P-08-93

Site investigation SFR

Geophysical borehole logging in the boreholes HFR101, HFR102, HFR105, KFR27 (0-148 m), KFR101 and HFM07

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December 2008

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ISSN 1651-4416
SKB P-08-93

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Keywords: P-report SKBDoc id 1195366, Review statement SKBDoc id 1195433, Appendix SKBDoc id 1195437, Geophysical borehole logging, SFR, Forsmark, AP SFR-08-004, Project SFR extension.

Abstract

Geophysical borehole logging has been performed in the boreholes HFR101, HFR102, HFR105, KFR27 (0–148 m) and KFR101, situated at SFR in Forsmark, Sweden. Also the reference borehole in Forsmark, HFM07 was logged.

The objective of the survey is to determine the physical properties of the rock mass around the borehole, e.g. to determine rock types and quantify the fracture frequency and localise deformation zones in the rock. Geophysical borehole logging was used to measure changes in physical properties in the borehole fluid and the bedrock surrounding the boreholes.

All boreholes were recorded from Top Of Casing (TOC). The logging in HFR101 was recorded to app. 210 m, HFR102 was recorded to app. 55 m, HFR105 was recorded to app. 200 m. KFR27 was recorded to app. 150 m and KFR101 was recorded to app. 340 m.

The logging in HFM07 was performed as a control logging, to compare logging results previously performed in the borehole, during the period of 2003 to 2007.

The present report comprises a description of the applied equipment and the performed logging program, the fieldwork, data delivery and a presentation and discussion of the results.

Composite sheets of all the processed logs are included in Appendix 1–6.

Sammanfattning

Geofysisk borrhålsloggning har genomförts i borrhålen HFR101, HFR102, HFR105, KFR27 och KFR101 vid SFR i Forsmark, samt i referensborrhålet HFM07.

Syftet med geofysisk borrhålsloggning är att bestämma bergets fysikaliska egenskaper för att bestämma bergartsfördelningen i det genomborrade bergpartiet samt att kvantifiera sprickfrekvensen och att lokalisera deformationszoner. Med geofysisk borrhålsloggning mäts bergets och borrhålsvattnets fysikaliska egenskaper i borrhålet och omgivande berg.

Den geofysiska borrhålsloggningen genomfördes i HFR101 från TOC till app. 210 m, i HFR102 från TOC till 55 m, i HFR105 från TOC till 200 m, i KFR27 från TOC till 150 m och i KFR101 från TOC till 340 m.

Den geofysiska borrhålsloggningen i HFM07 var genomförd som en kontrollmätning, för att kontrollera resultatet mot undersökningar genomförda i perioden 2003 till 2007.

Rapporten beskriver använd utrustning, genomfört loggningsprogram, fältarbete, leverans av data och en diskussion av resultatet.

Processerade loggar presenteras i Appendix 1 till 6.

Contents

1 Introduction

This document reports the results gained by the geophysical borehole logging in boreholes HFR101, HFR102, HFR105, KFR27, KFR101 and control well HFM07, which is one of the activities performed within the site investigation at SFR. The work was carried out in accordance with activity plan AP SFR-08-004. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents.

All measurements were conducted by RAMBØLL during the period July 1 to 3, 2008. All boreholes were recorded from Top Of Casing (TOC) to the bottom of the borehole. The technical data from the boreholes is shown in Table 1-2. The location of the borehole is shown in Figure 1-1.

The delivered raw and processed data have been inserted in the database of SKB (SICADA) and data are traceable by the activity plan number.

Table 1-1. Controlling documents for the performance of the activity (SKB internal controlling documents).

Activity plan	Number	Version
AP SFR-08-004 Geofysisk borrhålsloggning i HFR101, 102, 103, 104, 105 samt KFR27 och KFR101	AP SFR-08-004	1.0
Method description	**Number**	**Version**
Metodbeskrivning för geofysisk borrhålsloggning	SKB MD 221.002	3.0

Table 1-2. Technical data for boreholes HFR101, HFR102, HFR105, KFR27, KFR101 and HFM07.

Borehole Parameter	HFR101	HFR102	HFR105	KFR27	KFR101	HFM07
Co-ordinates (RT90)	6701725 1632839	6701729 1632975	6701377 1632687	6701714 1633176	6701736 1633351	6697416 1634716
Azimuth (TOC)	133.6°	85.0°	35.4°	248°	28.8°	342.3°
Inclination from horizontal (TOC)	–69.9°	–59.4°	–61.8°	–87.4°	–54.4°	–84.5°
Length [m]	209.3 m	55.0 m	200.5 m	148.50 m	341.8 m	122.5 m
Casing [m]	8.04 m	9.04 m	21.1 m	11.9 m	13.7 m	18.0 m

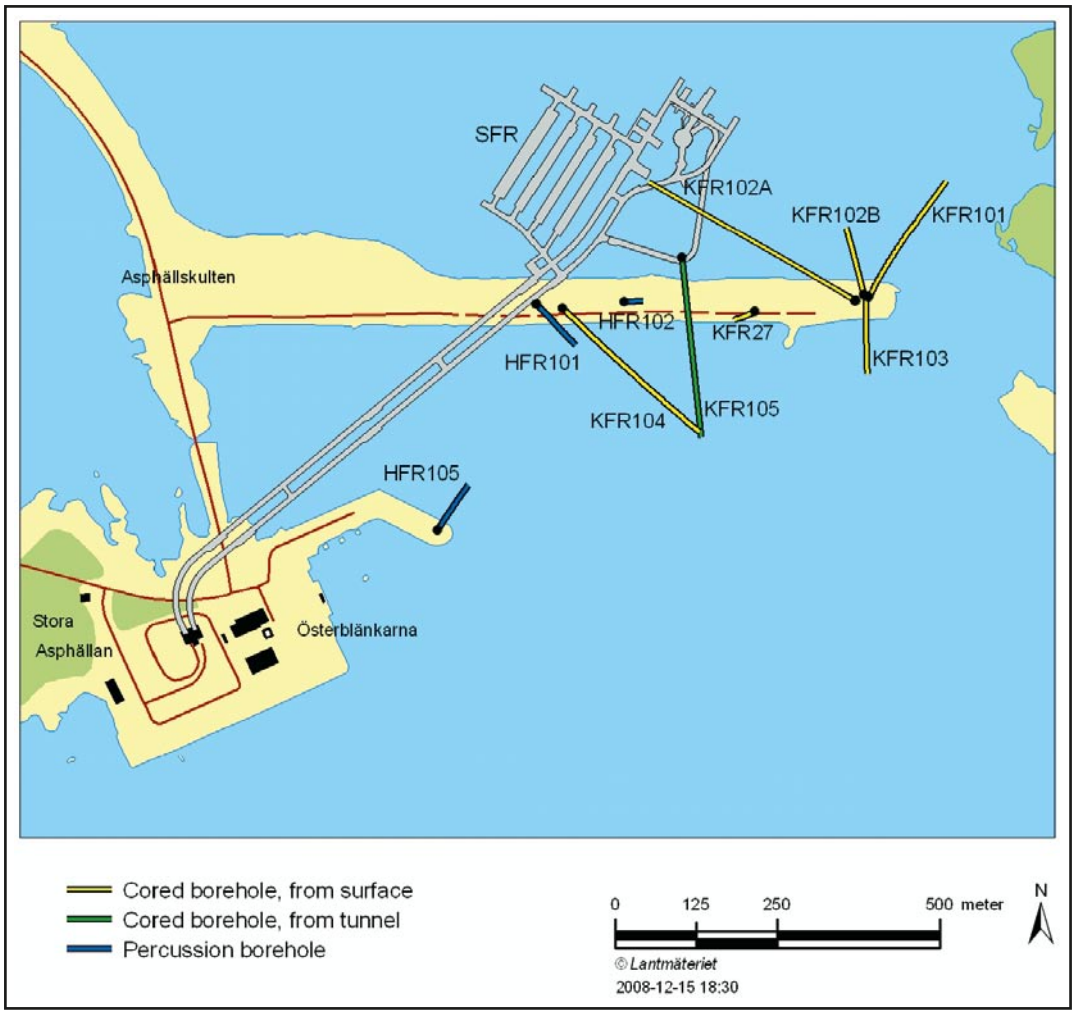


Figure 1-1. *General overview over the SFR area in Forsmark, showing the location of the percussion boreholes HFR101, HFR102 and HFR105 and the core borings KFR27 and KFR101.*

Technical data

Borehole HFR101

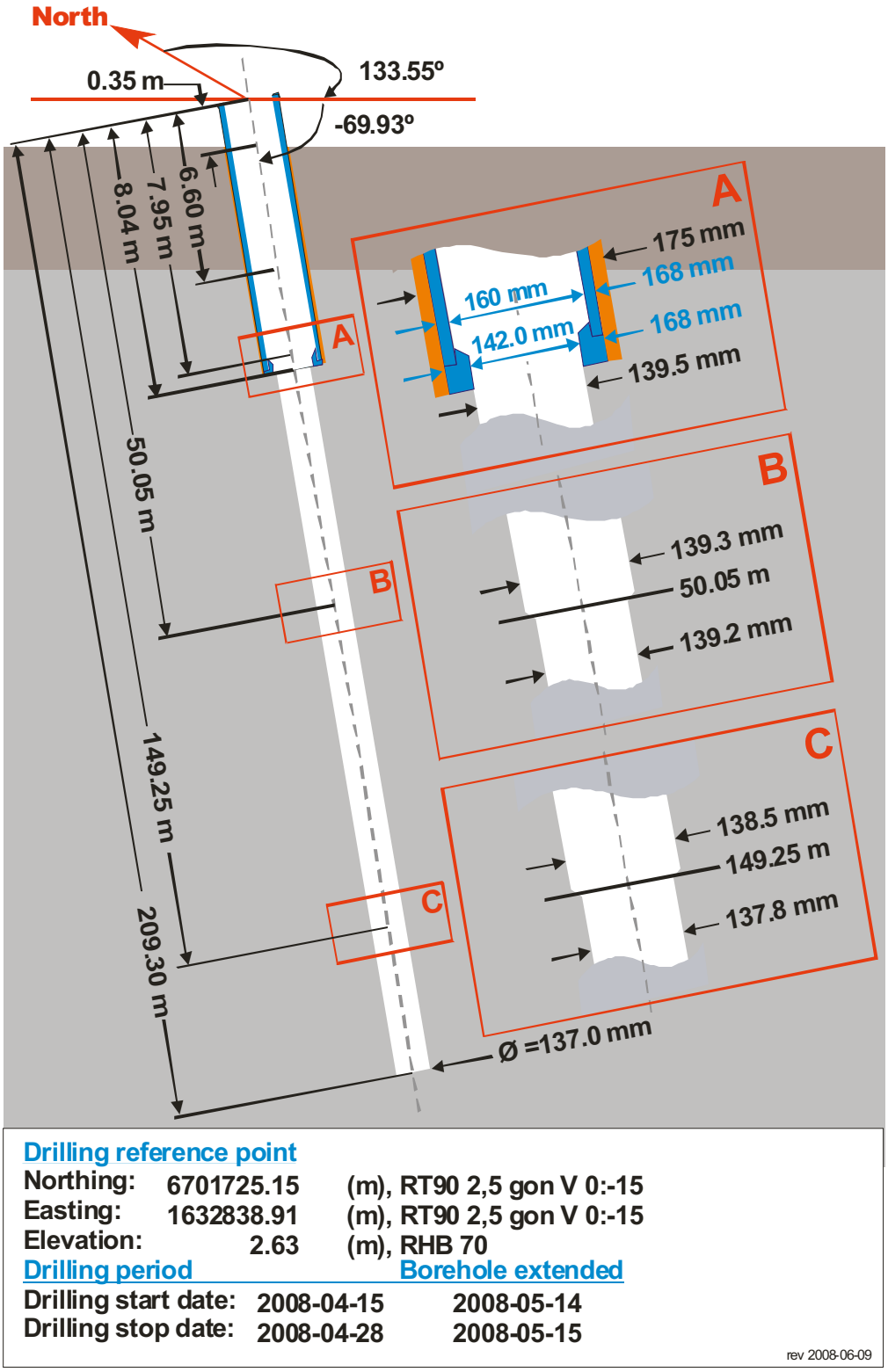
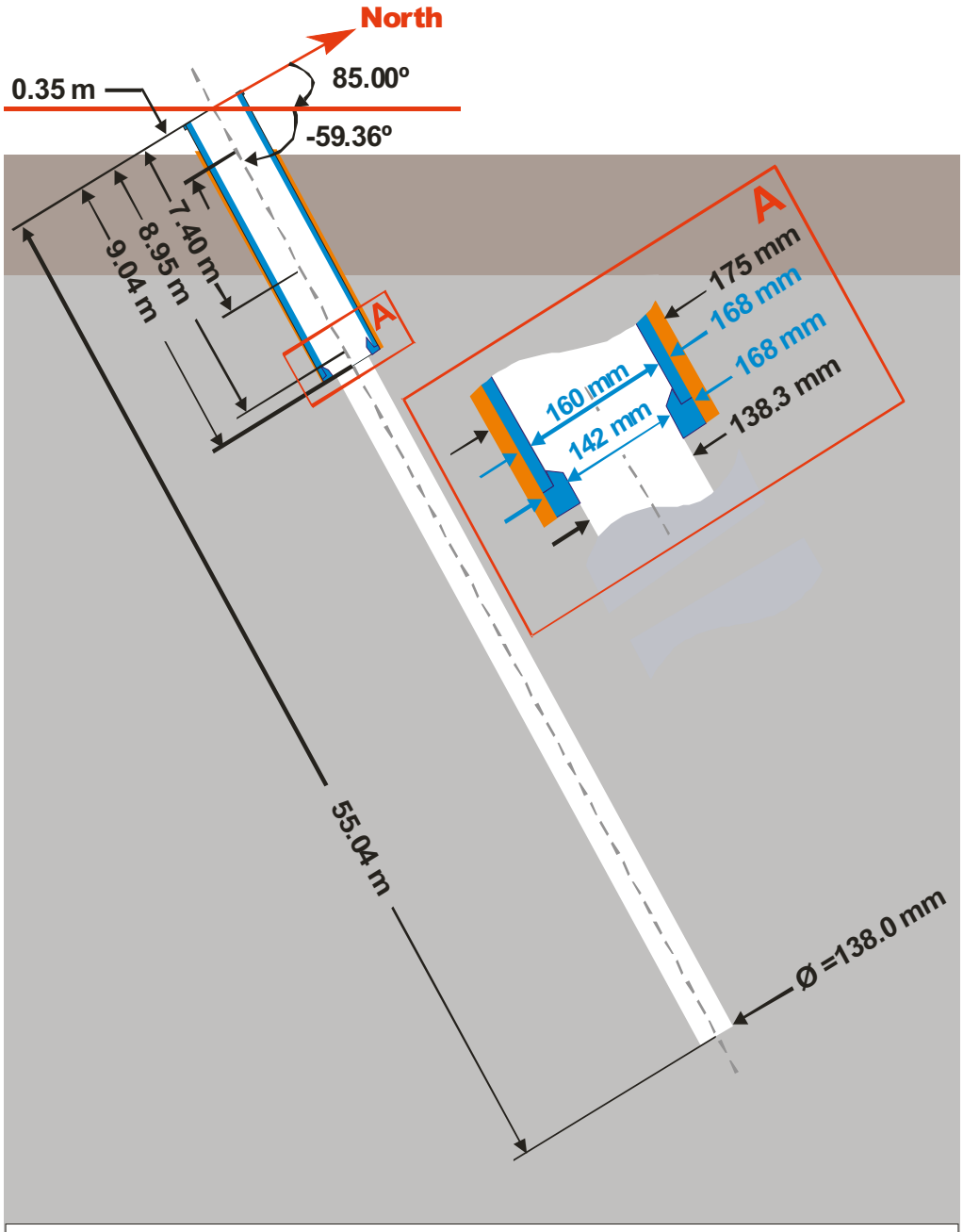


