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Site investigation SFR

Geophysical borehole logging in the boreholes KFR106, HFR106 and HFM07

Uffe Torben Nielsen, Jørgen Ringgaard
RAMBØLL

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Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co

Box 250, SE-101 24 Stockholm
Phone +46 8 459 84 00

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Abstract

Geophysical borehole logging has been performed in the boreholes KFR106, HFR106 and HFM07, all situated in Forsmark, Sweden.

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 KFR106 was recorded to approximately 300 m and HFM106 was recorded to approximately190 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 2009.

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 1–3.

Sammanfattning

Geofysisk borrhålsloggning har genomförts i borrhålen KFR106, HFR106 och HFM07 i Forsmark.

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

Den geofysiska borrhålsloggningen genomfördes i KFR106 från TOC till ca. 300 m och i HFR106 från TOC till ca. 190 m.

Den geofysiska borrhålsloggningen i HFM07 var genomfört som en kontrollmätning, för att kontrollera resultatet från tidigare undersökningar genomförda under perioden 2003 till 2009.

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

Processerade loggar presenteras i Appendix 1 till 3.

Contents

1 Introduction

This document reports the results gained by the geophysical borehole logging in boreholes KFR106, HFR106 and 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-09-018. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method description are SKB's internal controlling documents.

All measurements were conducted by RAMBØLL during September 9 and 10, 2009. 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 locations of the boreholes are shown in Figure 1-1, and the technical data for the boreholes are presented in Figure 1-2 and 1-3.

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.

Activity plan	**Number**	**Version**
Geofysisk borrhålsloggning i borrhålen KFR106 samt HFR106	AP SFR-09-018	1.0
Method description	**Number**	**Version**
Metodbeskrivning för geofysisk borrhålsloggning	SKB MD 221.002	3.0

Table 1-2. Technical data for boreholes KFR106, HFR106 and HFM07.

Borehole Parameter	**KFR106**	**HFR106**	**HFM07**
Co-ordinates (RT90)	6701541.18 1633592.14	6701574.11 1633579.85	6697416.25 1634715.69
Elevation (RHB70)	1.06	1.27	5.78
Azimuth (TOC)	195.11º	269.39º	342.32º
Inclination from horizontal (TOC)	–69.89º	–60.87º	–84.52º
Length [m]	300.13	190.4	122.50
Casing [m]	9.13	9.03	18.00
Borehole diameter [mm]	75.7	138.8	140
Cleaning level	Level 2	Level 2	Level 1

