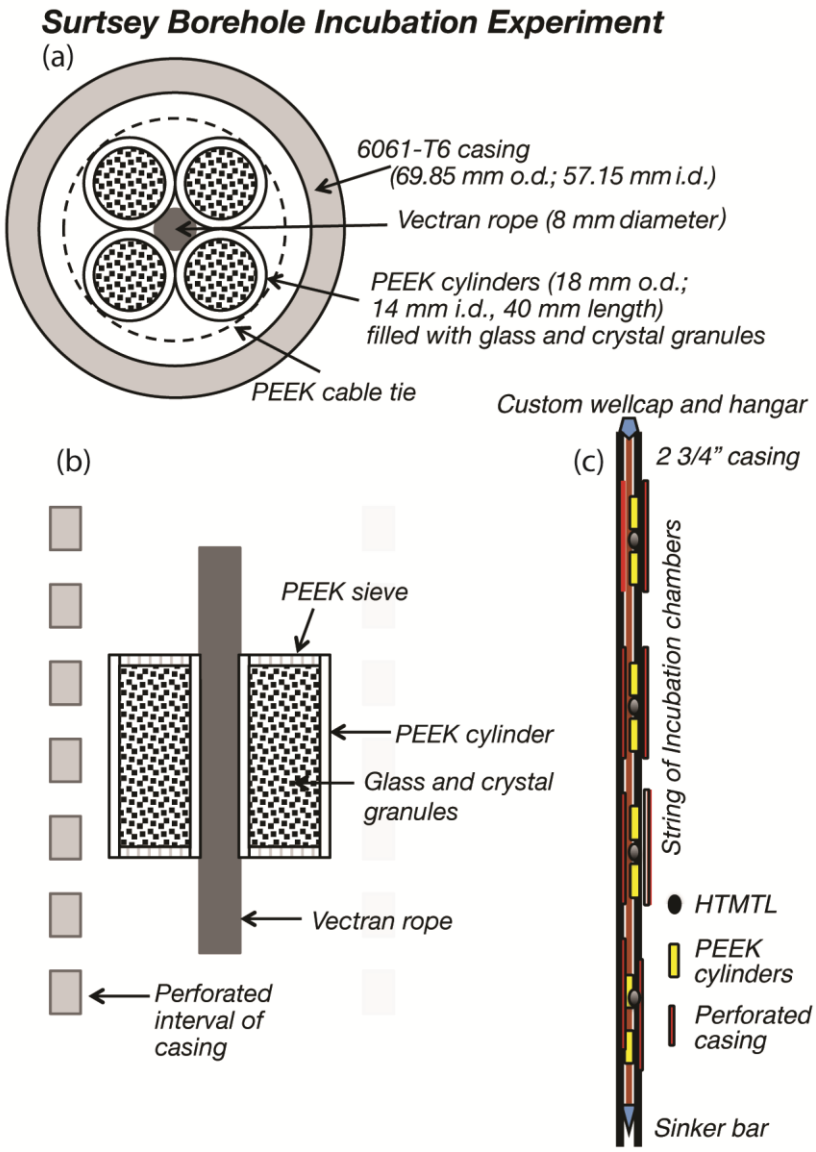

Figure 43. *Diagrams showing the components of the Surtsey Subsurface Observatory (after Kahl et al., 2017; Bach et al., 2017).*

13 Core processing in the Heimaey Laboratory

13.1 Core processing

The core processing operation on Heimaey from August 8 to September 29 took place in a large warehouse generously provided by the Vestmannaeyjar municipality (Figure 44, Figure 45). The

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workflow consisted of five principal tasks, planned and operated by scientists in charge MDJ and Andreas Türke (AT).

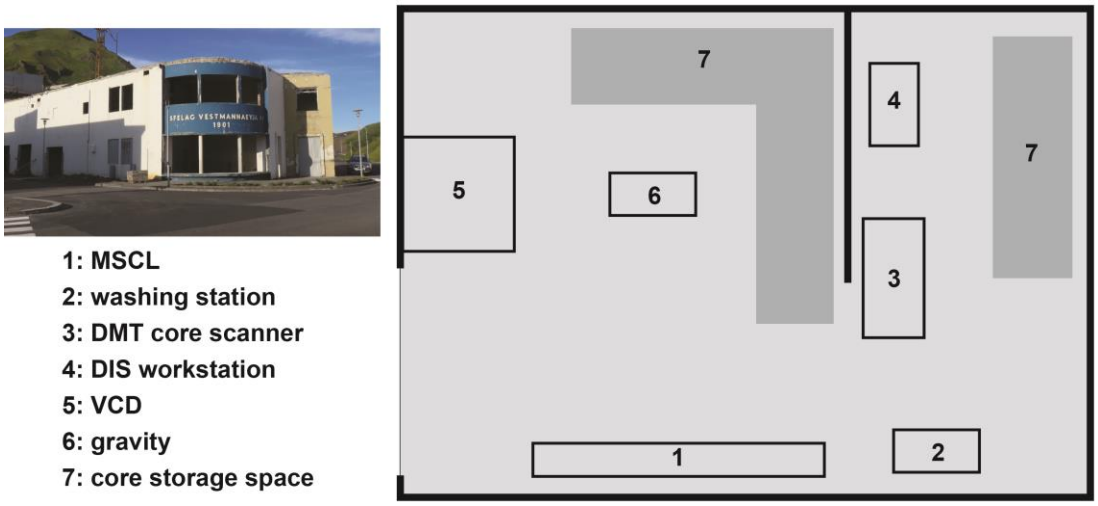

Figure 44. *Sketch of the Heimaey core processing location and arrangements of workstations. Photograph shows the northeastern corner of the municipal warehouse (photo: AB).*

i. Drill Core Inventory. Cores were delivered to Heimaey via helicopter from Surtsey at intermittent intervals. The inventory of core sections and the labels on plastic core liners and caps were verified with the driller reports, sample protocols, and core protocols and then entered into the DIS (Drilling Information System). Labels were printed on the basis of the DIS entries Several sections of the SE-02a core were reassigned on Heimaey, as they did not fit the one-meter-long panels of the core trays.

ii. Multi Sensor Core Logger (MSCL). All core sections were scanned while in the plastic core liner with a MSCL device provided by ICDP, to improve the resolution of the acquired data. The following parameter were logged at a 5 cm or 20 cm spacing interval: P-wave velocity, magnetic susceptibility, gamma density, natural gamma ray spectrum, and core diameter.

iii. Drill Core Cleaning and Packing in Core Trays. After completion of the MSCL scanning, the cores were removed from the plastic liners and gently cleaned with fresh seawater, obtained from the neighboring fish processing warehouse. Segments were fit together, if fractured, and marked with red and blue pens to record the "up" direction. The core was then assembled in four panel, plastic HQ Discoverer core trays; core information was entered into the DIS; and labels printed and pasted on and in the core boxes. Lengths of plastic foam tubes, or "pool-noodles", were used as placeholders to illustrate which sections of the core had been sampled on Surtsey for microbiological and geochemical studies.

iv. Digital core imaging. A DMT CoreScan 3 instrument provided by ICDP generated high-resolution images of the drill core, as arranged in the core trays. Each core section, as well as the entire core tray, were scanned in the planar mode giving fixed but detailed overview images. In addition, full circumference 360° scans of core sections were generated when the core was mainly intact. These form the basis of the unrolled images of the core. All images were uploaded into the DIS.

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v. Visual core descriptions (VCD): Macroscopic observations of the drill core were recorded in a visual core description template designated within the DIS. The organizational structure of these observations is described in Appendix G.

Figure 45. *Photographs from the core processing laboratory on Heimaey. a) Solveig Onstad, Amel Barich, and Simon Prause work on the Digital Information System (DIS). b) Steffen Leth Jørgensen washes a section of Surtsey drill core. c) Andreas Türke and Erica Massey operate the MSCL scanner. D) DMT core scanner. e) Carla Grimaldi describes sections of Surtsey drill core. f) Core boxes ready for transport to the archive at Icelandic Institute for Natural History in Gardabaer (photos: AT, Cedric Hamelin (CH), TBW).*

Core processing in the Heimaey laboratory covered the full description of the SE-02a core, partial description of the SE-02b core, and intermittent sections of the SE-03 core. In addition, specific gravity and water absorption tests were undertaken for 43 samples. Two physical volcanologists, Jocelyn McPhie (JMcP) and James D.L. White (JDLW), created comprehensive logs of the SE-02a, SE-02b cores and the lowermost and upper sections of the SE-03 core. From September 26-29 IceSUSTAIN team members dissembled and packed the lab equipment and cleaned the lab under the supervision of TBW. The core was transported to the Icelandic Institute of Natural History at Gardabaer, near Reykjavík on September 30.

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13.2 Sampling in the Heimaey Laboratory

13.2.1 Reference samples

Reference samples are core segments (Figure 46) and/or fluids available for analysis to all members of the scientific team. The reference samples were collected from pre-determined depths, at 3-4 m intervals in most cases, which were specified during the drilling and core processing operations. For boreholes SE-02a and SE-02b a 30 cm segment was taken at the drill site approximately every 9 m for microbiological and fluid geochemical studies. In angled hole SE-03 there were additional microbiological, fluid geochemical reference samples taken. In the Heimaey laboratory, thirty-three whole core segments were collected adjacent to these samples from the SE-02b and SE-03 cores. These whole core segments were cut into a 400-500 g archive whole round, to be stored at the Náttúrufraedistofnun Íslands, the Icelandic Institute for Natural History, and then further partitioned into smaller samples. These include a 200-300 g whole round ground for powder analyses (through JMR), four half-round pieces each 4-5 cm in length for production of thin sections, and four half-round rock slices each 4-5 cm in length for discretionary use. The samples have been distributed to the principal geographic clusters of the science team: IceSUSTAIN (Kristján Jónasson, KJ); SUSTAIN-EUR (Wolfgang Bach, WB); SUSTAIN-SOUTH (JDLW) and SUSTAIN-US (MDJ).

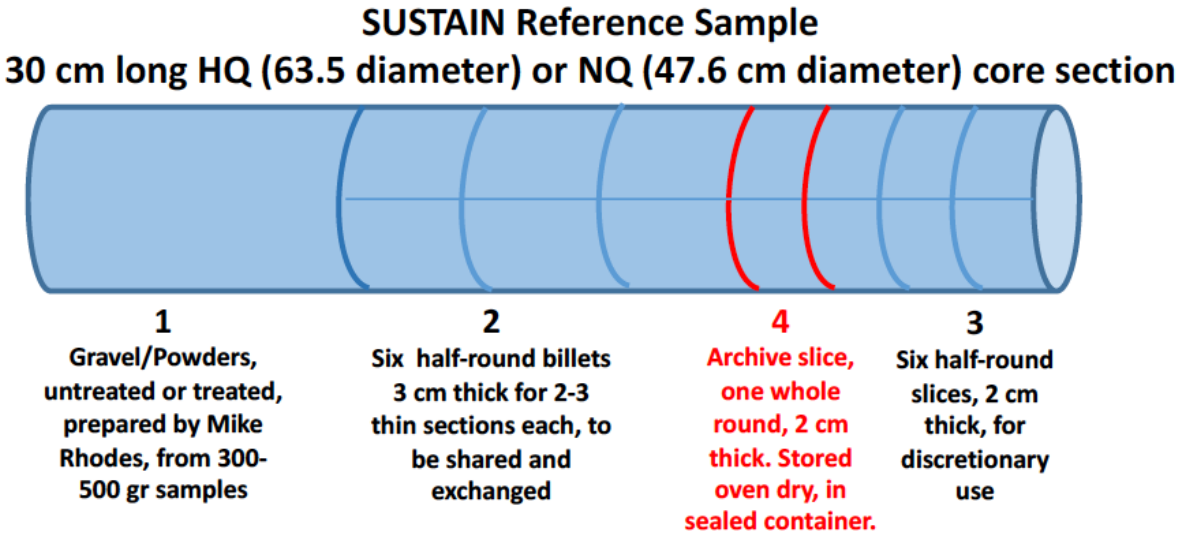

Figure 46. *Sketch showing the different types of reference samples.*

13.2.2 Bulk specific gravity and water absorption measurements

Water absorption and bulk specific gravity measurements of the freshly drilled core follow the guidelines of the American Standards for Testing of Materials C97/97M-09, Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone (ASTM 2000). Forty-three samples ranging from 2-10 cm in length were obtained from the SE-02a, SE-02b and SE-03 cores, mainly from whole round fragments already detached from longer core segments during drilling. The weight of the core sample, still saturated with hydrothermal fluid and/or seawater drilling fluid, was measured in air on the platform of an electronic balance with an error of ± 1–2 grams. The samples were then dried in a laboratory oven at 50-60 °C for 48 hours and weighed immediately in air on the platform of

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the electronic balance. The oven-dried sample was then suspended in a wire holder (Figure 47) attached to the base of the electronic balance, submerged in a bucket containing seawater (Figure 47), and weighed about 30 seconds later when any visible release of air bubbles terminated. The sample was then oven-dried for an additional 48 hours, wrapped tightly in plastic, and sealed in a plastic bag. The samples are now refrigerated in an air-tight bin at 2 °C for long term storage.

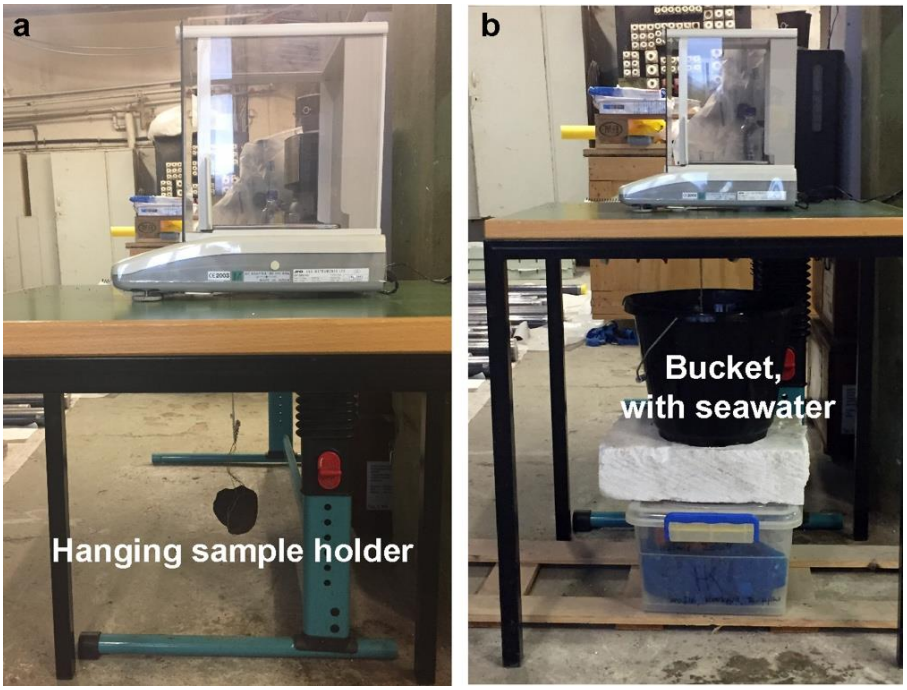

Figure 47. *Photographs of the equipment used to measure the weights of Surtsey core samples in air and in seawater for density, water absorption and specific gravity determinations.*

Absorption of water, Ab, is computed as (ASTM C97-96, ASTM 2000):

$$\frac{\text{weight}_{\text{water-soaked}} - \text{weight}_{\text{oven-dried}}}{\text{weight}_{\text{water-soaked}}}$$

Bulk specific gravity, G, is computed as (ASTM C97-96, ASTM 2000):

$$\frac{\text{weight}_{\text{oven-dried}}}{\text{weight}_{\text{water-soaked in air}} - \text{weight}_{\text{water-soaked in seawater}}}$$

The introductory assessment of specific gravity values (Figure 48) is plotted with the results from the 1979 drill core, obtained about one month after drilling (Jakobsson and Moore, 1982). The values are not directly comparable, however, since the 1979 determinations measure density and were performed on core samples taken directly from the core box archive and were not oven-dried. Full

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analyses of the data collected will include corrections for room and seawater temperatures, and a factor for seawater as compared with fresh water submersion.

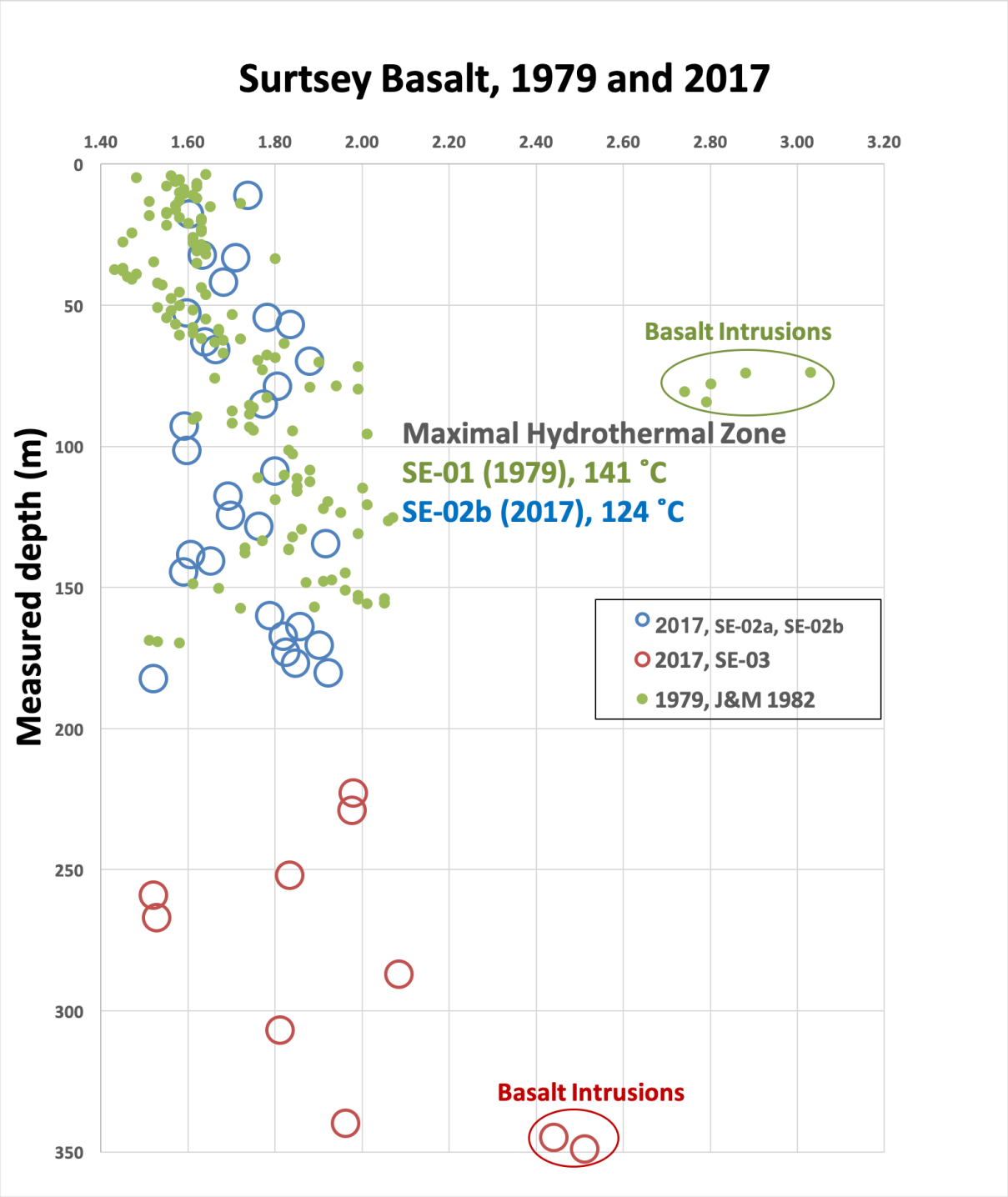

Figure 48. *Graphical comparison of 1979 density (Jakobsson and Moore, 1982) and 2017 specific gravity determinations of Surtsey tuff and basaltic intrusions. Note that the measured depth values for SE-03 are length along the axis of the inclined borehole.*

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13.2.3 Volcanology samples

During logging of the cores in the Heimaey Laboratory, specific features of particular volcanological interest were noted in the cores by JMcP and JDLW. These include composite lapilli, which consist of large and small lapilli-sized juvenile clasts, commonly scoriae, as well as coarse labradorite single crystals within the lapilli tuff. A small number of samples were designated as “volcanology samples” to be studied in collaboration investigations. Work on these samples is underway; seven samples containing composite lapilli are at University of Otago, and six samples containing large feldspar crystals are at University of Tasmania. In addition, four additional samples with very delicate mineral cements were packed in plastic, stored under air-tight conditions, brought to University of Utah, and refrigerated for fine scale mineralogical and spectroscopic analyses. A single sample of unconsolidated tephra has gone to University of Massachusetts, Amherst, to be analyzed with the reference samples.

13.3 Multi sensor core logger

All core sections of SE-02a, lower part of SE-02b (>140 m) and the upper part of SE-03 (<60 m) were logged at a 5 cm spacing interval, whereas the lower part of SE-03 (>60 m) was logged at a spacing of 20 cm, because of time constraints at the end of the core processing operation on Heimaey. The upper part of SE-02b was not logged. The following parameters were logged: P-wave velocity, magnetic susceptibility, gamma density, natural gamma ray spectrum, and core diameter. Due to the fact that the core was logged in the liner, no meaningful results for the P-wave velocity, which depends on core diameter, could be generated.

The MSCL profile for borehole SE-03 shows a gradual increase in density with increasing depth; a zones of higher density was also measured approximately 40-60 m measured depth. Magnetic susceptibility varies only slightly, but shows elevated values at approximately 60 m, close to sea level and the zone of tidal flux. Magnetic and mineralogical studies of drill core samples are currently underway; variations in ferromagnetic phases due to changing redox conditions in the tidal zone could be a possible explanation. Concentrations of radioactive elements, obtained by natural gamma ray spectra, do not show large variations. K content shows a slight decrease with increasing depth, while Th content is very low. Uranium content is less homogeneous, but does not show measurable downhole trends.

14 Core processing in Gardabaer

In order to complete the core processing, additional core processing took place at the Icelandic Institute of Natural History in Gardabaer, near Reykjavík (Figure 49). This was carried out by IceSUSTAIN team members, and was led by TBW and KJ. Equipment was provided by the Iceland GeoSurvey (ÍSOR), the Institute of Earth Sciences at the University of Iceland, and the Icelandic Institute of Natural History (IINH). The core processing began at the end of October and was completed at the end of December 2017.

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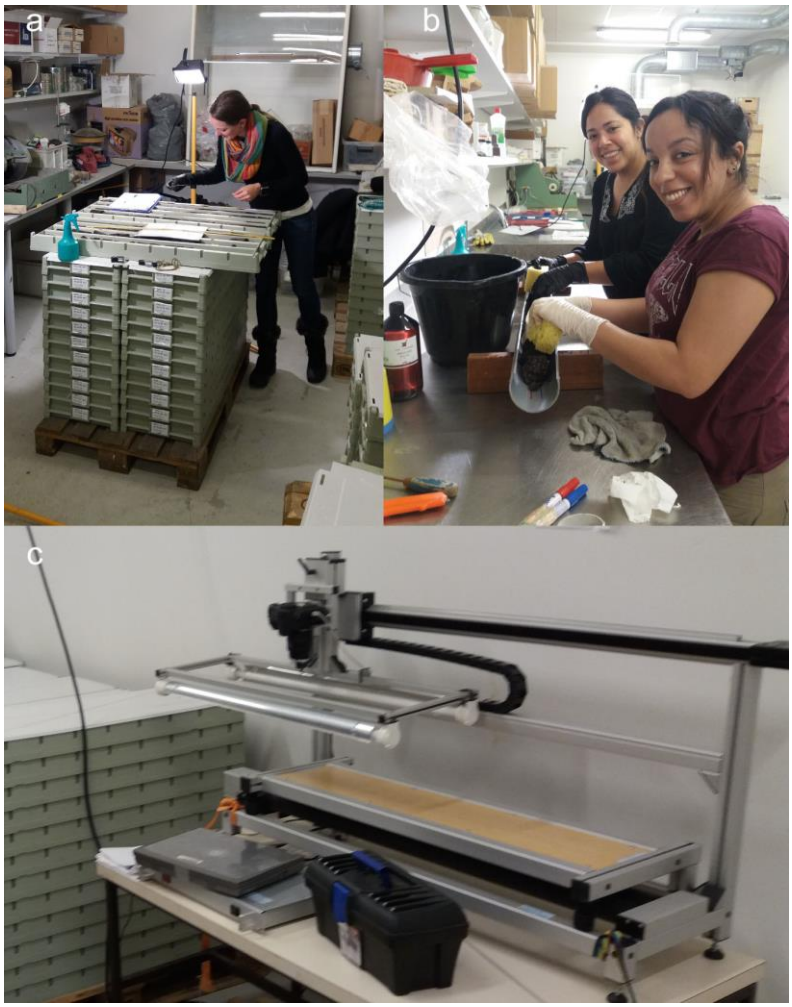

Figure 49. *Photographs of core processing at the Icelandic Institute of Natural History in Gardabaer, October-December 2017. a) Geologist Carolyn F. Gorny works on visual core descriptions. b) Velveth Perez and Amel Barich wash the core. c) ÍSOR core scanner (photo: TBW).*

The core processing included the following tasks:

- All core in liners that were stored in fish bins for transportation from Heimaey to the IINH were assigned to core trays, based on individual core runs.
- The core inventory for SE-02b and SE-03 was checked and corrected, if necessary. This included the redefinition of sections due to the fact that some primary sections, from which geochemical and biological samples had been collected on Surtsey, were greater than one meter in length. This required relabeling of core trays, sections, and samples.
- Database information for samples taken during the Heimaey core processing operation were corrected for SE-02b and SE-03. Placeholders labeled accordingly to ICDP standards marked the samples in the core trays.
- All core was removed from liners, marked with blue/black and red reference lines, and washed with fresh seawater, obtained from the Reykjavík zoo.
- Any mold was removed.
- Reference samples were imaged, documented, cut, and prepared for distribution.

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- Core from SE-02b and SE-03 was imaged with the ÍSOR core scanner smartCIS. Some sections already imaged in Heimaey needed to be imaged again, due to updating of the core inventory. Time and budget constraints precluded scanning for unrolled images of a part of the middle section of the SE-03 core. However, complete overview imaging was carried out for SE-02b and SE-03. Some core trays, sections and samples were relabeled.
- New visual core descriptions (VCD) were made by Carolyn F. Gorny (CFG) for cores SE-02b and SE-03 within a time period of 3.5 weeks.
- After completion of the October-December work, issues with DIS compatibility and entering logging information into the system were resolved by TBW in January in Potsdam, in collaboration with ICDP staff.

Two methods were used to describe the 2017 cores. A suite of macroscopic observations of the Surtsey tuff and tephra were developed in advance of the drilling project and organized within the DIS structure. These visual core descriptions were recorded for all of the SE-02a core, parts of the SE-02b core, and some of the SE-03 core in the Heimaey laboratory.

Additional standards for lithologic logging for SE-02b and SE-03 were defined by CFG with significant input from JDLW and JMcP, and followed a systematic methodology consistent with current volcanological research standards (Appendix G). All of the cores from SE-02b and SE-03 were described by the latter method during core processing in October-December 2017 at the Icelandic Institute for Natural History.

The images from the smartCIS core scanner required considerable cropping and editing before they were entered into the DIS. This, and many other required core processing tasks were finalized in April-May 2018 at the IINH in Gardabaer by the IceSUSTAIN and University of Utah groups, under the leadership of Samantha Couper.

14.1 Visual core descriptions of the SE-02a and SE-02b cores

The description of the SE-02a and SE-02b cores highlights three lithofacies: armored-lapilli tuff, lapilli tuff, and crystalline basalt. There were no significant variations noted between the two cores, though SE-02b has a small intrusion not present in SE-02a, and the depths of lithofacies transitions are slightly different (Figure 50). Armored lapilli tuff is most obvious in the upper 60 m of the cores but armored clasts may be present down to 80 m depth. The ability to distinguishing these clasts with certainty becomes increasingly difficult with increasing alteration. The lapilli tuff varies in grain size, degree of alteration and lithification along the core. Lapilli tuff at the base of the core is poorly consolidated to unconsolidated and relatively unaltered.

Crystalline basalt is present at two intervals in SE-02b. The first occurs at 16.62-17.50 m b.s. as a shallow intrusion with brecciated margins; the second occurs in the lowermost 15 cm of the core. This crystalline basalt has indistinct, planar margins and lacks an apparent glass rind or other in situ cooling features.

14.2 Visual core description of the SE-03 core

The description of the SE-03 highlights four lithofacies: armored-lapilli tuff, lapilli tuff, crystalline basalt and other clastic deposits (clay horizons and possible volcanic sandstone). The lapilli tuff in the

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SE-03 core includes two additional subfacies, one of which is fluidal-lapilli tuff, characterized by grains shaped by surface tension and formed by ductile fragmentation of magma (Morrissey et al., 2000; Taddeucci et al., 2007). The other is lapilli tuff breccia containing lithic clasts ≥64 mm. These two subfacies are present only in the core of the inclined hole, well below sea level within the diatreme or vent area of Surtur I.

Armored-lapilli tuff is present to 70.86 m depth with armored clasts becoming increasingly rare and indistinct with depth, as in the SE-02a and SE-02b cores. While armored clasts may be present deeper in the core, increased alteration obscures the characteristic features used for their identification.

Clay horizons occur at 70.6 m and 239.87 m within lapilli tuff. Well-sorted volcanic sandstone, called sandstone because the good sorting is inferred to indicate some form of sedimentary reworking, occurs as a thin stringer interbedded with lapilli tuff at 339.87-339.88 m, with subangular to well-rounded grains and extensive secondary minerals. An inconspicuous, permeable horizon, appearing under the binocular microscope to comprise very well sorted clastic material, occurs at 349.6-349.65 m, separating two crystalline basalt layers. Individual particles are nearly identical to crystalline basalt and difficult to distinguish. However, recognizable grains have blocky, platy, cuspate, and rather delicate grain shapes, and grain boundaries defined by broken vesicles, these features suggest limited transport distances and/or limited grain-interactions (Sohn et al., 2008). The upper contact with the overlying crystalline basalt appears rugged and micro-brecciated/hackled, whereas the lower contact appears diffuse and indistinct.

Crystalline basalt occurs at multiple levels within armored lapilli tuff and lapilli tuff as thin shallow intrusions with brecciated margins (60.01 m, 236.26 m, and 238.65 m). At 341 m crystalline basalt comprises a portion of the core with irregular, glassy contacts with lapilli tuff. At 343.83-349.6 m, crystalline basalt dominates the core with multiple phases of dike intrusion preserved as sharp glassy contacts or sharp contacts marked by a zone of enhanced secondary mineralization.

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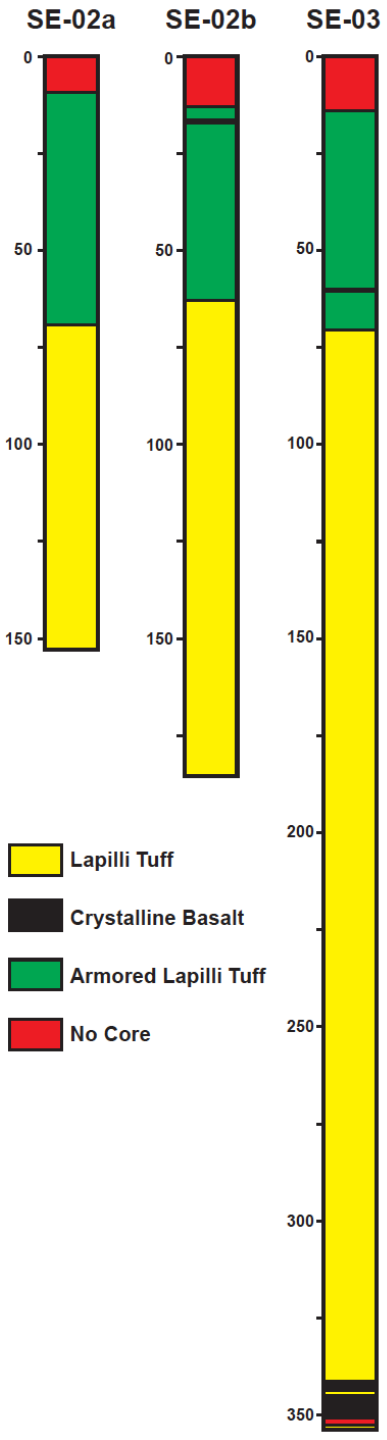

Figure 50. *Simplified lithological logs of the SE-02a, SE-02b and SE-03 cores. The scale is measured depth.*

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15 Core storage and preservation

The 1979 and 2017 Surtsey cores are stored in the rock and mineral collection facility at the Icelandic Institute of Natural History in Gardabaer. Initially, some core was stored moist and in liners at room temperature but this was abandoned as the development of mold was observed on some the cores. The core boxes are stacked on palettes in a basement room with a temperature of 21-24 °C and relative humidity of 20-30%. Nearly 300 m of the 2017 cores were sealed in plastic and flushed with nitrogen in May 2018, to prevent oxidation and carbonation. A small selection of these will be kept refrigerated at the IINH. Archive samples of the 33 reference samples have been kept sealed in plastic since drilling. They will be oven dried, packed in plastic, flushed with nitrogen and kept refrigerated at the IINH. The cores will remain at IINH during the moratorium period, and perhaps longer. Permanent storage is expected to be at the IINH core repository in Breiddalsvík.

16 Preliminary scientific assessment

16.1 Volcanology

The SE-02a and SE-02b cored boreholes traverse lithological sections very similar to that of the 1979 core borehole. The 1979 core includes an interval at 71.9-84.8 m dominated by basaltic intrusions with glassy margins against dense, greenish-grey lapilli tuff (Jakobsson and Moore, 1982). These intrusions do not occur in the SE-02a and SE-02b cores.

The SE-03 core transects lapilli tuff for about 100 m beneath the pre-eruption seafloor. This indicates that the diatreme structure hypothesized by Moore (1985) on the basis of the 1979 drill core is present beneath the Surtur I crater (Figure 7). The seafloor was excavated by explosive magma-seawater interactions and then backfilled, repeatedly, with reworked eruptive products. Among these products is a distinctive interval containing pyroclasts with strongly fluidal shapes. These suggest a period during the explosive eruptions of Surtur I when incandescent lava particles formed, deformed, and were deposited within the vent structure at depths greater than 130 m b.s.l.

The 1979 core and all three SUSTAIN cores recover lapilli tuff that is cut by very thin, <10 cm, sheets of coherent basalt, with various moderate to shallow dips. These are interpreted on the basis of their curvilinear contacts to have been intruded into the unconsolidated vent infill.

16.2 Thermal history

The temperature profile measured in SE-01 in August 2017 indicates that the gradual cooling of the hydrothermal zone continues (Figure 35). Since 1980, the maximum temperature at about 100 m b.s. has fallen by approximately 15 °C. Temperatures measured in the SUSTAIN boreholes in September 2017 must be interpreted with caution, since the low temperatures produced by the cool seawater drilling fluid had not yet recovered to predrilling conditions. There are indications that maximum temperatures in the inclined hole are greater than those of the vertical holes. Moreover, the section of SE-03 within the diatreme had an elevated temperature of ~60 °C on September 10, 2017, six days after drilling activities terminated.

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The thermal history of Surtsey will be investigated using numerical modelling techniques, with the aim of explaining the residual heat observed within the island 50 years after the eruption took place. This includes incorporating measurement of the elevated diatreme temperatures into a new conceptual model of the geothermal area. The effect of different intrusion geometries and volumes on the temperature field will be explored. The input parameters of the model will be based on measurements of the rock material properties, the temperature profiles from 1979 and 2017, the eruption history for 1963-1967 future temperature measurements, and the structure of the island as observed in the drill cores.

16.3 Authigenic mineral assemblages

Investigations of 1979 drill core samples in the early 1980s revealed variable rates of basaltic glass alteration in the tephra above and below sea level (Jakobsson and Moore, 1986). These rates were recorded by the thickness of an alteration layer around the perimeter of sideromelane lapilli and olivine crystal fragments, which increased with temperature. Iron-rich, smectitic clay mineral, principally nontronite, occupied these altered zones. Elements released through dissolution of glass produced alkaline solutions from which authigenic minerals crystallized. These are principally analcime, a sodic zeolite; phillipsite, a calcic, sodic and potassic zeolite; and anhydrite, a calcium sulfate mineral. Al-tobermorite, an unusual calcium-silicate-hydrate phyllosilicate with 11.3-11.4 Å (002) d-spacing occurred throughout. It is well-developed in the submarine hydrothermal system. The degree to which authigenic alteration phases have changed the geochemical, mineralogical and material properties of the tuff since 1979 is a central focus of SUSTAIN investigations.

During the two years prior to drilling, new studies of the 1979 core were undertaken to provide reference guidelines for measuring alteration in the 2017 cores. Investigations of altered glass and authigenic mineral assemblages used synchrotron-source X-ray microdiffraction and microfluoresence studies, S/TEM imaging and analyses, Raman spectroscopy, and bulk sample magnetic hysteresis properties (saturation magnetization, squareness, and coersivity). Bulk geochemistry of tuff powders has also been undertaken. Parallel analyses have now begun on the 2017 cores. Initial studies of crystallization sequences in authigenic microstructures indicate rapid growth of mineral cements in chemically dynamic microenvironments. Examples are shown in Figure 51.

A principal objective of SUSTAIN research is to describe how the cumulative effects of changes in the temperature and the compositions of interstitial fluids in the hydrothermal system have influenced the production of metastable mineral assemblages, including ferromagnetic phases, in the 50-year-old deposits. Whole rock geochemistry, fluid geochemistry, mineralogical, spectroscopic and electron microprobe investigations will be integrated with microbiological studies to assess the roles of abiotic and biotic processes. The results of material property and rock testing experiments will be compared with measurements made in 1980 to provide a record of changes in porosity, permeability, and unit weight. New measurements of thermal properties, seismic wave velocities, compressive strength, and elastic properties will provide insights into the complex feedback loops that produce interdependent changes in authigenic mineral fabrics and porosity and permeability characteristics.

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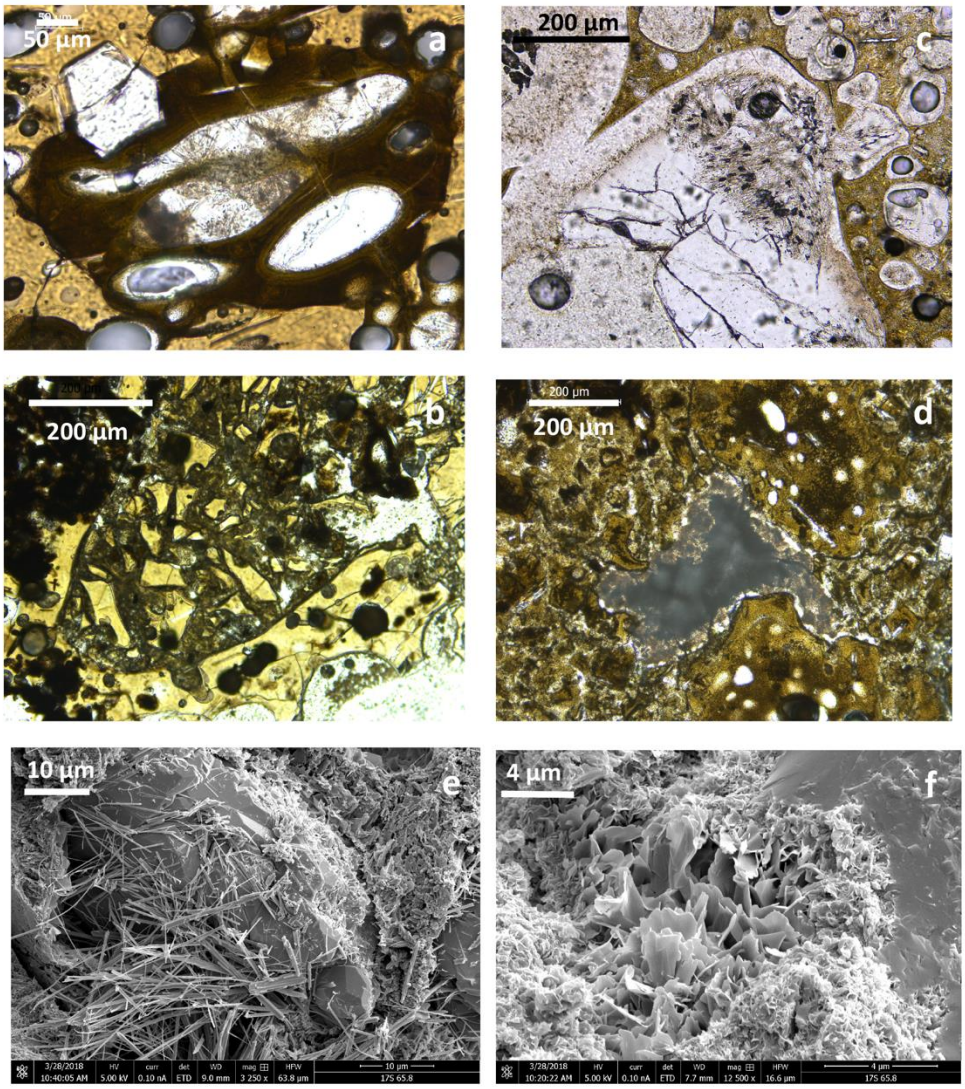

Figure 51. *Examples of authigenic mineral assemblages in the SE-02a core. Petrographic images, plane parallel light. a) Al-tobermorite in a vesicle alters to analcime and nontronite clay mineral, at 32.5 m (5059-1B-9Z-2, 67–69; SG-3); b) persistence of fresh glass, at 144.6 m (5059-1B-40Z-4, 0–3; SG-21); c) and d) dissolution of a labradorite crystal to form Al-tobermorite, and filling of a vesicle in the vitric matrix with Al-tobermorite, at 170.5 m (5059-1B-50Z-3, 27–36; SG-29). SEM secondary electron images, c) dissolution of analcime and associated Al-tobermorite, at 65 m (5059-1B-21Z-2, 65-67; SG-10), and f) alteration of glass to form nontronite clay mineral, at 107.5 m (5059-1B-37Z-2, 77-81; VS-2).*

16.4 Fluid geochemistry of pore-water and thermal fluids

Pore-water from the geochemistry samples were extracted by following the method described by Wheat et al. (1994). The chemistry of the extracted pore-water (Si, Na, K, Ca, Mg, Fe, Al, B, S, Cl) will be analyzed using the inductively coupled plasma optical emission spectrometer (ICP-OES) at the lab facilities at the Institute of Earth Sciences at the University of Iceland. The major chemical composition and water isotopes (δD and $\delta^{18}O$) of the thermal fluids retrieved by the bailer from boreholes will be analyzed using ICP-OES, ion chromatography (IC) and isotope ratio mass

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spectrometry (IRMS) at the lab facilities at University of Iceland. The $\delta^{34}S$ for SO_4 of the water will be analyzed using IRMS after conversion to Ag_2S at University of Iceland and the Massachusetts Institute of Technology (MIT) at Boston.

16.5 Microbiology

Fifty-six core samples were collected from the three drill holes in August and September 2017 and immediately stored on site under predetermined conditions (anaerobically at 4 °C, fixation, -20 °C-196 °C) for microbiome analysis. Seventeen samples were collected from SE-02a, seventeen from SE-02b and twenty-two from SE-03. These samples will be used for cultivation, molecular analyses and microscopic analyses. Microorganism cultivation is ongoing and 86 strains have been isolated from fluid samples in SE-01 and from core samples in SE-02a and SE-02b. DNA will be extracted from all core and water samples for metabarcoding, metagenome sequencing and for cells quantification by qPCR. Furthermore, tomography, biomarkers, Fluorescent In-Situ hybridization and molecular probe studies will be undertaken on the core samples. These analyses will investigate interactions among microorganisms and minerals.

In situ incubation experiments were installed in the Surtsey Subsurface Observatory in the SE-02b borehole in September 2017. It is expected that in summer 2019, 8 samples from the 5 incubation depths will be collected for investigations similar to those of the core samples, using cultivation, molecular and microscopy analyses. Thus, a total of 40 samples, installed in 2017 and collected in 2019, comprised of 20 fresh basaltic glass and 20 olivine experiments and their associated fluids will be analyzed. Data from the in-situ temperature loggers will also be collected, and additional fluid samples will be taken from each borehole

17 Outreach activities

The SUSTAIN project team has emphasized educational outreach, to provide information about the natural hydrothermal laboratory at Surtsey, the new drilling project, and its scientific objectives. This has been considered a critical objective, since Surtsey is a UNESCO World Heritage Site (https://whc.unesco.org/en/list/1267) and therefore has particular meaning and value to the global public. The objective was also to demonstrate that the drilling project would be carried out with zero impact on the Surtsey environment, and that it would generate high impact research results of true societal benefit.

To accomplish these goals, project scientists contributed to the ICDP website (http://surtsey.icdp-online.org). This describes the science team and provides a gallery of photos and daily reports from the drilling operation on Surtsey. In addition, graduate students and project scientists created a blogspace through the University of Utah (https://surtsey50years.utah.edu/), that describes SUSTAIN activities on Surtsey, on Heimaey and ongoing scientific contributions. The blogspace is linked to project Facebook and Twitter accounts describing SUSTAIN activities. Topics encouraging young peoples' interests in science and the natural world are particularly encouraged. Regular posts aimed at Icelandic audiences were put on the Institute of Earth Sciences Facebook page. These posts were closely tracked by the interested public and Icelandic media resulting in several interviews with team members in television, radio and newspapers in August and September 2017. Filming on Surtsey and

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Heimaey from August 20-22, 2017 by Talesmith Ltd. forms a component of a Smithsonian Institution production, “Life on Earth from Space”, was released in 2019.

Project scientists have also contributed to numerous international media requests describing the drilling and core processing operations and the scientific objectives of the SUSTAIN research. A July 21, 2017 news article in Nature, introduced the scientific community to the drilling project (Witze, 2017). A March 22, 2018 article in Coring Magazine (Adkins, 2018) describes the Atlas Copco rig and innovative coring strategies employed under the leadership of Beau Marshall in the drilling operation. A cover article in the June/July American Ceramic Society Bulletin (Jackson et al., 2018b) outlines the role of the Surtsey drill cores in creating templates for designing environmentally friendly concretes with basaltic aggregates that produce in situ mineral cements.

An informational trifold brochure (Appendix H) was distributed on Heimaey during the drilling and core processing operations as an informational guide to the SUSTAIN project operation and objectives. The brochure attracted residents and visitors to the island to the core processing operation and created opportunities for educational outreach for high school science students and Scouts International activities.

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18 Acknowledgements

The drilling effort on Surtsey would not have been possible without the dedicated support and commitment of many individuals, institutions and companies. Several people in our group worked as volunteers. The DOSECC drillers: Steve Cole, Justin Blouin, Anthony Vecchiarelli, Matthew Lyon and Michael Vinson, were instrumental in bringing this project to a successful conclusion, with their exemplary combination of enthusiasm and professional conduct. The engineers at Arconic Energy Systems, Jeffery Lehnert, Robert Schultz and at DOSECC Exploration Services, Brian Grzybowski, made critical contributions to the design and construction of the Surtsey Subsurface Observatory. The availability and willingness of the ICDP staff, notably Ronald Conze and Ulrich Harms, to provide advice and support throughout the operations was of great importance. The highly skilled technicians from IES-UI, ÍSOR and Matís, Thorsteinn Jónsson, Sveinbjörn SteinThórsson, Bjarni Kristinsson and Gísli Á. Sighvatsson worked tirelessly on solving the various problems that arose. The cooks Anna Líndal, Gro B.M. Pedersen, Unnur Flygenring, Herdís Schopka, Elísabet Atladóttir, Dagný Valdemarsdóttir and Hlynur Skagfjörd were important participants, as were the workers Bergur Einarsson, Daníel Másson, Deirdre Clark, Eiríkur Finnur Sigursteinsson, Gunnlaugur Bjarnason, Halldór Atlason, Jónas Gudnason, Robert Askew, Sidney Gunnarsson and Tryggvi Unnsteinsson. The dedicated staff of the IES-UI office Anna Jóna Baldursdóttir, Anna Kristín Árnadóttir and Sigurveig Grímsdóttir put in many hours obtaining provisions for Surtsey, sometimes well after office hours. The crews of the Icelandic Coast Guard vessel VS Thór and the TF-LÍF helicopter showed great dedication and enthusiasm for the major sling drop operations at the beginning and the end of the Surtsey work. The Vestmannaeyjar rescue group (Björgunarfélag Vestmannaeyja) and the Nordurflug Helicopter Service with their experienced chief pilot Jón K. Björnsson, at all times made it their priority to respond without delay to our requests and fulfill requirements for logistical support. The Landsvirkjun power company gave us full access to their warehouse for preparations and packing before and after the operation. The HS Orka power company made their rock saw available for our use during the entire operation. The Environment Agency of Iceland (Umhverfisstofnun) provided firm and fair assessment of our plans and played an important role through effective surveillance and helpful guidance in ensuring that the strict protection of Surtsey was not violated. The Surtsey Research Society has maintained the Pálsbaer II hut in an excellent condition and coordinated decades of scientific research in Surtsey, thus providing the infrastructure and background that made our project feasible.

This research used samples and/or data provided by the International Continental Scientific Drilling Program (ICDP) through the “SUSTAIN Drilling Project”. Funding for this project was provided by the ICDP, the Icelandic Research Fund (IRF-RANNÍS), the German Research Foundation (DFG), the Bergen Research Foundation and K.G. Jebsen Centre for Deep Sea Research through the Centre for GeoBiology at University of Bergen, Norway, DiSTAR, Federico II, University of Naples, Federico II, Italy, the University of Utah, USA, and the two Icelandic power companies Reykjavík Energy and Landvirkjun.

The town of Vestmannaeyjar provided facilities for core processing in Heimaey. The rector of the University of Iceland, Prof. Jón Atli Benediktsson, and Sigurdur Gudnason, the manager of the University of Iceland, Science Institute, have shown great understanding and guidance in the handling of challenging financial issues that arose during the Surtsey operation.

Finally, we want to acknowledge the decades of dedicated work on Surtsey by the late Sveinn P. Jakobsson, who was a key figure in Surtsey research for almost half a century, including leading with James G. Moore the 1979 drilling effort. Sveinn took an active part in the early preparations for the project but passed away in 2016.

