REPORT

Drainage Åknes

DATA REPORT CORE LOGGING KH-02-2018

DOC.NO. 20180662-04-R
REV.NO. 1 / 2019-02-04

NORWEGIAN GEOTECHNICAL INSTITUTE
NGI.NO

Project

Project title:	Drainage Åknes
Document title:	Data report core logging KH-02-2018
Document no.:	20180662-04-R
Date:	2019-01-18
Revision no. /rev. date:	1 / 2019-02-04

Client

Client:	NVE
Client contact person:	Gustav Pless
Contract reference:	Research and development contract, signed 12 September 2018

for NGI

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ISO 9001/14001
CERTIFIED BY BSI
FS 32989/EMS 612006

Summary

KH-02-18 is a core drilled bore hole at Kulen in the Åknes rock slope. The bore hole is 199.4 meter deep, and was core drilled during September-October 2018. Geodrilling AS performed the core drilling on assignment from Norwegian Water- and Energy directorate (NVE). Lise Tønset (NTNU) and Henrik Langeland performed engineering geological core logging in November-December 2018.

The rock type registered in KH-02-2018 is gneiss with variation in grain size and colour according to classification from ISO 14689.

The core logging shows that the core is intersected with crushed zones in the upper 20 meter. In this section also 3 intervals with core loss are registered. From 20 to about 70 meter depth the presence of crushed zones decrease, and crushed zones >10 cm is absent, however RQD and fractures/meter (FFm) values are varying. From about 70 meter to end of bore hole the rock mass is considered solid with a massive character. Crushed zones are sparsely registered and the rock mass is generally considered good, evaluating RQD- and FFm values.

An analysis show one joint with characteristics corresponding to low friction joint, at 91 meter depth. However, there are several crushed zones and core loss sections, not possible to analyse in detail, which also could have low friction properties.

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Review and reference page

1 Introduction

KH-02-18 is a core drilled bore hole at Kulen in the Åknes rock slope. The bore hole is 199.4 meter deep, and was drilled during September-October 2018. Geodrilling AS performed the core drilling on assignment from Norwegian Water- and Energy directorate (NVE). Lise Tønset (NTNU) and Henrik Langeland performed engineering geological core logging in November and December 2018.

The core drilling is undertaken to investigate the subsurface in the Åknes rock slope, e.g. degree of fracturing, weak zones, lithological composition. In addition to the core logging, several tests will be performed on selected core samples, e.g. to evaluate lithology, mineral composition and strength parameters.

This report gives an overview of the core logging of KH-02-18, method for core logging, and results. All ancillary data are organized in appendices:

Appendix A: Drilling report from Geodrilling
Appendix B: Core logging sheets (Logplot)
Appendix C: Pictures of cores

2 Core drilling KH-02-18

KH-02-18 is a vertical bore hole, located in the middle section in Åknes rock slope, 471.4 metres above sea level (Figure 1). Drilling depth is 199.4 m. Steel casing is placed down to 9 m. Core length, logged length, is 199.87 meter.

The core drilling has been performed with Diamec U-6 APC rig, with HQ diamond tipped core bit, giving a bore hole diameter of about 96 mm and a core diameter of about 63.5 mm. Geodrilling AS report from core drilling is given in Appendix A.

Core logging sheets, with results from core logging is shown in Appendix B, pictures of the cores is shown in Appendix C. The bore hole has also been logged with optical televiewer, flowmeter and geophysics after core extraction.

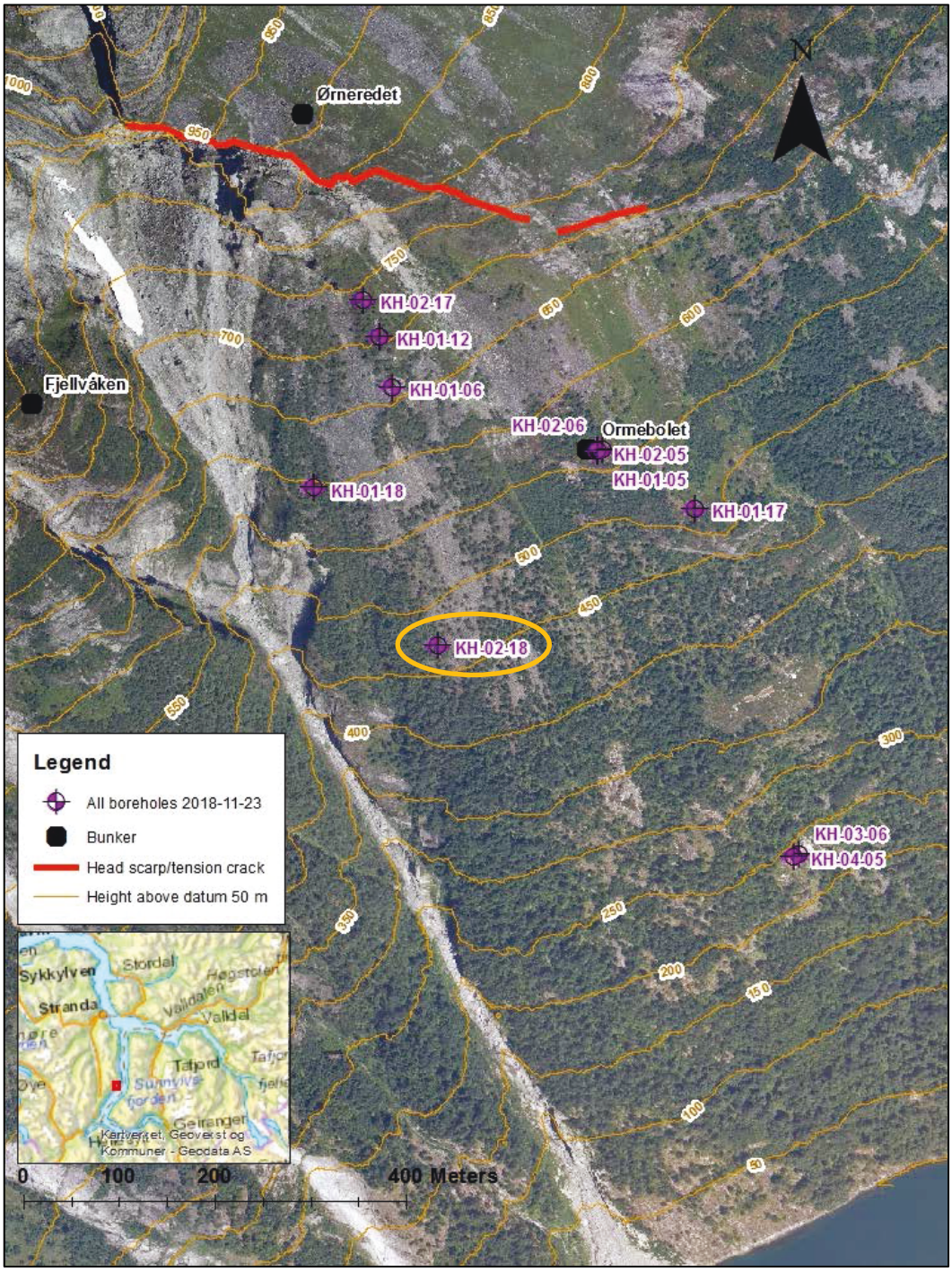

Figure 1. Overview of the Åknes rock slope with bore hole locations, including bore hole KH-02-18 in yellow ellipse.

3 Brief regional geological description

The geology at the Åknes rock slope is thoroughly described, by field mapping and core logging [1] [2] [3] [4].

Åknes is situated in the Western Gneiss Region (WGR), located west of the Caledonian thrust nappe [5]. WGR consists of autochthon Precambrian rocks, mainly granitic- to dioritic gneiss, in some places migmatitic [1]. These rocks are about 1850-1500 million years old, and contain features such as bands with mica rich gneiss and amphibolite [6].

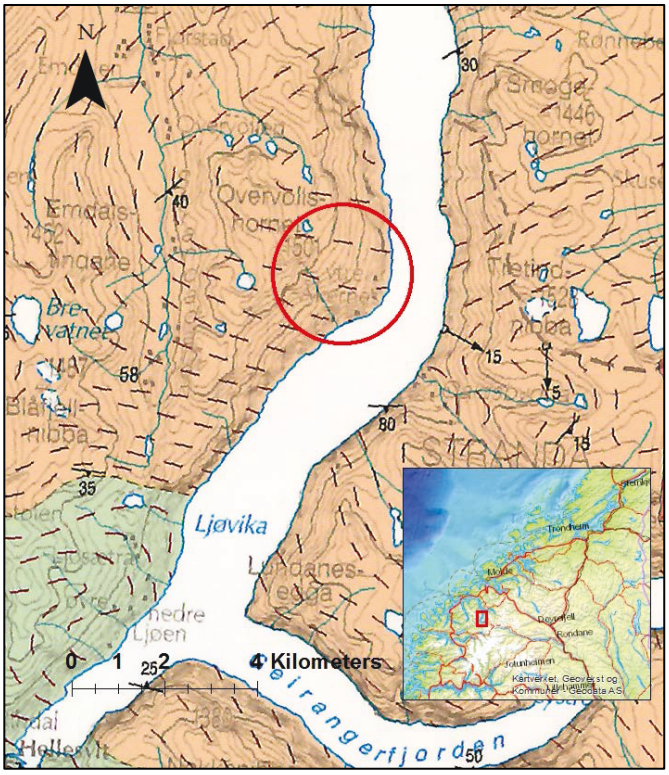

Figure 2. Excerpt of geological map 1:250 000 for the Åknes rock slope (red circle). Light orange color is mapped as: "Gneiss, not grouped, mainly quartzdioritic to granitic, in some places migmatitic" and light green colour is mapped as: "Mica gneiss, quartz mica gneiss, some garnet amphibolite, garnet mica schist, meta-arkose and anorthosite" [7].

The geological map from the area shows that at the Åknes rock slope the bedrock is defined as "Gneiss, not grouped, mainly quartzdioritic to granitic, in some places migmatitic" [7]. West-southwest of the Åknes rock slope the bedrock is mapped as (2): "Mica gneiss, quartz mica gneiss, some garnet amphibolite, garnet mica schist, meta-arkose and anorthosite".

4 Method

The core logging sheets present a geological description of the core according to ISO 14689:2017 [8], registration of core loss, crushed core, fracture frequency and Q method parameters; RQD (Rock Quality Designation), J_r (joint roughness number) and J_a (joint alteration number). The core is not oriented, but the bore hole has been logged with televiewer, and therefore an overview of joint sets and dip/dip-direction are reported by the Geological Survey of Norway (NGU).

4.1 Q-parameters

The Q-method is a classification system for rock mass in relation to stability of underground excavations such as tunnels and caverns [9]. By determining the 6 Q-parameters one can decide the Q-value for the rock mass:

$$Q = \frac{RQD}{J_n} + \frac{J_r}{J_a} + \frac{J_w}{SRF} \quad (1)$$

where:

RQD = Rock Quality Designation
J_n = Joint set number
J_r = Joint roughness number
J_a = Joint alteration number
J_w = Joint water reduction factor
SRF = Stress reduction factor

Evaluation of the 6 parameters is described by NGI [9]. The Q-value can vary from 0,001 (exceptionally poor) to 1000 (exceptionally good), where values above 10 is equivalent to good rock mass quality. By core logging one can determine the parameters RQD, J_n (if cores are oriented), J_r, og J_a, and by this determine the rock mass properties. The parameters J_w (Joint water reduction factor) and SRF (Stress reduction factor) cannot be determined from cores, and therefore a Q-value from core logging will represent a Q-value where J_w and SRF are not accounted for.

There is also uncertainty connected to J_r- and J_a values in core logging. By logging a 64 mm core, only a small excerpt of the joint is visible. A J_r value determined for a joint in the core is not necessary representative for the bulk scale joint. This is equivalent for the J_a value. Joint filling and -coating can vary along the joint, and drilling can affect the remaining joint infill after core extraction.

J_n-values are not registered during logging, as the core is not oriented. However, the televiewer analysis will describe joint sets and dip/dip-direction of joints.

4.2 Fracture frequency and crushed core

The fracture frequency (fractures/meter, FFm) is evaluated for every meter, based on the number of natural joints, inclusive crushed zones. For crushed zones an FFm value between 2 and 25 is given, counting one joint for every 4 cm of crushed zone in addition to joint in the start and end of crushed zone. Minimum FFm value for crushed zone would then be 2 if the crushed zone is shorter than 4 cm. Maximum FFm value would be 25 for 100 cm core, which implies that the entire core is a crushed zone.

However, deciding FFm from core logging is connected to uncertainty due to the presence of artificial joints caused by drilling and handling of cores in the wireline system. It's sometimes difficult to determine a natural joint from an artificial joint, and the result would be overestimation of joints in the core logging. Having the televiewer analysis in addition to the core logging makes it possible to compare the joint frequency.

The drillers are instructed to mark joints whichthey certainly know are artificial, with a permanent marker. However, the marking can disappear or artificial joints could not be marked by drillers due to difficulty identifying such joints. The joints interpreted by the logger to be artificial, but not marked with a permanent marker, is marked with X as J_r and J_a value. In the following J_r and J_a overview (chapter 5.2.2) joint no. is set as 0.

4.3 Core loss

Core loss is evaluated every meter, based on missing core sections. To be sure this is registered correctly, the drillers have to mark core loss in the core boxes.

5 Results

5.1 Overview bore hole

A simplified overview of RQD, average RQD every 10 meters, FFm, average FFm every 10 meters, crushed zone >10 cm and core loss distribution in the bore hole is shown in Figure 3.