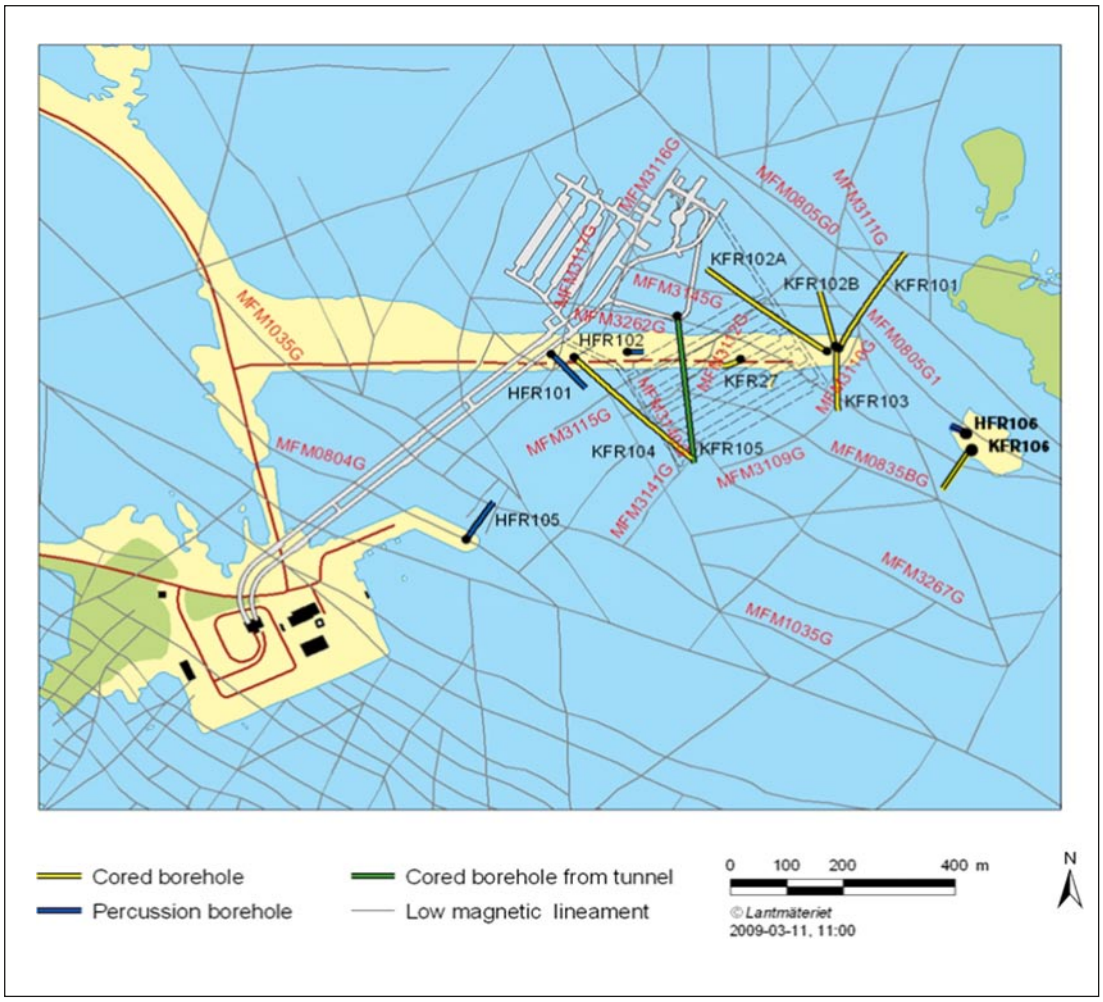
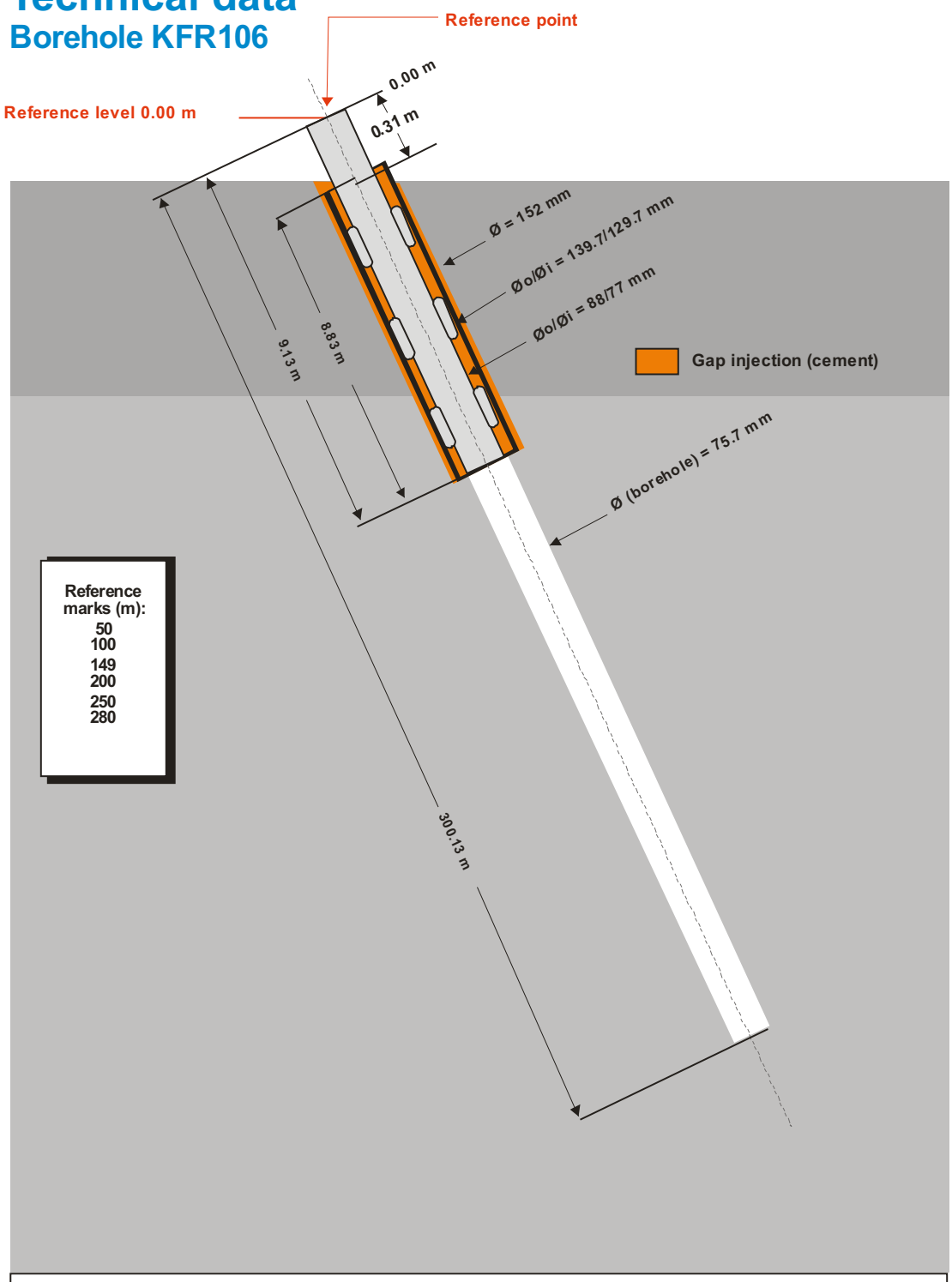


