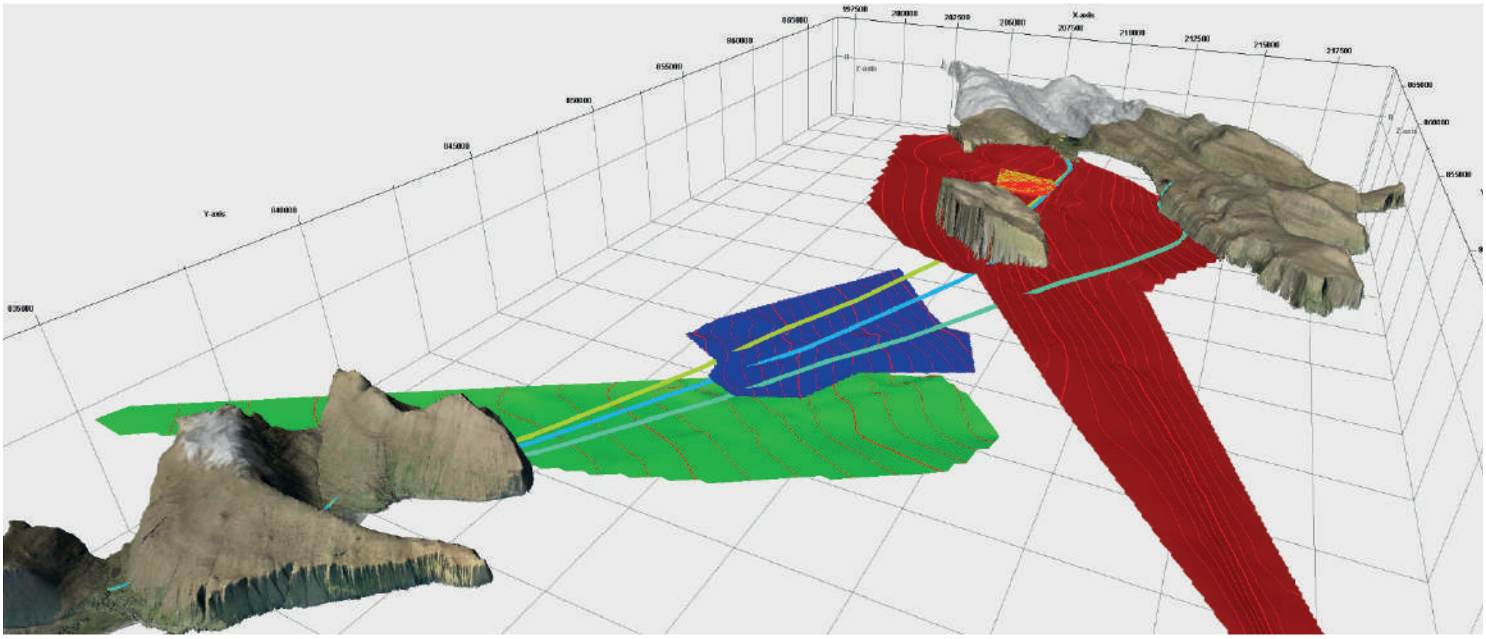
JARÐFEINGI
FAROESE GEOLOGICAL SURVEY

A revised geological description of the Suðuroy tunnel area. A work in progress. Status report ultimo 2021

Report to Landsverk



Content

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Executive summary

The objective is to give a full framework in connection with the plans of constructing the Suðuroy tunnel. This report is a status report of the ongoing investigations comprised of lithology, stratigraphy, and structural data.

The investigations are based on wireline logged boreholes, marine seismic data, and multibeam. Interpretation of wireline logs provides lithology, local stratigraphy, physical properties, and structural data. The seismic images show depth to bedrock and sediment thickness. The images also show intra basalt reflections that show strike and dip of the stratigraphic layers and can be used for correlation of boreholes. Multibeam provides a detailed image of the seabed that is interpreted for geological features such as fracture zones and prominent flow boundaries, and to describe the seabed morphology. The data analysis is combined into at stratigraphic description and framework of the area.

Introduction

Jarðfeingi has been commissioned by Landsverk to describe the geology along the three tunnel route options between the islands of Sandoy, Skúvoy, and Suðuroy. The description is based on interpretations from the marine seismic survey (Petersen, 2020b) and the six new boreholes drilled in connection with the preparations.

Geology of tunnel area

The Palaeogene (ca. 55 My) Faroe Islands Basalt Group (FIGB) consists of seven formations, which are, from oldest to youngest, Lopra, Beinisvørð, Prestfjall, Hvannhagi, Malinstindur, Sneis, and Enni Formations (Passey & Jolley, 2009; Rasmussen & Noe-Nygaard, 1969, 1970), Figure 1. The lowermost, Lopra Formation (>1,000 m thick), is composed of various volcaniclastic lithologies and sills and is only encountered in the Lopra-1/1A borehole. The Beinisvørð Formation (ca. 3,300 m thick) is dominated by thick, laterally extensive, aphyric sheet lobes (Figure 2) and is exposed to the south and the extreme west of the archipelago. The Prestfjall Formation (ca. 15 m thick) consists of various volcaniclastic sedimentary units including coal. The Hvannhagi Formation (< 100 m thick) is a mixture of interbedded basaltic tuffs and volcaniclastic sedimentary units. Prestfjall and Hvannhagi Formations are exposed in the northern part of Suðuroy and in the western part of Vágoy. The Malinstindur Formation (ca. 1,400 m thick) is predominantly composed of compound flows (Figure 2) consisting of olivine-phyric, through aphyric and plagioclase-phyric basalt, and is found throughout the islands except from the extreme southern, western, and eastern parts. The Sneis Formation (< 50 m thick) is a sandstone-conglomerate sequence that has been intruded by distinct aphyric tabular basalts. The uppermost Enni Formation (ca. 700 m thick) is composed of interbedded sheet lobes (akin to those of the Beinisvørð Formation) and compound lava flows (akin to those of the Malinstindur Formation) and is exposed throughout the central and northern regions. The Lopra, Beinisvørð, Malinstindur and Enni Formations constitute most of the total thickness of the FIBG.

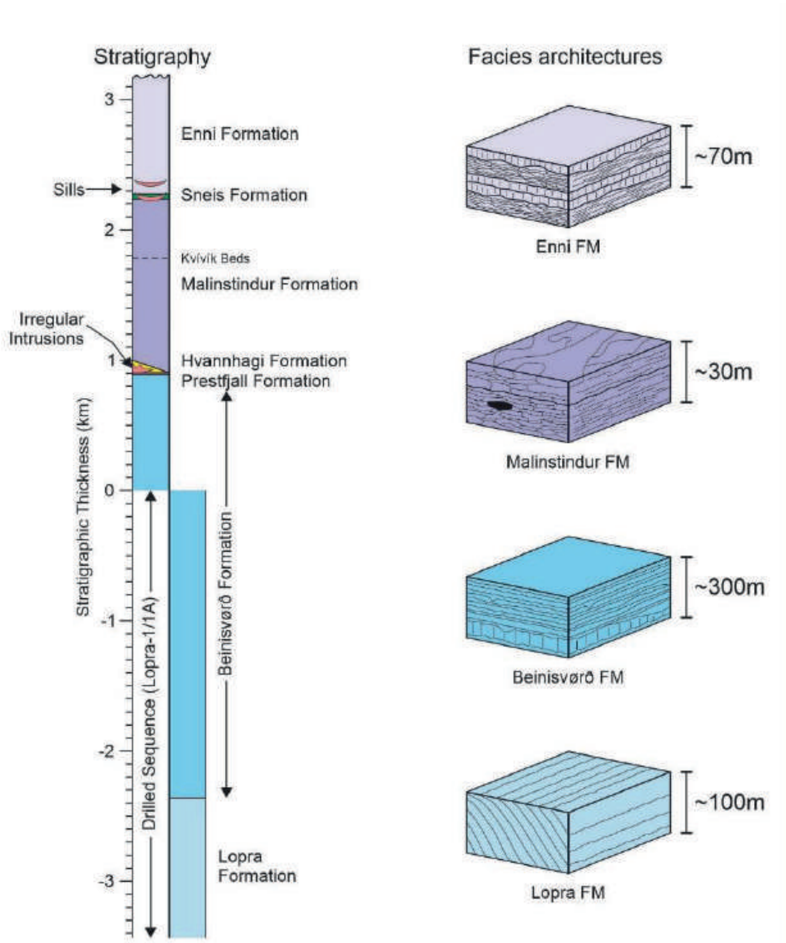


Figure 1. Stratigraphic column for the onshore Faroe Island Basalt Group. Facies architectures are given to the right of the column. After Rasmussen and Noe-Nygaard (1969) modified by Passey and Jolley (2009).

All three tunnel options between Sandoy and Suðuroy traverse significant parts of the stratigraphy mentioned above, except for the Lopra Formation, starting in the Enni Formation on Sandoy, going through most of Malinstindur Formation towards Suðuroy. The section between Sandoy and Skúvoy mainly consists of the Enni Formation, thus being composed of simple flows with thick sedimentary beds and of compound flows. The section between Skúvoy and Suðuroy mainly consists of the Malinstindur Formation, which is composed of compound lava flows having relative few and thin sedimentary units.

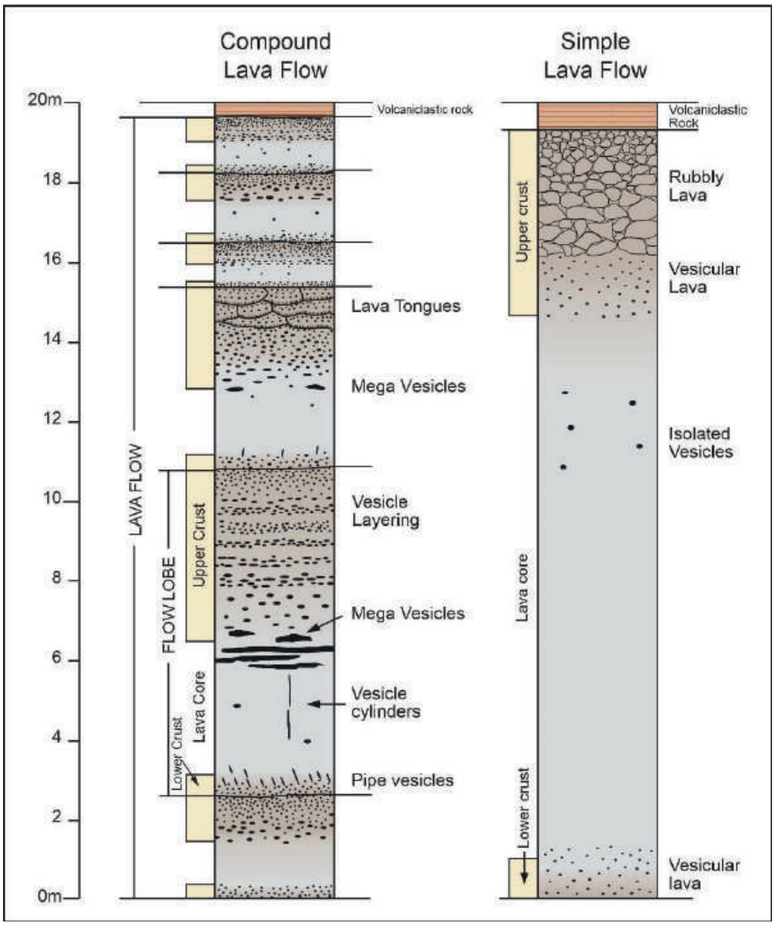


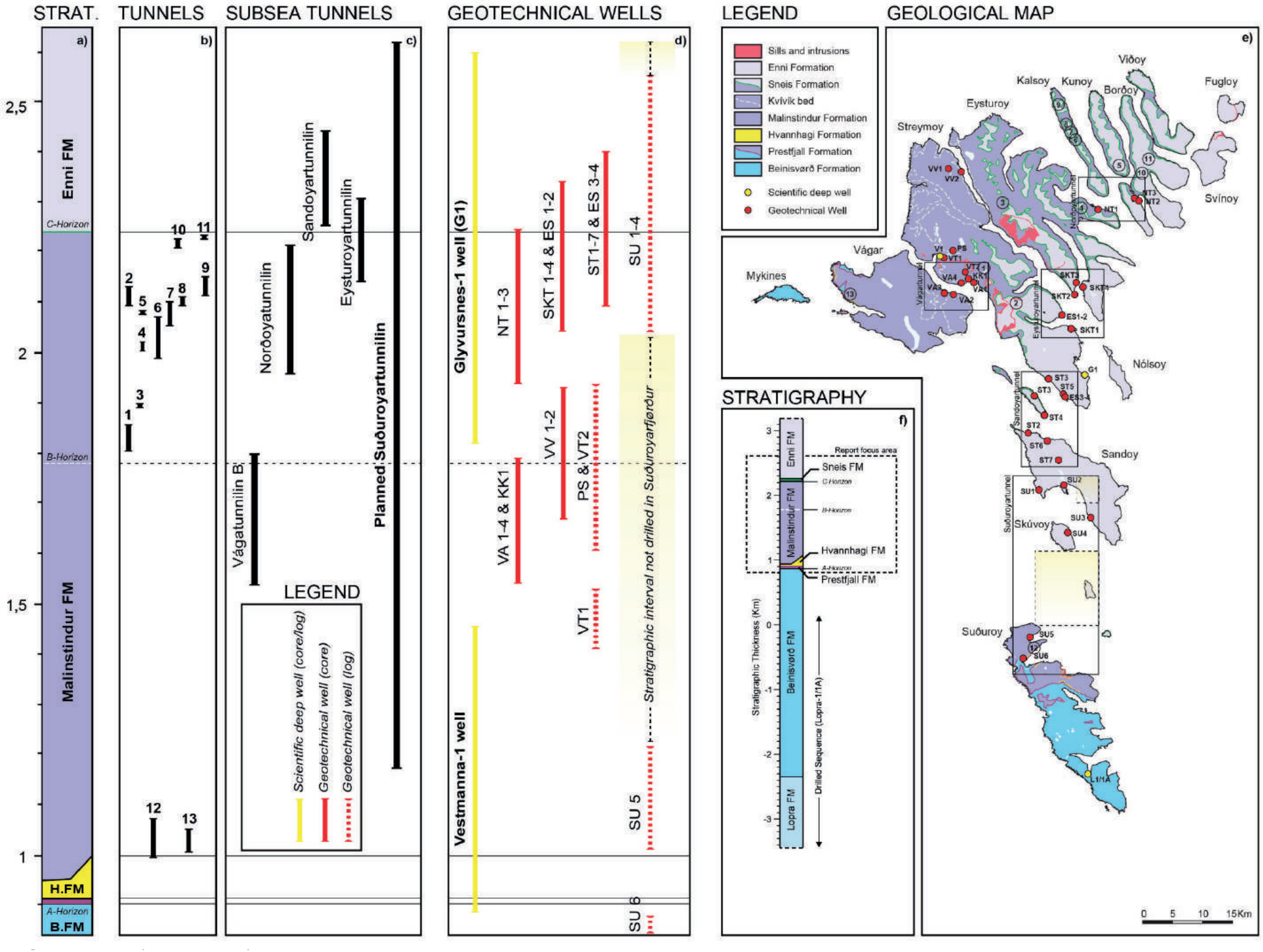
Figure 2. Simplified vertical sections through compound lava flows, typical for the Malinstindur Formation (left) and simple lava flow (sheet lobes), typical for the Beinisvørð Formation (right). The Enni Formation is composed of both above mentioned types. Modified after Waagstein (1998), and Passey and Bell (2007).

Previous studies

Previous tunnels in same stratigraphy

There are several large tunnel projects, both subsea and onshore, in the same stratigraphic interval as the planned Suðuroy tunnel. Figure 3b shows the stratigraphic location of the onshore tunnels. Figure 3c shows the stratigraphic location of the subsea tunnels and Figure 3d the related cores and wells. In addition, there are two scientific cored deep wells covering most of the stratigraphic interval of interest (Figure 3d).

These combined data sets and experience from tunnelling in the area supplements the data gathered for the Suðuroy tunnel. Reports and maps documenting these works are available from Jarðfeingi on request.



STRAT.
TUNNELS
SUBSEA TUNNELS
GEOTECHNICAL WELLS
LEGEND
GEOLOGICAL MAP
a)
b)
c)
d)
e)
f)
2,5
2
1,5
1
Enni FM
C-Horizon
B-Horizon
Malinstindur FM
H.FM
A-Horizon
B.FM
1
2
3
4
5
6
7
8
9
10
11
12
13
Sandoyartunnilin
Eysturoyartunnilin
Norðoyatunnilin
Vágatunnilin B
Planned Suðuroyartunnilin
LEGEND
Scientific deep well (core/log)
Geotechnical well (core)
Geotechnical well (log)
Glyvursnes-1 well (G1)
NT 1-3
SKT 1-4 & ES 1-2
ST1-7 & ES 3-4
SU 1-4
VA 1-4 & KK1
VV 1-2
PS & VT2
VT1
Stratigraphic interval not drilled in Suðuroyarfjørður
Vestmanna-1 well
SU 5
SU 6
Sills and intrusions
Enni Formation
Sneis Formation
Kvívík bed
Malinstindur Formation
Hvannhagi Formation
Prestfjall Formation
Beinisvørð Formation
Scientific deep well
Geotechnical Well
Viðoy
Kalsoy
Kunoy
Borðoy
Fugloy
Eysturoy
Streymoy
Svínoy
Vágar
Mykines
Nólsoy
Sandoy
Skúvoy
Suðuroy
VV1
VV2
V1
PS
VT1
VT2
VA4
KK1
VA3
VA1
VA2
NT1
NT2
NT3
SKT3
SKT2
SKT4
ES1-2
SKT1
G1
ST3
ST5
ES3-4
ST4
ST2
ST6
ST7
SU1
SU2
SU3
SU4
SU5
SU6
L1/1A
Norðoyatunnel
Vágartunnel
Eysturoyartunnel
Sandoyartunnel
Suðuroyartunnel
0
5
10
15Km
STRATIGRAPHY
Report focus area
Enni FM
Sneis FM
C-Horizon
B-Horizon
Malinstindur FM
Hvannhagi FM
A-Horizon
Prestfjall FM
Beinisvørð FM
Lopra FM
Stratigraphic Thickness (Km)
Drilled Sequence (Lopra-1/1A)
3
2
1
0
-1
-2
-3

Figure 3. Composite figure featuring the relevant section (inset map on f) of the FIBG stratigraphy (a), existing onshore tunnels (b), subsea tunnels (c), geotechnical and scientific wells (d), geologcial map of the Faroe Islands (e), and the full stratigraphic column (f). The tunnel numbers in (b) are shown on the map (e). Leynartunnilin (1), Kollfjarðartunnilin (2), Norðskálatunnilin (3), Leirvíkstunnilin (4), Kunoyartunnilin (5), Villingardalstunnilin (6), Ritudalstunnilin (7), Mikladalstunnilin (8), Trøllanestunnilin (9), Árnafjarðartunnilin (10), Hvannasundstunnilin (11), Sandvíkartunnilin (12) and Gásadalstunnilin (13). The areas for the subsea tunnels (c) are shown on the map (e) as boxes. Locations of the scientific and geotechnical wells (d) are shown as yellow and red circles on the map (e).

Results from the Eysturoy and Sandoy tunnels

The methods used for this project are based on experiences from the geological investigations for the Eysturoy and Sandoy subsea tunnels.

A significant challenge for the Eysturoy tunnel was to establish the depth and extent of a thick sedimentary basin underneath Tangafjørður. Several seismic surveys were performed with one of the main goals to establish the sediment thickness (GEOMAP, 2006; GEOPHYSIX, 2015; Neish, 2008). Especially good control of the sediment thickness was obtained from reprocessing and analysing the data acquired in 2007 (Neish, 2007; Petersen, 2016). Here an iterative processing of marine seismic data, combining refraction seismic analysis and stacking of data, gave very good velocity control, and thus gave good control of the depth to base of the sedimentary basin.

The results were consistent with the long onshore deviated coring under Tangafjørður as well as with recognisance upward drilling during tunnel construction. The combination of reflection seismic processing and refraction seismic analysis was essential to establish the velocity model, since not all velocity information was contained in the refraction seismic data due to a velocity inversion in the sediment basin (Petersen, 2016).

In the Sandoy tunnel area, the combination of reflection seismic data with onshore mapping and core descriptions, provided means for detailed mapping along the tunnel line with strike and dip of layers, and continuation of the stratigraphy. The mapped continuation and overlap of reflectors were a strong indication of lack of major faults previously suggested in the mapped area (Passey & Varming, 2010).

A reflection interpreted on seismic data to be related to the Sneis Formation has been verified by geological mapping during tunnel construction. Similarly, a seismic reflection tied to a sequence of thick sheet lobes observed in boreholes, was also verified by the mapping during tunnel construction.

Establishing fracture zones and dykes has been considered important challenges for the two previous tunnels. However, an important lesson to be learned from the previous tunnels, is that, generally, fracture zones do not show as low velocity zones on seabed, and that low velocity zones along the seabed are related to velocity differences of beds and flows intersecting the seabed.

Data

The following data have been acquired for the survey.

Well logs

Vertical wells were drilled using rotary percussion drilling. The wells were drilled in 2020 and 2021 using the same equipment that is used for the conventional drilling of geothermal wells. The wells are drilled by the companies Spf. Bora and Pf. Jarðhiti.

Positions of wells are measured by land surveyor at Landsverk.

Jarðfeingi acquired the wireline logs using logging equipment manufactured by Robertson GEO. Table 1 shows the logging suite. Table 2 shows location and depth of all wells. The location is shown on the map in figure 4.

The optical televiewer images are acquired with vertical and horizontal resolution of approximately 1 mm.

Table 1. Wire line logs.

Probe	Output logs
High Resolution Optical Televiewer	Image, Orientation
3-arm caliper probe	Diameter
Electric Log Probe	Resistivity, Natural gamma, Temperature

*Table 2. Positions of wells in FOTM (Projection: Foroyar Transversal Mercator). See Figure 4 for locations. *estimated preliminary position.*

Location	Latitude [m]	Longitude [m]	Elevation [m]	Length [m]	Well diameter [inch]
Søltuvík-2	859468.14	205944.99	46.30	320	5
Sandur-1	858750.03	209523.13	21.41	200	5
Skarvanes-1	853932.00	213311.97	16.24	400	5
Skúvoy-1*	851471	210345	6	400	6
Sandvík-1	835937.82	203656.65	28.48	200	5
Hvalba-1	832808.46	202300.50	26.84	300	5

Multibeam

The first multibeam survey for the Suðuroy subsea tunnel was done by Landsverk during the summer of 2018. Initially the focus was solely on tunnel option 1. The small survey boat, R/V Nísan, could only handle gentle wave swells and currents and was therefore not able to cover whole leg across Suðuroyarfjørður. The multibeam dataset was acquired with a Reson SeaBat 8125 multibeam echosounder that has a swath coverage of 120° using 240 beams at 455 kHz frequency onboard the boat R/V Nísan. The depth is relative to ground zero = average sea level. The positioning GNSS (Global Navigation Satellite System) is a Trimble BX982 on board the R/V Nísan, including a Motion sensor IXSEA Octans II, in combination with a base landstation Trimble R10. The GPS system has a centimetre level position accuracy.

The second multibeam survey was collected done by Landsverk early October 2021 onboard R/S Jákup Sverri. This time the focus was to cover the whole area around and including the three tunnel options. The multibeam datasets were acquired with a Simrad EM712 multibeam echosounder that has a swath coverage of 140° using 140 beams at 100 kHz frequency. The onboard RTK GNSS is a Kongsberg Seapath 380 that has centimetre level position accuracy. However, due to bad weather and unfavourable currents the survey was cut short leaving large caps uncovered in the study area (Figure 4). Follow up survey is currently being planned for 2022.

Seismic data

The marine seismic data were acquired in the summer 2020 with excellent weather conditions and good tidal current providing high quality data. The streamer was 600 m long with 96 channels at 6.25-m channel intervals. The source used was a 45 cubic inch airgun fired at 120 bars with 12.5-m shot intervals. See the processing report for further details (Petersen, 2020b).

The seismic profiles were planned along tunnel option 1. Between Sandoy and Skúvoy there is a threefold coverage with about 100 m offset centred at tunnel option 1, and between Skúvoy and Suðuroy there is similarly a threefold coverage with 200 m offset centred at tunnel option 1. There are several crossing profiles. These have a direction that is preferably perpendicular to the strike of the stratigraphic dip. This is to better distinguish coherent noise from primary signal when interpreting the seismic data. In addition, there are a few long profiles to aid the geological overview of the area (Appendix I).

At the time of the planning and acquisition of the seismic data, the request for preliminary investigations was for tunnel option 1 only. Later tunnel options 2 and 3 were included. The current data sets provides means for describing the stratigraphy of tunnel options 2 and 3, however, for sufficient coverage additional seismic data is needed along these profiles.

Overview map

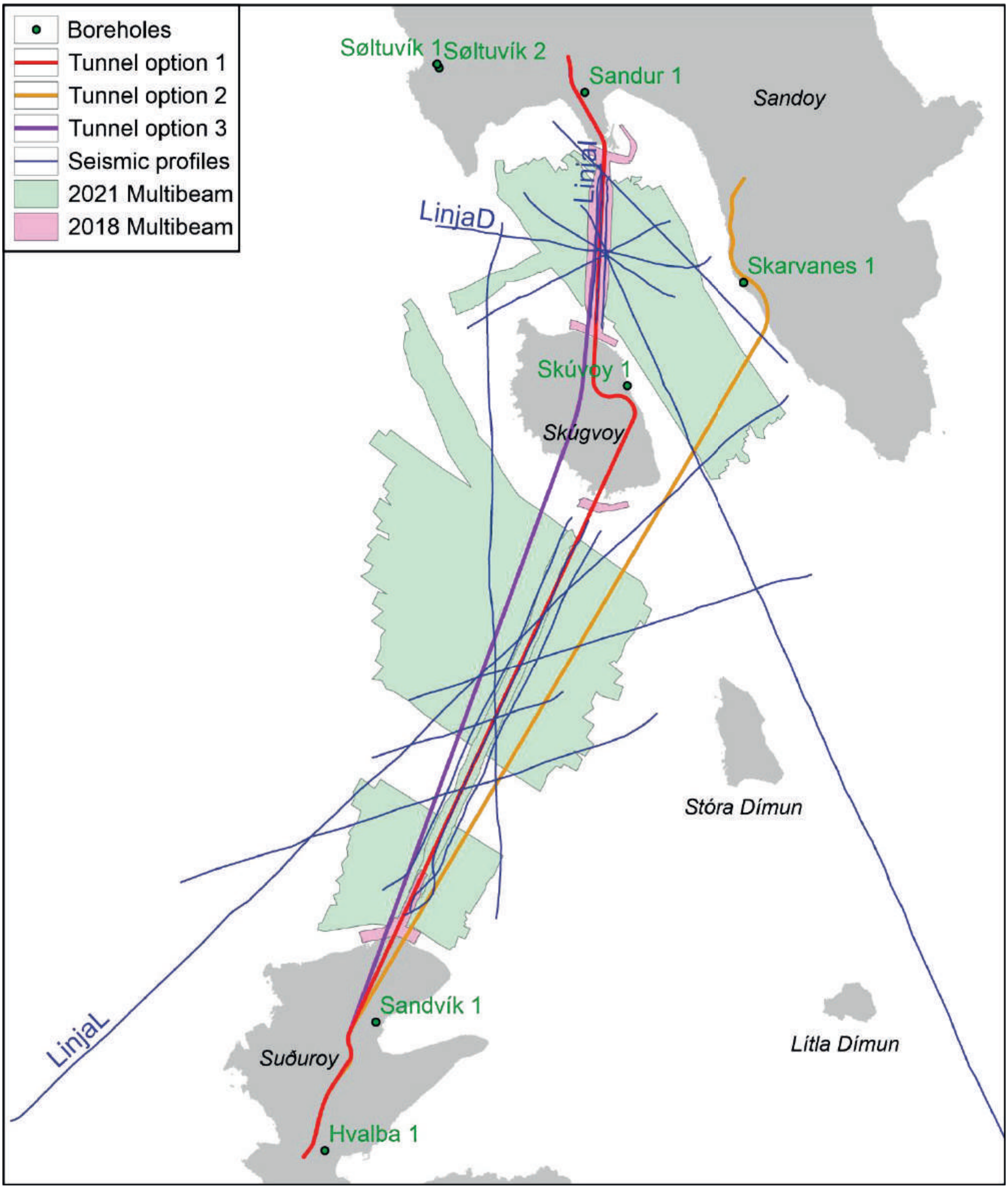


Figure 4. Data overview map. See Appendix I for detailed map.

Composite logs

The compilation of all data from the 6 onshore boreholes in Søltuvík, Sandur, Skúvoy, Skarvanes, Sandvík, and Hvalba are presented in a series of composite logs (Figures 5, 6, 7, 8, 9, and 10). The composite logs comprise a series of seven columns The first column shows the lithology. The next four columns show data from caliper, natural gamma (NGAM), point resistivity (SPR), and temperature logs. The last two columns present fracture density at 1-m intervals and structural data in 50-m intervals.

Lithology

The lithological interpretations are based on visual inspections of the optical televiewer images. The lithologies used are: Aphyric basalts, coarse grained feldspar-phyric basalt, fine grained feldspar-phyric basalt, and volcaniclastic sand- and claystone. Furthermore, the two descriptive features volcanic breccia and core stone are used. Flow boundaries are also indicated on the lithology log.

Wireline Logs

Below is a brief description of the use of the log data in a geological context.

The Caliper-log shows the diameter [mm] in the borehole and states the presence of larger cavities in the borehole. These data are used as support in interpretation of televiewer, NGAM and SPR logs.

The NGAM [API] data are used to constrain the presence of volcaniclastic sediment beds. In the composite logs the high NGAM spikes correlate very well to the interpreted volcaniclastic sediment beds in all the boreholes.

The SPR [Ohm] log measures resistivity in the rocks and gives physical parameters of the rock mass. High SPR values indicate massive core of lava flows, while lower values indicate lava crusts and bases, and volcaniclastic sediments. These data are therefore useful in adding to the lithological descriptions and correlation.

The Temperature [C°] logs show changes in the water temperature in the borehole. Where deviations from the general geothermal gradient are observed, these are taken as indications of high water-flow. Deviating geothermal gradients are most visible in the Søltuvík-2 and Sandur-1 logs. Here the temperature gradients in the uppermost 280 m in Søltuvík-2 and uppermost 75 m in Sandur-1 are nearly zero. This gives indications of a down-flow of water with surface temperatures down to these depths.

The SPR and NGAM logs are used together for correlation from well to well. In some cases, the correlation can be difficult if it is only based in image log interpretation. The combination of televiewer images, SPR, and NGM logs is therefore a much more rigid tool for correlating.

Structural data

Interpretation of structural data is done by measuring the intersection of the fractures with the orientated borehole teleview images. Here both strike and dip of the fractures are compiled for each fracture in the borehole.

All the fractures that were interpreted in the televiewer images were summed up by the fracture density plot (fractures pr. meter) in the composite figures. A noticeable feature is that there is a correlation between intervals with high fracture density and high SPR. These intervals correlate to massive sections of lave flows.

The rose diagrams sum up the structural data, for fractures steeper than 45 degrees, for each 50 meter in the boreholes. By using fractures steeper than 45 degrees we focus on fractures that display the tectonic fabric in the region.

Detailed log description is in appendices C to H. Log legend is in Appendix B.

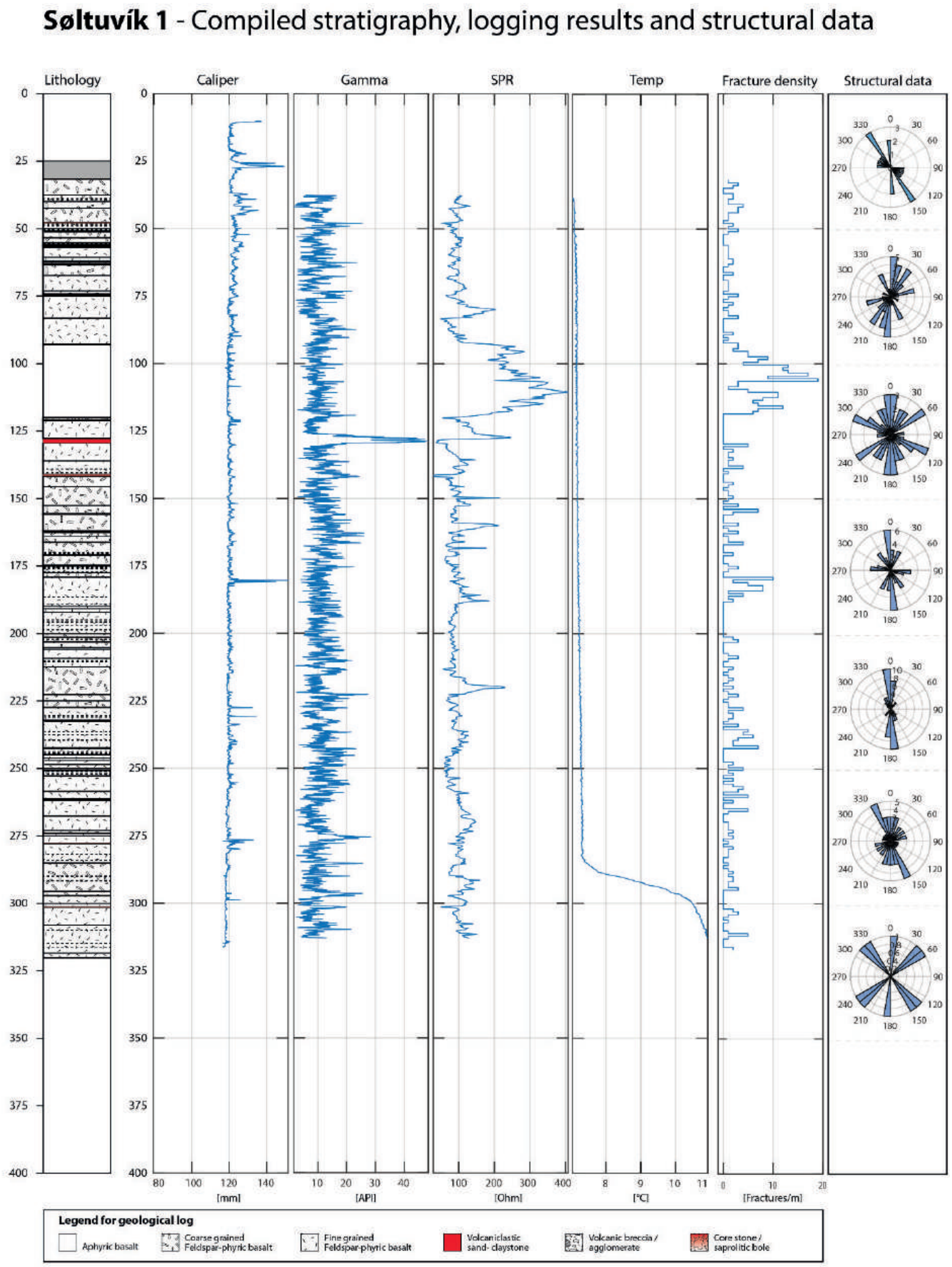


Figure 5. The composite logs for Søltuvík-2 comprise a series of columns. The first column shows the lithology, the next four columns show data from caliper, natural gamma (NGAM), point resistivity (SPR), and temperature logs. The last two columns present fracture density pr. meter and structural data in 50-m intervals

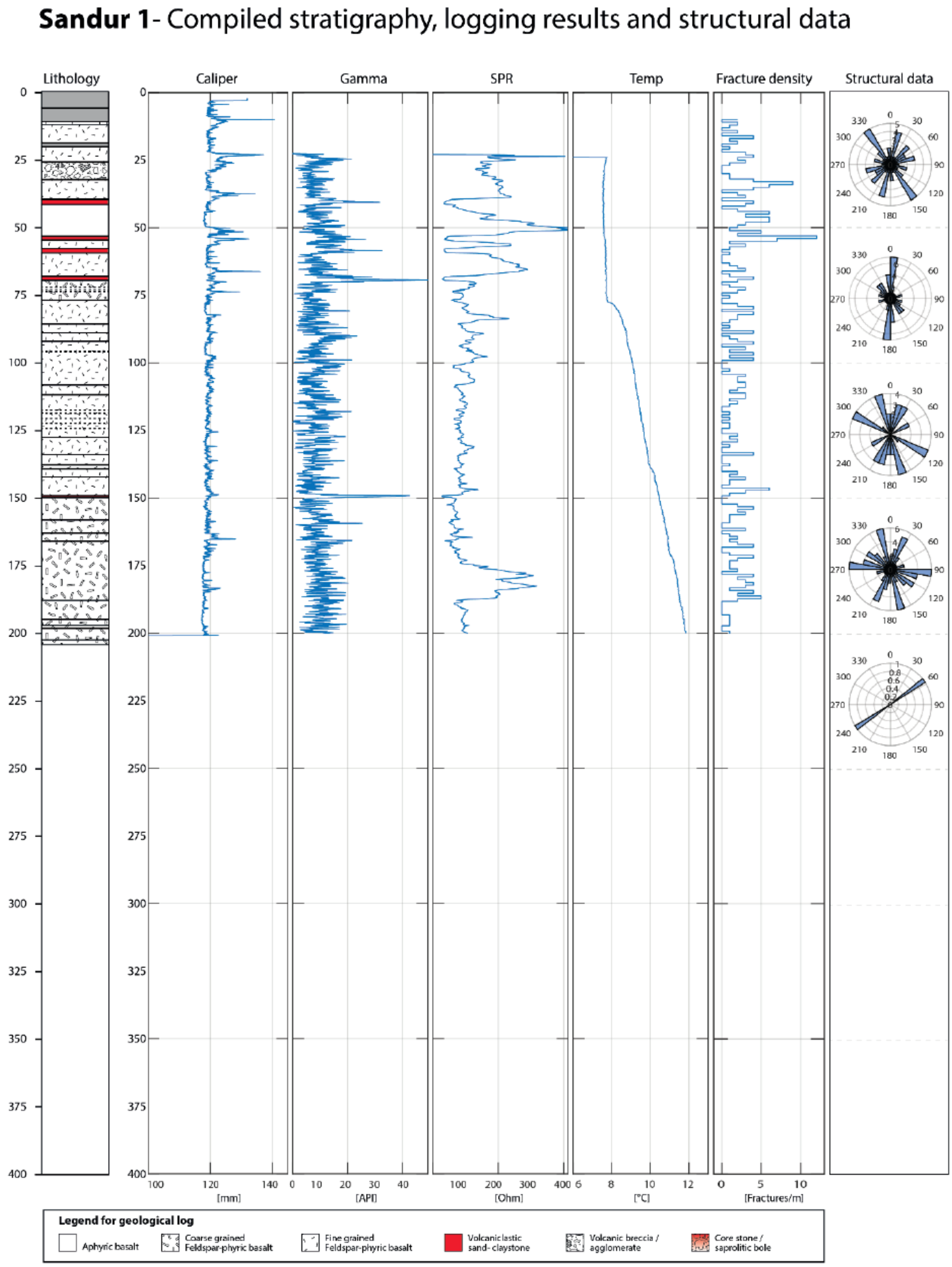


Figure 6. The composite logs for Sandur-1 comprise a series of columns. The first column shows the lithology, the next four columns show data from caliper, natural gamma (NGAM), point resistivity (SPR), and temperature logs. The last two columns present fracture density pr. meter and structural data in 50-m intervals.

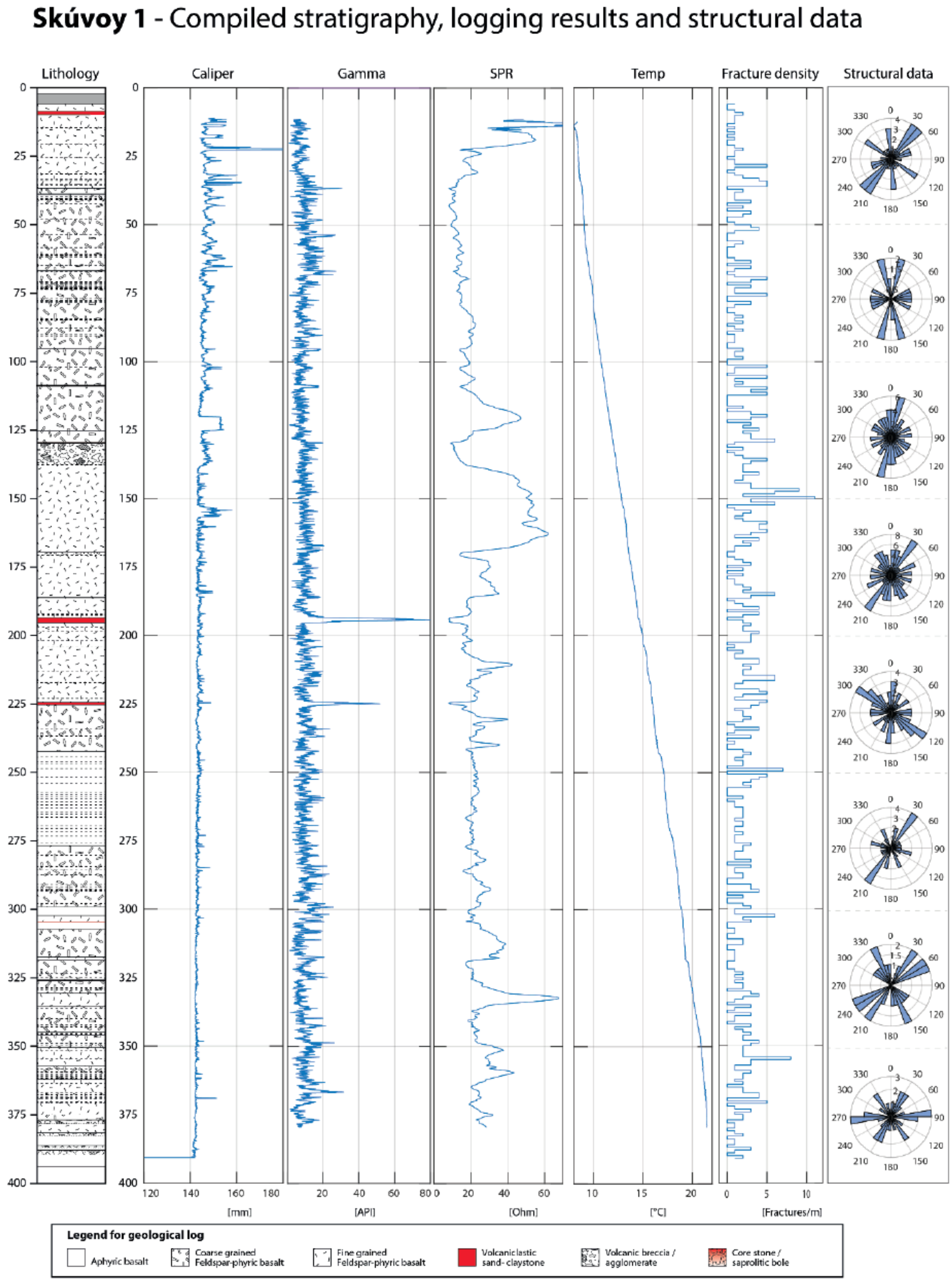


Figure 7. The composite logs for Skúvoy-1 comprise a series of columns. The first column shows the lithology, the next four columns show data from caliper, natural gamma (NGAM), point resistivity (SPR), and temperature logs. The last two columns present fracture density pr. meter and structural data in 50-m intervals.