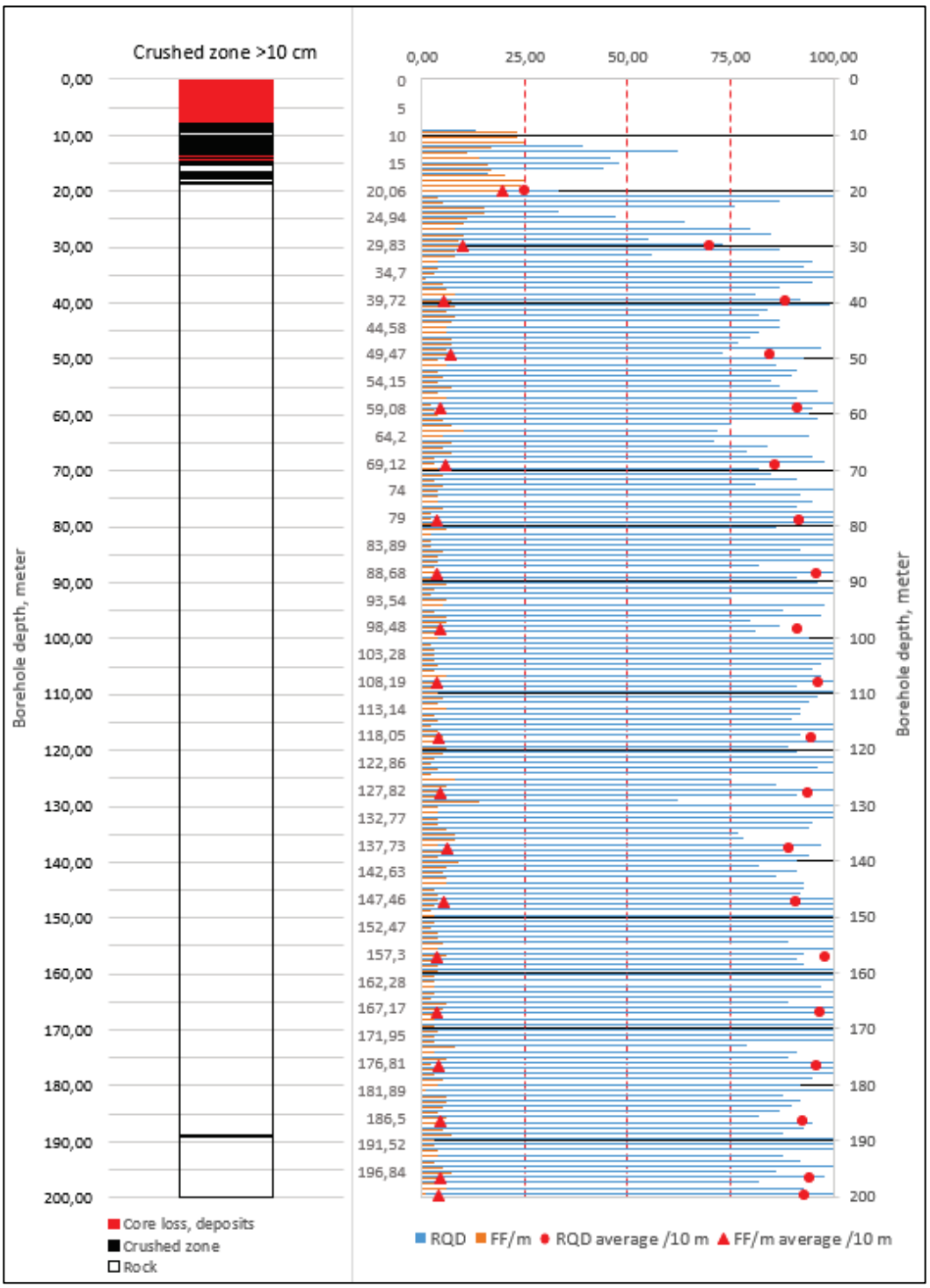

Figure 3. Simplified overview of RQD, average RQD every 10 meters, FFm, average FFm every 10 meters, crushed zone >10 cm and core loss distribution in KH-02-18.

5.2 Logging parameters

5.2.1 RQD and FFm

The upper 20 meters of the bore hole is intensely intersected with crushed zones, and 3 sections with core loss is registered. The average RQD value from 0 to 20 meter depth is 25 and the FFm value is 19.5 (Figure 3).

From 20 meter down to 69.1 meter the presence of crushed zones decrease, and crushed zones >10 cm is absent, however RQD and FFm values are varying. The average RQD value from 20 to 69.1 meter depth is 84 and the FFm value is 6.4 (Figure 3).

From 69.1 meter to end of bore hole the rock mass is considered solid with a rather massive character. Crushed zones are sparsely registered and the rock mass is generally considered good, evaluating RQD- and FFm values. The average RQD value from 69.1 to 199.87 meter is 94 and the FFm value is 4.3 (Figure 3).

5.2.2 J_r, J_a

J_r and J_a are registered for every joint, besides in the crushed zones where this is practical impossible. Figure 4 shows the frequency of J_r and J_a, from a-f and X. The J_r and J_a categories are given values according to NGI [9] and X describe artificial joints. J_a range from a-p according to NGI [9], but only values from a-g are registered.

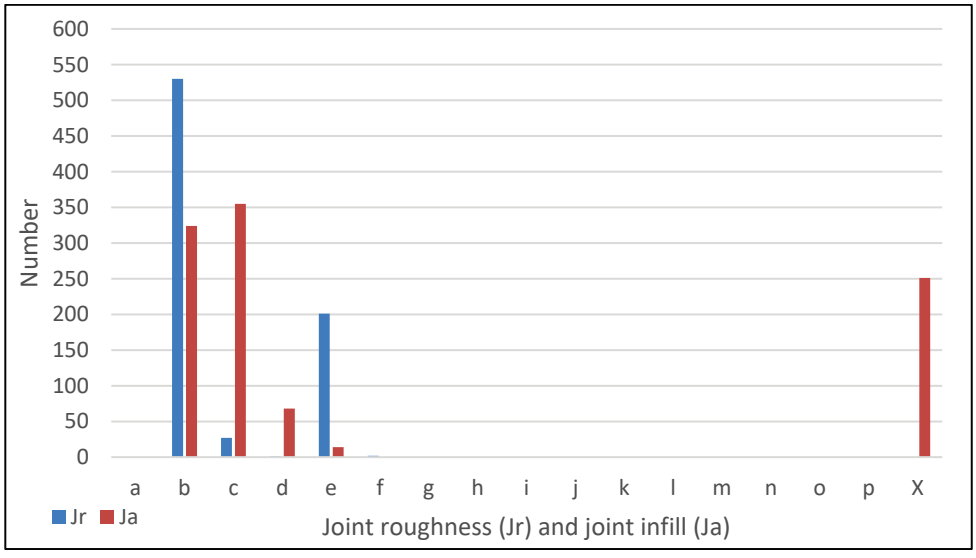

Figure 4. Histogram that represents the frequency of J_r and J_a values for the entire bore hole. J_a values can be determined in the range from a-p [9], but only values from a-f were registered.

The histogram shows that J_r categories of b (rough or irregular, undulating) and e (rough, irregular, planar) are dominating, and very few smooth planar (f) or slickensided undulating (d) categories are registered. The dominating J_a categories are b (Unaltered joint walls, surface staining only) and c (Slightly altered joint walls. Non-softening mineral coatings; sandy particles, clay free disintegrated rock, etc.). However, some joints are registered with coating or infilling (d and e).

Figure 5 and Figure 6 show distribution of J_r - and J_a values in relation to bore hole depth. J_r value 1 represent smooth and planar joints, and J_a values 3 and 4 represent coating or infill on joints. I.e. joints registered with J_r value 1 and J_a value 3 and 4 could represent low friction joints. An analysis of joints with such characteristics show that it is only registered one joint with such characteristics, at 91 meter depth. However there are several crushed zones and core loss sections, which is not possible to analyse in detail, which also could have low friction properties.

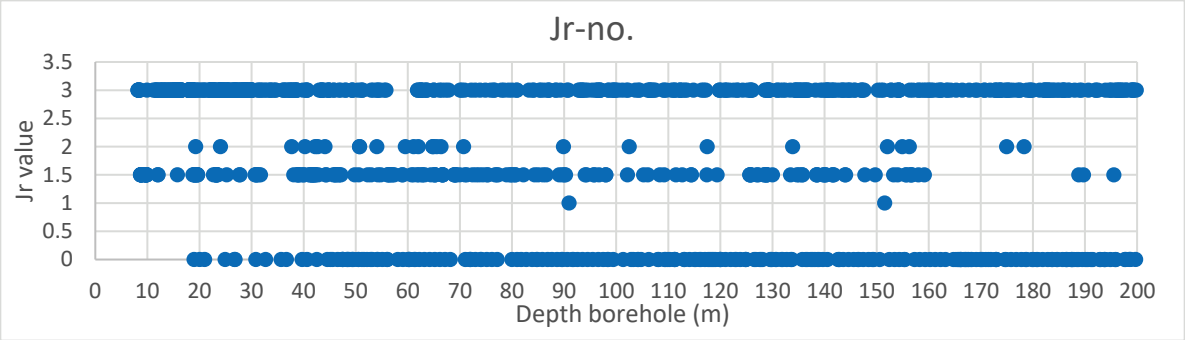

Figure 5. J_r values on joints in relation to bore hole depth.

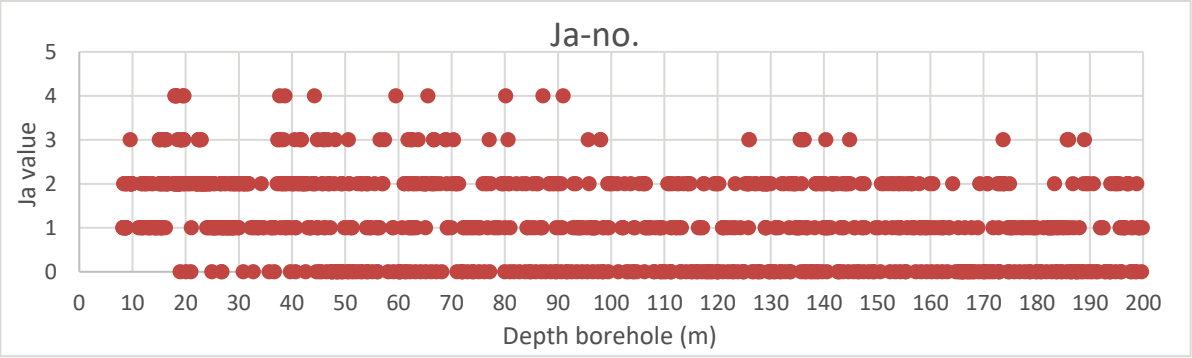

Figure 6. J_a values on joints in relation to bore hole depth.

The rock is dark, partly greenish at the low friction joint at 91 meter. The rock has high mica content (Figure 7).

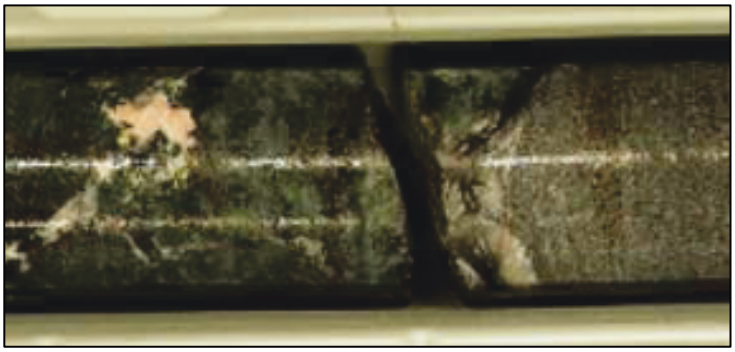

Figure 7. Low friction joint at 91 meters.

5.3 Description of the rock mass

Bore hole KH-02-2018 is located in an area, which according to NGU, consists of gneiss [7]. The rock type registered in KH-02-2018 is gneiss with variation in grain size and colour (Table 1) [8]. ISO [8] terms foliated metamorphic rock types as Gneiss, Schist and Slate for coarse-, medium- and fine grain size respectively. It is decided to classify the entire bore hole as Gneiss, but with specification of the different grain size and colour (Table 2 and Appendix B).

Table 1. Description of KH-02-18 rock type according to ISO 14689:2017 [8].

Identification	Core logging
Genetic group	Metamorphic
Structure	Foliated
Grain size	Coarse-fine
Mineralogical composition by visual inspection	Feldspar, quartz, mica

Table 2. Overview of evaluated rock type, grain size and colour in KH-02-18.

From	To	Length	Grain size	Colour	Rock type
0,00	8,00	8,00	Core loss		
8,00	13,87	5,87	Coarse	Dark grey	Gneiss
13,87	14	0,13	Core loss		
14,00	14,52	0,52	Coarse	Dark grey	Gneiss
14,52	14,73	0,21	Core loss		
14,73	16	1,27	Coarse	Dark grey	Gneiss
16,00	19,7	3,70	Medium	Dark grey to black	
19,70	21,84	2,14	Coarse	grey with light/pink bands	
21,84	23,97	2,13	Medium	Dark grey to black	
23,97	27,5	3,53	Medium to Coarse	Dark grey to black	
27,50	31,83	4,33	Medium to Coarse	Grey to light grey colour with white and pink bands	

Table 3. Table 2 continues.

31,83	39,72	7,89	Coarse	Grey to light grey colour with white and pink bands	Gneiss
39,72	43,56	3,84	Coarse	Grey to light grey colour with white and pink bands	
43,56	51,21	7,65	Coarse	Grey to light grey colour with white and pink bands	
51,21	59,08	7,87	Coarse	Grey to light grey colour with white and pink bands	
59,08	67,17	8,09	Coarse	Grey to light grey colour with white and pink bands	
67,17	75,17	8,00	Coarse	Grey to light grey colour with white and pink bands	
75,17	82,78	7,61	Coarse-medium	Grey to dark grey, partly black with pink and white bands	
82,78	86,85	4,07	Coarse	Grey to dark grey, partly black with white bands	
86,85	94,53	7,68	Medium to fine	Dark grey to black, some parts greenish	
94,53	102,3	7,77	Coarse to medium	Grey to dark grey, partly black with white bands	
102,30	103,69	1,39	Coarse	Grey to dark grey with pink and white bands	
103,69	106,45	2,76	Fine	Dark grey to black, partly greenish	
106,45	110,28	3,83	Coarse	Grey to dark grey with pink and white bands	
110,28	118,05	7,77	Coarse	Grey to dark grey with pink and white bands	
118,05	125,84	7,79	Coarse	Grey to dark grey with pink and white bands	

Table 4. Table 2 continues.