Figure 1-1. *General overview over the SFR area in Forsmark, showing the location of the boreholes KFR106 and HFR106.*

Technical data
Borehole KFR106



Drilling reference point

Northing:	6701541.18 (m), RT90 2,5 gon V 0:-15
Easting:	1633592.14 (m), RT90 2,5 gon V 0:-15
Elevation:	1.06 (m), RHB 70

Orientation

Bearing (degrees):	195.11°
Inclination (degrees):	-69.89°

Borehole

Length:	300.13 m

Percussion drilling period

Drilling start date:	2009-06-23
Drilling stop date:	2009-06-26

Core drilling period

Drilling start date:	2009-08-19
Drilling stop date:	2009-09-03

Rev. 2010-01-12

Figure 1-2. *Technical description of borehole KFR106.*

Technical data
Borehole HFR106

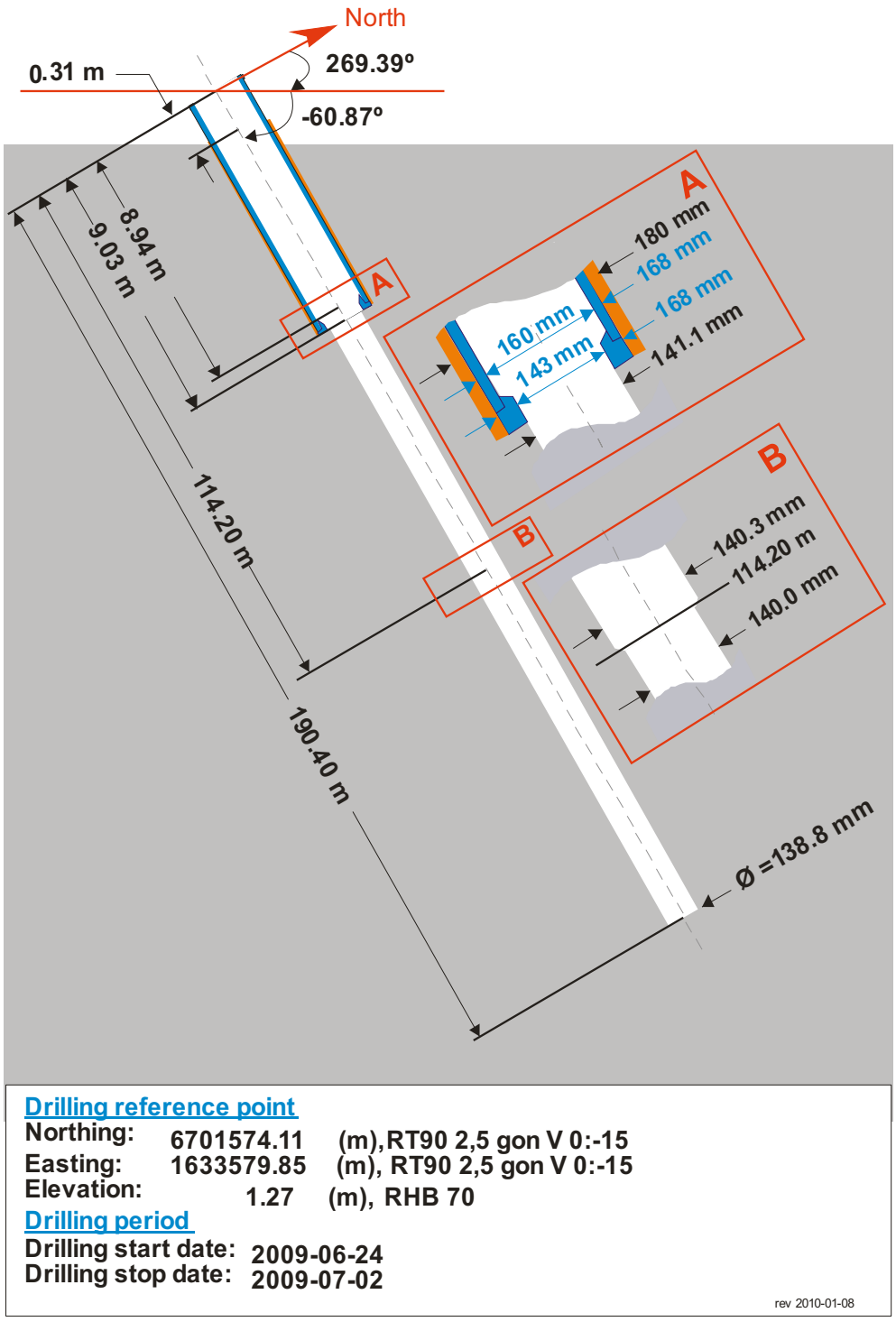


Figure 1-3. *Technical description of borehole HFR106.*

2 Objective and scope

The objective of the survey is to both receive information of the borehole water, 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 depth on drawings shown in Table 2-1.

Table 2-1. Appendix and drawing no.