Figure 1-2. *Technical description of borehole HFR101.*

Technical data

Borehole HFR102



Drilling reference point

Northing:	6701728.55	(m), RT90 2,5 gon V 0:-15
Easting:	1632974.54	(m), RT90 2,5 gon V 0:-15
Elevation:	2.32	(m), RHB 70

Drilling period

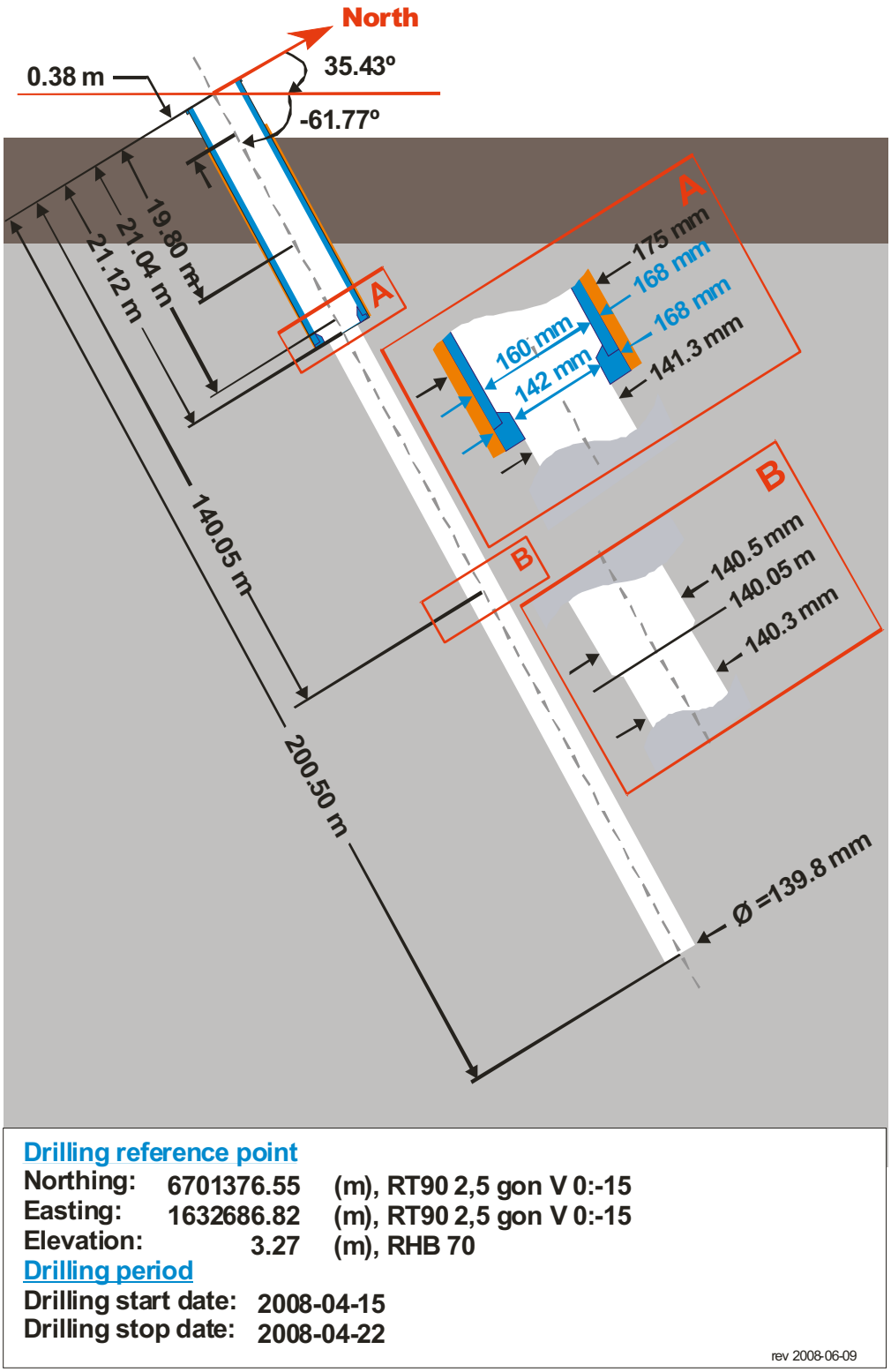
Drilling start date:	2008-04-29
Drilling stop date:	2008-05-05

rev 2008-05-13

Figure 1-3. *Technical description of borehole HFR102.*

Technical data

Borehole HFR105



Drilling reference point

Northing:	6701376.55	(m), RT90 2,5 gon V 0:-15
Easting:	1632686.82	(m), RT90 2,5 gon V 0:-15
Elevation:	3.27	(m), RHB 70

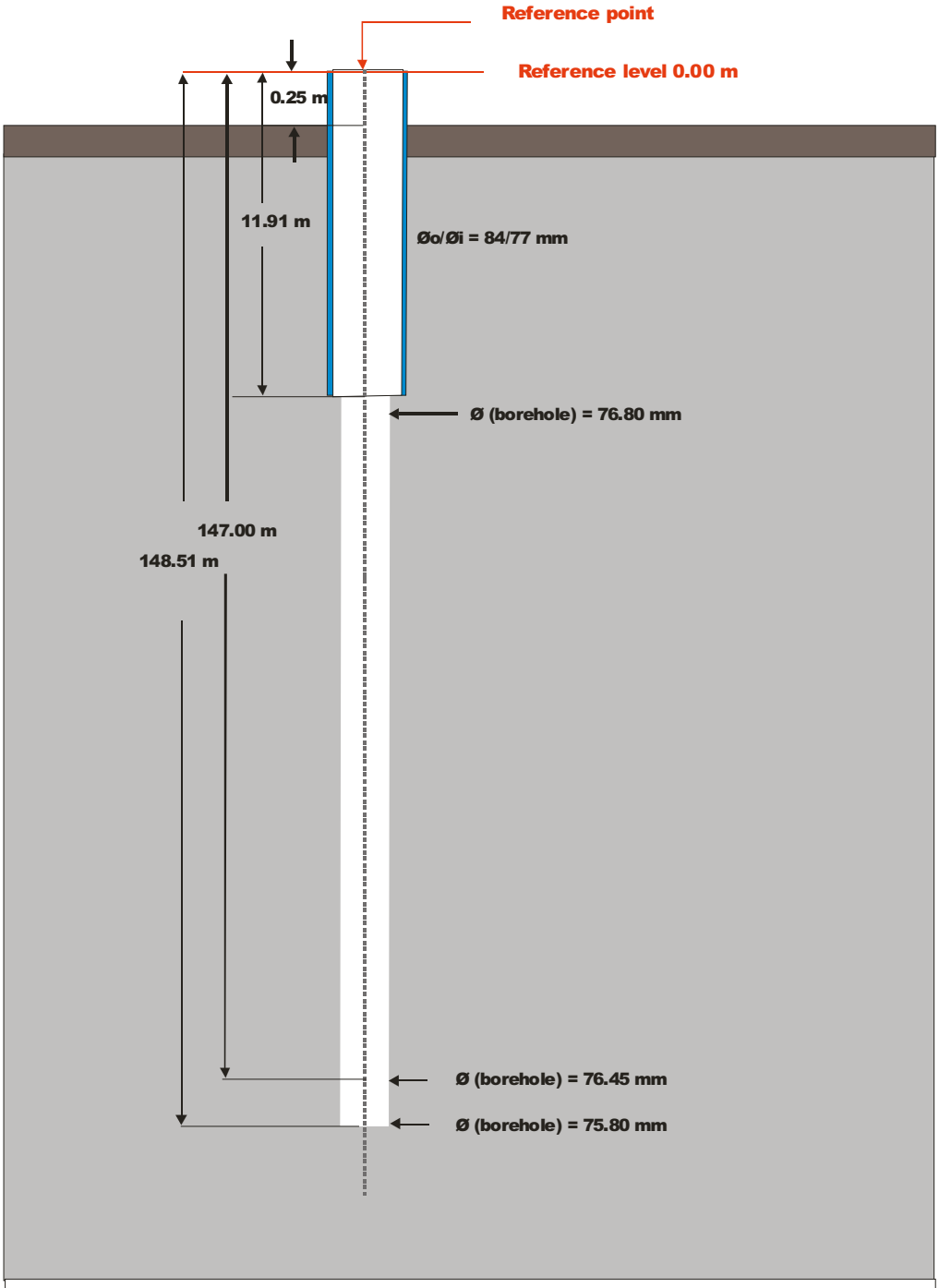
Drilling period

Drilling start date:	2008-04-15
Drilling stop date:	2008-04-22

rev 2008-06-09

Figure 1-4. *Technical description of borehole HFR105.*

Technical data
Borehole KFR27



Drilling reference point

Northing:	6701714.42 (m), RT90 2,5 gon V 0:-15
Easting:	1633175.52 (m), RT90 2,5 gon V 0:-15
Elevation:	2.87 (m), RHB 70

Orientation

Bearing (degrees):	248.20°
Inclination (degrees):	-87.42°

Borehole

Length:	148.51m

Core drilling period

Drilling start date:	1981-08-06
Drilling stop date:	1981-09-10

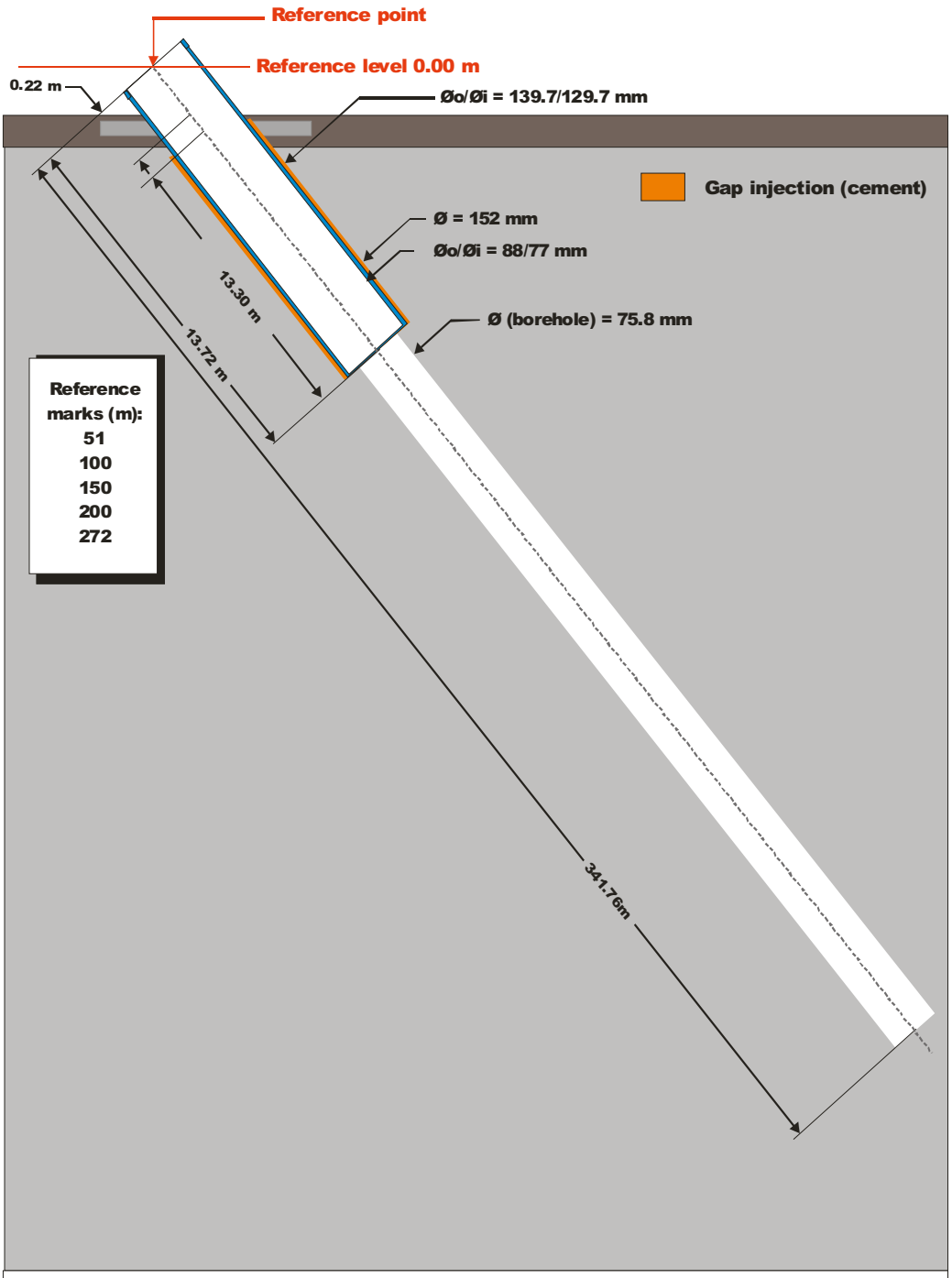
Extended core drilling period

Drilling start date:	2008-06-02
Drilling stop date:	2008-06-10

Rev. 2008-08-06

Figure 1-5. Technical description of borehole KFR27.