Skarvanes 1 - Compiled stratigraphy, logging results and structural data

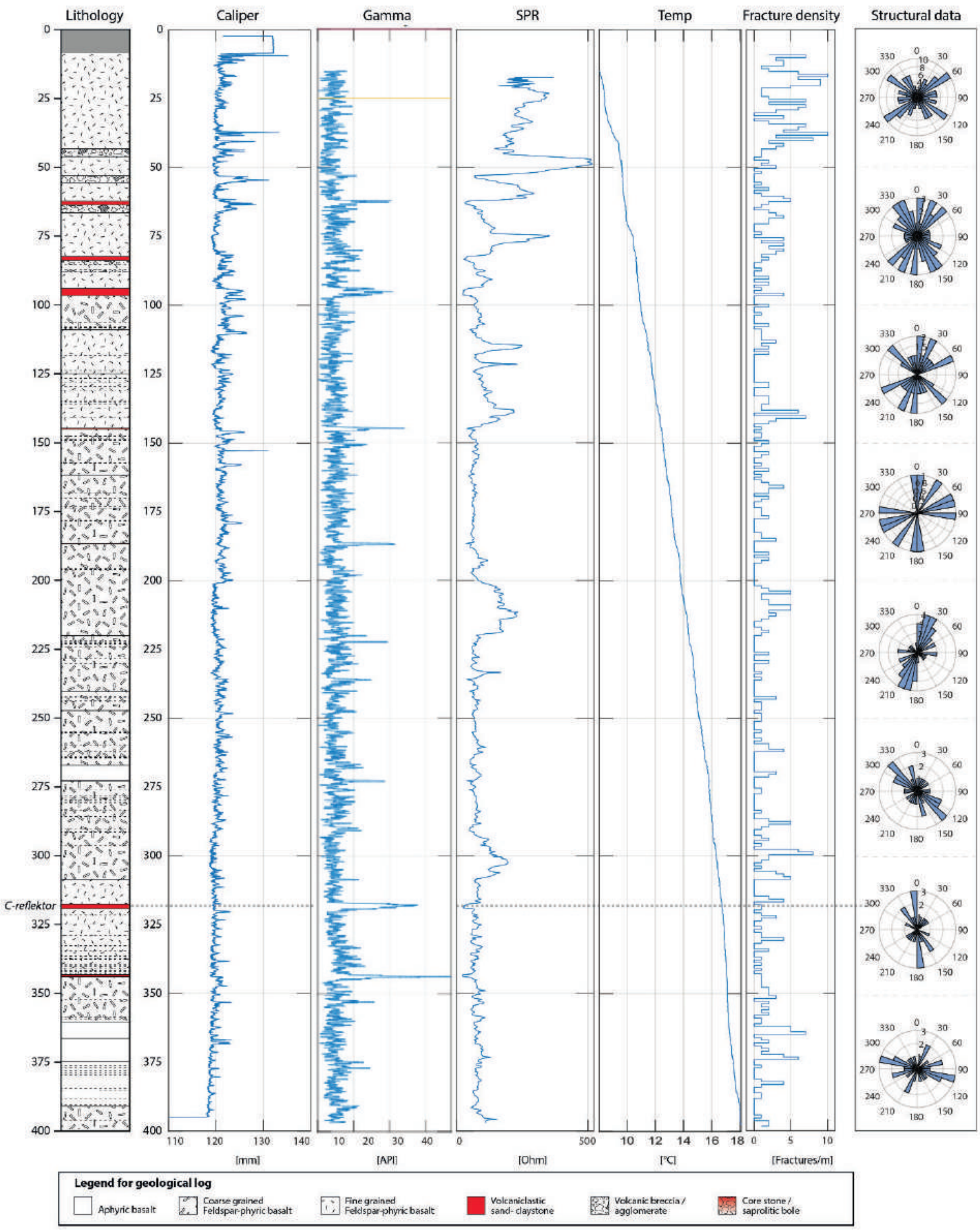


Figure 8. The composite logs for Skarvanes-1 comprise a series of columns. The first column shows the lithology, the next four columns show data from caliper, natural gamma (NGAM), point resistivity (SPR), and temperature logs. The last two columns present fracture density pr. meter and structural data in 50-m intervals.

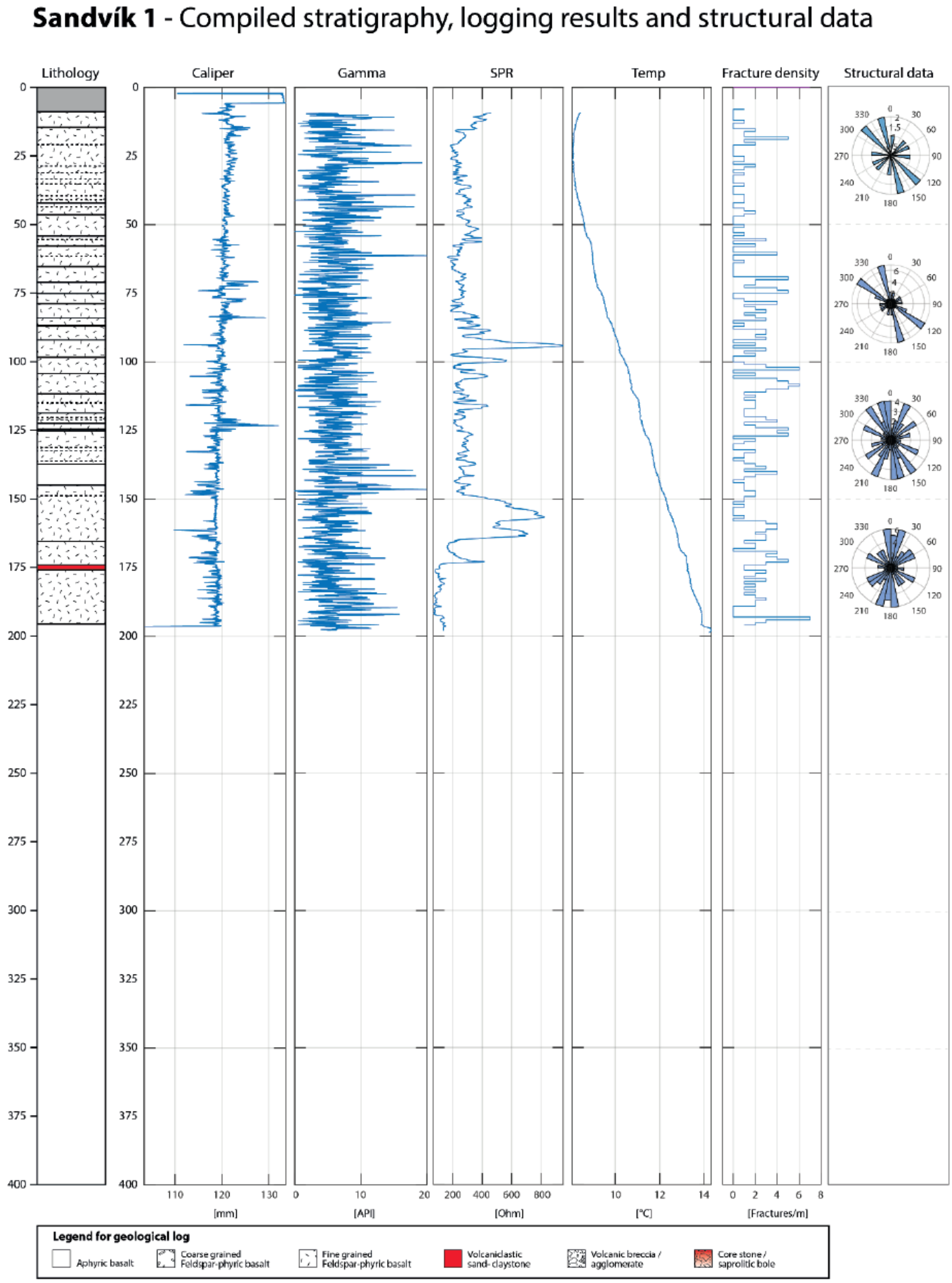


Figure 9. The composite logs for Sandvík-1 comprise a series of columns. The first column shows the lithology, the next four columns show data from caliper, natural gamma (NGAM), point resistivity (SPR), and temperature logs. The last two columns present fracture density pr. meter and structural data in 50-m intervals.

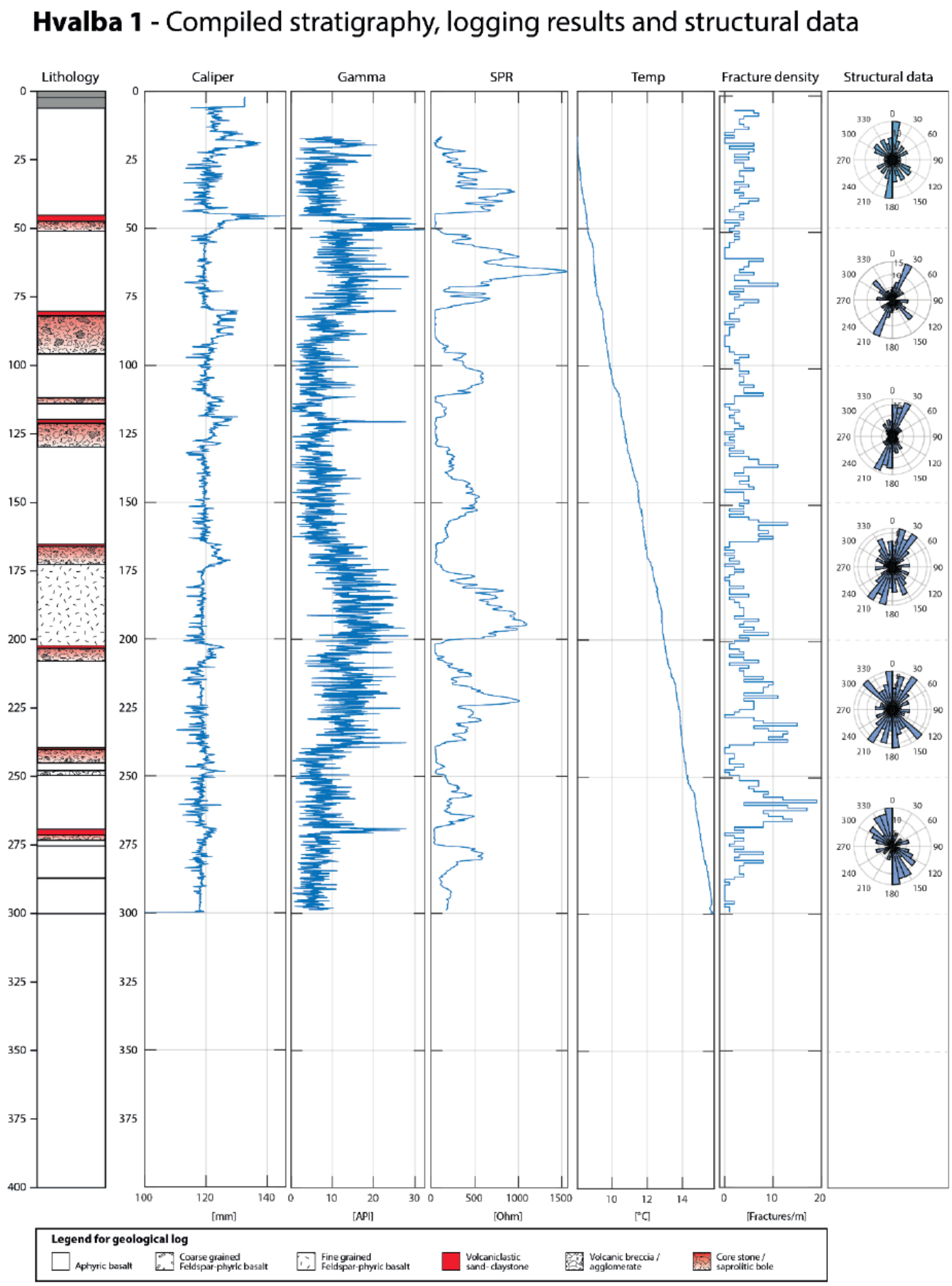


Figure 10. The composite logs for Hvalba-1 comprise a series of columns. The first column shows the lithology, the next four columns show data from caliper, natural gamma (NGAM), point resistivity (SPR), and temperature logs. The last two columns present fracture density pr. meter and structural data in 50-m intervals.

Correlation panels

A correlation panel spanning Skúvoyarfjørður includes the four surrounding boreholes: Søltuvík-2, Sandur-1, Skúvoy-1, and Skarvanes-1 (Figure 11). The correlation is based on integration of lithological interpretation of wireline logging combined with tie to seismic data in Skúvoyarfjørður. The seismic data provide the means to connect interpretations from well to well. The two remaining wells, Hvalba-1 and Sandvík-1 do not cover overlapping intervals, neither individually nor with the other four wells to the north (see Figure 3).

The Malinstindur Formation seen in the boreholes comprises typical compound flow facies architecture. Several thin flow lobes are observed in all the boreholes. Few volcaniclastic sand- and claystone beds are seen in the Malinstindur Formation. The Enni Formation is characterized by interfingering series of simple sheet flows and compound flows. This is also seen in all the three wells mentioned above.

A correlation between Søltuvík-2, Skúvoy-1, and Skarvanes-1 is based on an about 1.5 – 2 m thick sandstone underlain by first fine-grained feldspar phyric basalt and second by coarse-grained feldspar phyric basalt. The correlation is to a large degree also based both on a relatively high SPR signature in a 25 – 30 m interval, representing massive sheet flows, on top of a thin interval of a few meters, with very low SPR in combination with a high NGAM spike, representing sediments, that correlates to the low SPR value.

The stratigraphic level of the sediment is probably corresponding to the boundary between the Enni and the Malinstindur Formations. However, note that this differs from the C-horizon of Rasmussen and Noe-Nygaard (1969), where the boundary is placed 100 – 200 m higher up in this area, but it is more in agreement with the Malinstindur Sneis Unconformity (MSU) of Passey and Jolley (2009). In this report it will be named the *C-reflector*.

Another prominent correlation, between Sandur-1, Skúvoy-1, and Skarvanes-1, is a series of 3 – 4 sediment beds at about 175 – 225 m above the C-reflector. In Skúvoy-1 only the lowermost of these beds is present in the borehole, but at the drill site the correlating beds above are observed in the cliffs just above. The combined thicken of the sediment beds is 5 – 6 m. This sediment series will be named *Sandur Beds.* The Sandur Beds span a combined thickness with the interlaying lava flows of some 30 meters.

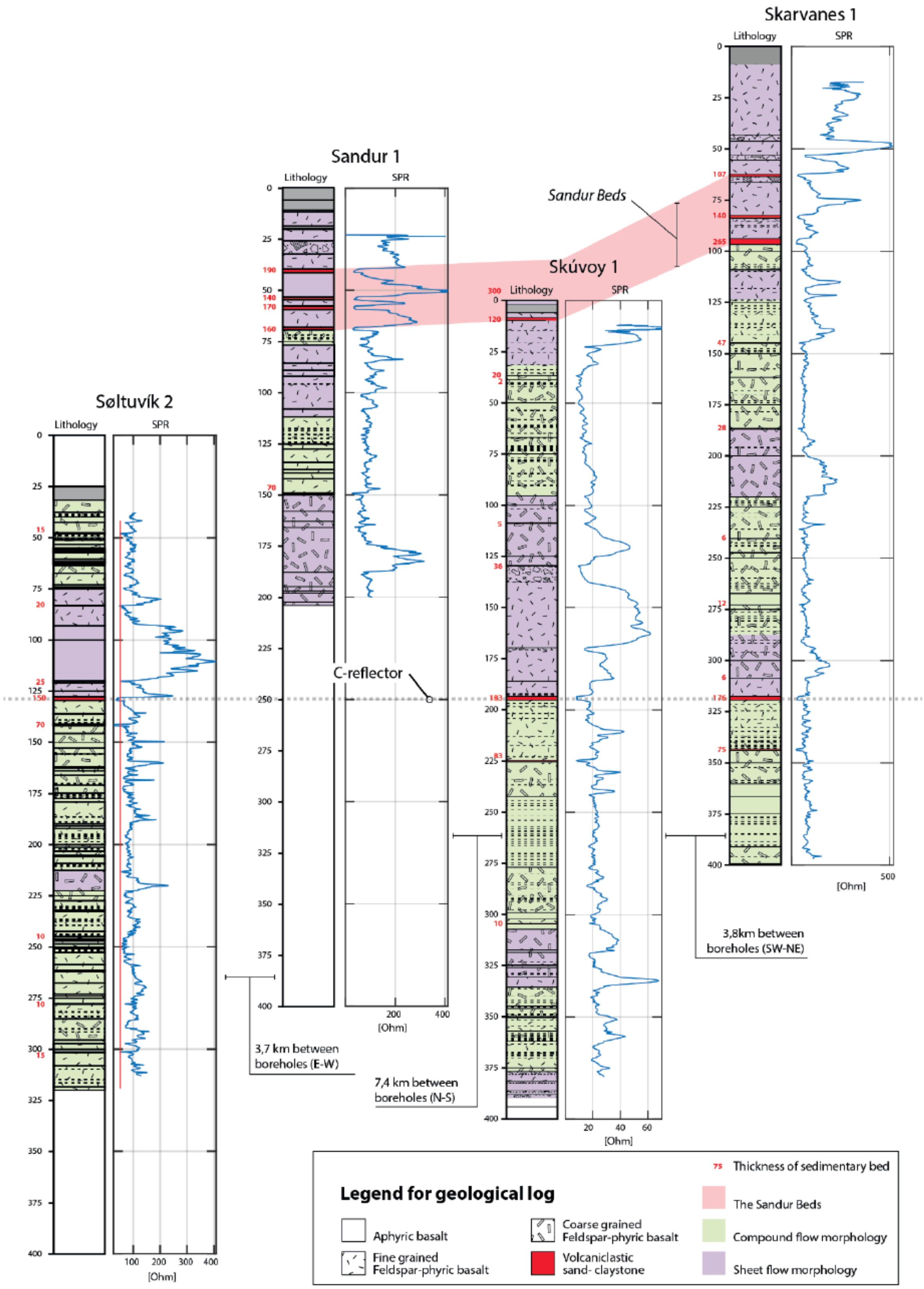


Figure 11. Correlation panel showing the four wells (Søltuvík-2, Sandur-1, Skúvoy-1, and Skarvanes-1) around Skúvoyarfjørður. Lithology and the SPR logs are used for the correlation. The logs are aligned to the C-reflector. The Sandur Beds have been highlighted in pink. Lava morphologies are marked in green (Compound flows) and purple (Sheet flows). Distances between the wells are indicated.

Interpretation of seismic data

The seismic survey utilizes the same method that was used in the planning of the Eysturoy and Sandoy subsea tunnels (Petersen, 2015, 2016). This method, acquiring marine reflection seismic data, and in an iterative process, combining refraction seismic modelling with interfaces from stacked seismic data, produces detailed velocity distribution along the seabed for the uppermost 100 m, and reflection seismic profiles suitable for interpretation of layering in the uppermost 100 – 300 m below seabed (See the prosessing report, Petersen, 2020b).

Reflection seismic imaging is based on reflections from reflectors in the subsurface (primary reflections). Reflectors, being interfaces defining changes in seismic properties i.e., density and velocity, define the *reflection coefficient*. The reflection coefficient is the amplitude of the reflected signal. The concept *Multiple reflections* is the situation of where the seismic signal is reflections several times between reflectors, typically between seabed and sea surface. Generally, the reflection coefficient is small, and the amplitude of multiple reflection is thus small relative to primary reflections. However, when there are interfaces with large reflection coefficients, multiple reflection can have high amplitude and thus pose a large problem for the seismic imaging.

The terminology for interpreted interfaces on seismic data is *a reflection* while the corresponding interface in the subsurface is named *a reflector*.

Generally, reflection seismic imaging in basalts is challenging, mainly due to the high scattering within the basalts. The high level of scattering is a result of high contrasts of rock properties related to core and crust of basalt flows and to interbedded sediments. But, in situations with few and thin sediment beds and less pronounced difference in rock properties for core and crust, as can be the case for compound flows, basalts can be quite transparent for seismic signals. A second challenging aspect of reflection seismic imaging in shallow waters, is the seabed multiple, which limits the depth range of seismic imaging. (Petersen, 2014; Petersen, Brown, & Andersen, 2015).

In the Sandoy – Skúvoy area, the basalt stratigraphy poses the challenging seismic properties, with many thick sedimentary beds and sheet lobes, and thus high level of scattered signal resulting in poor quality of stacks, although there are areas with good imaging within the basalt. In the Skúvoy – Suðuroy area, the basalt stratigraphy has the most advantageous seismic properties, with low noise level, thus providing very good seismic images.

The seismic interpretation presented in this section is all done on depth converted seismic profiles (Petersen, 2020b). All three tunnel options do, as described above, start in Sandoy, in the Enni Formation, and make their way all the way down through most of the Malinstindur Formation to just above base of the Malinstindur Formation in Suðuroy.

Skúvoy – Suðuroy

The basis for the seismic interpretation is taken in the seismic profile LinjaL (see Figure 4 for location). This profile is planed such that it covers the lowest part of the Enni Formation, down through all the Malinstindur Formation, and the profile is extended so it reaches to the top of the Beinisvørð Formation.

Figure 12 shows the depth converted seismic profile of LinjaL. First step is to identify multiple reflections. Figure 13 shows the first and second seabed multiple and some peg leg multiples. Above the first seabed multiple, primary reflections can be interpreted. Figure 14 shows four interpreted primary reflections intersecting the seabed. In fact, due to good quality of data, the reflections can even be interpreted well beyond the first seabed multiple. The interpreted reflections are named from the lowermost in the stratigraphy to the right, and going to the left upwards through the stratigraphy, as *A-reflection (green)*, *B-reflection (blue)*, *C-reflection (red)*, and *D-reflection (gray)*.

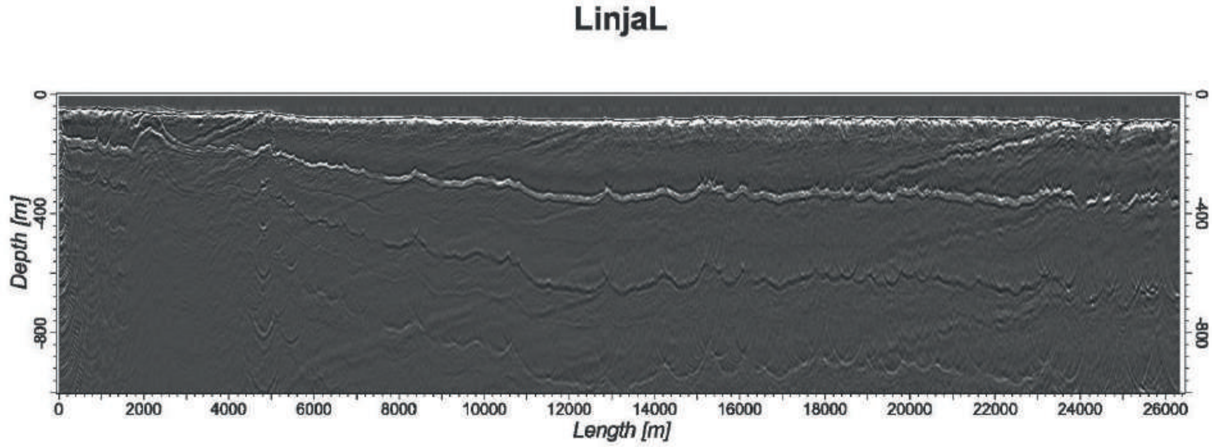


Figure 12. Depth migrated seismic profile LinjaL from north-east to south-west.

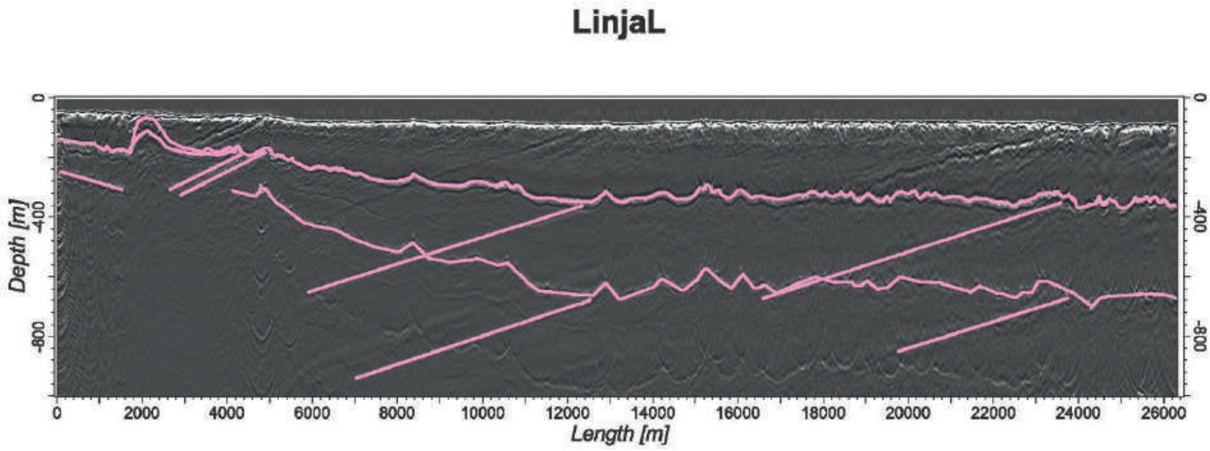


Figure 13. LinjaL with the first and second seabed multiple and the most pronounced peg leg multiples annotated.

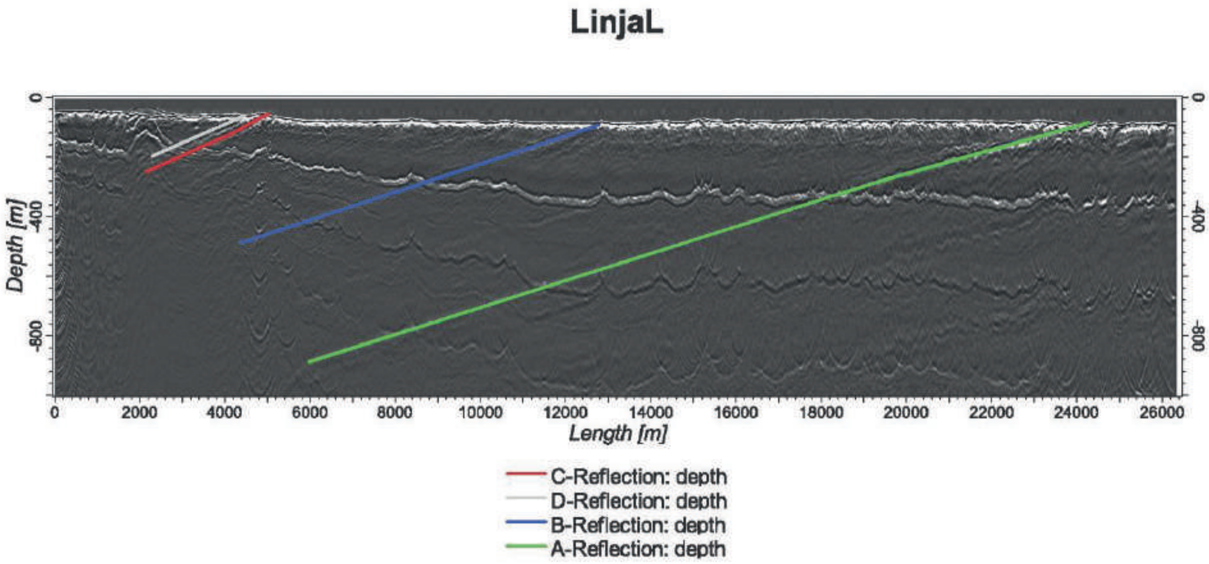


Figure 14. LinjaL with the four interpreted reflections.

Generally, high amplitude reflections are related to an interval with large difference in seismic properties relative to the surrounding stratigraphy. They have previously been associated with sedimentary beds

(Petersen, 2014; Petersen et al., 2015), but it must also be considered that local difference in seismic properties of basalt flows alone could result in high amplitude reflections.

From previous work, there is good constraint on the mapping of the base of Malinstindur Formation around the Faroes (Petersen, 2020a; Petersen et al., 2015). Based on this, the A-reflection is associated to the base of the Malinstindur Formation or the Hvannhagi-Malinstindur Unconformity (HMU).

The B-reflection is not possible to correlate to the stratigraphy, but it is worth noticing that the location in the stratigraphy makes the sedimentary Kvívík bed a good candidate (Figure 1).

The C-reflection is interpreted on several seismic profiles around Skúvoy. The C-reflector from the correlation panel (Figure 11), is tied to one of these seismic profiles in Skúvoyarfjørður (Figure 15) by Søltuvík-2 and Skúvoy-1 boreholes and coincides with C-reflection.

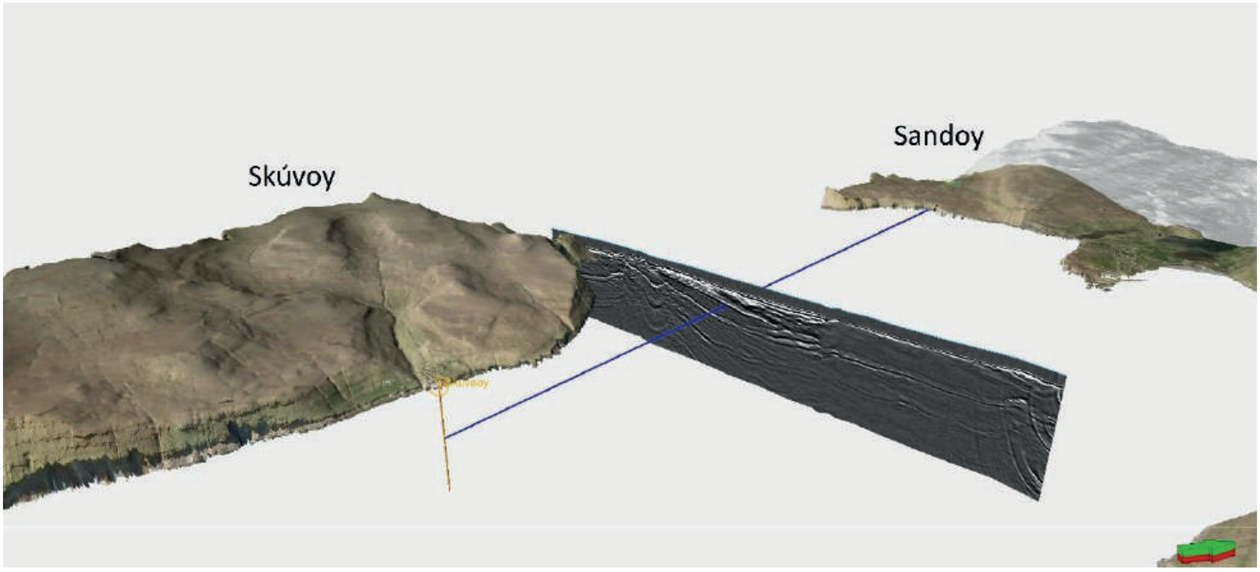


Figure 15. Thick blue line connects interpreted C-reflector in Søltuvík and Skúvoy well providing a tie to seismic data.

Skúvoy – Sandoy

Between Skúvoy and Sandoy, the seismic profile Linjal (Figure 16), parallel with tunnel option 1, but with about 100 m offset to the west, is taken as basis for describing the interpretation. Like above, first the multiple reflections must be identified. In addition to the seabed multiples, this profile also has multiples within a thick sediment basin on top of the bed rock. Figure 17 shows the sediment multiple, the first seabed multiple, and some peg leg multiples. Figure 18, shows the sediment basin and the two most significant reflections within the basalts above the first seabed multiple. The lower is the C-reflection mentioned above and the upper, about 60 m higher, is the D-reflection.

Whilst the C-reflection is related to a 1.5 – 2 m thick sediment bed drilled and correlated in the 3 wells surrounding Skúvoyarfjørður (Figure 11), the nature of the D-reflection is not related to a thick sediment bed, since none of the 3 wells has sediments of significant thickness in the interval about 60 m above the C-reflection where D-reflection is located. Instead, a 40-m thick sheet lobe with 8-m thick brecciated flow top, logged in the Skúvoy-1 well, is a good candidate for the D-reflection. The massive core poses a 32-m thick interval with homogenous seismic properties, different to the flow top and to the average surrounding seismic properties in general. The estimation of surroundings seismic properties is both from televiewer log interpretation and from resistivity log since there is a correlation between seismic velocity and resistivity logs (e.g. Waagstein & Andersen, 2003).

Similar resistivity logs are in both Søltuvík-2 and Skarvanes-1. But whilst the low resistivity related to the top of the 32-m thick core in Skúvoy is at about 60 m above the C-reflection, a similar high resistivity followed by low resistivity on top is only at about 40 m above the C-reflection in Søltuvík-2. In Skarvanes-1 similar resistive is logged about 30 m above the C-reflector.

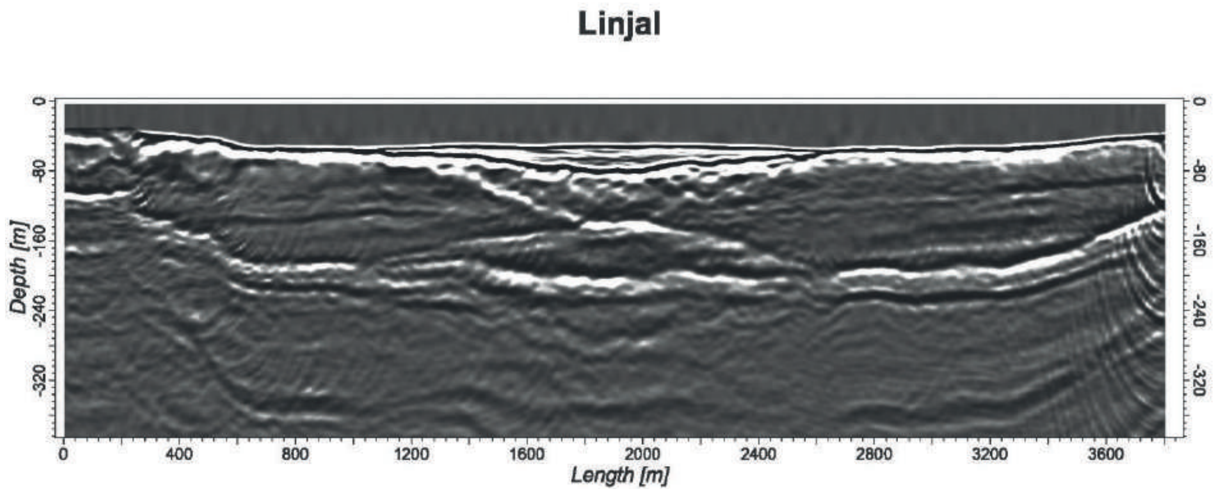


Figure 16. Depth migrated seismic profile LinjaI from north to south.

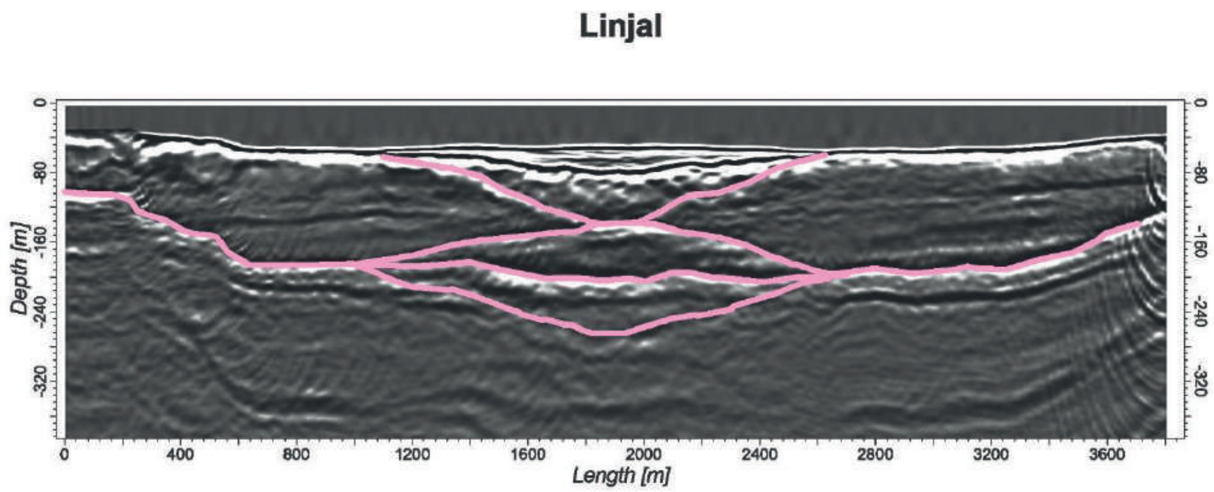


Figure 17. LinjaI with the sediment multiple, the first seabed multiple, and some peg leg multiples

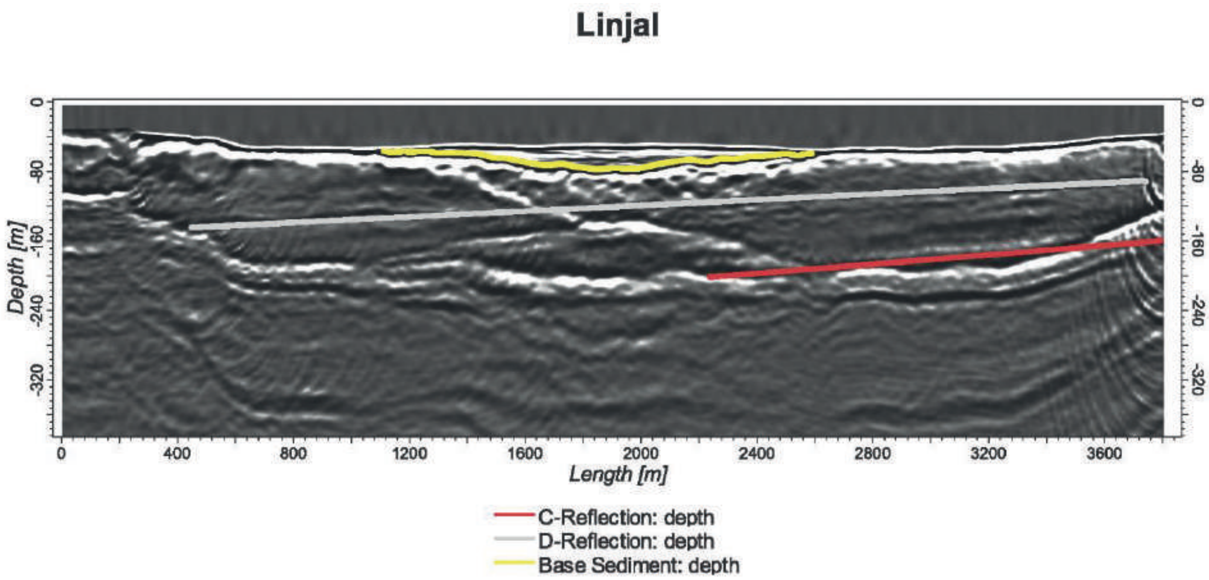


Figure 18. LinjaI with interpreted base sediment, C-Reflection, and D-reflection.

As stated above, the Sandoy – Skúvoy area poses challenging circumstances for the seismic imaging. But in the area of tunnel option-1 and to the west, there is reasonable seismic imaging. However, just to the east of the tunnel option 1, the seismic imaging fails completely. It must thus be kept in mind that there is an area with no constraint from reflection seismic data (Figure 19). The bad seismic data can be related to the effect of Sandur beds on seismic wave propagation.