Borehole	Drawing no.	Appendix
KFR106	1.1	1
HFR106	2.1	2
HFM07	3.1	3

3 Equipment

The geophysical borehole logging program were performed with five tools and resulted in the suite of logs, 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
GeoVista Natural Gamma	Natural gamma	70 x 3.8 cm		
GeoVista Dual Guard Focused Resistivity Sonde	Medium and a Deep LL3 focused resistivity	237 x 3.8 cm		
GeoVista Sidewall Compensated Density	Density, 1-arm caliper	189 x 6.6 cm	16 cm 100 mCi Cs137	
GeoVista Acoustic televiewer	Full waveform acoustic amplitude and traveltime, 360° orientated acoustic image, 360° very high resolution caliper, borehole azimuth and dip and natural gamma	210 x 4.2 cm		
GeoVista Magnetic susceptibility	Magnetic susceptibility	200 x 3.6 cm		

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 during the period September 9 and 10, 2009. 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 the density tool recording a repeat section in upward direction controls the data. The depth 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.

All data was recorded with max.10 cm sample interval. The speed of the logging for the density tool was 5 m/min and for all other tools 10 m/min, except for the HiRAT Acoustic tool in the borehole where the speed was 2.3 m/min.

4.2 Nonconformities

The logging has been performed in accordance with the activity plan AP SFR-09-018 without any nonconformities.

5 Results

5.1 Presentation

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

Logs presented in drawings no. 1.1 and 2.1 are presented in Apendices 1 and 2, Table 5-1.

5.2 Orientation, alignment and stretch of logs

5.2.1 Orientation of images

The orientation of the results from the Acoustic televiewer tool are processed 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 track marks made while drilling are used. In boreholes without track marks, gamma events in the top and the bottom of the borehole are used. The connection between the track marks and the logs is obtained from the Acoustic Televiewer tool. The length values from the track marks and from the Acoustic Televiewer 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 and 2.1 in Apendices 1 and 2.

Log	Log name short	Unit
Fluid temperature	TEMP(FL)	deg C
Fluid resistivity	RES(FL)	ohm-m
Magnetic susceptibility	MAGSUSCEP	SI*10^{-5}
Caliper, 1-arm	CALIPER1	mm
Gamma-gamma density	DENSITY	kg/m^3
Medium focused guard log resistivity	RES(SG)	ohm-m
Natural gamma	GAM(NAT)	µR/h
Deep focused guard log resistivity	RES(DG)	ohm-m
Caliper, high resolution. 360°	CALIPER 3D	mm
High resolution 1D Caliper	CALIPER MEAN	mm
360° orientated acoustic travel time	RADIUS	deg
360° orientated acoustic travel time	AMPLITUDE	–

5.2.4 Stretch of logs

Minor differences can occur between the length registration from up- and down runs for the used winch. To compensate for this, the logs are stretched using another new length scale for each tool. The length scale is constructed by using gamma events from the tool compared with the same gamma events from the Acoustic Televiewer tool. The events in both files are matched, and the new length scale is applied to the log. The bottom of the borehole is considered in stretching the logs in order to assure 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 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

The values from fluid temperature and resistivity logs are normally used in the conversion of data from the Acoustical televiewer from Travel Time to caliper. Due to the fluid mix-up in these boreholes, the standard formulas give unrealistic values. Therefore the compensation has been done the other way around, assuming that the borehole has a constant average value, a formula to compensate for fluid- and sonde internal traveltime has been derived and applied for in each borehole.

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 for 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 KFR106

In order to obtain an exact depth calibration in borehole KFR106, the reference track marks made while drilling are used. The correlation between the track marks and the logs is obtained from the Acoustic televiewer tool.

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

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 length scale. The new length scale is applied to the Acoustic televiewer file. In this way a perfect match between given length values of the reference marks and the recorded data is obtained. By means of alignment of the observed gamma events in KFR106, between all log runs, the obtained reference mark correlation is transferred to the other logs.

The complete log suite for borehole KFR106 is presented as composite log sheets in drawing 1.1 in Appendix 1. The logs presented in drawing no. 1.1 are listed in Table 5-1.

5.6 Borehole HFR106

Using the natural gamma from the fluid temperature and resistivity tool as reference, the natural gamma logs from the other tools 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 HFR106 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.

5.7 Borehole HFM07

Using the natural gamma from the fluid temperature and resistivity tool as reference, the natural gamma logs from the other tools 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. 3.1 in Appendix 3. The logs presented in drawing no. 3.1 are listed in Table 5-1.

Table 5-3. The reference track marks in the borehole and the recorded track marks from the HiRAT in borehole KFR106.

Reference mark	HIRAT recorded
50,00	49,884
100,00	99,946
149,00	148,924
200,00	199,962
250,00	250,015
280,00	280,04

6 Data delivery

Geophysical logging data from the measurements, recorded in GeoVista 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 GeoVista format used for processing.