Technical data-prel
Borehole KFR101



Drilling reference point

Northing:	6701736.32 (m), RT90 2,5 gon V 0:-15
Easting:	1633351.40 (m), RT90 2,5 gon V 0:-15
Elevation:	2.44 (m), RHB 70

Orientation

Bearing (degrees):	28.77°
Inclination (degrees):	-54.44°

Borehole

Length:	341.76 m

Percussion drilling period

Drilling start date:	2008-05-05
Drilling stop date:	2008-05-06

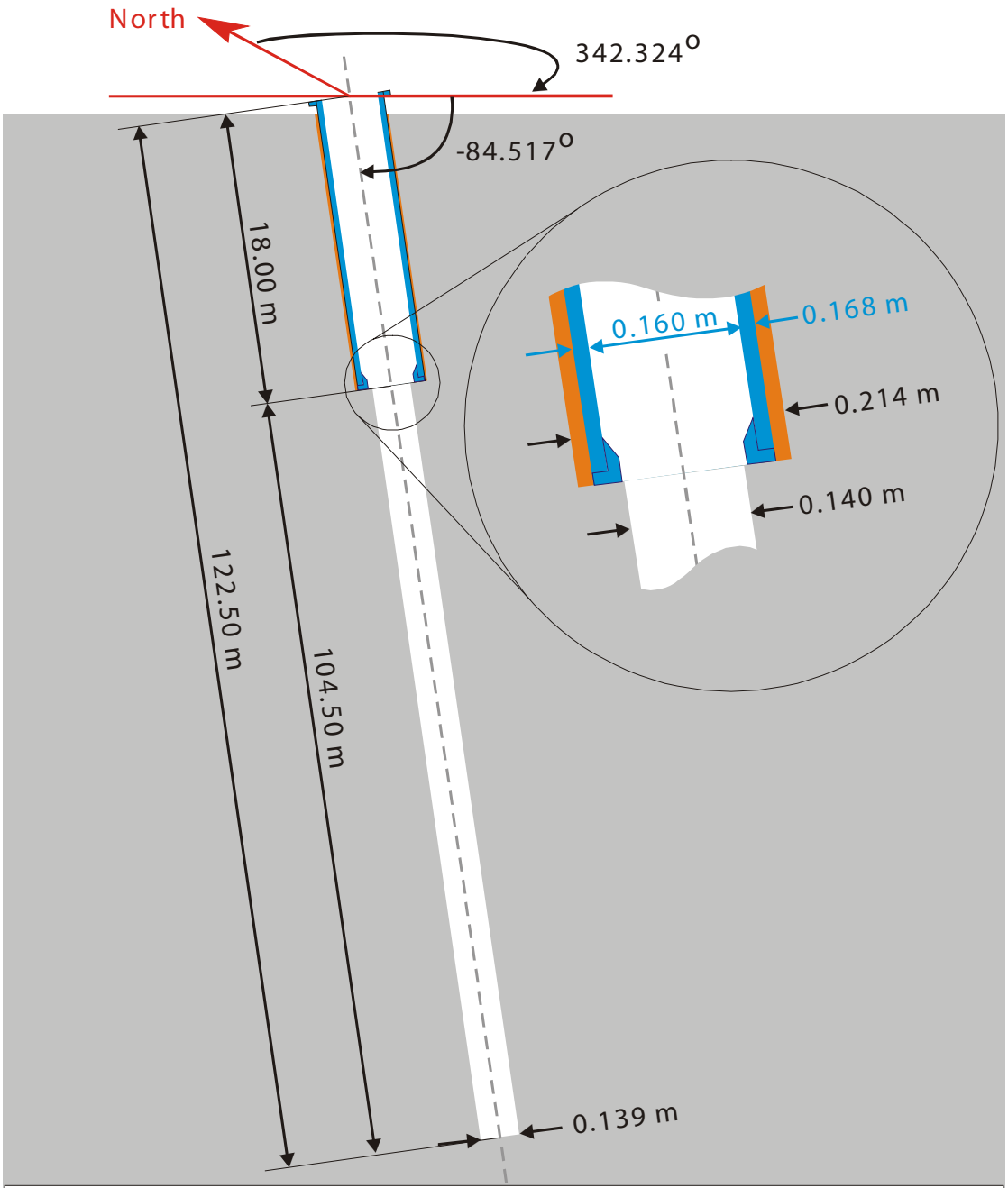
Core drilling period

Drilling start date:	2008-06-12
Drilling stop date:	2008-07-02

Rev. 2008-07-04

Figure 1-6. Technical description of borehole KFR101.

Technical data
Borehole HFM 07



Drilling reference point	
Northing:	6697416.248 (m), RT90 2,5 gon V 0:-15
Easting:	1634715.687 (m), RT90 2,5 gon V 0:-15
Elevation:	5.781 (m), RHB 70
Drilling period	
Drilling start date:	2003-01-16
Drilling stop date:	2003-01-28

Figure 1-7. *Technical description of borehole HFM07.*

2 Objective and scope

The objective of the survey is to both receive information of the borehole itself, and from the rock mass around the borehole. Geophysical borehole logging was used to measure changes in physical properties in the borehole fluid and the bedrock surrounding the boreholes.

This field report describes the equipment used as well as the measurement procedures. Geophysical borehole logging data is presented in graphs as a function of borehole length on drawings shown in Table 2-1.

Table 2-1. Appendix and drawing no.

Borehole	Drawing no.	Appendix
HFR101	1.1	1
HFR102	2.1	2
HFR105	3.1	3
KFR27	4.1	4
KFR101	5.1	5
HFM07	6.1	6

3 Equipment

The geophysical borehole logging program were performed with 5 multi tool probes and resulted in a suite of 15 log types, listed in Table 5-1. The tools and recorded logs are listed in Table 3-1.

Table 3-1. Logging tools and logs recorded.

Tool	Recorded logs	Dimension	Source detector spacing and type	Tool position in borehole
Century 8622 Magnetic susceptibility.	Magnetic susceptibility, natural gamma.	203 · 4.1 cm		
Century 9042 Fluid temperatur and fluid resistivity	Fluid temperatur, fluid resistivity and natural gamma.	137 · 4.1 cm		
Century 9072 3 m focused guard.	3 m focused guard log resistivity and natural gamma.	310 · 6.4 cm		
Century 9139 Compensated gamma density.	Compensated Gamma density, natural gamma, 140 cm focused guard log resistivity, 1-arm caliper.	380.3 · 5.6 cm	20.3 cm 125 m 200 mCi Cs137	Sidewall. Gamma source focused.
RG 25 112 000 HiRAT. Acoustic televiewer.	Full waveform acoustic amplitude and travel-time, 360° orientated acoustic image, 360° very high resolution caliper, borehole azimuth and dip and natural gamma.	246 · 4 cm		Centralized.

4 Execution

4.1 General

In general the measurement procedures follow the SKB method description (MD 221.002, SKB internal controlling document). The logging program was executed in the period July 1 to 3, 2008. All relevant logging events are described in the daily report sheets delivered to Sicada and are traceable by the activity plan number.

The fluid resistivity and temperature logs are recorded in downward direction, as the first log run. All other log types are recorded running the tool in upward direction in the borehole.

The applied logging equipment was calibrated and cleaned before arriving at the site according to SKB cleaning level 2 (SKB internal controlling document SKB MD 600.004). Furthermore, all equipment was wiped with alcohol before it was lowered into the borehole.

For control, each log run is normally recorded both in down and in upward direction using the down run as a repeat section. For logging tool 9139 recording a repeat section in upward direction controls the data. The length of the probe in the borehole is shown on both the recording computer and the winch. On the winch the tension of the cable is also shown. The winch will automatically stop, if the tension changes rapidly. The tension was recorded on all log runs using Century equipment, except tool 9310.

All data was recorded with max.10 cm sample interval. The speed of the logging for the 9139 tool was 5 m/min, for the 8622 tool 20 m/min and for all other tools 10 m/min, except for the HiRAT Acoustic tool in borehole where the speed was 2 m/min.

4.2 Nonconformities

The logging has been performed in accordance with the activity plan AP SFR-08-004 with no nonconformities.

5 Results

5.1 Presentation

All relevant logging events were described in the daily report sheets, which were delivered separately.

Logs presented in drawing no. 1.1 are presented in Table 5-1.

5.2 Orientation, alignment and stretch of logs

5.2.1 Orientation of images

The orientation of the results from the HiRAT Acoustic tool, are processed in the tool while recording, using the magnetometers and accelerometers in the tool.

5.2.2 Overlapping data

If the log data from one probe have been recorded in more than one file, the files are merged using events in both files. Overlapping in data is always used from the topmost-recorded file (overlapping data are never the mean value from two log runs).

5.2.3 Alignment of data

In order to obtain an exact length calibration, the length calibration marks by grove milling are used. In boreholes without calibration marks, gamma events in the top and the bottom of the borehole are used. The connection between the length calibration marks and the logs is obtained from the HiRAT Acoustic tool. The lengths from the track marks and from the HiRAT tool are used to create a new length scale in WellCAD. All log files are shifted using the new length scale.

Table 5-1. Logs presented in drawings no. 1.1 in Appendices 1.

Log	Log name short	Unit	Tool
Fluid temperature	TEMP(FL)	Deg C	9042
Fluid resistivity	RES(FL)	Ohm-m	9042
Magnetic susceptibility	MAGSUSCEP	SI · 10^{-5}	8622
Caliper, 1-arm	CALIPER1	mm	9139
Gamma-gamma density	DENSITY	kg/m^3	9139
Focused guard log resistivity, 128 cm	RES(SG)	Ohm-m	9139
Natural gamma	GAM(NAT)	µR/h	9072
Natural gamma	GAM(NAT)	µR/h	HIRAT
Focused guard log resistivity, 300 cm	RES(DG)	Ohm-m	9072
Caliper, high resolution. 360°	CALIPER 3D	mm	HiRAT
High resolution 1D Caliper	CALIPER MEAN	mm	HiRAT
Borehole azimuth magnetic north	AZIMUTH MN	Deg	HIRAT
Borehole inclination from horizontal	DIP	Deg	HIRAT
360° orientated acoustic travel time	TRAVEL TIME	100 ns	HiRAT
360° orientated acoustic travel time	AMPLITUDE	–	HiRAT

5.2.4 Stretch of logs

There is a minor difference in the length registration between up- and down runs for the used winch. The size of the defect is about 1.5 m/km. To compensate for this the logs are stretched using another new length scale for each tool. The length scale is made by using gamma events from the tool compared with the same gamma events from the HiRAT tool. The events in both files are matched, and the new length scale is made and added to the log. The bottom of the borehole is considered in stretching the logs in case that no data will occur below the bottom of the borehole.

5.2.5 Removing of data

The processing of the data includes removing of spikes, negative and unrealistic values and data in the casing.

5.3 Calculated log curves

The different logs are calculated as described in Table 5-2.

5.4 Borehole HFR101

Using the natural gamma from the 9042 as reference, the natural gamma logs from the other probes are aligned to the same borehole length. A new borehole length scale is added to each log and afterwards the logs are stretched using different gamma events.

The complete log suite for borehole HFR101 is presented as composite log sheet in drawing no. 1.1 in Appendix 1. The logs presented in drawing no. 1.1 are listed in Table 5-1.

Table 5-2. Calculated log curves.

Log	Description of log calculation
Caliper, 1-arm	The Caliper was converted from [cm] to [mm] units by multiplying [cm] with 10.
Gamma-gamma density	The Gamma-gamma was converted from [g/cm^3] to [kg/m^3] units by multiplying with 1,000.
Focused guard log resistivity, 128 cm	–
Natural gamma	The natural gamma log was converted from CPS to µR/h by multiplying the constant 0.077. This constant was computed from the logs previously performed in borehole KLX02 located in Oskarshamn.
Fluid temperature	–
Fluid resistivity	–
Focused guard log resistivity, 300 cm	–
Magnetic susceptibility	The magnetic susceptibility was converted from CGS units to SI units by multiplying the CGS value by 4π.
Caliper, high resolution 360° CALIPER 3D	The Caliper 3D is calculated using the acoustic travel time and the velocity in the borehole fluid. The velocity in the fluid is calculated using the fluid temperature and fluid conductivity.
High resolution 1D Caliper CALIPER MEAN	The Caliper mean is calculated using the mean travel time from the acoustic televiewer, the fluid temperature, fluid velocity and the internal travel time in the acoustic televiewer.
360° orientated acoustic travel time	–
360° orientated acoustic amplitude	–

5.5 Borehole HFR102

Using the natural gamma from the 9042 as reference, the natural gamma logs from the other probes are aligned to the same borehole length. A new borehole length scale is added to each log and afterwards the logs are stretched using different gamma events.

The complete log suite for borehole HFR102 is presented as composite log sheet in drawing no. 2.1 in Appendix 2. The logs presented in drawing no. 2.1 are listed in Table 5-1.

5.6 Borehole HFR105

Using the natural gamma from the 9042 as reference, the natural gamma logs from the other probes are aligned to the same borehole length. A new borehole length scale is added to each log and afterwards the logs are stretched using different gamma events.

The complete log suite for borehole HFR105 is presented as composite log sheet in drawing no. 3.1 in Appendix 3. The logs presented in drawing no. 3.1 are listed in Table 5-1.

5.7 Borehole KFR27

Using the natural gamma from the 9042 as reference, the natural gamma logs from the other probes are aligned to the same borehole length. A new borehole length scale is added to each log and afterwards the logs are stretched using different gamma events.

The complete log suite for borehole KFR27 is presented as composite log sheet in drawing no. 4.1 in Appendix 4. The logs presented in drawing no. 4.1 are listed in Table 5-1.

5.8 Borehole KFR101

In order to obtain an exact length calibration in borehole KFR101, the reference track marks made while drilling are used. The correlation between the track marks and the logs is obtained from the HiRAT Acoustic tool.

The reference track marks in the borehole and the recorded track marks from the HiRAT are observed in the following borehole lengths, Table 5-3.

Table 5-3. The reference track marks in the borehole and the recorded track marks form the HiRAT in borehole KFR101.

To compensate for the difference between the reference track marks and the recorded track marks the logs are stretched. The result from the stretching is a new borehole length scale. The new borehole length scale is applied to the HiRAT file. In this way a perfect match between given length of the reference marks and the recorded data is obtained. By means of alignment of the observed gamma events in KFR101, between all log runs, the obtained reference mark correlation is transferred to the other logs.

The complete log suite for borehole KFR101is presented as composite log sheets in drawing 5.1 in Appendix 5. The logs presented in drawing no. 5.1 are listed in Table 5-1.

5.9 Borehole HFM07

Using the natural gamma from the 9042 as reference, the natural gamma logs from the other probes are aligned to the same borehole length. A new length scale is added to each log and afterwards the logs are stretched using different gamma events.

The complete log suite for borehole HFM07 is presented as composite log sheet in drawing no. 6.1 in Appendix 6. The logs presented in drawing no. 6.1 are listed in Table 5-1.

6 Data delivery

Geophysical logging data from the measurements, recorded in Century and Robertson format, were delivered directly after the termination of the field activities. The recorded data files used in the processing have also been delivered in WellCAD format, Table 6-1.

The delivered data have been inserted in the database (SICADA) of SKB and are traceable by the activity plan number.

The processed files shown on the drawings have been delivered in WellCAD, Table 6-2, and as excel files (one for each borehole) in SICADA format, Table 6-3.

Table 6-1. Recorded log files in Century or Robertson format used for processing.