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19 Glossary

AB	Amel Barich (participant)
API	American Petroleum Institute
ASTM	American Standards for Testing of Materials
AT	Andreas Türke (participant)
ATHG	Agúst Thór Gunnlaugsson (participant)
ATV	All-Terrain Vehicle
BK	Barbara Kleine (participant)
BM	Beau Marshall (participant)
BQ	Bit size: 60 mm outer diameter, 36.5 mm inner diameter
CH	Cedric Hamelin (participant)
CS	Casing
CS1000	Drill rig Atlas Copco CS1000
DEVI	DEVIation (downhole logging)
DFG	German Research Foundation (Deutsche Forschungsgemeinschaft)
DIS	Drilling Information System
DiSTAR	Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, Naples, Italy
DLL	Dual Lateral Log (downhole logging)
DMT	German Montan Technology (Deutsche Montan Technologie)
DOSECC-ES, DES	Deep Observation and Sampling of the Earth's Continental Crust, Exploration Services
FISH	Fluorescent In Situ Hybridization
Fo90	Olivine: Forsterite of 90% Mg_2SiO_4
GFZ	German Research Centre for Geosciences (Deutsches GeoForschungsZentrum GFZ)
GR	Gamma Ray (downhole logging)
HOBO	HoBo® data loggers, subsurface memory tool
HQ	Bit size: 96 mm outer diameter, 63.5 mm inner diameter
HQ3, HQTT	HQ Triple Tube, Bit size: 95.6 mm outer diameter
HRQ	Drill rod: 88.9 mm outer diameter, 77.8 mm inner diameter
HTMTL	High Temperature Miniaturised Temperature Data Loggers
HW	Casing size: 114.3 mm outer diameter, 101.6 mm inner diameter
HWT	Casing size: 114.3 mm outer diameter, 101.6 mm inner diameter
IC	Ion Chromatography
ICDP	International Continental Scientific Drilling Program
ICF-RANNÍS	Icelandic Centre for Research-Rannsóknamidstöd Íslands
ICP-OES	Inductively Coupled Plasma Optical Emission Spectrometer
ID	Inner Diameter
IES-UI	Institute of Earth Sciences, University of Iceland
IINH	Icelandic Institute of Natural History
IRMS	Isotope Ratio Mass Spectrometry
ISK	Icelandic Króna
ÍSN93	Icelandic geodetic system
ÍSOR	Iceland GeoSurvey (Íslenskar orkurannsóknir)
JDLW	James D.L. White (participant)
JMcP	Jocelyn McPhie (participant)
JMR	J. Michael Rhodes (participant)
KJ	Kristián Jónasson (participant)

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m a.s.l.	meters above sea level
m b.s.	meters below surface
m b.s.l.	meters below sea level
Matís	Icelandic Food and Biotech, Research and Development
MDJ	Marie Dolores Jackson (participant)
MIT	Massachusetts Institute of Technology
MRES	Mud RESistivity (downhole logging)
MS	Magnetic Susceptibility (downhole logging)
MSCL	Multi Sensor Core Logger
MTG	Magnús Tumi Gudmundsson (participant)
NQ	bit size: 75.7 mm outer diameter, 47.6 mm inner diameter
NQ3	NQ Triple Tube, bit size: 75.7 mm outer diameter, 47.6 mm inner diameter
NRQ	Bit size: 69.9 mm outer diameter, 60.3 mm inner diameter
OD	Outer Diameter
OSG	Operational Support Group
PB	Pauline Bergsten (participant)
PEEK	PolyEtherEtherKeton
PQ	Bit size: 122.6 mm outer diameter, 85 mm inner diameter
PVC	PolyVinylChloride
P-wave	Pressure/Primary wave (seismic velocity)
qPCR	Real-time Polymerase Chain Reaction
rRNA	Ribosomal RiboNucleic Acid
SC	Samantha Couper (participant)
SE-0xy	SE: Surtsey is the island of Surtur; composed of Surts and Ey, and therefore abbreviated SE
SGR	Spectral Gamma Ray (downhole logging)
smartCIS	smartcube® - Camera Image Scanner
SP	Spontaneous Potential (downhole logging)
SUSTAIN	Surtsey Underwater volcanic System for Thermophiles, Alteration processes and INnovative concretes
TBW	Tobias Björn Weisenberger (participant)
TEMP	Temperature (downhole logging)
TF-HDU	Nordurflug Dauhpin helicopter
TF-LÍF	Coast Guard Super Puma helicopter
THH	Thórdís Högnadóttir (participant)
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America
UV	UltraViolet
VCD	Visual Core Description
Vectran	Manufactured fiber spun from a liquid-crystal polymer
VS-Thór	Icelandic Coast Guard Vessel
VTHM	Viggó Thór Marteinsson (participant)
WH	Weather Heaven®, Expedition tent structures

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SUSTAIN Operational Report – Appendices

Appendix A – Personnel overview

Appendix B – Helicopter and boat transport to Surtsey

Appendix C – Transport by the Icelandic Coast Guard

Appendix D – Permits

Appendix E – Environmental protection requirements

Appendix F – Safety requirements

Appendix G – Description guide for visual core description

Appendix H – Outreach brochure

Appendix I – Daily reports from Surtsey

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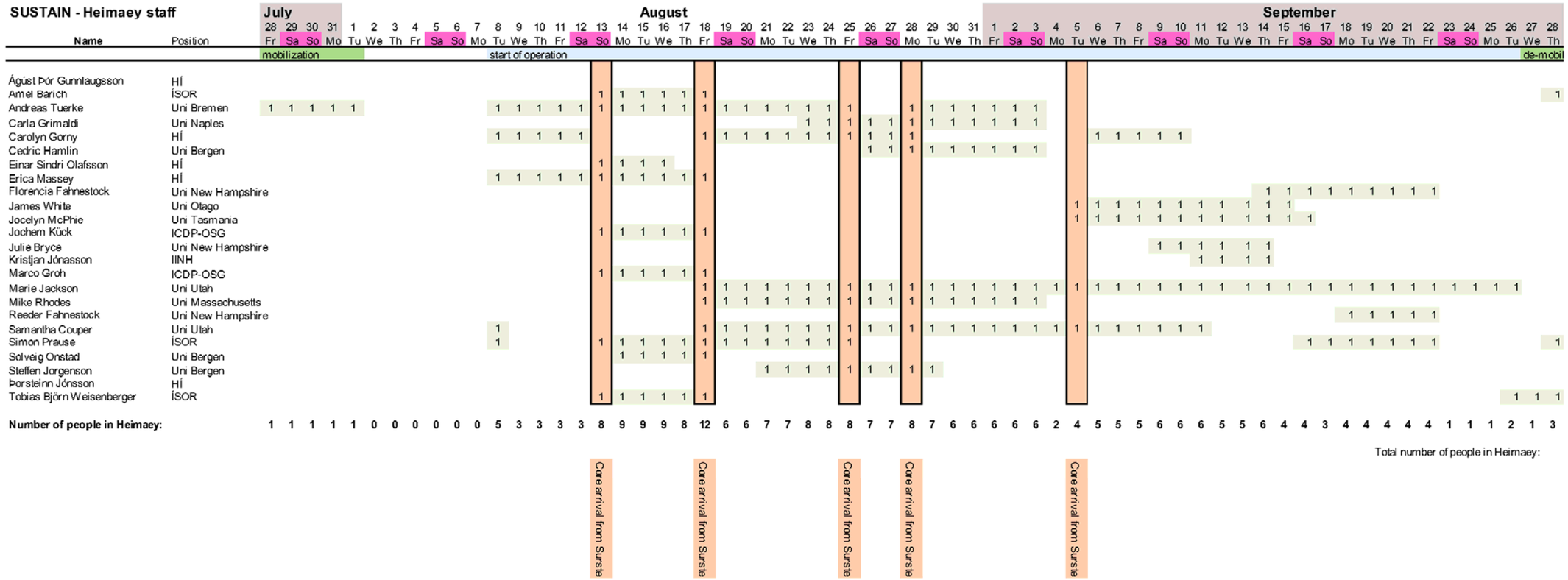
Appendix A – Personnel overview



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SUSTAIN - Surtsey staff

Name	Position	work in August	July 23	24	25	26	27	28	29	30	31	August 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
			So	Mo	Tu	We	Th	Fr	Sa	So	Mo	Tu	We	Th	Fr	Sa	So	Mo	Tu	We	Th	Fr	Sa	So	Mo	Tu	We	Th
Drillers			preparation					mobilization													Drilling of SE02a							
Beau Marshall	DOSECC	Supervisor						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Steve Cole	DOSECC	Driller			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Justin Blouin	DOSECC	Driller			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Anthony Vecchiarelli	DOSECC	Helper						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Michael Vinson	DOSECC	Helper			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1								
Matthew Lyon	DOSECC	Helper																						1	1	1	1	1
Scientists																												
Tobias Weisenberger	Ísor	Geologist																										
Magnús Tumi	UI	Geophysicist	1	1	1	1	1	1	1	1														1				
Andreas Turke	Bremen	Observatory																										
Marie Jackson	Uni Utah	Geologist								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Barbara Kleine	UI	drilling geologist								1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1
Snorri P. Snorrason	Verkis	drilling geologist								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Ágúst Guðmundsson	Jarðfræðistofan	drilling geologist																										
Sigurður Sveinn Jónsson	Ísor	drilling geologist														1	1	1	1	1								
Hjalti Franzson	Ísor	drilling geologist										1	1	1	1	1												
Carolyn Gorny	UI*	drilling geologist																						1	1	1	1	1
Jochem Kueck	ICDP-OSG	Logging Engineer																										
Marco Groh	ICDP-OSG	Logging Engineer																										
Andri Stefánsson	UI	Geochemist																										
Solveig Lie Onstad	Bergen	drilling geologist																										
Viggó Þ. Marteinsson	Matís	Microbiologist								1	1	1	1	1	1	1												
Alexandra Klonowski	Matís	Microbiologist								1	1	1	1	1	1	1	1	1	1	1								
Pauline Bergsten	Matís	Microbiologist														1	1	1	1	1	1	1	1	1	1	1	1	1
Simon Prause	Ísor	drilling geologist																		1	1	1	1	1				
Einar Sindri	UI	drilling geol/logistics																						1	1	1	1	1
Amel Barich	Ísor	drilling geologist																										
Samantha Couper	Uni Utah	drilling geologist																		1	1	1	1	1	1	1	1	1
Erica Massey	UI*	drilling geologist																										
Support																												
Ágúst Þór Gunnlaugsson	UI	Camp manager - logistics facilitator								1	1	1	1	1	1	1								1	1	1	1	1
Gísli Á. Sighvatsson	Matís	Camp manager															1	1	1	1	1	1	1	1				
Bjarni Kristinsson	Ísor	Camp manager																						1	1	1	1	1
Þorsteinn Jónsson	UI	Camp manager	1	1	1	1	1	1	1	1																		
Sveinbjörn Steinþórsson	UI	Camp manager																										
Gro B M Pedersen	UI	Cook								1	1	1	1	1	1	1												
Herdís Schopka	UI*	Cook														1	1	1	1	1	1	1	1	1				
Unnur Flygenring	UI*	Cook																						1	1	1	1	1
Elísabet Atladóttir	UI*	Cook																										
Dagný Valdimarsdóttir	UI*	Cook																										
Hlynur Skagfjörð Pálsson	UI*	Cook																										
Þórdís Högnadóttir	UI	logistics						1																				
Gunnlaugur Bjarnason	UI*	logistics						1	1	1																		
Bergur Einarsson	UI*	logistics						1	1	1																		
Anna Líndal	UI*	logistics						1	1	1																		
Eiríkur Finnur	UI*	logistics	1	1	1	1	1	1	1	1																		
Robert Aschew	UI	logistics																										
Daníel Másson	UI*	logistics																										
Sidney Gunnarsson	UI	logistics																										
Envrionment Agency																												
Þórdís V. Bragadóttir	EA	Inspection			1	1	1	1	1	1																		
Gottskálk Friðgeirsson	EA	Inspection																						1				
			B		N			CG		CG		N				N				Th				N				
Number of people in Surtsey:			3 3	3	7	7	7	13	12	19	12	13	13	13	13	16	12	12	12	15	12	12	12	20	14	14	14	14

Name	August 18	19	20	21	22	23	24	25	26	27	28	29	30	31	September 1	2	3	4	5	6	7	8	9	10	11	12
	Fr	Sa	So	Mo	Tu	We	Th	Fr	Sa	So	Mo	Tu	We	Th	Fr	Sa	So	Mo	Tu	We	Th	Fr	Sa	So	Mo	Tu
Drillers		Drilling of SE02b							logging		Drilling of SE03									de-mobilization						
Beau Marshall	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Steve Cole	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Justin Blouin	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Anthony Vecchiarelli	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Michael Vinson																										
Matthew Lyon	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Scientists																										
Tobias Weisenberger	1	1	1	1	1	1	1	1	1	1	1								1	1						
Magnús Tumi											1	1	1	1	1	1	1	1	1					1		1
Andreas Turke								1	1	1	1															
Marie Jackson	1																									
Barbara Kleine	1	1	1	1	1	1	1	1	1	1	1															
Snorri P. Snorrason																										
Ágúst Guðmundsson											1	1	1	1	1	1	1	1	1							
Sigurður Sveinn Jónsson																										
Hjalti Franzson																										
Carolyn Gorny	1										1	1	1	1	1	1	1	1	1							1
Jochem Kueck								1	1	1	1															
Marco Groh								1	1	1	1															
Andri Stefánsson																			1	1						
Solveig Lie Onstad	1	1	1	1	1	1	1	1																		
Viggó Þ. Marteinsson								1														1				
Alexandra Klonowski																			1	1						
Pauline Bergsten	1	1	1	1	1	1	1	1																		
Simon Prause											1	1	1	1	1	1	1	1	1							
Einar Sindri	1							1	1	1	1	1	1	1	1	1	1	1	1							
Amel Barich	1	1	1	1	1	1	1	1																		
Samantha Couper	1																									
Erica Massey	1	1	1	1																						
Support																										
Ágúst Þór Gunnlaugsson	1			1	1	1	1	1											1	1	1	1	1	1	1	1
Gísli Á. Sighvatsson																										
Bjarni Kristinsson	1																									
Þorsteinn Jónsson	1	1	1	1	1	1	1	1																1	1	1
Sveinbjörn Steinþórsson								1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	
Gro B M Pedersen																										
Herdís Schopka																						1	1	1		
Unnur Flygenring	1							1	1	1	1	1	1	1	1	1	1	1	1							
Elísabet Atladóttir	1	1	1	1																						
Dagný Valdimarsdóttir				1	1	1	1	1																		
Hlynur Skagfjörð Pálsson																			1	1	1	1				
Þórdís Högnadóttir								1																		
Gunnlaugur Bjarnason																										
Bergur Einarsson																										
Anna Líndal																										
Eiríkur Finnur																										
Robert Aschew													1	1	1	1	1	1	1							
Daníel Másson																			1	1	1	1	1	1	1	1
Sidney Gunnarsson																								1	1	1
Envrionment Agency																										
Þórdís V. Bragadóttir																			1	1	1	1	1	1		
Gottskálk Friðgeirsson																										
	N			B				N			N		B						N	N		N		CG	CG	CG
Number of people in Surtsey:	20	13	13	15	13	13	13	21	13	13	17	12	13	13	13	13	13	13	20	12	9	12	10	13	5	6

UI* = Affiliated with University of Iceland

N = Norðurflug helicopter

CG = Coast Guard helicopter

Th = Helicopter Service of Iceland

B = Boat from Heimaey

Total number of nights in Surstey: 655

Þór Coast Guard ship			July 27	28	29	30	September 9	10	11	12
Jónas Guðnason	UI	logistics	x	x	x	x				
Diedrie	UI	logistics	x	x	x	x				
Halldór Atlason	UI*	logistics					x	x	x	x
Tryggvi Unnsteinsson	UI*	logistics					x	x	x	x

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SUSTAIN - IINH staff (working hours)

Name	Position	October 30 Mo	31 Tu	November 1 We	2 Th	3 Fr	4 Sa	5 So	6 Mo	7 Tu	8 We	9 Th	10 Fr	11 Sa	12 So
Kristjan Jónasson	IINH	2	8	8	8	8			8	8	4	4	8		
Tobias Björn Weisenberger	ÍSOR	4	8	8	8	4			8	8	8	4	4		
Simon Prause	ÍSOR	2		4	4	8					8	8	4		
Barbara Kleine	UI	2			8	8						8	8		
Pauline Bergsten	MATÍS	2			8	8							8		
Alexandra Klonowski	MATÍS	2		4						4					
Amel Barich	ÍSOR	2	8						8	8					
Viggó Þ. Marteinsson	MATÍS	2													
Velveth Perez	UI	2	4							8		8			
Carolyn Gorny	UI														
Workig horus per day:		**20**	**28**	**24**	**36**	**36**	**0**	**0**	**24**	**36**	**20**	**32**	**32**	**0**	**0**

Name	Position	13 Mo	14 Tu	15 We	16 Th	17 Fr	18 Sa	19 So	20 Mo	21 Tu	22 We	23 Th	24 Fr	25 Sa	26 So	27 Mo	28 Tu	29 We	30 Fr
Kristjan Jónasson	IINH			2															
Tobias Björn Weisenberger	ÍSOR	8	8	10	8	4		1	8	8	8	4	4		1	4	8	4	4
Simon Prause	ÍSOR			8	8						8						4		8
Barbara Kleine	UI					8												8	
Pauline Bergsten	MATÍS					8													
Alexandra Klonowski	MATÍS																		
Amel Barich	ÍSOR	8	8						8						8				
Viggó Þ. Marteinsson	MATÍS																		
Velveth Perez	UI		8							4		8							
Carolyn Gorny	UI			10	10	10		10	10	10	10	10	10		10	10	10	10	10
Workig horus per day:		**16**	**24**	**30**	**26**	**30**	**0**	**11**	**26**	**22**	**26**	**22**	**14**	**0**	**19**	**14**	**22**	**22**	**22**

Name	Position	December 1 Fr	2 Sa	3 So	4 Mo	5 Tu	6 We	7 Th	8 Fr	9 Sa	10 So	11 Mo	12 Tu	13 We	14 Th	15 Fr	16 Sa	17 So	18 Mo	19 Tu	20 We	21 Th
Kristjan Jónasson	IINH																			4		
Tobias Björn Weisenberger	ÍSOR					8		8	4			8	8	8						8		
Simon Prause	ÍSOR	4					8	4						4						8		
Barbara Kleine	UI				8																	
Pauline Bergsten	MATÍS																					
Alexandra Klonowski	MATÍS	8																				
Amel Barich	ÍSOR																					
Viggó Þ. Marteinsson	MATÍS																					
Velveth Perez	UI												8									
Carolyn Gorny	UI	10		10	10	10	10	10	10													
Workig horus per day:		**22**	**0**	**10**	**18**	**18**	**18**	**22**	**14**	**0**	**0**	**8**	**16**	**12**	**0**	**0**	**0**	**0**	**0**	**20**	**0**	**0**

Total number of hours: 812

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Figure A1 provides information on the affiliation of scientists that took part in the Surtsey operation. More than 80% of the scientists were provided from the Icelandic team. In addition, two scientists from the University of Utah and one from the University of Bergen and one from the University of Bremen joined the scientist team on Surtsey. All camp managers and cooks where provided by the Icelandic team and are affiliated to the Institute of Earth Sciences University of Iceland (IES-UI), Iceland GeoSurvey (ÍSOR), Matís, VERKÍS, and Jarðtæknistofan. For the wireline logging in SE-02b two logging engineers from the ICDP-OSG (Operational Support Group) spent 4 days on Surtsey.

The core processing was planned and operated by the scientists in charge Marie D. Jackson and Andreas Türke. Figure A2 shows the workload of the participating institutions on core processing on Heimaey.

The core processing was carried out exclusively by members of the IceSUSTAIN team and was led by Tobias Björn Weisenberger and Kristján Jónasson. Figure A3 provides an overview of the team members that took part in the additional core processing at IINH, their affiliation and their work load.

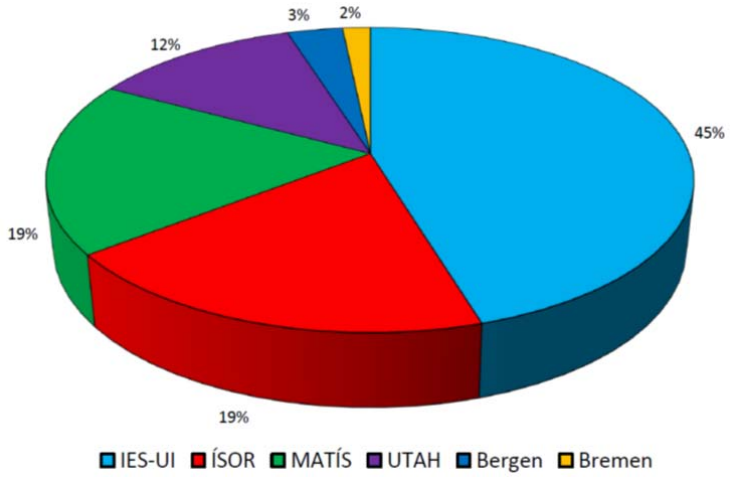

Figure A1. *Pie-chart showing affiliation of scientists on Surtsey. (IES-UI includes Jardðtæknistofan and VERKÍS).*

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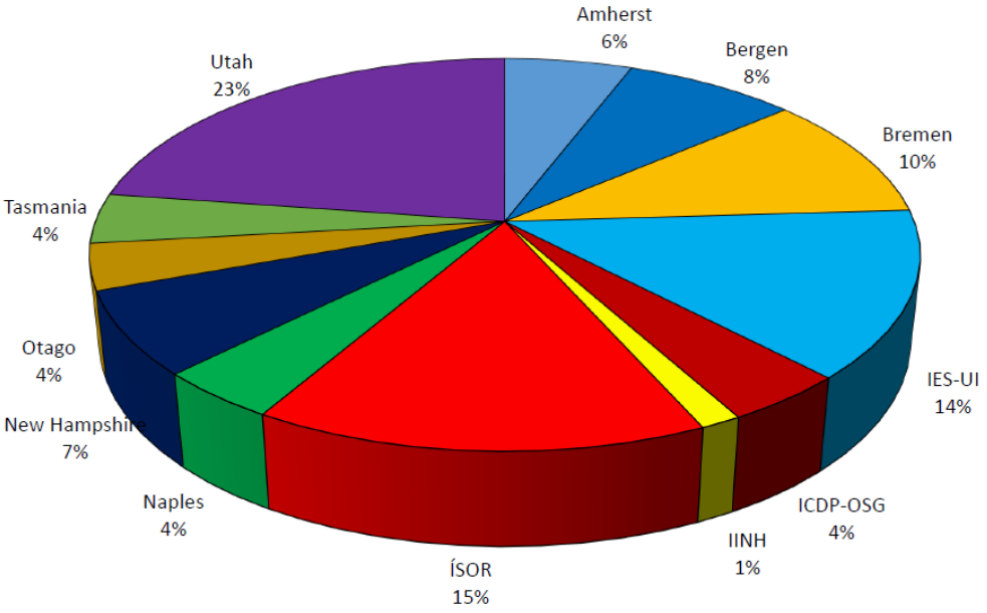

Figure A2. *Pie-chart showing affiliation of scientists that participated in the core processing on Heimaey.*

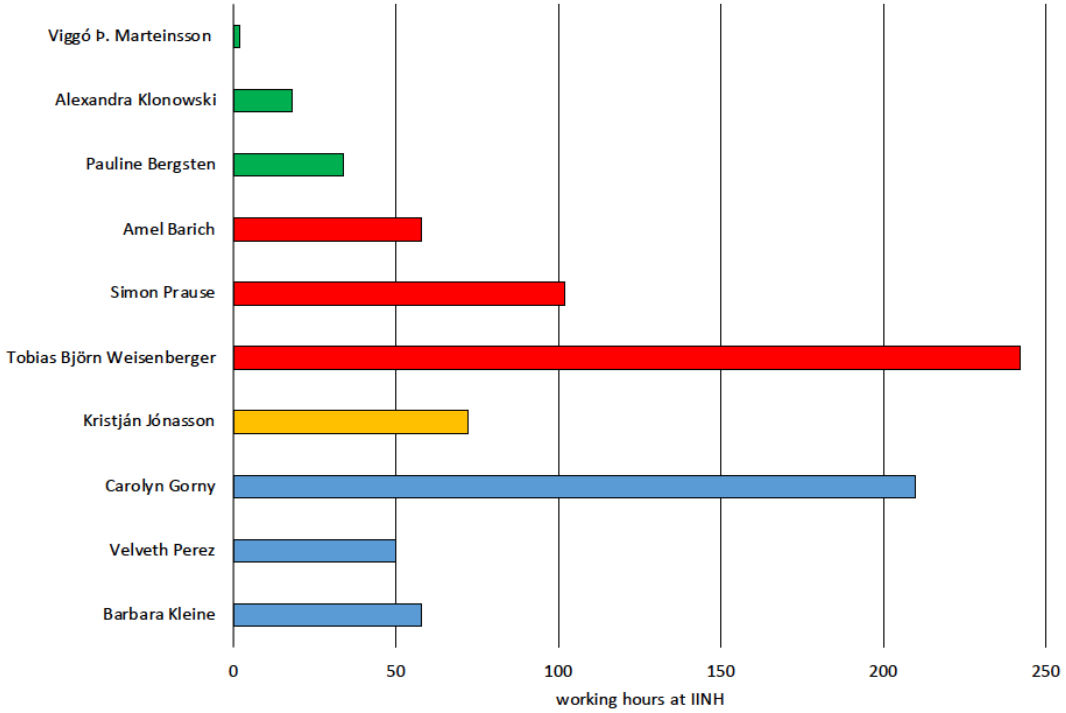

Figure A3. *Overview of working hours required to finalize the additional core processing in Reykjavik at the Icelandic Institute for Natural History. Color coding for affiliation: green: Matís, red: ÍSOR, yellow: IINH, blue: IES-UI.*

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Appendix B – Helicopter and boat transport to Surtsey

B.1 Boat trips

We had an agreement with Björgunarfélag Vestmannaeyja (the Vestmannaeyjar Rescue Group) that they would support us in our operations, using their rescue boat Þór, a 14.6 m long, 4.4 m wide Alusafe 1500, made of aluminum, specifically designed for rescue operations with maximum speed of 27 knots. Þór carried the advance crew of three with about 3.5 tons of equipment and various provisions for preparation of the drilling operation, including the material for a platform for the drill rig. Þór did repeated trips in August and into September bringing people or provisions to Surtsey. A list of trips made by Þór is in Table B1. In addition to these trips by the rescue vessel, a boat from Ribsafari in Heimaey arrived with a film crew and the EA representative for a one day visit on the 21st of August. Minor personnel changes and transport of food for the Surtsey camp took place.

Table B1. *Boat trips to Surtsey made by Björgunarfélag Vestmannaeyja on rescue vessel Þór.*

Date	Task
23.07	Advance party of three + transport of 3.5 tons of materials and equipment for drilling platform (Þór + a smaller boat), two trips made between Heimaey and Surtsey
02.08	DOSECC driller transported to Heimaey for treatment of ear infection.
04.08	DOSECC driller transported back to Surtsey.
13.08	Transport of sixteen 1100 liter water tanks to Surtsey for construction of a new water reservoir onshore.
19.08	Transport of cement to Surtsey.
30.08	Transport of water-line worker to Surtsey.
06.09	Retrieval of water tank in sea, dropped in helicopter sling operation while moving materials from Peninsula to camp site.

B.2 Helicopter trips

Transport of personnel to and from Surtsey during the operations (July 23rd –September 12th) mainly took place by helicopter. These services were provided by private contractor Norðurflug Helicopters (helicopter.is). For transport of personnel, core and other provisions, an AS365N Dauphin twin engine was used. It has carrying capacity of about 1000 kg, either 8-9 passengers or loads of e.g. core, fuel or any other materials. Sling load capacity is 500-800 kg. For drill rig setup and disassembly an AS 350 B2 Ecureuil Astar was used (passenger capacity 5, sling load capacity 1000 kg). On one occasion (9 August) a Bell 407 of Þyrluþjónustan (Helicopter Service of Iceland) provided service to us, as Norðurflug could not free their Astar at the short notice given, when the seawater pump had to be retrieved from the ocean and repaired. On the 5th of September a 200 liter barrel of petrol had to be sling-transported with the Dauphin from Heimaey, as electric generators were running out of fuel. Table B2 provides an overview of the required helicopter flights during operation in 2017.

Table B2. *Helicopter trips to Surtsey by Norðurflug (11 flights) and Þyrluþjónustan (1 flight).*

Date	Helicopter	Task
25.07	Dauphin - Norðurflug	Transport of drillers to Surtsey, sling drops from Peninsula to drill site
30.07	Astar- Norðurflug	Rig assembly
01.08	Astar - Norðurflug	Placement of water line pump in sea on west side of Peninsula
05.08	Dauphin - Norðurflug	Transport of personnel
09.08	Bell 407 – Helicopter Service of Iceland	Pump retrieval and relocation in ocean, transport of personnel, transport of waste.

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Date	Helicopter	Task
13.08	Dauphin - Norðurflug	Transport of personnel and provisions, transport of core to Heimaey, transport of waste.
18.08	Dauphin - Norðurflug	Transport of personnel and provisions, transport of core to Heimaey, transport of waste.
25.08	Dauphin - Norðurflug	Transport of personnel and provisions, transport of core to Heimaey, transport of waste.
28.08	Dauphin - Norðurflug	Transport of personnel and provisions, transport of core to Heimaey, transport of waste.
05.09	Dauphin - Norðurflug	Transport of personnel and provisions, transport of core to Heimaey, sling transport of a 200 liter barrel of petrol from Heimaey
06.09	Astar - Norðurflug	Rig disassembly, lifting of pump from ocean, transport of samples and personnel
08.09	Dauphin - Norðurflug	Transport of personnel

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Appendix C –Transport by the Icelandic Coast Guard

The drill rig, rods, fuel, camp materials and provisions were transported by the Icelandic Coast Guard vessel VS Þór and sling dropped from Þór to Surtsey by the Coast Guard Super Puma helicopter TF-LÍF. Þór is a 90 m long and 16 m wide, 4000 tons vessel built for rescue and patrol operations around Iceland. The Super Puma has a lifting capacity of 1200-1800 kg, however in the interest of speed and ease of handling, most loads were 600-900 kg. The material to be transported was taken on lorries from Reykjavík to Þorlákshöfn harbor on the south coast, about 70 km northwest of Surtsey. The ship was loaded in Þorlákshöfn on 26th-27th of July and arrived at the island in the early morning of the 28th. Conditions for sling drops were favorable, as winds were light and visibility good. TF-LÍF arrived at about 10:00. Sling operations continued throughout the day, with the helicopter going to Heimaey for re-fueling every three hours before heading back to Reykjavík. In the evening of the 28th Þór returned to Þorlákshöfn taking the remaining loads to Surtsey. TF-LÍF continued the work for about 4 hours on the 29th with the remaining loads being taken to Surtsey on the 30th. In total 110 loads were sling-dropped on Surtsey, having a total weight of about 70 tons. The loads were dropped in three places: (1) At drill site where most of the loads were taken, (2) the camp site adjacent to Pálsbær hut, and (3) the pump site on the northern peninsula.

The retrieval operation took place in September 10-12. VS Þór arrived in the early morning of September 10 and TF-LÍF at noon. Turbulence caused by a northerly wind of 20 knots precluded sling transport from drill site but all loads from the camp site could be taken to Þór, with the helicopter returning to Reykjavík in at 16:00. The winds prevailed until afternoon the following day, but dropped in the afternoon. All material at the drill site could be transported in four hours while the remaining five loads at the camp site were taken and the island cleared in the early morning of the 12th of September. VS Þór left Surtsey shortly after 10:00, arriving in Reykjavík Harbor about 10 hours later. The ship was unloaded in the evening, mostly into containers that were taken the following day to the Landsvirkjun warehouse at Völuteigur.

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Appendix D – Permits

Project Permit from the Environment Agency of Iceland issued on 14 July 2017

ENVIRONMENT AGENCY

Háskóli Íslands Jarðvísindastofnun - Askja
Sturlugötu 7
101 Reykjavík

Vestmannaeyjum 14. júlí 2017
UST201605-001/Þ.V.B

Subject: SUSTAIN project-permitt

The Environment Agency of Iceland has received a request from Marie Jackson and Magnús Tumi Guðmundsson on behalf of SUSTAIN drilling program, dated April 29th 2016, with a request for permission to drill two boreholes in Surtsey for scientific purposes.

Surtsey was declared a nature reserve in 1965. Since then human visits have been restricted to prevent biological contamination and to protect Surtsey´s delicate environment. Written permission must be obtained from the Environment Agency of Iceland to visit the island Surtsey and dive inside the nature reserve.

Description of the project:
The principal research foci of the SUSTAIN drilling project involve interdisciplinary studies in volcanology, hydrothermal processes, mineralogy and microbiology that integrate scientific investigations by international researches with a broad range of research expertise. The principal global scientific and societal benefits of the research project will be directed towards 1) investigating explosive fragmentation processes of basaltic tephra as a means to refine predictions of hazards associated with sub-aerial explosive eruptions and rapid edifice growth of seafloor volcanoes, 2) describing the chemical-mechanical changes in the Surtsey tephra through hydrothermal rock-water interactions as a means to refine geophysical monitoring of fluid/waste disposal or storage sites and thermal and chemical stimulation of hydrothermal reservoirs in pyroclastic rocks, and 3) determining the role of geochemical and biochemical processes in the development of Al-tobermorite-zeolite mineral assemblages in Surtsey tephra, assessing their cation exchange properties for radionucleides and heavy metals, and transferring this information to applied laboratory studies to reproduce these cementitious fabrics in innovative pyroclastic rock concretes in the built environment and, potentially, encapsulations of wastes using basaltic tephra investigating. The plan is to make two new drill holes in Surtsey which will replace older one form 1979. The new drill holes will be situated within 5-10 m from the 1979 hole. The 1979 hole is located 200 meters from the hut Pálsbær and the helicopter platform.

Hole 1 is an oriented, continuously cored (HQ initially - 96 mm hole size) vertical hole, that will attempt to reach sediment of the pre-eruptive seafloor beneath the volcano, thereby recovering the earliest and, as yet, unsampled phase of the Surtsey eruption. During drilling, samples for pore water and microbiological analyses will be collected on a 30 cm core segment every 10 m; down-hole water samples will be collected after drilling is complete. Estimated total depth is ~210 m. The design of Hole #1 is intended to provide a future laboratory for in situ studies of water chemistry, microbiology, and mineralogy in the Surtsey Subsurface Observatory.

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Hole 2 is an oriented, continuously cored (HQ possibly to NQ - 75.5 mm hole size) hole at a 50° angle from horizontal, inclined towards the SE tephra crater with the intent to (1) intersect additional dikes and intrusions beneath the crater, (2) gain additional information on stratigraphy and structure, and (3) investigate the higher temperature portions of the hydrothermal system. The estimated total depth will be ~300 m. Regarding the temporary drill site structure no concrete or gravel pad or other permanent construction will be installed at the proposed drill site. Rather, the drill will be set on a level pad excavated from the volcanic substrate adjacent to the 1979 drill site. The drill site layout will have dimensions 7.5 by 4.5 meters (25' X 15'). Alternative methods are foreseen to fasten the drill platform securely to the ground. If tephra thickness is <0.5 m: The platform will be fastened to the ground by drilling ~50 cm deep, 2–3" wide holes into the lava surface after removal of the uppermost layer of tephra. Iron rods will be cemented into the holes and the platform fastened onto these foundations by welding or in some other acceptable way. If tephra thickness is >0.5 m: A closed, elongated 0.5 m wide and about 0.5 m thick sandbag-like closed gabion filled with tephra from the site. It will be made of chicken wire and sturdy plastic. Iron rods will be founded within the gabion and the frame of the drilling platform fastened to the rods. In both cases foreign parts (rods, gabions etc.) will be removed after drilling and the tephra used in the gabion left in its original location, leaving only the two drill heads 50-70 cm above ground.

The two SUSTAIN holes will be drilled using a helicopter-transportable CS-500 diamond core rig. All components of the drill will be washed and sterilized prior to shipping to Iceland. Rubber rig mats weightening down the drilling equipment would surround the drill site, and the volcanic substrate would be protected from disaggregation and erosion. Rig mats, anchored to the drilling platform, will also underlie a temporary drilling support shelter, which will be held stationary for the drilling of both holes. A separate area for core processing will be designated closer to the Pálsbær hut. The drill rig is going to be around 105 db-115 db loud while drilling. The primary drill string will be HQ with an NQ string as back up. Both proposed holes will be drilled in a similar fashion: 1) rotary drill 6-3/4 inch hole to a depth of 10 m; 2) run in hole with 4-1/2 inch casing and cement to surface; 3) run in hole with HQ coring string and core to total depth (TD). If conditions require, the string will reduce to NQ. Upon reaching TD, the holes will be logged using a suite of slim hole logging sondes deployed from a motorized winch to the base of the holes at 200–300 m depth. Hole 2 will be completed with 2-3/8 inch steel liner that will preserve it for subsequent temperature logging and monitoring, similar to the 1979 hole. Hole 1 will be fitted with anodized aluminum casing (6061-T6, solutionized and artificially aged), with 1.2 m long perforated intervals installed with the rest of the casing, immediately after drilling.

The holes will be cored using seawater as drilling fluid, as was done in the 1979 drilling project. A diesel-powered generator will pump the seawater upslope to the drill site. The pump will be around 96 db but sound walls can be constructed to recuce the noise pollution. Water will be pumped from the sea, either on the NE-shore or on the western side of the northern peninsula. The location will be chosen on the basis of the least chance of wave action damaging the intake pipe. The NE-option calls for about 800 m long pipe traversing the Surtsey substrate. For the NW-shore option the pipe would be about 1200 m. The pumps will be running continuously with breaks only happening to check the oil and fuel wich is every 12 hours.

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The inlet for seawater will be at >20 to 30 m depth, and >50 m from the coastline. The hos for the inlet will be wheigted down with weights at the end. Steel cable will be attached at th end and a float at the surface to mark the spot. A nylon rope will also be placed at the inlet i case the float is released by accident in bad weathers. A >50 m-long plastic pipe will b securely mounted at the shore, with weights attached at the seawater intake and along th pipeline to prevent movements. A mesh screen will cover the pipe opening to prevent th influx of fine-gravel-sized particles. Small buoys attached to the midsection will mark th underwater path of the pipe. The pipeline will be checked on a daily basis to make sure that i does not become unmoored or break off in stormy weather. The seawater will be held in secondary container tank at the drill site and sterilized by UV light to minimize contaminatio of Surtsey subsurface deposits with surficial marine organisms. A 1'' ''Oroflex'' hose wic is flat style fire hose will transport the drill fluid (sea water with drill cuttings) to the coas through a pipe, releasing the fluid by the northern end of the sea cliff. The residual solids fro the drill fluid would be transported off Surtsey to Heimaey during helicopter resupply trips t prevent spilling of polymer onto Surtsey substrateIt is anticipate that polymer may be require to effectively clean both holes below 138 m depth, where unconsolidated tephra wa intersected in the 1979 hole. The polymer would be used only if necessary and in smal quantities, in order to increase the viscosity of the drilling fluid and lift the cuttings mor efficiently so that drilling can proceed downsection. The polymer used is GS-550. This is water-soluble polymer/polyacrylamide powder with a high molecular weight. This is a non- biodegeradable product. At Hole 2 additional mud-polymer beyond GS-550 may be needed to continue drilling to the seafloor. The preferred material is attapulgite, a needle-like cla mineral or "fullers earth" that has been employed in scientific drilling for >50 years. This is non-swelling material that would have minimal impact on the Surtsey basaltic deposits. Thi is a non-reactive, non biodegradable attapulgite clay. In both holes a mix/storage tank with seawater would be used so that the material could be re-circulated, reducing the amount required for the drilling. If used, the maximum amount would be about 500 kg for each hole. About 250 kg of each polymer would be transported to Surtsey and a reserve held on Heimaey, to be used only if necessary to deepen the angled hole through unconsolidated deposits. The products of polymer proposed for use in the Surtsey drilling operation are the most environmentally benign materials presently available for scientific drilling. During use in the drilling operation, product containers will be placed on plastic boxes and sheeting mounted on rig mats immediately adjacent to the "mud" tank. Any spillage will be immediately managed with absorbent and then transported to a garbage receptacle for transport to the waste treatment facility on Heimaey via helicopter.

On site logging of drill core will provide labeling and initial observations of rock type, consolidation, and structural features, with detailed lithological logging to take place on Heimaey. A series of reference samples will be designated at about 4 m intervals through the two holes above and below sea-level, giving about 50–60 samples per hole. The study of the subsurface microbiology and water geochemistry will involve three stages: 1) on-site pore water and microbiological sampling during drilling, 2) downhole water and microbiological sampling after drilling, and 3) preparation of the eventual Surtsey Subsurface Observatory. Subsequent to downhole logging, microbial incubation chambers and plugs would be installed for present and future tephra alteration, mineralogy, fluid geochemistry and microbiology studies. The plan is leaving the first incubation experiment inside the borehole for two years.

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The experiment chambers could be retrieved during the annual Surtsey Research Society visits. After the experiment is complete, the cylinders would be removed from the rope. For each substrate type and depth interval, one cylinder would be dedicated to microbiological studies involving potentially indigenous bacteria and archaea from the hydrothermal waters and the other one will be used for mineralogical studies. When the HTMTL data is downloaded the data will provide a two-year record of temperature evolution. They would show how quickly the hole temperatures rebounded to its natural state. Subsequent incubation experiments would be proposed based on the findings of the first experiment installed in 2017.

The fuel for the drill rig should be sling dropped in standard 210 liter barrels at the drill site. Fuel will be stored in a secondary containment site at the drill site. A berm of volcanic ash will be covered with a thick plastic liner; the fuel drums placed on the plastic liner, and additional volcanic ash bermed around the drums. The secondary container site should be close enough, about 15 m (50') from the rig to fuel the rig using a 12v transfer pump and fuel hose. About 350-400 liters (100 gallons) of diesel fuel per day during 24 hours continuous operation are projected to be used. In order to prevent contamination, open, leakage-proof containers (of a type similar to fiskikar or bigger) will be used as a secure platform for opening of barrels and re-fueling pumps, drill and generators. Full barrels will be stored together at all depots and empty ones fastened with straps to the bundle of filled barrels. About 75 barrels of diesel fuel are projected to be transported to Surtsey. Fuel barrels, when flown to the island, will be wrapped in thick plastic to minimize the risk of holes forming and leakage during transport and subsequent storage on the island. A strict protocol will be developed and used for all fuel handling to prevent contamination and leakage. About ¾ of the barrels will be sling-dropped at the drill site onto a secure plastic base and then surrounded by berms of volcanic ash. About ¼ of the barrels will be sling-dropped at a depot by the site of the temporary sheds for operating the generator, or at the seawater pumping site on the shoreline. The barrels will be placed on a plastic base, surrounded with thick berms of volcanic ash, and bound together with straps. The type of plastic the barrels will be wrapped in and stored is Americover. It is fluted and does not tear easily. The thicknes is 6-mil (0.15 mm) and it is estimated to use it in four layers under the fuel barrels and the ATM. A heavy duty absorbent diesel fuel spill kit will be kept on reserve at the drill site to manage any spill or leakage, and the absorbent materials flown off island with the emptied fuel containers. Diesel fuel will be used for the drill and pumps but generators and ATM will use gasoline.

In order to provide secure accommodation as well as working conditions for both fluid sample and core preparation for transport to Heimaey, two high strength portable shelters will be brought to the Island and placed northeast of Pálsbær. The details of the shelter have not yet been defined. The shelters/tents will have a solid floor to provide stable and dry working environment, preventing contamination and preserving the Surtsey surface substrate. Each unit will weigh at maximum 1000 kg, and consist of a frame structure, a floor and probably walls made of water-proof thick canvas. The shelter/tent will be fastened down by plastic barrels (100-200 liters each) filled with water-saturated tephra. As many barrels as are considered needed from assessment of wind forces will be used. After use, the tephra will be replaced to the surface where it was before. Shower for the drillers will be located within a sturdy tent-unit. This shed will have a wooden floor and it is expected that the shower water will be collected into a tank underneath the shower. This will be arranged in such a way that the changes of shower water being spilled into the ground will be remote.

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The collection tank will be emptied after use: Either into larger tank that would be connected to the hose leading releasing drilling waste water to the sea, or the tank will be transported with the ATV to the shore where the water will be poured directly into the ocean. To minimize any possible introduction of plant or animal life to Surtsey, all food preparation and consumption will take place in designated areas in or near Pálsbær so that no food scraps or trash (tomato, cucumber or melon seeds, for example) will be dispersed on the Surtsey substrate. Two portable toilets will be installed, one at the drill site and the other at the Pálsbær hut to capture all human waste. The toilets will be fastened down by plastic barrels (100-200 liters each) filled with water-saturated tephra. As many barrels as are considered needed from assessment of wind forces will be used. After use, the tephra will be replaced to the surface where it was before. The same will be done with boxes/containers for samples, equipment and refuse. A strict protocol on handling of refuse and human waste will be followed to minimize the risk of accidental spillage. The waste will be compacted in the liner, placed in a designated receptacle, and then transported by helicopter to Vestmannaeyjar and delivered to the waste treatment facility on Heimaey on a weekly basis. Receptacles will be sanitized on Heimaey and returned to Surtsey in subsequent helicopter flights. All shoes could be dipped in a disinfectant bath, either upon exiting the helicopter at Surtsey or upon entering it at Heimaey, so that no organisms will be brought by foot traffic to the island. A current map of sensitive biological sites will be distributed to each member of the SUSTAIN work teams, and an integral component of the safety training will be to describe the nature and location of these sites, and the care that must be taken to avoid any disruption of these habitats. Prevention of work site injuries and conservation of the Surtsey substrate and surface ecology at the drill site will be a primary concern of the drilling operation. DES drilling staff have extensive safety training, and all scientists working on the island will be required to undertake safety and conservation training on Heimaey before their arrival on Surtsey.

One ATV (6 wheel) be transported to the island and will only be used for the following purposes: a) Transport core from drill rig to camp by hut. b) Transport tools and similar material from camp towards pumps. c) Transport water used in shower, if this way of water disposal will be chosen. d) No trips that are not explicitly needed for the drilling operation will be allowed. Between camp and drill-site and camp and the shore at the end of the lava north of the camp a designated path will be followed – in loose tephra. It is expected that the ATV will always be parked at the same spot between trips. This will either be a wooden platform or a secured designated spot. It is expected that a thick plastic containment will be placed under the ATV at this park site to catch drips and leaks; this also includes a drip containment while fuelling any equipment. Any traces of foot traffic between the drill site, core processing area, and Pálsbær will be removed through raking of volcanic ash after the drilling operation is complete.

Seventeen research projects involving 42 scientists from 10 countries (Australia, Germany, Iceland, Italy, New Zealand, Norway, Sweden, Switzerland, United Kingdom, USA) have been proposed for study of the new cores and geothermal fluids. The overall responsibility for daily management of the project, internal/external communications, and organizational aspects of the drilling campaign rests with M. D. Jackson and M. T. Gudmundsson, supported by DOSECC and University of Iceland. It is anticipated that the entire project should be completed in 6 weeks, including the mobilization and demobilization operations.

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It is estimated to start the program on July 22th with a small group of 6 persons to prepare the drill site for equipment drops, prepare foundations for temporary sheds, arranged for the berms of volcanic ash to protect fuel barrel storage, and install the sea-water intake system. In the next few days the equipment will be transported to the island with assistance from the Coast Guard. This should take 1-2 days. The optimum estimated time of completion of each of the two drill holes is 15 days. Approximate 38 people will need to enter the island during the project. Not all of them will stay in the island at the same time. Maximum number of people needed for Hole 1 is 13 persons and 9 persons for Hole 2. The drilling will be done during 12 hours shifts. Only individuals whose work is essential to the logistical and drilling operations will be considered for visits to Surtsey. Safety and conservation training on Surtsey will be required of all individuals before arrival on the island. It is estimated that the drilling project will finish before middle of September and all equipment been packed for transport. The equipment will be packed so it can withstand severe weather. All equipment will be removed after September 5th or when the Coast Guard ship is available. In case the removal of the drill and equipment delays a small group will be sent to the island to secure it more securely and material that might be blown away in winter storms will be moved in the container that is part of the drill equipment. The cores sampled will be stored at the Iceland Institute of Natural History.

Reviews

The application was sent for a review to agencies conducting research in Surtsey and other stakeholders. Review was received from the Agricultural University of Iceland, Icelandic Institute of Natural History, Marine and Fresh Water research institute and South Iceland Nature Research Iceland. In their reviews there were no objections towards the project. The drilling will take place where there is little vegetation and birdlife. The main concern was that there would be too much disturbance on the peninsula where the grey seal colony is located since they breed in the fall.

Impact assessment

The implementation as such will have a significant impact on the drilling site and vicinity during the period it will take place although it is thought to have little or no negative affect in the long run. The drilling site is outside important bird areas and the vegetation is scattered. The Environment Agency of Iceland, for its part, authorizes the drilling of the two drill holes in Surtsey in the summer of 2017 under the following conditions:

Conditions

- This license is for the drilling and temporal facilities and is valid for the period 22th of July til 10th of September. Travel permits for the staff conducting the drilling, preparation and wrap up will be issued separately since they are given out to individuals.
- The Environment Agency of Iceland must be informed in advance of all changes from the description of the project as described in this permit and must consent to them before they can be implemented.
- All equipment must be thoroughly cleaned before it is transported to the island to make sure no soil, seeds or organism is brought to Surtsey.
- When the drilling is over all traces of the operation shall be removed.
- During the implementation of the project all equipment must be securely fastened or tied down to prevent it from loosening in bad weather.

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- In order to minimize environment impact when possible sand anchors are to be used to secure equipment instead of barrels full of sand.
- Use of polymer is to be minimized. Water carrying polymer shall not be discharged on land.
- All waste shall be removed from Surtsey when the project has ended.
- Waste water from showers shall should not be discharged on the Island.
- Environmental certified sanitary and cleaning products are to be used for showers and cleaning.
- Sound from pumps and generators shall be minimized to reduce noise pollution impacts on bird and seal colonies.
- Before August 15th it is not allowed to enter bird nesting areas without permission from the Environment Agency.
- After September 1st traffic on the peninsula on the north side of the island is prohibited without supervision from Environment Agency staff on site to reduce stress in the grey seal colony.
- Oil barrels and other pollution material shall be stored in thick fish tub when in use. Empty barrels and those who are not in use shall be stored on a plastic canvas (Americover) in four layers. Extra care must be taken while handling the barrels.
- The ATM vehicle is to be stored on a plastic canvas in four layers and mats that will absorb oil while not in use near Pálsbæ and the drill site.
- The ATM vehicle is only to be used inside a marked path between Pálsbæ and the drill site. The use of the vehicle is not allowed outside this path.
- The ATM vehicle shall only be used to transport equipment and drivers.
- The speed limit for the ATM vehicle is 15 km/hr.
- Drivers of the ATM vehicle shall have a valid driver's license and have had training using the vehicle.
- During the project adequate oil clean-up equipment shall be at hand in order to handle all possible oil spills during transport, handling or storage.
- The Environment Agency of Iceland wishes to be secured, free of charge, a copy of all reports and scientific articles that result from the research project.

Fees charged

The Environment Agency of Icleand charges af fee of ISK 39.400 for processing and passing permits for construction and activities inside protected areas that may have negative impact on the site.

Surveillance

The Environment Agency of Iceland will monitor the project as it sees necessary and charge a fee of ISK 13.200 per hour as well as charging for all expenses related to the surveillance including travel and food for the inspector during the stay in Surtsey, in accordance with the surveillance plan.

Permission from the municipality Vestmannaeyjar must be obtained for this project. The applicant must also receive license from the Environmental and Public Health Authorities of South Iceland.

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ENVIRONMENT AGENCY

In order to export any samples taken in Surtey from Iceland permission must be obtained from the Icelandic Institute of Natural History.

Sincerely

Kristin Linda Árnadóttir
Director

Þórdís Vilhelmína Bragadóttir
Advisor

GFZ German Research Centre for Geosciences.
DOI: 10.2312/ICDP.5059.001

Planning Agency result from 9 November 2015 on that a special impact assessment for the Surtsey drilling was not required.

Skipulagsstofnun

Jarðvísindastofnun Íslands
Magnús Tumi Guðmundsson
Sturlugata 7
101 Reykjavík

Reykjavík, 9. nóvember 2015
Tilvísun: 201401016 / 2.8.2

Efni: Borun rannsóknarholu í Surtsey. Fyrirspurn um tilkynningarskyldu.