Borehole	Probe	Log direction	WellCAD File
HFR106	NGRS_TCME	Down	HFR106_NGRS_TCME_20090909_0914_dn.Hdr
HFR106	DLL3_NGRS_ MSUS	Up	HFR106_DLL3_NGRS_MSUS_20090909_1007_up.Hdr
HFR106	NGRS_FDSB	Up	HFR106_NGRS_FDSB_20090909_1055_up.Hdr
HFR106	BHTV	Up	HFR106_BHTV_20090909_1217_up.HED
KFR106	NGRS_TCME	Down	KFR106_NGRS_TCME_20090909_1457_dn.Hdr
KFR106	BHTV	Up	KFR106_BHTV_20090910_0755_up.HED
KFR106	NGRS_FDSB	Up	KFR106_NGRS_FDSB_20090909_1658_up.Hdr
KFR106	DLL3_NGRS_ MSUS	Up	KFR106_DLL3_NGRS_MSUS_20090909_1603_up.Hdr
HFM07	NGRS_FDSB	Up	HFM07_NGRS_FDSB_20090910_1233_up.RDF
HFM07	DLL3_NGRS_ MSUS	Up	HFM07_DLL3_NGRS_MSUS_20090910_1210_up.RDF
HFM07	NGRS_TCME	Down	HFM07_NGRS_TCME_20090910_1131_dn.RDF

Table 6-2. Drawing files in WellCad format.

Borehole	Drawing	WellCad file
KFR106	1.1	KFR106_Presentation.WCL
HFR106	2.1	HFR106_Presentation.WCL
HFM07	3.1	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	Medium
“Borehole”_RES(DG)_GP162 – Resistivity, focused 300 cm.xls	Deep
“Borehole”_GP830 - Acoustic televiewer.xls	

Borehole KFR106. Drawing no. 1.1. Borehole logs

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

Northing: 6701541.18 m Easting: 1633592.14 m Elevation: 1.06 m, RHB70

Diameter:	75.7 mm
Reaming Diameter:	152 mm
Outer Casing:	88 mm
Inner Casing:	77 mm
Casing Length:	9.13 m
Borehole Length:	300.13 m
Cone:	
Inclination at ground surface:	-69.89°
Azimuth:	195.11°
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9139/FDSB	mm
DENSITY		9139/FDSB	kg/m³
RES(SG)	Focused guard log resistivity, 128 cm	9139/DLL3	ohm-m
GAM(NAT)	Natural gamma	9042/NGAM	µR/h
TEMP(FL)	Fluid temperature	9042/TCME	deg C
RES(FL)	Fluid resistivity	9042/TCME	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072/DLL3	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/MSUS	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT/BHTV	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT/BHTV	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT/BHTV	deg
DIP	Borehole inclination from horizontal	HiRAT/BHTV	deg
RADIUS	360 degrees orientated acoustic radius	HiRAT/BHTV	mm
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT/BHTV	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent

Rev.	Date	Drawn by	Control	Approved
0	2009-11-03	JRI	UTN	UTN

Job: 547310A

Scale: 1:500

RAMBØLL

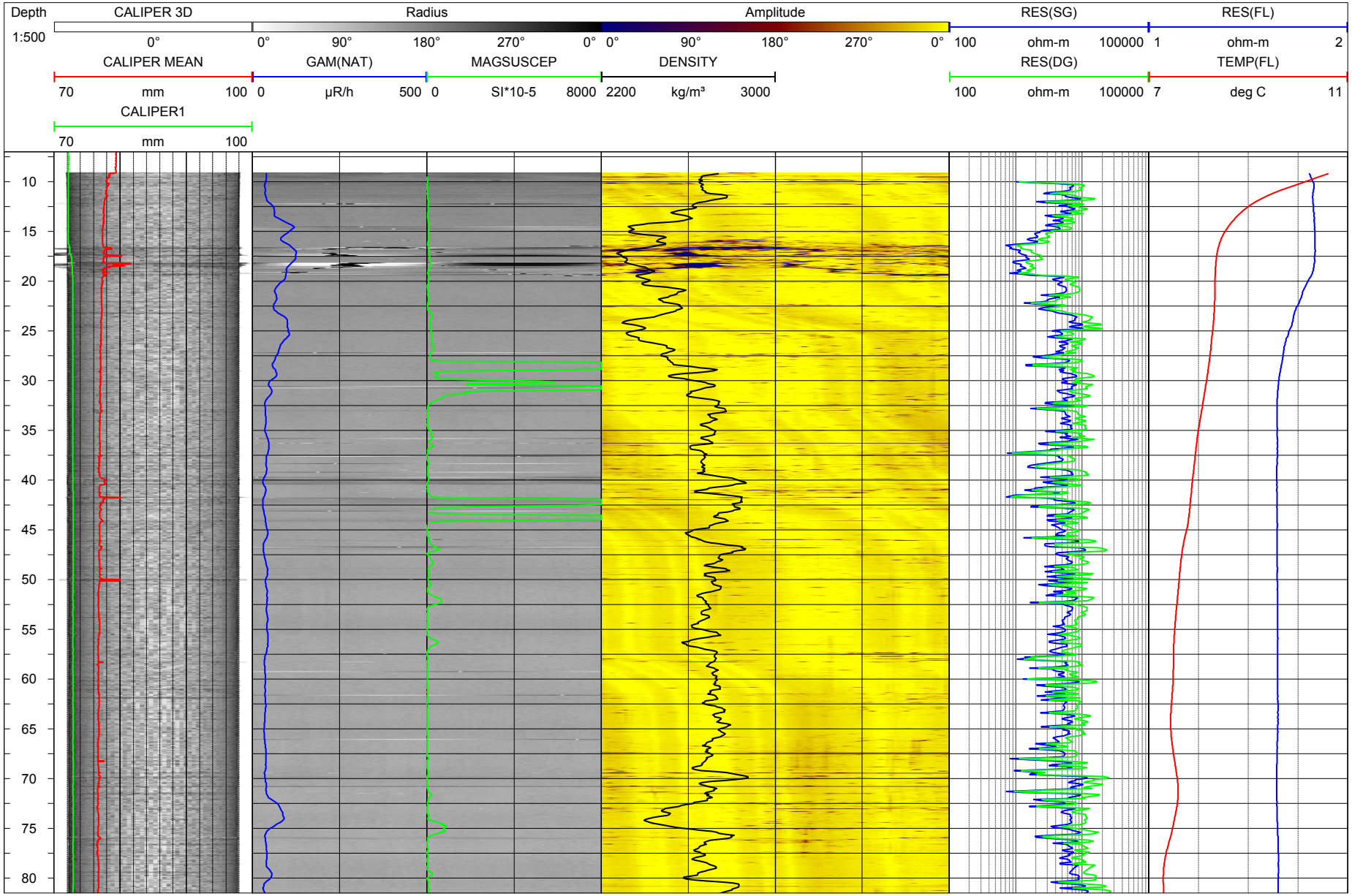
Rambøll. Bredevej 2, DK-2830 Virum
Phone + 45 45 98 60 00, Fax + 45 45 98 67 00