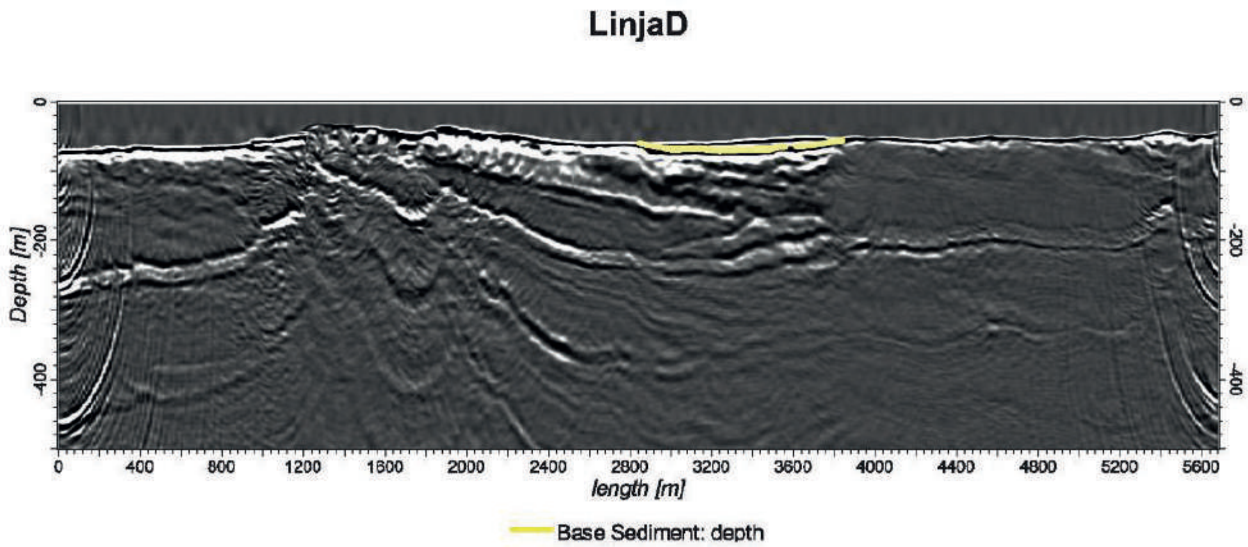


Figure 19. LinjaD from west to east. Example of seismic profile where imaging fails. To the right, east of the sediment basin, there is no primary signal. Similar can be seen on profiles: LinjaC1, LinjaP, LinjaF, and LinjaA (see processing report Petersen, 2020b). See Appendix I for location

Surfaces of the seismic interpretation are in Figure 20 and show the data coverage.

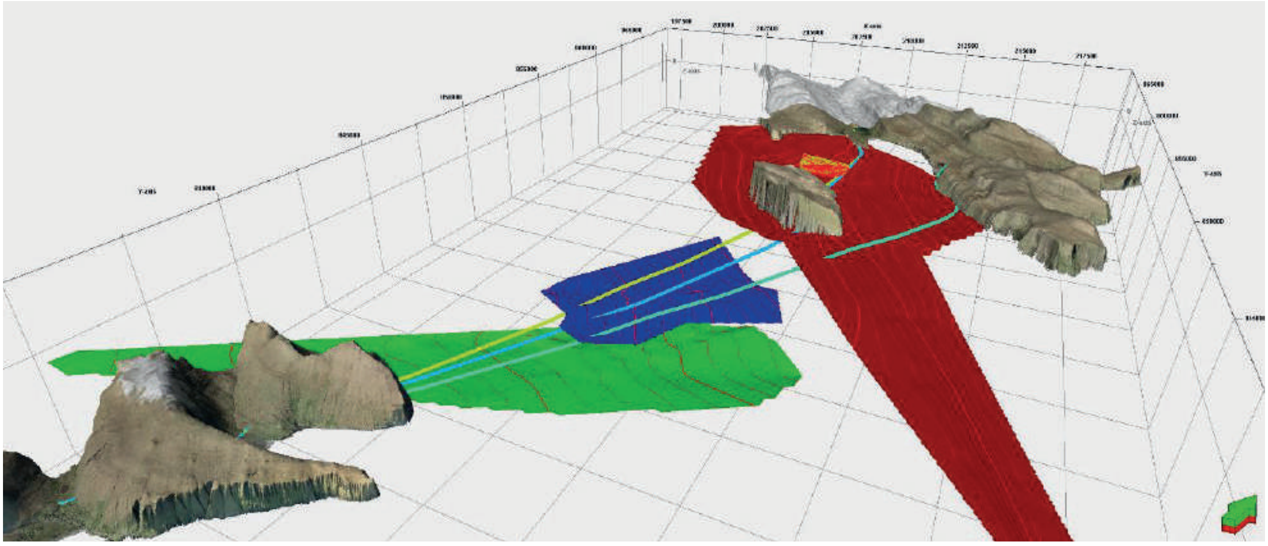


Figure 20. Interpreted surfaces used for the profiles: A-Reflection (green), B-Reflection (blue), C-Reflection (red), and Base sediment (yellow). The D-Reflection is not on the figure. All surfaces are based only on seismic interpretation except for the C-Reflection where the interpreted C-Reflector in Skúvoy-1, Søltuvík-2, and Skarvanes-1 well logs were used as additional guiding points. Tunnel options 1, 2, and 3 are blue, green, and yellow respectively.

Geology of tunnel profiles

Three geological profiles are presented, one for each tunnel option (Figures 21, 22, and 23). The route for tunnel option 1 in this report was drafted by Landsverk in 2016 while option 2 and 3 were initially drafted by the work group in 2019 (Brimnes et al. 2019). All three tunnel routes were based on the available topographic and bathymetric data at the time. The latter, bathymetry, was very scarce or non-existing in large parts of the study area. Lack of bathymetric data affects the confidence of the overburden below the seabed along the tunnel routes. The initial terrain models used for the tunnel option drafts are therefore presented along with new multibeam and seismic data in the geological profiles. It is evident, from the multibeam data, that the nearshore bathymetry south of Sandur and north of Skúvoy is shallower than the initial estimated terrain model, while the nearshore multibeam bathymetry south of Skúvoy and north of Suðuroy is deeper than originally estimated. Unfortunately, there are still gaps in the nearshore multibeam data south of Skúvoy and Skarvanes and in places further from the shore. The seismic profiles in Skúvoyarfjørður have uncovered a sediment basin in the middle of the fjord which, naturally, increases locally the depth to the bedrock below the seabed.

The interpreted seismic reflections A, B, C and D from above are included in the profiles as A, B, C, and D reflectors. Similarly, the base of the sediment basin in Skúvoyarfjørður is included.

The boreholes presented in this report are projected on the geological profiles along the shortest path between each relevant borehole and profile. The elevation of each projected borehole is set to the stratigraphic interval they represent.

The sediments found in Sandur-1, Skarvanes-1 and Skúvoy-1 boreholes have been tentatively projected to the profiles in the following manner. The second lowest sediment bed from the Sandur Beds series has previously been mapped and correlated between Sandoy, Skúvoy and Stóra Dímun (Heinesen, Madsen, & Højgaard, 2018; Højgaard, 2012; Rasmussen & Noe-Nygaard, 1969; Vosgerau et al., 2011). This sediment bed has been spline interpolated and projected to the profiles and has been used as a baseline for other sediment units, from the previous mentioned boreholes, to be parallel shifted against. While the spline interpolation seems to fit well with the C-reflector and land- and seabed morphology between Sandur and Skúvoy (i.e. the projected Sandur Beds fit well with breaks in the slope on land and near shore around Sandur in Figures 21 and 23), the spline interpolation did not fit too well with the slope of the C-reflector between Skúvoy and Skarvanes. Therfore, the C-reflector has been used as the baseline for parallel shifting sediment units below the seabed between Skúvoy and Skarvanes (Figure 22).

Finally, the Malinstindur-Sneis Unconformity (MSU) and the Hvannhagi-Malinstindur Unconformity (HMU) have been tentatively projected to the profiles by parallel shifting the spline interpolated sediment bed or extrapolate the A-reflector, respectively.

Profile of options 1

The tunnel entrance on Sandoy will start in the Enni Formation lavas characterised by sheet flows and interbedded sedimentary horizons.

The tunnel will intersect all the Sandur beds during the first few kilometres and will intersect the Sandur beds again on the uppermost part on Skúvoy.

The leg between Sandoy and Skúvoy crosses the location of the sedimentary basin mapped on the seabed in Skúvoyarfjørður (Figure 18 and Appendix I). The maximum thickness of the sedimentary basin is about 50 m, however, the tunnel is placed relatively close to the eastern edge of the sedimentary basin where the thickness is about 20 m.

The basalt morphology below the Sandur beds down to the Malinstindur-Sneis Unconformity (MSU) is characterized by a mixture of sheet lobes and compound flows with few thin sedimentary beds. The tunnel will potentially cross and follow the D-Reflector, likely a thick massive sheet lobe, towards Skúvoy.

Continuing southwards through Skúvoy, the geology in the first few 100 m, will again intersect the lower part of Sandur beds and continue through the lowest part of the Enni Formation and cross the MSU just south of Skúvoy. After the MSU the tunnel continues downwards through most of the Malinstindur Formation crossing the B-Reflector and ending about 200 m above the base Malinstindur Formation in Sandvík.

The Malinstindur Formation is characterized by compound flows with few thin sediment beds. However, given the morphology of the compound flows, local sedimentary beds that can be up to meters thick (Petersen & Madsen, 2021).

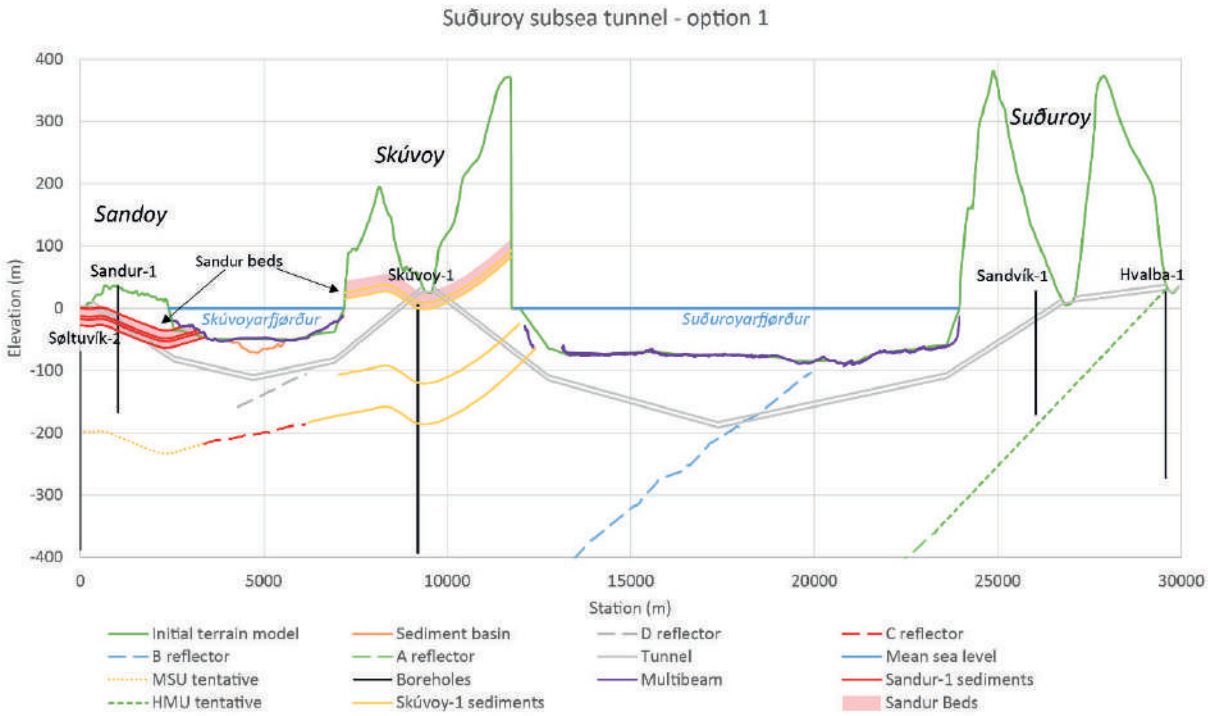


Figure 21. Profile of tunnel option 1.

Profile of tunnel option 2

The tunnel option 2 starts higher in the stratigraphy than option 1.

Several thick sediment horizons above the level logged in Skarvanes-1 borehole have been observed along the road from Sandur to Skarvanes. These are not included on the profile although the tunnel will intersect these. Additional work is necessary for detailed mapping. Following these sedimentary horizons, the tunnel will intersect the Sandur beds.

Just south of Skúvoy the tunnel intersects the C-reflector (MSU), and the tunnel continues downwards through the Malinstindur Formation like option 1 described above. Southeast of Skúvoy multibeam data shows a large sandbank (dune). The seismic data verify that there is no basin underneath.

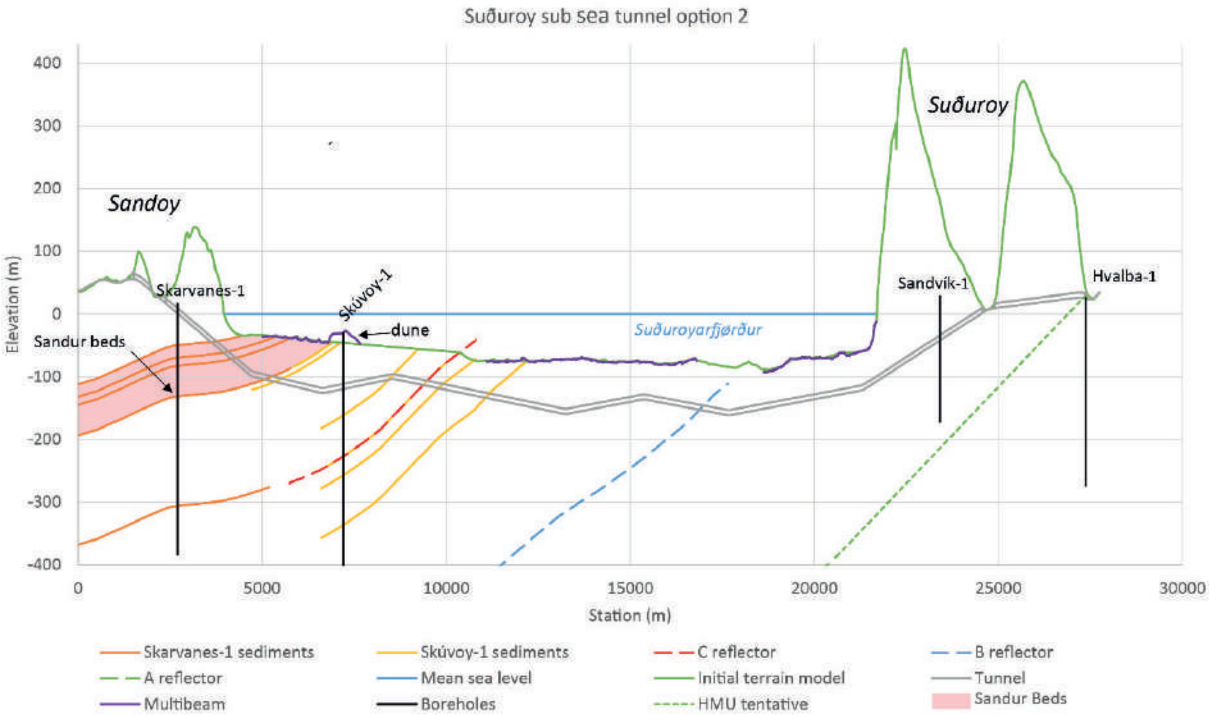


Figure 22. Profile of tunnel option 2.

Profile of tunnel option 3

Tunnel option 3 starts in same location as option-1. The main difference between profile-1 and 3 is that profile-3 goes directly to Sandvík so the Sandur beds will only be intersected on the entrance from Sandur.

In Skúvoyarfjørður the tunnel is located more to the west and the depth of the sediment basin is thus larger, about 26 m.

The description of the profile is otherwise similar to the tunnel option-1 above.

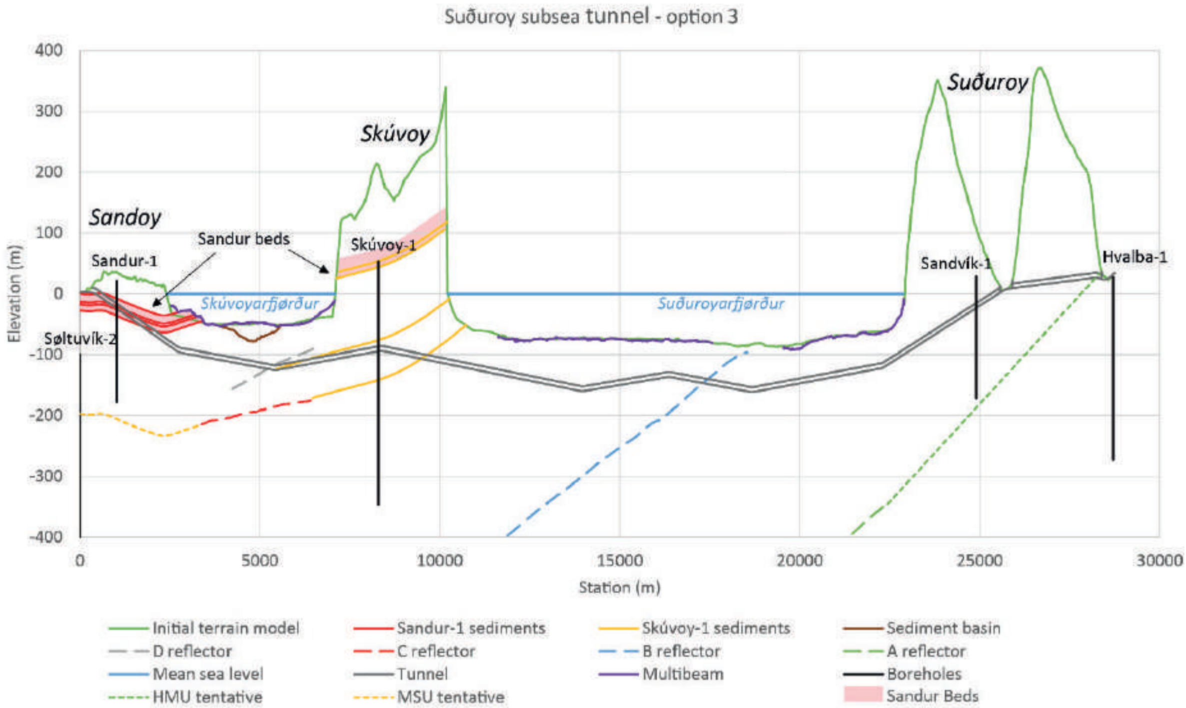


Figure 23. Profile of tunnel option 3.

Stratigraphic intervals not drilled

Figure 24 illustrates the stratigraphic intervals along the tunnel profile not drilled. It concerns the middle and lower part of the Malinstindur Fm north of Suðuroy, and Enni Formation north of Skarvanes.

However, the mapping of the lateral extent of the main formations in the Faroe Islands, i.e. Enni Fm, Malinstindur Formation, and Beinisvørð Formation (Rasmussen & Noe-Nygaard, 1969, 1970), provides means for extrapolation of information from different localities in the Faroes in order to cover the missing intervals.

The middle and lower part of the Malinstindur Formation is covered by the Gásadal tunnel, Sandvík tunnel, the Vestmanna-1 well, VA 1-4 & KK1 and SU 5 cores. The level of the Enni Formation north of Skarvanes is covered by Glyvursnes-1 scientific well, ST1-7 & ES 3-4, SU 1-4, Eysturoy tunnel, and Sandoy tunnel (Figure 3).

The seismic interpretation in this report is also done relating to the stratigraphical mapping of the Faroes and is consistent with this. Further, the refraction seismic velocities along the seabed, correspond very well to logged velocities of same stratigraphy but in other locations in the Faroes, thus providing rock properties for the Skúvoy – Suðuroy area (Figure 32 in

Appendix A).

However, although general information for the stratigraphy can be extrapolated to the Suðuroy tunnel area, there is the need for local mapping of the missing stratigraphy and lateral variations.

Mapping of the northernmost mountain an Suðuroy, Borgin, would cover the Malinstindur interval of interest (Figure 24). Ideally, a 400 m deep well on the mountain would be the best solution, but this would be a great logistic challenge. The cliff is very step so traditional field logging must be considered impossible. A more practical solution is photogrammetry from drone, possibly combined with mountain climbing. Alternatively, a number of seabed cores, can be drilled to cover the stratigraphic interval.

The unmapped stratigraphic level in the Enni Fm north of Skarvanes, is only of relevancy for the tunnel option 2. All methods above are feasible. If a well is drilled, it should be 200 – 300 m deep.

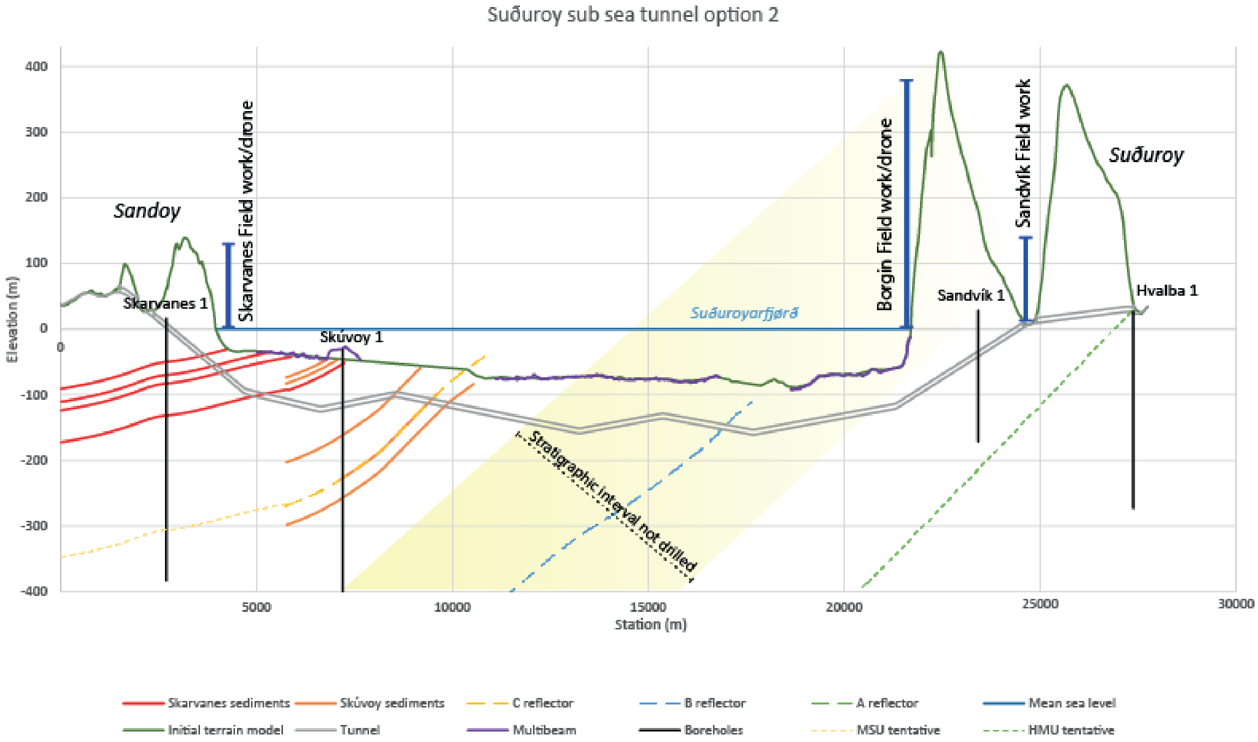


Figure 24. Tunnel profile of option 2 with stratigraphic interval not drilled annotated. Vertical blue lines show suggested field work to cover the missing interval.

Fracture zones

Mapping of fracture zones is of great importance for the tunnel construction. This work is ongoing and not completed yet. To some extent mapping of fractures can be based on onshore mapping extrapolated offshore. However, at large distances from shore the multibeam mapping of the seabed is the main source.

The acquisition of multibeam is not completed yet due to logistics in relation to the research vessel Jakup Sverri. There has been one attempt for the acquisition, but the weather conditions were not good, which affected the data quality significantly. Therefore, it was decided to continue the acquisition when conditions are suitable.

Detailed interpretation of fracture zones will be in a future report, incorporated with the previous report on fractures from (Heinesen et al., 2018).

Suggested supplement for detecting fractures zones

During the ongoing work, it has become clear, that an alternative method of detecting fractures zones might be feasible. We have observed that there are cases, where there is a back scattering of energy from the normal move out on shot gathers. The back scattering is a reflection from a relatively steep reflector, that could be a dyke or a fracture zone. Figure 25 shows a series of shot gathers on a seismic profile from the Sandoy tunnel data where back scattering is visible.

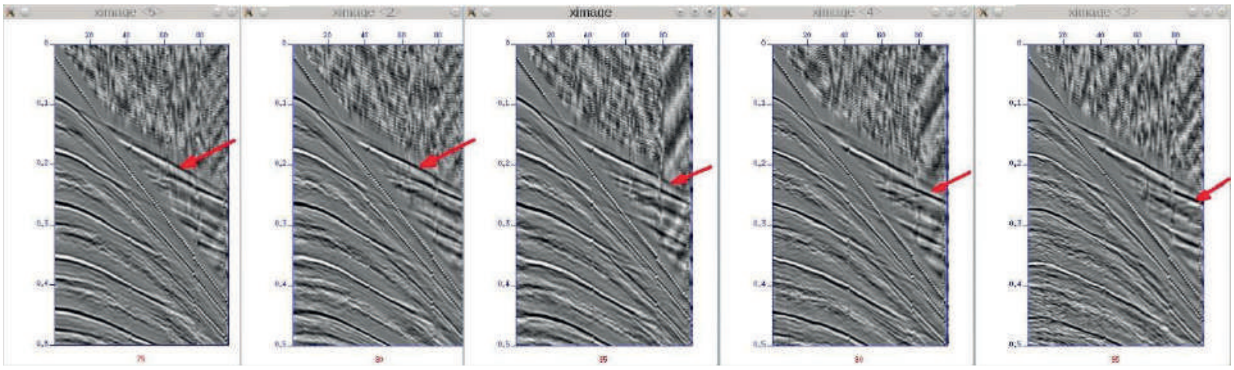


Figure 25. Five shot gathers at 5-point intervals from a seismic profile from the Sandoy tunnel seismic survey. Lowermost red numbers are shot numbers. Red annotated arrow on shot gathers indicates location of backscattering moving for each position in accordance with the streamer movement during acquisition.

The method has not been developed yet but we expect that systematically analysing, and mapping, all shot gathers for back scattering could be an important supplement to qualify fracture zones mapped by other means, and even to detect fractures zones not mapped be other methods. But, at this point of development, it is also important to mention, that the method cannot be trusted to detect all large fractures zones. Especially because dip in non-optimal direction relative to shot direction, is expected to diverge the energy. A second cause to not detect a fracture zone is that, although it is a fracture zone, it might not exhibit the properties of a reflector. Potentially the method can, in addition to determine strike, also determine dip of the reflector.

A few locations on the seismic profiles show indications of fractures/dykes/sills. Figure 26 shows two such examples, however, such events have to be investigated further on shot gathers and related to multibeam mapping of seabed and will be a natural part of the shot gather analysis mentioned just above.

We suggest continuing this work, but it will demand a certain development and further discussions with involved parties are necessary before the work is continued.

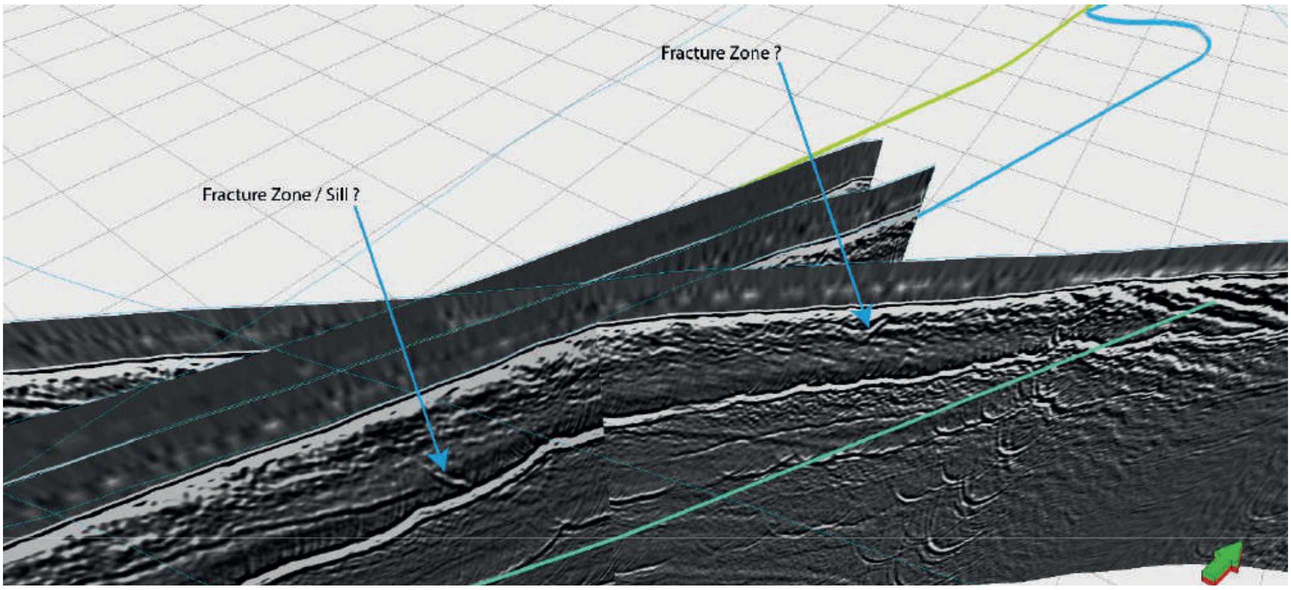


Figure 26. Blue arrows show locations of possible fracture zones, dykes, or sills Tunnel options 1, 2, and 3 are blue, green, and yellow ,respectively, south of Skúvoy.

Seabed sediment coverage

Although the multibeam acquisition is not completed yet, the current data cover parts between Skúvoy and Suðuroy, and between Skúvoy and Sandoy. These data show morphology of the seabed and thus areas with exposed bedrock and sediment covered seabed. Mostly, the sediments infill the small depth variations in bedrock, but it is nevertheless important to establish the depth to bedrock, as was seen in Skúvoyarfjørður, where an apparently shallow sediment deposit turned out to be a relative deep sediment basin (Figure 18).

Another place with thick sediments, is south-east of Skúvoy, the multibeam data show a significant dune (Figure 27) and the crossing seismic profile LinjaL, images the base of the dune (Figure 28).

The main source to establish top bed rock is the seismic data. Completion of the sediment mapping will be together with the completion of the analysis of multibeam mapping.

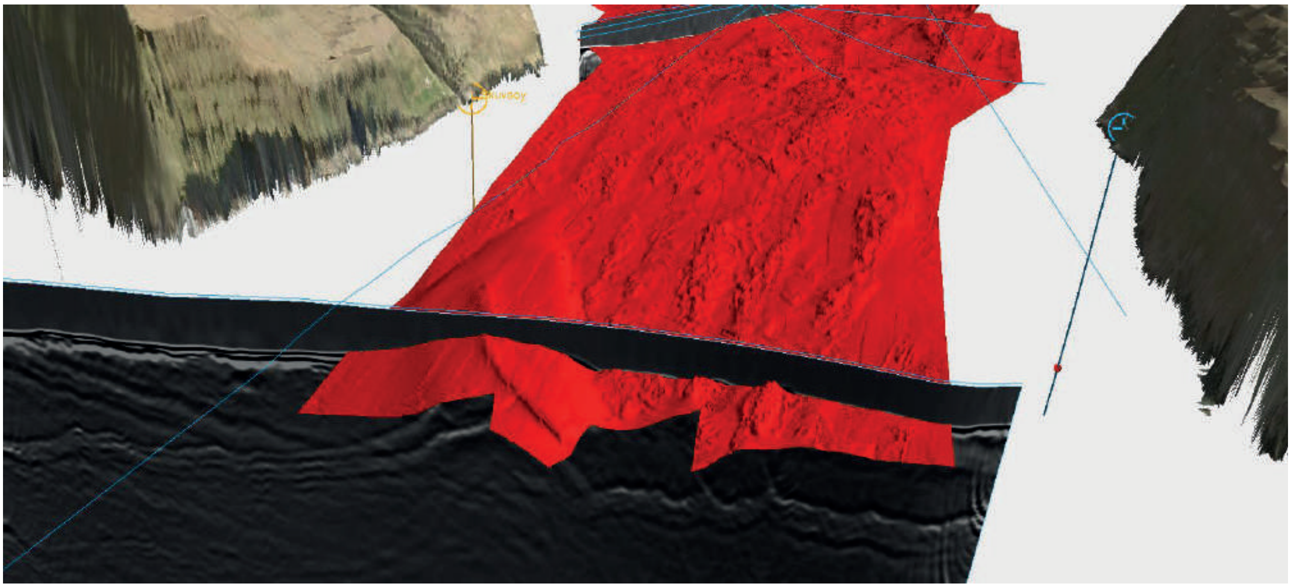


Figure 27. SE of Skúvoy, between Skarvanes and Skúvoy.

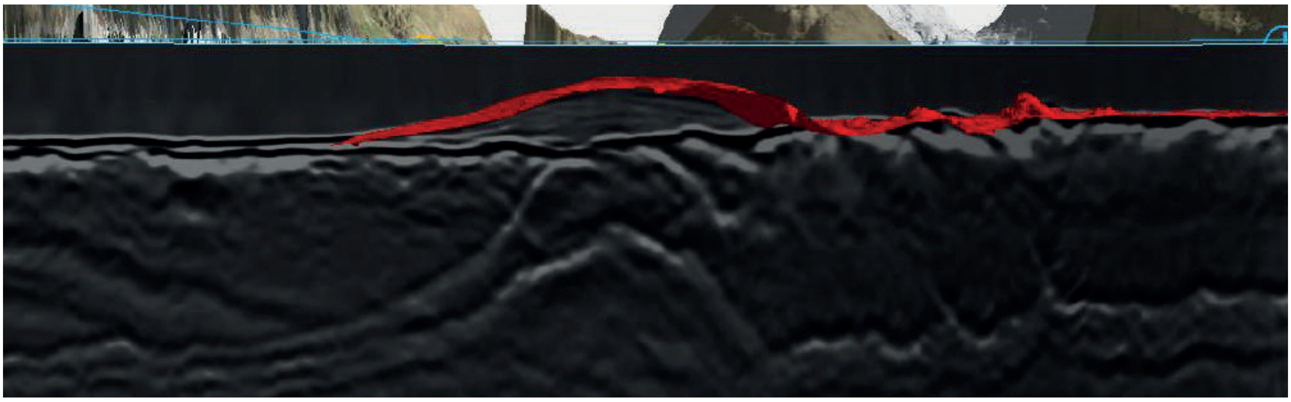


Figure 28

Recommendations

Depending on choice of tunnel option the following additional work is recommended.

- Multibeam: Complete the survey.
- Reflection seismic data: If tunnel options 2 or 3 are included in further planning, additional seismic data is needed along these profiles.
- Fracture zones: Interpret multibeam data, when acquisition is completed, in combination with additional field work and photogrammetry. Combined interpretation of seismic shot gathers and seismic profiles regarding fractures.
- Unmapped stratigraphy: Additional field work, both traditional and in steep cliff sections, photogrammetry, and additional boreholes.
- Rock quality estimation: Test of rock strength, rock mass quality, durability, swelling clay content etc. from field work, seabed sampling, and boreholes.

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Appendix A

Refraction seismic velocities

Further information on the rock quality in this area is from the velocity distribution of the uppermost part of the seabed, obtained from refraction seismic modelling of the marine seismic data. Figure 29 shows the modelled velocity 30 m below seabed projected onto seabed. Figure 30 shows the velocity for profile LinjaL.

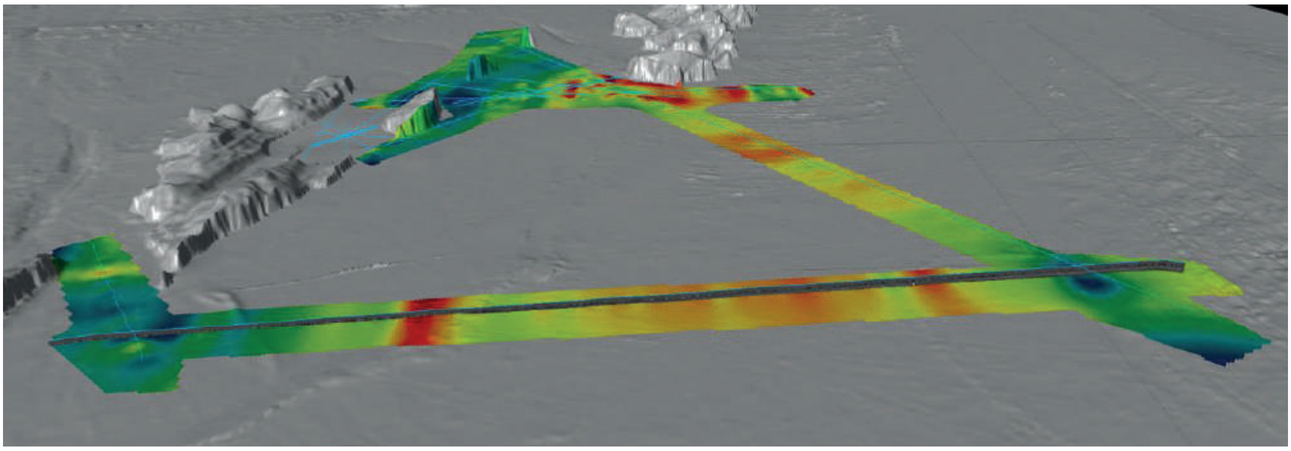


Figure 29. The figure shows combined topography and bathymetry seen from NW towards SE. Colours show modelled velocity distribution along the uppermost basalts (ref processing report) along the profiles extracted laterally.   Vertical scale ratio 3 times

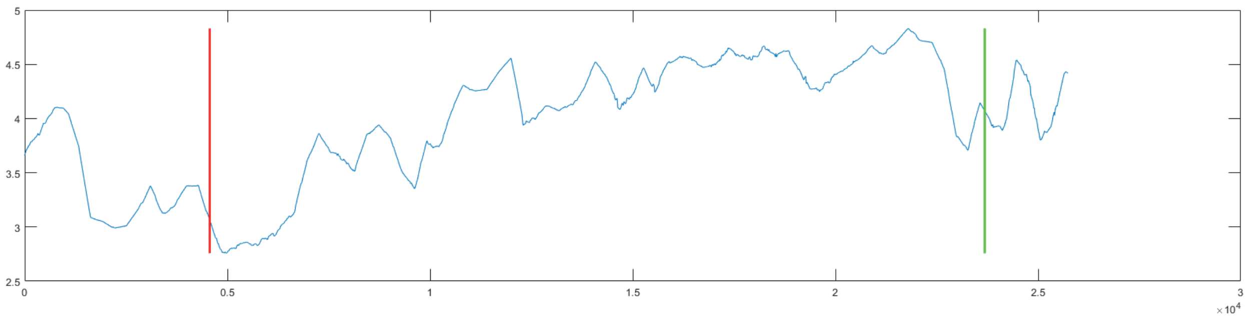


Figure 30. Velocity profile at seabed along the profile LinjaL. Red line marks location of C-horizon at seabed and green line marks location of A-horizon at seabed.

The “horizontal” velocity profile in Figure 30, resembles the velocity distribution of the Lopra, Malinstindur and Enni Formations obtained from well logs in Lopra, Glyvursnes, and Vestmanna.

Petersen (2014) constructed a vertical velocity profile (Figure 31) representing the main stratigraphy of the Faroes based on the three deep onshore wells in the Faroes (Lopra, Glyvursnes, and Vestmanna). The “horizontal” velocity profile in Figure 30, resembles the velocity distribution from well logs (Figure 32).

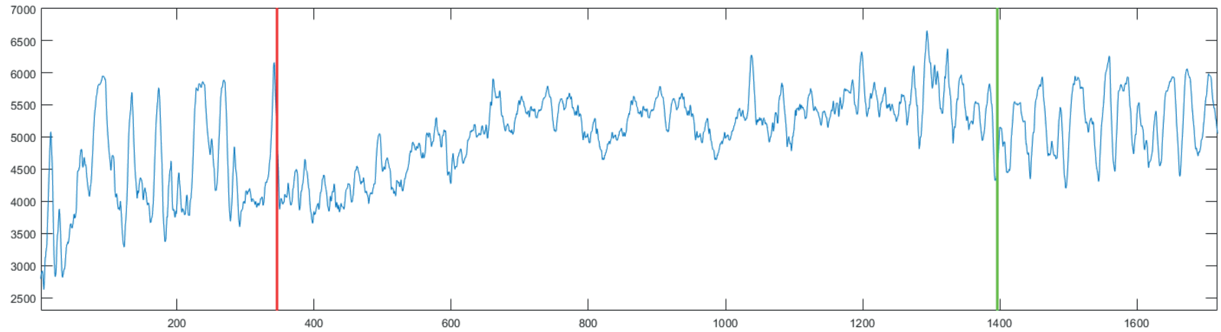


Figure 31. Vertical velocity profile. Red line marks location of C-horizon and green line the A-horizon.

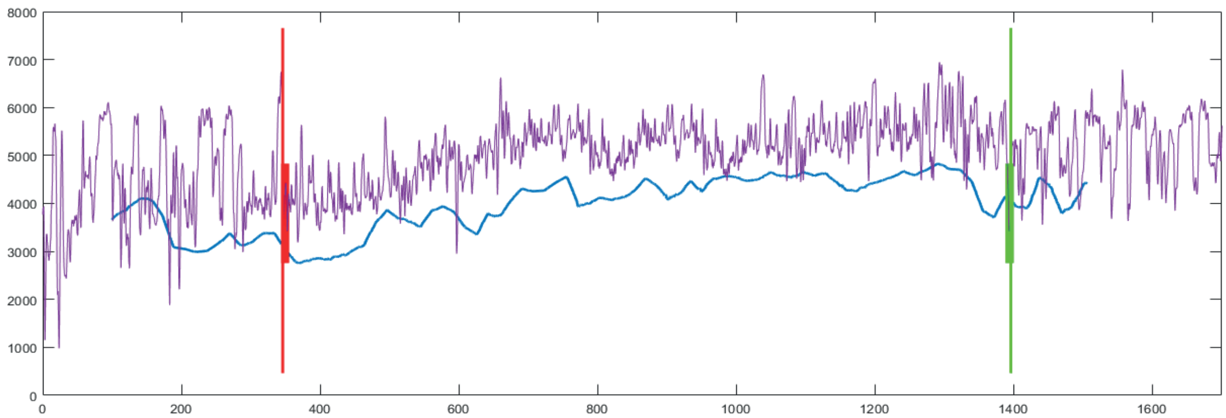


Figure 32. The velocity profile in Figure 30 is squeezed so that C-horizon and A-horizon fits to that of Figure 31

Comparison of the velocities from refraction seismic modelling to log velocities show similar trends for different sections of the stratigraphy, however, the refraction seismic velocities are generally lower than log velocities. This is in line with previous studies by Kiørboe and Petersen (1995) and Petersen, Brown, and Andersen (2013).