Borehole	Probe	Log direction	WellCAD File	Description
HFR101	8622	Up	HFR101_07-01-08_17-37_8622C_.10_-0.10_210.00_ORIG.log	Start Depth: 210 m. End Depth: –0.1 m.
HFR101	9042	Down	HFR101_07-01-08_16-50_9042C_.10_0.20_210.50_ORIG.log	Start Depth: 0.2 m. End Depth: 210.5 m.
HFR101	9072	Up	HFR101_07-01-08_17-59_9072C_.10_0.50_207.70_ORIG.log	Start Depth: 207.7 m. End Depth: 0.5 m.
HFR101	9139	Up	HFR101_07-02-08_09-10_9139A_.10_0.40_207.30_ORIG.log	Start Depth: 207.3 m. End Depth: 0.4 m.
HFR101	9310	Up	HFR101_07-02-08_08-34_9310C2_.10_0.60_206.60_ORIG.log	Start Depth: 206.6 m. End Depth: 0.6 m.
HFR101	HiRAT	Up	HFR101_Hirat_180pixels_2mm_agc_up_run2.HED	Start Depth: 207 m. End Depth: 0 m.
HFR102	8622	Up	HFR102_07-02-08_11-10_8622C_.10_0.20_54.30_ORIG.log	Start Depth: 54.3 m. End Depth: 0.2 m.
HFR102	9042	Down	HFR102_07-02-08_10-31_9042C_.10_0.20_55.00_ORIG.log	Start Depth: 0.2 m. End Depth: 55 m.
HFR102	9072	Up	HFR102_07-02-08_10-56_9072C_.10_0.30_54.60_ORIG.log	Start Depth: 54.6 m. End Depth: 0.3 m.
HFR102	9139	Up	HFR102_07-02-08_11-46_9139A_.10_0.30_54.70_ORIG.log	Start Depth: 54.7 m. End Depth: 0.3 m.
HFR102	9310	Up	HFR102_07-02-08_11-30_9310C2_.10_0.30_54.20_ORIG.log	Start Depth: 54.2 m. End Depth: 0.3 m.
HFR102	HiRAT	Up	HFR102_Hirat_180pixels_2mm_agc_up_run2.HED	Start Depth: 55 m. End Depth: 0 m.
HFR105	8622	Up	HFR105_07-01-08_11-28_8622C_.1_0.10_199.50_ORIG.log	Start Depth: 199.5 m. End Depth: 0.1 m.
HFR105	9042	Down	HFR105_07-01-08_10-41_9042C_.01_0.22_199.84_ORIG.log	Start Depth: 0.22 m. End Depth: 199.84 m.
HFR105	9072	Up	HFR105_07-01-08_11-54_9072C_.1_0.20_200.70_ORIG.log	Start Depth: 200.7 m. End Depth: 0.2 m.
HFR105	9139	Up	HFR105_07-01-08_13-25_9139_.10_-0.50_198.80_ORIG.log	Start Depth: 198.8 m. End Depth: –0.5 m.
HFR105	9310	Up	HFR105_07-01-08_12-34_9310C2_.10_0.10_198.70_ORIG.log	Start Depth: 198.7 m. End Depth: 0.1 m.
HFR105	HiRAT	Up	HFR105_Hirat_180pixels_2mm_agc_up_run2.HED	Start Depth: 198 m. End Depth: 0 m.
KFR27	8622	Up	KFR27_07-02-08_13-53_8622C_.10_0.50_147.00_ORIG.log	Start Depth: 147 m. End Depth: 0.5 m.
KFR27	9042	Down	KFR27_07-02-08_13-20_9042C_.10_0.20_147.80_ORIG.log	Start Depth: 0.2 m. End Depth: 147.8 m.
KFR27	9072	Up	KFR27_07-02-08_14-12_9072C_.10_0.30_146.10_ORIG.log	Start Depth: 146.1 m. End Depth: 0.3 m.
KFR27	9139	Up	KFR27_07-02-08_15-24_9139A_.10_-1.10_145.70_ORIG.log	Start Depth: 145.7 m. End Depth: –1.1 m.
KFR27	9310	Up	KFR27_07-02-08_14-43_9310A2_.10_2.20_144.70_ORIG.log	Start Depth: 144.7 m. End Depth: 2.2 m.
KFR27	HiRAT	Up	KFR27_HiRAT_120pixels_up_unaligned_run4.HED	Start Depth: 146 m. End Depth: 0 m.

Borehole	Probe	Log direction	WellCAD File	Description
KFR101	8622	Up	KFR101_07-03-08_08-37_8622C_.10_-1.70_337.00_ORIG.log	Start Depth: 337 m. End Depth: –1.7 m.
KFR101	9042	Down	KFR101_07-03-08_08-56_9042C_.10_0.20_338.30_ORIG.log	Start Depth: 0.2 m. End Depth: 338.3 m.
KFR101	9072	Up	KFR101_07-03-08_09-45_9072C_.10_-0.80_336.80_ORIG.log	Start Depth: 336.8 m. End Depth: –0.8 m.
KFR101	9139	Up	KFR101_07-03-08_11-48_9139A_.10_-1.10_336.30_ORIG.log	Start Depth: 336.3 m. End Depth: –1.1 m.
KFR101	9310	Up	KFR101_07-03-08_10-43_9310C2_.10_-1.20_334.40_ORIG.log	Start Depth: 334.4 m. End Depth: –1.2 m.
KFR101	HiRAT	Up	KFR101_HiRAT_120pixels_up_unaligned_run.HED	Start Depth: 336 m. End Depth: 0 m.
HFM07	8622	Up	HFM07_07-02-08_18-58_8622C_.10_0.10_121.10_ORIG.log	Start Depth: 121.1 m. End Depth: 0.1 m.
HFM07	9042	Down	HFM07_07-02-08_18-31_9042C_.10_0.20_120.80_ORIG.log	Start Depth: 0.2 m. End Depth: 120.8 m.
HFM07	9072	Up	HFM07_07-02-08_19-13_9072C_.10_-0.30_120.20_ORIG.log	Start Depth: 120.2 m. End Depth: –0.3 m.
HFM07	9139	Up	HFM07_07-02-08_19-39_9139A_.10_7.30_120.40_ORIG.log	Start Depth: 120.4 m. End Depth: 7.3 m.

Table 6-2. Drawing files in WellCad format.

Borehole	Drawing	WellCad file
HFR101	1.1	HFR101_Presentation.WCL
HFR102	2.1	HFR102_Presentation.WCL
HFR105	3.1	HFR105_Presentation.WCL
KFR27	4.1	KFR27_Presentation.WCL
KFR101	5.1	KFR101_Presentation.WCL
HFM07	6.1	HFM07_Presentation.WCL

Table 6-3. Data files in SICADA format.

Sheet	Comment
“Borehole”_CALIPER1_GP040 – Caliper logging.xls	
“Borehole”_CALIPER MEAN_GP041 – 3-D caliper.xls	
“Borehole”_TEMP(FL)_RES(FL)_GP060 – Fluid temperature and resistivity logging.xls	
“Borehole”_DENSITY_GP090 – Density logging.xls	
“Borehole”_MAGSUSCEP_GP110 – Magnetic susceptibility logging.xls	
“Borehole”_GAM(NAT)_GP120 – Natural gamma logging.xls	
“Borehole”_RES(SG)_GP159 – Resistivity, focused 128 cm.xls	
“Borehole”_RES(DG)_GP162 – Resistivity, focused 300 cm.xls	
“Borehole”_GP830 – Acoustic televiewer.xls	

Borehole No. HFR101

Co-ordinates in RT90 2,5 gon V 0:-15

Northing: 6701725.15 m Easting: 1632838.91 m Elevation: 2.63 m. RHB70

Diameter:	137 - 139.5 mm
Reaming Diameter:	-
Outer Casing:	168 mm
Inner Casing:	160 mm
Casing Length:	8.04 m
Borehole Length:	209.3 m
Cone:	
Inclination at ground surface:	-69.93°
Azimuth:	133.55° GN
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9139	mm
DENSITY	Compensated gamma-gamma density	9139	kg/m³
RES(SG)	Focused guard log resistivity, 128 cm	9139	ohm-m
GAM(NAT)	Natural gamma	9072	µR/h
TEMP(FL)	Fluid temperature	9042	deg C
RES(FL)	Fluid resistivity	9042	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9310	m/s
AMP(N)	Full wave form, near receiver	9310	µs
AMP(F)	Full wave form, far receiver	9310	µs
MAGSUSCEP	Magnetic susceptibility	8622	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT	deg
DIP	Borehole inclination from horizontal	HiRAT	deg
RADIUS	360 degrees orientated acoustic radius	HiRAT	mm
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent
RES(16N)	Normal resistivity 16 inch	8144	ohm-m
RES(64N)	Normal resistivity 64 inch	8144	ohm-m
LATERAL	Lateral resistivity	8144	ohm-m
SPR	Single point resistivity	8144	ohm
SP	Self Potential	8144	V

Rev.	Date	Drawn by	Control	Approved
1	2008-12-10	JRI	UTN	UTN

Job 547310A

Scale 1:500

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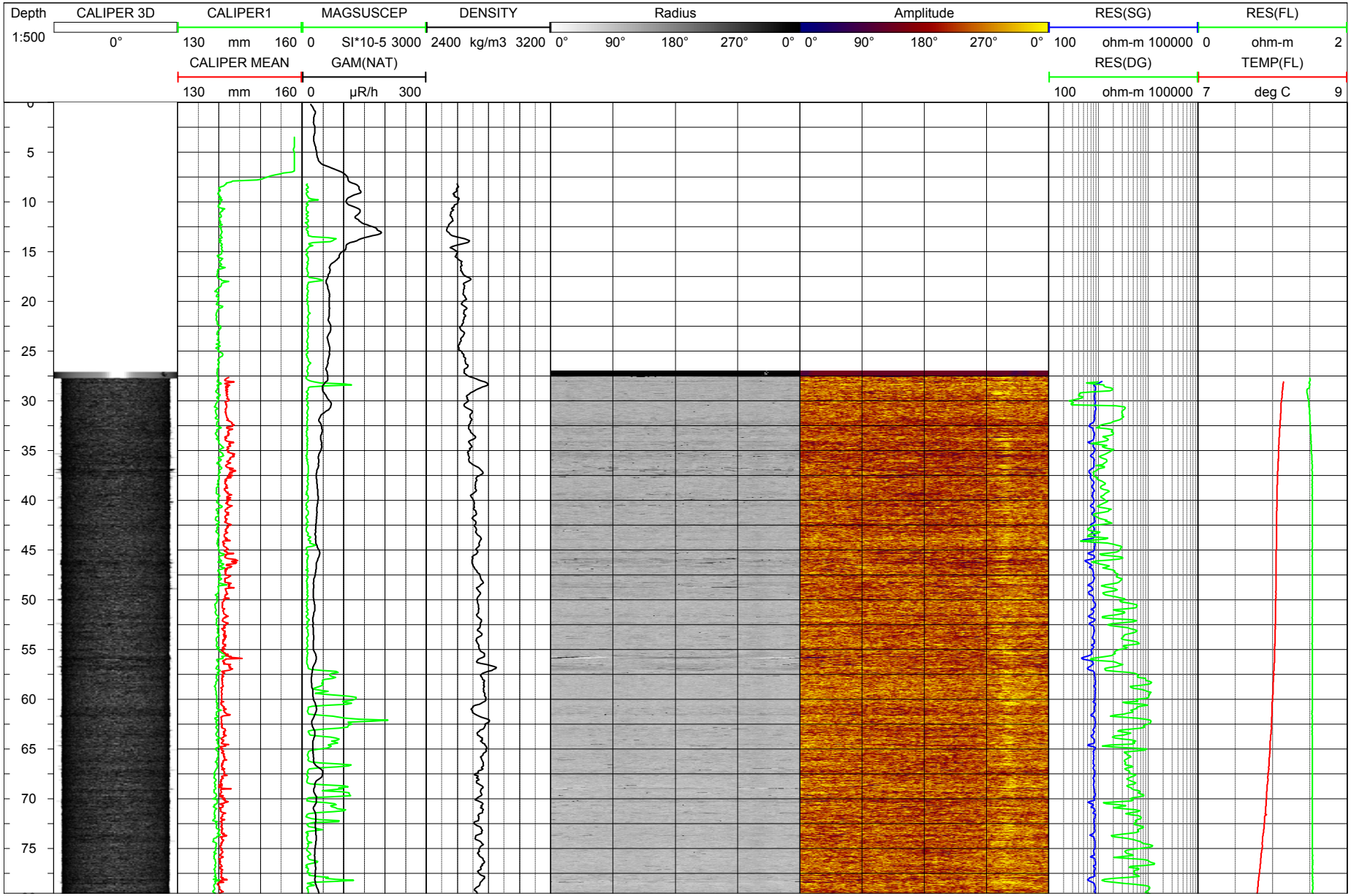
SKB geophysical borehole logging
Borehole HFR101