125,84	133,74	7,90	Medium to fine	Dark grey with white and pink bands	Gneiss
133,74	141,6	7,86	Coarse to medium	Grey to dark grey with pink and white bands	
141,60	149,44	7,84	Coarse	Grey to dark grey with pink and white bands	
149,44	157,3	7,86	Coarse	Grey to dark grey with white bands	
157,30	165,23	7,93	Coarse	Grey with white bands	
165,23	167,8	2,57	Coarse	Grey to dark grey, white and pink bands	
167,80	168,95	1,15	Fine	Dark grey to black	
168,95	172,94	3,99	Coarse	Grey to dark grey, white and pink bands	
172,94	180,9	7,96	Coarse	Grey to dark grey with white/pink bands	
180,90	188,39	7,49	Coarse	Grey with white and pink bands	
188,39	196,84	8,45	Coarse	Grey to dark grey with white and pink bands	

5.3.1 Gneiss, coarse grained

Example of a coarse grained rock, with colour grey to light grey with white and pink bands is shown in Figure 8.

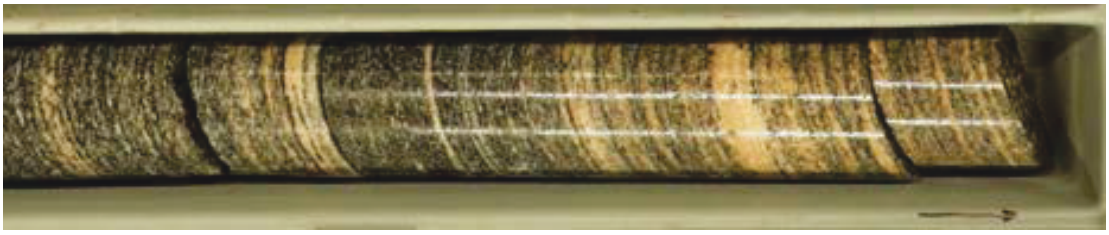

Figure 8. Core box 10, ca. 47.0-47.5 meters.

5.3.2 Gneiss, medium to fine grained

Example of a medium- to fine grained rock, with colour dark grey with white and pink bands is shown in Figure 9.

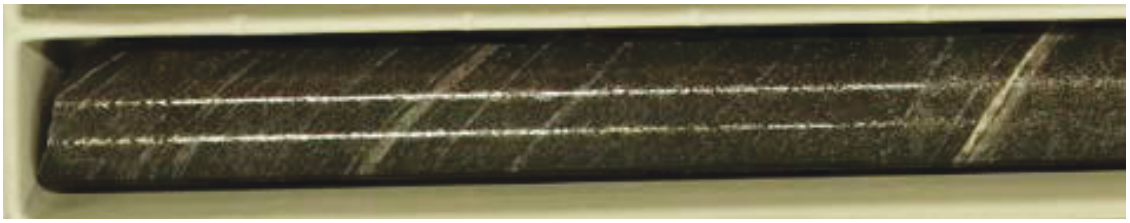

Figure 9. Core box 32, ca. 132.77-133.27 meters.

5.3.3 Gneiss, fine grained

Example of a fine grained rock, with colour dark grey to black, partly greenish is shown in Figure 10.

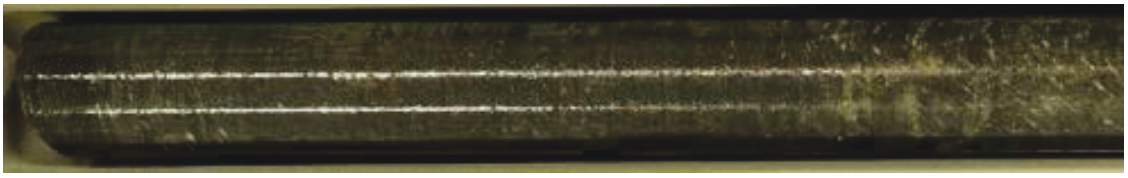

Figure 10. Core box 25, ca. 105.3-105.8 meters.

6 Reference

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Appendix A

GEODRILLING, REGISTERED DRILLING DATA KH-02-2018

Contents

A1 Geodrilling, Registered drilling data KH-02-2018

GEO DRILLING AS	REGISTRERING BOREDATA						SIDE 1	GEO DRILLING	
PROSJEKT: P - 170118	STED: Åknes			HULL-NR: BH - 02 - 18		KRONE: HQ	DATO: September	MASKIN: Diamec U-6 APC	FALL/RETNING: Lodd
FRA BOREDYP	TIL BOREDYP	KJERNE LENGDE	ROTASJON RPM	MATEKRAFT KILO	PENETRERING ca CM/MIN	Mottrykk Spyl.vann Bar	FARVE SPYLEVANN	KOMMENTAR	
0,00	8,00	0,00	350-500	950-2350	0-10	3-20	Grått	Casing gjennom dårlig dagfjell, casing til 9,00 meter, fjell fra 8,00 meter	
8,00	9,00	1,00	500	900-1100	7-8	0-3			
9,00	10,50	1,50	600	800-2200	10-15	0-3		Oppsprukket, returvann borte	
10,50	11,50	1,00	600	1400-2000	12-15	0-5			
11,50	13,10	1,60	600	500-1800	12-15	0		Oppsprukket, dårlige soner	
13,10	14,10	1,00	600	200-1600	11-20	0		Meget dårlig, vibrasjon, tørt hull	
14,10	15,00	0,90	600	800-2400	13-15	0			
15,00	17,30	2,30	600	900-2100	8-15	0		Oppsprukket, dårlig	
17,30	17,50	0,20	600	1000-1300	10-12	0		Mye rensking, rassoner	
17,50	18,00	0,50	600	800-1300	8-13	0			
18,00	19,70	1,70	600	1100-1400	15	0		Løse soner, ras	
19,70	20,80	1,10	600	1500-2400	5-15	0		Hardt fint fjell	
20,80	21,10	0,30	600	2400-2600	5	0		Hardt fint fjell	
21,10	24,00	2,90	600	1300-1600	15	0-3			
24,00	24,50	0,50	600	1400-1600	15	0-3		Oppsprukket	
24,50	25,90	1,40	600	1300-2200	15	0-3			
25,90	27,00	1,10	600	2000-2600	8-15	0-3		OK fjell, hardt	
27,00	28,50	1,50	600	2500-2900	5-11	0-3			
28,50	29,00	0,50	600	2700-3000	3-8	0-3		OK fjell, hardt	
29,00	30,00	1,00	600	1600-2300	15	0-3			
30,00	33,00	3,00	600	1800-2400	15	3-4		OK fjell, hardt	
33,00	34,70	1,70	600	2600-3000	5-11	0-3			
34,70	36,00	1,30	600	2800-3200	5-12	0-3		OK fjell, hardt	
36,00	36,30	0,30	600	3000-3400	3-5	0-3			
36,30	38,80	2,50	600	2800-3400	5-12	0-3		Oppsprukket	
38,80	41,80	3,00	600	2300-2800	12-15	3-7			
41,80	44,90	3,10	600	1700-2800	13-15	4-7		Fint fjell	
44,90	48,00	3,10	600	1900-3000	10-15	0-8			
48,00	50,40	2,40	750	2900-4500	8-11	4-12		Mistet mottrykk, 49,50 meter	
50,40	51,00	0,60	750	2000-2400	8-12	0-4		Sand, leire i sprekkesoner	
51,00	54,00	3,00	750	2000-3000	10-12	0-4		Mykere soner, langsgående sprekk	
SUM	54,00	46,00							

GEO DRILLING AS		REGISTRERING BOREDATA						SIDE 2		GEO DRILLING
PROSJEKT: P - 170118		STED: Åknes			HULL-NR: BH - 02 - 18		KRONE: HQ	DATO: September	MASKIN: Diamec U-6 APC	FALL/RETNING: Lodd
FRA BOREDYP	TIL BOREDYP	KJERNE LENGDE	ROTASJON RPM	MATEKRAFT KILO	PENETRERING ca CM/MIN	Mottrykk Spyl.vann Bar	FARVE SPYLEVANN	KOMMENTAR		
54,00	57,10	3,10	750	2400-3900	10-13	0-4		Noe hardere, sprukket		
57,10	60,10	3,00	750	3500-4600	10-11	0-3		Mistet mottrykk		
60,10	63,00	2,90	750	3700-4800	10-12	0-3				
63,00	66,10	3,10	750	3500-4800	10-13	0-3		OK hardt		
66,10	69,20	3,10	750	3500-4800	10-13	0				
69,20	72,20	3,00	750	3700-4200	10-13	0		Delvis hardt, svake soner		
72,20	74,90	2,70	750	3200-5200	6-15	0-3				
74,90	78,00	3,10	750	3500-5200	10-15	0-3		Delvis hardt, svake soner		
78,00	81,00	3,00	750	3400-4000	10-13	0				
81,00	84,20	3,20	750	2600-3600	12-14	0-3		Bra fjell, lettboret		
84,20	87,20	3,00	750	3200-4000	12-14	0-3				
87,20	90,30	3,10	750	3200-4000	12-14	0-3		Bra fjell, noe kil		
90,30	93,30	3,00	750	3000-4200	12-14	0				
93,30	96,30	3,00	750	2600-3800	12-16	0-3		Sone ved 94,00 meter, helt fjell		
96,30	99,30	3,00	750	3500-4800	11-13	0				
99,30	102,30	3,00	750	3500-5000	10-14	0-3		Hardt, bra fjell		
102,30	105,30	3,00	750	2700-3500	10-14	0-3				
105,30	108,40	3,10	750	2800-3700	12-15	0		Bra fjell		
108,40	111,40	3,00	750	2600-3500	12-14	0-3				
111,40	114,40	3,00	750	2500-3000	12-14	0-3		Myke soner, sand/leire ?		
114,40	116,80	2,40	750	2700-4000	11-14	3-4				
116,80	117,20	0,40	750	4000-5200	3-5	0		Hardt og helt		
117,20	120,20	3,00	750	3000-4500	10-13	0				
120,20	123,30	3,10	750	2700-3400	10-14	0-3		Hardt og helt		
123,30	126,00	2,70	750	3400-5000	8-12	0-3				
126,00	129,10	3,10	750	3500-4200	10-12	0-3		Helt fjell, noe løsere		
129,10	132,10	3,00	750	2700-4000	10-12	0-3				
132,10	135,20	3,10	750	2700-4200	10-12	0-4		Helt fjell, noe løsere		
0,00	0,00	0,00								
0,00	0,00	0,00								
0,00	0,00	0,00								
SUM	135,20	81,20								

GEO DRILLING AS	REGISTRERING BOREDATA						SIDE 3	GEO DRILLING
PROSJEKT: P - 170118	STED: Åknes			HULL-NR: BH - 02 - 18		KRONE: HQ	DATO: Sept - Oktober	MASKIN: Diamec U-6 APC	FALL/RETNING: Lodd
FRA BOREDYP	TIL BOREDYP	KJERNE LENGDE	ROTASJON RPM	MATEKRAFT KILO	PENETRERING ca CM/MIN	Mottrykk Spyl.vann Bar	FARVE SPYLEVANN	KOMMENTAR	
135,20	138,30	3,10	750	2000-3700	10-13	0-3		Helt og hardt	
138,30	141,30	3,00	750	2000-4000	10-12	0-3			
141,30	144,30	3,00	750	2500-4000	10-12	0-3		Helt og hardt	
144,30	147,30	3,00	750	2700-3500	10-12	3-4			
147,30	150,30	3,00	750	3000-3800	10-12	0-3		Helt fjell	
150,30	153,30	3,00	750	3200-4000	10-12	0-3			
153,30	156,30	3,00	750	2600-3000	10-12	3-5		Helt fjell	
156,30	159,10	2,80	750	2300-3000	10-12	3-4			
159,10	162,20	3,10	750	3500-4700	10-12	3-4		Hardt	
162,20	162,50	0,30	750	3900	10	4-5			
162,50	165,30	2,80	750	3500-4500	10-12	0-3		Hardt	
165,30	167,80	2,50	750	3300-4500	5-13	0-3			
167,80	170,80	3,00	750	1100-1700	15	5		Hardt fint fjell	
170,80	173,90	3,10	750	1700-2800	15	5			
173,90	177,00	3,10	750	1500-3200	15	3-5		Hardt fint fjell	
177,00	180,00	3,00	750	2200-3600	12-15	3-5			
180,00	182,20	2,20	750	1800-2600	15	3-5		Hardt fint fjell	
182,20	183,00	0,80	600	2400-3000	12-15	4-5			
183,00	186,00	3,00	600	2600-3500	11-15	3-5		Hardt fint fjell	
186,00	189,00	3,00	600	2300-3800	12-15	3-18			
189,00	192,00	3,00	600	2400-2900	15	3-5		Hardt fint fjell	
192,00	194,50	2,50	600	2200-2500	15	4-5			
194,50	197,30	2,80	600	2200-2800	15	4-5		Hardt fint fjell	
197,30	199,40	2,10	600	2800-4300	3-11	3-5			
0,00	0,00	0,00							
0,00	0,00	0,00							
0,00	0,00	0,00							
0,00	0,00	0,00							
0,00	0,00	0,00							
0,00	0,00	0,00							
0,00	0,00	0,00							
SUM	199,40	64,20							

Appendix B

CORE LOGGING SHEETS (LOGPLOT) KH-02-2018

Contents

B1 Core logging sheets (Logplot) KH-02-2018

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
PROJECT NAME: **Åknes drainage**

DRILLED LENGTH: **199,4**
ELEVATION: **471,4**
ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE:
Gneiss

ZONES:
Fractured zone
Core loss

JOINT INNFILL MATERIAL:
cy, Clay
cl, Chlorite
mc, Mica
py, Pyrite
sl, Silt

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
0			Core loss, deposits								
-1											
-2											
-3											
-4											
-5											
-6											
-7											

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
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LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
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ROCK TYPE:
Gneiss

ZONES:
Fractured zone
Core loss

JOINT INNFILL MATERIAL:
cy, Clay
cl, Chlorite
mc, Mica
py, Pyrite
sl, Silt

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-8	1		Foliated gneiss, coarse grainsize. Dark grey colour, Quartz, feltspar and biotite								
-9											
-10							cy, sl				
-11											
-12	2										
-13											
-14			Core loss Foliated gneiss, coarse grainsize. Dark grey colour, Quartz, feltspar and biotite								
-15			Core loss Foliated gneiss, coarse grainsize. Dark grey colour, Quartz, feltspar and biotite				cy				

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
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ELEVATION: **471,4**
ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-16	3		Slightly foliated, dark grey to black colour, medium grain size. Some quartz bands/veins intersecting. High mica content.				cy cy, sl cy, sl				
-17											
-18							cy, sl cy, sl				
-19							cy, sl				
-20	4		Foliated gneiss, coarse grain size. Grey colour with light/pink bands (quartz and feldspar)				cy, sl, mc cy, sl, mc				
-21											
-22			Weak foliation, gneiss, medium grain size. Dark grey to black colour. Very weak foliation. High mica content.								
-23											

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
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DRILLED LENGTH: **199,4**
ELEVATION: **471,4**
ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH | BOX NO. | ROCK TYPE | DESCRIPTION/COMMENTS | CORELOSS, CM | Jr | Ja | Joint infill material | RQD, % (20 40 60 80) | JOINT FREQUENCY natural joints pr. m. (5 10 15 20) | WATERLOSS MEASUREMENT Lugeon (1 10 100) | OVERPRESSURE, MPa

-24
-25
-26
-27
-28
-29
-30
-31

5

Weak foliated Gneiss, medium to coarse grain size. Content of mica, quartz and feldspar.