Vísað er til erindis Magnúsar Tuma Guðmundssonar dags. 5. ágúst 2015 þar sem óskað er leiðbeininga Skipulagsstofnunar um hvort að fyrirhugaðar boranir í Surtsey kalli á málsmeðferð skv. lögum um mat á umhverfisáhrifum. Fram kemur í erindinu að uppi séu ráðagerðir um að vinna nokkuð umfangsmikið borverkefni í Surtsey, annaðhvort sumarið 2016 eða 2017 með borun tveggja rannsóknaholna. Önnur yrði boruð lóðrétt, niður á um 200 m dýpi en hin skáboruð 300 m löng hola niður á svipað dýpi.

Gert er ráð fyrir að borunin taki nokkrar vikur og fari fram seinni hluta sumars og í september, eftir að fuglar hafi komið upp ungum. Vegna borunarinnar þarf að flytja út í eyjuna jarðbor og ýmis konar búnað s.s. eins og dælur, borstangir, eldsneyti, mælitæki, kjarnakassa, vistir og hluti sem snúa að aðstöðu bormanna. Gert er ráð fyrir að búnaðurinn verði fluttur á varðskipi að eynni en honum síðan skipað í land með þyrlum. Sami háttur yrði hafður á þegar búnaðurinn yrði fluttur burtu að loknum borunum. Enginn vegur verður lagður á eynni og gert er ráð fyrir að búnaði sé slakað niður þar sem á að nota hann. Reiknað er með að fjór- eða sexhjól verði á staðnum til að flytja til olíutunnur o.þ.h., enda öruggara að flytja til þunga hluti þannig og líkur á óhöppum minni. Reikna má með að för myndist eftir fjórhjólið í laust yfirborðið (gjósku og vikur) meðan á borun stendur, en þeim förum yrði svo rakað burtu að framkvæmdum loknum.

Fram kemur að athafnasvæði vegna borunarinnar nái aðeins til lítils hluta Surtseyjar og verði borholurnar staðsettar á hrauni við austurbarm gjóskugígsins Surts I, um 200 m frá Pálsbúð, skálanum í Eynni. Borinn verður hífður upp á pall sem mun standa á nokkrum lóðréttum rörum sem annaðhvort verður grafið fyrir eða þau boruð niður í klöppina undir gjóskunni. Þessi pallur verður fjarlægður að fullu að lokinni borun ásamt rörunum og hans mun ekki sjá neinn stað að verkinu loknu. Meðan á borun stæði yrði sjó dælt frá ströndinni austan við borstaðinn og hann notaður sem skolvatn við borunina. Eldsneyti yrði geymt í tunnum og gengið þannig frá að tunnurnar yrðu í kerum eða öðrum ílátum. Að lokinni borun yrðu ekki önnur ummerki eftir í eynni en tveir holutoppar, um 10 m frá þeim núverandi holutoppi. Holurnar yrðu fóðraðar til að varðveita þær, en þannig verður hægt að nýta þær á komandi árum til áframhaldandi rannsókna á jarðhita og lífríki í jarðhitakerfi Surtseyjar, eins og gert hefur verið með þá holu sem boruð var 1979. Tilgangur með borununum er að stunda þverfaglegar rannsóknir á gagnkvæmum áhrifum og samspili jarðhita og baktería við basíska gosösku.

Fram kemur að Surtsey sé friðuð sem friðland skv. lögum um náttúruvernd, nr. 44/1999 og fari Umverfisstofnun með umsjón friðlandsins, sbr. auglýsingum um friðlýsingu Surtseyjar. Surtsey hafi upphaflega verið friðlýst árið 1965 með vísan til laga um náttúruvernd nr. 48/1956 og friðlýsingin uppfærð árið 1974 í samræmi við lög um náttúruvernd nr. 47/1971. Árið 2006 hafi friðlýsingin enn verið uppfærð í samræmi við lög um náttúruvernd nr. 44/1999 og breytt lítillega árið 2011. Fram

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verið uppfærð í samræmi við lög um náttúruvernd nr. 44/1999 og breytt lítillega árið 2011. Fram kemur að leyfi til framkvæmda þarf frá Umhverfisstofnun og sveitarstjórn Vestmannaeyjabæjar að fenginni umsögn Surtseyjarfélagsins, sbr. auglýsingu um friðlýsingu Surtseyjar nr. 50/2006.

Niðurstaða. Kafli 2 í 1. viðauka laga um mat á umhverfisáhrifum nr. 106/2000 ber yfirskriftina námuiðnaður. Undir þessum kafla eru nokkrir töluliðir, m.a. tl. 2.06 þar sem fram kemur að djúpborun á vinnslu- og rannsóknarholum á háhitasvæðum séu tilkynningarskyldar til Skipulagsstofnunar. Fyrirhugaðar framkvæmir í Surtsey falla ekki undir kaflann (námuiðnaður) eða tölulið 2.06 þar sem ekki er verið að bora rannsóknarholu í því skyni að fjarlægja efni, þ.e. ekki er um námuiðnað að ræða. Auk þess er ekki um að ræða djúpborun rannsóknarholu þar sem holurnar eru einungis um 200m djúpar en Skipulagsstofnun hefur litið svo á að ákvæðið ætti við djúpborun sem fæli í sér borun holu a.m.k. meira en 1000 m djúpa sem kallaði gerð borplans og notkun öflugs bors. Það er því niðurstaða Skipulagsstofnunar að fyrirhugaðar boranir í Surtsey falli ekki undir ákvæði laga um mat á umhverfisáhrifum.

Beðist er velvirðingar á að hvað dregist hefur að svara erindinu.

Jakob Gunnarsson

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Health Inspectorate of South Iceland permit to operate a camp in Surtsey:

LEYFI

Með vísan til ákvæða laga nr. 7/1998 um hollustuhætti og mengunarvarnir með síðari breytingum, laga nr. 93/1995 um matvæli msbr., þegar um matvæli er að ræða og efnalaga nr. 61/2013 eftir því sem við á, veitir Heilbrigðiseftirlit Suðurlands hér með tímabundið leyfi til neðangreinds:

Leyfishafi:	**Raunvísindastofnun Háskóla Íslands** **kt: 530269 2219** **Öskju, Sturlugötu 7** **101 Reykjavík**
Vegna:	**Jarðborunar og starfsmannabúða í tengslum við SUSTAIN verkefnið í Surtsey**
Staðsetning:	**Surtsey**
Gildistími:	**22. júlí 2017 – 10. september 2017**
Ábyrgðaraðili:	**Magnús Tumi Guðmundsson , kt. 080561 5639, gsm: 861 5867**

Starfsemin skal uppfylla meðfylgjandi starfsleyfisskilyrði fyrir mengandi starfsemi og fyrir starfsmannabúðir, eftir því sem við á.

Leyfi þetta er bundið við ofanskráða kennitölu, starfsemi, staðsetningu og tímabil. Leyfishafi skal uppfylla allar þær kröfur sem gerðar eru til starfseminnar í lögum. Leyfið fellur úr gildi ef eitt eða fleiri nefndra atriða breytast. Óheimilt er að hefja aðra starfsemi en leyfið nær til, nema að fengnu samþykki Heilbrigðiseftirlits Suðurlands.

Selfossi, 18. júlí 2017,

F.h. Heilbrigðiseftirlits Suðurlands,

Stella Hrönn

Stella Hrönn Jóhannsdóttir,
heilbrigðisfulltrúi

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Municipality of Vestmannaeyjar permit to operate a drilling project in Surtsey

Vestmannaeyjabær

Háskóli Íslands
Magnus T. Gudmundsson
Suðurgötu
101 Reykjavík

Vestmannaeyjum, 31. júlí 2017
erindi nr. 201707065 ssb

Tilkynning um afgreiðslu á erindinu: Borun rannsóknarholu í Surtsey

Á 271 fundi Umhverfis-og skipulagsráðs, var erindið hér að neðan tekið til umfjöllunar og svohljóðandi bókun gerð:

201707065 - Borun rannsóknarholu í Surtsey

Magnús Tumi Guðmundsson f.h. Raunvísindastofnunar Háskóla Íslands sækir um framkvæmdaleyfi fyrir tveimur borholum í Surtsey sbr. innsend gögn. Áformað er að taka tvo borkjarna, 210 m langan lóðréttan kjarna auk kjarna úr 300 m langri skáholu.
Fyrir liggur samþykki Umhverfisstofnunar, Heilbrigðiseftirlits Suðurlands og afgreiðsla Skipulagsstofnunar.

Ráðið samþykkir erindið.
Framkvæmdaleyfisgjald kr. 81.411 sbr. gjaldskrá nr. 100/2017. Afgreiðsla þessi er skv. reglugerð nr. 772/2012.

Afgreiðsla þessi er háð samþykki bæjarstjórnar, og verður yður tilkynnt tafarlaust ef hún breytist.

Nánari upplýsingar gefur undirritaður starfsmaður Vestmannaeyjabæjar á skrifstofu sinni að Skildingavegi 5.
Þetta tilkynnist hér með.

Virðingarfyllst,

Sigurður Smári Benónýsson
Skipulags- og byggingarfulltrúi

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Appendix E –Environmental protection requirements

Surtsey

Special Environmental Protection of Surtsey

Surtsey has been a natural reserve since 1965 and human visits there have been restricted to prevent biological contamination and to protect its delicate environment. Surtsey and its surroundings were made a UNESCO World Heritage Site in 2008. Special written permission is required to visit the island and to dive in the waters inside the natural reserve.

SUSTAIN has been granted a special permit to drill on Surtsey, issued on 14 July 2017 by the Environmental Agency of Iceland. The permit sets numerous conditions on how the project is to be carried out. A special representative of the Environment Agency will oversee all our activities. The project participants are committed to honor the conditions set in the permit and follow all directions given by the Environment Agency. We all need to be fully aware of the responsibility we take on: to carry out the drilling project with close to zero impact on the island and leave it in the same state as when we arrived, apart from the two new drill holes.

Every participant must follow these guidelines:

Clothing:

- All clothing taken to Surtsey must be washed before arrival. If clothes cannot be washed in a washing machine they must be vacuumed or cleaned with brush or a cloth to remove all dirt and traces of plants or seeds. If this is not possible, then those garments should not be taken to Surtsey.
- All seams, zips, pockets, and folds in clothing must be inspected and cleaned, to make sure that these contain no plant remains or seeds.
  Velcro closures have to be cleaned thoroughly for the same reason.

Shoes:

- All visible dirt on shoes or boots need to be cleaned with water and soles thoroughly scrubbed.
- Shoe laces need to be removed and any dirt or plant remains or seeds that may be hidden under them removed.

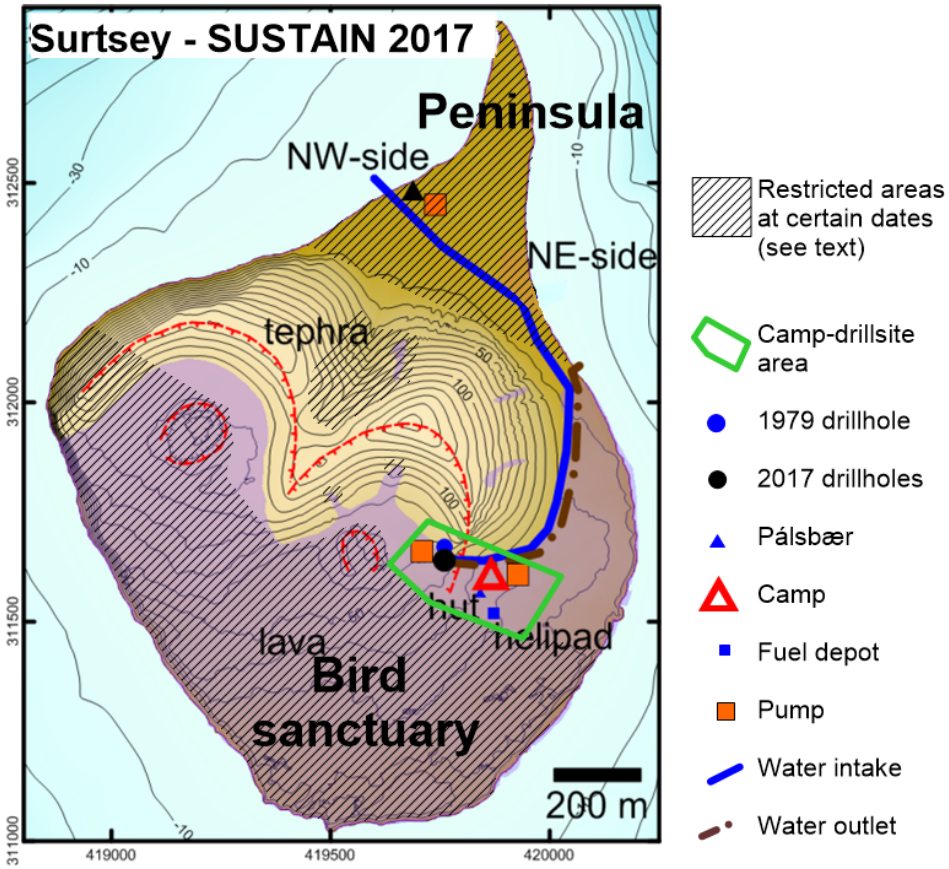
Luggage, equipment, tools:

- All seams, zips, pockets, and folds in rucksacks and other bags taken to Surtsey must be free of plant remains or seeds.
- All luggage should be stored in such a way prior to departure to Surtsey (with helicopter or boat), that no contact with plants happens.
- Surfaces (boxes, suitcases, etc.) need to be cleaned and the insides of all boxes vacuumed and washed to ensure that there is no soil, plant remains or seeds.
- All equipment taken to the island needs to be inspected to make sure it is clean and contains no foreign organic remains.
- All surveying and drilling equipment needs to be washed and cleaned prior to being taken to Surtsey. In particular, all holes, cracks and surfaces must be cleaned.

Permits to enter the island are issued to individuals; the Environment Agency needs to have a full record of all names and the duties of every participant.

Environmental concerns and restrictions

- Special care must be taken that all rubbish is disposed of in designated bins. This will all be transported off island, and applies to everything (wrappings, sawdust, etc.)
- As work will be concentrated at two locations (drill site and camp), food is to be consumed at only at the Pálsbær hut or, for drillers on duty, within their shed at the drill site.
- Several study plots, a few meters across and usually marked with a peg, are designated for various biological long-term investigations. We must take care to avoid any interference. This applies especially to laying down of water pipe, footpaths, and tracks made by the six-wheel ATV.
- The ATV will be used only to transport core and necessary materials between the camp and the drill site, and along the waterline in the area between the camp and the northern end of the lava flow. Maximum speed is 15 km/h. Helmets must be worn when driving the ATV.
- ATV will have only three permissible parking spaces, that have been specially protected with a plastic liner to prevent any oil spillage.
- Only people with a valid driving license will be allowed to drive the ATV and the need to have a briefing on how to operate it.
- There will be two toilets, one at the camp and another at the drill site. These are the only places where human waste (urine, feces) may be deposited on the island. All human waste will be removed from the island at the end of operations.
- It is not allowed to take rocks, soil, plants or animal remains away from the island.
- It is forbidden to disturb flora and fauna.



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Appendix F – Safety requirements

Safety on Surtsey

A printed sheet of safety protocols and an emergency plan for Surtsey will be given to each participant and posted at several locations on site. Here we identify four zones on Surtsey:

- **Camp-Drill site area** – the approximately 200 x 200 m area covering the drill site and the camp.
- **Waterline** – the path from the drill site to the peninsula on the north side
- **Peninsula** – the spit on the north side of the island where the water intake will be located.
- **Craters –** the tuff rings and the lava craters within them.
- **Lava – Bird Sanctuary** – the area to the south of the camp and drill site. We stay out of this area until mid-August. Same applies to other sensitive areas (shaded in map)

Trips outside the Camp and Drill site area:

- For each shift, one of the non-drilling crew will be designated the role of safety officer. That person needs to be notified of all travel outside the Camp-Drill site area. That person carries a VHF radio throughout the shift.
- For trips outside the Camp-Drill site area a person must carry a radio (VHF radios will be available).
- Trips onto the Lava - Bird Sanctuary are forbidden until after 15 August – then the bird nesting season will be over.
- Trips onto the peninsula after 1 September, should they be needed, are forbidden without being accompanied by the EA representative.

It is recommended that recreational walking be done with another person, using a buddy system, and always carrying a radio.

Hazard, danger (weather, other):

- If a known hazard or danger is imminent or occurring, all persons are to gather in the Pálsbær hut. If the hut is not safe, the Weather Haven tents serve as backup.
- The main natural hazard in Surtsey is weather. The Weather Haven tent structures are extremely sturdy and strong and should withstand all weather. In case they are damaged and not safe, we gather together in the hut. Weather forecasts of incoming storms for this area are reliable.
- Fire extinguishers will be in both Weather Haven tents, the Pálsbær hut, at the drill site and by the camp electric generator.
- The likelihood of volcanic eruption is remote. The area is monitored closely be the seismic network of the Iceland Meteorological Office (IMO). Judging from previous eruptions in Vestmannaeyjar, the precursors are expected to last for many hours or days. If, however, such precursors are detected, at the advice of Iceland Civil Protection and/or the IMO, the island will be evacuated.

Emergency response:

- In the case of accident or potentially serious illness, the scientist in charge will seek advice or call for help by calling 112. PI's will need to be notified, yet the course of events will dictated

by 112 consultation with emergency doctors on duty and the Coast Guard (see p. 16).
- In the case of minor injuries, the situation will be assessed and medical consultation sought as needed.
- First aid kits will be in Pálsbær hut and at the drill site for immediate response to accidents.
- Information on any medical conditions that may be relevant in case of injury or illness needs to be reported in advance and included on the medical questionnaire (see below). The scientist in charge (and others) will be updated on a need to know basis.

Drill site:

- The drill site has many heavy mechanical moving parts and is a dangerous place. It is also the workplace of the drillers. It is important for both their safety and the safety of others that ***all rules set by DES/drillers must be strictly followed.***
- People only enter the drill site with the agreement of the drillers.
- When entering the drill site make sure that the drillers see you approaching.

Fuel depot:

- There should be no unnecessary traffic at the fuel depot. It is only to be accessed by the drillers or the camp manager or under their supervision.

Water intake at peninsula:

- Sea water is pumped by an underwater pump powered by a generator on land. In case of failure or break down, special care must be taken that the ocean and the salty wet rocks on the coast may be carrying a strong electric current!
- Walking on the polished, wet, lava boulders along the peninsula requires care not to slip, especially when algae and moss is present.

Camp electricity generators:

- The camp generators are the responsibility of the camp manager. All handling and management of these should take place by him/her or directly supervised by him/her.

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Appendix G – Description guide for visual core description

G.1 Description guide for SE-02a DIS entries

Identifiers for the DIS, converted from the original spreadsheet, consist of page values (numbered below) and value lists included on each page.

i. Section unit
   a. Unit class (Surtsey volcano, Surtsey seafloor, other)
   b. Unit type (lava flow, hyaloclastite tuff, unconsolidated tephra, intrusion, pillow lava, other, marine sediments)
   c. Colour (following Munsell colour chart),
   d. Contact top (Magmatic-Magmatic, Magmatic-Pyroclastic, other, Pyroclastic-Pyroclastic)
   e. Lithification (unconsolidated, poorly consolidated, moderately consolidated, well lithified, other
   f. Strength (1- extremely friable, 2- easily to disaggregate, 3- difficult to disaggregate, 4- well-bonded, 5- undefined
   g. Vesicle abundance (none, low < 5%, moderate 5-10%, abundant 10-20%, very abundant >20%, and variable)
   h. Vesicle rounding (angular, rounded, sub-angular, sub-rounded, very angular, well rounded)
   i. Vesicle orientation (yes or no)
   j. Minerals (olivine, feldspar, Cr-Spinel, magnetite, clinopyroxene, other, carbonate, zeolite, clay minerals, halite, thenardite, opal, gypsum, anhydrite, palagonite

Vesicles in this section refer to tuff vesicles and crystalline basalt vesicles.

ii. Clasts
   a. Clast type (fine ash (<0.063 mm), coarse ash (< 2mm), lapilli-sized clasts (<64 mm), bomb-sized clasts (>64 mm), accretionary lapilli, tachylite lapilli, vitric matrix, cognate rock clast, xenolithic rock clast, other)
   b. Colour
   c. Orientation (yes or no)
   d. Clast sorting (very well sorted, well sorted , moderately well sorted, moderately sorted, poorly sorted, very poorly sorted)
   e. Clast type (sideromelane, tachylite, palagonite)
   f. Clast shape (angular, sub-angular, sub-rounded, rounded, irregular, variable)
   g. Vesicle rounding (spherical, sub-spherical, elliptical, polylobate/amoeboid, wrinkled/convoluted, ragged/serrated)
   h. Vesicle abundance (dense (0-5% vesicles), poorly vesicular (5-40% vesicles), moderately vesicular (40-60% vesicles), and highly vesicular (60%+ vesicles), variable
   i. Vesicle orientation (yes or no)

iii. Layering
   a. Massive fabric
   b. Size-sorted layering (a layer where a sudden change in particle size or sorting occurs)

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c. Finely-bedded
d. Crudely bedded
e. Reworked layer
f. Graded bedding

iv. Structures
    a. Structures (Slump structure {The slump structures formed during pre-consolidation movement, they are defined by thin layers enriched in fine-grained material, which were apparently soft and wet at the time of slumping. These beds are generally steeper than primary bedding. In places they truncate primary bedding layers and hence are younger}, graded bedding in slump deposit, soft sediment deformation in slump deposit, shear structures {These were formed by shearing and faulting of semi-consolidated or solid material. They probably form a continuum with slump structures and are formed by gravity-controlled processes occurring during deposition and consolidation of the tephra. The shears occur in clusters and commonly contain open fractures, which in places are filled with stringers of secondary minerals}, translational)
    b. Displacement type (both, none, opening, translational)
    c. Displacement orientation (yes, no)
    d. Colour (Munsell colour chart)
    e. Mineral filling (carbonate, zeolite, clay minerals, halite, thenardite, opal, gypsum, anhydrite)

G.2 Description guide for SE-02b and SE-03

Information was omitted from descriptions when it could not be accurately determined. In the case of multiple facies being present in a given core section they are described separately with their respective depth. When possible (i.e. when the differences between facies were subtle), the core section was described as a whole in addition to the individual facies descriptions.

Specific to SE-03, grading was difficult to accurately determine in upper armored lapilli tuff beds due to depositional angle and angle of core. Due to the smaller size of the NQ core (4.5 cm in diameter) the assessment of bedding, grading, and average clast size was limited. Furthermore, these cores are often fractured into numerous disks and disk rotation during the drilling/coring process most certainly occurred. Excluding field sampling, additional material was removed prior to the cores being scanned and described. The resulting absence of information affects the completeness of data collected.

G.2.1 Pyroclastic rocks

i. Colour (wet): subjective estimate of the overall colour, does not follow any colour chart.

ii. Extent of lithification: unconsolidated-0: loose material; poorly consolidated-1: sediment easily crumbles with any applied force porosity remains high; moderately consolidated-2: firm but slightly friable with incomplete/early cementation/alteration and low porosity; lithified-3: rock is hard with developed cements and very low porosities, well lithified-4; rock is strong, coherent, with well-developed mineral cements and extremely low porosities.

iii. Sorting: For sorting Figure was used as a guidance.

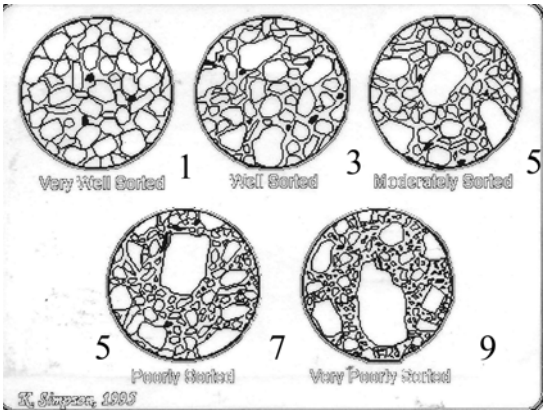

Figure G1. *Sorting chart after Compton (1985).*

iv. Support: framework/clast, openwork {no fines between grains}, matrix.

v. Stratification: Bedding/lamination and defining characteristics (crudely stratified- few isolated very poorly developed bands/domains, often discontinuous and irregular, and often not obvious with diffuse transitions, if highly irregular modified with "very"; weakly stratified- poorly developed but observable/ noticeable differences in grain size across/along core; moderately bedded- distinct changes in grain size and/or sorting with diffuse/poorly defined contacts; well bedded- distinct changes in grain size and/or sorting with clearly defined contacts between layers).

vi. Grading: massive, normal, reverse, coarse-tail (fines distributed throughout).

vii. Rock type based on maximum average grain size: (described using primary volcaniclastic terminology defined by White and Houghton, 2006): e.g. coarse lapilli tuff, medium armored lapilli tuff, medium tuff.

viii. Extent of alteration: Rough estimate based on the overall rock color, and often refers to the fine- to very fine-grained matrix or intergranular material (when present). However, this does not imply the absence of unaltered fragments. If the extent of alteration could not be determined with confidence, the section was left blank.

   a. Unaltered-black, unconsolidated
   b. Weakly altered-orange, poor to moderately consolidated
   c. Moderately altered- lithified, grayish black, blackish green
   d. Highly altered- well lithified, green

ix. Secondary mineral growth: if present and where.

x. Factures: Inclination and secondary mineral growth.

xi. Clast type:

   a. Lapilli: a particle 2-64 mm in size derived directly from erupting magma (White and Houghton, 2006)

      I. Simple- variably vesicular fragments of a single texture.

      II. Zoned- with a more vesicular interior and a full or partial less vesicular outer 'rind', and/or different textures/colors between the interior and margin.

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b. Composites: a clast that contains, or consists of, multiple smaller clasts.

c. Armored: Lapilli to coarse ash with a fine to extremely fine ash coating of variable thickness. These fragments become less obvious with depth and increased secondary mineral growth and alteration.

d. Lithics: these include clasts of intraformational tuff, included basalt, dense-coarsely vesicular magnetic basalt, basaltic sandstone, crystalline clasts, pink gneiss, etc. These fragments generally make up ≤ 1% of the total clast population for a given core segment or run with few notable exceptions.

xii. Matrix: refers to the ash size fraction (≤2 mm) of the rocks and is commonly altered.

xiii. Approximate volume fraction of lithic fragments (vol %): this is the overall volume fraction of lithic fragments for a given core section (for SE-03, usually provided in the first lithofacies described i.e. 0-XX cm depth) or core box (SE-02b usually applies to each section unless otherwise stated in this category or in clast types) and not for individual facies. For SE-02b, when core sections are described separately, the lithic content will be listed in the first section for a given core run but will apply to all core sections.

xiv. Comments

G.2.2 Crystalline basalt

i. Grain size (aphanitic/aphyric, porphyritic).

ii. Phenocrysts (mineralogy and size)

iii. Phenocryst abundance.

iv. Vesicularity: described as dense (0-5% vesicles), poorly vesicular (5-40% vesicles), moderately vesicular (40-60% vesicles), and highly vesicular (60%+ vesicles), modified from the vesicularity index laid out in Houghton and Wilson (1989).

v. Vesicle textures/Patterns.

vi. Contacts features (planar or irregular, orientation, any signs of adjacent host being locally indurated or lithified, any signs of basalt being chilled or brecciated. If peperitic: note juvenile clast shape, size, margins, and dispersal if possible).

vii. Jointing.

viii. Comments (groundmass texture, and any notable features).

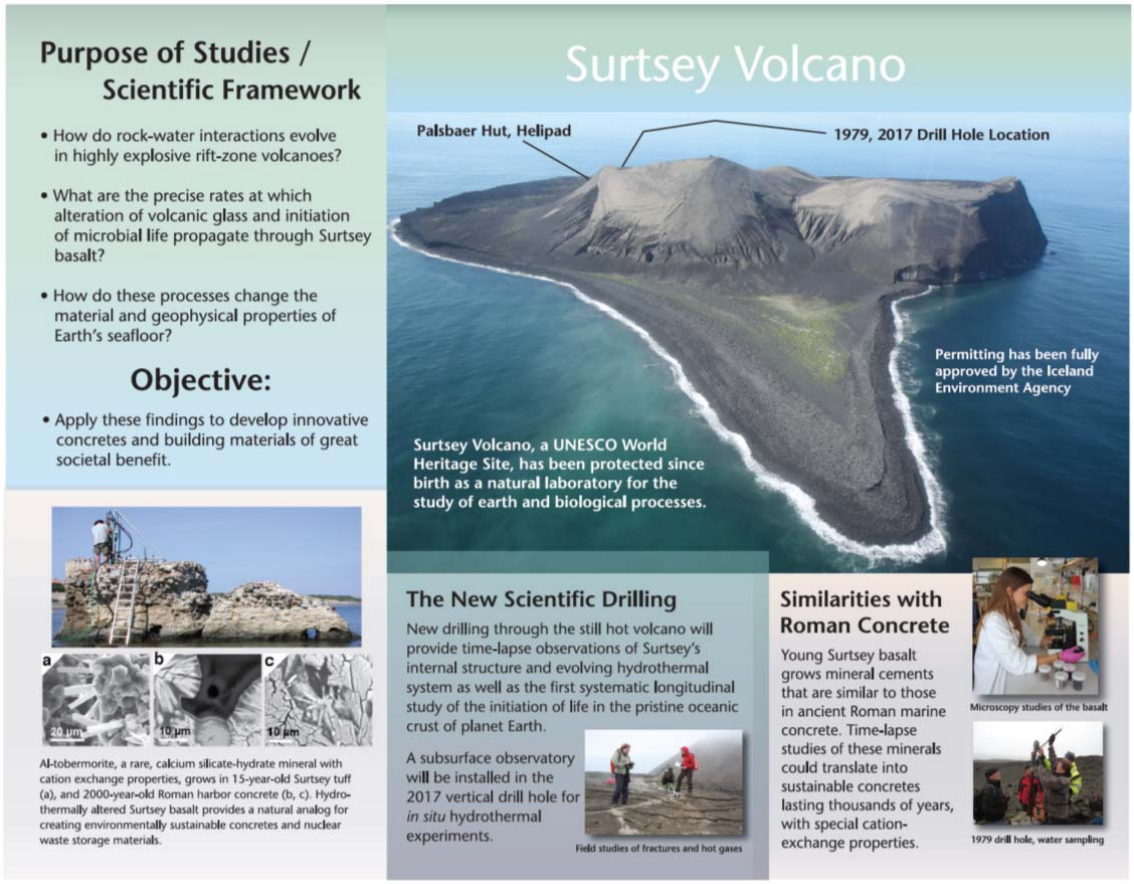
G.3 References

Compton, R. (1985). Geology in the Field. *Wiley*, 416 p.

Houghton, B.F. and Wilson, C.J N. (1989). A vesicularity index for pyroclastic deposits: Bulletin of Volcanology, 51, 451-462.

White, J.D.L. and Houghton, B.F. (2006). Primary volcaniclastic rocks. *Geology*, 34(8), 677-680.

Appendix H – Outreach brochure



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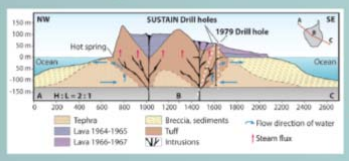
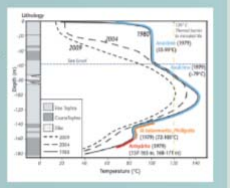
Geologic Framework



Temperatures continue to change in the 1979 drill hole. Microbiological studies of water samples (1, 2) have recently discovered seafloor bacteria and archaea colonization deep in the volcano.



Vestmannaeyjar is a young, active, basaltic volcanic system. Historic eruptions have occurred at Hellisey (1896), at Surtsey (1963–1967), and at Heimaey (1973).

S U S T A I N

The Surtsey Underwater Volcanic System for Thermophiles, Alteration Processes and Innovative Concretes.

International Continental Scientific Drilling Program

http://surtsey.icdp-online.org

This scientific drilling project involves an international team of scientists from nine countries including Iceland, Germany, Norway, Sweden, Italy, United Kingdom, New Zealand, Australia, and the United States.

Funded through:

- ICDP, GFZ Deutsches GeoForschungs Zentrum
- Rannsóknamiðstöð Íslands, RANNÍS
- Center for Geobiology, University of Bergen, Norway
- DFG, Deutsche Forschungsgemeischaft
- DiSTAR,Universitá Federico II, Napoli, Italia
- University of Utah, USA
- Landsvirkun, Ísland
- Reykjavík Energy, Ísland

For more information:

WEB:
Surtsey Research Society
http://whc.unesco.org/en/list/1267
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SURTSEY VOLCANO AFTER 50 YEARS

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Appendix I – Daily reports from Surtsey

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ÍSOR ICELAND GEOSURVEY

SUSTAIN

Location	Daily Report #1	? working day
Surtsey	Preliminary data collection	19st of August 2017

Well Name:	**SE-02b**	*Drilling Company:*	**DES**	*Geologist:*	**TBW**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	
Drill-bit diameter:	**6⅛"**	*Depth at midnight:*	**0 m**	*Hole made last 24 hrs*	**- m**
Drilling fluid:	**mud**	*Depth at 9 AM:*	**12 m**	*Drilling time:*	**- hrs.**
Sterilized fluid:	**no**	*Circulation losses:*	**TLC**	*Average ROP:*	**- m/hr**

Drilling operations

After the drill string got stuck at a TMD of 151.57 m on August 16th, and freeing was not possible it was decided to cut drilling rods on the early morning of August 18th. In total 4 cuts were done without success. The string was cut at following HQ rod 37, 34, 18 and 15 with the NQ string and cutter. The uppermost cut was at about 46 m. Therefore, the string was left within the hole and the well SE-2a (Figure 1) was declared abandoned The surface rod was cut but no well-head cap was installed as only 2 well-heads caps are available on Surtsey. Afterwards the rig was partial dismantled and the rig was "moved" in order to a drill a new vertical well.

Drilling with a 6⅛" rotary tricone drill bit was carried from 0:30 to 4:30 AM on August 19th down to 12 m for well SE-2b. Figure 2 shows the picture of the rig site, showing the 1979 well-head and SE-2a; the rough location of the new vertical well SE-2b verified by the location of the drill rig. During drilling TLC occurred and not cutting samples were retrieved. According to the drillers the lower most section indicated a stable formation conditions. Subsequently 4 surface casing rods were inserted and cemented afterwards. In total 4 bags each 30 kg of cement was used. However, an unknown volume of the cement was not useable due to fact that the cement bags got wet and was partially hardened (Figure 3). Currently the drilling crew is WOC. Due to the shortage of the cement and problems with the hardened cement that got wet during storage, it remains unclear how much cement reached the casing shoe. We will try to locate the TOC to make some estimation.

A damaged of one of the ocean seater water pipe was observed yesterday evening. The damage was repaid by the camp manager this morning during low tide.

Logistics

New delivery of cement was requested shortly after the crew change and helicopter was completed on August 18th. In addition, problems occurred with the onsite cement supply on August 19th as some of the cement bags got wet and cement hardened and therefore was not useable. New delivery of cement should be considered to bring in soon.

Well Monitoring

A well monitoring string has been arranged during the last day, which was flew in on August 18th. The monitoring string has following arrangement starting from the start of the string: 0 m (175 m depth) for T (hobo), 40 m (135 m depth) for T (hobo), 75 m (100 m depth) for T (hobo), 100 m (165 m depth) for PT (MadgeTech), and 175 m mark (surface).

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Figure 1. Picture showing the abandoned well SE-2a on August 19th, 2017 (image source: TBW).

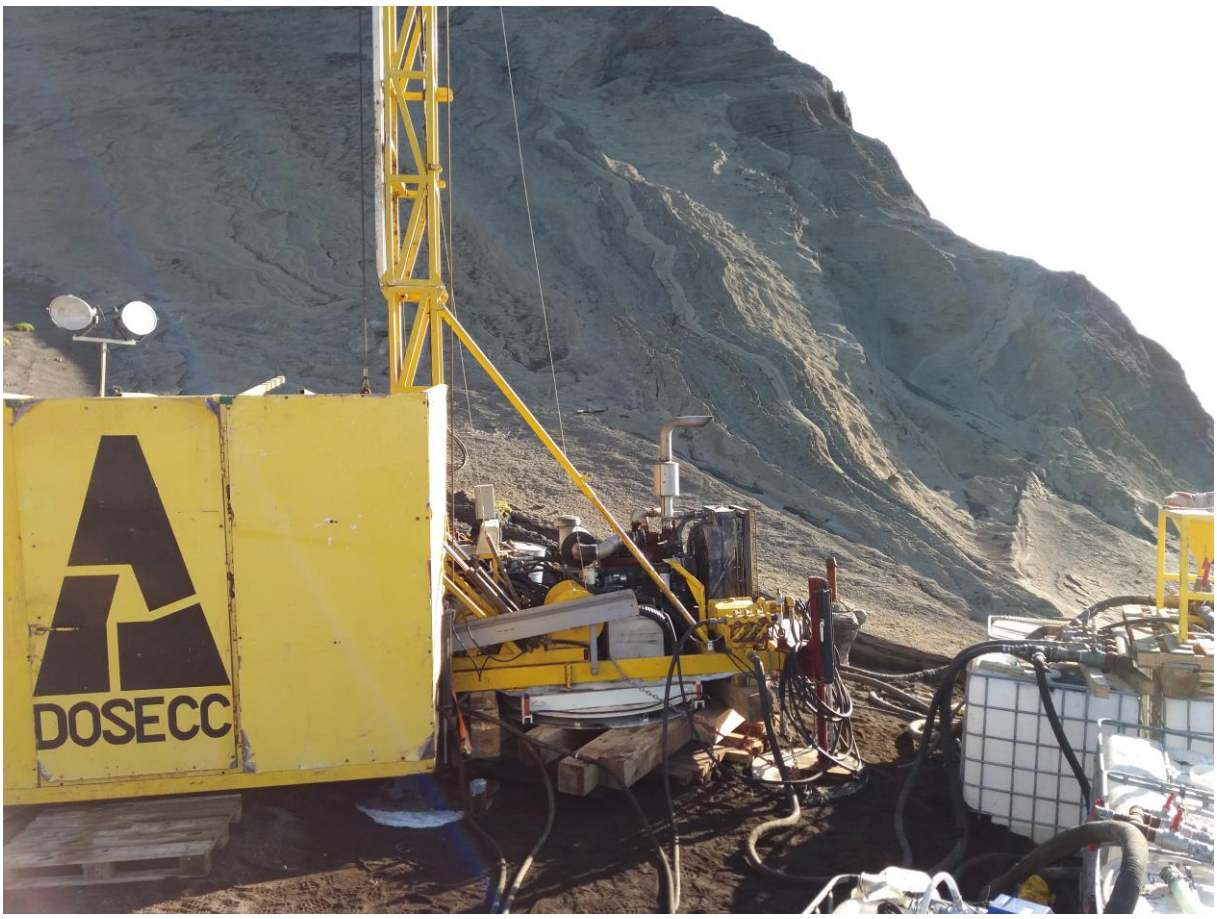

Figure 1. Picture showing rig site on August 19th, 2017 (image source: TBW).

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Figure 3. Picture showing cement fragments (left side) that hardened during storage and were not usable for cementing the surface casing of SE-2b (image source: TBW).

DOI: 10.2312/ICDP.5059.001

Onsite science team

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BK	Barbara Kleine	HÍ			Geologist
PB	Pauline Bergsten	MATIS			Microbiologist
AB	Amel Barich				Geologist
EM	Erica Massey				Geologist
SO	Solveig Onstad				Geologist

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SUSTAIN

Location	Daily Report #2	? working day
Surtsey	Preliminary data collection	20st of August 2017

Well Name:	**SE-02b**	*Drilling Company:*	**DES**	*Geologist:*	**TBW**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	
Drill-bit diameter:	**6⅛"**	*Depth at midnight:*	**12 m**	*Hole made last 24 hrs*	**12 m**
Drilling fluid:	**mud**	*Depth at 9 AM:*	**12 m**	*Drilling time:*	**4 hrs.**
Sterilized fluid:	**yes**	*Circulation losses:*	**unclear**	*Average ROP:*	**3 m/hr**

Drilling operations

Drilling with a 6⅛" rotary tricone drill bit was carried from 0:30 to 4:30 AM on August 19th down to 12 m for well SE-2b. During drilling TLC occurred and not cutting samples were retrieved. According to the drillers the lower most section indicated a stable formation conditions. Subsequently 4 surface casing rods were inserted and cemented afterwards. In total 4 bags each 30 kg of cement was used. However, an unknown volume of the cement was not useable due to fact that the cement bags got wet and was partially hardened. Afterwards the drilling crew was WOC. While WOC the rig crew continued to install the rig site after the rig rotation. Due to the shortage of the cement and problems with the hardened cement that got wet during storage, it remained unclear how much cement reached the casing shoe and the Surtsey team contacted the MTG to arrange the transport of cement to secure further progress of drilling. Eventually 300 kg (12 bags each 25 kg) could be sourced on Heiamey and transported by the Heimaey rescue boat to Surtsey in the evening on August 19th. The boat arrived at 6:30 PM at the east short at the tip of the island and by a great teamwork of the Surtsey team the cement could be carried to the rog side and 4 bag of cement were used right just before the shift change at about 7:30 PM to further cement the well. A damaged of one of the ocean seater water pipe was observed on the evening of August 18th. The damage was repaid by the camp manager in the morning of August 19th during low tide.

WOC on cement continued on August 20th. Coring of SE-2b should start this morning after a decision is made whether the well will slightly tilted to limit the risk of intersection with SE-2a.

Figure 1 shows an image of the well drilled so far. Figure 2 shows a map view of the wells. Figure 3 shows the drilling progress of SE-2b. Figure 4 to 6 shows pictures of the arrival of 300 kg on Surtsey.

Logistics

New delivery of cement was requested shortly after the crew change and helicopter was completed on August 18th. In addition, problems occurred with the onsite cement supply on August 19th as some of the cement bags got wet and cement hardened and therefore was not useable. New delivery of cement was arrange in the evening of August 19th and 300 kg (12 bags each 25 kg) were transported by the rescue boat from Heimaey to Surtsey and the issue was there solved. After the usage of 4 bags, 8 cement bags are on stock.

Well Monitoring

A well monitoring string has been arranged during the last day, which was flew in on August 18th. The monitoring string has following arrangement starting from the start of the string: 0 m (175 m depth) for T (hobo), 40 m (135 m depth) for T (hobo), 75 m (100 m depth) for T (hobo), 100 m (165 m

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depth) for PT (MadgeTech), and 175 m mark (surface). The monitoring string was lower in SE-01 at 3 PM by EM, AB and TBW. Figure 7 shows a picture while lowering the tool.

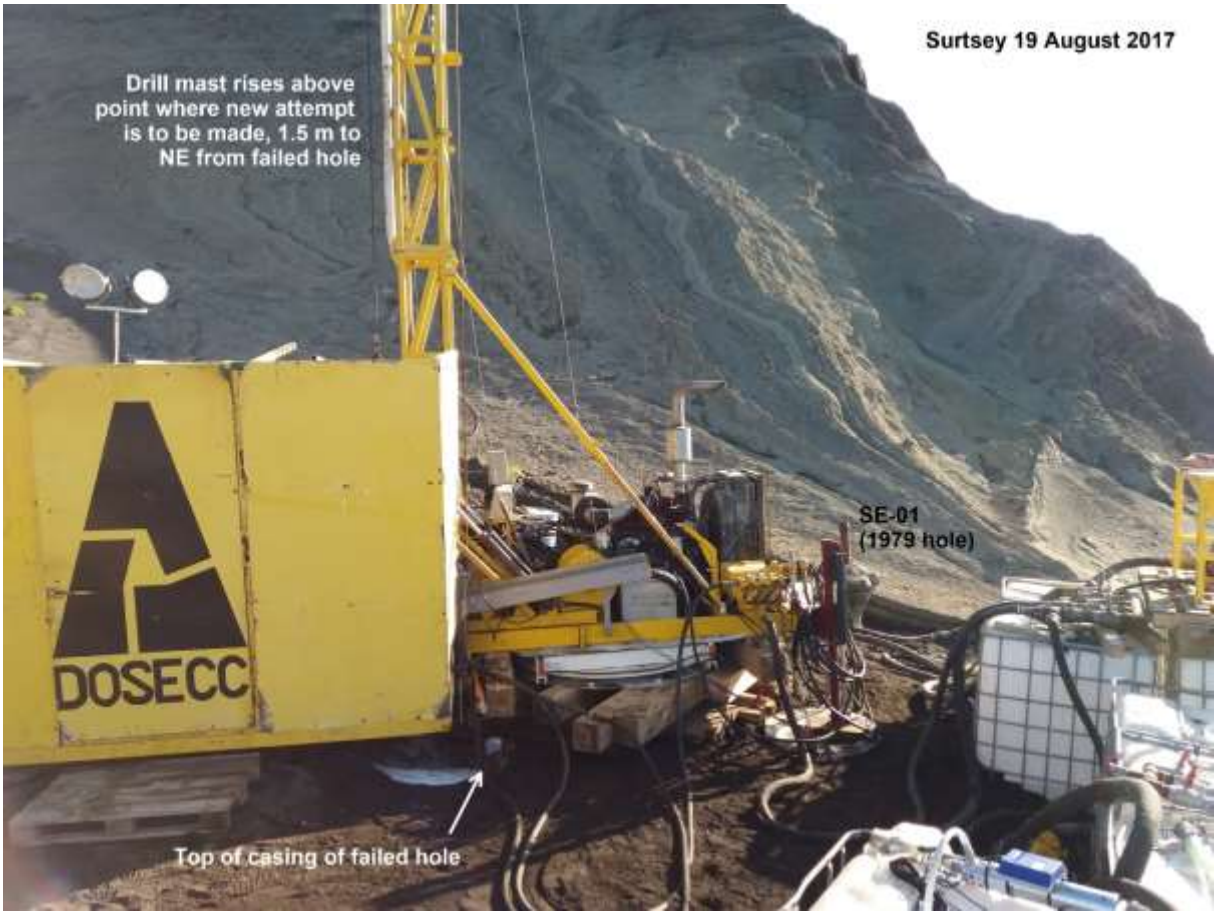

Figure 1. Image showing the location of SE-1, SE-2a and SE-2b (compilation done by MTG).

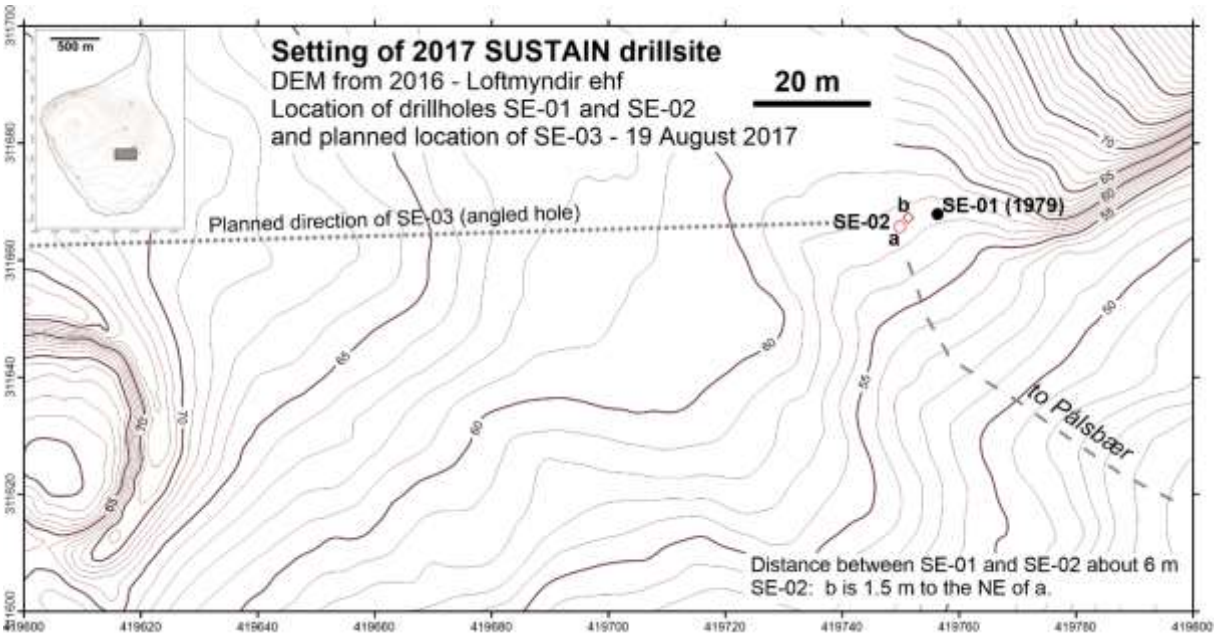

Figure 2. Map view showing the location of SE-1, SE-2a and SE-2b (MTG).

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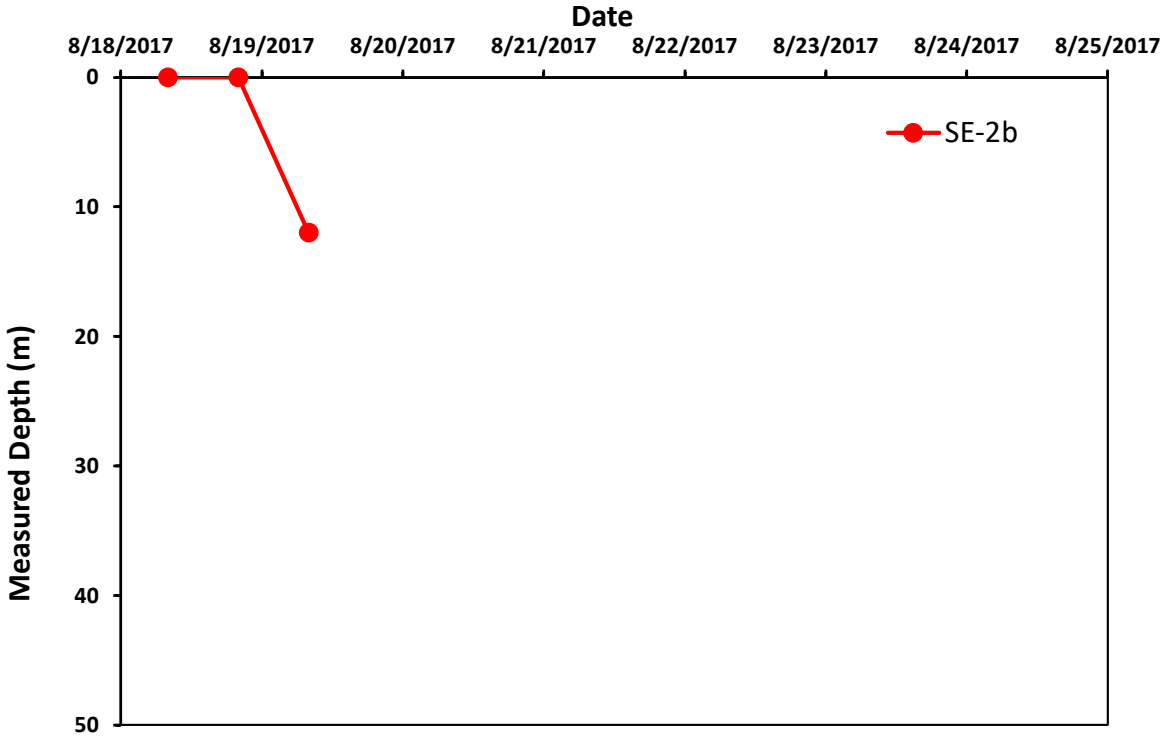

Figure 3. Drilling progress from SE-2b

Figure 4. Picture showing the Surtsey team receiving 300 kg cement delivered by the rescue boats from Heimaey on August 19th, 2017 (image source: AB).