Presentation

Filename: HFR101_Presentation.wcl

Drawing no.: **1.1**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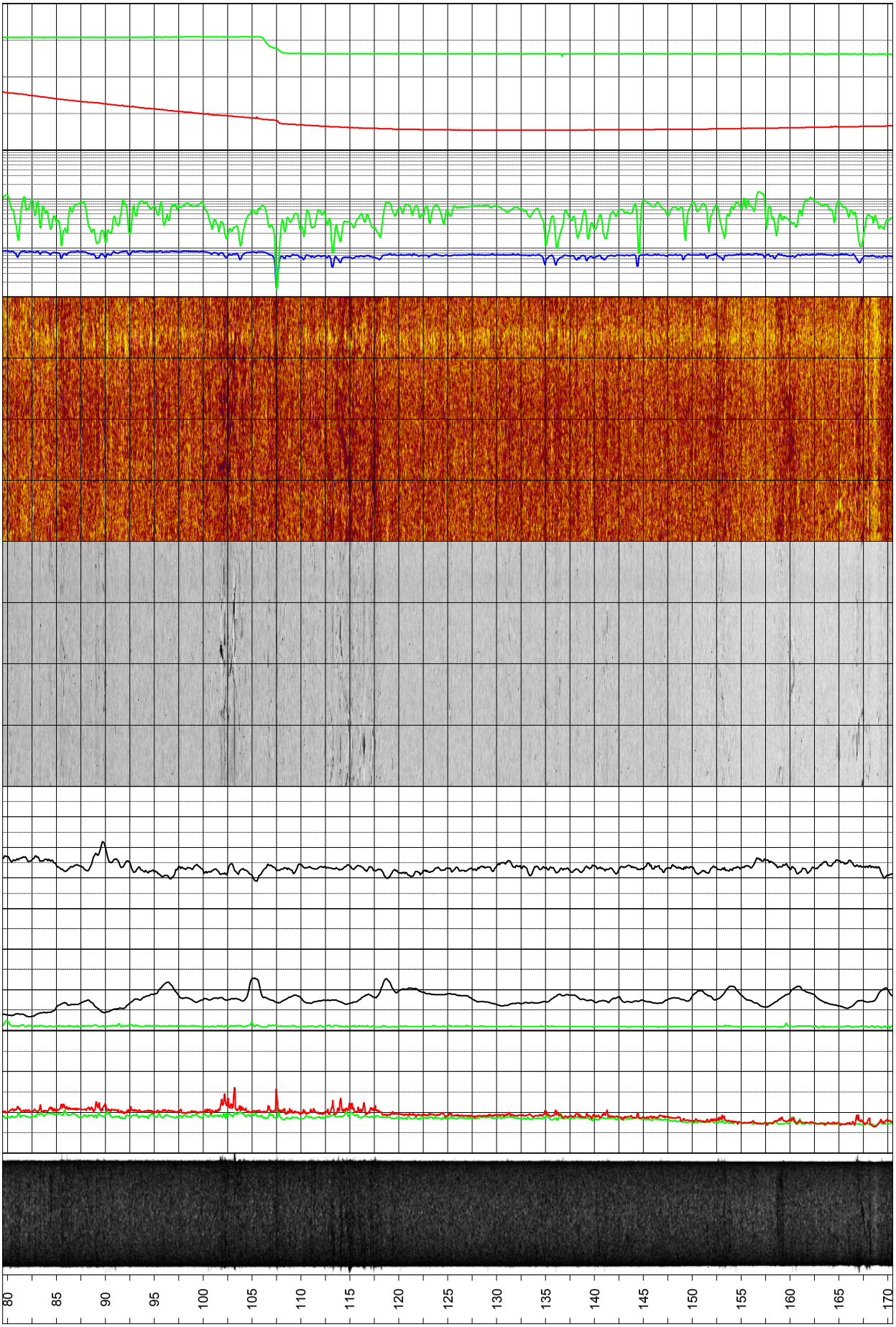
0°
CALIPER1
130 mm 160
CALIPER MEAN
130 mm 160
MAGSUSCEP
0 SI*10-5 3000
GAM(NAT)
0 µR/h 300
DENSITY
2400 kg/m3 3200
Radius
0° 90° 180° 270° 0°
Amplitude
0° 90° 180° 270° 0°
RES(SG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
RES(FL)
0 ohm-m 2
TEMP(FL)
7 deg C 9
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75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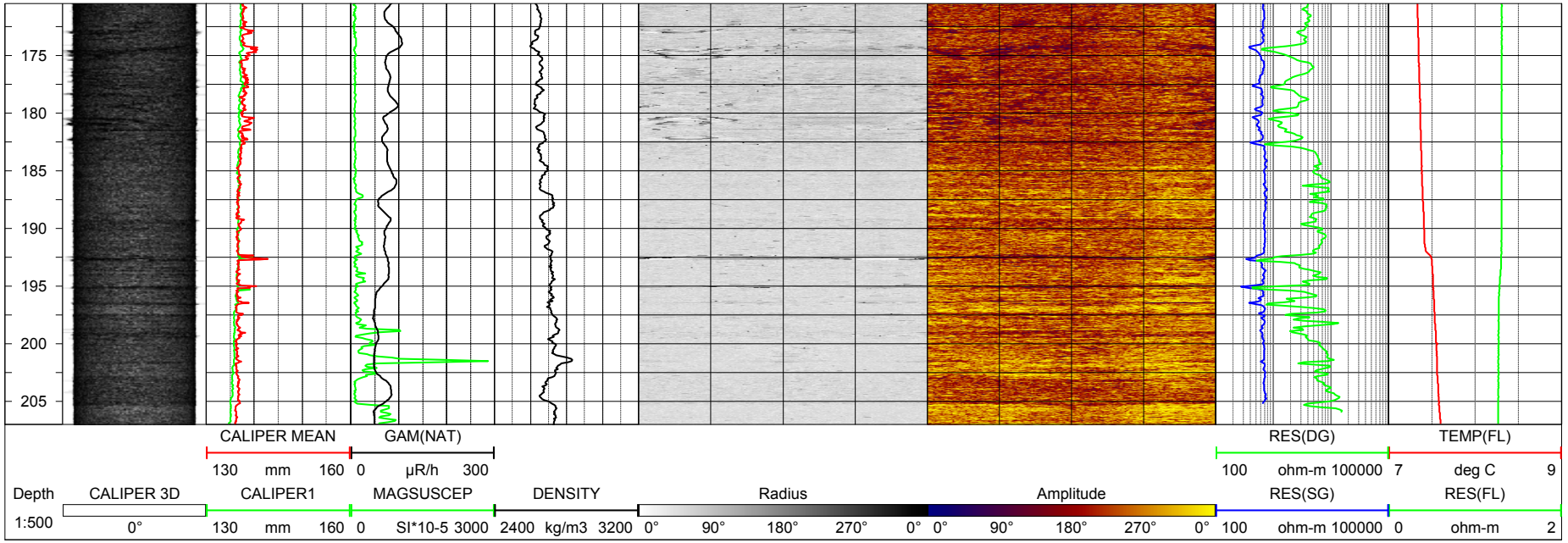
175
180
185
190
195
200
205
CALIPER MEAN
GAM(NAT)
RES(DG)
TEMP(FL)
130 mm 160
0 µR/h 300
100 ohm-m 100000
7 deg C 9
Depth
CALIPER 3D
CALIPER1
MAGSUSCEP
DENSITY
Radius
Amplitude
RES(SG)
RES(FL)
1:500
0°
130 mm 160
0 SI*10-5 3000
2400 kg/m3 3200
0° 90° 180° 270° 0°
0° 90° 180° 270° 0°
100 ohm-m 100000
0 ohm-m 2

Borehole No. HFR102

Co-ordinates in RT90 2,5 gon V 0:-15

Northing: 6701728.55 m Easting: 1632974.54 m Elevation: 2.32 m. RHB70

Diameter:	138 - 138.3 mm
Reaming Diameter:	-
Outer Casing:	168 mm
Inner Casing:	160 mm
Casing Length:	9.04 m
Borehole Length:	55.04 m
Cone:	
Inclination at ground surface:	-59.36°
Azimuth:	85.00° GN
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9139	mm
DENSITY	Compensated gamma-gamma density	9139	kg/m³
RES(SG)	Focused guard log resistivity, 128 cm	9139	ohm-m
GAM(NAT)	Natural gamma	9072	µR/h
TEMP(FL)	Fluid temperature	9042	deg C
RES(FL)	Fluid resistivity	9042	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9310	m/s
AMP(N)	Full wave form, near receiver	9310	µs
AMP(F)	Full wave form, far receiver	9310	µs
MAGSUSCEP	Magnetic susceptibility	8622	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT	deg
DIP	Borehole inclination from horizontal	HiRAT	deg
RADIUS	360 degrees orientated acoustic radius	HiRAT	mm
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent
RES(16N)	Normal resistivity 16 inch	8144	ohm-m
RES(64N)	Normal resistivity 64 inch	8144	ohm-m
LATERAL	Lateral resistivity	8144	ohm-m
SPR	Single point resistivity	8144	ohm
SP	Self Potential	8144	V

Rev.	Date	Drawn by	Control	Approved
1	2008-12-11	JRI	UTN	UTN

Job 547310A

Scale 1:500

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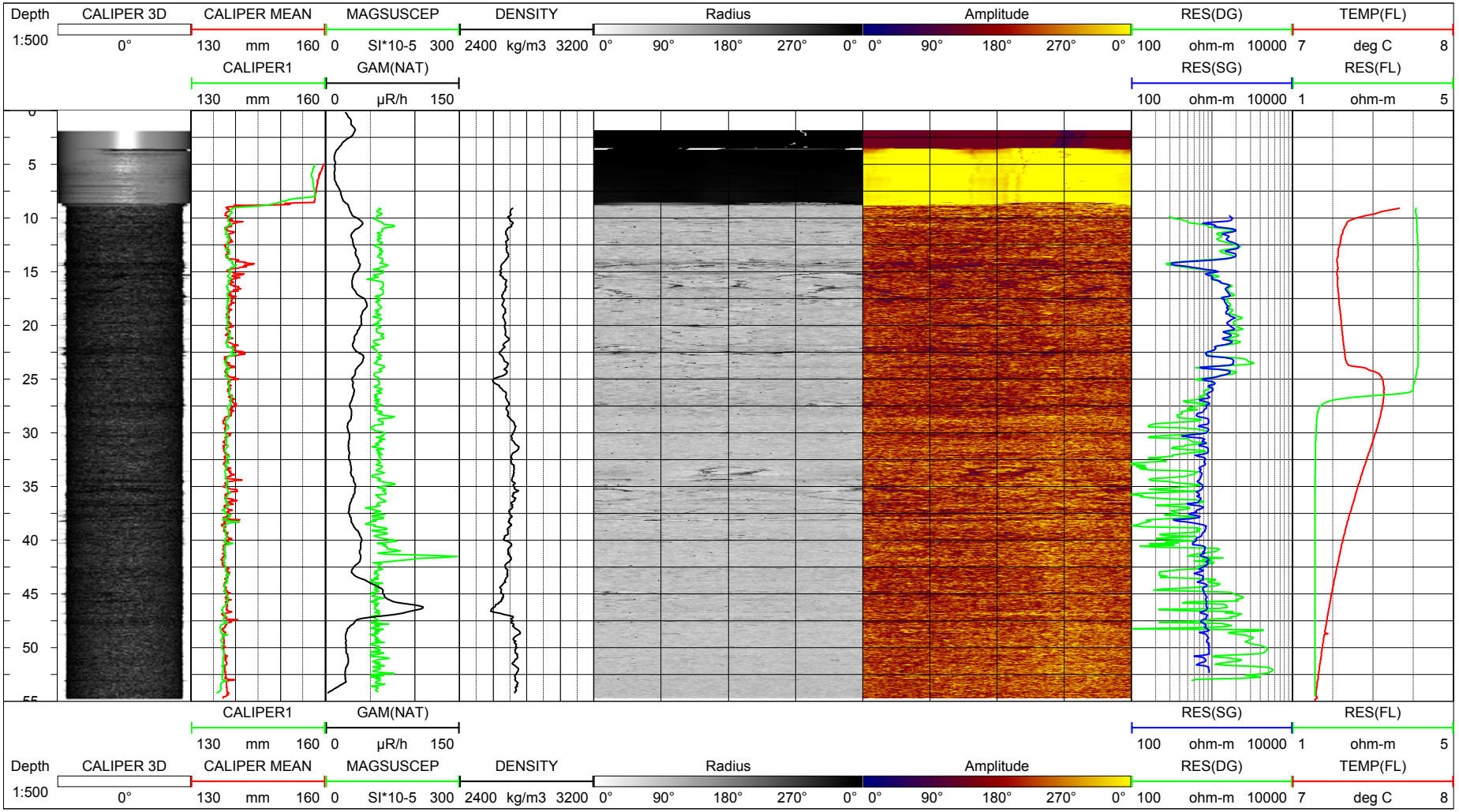
SKB geophysical borehole logging
Borehole HFR102

Presentation

Filename: HFR102_Presentation.wcl

Drawing no.: **2.1**


Depth
1:500
CALIPER 3D
0°
CALIPER MEAN
130 mm 160
MAGSUSCEP
0 SI*10-5 300
DENSITY
2400 kg/m3 3200
Radius
0° 90° 180° 270° 0°
Amplitude
0° 90° 180° 270° 0°
RES(DG)
100 ohm-m 10000
TEMP(FL)
7 deg C 8
CALIPER1
130 mm 160
GAM(NAT)
0 µR/h 150
RES(SG)
100 ohm-m 10000
RES(FL)
1 ohm-m 5
0
5
10
15
20
25
30
35
40
45
50
55

Borehole No. HFR105

Co-ordinates in RT90 2,5 gon V 0:-15

Northing: 6701376.55 m Easting: 1632686.82 m Elevation: 3.27 m. RHB70

Diameter:	139.8 -141.3 mm
Reaming Diameter:	-
Outer Casing:	168 mm
Inner Casing:	160 mm
Casing Length:	21.12 m
Borehole Length:	200.5 m
Cone:	
Inclination at ground surface:	-61.77°
Azimuth:	35.43° GN
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9139	mm
DENSITY	Compensated gamma-gamma density	9139	kg/m³
RES(SG)	Focused guard log resistivity, 128 cm	9139	ohm-m
GAM(NAT)	Natural gamma	9072	µR/h
TEMP(FL)	Fluid temperature	9042	deg C
RES(FL)	Fluid resistivity	9042	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9310	m/s
AMP(N)	Full wave form, near receiver	9310	µs
AMP(F)	Full wave form, far receiver	9310	µs
MAGSUSCEP	Magnetic susceptibility	8622	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT	deg
DIP	Borehole inclination from horizontal	HiRAT	deg
RADIUS	360 degrees orientated acoustic radius	HiRAT	mm
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent
RES(16N)	Normal resistivity 16 inch	8144	ohm-m
RES(64N)	Normal resistivity 64 inch	8144	ohm-m
LATERAL	Lateral resistivity	8144	ohm-m
SPR	Single point resistivity	8144	ohm
SP	Self Potential	8144	V

Rev.	Date	Drawn by	Control	Approved
1	2008-12-10	JRI	UTN	UTN

Job 547310A

Scale 1:500

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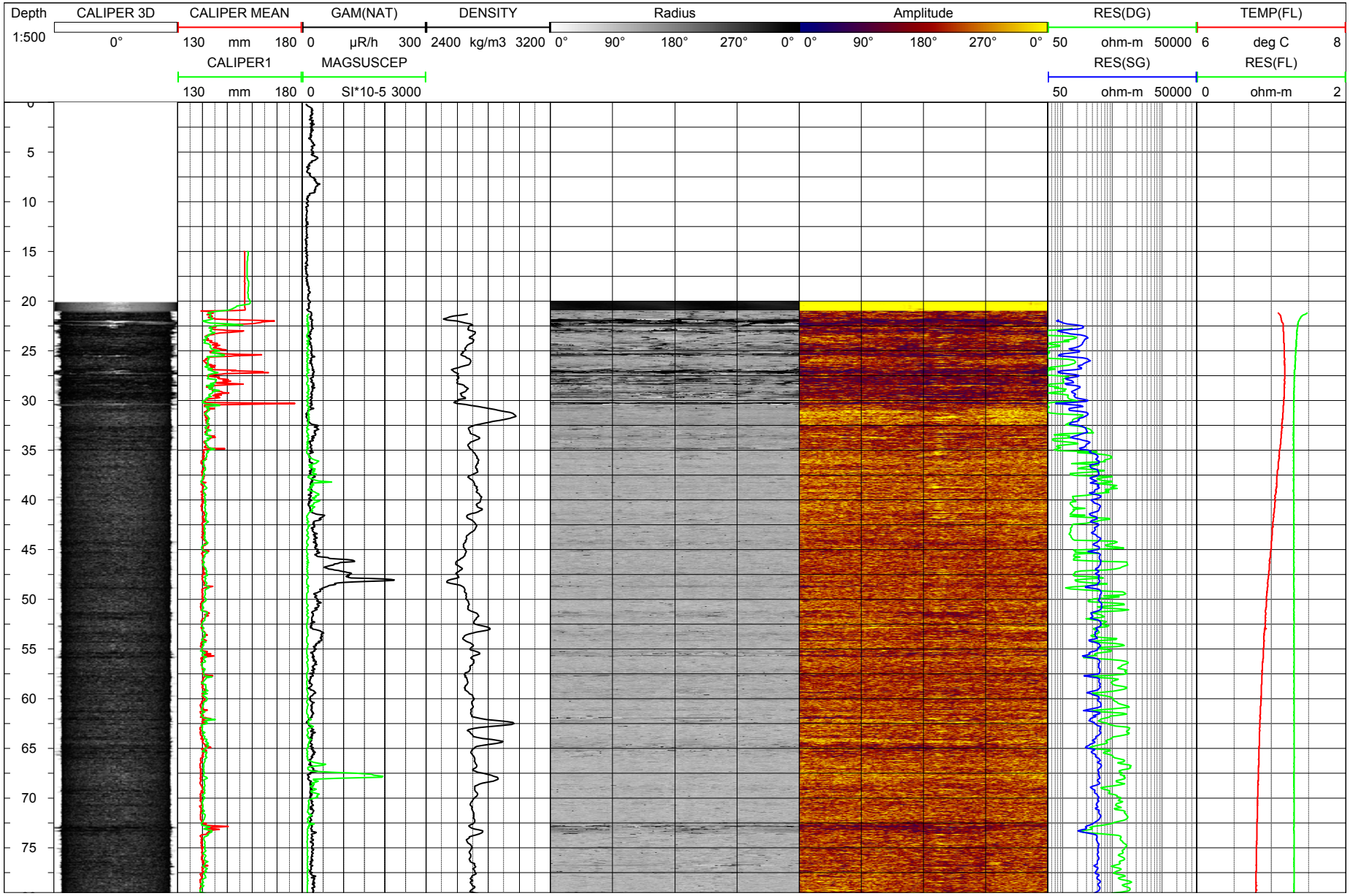
SKB geophysical borehole logging
Borehole HFR105