6

Foliated gneiss, medium to coarse grain size. Light bands of quartz and feldspar. High mica content.

Joint infill material: py, mc, py, mc

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

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REPORT NO.: **20180662**
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ORIENTATION: **Vertical**
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NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-32	7		Foliated gneiss, coarse grain size. Grey to light grey colour with white and pink quartz/feldspar bands. Quartz, feldspar, mica		b	c	mc				
-33					b	b					
-34					b	c					
-35					b	b					
-36	8				x	x					
-37					b	c	mc				
-38					e	c	cy, sl, mc				

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CORE DRILLING- CORELOG

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NAME: **Lise Tønset and Henrik Langeland**

File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-39											
	9		Foliated gneiss, coarse grain size. Grey to dark grey colour with white and pink quartz/feldspar bands. Small sections with medium-coarse grains and weak foliation, dark, and mica rich.								
-40											
-41							cy, sl				
							sl				
-42							cy,sl				
-43											
	10		Foliated gneiss. Coarse grained. Grey/dark grey colour with pink and white bands parallell foliation. Quartz feldspar and mica.				mc				
-44											
							cy, sl				
-45							cy, sl				
-46							cy, sl				

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CORE DRILLING- CORELOG

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ELEVATION: **471,4**
ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-47							cy, sl				
	11										
-48							cy, sl				
-49											
-50											
							cy, sl				
-51							mc				
	12		Coarse grain size, grey to dark grey colour with pink and white bands. Quartz, feldspar, mica								
-52											
-53											
-54							mc				

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CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
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DRILLED LENGTH: **199,4**
ELEVATION: **471,4**
ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-55	13				b	b					
					e	b					
					x	x					
					b	c					
-56					b	b					
					x	x					
					e	b					
					e	b					
					e	d					
-57					e	c					
					e	c					
					e	d					
-58					x	x					
-59					e	b					
	14		Coarse grain size, grey to dark grey colour with pink and white bands. Quartz, feldspar, mica		x	x					
					c	e	cy, sl				
-60					x	x					
					x	x					
					x	x					
					e	b					
-61					e	c					
					x	x					
					x	x					
-62					e	d	cy, sl				

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ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**

File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-63	15										
-64											
-65											
-66											
-67							mc				
-68	16		Coarse grain size, grey to dark grey colour with pink and white bands. Quartz, feldspar, mica				mc, cy, cy, sl				
-69											
-70											

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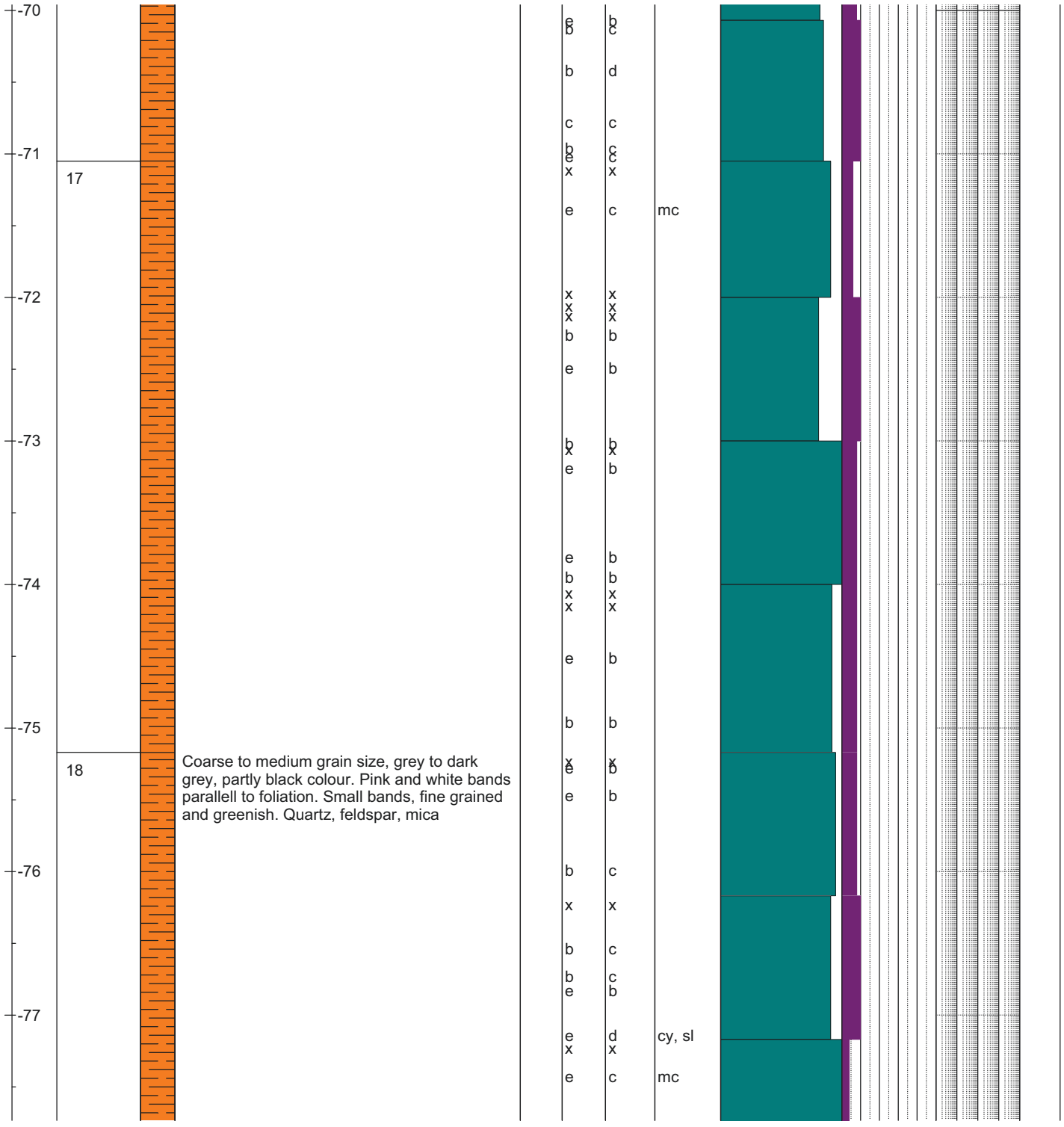
ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**



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CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
PROJECT NAME: **Åknes drainage**

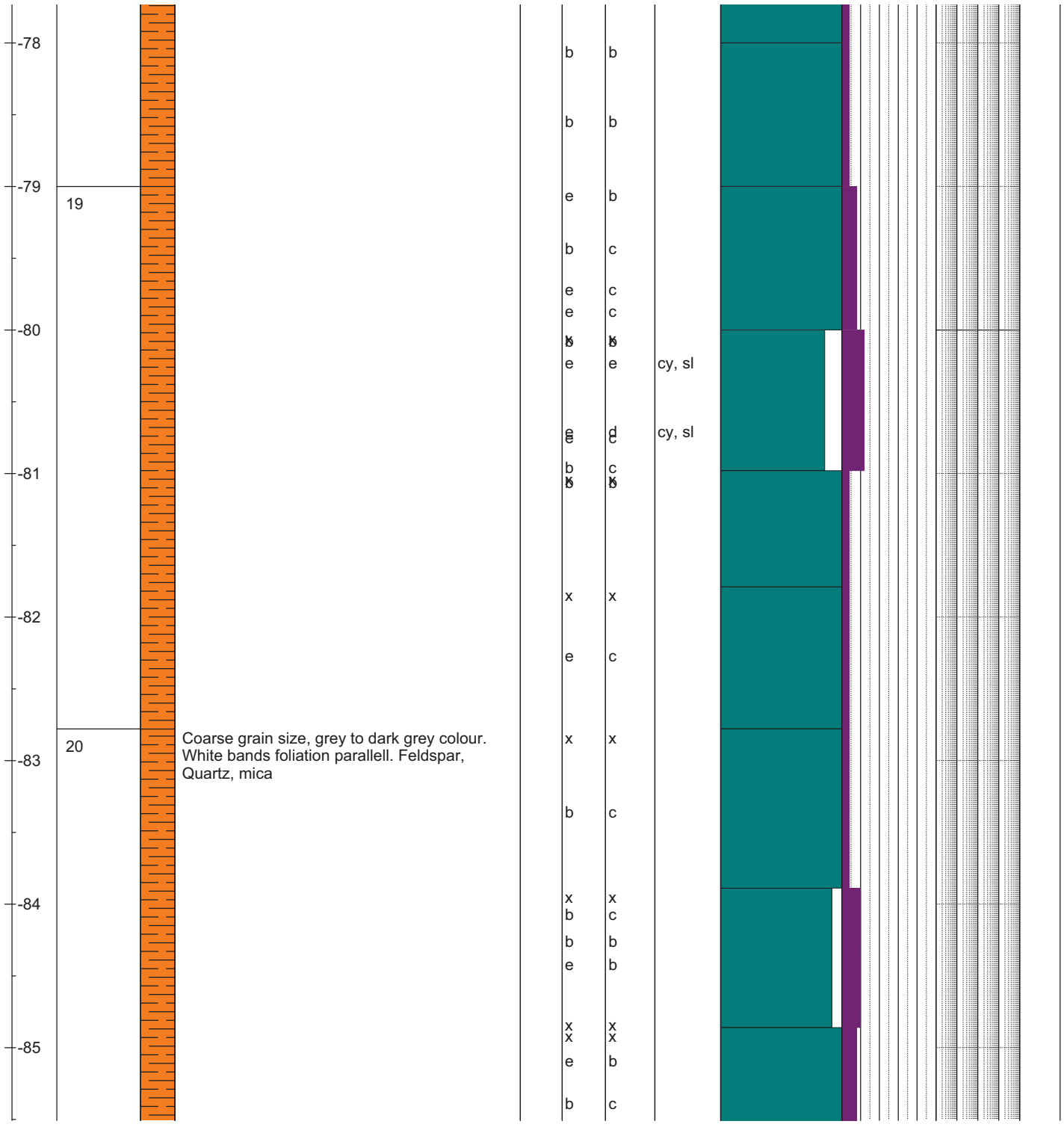
DRILLED LENGTH: **199,4**
ELEVATION: **471,4**
ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-78					b	b					
					b	b					
-79	19				e	b					
					b	c					
					e	c					
-80					e	c					
					e	e	cy, sl				
					e	c	cy, sl				
-81					b	c					
					x	x					
-82					e	c					
	20		Coarse grain size, grey to dark grey colour. White bands foliation parallell. Feldspar, Quartz, mica		x	x					
-83					b	c					
-84					x	x					
					b	c					
					b	b					
					e	b					
-85					x	x					
					x	x					
					e	b					
					b	c					



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NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material
-86					b	b	
					x	x	
					e	c	
					b	c	
					e	b	
-87	21		Weak foliation, medium to fine grain size. Dark grey to black colour, some parts greenish. Quarts clast, mica rich		x	x	
					b	b	
					b	e	mc
					x	x	
-88							
					b	c	
					b	c	
					x	x	
-89							
					e	c	
					b	c	
					x	x	
					e	b	
-90					c	c	mc
					e	c	
					e	b	
	22				x	x	
					b	b	
-91					f	e	mc
					x	x	
					x	x	
-92							
					x	x	
					b	b	
-93					b	c	mc

RQD, % (20 40 60 80)

JOINT FREQUENCY natural joints pr. m. (5 10 15 20)

WATERLOSS MEASUREMENT Lugeon (1 10 100)

OVERPRESSURE, MPa

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

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ELEVATION: **471,4**
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NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH | BOX NO. | ROCK TYPE | DESCRIPTION/COMMENTS | CORELOSS, CM | Jr | Ja | Joint infill material | RQD, % (20 40 60 80) | JOINT FREQUENCY natural joints pr. m. (5 10 15 20) | WATERLOSS MEASUREMENT Lugeon (1 10 100) | OVERPRESSURE, MPa