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Figure 5. Picture showing the Surtsey team receiving 300 kg cement delivered by the rescue boats from Heimaey on August 19th, 2017 (image source: AB).

Figure 6. Picture showing Tobias B. Weisenberger from the Surtsey team carrying 50 kg cement from the beach to the ATV on August 19th, 2017 (image source: AB).

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Figure 7. Picture showing Tobias B. Weisenberger and Erica Massey installing a temperature and pressure monitor string in SE-1 on August 19th, 2017 (image source: AB).

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Onsite science team

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BK	Barbara Kleine	HÍ			Geologist
PB	Pauline Bergsten	MATIS			Microbiologist
AB	Amel Barich				Geologist
EM	Erica Massey				Geologist
SO	Solveig Onstad				Geologist

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SUSTAIN

Location	Daily Report #3	? working day
Surtsey	Preliminary data collection	21st of August 2017

Well Name:	**SE-02b**	*Drilling Company:*	**DES**	*Geologist:*	**TBW**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	
Drill-bit diameter:	**HQ**	*Depth at midnight:*	**17.79 m**	*Hole made last 24 hrs*	**20.84 m**
Drilling fluid:	**mud**	*Depth at 9 AM:*	**20.84 m**	*Drilling time:*	**3 hrs.**
Sterilized fluid:	**yes**	*Circulation losses:*	**TLC**	*Average ROP:*	**2.7 m/hr**

Drilling operations

WOC on cement continued on August 20th. During the early morning hours on August 20th it was realized that the water storage on Surtsey was not enough and problems with the seawater pumps on the north eastern side of Surtsey occurred. The rig crew was trying to fill up water storage and was later supported by the on-site team crew. Filling up the water storage at the rig site and the storage space at the shore was completed by using a newly installed pump (waste pump) at about 5 PM. After some further preparation at the drill site (e.g. digging out a cellar at SE-2b) coring started at 10 PM on August 21st. In total three core runs were executed to a TVD od 20.84 m.

The third core run got stuck and it took several ours in the morning of August 21st to get free again. When POOH with the drill string the surface casing became lose. Subsequently, a cement job was carried out. Currently it is WOC. While WOC, th rig crew and onsite team is solving some problems with the electricity at the rig site.

Figure 1 shows the drilling progress of SE-2b. Figures 2 and 3 show the rig activity during the first core run.

Coring

Table 1. *Overview of conducted core runs in SE-2b in 2017.*

Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)*
SE-2b	1	20.08.2017	10:00 - 10:15 PM	12.86	14.74	1.88	1.685	90
SE-2b	2	20.08.2017	10:50 - 11:15 PM	14.74	17.79	3.05	3.01	99
SE-2b	3	21.08.2017	0:20 - 0:55 AM	17.79	20.84	3.05	3.03	99
				Total	**20.84**	**7.98**	**7.725**	**97**

* should be measured again at the core processing on Heimaey.

Core description:

Core 1: consolidated tuff

Core 2: top is consolidated tuff (becomes likely basalt?)

Core 3: consolidated tuff

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Table 2. *Overview of conducted core runs in SE-2b in 2017.*

Well	Core run no.	Section no.	Date	Length (m)*	Core box (no)	Slot (no)	Comment
SE-2b	1	1	20.08.2017	0.99	b1	1	No cement plug drilled. Only some plastic pieces were found on top of the core
SE-2b	1	2	20.08.2017	0.57	b1	2	
SE-2b	1	CC	20.08.2017	0.155	b1	2	
SE-2b	2	1	20.08.2017	0.98	b2	1	
SE-2b	2	2	20.08.2017	0.98	b2	2	
SE-2b	2	3	20.08.2017	0.955	b2	3	
SE-2b	2	4	20.08.2017	0.165	b2	4	
SE-2b	2	CC	20.08.2017	0.17	b2	4	
SE-2b	3	1	21.08.2017	0.91	b3	1	Problems during drilling. Missing liner in the core barrel caused damage on the core. Drilling crew had to pump the core out of the core barrel.
SE-2b	3	2	21.08.2017	0.55	b3	2	
SE-2b	3	3	21.08.2017	0.335	b3	2	
SE-2b	3	4	21.08.2017	0.875	b3	3	
SE-2b	3	CC	21.08.2017	0.36	b3	4	

* should be measured again at the core processing on Heimaey.

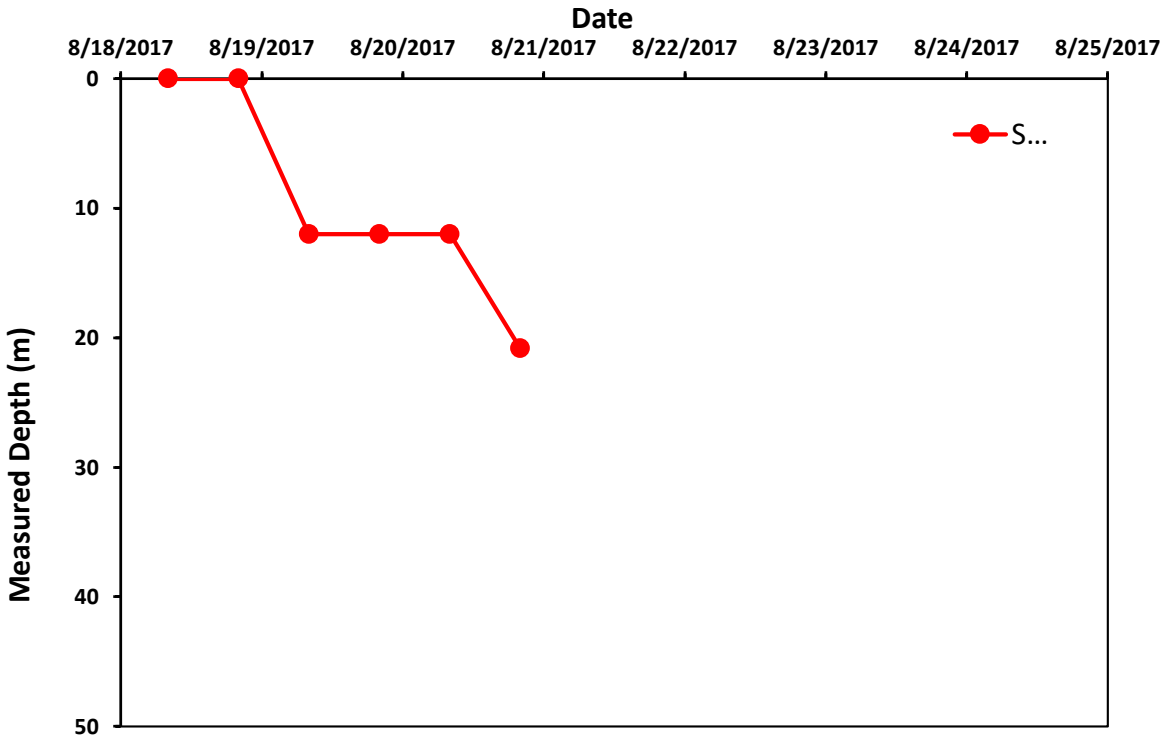

Figure 1. Drilling progress from SE-2b

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Figure 2. Picture showing the drill rig while coring at SE-2b on Surtsey on August 20th, 2017 (image source: AB).

Figure 3. Picture showing the on-site scientists retrieving the first core run at SE-2b on Surtsey on August 20th, 2017 (image source: AB).

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Onsite science team

Initials	Name	Affiliation	Email	Cell phone no	Function
TBW	Tobias B. Weisenberger	ÍSOR	tobias.b.weisenberger@isor.is	+354 661 3406	Geologist
BK	Barbara Kleine	HÍ			Geologist
PB	Pauline Bergsten	MATIS			Microbiologist
AB	Amel Barich				Geologist
EM	Erica Massey				Geologist
SO	Solveig Onstad				Geologist

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SUSTAIN

Location	Daily Report #4	? working day
Surtsey	Preliminary data collection	22nd of August 2017

Well Name:	**SE-02b**	*Drilling Company:*	**DES**	*Geologist:*	**TBW**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	
Drill-bit diameter:	**HQ**	*Depth at midnight:*	**20.84 m**	*Hole made last 24 hrs*	**20.84 m**
Drilling fluid:	**mud**	*Depth at 9 AM:*	**20.84 m**	*Drilling time:*	**3 hrs.**
Sterilized fluid:	**yes**	*Circulation losses:*	**unclear**	*Average ROP:*	**2.7 m/hr**

Drilling operations

Coring was completed on August 21st. However, the third core run got stuck and it took several ours in the morning of August 21st to get free again. When POOH with the drill string the surface casing became lose. Subsequently, a cement job was carried out. Afterwards it was WOC. While WOC, the rig crew and onsite team was solving some problems with the electricity at the rig site.

WOC continued on August 22nd and currently the rig crew is preparing to start coring again this morning.

Figure 1 shows the drilling progress of SE-2b. Figure 2 shows the rig activity today.

Logistics

A television team arrived in the morning on August 21st. The boat trip was used to exchange to team members. Erica Massey and Elisabeth (cook) left the Surtsey, whereas Águst Þór and Dagny (cook) joined the team on Surtsey. The boat trip in the evening, which picked up the film team was used to provide the Surtsey team with items that run out (milk, cat litter, toilet bags). In addition, some electronic parts came in to secure the safety.

Coring

Table 1. *Overview of conducted core runs in SE-2b in 2017.*

Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)*
SE-2b	1	20.08.2017	10:00 - 10:15 PM	12.86	14.74	1.88	1.685	90
SE-2b	2	20.08.2017	10:50 - 11:15 PM	14.74	17.79	3.05	3.01	99
SE-2b	3	21.08.2017	0:20 - 0:55 AM	17.79	20.84	3.05	3.03	99
				Total	**20.84**	**7.98**	**7.725**	**97**

* should be measured again at the core processing on Heimaey.

Core description:

Core 1: consolidated tuff

Core 2: top is consolidated tuff (becomes likely basalt?)

Core 3: consolidated tuff

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Table 2. *Overview of conducted core runs in SE-2b in 2017.*

Well	Core run no.	Section no.	Date	Length (m)*	Core box (no)	Slot (no)	Comment
SE-2b	1	1	20.08.2017	0.99	b1	1	No cement plug drilled. Only some plastic pieces were found on top of the core
SE-2b	1	2	20.08.2017	0.57	b1	2	
SE-2b	1	CC	20.08.2017	0.155	b1	2	
SE-2b	2	1	20.08.2017	0.98	b2	1	
SE-2b	2	2	20.08.2017	0.98	b2	2	
SE-2b	2	3	20.08.2017	0.955	b2	3	
SE-2b	2	4	20.08.2017	0.165	b2	4	
SE-2b	2	CC	20.08.2017	0.17	b2	4	
SE-2b	3	1	21.08.2017	0.91	b3	1	Problems during drilling. Missing liner in the core barrel caused damage on the core. Drilling crew had to pump the core out of the core barrel.
SE-2b	3	2	21.08.2017	0.55	b3	2	
SE-2b	3	3	21.08.2017	0.335	b3	2	
SE-2b	3	4	21.08.2017	0.875	b3	3	
SE-2b	3	CC	21.08.2017	0.36	b3	4	

* should be measured again at the core processing on Heimaey.

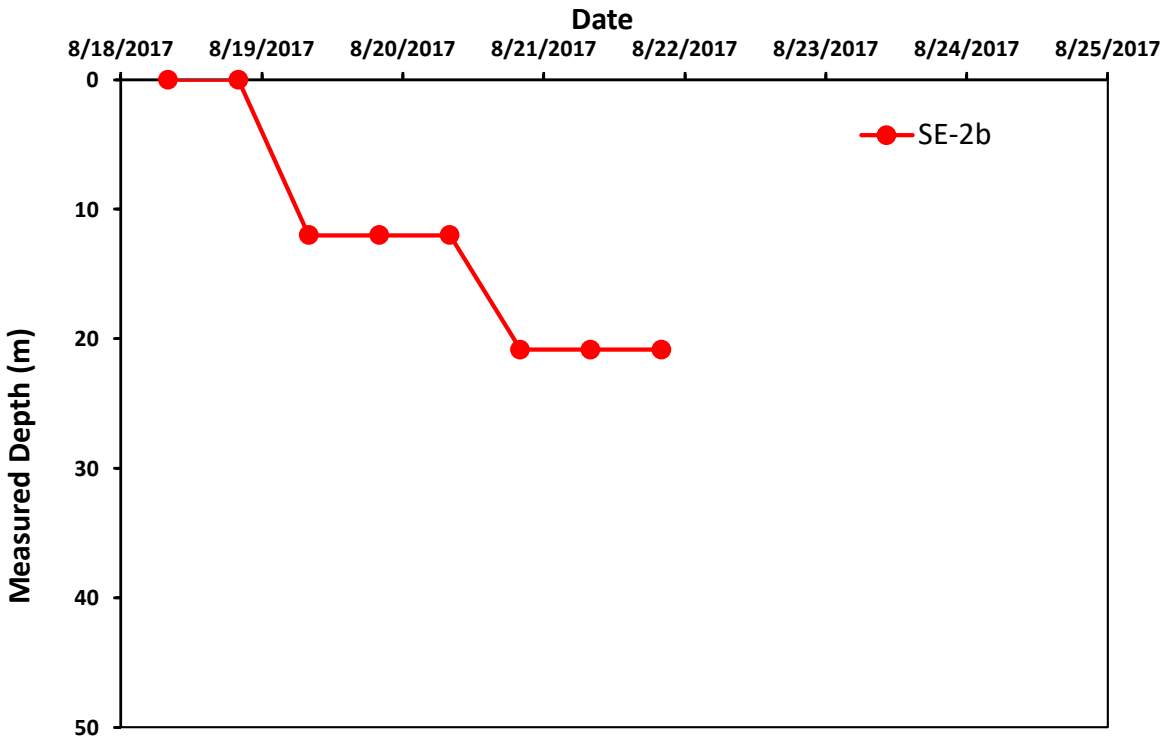

Figure 1. Drilling progress from SE-2b

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Figure 2. Scientist Barbara Kleine (left) and Amel Barich (right) waiting for the start of coring at SE-2b on Surtsey on the morning of August 22nd, 2017 (image source: TBW).

Onsite science team

Initials	Name	Affiliation	Email	Cell phone no	Function
TBW	Tobias B. Weisenberger	ÍSOR	tobias.b.weisenberger@isor.is	+354 661 3406	Geologist
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PB	Pauline Bergsten	MATIS			Microbiologist
AB	Amel Barich				Geologist
SO	Solveig Onstad				Geologist

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SUSTAIN

Location	Daily Report #5	? working day
Surtsey	Preliminary data collection	23rd of August 2017

Well Name:	**SE-02b**	*Drilling Company:*	**DES**	*Geologist:*	**TBW**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	
Drill-bit diameter:	**HQ**	*Depth at midnight:*	**54 m**	*Hole made last 24 hrs*	**54.84 m**
Drilling fluid:	**mud**	*Depth at 8 AM:*	**75.74 m**	*Drilling time:*	**20.5 hrs.**
Sterilized fluid:	**yes**	*Circulation losses:*	**unclear**	*Average ROP:*	**2.7 m/hr**

Drilling operations

WOC continued on August 22nd and currently the rig crew is preparing to start coring again. Drilling started again at about 10 AM and top of the cement was detected (depth not reported) and after the cement was drilled out subsequently coring into formation continued at 11:30 AM at a depth of 20.84 m. Coring went very well throughout the day. Some minor delays occurred due to the fact that the flow rate of filter system could not scope with flow rate needed for drilling. At the shift change (8 PM) 12 core runs were completed with a TVD of 42.19 m. Coring continued and at midnight in total 16 core runs were completed with a TVD of about 54 m. TLC occurred at a depth of about 45 m.

Coring continued on August 23rd and at the shift change at 8 AM, 26 core runs were completed, resulting in a TVD of 75.74 m. During coring of the night shift minimum one clay pill were used to circulated the well.

After the 28th core run, it was realized that the surface casing sunk down. Therefore coring activity was stopped at about 10:30 AM. The coring string (HQ) as well as the PQ surface casing was POOH and currently the drill crew is adding one rod and install a hanging casing

Figure 1 shows the drilling progress of SE-2b. Figure 2 shows the Surtsey team members installing a GPS station.

Table 1. *Overview of conducted core runs in SE-2b in 2017.*

Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	1	20.08.2017	10:00 - 10:15 PM	12.86	14.74	1.88	1.685	90
SE-2b	2	20.08.2017	10:50 - 11:15 PM	14.74	17.79	3.05	3.01	99
SE-2b	3	21.08.2017	0:20 - 0:55 AM	17.79	20.84	3.05	3.03	99
SE-2b	4	22.08.2017	11:30 AM - 12:15 PM	20.84	23.89	3.05	3.138	103
SE-2b	5	22.08.2017	12:15 - 1:05 PM	23.89	26.94	3.05	3.09	101
SE-2b	6	22.08.2017	1:05 - 2:15 PM	26.94	29.99	3.05	3.09	101
SE-2b	7	22.08.2017	2:15 - 3:15 PM	29.99	31.64	1.65	1.71	104

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	8	22.08.2017	3:55 - 4:25 PM	31.64	33.04	1.40	1.44	103
SE-2b	9	22.08.2017	4:25 - 5:45 PM	33.04	36.09	3.05	3.07	101
SE-2b	10	22.08.2017	5:45 - 6:10 PM	36.09	37.09	1.00	**	**
SE-2b	11	22.08.2017	6:10 - 6:55 PM	37.09	39.14	2.05	1.78	87
SE-2b	12	22.08.2017	6:55 – 7:45 PM	39.14	42.19	3.05	3.20	105
SE-2b	13	22.08.2017	8:30 - 9:06 PM	42.19	45.24	3.05	2.465	81
SE-2b	14	22.08.2017	9:43 – 10:15 PM	45.24	48.29	3.05	2.615	86
SE-2b	15	22.08.2017	10:40 - 11:10 PM	48.29	51.14	2.85	3.15	111
SE-2b	16	22.08.2017	11:20 - 11:54 PM	51.14	54.06	2.92	1.67	57
SE-2b	17	23.08.2017	12:08 - 12:28 AM	54.06	55.68	1.64	2.58	157
SE-2b	18	23.08.2017	1:12 - 1:26 AM	55.68	57.44	1.47	1.14	78
SE-2b	19	23.08.2017	1:42 - 2:14 AM	57.44	59.89	2.45	3.11	127
SE-2b	20	23.08.2017	2:30 - 2:55 AM	59.89	62.54	2.65	2.665	101
SE-2b	21	23.08.2017	3:15 - 3:32 AM	62.54	63.54	1.00	0.80	80
SE-2b	22	23.08.2017	4:10 - 4:48 AM	63.54	66.59	3.05	3.11	102
SE-2b	23	23.08.2017	5:10 - 5:50 AM	66.59	69.64	3.05	2.62	86
SE-2b	24	23.08.2017	6:05 - 6:25 AM	69.64	71.59	1.95	2.105	108
SE-2b	25	23.08.2017	6:36 - 6:55 AM	71.59	72.69	1.10	0.925	84
SE-2b	26	23.08.2017	7:05 - 8:00 AM	72.69	75.74	3.05	3.10	102
SE-2b	27	23.08.2017	??	75.74	??	?	3.03	?
SE-2b	28	23.08.2017	??	??	?	?	3.05	?

* based on geologist documentation, should be measured again at the core processing on Heimaey

** could not be measured

Core description:

Core 1: consolidated tuff

Core 2: top is consolidated tuff (becomes likely basalt?)

Core 3: consolidated tuff

Core 4: moderate consolidated tuff, fractured

Core 5: poorly consolidated tuff, fractured

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Core 6: poorly consolidated tuff, fractured

Core 7: consolidated tuff, fractured

Core 8: consolidated tuff, fractured

Core 9: consolidated tuff, partly fractured

Core 10: well consolidated tuff, fractured

Core 11: basalt, fractured

Core 12: basalt, a few fractures, steaming, liners were deformed (melted)

Core 13: basalt

Core 14: basalt

Core 15: consolidated tuff with fragments of basalt

Core 16: consolidated tuff

Core 17: consolidated tuff

Core 18: consolidated tuff and basalt

Core 19: basalt with partially filled vesicles with something white

Core 20: Basalt, the whole core run is very fractured

Core 21: Basalt, fractured

Core 22: Basalt

Core 23: Basalt

Core 24: Basalt

Core 25: Basalt

Core 26: Basalt

Core 27: Basalt, a few fractures, steaming

Core 28: Basalt, fractured, steaming

Table 2. *Overview of conducted core runs in SE-2b in 2017.*

Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	1	1	20.08.2017	0.99		0-99	b2-1	No cement plug drilled. Only some plastic pieces were found on top of the core
SE-2b	1	2	20.08.2017	0.57		0-57	b2-1	
SE-2b	1	CC	20.08.2017	0.155		0-15.5	b2-1	
SE-2b	2	1	20.08.2017	0.98		0-98	b2-2	
SE-2b	2	2	20.08.2017	0.98		0-98	b2-2	
SE-2b	2	3	20.08.2017	0.955		0-95.5	b2-2	
SE-2b	2	4	20.08.2017	0.165		0-16.5	b2-2	
SE-2b	2	CC	20.08.2017	0.17		0-17	b2-2	
SE-2b	3	1	21.08.2017	0.91		0-91	b2-3	Problems during drilling. Missing liner in the core barrel caused damage on the core. Drilling crew had to pump the core out of the core barrel.
SE-2b	3	2	21.08.2017	0.55		0-55	b2-3	
SE-2b	3	3	21.08.2017	0.335		0-33.5	b2-3	
SE-2b	3	4	21.08.2017	0.875		0.875	b2-3	
SE-2b	3	CC	21.08.2017	0.36		0-36	b2-3	
SE-2b	4	1	22.08.2017	0.48		0-48	b2-4	
SE-2b	4	2	22.08.2017	0.54		0-54	b2-4	
SE-2b	4	3	22.08.2017	0.845		0-845	b2-4	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	4	4	22.08.2017	1.00	x	10-100	b2-4	
SE-2b	4	5	22.08.2017	0.19		0-19	b2-4	
SE-2b	4	Cc	22.08.2017	0.138		0-138	b2-4	
SE-2b	5	1	22.08.2017	0.99		0-99	b2-5	
SE-2b	5	2	22.08.2017	0.975		0-97.5	b2-5	
SE-2b	5	3	22.08.2017	0.98		0-98	b2-5	
SE-2b	5	4	22.08.2017	0.16		0-16	b2-5	
SE-2b	5	Cc	22.08.2017	0.13		0-13	b2-5	
SE-2b	6	1	22.08.2017	0.93		0-93	b2-6	
SE-2b	6	2	22.08.2017	0.84		0-84	b2-6	
SE-2b	6	3	22.08.2017	0.78		0-78	b2-6	
SE-2b	6	Cc	22.08.2017	0.47		0-47	b2-6	
SE-2b	7	1	22.08.2017	0.94		0-94	b2-7	
SE-2b	7	2	22.08.2017	0.63		0-63	b2-7	
SE-2b	7	Cc	22.08.2017	0.11		0-11	b2-7	
SE-2b	8	1	22.08.2017	0.52		0-52	b2-8	
SE-2b	8	2	22.08.2017	0.65		0-65	b2-8	
SE-2b	8	Cc	22.08.2017	0.23		0-23	b2-8	
SE-2b	9	1	22.08.2017	0.965		0-96.5	b2-9	
SE-2b	9	2	22.08.2017	0.875		0-87.5	b2-9	
SE-2b	9	3	22.08.2017	1.06	x	11-106	b2-9	
SE-2b	9	Cc	22.08.2017	0.20		0-20	b2-9	
SE-2b	10	1	22.08.2017	0.73		0-73	b2-10	Core liner scrambled up in rod. Section 3 is not orientated (small pieces)
SE-2b	10	2	22.08.2017	0.08		0-8	b2-10	
SE-2b	10	3	22.08.2017	0.23		0-23	b2-10	
SE-2b	10	Cc	22.08.2017	0.17		0-17	b2-10	
SE-2b	11	1	22.08.2017	0.82		0-82	b2-11	
SE-2b	11	2	22.08.2017	0.90		0-90	b2-11	
SE-2b	11	Cc	22.08.2017	0.06		0-6	b2-11	
SE-2b	12	1	22.08.2017	0.93		0-93	b2-12	Liner deformed (melted)
SE-2b	12	2	22.08.2017	0.98		0-98	b2-12	
SE-2b	12	3	22.08.2017	0.34		0-34	b2-12	
SE-2b	12	4	22.08.2017	0.73		0-73	b2-12	
SE-2b	12	Cc	22.08.2017	0.23		0-23	b2-12	
SE-2b	13	1	22.08.2017	0.855		0-85.5	b2-13	Slipped core run, section numbering needs to be double checked with the shift geologists
SE-2b	13	2	22.08.2017	0.69		0-69	b2-13	
SE-2b	13	3	22.08.2017	0.92	x	9-92	b2-13	
SE-2b	14	1	22.08.2017	0.99		0-99	b2-14	
SE-2b	14	2	22.08.2017	0.925		0-92.5	b2-14	
SE-2b	14	3	22.08.2017	0.715		0-71.5	b2-14	
SE-2b	14	Cc	22.08.2017	0.11		0.11	b2-14	
SE-2b	15	1	22.08.2017	0.99		0-99	b2-15	
SE-2b	15	2	22.08.2017	0.98		0-98	b2-15	
SE-2b	15	3	22.08.2017	0.985		0-98.5	b2-15	
SE-2b	15	Cc	22.08.2017	0.28		0.28	b2-15	
SE-2b	16	1	22.08.2017	0.995		0-99.5	b2-16	
SE-2b	16	2	22.08.2017	0.71		0-71	b2-16	
SE-2b	17	1	23.08.2017	0.98		0-98	b2-17	
SE-2b	17	2	23.08.2017	0.98		0-98	b2-17	
SE-2b	17	3	23.08.2017	0.56	x	10-56	b2-17	
SE-2b	18	1	23.08.2017	0.315		0-31.5	b2-18	Slipped core run, section numbering
SE-2b	18	2	23.08.2017	0.725		0-72.5	b2-18	TBW: needs to be double checked with
SE-2b	18	Cc	23.08.2017	0.12		0-12	b2-18	the shift geologists, as a slipped core run should not have a Cc
SE-2b	19	1	23.08.2017	0.985		0-98.5	b2-19	
SE-2b	19	2	23.08.2017	0.92		0-92	b2-19	
SE-2b	19	3	23.08.2017	0.84		0-84	b2-19	
SE-2b	19	4	23.08.2017	0.33		0-33	b2-19	
SE-2b	19	Cc	23.08.2017	0.07		0-7	b2-19	In pieces
SE-2b	20	1	23.08.2017	0.98		0-98	b2-20	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	20	2	23.08.2017	0.96		0-96	b2-20	
SE-2b	20	3	23.08.2017	0.735		0-73.5	b2-20	
SE-2b	21	1	23.08.2017	0.80		0-80	b2-21	
SE-2b	22	1	23.08.2017	1.00		0-100	b2-22	
SE-2b	22	1	23.08.2017	0.95		0-95	b2-22	
SE-2b	22	1	23.08.2017	1.04	x	10-104	b2-22	
SE-2b	22	1	23.08.2017	0.16		0-16	b2-22	
SE-2b	23	1	23.08.2017	0.91		0-91	b2-23	
SE-2b	23	1	23.08.2017	0.96		0-96	b2-23	
SE-2b	23	1	23.08.2017	0.77		0-77	b2-23	
SE-2b	24	1	23.08.2017	0.915		0-91.5	b2-24	
SE-2b	24	1	23.08.2017	0.98		0-98	b2-24	
SE-2b	24	1	23.08.2017	?		?	b2-24	fell off, pieces, not orientated
SE-2b	25	1	23.08.2017	0.925		0-92.5	b2-25	
SE-2b	26	1	23.08.2017	0.725		0-72.5	b2-26	
SE-2b	26	1	23.08.2017	0.965		0-96.5	b2-26	
SE-2b	26	1	23.08.2017	0.925		0-92.5	b2-26	
SE-2b	26	1	23.08.2017	0.46		0-46	b2-26	
SE-2b	26	1	23.08.2017	0.06		0-6	b2-26	
SE-2b	27	1	23.08.2017	0.75		0-75	b2-27	
SE-2b	27	2	23.08.2017	0.98		0-98	b2-27	
SE-2b	27	3	23.08.2017	0.94	x	10-94	b2-27	
SE-2b	27	4	23.08.2017	0.30		0-30	b2-27	
SE-2b	27	Cc	23.08.2017	0.07		0-7	b2-27	
SE-2b	28	1	23.08.2017	0.02		0-2	b2-28	2 cm was packed in a plastic bag as is broke off from the top of the section
				0.97		2-99		
SE-2b	28	2	23.08.2017	0.97		0-97	b2-28	
SE-2b	28	3	23.08.2017	0.99		0-99	b2-28	
SE-2b	28	4	23.08.2017	0.11		0-11	b2-28	

* should be measured again at the core processing on Heimaey

** each core is stored in one single core box, please keep in mind that there might be some inconsistencies in the slots, to fit all core in one box

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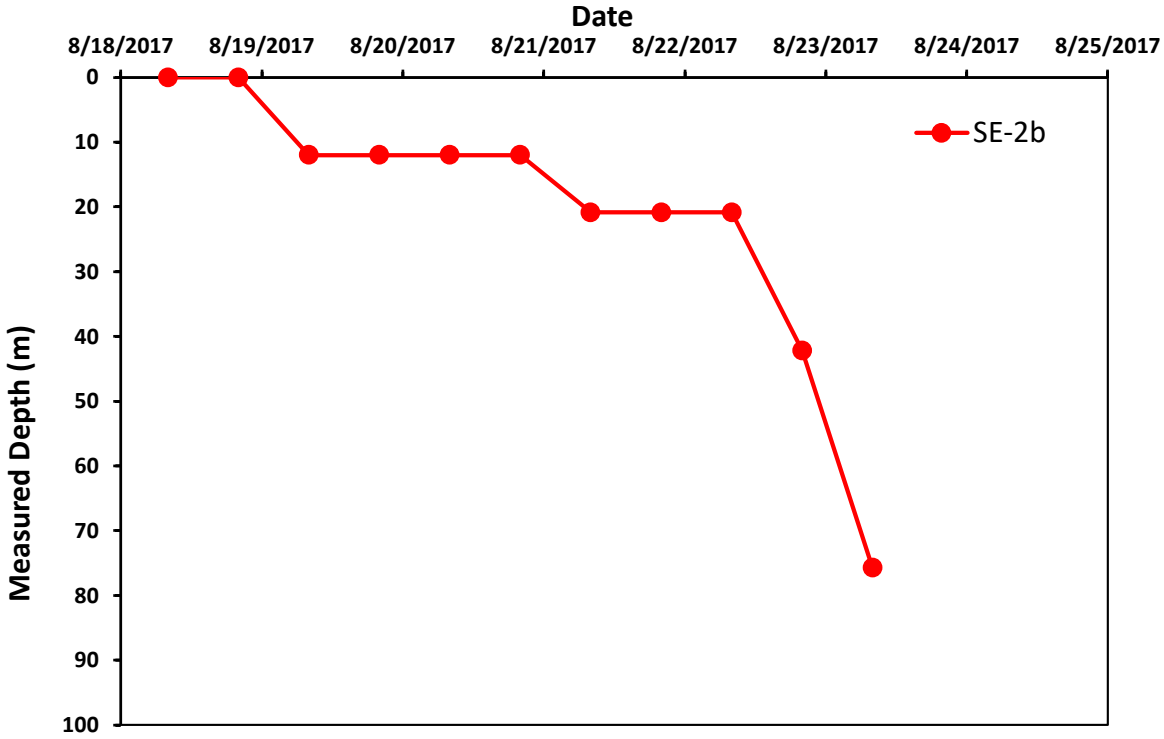

Figure 1. Drilling progress from SE-2b.

Figure 2. The Surtsey on-site team (Þórstein, Águst Þór and Dagny) installing a GPS station on Surtsey on August 22nd, 2017 (image source: TBW).

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Onsite science team

Initials	Name	Affiliation	Email	Cell phone no	Function
TBW	Tobias B. Weisenberger	ÍSOR	tobias.b.weisenberger@isor.is	+354 661 3406	Geologist
BK	Barbara Kleine	HÍ			Geologist
PB	Pauline Bergsten	MATIS			Microbiologist
AB	Amel Barich				Geologist
SO	Solveig Onstad				Geologist

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SUSTAIN

Location	Daily Report #6	? working day
Surtsey	Preliminary data collection	24th of August 2017

Well Name:	**SE-02b**	*Drilling Company:*	**DES**	*Geologist:*	**TBW**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	

Drill-bit diameter:	**HQ**	*Depth at midnight:*	**92.09 m**	*Hole made last 24 hrs*	**33.55 m**
Drilling fluid:	**Seawater with some mud pills**	*Depth at 8 AM:*	**109.29 m**	*Drilling time:*	**10 hrs.**
Sterilized fluid:	**Yes, but no sterilized fluid was used between 0:00-3:00, 24.08.2017**	*Circulation losses:*	**unclear**	*Average ROP:*	**3.4 m/hr**

Drilling operations

Coring continued on August 23rd and at the shift change at 8 AM, 26 core runs were completed, resulting in a TVD of 75.74 m. During coring of the night shift minimum two clay pill were used to circulated the well (core run 15 and 20). The coring activity was stopped at about 10:30 AM after the core run 28 when spike in torque were observed. Inspection indicated that the surface casing dropped and most likely cause the torque spikes. After the HQ drill string was POOH, the surface casing was POOH by using a spear. However, only 2 rods could be retrieved and the thread showed some damages. Subsequently, 2 new surface casing rods where welded together and RIH and screwed on the remaining casing, which are very well fixed within the bedrock. Afterwards an additional 1.5 m 4.5" inch casing was added. The surface casing is now about 1.50 m deeper than before. Coring continued at 7 PM and core run 29 was retrieved at 8 PM at a TVD of 84:89 m. Coring continued and at midnight the well had a TVD of 92.09.

Coring continued on August 24th. Due to the low filtering rate it was changed to unfiltered after midnight. Coring was stopped after core run 37 at a TVD of 106.24 m at 3 AM due to some problems with the water storage at the peninsular. Coring continued at 6 AM with filtered seawater and at shift change the well was 109.29 m. Currently (11:30 PM), 41 core runs were completed with a TVD of 118.44 m

Table 1 shows the compilation of all core runs conducted in SE-2b. Table 2 show the compilation of all core runs and division into sections and location of samples taken on Surtsey. Figure 1 shows the drilling progress of SE-2b. Figure 2 shows the new core bit before coring and after 28 core.

Table 1. *Overview of conducted core runs in SE-2b in 2017.*

Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	1	20.08.2017	10:00 - 10:15 PM	12.86	14.74	1.88	1.685	90
SE-2b	2	20.08.2017	10:50 - 11:15 PM	14.74	17.79	3.05	3.01	99

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	3	21.08.2017	0:20 - 0:55 AM	17.79	20.84	3.05	3.03	99
SE-2b	4	22.08.2017	11:30 AM - 12:15 PM	20.84	23.89	3.05	3.138	103
SE-2b	5	22.08.2017	12:15 - 1:05 PM	23.89	26.94	3.05	3.09	101
SE-2b	6	22.08.2017	1:05 - 2:15 PM	26.94	29.99	3.05	3.09	101
SE-2b	7	22.08.2017	2:15 - 3:15 PM	29.99	31.64	1.65	1.71	104
SE-2b	8	22.08.2017	3:55 - 4:25 PM	31.64	33.04	1.40	1.44	103
SE-2b	9	22.08.2017	4:25 - 5:45 PM	33.04	36.09	3.05	3.07	101
SE-2b	10	22.08.2017	5:45 - 6:10 PM	36.09	37.09	1.00	**	**
SE-2b	11	22.08.2017	6:10 - 6:55 PM	37.09	39.14	2.05	1.78	87
SE-2b	12	22.08.2017	6:55 – 7:45 PM	39.14	42.19	3.05	3.20	105
SE-2b	13	22.08.2017	8:30 - 9:06 PM	42.19	45.24	3.05	2.465	81
SE-2b	14	22.08.2017	9:43 – 10:15 PM	45.24	48.29	3.05	2.615	86
SE-2b	15	22.08.2017	10:40 - 11:10 PM	48.29	51.14	2.85	3.15	111
SE-2b	16	22.08.2017	11:20 - 11:54 PM	51.14	54.06	2.92	1.67	57
SE-2b	17	23.08.2017	12:08 - 12:28 AM	54.06	55.68	1.64	2.58	157
SE-2b	18	23.08.2017	1:12 - 1:26 AM	55.68	57.44	1.47	1.14	78
SE-2b	19	23.08.2017	1:42 - 2:14 AM	57.44	59.89	2.45	3.11	127
SE-2b	20	23.08.2017	2:30 - 2:55 AM	59.89	62.54	2.65	2.665	101
SE-2b	21	23.08.2017	3:15 - 3:32 AM	62.54	63.54	1.00	0.80	80
SE-2b	22	23.08.2017	4:10 - 4:48 AM	63.54	66.59	3.05	3.11	102
SE-2b	23	23.08.2017	5:10 - 5:50 AM	66.59	69.64	3.05	2.62	86
SE-2b	24	23.08.2017	6:05 - 6:25 AM	69.64	71.59	1.95	2.105	108
SE-2b	25	23.08.2017	6:36 - 6:55 AM	71.59	72.69	1.10	0.925	84
SE-2b	26	23.08.2017	7:05 - 8:00 AM	72.69	75.74	3.05	3.10	102
SE-2b	27	23.08.2017	8:30 - 9:15 AM	75.74	78.79	3.05	3.03	99
SE-2b	28	23.08.2017	9:15 – 10:15 AM	78.79	81.84	3.05	3.05	100
SE-2b	29	23.08.2017	6:50 – 8:00 PM	81.84	84.89	3.05	3.01	99

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	30	23.08.2017	8:30 – 8:50 PM	84.89	87.54	2.65	2.77	105
SE-2b	31	23.08.2017	9:25 – 9:40 PM	87.54	89.39	1.85	1.70	92
SE-2b	32	23.08.2017	10:05 – 10:30 PM	89.39	90.99	1.60	1.20	75
SE-2b	33	23.08.2017	11:00 – 11:25 PM	90.99	94.04	3.05	2.95	97
SE-2b	34	24.08.2017	11:45 – 12:10 AM	94.04	97.09	3.05	3.14	103
SE-2b	35	24.08.2017	12:30 – 12:55 AM	97.09	100.14	3.05	2.84	93
SE-2b	36	24.08.2017	1:10 – 1:35 AM	100.14	103.19	3.05	2.86	94
SE-2b	37	24.08.2017	2:30 – 3:00 AM	103.19	106.24	3.05	3.01	99
SE-2b	38	24.08.2017	6:10 – 6:35 AM	106.24	109.29	3.05	3.11	102
SE-2b	39	24.08.2017	8:30 – 9:15 AM	109.29	112.34	3.05	3.12	102
SE-2b	40	24.08.2017	9:15 – 10:15 AM	112.34	115.39	3.05	?	?
SE-2b	41	24.08.2017	10:15 – 11:20 AM	115.39	118.44	3.05	?	?

* based on geologist documentation, should be measured again at the core processing on Heimaey

** could not be measured

Core description (based on field book notes. Verification during VCD is needed)

Core 1: consolidated tuff

Core 2: top is consolidated tuff (becomes likely basalt?)

Core 3: consolidated tuff

Core 4: moderate consolidated tuff, fractured

Core 5: poorly consolidated tuff, fractured

Core 6: poorly consolidated tuff, fractured

Core 7: consolidated tuff, fractured

Core 8: consolidated tuff, fractured

Core 9: consolidated tuff, partly fractured

Core 10: well consolidated tuff, fractured

Core 11: basalt, fractured

Core 12: basalt, a few fractures, steaming, liners were deformed (melted)

Core 13: basalt

Core 14: basalt

Core 15: consolidated tuff with fragments of basalt

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Core 16: consolidated tuff

Core 17: consolidated tuff

Core 18: consolidated tuff and basalt

Core 19: basalt with partially filled vesicles with something white

Core 20: Basalt, the whole core run is very fractured

Core 21: Basalt, fractured

Core 22: Basalt

Core 23: Basalt

Core 24: Basalt

Core 25: Basalt

Core 26: Basalt

Core 27: Basalt, a few fractures, steaming

Core 28: Basalt, fractured, steaming

Core 29: Basalt, barely fractured, zeolites, steaming

Core 30: Basalt

Core 31: Basalt. Core catcher was filled with clay.

Core 32: ?

Core 33: Basalt

Core 34: Basalt

Core 35: Basalt

Core 36: ?

Core 37: Basalt

Core 38: Basalt

Core 38: Basalt

Table 2. *Overview of conducted core runs in SE-2b in 2017. Red marked entries are updated/corrected from the previously published daily report.*

Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	1	1	20.08.2017	0.99		0-99	b2-1	No cement plug drilled. Only some plastic pieces were found on top of the core
SE-2b	1	2	20.08.2017	0.57		0-57	b2-1	
SE-2b	1	CC	20.08.2017	0.155		0-15.5	b2-1	
SE-2b	2	1	20.08.2017	0.98		0-98	b2-2	
SE-2b	2	2	20.08.2017	0.98		0-98	b2-2	
SE-2b	2	3	20.08.2017	0.955		0-95.5	b2-2	
SE-2b	2	4	20.08.2017	0.165		0-16.5	b2-2	
SE-2b	2	CC	20.08.2017	0.17		0-17	b2-2	
SE-2b	3	1	21.08.2017	0.91		0-91	b2-3	Problems during drilling. Missing liner in the core barrel caused damage on the
SE-2b	3	2	21.08.2017	0.55		0-55	b2-3	
SE-2b	3	3	21.08.2017	0.335		0-33.5	b2-3	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	3	4	21.08.2017	0.875		0.875	b2-3	core. Drilling crew had to pump the core
SE-2b	3	CC	21.08.2017	0.36		0-36	b2-3	out of the core barrel.
SE-2b	4	1	22.08.2017	0.48		0-48	b2-4	
SE-2b	4	2	22.08.2017	0.54		0-54	b2-4	
SE-2b	4	3	22.08.2017	0.845		0-845	b2-4	
SE-2b	4	4	22.08.2017	1.00	x	20-100	b2-4	
SE-2b	4	5	22.08.2017	0.19		0-19	b2-4	
SE-2b	4	Cc	22.08.2017	0.138		0-138	b2-4	
SE-2b	5	1	22.08.2017	0.99		0-99	b2-5	
SE-2b	5	2	22.08.2017	0.975		0-97.5	b2-5	
SE-2b	5	3	22.08.2017	0.98		0-98	b2-5	
SE-2b	5	4	22.08.2017	0.16		0-16	b2-5	
SE-2b	5	Cc	22.08.2017	0.13		0-13	b2-5	
SE-2b	6	1	22.08.2017	0.93		0-93	b2-6	
SE-2b	6	2	22.08.2017	0.84		0-84	b2-6	
SE-2b	6	3	22.08.2017	0.78		0-78	b2-6	
SE-2b	6	Cc	22.08.2017	0.47		0-47	b2-6	
SE-2b	7	1	22.08.2017	0.94		0-94	b2-7	
SE-2b	7	2	22.08.2017	0.63		0-63	b2-7	
SE-2b	7	Cc	22.08.2017	0.11		0-11	b2-7	
SE-2b	8	1	22.08.2017	0.52		0-52	b2-8	
SE-2b	8	2	22.08.2017	0.65		0-65	b2-8	
SE-2b	8	Cc	22.08.2017	0.23		0-23	b2-8	
SE-2b	9	1	22.08.2017	0.965		0-96.5	b2-9	
SE-2b	9	2	22.08.2017	0.875		0-87.5	b2-9	
SE-2b	9	3	22.08.2017	1.06	x	21-106	b2-9	
SE-2b	9	Cc	22.08.2017	0.20		0-20	b2-9	
SE-2b	10	1	22.08.2017	0.73		0-73	b2-10	Core liner scrambled up in rod. Section 3
SE-2b	10	2	22.08.2017	0.08		0-8	b2-10	is not orientated (small pieces)
SE-2b	10	3	22.08.2017	0.23		0-23	b2-10	
SE-2b	10	Cc	22.08.2017	0.17		0-17	b2-10	
SE-2b	11	1	22.08.2017	0.82		0-82	b2-11	
SE-2b	11	2	22.08.2017	0.90		0-90	b2-11	
SE-2b	11	Cc	22.08.2017	0.06		0-6	b2-11	
SE-2b	12	1	22.08.2017	0.93		0-93	b2-12	Liner deformed (melted)
SE-2b	12	2	22.08.2017	0.98		0-98	b2-12	
SE-2b	12	3	22.08.2017	0.34		0-34	b2-12	
SE-2b	12	4	22.08.2017	0.73		0-73	b2-12	
SE-2b	12	Cc	22.08.2017	0.23		0-23	b2-12	
SE-2b	13	1	22.08.2017	0.855		0-85.5	b2-13	
SE-2b	13	2	22.08.2017	0.69		0-69	b2-13	Slipped core run
SE-2b	13	3	22.08.2017	0.92	x	19-92	b2-13	
SE-2b	14	1	22.08.2017	0.99		0-99	b2-14	
SE-2b	14	2	22.08.2017	0.925		0-92.5	b2-14	
SE-2b	14	3	22.08.2017	0.715		0-71.5	b2-14	
SE-2b	14	Cc	22.08.2017	0.11		0.11	b2-14	
SE-2b	15	1	22.08.2017	0.99		0-99	b2-15	
SE-2b	15	2	22.08.2017	0.98		0-98	b2-15	
SE-2b	15	3	22.08.2017	0.985		0-98.5	b2-15	
SE-2b	15	Cc	22.08.2017	0.28		0.28	b2-15	
SE-2b	16	1	22.08.2017	0.995		0-99.5	b2-16	
SE-2b	16	2	22.08.2017	0.71		0-71	b2-16	
SE-2b	17	1	23.08.2017	0.98		0-98	b2-17	
SE-2b	17	2	23.08.2017	0.98		0-98	b2-17	
SE-2b	17	3	23.08.2017	0.56	x	20-56	b2-17	
SE-2b	18	1	23.08.2017	0.315		0-31.5	b2-18	
SE-2b	18	2	23.08.2017	0.12		0-12	b2-18	
SE-2b	18	3	23.08.2017	0.725		0-72.5	b2-18	
SE-2b	19	1	23.08.2017	0.985		0-98.5	b2-19	
SE-2b	19	2	23.08.2017	0.92		0-92	b2-19	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	19	3	23.08.2017	0.84		0-84	b2-19	
SE-2b	19	4	23.08.2017	0.33		0-33	b2-19	
SE-2b	19	Cc	23.08.2017	0.07		0-7	b2-19	In pieces
SE-2b	20	1	23.08.2017	0.98		0-98	b2-20	
SE-2b	20	2	23.08.2017	0.96		0-96	b2-20	
SE-2b	20	3	23.08.2017	0.735		0-73.5	b2-20	
SE-2b	21	1	23.08.2017	0.80		0-80	b2-21	
SE-2b	22	1	23.08.2017	1.00		0-100	b2-22	
SE-2b	22	1	23.08.2017	0.95		0-95	b2-22	
SE-2b	22	1	23.08.2017	1.04	x	20-104	b2-22	
SE-2b	22	1	23.08.2017	0.16		0-16	b2-22	
SE-2b	23	1	23.08.2017	0.91		0-91	b2-23	
SE-2b	23	1	23.08.2017	0.96		0-96	b2-23	
SE-2b	23	1	23.08.2017	0.77		0-77	b2-23	
SE-2b	24	1	23.08.2017	0.915		0-91.5	b2-24	
SE-2b	24	1	23.08.2017	0.98		0-98	b2-24	
SE-2b	24	1	23.08.2017	?		?	b2-24	fell off, pieces, not orientated
SE-2b	25	1	23.08.2017	0.925		0-92.5	b2-25	
SE-2b	26	1	23.08.2017	0.725		0-72.5	b2-26	
SE-2b	26	1	23.08.2017	0.965		0-96.5	b2-26	
SE-2b	26	1	23.08.2017	0.925		0-92.5	b2-26	
SE-2b	26	1	23.08.2017	0.46		0-46	b2-26	
SE-2b	26	1	23.08.2017	0.06		0-6	b2-26	
SE-2b	27	1	23.08.2017	0.75		0-75	b2-27	
SE-2b	27	2	23.08.2017	0.98		0-98	b2-27	
SE-2b	27	3	23.08.2017	0.94	x	20-94	b2-27	
SE-2b	27	4	23.08.2017	0.30		0-30	b2-27	
SE-2b	27	Cc	23.08.2017	0.07		0-7	b2-27	
SE-2b	28	1	23.08.2017	0.02		0-2	b2-28	2 cm was packed in a plastic bag as is broke off from the top of the section
				0.97		2-99		
SE-2b	28	2	23.08.2017	0.97		0-97	b2-28	
SE-2b	28	3	23.08.2017	0.99		0-99	b2-28	
SE-2b	28	4	23.08.2017	0.11		0-11	b2-28	
SE-2b	29	1	23.08.2017	0.92		0-92	b2-29	
SE-2b	29	2	23.08.2017	0.98		0-98	b2-29	
SE-2b	29	3	23.08.2017	0.59		0-59	b2-29	
SE-2b	29	4	23.08.2017	0.50		0-50	b2-29	
SE-2b	30	1	23.08.2017	0.78		0-78	b2-30	
SE-2b	30	2	23.08.2017	0.675		0-67.5	b2-30	
SE-2b	30	3	23.08.2017	0.44		0-44	b2-30	
SE-2b	30	3	23.08.2017	0.91		0-91	b2-30	
SE-2b	31	1	23.08.2017	0.95		0-95	b2-31	Liner melted. Core got damaged during removal out of the core barrel.
SE-2b	31	2	23.08.2017	0.185		0-18.5	b2-31	
SE-2b	31	3	23.08.2017	0.68		0-68	b2-31	Only pieces, not orientated
SE-2b	31	Cc	23.08.2017	?		?	b2-31	Only pieces
SE-2b	32	1	23.08.2017	0.75		0-75	b2-32	
SE-2b	32	2	23.08.2017	0.41?		0-41?	b2-32	In a liner of 41 cm, not orientated
SE-2b	32	Cc	23.08.2017	?			b2-32	
SE-2b	33	1	23.08.2017	0.99		0-99	b2-33	
SE-2b	33	2	23.08.2017	0.91		0-91	b2-33	
SE-2b	33	3	23.08.2017	1.10	x	23-110	b2-33	
SE-2b	34	1	24.08.2017	0.995		0-99.5	b2-35	
SE-2b	34	2	24.08.2017	0.98		0-98	b2-35	
SE-2b	34	3	24.08.2017	0.94		0-94	b2-35	
SE-2b	34	4	24.08.2017	0.15		0-15	b2-35	
SE-2b	34	Cc	24.08.2017	0.10		0-10	b2-35	
SE-2b	35	1	24.08.2017	0.63		0-63	b2-35	
SE-2b	35	2	24.08.2017	0.39		0-39	b2-35	
SE-2b	35	3	24.08.2017	0.98		0-98	b2-35	

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SE-2b	35	4	24.08.2017	0.915		0-91.5	b2-35	
SE-2b	36	1	24.08.2017	0.94		0-94	b2-36	
SE-2b	36	2	24.08.2017	0.86		0-86	b2-36	
SE-2b	36	3	24.08.2017	1.09	x	23-109	b2-36	
SE-2b	36	Cc	24.08.2017	0.29		0-29	b2-36	
SE-2b	37	1	24.08.2017	0.98		0-98	b2-37	
SE-2b	37	2	24.08.2017	0.98		0-98	b2-37	
SE-2b	37	3	24.08.2017	0.97		0-97	b2-37	
SE-2b	37	4	24.08.2017	0.08		0-8	b2-37	
SE-2b	38	1	24.08.2017	0.85		0-85	b2-38	
SE-2b	38	2	24.08.2017	0.98		0-98	b2-38	
SE-2b	38	3	24.08.2017	0.86		0-86	b2-38	
SE-2b	38	4	24.08.2017	0.40		0-40	b2-38	
SE-2b	39	1	24.08.2017	0.98		0-98	b2-39	
SE-2b	39	2	24.08.2017	0.98		0-98	b2-39	
SE-2b	39	3	24.08.2017	0.85		20-85	b2-39	
SE-2b	39	4	24.08.2017	0.33	x	0-33	b2-39	

* should be measured again at the core processing on Heimaey

** each core is stored in one single core box, please keep in mind that there might be some inconsistencies in the slots, to fit all core in one box

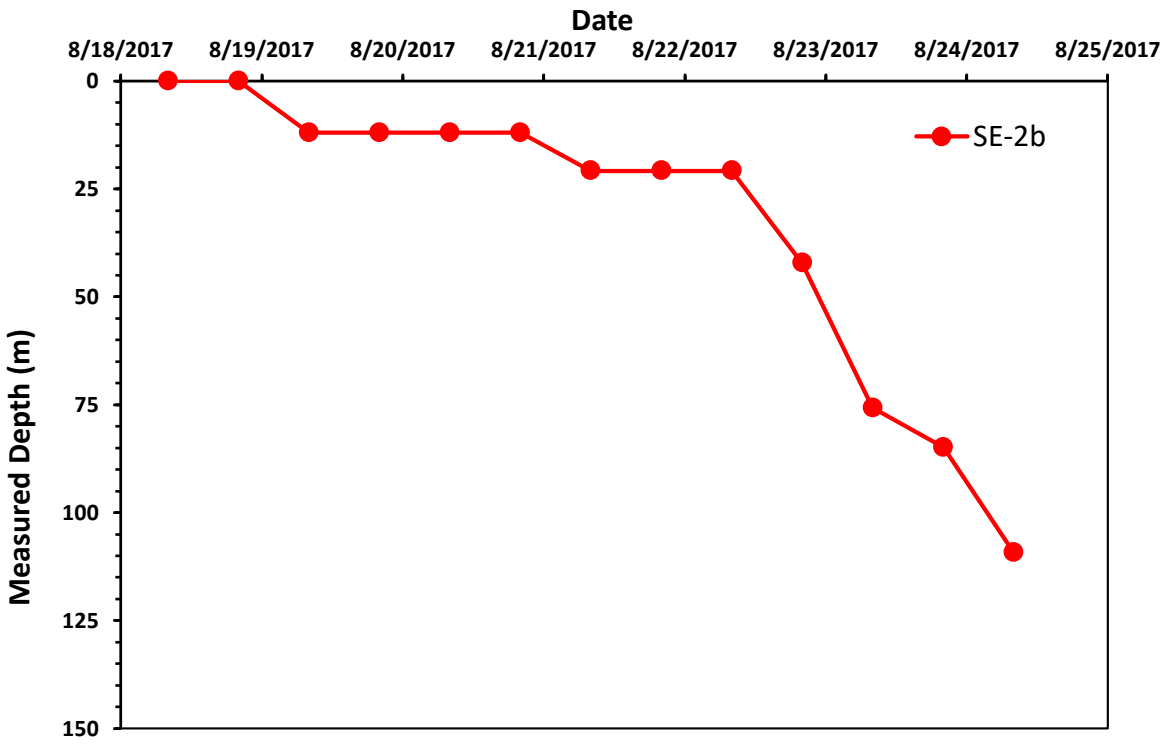

Figure 1. Drilling progress from SE-2b.