Presentation

Filename: HFR105_Presentation.wcl

Drawing no.: **3.1**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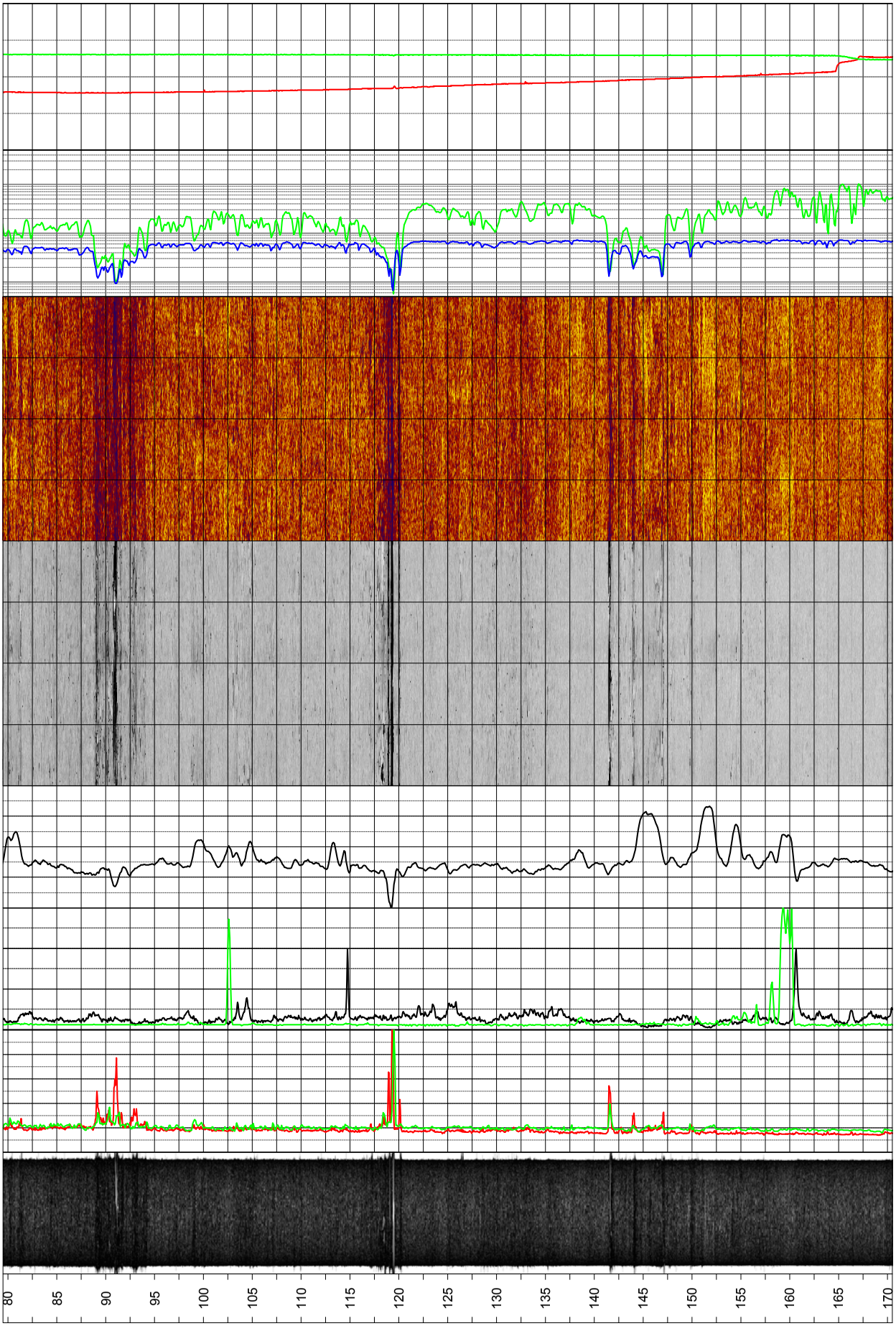
1:500
CALIPER 3D
0°
CALIPER MEAN
130 mm 180
CALIPER1
130 mm 180
GAM(NAT)
0 µR/h 300
MAGSUSCEP
0 SI*10-5 3000
DENSITY
2400 kg/m3 3200
Radius
0° 90° 180° 270° 0°
Amplitude
0° 90° 180° 270° 0°
RES(DG)
50 ohm-m 50000
RES(SG)
50 ohm-m 50000
TEMP(FL)
6 deg C 8
RES(FL)
0 ohm-m 2
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75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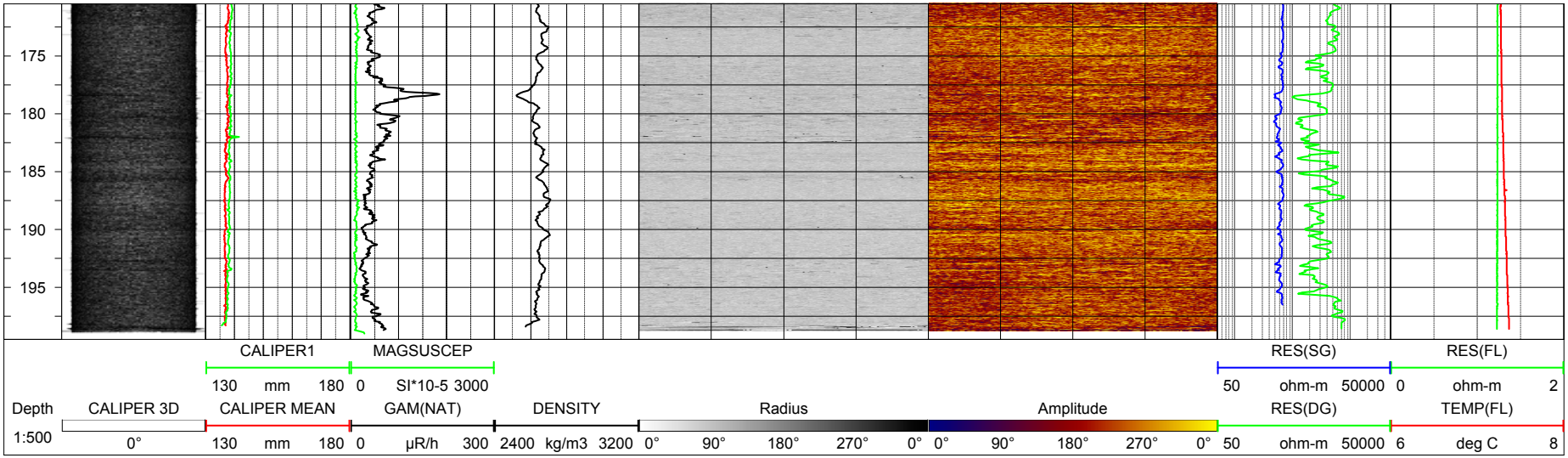
175
180
185
190
195
CALIPER1
MAGSUSCEP
RES(SG)
RES(FL)
130 mm 180
0 SI*10-5 3000
50 ohm-m 50000
0 ohm-m 2
Depth
CALIPER 3D
CALIPER MEAN
GAM(NAT)
DENSITY
Radius
Amplitude
RES(DG)
TEMP(FL)
1:500
0°
130 mm 180
0 µR/h 300
2400 kg/m3 3200
0° 90° 180° 270° 0°
0° 90° 180° 270° 0°
50 ohm-m 50000
6 deg C 8

Borehole No. KFR27

Co-ordinates in RT90 2,5 gon V 0:-15

Northing: 6701714.42 m Easting: 1633175.52 m Elevation: 2.87 m, RHB70

Diameter:	75.8 -76.8 mm
Reaming Diameter:	-
Outer Casing:	84 mm
Inner Casing:	77 mm
Casing Length:	11.91 m
Borehole Length:	148.51 m
Cone:	
Inclination at ground surface:	-87.42°
Azimuth:	248.20°
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9139	mm
DENSITY	Compensated gamma-gamma density	9139	kg/m³
RES(SG)	Focused guard log resistivity, 128 cm	9139	ohm-m
GAM(NAT)	Natural gamma	9072	µR/h
TEMP(FL)	Fluid temperature	9042	deg C
RES(FL)	Fluid resistivity	9042	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9310	m/s
AMP(N)	Full wave form, near receiver	9310	µs
AMP(F)	Full wave form, far receiver	9310	µs
MAGSUSCEP	Magnetic susceptibility	8622	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT	deg
DIP	Borehole inclination from horizontal	HiRAT	deg
RADIUS	360 degrees orientated acoustic radius	HiRAT	mm
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent
RES(16N)	Normal resistivity 16 inch	8144	ohm-m
RES(64N)	Normal resistivity 64 inch	8144	ohm-m
LATERAL	Lateral resistivity	8144	ohm-m
SPR	Single point resistivity	8144	ohm
SP	Self Potential	8144	V

Rev.	Date	Drawn by	Control	Approved
1	2008-12-11	JRI	UTN	UTN

Job 547310A

Scale 1:500

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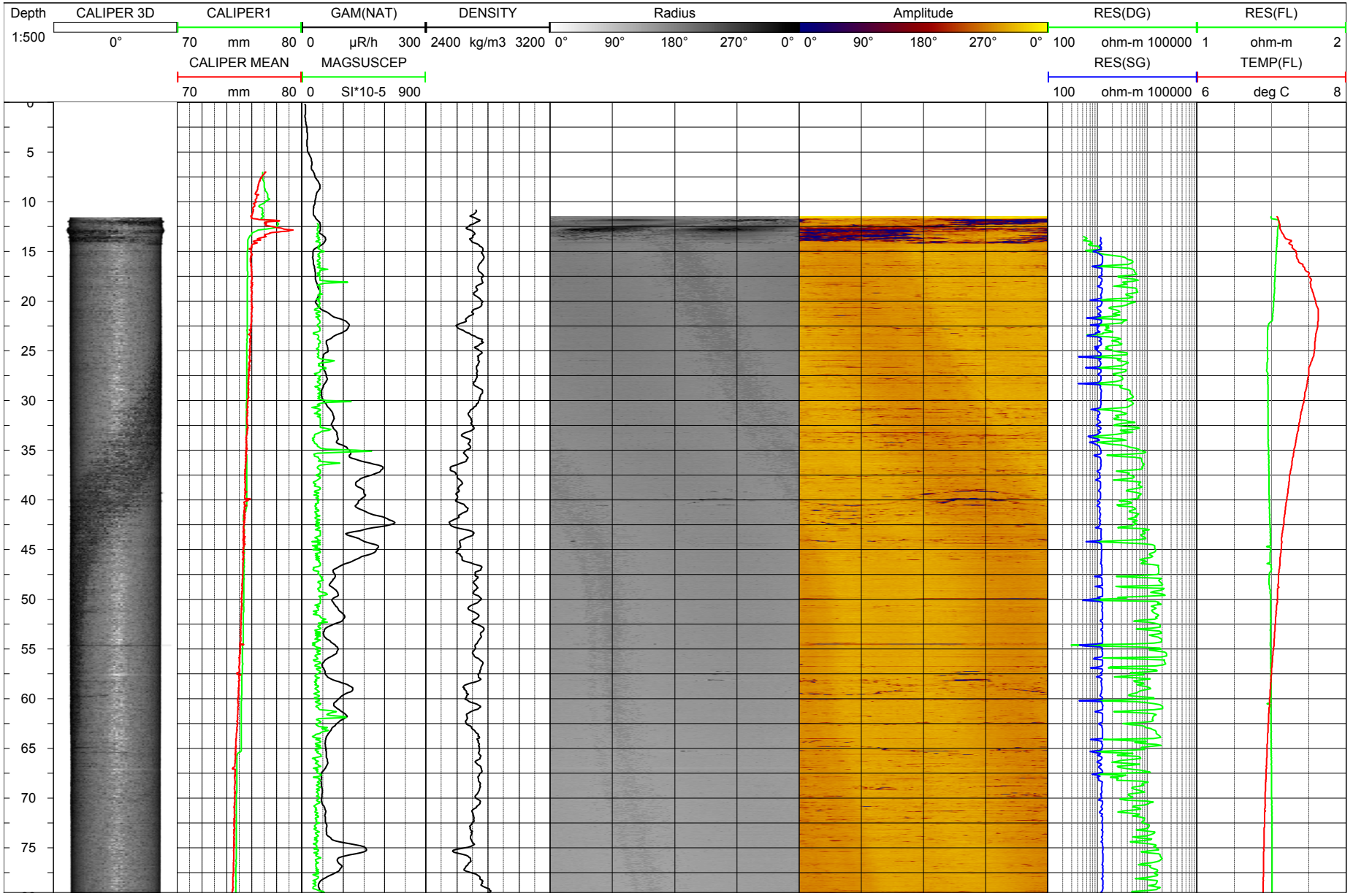
SKB geophysical borehole logging
Borehole KFR27