-94
-95
-96
-97
-98
-99
-100
-101

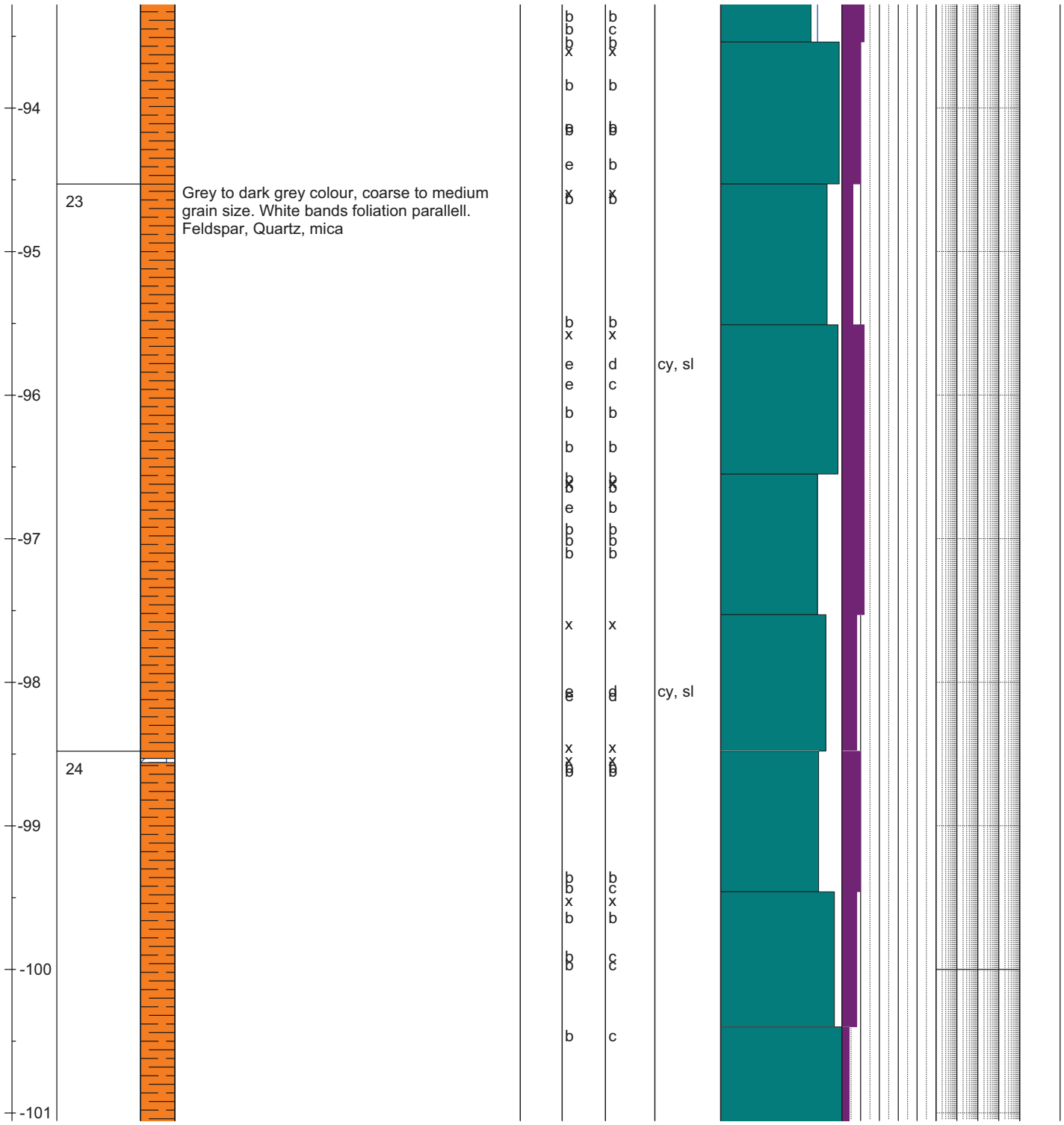
23

24

Grey to dark grey colour, coarse to medium grain size. White bands foliation parallell. Feldspar, Quartz, mica

cy, sl

cy, sl



Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
PROJECT NAME: **Åknes drainage**

DRILLED LENGTH: **199,4**
ELEVATION: **471,4**
ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-101					b	c	mc				
					x	x					
-102					b	b					
					e	b					
	25		Coarse grained, grey to dark grey colour. White and pink bands foliation parallell.		b	b					
					c	c					
-103					x	x					
					x	x					
			Fine grained, dark grey to black, partly greenish.		b	c					
-104					x	x					
					x	x					
					b	b					
					x	x					
-105					e	c					
-106					b	c					
					e	c					
	26				x	x					
			Grey to dark grey colour. White and pink bands foliation parallell		b	b					
					b	b					
-107					b	b					
					b	b					
					b	b					
-108					x	x					
					x	x					
					e	b					

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
PROJECT NAME: **Åknes drainage**

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LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
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ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-109					b	b					
					e	b					
					b	b					
					x	x					
					x	x					
					b	b					
-110					x	x					
	27		Grey to dark grey colour with white and pink bands foliation parallell. Quartz, feldspar, mica.		x	x					
					b	c					
-111					b	c					
					b	b					
					b	b					
					e	c					
-112					b	b					
					b	c					
					e	c					
-113					b	b					
					x	x					
					x	x					
					b	b					
					b	c					
-114											
	28				x	x					
					e	c					
					e	c					
-115					b	c					
					x	x					
					x	x					
-116					x	x					
					x	x					
					b	b					

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

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ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-117					b	b					
					x	x					
					b	b					
					e	c	mc				
					c	c	mc				
					x	x					
-118	29		Grey to dark grey colour with white and pink bands foliation parallell. Quartz, feldspar, mica.		x	x					
					x	x					
					x	x					
-119					x	x					
					e	c					
-120					b	c					
-121					b	b					
					b	b					
-122	30				x	x					
					b	b					
-123					x	x					
					x	x					
					b	c					
-124					x	x					

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ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-125					b	b					
					x	x					
					b	c					
					e	c					
					e	c					
					b	c					
-126	31		Dark grey colour with white and pink bands foliation parallell. Quartz, feldspar, mica.		e	d	cy; sl				
					b	c					
					x	x					
					x	x					
-127					e	c					
					e	c					
					x	x					
					x	x					
-128					x	x					
					e	c					
					e	c					
					b	c					
					b	c					
					e	c					
-129					e	c					
					b	c					
					b	c					
					e	c					
					x	x					
					x	x					
-130	32				e	c					
					x	x					
					x	x					
					b	b					
-131					b	b					
					b	b					
					x	x					
					x	x					
-132					x	x					

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CORE DRILLING- CORELOG

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LOGGING DATE: **2018-11 to 2018-12**
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ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-133					b	c					
					b	c					
					x	x					
					b	c					
					e	c					
					x	x					
	33		Grey to dark grey colour. White and pink bands foliation parallell. Feldspar, Quartz, mica. 136.91-137.73 meter greenish colour		x	x					
-134					c	c					
					b	c					
					b	c					
					b	c					
					b	x					
					c	c					
-135					b	b					
					b	b					
					b	b					
					b	b					
					b	d	cy, sl				
					e	d	cy, sl				
					x	x					
-136					c	c					
					b	d	cy, sl				
					b	d	cy, sl				
					b	d	cy, sl				
					x	x					
					b	b					
					x	x					
					c	c					
-137					b	b					
					x	x					
	34				x	x					
-138					x	x					
					b	b					
					e	c					
					e	c					
					x	x					
-139					x	x					
					b	c					
					b	c	mc				
					x	x					
					e	c					

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
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ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-140					e	b					
					b	b					
					e	b					
					e	c					
					b	d	cy, sl				
					b	b					
					x	x					
					b	b					
-141					b	b					
					b	b					
					b	c					
	35		Grey to dark grey colour, white and pink bands parallell to foliation. Quartz, feldspar, mica		e	c					
					b	c					
-142					e	c					
					b	c					
					b	c					
					x	x					
					x	x					
-143					x	x					
					b	b					
					b	c	mc				
					b	b	mc				
					x	x					
					b	b					
-144					e	c					
					e	c					
					b	c					
					b	c	mc				
					x	x					
					b	d	cy, sl				
-145					b	c					
					x	x					
	36				b	b					
					b	b					
-146					x	x					
					x	x					
					b	c					
					b	b					
-147					b	b					
					x	x					
					b	c					

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CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
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LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-148					e	b					
					x	x					
-149					x	x					
	37		Grey to dark grey colour, white bands parallell to foliation. Quartz, feldspar, mica		x	x					
					e	b					
-150					b	b					
					x	x					
					b	c	mc				
-151					b	c	mc				
					f	b					
-152					c	c	mc				
					x	x					
					b	c					
-153					b	b					
					e	c					
	38				x	x					
					b	b					
-154					e	c					
					b	b					
-155					c	c	mc				
					x	x					

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

BOREHOLE: KH-02-18

REPORT NO.: **20180662**
PROJECT NAME: **Åknes drainage**

DRILLED LENGTH: **199,4**
ELEVATION: **471,4**
ORIENTATION: **Vertical**
LOGGING DATE: **2018-11 to 2018-12**
NAME: **Lise Tønset and Henrik Langeland**
File: *P:\2018\06\20180662\Beregninger\Borehull\KH-02-2018\Logplot*

ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material
-156					x	x	
					e	b	
					d	c	
					c	c	mc
					b	b	
					e	c	mc
					e	c	
-157					e	b	
					b	b	
	39		White bands parallell to foliation. Quartz, feldspar, mica		x	x	
-158					b	c	
					e	b	
					b	b	
					x	x	
					b	b	
-159					b	b	
					e	b	
					x	x	
					b	b	
-160					b	c	
					b	b	
					x	x	
					b	c	
-161					b	b	
	40				x	x	
					b	b	
-162					b	b	
					x	x	
					b	b	
-163					b	b	

RQD, % (20 40 60 80)

JOINT FREQUENCY natural joints pr. m. (5 10 15 20)

WATERLOSS MEASUREMENT Lugeon (1 10 100)

OVERPRESSURE, MPa

Norwegian Geotechnical Institute

CORE DRILLING- CORELOG

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ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-164					x	x					
					b	b					
					b	b					
					b	c					
-165					x	x					
	41		Foliated Gneiss, coarse grained. grey to dark grey, white and pink bands.		x	x					
					b	b					
					x	x					
					x	x					
-166					x	x					
					x	x					
					x	x					
					b	b	mc				
-167					x	x					
					x	x					
					x	x					
					x	x					
					x	x					
-168			Foliated gneiss, fine grained. Dark grey to black, weak foliation		b	b					
					x	x					
					x	x					
-169			Foliated Gneiss, coarse grained. grey to dark grey, white and pink bands.		b	b					
	42				x	x					
					b	c					
-170					x	x					
					x	x					
					x	x					
-171					b	c					
					b	c					

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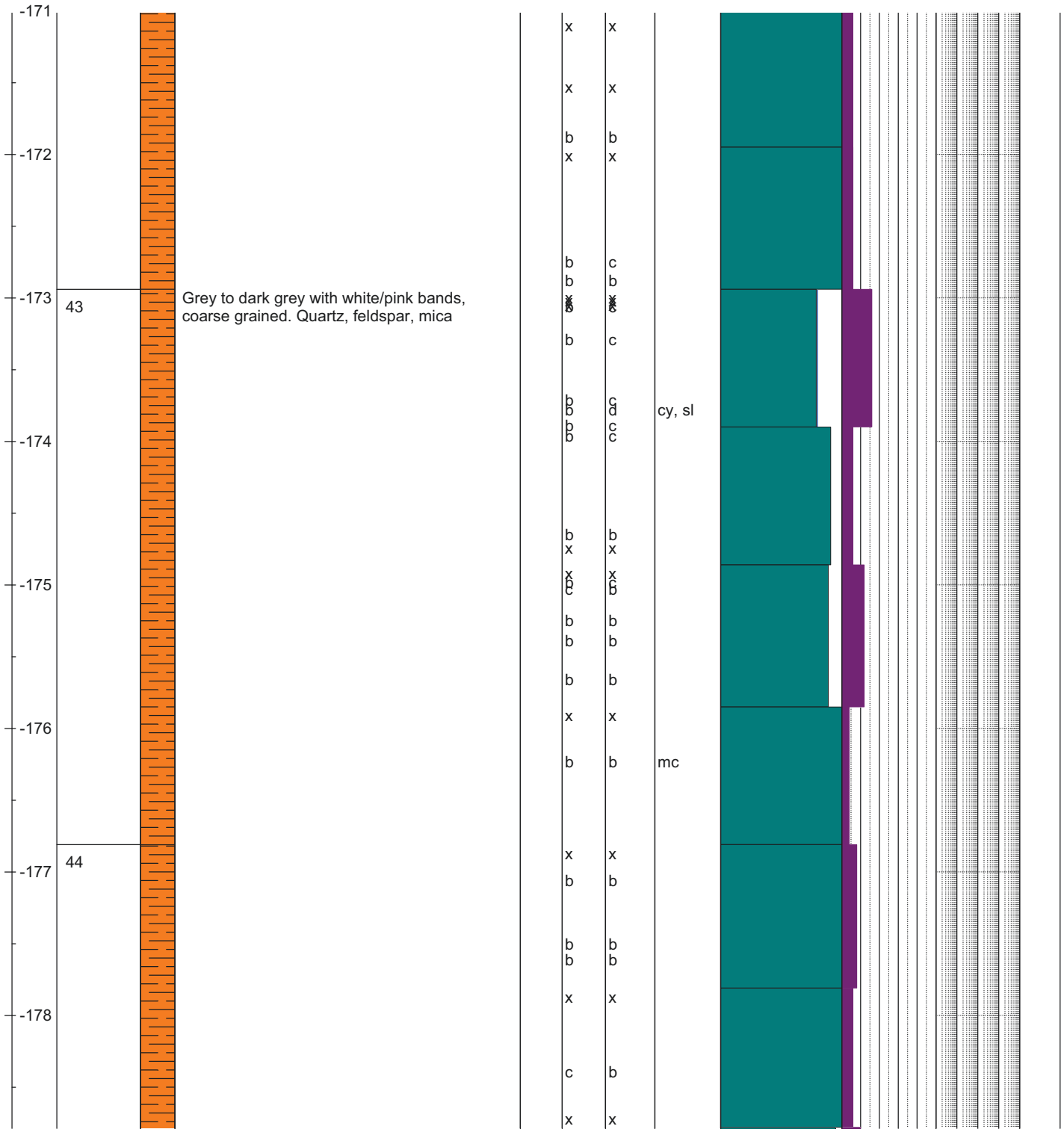
ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**



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ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**

HOLE DEPTH	BOX NO.	ROCK TYPE	DESCRIPTION/COMMENTS	CORELOSS, CM	Jr	Ja	Joint infill material	RQD, % (20 40 60 80)	JOINT FREQUENCY natural joints pr. m. (5 10 15 20)	WATERLOSS MEASUREMENT Lugeon (1 10 100)	OVERPRESSURE, MPa
-179					b	b					
					b	b					
					b	b					
-180					x	x					
					b	b					
					x	x					
					x	x					
-181	45		Grey with white and pink bands foliation parallell, coarse grained. Quartz, feldspar and mica		x	x					
					b	b					
-182					x	x					
					b	b					
					b	b					
					b	b					
-183					x	x					
					b	c					
					b	b					
					x	x					
-184					b	b					
					b	b					
					x	x					
	46				x	x					
-185					b	b					
					b	b					
					b	b					
					x	x					
					b	d	cy, sl				
-186					b	d	cy, sl				
					b	b					
					x	x					