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Figure 2. Core bit after 28 core runs at SE-2b after the drill string was POOH August 23rd, 2017 (right). A image of the new core bit (left) before RIH is given for comparison (image source: TBW).

Onsite science team

Initials	Name	Affiliation	Email	Cell phone no	Function
TBW	Tobias B. Weisenberger	ÍSOR	tobias.b.weisenberger@isor.is	+354 661 3406	Geologist
BK	Barbara Kleine	HÍ			Geologist
PB	Pauline Bergsten	MATIS			Microbiologist
AB	Amel Barich				Geologist
SO	Solveig Onstad				Geologist

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SUSTAIN

Location	Daily Report #7	? working day
Surtsey	Preliminary data collection	25th of August 2017

Well Name:	**SE-02b**	*Drilling Company:*	**DES**	*Geologist:*	**TBW**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	
Drill-bit diameter:	**HQ**	*Depth at midnight:*	**138.09 m**	*Hole made last 24 hrs*	**45.75**
Drilling fluid:	**Seawater with some mud pills**	*Depth at 8 AM:*	**155.04 m**	*Drilling time:*	**16.5 hrs.**
Sterilized fluid:	**Some non-sterilized water was used**	*Circulation losses:*	**unclear**	*Average ROP:*	**2.7 m/hr**

Drilling operations

Coring continued on August 24th. Due to the low filtering rate it was changed to unfiltered after midnight. Coring was stopped after core run 37 at a TVD of 106.24 m at 3 AM due to some problems with the water storage at the peninsular. Coring continued at 6 AM with filtered seawater and at shift change the well was 109.29 m. Drilling continued for the entire day shift and at the end of the day shift a TVD of 138.09 m was reached. However, problems occurred, due to the melting of the plastic liners. Non-sterilized water was used for core run 40. Mud was used in core run 42. Just at the shift change the tube got stuck. The rig crew tried to fish it, without success. Subsequently the night shift POOH the drilling string to remove the string.

RIH with the drill string was conducted slightly after midnight on August 25th and coring of formations started again at 1:45 AM at 138.09 m. Drilling continued continued until end of the morning shift to a TVD of 155.04. While drilling mud was used for in core runs 49, 50 and 51. It remains unclear whether only non-sterilized seawater was used. Drilling continued with the day shift and at 4 PM a TVD of about 170 m and 60 core runs are completed.

Table 1 shows the compilation of all core runs conducted in SE-2b. Table 2 show the compilation of all core runs and division into sections and location of samples taken on Surtsey. Figure 1 shows the drilling progress of SE-2b. Figure 2 shows the on-site geologist cutting the core.

Logistics

Today a crew change took place. Geologists Amel Barich, Solvei Onstat, as well as the cook (Dagny) and 2 camp manager (Águst Þór, Þórstein) left Surtsey. New on the island are 2 loggers from the ICDP OSG Team (Jochem Kueck, Marco Groh), geologists Andreas Tuerke, 2 camp managers (Einar Sindri, Sveinbjörn) and Unnur as cook.

Table 1. *Overview of conducted core runs in SE-2b in 2017.*

Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	1	20.08.2017	10:00 - 10:15 PM	12.86	14.74	1.88	1.685	90
SE-2b	2	20.08.2017	10:50 - 11:15 PM	14.74	17.79	3.05	3.01	99

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	3	21.08.2017	0:20 - 0:55 AM	17.79	20.84	3.05	3.03	99
SE-2b	4	22.08.2017	11:30 AM - 12:15 PM	20.84	23.89	3.05	3.138	103
SE-2b	5	22.08.2017	12:15 - 1:05 PM	23.89	26.94	3.05	3.09	101
SE-2b	6	22.08.2017	1:05 - 2:15 PM	26.94	29.99	3.05	3.09	101
SE-2b	7	22.08.2017	2:15 - 3:15 PM	29.99	31.64	1.65	1.71	104
SE-2b	8	22.08.2017	3:55 - 4:25 PM	31.64	33.04	1.40	1.44	103
SE-2b	9	22.08.2017	4:25 - 5:45 PM	33.04	36.09	3.05	3.07	101
SE-2b	10	22.08.2017	5:45 - 6:10 PM	36.09	37.09	1.00	**	**
SE-2b	11	22.08.2017	6:10 - 6:55 PM	37.09	39.14	2.05	1.78	87
SE-2b	12	22.08.2017	6:55 – 7:45 PM	39.14	42.19	3.05	3.20	105
SE-2b	13	22.08.2017	8:30 - 9:06 PM	42.19	45.24	3.05	2.465	81
SE-2b	14	22.08.2017	9:43 – 10:15 PM	45.24	48.29	3.05	2.615	86
SE-2b	15	22.08.2017	10:40 - 11:10 PM	48.29	51.14	2.85	3.15	111
SE-2b	16	22.08.2017	11:20 - 11:54 PM	51.14	54.06	2.92	1.67	57
SE-2b	17	23.08.2017	12:08 - 12:28 AM	54.06	55.68	1.64	2.58	157
SE-2b	18	23.08.2017	1:12 - 1:26 AM	55.68	57.44	1.47	1.14	78
SE-2b	19	23.08.2017	1:42 - 2:14 AM	57.44	59.89	2.45	3.11	127
SE-2b	20	23.08.2017	2:30 - 2:55 AM	59.89	62.54	2.65	2.665	101
SE-2b	21	23.08.2017	3:15 - 3:32 AM	62.54	63.54	1.00	0.80	80
SE-2b	22	23.08.2017	4:10 - 4:48 AM	63.54	66.59	3.05	3.11	102
SE-2b	23	23.08.2017	5:10 - 5:50 AM	66.59	69.64	3.05	2.62	86
SE-2b	24	23.08.2017	6:05 - 6:25 AM	69.64	71.59	1.95	2.105	108
SE-2b	25	23.08.2017	6:36 - 6:55 AM	71.59	72.69	1.10	0.925	84
SE-2b	26	23.08.2017	7:05 - 8:00 AM	72.69	75.74	3.05	3.10	102
SE-2b	27	23.08.2017	8:30 - 9:15 AM	75.74	78.79	3.05	3.03	99
SE-2b	28	23.08.2017	9:15 – 10:15 AM	78.79	81.84	3.05	3.05	100
SE-2b	29	23.08.2017	6:50 – 8:00 PM	81.84	84.89	3.05	3.01	99

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	30	23.08.2017	8:30 – 8:50 PM	84.89	87.54	2.65	2.77	105
SE-2b	31	23.08.2017	9:25 – 9:40 PM	87.54	89.39	1.85	1.70	92
SE-2b	32	23.08.2017	10:05 – 10:30 PM	89.39	90.99	1.60	1.20	75
SE-2b	33	23.08.2017	11:00 – 11:25 PM	90.99	94.04	3.05	2.95	97
SE-2b	34	24.08.2017	11:45 – 12:10 AM	94.04	97.09	3.05	3.14	103
SE-2b	35	24.08.2017	12:30 – 12:55 AM	97.09	100.14	3.05	2.84	93
SE-2b	36	24.08.2017	1:10 – 1:35 AM	100.14	103.19	3.05	2.86	94
SE-2b	37	24.08.2017	2:30 – 3:00 AM	103.19	106.24	3.05	3.01	99
SE-2b	38	24.08.2017	6:10 – 6:35 AM	106.24	109.29	3.05	3.11	102
SE-2b	39	24.08.2017	8:30 – 9:15 AM	109.29	112.34	3.05	3.12	102
SE-2b	40	24.08.2017	9:15 – 10:15 AM	112.34	115.39	3.05	3.03	99
SE-2b	41	24.08.2017	10:15 – 11:20 AM	115.39	118.44	3.05	3.09	101
SE-2b	42	24.08.2017	11:20 – 12:25 PM	118.44	121.49	3.05	3.09	101
SE-2b	43	24.08.2017	12:25 – 1:35 PM	121.49	124.54	3.05	2.95	97
SE-2b	44	24.08.2017	1:35 – 2:45 PM	124.54	127.59	3.05	2.63	86
SE-2b	45	24.08.2017	2:45 – 4:00 PM	127.59	130.64	3.05	3.15	103
SE-2b	46	24.08.2017	4:00 – 5:10 PM	130.64	133.69	3.05	3.065	100
SE-2b	47	24.08.2017	5:10 – 6:20 PM	133.69	136.74	3.05	2.99	98
SE-2b	48	24.08.2017	6:20 – 7:10 PM	136.74	138.09	1.35	?	?
SE-2b	49	25.08.2017	1:45 – 2:00 AM	138.09	139.79	1.70	?	?
SE-2b	50	25.08.2017	2:30 – 2:45 AM	139.79	142.84	3.05	2.99	98
SE-2b	51	25.08.2017	4:10 – 4:25 AM	142.84	145.89	3.05	3.01	99
SE-2b	52	25.08.2017	4:40 – 5:00 AM	145.89	148.94	3.05	3.09	101
SE-2b	53	25.08.2017	5:15 – 5:45 AM	148.94	151.99	3.05	3.06	100
SE-2b	54	25.08.2017	6:20 – 7:10 AM	151.99	155.04	3.05	2.88	94

* based on geologist documentation, should be measured again at the core processing on Heimaey

** could not be measured

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Core description (based on field book notes. Verification during VCD is needed)

Core 1: consolidated tuff

Core 2: top is consolidated tuff (becomes likely basalt?)

Core 3: consolidated tuff

Core 4: moderate consolidated tuff, fractured

Core 5: poorly consolidated tuff, fractured

Core 6: poorly consolidated tuff, fractured

Core 7: consolidated tuff, fractured

Core 8: consolidated tuff, fractured

Core 9: consolidated tuff, partly fractured

Core 10: well consolidated tuff, fractured

Core 11: basalt, fractured

Core 12: basalt, a few fractures, steaming, liners were deformed (melted)

Core 13: basalt

Core 14: basalt

Core 15: consolidated tuff with fragments of basalt

Core 16: consolidated tuff

Core 17: consolidated tuff

Core 18: consolidated tuff and basalt

Core 19: basalt with partially filled vesicles with something white

Core 20: Basalt, the whole core run is very fractured

Core 21: Basalt, fractured

Core 22: Basalt

Core 23: Basalt

Core 24: Basalt

Core 25: Basalt

Core 26: Basalt

Core 27: Basalt, a few fractures, steaming

Core 28: Basalt, fractured, steaming

Core 29: Basalt, barely fractured, zeolites, steaming

Core 30: Basalt

Core 31: Basalt. Core catcher was filled with clay.

Core 32: ?

Core 33: Basalt

Core 34: Basalt

Core 35: Basalt

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Core 36: ?

Core 37: Basalt

Core 38: Basalt

Core 39: Basalt

Core 40: Basalt, steaming

Core 41: Basalt, steaming, fractured

Core 42: Basalt, steaming, fractured

Core 43: basalt, steaming

Core 44: Basalt, steaming, fractured

Core 45: Basalt, steaming, fractured

Core 46: Basalt, steaming, zeolites, no fractures

Core 47: basalts, fractured, steaming

Core 48: Basalt

Core 49: Basalt

Core 50: Basalt (looked more granulated with some larger phenocrysts of plagioclase=

Core 51: Pretty fragile basalt

Core 52: Granular and fragile in the top, stronger and more consolidated to the bottom

Core 53: ?

Core 54: ?

Table 2. *Overview of conducted core runs in SE-2b in 2017. Red marked entries are updated/corrected from the previously published daily report.*

Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	1	1	20.08.2017	0.99		0-99	b2-1	No cement plug drilled. Only some plastic pieces were found on top of the core
SE-2b	1	2	20.08.2017	0.57		0-57	b2-1	
SE-2b	1	CC	20.08.2017	0.155		0-15.5	b2-1	
SE-2b	2	1	20.08.2017	0.98		0-98	b2-2	
SE-2b	2	2	20.08.2017	0.98		0-98	b2-2	
SE-2b	2	3	20.08.2017	0.955		0-95.5	b2-2	
SE-2b	2	4	20.08.2017	0.165		0-16.5	b2-2	
SE-2b	2	CC	20.08.2017	0.17		0-17	b2-2	
SE-2b	3	1	21.08.2017	0.91		0-91	b2-3	Problems during drilling. Missing liner in the core barrel caused damage on the core. Drilling crew had to pump the core out of the core barrel.
SE-2b	3	2	21.08.2017	0.55		0-55	b2-3	
SE-2b	3	3	21.08.2017	0.335		0-33.5	b2-3	
SE-2b	3	4	21.08.2017	0.875		0.875	b2-3	
SE-2b	3	CC	21.08.2017	0.36		0-36	b2-3	
SE-2b	4	1	22.08.2017	0.48		0-48	b2-4	
SE-2b	4	2	22.08.2017	0.54		0-54	b2-4	
SE-2b	4	3	22.08.2017	0.845		0-845	b2-4	
SE-2b	4	4	22.08.2017	1.00	x	20-100	b2-4	
SE-2b	4	5	22.08.2017	0.19		0-19	b2-4	
SE-2b	4	Cc	22.08.2017	0.138		0-138	b2-4	
SE-2b	5	1	22.08.2017	0.99		0-99	b2-5	
SE-2b	5	2	22.08.2017	0.975		0-97.5	b2-5	
SE-2b	5	3	22.08.2017	0.98		0-98	b2-5	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	5	4	22.08.2017	0.16		0-16	b2-5	
SE-2b	5	Cc	22.08.2017	0.13		0-13	b2-5	
SE-2b	6	1	22.08.2017	0.93		0-93	b2-6	
SE-2b	6	2	22.08.2017	0.84		0-84	b2-6	
SE-2b	6	3	22.08.2017	0.78		0-78	b2-6	
SE-2b	6	Cc	22.08.2017	0.47		0-47	b2-6	
SE-2b	7	1	22.08.2017	0.94		0-94	b2-7	
SE-2b	7	2	22.08.2017	0.63		0-63	b2-7	
SE-2b	7	Cc	22.08.2017	0.11		0-11	b2-7	
SE-2b	8	1	22.08.2017	0.52		0-52	b2-8	
SE-2b	8	2	22.08.2017	0.65		0-65	b2-8	
SE-2b	8	Cc	22.08.2017	0.23		0-23	b2-8	
SE-2b	9	1	22.08.2017	0.965		0-96.5	b2-9	
SE-2b	9	2	22.08.2017	0.875		0-87.5	b2-9	
SE-2b	9	3	22.08.2017	1.06	x	21-106	b2-9	
SE-2b	9	Cc	22.08.2017	0.20		0-20	b2-9	
SE-2b	10	1	22.08.2017	0.73		0-73	b2-10	Core liner scrambled up in rod. Section 3
SE-2b	10	2	22.08.2017	0.08		0-8	b2-10	is not orientated (small pieces)
SE-2b	10	3	22.08.2017	0.23		0-23	b2-10	
SE-2b	10	Cc	22.08.2017	0.17		0-17	b2-10	
SE-2b	11	1	22.08.2017	0.82		0-82	b2-11	
SE-2b	11	2	22.08.2017	0.90		0-90	b2-11	
SE-2b	11	Cc	22.08.2017	0.06		0-6	b2-11	
SE-2b	12	1	22.08.2017	0.93		0-93	b2-12	Liner deformed (melted)
SE-2b	12	2	22.08.2017	0.98		0-98	b2-12	
SE-2b	12	3	22.08.2017	0.34		0-34	b2-12	
SE-2b	12	4	22.08.2017	0.73		0-73	b2-12	
SE-2b	12	Cc	22.08.2017	0.23		0-23	b2-12	
SE-2b	13	1	22.08.2017	0.855		0-85.5	b2-13	
SE-2b	13	2	22.08.2017	0.69		0-69	b2-13	Slipped core run
SE-2b	13	3	22.08.2017	0.92	x	19-92	b2-13	
SE-2b	14	1	22.08.2017	0.99		0-99	b2-14	
SE-2b	14	2	22.08.2017	0.925		0-92.5	b2-14	
SE-2b	14	3	22.08.2017	0.715		0-71.5	b2-14	
SE-2b	14	Cc	22.08.2017	0.11		0.11	b2-14	
SE-2b	15	1	22.08.2017	0.99		0-99	b2-15	
SE-2b	15	2	22.08.2017	0.98		0-98	b2-15	
SE-2b	15	3	22.08.2017	0.985		0-98.5	b2-15	
SE-2b	15	Cc	22.08.2017	0.28		0.28	b2-15	
SE-2b	16	1	22.08.2017	0.995		0-99.5	b2-16	
SE-2b	16	2	22.08.2017	0.71		0-71	b2-16	
SE-2b	17	1	23.08.2017	0.98		0-98	b2-17	
SE-2b	17	2	23.08.2017	0.98		0-98	b2-17	
SE-2b	17	3	23.08.2017	0.56	x	20-56	b2-17	
SE-2b	18	1	23.08.2017	0.315		0-31.5	b2-18	
SE-2b	18	2	23.08.2017	0.12		0-12	b2-18	
SE-2b	18	3	23.08.2017	0.725		0-72.5	b2-18	
SE-2b	19	1	23.08.2017	0.985		0-98.5	b2-19	
SE-2b	19	2	23.08.2017	0.92		0-92	b2-19	
SE-2b	19	3	23.08.2017	0.84		0-84	b2-19	
SE-2b	19	4	23.08.2017	0.33		0-33	b2-19	
SE-2b	19	Cc	23.08.2017	0.07		0-7	b2-19	In pieces
SE-2b	20	1	23.08.2017	0.98		0-98	b2-20	
SE-2b	20	2	23.08.2017	0.96		0-96	b2-20	
SE-2b	20	3	23.08.2017	0.735		0-73.5	b2-20	
SE-2b	21	1	23.08.2017	0.80		0-80	b2-21	
SE-2b	22	1	23.08.2017	1.00		0-100	b2-22	
SE-2b	22	1	23.08.2017	0.95		0-95	b2-22	
SE-2b	22	1	23.08.2017	1.04	x	20-104	b2-22	
SE-2b	22	1	23.08.2017	0.16		0-16	b2-22	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	23	1	23.08.2017	0.91		0-91	b2-23	
SE-2b	23	1	23.08.2017	0.96		0-96	b2-23	
SE-2b	23	1	23.08.2017	0.77		0-77	b2-23	
SE-2b	24	1	23.08.2017	0.915		0-91.5	b2-24	
SE-2b	24	1	23.08.2017	0.98		0-98	b2-24	
SE-2b	24	1	23.08.2017	?		?	b2-24	fell off, pieces, not orientated
SE-2b	25	1	23.08.2017	0.925		0-92.5	b2-25	
SE-2b	26	1	23.08.2017	0.725		0-72.5	b2-26	
SE-2b	26	1	23.08.2017	0.965		0-96.5	b2-26	
SE-2b	26	1	23.08.2017	0.925		0-92.5	b2-26	
SE-2b	26	1	23.08.2017	0.46		0-46	b2-26	
SE-2b	26	1	23.08.2017	0.06		0-6	b2-26	
SE-2b	27	1	23.08.2017	0.75		0-75	b2-27	
SE-2b	27	2	23.08.2017	0.98		0-98	b2-27	
SE-2b	27	3	23.08.2017	0.94	x	20-94	b2-27	
SE-2b	27	4	23.08.2017	0.30		0-30	b2-27	
SE-2b	27	Cc	23.08.2017	0.07		0-7	b2-27	
SE-2b	28	1	23.08.2017	0.02		0-2	b2-28	2 cm was packed in a plastic bag as is broke off from the top of the section
				0.97		2-99		
SE-2b	28	2	23.08.2017	0.97		0-97	b2-28	
SE-2b	28	3	23.08.2017	0.99		0-99	b2-28	
SE-2b	28	4	23.08.2017	0.11		0-11	b2-28	
SE-2b	29	1	23.08.2017	0.92		0-92	b2-29	
SE-2b	29	2	23.08.2017	0.98		0-98	b2-29	
SE-2b	29	3	23.08.2017	0.59		0-59	b2-29	
SE-2b	29	4	23.08.2017	0.50		0-50	b2-29	
SE-2b	30	1	23.08.2017	0.78		0-78	b2-30	
SE-2b	30	2	23.08.2017	0.675		0-67.5	b2-30	
SE-2b	30	3	23.08.2017	0.44		0-44	b2-30	
SE-2b	30	3	23.08.2017	0.91		0-91	b2-30	
SE-2b	31	1	23.08.2017	0.95		0-95	b2-31	Liner melted. Core got damaged during removal out of the core barrel.
SE-2b	31	2	23.08.2017	0.185		0-18.5	b2-31	
SE-2b	31	3	23.08.2017	0.68		0-68	b2-31	Only pieces, not orientated
SE-2b	31	Cc	23.08.2017	?		?	b2-31	Only pieces
SE-2b	32	1	23.08.2017	0.75		0-75	b2-32	
SE-2b	32	2	23.08.2017	0.41?		0-41?	b2-32	In a liner of 41 cm, not orientated
SE-2b	32	Cc	23.08.2017	?			b2-32	
SE-2b	33	1	23.08.2017	0.99		0-99	b2-33	
SE-2b	33	2	23.08.2017	0.91		0-91	b2-33	
SE-2b	33	3	23.08.2017	1.10	x	23-110	b2-33	
SE-2b	34	1	24.08.2017	0.995		0-99.5	b2-35	
SE-2b	34	2	24.08.2017	0.98		0-98	b2-35	
SE-2b	34	3	24.08.2017	0.94		0-94	b2-35	
SE-2b	34	4	24.08.2017	0.15		0-15	b2-35	
SE-2b	34	Cc	24.08.2017	0.10		0-10	b2-35	
SE-2b	35	1	24.08.2017	0.63		0-63	b2-35	
SE-2b	35	2	24.08.2017	0.39		0-39	b2-35	
SE-2b	35	3	24.08.2017	0.98		0-98	b2-35	
SE-2b	35	4	24.08.2017	0.915		0-91.5	b2-35	
SE-2b	36	1	24.08.2017	0.94		0-94	b2-36	
SE-2b	36	2	24.08.2017	0.86		0-86	b2-36	
SE-2b	36	3	24.08.2017	1.09	x	23-109	b2-36	
SE-2b	36	Cc	24.08.2017	0.29		0-29	b2-36	
SE-2b	37	1	24.08.2017	0.98		0-98	b2-37	
SE-2b	37	2	24.08.2017	0.98		0-98	b2-37	
SE-2b	37	3	24.08.2017	0.97		0-97	b2-37	
SE-2b	37	4	24.08.2017	0.08		0-8	b2-37	
SE-2b	38	1	24.08.2017	0.85		0-85	b2-38	
SE-2b	38	2	24.08.2017	0.98		0-98	b2-38	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	38	3	24.08.2017	0.86		0-86	b2-38	
SE-2b	38	4	24.08.2017	0.40		0-40	b2-38	
SE-2b	39	1	24.08.2017	0.98		0-98	b2-39	
SE-2b	39	2	24.08.2017	0.98		0-98	b2-39	
SE-2b	39	3	24.08.2017	0.85	x	20-85	b2-39	
SE-2b	39	4	24.08.2017	0.33		0-33	b2-39	
SE-2b	40	1	24.08.2017	0.98		0-98	b2-40	
SE-2b	40	2	24.08.2017	0.97		0-97	b2-40	
SE-2b	40	3	24.08.2017	0.25		0-25	b2-40	
SE-2b	40	4	24.08.2017	0.75		0-75	b2-40	
SE-2b	40	Cc	24.08.2017	0.08		0-8	b2-40	
SE-2b	41	1	24.08.2017	0.93		0-93	b2-41	
SE-2b	41	2	24.08.2017	0.86		0-86	b2-41	
SE-2b	41	3	24.08.2017	0.69		0-69	b2-41	
SE-2b	41	4	24.08.2017	0.54		0-54	b2-41	
SE-2b	41	Cc	24.08.2017	0.08		0-08	b2-41	
SE-2b	42	1	24.08.2017	1.00		0-100	b2-42	
SE-2b	42	2	24.08.2017	0.98		0-98	b2-42	
SE-2b	42	3	24.08.2017	1.05	x	21-105	b2-42	
SE-2b	42	Cc	24.08.2017	0.05		0-5	b2-42	
SE-2b	43	1	24.08.2017	0.995		0-99.5	b2-43	Mud was used
SE-2b	43	2	24.08.2017	0.99		0-99	b2-43	
SE-2b	43	3	24.08.2017	0.97		0-97	b2-43	
SE-2b	44	1	24.08.2017	0.84		0-84	b2-44	
SE-2b	44	2	24.08.2017	0.73		0-73	b2-44	Needed to be shoot out of the rod as it was stuck
SE-2b	44	3	24.08.2017	0.94		0-94	b2-44	
SE-2b	44	4	24.08.2017	0.12		0-12	b2-44	
SE-2b	45	1	24.08.2017	1.00	x	0-81	b2-45	Needed to be shoot out of the rod as it was stuck. Samples were taken from section 1 as this part was still in the original liner
SE-2b	45	2	24.08.2017	0.22		0-22	b2-45	
SE-2b	45	3	24.08.2017	0.98		0-98	b2-45	
SE-2b	45	4	24.08.2017	0.95		0-95	b2-45	
SE-2b	46	1	24.08.2017	0.98		0-98	b2-46	
SE-2b	46	2	24.08.2017	0.97		0-97	b2-46	
SE-2b	46	3	24.08.2017	0.94		0-94	b2-46	
SE-2b	46	4	24.08.2017	0.16		0-16	b2-46	
SE-2b	46	Cc	24.08.2017	0.045		0-4.5	b2-46	
SE-2b	47	1	24.08.2017	0.81		0-81	b2-47	
SE-2b	47	2	24.08.2017	0.81		0-81	b2-47	Liner melted in rod
SE-2b	47	3	24.08.2017	0.73		0-73	b2-47	
SE-2b	47	4	24.08.2017	0.63		0-63	b2-47	
SE-2b	48	1	24.08.2017	0.85		0-85	b2-48	Mud was used
SE-2b	48	2	24.08.2017	0.51		0-51	b2-48	In pieces, not orientated
SE-2b	48	3	24.08.2017	0.21		0-21	b2-48	
SE-2b	49	1	24.08.2017	0.09		0-9	b2-49	
SE-2b	49	2	24.08.2017	0.05		0-5	b2-49	fragments
SE-2b	49	3	25.08.2017	0.97		0-97	b2-49	
SE-2b	49	4	25.08.2017	0-68	x	29-68	b2-49	
SE-2b	50	1	25.08.2017	0.96		0-96	b2-50	Drilled with mud
SE-2b	50	2	25.08.2017	0.93		0-93	b2-50	
SE-2b	50	3	25.08.2017	0.55		0-55	b2-50	
SE-2b	50	4	25.08.2017	0.59		0-59	b2-50	
SE-2b	51	1	25.08.2017	0.97		0-97	b2-51	
SE-2b	51	2	25.08.2017	0.88		0-88	b2-51	
SE-2b	51	3	25.08.2017	0.55		0-55	b2-51	
SE-2b	51	4	25.08.2017	0.65		0-64	b2-51	
SE-2b	51	Cc	25.08.2017	0.11		0-11	b2-51	
SE-2b	52	1	25.08.2017	0.97		0-97	b2-52	
SE-2b	52	2	25.08.2017	0.98		0-98	b2-52	
SE-2b	52	3	25.08.2017	0.89	x	30-89	b2-52	
SE-2b	52	Cc	25.08.2017	0.36		0-36	b2-52	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	53	1	25.08.2017	0.99		0-99	b2-53	
SE-2b	53	2	25.08.2017	0.61		0-61	b2-53	
SE-2b	53	3	25.08.2017	0.62		0-62	b2-53	
SE-2b	53	4	25.08.2017	0.875		0-875	b2-53	
SE-2b	54	1	25.08.2017	0.47		0-47	b2-54	
SE-2b	54	2	25.08.2017	0.81		0-81	b2-54	
SE-2b	54	3	25.08.2017	0.85		0-85	b2-54	
SE-2b	54	4	25.08.2017	0.88		0-88	b2-54	

* should be measured again at the core processing on Heimaey

** each core is stored in one single core box, please keep in mind that there might be some inconsistencies in the slots, to fit all core in one box

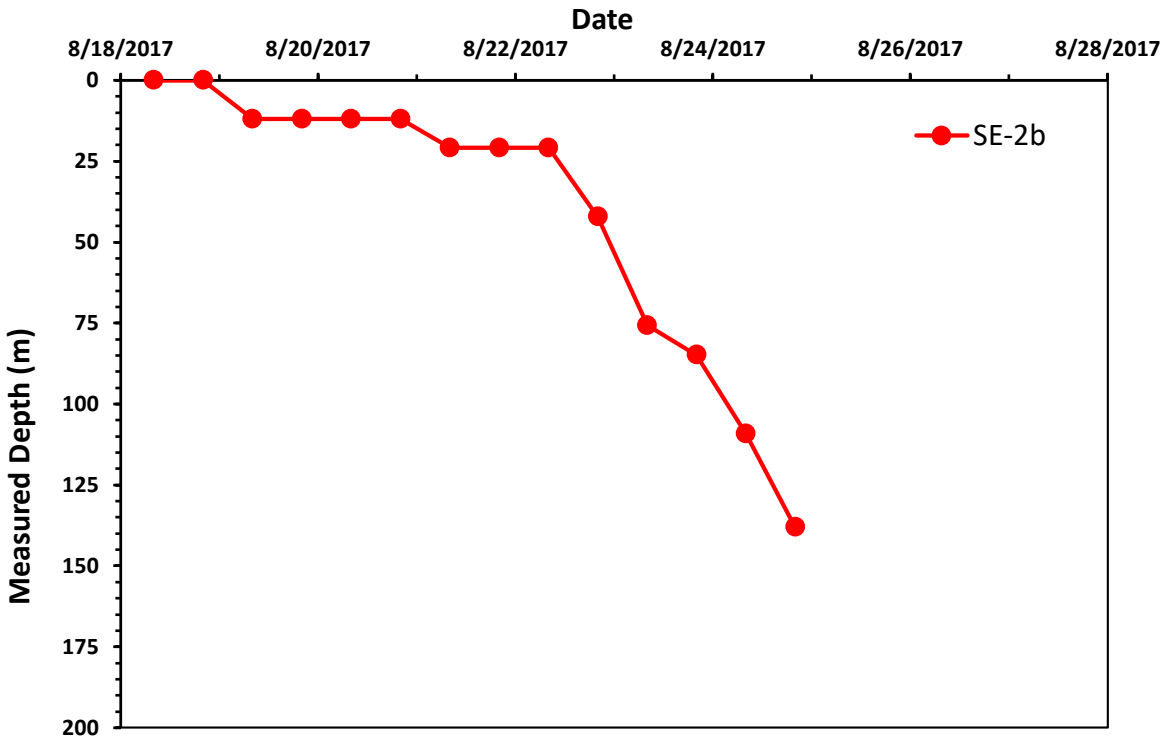

Figure 1. Drilling progress from SE-2b.

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Figure 2. On-site geologist Barbara Kleine and Amel Barich cutting the core (image TBW).

Onsite science team

Initials	Name	Affiliation	Email	Cell phone no	Function
TBW	Tobias B. Weisenberger	ÍSOR	tobias.b.weisenberger@isor.is	+354 661 3406	Geologist
BK	Barbara Kleine	HÍ			Geologist
PB	Pauline Bergsten	MATIS			Microbiologist
AB	Amel Barich				Geologist
SO	Solveig Onstad				Geologist

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SUSTAIN

Location	Daily Report #8	? working day
Surtsey	Preliminary data collection	26th of August 2017

Well Name:	**SE-02b**	*Drilling Company:*	**DES**	*Geologist:*	**TBW**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	
Drill-bit diameter:	**HQ**	*Depth at midnight:*	**191.64 m**	*Hole made last 24 hrs*	**36.6**
Drilling fluid:	**Seawater with some mud pills**	*Depth at 8 AM:*	**191.64 m**	*Drilling time:*	**14 hrs.**
Sterilized fluid:	**Non sterilized water used for core run 56, 58**	*Circulation losses:*	**unclear**	*Average ROP:*	**2.6 m/hr**

Drilling operations

RIH with the drill string was conducted slightly after midnight on August 25th and coring of formations started again at 1:45 AM at 138.09 m. Drilling continued until end of the morning shift to a TVD of 155.04. While drilling mud was used for in core runs 49, 50 and 51. It remains unclear whether only non-sterilized seawater was used. Drilling continued with the day shift. Drilling continued for the entire day shift and at shift change in total 63 core runs were completed with a TVD of 176.39 m. Non sterilized seawater was used in core runs 56 and 58. Drilling into formation continued with the night shift. Directly after core run 65 the on-site scientists observed a change in formation from a consolidate tuff to an unconsolidated tuff at a depth of about 181 m. Simultaneous to this observation the driller (Justin) informed the on-site scientist in charge (TBW) about a change in drilling behavior. Coring commenced with core run 66. However, for core run 66 only one section of 98 cm in length was recovered (32% core recovery), which consists of similar type of unconsolidated tuff as observed in core run 65. After observation and evaluation of the recovered rock another core run was carried. During core run 67, only 38 cm of core were recovered (12 % core recovery). Primary core observation indicated the penetration of a fine-grained rock formation (sediment?). Core recovery for core run 68 was 0%. Further evaluation between the driller and the scientist in charge were carried out and another core run was carried out. Coring conditions were very difficult during core run and the driller reported possible washouts of the drilled sections. As in the previous 2 core runs, the drill string was immediately POOH by a few rod lengths to limit the risk to get stuck. The unconsolidated nature of the drilled rock formation was confirmed by retrieval of an empty tube. Both, the driller (Justin) and scientist in charger agreed that further drilling is highly risky and after consulting the PI (MTG) the well SE-2b was completed after 68 core runs resulting in a TD of 191.64 m. The well was circulated with pills of mud after the last core runs.

Subsequently the drill string was POOH of about 50 m shortly after midnight on August 26th and the drill crew was waiting for the logging to be started. The ICDP OSG started preparation for logging activity at SE-2b at about 8:30 AM on August 26th. After consulting with the steering committee the well logging was defined and wireline logging started at noon with a temperature, pressure, natural gamma and mud resistivity log. This was followed by following logs: magnetic susceptibility, inclination, resistivity and spontaneous potential. All this logs were carried out to a maximum depth of 180 m. Subsequently, the drilling steering committee made the decision not to conduct a sonic log nor try to log the temperature below 180 m. Logging was completed at about 8 PM. The drill crew will POOH the drill string and RIH with the Al casing will commence soon.

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Following achievements were done early this morning:

- drilled a well deeper than the 1979 well

- primary core inspections indicate that the consolidate part of SE-2b reaches deeper down than during drilling in 1979

- well deep enough for the Surtsey observatory is provided

Table 1 shows the compilation of all core runs conducted in SE-2b. Table 2 show the compilation of all core runs and division into sections and location of samples taken on Surtsey. Figure 1 shows the drilling progress of SE-2b. Figure 2 showing the final drillers log providing in formation of the last core run. Figure 3 shows the ICDP OSG team (Jochem and Marco) carrying out wireline logging at SE-2b.

Table 1. *Overview of conducted core runs in SE-2b in 2017.*

Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	1	20.08.2017	10:00 - 10:15 PM	12.86	14.74	1.88	1.685	90
SE-2b	2	20.08.2017	10:50 - 11:15 PM	14.74	17.79	3.05	3.01	99
SE-2b	3	21.08.2017	0:20 - 0:55 AM	17.79	20.84	3.05	3.03	99
SE-2b	4	22.08.2017	11:30 AM - 12:15 PM	20.84	23.89	3.05	3.138	103
SE-2b	5	22.08.2017	12:15 - 1:05 PM	23.89	26.94	3.05	3.09	101
SE-2b	6	22.08.2017	1:05 - 2:15 PM	26.94	29.99	3.05	3.09	101
SE-2b	7	22.08.2017	2:15 - 3:15 PM	29.99	31.64	1.65	1.71	104
SE-2b	8	22.08.2017	3:55 - 4:25 PM	31.64	33.04	1.40	1.44	103
SE-2b	9	22.08.2017	4:25 - 5:45 PM	33.04	36.09	3.05	3.07	101
SE-2b	10	22.08.2017	5:45 - 6:10 PM	36.09	37.09	1.00	**	**
SE-2b	11	22.08.2017	6:10 - 6:55 PM	37.09	39.14	2.05	1.78	87
SE-2b	12	22.08.2017	6:55 – 7:45 PM	39.14	42.19	3.05	3.20	105
SE-2b	13	22.08.2017	8:30 - 9:06 PM	42.19	45.24	3.05	2.465	81
SE-2b	14	22.08.2017	9:43 – 10:15 PM	45.24	48.29	3.05	2.615	86
SE-2b	15	22.08.2017	10:40 - 11:10 PM	48.29	51.14	2.85	3.15	111
SE-2b	16	22.08.2017	11:20 - 11:54 PM	51.14	54.06	2.92	1.67	57
SE-2b	17	23.08.2017	12:08 - 12:28 AM	54.06	55.68	1.64	2.58	157
SE-2b	18	23.08.2017	1:12 - 1:26 AM	55.68	57.44	1.47	1.14	78

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	19	23.08.2017	1:42 - 2:14 AM	57.44	59.89	2.45	3.11	127
SE-2b	20	23.08.2017	2:30 - 2:55 AM	59.89	62.54	2.65	2.665	101
SE-2b	21	23.08.2017	3:15 - 3:32 AM	62.54	63.54	1.00	0.80	80
SE-2b	22	23.08.2017	4:10 - 4:48 AM	63.54	66.59	3.05	3.11	102
SE-2b	23	23.08.2017	5:10 - 5:50 AM	66.59	69.64	3.05	2.62	86
SE-2b	24	23.08.2017	6:05 - 6:25 AM	69.64	71.59	1.95	2.105	108
SE-2b	25	23.08.2017	6:36 - 6:55 AM	71.59	72.69	1.10	0.925	84
SE-2b	26	23.08.2017	7:05 - 8:00 AM	72.69	75.74	3.05	3.10	102
SE-2b	27	23.08.2017	8:30 - 9:15 AM	75.74	78.79	3.05	3.03	99
SE-2b	28	23.08.2017	9:15 – 10:15 AM	78.79	81.84	3.05	3.05	100
SE-2b	29	23.08.2017	6:50 – 8:00 PM	81.84	84.89	3.05	3.01	99
SE-2b	30	23.08.2017	8:30 – 8:50 PM	84.89	87.54	2.65	2.77	105
SE-2b	31	23.08.2017	9:25 – 9:40 PM	87.54	89.39	1.85	1.70	92
SE-2b	32	23.08.2017	10:05 – 10:30 PM	89.39	90.99	1.60	1.20	75
SE-2b	33	23.08.2017	11:00 – 11:25 PM	90.99	94.04	3.05	2.95	97
SE-2b	34	24.08.2017	11:45 – 12:10 AM	94.04	97.09	3.05	3.14	103
SE-2b	35	24.08.2017	12:30 – 12:55 AM	97.09	100.14	3.05	2.84	93
SE-2b	36	24.08.2017	1:10 – 1:35 AM	100.14	103.19	3.05	2.86	94
SE-2b	37	24.08.2017	2:30 – 3:00 AM	103.19	106.24	3.05	3.01	99
SE-2b	38	24.08.2017	6:10 – 6:35 AM	106.24	109.29	3.05	3.11	102
SE-2b	39	24.08.2017	8:30 – 9:15 AM	109.29	112.34	3.05	3.12	102
SE-2b	40	24.08.2017	9:15 – 10:15 AM	112.34	115.39	3.05	3.03	99
SE-2b	41	24.08.2017	10:15 – 11:20 AM	115.39	118.44	3.05	3.09	101
SE-2b	42	24.08.2017	11:20 – 12:25 PM	118.44	121.49	3.05	3.09	101
SE-2b	43	24.08.2017	12:25 – 1:35 PM	121.49	124.54	3.05	2.95	97
SE-2b	44	24.08.2017	1:35 – 2:45 PM	124.54	127.59	3.05	2.63	86
SE-2b	45	24.08.2017	2:45 – 4:00 PM	127.59	130.64	3.05	3.15	103

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	46	24.08.2017	4:00 – 5:10 PM	130.64	133.69	3.05	3.065	100
SE-2b	47	24.08.2017	5:10 – 6:20 PM	133.69	136.74	3.05	2.99	98
SE-2b	48	24.08.2017	6:20 – 7:10 PM	136.74	138.09	1.35	?	?
SE-2b	49	25.08.2017	1:45 – 2:00 AM	138.09	139.79	1.70	?	?
SE-2b	50	25.08.2017	2:30 – 2:45 AM	139.79	142.84	3.05	2.99	98
SE-2b	51	25.08.2017	4:10 – 4:25 AM	142.84	145.89	3.05	3.01	99
SE-2b	52	25.08.2017	4:40 – 5:00 AM	145.89	148.94	3.05	3.09	101
SE-2b	*53*	*25.08.2017*	*5:15 – 5:45 AM*	*148.94*	*151.99*	*3.05*	*3.06*	*100*
SE-2b	54	25.08.2017	6:20 – 7:10 AM	151.99	155.04	3.05	2.88	94
SE-2b	55	25.08.2017	8:30 – 10:15 AM	155.04	158.09	3.05	3.08	101
SE-2b	56	25.08.2017	10:15 – 11:25 AM	158.09	161.14	3.05	3.06	100
SE-2b	57	25.08.2017	11:25 – 11:45 AM	161.14	161.84	0.70	0.58	83
SE-2b	58	25.08.2017	11:45 – 12:45 PM	161.84	164.19	2.35	2.28	97
SE-2b	59	25.08.2017	12:45 – 2:05 PM	164.19	167.24	3.05	2.76	90
SE-2b	60	25.08.2017	2:05 – 3:40 PM	167.24	170.29	3.05	3.11	102
SE-2b	61	25.08.2017	3:40 – 5:25 PM	170.29	173.34	3.05	2.66	87
SE-2b	62	25.08.2017	5:25 – 6:45 PM	173.34	176.14	2.80	3.18	114
SE-2b	63	25.08.2017	6:45 – 7:10 PM	176.14	176.39	0.25	0.28	112
SE-2b	64	25.08.2017	8:15 – 5:50 PM	176.39	179.44	3.05	3.08	101
SE-2b	65	25.08.2017	9:05 – 9:30 PM	179.44	182.49	3.05	3.14	103
SE-2b	66	25.08.2017	10:00 – 10:15 PM	182.49	185.54	3.05	0.98	32
SE-2b	67	25.08.2017	10:30 – 10:50 PM	185.54	188.59	3.05	0.38	12
SE-2b	68	25.08.2017	11:20 – 11:35 PM	188.59	191.64	3.05	-	0

* based on geologist documentation, should be measured again at the core processing on Heimaey

** could not be measured

Core description (based on field book notes. Verification during VCD is needed)

Core 1: consolidated tuff

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Core 2: top is consolidated tuff (becomes likely basalt?)

Core 3: consolidated tuff

Core 4: moderate consolidated tuff, fractured

Core 5: poorly consolidated tuff, fractured

Core 6: poorly consolidated tuff, fractured

Core 7: consolidated tuff, fractured

Core 8: consolidated tuff, fractured

Core 9: consolidated tuff, partly fractured

Core 10: well consolidated tuff, fractured

Core 11: basalt, fractured

Core 12: basalt, a few fractures, steaming, liners were deformed (melted)

Core 13: basalt

Core 14: basalt

Core 15: consolidated tuff with fragments of basalt

Core 16: consolidated tuff

Core 17: consolidated tuff

Core 18: consolidated tuff and basalt

Core 19: basalt with partially filled vesicles with something white

Core 20: Basalt, the whole core run is very fractured

Core 21: Basalt, fractured

Core 22: Basalt

Core 23: Basalt

Core 24: Basalt

Core 25: Basalt

Core 26: Basalt

Core 27: Basalt, a few fractures, steaming

Core 28: Basalt, fractured, steaming

Core 29: Basalt, barely fractured, zeolites, steaming

Core 30: Basalt

Core 31: Basalt. Core catcher was filled with clay.

Core 32: ?

Core 33: Basalt

Core 34: Basalt

Core 35: Basalt

Core 36: ?

Core 37: Basalt

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Core 38: Basalt

Core 39: Basalt

Core 40: Basalt, steaming

Core 41: Basalt, steaming, fractured

Core 42: Basalt, steaming, fractured

Core 43: basalt, steaming

Core 44: Basalt, steaming, fractured

Core 45: Basalt, steaming, fractured

Core 46: Basalt, steaming, zeolites, no fractures

Core 47: basalts, fractured, steaming

Core 48: Basalt

Core 49: Basalt

Core 50: Basalt (looked more granulated with some larger phenocrysts of plagioclase=

Core 51: Pretty fragile basalt

Core 52: Granular and fragile in the top, stronger and more consolidated to the bottom

Core 53: ?

Core 54: ?

Core 55: Tuff

Core 56: Tuff, fractured

Core 57: Tuff

Core 58: Tuff, well consolidated, heavily fractured

Core 59: Tuff, very well consolidated, fractured

Core 60: Tuff, fractured, well consolidated

Core 61: Tuff, well consolidated, heavily fracture

Core 62: Tuff, well consolidated, fractured

Core 63: Tuff

Core 64: Tuff, consolidated

Core 65: Tuff, significant change at about 181 m from consolidated to unconsolidated tuff (section 3 & 4). Observation are concordant to the drilling change observed by the driller

Core 66: Tuff, unconsolidated, low core recovery

Core 67: Fine-grained dark formation (seafloor sediment?)