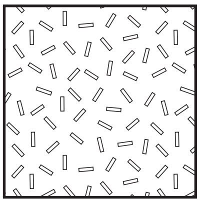
Appendix B

Legend

KEY FOR JARÐFEINGI LITHOLOGY LOGS

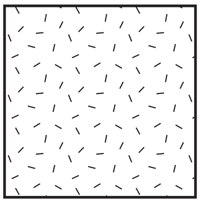
USGS Standard Pattern Chart (FGDCgeostdTM11A2_PattCh_poster.pdf)

Types of basaltic lithologies



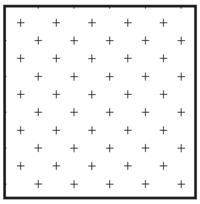
730

Coarse-grained Feldspar porphyric basalt



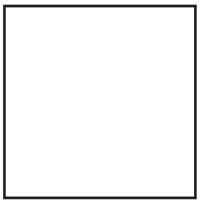
302-K

Fine-grained Feldspar porphyric basalt

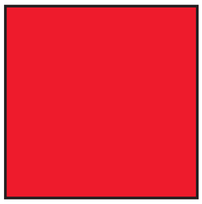


327-K

Olivin porphyric basalt



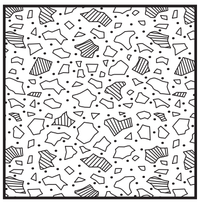
Aphyric basalt



Pantone 485 CVU

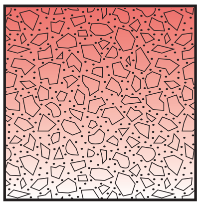
Volcaniclastic sand- and claystone (red)

Types of descriptive features



715

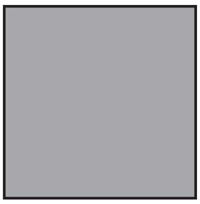
Volcanic breccia or agglomerate



606 + (0/70/50/2)

Core stone / saprolithic bole

Other features

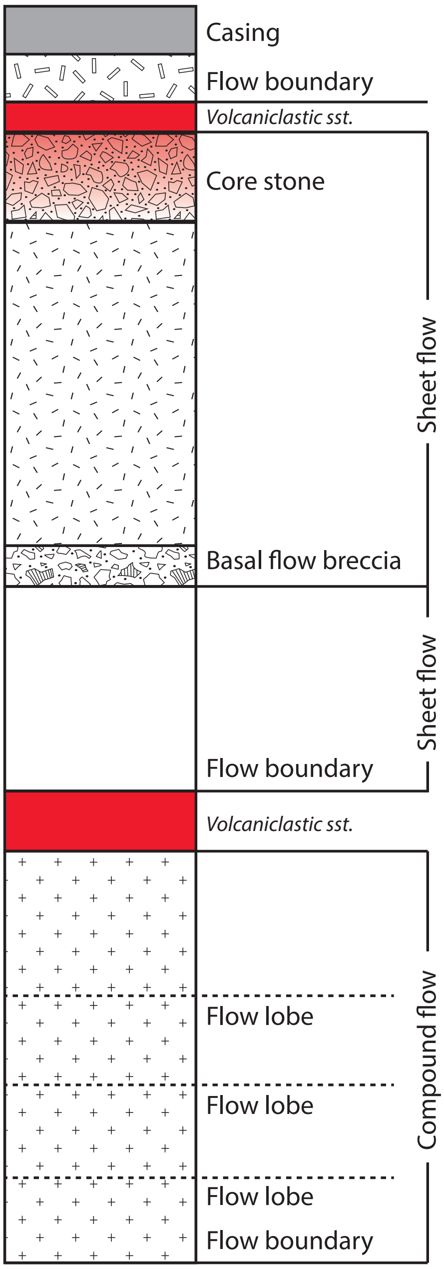


K40

Casing - No log

Log-Example

Lithology



KEY FOR JARÐFEINGI FRACTURE LOGS

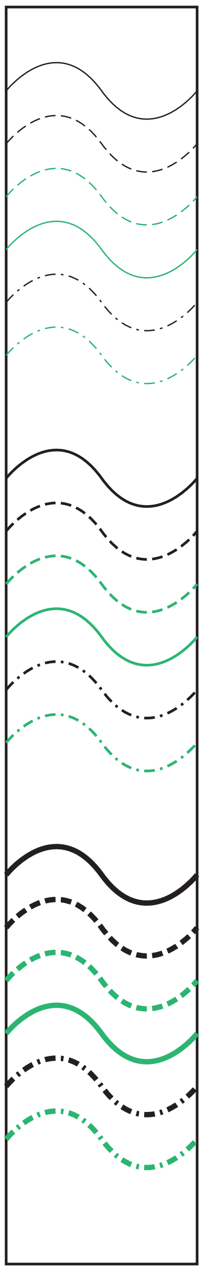
The fracture data are divided into classes defined by visual inspection of the teleview log. The fractures were divided into following classes:

SIZE OF FRACTURE
Regular (< 2 mm)
Large (2 – 5 mm)
Mega Large (> 5 mm)

FRACTURE TYPE
Open
Filled
Healed
Altered

Log-Example

Fractures



Regular (< 2mm)
Open
Open filled
Open filled altered
Open altered
Healed
Healed altered

Large (2-5 mm)
Open
Open filled
Open filled altered
Open altered
Healed
Healed altered

Mega Large (>5 mm)
Open
Open filled
Open filled altered
Open altered
Healed
Healed altered

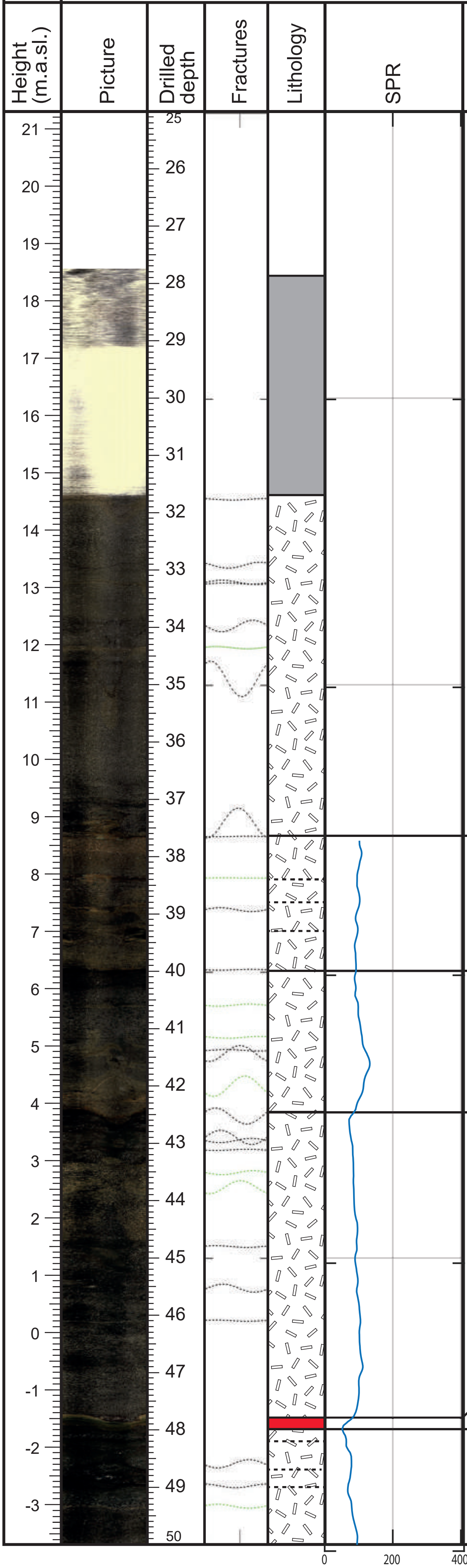
Appendix C

Søltuvík-2 borehole

1	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM

Height (m.a.sl.)	Picture	Drilled depth	Fractures	Lithology	SPR	Remarks
						0-31,7: Low to no data from televiewer

2	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

27,8-31,7: Low to no data from televiewer

31,7-37,6m: Coarse-grained plagioclasephyric compound flow

37,6-40,0m Coarse-grained feldspar-phyric compound flow. 4 thin flow-lobes

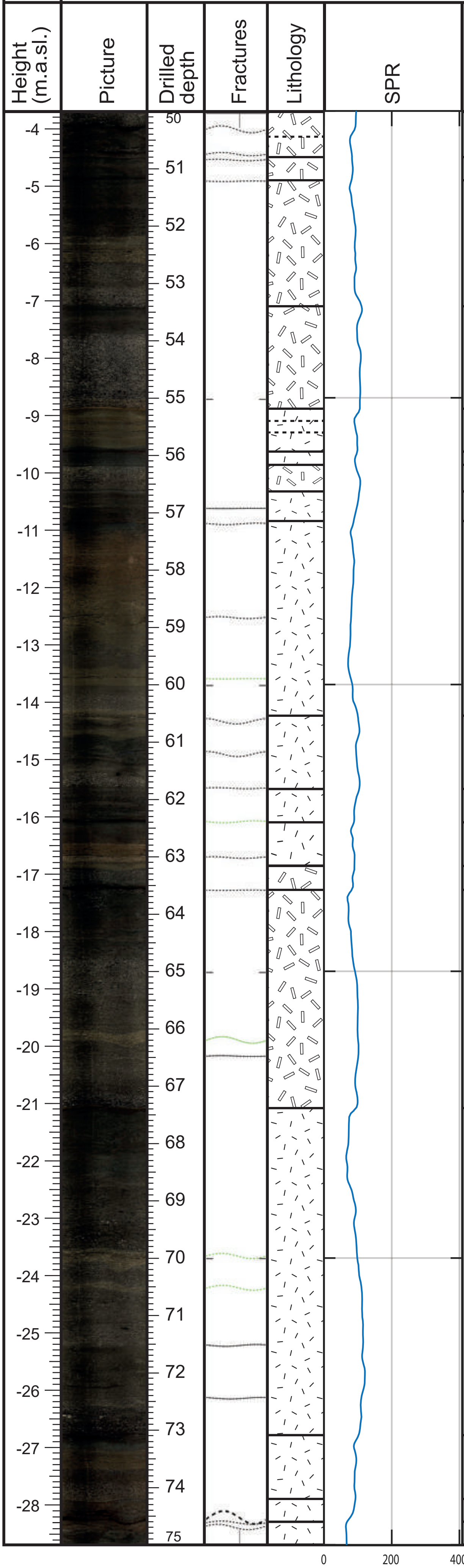
40,0-42,5m Coarse-grained plagioclasephyric compound flow.

42,5-47,8m Coarse-grained plagioclasephyric compound flow.

47,8-48,0m Volcaniclastic sediment. 20cm thick. Grayish green

48,0-50,8m Coarse-grained plagioclasephyric compound flow. Several flow lobes

3	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

50,8-51,3m Coarse-grained plagioclasephyric compound flow. Several flow lobes

51,3m-53,5 Coarse-grained plagioclasephyric compound flow.

53,5-55,2m Coarse-grained plagioclasephyric compound flow.

55,2-55,9m Fine-grained plagioclasephyric compound flow. Several thin flow lobes

57,3-60,5m. Fine-grained plagioclasephyric compound flow.

60,5-61,8m. Fine-grained plagioclasephyric compound flow.

61,8-62,3m. Fine-grained plagioclasephyric compound flow.

62,3-63,6m. Fine-grained plagioclasephyric compound flow.

62,3-63,6m. Coarse-grained plagioclasephyric compound flow.

63,6-67,4m. Coarse-grained plagioclasephyric compound flow.

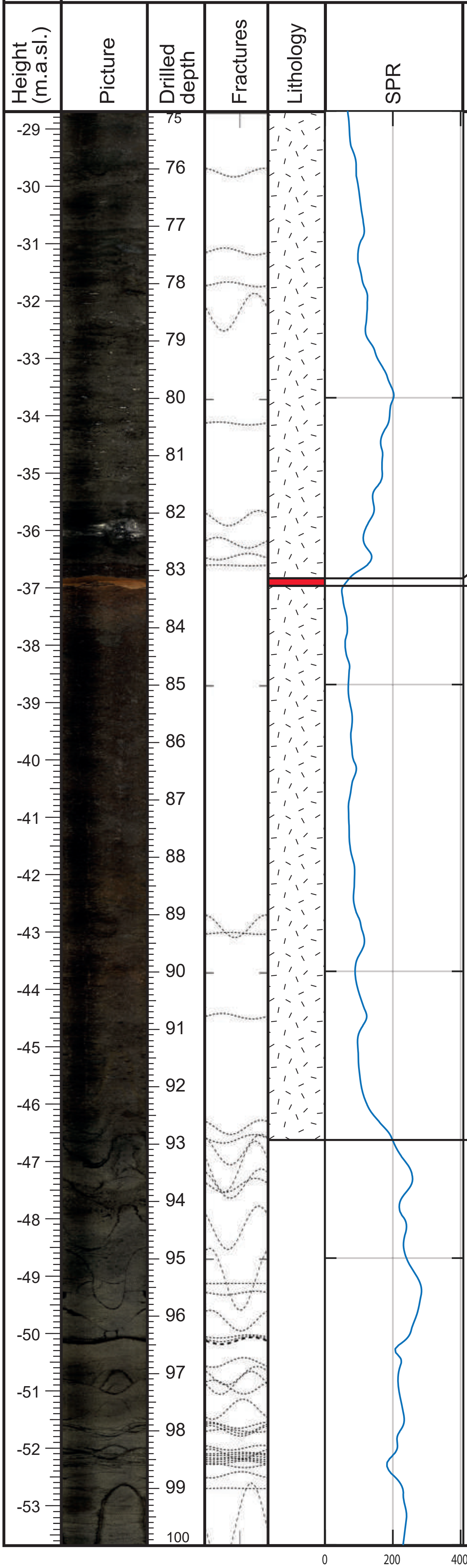
67,4-73,0m. Fine-grained plagioclasephyric compound flow.

73,0-74,3m. Fine-grained plagioclasephyric compound flow.

74,3-74,7m. Fine-grained plagioclasephyric compound flow.

74,7-83,2m. Fine-grained plagioclasephyric compound flow.

4	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

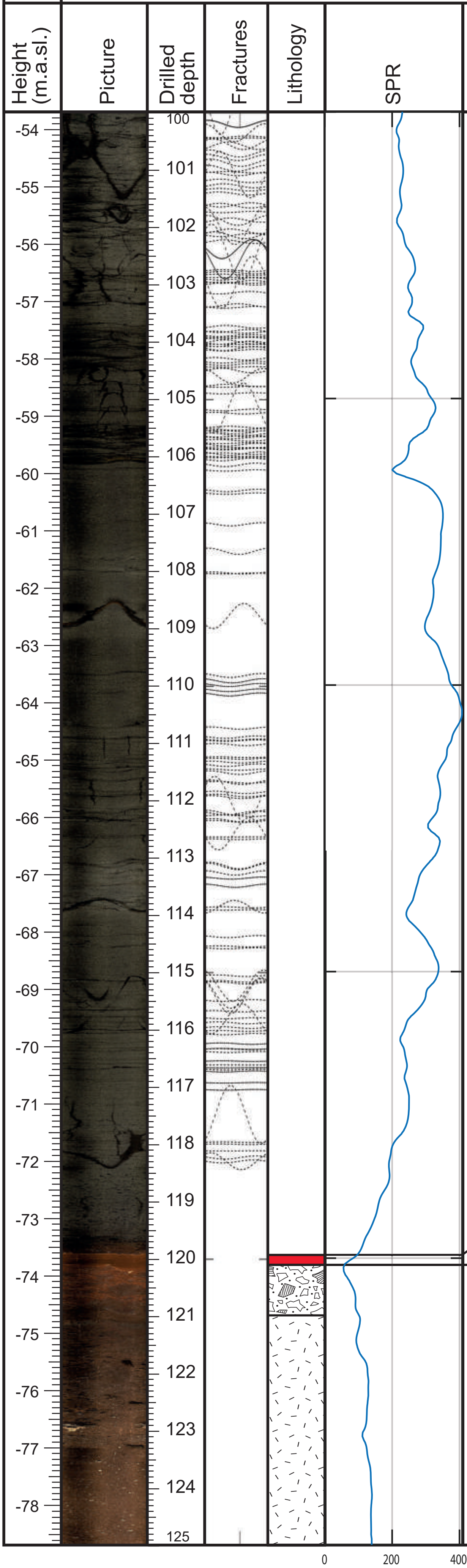
74,7-83,2m. Fine-grained plagioclasephyric compound flow.

83,2-83,4m. Volcaniclastic sediment. 20cn thick. Orange.

83,4-93,0m. Fine-grained plagioclasephyric sheet flow.

93,0-119,9m. Aphanitic to fine-grained plagioclasephyric sheet flow.

5	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



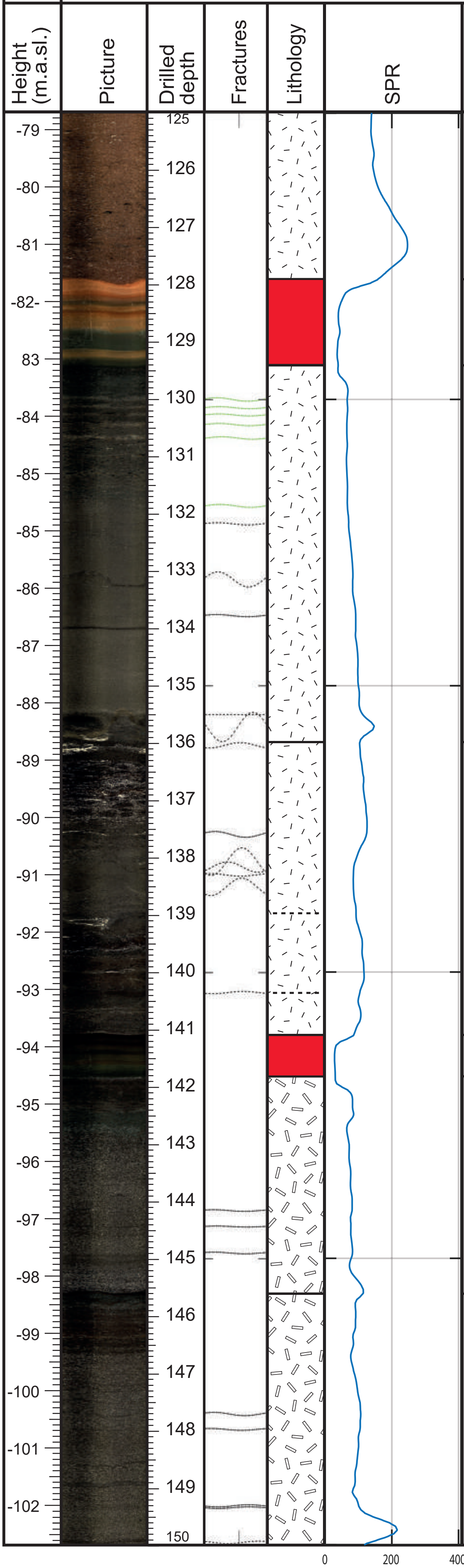
Remarks

93,0-119,9m. Aphanitic to fine-grained plagioclasephyric sheet flow. Highly fractured in massive parts of the flow.

119,9-120,15m. Volcaniclastic sediment. 25cm thick. Orange.

121,15-127,9m. Fine-grained plagioclasephyric sheet flow. Highly weathered/breciated upper crust.

6	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

121,15-127,9m. Fine-grained plagioclasephyric sheet flow. Highly weathered/breciated upper crust.

127,9-129,4m. Volcaniclastic sediment. 1,5m thick. Orange to green.

129,4-136m. Fine-grained plagioclasephyric compound flow.

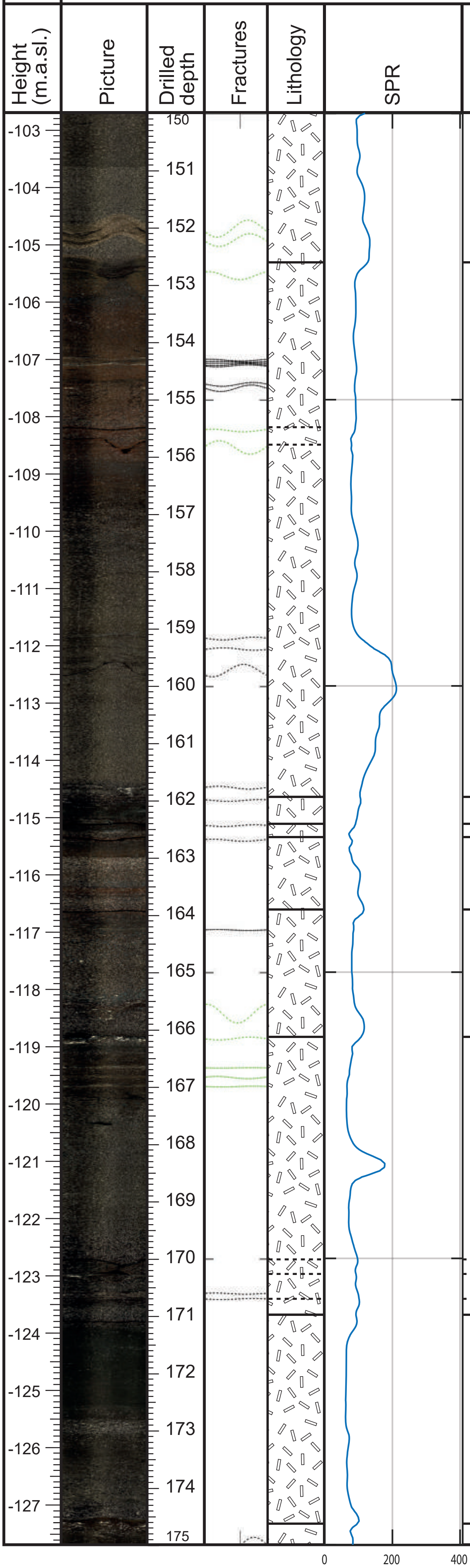
136-141,1m. Fine-grained plagioclasephyric compound flow with 3 lobes. Highly vesicular.

141,1-141,8m. Volcaniclastic sediment. 0,7m thick. Dark green.

141,8-145,5m. Coarse-grained plagioclasephyric flow.

145,5-152,6m. Coarse-grained plagioclasephyric flow.

7	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

145,5-152,6m. Coarse-grained plagioclasephyric compound flow.

152,6-162,0m. Coarse-grained plagioclasephyric compound flow.

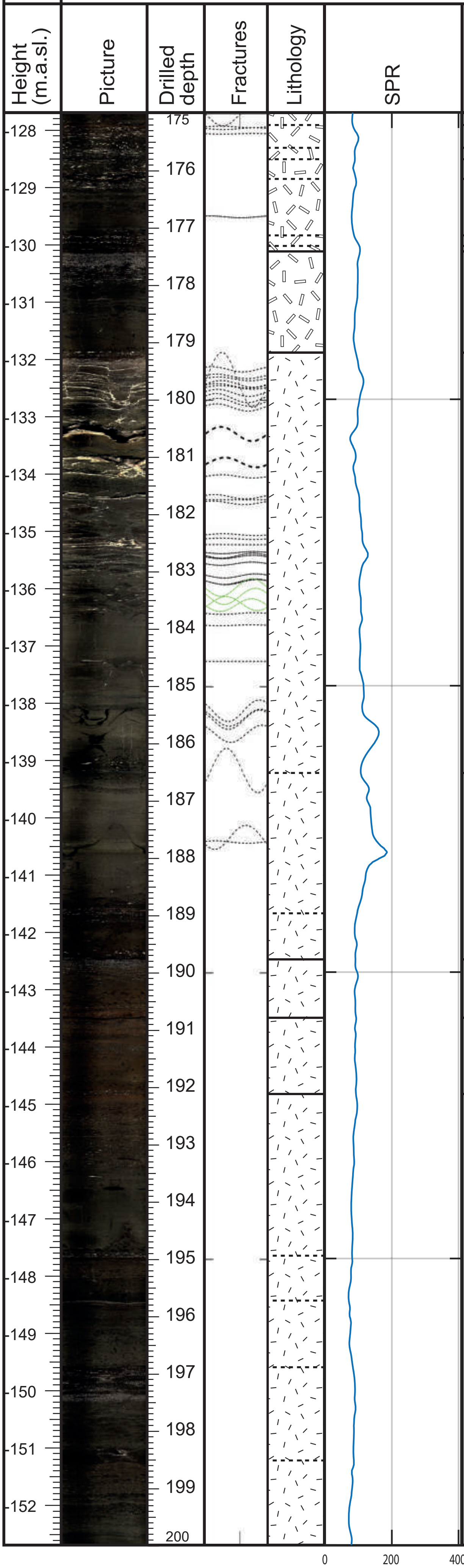
162,7-163,9m. Coarse-grained plagioclasephyric compound flow.

163,9-166,1m. Coarse-grained plagioclasephyric compound flow.

166,1-171m. Coarse-grained plagioclasephyric compound flow. Several flow lobes.

171-174,6m. Coarse-grained plagioclasephyric compound flow.

8	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

174,6-177,4m. Coarse-grained plagioclasephyric compound flow. Several flow lobes.

177,4-179,2m. Coarse-grained plagioclasephyric compound flow.

179,2-189,8m. Fine-grained plagioclasephyric compound flow. Several flow lobes.

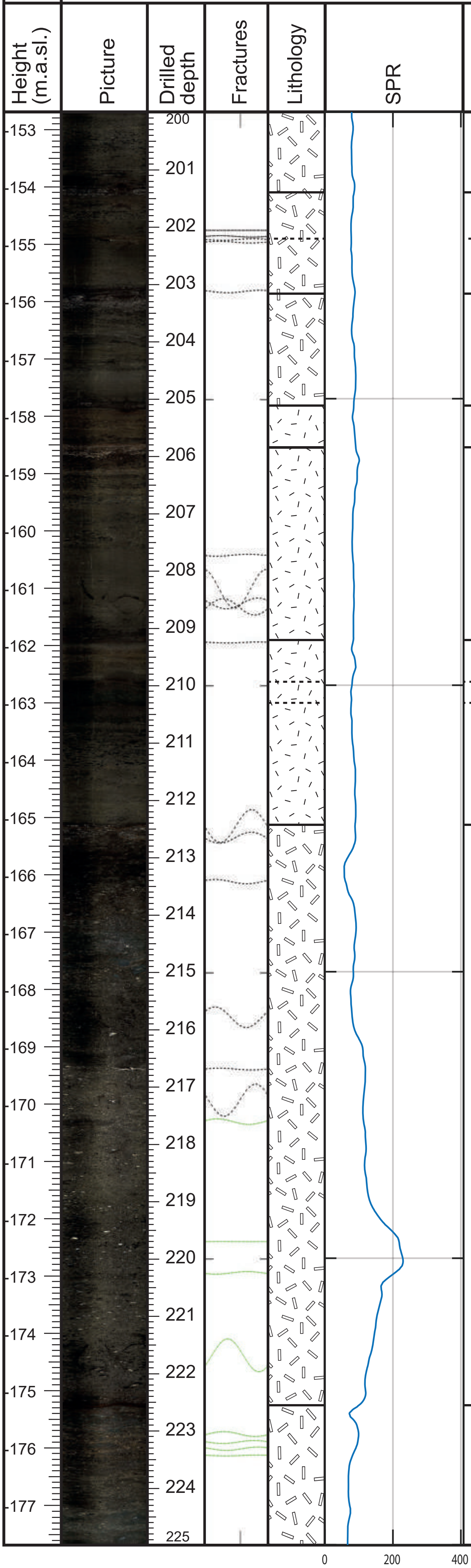
179,4 - 182,5m: Highly fractured interval with mineralized fractures, both open and closed.

189,8-190,8m. Fine-grained plagioclasephyric compound flow.

190,8-192,1m. Coarse-grained plagioclasephyric compound flow.

192,1-201,4m. Coarse-grained plagioclasephyric compound flow. Several flow lobes.

9	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

192,1-201,4m. Coarse-grained plagioclasephyric compound flow. Several flow lobes.

201,4-203,1m. Coarse-grained plagioclasephyric compound flow. Two flow lobes.

203,1-205,1m. Coarse-grained plagioclasephyric compound flow.

205,1-205,9m. Fine-grained plagioclasephyric compound flow.

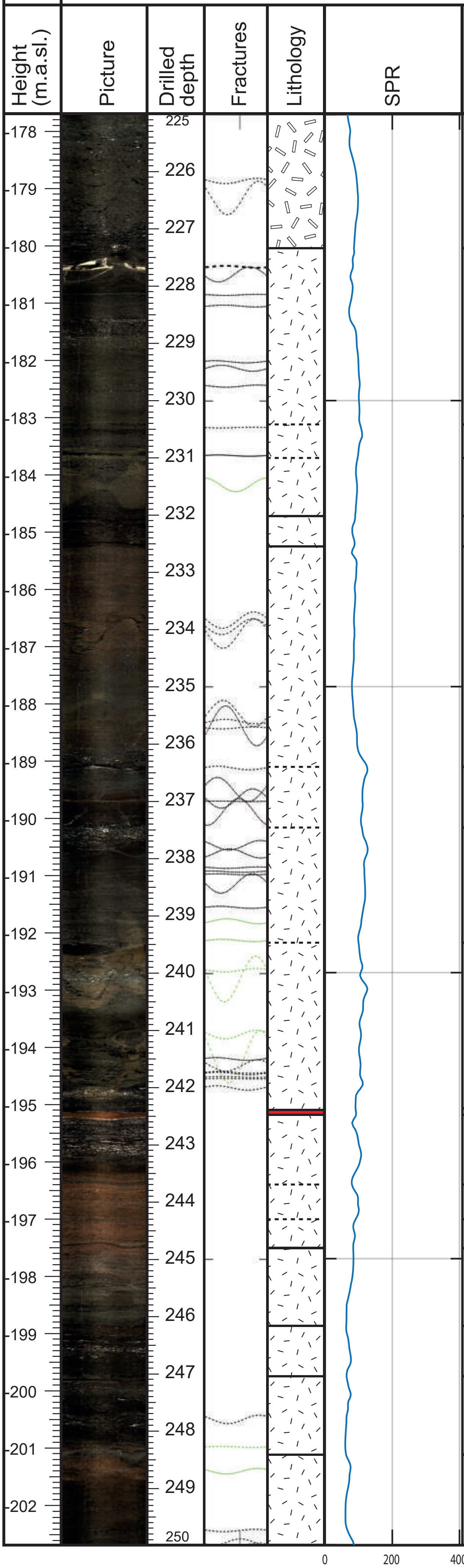
205,9-209,3m. Fine-grained plagioclasephyric compound flow.

209,3-212,4m. Fine-grained plagioclasephyric compound flow.

212,4-222,5m. Coarse-grained plagioclasephyric sheet flow.

212,4-222,5m. Coarse-grained plagioclasephyric compound flow.

10	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

222,5-227,4m. Coarse-grained plagioclasephyric compound flow.

227,4-232m. Fine-grained plagioclasephyric compound flow. Several flow lobes.

232-232,6m. Fine-grained plagioclasephyric compound flow.

232,6-242,4m. Fine-grained plagioclasephyric compound flow. Several flow lobes. Some fractures.

242,4-242,5m. Volcaniclastic sediment. 10cm thick. Orange.

242,3-244,8m. Fine-grained plagioclasephyric compound flow. Three flow lobes.

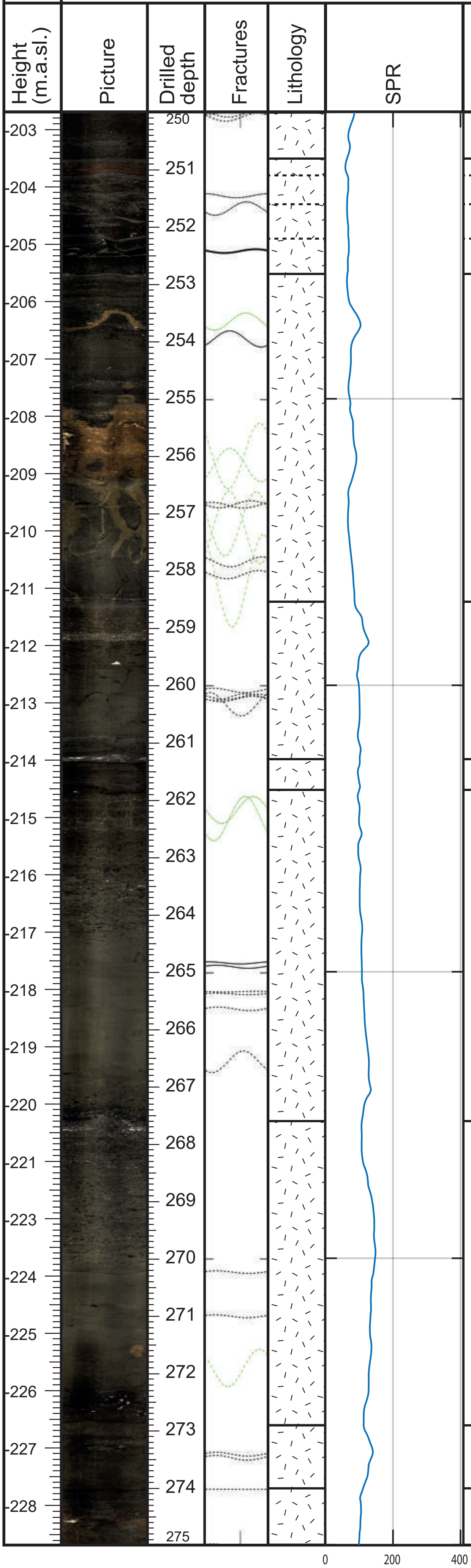
244,8-246,1m. Fine-grained plagioclasephyric compound flow.

246,1-247,1m. Fine-grained plagioclasephyric compound flow.

247,1-248,4m. Fine-grained plagioclasephyric compound flow.

248,4-250,8m. Fine-grained plagioclasephyric compound flow.

11	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

248,4-250,8m. Fine-grained plagioclase phyric compound flow.

250,8-252,8m. Fine-grained plagioclase phyric compound flow.

252,8-258,5m. Fine-grained plagioclase phyric compound flow.

258,5-261,3m. Fine-grained plagioclase phyric compound flow.

261,3-261,9m. Fine-grained plagioclase phyric compound flow.

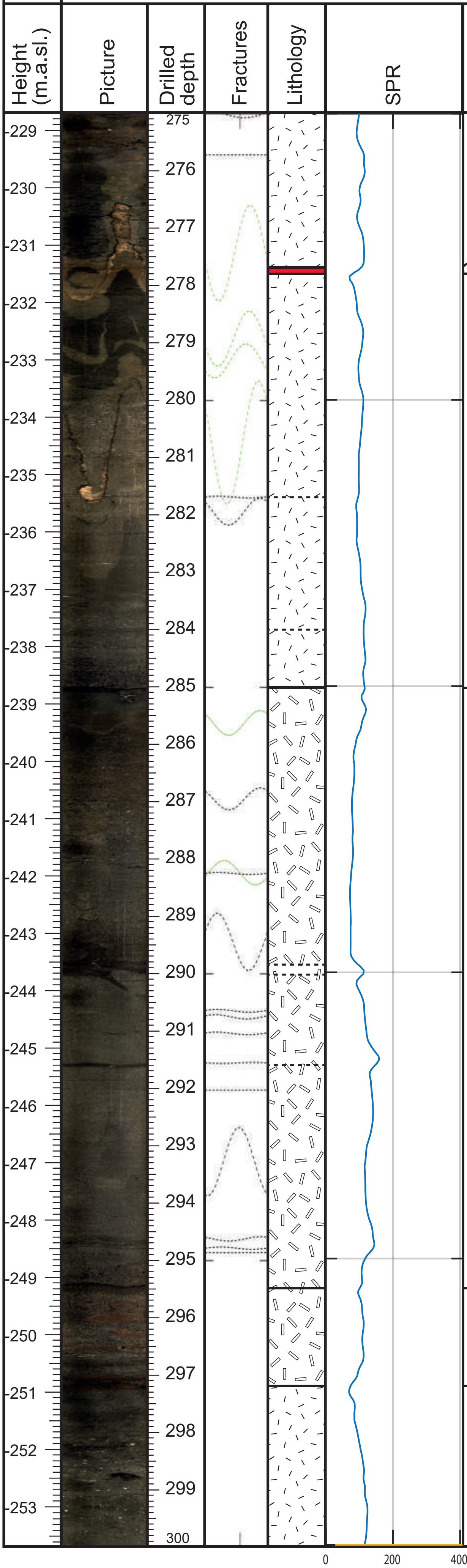
261,9-267,7m. Fine-grained plagioclase phyric compound flow.

267,7-272,9m. Fine-grained plagioclase phyric compound flow.

272,9-274m. Fine-grained plagioclase phyric compound flow.

274-277,7m. Fine-grained plagioclase phyric compound flow.

12	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

274-277,7m. Fine-grained plagioclase phyric compound flow.

277,7-277,9m. Volcaniclastic sediment. 20cm thick. Orange.

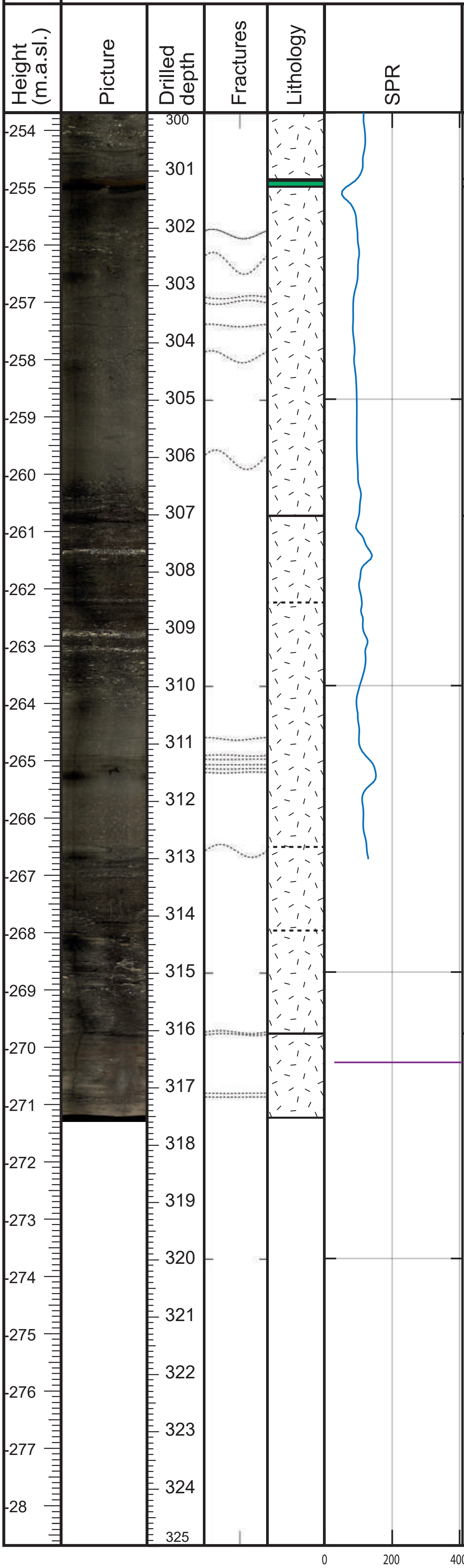
277,9-285m. Fine-grained plagioclase phyric compound flow. Several flows.

285-295,5m. Coarse-grained plagioclase phyric compound flow. Several flows.

295,5-297,3m. Coarse-grained plagioclase phyric compound flow.

297-301,2m. Fine-grained plagioclase phyric compound flow.

13	Project: Suðuroyartunnilin	Year: 2021	Location: Søltuvík	Borehole 02
	Position: Y=205944.99 X=859468.14 Z=46,30 m			Datum: FOTM



Remarks

297-301,2m. Fine-grained plagioclase phyric compound flow.

301,2-301,4m. Volcaniclastic sediment. 20cm thick. Green.

301,4-307m. Fine-grained plagioclase phyric compound flow.

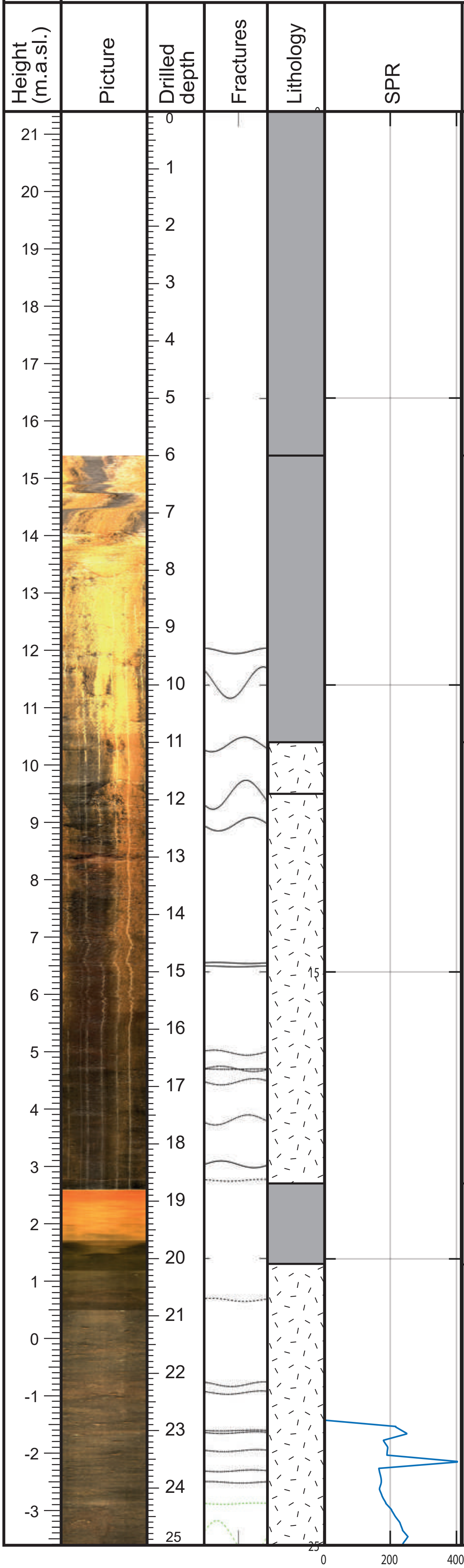
307-316m. Fine-grained plagioclase phyric compound flow. Several flow lobes.