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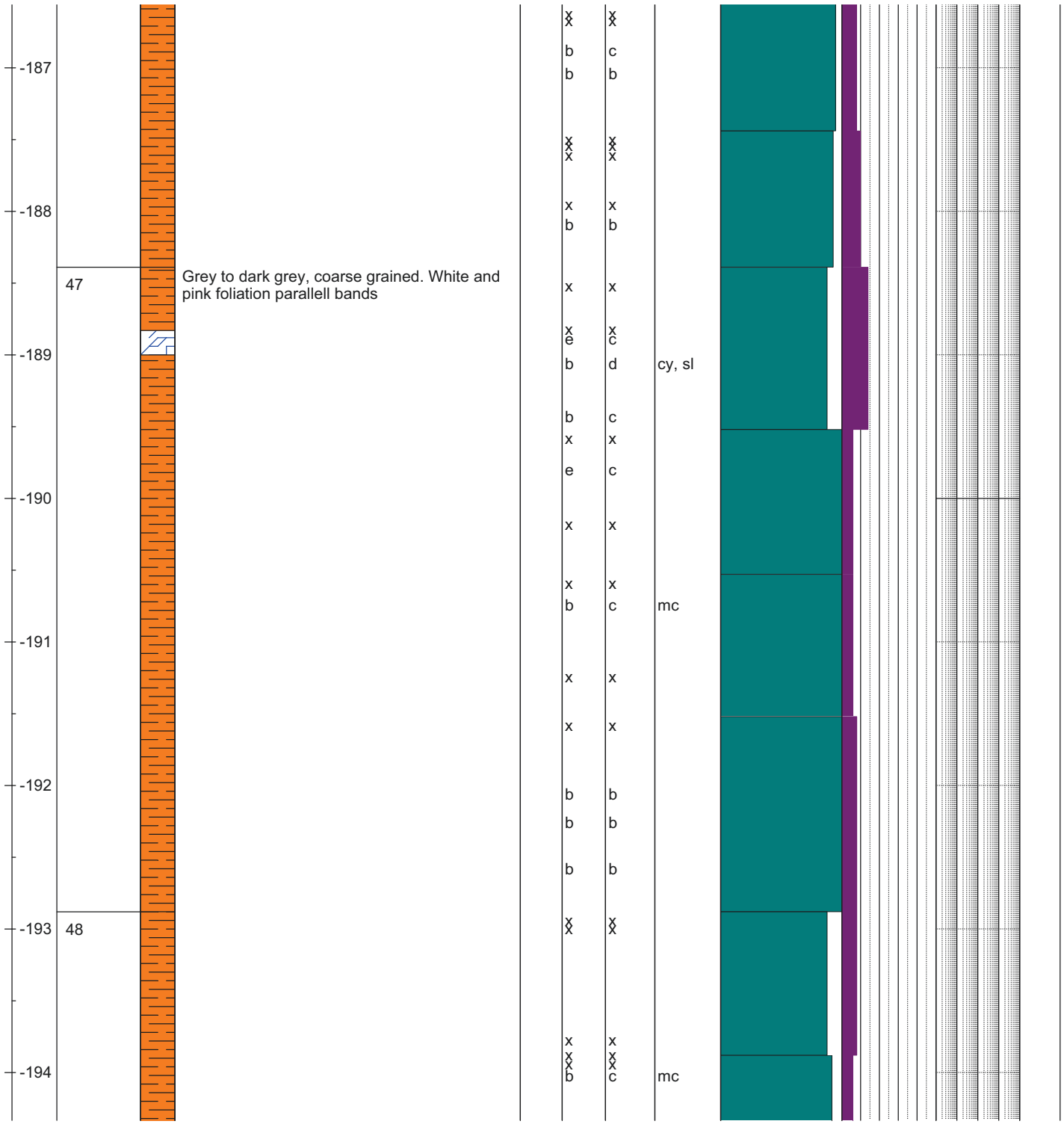
ROCK TYPE: **Gneiss**

ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**



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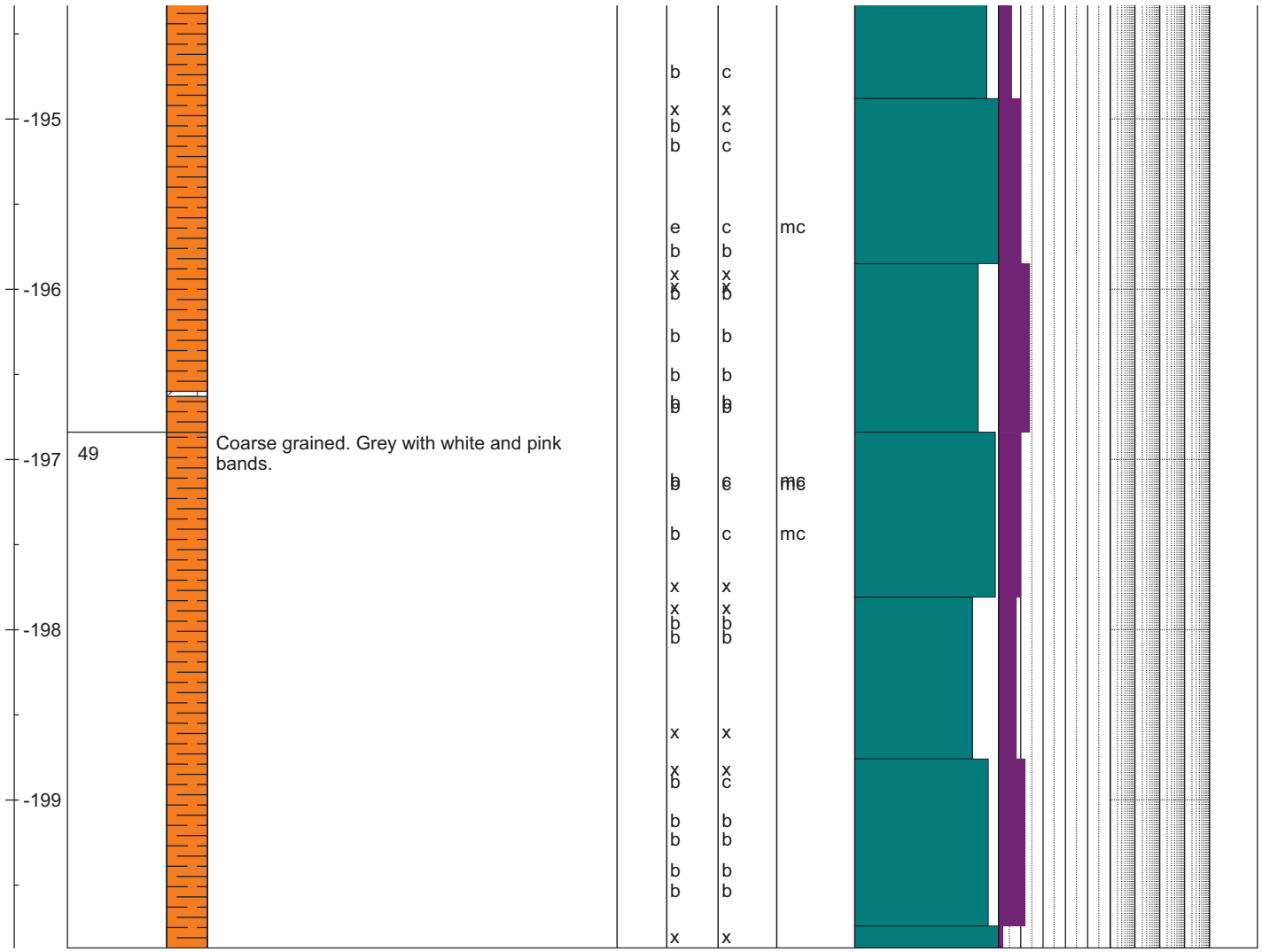
ZONES: **Fractured zone**, **Core loss**

JOINT INNFILL MATERIAL: **cy, Clay**, **cl, Chlorite**, **mc, Mica**, **py, Pyrite**, **sl, Silt**



Appendix C

PICTURES OF CORES KH-02-2018

Contents

C1 Pictures of cores KH-02-2018

Table 1. Overview of case no. and core length in KH-02-18.

Case no.	From	To	Length		Case no.	From	To	Length
1	8	12	12		26	106,27	110,28	4,01
2	12	16	4		27	110,28	114,12	3,84
3	16	20,06	4,06		28	114,12	118,05	3,93
4	20,06	24,47	4,41		29	118,05	122,02	3,97
5	24,47	27,9	3,43		30	122,02	125,84	3,82
6	27,9	31,83	3,93		31	125,84	129,82	3,98
7	31,83	35,70	3,87		32	129,82	133,74	3,92
8	35,7	39,72	4,02		33	133,74	137,73	3,99
9	39,72	43,56	3,84		34	137,73	141,60	3,87
10	43,56	47,50	3,94		35	141,6	145,61	4,01
11	47,5	51,21	3,71		36	145,61	149,44	3,83
12	51,21	55,13	3,92		37	149,44	153,46	4,02
13	55,13	59,08	3,95		38	153,46	157,30	3,84
14	59,08	63,20	4,12		39	157,3	161,25	3,95
15	63,2	67,17	3,97		40	161,25	165,23	3,98
16	67,17	71,05	3,88		41	165,23	169,14	3,91
17	71,05	75,17	4,12		42	169,14	172,94	3,8
18	75,17	79,00	3,83		43	172,94	176,81	3,87
19	79	82,78	3,78		44	176,81	180,90	4,09
20	82,78	86,85	4,07		45	180,9	184,71	3,81
21	86,85	90,63	3,78		46	184,71	188,39	3,68
22	90,63	94,53	3,9		47	188,39	192,88	4,49
23	94,53	98,48	3,95		48	192,88	196,84	3,96
24	98,48	102,30	3,82		49	196,84	199,87	3,03
25	102,3	106,27	3,97					

K1

K2

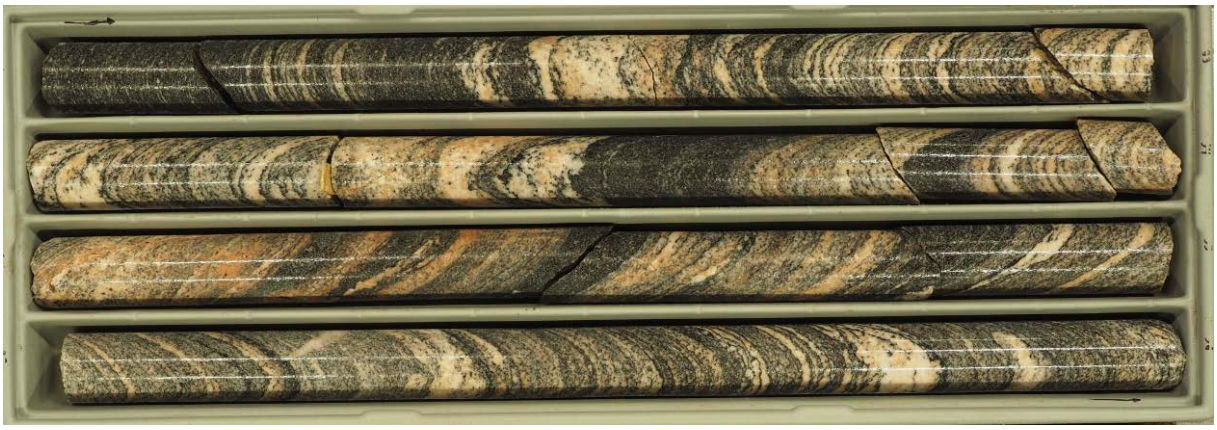
K3

K4

K5

K6

K7



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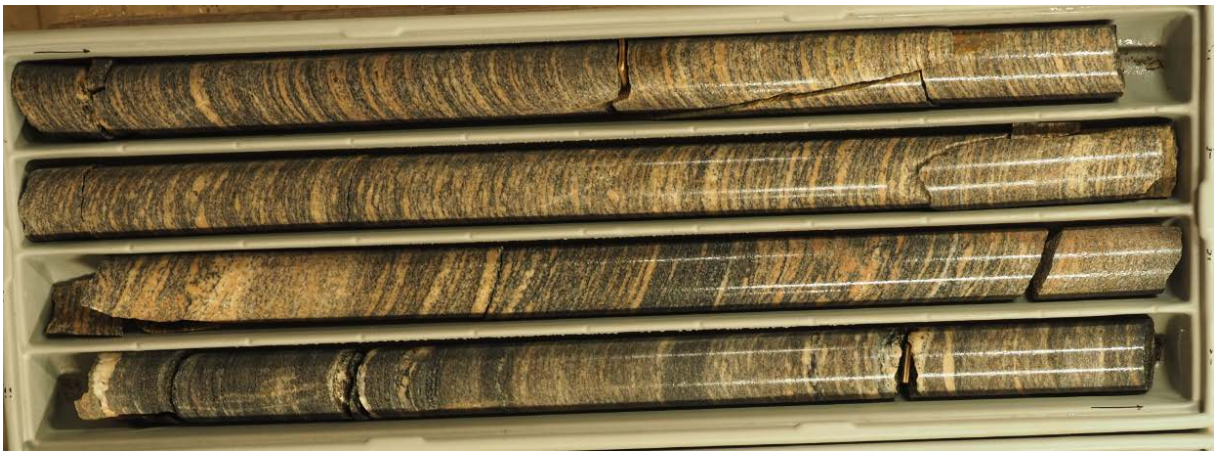

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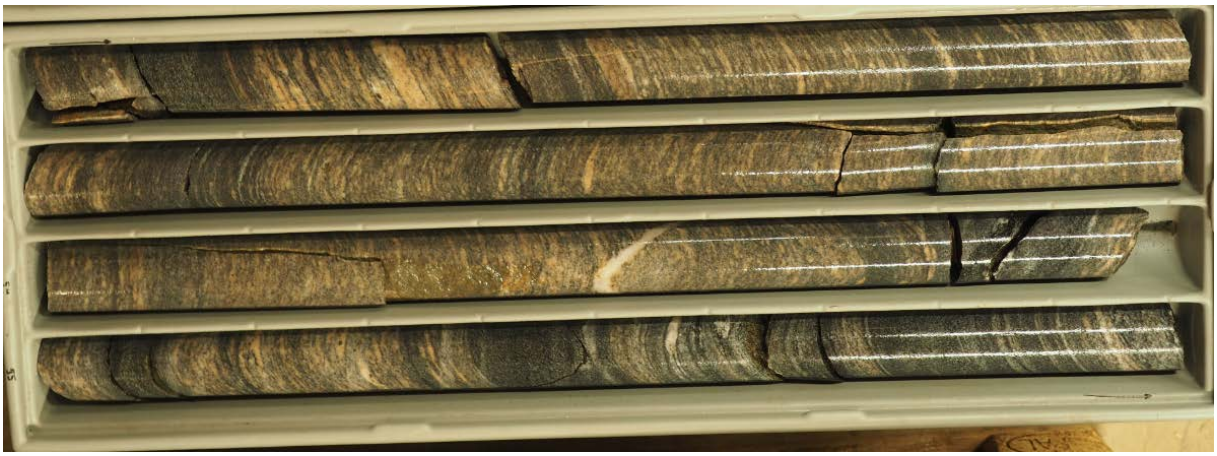