SKB geophysical borehole logging
Borehole KFR106

Presentation

Filename: KFR106_Presentation.wcl

Drawing no.: **1.1**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mm
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270°
0°
GAM(NAT)
0
µR/h
500
MAGSUSCEP
0
SI*10-5
8000
Amplitude
0°
90°
180°
270°
0°
DENSITY
2200
kg/m³
3000
RES(SG)
100
ohm-m
100000
RES(DG)
100
ohm-m
100000
RES(FL)
1
ohm-m
2
TEMP(FL)
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deg C
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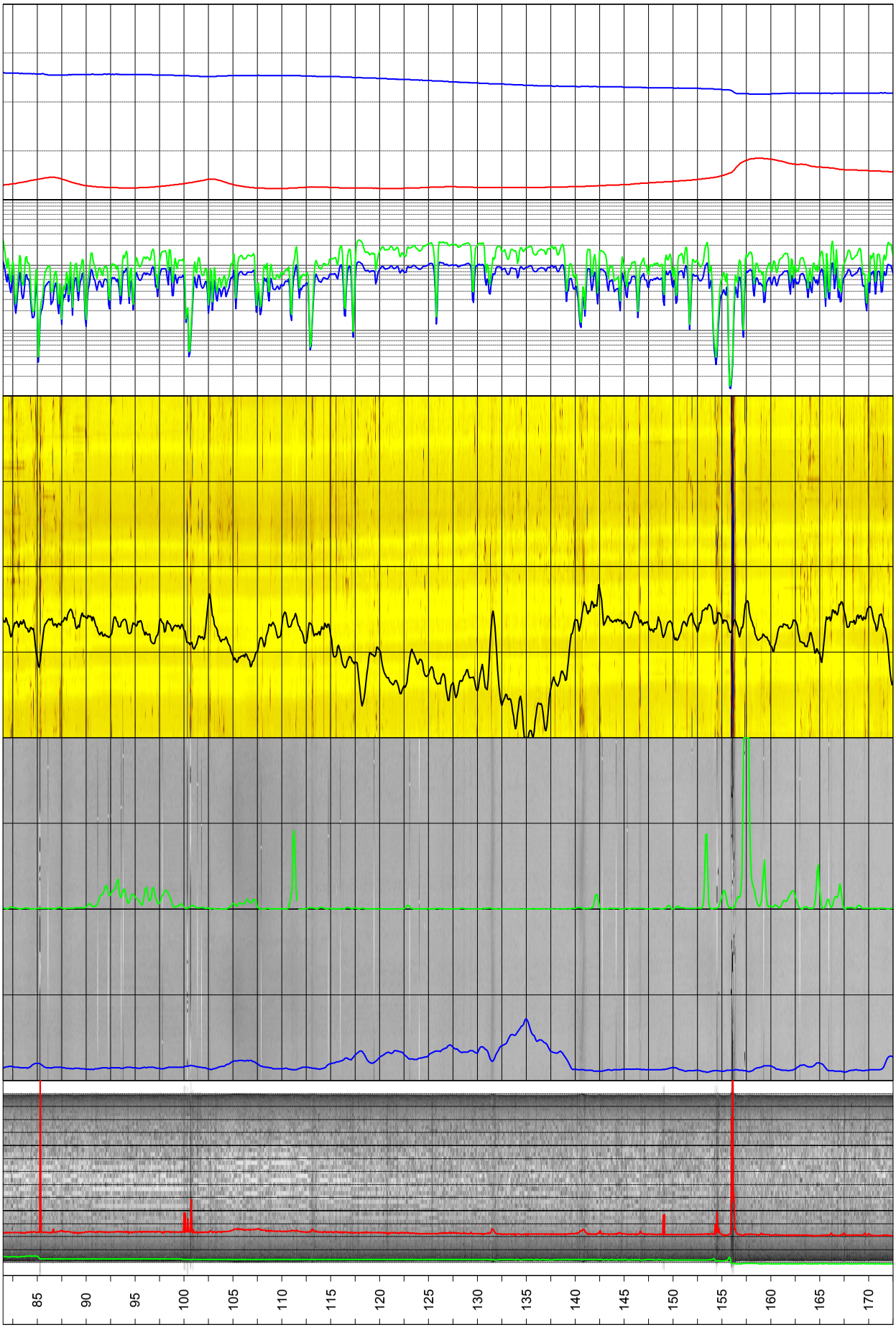