316-m. Fine-grained plagioclase phyric compound flow.

Appendix D

Sandur-1 borehole

1	Project: Suðuroyartunnilin	Year: 2021	Location: Sandur	Borehole 01
	Position: Y=209523.13 X=858750.03 Z=21.41 m			Datum: FOTM



Remarks

0-6m: Casing

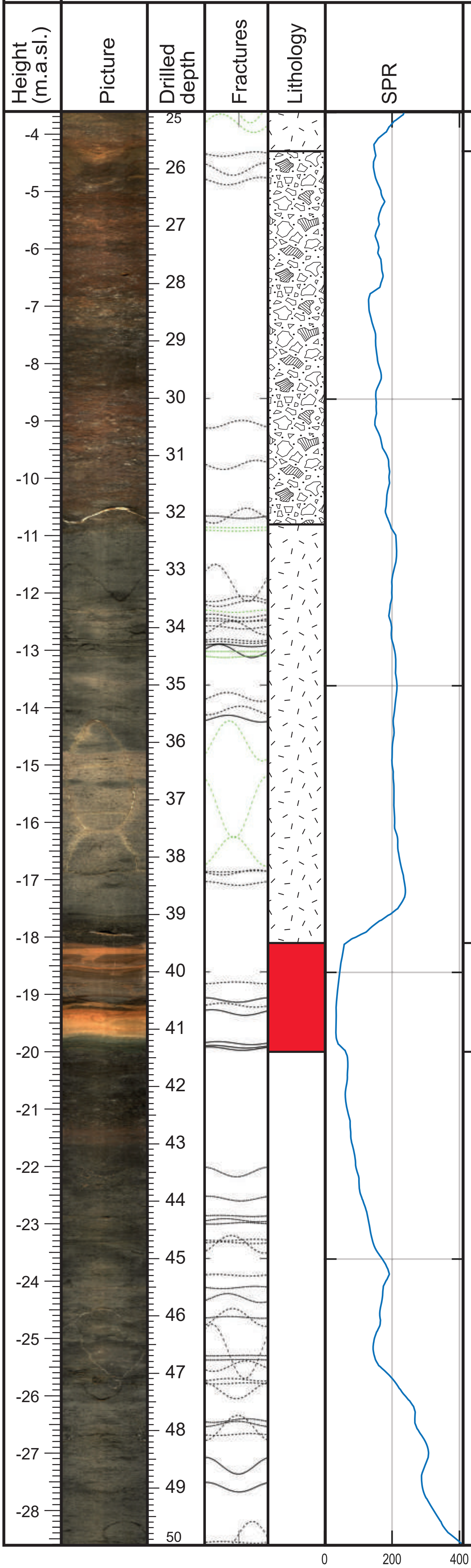
6-11m: Very poor data quality

11-19m: Fine-grained plagioclase phyric basalt. Very poor data

18,8-20,1m: Very poor data quality

20,1-26,7m: Fine-grained plagioclase phyric lava flow.

2	Project: Suðuroyartunnilin	Year: 2021	Location: Sandur	Borehole 01
	Position: Y=209523.13 X=858750.03 Z=21.41 m			Datum: FOTM



Remarks

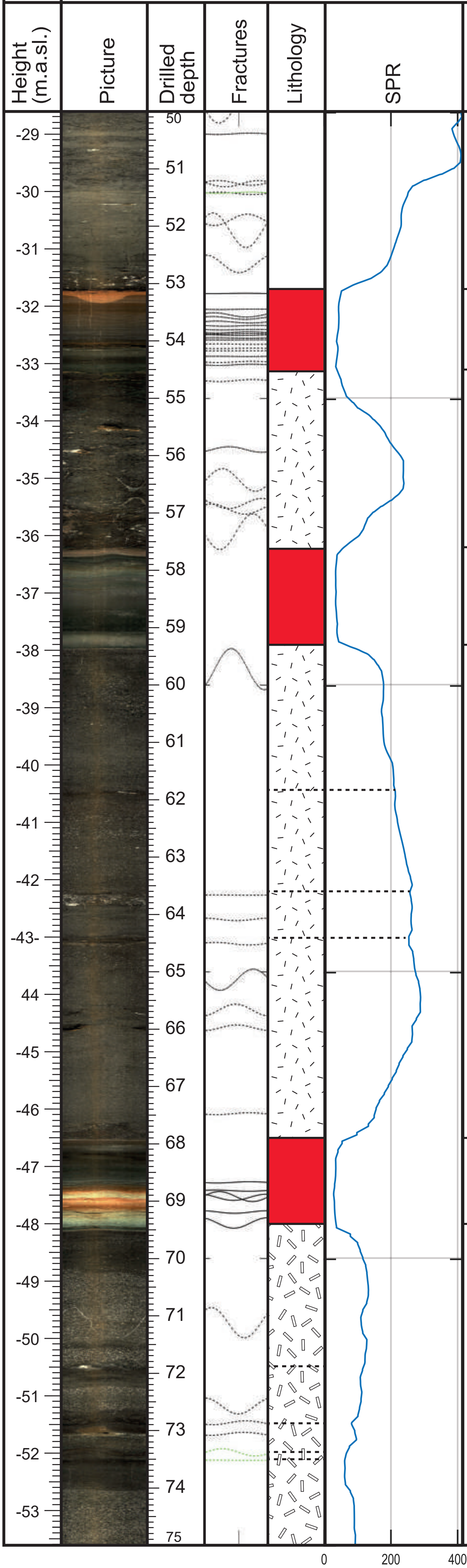
25,7-39,5m. Fine-grained plagioclasphyric sheet flow.
25,7-32m. Highly weathered top of sheet flow.

Highly fractured part of lava flow.

39,5-41,4m. Volcaniclastic sediment. Orande ot green. 1,9m thich.

41,4-53,15m. Fine-grained to aphanitic plagioclase phyriclava flow.
Weathered top of sheet flow.

3	Project: Suðuroyartunnilin	Year: 2021	Location: Sandur	Borehole 01
	Position: Y=209523.13 X=858750.03 Z=21.41 m			Datum: FOTM



Remarks

41,4-53,15m. Fine-grained to aphanitic plagioclase phyriclava flow.

53,15-54,5m. Volcaniclastic Sediment, green to orange. 1,3m thich.

54,5-57,6m: Fine-grained plagioclase-phyric basalt.

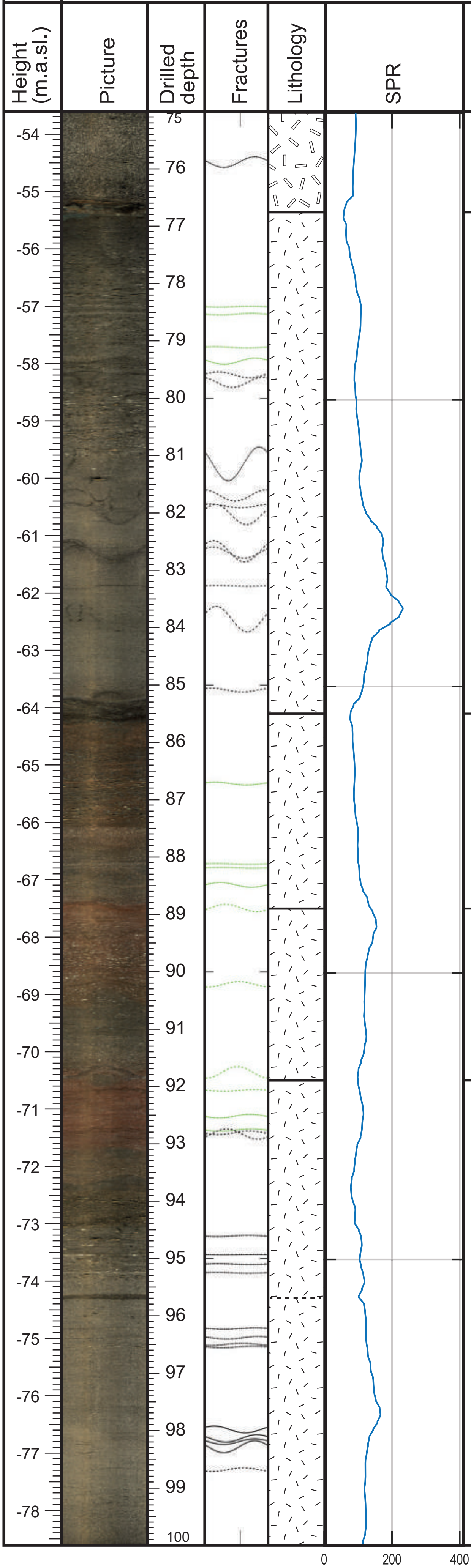
57,6-59,3m. Volcaniclastic Sediment, greenish grey. 1,7m thich.

59,3-67,9m: Fine-grained plagioclase-phyric basalt.

67,9-69,5m. Volcaniclastic Sediment, green ro orange. 1,6m thich.

69,5-76,8m: Coarse-grained plagioclase phyric basalt.Several thin flow lobes with vesicular banding.

4	Project: Suðuroyartunnilin	Year: 2021	Location: Sandur	Borehole 01
	Position: Y=209523.13 X=858750.03 Z=21.41 m			Datum: FOTM



Remarks

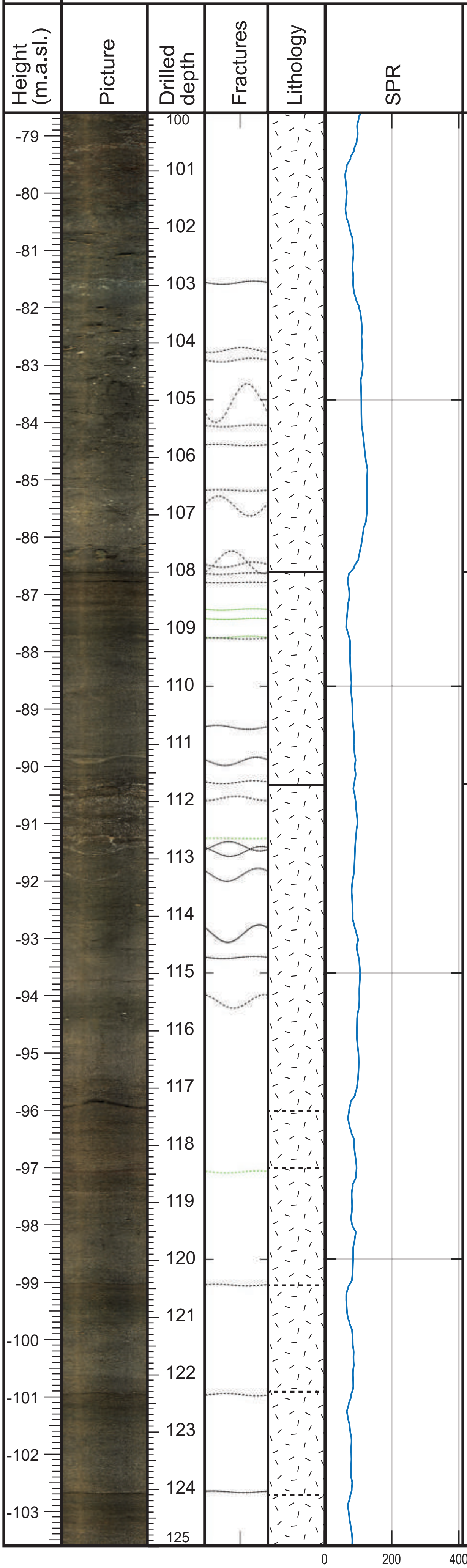
76,8-85,5m: Fine-grained plagioclase phyric basalt.

85,5-88,9m: Fine-grained plagioclase phyric basalt.With vesicular banding and reddish crust.

88,9-91,9m: Fine-grained plagioclase phyric basalt.With vesicular banding and reddish crust.

91,9-108,0m: Fine-grained plagioclase phyric basalt.Two flow lobes with vesicular banding and reddish crust.

5	Project: Suðuroyartunnilin	Year: 2021	Location: Sandur	Borehole 01
	Position: Y=209523.13 X=858750.03 Z=21.41 m			Datum: FOTM



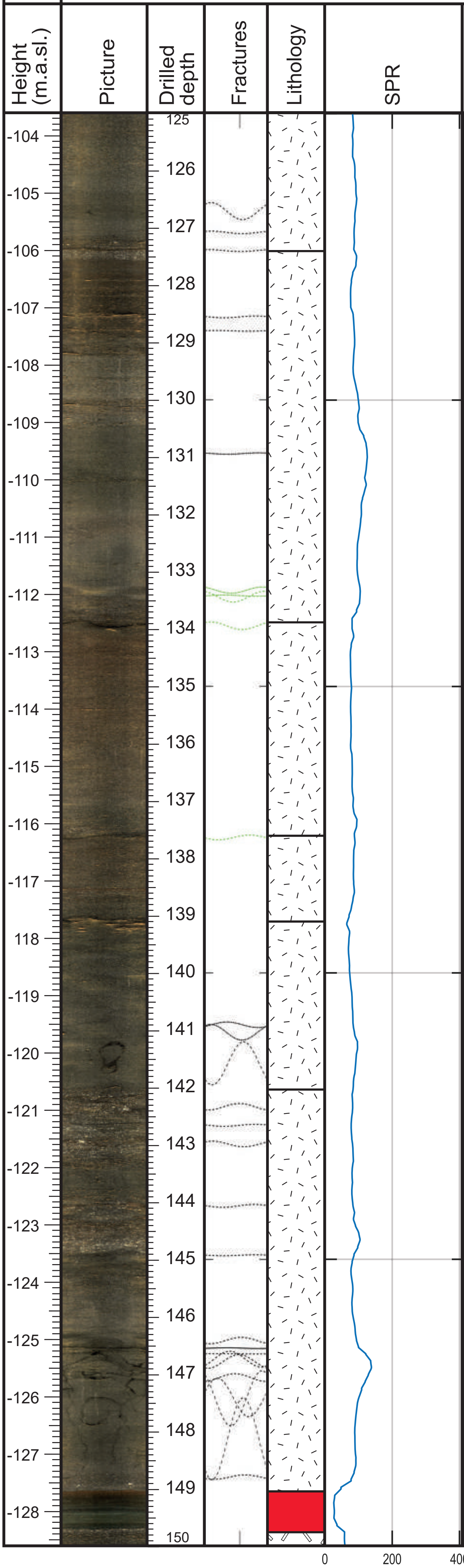
Remarks

91,9-108,0m: Fine-grained plagioclase phyric basalt.Two flow lobes with vesicular banding and reddish crust.

108,0-111,7m: Fine-grained plagioclase-phyric basalt.

111,7-127,5m: Fine-grained plagioclase phyric basalt. Several flow lobes with vesicular banding and reddish crust.

6	Project: Suðuroyartunnilin	Year: 2021	Location: Sandur	Borehole 01
	Position: Y=209523.13 X=858750.03 Z=21.41 m			Datum: FOTM



Remarks

111,7-127,5m: Fine-grained plagioclase-phyric basalt. Several flow lobes with vesicular banding and reddish crust.

127,5-134,0m: Fine-grained plagioclase phyric basalt. Vesicular banding and reddish crust.

134,0-137,6m: Fine-grained plagioclase phyric basalt. Vesicular banding and reddish crust.

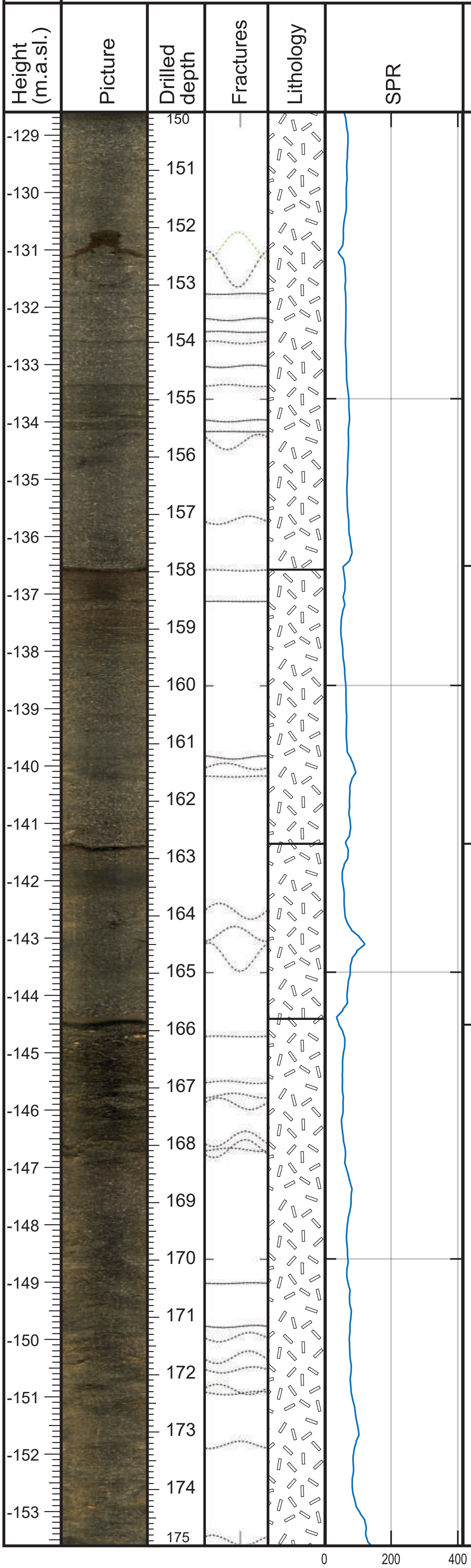
137,6-139,0m: Fine-grained plagioclase phyric basalt.

139,0-142,0m: Fine-grained plagioclase phyric basalt.

142,0-149,0m: Fine-grained plagioclase phyric basalt. Vesicular banding and more fractured basal part.

149,0-149,7m. Volcaniclastic Sediment, green ro orange. 0,7m thich.

7	Project: Suðuroyartunnilin	Year: 2021	Location: Sandur	Borehole 01
	Position: Y=209523.13 X=858750.03 Z=21.41 m			Datum: FOTM



Remarks

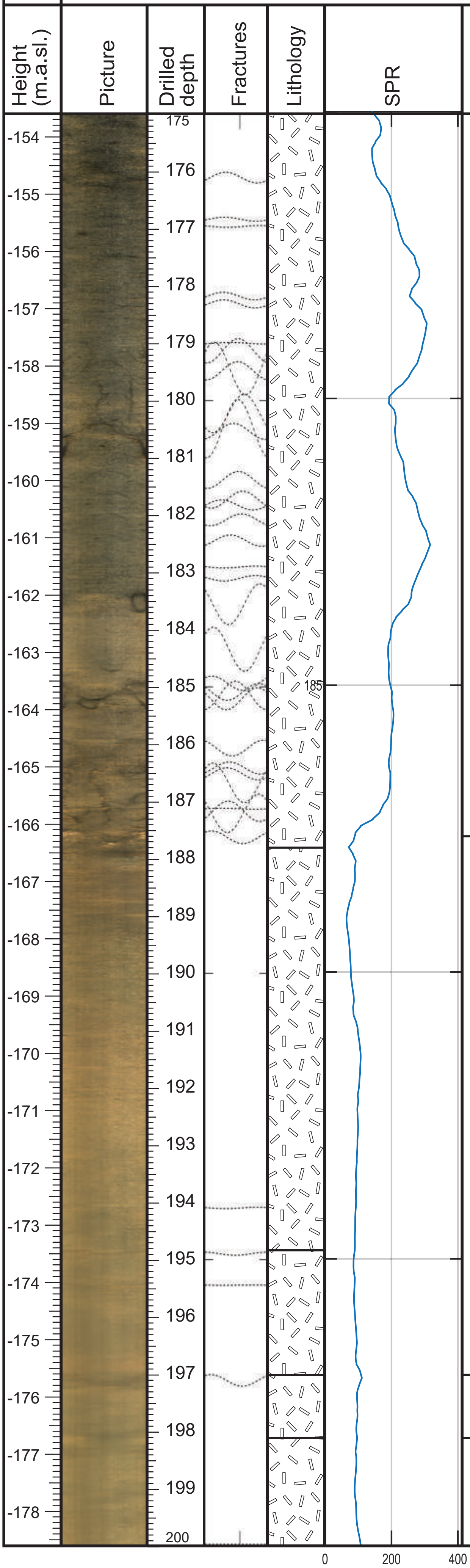
149,7-158,0m: Coarse-grained plagioclase phyric basalt. Vesicular banding.

158,0-162,8m: Coarse-grained plagioclase phyric basalt. Vesicular banding.

162,8-165,8m: Coarse-grained plagioclase phyric basalt. Vesicular banding.

165,8-187,8m: Coarse-grained plagioclase phyric basalt. Vesicular banding. Sheet flow.

8	Project: Suðuroyartunnilin	Year: 2021	Location: Sandur	Borehole 01
	Position: Y=209523.13 X=858750.03 Z=21.41 m			Datum: FOTM



Remarks

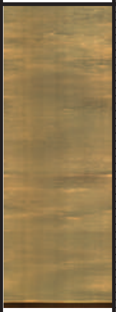
165,8-187,8m: Coarse-grained plagioclase-phyric basalt. Vesicular banding. Sheet flow.

187,8-197,0m: Coarse-grained plagioclase-phyric basalt. Poor imaging and low confidence.

197,0-198,0m: Coarse-grained plagioclase-phyric basalt. Poor imaging and low confidence.

198,0-202,2m: Coarse-grained plagioclase-phyric basalt. Poor imaging and low confidence.

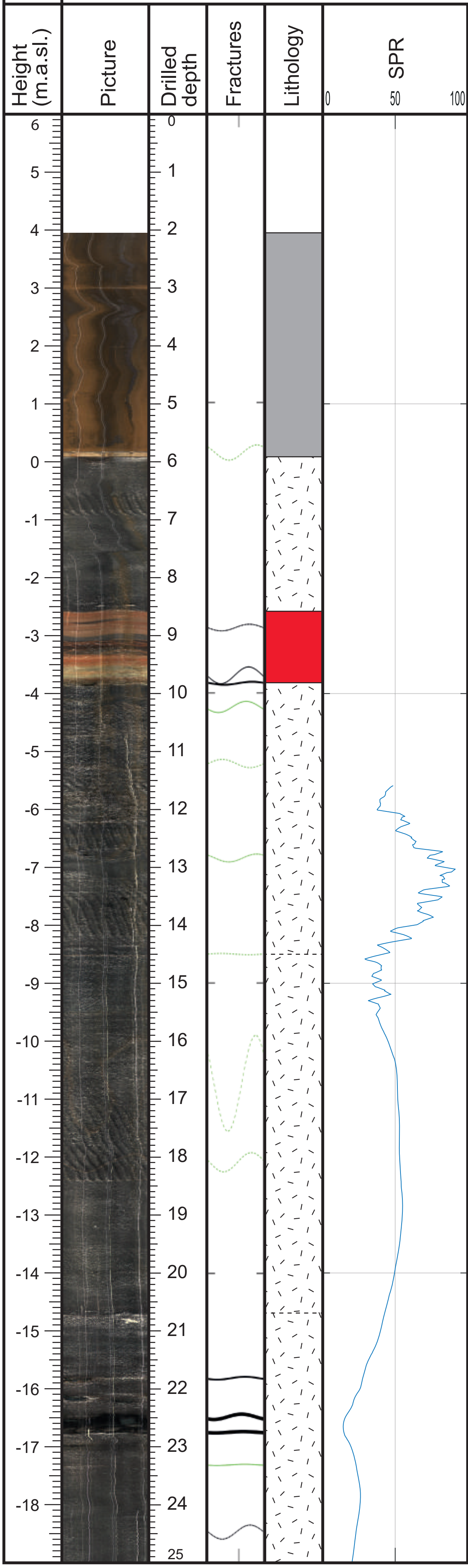
9	Project: Suðuroyartunnilin	Year: 2021	Location: Sandur	Borehole 01
	Position: Y=209523.13 X=858750.03 Z=21.41 m			Datum: FOTM

Height (m.a.sl.)	Picture	Drilled depth	Fractures	Lithology	SPR	Remarks
		200				
-179		201				198,0-202,2m: Coarse-grained plagioclase-phyric basalt. Poor imaging and low confidence.
-180		202				
-181		203				
-182		204				
-183		205				
-184		206				
-185		207				
-186		208				
-187		209				
-188		210				
-189		211				
-190		212				
-191		213				
-192		214				
-193		215				
-194		216				
-195		217				
-196		218				
-197		219				
-198		220				
-199		221				
-200		222				
-201		223				
-202		224				
-203		225				

Appendix E

Skúvoy-1 borehole

1	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



Remarks

Borehole starts at the lower boundary of a ca 3 m thick volcaniclastic sandstone.

0-5,9 m: Casing.

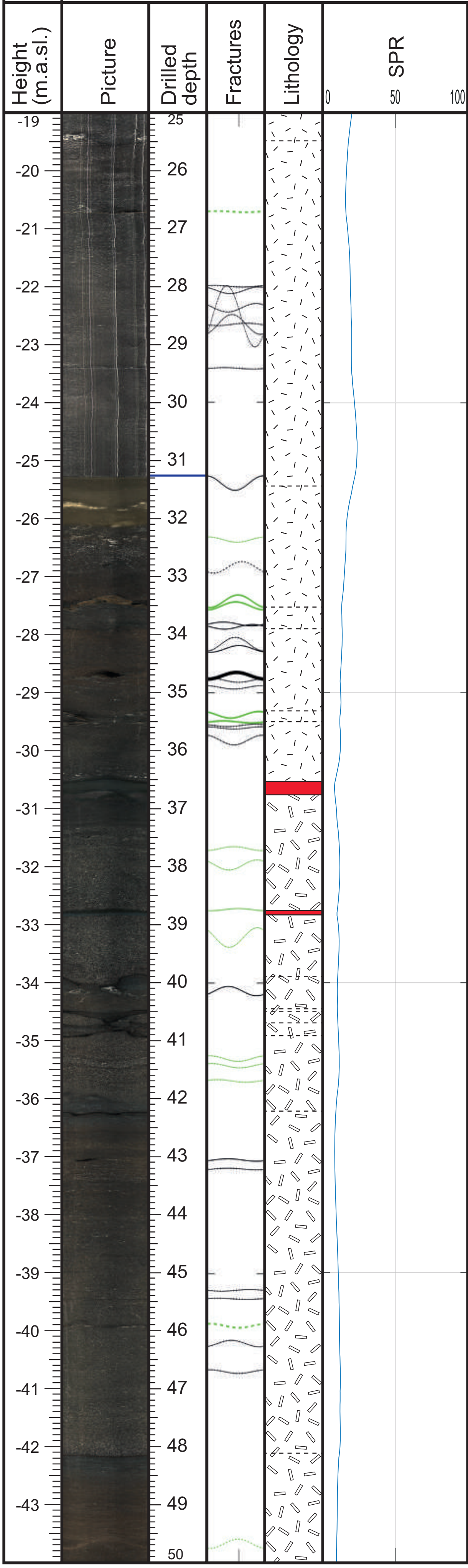
Fine feldspar phyric basalt. Probably 8-9 m thick.

Volcaniclastic sandstone. 8,6-9,8 m. 1,2 m thick. Banded. Light brown and grayish yellow to grayish green bands.

Fine feldspar phyric basalt. 27 m thick compound flow. 0,2-6 m thick flow units.

30 cm high cavity marked as two large fractures on the log. Above are megavesicles.

2	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



Remarks

Fine feldspar phyric basalt. 27 m thick compound flow. 0,2-6 m thick flow units.

31,26 m drilled depth: water level in well.

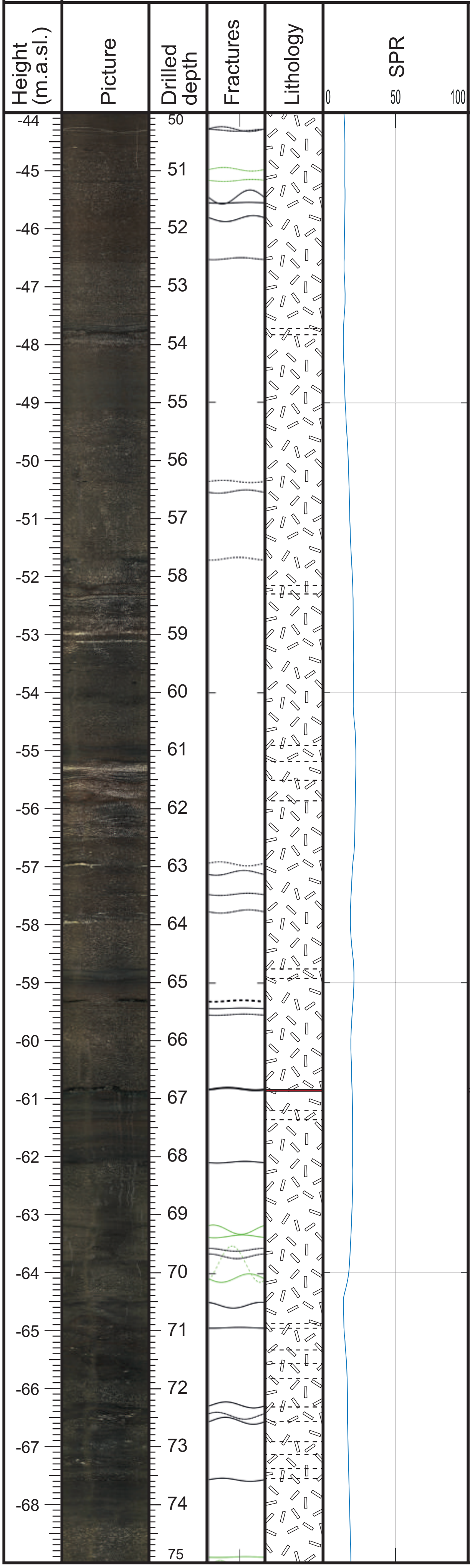
Volcaniclastic bed. 36,52-36,72 m. 20 cm thick. Grayish green.

Coarse feldspar phyric basalt. 2m thick.

Volcaniclastic sediment. 38,75-38,83 cm. 6 cm thick. Grayish green to blue green.

Coarse feldspar phyric basalt. 28 m thick compound flow with 0,1-6 m thick flow units.

3	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



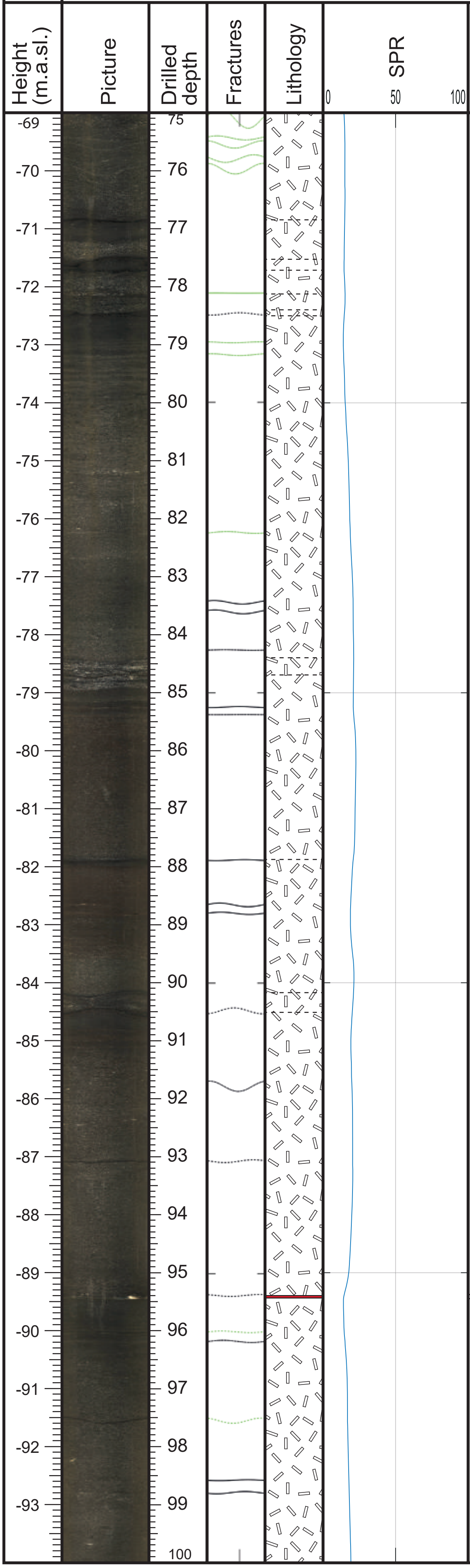
Remarks

Coarse feldspar phyric basalt. 28 m thick compound flow. 0,1-6 m thick flow units.

Thin (<2 cm) volcaniclastic. Dark green. 66,85 m.

Coarse feldspar phyric basalt. 29 m thick compound flow. 0,1-6 m thick flow units.

4	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



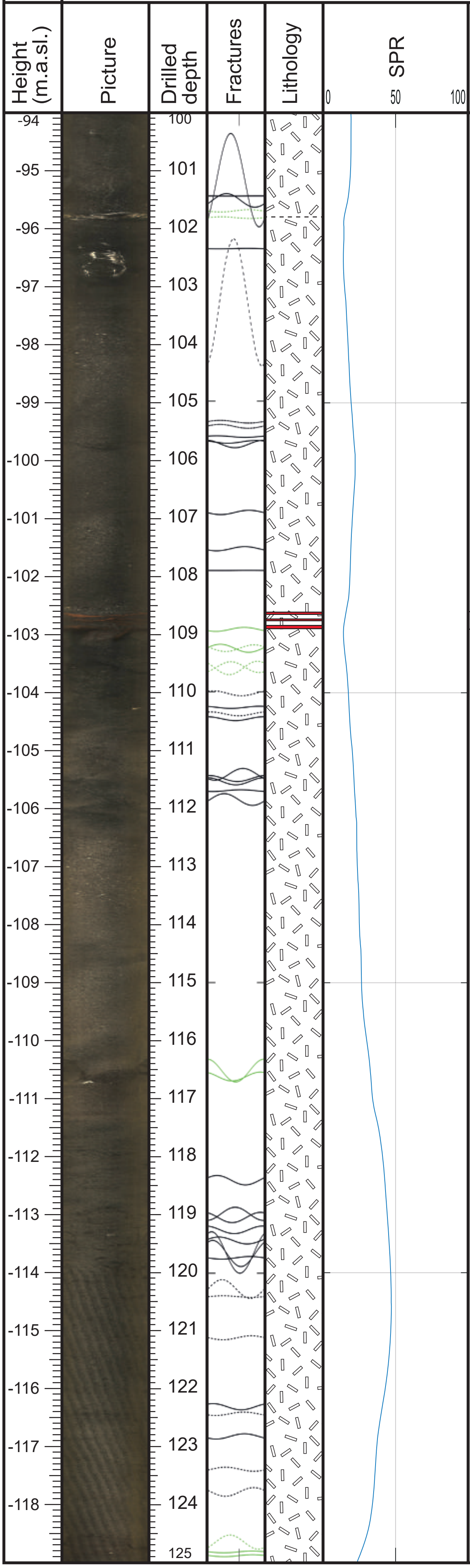
Remarks

Coarse feldspar phyric basalt. 29 m thick compound flow with 0,1-6 m thick flow units.

Thin volcaniclastic (<2 cm). Dark green.

Coarse feldspar phyric basalt. 13 m thick compound flow consisting of two 6 an 8 m thick flow units.

5	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



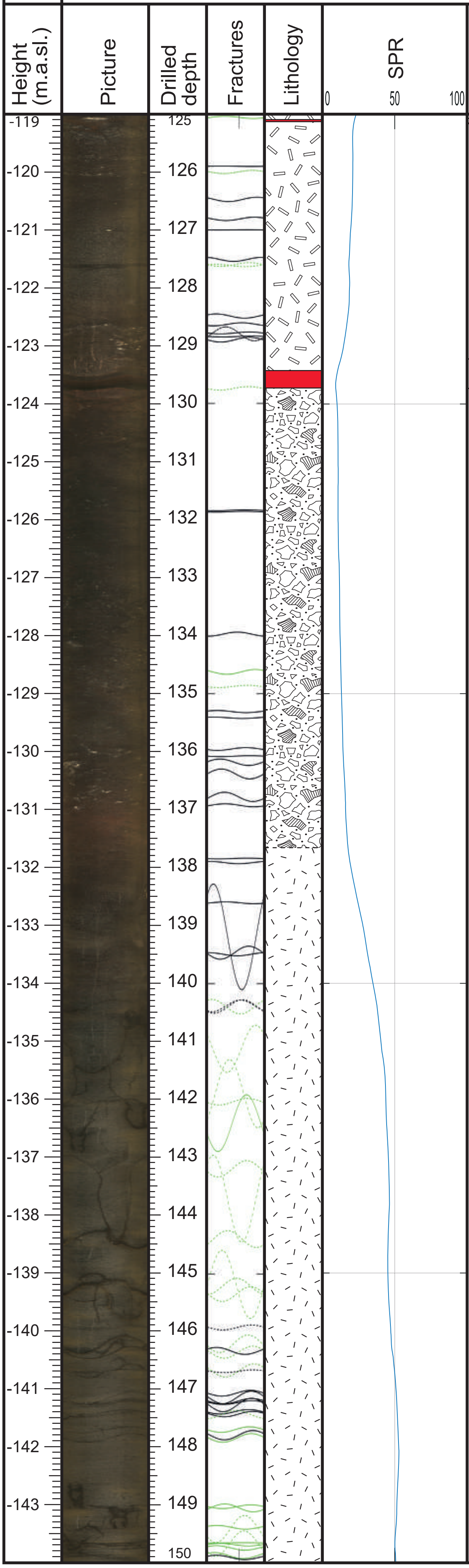
Remarks

Coarse feldspar phyric basalt. 13 m thick compound flow consisting of two 6 an 8 m thick flow units.

108,6-109,0: three 2-6 cm thick light brown volcaniclastic layers

Coarse feldspar phyric basalt. Sheet lobe. 16 m thick.

6	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



Remarks

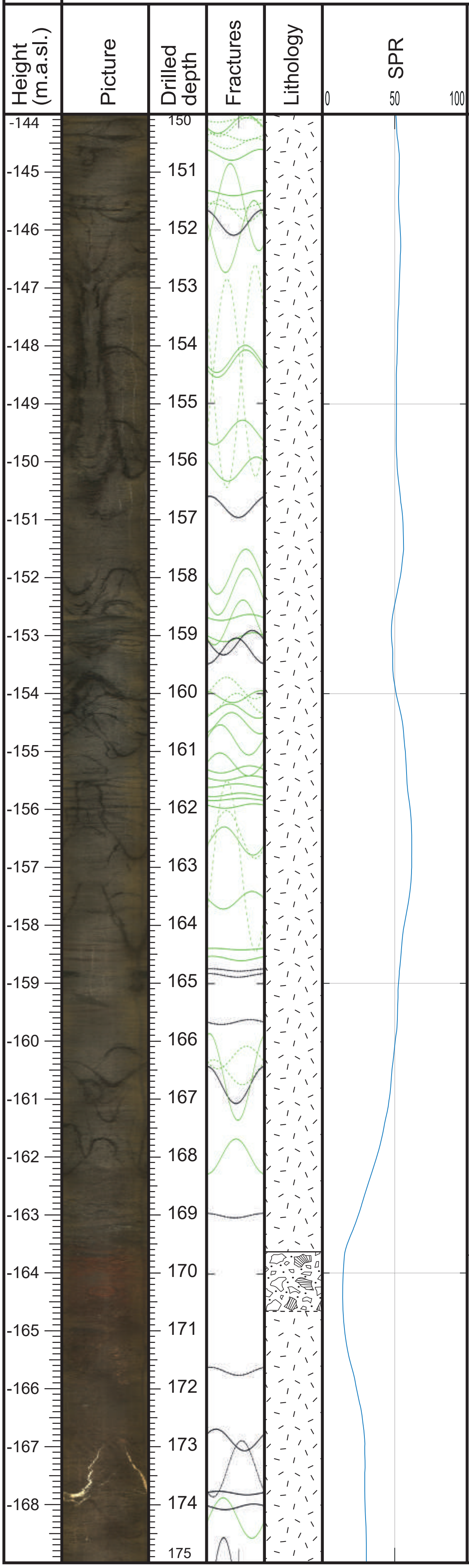
Thin volcaniclastic sediment.

Coarse feldspar phyric basalt. ca 4 m thick.

Volcaniclastic sediment. 129,37-129,73 m. 36 cm thick.
Moderate brown to grayish brown.

Fine feldspar phyric basalt. 40 m thick sheet lobe with a brecciated flow top (8 m) and a massive lower part (32 m).