Core 68: no core recovered

Table 2. *Overview of conducted core runs in SE-2b in 2017. Red marked entries are updated/corrected from the previously published daily report.*

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	1	1	20.08.2017	0.99		0-99	b2-1	No cement plug drilled. Only some plastic pieces were found on top of the core
SE-2b	1	2	20.08.2017	0.57		0-57	b2-1	
SE-2b	1	CC	20.08.2017	0.155		0-15.5	b2-1	
SE-2b	2	1	20.08.2017	0.98		0-98	b2-2	
SE-2b	2	2	20.08.2017	0.98		0-98	b2-2	
SE-2b	2	3	20.08.2017	0.955		0-95.5	b2-2	
SE-2b	2	4	20.08.2017	0.165		0-16.5	b2-2	
SE-2b	2	CC	20.08.2017	0.17		0-17	b2-2	
SE-2b	3	1	21.08.2017	0.91		0-91	b2-3	Problems during drilling. Missing liner in the core barrel caused damage on the core. Drilling crew had to pump the core out of the core barrel.
SE-2b	3	2	21.08.2017	0.55		0-55	b2-3	
SE-2b	3	3	21.08.2017	0.335		0-33.5	b2-3	
SE-2b	3	4	21.08.2017	0.875		0.875	b2-3	
SE-2b	3	CC	21.08.2017	0.36		0-36	b2-3	
SE-2b	4	1	22.08.2017	0.48		0-48	b2-4	
SE-2b	4	2	22.08.2017	0.54		0-54	b2-4	
SE-2b	4	3	22.08.2017	0.845		0-845	b2-4	
SE-2b	4	4	22.08.2017	1.00	x	20-100	b2-4	
SE-2b	4	5	22.08.2017	0.19		0-19	b2-4	
SE-2b	4	Cc	22.08.2017	0.138		0-138	b2-4	
SE-2b	5	1	22.08.2017	0.99		0-99	b2-5	
SE-2b	5	2	22.08.2017	0.975		0-97.5	b2-5	
SE-2b	5	3	22.08.2017	0.98		0-98	b2-5	
SE-2b	5	4	22.08.2017	0.16		0-16	b2-5	
SE-2b	5	Cc	22.08.2017	0.13		0-13	b2-5	
SE-2b	6	1	22.08.2017	0.93		0-93	b2-6	
SE-2b	6	2	22.08.2017	0.84		0-84	b2-6	
SE-2b	6	3	22.08.2017	0.78		0-78	b2-6	
SE-2b	6	Cc	22.08.2017	0.47		0-47	b2-6	
SE-2b	7	1	22.08.2017	0.94		0-94	b2-7	
SE-2b	7	2	22.08.2017	0.63		0-63	b2-7	
SE-2b	7	Cc	22.08.2017	0.11		0-11	b2-7	
SE-2b	8	1	22.08.2017	0.52		0-52	b2-8	
SE-2b	8	2	22.08.2017	0.65		0-65	b2-8	
SE-2b	8	Cc	22.08.2017	0.23		0-23	b2-8	
SE-2b	9	1	22.08.2017	0.965		0-96.5	b2-9	
SE-2b	9	2	22.08.2017	0.875		0-87.5	b2-9	
SE-2b	9	3	22.08.2017	1.06	x	21-106	b2-9	
SE-2b	9	Cc	22.08.2017	0.20		0-20	b2-9	
SE-2b	10	1	22.08.2017	0.73		0-73	b2-10	Core liner scrambled up in rod. Section 3 is not orientated (small pieces)
SE-2b	10	2	22.08.2017	0.08		0-8	b2-10	
SE-2b	10	3	22.08.2017	0.23		0-23	b2-10	
SE-2b	10	Cc	22.08.2017	0.17		0-17	b2-10	
SE-2b	11	1	22.08.2017	0.82		0-82	b2-11	
SE-2b	11	2	22.08.2017	0.90		0-90	b2-11	
SE-2b	11	Cc	22.08.2017	0.06		0-6	b2-11	
SE-2b	12	1	22.08.2017	0.93		0-93	b2-12	Liner deformed (melted)
SE-2b	12	2	22.08.2017	0.98		0-98	b2-12	
SE-2b	12	3	22.08.2017	0.34		0-34	b2-12	
SE-2b	12	4	22.08.2017	0.73		0-73	b2-12	
SE-2b	12	Cc	22.08.2017	0.23		0-23	b2-12	
SE-2b	13	1	22.08.2017	0.855		0-85.5	b2-13	
SE-2b	13	2	22.08.2017	0.69		0-69	b2-13	Slipped core run
SE-2b	13	3	22.08.2017	0.92	x	19-92	b2-13	
SE-2b	14	1	22.08.2017	0.99		0-99	b2-14	
SE-2b	14	2	22.08.2017	0.925		0-92.5	b2-14	
SE-2b	14	3	22.08.2017	0.715		0-71.5	b2-14	
SE-2b	14	Cc	22.08.2017	0.11		0.11	b2-14	
SE-2b	15	1	22.08.2017	0.99		0-99	b2-15	
SE-2b	15	2	22.08.2017	0.98		0-98	b2-15	
SE-2b	15	3	22.08.2017	0.985		0-98.5	b2-15	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	15	Cc	22.08.2017	0.28		0.28	b2-15	
SE-2b	16	1	22.08.2017	0.995		0-99.5	b2-16	
SE-2b	16	2	22.08.2017	0.71		0-71	b2-16	
SE-2b	17	1	23.08.2017	0.98		0-98	b2-17	
SE-2b	17	2	23.08.2017	0.98		0-98	b2-17	
SE-2b	17	3	23.08.2017	0.56	x	20-56	b2-17	
SE-2b	18	1	23.08.2017	0.315		0-31.5	b2-18	
SE-2b	18	2	23.08.2017	0.12		0-12	b2-18	
SE-2b	18	3	23.08.2017	0.725		0-72.5	b2-18	
SE-2b	19	1	23.08.2017	0.985		0-98.5	b2-19	
SE-2b	19	2	23.08.2017	0.92		0-92	b2-19	
SE-2b	19	3	23.08.2017	0.84		0-84	b2-19	
SE-2b	19	4	23.08.2017	0.33		0-33	b2-19	
SE-2b	19	Cc	23.08.2017	0.07		0-7	b2-19	In pieces
SE-2b	20	1	23.08.2017	0.98		0-98	b2-20	
SE-2b	20	2	23.08.2017	0.96		0-96	b2-20	
SE-2b	20	3	23.08.2017	0.735		0-73.5	b2-20	
SE-2b	21	1	23.08.2017	0.80		0-80	b2-21	
SE-2b	22	1	23.08.2017	1.00		0-100	b2-22	
SE-2b	22	1	23.08.2017	0.95		0-95	b2-22	
SE-2b	22	1	23.08.2017	1.04	x	20-104	b2-22	
SE-2b	22	1	23.08.2017	0.16		0-16	b2-22	
SE-2b	23	1	23.08.2017	0.91		0-91	b2-23	
SE-2b	23	1	23.08.2017	0.96		0-96	b2-23	
SE-2b	23	1	23.08.2017	0.77		0-77	b2-23	
SE-2b	24	1	23.08.2017	0.915		0-91.5	b2-24	
SE-2b	24	1	23.08.2017	0.98		0-98	b2-24	
SE-2b	24	1	23.08.2017	?		?	b2-24	fell off, pieces, not orientated
SE-2b	25	1	23.08.2017	0.925		0-92.5	b2-25	
SE-2b	26	1	23.08.2017	0.725		0-72.5	b2-26	
SE-2b	26	1	23.08.2017	0.965		0-96.5	b2-26	
SE-2b	26	1	23.08.2017	0.925		0-92.5	b2-26	
SE-2b	26	1	23.08.2017	0.46		0-46	b2-26	
SE-2b	26	1	23.08.2017	0.06		0-6	b2-26	
SE-2b	27	1	23.08.2017	0.75		0-75	b2-27	
SE-2b	27	2	23.08.2017	0.98		0-98	b2-27	
SE-2b	27	3	23.08.2017	0.94	x	20-94	b2-27	
SE-2b	27	4	23.08.2017	0.30		0-30	b2-27	
SE-2b	27	Cc	23.08.2017	0.07		0-7	b2-27	
SE-2b	28	1	23.08.2017	0.02		0-2	b2-28	2 cm was packed in a plastic bag as is broke off from the top of the section
				0.97		2-99		
SE-2b	28	2	23.08.2017	0.97		0-97	b2-28	
SE-2b	28	3	23.08.2017	0.99		0-99	b2-28	
SE-2b	28	4	23.08.2017	0.11		0-11	b2-28	
SE-2b	29	1	23.08.2017	0.92		0-92	b2-29	
SE-2b	29	2	23.08.2017	0.98		0-98	b2-29	
SE-2b	29	3	23.08.2017	0.59		0-59	b2-29	
SE-2b	29	4	23.08.2017	0.50		0-50	b2-29	
SE-2b	30	1	23.08.2017	0.78		0-78	b2-30	
SE-2b	30	2	23.08.2017	0.675		0-67.5	b2-30	
SE-2b	30	3	23.08.2017	0.44		0-44	b2-30	
SE-2b	30	3	23.08.2017	0.91		0-91	b2-30	
SE-2b	31	1	23.08.2017	0.95		0-95	b2-31	Liner melted. Core got damaged during removal out of the core barrel.
SE-2b	31	2	23.08.2017	0.185		0-18.5	b2-31	
SE-2b	31	3	23.08.2017	0.68		0-68	b2-31	Only pieces, not orientated
SE-2b	31	Cc	23.08.2017	?		?	b2-31	Only pieces
SE-2b	32	1	23.08.2017	0.75		0-75	b2-32	
SE-2b	32	2	23.08.2017	0.41?		0-41?	b2-32	In a liner of 41 cm, not orientated
SE-2b	32	Cc	23.08.2017	?			b2-32	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	33	1	23.08.2017	0.99		0-99	b2-33	
SE-2b	33	2	23.08.2017	0.91		0-91	b2-33	
SE-2b	33	3	23.08.2017	1.10	x	23-110	b2-33	
SE-2b	34	1	24.08.2017	0.995		0-99.5	b2-35	
SE-2b	34	2	24.08.2017	0.98		0-98	b2-35	
SE-2b	34	3	24.08.2017	0.94		0-94	b2-35	
SE-2b	34	4	24.08.2017	0.15		0-15	b2-35	
SE-2b	34	Cc	24.08.2017	0.10		0-10	b2-35	
SE-2b	35	1	24.08.2017	0.63		0-63	b2-35	
SE-2b	35	2	24.08.2017	0.39		0-39	b2-35	
SE-2b	35	3	24.08.2017	0.98		0-98	b2-35	
SE-2b	35	4	24.08.2017	0.915		0-91.5	b2-35	
SE-2b	36	1	24.08.2017	0.94		0-94	b2-36	
SE-2b	36	2	24.08.2017	0.86		0-86	b2-36	
SE-2b	36	3	24.08.2017	1.09	x	23-109	b2-36	
SE-2b	36	Cc	24.08.2017	0.29		0-29	b2-36	
SE-2b	37	1	24.08.2017	0.98		0-98	b2-37	
SE-2b	37	2	24.08.2017	0.98		0-98	b2-37	
SE-2b	37	3	24.08.2017	0.97		0-97	b2-37	
SE-2b	37	4	24.08.2017	0.08		0-8	b2-37	
SE-2b	38	1	24.08.2017	0.85		0-85	b2-38	
SE-2b	38	2	24.08.2017	0.98		0-98	b2-38	
SE-2b	38	3	24.08.2017	0.86		0-86	b2-38	
SE-2b	38	4	24.08.2017	0.40		0-40	b2-38	
SE-2b	39	1	24.08.2017	0.98		0-98	b2-39	
SE-2b	39	2	24.08.2017	0.98		0-98	b2-39	
SE-2b	39	3	24.08.2017	0.85	x	20-85	b2-39	
SE-2b	39	4	24.08.2017	0.33		0-33	b2-39	
SE-2b	40	1	24.08.2017	0.98		0-98	b2-40	
SE-2b	40	2	24.08.2017	0.97		0-97	b2-40	
SE-2b	40	3	24.08.2017	0.25		0-25	b2-40	
SE-2b	40	4	24.08.2017	0.75		0-75	b2-40	
SE-2b	40	Cc	24.08.2017	0.08		0-8	b2-40	
SE-2b	41	1	24.08.2017	0.93		0-93	b2-41	
SE-2b	41	2	24.08.2017	0.86		0-86	b2-41	
SE-2b	41	3	24.08.2017	0.69		0-69	b2-41	
SE-2b	41	4	24.08.2017	0.54		0-54	b2-41	
SE-2b	41	Cc	24.08.2017	0.08		0-08	b2-41	
SE-2b	42	1	24.08.2017	1.00		0-100	b2-42	
SE-2b	42	2	24.08.2017	0.98		0-98	b2-42	
SE-2b	42	3	24.08.2017	1.05	x	21-105	b2-42	
SE-2b	42	Cc	24.08.2017	0.05		0-5	b2-42	
SE-2b	43	1	24.08.2017	0.995		0-99.5	b2-43	Mud was used
SE-2b	43	2	24.08.2017	0.99		0-99	b2-43	
SE-2b	43	3	24.08.2017	0.97		0-97	b2-43	
SE-2b	44	1	24.08.2017	0.84		0-84	b2-44	
SE-2b	44	2	24.08.2017	0.73		0-73	b2-44	Needed to be shoot out of the rod as it was stuck
SE-2b	44	3	24.08.2017	0.94		0-94	b2-44	
SE-2b	44	4	24.08.2017	0.12		0-12	b2-44	
SE-2b	45	1	24.08.2017	1.00	x	0-81	b2-45	Needed to be shoot out of the rod as it was stuck. Samples were taken from section 1 as this part was still in the original liner
SE-2b	45	2	24.08.2017	0.22		0-22	b2-45	
SE-2b	45	3	24.08.2017	0.98		0-98	b2-45	
SE-2b	45	4	24.08.2017	0.95		0-95	b2-45	
SE-2b	46	1	24.08.2017	0.98		0-98	b2-46	
SE-2b	46	2	24.08.2017	0.97		0-97	b2-46	
SE-2b	46	3	24.08.2017	0.94		0-94	b2-46	
SE-2b	46	4	24.08.2017	0.16		0-16	b2-46	
SE-2b	46	Cc	24.08.2017	0.045		0-4.5	b2-46	
SE-2b	47	1	24.08.2017	0.81		0-81	b2-47	Liner melted in rod
SE-2b	47	2	24.08.2017	0.81		0-81	b2-47	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	47	3	24.08.2017	0.73		0-73	b2-47	
SE-2b	47	4	24.08.2017	0.63		0-63	b2-47	
SE-2b	48	1	24.08.2017	0.85		0-85	b2-48	Mud was used
SE-2b	48	2	24.08.2017	0.51		0-51	b2-48	In pieces, not orientated
SE-2b	48	3	24.08.2017	0.21		0-21	b2-48	
SE-2b	49	1	24.08.2017	0.09		0-9	b2-49	
SE-2b	49	2	24.08.2017	0.05		0-5	b2-49	fragments
SE-2b	49	3	25.08.2017	0.97		0-97	b2-49	
SE-2b	49	4	25.08.2017	0-68	x	29-68	b2-49	
SE-2b	50	1	25.08.2017	0.96		0-96	b2-50	Drilled with mud
SE-2b	50	2	25.08.2017	0.93		0-93	b2-50	
SE-2b	50	3	25.08.2017	0.55		0-55	b2-50	
SE-2b	50	4	25.08.2017	0.59		0-59	b2-50	
SE-2b	51	1	25.08.2017	0.97		0-97	b2-51	
SE-2b	51	2	25.08.2017	0.88		0-88	b2-51	
SE-2b	51	3	25.08.2017	0.55		0-55	b2-51	
SE-2b	51	4	25.08.2017	0.65		0-64	b2-51	
SE-2b	51	Cc	25.08.2017	0.11		0-11	b2-51	
SE-2b	52	1	25.08.2017	0.97		0-97	b2-52	
SE-2b	52	2	25.08.2017	0.98		0-98	b2-52	
SE-2b	52	3	25.08.2017	0.89	x	30-89	b2-52	
SE-2b	52	Cc	25.08.2017	0.36		0-36	b2-52	
SE-2b	53	1	25.08.2017	0.99		0-99	b2-53	
SE-2b	53	2	25.08.2017	0.61		0-61	b2-53	
SE-2b	53	3	25.08.2017	0.62		0-62	b2-53	
SE-2b	53	4	25.08.2017	0.875		0-875	b2-53	
SE-2b	54	1	25.08.2017	0.47		0-47	b2-54	
SE-2b	54	2	25.08.2017	0.81		0-81	b2-54	
SE-2b	54	3	25.08.2017	0.85		0-85	b2-54	
SE-2b	54	4	25.08.2017	0.88		0-88	b2-54	
SE-2b	55	1	25.08.2017	0.98		0-98	b2-55	
SE-2b	55	2	25.08.2017	0.985		0-98.5	b2-55	
SE-2b	55	3	25.08.2017	1.02	x	30-102	b2-55	
SE-2b	55	Cc	25.08.2017	0.08		0-8	b2-55	
SE-2b	56	1	25.08.2017	0.92		0-92	b2-56	
SE-2b	56	2	25.08.2017	0.94		0-94	b2-56	
SE-2b	56	3	25.08.2017	0.97		0-97	b2-56	
SE-2b	56	4	25.08.2017	0.20		0-20	b2-56	
SE-2b	56	Cc	25.08.2017	0.03		0-3	b2-56	
SE-2b	57	1	25.08.2017	0.47		0-47	b2-57	
SE-2b	57	Cc	25.08.2017	0.09		0-9	b2-57	Liner scrumbled up in the rod. Core needed to get hammered out. Top to bottom orientation correct, however side-to-side orientation messed. Core in very small pieces, partly.
SE-2b	58	1	25.08.2017	0.83		0-83	b2-58	Non sterilized water used
SE-2b	58	2	25.08.2017	0.99		0-99	b2-58	
SE-2b	58	3	25.08.2017	0.37		0-37	b2-58	
SE-2b	58	Cc	25.08.2017	0.05		0-5	b2-58	
SE-2b	59	1	25.08.2017	0.92		0-92	b2-59	
SE-2b	59	2	25.08.2017	0.73		0-73	b2-59	
SE-2b	59	3	25.08.2017	1.01	X	33-101	b2-59	
SE-2b	59	Cc	25.08.2017	0.02		0-2	b2-59	
SE-2b	60	1	25.08.2017	0.94		0-94	b2-60	Core run got divided and 2 second tube had to send down to catch the entire core. Sections 1 to 3 were POOH with the original tube, whereas section 4 came was POOH with an extra tube
SE-2b	60	2	25.08.2017	0.91		0-91	b2-60	
SE-2b	60	3	25.08.2017	0.54		0-54	b2-60	
SE-2b	60	4	25.08.2017	0.76		0-76	b2-60	
SE-2b	61	1	25.08.2017	0.96		0-96	b2-61	Core run got divided and 2 second tube had to send down to catch the entire core. Sections 1 to 2 were POOH with
SE-2b	61	2	25.08.2017	0.94		0-94	b2-61	
SE-2b	61	3	25.08.2017	0.72		0-72	b2-61	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
								the original tube, whereas section 3 came was POOH with an extra tube
SE-2b	62	1	25.08.2017	0.92		0-92	b2-62	
SE-2b	62	2	25.08.2017	1.00		0-100	b2-62	
SE-2b	62	3	25.08.2017	1.11	x	30-111	b2-62	
SE-2b	62	4	25.08.2017	0.06		0-6	b2-62	
SE-2b	62	Cc	25.08.2017	0.11		0-11	b2-62	
SE-2b	63	1	25.08.2017	0.20		0-20	b2-63	Short core run to complete rod
SE-2b	63	Cc	25.08.2017	0.08		0-8	b2-63	
SE-2b	64	1	25.08.2017	0.95		0-95	b2-64	
SE-2b	64	2	25.08.2017	1.00		0-100	b2-64	
SE-2b	64	3	25.08.2017	0.96		0-96	b2-64	
SE-2b	64	Cc	25.08.2017	0.15		0-15	b2-64	
SE-2b	65	1	25.08.2017	0.96		0-95	b2-65	
SE-2b	65	2	25.08.2017	0.99	x	30-99	b2-65	
SE-2b	65	3	25.08.2017	0.98		0-98	b2-65	
SE-2b	65	4	25.08.2017	0.17		0-17	b2-65	
SE-2b	65	Cc	25.08.2017	0.11		0-11	b2-65	
SE-2b	66	1	25.08.2017	0.98		0-98	b2-66	Mud and non-sterilized seawater used
SE-2b	67	1	25.08.2017	0.38		0-38	b2-66	
SE-2b	68	-	25.08.2017	0		0	-	No core retrieved

* should be measured again at the core processing on Heimaey

** each core is stored in one single core box, please keep in mind that there might be some inconsistencies in the slots, to fit all core in one box

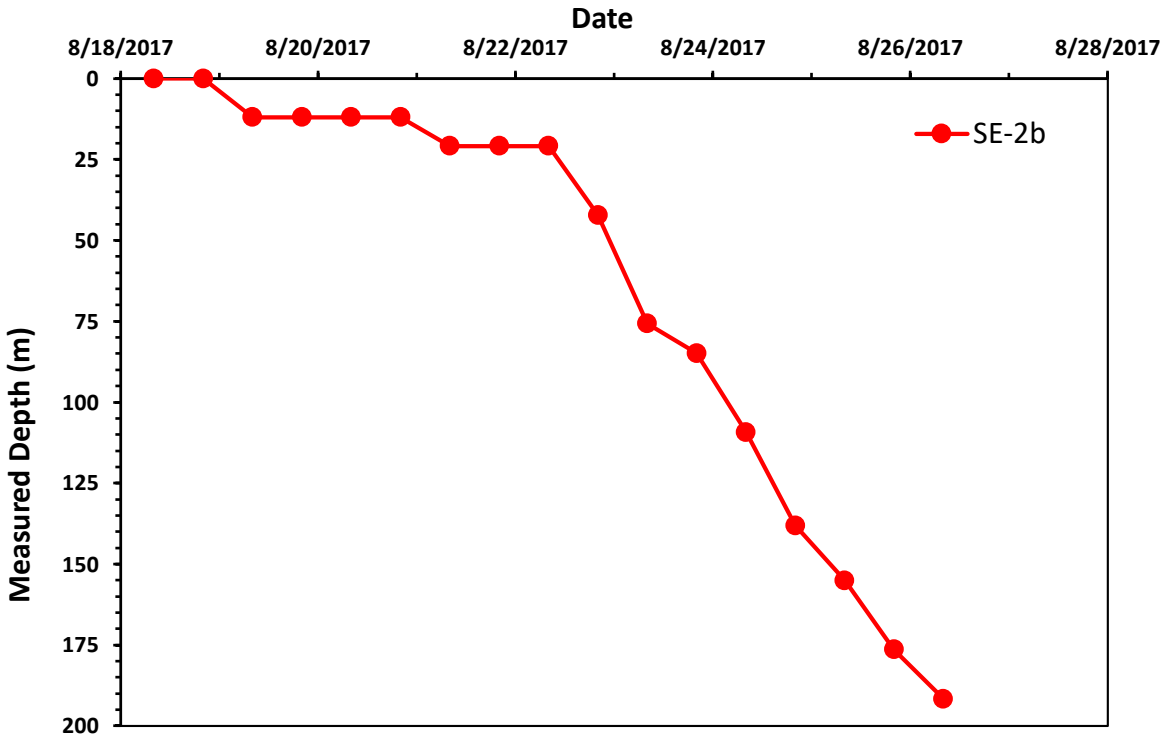

Figure 1. Drilling progress from SE-2b.

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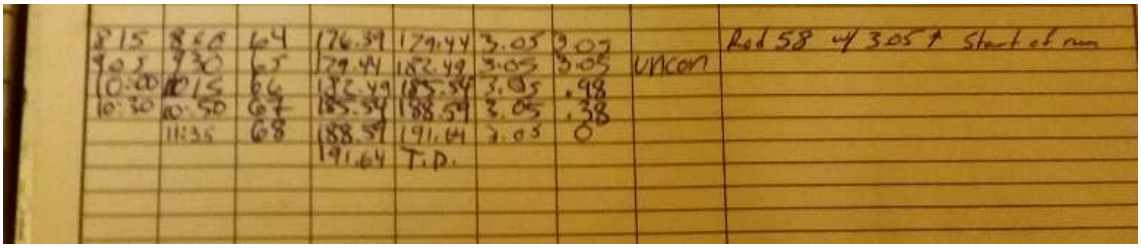

Figure 2. Picture showing the drill log of the final core run in SE-2b (image TBW).

Figure 3. Picture showing the ICDP OSG team (Jochem and Marco) carrying wireline logging in SE-2b (image TBW).

Onsite science team

Initials	Name	Affiliation	Email	Cell phone no	Function
TBW	Tobias B. Weisenberger	ÍSOR	tobias.b.weisenberger@isor.is	+354 661 3406	Geologist
BK	Barbara Kleine	HÍ			Geologist
PB	Pauline Bergsten	MATIS			Microbiologist
AT	Andreas Tuerke	University of Bremen			Geologist

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SUSTAIN

Location	Daily Report #9	? working day
Surtsey	Preliminary data collection	27th of August 2017

Well Name:	**SE-02b**	*Drilling Company:*	**DES**	*Geologist:*	**TBW, AT**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	**BK, PB**
Drill-bit diameter:	**HQ**	*Depth at midnight:*	**191.64 m**	*Hole made last 24 hrs*	**-**
Drilling fluid:	**-**	*Depth at 8 AM:*	**191.64 m**	*Drilling time:*	**- hrs.**
Sterilized fluid:	**-**	*Circulation losses:*	**unclear**	*Average ROP:*	**- m/hr**

Drilling operations

After reaching the TD of 191.64 m the drill string was POOH of about 50 m shortly after midnight on August 26th and the drill crew was waiting for the logging to be started. The ICDP OSG started preparation for logging activity at SE-2b at about 8:30 AM on August 26th, while the drill rig crew POOH the drill string, but leaving 10 drill rods and the BHA inside the borehole in respect to limit the risk of collapse in the upper most section. After consulting with the steering committee the well logging was defined and wireline logging started at noon with a temperature, pressure, natural gamma and mud resistivity log. This was followed by following logs: magnetic susceptibility, inclination, resistivity and spontaneous potential. All this logs were carried out to a maximum depth of 180 m. Subsequently, the drilling steering committee made the decision not to conduct a sonic log nor try to log the temperature below 180 m. Logging was completed at about 8 PM. Subsequently the drill crew was POOH the remaining drill string. At about 10 PM a briefing at the drill site was done between the drill crew and the onsite science team in respect to go through the delicate RIH of the Al casing and aspects to avoid any risk. Running in with the Al casing started at about 11 AM. RIH with the 12 ft pipes went very smoothly and ID number of each pipe was documented.

RIH with the Al casing continued on August 27th. After 16 Al pipes were RIH, it was observed that in contrast to the provided information, the casing pipes are different in length. Based on this observation, the drill crew and the on-site scientist went through all the remaining Al casing pipes in order to make an inventory. Thereby it was realized that the ID number of the casing are systematical linked to the length of each casing pipe. RIH commenced after about 1.5 hours. The last 5 Al casing pipe were RIH with an attached PVC centralizer pipe in order to protect the corrosion of the Al in contact with the steal surface casing. RIH with the Al casing was completed at about 6 AM on August 27th by the installation of the well-head and the casing hanger for the Al casing. Well SE-2b was completed by cementing the top of the casing. After completion of SE-2b rigging down and rigging up again for the new angle well SE-3 was carried out.

Table 1 shows the compilation of all core runs conducted in SE-2b. Table 2 show the compilation of all core runs and division into sections and location of samples taken on Surtsey. Table 3 shows a compilation of samples for microbiological and geochemical studies that collected directly after retrieval of the core to limit contamination of the samples. Table 4 shows the casing tally for the Al casing in SE-2b. Figure 1 shows the drilling progress of SE-2b. Figures 2 to 4 show images of while RIH of the Al casing. Figure 5 shows the well-head of SE-2b. Figure 6 shows the on-site team enjoying a break after successful completion of well SE-2b. Figure 7 shows the rig after orientation for the angled well SE-3.

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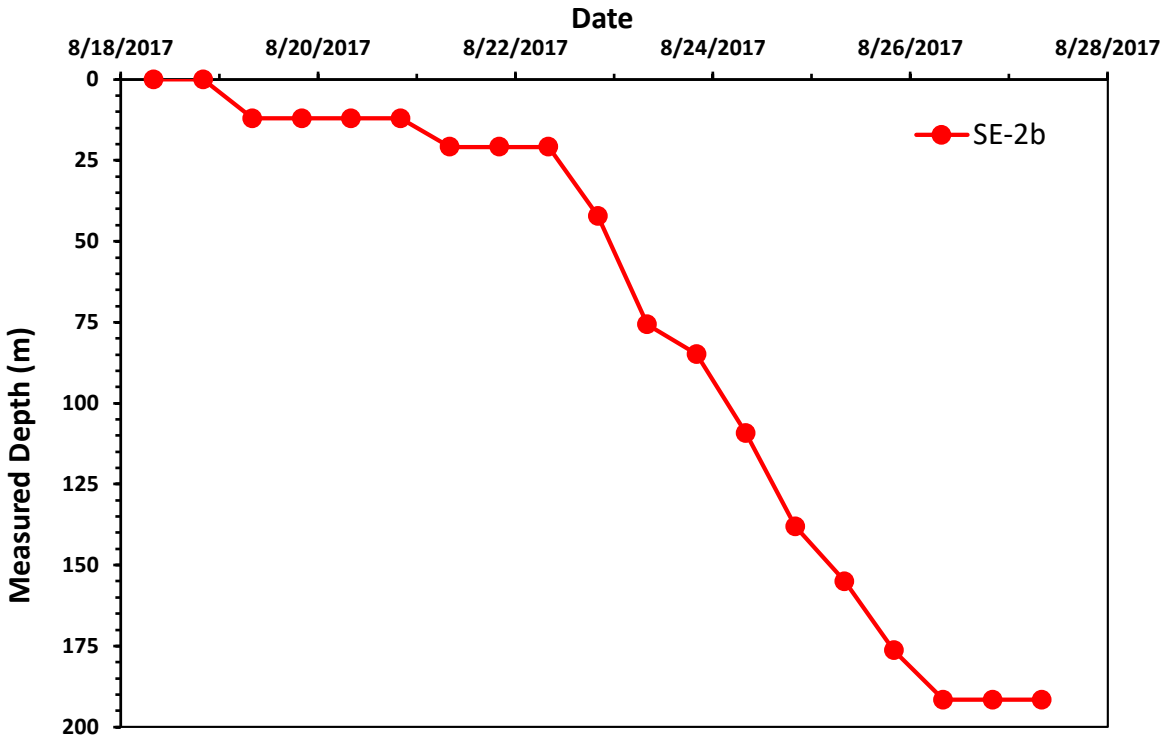

Figure 1. Drilling progress from SE-2b.

Table 1. *Overview of conducted core runs in SE-2b in 2017.*

Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	1	20.08.2017	10:00 - 10:15 PM	12.86	14.74	1.88	1.685	90
SE-2b	2	20.08.2017	10:50 - 11:15 PM	14.74	17.79	3.05	3.01	99
SE-2b	3	21.08.2017	0:20 - 0:55 AM	17.79	20.84	3.05	3.03	99
SE-2b	4	22.08.2017	11:30 AM - 12:15 PM	20.84	23.89	3.05	3.138	103
SE-2b	5	22.08.2017	12:15 - 1:05 PM	23.89	26.94	3.05	3.09	101
SE-2b	6	22.08.2017	1:05 - 2:15 PM	26.94	29.99	3.05	3.09	101
SE-2b	7	22.08.2017	2:15 - 3:15 PM	29.99	31.64	1.65	1.71	104
SE-2b	8	22.08.2017	3:55 - 4:25 PM	31.64	33.04	1.40	1.44	103
SE-2b	9	22.08.2017	4:25 - 5:45 PM	33.04	36.09	3.05	3.07	101
SE-2b	10	22.08.2017	5:45 - 6:10 PM	36.09	37.09	1.00	**	**
SE-2b	11	22.08.2017	6:10 - 6:55 PM	37.09	39.14	2.05	1.78	87

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	12	22.08.2017	6:55 – 7:45 PM	39.14	42.19	3.05	3.20	105
SE-2b	13	22.08.2017	8:30 - 9:06 PM	42.19	45.24	3.05	2.465	81
SE-2b	14	22.08.2017	9:43 – 10:15 PM	45.24	48.29	3.05	2.615	86
SE-2b	15	22.08.2017	10:40 - 11:10 PM	48.29	51.14	2.85	3.15	111
SE-2b	16	22.08.2017	11:20 - 11:54 PM	51.14	54.06	2.92	1.67	57
SE-2b	17	23.08.2017	12:08 - 12:28 AM	54.06	55.68	1.64	2.58	157
SE-2b	18	23.08.2017	1:12 - 1:26 AM	55.68	57.44	1.47	1.14	78
SE-2b	19	23.08.2017	1:42 - 2:14 AM	57.44	59.89	2.45	3.11	127
SE-2b	20	23.08.2017	2:30 - 2:55 AM	59.89	62.54	2.65	2.665	101
SE-2b	21	23.08.2017	3:15 - 3:32 AM	62.54	63.54	1.00	0.80	80
SE-2b	22	23.08.2017	4:10 - 4:48 AM	63.54	66.59	3.05	3.11	102
SE-2b	23	23.08.2017	5:10 - 5:50 AM	66.59	69.64	3.05	2.62	86
SE-2b	24	23.08.2017	6:05 - 6:25 AM	69.64	71.59	1.95	2.105	108
SE-2b	25	23.08.2017	6:36 - 6:55 AM	71.59	72.69	1.10	0.925	84
SE-2b	26	23.08.2017	7:05 - 8:00 AM	72.69	75.74	3.05	3.10	102
SE-2b	27	23.08.2017	8:30 - 9:15 AM	75.74	78.79	3.05	3.03	99
SE-2b	28	23.08.2017	9:15 – 10:15 AM	78.79	81.84	3.05	3.05	100
SE-2b	29	23.08.2017	6:50 – 8:00 PM	81.84	84.89	3.05	3.01	99
SE-2b	30	23.08.2017	8:30 – 8:50 PM	84.89	87.54	2.65	2.77	105
SE-2b	31	23.08.2017	9:25 – 9:40 PM	87.54	89.39	1.85	1.70	92
SE-2b	32	23.08.2017	10:05 – 10:30 PM	89.39	90.99	1.60	1.20	75
SE-2b	33	23.08.2017	11:00 – 11:25 PM	90.99	94.04	3.05	2.95	97
SE-2b	34	24.08.2017	11:45 – 12:10 AM	94.04	97.09	3.05	3.14	103
SE-2b	35	24.08.2017	12:30 – 12:55 AM	97.09	100.14	3.05	2.84	93
SE-2b	36	24.08.2017	1:10 – 1:35 AM	100.14	103.19	3.05	2.86	94
SE-2b	37	24.08.2017	2:30 – 3:00 AM	103.19	106.24	3.05	3.01	99
SE-2b	38	24.08.2017	6:10 – 6:35 AM	106.24	109.29	3.05	3.11	102

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	39	24.08.2017	8:30 – 9:15 AM	109.29	112.34	3.05	3.12	102
SE-2b	40	24.08.2017	9:15 – 10:15 AM	112.34	115.39	3.05	3.03	99
SE-2b	41	24.08.2017	10:15 – 11:20 AM	115.39	118.44	3.05	3.09	101
SE-2b	42	24.08.2017	11:20 – 12:25 PM	118.44	121.49	3.05	3.09	101
SE-2b	43	24.08.2017	12:25 – 1:35 PM	121.49	124.54	3.05	2.95	97
SE-2b	44	24.08.2017	1:35 – 2:45 PM	124.54	127.59	3.05	2.63	86
SE-2b	45	24.08.2017	2:45 – 4:00 PM	127.59	130.64	3.05	3.15	103
SE-2b	46	24.08.2017	4:00 – 5:10 PM	130.64	133.69	3.05	3.065	100
SE-2b	47	24.08.2017	5:10 – 6:20 PM	133.69	136.74	3.05	2.99	98
SE-2b	48	24.08.2017	6:20 – 7:10 PM	136.74	138.09	1.35	?	?
SE-2b	49	25.08.2017	1:45 – 2:00 AM	138.09	139.79	1.70	?	?
SE-2b	50	25.08.2017	2:30 – 2:45 AM	139.79	142.84	3.05	2.99	98
SE-2b	51	25.08.2017	4:10 – 4:25 AM	142.84	145.89	3.05	3.01	99
SE-2b	52	25.08.2017	4:40 – 5:00 AM	145.89	148.94	3.05	3.09	101
SE-2b	*53*	*25.08.2017*	*5:15 – 5:45 AM*	*148.94*	*151.99*	*3.05*	*3.06*	*100*
SE-2b	54	25.08.2017	6:20 – 7:10 AM	151.99	155.04	3.05	2.88	94
SE-2b	55	25.08.2017	8:30 – 10:15 AM	155.04	158.09	3.05	3.08	101
SE-2b	56	25.08.2017	10:15 – 11:25 AM	158.09	161.14	3.05	3.06	100
SE-2b	57	25.08.2017	11:25 – 11:45 AM	161.14	161.84	0.70	0.58	83
SE-2b	58	25.08.2017	11:45 – 12:45 PM	161.84	164.19	2.35	2.28	97
SE-2b	59	25.08.2017	12:45 – 2:05 PM	164.19	167.24	3.05	2.76	90
SE-2b	60	25.08.2017	2:05 – 3:40 PM	167.24	170.29	3.05	3.11	102
SE-2b	61	25.08.2017	3:40 – 5:25 PM	170.29	173.34	3.05	2.66	87
SE-2b	62	25.08.2017	5:25 – 6:45 PM	173.34	176.14	2.80	3.18	114
SE-2b	63	25.08.2017	6:45 – 7:10 PM	176.14	176.39	0.25	0.28	112
SE-2b	64	25.08.2017	8:15 – 5:50 PM	176.39	179.44	3.05	3.08	101
SE-2b	65	25.08.2017	9:05 – 9:30 PM	179.44	182.49	3.05	3.14	103

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-2b	66	25.08.2017	10:00 – 10:15 PM	182.49	185.54	3.05	0.98	32
SE-2b	67	25.08.2017	10:30 – 10:50 PM	185.54	188.59	3.05	0.38	12
SE-2b	68	25.08.2017	11:20 – 11:35 PM	188.59	191.64	3.05	-	0

* based on geologist documentation, should be measured again at the core processing on Heimaey

** could not be measured

Core description (based on field book notes. Verification during VCD is needed)

Core 1: consolidated tuff

Core 2: top is consolidated tuff (becomes likely basalt?)

Core 3: consolidated tuff

Core 4: moderate consolidated tuff, fractured

Core 5: poorly consolidated tuff, fractured

Core 6: poorly consolidated tuff, fractured

Core 7: consolidated tuff, fractured

Core 8: consolidated tuff, fractured

Core 9: consolidated tuff, partly fractured

Core 10: well consolidated tuff, fractured

Core 11: basalt, fractured

Core 12: basalt, a few fractures, steaming, liners were deformed (melted)

Core 13: basalt

Core 14: basalt

Core 15: consolidated tuff with fragments of basalt

Core 16: consolidated tuff

Core 17: consolidated tuff

Core 18: consolidated tuff and basalt

Core 19: basalt with partially filled vesicles with something white

Core 20: Basalt, the whole core run is very fractured

Core 21: Basalt, fractured

Core 22: Basalt

Core 23: Basalt

Core 24: Basalt

Core 25: Basalt

Core 26: Basalt

Core 27: Basalt, a few fractures, steaming

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Core 28: Basalt, fractured, steaming

Core 29: Basalt, barely fractured, zeolites, steaming

Core 30: Basalt

Core 31: Basalt. Core catcher was filled with clay.

Core 32: ?

Core 33: Basalt

Core 34: Basalt

Core 35: Basalt

Core 36: ?

Core 37: Basalt

Core 38: Basalt

Core 39: Basalt

Core 40: Basalt, steaming

Core 41: Basalt, steaming, fractured

Core 42: Basalt, steaming, fractured

Core 43: basalt, steaming

Core 44: Basalt, steaming, fractured

Core 45: Basalt, steaming, fractured

Core 46: Basalt, steaming, zeolites, no fractures

Core 47: basalts, fractured, steaming

Core 48: Basalt

Core 49: Basalt

Core 50: Basalt (looked more granulated with some larger phenocrysts of plagioclase=

Core 51: Pretty fragile basalt

Core 52: Granular and fragile in the top, stronger and more consolidated to the bottom

Core 53: ?

Core 54: ?

Core 55: Tuff

Core 56: Tuff, fractured

Core 57: Tuff

Core 58: Tuff, well consolidated, heavily fractured

Core 59: Tuff, very well consolidated, fractured

Core 60: Tuff, fractured, well consolidated

Core 61: Tuff, well consolidated, heavily fracture

Core 62: Tuff, well consolidated, fractured

Core 63: Tuff

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Core 64: Tuff, consolidated

Core 65: Tuff, significant change at about 181 m from consolidated to unconsolidated tuff (section 3 & 4). Observation are concordant to the drilling change observed by the driller

Core 66: Tuff, unconsolidated, low core recovery

Core 67: Fine-grained dark formation (seafloor sediment?)

Core 68: no core recovered

Table 2. *Overview of conducted core runs in SE-2b in 2017. Red marked entries are updated/corrected from the previously published daily report.*

Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	1	1	20.08.2017	0.99		0-99	b2-1	No cement plug drilled. Only some plastic pieces were found on top of the core
SE-2b	1	2	20.08.2017	0.57		0-57	b2-1	
SE-2b	1	CC	20.08.2017	0.155		0-15.5	b2-1	
SE-2b	2	1	20.08.2017	0.98		0-98	b2-2	
SE-2b	2	2	20.08.2017	0.98		0-98	b2-2	
SE-2b	2	3	20.08.2017	0.955		0-95.5	b2-2	
SE-2b	2	4	20.08.2017	0.165		0-16.5	b2-2	
SE-2b	2	CC	20.08.2017	0.17		0-17	b2-2	
SE-2b	3	1	21.08.2017	0.91		0-91	b2-3	Problems during drilling. Missing liner in the core barrel caused damage on the core. Drilling crew had to pump the core out of the core barrel.
SE-2b	3	2	21.08.2017	0.55		0-55	b2-3	
SE-2b	3	3	21.08.2017	0.335		0-33.5	b2-3	
SE-2b	3	4	21.08.2017	0.875		0.875	b2-3	
SE-2b	3	CC	21.08.2017	0.36		0-36	b2-3	
SE-2b	4	1	22.08.2017	0.48		0-48	b2-4	
SE-2b	4	2	22.08.2017	0.54		0-54	b2-4	
SE-2b	4	3	22.08.2017	0.845		0-845	b2-4	
SE-2b	4	4	22.08.2017	1.00	x	20-100	b2-4	
SE-2b	4	5	22.08.2017	0.19		0-19	b2-4	
SE-2b	4	Cc	22.08.2017	0.138		0-138	b2-4	
SE-2b	5	1	22.08.2017	0.99		0-99	b2-5	
SE-2b	5	2	22.08.2017	0.975		0-97.5	b2-5	
SE-2b	5	3	22.08.2017	0.98		0-98	b2-5	
SE-2b	5	4	22.08.2017	0.16		0-16	b2-5	
SE-2b	5	Cc	22.08.2017	0.13		0-13	b2-5	
SE-2b	6	1	22.08.2017	0.93		0-93	b2-6	
SE-2b	6	2	22.08.2017	0.84		0-84	b2-6	
SE-2b	6	3	22.08.2017	0.78		0-78	b2-6	
SE-2b	6	Cc	22.08.2017	0.47		0-47	b2-6	
SE-2b	7	1	22.08.2017	0.94		0-94	b2-7	
SE-2b	7	2	22.08.2017	0.63		0-63	b2-7	
SE-2b	7	Cc	22.08.2017	0.11		0-11	b2-7	
SE-2b	8	1	22.08.2017	0.52		0-52	b2-8	
SE-2b	8	2	22.08.2017	0.65		0-65	b2-8	
SE-2b	8	Cc	22.08.2017	0.23		0-23	b2-8	
SE-2b	9	1	22.08.2017	0.965		0-96.5	b2-9	
SE-2b	9	2	22.08.2017	0.875		0-87.5	b2-9	
SE-2b	9	3	22.08.2017	1.06	x	21-106	b2-9	
SE-2b	9	Cc	22.08.2017	0.20		0-20	b2-9	
SE-2b	10	1	22.08.2017	0.73		0-73	b2-10	Core liner scrambled up in rod. Section 3 is not orientated (small pieces)
SE-2b	10	2	22.08.2017	0.08		0-8	b2-10	
SE-2b	10	3	22.08.2017	0.23		0-23	b2-10	
SE-2b	10	Cc	22.08.2017	0.17		0-17	b2-10	
SE-2b	11	1	22.08.2017	0.82		0-82	b2-11	
SE-2b	11	2	22.08.2017	0.90		0-90	b2-11	
SE-2b	11	Cc	22.08.2017	0.06		0-6	b2-11	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	12	1	22.08.2017	0.93		0-93	b2-12	Liner deformed (melted)
SE-2b	12	2	22.08.2017	0.98		0-98	b2-12	
SE-2b	12	3	22.08.2017	0.34		0-34	b2-12	
SE-2b	12	4	22.08.2017	0.73		0-73	b2-12	
SE-2b	12	Cc	22.08.2017	0.23		0-23	b2-12	
SE-2b	13	1	22.08.2017	0.855		0-85.5	b2-13	
SE-2b	13	2	22.08.2017	0.69		0-69	b2-13	Slipped core run
SE-2b	13	3	22.08.2017	0.92	x	19-92	b2-13	
SE-2b	14	1	22.08.2017	0.99		0-99	b2-14	
SE-2b	14	2	22.08.2017	0.925		0-92.5	b2-14	
SE-2b	14	3	22.08.2017	0.715		0-71.5	b2-14	
SE-2b	14	Cc	22.08.2017	0.11		0.11	b2-14	
SE-2b	15	1	22.08.2017	0.99		0-99	b2-15	
SE-2b	15	2	22.08.2017	0.98		0-98	b2-15	
SE-2b	15	3	22.08.2017	0.985		0-98.5	b2-15	
SE-2b	15	Cc	22.08.2017	0.28		0.28	b2-15	
SE-2b	16	1	22.08.2017	0.995		0-99.5	b2-16	
SE-2b	16	2	22.08.2017	0.71		0-71	b2-16	
SE-2b	17	1	23.08.2017	0.98		0-98	b2-17	
SE-2b	17	2	23.08.2017	0.98		0-98	b2-17	
SE-2b	17	3	23.08.2017	0.56	x	20-56	b2-17	
SE-2b	18	1	23.08.2017	0.315		0-31.5	b2-18	
SE-2b	18	2	23.08.2017	0.12		0-12	b2-18	
SE-2b	18	3	23.08.2017	0.725		0-72.5	b2-18	
SE-2b	19	1	23.08.2017	0.985		0-98.5	b2-19	
SE-2b	19	2	23.08.2017	0.92		0-92	b2-19	
SE-2b	19	3	23.08.2017	0.84		0-84	b2-19	
SE-2b	19	4	23.08.2017	0.33		0-33	b2-19	
SE-2b	19	Cc	23.08.2017	0.07		0-7	b2-19	In pieces
SE-2b	20	1	23.08.2017	0.98		0-98	b2-20	
SE-2b	20	2	23.08.2017	0.96		0-96	b2-20	
SE-2b	20	3	23.08.2017	0.735		0-73.5	b2-20	
SE-2b	21	1	23.08.2017	0.80		0-80	b2-21	
SE-2b	22	1	23.08.2017	1.00		0-100	b2-22	
SE-2b	22	1	23.08.2017	0.95		0-95	b2-22	
SE-2b	22	1	23.08.2017	1.04	x	20-104	b2-22	
SE-2b	22	1	23.08.2017	0.16		0-16	b2-22	
SE-2b	23	1	23.08.2017	0.91		0-91	b2-23	
SE-2b	23	1	23.08.2017	0.96		0-96	b2-23	
SE-2b	23	1	23.08.2017	0.77		0-77	b2-23	
SE-2b	24	1	23.08.2017	0.915		0-91.5	b2-24	
SE-2b	24	1	23.08.2017	0.98		0-98	b2-24	
SE-2b	24	1	23.08.2017	?		?	b2-24	fell off, pieces, not orientated
SE-2b	25	1	23.08.2017	0.925		0-92.5	b2-25	
SE-2b	26	1	23.08.2017	0.725		0-72.5	b2-26	
SE-2b	26	1	23.08.2017	0.965		0-96.5	b2-26	
SE-2b	26	1	23.08.2017	0.925		0-92.5	b2-26	
SE-2b	26	1	23.08.2017	0.46		0-46	b2-26	
SE-2b	26	1	23.08.2017	0.06		0-6	b2-26	
SE-2b	27	1	23.08.2017	0.75		0-75	b2-27	
SE-2b	27	2	23.08.2017	0.98		0-98	b2-27	
SE-2b	27	3	23.08.2017	0.94	x	20-94	b2-27	
SE-2b	27	4	23.08.2017	0.30		0-30	b2-27	
SE-2b	27	Cc	23.08.2017	0.07		0-7	b2-27	
SE-2b	28	1	23.08.2017	0.02		0-2	b2-28	2 cm was packed in a plastic bag as is
				0.97		2-99		broke off from the top of the section
SE-2b	28	2	23.08.2017	0.97		0-97	b2-28	
SE-2b	28	3	23.08.2017	0.99		0-99	b2-28	
SE-2b	28	4	23.08.2017	0.11		0-11	b2-28	
SE-2b	29	1	23.08.2017	0.92		0-92	b2-29	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	29	2	23.08.2017	0.98		0-98	b2-29	
SE-2b	29	3	23.08.2017	0.59		0-59	b2-29	
SE-2b	29	4	23.08.2017	0.50		0-50	b2-29	
SE-2b	30	1	23.08.2017	0.78		0-78	b2-30	
SE-2b	30	2	23.08.2017	0.675		0-67.5	b2-30	
SE-2b	30	3	23.08.2017	0.44		0-44	b2-30	
SE-2b	30	3	23.08.2017	0.91		0-91	b2-30	
SE-2b	31	1	23.08.2017	0.95		0-95	b2-31	Liner melted. Core got damaged during removal out of the core barrel.
SE-2b	31	2	23.08.2017	0.185		0-18.5	b2-31	
SE-2b	31	3	23.08.2017	0.68		0-68	b2-31	Only pieces, not orientated
SE-2b	31	Cc	23.08.2017	?		?	b2-31	Only pieces
SE-2b	32	1	23.08.2017	0.75		0-75	b2-32	
SE-2b	32	2	23.08.2017	0.41?		0-41?	b2-32	In a liner of 41 cm, not orientated
SE-2b	32	Cc	23.08.2017	?			b2-32	
SE-2b	33	1	23.08.2017	0.99		0-99	b2-33	
SE-2b	33	2	23.08.2017	0.91		0-91	b2-33	
SE-2b	33	3	23.08.2017	1.10	x	23-110	b2-33	
SE-2b	34	1	24.08.2017	0.995		0-99.5	b2-35	
SE-2b	34	2	24.08.2017	0.98		0-98	b2-35	
SE-2b	34	3	24.08.2017	0.94		0-94	b2-35	
SE-2b	34	4	24.08.2017	0.15		0-15	b2-35	
SE-2b	34	Cc	24.08.2017	0.10		0-10	b2-35	
SE-2b	35	1	24.08.2017	0.63		0-63	b2-35	
SE-2b	35	2	24.08.2017	0.39		0-39	b2-35	
SE-2b	35	3	24.08.2017	0.98		0-98	b2-35	
SE-2b	35	4	24.08.2017	0.915		0-91.5	b2-35	
SE-2b	36	1	24.08.2017	0.94		0-94	b2-36	
SE-2b	36	2	24.08.2017	0.86		0-86	b2-36	
SE-2b	36	3	24.08.2017	1.09	x	23-109	b2-36	
SE-2b	36	Cc	24.08.2017	0.29		0-29	b2-36	
SE-2b	37	1	24.08.2017	0.98		0-98	b2-37	
SE-2b	37	2	24.08.2017	0.98		0-98	b2-37	
SE-2b	37	3	24.08.2017	0.97		0-97	b2-37	
SE-2b	37	4	24.08.2017	0.08		0-8	b2-37	
SE-2b	38	1	24.08.2017	0.85		0-85	b2-38	
SE-2b	38	2	24.08.2017	0.98		0-98	b2-38	
SE-2b	38	3	24.08.2017	0.86		0-86	b2-38	
SE-2b	38	4	24.08.2017	0.40		0-40	b2-38	
SE-2b	39	1	24.08.2017	0.98		0-98	b2-39	
SE-2b	39	2	24.08.2017	0.98		0-98	b2-39	
SE-2b	39	3	24.08.2017	0.85	x	20-85	b2-39	
SE-2b	39	4	24.08.2017	0.33		0-33	b2-39	
SE-2b	40	1	24.08.2017	0.98		0-98	b2-40	
SE-2b	40	2	24.08.2017	0.97		0-97	b2-40	
SE-2b	40	3	24.08.2017	0.25		0-25	b2-40	
SE-2b	40	4	24.08.2017	0.75		0-75	b2-40	
SE-2b	40	Cc	24.08.2017	0.08		0-8	b2-40	
SE-2b	41	1	24.08.2017	0.93		0-93	b2-41	
SE-2b	41	2	24.08.2017	0.86		0-86	b2-41	
SE-2b	41	3	24.08.2017	0.69		0-69	b2-41	
SE-2b	41	4	24.08.2017	0.54		0-54	b2-41	
SE-2b	41	Cc	24.08.2017	0.08		0-08	b2-41	
SE-2b	42	1	24.08.2017	1.00		0-100	b2-42	
SE-2b	42	2	24.08.2017	0.98		0-98	b2-42	
SE-2b	42	3	24.08.2017	1.05	x	21-105	b2-42	
SE-2b	42	Cc	24.08.2017	0.05		0-5	b2-42	
SE-2b	43	1	24.08.2017	0.995		0-99.5	b2-43	Mud was used
SE-2b	43	2	24.08.2017	0.99		0-99	b2-43	
SE-2b	43	3	24.08.2017	0.97		0-97	b2-43	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	44	1	24.08.2017	0.84		0-84	b2-44	
SE-2b	44	2	24.08.2017	0.73		0-73	b2-44	Needed to be shoot out of the rod as it was stuck
SE-2b	44	3	24.08.2017	0.94		0-94	b2-44	
SE-2b	44	4	24.08.2017	0.12		0-12	b2-44	
SE-2b	45	1	24.08.2017	1.00	x	0-81	b2-45	Needed to be shoot out of the rod as it was stuck. Samples were taken from section 1 as this part was still in the original liner
SE-2b	45	2	24.08.2017	0.22		0-22	b2-45	
SE-2b	45	3	24.08.2017	0.98		0-98	b2-45	
SE-2b	45	4	24.08.2017	0.95		0-95	b2-45	
SE-2b	46	1	24.08.2017	0.98		0-98	b2-46	
SE-2b	46	2	24.08.2017	0.97		0-97	b2-46	
SE-2b	46	3	24.08.2017	0.94		0-94	b2-46	
SE-2b	46	4	24.08.2017	0.16		0-16	b2-46	
SE-2b	46	Cc	24.08.2017	0.045		0-4.5	b2-46	
SE-2b	47	1	24.08.2017	0.81		0-81	b2-47	
SE-2b	47	2	24.08.2017	0.81		0-81	b2-47	Liner melted in rod
SE-2b	47	3	24.08.2017	0.73		0-73	b2-47	
SE-2b	47	4	24.08.2017	0.63		0-63	b2-47	
SE-2b	48	1	24.08.2017	0.85		0-85	b2-48	Mud was used
SE-2b	48	2	24.08.2017	0.51		0-51	b2-48	In pieces, not orientated
SE-2b	48	3	24.08.2017	0.21		0-21	b2-48	
SE-2b	49	1	24.08.2017	0.09		0-9	b2-49	
SE-2b	49	2	24.08.2017	0.05		0-5	b2-49	fragments
SE-2b	49	3	25.08.2017	0.97		0-97	b2-49	
SE-2b	49	4	25.08.2017	0-68	x	29-68	b2-49	
SE-2b	50	1	25.08.2017	0.96		0-96	b2-50	Drilled with mud
SE-2b	50	2	25.08.2017	0.93		0-93	b2-50	
SE-2b	50	3	25.08.2017	0.55		0-55	b2-50	
SE-2b	50	4	25.08.2017	0.59		0-59	b2-50	
SE-2b	51	1	25.08.2017	0.97		0-97	b2-51	
SE-2b	51	2	25.08.2017	0.88		0-88	b2-51	
SE-2b	51	3	25.08.2017	0.55		0-55	b2-51	
SE-2b	51	4	25.08.2017	0.65		0-64	b2-51	
SE-2b	51	Cc	25.08.2017	0.11		0-11	b2-51	
SE-2b	52	1	25.08.2017	0.97		0-97	b2-52	
SE-2b	52	2	25.08.2017	0.98		0-98	b2-52	
SE-2b	52	3	25.08.2017	0.89	x	30-89	b2-52	
SE-2b	52	Cc	25.08.2017	0.36		0-36	b2-52	
SE-2b	53	1	25.08.2017	0.99		0-99	b2-53	
SE-2b	53	2	25.08.2017	0.61		0-61	b2-53	
SE-2b	53	3	25.08.2017	0.62		0-62	b2-53	
SE-2b	53	4	25.08.2017	0.875		0-875	b2-53	
SE-2b	54	1	25.08.2017	0.47		0-47	b2-54	
SE-2b	54	2	25.08.2017	0.81		0-81	b2-54	
SE-2b	54	3	25.08.2017	0.85		0-85	b2-54	
SE-2b	54	4	25.08.2017	0.88		0-88	b2-54	
SE-2b	55	1	25.08.2017	0.98		0-98	b2-55	
SE-2b	55	2	25.08.2017	0.985		0-98.5	b2-55	
SE-2b	55	3	25.08.2017	1.02	x	30-102	b2-55	
SE-2b	55	Cc	25.08.2017	0.08		0-8	b2-55	
SE-2b	56	1	25.08.2017	0.92		0-92	b2-56	
SE-2b	56	2	25.08.2017	0.94		0-94	b2-56	
SE-2b	56	3	25.08.2017	0.97		0-97	b2-56	
SE-2b	56	4	25.08.2017	0.20		0-20	b2-56	
SE-2b	56	Cc	25.08.2017	0.03		0-3	b2-56	
SE-2b	57	1	25.08.2017	0.47		0-47	b2-57	Liner scrumbled up in the rod. Core needed to get hammered out. Top to bottom orientation correct, however side-to-side orientation messed. Core in very small pieces, partly.
SE-2b	57	Cc	25.08.2017	0.09		0-9	b2-57	
SE-2b	58	1	25.08.2017	0.83		0-83	b2-58	Non sterilized water used