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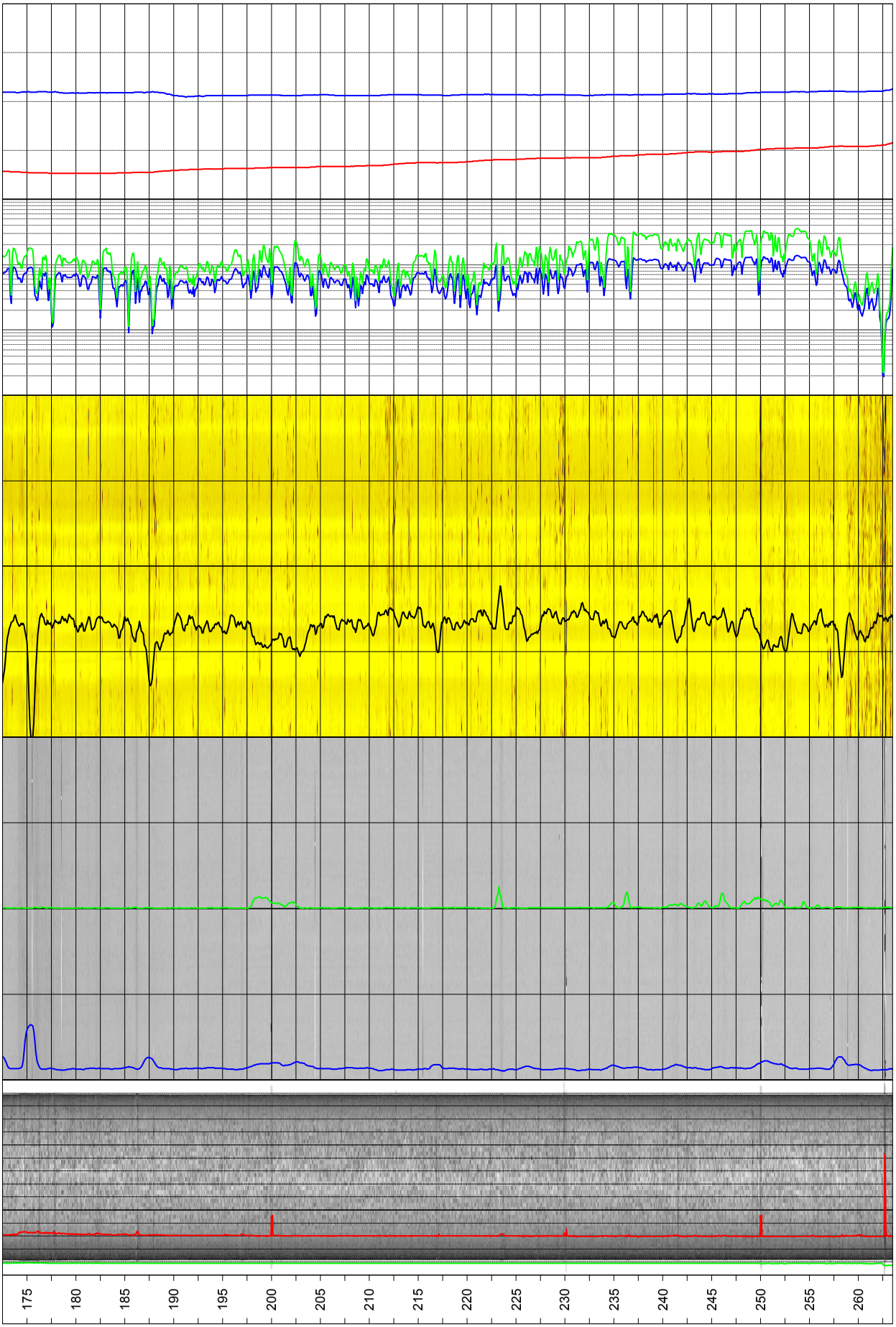
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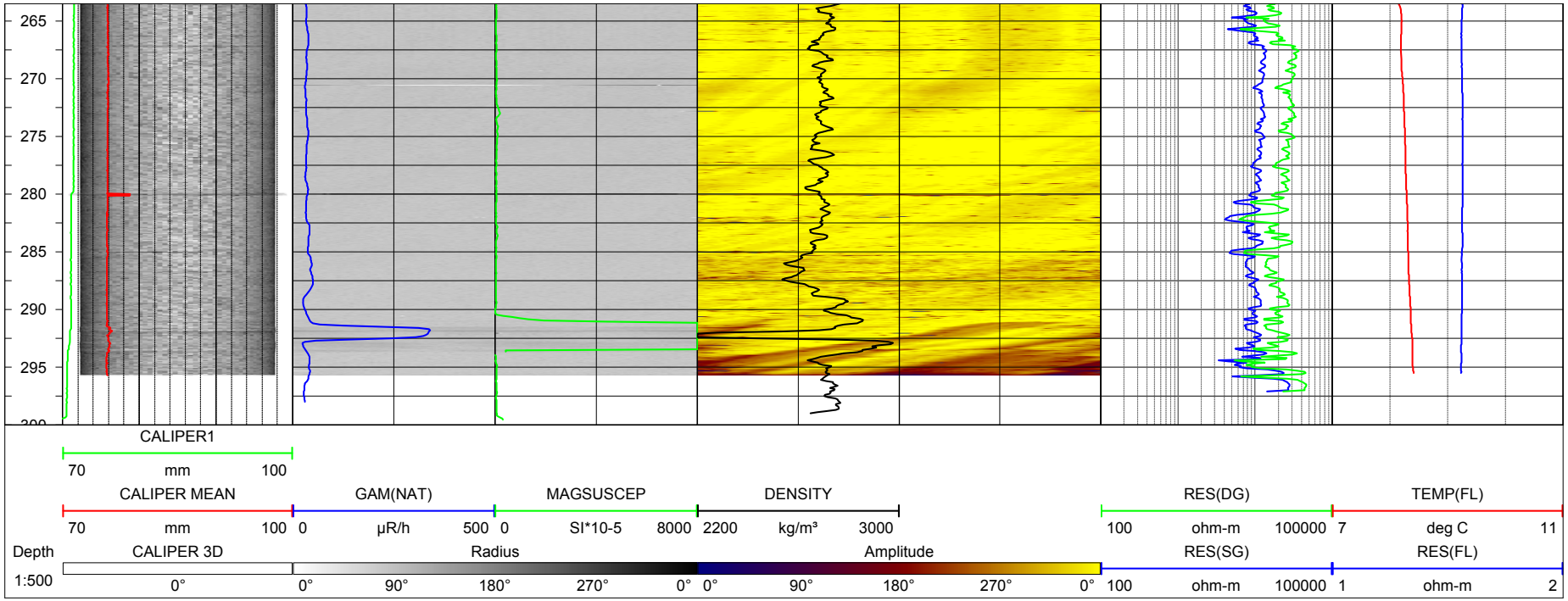
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mm
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70
mm
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GAM(NAT)
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µR/h
500
MAGSUSCEP
0
SI*10-5
8000
DENSITY
2200
kg/m³
3000
RES(DG)
100
ohm-m
100000
TEMP(FL)
7
deg C
11
Depth
1:500
CALIPER 3D
0°
Radius
0°
90°
180°
270°
0°
Amplitude
0°
90°
180°
270°
0°
RES(SG)
100
ohm-m
100000
RES(FL)
1
ohm-m
2