7	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM

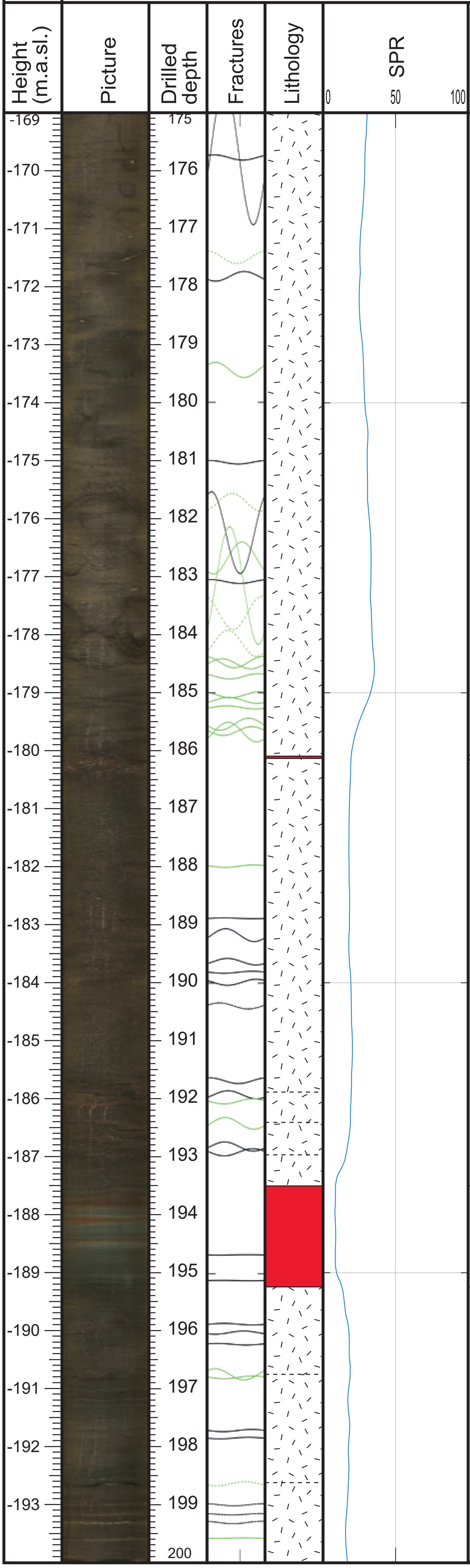


Remarks

Fine feldspar phyric basalt. 40 m thick sheet lobe with a brecciated flow top (8 m) and a massive lower part (32 m).

Fine feldspar phyric basalt. 16 m thick sheet lobe with a brecciated flow top (1 m) and a massive lower part.

8	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



Remarks

Fine feldspar phyric basalt. 16 m thick sheet lobe with a brecciated flow top (1 m) and a massive lower part.

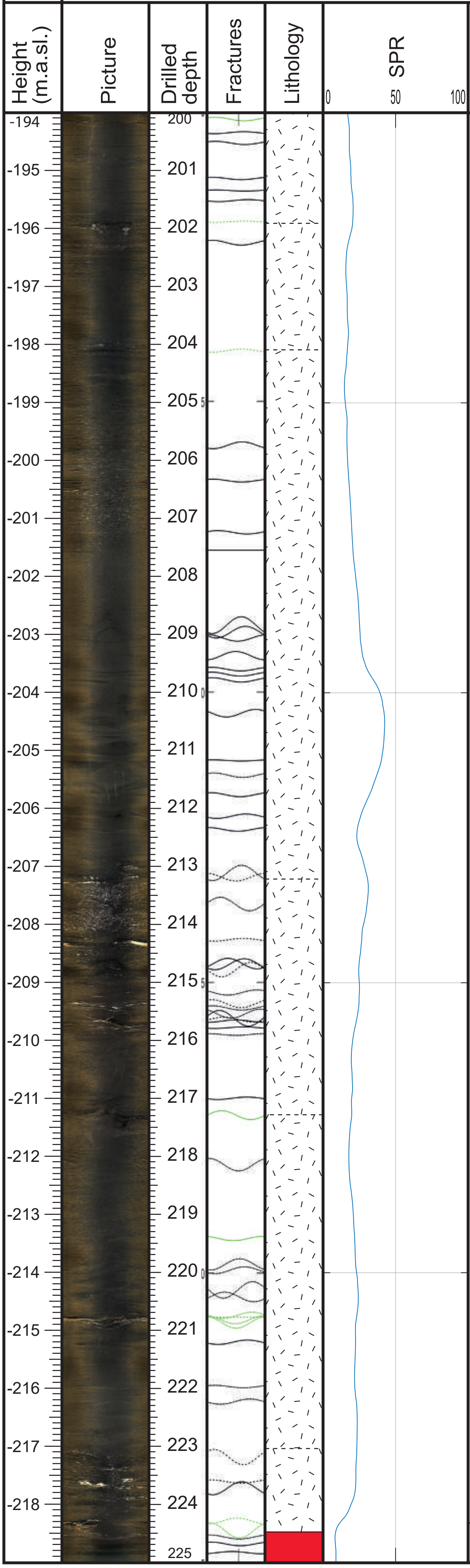
Thin volcaniclastic sediment. 186,1 m. Light brown.

Fine feldspar phyric basalt. 7 m thick compound flow with 0,5 to 6 m thick flow units.

Volcaniclastic sediment. Striped dominantly green and minor red. 193,45-195,28 m. 1,83 m thick. Three units, where the upper part is light brown and the lower part is moderat yellowish green to grayish green.

Fine feldspar phyric basalt. 29 m thick compound flow with 1-9 m thick flow units.

9	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM

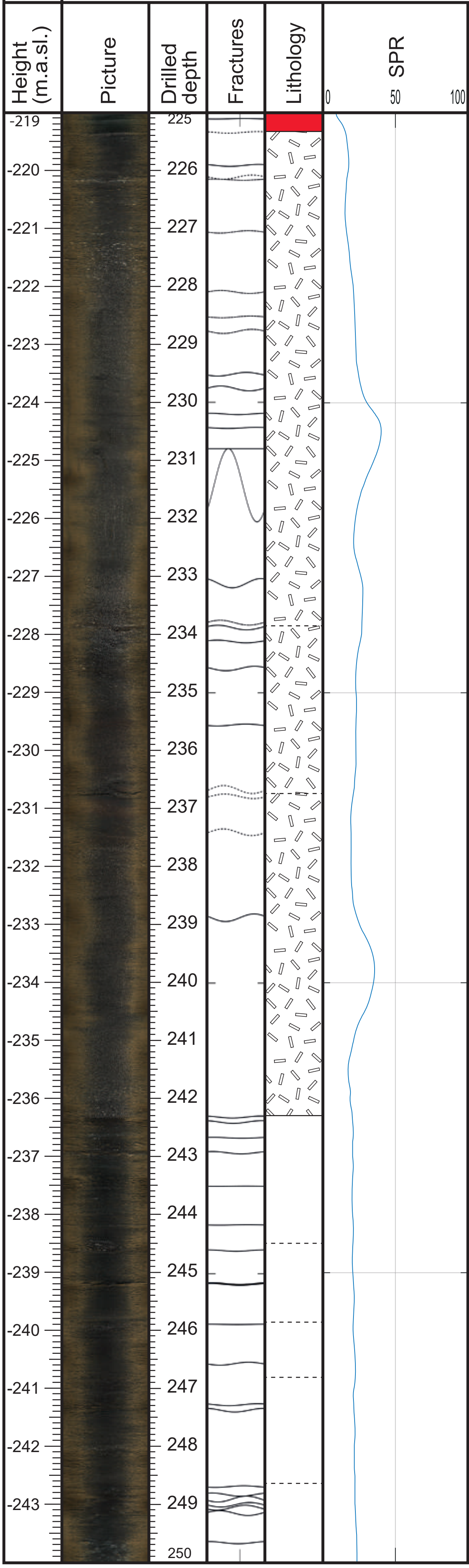


Remarks

Fine feldspar phyric basalt. 29 m thick compound flow with 1-9 m thick flow units.

Volcaniclastic sediment. 224,50-225,33 m. 83 cm thick. Banded. grayish brown and pale green bands.

10	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



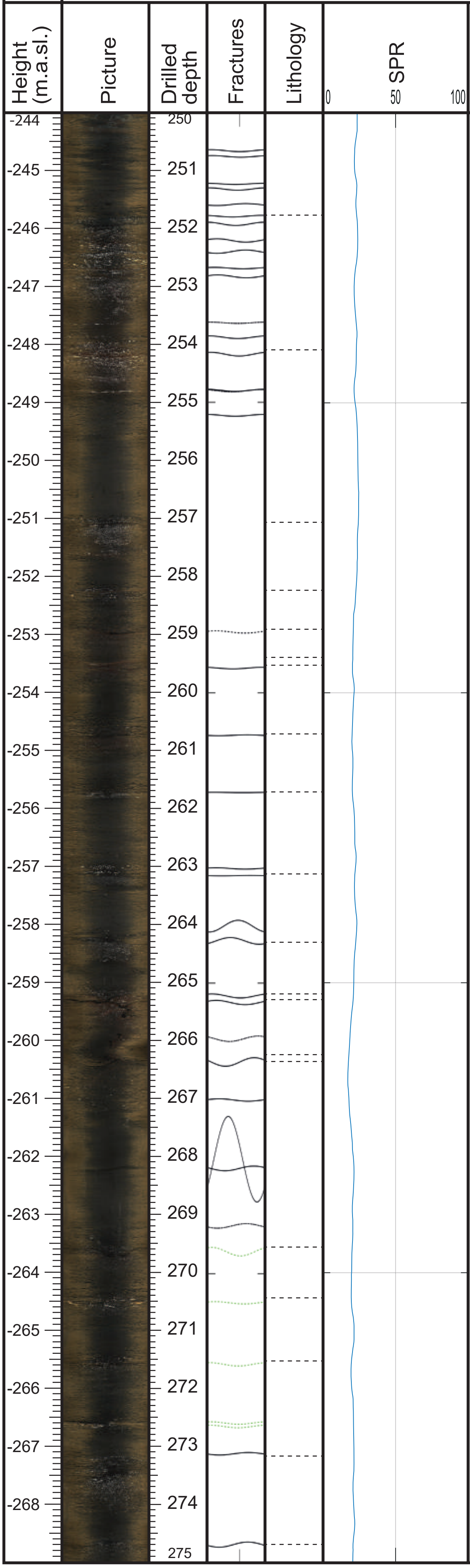
Remarks

Volcaniclastic sediment. 224,50-225,33 m. 83 cm thick. Banded. grayish brown and pale green bands.

Coarse feldspar phyric basalt. 17 m thick compound flow with 3-9 m thick flow units.

Dominantly aphyric basalt. 35 m thick compound flow with 0,1- 3 m flow units.
Pipe vesicles and thin lava tongues are observed.

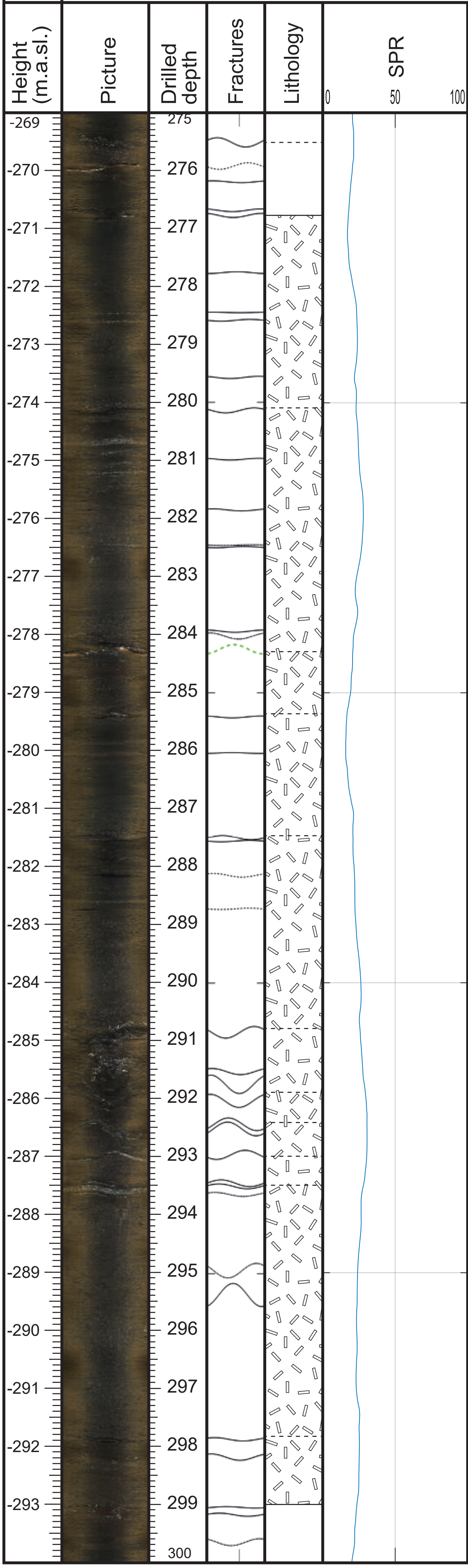
11	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



Remarks

Dominantly aphyric basalt. 35 m thick compound flow with 0,1- 3 m flow units.
Pipe vesicles and thin lava tongues are observed.

12	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



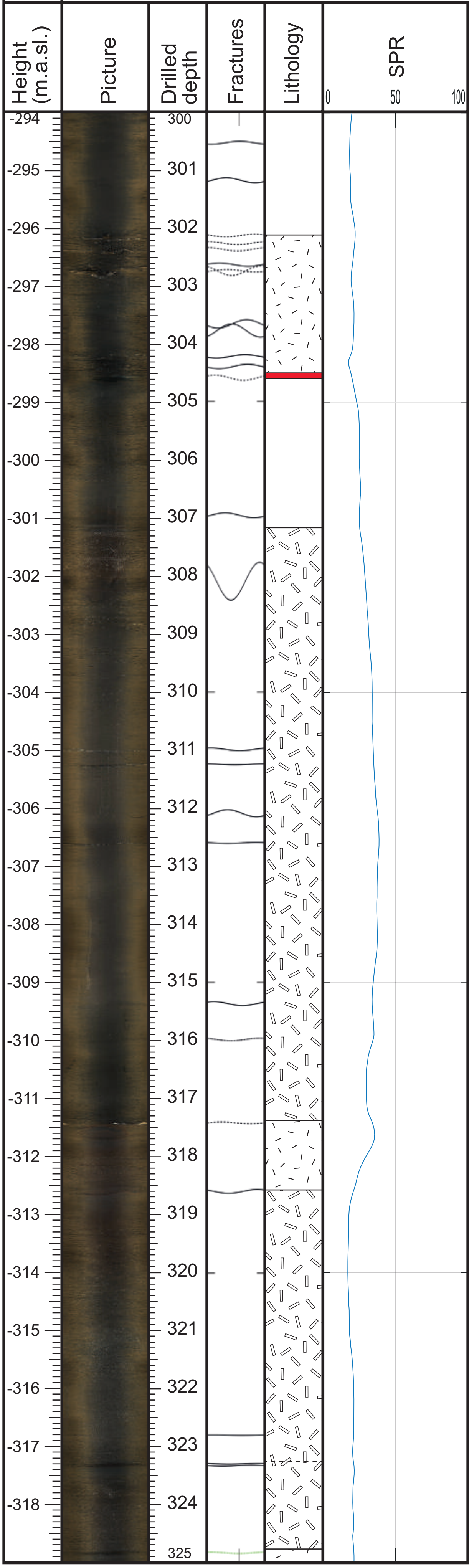
Remarks

Aphyric basalt. 35 m thick compound flow with 0,1- 3 m flow units.

Coarse feldspar phyric basalt. 22 m thick compound flow with 0,5 m to 4 m flow units.

Aphyric basalt. 3 m thick.

13	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



Remarks

Aphyric basalt.3 m thick.

Fine feldspar porphyritic basalt. 2,3 m thick.

Pale green volcaniclastic sediment. 304,5-304,6 m. ca 10 cm

Aphyric basalt. 2,5 m thick.

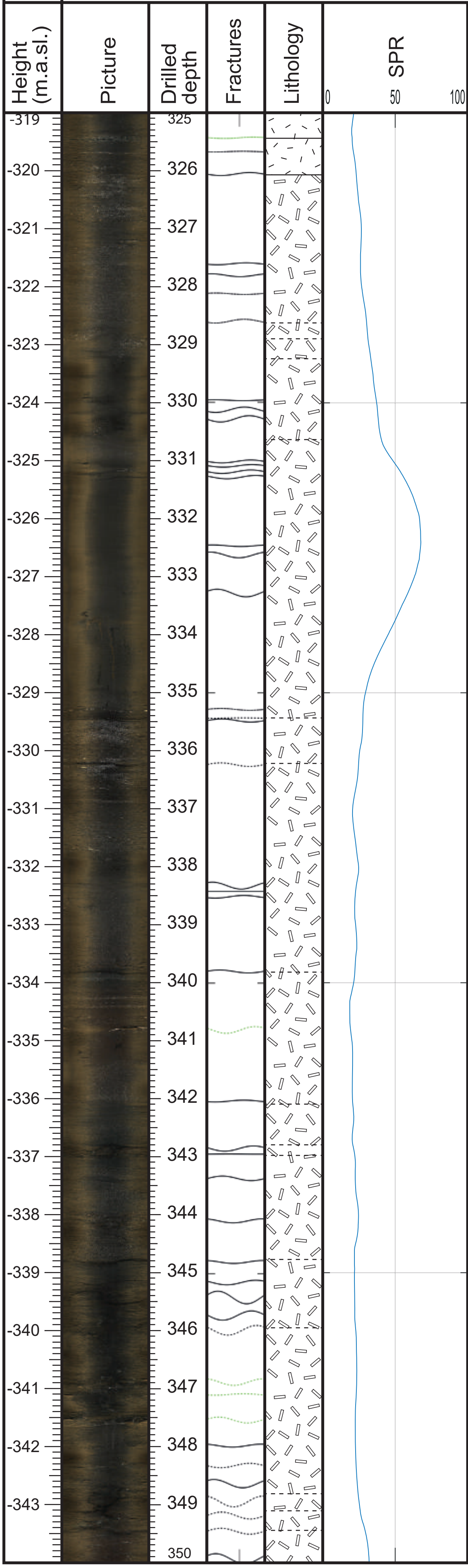
Sparse coarse and fine feldspar porphyritic basalt. 10 m thick.

Fine feldspar porphyritic basalt. 1, 2 m thick.

Coarse feldspar porphyritic basalt. 6 m thick. Two flow units, that are 4,7 and 1,5 m thick.

Fine feldspar porphyritic basalt. 1, 2 m thick.

14	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



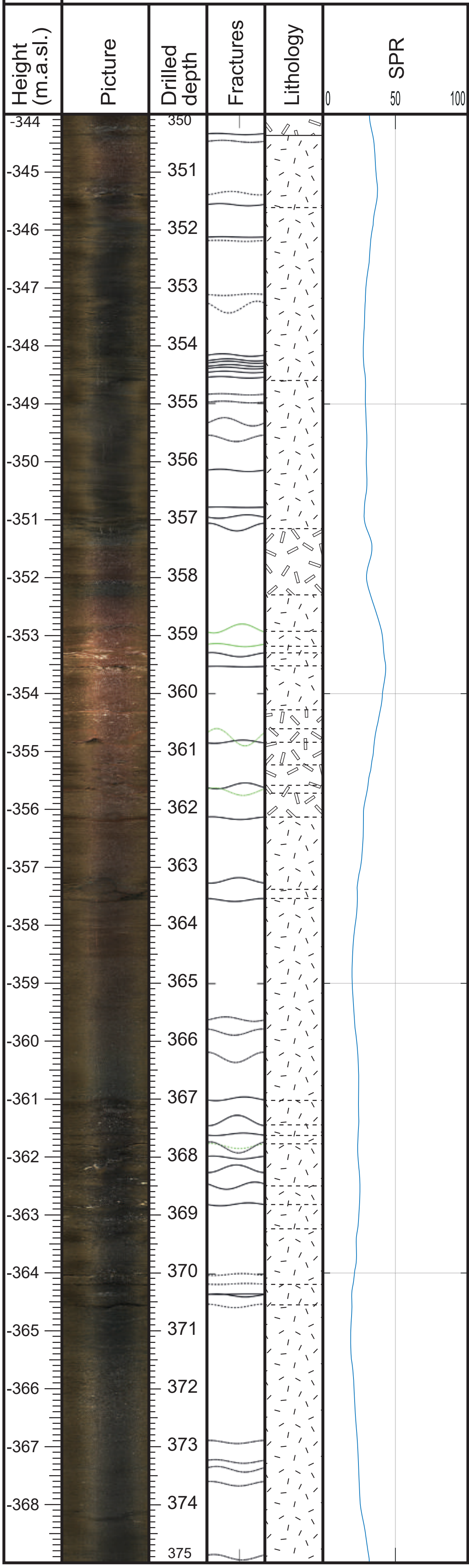
Remarks

Fine feldspar phyric basalt. 1,2 m thick. Two flow units.

Coarse grained feldspar-phyric basalt. 25 m thick compound flow with 0,2 m to 5 m thick flow units. Varying size and content of feldspar.

Zone with magma mixing signatures

15	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



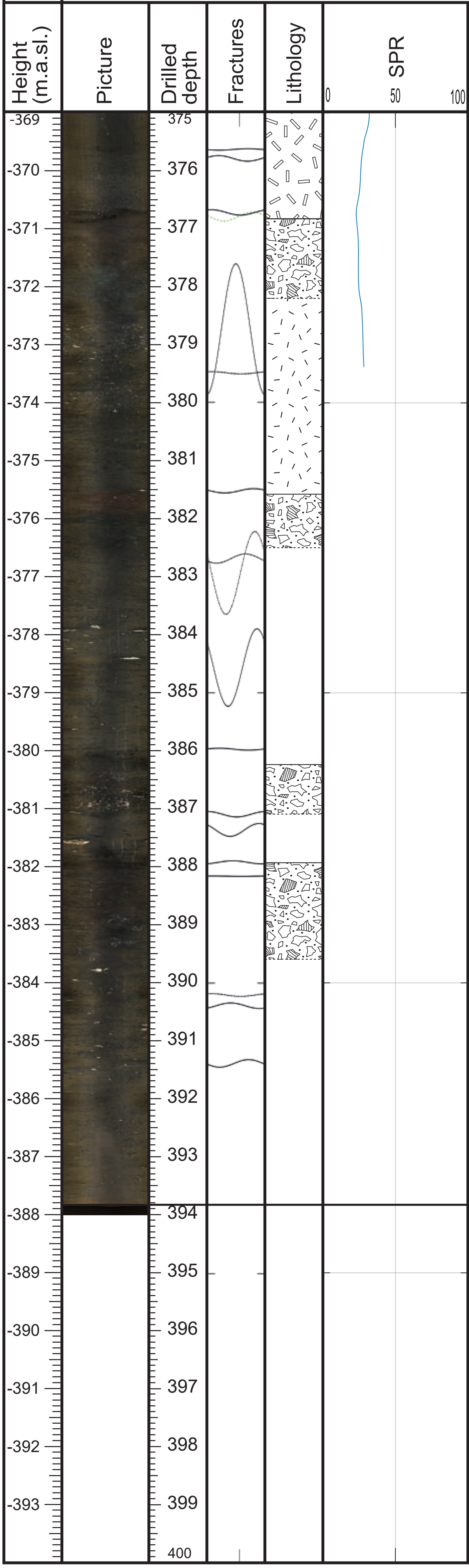
Remarks

Dominantly fine feldspar phyric basalt with some coarse feldspar. 27 m thick compound flow with 0,5 m to 7 m thick flow units.

Zone with magma mixing signatures

357-362 m: Reddish and altered basalt. Alteration probably fracture related.

16	Project: Suðuroyartunnilin	Year: 2021	Location: Skúvoy	Borehole 01
	Position: Y= ca 851471 X=ca 210345 Z= ca 6 m			Datum: FOTM



Remarks

Dominantly fine feldspar phyric basalt with some coarse feldspar. 27 m thick compound flow with 0,5 m to 7 m thick flow units.

Fine feldspar phyric to aphyric basalt. 5 m thick sheet lobe with brecciated crust (1,4 m).

Aphyric basalt. 5 m thick sheet lobe with brecciated crust (0,9 m).

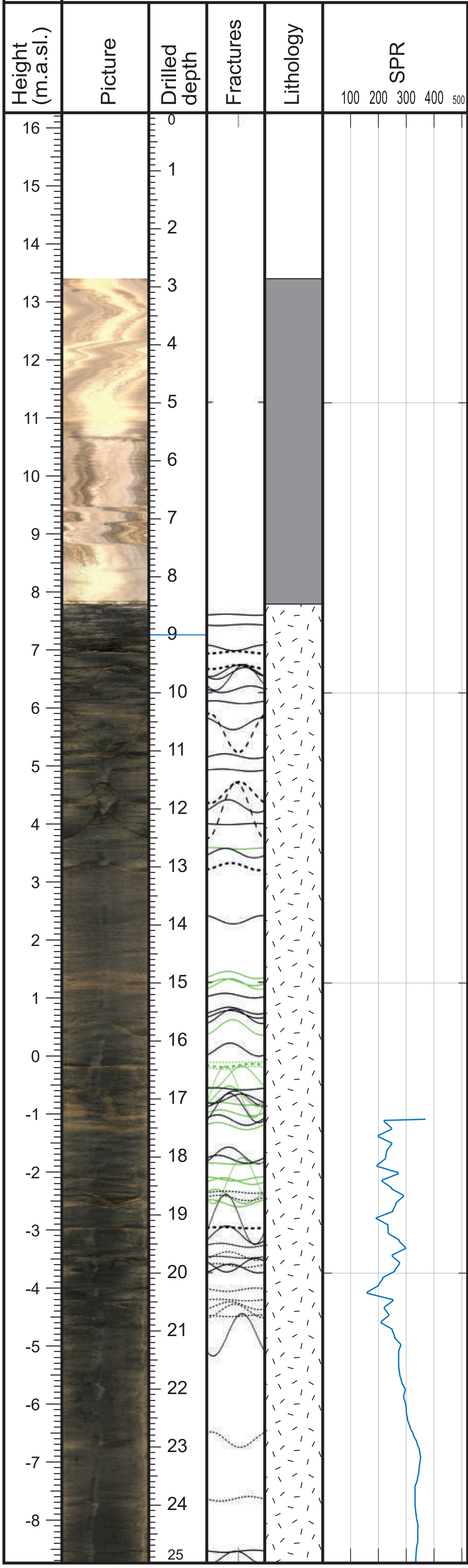
Aphyric basalt. 1,7 m thick sheet lobe with brecciated crust (0,9 m).

Aphyric basalt. >6 m thick sheet lobe with brecciated crust (1,7 m).

Appendix F

Skarvanes-1 borehole

1	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



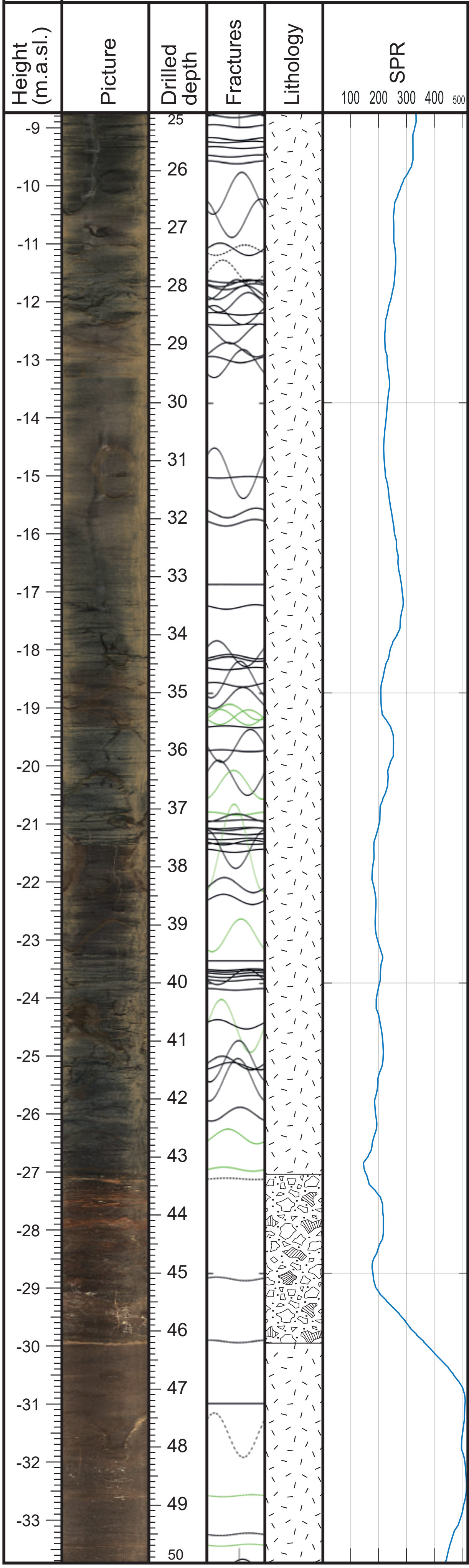
Remarks

Casing 0-8,47 m.

Finegrained feldspar-phyric basalt. Massive sheetlobe with numerous fractures. >35 m thick.

Water level in well is 9,0 m.

2	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM

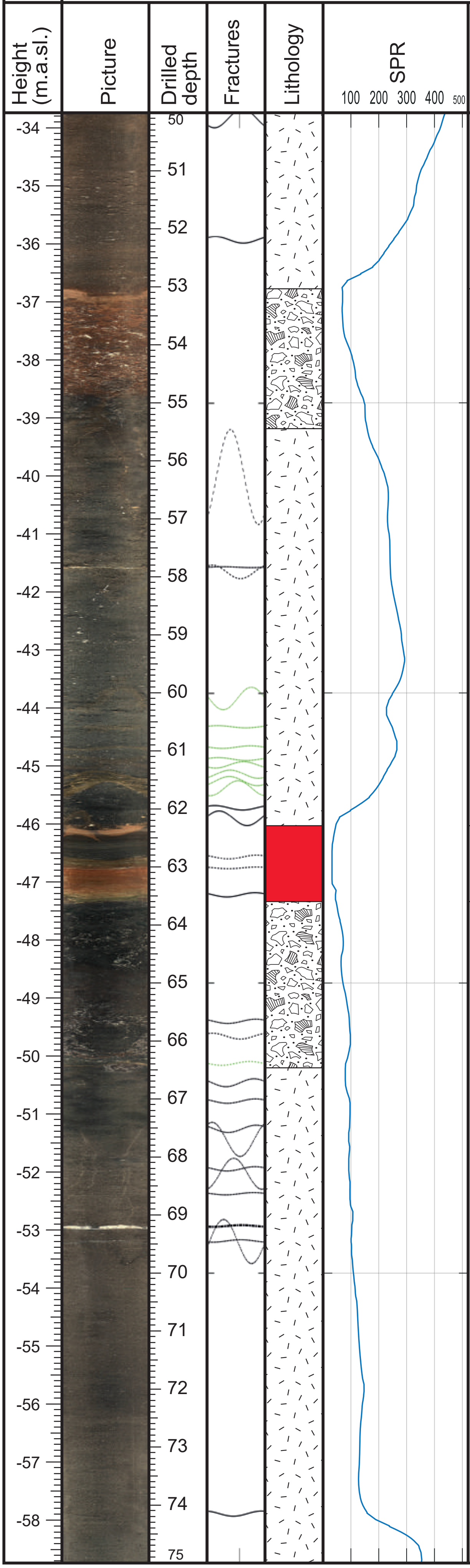


Remarks

Finegrained feldspar-phyric basalt. Massive sheetlobe with numerous fractures. >35 m thick.

Finegrained feldspar-phyric basalt. 9,7 m thick massive sheetlobe with brecciated flow top (2,9 m). Numerous fractures in the lower massive part of the flow.

3	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



Remarks

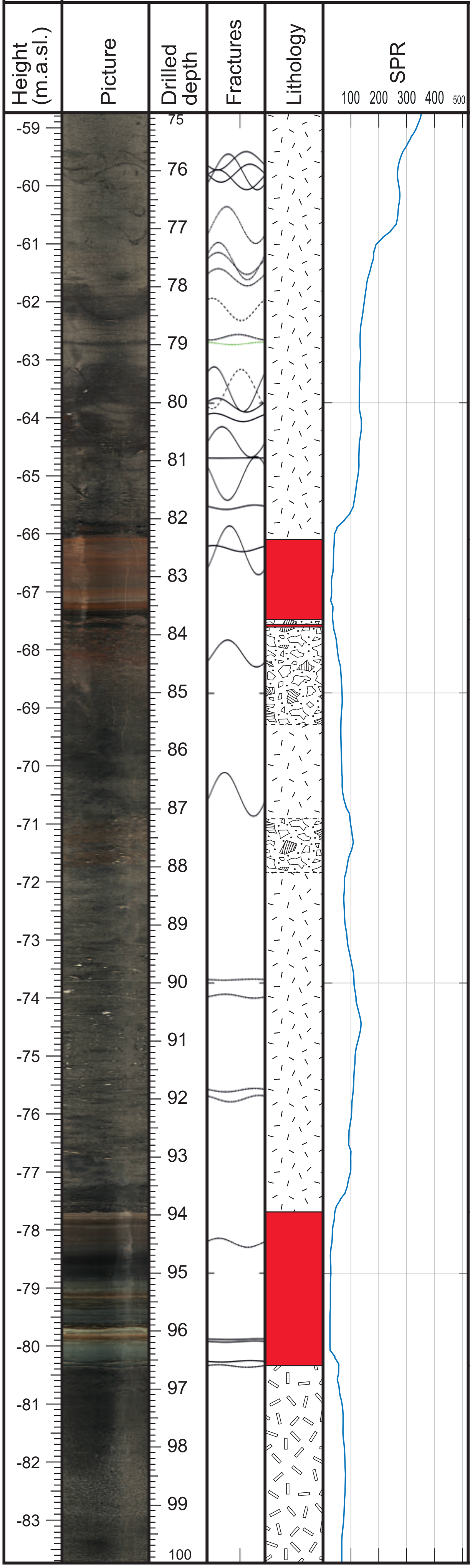
Finegrained feldspar-phyric basalt. 9,7 m thick massive sheetlobe with numerous fractures.

Finegrained feldspar-phyric basalt. 9,5 m thick massive sheetlobe with brecciated flow top (2,5 m) . Numerous fractures in the lower massive part of the flow.

Volcaniclastic sandstone. 62,43-63,5 m: 1,07 m thick. Upper unit is dark greenish grey to dusky yellow green. Lower unit is light brown.

Finegrained feldspar-phyric basalt. 19 m thick massive sheetlobe with brecciated flow top (3,0 m). Numerous fractures in the lower massive part of the flow.

4	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



Remarks

Finegrained feldspar-phyric basalt. 19 m thick massive sheetlobe with brecciated flow top (3,0 m). Numerous fractures in the lower massive part of the flow.

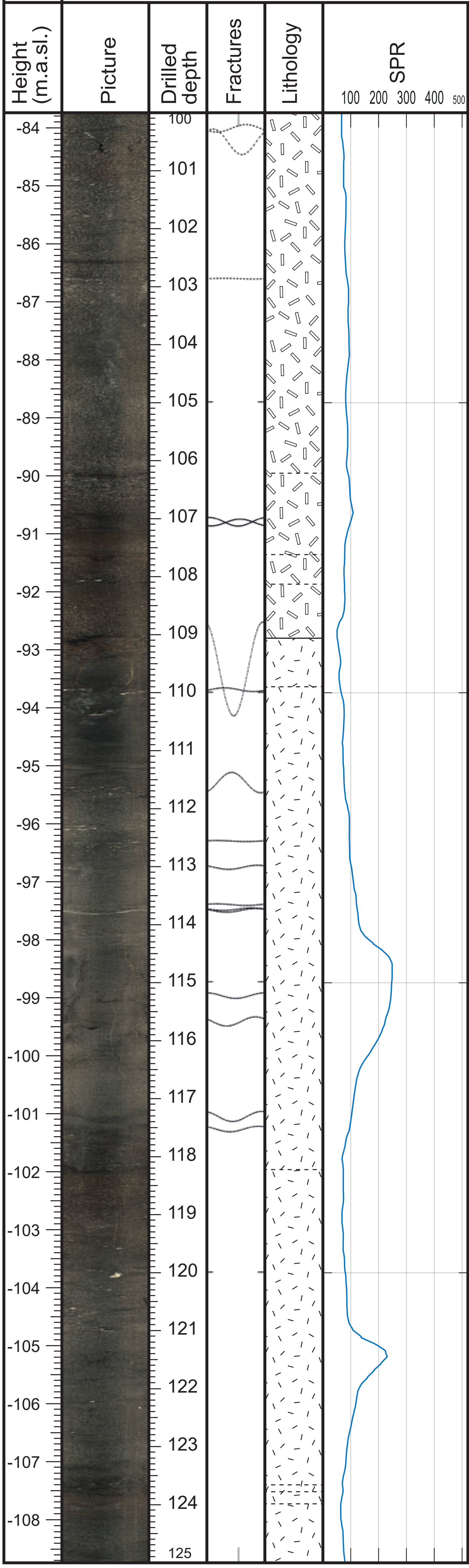
Volcaniclastic sandstone 82,35-83,75 m. 1,4 m thick. Innfilling brecciated flow top. Mostly pale brown tolight brown. Lowermost 20-30 cm are dusky green.

Finegrained feldspar-phyric basalt. 10 m thick massive sheetlobe with brecciated flow top (1,8 m) and brecciated zone in middle of flow. Numerous fractures in the lower massive part of the flow.

Volcaniclastic sandstone 93,95-96,60 m drilled depth. 2,65 m thick. Laminated and striped. 3 units. Upper unit is pale yellowish brown to dusky yellowish brown and dark grey. Middle and lower unit are pale green to grayish green and pale greenish yellow and light brown.

Coarsegrained feldspar-phyric basalt. 12,5 m thick compound flow with flow units, that are 0,5-9,5 m thick.

5	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM

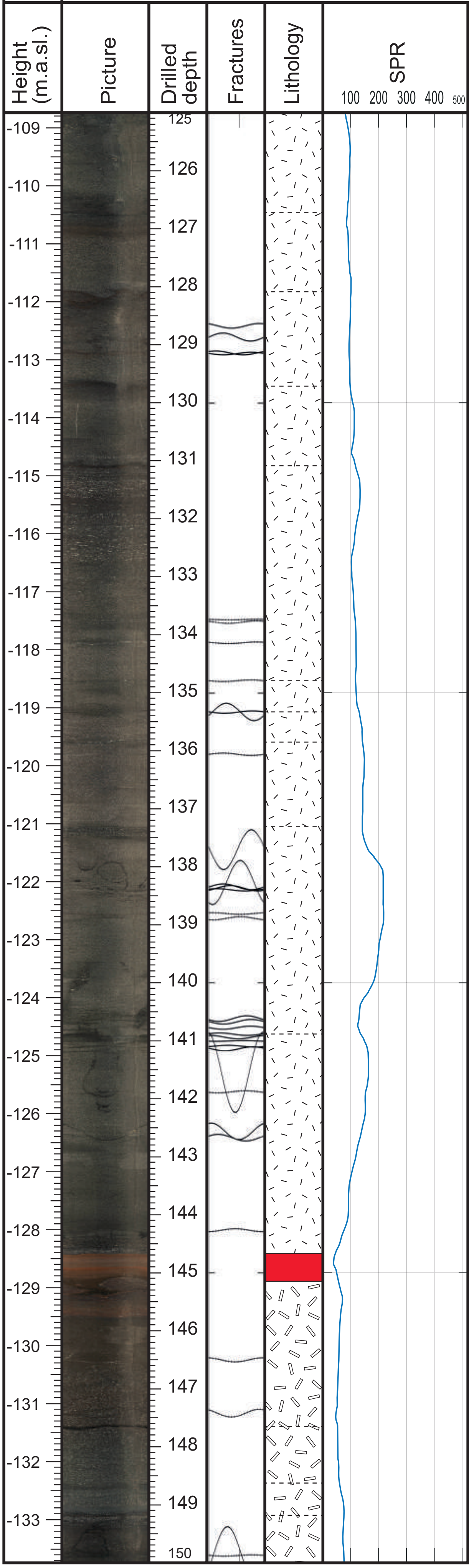


Remarks

Coarsegrained feldspar-phyric basalt. 12,5 m thick compound flow with flow units, that are 0,5-9,5 m thick.

Finegrained feldspar-phyric basalt. 36 m thick compound flow with flow units, that are 0,2-8,5 m thick.

6	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



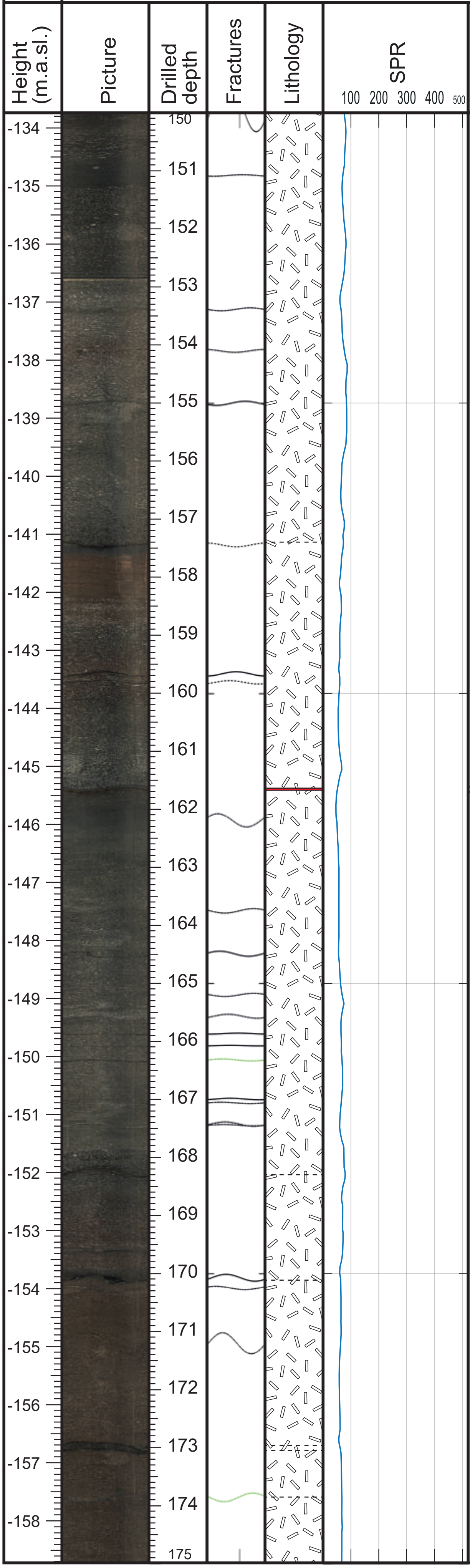
Remarks

Finegrained feldspar-phyric basalt. 36 m thick compound flow with flow units, that are 0,2-8,5 m thick.