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Core box (no)**	Comment
SE-2b	58	2	25.08.2017	0.99		0-99	b2-58	
SE-2b	58	3	25.08.2017	0.37		0-37	b2-58	
SE-2b	58	Cc	25.08.2017	0.05		0-5	b2-58	
SE-2b	59	1	25.08.2017	0.92		0-92	b2-59	
SE-2b	59	2	25.08.2017	0.73		0-73	b2-59	
SE-2b	59	3	25.08.2017	1.01	X	33-101	b2-59	
SE-2b	59	Cc	25.08.2017	0.02		0-2	b2-59	
SE-2b	60	1	25.08.2017	0.94		0-94	b2-60	Core run got divided and 2 second tube had to send down to catch the entire core. Sections 1 to 3 were POOH with the original tube, whereas section 4 came was POOH with an extra tube
SE-2b	60	2	25.08.2017	0.91		0-91	b2-60	
SE-2b	60	3	25.08.2017	0.54		0-54	b2-60	
SE-2b	60	4	25.08.2017	0.76		0-76	b2-60	
SE-2b	61	1	25.08.2017	0.96		0-96	b2-61	Core run got divided and 2 second tube had to send down to catch the entire core. Sections 1 to 2 were POOH with the original tube, whereas section 3 came was POOH with an extra tube
SE-2b	61	2	25.08.2017	0.94		0-94	b2-61	
SE-2b	61	3	25.08.2017	0.72		0-72	b2-61	
SE-2b	62	1	25.08.2017	0.92		0-92	b2-62	
SE-2b	62	2	25.08.2017	1.00		0-100	b2-62	
SE-2b	62	3	25.08.2017	1.11	x	30-111	b2-62	
SE-2b	62	4	25.08.2017	0.06		0-6	b2-62	
SE-2b	62	Cc	25.08.2017	0.11		0-11	b2-62	
SE-2b	63	1	25.08.2017	0.20		0-20	b2-63	Short core run to complete rod
SE-2b	63	Cc	25.08.2017	0.08		0-8	b2-63	
SE-2b	64	1	25.08.2017	0.95		0-95	b2-64	
SE-2b	64	2	25.08.2017	1.00		0-100	b2-64	
SE-2b	64	3	25.08.2017	0.96		0-96	b2-64	
SE-2b	64	Cc	25.08.2017	0.15		0-15	b2-64	
SE-2b	65	1	25.08.2017	0.96		0-95	b2-65	
SE-2b	65	2	25.08.2017	0.99	x	30-99	b2-65	
SE-2b	65	3	25.08.2017	0.98		0-98	b2-65	
SE-2b	65	4	25.08.2017	0.17		0-17	b2-65	
SE-2b	65	Cc	25.08.2017	0.11		0-11	b2-65	
SE-2b	66	1	25.08.2017	0.98		0-98	b2-66	Mud and non-sterilized seawater used
SE-2b	67	1	25.08.2017	0.38		0-38	b2-66	
SE-2b	68	-	25.08.2017	0		0	-	No core retrieved

* should be measured again at the core processing on Heimaey

** each core is stored in one single core box, please keep in mind that there might be some inconsistencies in the slots, to fit all core in one box

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Table 3. *Compilation of samples from SE-2b for microbiological and geochemical studies that collected directly after retrieval of the core to limit contamination of the samples. List compiled by PB and BK.*

Core run no. (Drillers record this on the DES Shift Report)	*Date*	*Depth (m)*		*Sample labeled (B-#Z- #,#-#, ...)*	*Sample purpose**	*Storing conditions*	*Rock Type /Comments*	**Others comments/ Observations**
		From	*To*					
4	*8/22/2017*	*20.84*	*23.89*	*1C-4Z-4, 0-10, MA*	*MA*	*-196°C*		moderate consolidated, fractured tuff
9	*8/22/2017*	*33.04*	*36.09*	*1C-9Z-3, 0-11, MA*	*MA*	*-196°C*	*??*	consolidated, partly fractured tuff
13	*8/22/2017*	*42.19*	*45.24*	*1C-13Z-3, 0-9, MA*	*MA*	*-196°C*		basalt well consolidated but fragmented
17	*8/23/2017*	*54.06*	*55.68*	*1C-17Z-3, 0-10, MA*	*MA*	*-196°C*		basalt well consolidated but fragmented
22	*8/23/2017*	*63.54*	*66.49*	*1C-22Z-3, 0-10, MA*	*MA*	*-196°C*		basalt well consolidated but fragmented
27	*8/23/2017*	*74.74*	*78.79*	*1C-27Z-3, 0-10, MA*	*MA*	*-196°C*		basalt well consolidated
33	*8/24/2017*	*90.99*	*94.04*	*1C-33Z-3, 0-13, MA*	*MA*	*-196°C*		
	8/24/2017			*1C-33Z-3, 13-23, PW*	*PW*	*4°C*		
36	*8/24/2017*	*100.14*	*103.19*	*1C-36Z-3, 0-10, MA*	*MA*	*-196°C*	*??*	
	8/24/2017			*1C-36Z-3, 10-23, PW*	*PW*	*4°C*		
39	*8/24/2017*	*109.29*	*112.34*	*1C-39Z-3, 0-10, PW*	*PW*	*4°C*		
	8/24/2017			*1C-39Z-3, 10-20, MA*	*MA*	*-196°C*		
42	*8/24/2017*	*118.44*	*121.49*	*1C-42Z-3, 1-10, PW*	*PW*	*4°C*		
	8/24/2017			*1C-42Z-3, 10-21, MA*	*MA*	*-196°C*		
45	*8/24/2017*	*127.49*	*130.64*	*1C-45Z-1, 81-91, MA*	*MA*	*-196°C*		
	8/24/2017			*1C-45Z-1, 91-100, PW*	*PW*	*4°C*		
49 (50)	*8/25/2017*	*138.09*	*139.29*	*1C-49Z-4, 0-2, M*	*M*	*4°C*	*Basalt, core smoked. Surlfur smell ???*	
	8/25/2017			*1C-49Z-4, 2-9, Cu*	*Cu*	*4°C*	*4h incubation*	
	8/25/2017			*1C-49Z-4, 9-19, MA*	*MA*	*-196°C*		
	8/25/2017			*1C-49Z-4, 19-29, PW*	*PW*	*4°C*		
52 (53)	*8/25/2017*	*145.89*	*148.94*	*1C-52Z-3, 0-9, Cu*	*Cu*	*4°C*		
	8/25/2017			*1C-52Z-3, 9-10, M*	*M*	*4°C*		4h
	8/25/2017			*1C-52Z-3, 10-20, MA*	*MA*	*-196°C*		

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Core run no. (Drillers record this on the DES Shift Report)	*Date*	*Depth (m)*		*Sample labeled (B-#Z- #,#-#, ...)*	*Sample purpose**	*Storing conditions*	*Rock Type /Comments*	**Others comments/ Observations**
		From	*To*					
	8/25/2017			*1C-52Z-3, 20-30, PW*	*PW*	4°C		
55	8/25/2017	155.04	158.09	1C-55Z-3, 0-10, PW	PW	4°C		
	8/25/2017			1C-55Z-3, 10-20, MA	MA	-196°C	TUFF	
	8/25/2017			1C-55Z-3, 20-22, M	M	4°C		4h
	8/25/2017			1C-52Z-3, 22-30, Cu	Cu	4°C		
59	8/25/2017	164.19	167.24	1C-59Z-3, 0-13, PW	PW	4°C		
	8/25/2017			1C-59Z-3, 13-15, M	M	4°C	TUFF	4h
	8/25/2017			1C-59Z-3, 15-22, Cu	Cu	4°C		
	8/25/2017			1C-59Z-3, 22-33, MA	MA	-196°C	surtsey	
62	8/25/2017	173.34	176.14	1C-62Z-3, 0-11, PW	PW	4°C		
	8/25/2017			1C-62Z-3, 11-19, Cu	Cu	4°C	TUFF	
	8/25/2017			1C-62Z-3, 19-28, MA	MA	-196°C	surtsey	
	8/25/2017			1C-62Z-3, 28-30, M	M	4°C		4h
65	8/25/2017	179.44	182.49	1C-65Z-2, 0-9, MA	MA	-196°C	Mix Tuff and sediments	
	8/25/2017			1C-65Z-2, 9-14, Cu	Cu	4°C	surtsey	
	8/25/2017			1C-65Z-2, 14-17, M	M	4°C		4h
	8/25/2017			1C-65Z-2, 17-30, PW	PW	4°C		

Abbreviations: pore water: PW, molecular analyses: MA, cultivation: Cu, microscopy: M, Controls: C

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Table 3. *Preliminary casing tally for the Al casing in SE-2b. Entries in red font color are uncertain and should be double checked. Joint offset is based on 2 measurements during installation.*

Number of installation	Number from top to bottom	ID (WO: 3272310 xxx)	Pipe type	Length (m)	Per-forated	Top depth (m)	Bottom depth (m)	Joint offset (m)
50	1	002	normal	3.60		0.00	3.60	
49	2	005	normal	3.60		3.62	7.22	0.015
48	3	016	normal	3.60		7.23	10.83	0.015
47	4	038	normal	3.60		10.85	14.45	0.015
46	5	022	normal	3.60		14.46	18.06	0.015
45	6	001	normal	3.60		18.08	21.68	0.015
44	7	031	normal	3.60		21.69	25.29	0.015
43	8	003	normal	3.60		25.31	28.91	0.015
42	9	013	normal	3.60		28.92	32.52	0.015
41	10	014	normal	3.60		32.54	36.14	0.015
40	11	049 JT8 PC1	long	3.75	x	36.15	39.90	0.015
39	12	036	normal	3.60		39.92	43.52	0.015
38	13	034	normal	3.60		43.53	47.13	0.015
37	14	017	normal	3.60		47.15	50.75	0.015
36	15	007	normal	3.60		50.76	54.36	0.015
35	16	037	normal	3.60		54.38	57.98	0.015
34	17	055 JT5 PC2	short	3.45		57.99	61.44	0.015
33	18	046 JT6 PC1	long	3.75	x	61.46	65.21	0.015
32	19	052 JT2 PC2	short	3.45		65.22	68.67	0.015
31	20	020	normal	3.60		68.69	72.29	0.015
30	21	028	normal	3.60		72.30	75.90	0.015
29	22	018	normal	3.60		75.92	79.52	0.015
28	23	032	normal	3.60		79.53	83.13	0.015
27	24	042 JT2 PC1	long	3.75		83.15	86.90	0.015
26	25	002 JT7 PC2	short	3.45		86.91	90.36	0.015
25	26	021	normal	3.60		90.38	93.98	0.015
24	27	024	normal	3.60		93.99	97.59	0.015
23	28	008	normal	3.60		97.61	101.21	0.015
22	29	027	normal	3.60		101.22	104.82	0.015
21	30	047	long	3.75	x	104.84	108.59	0.015
20	31	??? JT3 PC2	short	3.45		108.60	112.05	0.015
19	32	044	long	3.75		112.07	115.82	0.015
18	33	010 JT2	short	3.45		115.83	119.28	0.015
17	34	012	normal	3.60		119.30	122.90	0.015
16	35	026	unclear	3.60		122.91	126.51	0.015
15	36	015	unclear	3.60		126.53	130.13	0.015
14	37	025	unclear	3.60		130.14	133.74	0.015
13	38	050	unclear	3.75	x	133.76	137.51	0.015
12	39	010	unclear	3.60		137.52	141.12	0.015
11	40	010	unclear	3.60		141.14	144.74	0.015
10	41	009	unclear	3.60		144.75	148.35	0.015
9	42	025	unclear	3.60		148.37	151.97	0.015
8	43	033	unclear	3.60		151.98	155.58	0.015
7	44	011	unclear	3.60		155.60	159.20	0.015
6	45	048	unclear	3.75	x	159.21	162.96	0.015
5	46	030	unclear	3.60		162.98	166.58	0.015
4	47	020	unclear	3.60		166.59	170.19	0.015
3	48	006	unclear	3.60		170.21	173.81	0.015
2	49	004	unclear	3.60		173.82	177.42	0.015
1	50	035	unclear	3.60		177.44	181.04	0.015
Casing shoe	Casing shoe			?		181.05	181.05 + ?	0.015

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Figure 2. Drilling crew while RIH with the Al casing SE-2b (image TBW).

Figure 3. Picture showing slotted Al casing for SE-2b (image TBW).

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Figure 4. Picture showing the different length of the pipe for the Al casing for SE-2b (image TBW).

Figure 5. Well-head of SE-2b (image TBW).

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Figure 6. Surtsey on-site team enjoying a break after completion of SE-2b (image TBW).

Figure 7. Rig orientated for drilling the angled well SE-3 (image TBW).

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PB	Pauline Bergsten	MATIS			Microbiologist
AT	Andreas Tuerke	University of Bremen			Geologist

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SUSTAIN

Location	Daily Report #10	? working day
Surtsey	Preliminary data collection	28th of August 2017

Well Name:	**SE-03**	*Drilling Company:*	**DES**	*Geologist:*	**TBW**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	
Drill-bit diameter:	**PQ**	*Depth at midnight:*	**0 m**	*Hole made last 24 hrs*	**10**
Drilling fluid:	**mud**	*Depth at 8 AM:*	**12.6 m**	*Drilling time:*	**2.9 hrs.**
Sterilized fluid:	**no**	*Circulation losses:*	**TLC**	*Average ROP:*	**- m/hr**

Drilling operations

RIH with the Al casing continued on August 27th. After 16 Al pipes were RIH, it was observed that in contrast to the provided information, the casing pipes are different in length. Based on this observation, the drill crew and the on-site scientist went through all the remaining Al casing pipes in order to make an inventory. Thereby it was realized that the ID number of the casing are systematical linked to the length of each casing pipe. RIH commenced after about 1.5 hours. The last 5 Al casing pipe were RIH with an attached PVC centralizer pipe in order to protect the corrosion of the Al in contact with the steal surface casing. RIH with the Al casing was completed at about 6 AM on August 27th by the installation of the well-head and the casing hanger for the Al casing. Well SE-2b was completed by cementing the top of the casing. The top well-head is at similar height as the depth reference during drilling. After completion of SE-2b rigging down and rigging up again for the new angle well SE-3 was carried out with an inclination of 35° (difference from vertical). Rigging up continued for the rest of the day.

Rigging up continued on August 28th and SE-3 was spudded at 2:30 AM by drilling a pilot hole for the surface casing using a PQ tricon rotary drill bit. As shift change the well was drilled 10 m and after another short drilling period the pilot hole was completed at about 11 AM to a TVD of 12.6 m. Subsequently the drill string was POOH and running in with the surface casing was completed at about 12:30 PM and currently the surface casing is cemented which will be followed by 24 hours WOC.

Figure 1 shows the drilling progress of SE-3. Figure 2 shows the rig aligned for drilling the angle well SE-3. Figure 3 shows the tricone drill bit used for the pilot hole. Figure 4 shows a happy geologist after completion of SE-2b in a lava cave on Surtsey.

Drilling operations

A helicopter transport is scheduled for this afternoon. The helicopter transport will also be used to exchange the on-site science team and transport core to Heimaey as well as for transport of other logistic items needed on Surtsey.

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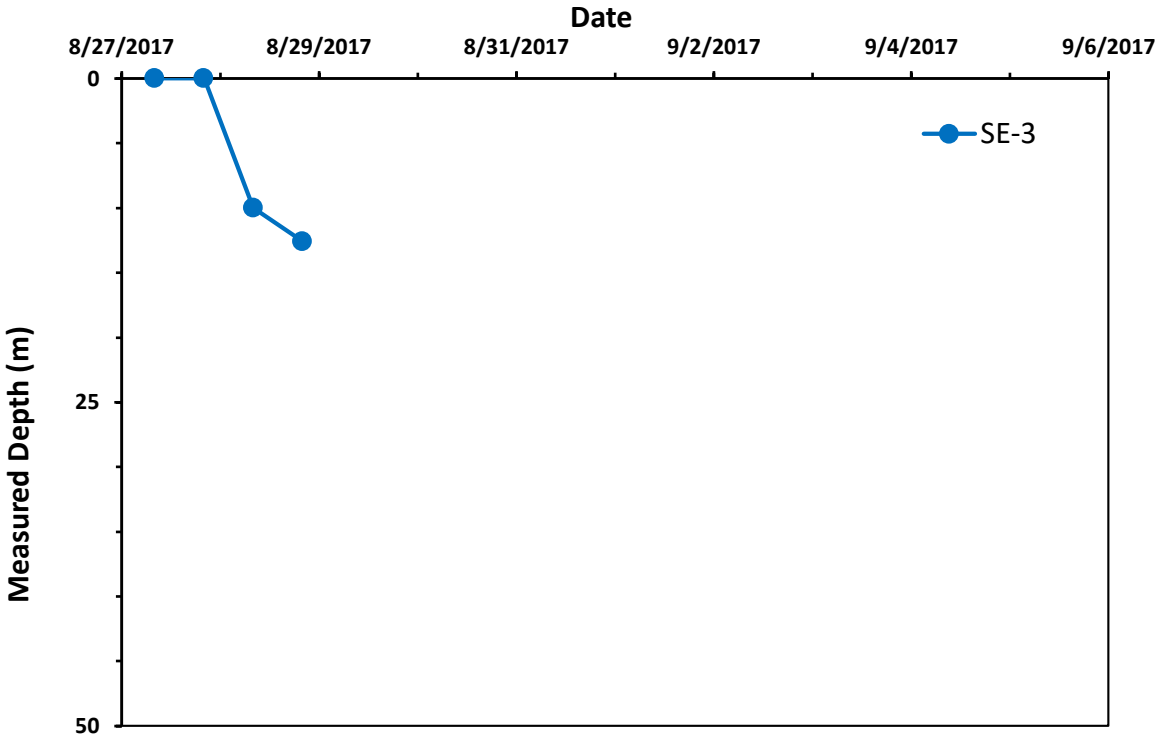

Figure 1. Drilling progress from SE-3.

Figure 2. Picture showing the rig orientated along the drilling direction (left picture) and the angled mast (right picture) (image TBW).

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Figure 3. Tricone rotary drill bit used for drilling the pilot hole for SE-3 (image TBW).

Figure 4. Happy geologist after completion of SE-2b (image Jochem Kueck).

Onsite science team

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AT	Andreas Tuerke	University of Bremen			Geologist

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SUSTAIN

Location	Daily Report #11	? working day
Surtsey	Preliminary data collection	29th of August 2017

Well Name:	**SE-03**	*Drilling Company:*	**DES**	*Geologist:*	**MTG**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	**SP**
Drill-bit diameter:	**PQ**	*Depth at midnight:*	**12.6 m**	*Hole made last 24 hrs*	**0**
Drilling fluid:	**-**	*Depth at 8 AM:*	**12.6 m**	*Drilling time:*	**0**
Sterilized fluid:	**-**	*Circulation losses:*	**-**	*Average ROP:*	**- m/hr**

Drilling operations

WOC since early afternoon yesterday 28th of August, when 12 m of PQ casing was inserted. A change in shift took place yesterday with the Nordurflug Dauphin bringing in MTG, ÁG, CG and SP while TBW, BK, AT and PB left for Heimaey or Reykjavík. Coring is expected to start in late afternoon using HQ. The hole has an angle of 35° from the vertical, with an azimuth approximately 6° south of west (264°).

All water reservoirs are full and pumps are operational. The on-site team is looking into ways of increasing the efficiency of the peninsula reservoir. The tidal range has been decreasing over the last few days and will stay within 1 m until 3rd of September, compared to e.g. tidal range of 3 m four days ago. This is favorable for water pumping over the next few days as it reduces the hard work of moving pumps around and cleaning them of sea weed at very low tide. Sveinbjörn Steinþórsson and Einar Sindri Ólafsson operate the water line.

Onsite science team

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Figure 1. The Surtsey camp, the Pálsbær hut and the drillsite on the eastern shoulder of Surtur I crater (image MTG).

Figure 2. Barbara, Pauline and Tobias leaving Surtsey on August 28th. Andreas had already left with a flight to Heimaey (image MTG).

Figure 3. ICDP loggers Marco Groh and Jochem Kueck leaving Surtsey after successful logging of SE-02b (image MTG).

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SUSTAIN

Location	Daily Report #12	? working day
Surtsey	Preliminary data collection	30th of August 2017

Well Name:	**SE-03**	*Drilling Company:*	**DES**	*Geologist:*	**MTG**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	**SP**
Drill-bit diameter:	**HQ**	*Depth at midnight:*	**26.3 m**	*Hole made last 24 hrs*	**62.3 m**
Drilling fluid:	**Water and mud**	*Depth at 8 AM:*	**56.8 m**	*Drilling time:*	**20 hr**
Sterilized fluid:	**None**	*Circulation losses:*	**TLC**	*Average ROP:*	**3.1 m/hr**

Drilling operations

Coring began just after 20:00 on August 29th. At the shift change at 08:00 (Aug. 30th) 16 core runs had been completed. The hole has an angle of 35° from the vertical, directed 6° south of west. At first coring was done using only water, but mud was used from core run 8 onwards. No fluid sterilization is used for this hole. No delays due to water problems occurred. Pumping from the peninsula stopped at 1 AM. The waterline crew vent to the peninsula and found that a generator had stopped, resulting in no power to pumps. This was quickly fixed and no delay at drill site was experienced. The TD at shift change was 56.8 m, corresponding to TVD of 46.6 m.

The day shift continued drilling without incident until 12, when the drill got stuck. It was freed soon but the drill string was pulled up as the core barrel could not be retrieved through the string. Coring continued after 16:00. A total of 7 core runs were retrieved during the day shift, with a TD of 75.5 m and TVD of 61.9 m at 20:00.

The material drilled is principally consolidated lapilli tuff to coarse to medium tuff. The section between 65 and 75 m is A substantial section (~10 m thickness) is crystalline basalt (provincially expected to be porous shallow intrusions) at 65-75 m TLC. A core run compilation will be given in a subsequent drilling report.

Sampling

Geochemical samples were collected at approximately 9 m intervals, as 10 cm segments of core. These are stored at 4°C in a cooler at the camp.

Personnel

Today Robert Aschew arrived with the rescue boat Þór. He will work on water line maintenance and help out with core as needed. With his arrival two people are always available for shift work on core.

Onsite science team

Initials	Name	Affiliation	Email	Cell phone no	Function
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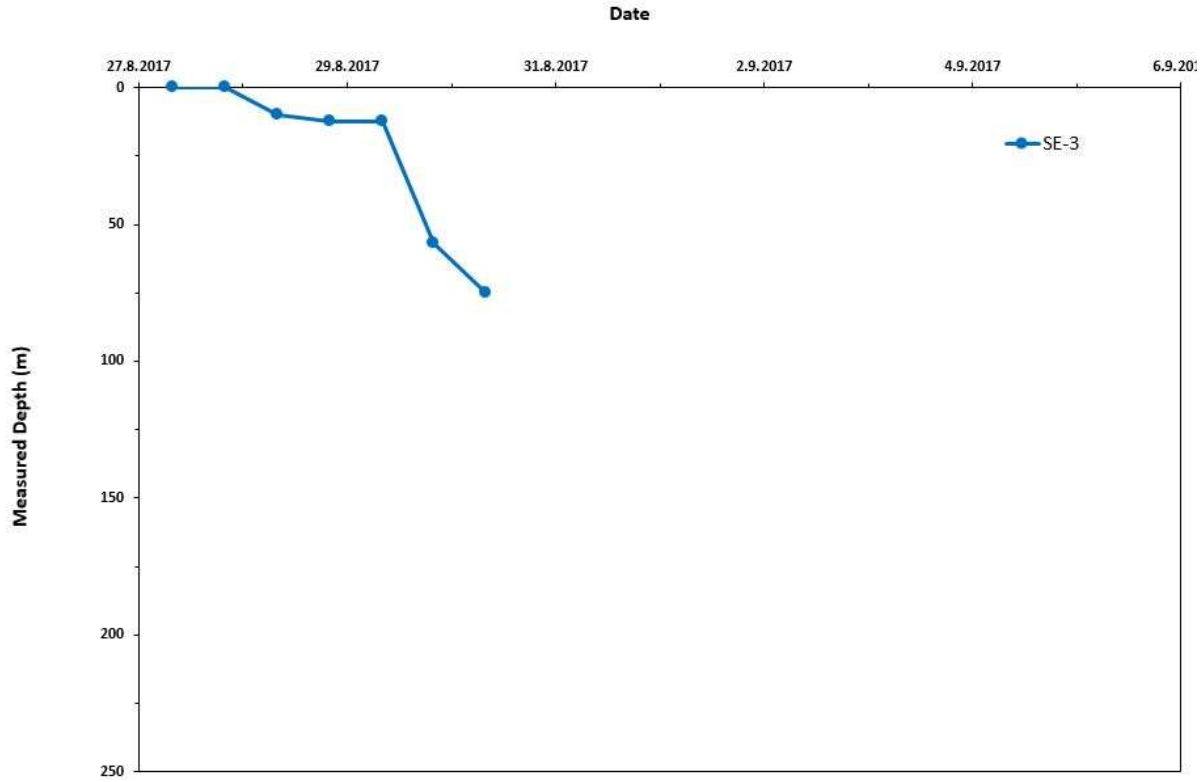

Figure 1. Drilling rate of SE-03.

Figure 2. Drill rig with tilted mast (image MTG).

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Figure 3. Ágúst Guðmundsson working in the core processing shed (image MTG).

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SUSTAIN

Location	Daily Report #13	? working day
Surtsey	Preliminary data collection	31th of August 2017

Well Name:	**SE-03**	*Drilling Company:*	**DES**	*Geologist:*	**MTG**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	**SP**
Drill-bit diameter:	**HQ**	*Depth at midnight:*	**90.4 m**	*Hole made last 24 hrs*	**76.25 m**
Drilling fluid:	**Water and mud**	*Depth at 8 AM:*	**117.84 m**	*Drilling time:*	**24 hr**
Sterilized fluid:	**None**	*Circulation losses:*	**TLC**	*Average ROP:*	**3.2 m/hr**

Drilling operations

A total of 24 core runs were made over the 24 hours from 20:00 on August 30th to 20:00 tonight. Drilling was continued without incident over the whole period. Pumping of water from the peninsula stopped a few times but resumed quickly as the waterline team restarted generators so no delays occurred. For some runs drilling was done using water only while other were done with mud. The TD at shift change was 151.4 m, corresponding to TVD of 124.1 m.

The material drilled is principally dark lithified lapilli tuff, course to medium to fine.

Sampling

Geochemical samples were collected at approximately 9 m intervals, as 10 cm segments of core. These are stored at 4°C in a cooler at the camp. A biological sample was taken during the day shift, from core run 44 (TD 139 m).

Onsite science team

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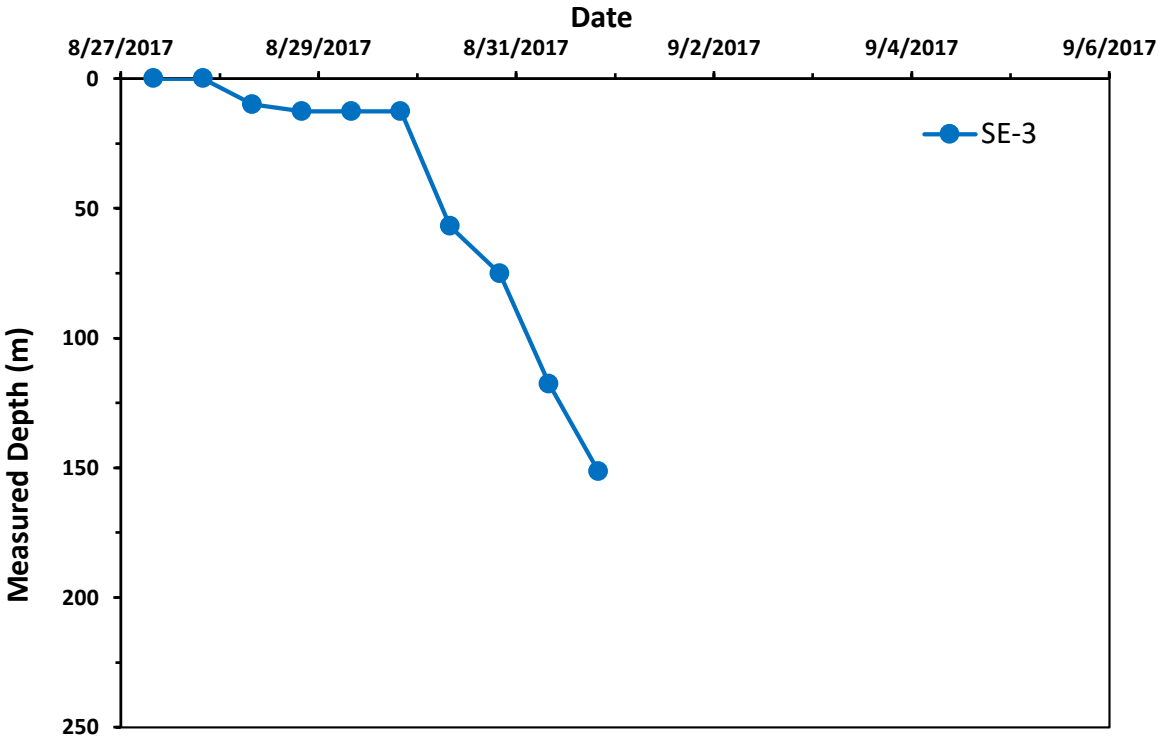

Figure 1. Drilling rate of SE-03 – latest update at 20:00 on 31 August.

Figure 2. Night shift: Einar Sindri and Carolyn Gorny (image MTG).

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SUSTAIN

Location	Daily Report #14	? working day
Surtsey	Preliminary data collection	1th of September 2017

Well Name:	**SE-03**	*Drilling Company:*	**DES**	*Geologist:*	**MTG**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	**SP**
Drill-bit diameter:	**HQ**	*Depth at midnight:*	**166.64 m**	*Hole made last 24 hrs*	**62.5 m**
Drilling fluid:	**Water and mud**	*Depth at 8 AM:*	**194.19 m**	*Drilling time:*	**17.5 hr**
Sterilized fluid:	**None**	*Circulation losses:*	**TLC**	*Average ROP:*	**3.6 m/hr**

Drilling operations

A total of 21 core runs were made over the 17.5 hours from 20:00 on August 31th to 13:30 today. At 13:30 TD was 213.9 m and TVD 175 m. Drilling had progressed at a steady rate and without incident until the drillers ran out of HQ rods after core run 69 (about 140 m of rods were lost when SE-02a collapsed). Preparations were made to continue by POOH to replace HQ with an NQ string. Coring was expected to resume shortly after midnight.

The formation drilled is similar throughout, principally dark lithified lapilli tuff, course to medium to fine. Alteration minerals considered to be gypsum were observed in the lowermost cores. Temperatures in fresh cuts in cores have been recorded using a KiRay 200 infrared thermometer. Temperatures recorded have ranged from 20-25°C at 120 m depth to 40-45°C at 160-200 m depth. The relevance of these temperature measurements is unclear but it is noted that no cooling has occurred below 100 m vertical depth as is seen in SE-01.

Sampling

Geochemical samples were collected at approximately 9 m intervals, as 10 cm segments of core. These are stored at 4°C in a cooler at the camp. Biological sampling has taken place at every 4th core run.

Onsite science team

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RA	Robert Aschew	HÍ	raa22@hi.is	+354-862-0946	Geologist/water
SP	Simon Prause	ÍSOR	Simon.Prause@isor.is	+354 841-9685	Geochemist

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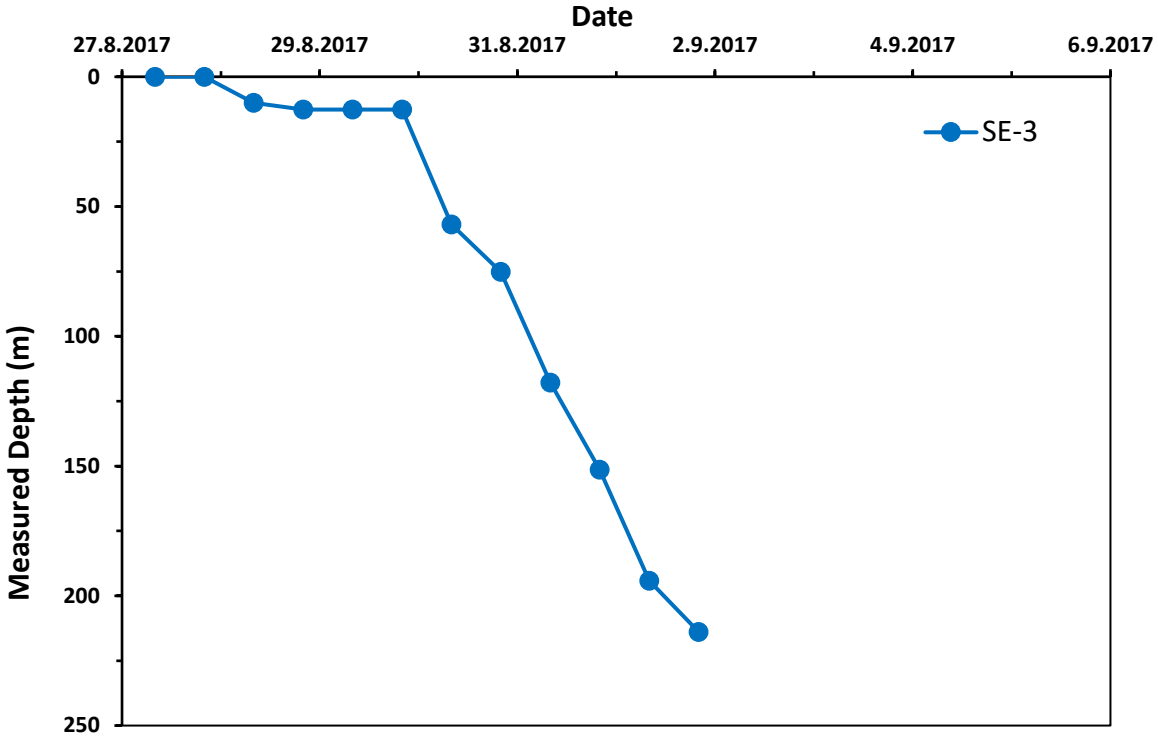

Figure 1. Drilling rate of SE-03 – latest update at 20:00 on 1 September.

Figure 2. Alteration minerals in the core close to 200 m depth (image MTG).

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SUSTAIN

Location	Daily Report #15	? working day
Surtsey	Preliminary data collection	2th of September 2017

Well Name:	**SE-03**	*Drilling Company:*	**DES**	*Geologist:*	**MTG**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	**SP**
Drill-bit diameter:	**NQ**	*Depth at midnight:*	**213.89 m**	*Hole made last 24 hrs*	**22.36 m**
Drilling fluid:	**Water and mud**	*Depth at 8 AM:*	**214.10 m**	*Drilling time:*	**6.5 hr**
Sterilized fluid:	**None**	*Circulation losses:*	**TLC**	*Average ROP:*	**3.4 m/hr**

Drilling operations

A total of 9 core runs were made over the 6.5 hours of drilling time between 20:00 on Sept 1th to 20:00 today. At 20:00 TD was 236.3 m and TVD 194 m. The change to NQ was completed at the end of day shift on 1st of September. Rust inside the NQ pipes caused problems by clogging up water flow resulting in POOH of the NQ to retrieve the core barrel. Near end of the night shift these problems had been resolved using mud to flush hole, and drilling could commence. 8 core runs were made during day shift.

The formation drilled is principally dark lithified lapilli tuff, course to medium to fine. Recorded core temperatures (using KiRay 200) ranged from 25-40°C).

Sampling

Geochemical samples were collected at approximately 9 m intervals, as 10 cm segments of core. These are stored at 4°C in a cooler at the camp. Biological sampling has taken place at every 3rd core run.

Onsite science team

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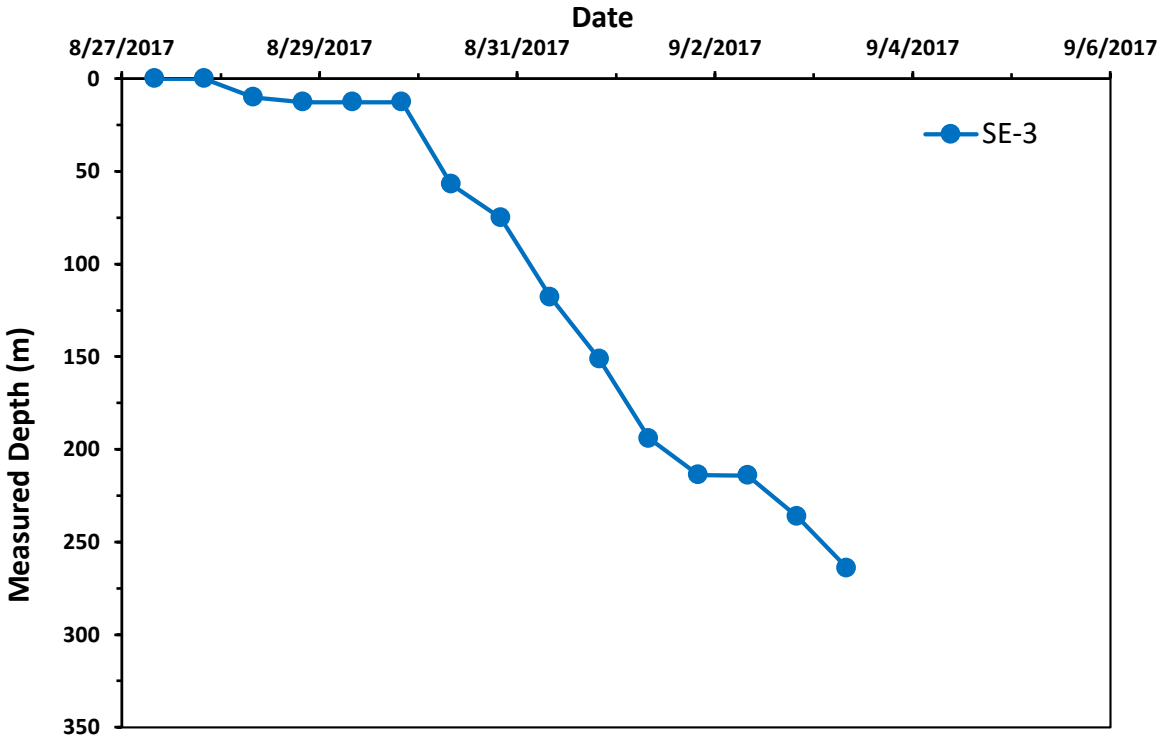

Figure 1. Drilling rate of SE-03 – latest update at 08:00 on 3 September.

Figure 2. The Pálsbær hut, our base, in the fog on the evening of 2nd of September. (photo MTG).

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SUSTAIN

Location	Daily Report #16	? working day
Surtsey	Preliminary data collection	3th of September 2017

Well Name:	SE-03	*Drilling Company:*	DES	*Geologist:*	MTG
Well-Id:	unknown	*Drill-Rig:*	CS1000	*Microbiologist/Geochemist:*	SP
Drill-bit diameter:	NQ	*Depth at midnight:*	242.71 m	*Hole made last 24 hrs*	76.66 m
Drilling fluid:	Water and mud	*Depth at 8 AM:*	264.11 m	*Drilling time:*	24 hr
Sterilized fluid:	None	*Circulation losses:*	TLC	*Average ROP:*	3.2 m/hr

Drilling operations

A total of 27 core runs were made as the drilling progressed without interruption for 24 hours between 20:00 on Sept 2th to 20:00 today. At 20:00 TD was 312.9 m and TVD 256 m. This is 60-70 m below the level of the old sea floor before the eruption in 1963-67.

The formation drilled down to about 190-195 m TVD is lapilli tuff. A small intrusion was encountered in core run 80 (TD 195 m). Below the intrusion a layer of lapilli tuff was found, underlain by 7.5 cm of grayish clay. Below this layer lapilli tuff was observed. The remaining core runs have been lapilli tuffs. The clay layer may indicate that a section of pre-eruption sea bed was briefly encountered, and that since midnight we have been drilling into the central conduit of Surtur 1.

Recorded core temperatures (using KiRay 200) have given similar values throughout the day, 20-30°C.

Today the strong team spirit at Surtsey was very much in display, with everybody excited about reaching the central conduit of the volcano. It is therefore decided to continue drilling until Monday morning. The camp is running out of petrol and may only be able to maintain pumps for waterline operating until tomorrow morning. Rigging down will start tomorrow.

Sampling

Geochemical samples were collected at approximately 9 m intervals, as 10 cm segments of core. These are stored at 4°C in a cooler at the camp. Biological sampling has taken place at every 3rd core run.

Temperature measurements in SE-01

A string of temperature sensors was placed in the 1979 hole on 19th of August. The string was retrieved today. A capsule with a Hobo sensor at the bottom of the hole did not come up with the string. The clamps used to fasten it at the bottom of the string had disappeared with the sensor. At first glance little or no effect from the drilling of SE-02b or SE-03 can be seen in the temperature data; the temperatures remain about the same throughout the period of drilling.

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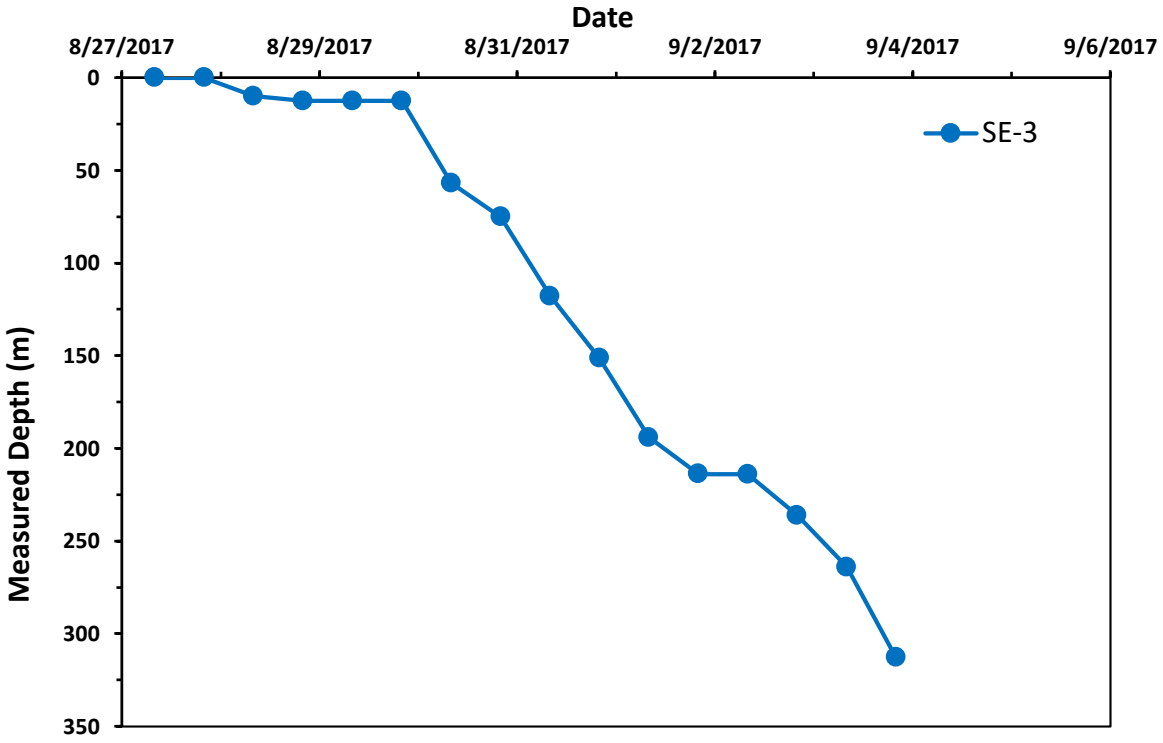

Figure 1. Drilling rate of SE-03 – latest update at 20:00 on 3 September.

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Figure 2. Carolyn Gorny observing a core fragment in the shed by the drill rig. (photo MTG).

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SUSTAIN

Location	Daily Report #17	? working day
Surtsey	Preliminary data collection	4th of September 2017

Well Name:	SE-03	*Drilling Company:*	DES	*Geologist:*	MTG
Well-Id:	unknown	*Drill-Rig:*	CS1000	*Microbiologist/Geochemist:*	SP
Drill-bit diameter:	NQ	*Depth at midnight:*	328.15 m	*Hole made last 24 hrs*	41.14 m
Drilling fluid:	Water and mud	*Depth at 8 AM:*	350.50 m	*Drilling time:*	14.5 hr
Sterilized fluid:	None	*Circulation losses:*	TLC	*Average ROP:*	2.84 m/hr

Drilling operations

Drilling of the inclined hole SE-03, with an angle of 35° from vertical, was completed today at 10:30. A total of 123 core runs were made since start of coring, reaching a total depth of 354 m, corresponding to a TVD of 290 m.

In the 14.5 hours between 20:00 last night to 10:30 today a total of 18 core runs were made. Core recovery was close to 100% when drilling through lapilli tuff. At TD 343 m the drill entered crystalline basalt. Core recovery was variable in the basalt, 40-90%. At TD 352-353 m the lithology changed again, with greenish lapilli tuff appearing again, identical to that found before entering the intrusion. This intrusion, approximately 5-7 m wide, is located about 300 m depth, directly below the center of Surtur I, the crater where effusive activity occurred between 19 August 1966 and 5 June 1967. This intrusion is therefore considered to be the feeder dyke of the 1966-1967 effusive eruption.

The NQ rods are left in the hole as casing. This will allow future monitoring of temperature and water chemistry. The HQ rods left in the hole down to 214 m after NQ drilling started could not be retrieved. They will therefore have to be left in the hole which therefore has a double casing in the upper 214 m. This should not affect future use of the hole for temperature logging.

Sampling

Geochemical samples were collected at approximately 9 m intervals, as 10 cm segments of core. These are stored at 4°C in a cooler at the camp. Biological sampling has taken place at every 3rd core run.