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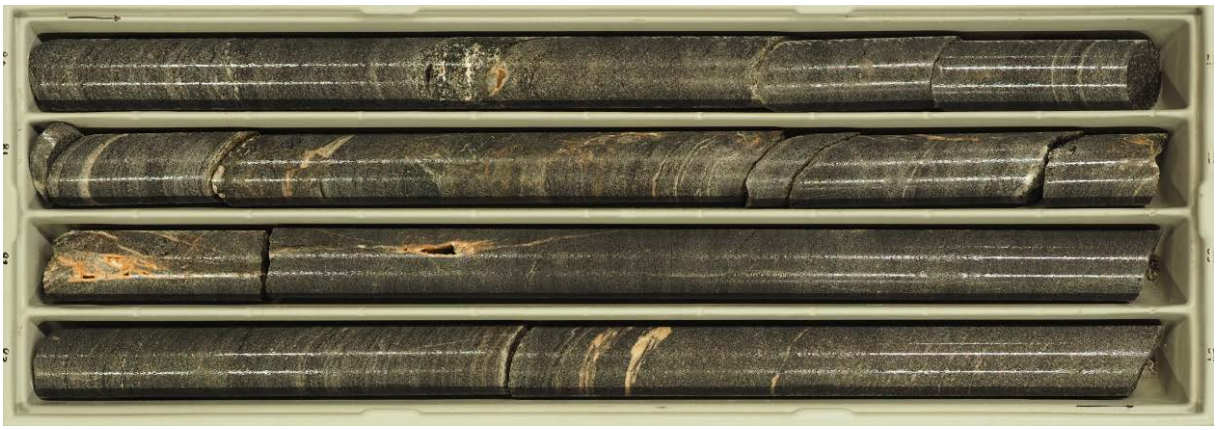

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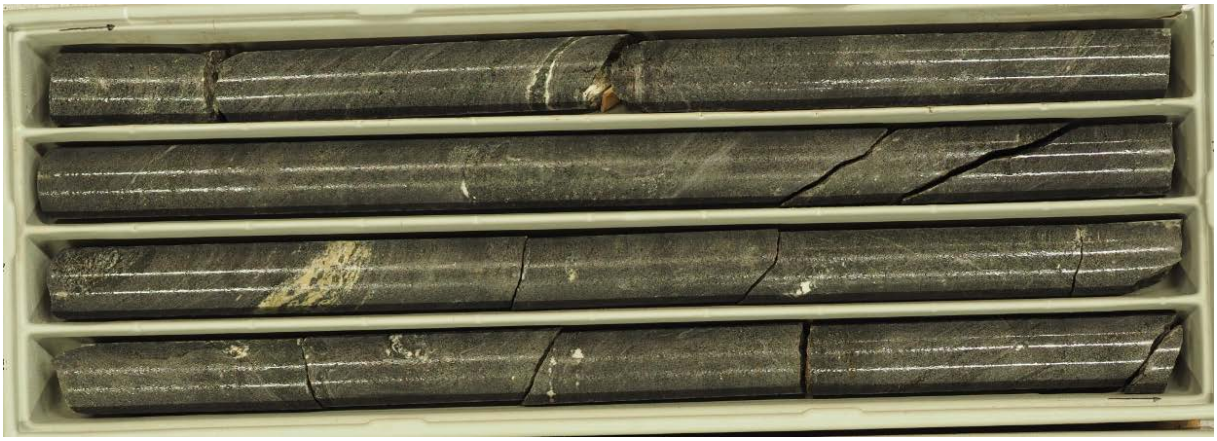

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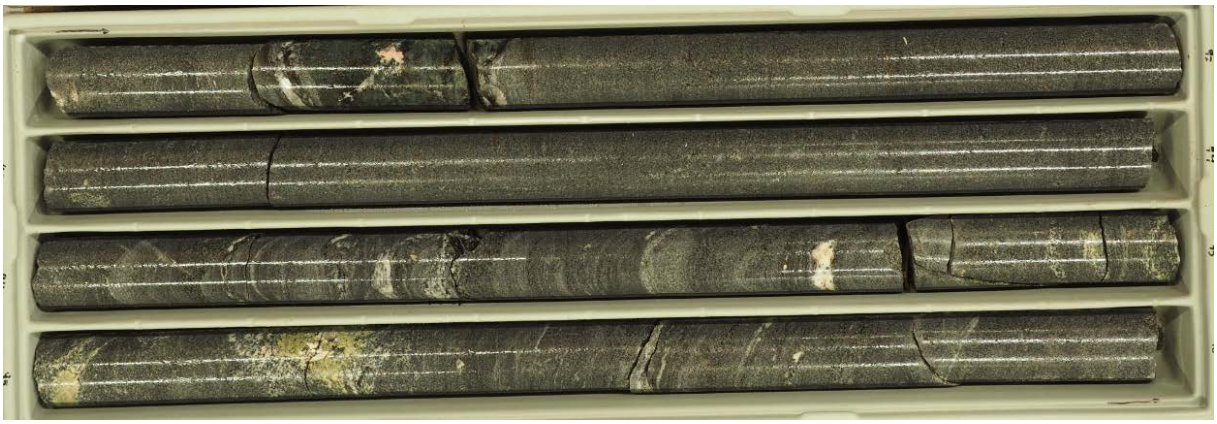

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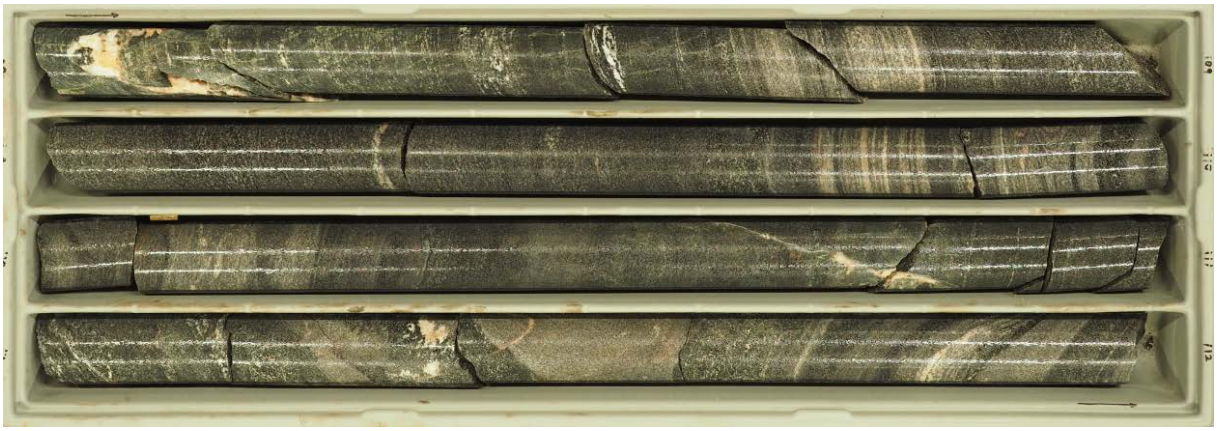

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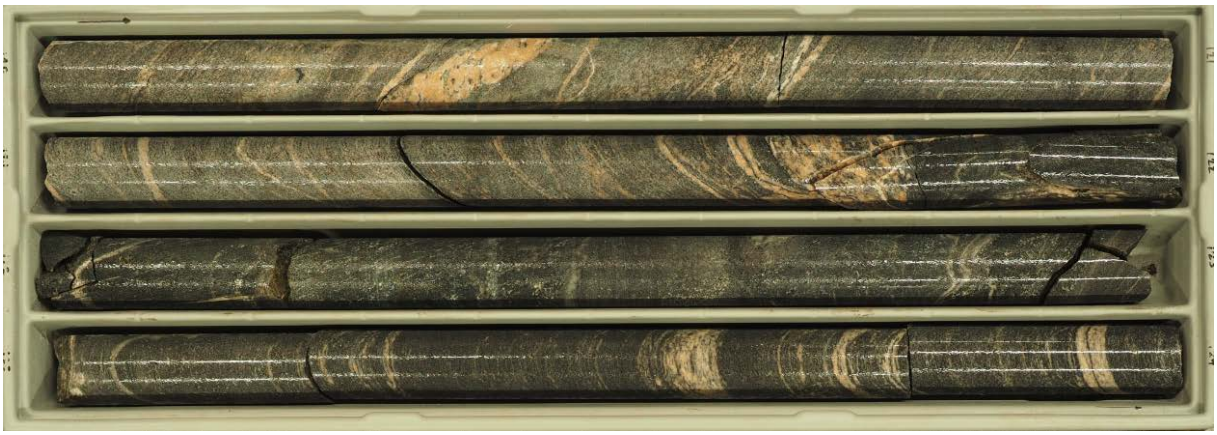

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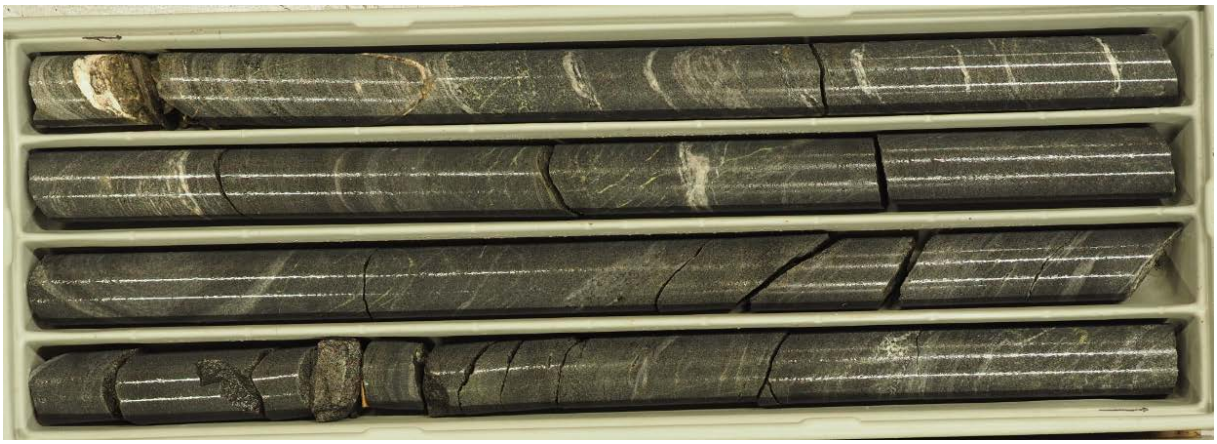

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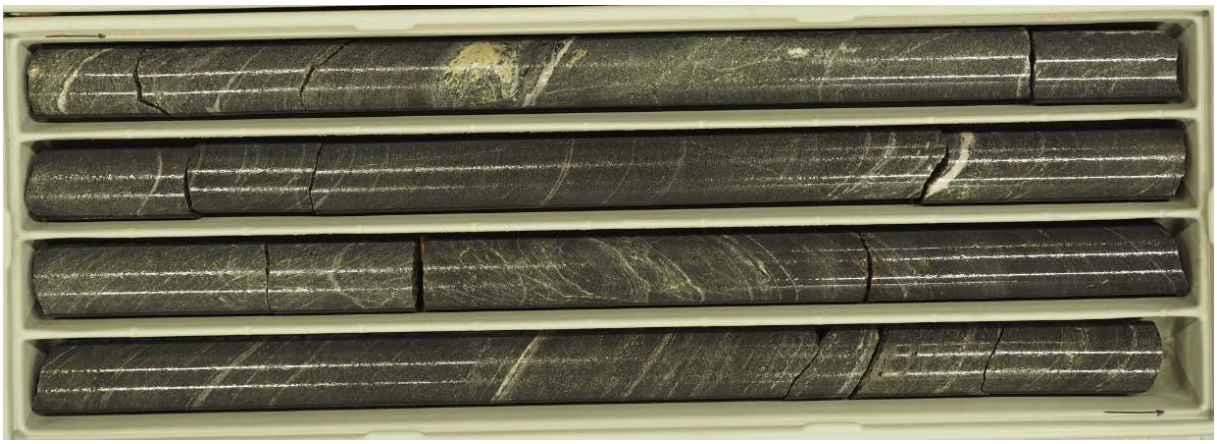

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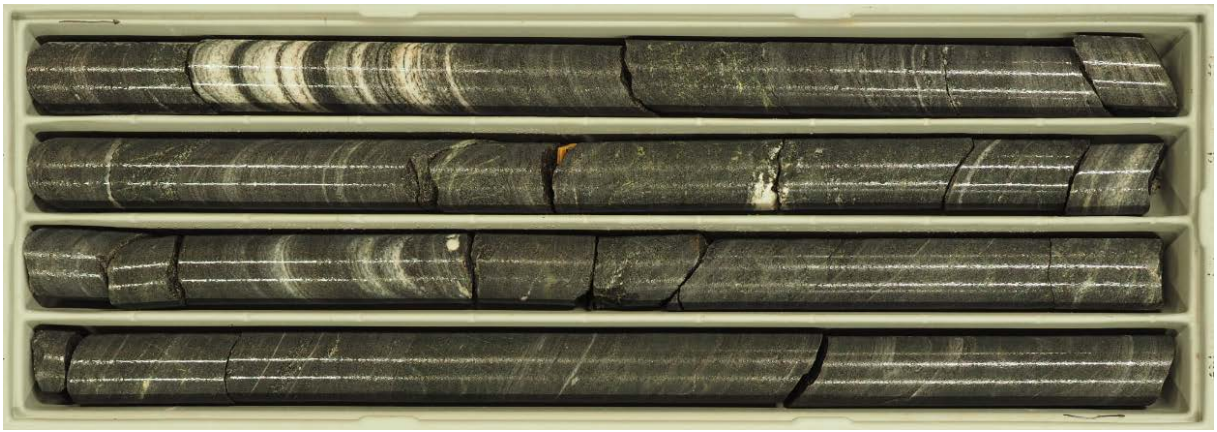