Presentation

Filename: KFR27_Presentation.wcl

Drawing no.: **4.1**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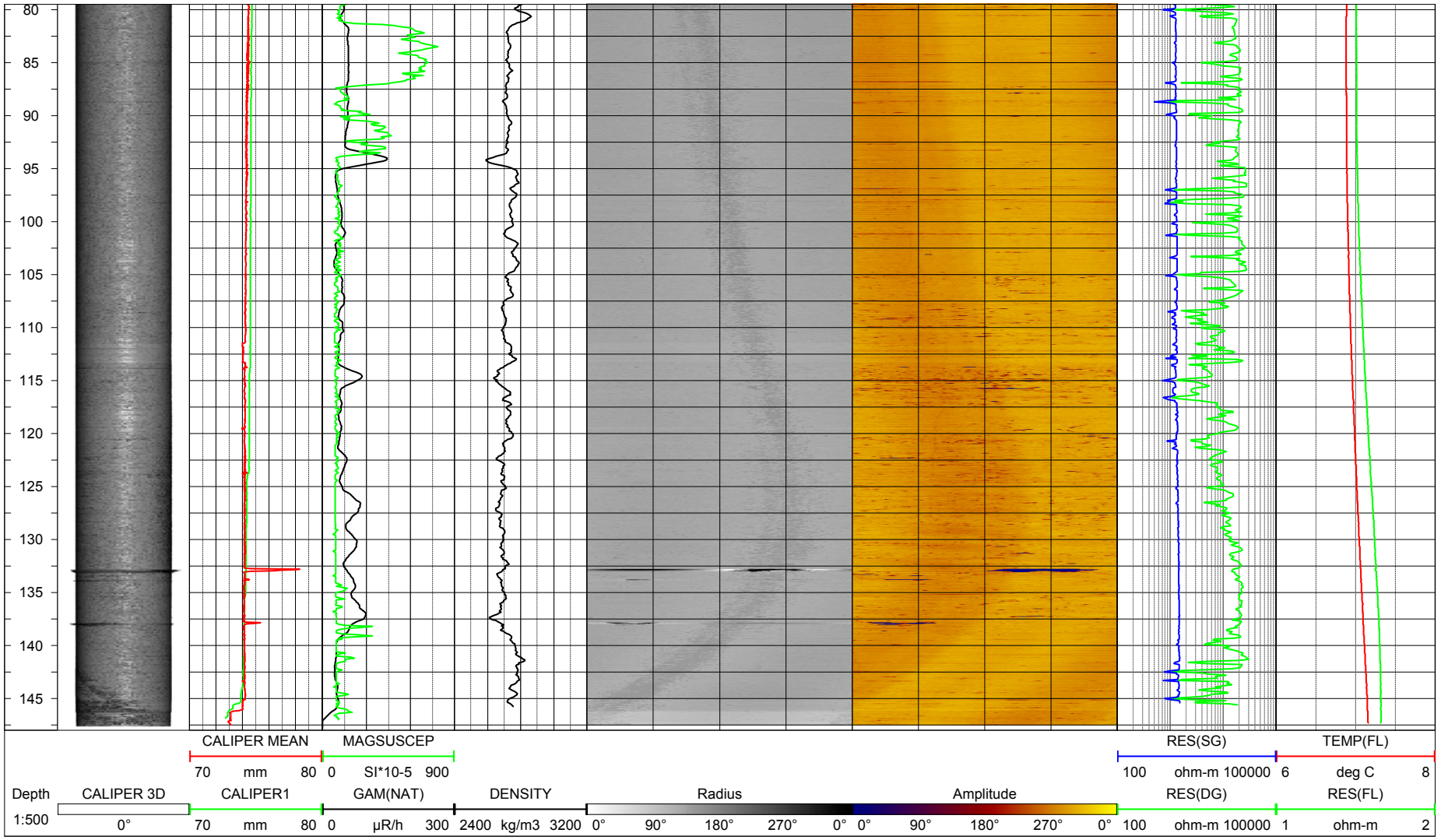
1:500
CALIPER 3D
0°
CALIPER1
70 mm 80
CALIPER MEAN
70 mm 80
GAM(NAT)
0 µR/h 300
MAGSUSCEP
0 SI*10-5 900
DENSITY
2400 kg/m3 3200
Radius
0° 90° 180° 270° 0°
Amplitude
0° 90° 180° 270° 0°
RES(DG)
100 ohm-m 100000
RES(SG)
100 ohm-m 100000
RES(FL)
1 ohm-m 2
TEMP(FL)
6 deg C 8
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75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115
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135
140
145
CALIPER MEAN
MAGSUSCEP
RES(SG)
TEMP(FL)
70 mm 80
0 SI*10-5 900
100 ohm-m 100000
6 deg C 8
Depth
CALIPER 3D
CALIPER1
GAM(NAT)
DENSITY
Radius
Amplitude
RES(DG)
RES(FL)
1:500
0°
70 mm 80
0 µR/h 300
2400 kg/m3 3200
0° 90° 180° 270° 0°
0° 90° 180° 270° 0°
100 ohm-m 100000
1 ohm-m 2

Borehole No. KFR101

Co-ordinates in RT90 2,5 gon V 0:-15

Northing: 6701736.32 m Easting: 1633351.40 m Elevation: 2.44 m, RHB70

Diameter:	75.8 mm
Reaming Diameter:	-
Outer Casing:	88 mm
Inner Casing:	77 mm
Casing Length:	13.72 m
Borehole Length:	341.7 m
Cone:	
Inclination at ground surface:	-54.44°
Azimuth:	28.77° GN
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9139	mm
DENSITY	Compensated gamma-gamma density	9139	kg/m³
RES(SG)	Focused guard log resistivity, 128 cm	9139	ohm-m
GAM(NAT)	Natural gamma	9072	µR/h
TEMP(FL)	Fluid temperature	9042	deg C
RES(FL)	Fluid resistivity	9042	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9310	m/s
AMP(N)	Full wave form, near receiver	9310	µs
AMP(F)	Full wave form, far receiver	9310	µs
MAGSUSCEP	Magnetic susceptibility	8622	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT	deg
DIP	Borehole inclination from horizontal	HiRAT	deg
RADIUS	360 degrees orientated acoustic radius	HiRAT	mm
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent
RES(16N)	Normal resistivity 16 inch	8144	ohm-m
RES(64N)	Normal resistivity 64 inch	8144	ohm-m
LATERAL	Lateral resistivity	8144	ohm-m
SPR	Single point resistivity	8144	ohm
SP	Self Potential	8144	V

Rev.	Date	Drawn by	Control	Approved
1	2008-12-10	JRI	UTN	UTN

Job 547310A

Scale 1:500

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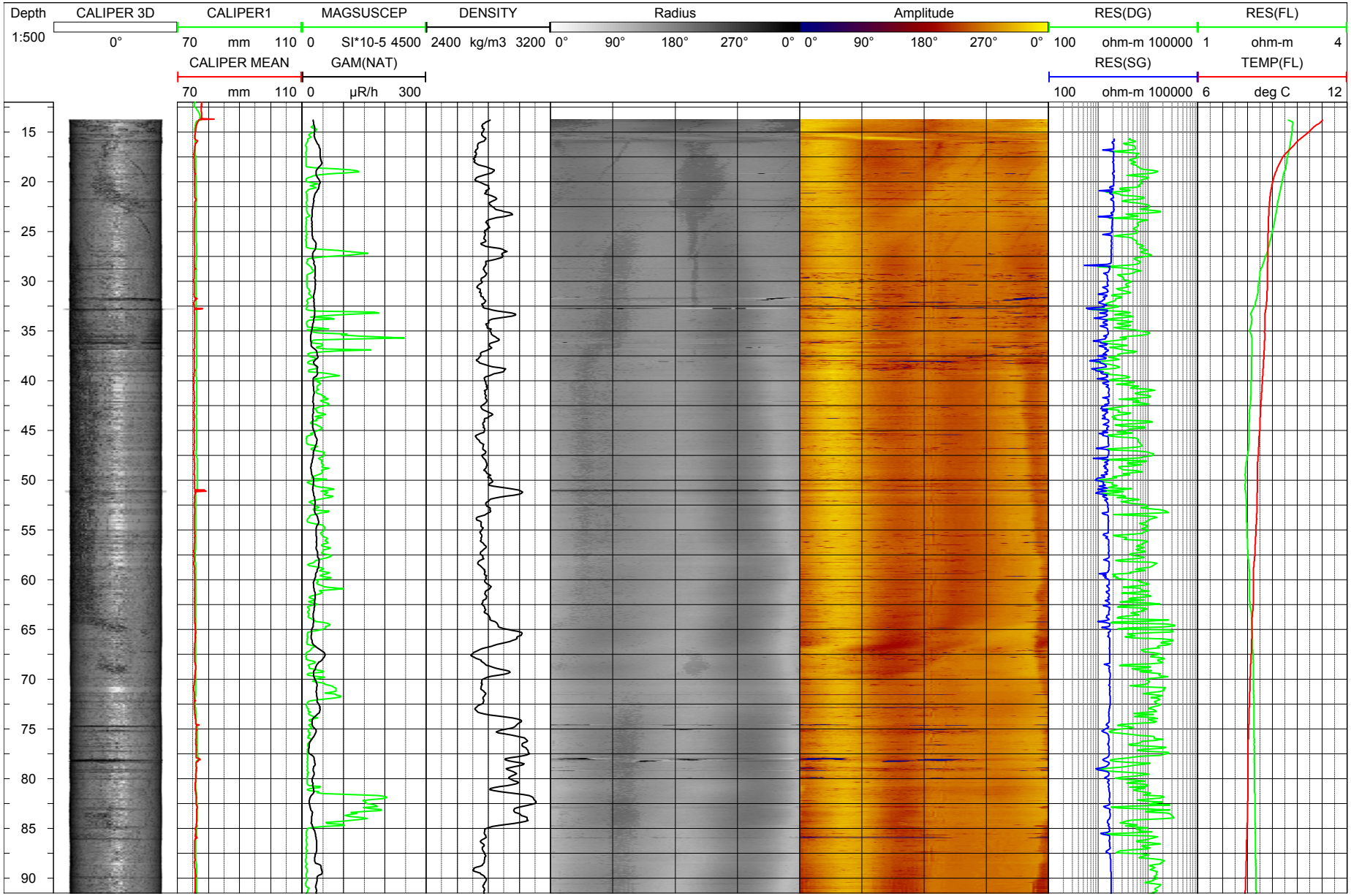
SKB geophysical borehole logging
Borehole KFR101