Work ahead in Surtsey

In the coming days demobilization work will take place, involving taking down the drill rig, removing water line, water totes, remaining mud, drill rods and other materials. The camp will also be taken down. On Sunday 10th of September the Coast Guard ship Þór will arrive and the Coast Guard Super Puma helicopter will arrive and lift drill rig and everything else onto the ship in something like 50 loads. A small group will then remain for 1-2 days for further cleanup operation at drill site.

At the completion of the drilling operation everybody in Surtsey is very satisfied and have done their utmost to reach this goal. The DES drilling team deserve the highest praise for their dedication, enthusiasm and drive in bringing the drilling operation to such a grand finish. The effort put in by the waterline workers and the science team has been exemplary. The hard work of the Heimaey team, that has by now analyzed and scanned the core from SE-02, should also be noted here. Same applies to the people at the Institute of Earth Sciences, University of Iceland, who have worked hard at

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servicing the Surtsey team throughout the drilling operation. The good work of Norðurflug helicopters and the Rescue Group of Vestmannaeyjar in transporting people and goods also deserves mention here.

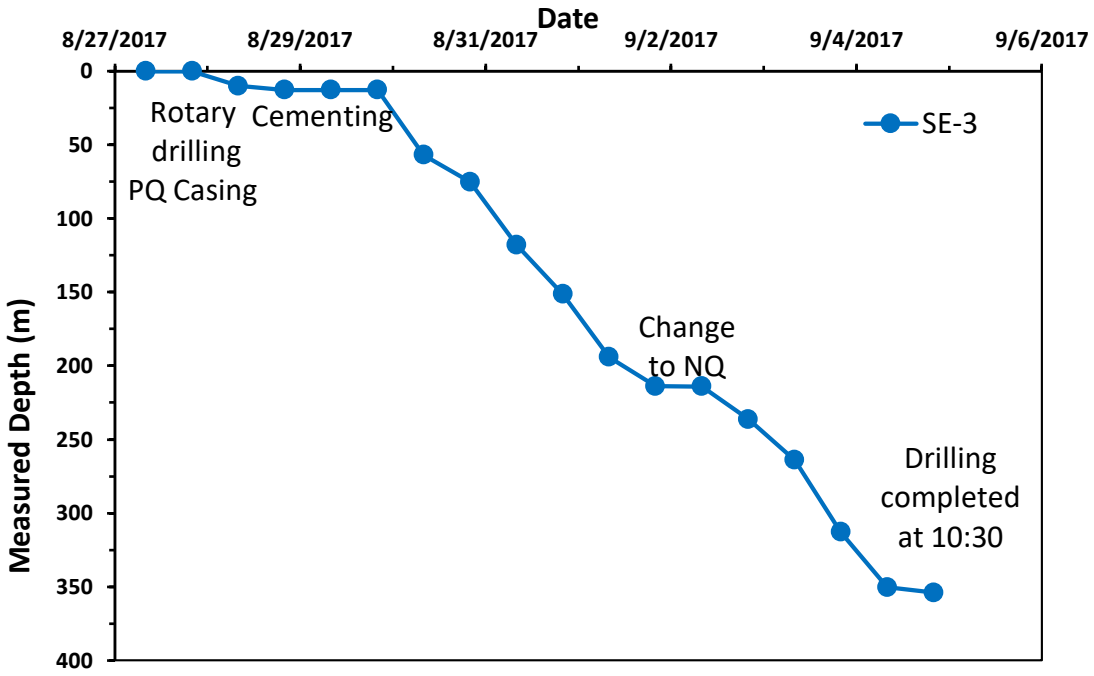

Figure 1. Drilling rate of SE-03. Coring started in the evening of the 29th of August, reaching 354 m TD in the morning of the 4th of September. An average drilling rate of about 60 m/day.

Figure 2. The supply of water was the greatest challenge in the early part of the project. This problem was finally brought under control by having two designated water men operating an array of pumps. The inset shows Einar Sindri on beach fastening pumps to large bolders. (photos Sveinbjörn Steinþórsson).

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Figure 3. The DES drilling crew with some of the last core segments retrieved from SE-03 at the end of a remarkable series of shifts. From left to right: Steve Cole, Justin Blouin, Anthony Vecchiarelli, Beau Marshall and Matthew Lyon (photo: MTG).

Figure 4. Surtsey ran out of core boxes and temporary storage had to be quickly arranged (photo MTG).

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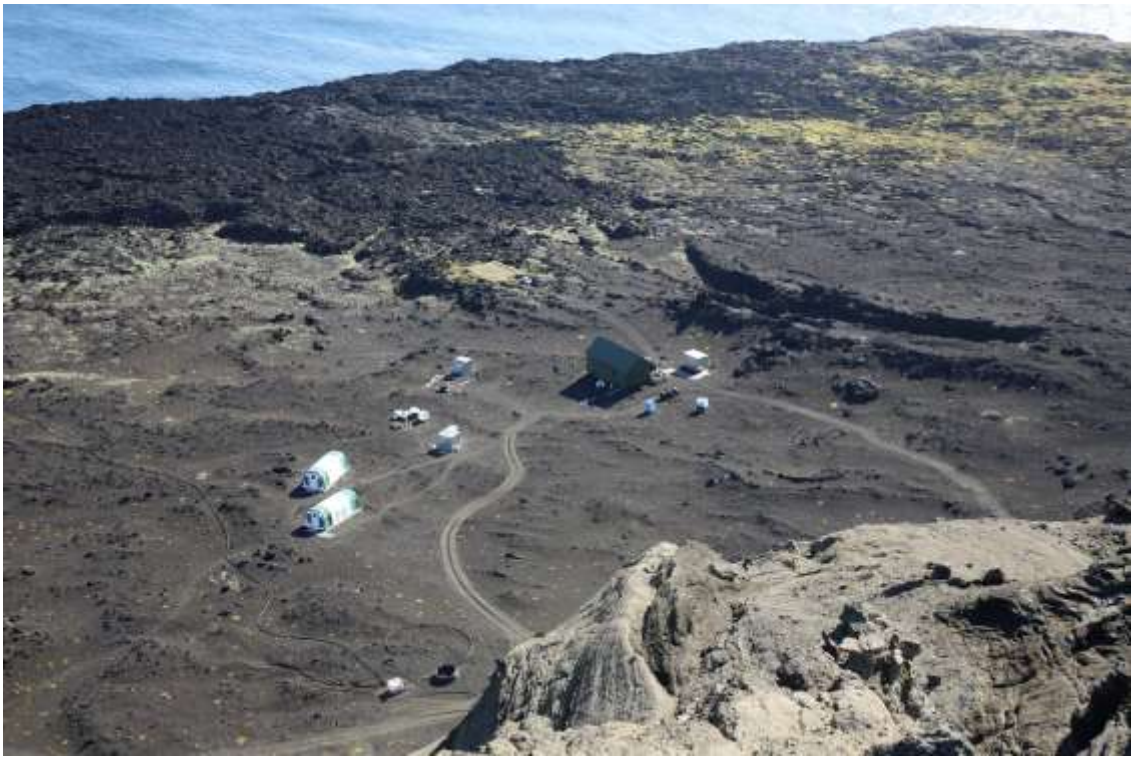

Figure 5. The Surtsey camp with the Weatherhaven sleeping tents on the left and Pálsbær hut on the right. The tracks from the ATV and any marks from tents, containers etc. will be removed in the coming days (Photo: ÁG).

Figure 6. The drillsite on the left with the 1966-67 crater of effusive activity (Surtur I) on the right (Photo MTG).

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SUSTAIN

Location Surtsey	Daily Report #18 Preliminary data collection	? working day 5th of September 2017

Well Name:	**SE-03**	*Drilling Company:*	**DES**	*Geologist:*	**TBW**
Well-Id:	**unknown**	*Drill-Rig:*	**CS1000**	*Microbiologist/Geochemist:*	
Drill-bit diameter:	-	*Depth at midnight:*	-	*Hole made last 24 hrs*	-
Drilling fluid:	-	*Depth at 8 AM:*	-	*Drilling time:*	-
Sterilized fluid:	-	*Circulation losses:*	-	*Average ROP:*	-

Drilling operations

After completion of SE-3 rigging down and preparing for de-mobilization started on Monday, September 4th. Due to unfavorable weather conditions a helicopter transport planned for Monday, September 4th was postponed to September 5th.

Rigging down continued on September 5th. At about 9 AM the helicopter from Reykjavik arrived on Surtsey and brought in 3 new scientists (TBW, AS, AMK) who are staying for 2 days to conduct fluid sampling of the wells. In addition, 2 new camp managers (Águst Þór and Daníel) as well a new cook Hlynur) The helicopter transported all core from SE-3 to Heimaey and also brought some equipment to Surtsey. Following scientists left Surtsey: MTG, SP; ÁG, CG, ESÓ and RA, as well as Sveinbjörn (camp manager) and Unnur (cook)

Sampling and Well monitoring

The on-site scientists used the ÍSOR bailer to collect fluids from SE-1 and SE-2b. Within SE-1 fluids were sampled within a 20-meter interval. For SE-2b fluid were sampled in a 10-meter interval.

Figure 1 shows the scientists during fluid sampling. Table 1 shows a compilation of all cure runs in SE-3 and table 2 show each core run and the division into sections and the location of samples.

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Figure 1. Andri Stefansson working on fluid samples retrieved from the Surtsey wells (photo TBW).

Table 1. *Overview of conducted core runs in SE-3 in 2017. Core run 1-69 are drilled with HQ. Core runs 70-123 are drilled with NQ.*

Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-3	1	29.08.2017	7:20 - 8:00 PM	11.39	14.14	2.75	0.00	0
SE-3	2	29.08.2017	8:30 - 9:20 PM	14.14	16.45	2.31	1.48	64
SE-3	3	29.08.2017	9:35 - 9:45 PM	16.45	17.19	0.74	0.74	100
SE-3	4	29.08.2017	9:55 – 10:20 PM	17.19	20.24	3.05	2.51	82
SE-3	5	29.08.2017	10:30 – 10:55 PM	20.24	23.29	3.05	3.01	98
SE-3	6	29.08.2017	11:05 – 11:40 PM	23.29	26.34	3.05	3.095	102
SE-3	7	30.08.2017	11:55 – 12:20 AM	26.34	29.39	3.05	3.105	102
SE-3	8	30.08.2017	12:30 – 12:55 AM	29.39	32.44	3.05	3.055	100
SE-3	9	30.08.2017	1:05 – 1:50 AM	32.44	23.49	3.05	3.025	99
SE-3	10	30.08.2017	2:05 – 2:45 AM	35.49	38.54	3.05	3.12	102
SE-3	11	30.08.2017	3:00 – 3:35 AM	38.54	41.59	3.05	3.03	99

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-3	12	30.08.2017	3:45 – 4:35 AM	41.59	44.64	3.05	3.05	100
SE-3	13	30.08.2017	4:45 – 5:30 AM	44.64	47.69	3.05	3.05	100
SE-3	14	30.08.2017	5:40 – 6:15 AM	47.69	50.74	3.05	3.05	100
SE-3	15	30.08.2017	6:30 – 7:05 AM	50.74	53.79	3.05	3.15	103
SE-3	16	30.08.2017	7:15 – 7:45 AM	53.79	56.84	3.05	3.04	100
SE-3	17	30.08.2017	8:30 – 9:15 AM	56.84	59.89	3.05	3.10	102
SE-3	18	30.08.2017	9:15 – 10:20 AM	59.89	62.94	3.05	3.08	101
SE-3	19	30.08.2017	10:20 – 11:00 AM	62.94	65.66	3.05	3.12	102
SE-3	20	30.08.2017	11:00 – 11:40 AM	65.99	69.04	3.05	3.07	101
SE-3	21	30.08.2017	11:40 – 12:10 PM	69.04	70.84	1.80	1.82	100
SE-3	22	30.08.2017	6:10 – 7:05 PM	70.84	72.09	1.25	1.36	105
SE-3	23	30.08.2017	7:05 – 8:00 PM	72.09	75.14	3.05	3.12	102
SE-3	24	30.08.2017	8:00 – 8:45 PM	75.14	78.19	3.05	3.11	102
SE-3	25	30.08.2017	9:05 – 9:35 PM	78.19	81.24	3.05	3.00	98
SE-3	26	30.08.2017	9:45 – 10:15 PM	81.24	84.29	3.05	316.5	104
SE-3	27	30.08.2017	10:35 – 11:05 PM	84.29	87.34	3.05	3.06	100
SE-3	28	30.08.2017	11:20 – 12:00 AM	87.34	90.39	3.05	3.065	100
SE-3	29	31.08.2017	12:15 – 12:45 AM	90.39	93.44	3.05	3.07	101
SE-3	30	31.08.2017	1:00 – 1:30 AM	93.44	96.49	3.05	3.07	101
SE-3	31	31.08.2017	1:50 – 2:20 AM	96.49	99.54	3.05	3.09	101
SE-3	32	31.08.2017	2:40 – 3:10 AM	99.54	102.59	3.05	3.03	99
SE-3	33	31.08.2017	3:25 – 4:05 AM	102.59	105.64	3.05	3.10	102
SE-3	34	31.08.2017	4:20 – 4:55 AM	105.64	108.69	3.05	3.085	102
SE-3	35	31.08.2017	5:10 – 5:45 AM	108.69	111.74	3.05	3.04	100
SE-3	36	31.08.2017	6:00 – 6:40 AM	111.74	114.79	3.05	3.08	101
SE-3	37	31.08.2017	6:50 – 7:25 AM	114.79	117.84	3.05	3.06	100
SE-3	38	31.08.2017	8:30 – 8:40 AM	117.84	120.89	3.05	3.04	100

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-3	39	31.08.2017	8:40 – 9:40 AM	120.89	123.94	3.05	3.06	100
SE-3	40	31.08.2017	9:40 – 10:35 AM	123.94	126.99	3.05	3.05	100
SE-3	41	31.08.2017	10:35 – 11:40 AM	126.99	130.04	3.05	3.08	101
SE-3	42	31.08.2017	11:40 – 12:40 PM	130.04	133.09	3.05	3.04	100
SE-3	43	31.08.2017	12:40 – 2:15 PM	133.09	136.14	3.05	3.13	13
SE-3	44	31.08.2017	2:15 – 3:20 PM	136.14	139.19	3.05	3.05	100
SE-3	45	31.08.2017	3:20 – 4:20 PM	139.19	142.24	3.05	3.06	100
SE-3	46	31.08.2017	4:20 – 5:20 PM	142.24	145.29	3.05	3.04	100
SE-3	47	31.08.2017	5:20 – 6:10 PM	145.29	148.34	3.05	3.06	100
SE-3	48	31.08.2017	6:10 – 7:15 PM	148.34	151.39	3.05	3.07	101
SE-3	49	31.08.2017	7:15 – 8:00 PM	151.39	154.44	3.05	3.045	100
SE-3	50	31.08.2017	8:25 – 8:55 PM	154.44	157.49	3.05	3.095	102
SE-3	51	31.08.2017	9:20 – 9:50 PM	157.49	160.54	3.05	3.035	99
SE-3	52	31.08.2017	10:15 – 10:45 PM	160.54	163.59	3.05	3.07	101
SE-3	53	31.08.2017	11:15 – 11:45 PM	163.59	166.64	3.05	3.00	98
SE-3	54	01.09.2017	12:10 – 12:35 AM	166.64	169.69	3.05	3.065	100
SE-3	55	01.09.2017	12:55 – 1:25 AM	169.69	172.74	3.05	3.05	100
SE-3	56	01.09.2017	1:40 – 2:15 AM	172.74	175.79	3.05	3.085	101
SE-3	57	01.09.2017	2:30 – 3:00 AM	175.79	178.84	3.05	3.05	100
SE-3	58	01.09.2017	3:30 – 4:05 AM	178.84	181.89	3.05	3.067	100
SE-3	59	01.09.2017	4:35 – 5:10 AM	181.89	184.94	3.05	3.065	100
SE-3	60	01.09.2017	5:25 – 6:00 AM	184.94	187.99	3.05	3.025	99
SE-3	61	01.09.2017	6:15 – 6:40 AM	187.99	191.04	3.05	3.109	102
SE-3	62	01.09.2017	7:00 – 7:25 AM	191.04	194.09	3.05	3.04	100
SE-3	63	01.09.2017	8:30 – 8:45 AM	194.09	197.14	3.05	3.05	100
SE-3	64	01.09.2017	8:45 – 9:15 AM	197.14	200.19	3.05	3.06	100
SE-3	65	01.09.2017	9:15 – 10:30 AM	200.19	203.24	3.05	3.00	98

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-3	66	01.09.2017	10:30 – 11:15 AM	203.24	206.29	3.05	3.13	103
SE-3	67	01.09.2017	11:15 – 12:05 PM	206.29	209.34	3.05	3.13	103
SE-3	68	01.09.2017	12:05 – 1:00 PM	209.34	212.39	3.05	3.00	98
SE-3	69	01.09.2017	1:00 – 2:00 PM	212.39	213.89	1.50	1.59	106
SE-3	70	02.09.2017	4:00 – 4:30 AM	213.89	214.10	0.21	0.21	95
SE-3	71	02.09.2017	8:30 – 9:30 AM	214.10	150.30	1.20	1.10	92
SE-3	72	02.09.2017	9:30 – 11:15 AM	215.30	218.35	3.05	3.03	99
SE-3	73	02.09.2017	11:15 – 12:23 PM	218.35	221.40	3.05	3.12	103
SE-3	74	02.09.2017	1:00 – 3:30 PM	221.40	224.45	3.05	3.00	98
SE-3	75	02.09.2017	3:30 – 4:50 PM	224.45	227.50	3.05	3.08	101
SE-3	76	02.09.2017	4:50 – 5:55 PM	227.50	230.55	3.05	3.06	100
SE-3	77	02.09.2017	5:55 – 7:00 PM	230.55	233.55	3.05	2.97	97
SE-3	78	02.09.2017	7:00 – 8:00 PM	233.60	236.25	2.65	2.65	100
SE-3	79	02.09.2017	8:30 – 9:10 PM	236.25	238.11	1.86	1.04	56
SE-3	80	02.09.2017	10:00 – 10:25 PM	238.11	239.71	1.60	167	104
SE-3	81	02.09.2017	11:20 – 11:35 PM	239.71	240.02	0.31	0.31	100
SE-3	82	02.09.2017	11:35 – 12:00 AM	240.02	242.76	2.74	3.065	112
SE-3	83	03.09.2017	12:20 – 1:00 AM	242.76	245.81	3.05	3.05	100
SE-3	84	03.09.2017	1:00 – 2:20 AM	245.81	248.86	3.05	3.04	100
SE-3	85	03.09.2017	2:25 – 3:30 AM	248.86	251.91	3.05	2.96	97
SE-3	86	03.09.2017	4:10 – 4:35 AM	251.91	254.96	3.05	3.07	101
SE-3	87	03.09.2017	5:00 – 5:30 AM	254.96	258.01	3.05	3.095	102
SE-3	88	03.09.2017	6:00 – 6:30 AM	258.01	261.06	3.05	3.05	100
SE-3	89	03.09.2017	6:50 – 7:20 AM	261.06	264.11	3.05	3.03	99
SE-3	90	03.09.2017	8:30 – 8:40 AM	264.10	267.15	3.05	3.01	98
SE-3	91	03.09.2017	8:40 – 9:25 AM	267.15	270.20	3.05	3.00	98
SE-3	92	03.09.2017	9:25 – 10:10 AM	270.20	273.25	3.05	3.02	99

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-3	93	03.09.2017	10:10 – 10:55 AM	273.25	276.30	3.05	3.05	100
SE-3	94	03.09.2017	10:55 – 11:35 AM	276.30	279.35	3.05	3.08	101
SE-3	95	03.09.2017	11:35 – 12:15 PM	279.35	282.40	3.05	3.01	99
SE-3	96	03.09.2017	12:15 – 1:05 PM	282.40	285.45	3.05	3.08	101
SE-3	97	03.09.2017	1:05 – 2:00 PM	285.45	288.50	3.05	3.04	100
SE-3	98	03.09.2017	2:00 – 2:50 PM	288.50	291.55	3.05	3.03	99
SE-3	99	03.09.2017	2:50 – 3:35 PM	291.55	294.60	3.05	2.95	97
SE-3	100	03.09.2017	3:35 – 4:20 PM	294.60	297.65	3.05	3.04	100
SE-3	101	03.09.2017	4:20 – 5:10 PM	297.65	300.70	3.05	3.10	102
SE-3	102	03.09.2017	5:10 – 5:50 PM	300.70	303.75	3.05	3.04	100
SE-3	103	03.09.2017	5:50 – 6:30 PM	303.75	306.80	3.05	3.04	100
SE-3	104	03.09.2017	6:30 – 7:10 PM	306.80	309.85	3.05	3.04	100
SE-3	105	03.09.2017	7:10 – 7:45 PM	309.85	312.90	3.05	3.08	101
SE-3	106	03.09.2017	7:45 – 8:10 PM	312.90	315.95	3.05	3.05	100
SE-3	107	03.09.2017	8:30 – 8:55 PM	315.95	319.00	3.05	2.90	95
SE-3	108	03.09.2017	9:20 – 9:45 PM	319.00	322.05	3.05	3.09	102
SE-3	109	03.09.2017	10:05 – 10:35 PM	322.05	325.10	3.05	310	102
SE-3	110	03.09.2017	10:55 – 11:20 PM	325.10	328.15	3.05	3.125	103
SE-3	111	04.09.2017	11:30 – 12:15 AM	328.15	331.20	3.05	2.98	98
SE-3	112	04.09.2017	12:40 – 1:00 AM	331.20	334.25	3.05	3.10	102
SE-3	113	04.09.2017	1:35 – 1:55 AM	334.25	337.30	3.05	3.07	101
SE-3	114	04.09.2017	2:15 – 2:40 AM	337.30	340.35	3.05	3.05	100
SE-3	115	04.09.2017	3:05 – 3:25 AM	340.35	343.40	3.05	2.54	83
SE-3	116	04.09.2017	3:35 – 4:10 AM	343.40	346.45	3.05	3.01	98
SE-3	117	04.09.2017	4:40 – 4:50 AM	346.45	347.25	0.80	0.69	86
SE-3	118	04.09.2017	?	347.25	347.65	0.40	0.30	75
SE-3	119	04.09.2017	?	347.65	348.70	1.05	0.07	7
SE-3	120	04.09.2017	?	348.70	349.50	0.80	1.21	151
SE-3	121	04.09.2017	? – 8:00 AM	349.50	350.50	1.00	1.145	115

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Well	Core run no.	Date	Coring time	Starting depth (m)	End depth (m)	Cored length (m)	Recovered core (m)*	Core recovery (%)
SE-3	122	04.09.2017	? – 10:00 AM	350.50	352.55	2.05	0	0
SE-3	123	04.09.2017	? AM	352.55	354.05	2.50	1.15	46

* based on geologist documentation, should be measured again at the core processing on Heimaey.

Table 2. *Overview of conducted core runs in SE-3 in 2017.*

Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Comment
SE-3	1	-	29.08.2017	0		-	No recovery
SE-3	2	1	29.08.2017	0.70		0-70	
SE-3	2	2	29.08.2017	0.69		0-69	
SE-3	2	Cc	29.08.2017	0.09		0-9	
SE-3	3	1	29.08.2017	0.65		0-65	
SE-3	3	Cc	29.08.2017	0.09		0-9	
SE-3	4	1	29.08.2017	0.98		0-98	
SE-3	4	2	29.08.2017	0.98		0-98	
SE-3	4	3	29.08.2017	0.40		0-40	
SE-3	4	Cc	29.08.2017	0.15		0-15	
SE-3	5	1	29.08.2017	0.98		0-98	
SE-3	5	2	29.08.2017	0.98		0-98	
SE-3	5	3	29.08.2017	0.94	x	10-84	
SE-3	5	Cc	29.08.2017	0.16		0-16	
SE-3	6	1	29.08.2017	0.98		0-98	
SE-3	6	2	29.08.2017	0.98		0-98	
SE-3	6	3	29.08.2017	0.65		0-65	
SE-3	6	4	29.08.2017	0.375		0-37.5	
SE-3	6	Cc	29.08.2017	0.115		0-11.5	
SE-3	7	1	30.08.2017	0.98		0-98	
SE-3	7	2	30.08.2017	0.98		0-98	
SE-3	7	3	30.08.2017	0.98		0-98	
SE-3	7	Cc	30.08.2017	0.16		0-16	
SE-3	8	1	30.08.2017	0.98		0-98	
SE-3	8	2	30.08.2017	0.98		0-98	
SE-3	8	3	30.08.2017	1.00		0-100	
SE-3	8	Cc	30.08.2017	0.11		0-11	
SE-3	9	1	30.08.2017	0.98		0-98	
SE-3	9	2	30.08.2017	0.98		0-98	
SE-3	9	3	30.08.2017	0.975		0-97.5	
SE-3	9	Cc	30.08.2017	0.115		0-11.5	
SE-3	10	1	30.08.2017	0.98		0-98	
SE-3	10	2	30.08.2017	0.98		0-98	
SE-3	10	3	30.08.2017	0.88	x	10-88	
SE-3	10	4+Cc	30.08.2017	0.29		0-29	
SE-3	11	1	30.08.2017	0.98		0-98	
SE-3	11	2	30.08.2017	0.98		0-98	
SE-3	11	3	30.08.2017	0.935		0-93.5	
SE-3	11	Cc	30.08.2017	0.15		0-15	
SE-3	12	1	30.08.2017	0.955		0-95.5	
SE-3	12	2	30.08.2017	0.97		0-97	
SE-3	12	3	30.08.2017	0.92		0-42	
SE-3	12	4	30.08.2017	0.71		0-71	
SE-3	13	1	30.08.2017	0.98		0-98	
SE-3	13	2	30.08.2017	0.98		0-98	
SE-3	13	3	30.08.2017	0.60	x	10-60	
SE-3	13	4	30.08.2017	0.50		0-50	
SE-3	14	1	30.08.2017	0.98		0-98	
SE-3	14	2	30.08.2017	0.98		0-98	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Comment
SE-3	14	3	30.08.2017	0.55		0-55	
SE-3	14	4	30.08.2017	0.54		0-54	
SE-3	15	1	30.08.2017	0.97		0-97	
SE-3	15	2	30.08.2017	0.98		0-98	
SE-3	15	3	30.08.2017	0.525		0-52.5	
SE-3	15	4	30.08.2017	0.515		0-51.5	
SE-3	15	Cc	30.08.2017	0.15		0-15	
SE-3	16	1	30.08.2017	0.98		0-98	
SE-3	16	2	30.08.2017	0.98		0-98	
SE-3	16	3	30.08.2017	1.005	x	10-100.5	
SE-3	16	Cc	30.08.2017	0.12		0-12	
SE-3	17	1	30.08.2017	0.85		0-85	
SE-3	17	2	30.08.2017	0.53		0-53	
SE-3	17	3	30.08.2017	0.48		0-48	
SE-3	17	4	30.08.2017	0.51		0-51	
SE-3	17	5	30.08.2017	0.52		0-52	
SE-3	17	Cc	30.08.2017	0.23		0-23	
SE-3	18	1	30.08.2017	0.98		0-98	
SE-3	18	2	30.08.2017	0.97		0-97	
SE-3	18	3	30.08.2017	0.56		0-56	
SE-3	18	4	30.08.2017	0.57		0-57	
SE-3	19	1	30.08.2017	0.98		0-98	
SE-3	19	2	30.08.2017	0.98		0-98	
SE-3	19	3	30.08.2017	0.96		0-96	
SE-3	19	4	30.08.2017	0.10		0-10	
SE-3	20	1	30.08.2017	0.94		0-94	
SE-3	20	2	30.08.2017	0.93		0-93	
SE-3	20	3	30.08.2017	0.98		0-98	
SE-3	20	4	30.08.2017	0.22		0-22	
SE-3	21	1	30.08.2017	0.74		0-74	
SE-3	21	2	30.08.2017	0.93		0-93	
SE-3	21	3	30.08.2017	0.15		0-15	
SE-3	22	1	30.08.2017	0.81		0-81	
SE-3	22	2	30.08.2017	0.45	x	10-45	
SE-3	23	1	30.08.2017	0.50		0-50	
SE-3	23	2	30.08.2017	0.97		0-97	
SE-3	23	3	30.08.2017	0.97		0-97	
SE-3	23	4	30.08.2017	0.68		0-68	
SE-3	24	1	30.08.2017	0.98		0-98	
SE-3	24	2	30.08.2017	0.98		0-98	
SE-3	24	3	30.08.2017	0.98		0-98	
SE-3	24	4	30.08.2017	0.17		0-17	
SE-3	25	1	30.08.2017	0.98		0-98	
SE-3	25	2	30.08.2017	0.98		0-98	
SE-3	25	3	30.08.2017	0.99	x	10-99	
SE-3	25	Cc	30.08.2017	0.05		0-5	
SE-3	26	1	30.08.2017	0.97		0-97	
SE-3	26	2	30.08.2017	0.96		0-96	
SE-3	26	3	30.08.2017	0.822		0-82.2	
SE-3	26	4	30.08.2017	0.42		0-43	
SE-3	27	1	30.08.2017	0.98		0-98	
SE-3	27	2	30.08.2017	0.98		0-98	
SE-3	27	3	30.08.2017	0.95		0-95	
SE-3	27	4	30.08.2017	0.175		0-17.5	
SE-3	28	1	30.08.2017	0.645		0-64.5	
SE-3	28	2	30.08.2017	0.98		0-98	
SE-3	28	3	30.08.2017	0.98	x	10-98	
SE-3	28	4	30.08.2017	0.375		0-37.5	
SE-3	29	1	31.08.2017	0.98		0-98	
SE-3	29	2	31.08.2017	0.98		0-98	

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SE-3	29	3	31.08.2017	0.62		0-62	
SE-3	29	4	31.08.2017	0.49		0-49	
SE-3	30	1	31.08.2017	0.98		0-98	
SE-3	30	2	31.08.2017	0.98		0-98	
SE-3	30	3	31.08.2017	0.48		0-48	
SE-3	30	4	31.08.2017	0.61		0-61	
SE-3	31	1	31.08.2017	0.347		0-34.7	
SE-3	31	2	31.08.2017	0.98		0-98	
SE-3	31	3	31.08.2017	0.98	x	10-98	
SE-3	31	4	31.08.2017	0.69		0-69	
SE-3	32	1	31.08.2017	0.98		0-98	
SE-3	32	2	31.08.2017	0.98		0-98	
SE-3	32	3	31.08.2017	0.54		0-54	
SE-3	32	4	31.08.2017	0.34		0-34	
SE-3	33	1	31.08.2017	0.98		0-98	
SE-3	33	2	31.08.2017	0.98		0-98	
SE-3	33	3	31.08.2017	0.795		0-79.5	
SE-3	33	4	31.08.2017	0.385		0-38.5	
SE-3	34	1	31.08.2017	0.98		0-98	
SE-3	34	2	31.08.2017	0.98		0-98	
SE-3	34	3	31.08.2017	0.715	x	10-71.5	
SE-3	34	4	31.08.2017	0.425		0-42.5	
SE-3	35	1	31.08.2017	0.94		0-94	
SE-3	35	2	31.08.2017	0.98		0-98	
SE-3	35	3	31.08.2017	0.51		0-51	
SE-3	35	4	31.08.2017	0.695		0-69.5	
SE-3	36	1	31.08.2017	0.98		0-98	
SE-3	36	2	31.08.2017	0.98		0-98	
SE-3	36	3	31.08.2017	0.90		0-90	
SE-3	36	4	31.08.2017	0.21		0-21	
SE-3	37	1	31.08.2017	0.98		0-98	
SE-3	37	2	31.08.2017	0.98		0-98	
SE-3	37	3	31.08.2017	0.70	x	10-70	
SE-3	37	4	31.08.2017	0.40		0-40	
SE-3	38	1	31.08.2017	0.58		0-58	
SE-3	38	2	31.08.2017	0.98		0-98	
SE-3	38	3	31.08.2017	0.99		0-99	
SE-3	38	4	31.08.2017	0.51		0-51	
SE-3	39	1	31.08.2017	0.45		0-45	
SE-3	39	2	31.08.2017	0.97		0-97	
SE-3	39	3	31.08.2017	0.97		0-97	
SE-3	39	4	31.08.2017	0.66		0-66	
SE-3	40	1	31.08.2017	0.98		0-98	
SE-3	40	2	31.08.2017	0.98		0-98	
SE-3	40	3	31.08.2017	0.97	x	10-97	
SE-3	40	Cc	31.08.2017	0.12		0-12	
SE-3	41	1	31.08.2017	0.83		0-83	
SE-3	41	2	31.08.2017	0.98		0-98	
SE-3	41	3	31.08.2017	0.98		0-98	
SE-3	41	4	31.08.2017	0.30		0-30	
SE-3	42	1	31.08.2017	0.96		0-96	
SE-3	42	2	31.08.2017	1.00		0-100	
SE-3	42	3	31.08.2017	0.51		0-51	
SE-3	42	4	31.08.2017	0.57		0-57	
SE-3	43	1	31.08.2017	0.36		0-36	
SE-3	43	2	31.08.2017	0.97		0-97	
SE-3	43	3	31.08.2017	0.97		0-97	
SE-3	43	4	31.08.2017	0.82	x	10-82	
SE-3	44	1	31.08.2017	0.97		0-97	
SE-3	44	2	31.08.2017	0.98		0-98	

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SE-3	44	3	31.08.2017	0.54		0-54	
SE-3	44	4	31.08.2017	0.55	x	20-55	
SE-3	45	1	31.08.2017	0.97		0-97	
SE-3	45	2	31.08.2017	0.97		0-97	
SE-3	45	3	31.08.2017	0.97		0-97	
SE-3	45	4	31.08.2017	0.16		0-16	
SE-3	46	1	31.08.2017	0.80		0-80	
SE-3	46	2	31.08.2017	0.98		0-98	
SE-3	46	3	31.08.2017	0.62		0-62	
SE-3	46	4	31.08.2017	0.64	x	10-64	
SE-3	47	1	31.08.2017	0.43		0-43	
SE-3	47	2	31.08.2017	0.97		0-97	
SE-3	47	3	31.08.2017	0.97		0-97	
SE-3	47	4	31.08.2017	0.71		0-71	
SE-3	48	1	31.08.2017	0.97		0-97	
SE-3	48	2	31.08.2017	0.98		0-98	
SE-3	48	3	31.08.2017	0.50		0-50	
SE-3	48	4	31.08.2017	0.67	x	20-67	
SE-3	49	1	31.08.2017	0.98		0-98	
SE-3	49	2	31.08.2017	0.98		0-98	
SE-3	49	3	31.08.2017	1.085	x	10-108.5	
SE-3	50	1	31.08.2017	0.98		0-98	
SE-3	50	2	31.08.2017	0.98		0-98	
SE-3	50	3	31.08.2017	0.98		0-98	
SE-3	50	4	31.08.2017	0.155		0-15.5	
SE-3	51	1	31.08.2017	0.99		0-99	
SE-3	51	2	31.08.2017	0.98		0-98	
SE-3	51	3	31.08.2017	0.90		0-90	
SE-3	51	4	31.08.2017	0.17		0-17	
SE-3	52	1	31.08.2017	0.98		0-98	
SE-3	52	2	31.08.2017	0.98		0-98	
SE-3	52	3	31.08.2017	1.10	x	30-110	
SE-3	52	4	31.08.2017	0.123		0-12.3	
SE-3	53	1	31.08.2017	0.98		0-98	
SE-3	53	2	31.08.2017	0.98		0-98	
SE-3	53	3	31.08.2017	0.75		0-75	
SE-3	53	4	31.08.2017	0.29		0-29	
SE-3	54	1	01.09.2017	0.93		0-93	
SE-3	54	2	01.09.2017	0.98		0-98	
SE-3	54	3	01.09.2017	0.32		0-32	
SE-3	54	4	01.09.2017	0.855		0-85.5	
SE-3	55	1	01.09.2017	0.98		0-98	
SE-3	55	2	01.09.2017	0.98		0-98	
SE-3	55	3	01.09.2017	1.095	x	10-109.5	
SE-3	56	1	01.09.2017	0.98		0-98	
SE-3	56	2	01.09.2017	1.18	x	20-118	
SE-3	56	4	01.09.2017	0.93		0-93	
SE-3	57	1	01.09.2017	0.98		0-98	
SE-3	57	2	01.09.2017	0.98		0-98	
SE-3	57	3	01.09.2017	0.90		0-90	
SE-3	57	4	01.09.2017	0.19		0-19	
SE-3	58	1	01.09.2017	0.98		0-98	
SE-3	58	2	01.09.2017	0.99		0-99	
SE-3	58	4	01.09.2017	1.095	x	10-109.5	
SE-3	59	1	01.09.2017	0.98		0-98	
SE-3	59	2	01.09.2017	0.98		0-98	
SE-3	59	3	01.09.2017	0.75		0-75	
SE-3	59	4	01.09.2017	0.35		0-35	
SE-3	60	1	01.09.2017	0.60		0-60	
SE-3	60	2	01.09.2017	0.98		0-98	

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SE-3	60	3	01.09.2017	1.18	x	20-118	
SE-3	60	4	01.09.2017	0.28		0-28	
SE-3	61	1	01.09.2017	0.98		0-98	
SE-3	61	2	01.09.2017	0.98		0-98	
SE-3	61	3	01.09.2017	1.005	x	10-100.5	
SE-3	61	4	01.09.2017	0.125		0-12.5	
SE-3	62	1	01.09.2017	0.98		0-98	
SE-3	62	2	01.09.2017	0.98		0-98	
SE-3	62	3	01.09.2017	0.90		0-90	
SE-3	62	4	01.09.2017	0.19		0-19	
SE-3	63	1	01.09.2017	0.77		0-77	
SE-3	63	2	01.09.2017	0.98		0-98	
SE-3	63	3	01.09.2017	0.98		0-98	
SE-3	63	4	01.09.2017	0.33		0-33	
SE-3	64	1	01.09.2017	0.64		0-64	
SE-3	64	2	01.09.2017	0.98		0-98	
SE-3	64	3	01.09.2017	0.98		0-98	
SE-3	64	4	01.09.2017	0.45	x	30-45	
SE-3	65	1	01.09.2017	0.80		0-80	
SE-3	65	2	01.09.2017	0.98		0-98	
SE-3	65	3	01.09.2017	0.98		0-98	
SE-3	65	4	01.09.2017	0.23		0-23	
SE-3	66	1	01.09.2017	0.68		0-68	
SE-3	66	2	01.09.2017	0.97		0-97	
SE-3	66	3	01.09.2017	0.97		0-97	
SE-3	66	4	01.09.2017	0.46		0-46	
SE-3	67	1	01.09.2017	0.50		0-50	
SE-3	67	2	01.09.2017	0.98		0-98	
SE-3	67	3	01.09.2017	0.98		0-98	
SE-3	67	4	01.09.2017	0.65	x	10-65	
SE-3	68	1	01.09.2017	0.42		0-42	
SE-3	68	2	01.09.2017	0.98		0-98	
SE-3	68	3	01.09.2017	0.60		0-6	
SE-3	68	4	01.09.2017	1.10	x	33-110	
SE-3	69	1	01.09.2017	0.98		0-98	
SE-3	69	2	01.09.2017	0.62		0-62	
SE-3	70	1	02.09.2017	0.21		0-21	
SE-3	71	1	02.09.2017	0.51		0-51	
SE-3	71	2	02.09.2017	0.64	x	43-64	
SE-3	72	1	02.09.2017	0.97		0-97	
SE-3	72	2	02.09.2017	0.93		0-93	
SE-3	72	3	02.09.2017	0.61		0-61	
SE-3	72	4	02.09.2017	0.56		0-56	
SE-3	73	1	02.09.2017	0.39		0-39	
SE-3	73	2	02.09.2017	0.98		0-98	
SE-3	73	3	02.09.2017	0.98		0-98	
SE-3	73	4	02.09.2017	0.84	x	9-84	
SE-3	74	1	02.09.2017	0.96		0-96	
SE-3	74	2	02.09.2017	096		0-96	
SE-3	74	3	02.09.2017	0.98	x	10-98	
SE-3	74	4	02.09.2017	0.09		0-9	
SE-3	75	1	02.09.2017	0.96		0-96	
SE-3	75	2	02.09.2017	0.97		0-97	
SE-3	75	3	02.09.2017	0.65		0-65	
SE-3	75	4	02.09.2017	0.50		0-50	
SE-3	76	1	02.09.2017	0.45		0-45	
SE-3	76	2	02.09.2017	0.97		0-97	
SE-3	76	3	02.09.2017	1.18	x	20-118	
SE-3	76	4	02.09.2017	0.48		0-48	
SE-3	77	1	02.09.2017	0.45		0-45	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Comment
SE-3	77	2	02.09.2017	0.93		0-93	
SE-3	77	3	02.09.2017	0.97		0-97	
SE-3	77	4	02.09.2017	0.57		0-57	
SE-3	78	1	02.09.2017	0.98		0-98	
SE-3	78	2	02.09.2017	0.98		0-98	
SE-3	78	3	02.09.2017	0.60		0-60	
SE-3	78	4	02.09.2017	0.13		0-13	Unclear if this is the same as Cc
SE-3	78	Cc	02.09.2017	0.13		0-13	Fragments of basalt
SE-3	79	1	02.09.2017	0.19		0-19	
SE-3	79	2	02.09.2017	0.695		0-69.5	
SE-3	79	3	02.09.2017	0.10 to 0.15		0-10 to 15	in bag
SE-3	79	3	02.09.2017	0.075		0-7.5	in bag
SE-3	80	1	02.09.2017	0.96		0-96	
SE-3	80	2	02.09.2017	0.717		0-71.7	
SE-3	81	1	02.09.2017	0.16		0-16	
SE-3	81	2	02.09.2017	0.075		0-7.5	
SE-3	81	Cc	02.09.2017	0.075		0-7.5	
SE-3	82	1	02.09.2017	0.625		0-62.5	
SE-3	82	2	02.09.2017	0.97		0-97	
SE-3	82	3	02.09.2017	0.455		0-45.5	
SE-3	82	4	02.09.2017	0.945	x	30-94.5	
SE-3	83	1	03.09.2017	0.915		0-91.5	
SE-3	83	2	03.09.2017	0.98		0-98	
SE-3	83	3	03.09.2017	0.57		0-57	
SE-3	83	4	03.09.2017	0.59		0-59	
SE-3	84	1	03.09.2017	0.98		0-98	
SE-3	84	2	03.09.2017	0.90		0-90	
SE-3	84	3	03.09.2017	0.74		0-74	
SE-3	84	4	03.09.2017	0.41		0-41	
SE-3	85	1	03.09.2017	0.98		0-98	
SE-3	85	2	03.09.2017	0.90		0-90	
SE-3	85	3	03.09.2017	1.04	x	30-104	
SE-3	86	1	03.09.2017	0.98		0-98	
SE-3	86	2	03.09.2017	0.94		0-94	
SE-3	86	3	03.09.2017	0.98		0-98	
SE-3	86	4	03.09.2017	0.18		0-18	
SE-3	87	1	03.09.2017	0.915		0-91.5	
SE-3	87	2	03.09.2017	0.93		0-93	
SE-3	87	3	03.09.2017	0.88		0-88	
SE-3	87	4	03.09.2017	0.39		0-39	
SE-3	88	1	03.09.2017	0.50		0-50	
SE-3	88	2	03.09.2017	0.98		0-98	
SE-3	88	3	03.09.2017	1.17	x	30-117	
SE-3	88	4	03.09.2017	0.43		0-43	
SE-3	89	1	03.09.2017	0.50		0-50	
SE-3	89	2	03.09.2017	0.98		0-98	
SE-3	89	3	03.09.2017	0.98		0-98	
SE-3	89	4	03.09.2017	0.57		0-57	
SE-3	90	1	03.09.2017	0.97		0-97	
SE-3	90	2	03.09.2017	0.97		0-97	
SE-3	90	3	03.09.2017	0.97		0-97	
SE-3	90	4	03.09.2017	0.15		0-15	
SE-3	91	1	03.09.2017	0.82		0-82	
SE-3	91	2	03.09.2017	0.97		0-97	
SE-3	91	3	03.09.2017	0.77		0-77	
SE-3	91	4	03.09.2017	0.47	x	24-47	
SE-3	92	1	03.09.2017	0.74		0-74	
SE-3	92	2	03.09.2017	0.98		0-98	
SE-3	92	3	03.09.2017	0.98		0-98	
SE-3	92	4	03.09.2017	0.33		0-33	

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Well	Core run no.	Section no.	Date	Length (m)*	Sample from section	Curated length (cm)*	Comment
SE-3	93	1	03.09.2017	0.64		0-64	
SE-3	93	2	03.09.2017	0.97		0-97	
SE-3	93	3	03.09.2017	0.96		0-96	
SE-3	93	4	03.09.2017	0.49		0-49	
SE-3	94	1	03.09.2017	0.45		0-45	
SE-3	94	2	03.09.2017	0.97		0-97	
SE-3	94	3	03.09.2017	0.97		0-97	
SE-3	94	4	03.09.2017	0.74	x	24-74	
SE-3	95	1	03.09.2017	0.45		0-45	
SE-3	95	2	03.09.2017	0.97		0-97	
SE-3	95	3	03.09.2017	0.97		0-97	
SE-3	95	4	03.09.2017	0.63		0-63	
SE-3	96	1	03.09.2017	0.35		0-35	
SE-3	96	2	03.09.2017	0.98		0-98	
SE-3	96	3	03.09.2017	0.97		0-97	
SE-3	96	4	03.09.2017	0.80		0-80	
SE-3	97	1	03.09.2017	0.98		0-98	
SE-3	97	2	03.09.2017	0.98		0-98	
SE-3	97	3	03.09.2017	1.09	x	20-109	
SE-3	98	1	03.09.2017	0.90		0-90	
SE-3	98	2	03.09.2017	0.97		0-97	
SE-3	98	3	03.09.2017	0.97		0-97	
SE-3	98	4	03.09.2017	0.13		0-13	
SE-3	99	1	03.09.2017	0.79		0-79	
SE-3	99	2	03.09.2017	0.95		0-95	
SE-3	99	3	03.09.2017	0.94		0-94	
SE-3	99	4	03.09.2017	0.26		0-26	
SE-3	100	1	03.09.2017	0.72		0-72	
SE-3	100	2	03.09.2017	0.97		0-97	
SE-3	100	3	03.09.2017	0.62		0-62	
SE-3	100	4	03.09.2017	0.72	x	30-72	
SE-3	101	1	03.09.2017	0.57		0-57	
SE-3	101	2	03.09.2017	0.98		0-98	
SE-3	101	3	03.09.2017	0.97		0-97	
SE-3	101	4	03.09.2017	0.59		0-59	
SE-3	102	1	03.09.2017	0.40		0-40	
SE-3	102	2	03.09.2017	0.97		0-97	
SE-3	102	3	03.09.2017	0.97		0-97	
SE-3	102	4	03.09.2017	0.70		0-70	
SE-3	103	1	03.09.2017	0.82		0-82	
SE-3	103	2	03.09.2017	0.82		0-82	
SE-3	103	3	03.09.2017	0.82		0-82	
SE-3	103	4	03.09.2017	0.58	x	30-58	
SE-3	104	1	03.09.2017	0.82		0-82	
SE-3	104	2	03.09.2017	0.82		0-82	
SE-3	104	3	03.09.2017	0.82		0-82	
SE-3	104	4	03.09.2017	0.59		0-59	
SE-3	105	1	03.09.2017	0.82		0-82	
SE-3	105	2	03.09.2017	0.82		0-82	
SE-3	105	3	03.09.2017	0.82		0-82	
SE-3	105	4	03.09.2017	0.62		0-62	
SE-3	106	1	03.09.2017	0.83		0-83	
SE-3	106	2	03.09.2017	0.82		0-82	
SE-3	106	3	03.09.2017	1.00	x	20-100	
SE-3	106	4	03.09.2017	0.40		0-40	
SE-3	107	1	03.09.2017	0.80		0-80	
SE-3	107	2	03.09.2017	0.80		0-80	
SE-3	107	3	03.09.2017	0.80		0-80	
SE-3	107	4	03.09.2017	0.445		0-44.5	
SE-3	108	1	03.09.2017	0.80		0-80	

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SE-3	108	2	03.09.2017	0.80		0-80	
SE-3	108	3	03.09.2017	0.80		0-80	
SE-3	108	4	03.09.2017	0.68		0-68	
SE-3	109	1	03.09.2017	0.80		0-80	
SE-3	109	2	03.09.2017	0.80		0-80	
SE-3	109	3	03.09.2017	0.80		0-80	
SE-3	109	4	03.09.2017	0.70	x	20-70	
SE-3	110	1	03.09.2017	0.80		0-80	
SE-3	110	2	03.09.2017	0.80		0-80	
SE-3	110	3	03.09.2017	0.80		0-80	
SE-3	110	4	03.09.2017	0.745		0-74.5	
SE-3	111	1	04.09.2017	0.80		0-80	
SE-3	111	2	04.09.2017	0.80		0-80	
SE-3	111	3	04.09.2017	0.87		0-87	
SE-3	111	4	04.09.2017	0.62		0-62	
SE-3	112	1	04.09.2017	0.81		0-81	
SE-3	112	2	04.09.2017	0.80		0-80	
SE-3	112	3	04.09.2017	1.10	x	30-110	
SE-3	112	4	04.09.2017	0.42		0-42	
SE-3	113	1	04.09.2017	0.80		0-80	
SE-3	113	2	04.09.2017	0.77		0-77	
SE-3	113	3	04.09.2017	0.80		0-80	
SE-3	113	4	04.09.2017	0.695		0-69.5	
SE-3	114	1	04.09.2017	0.80		0-80	
SE-3	114	2	04.09.2017	0.80		0-80	
SE-3	114	3	04.09.2017	0.80		0-80	
SE-3	114	4	04.09.2017	0.65		0-65	
SE-3	115	1	04.09.2017	0.765		0-76.5	
SE-3	115	2	04.09.2017	0.77		0-77	
SE-3	115	3	04.09.2017	0.59		0-59	
SE-3	115	4	04.09.2017	0.08		0-8	
SE-3	115	5	04.09.2017	0.14		0-14	
SE-3	115	Cc	04.09.2017	0.035		0-3.5	There seems to be some more samples, unclear fieldnotes
SE-3	116	1	04.09.2017	0.77		0-77	
SE-3	116	2	04.09.2017	0.80		0-80	
SE-3	116	3	04.09.2017	0.80		0-80	
SE-3	116	4	04.09.2017	0.64	x	30-64	
SE-3	117	1	04.09.2017	0.53		0-53	
SE-3	117	2	04.09.2017	0.09		0-9	
SE-3	117	Cc	04.09.2017	0.07		0-7	
SE-3	118	1	04.09.2017	0.22		0-22	
SE-3	118	2	04.09.2017	0.?		0-?	Fragments in a bag
SE-3	118	Cc	04.09.2017	0.09		0-9	
SE-3	119	Cc	04.09.2017	0.7		0-	
SE-3	120	1	04.09.2017	0.37		0-37	
SE-3	120	1	04.09.2017	0.85		0-85	
SE-3	121	1	04.09.2017	0.685		0-68.5	
SE-3	121	2	04.09.2017	0.12		0-12	
SE-3	121	3	04.09.2017	0.16		0-16	
SE-3	121	4	04.09.2017	0.18		0-18	
SE-3	122	-	04.09.2017	0	-	-	No core recovery
SE-3	123	1	04.09.2017	0.60		0-60	
SE-3	123	2	04.09.2017	0.55		0-55	

* should be measured again at the core processing on Heimaey

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