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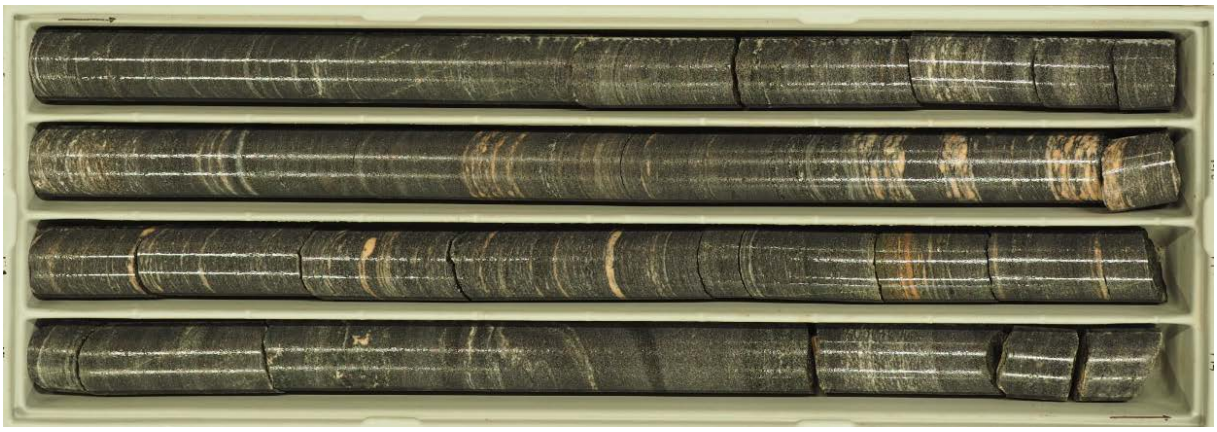

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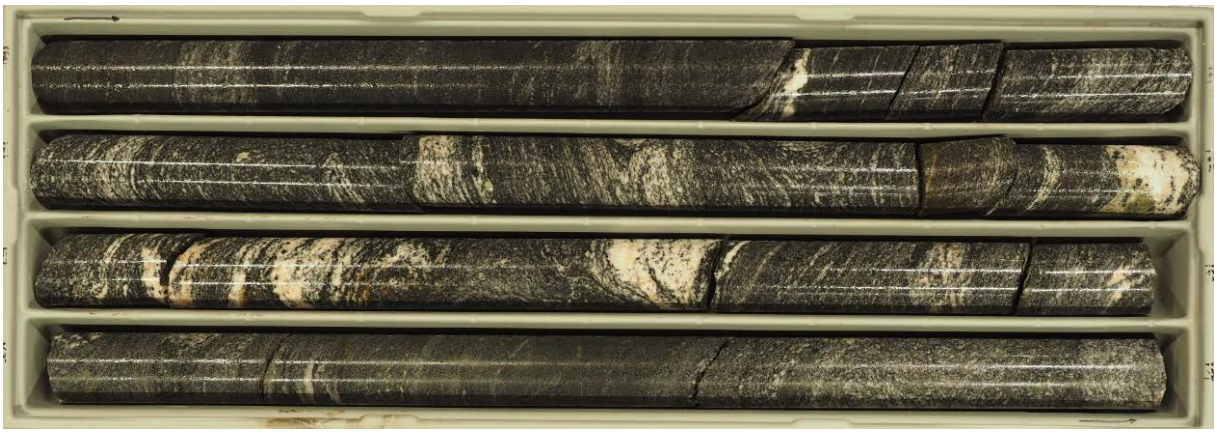

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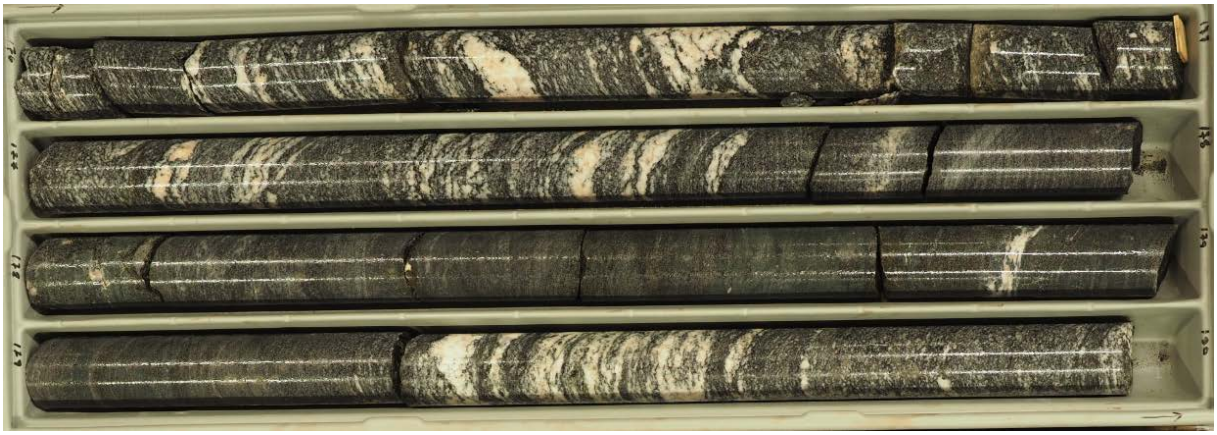

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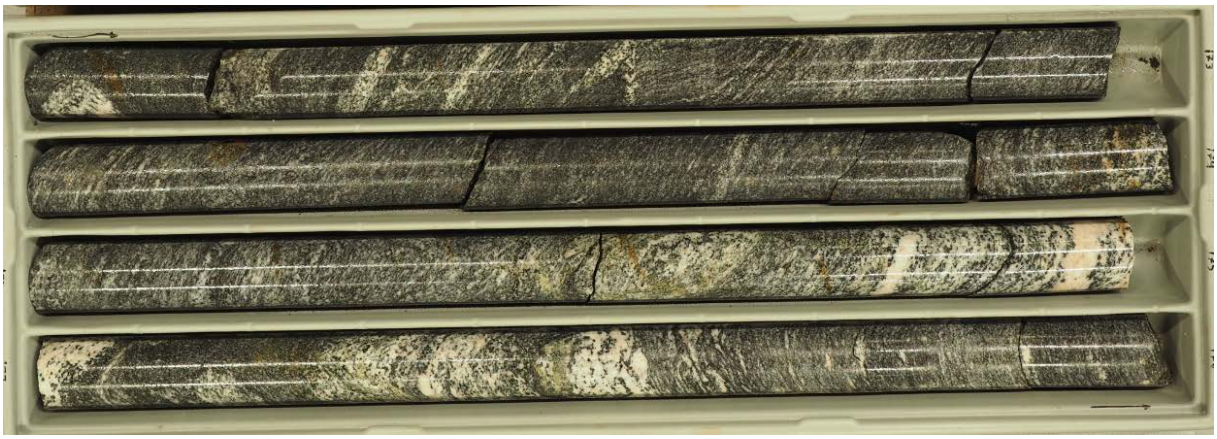

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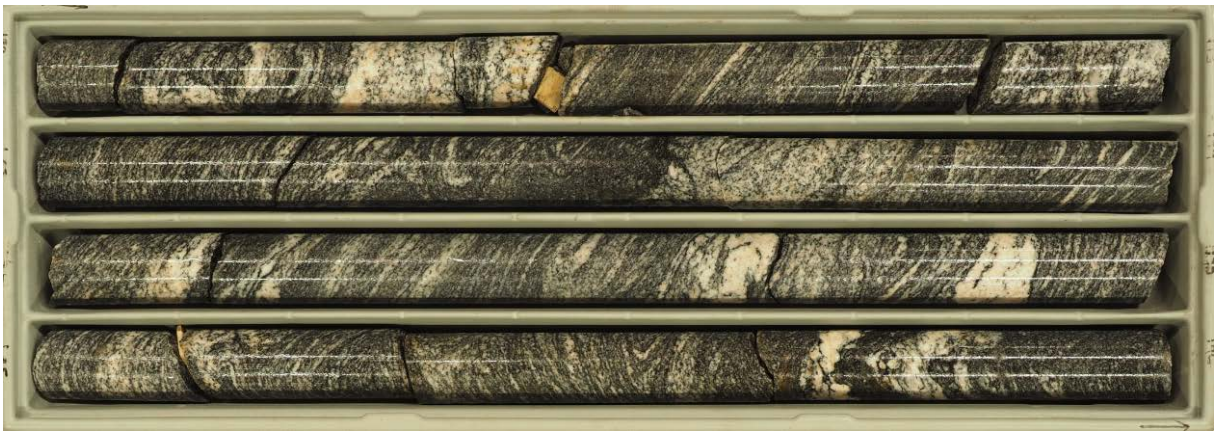

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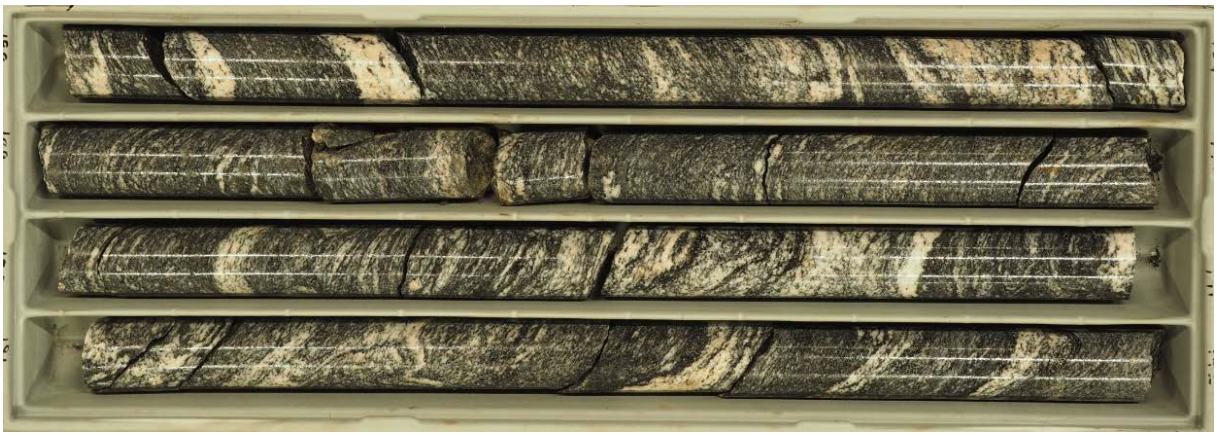

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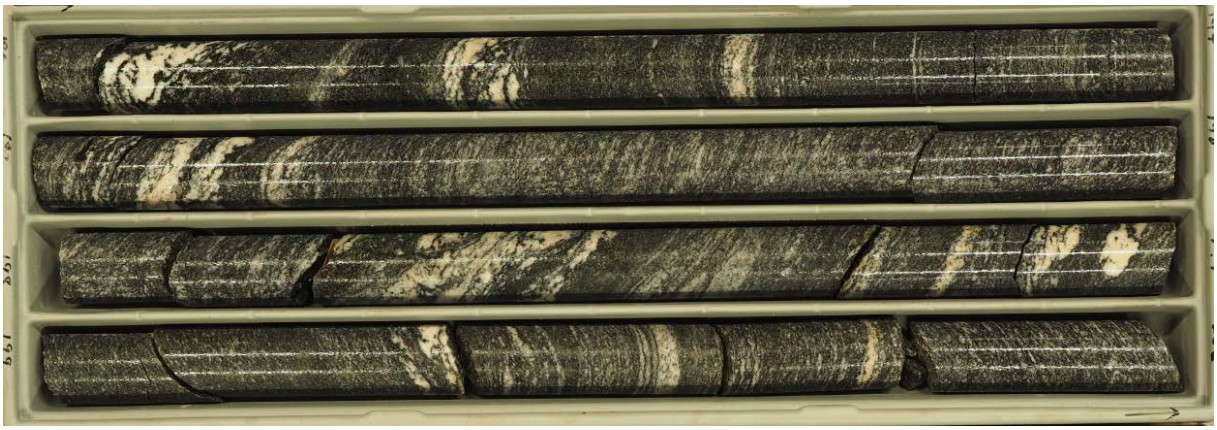

K49

Kontroll- og referanseside/ Review and reference page

Dokumentinformasjon/*Document information*		
Dokumenttittel/*Document title* Datareport corelogging KH-02-2018		**Dokumentnr./*Document no.*** 20180662-04-R
Dokumenttype/*Type of document* Rapport / Report	**Oppdragsgiver/*Client*** NVE	**Dato/*Date*** 2019-01-18
Rettigheter til dokumentet iht kontrakt/ *Proprietary rights to the document according to contract* NGI		**Rev.nr.&dato/*Rev.no.&date*** 1 / 2019-02-04
Distribusjon/*Distribution* BEGRENSET: Distribueres til oppdragsgiver og er tilgjengelig for NGIs ansatte / LIMITED: Distributed to client and available for NGI employees		
Emneord/*Keywords* Corelogging, RQD, fracture frequency		

Stedfesting/*Geographical information*	
Land, fylke/*Country* Norway	**Havområde/*Offshore area***
Kommune/*Municipality* Stranda	**Feltnavn/*Field name***
Sted/*Location* Åknes	**Sted/*Location***
Kartblad/*Map* 1219-2 Geiranger	**Felt, blokknr./*Field, Block No.***
UTM-koordinater/*UTM-coordinates* **Zone:** 33N**East:** 84568,29**North:** 6919727,39	**Koordinater/*Coordinates*** **Projection, datum: East: North:**

Dokumentkontroll/*Document control*
Kvalitetssikring i henhold til/*Quality assurance according to NS-EN ISO9001*

Rev/ *Rev.*	**Revisjonsgrunnlag/*Reason for revision***	**Egenkontroll av/ *Self review by:***	**Sidemanns-kontroll av/ *Colleague review by:***	**Uavhengig kontroll av/ *Independent review by*:**	**Tverrfaglig kontroll av/ *Interdisciplinary review by:***
0	Original document	2019-01-18 Henrik Langeland	2019-01-10 Kristin H. Holmøy		
1	Revision of Appendix B due to errors with Logplot value; fracture frequency per metre (FFm)	2019-02-04 Henrik Langeland	2019-02-04 Kristin H. Holmøy		

Dokument godkjent for utsendelse/ *Document approved for release*	**Dato/*Date***	**Prosjektleder/*Project Manager***
	4 February 2019	Kristin H. Holmøy

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