Presentation

Filename: KFR101_Presentation.wcl

Drawing no.: **5.1**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1:500
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0°
CALIPER1
70 mm 110
CALIPER MEAN
70 mm 110
MAGSUSCEP
0 SI*10-5 4500
GAM(NAT)
0 µR/h 300
DENSITY
2400 kg/m3 3200
Radius
0° 90° 180° 270° 0°
Amplitude
0° 90° 180° 270° 0°
RES(DG)
100 ohm-m 100000
RES(SG)
100 ohm-m 100000
RES(FL)
1 ohm-m 4
TEMP(FL)
6 deg C 12
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30
35
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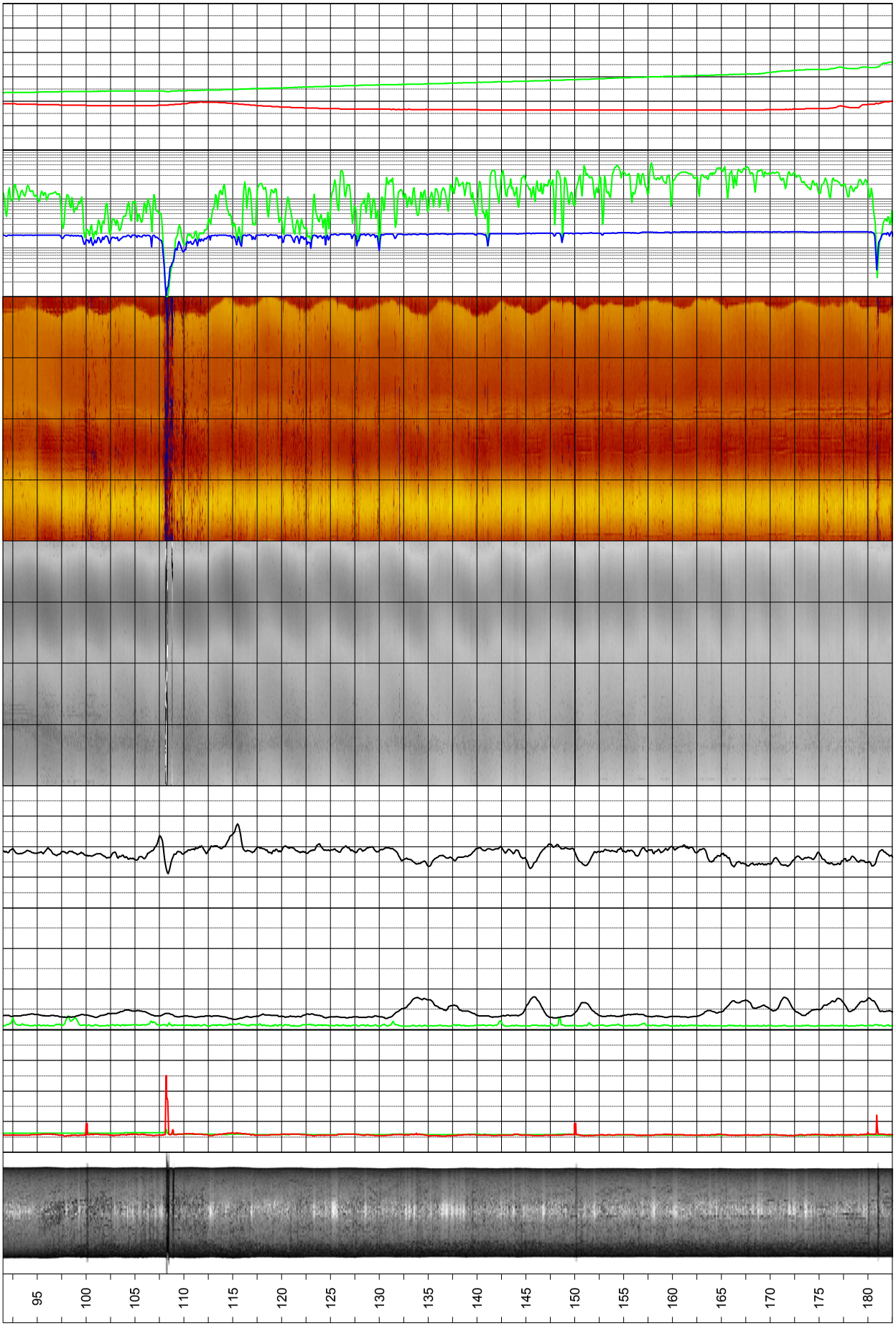
45
50
55
60
65
70
75
80
85
90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175
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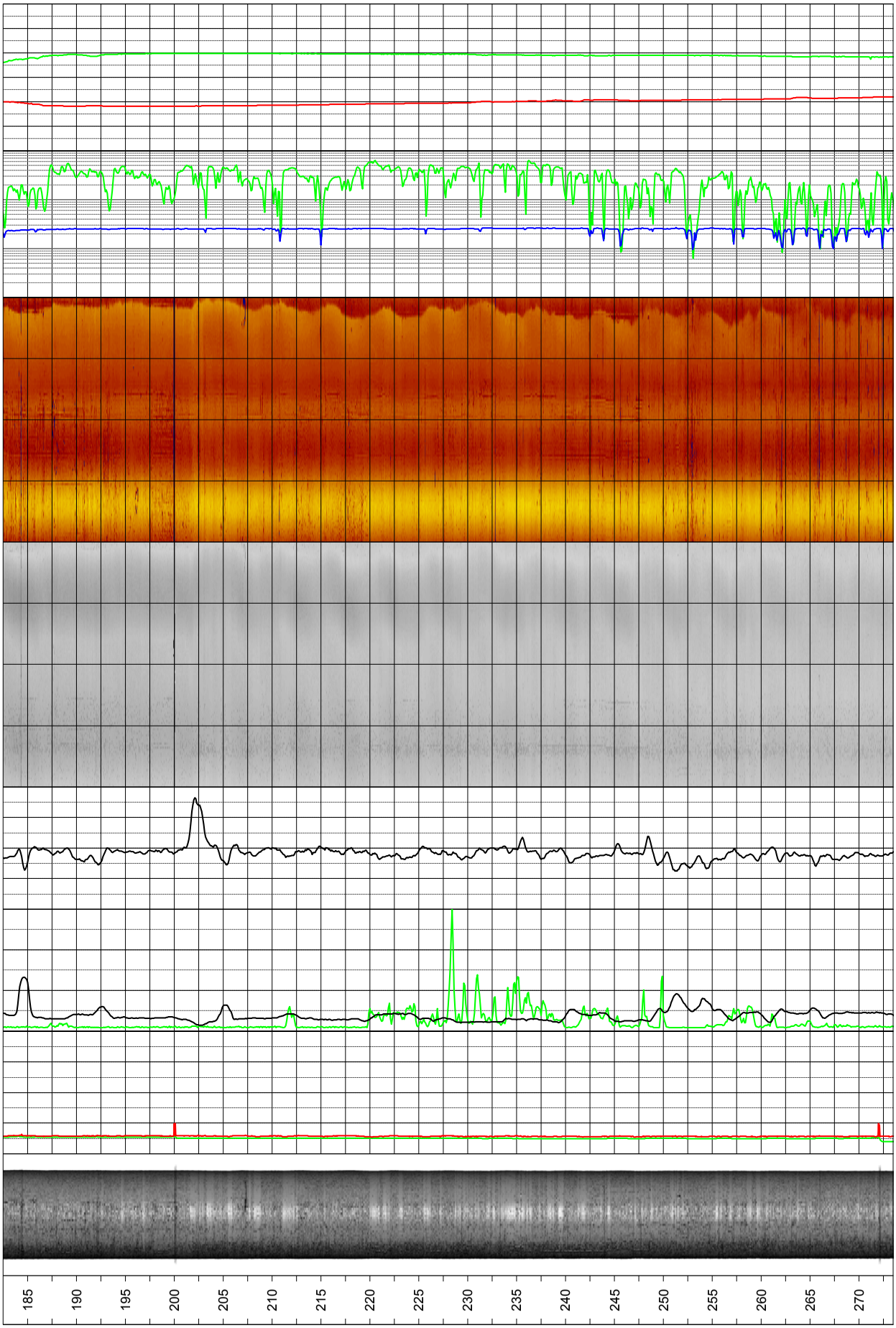
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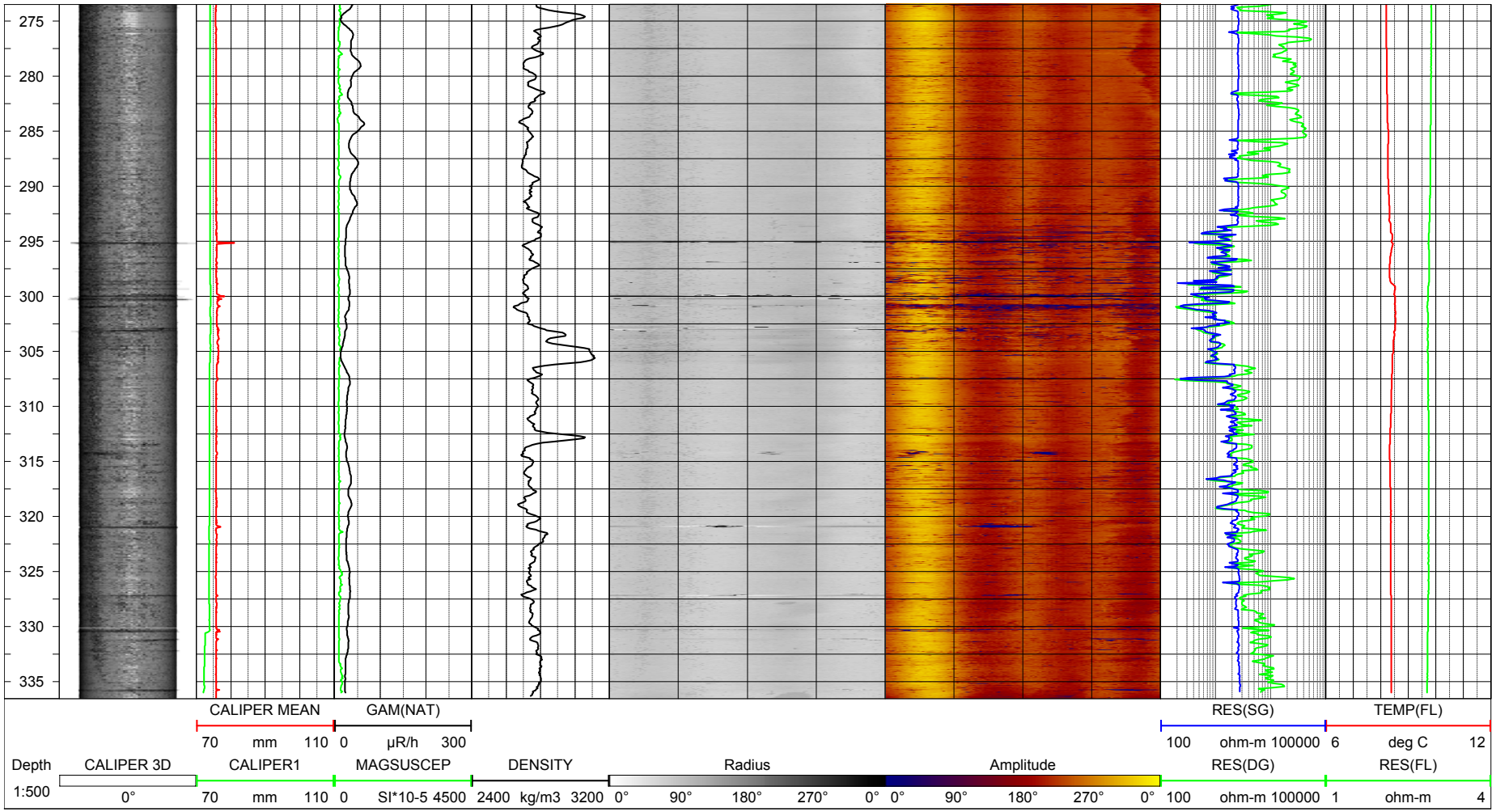
265
270


275
280
285
290
295
300
305
310
315
320
325
330
335
CALIPER MEAN
GAM(NAT)
RES(SG)
TEMP(FL)
70 mm 110
0 µR/h 300
100 ohm-m 100000
6 deg C 12
Depth
1:500
CALIPER 3D
CALIPER1
MAGSUSCEP
DENSITY
Radius
Amplitude
RES(DG)
RES(FL)
0°
70 mm 110
0 SI*10-5 4500
2400 kg/m3 3200
0° 90° 180° 270° 0°
0° 90° 180° 270° 0°
100 ohm-m 100000
1 ohm-m 4

Borehole No. HFM07

Co-ordinates in RT90 2,5 gon V 0:-15

Northing: 6697416.248m Easting: 1634715.687m Elevation: 5.781m, RHB70

Diameter:	139 mm
Reaming Diameter:	214 mm
Outer Casing:	168 mm
Inner Casing:	160 mm
Casing Length:	18 m
Borehole Length:	122.5 m
Cone:	
Inclination at ground surface:	-84.517°
Azimuth:	342.324°
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9139	mm
DENSITY	Gamma-gamma density	9139	kg/m³
RES(SG)	Focused guard log resistivity, 128 cm	9139	ohm-m
GAM(NAT)	Natural gamma	9072	µR/h
TEMP(FL)	Fluid temperature	9042	deg C
RES(FL)	Fluid resistivity	9042	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9310	m/s
AMP(N)	Full wave form, near receiver	9310	µs
AMP(F)	Full wave form, far receiver	9310	µs
MAGSUSCEP	Magnetic susceptibility	8622	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT	deg
DIP	Borehole inclination from horizontal	HiRAT	deg
RADIUS	360 degrees orientated acoustic radius	HiRAT	mm
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent
RES(16N)	Normal resistivity 16 inch	8144	ohm-m
RES(64N)	Normal resistivity 64 inch	8144	ohm-m
LATERAL	Lateral resistivity	8144	ohm-m
SPR	Single point resistivity	8144	ohm
SP	Self Potential	8144	V

Rev.	Date	Drawn by	Control	Approved
0	2008-11-20	JRI	UTN	UTN

Job 547310A

Scale 1:500

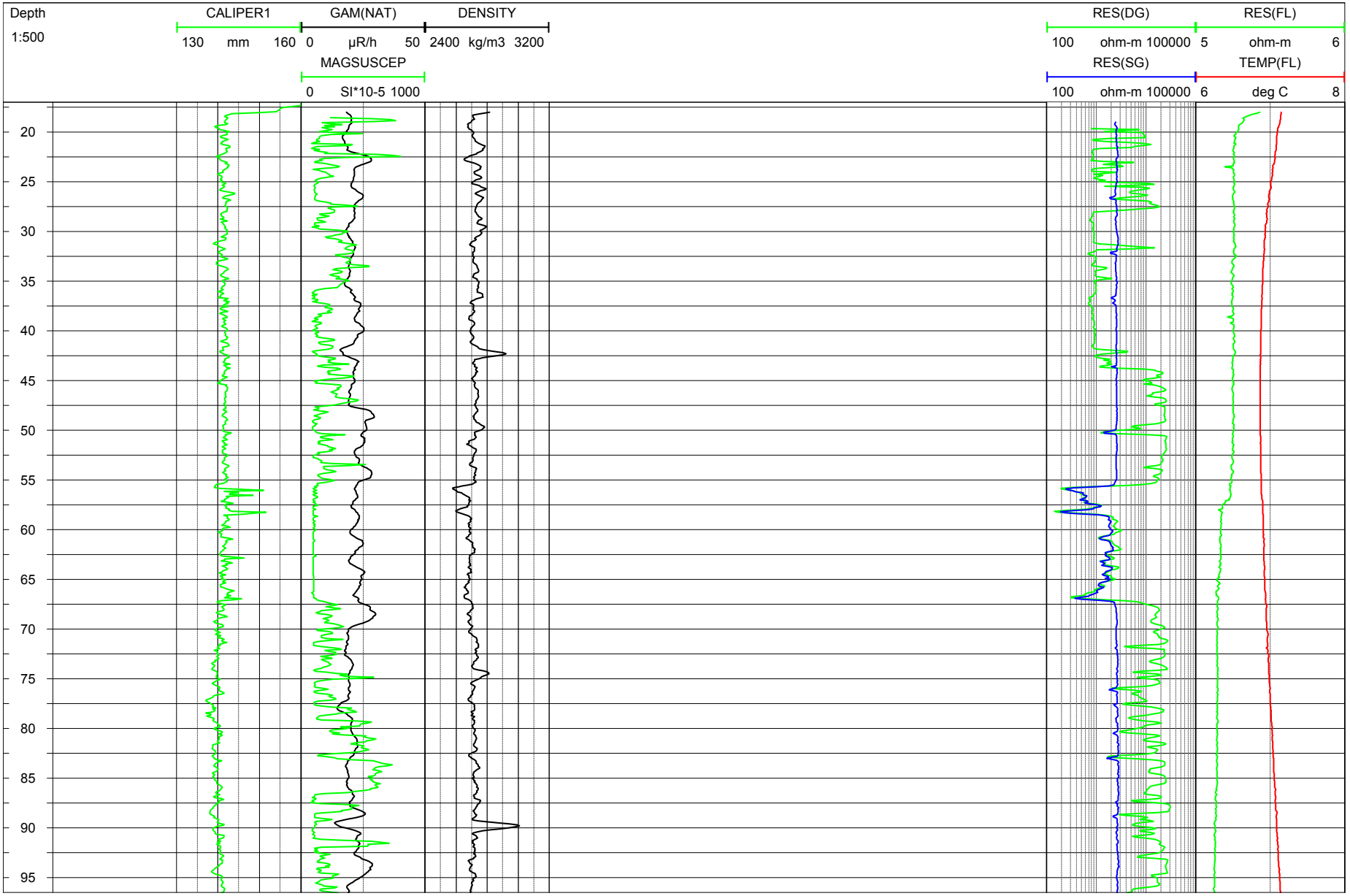
RAMBØLL
Ramboll, Stenhøj 2, DK-2830 Virum
Phone + 45 45 98 60 00, Fax + 45 45 98 67 00

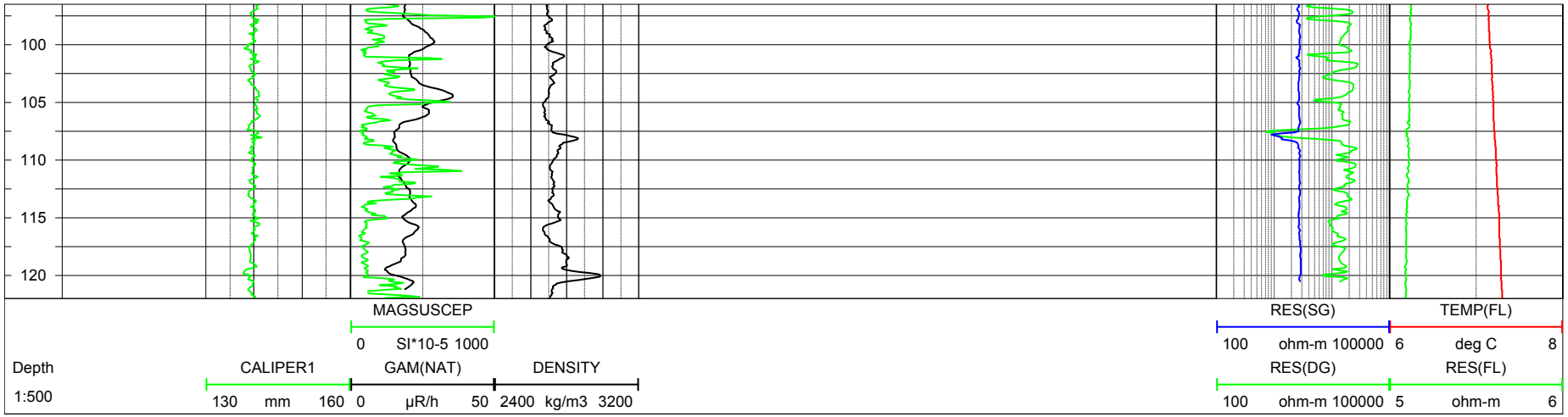
SKB geophysical borehole logging
Borehole HFM07

Presentation

Filename: HFM07_Presentation_July_2008.wcl

Drawing no.: **6.1**


Depth
1:500
CALIPER1
130 mm 160
GAM(NAT)
0 µR/h 50
DENSITY
2400 kg/m3 3200
MAGSUSCEP
0 SI*10-5 1000
RES(DG)
100 ohm-m 100000
RES(FL)
5 ohm-m 6
RES(SG)
100 ohm-m 100000
TEMP(FL)
6 deg C 8
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95


100
105
110
115
120
MAGSUSCEP
0 SI*10-5 1000
RES(SG)
100 ohm-m 100000
TEMP(FL)
6 deg C 8
Depth
1:500
CALIPER1
130 mm 160
GAM(NAT)
0 µR/h 50
DENSITY
2400 kg/m3 3200
RES(DG)
100 ohm-m 100000
RES(FL)
5 ohm-m 6