Volcaniclastic sandstone. 144,67-145,14 m. 47 cm thick. Light brown to moderate reddish brown.

Coarsegrained feldspar-phyric basalt. 16,5m thick compound flow with flow units, that are 0,5-8,5 m thick.

7	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



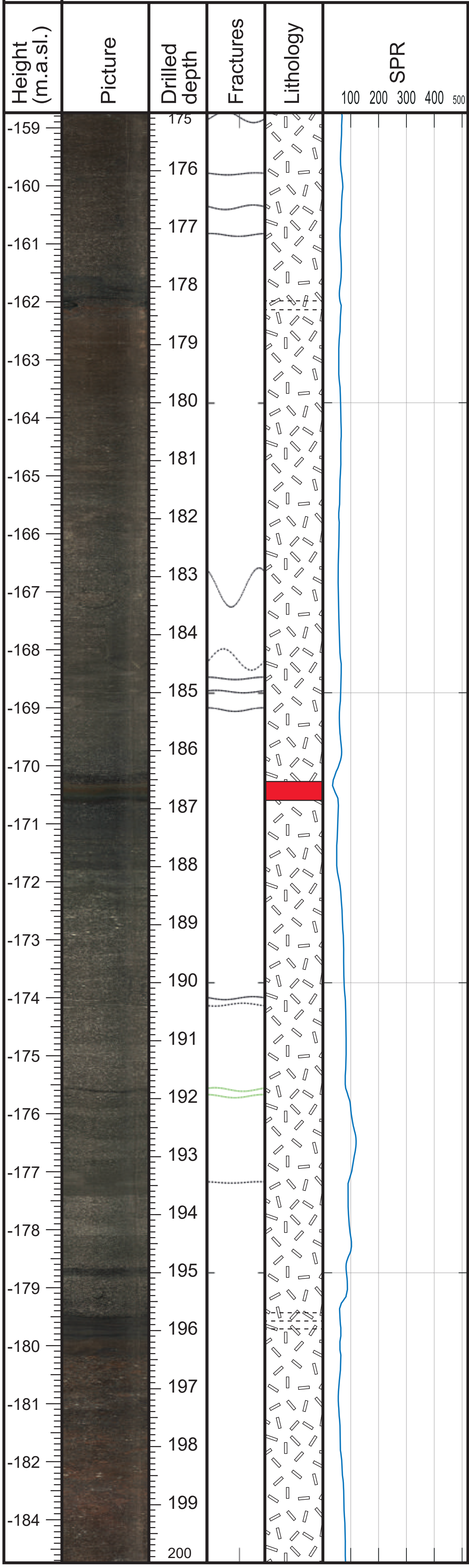
Remarks

Coarsegrained feldspar phyric basalt. 16,5m thick compound flow with flow units, that are 0,5-8,5 m thick.

Cm-thick volcaniclastic layer.

Coarsegrained feldspar phyric basalt. 25 m thick compound flow with flow units that are 0,2-8,0 m thick.

8	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



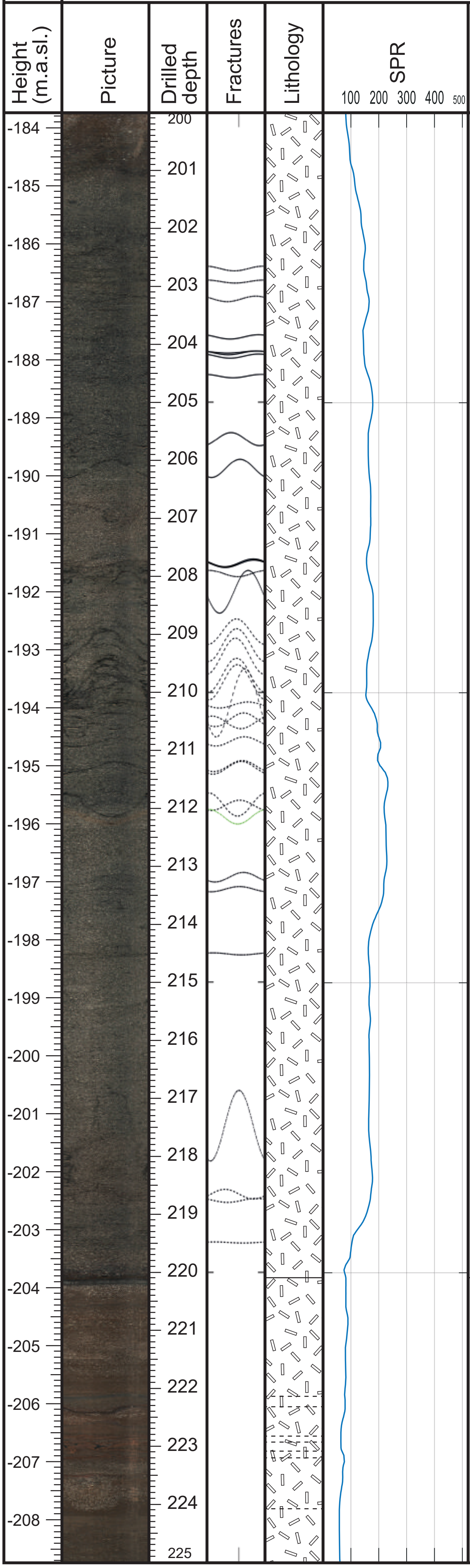
Remarks

Coarsegrained feldspar phyric basalt. 25 m thick compound flow with flow units that are 0,2-8,0 m thick.

Volcaniclastic sandstone. 186,54-186,78. 28 cm thick. Moderate brown to dusky brown and pale green to grayish green.

Coarsegrained feldspar phyric basalt. 33 m thick compound flow with flow units that are 0,2-24 m thick.

9	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



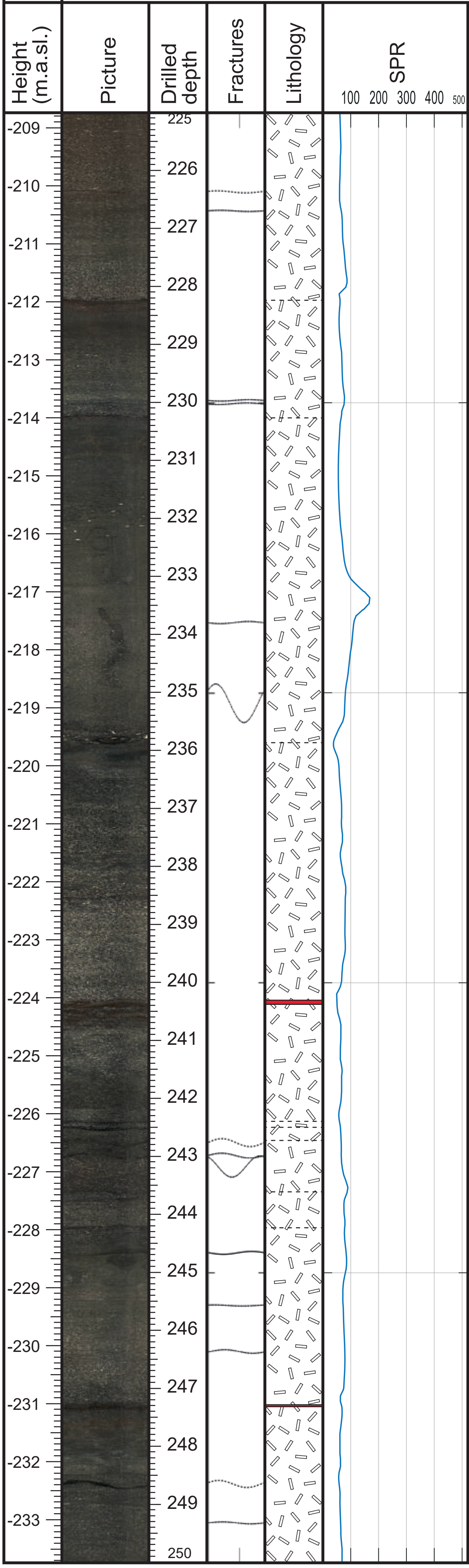
Remarks

Coarsegrained feldspar phyric basalt. 33 m thick compound flow with flow units that are 0,2-24 m thick.

Coarsegrained feldspar phyric basalt. 20 m thick compound flow with flow units that are 0,2-5,5 m thick.

Lava tongues.

10	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



Remarks

Coarsegrained feldspar phyric basalt. 20 m thick compound flow with flow units that are 0,2-5,5 m thick.

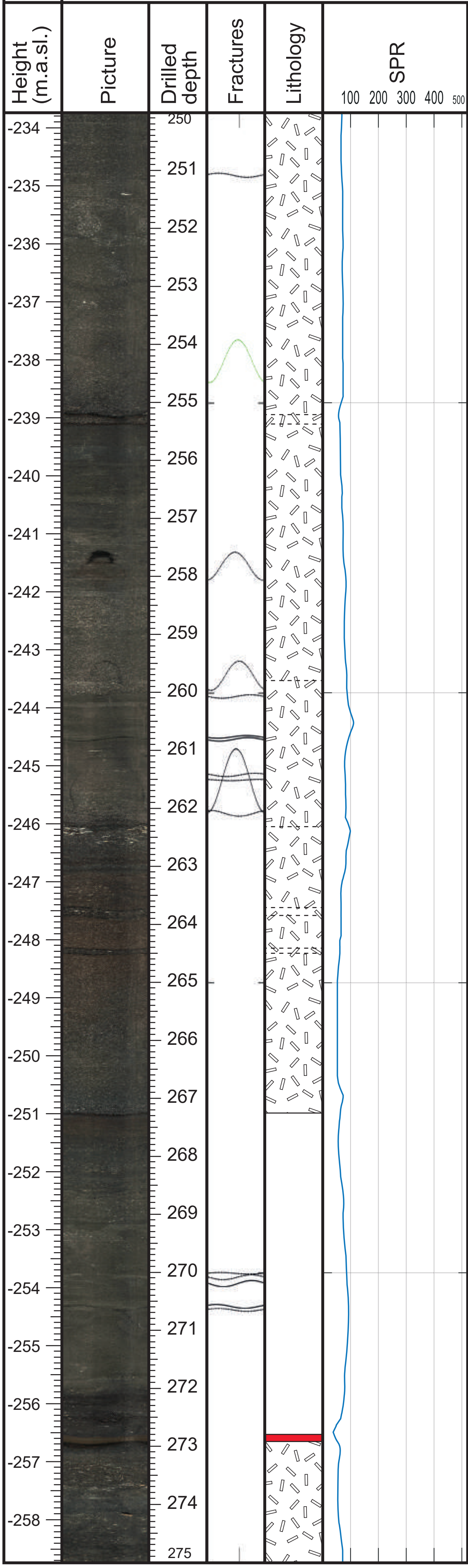
Volcaniclastic sandstone. 240,30-240,36 m. 6 cm thick. Light brown.

Coarse feldspar-phyric basalt. 7 m thick compound flow with 0,2 to 3 m thick flow units.

Volcaniclastic sandstone. 247,29-247,30 m. 1 cm thick.

Coarse feldspar-phyric basalt. 20 m thick compound flow with 0,2 to 8 m thick flow units.

11	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



Remarks

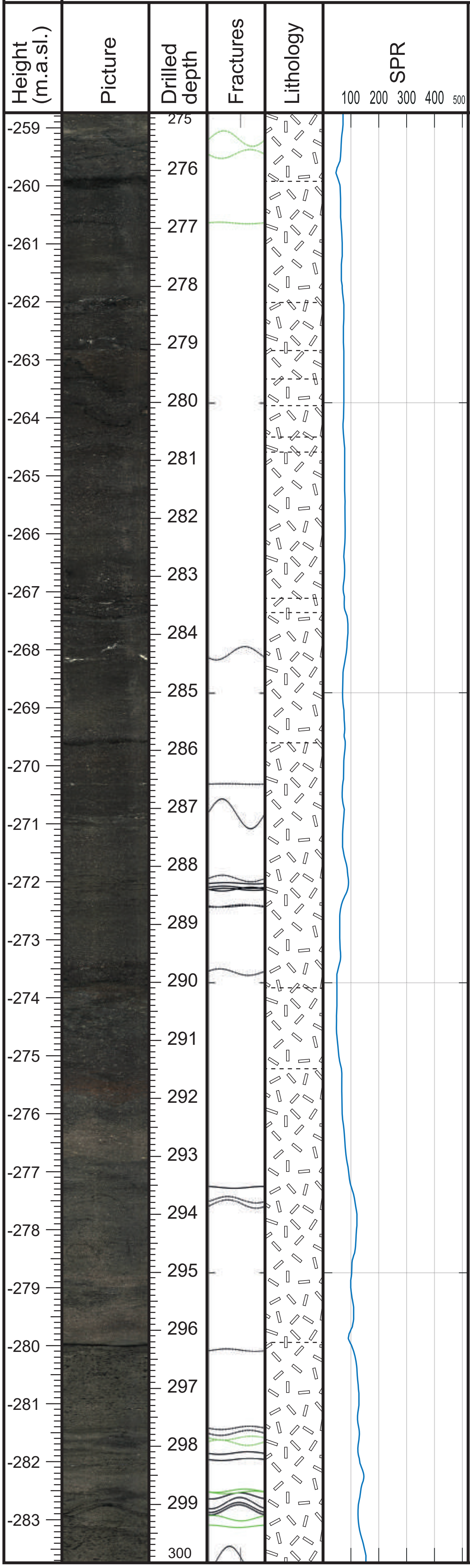
Coarse feldspar-phyric basalt. 20 m thick compound flow with 0,2 to 8 m thick flow units.

Aphyric basalt. 7 m thick.

Volcaniclastic sandstone. 272,78-272,90 m . 12 cm thick. Light brown.

Coarse feldspar-phyric basalt. 36 m thick compound flow with 0,2 to 12,5 m thick flow units.

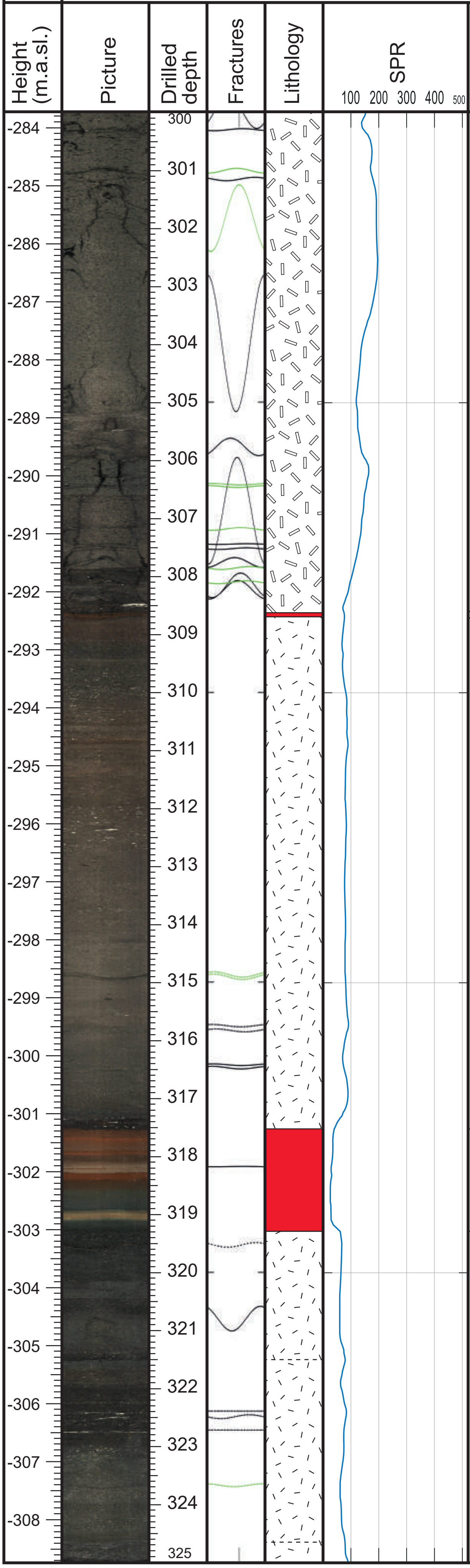
12	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



Remarks

Coarse feldspar-phyric basalt. 36 m thick compound flow with 0,2 to 12,5 m thick flow units.

13	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



Remarks

Coarse feldspar-phyric basalt. 36 m thick compound flow with 0,2 to 12,5 m thick flow units.

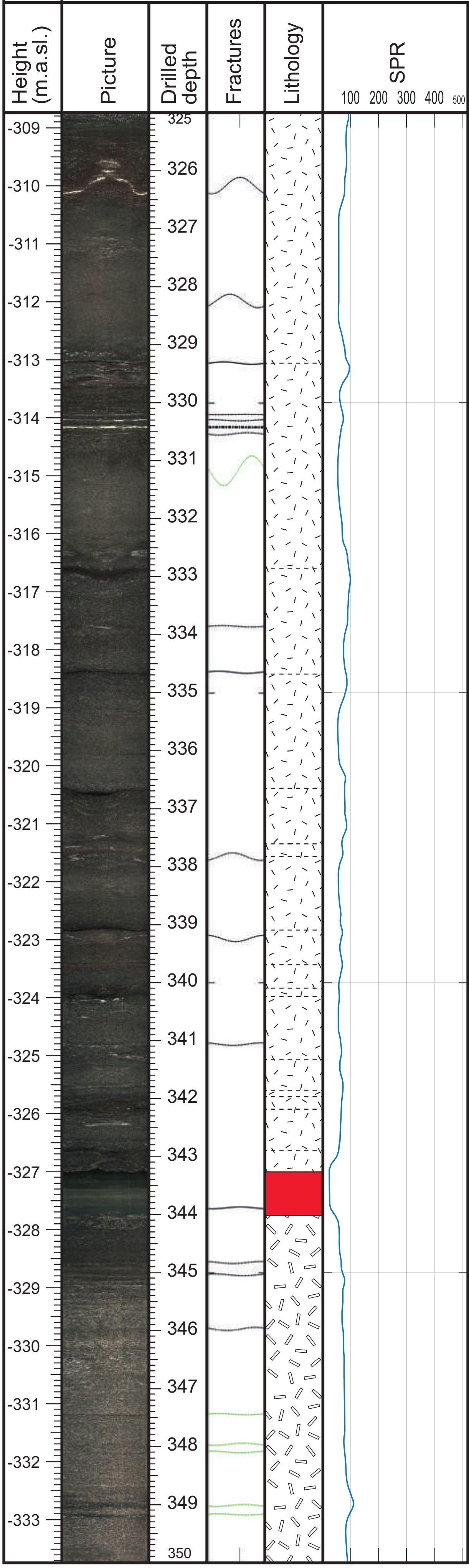
Volcaniclastic sandstone. 308,62-308,62 m. 6 cm thick.

Fine feldspar porphyritic basalt. 9 m thick.

Volcaniclastic sandstone. 317,52-319,28 m. 1,76 m thick. The upper unit is light brown to moderate brown with some very pale orange. Lower unit is pale green to grayish green with some very pale orange.

Fine feldspar phyric basalt. 24 m thick compound flow with 0,2-5 m thick flow lobes.

14	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



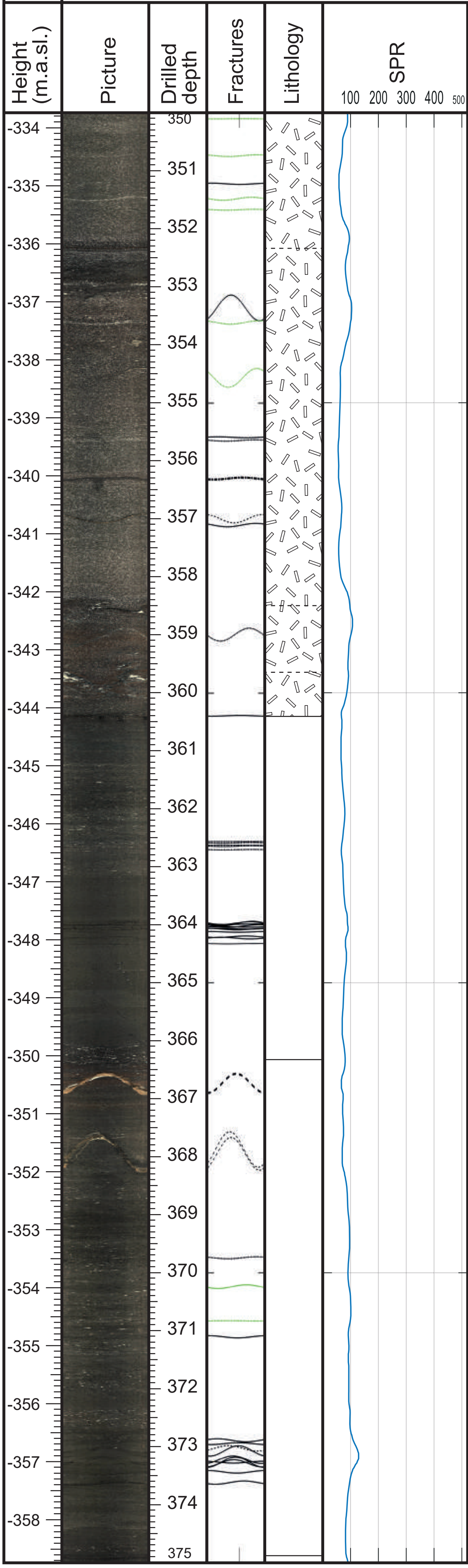
Remarks

Fine feldspar phyric basalt. 24 m thick compound flow with 0,2-5 m thick flow lobes.

Volcaniclastic sandstone. 343,26-344,01 m.a.sl. 75 cm thick. Greyish green to pale green.

Coarse feldspar phyric basalt. 16 m thick compound flow with 1-8 m thick flow lobes.

15	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM

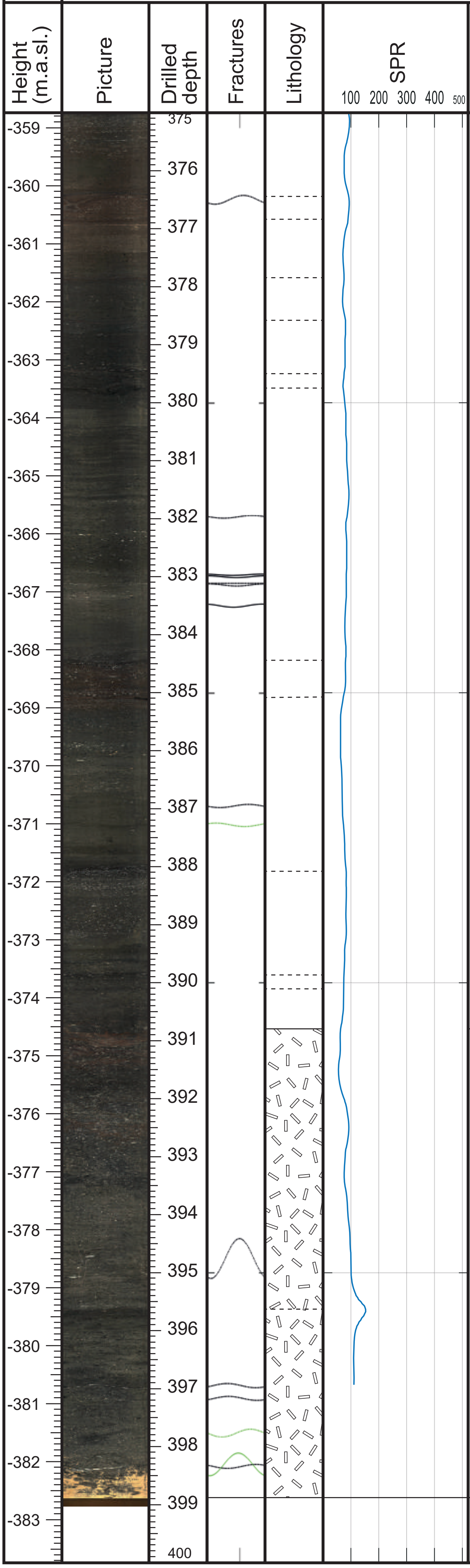


Remarks

Coarse feldspar phyric basalt. 16 m thick compound flow with 1-8 m thick flow lobes.

Aphyric to sparse fine feldspar phyric basalt. 30 m thick compound flow with 0,2-8 m thick flow units.

16	Project: Suðuroyartunnilin	Year: 2021	Location: Skarvanes	Borehole 01
	Position: Y=853932,00 X=213311,97 Z=16,24 m			Datum: FOTM



Remarks

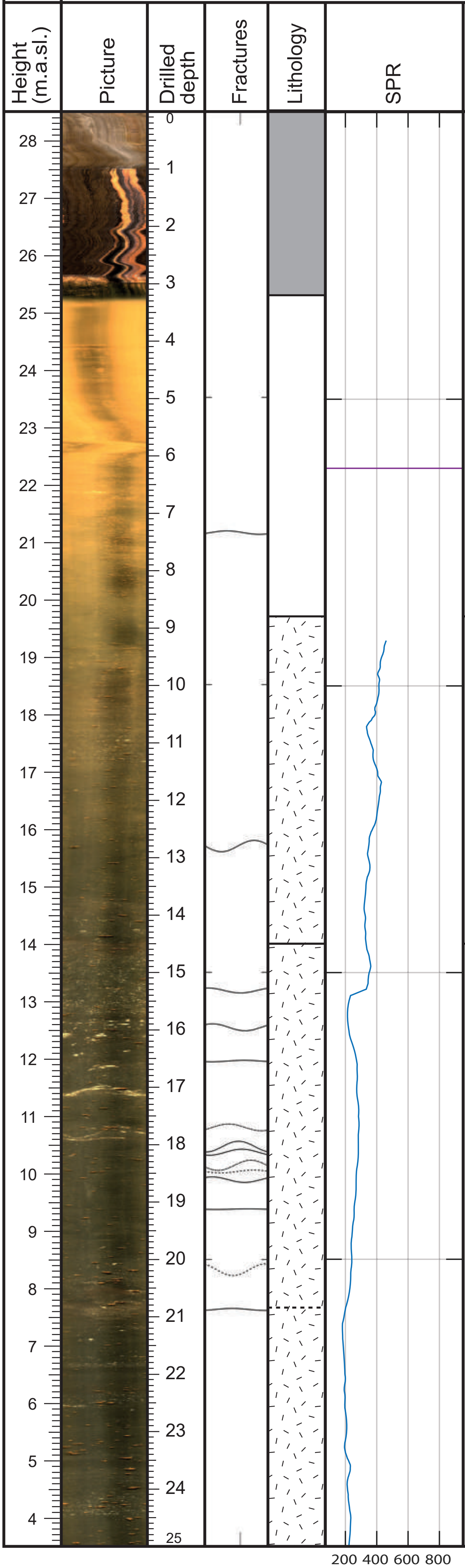
Aphyric to sparse fine feldspar phyric basalt. 30 m thick compound flow with 0,2-8 m thick flow units.

Coarse feldspar phyric basalt. >8 m thick compound flow. 2 flow units that are 5 m and >3 m thick are drilled.

Appendix G

Sandvík-1 borehole

1	Project: Suðuroyartunnilin	Year: 2021	Location: Sandvík	Borehole 01
	Position: Y=203656.65 X=835937.82 Z=28.48 m			Datum: FOTM



Remarks

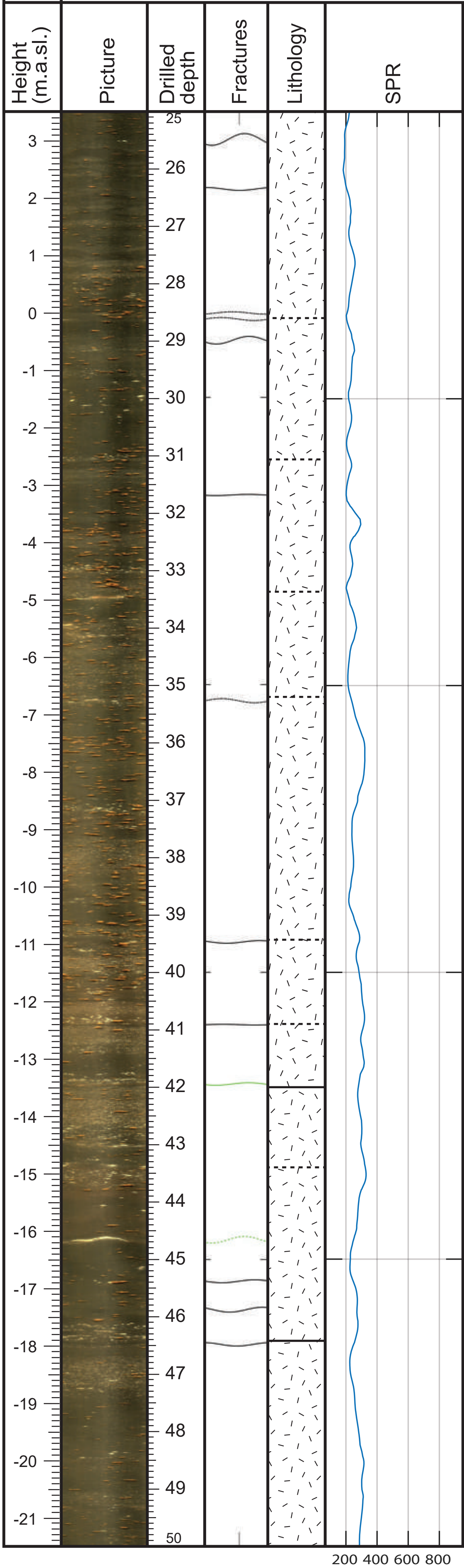
Casing / no log

3-8,8m: Very poor image quality

8,8-14,5m: Fine-grained plagioclase phyric compound flow.

14,5-42,0m: Fine-grained plagioclase phyric compound flow.
Several highly vesicular flow lobes.

2	Project: Suðuroyartunnilin	Year: 2021	Location: Sandvík	Borehole 01
	Position: Y=203656.65 X=835937.82 Z=28.48 m			Datum: FOTM



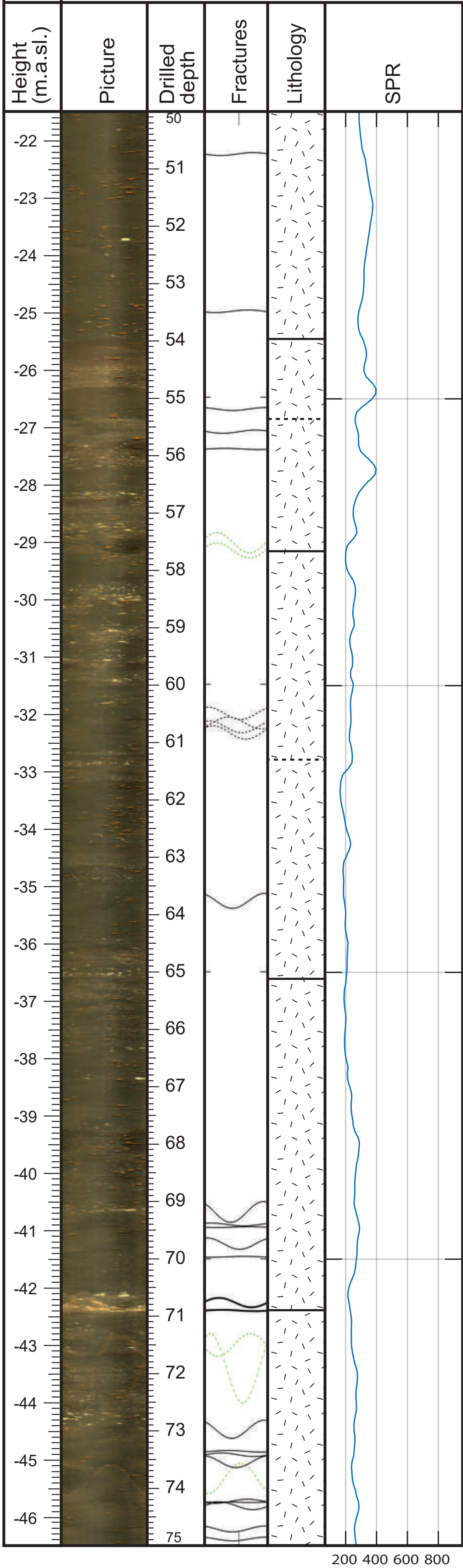
Remarks

14,5-42,0m: Fine-grained plagioclase phyric compound flow. Several flow lobes.

42,0-46,5m: Fine-grained plagioclase phyric compound flow. Two flow lobes.

46,5-54,0m: Fine-grained plagioclase phyric compound flow. Several flow lobes.

3	Project: Suðuroyartunnilin	Year: 2021	Location: Sandvík	Borehole 01
	Position: Y=203656.65 X=835937.82 Z=28.48 m			Datum: FOTM



Remarks

46,5-54,0m: Fine-grained plagioclase phyric compound flow.

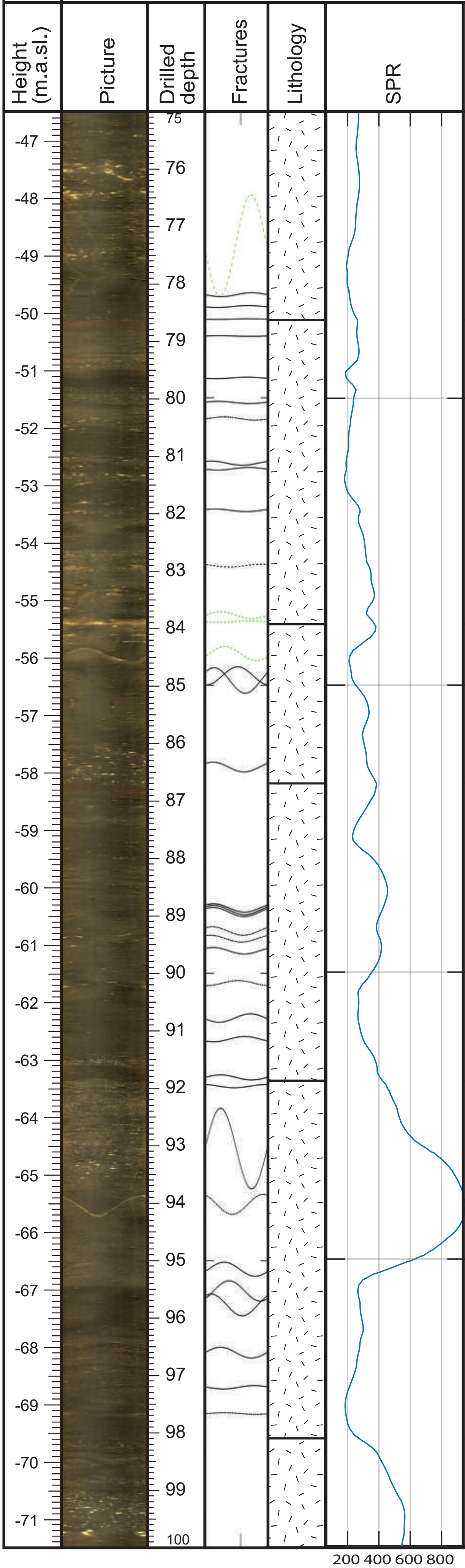
54,0-57,75m: Fine-grained plagioclase phyric compound flow.
Two flow lobes.

57,75-65,1m: Fine-grained plagioclase phyric compound flow.
Two flow lobes.

65,1-71,0m: Fine-grained plagioclase phyric compound flow.

71,0-78,6m: Fine-grained plagioclase phyric compound flow.

4	Project: Suðuroyartunnilin	Year: 2021	Location: Sandvík	Borehole 01
	Position: Y=203656.65 X=835937.82 Z=28.48 m			Datum: FOTM



Remarks

71,0-78,6m: Fine-grained plagioclase phyric compound flow.

78,6-84,0m: Fine-grained plagioclase phyric compound flow.
Red, altered flow top.

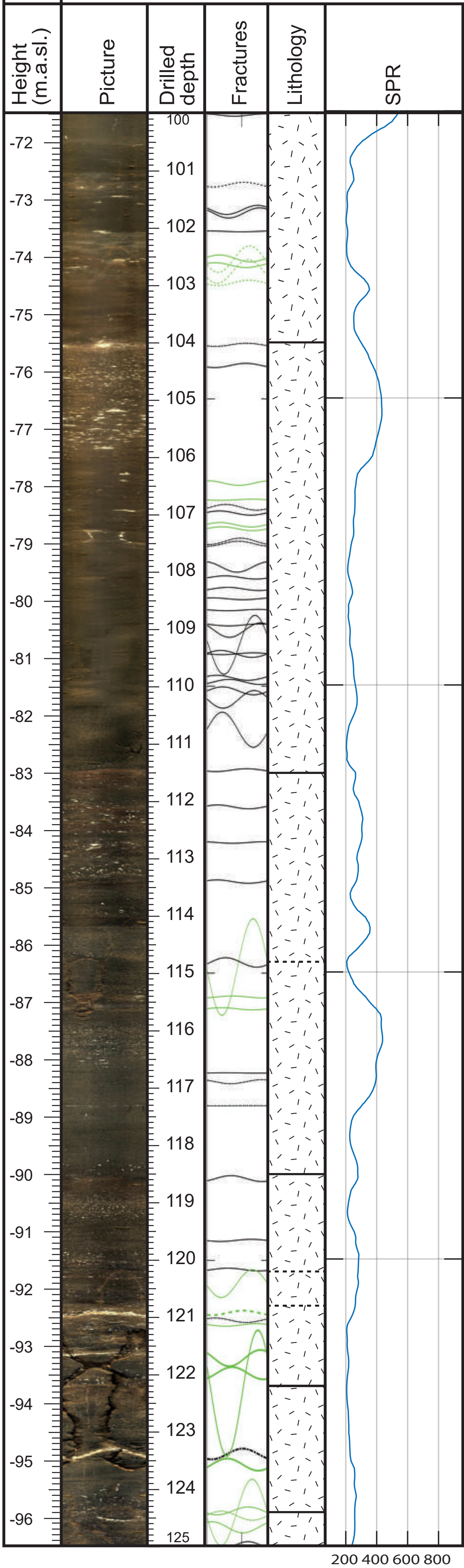
84,0-86,7m: Fine-grained plagioclase phyric compound flow.

86,7-92,0m: Fine-grained plagioclase phyric compound flow.
Red flow top.

92,0-98,1m: Fine-grained plagioclase phyric compound flow.

98,1-104,0m: Fine-grained plagioclase phyric compound flow.

5	Project: Suðuroyartunnilin	Year: 2021	Location: Sandvík	Borehole 01
	Position: Y=203656.65 X=835937.82 Z=28.48 m			Datum: FOTM



Remarks

98,1-104,0m: Fine-grained plagioclase phyric compound flow.

104,0-111,5m: Fine-grained plagioclase phyric compound flow.
Highly vesicular flow top and more massive flow base

111,5-118,5m: Fine-grained plagioclase phyric compound flow.
Red highly vesiculated flow top. Two seperate flowe lobes

118,5-122,2m: Fine-grained plagioclase phyric compound flow.
Three seperate flowe lobes.

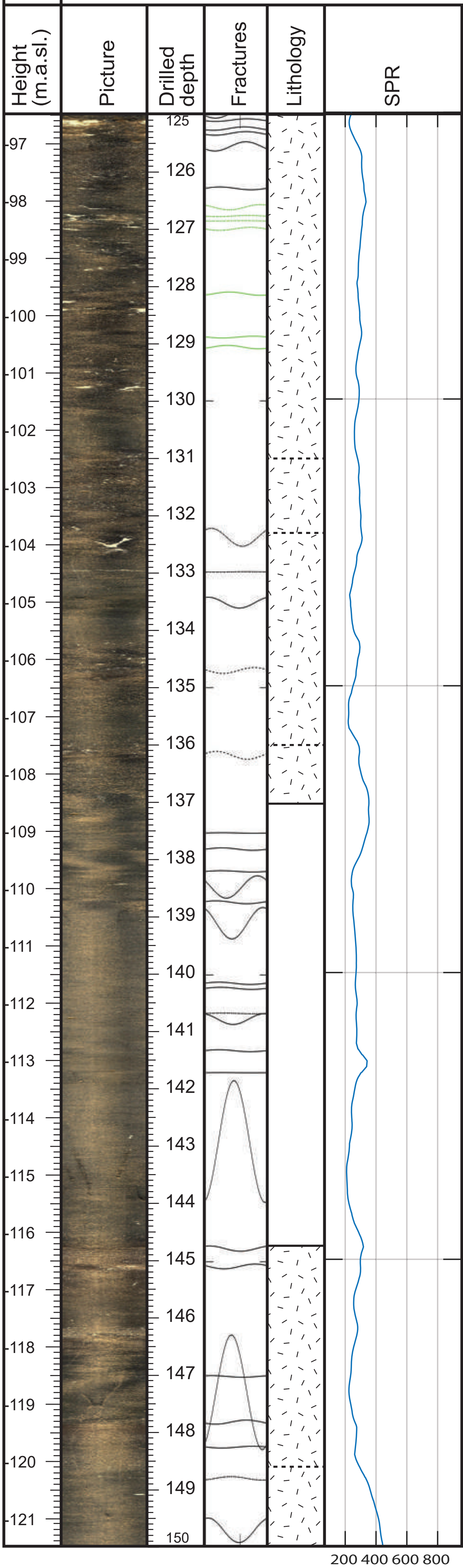
120-124: Fracture zone
Large open fractures with mineralization. Some healed.

122,2-124,5m: Fine-grained plagioclase phyric compound flow.

120-124: Fracrure zone.

124,5-137m: Fine-grained plagioclase phyric compound flow.

6	Project: Suðuroyartunnilin	Year: 2021	Location: Sandvík	Borehole 01
	Position: Y=203656.65 X=835937.82 Z=28.48 m			Datum: FOTM



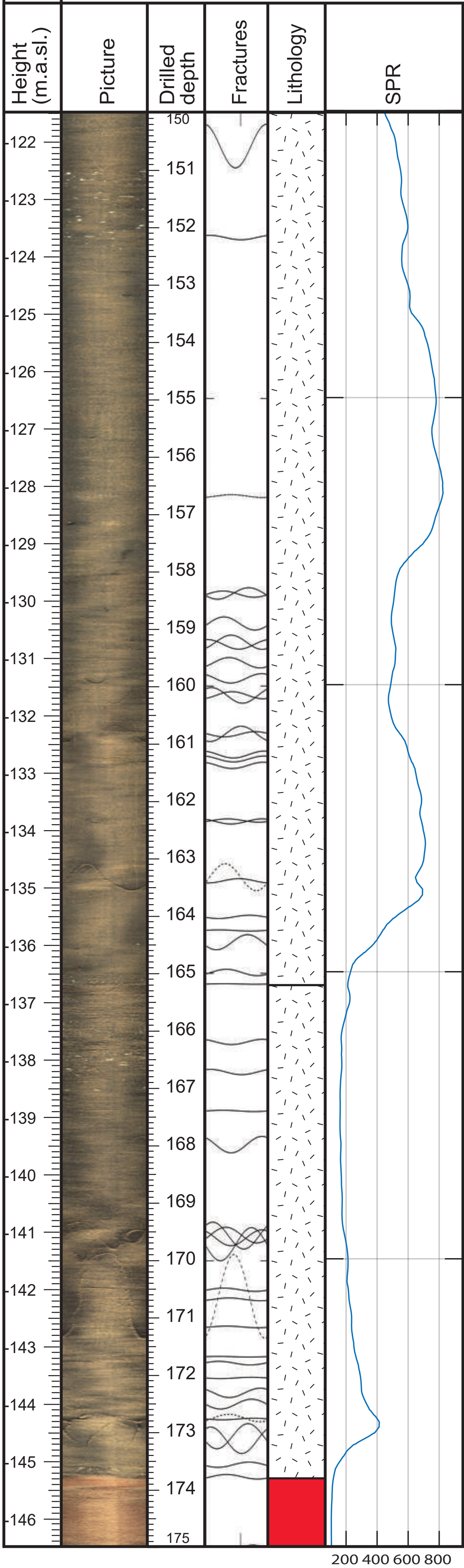
Remarks

124,5-137m: Fine-grained plagioclase phyric compound flow. Several flow lobes with vesicular banding.

137-144,8m: Aphyric to Fine-grained plagioclase phyric compound flow.

144,8-165,2m: Fine-grained plagioclase phyric compound flow. Several flow lobes with vesicular banding.

7	Project: Suðuroyartunnilin	Year: 2021	Location: Sandvík	Borehole 01
	Position: Y=203656.65 X=835937.82 Z=28.48 m			Datum: FOTM



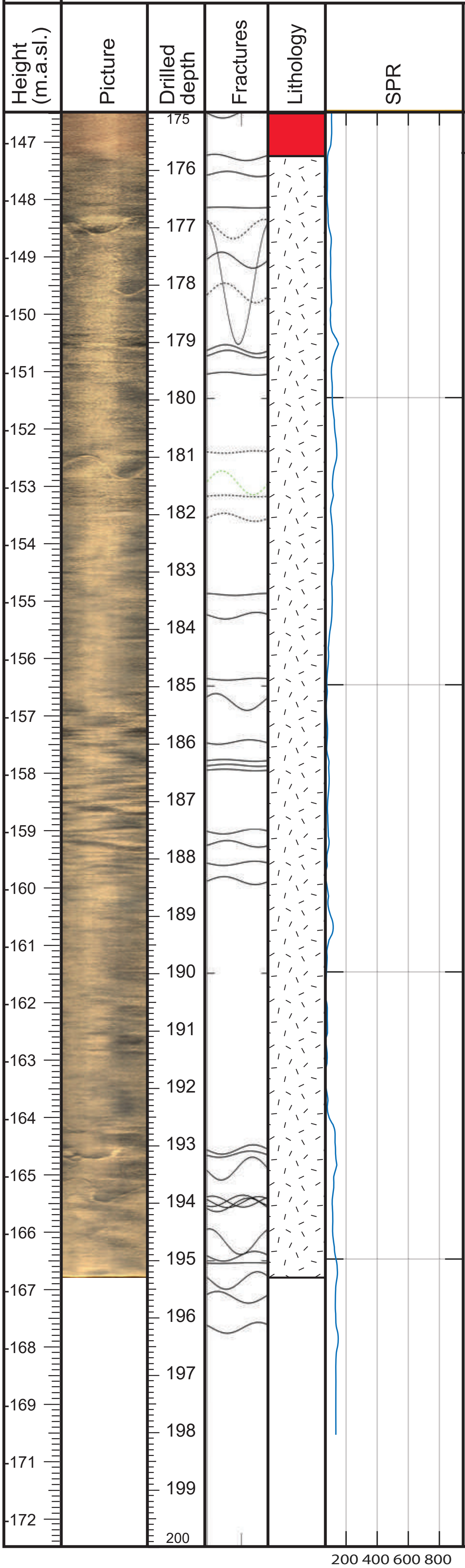
Remarks

144,8-165,2m: Aphyric to Fine-grained plagioclase phyric compound flow. Massive in parts.
Several flow lobes with vesicular banding and more massive parts.

165,2-173,8m: Fine-grained plagioclase phyric compound flow. Massive in parts.
Highly fractured in basal parts.

173,8-175,8m: Volcaniclastis sand- claystone. 2m thick, orange.
Poor confidence on imag, RPS log guiding the litholgical interpr.

8	Project: Suðuroyartunnilin	Year: 2021	Location: Sandvík	Borehole 01
	Position: Y=203656.65 X=835937.82 Z=28.48 m			Datum: FOTM



Remarks

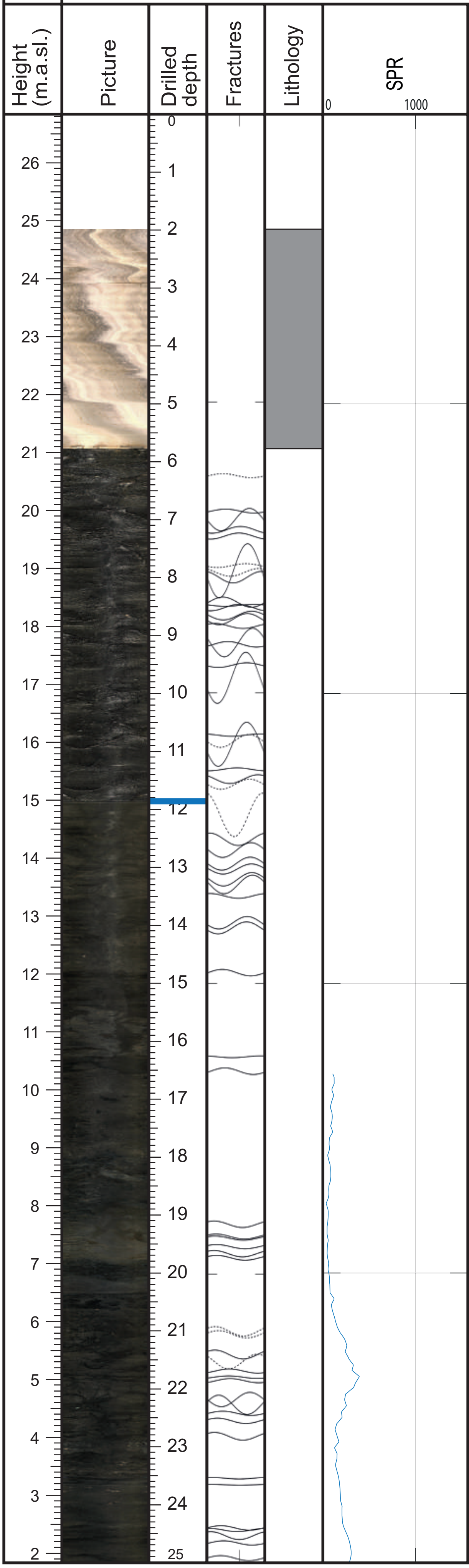
173,8-175,8m: Volcaniclastis sand- claystone. 2m thick, orange.
Poor confidence on imag. RPS log guiding the litholgical interpr.

175,8-195m: Fine-grained plagioclase phyric compound flow.
Very poor images.

Appendix H

Hvalba-1 borehole

1	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM



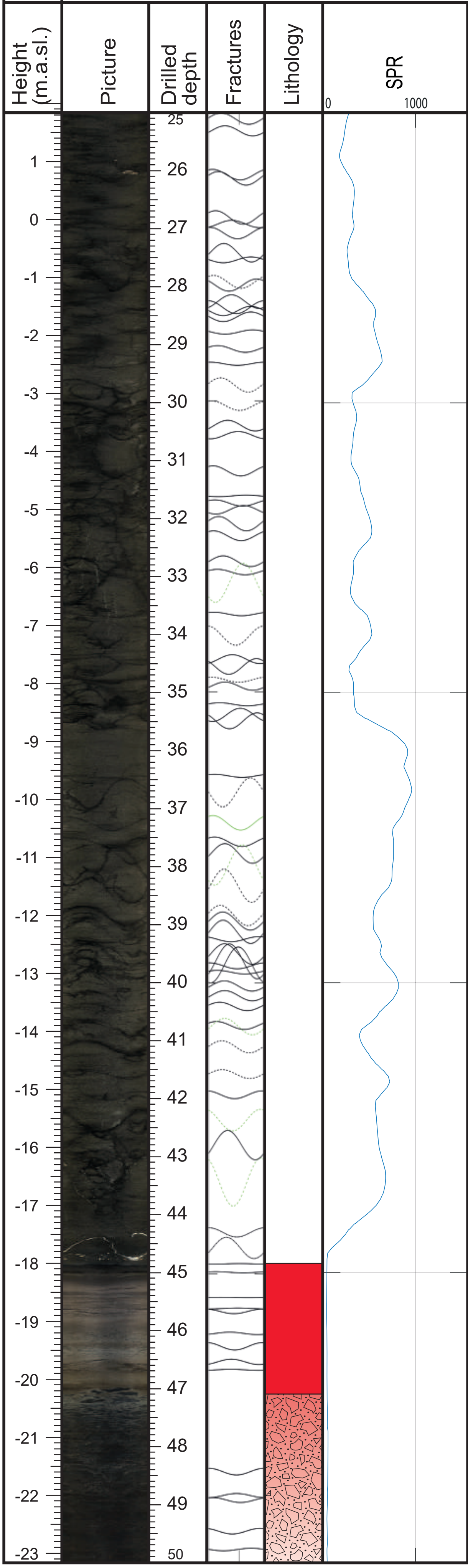
Remarks

0,00-5,77 m: Casing

Massive aphyric sheet lobe >40 m thick. Numerous fractures.

11,85 m drilled depth: water level in well.

2	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM



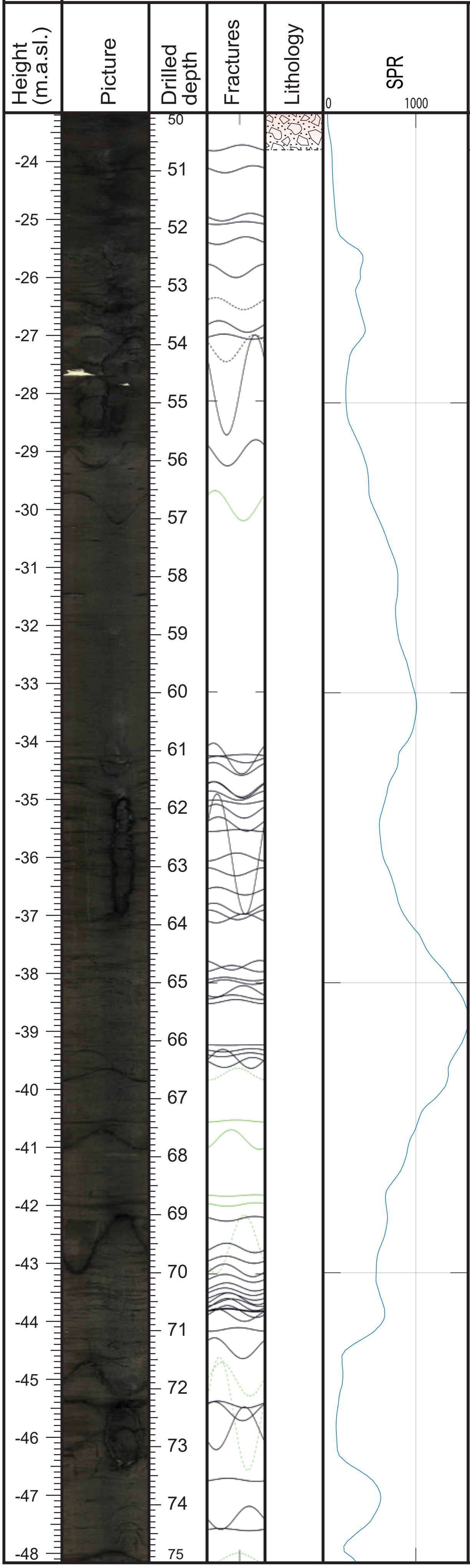
Remarks

Massive aphyric sheet lobe >40 m thick. Numerous fractures.

44.83-46.95: Volcaniclastic sediment. Brownish grey. 2,12 m thick.

Core stone. Brecciated and heavily altered flow top. 3,65 m thick.

3	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM

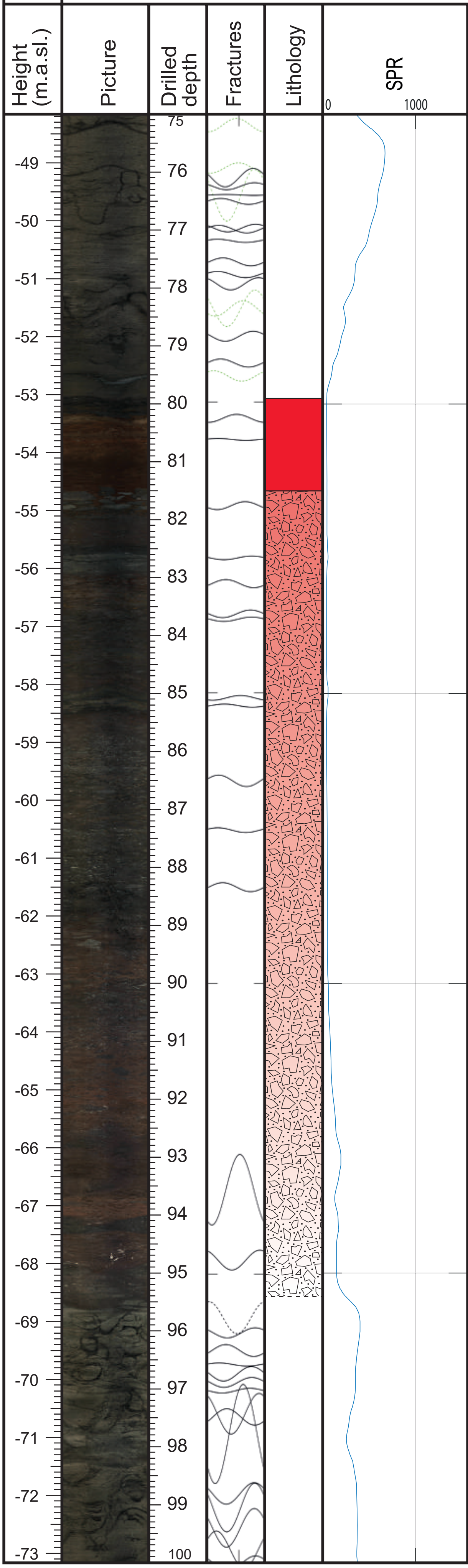


Remarks

Core stone

Massive aphyric sheet lobe. Massive part of flow is 28.5 m thick. Numerous fractures.

4	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM



Remarks

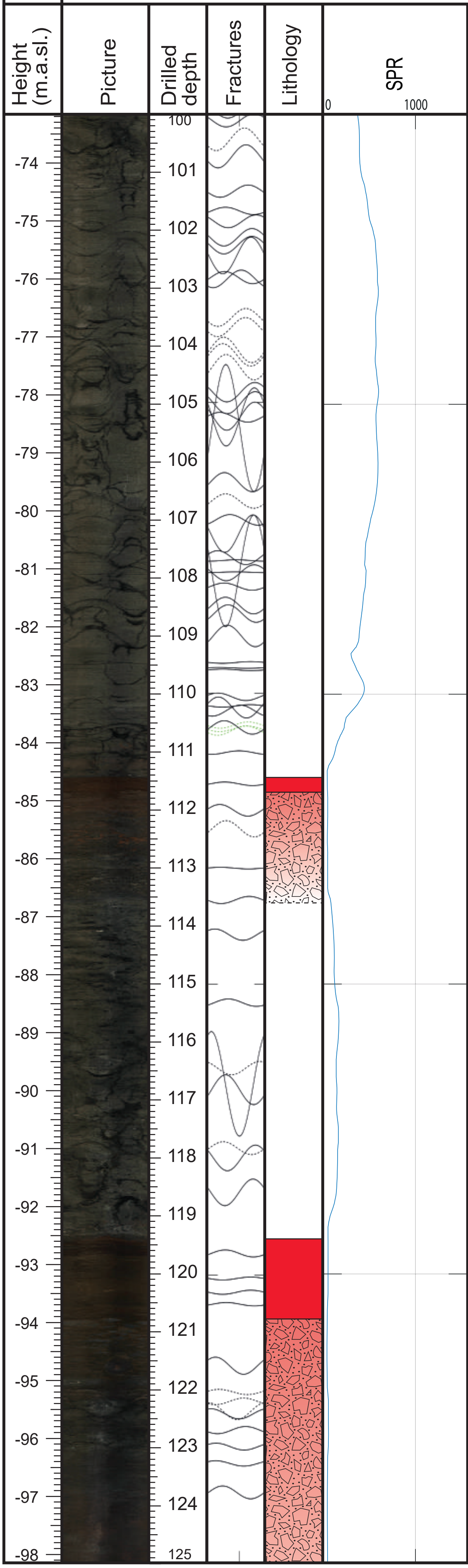
Massive aphyric sheet lobe. Massive part is 28.5 m thick.

Volcaniclastic sediment. 79,1-81,5 m. 2,6 m thick. Brownish red.

13.5 m thick core stone - brecciated and heavily altered flow top.

Massive aphyric sheet lobe . The massive part of the flow is 13.5 m thick. Numerous fractures.

5	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM



Remarks

Aphyric sheet lobe . The massive lower part of the flow is 13.5 m thick. Numerous fractures.

Volcaniclastic sediment. 111,43-111,7 m. 27 cm thick.

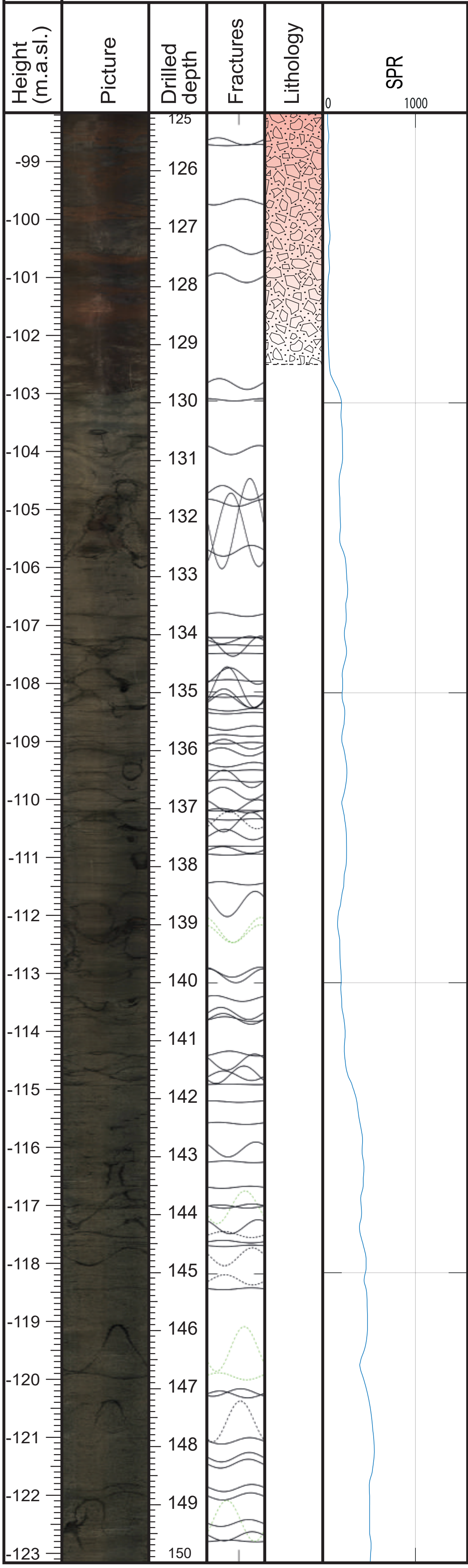
Aphyric sheet lobe. Core stone. Brecciated and heavily altered flow top. 1,9 m thick.

Aphyric sheet lobe. Massive lower part. 6 m thick. Numerous fractures.

Volcaniclastic sediment. 119,5-120,8 m. 1,3 m thick. Brownish red.

Aphyric sheet lobe. Core stone. Brecciated and heavily altered flow top. 8,5 m thick.

6	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM

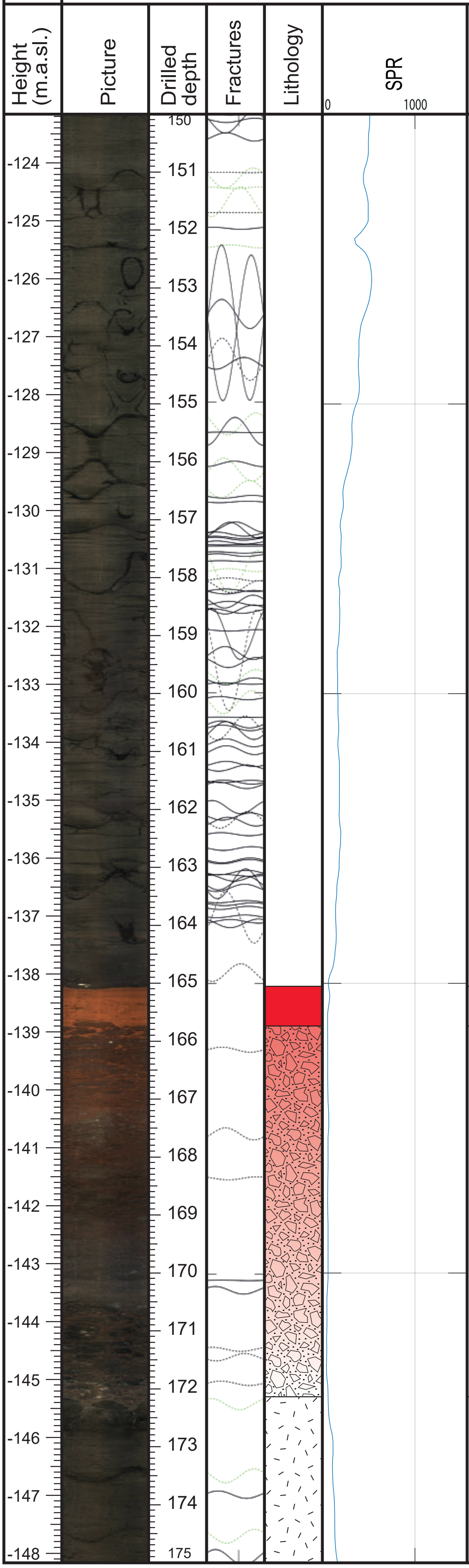


Remarks

Aphyric sheet lobe. Core stone. Brecciated and heavily altered flow top. 8,5 m thick.

Aphyric sheet lobe . The massive lower part of the flow is 36 m thick. Numerous fractures.

7	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM



Remarks

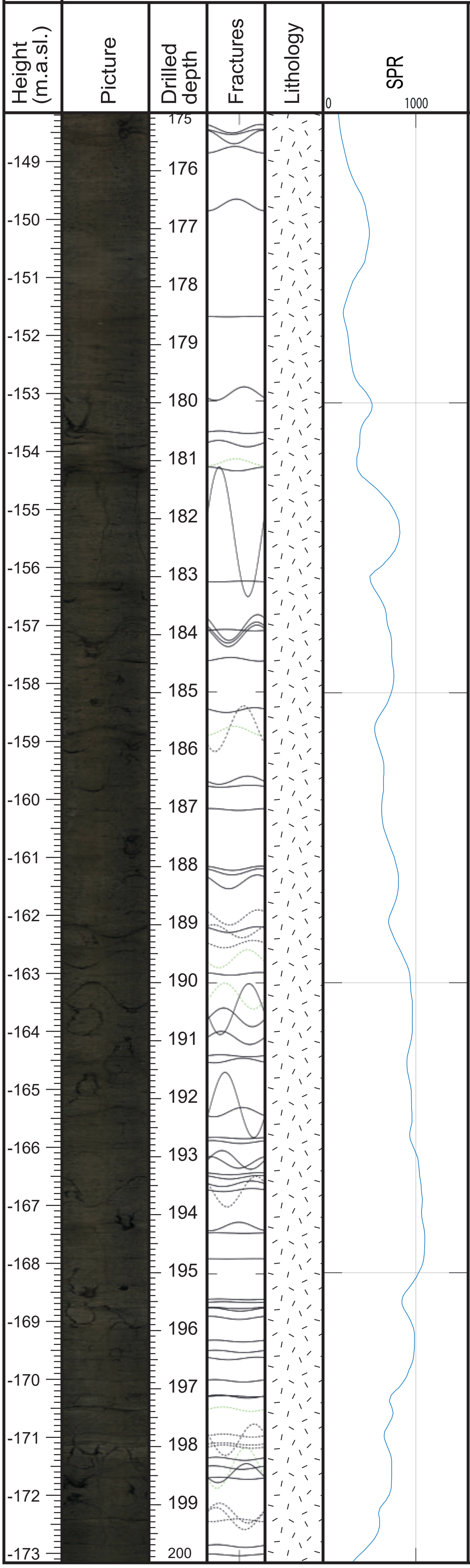
Aphyric sheet lobe . The massive lower part of the flow is 36 m thick. Numerous fractures.

165,05-165,72 m. Volcaniclastic sediment. 67 cm thick. Brick red.

Very sparse fine feldspar phyric sheet lobe. Core stone. Brecciated and heavily altered flow top. 6,6 m thick.

Very sparse fine feldspar phyric sheet lobe. Lower massive part of flow is almost 30 m thick with numerous fractures.

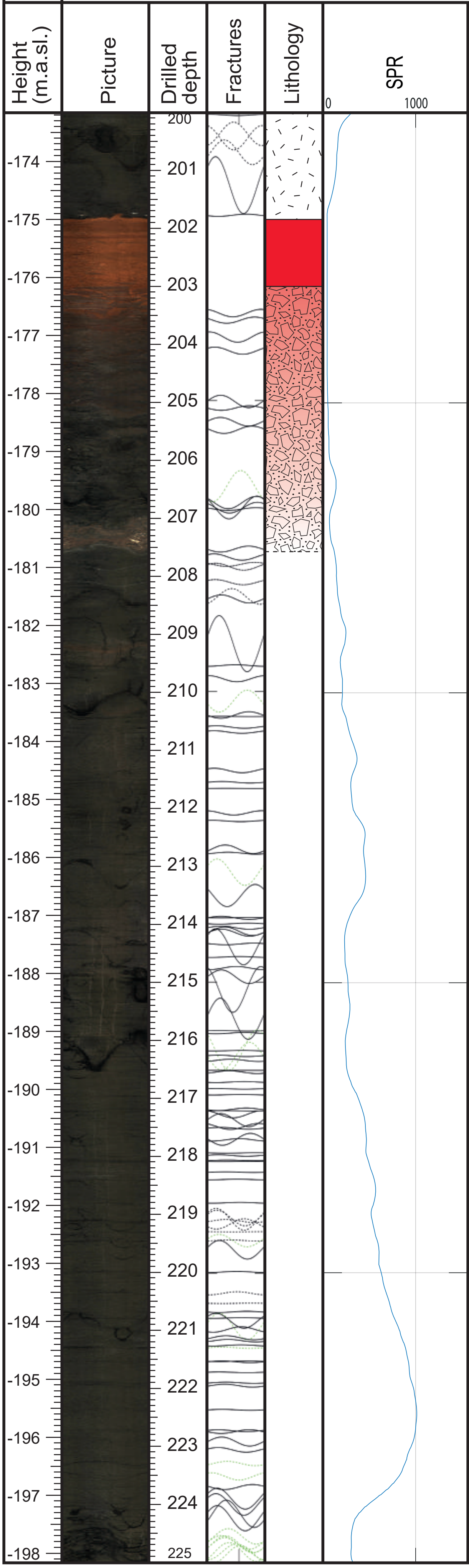
8	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM



Remarks

Very sparse fine feldspar phyric sheet lobe. Lower massive part of flow is almost 30 m thick with numerous fractures.

9	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM



Remarks

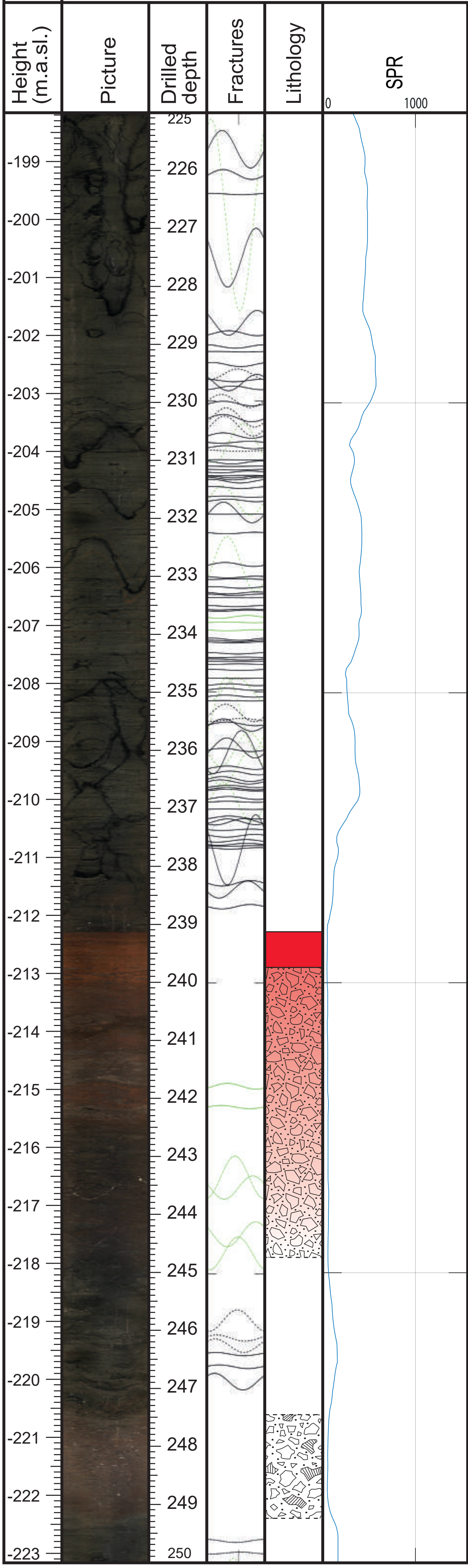
Very sparse fine feldspar phyric sheet lobe. Lower massive part of flow is almost 30 m thick with numerous fractures.

Volcaniclastic sediment. 201,85-203,0 m. 1,15 cm thick. Brick red.

Aphyric sheet lobe. Core stone. Brecciated and heavily altered flow top. 4,5 m thick.

Aphyric sheet lobe. Massive lower part. Numerous fractures. Almost 32 m thick.

10	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM



Remarks

Aphyric sheet lobe. Massive lower part. 6 m thick. Numerous fractures. Almost 32 m thick.

Volcaniclastic sediment. 239,13-239,75 m. 62 cm thick.

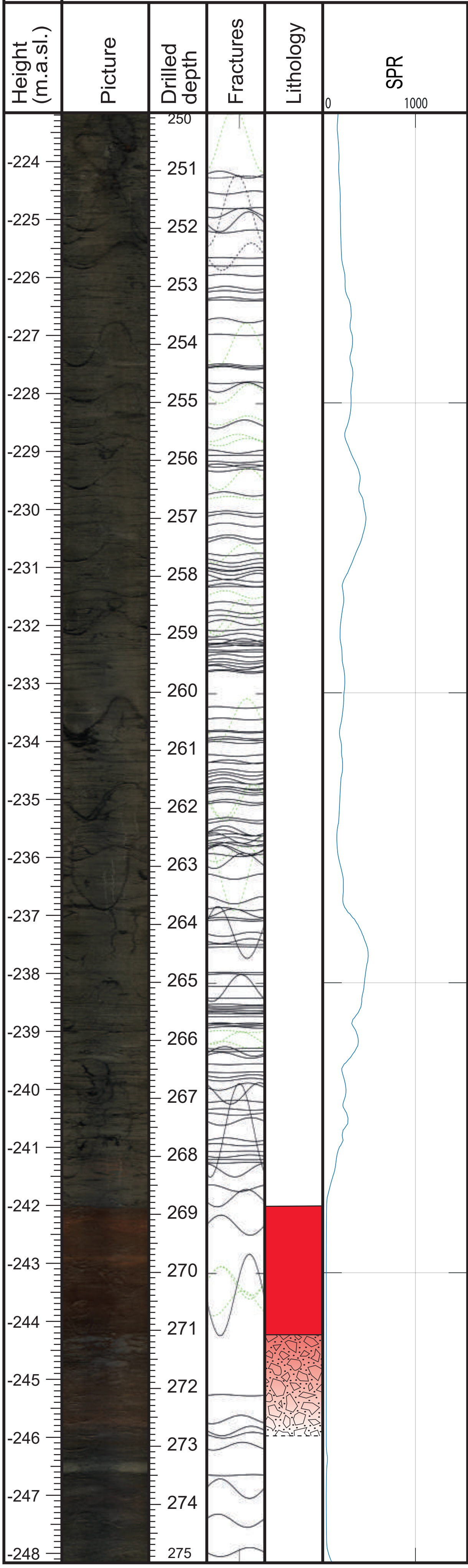
Aphyric sheet lobe. Core stone. Brecciated and heavily altered flow top. 5 m thick.

Aphyric sheet lobe. Massive lower part. 24 m thick. Numerous fractures.

Brecciated zone. 1,7 m thick.

Aphyric sheet lobe. Massive lower part. 24 m thick.

11	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM



Remarks

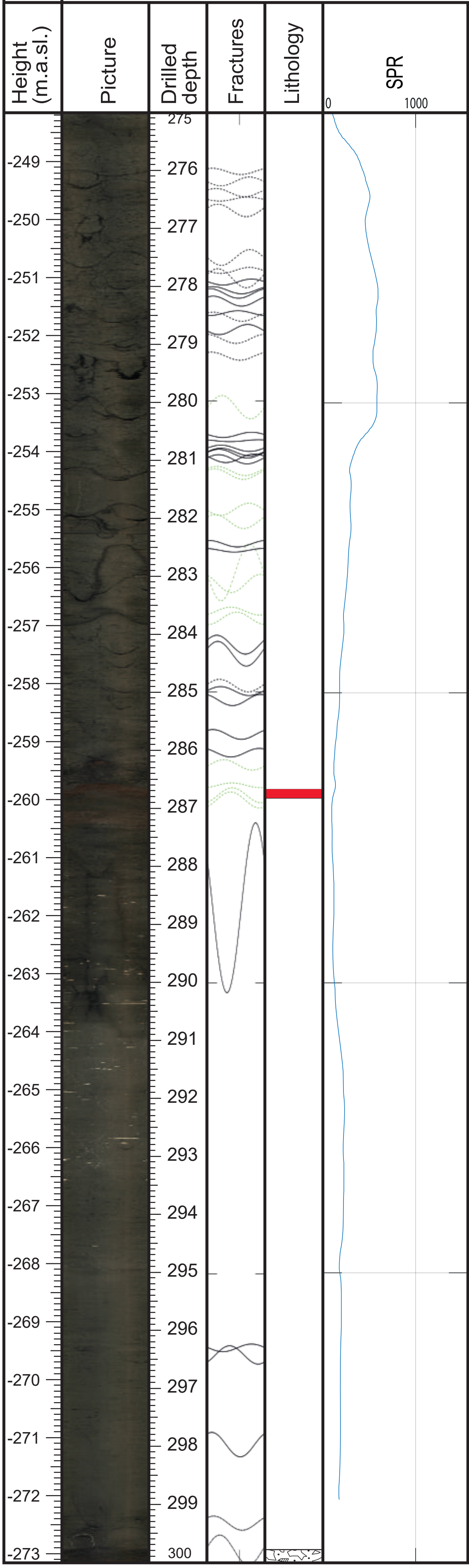
Aphyric sheet lobe. Massive lower part. 24 m thick. Numerous fractures.

Volcaniclastic sediment. 268,86-271,08 m. 2,22 m thick. Brownish red.

Aphyric sheet lobe. Core stone. Brecciated and heavily altered flow top. 1,7 m thick.

Aphyric sheet lobe. Massive lower part. 13 m thick. Numerous fractures.

12	Project: Suðuroyartunnilin	Year: 2021	Location: Hvalba	Borehole 01
	Position: Y=202300,50 m X=832808,46 m Z=26,84 m			Datum: FOTM



Remarks

Aphyric sheet lobe. Massive lower part. 13 m thick. Numerous fractures.

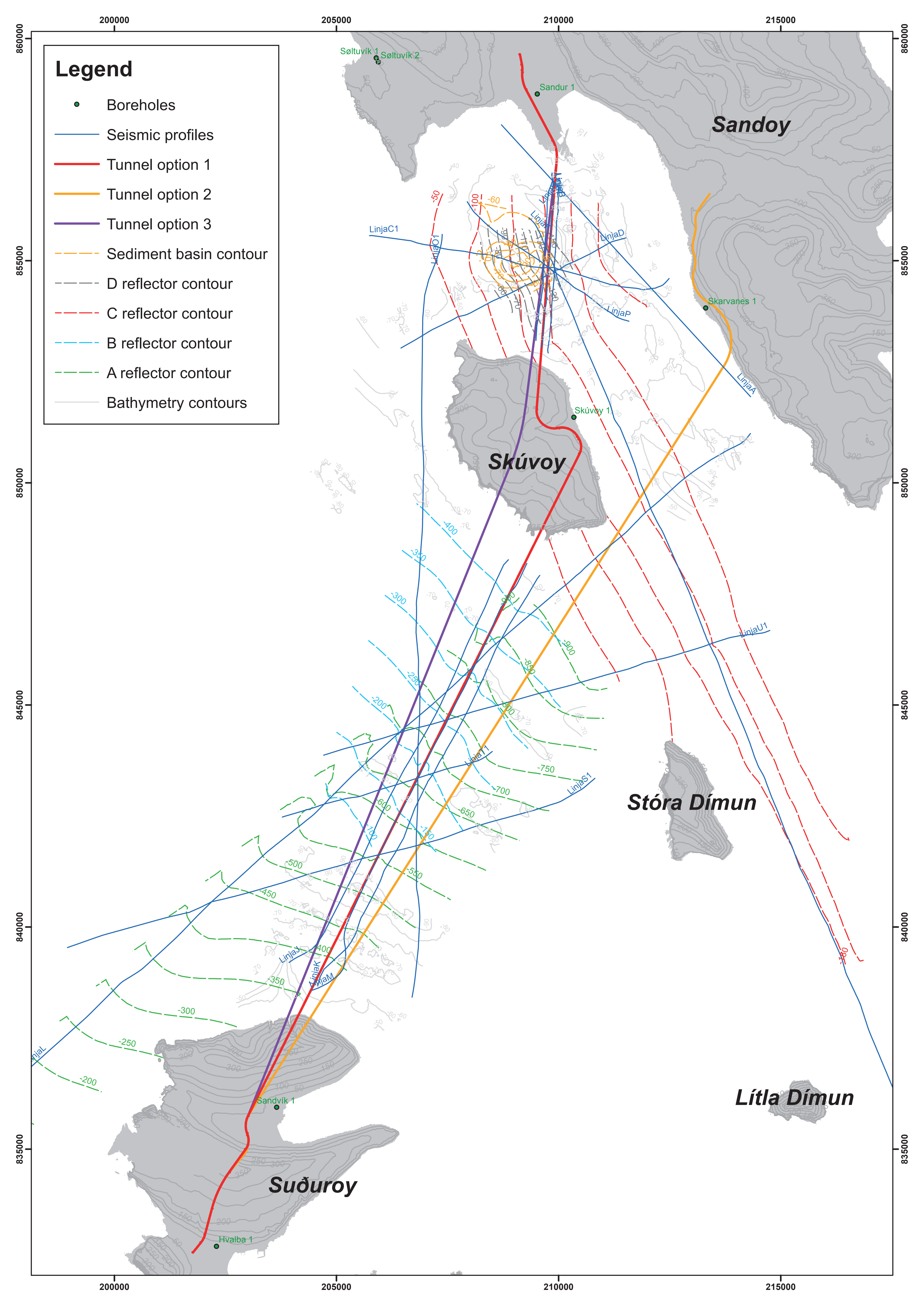
Volcaniclastic sediment. 286,68-286,82 m. 14 cm thick.

Aphyric sheet lobe. Massive. 13 m thick.

Aphyric sheet lobe. Brecciated crust.

Appendix I

Map of Suðuroyar subsea tunnel


Legend
Boreholes
Seismic profiles
Tunnel option 1
Tunnel option 2
Tunnel option 3
Sediment basin contour
D reflector contour
C reflector contour
B reflector contour
A reflector contour
Bathymetry contours
Sandoy
Skúvoy
Stóra Dímun
Lítla Dímun
Suðuroy
Søltuvík 1
Søltuvík 2
Sandur 1
Skarvanes 1
Skúvoy 1
Sandvík 1
Hvalba 1
LinjaC1
LinjaD
LinjaP
LinjaA
LinjaO1
LinjaU1
LinjaT1
LinjaS1
LinjaJ
LinjaK
LinjaM
200000
205000
210000
215000
860000
855000
850000
845000
840000
835000

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