Borehole HFR106. Drawing no. 2.1. Borehole logs

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

Northing: 6701574.11 m Easting: 163579.85 m Elevation: 1.27 m, RHB70

Diameter:	138.8-141.1 mm
Reaming Diameter:	180 mm
Outer Casing:	168 mm
Inner Casing:	160 mm
Casing Length:	9.03 m
Borehole Length:	190.40 m
Cone:	
Inclination at ground surface:	-60.87°
Azimuth:	269.39°
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9139/FDSB	mm
DENSITY	Gamma-gamma density	9139/FDSB	kg/m³
RES(SG)	Focused guard log resistivity, 128 cm	9139/DLL3	ohm-m
GAM(NAT)	Natural gamma	9042/NGAM	µR/h
TEMP(FL)	Fluid temperature	9042/TCME	deg C
RES(FL)	Fluid resistivity	9042/TCME	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072/DLL3	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/MSUS	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT/BHTV	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT/BHTV	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT/BHTV	deg
DIP	Borehole inclination from horizontal	HiRAT/BHTV	deg
RADIUS	360 degrees orientated acoustic radius	HiRAT/BHTV	mm
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT/BHTV	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent

Rev.	Date	Drawn by	Control	Approved
1	2009-11-03	JRI	UTN	UTN

Job: 547310A

Scale: 1:500

RAMBØLL

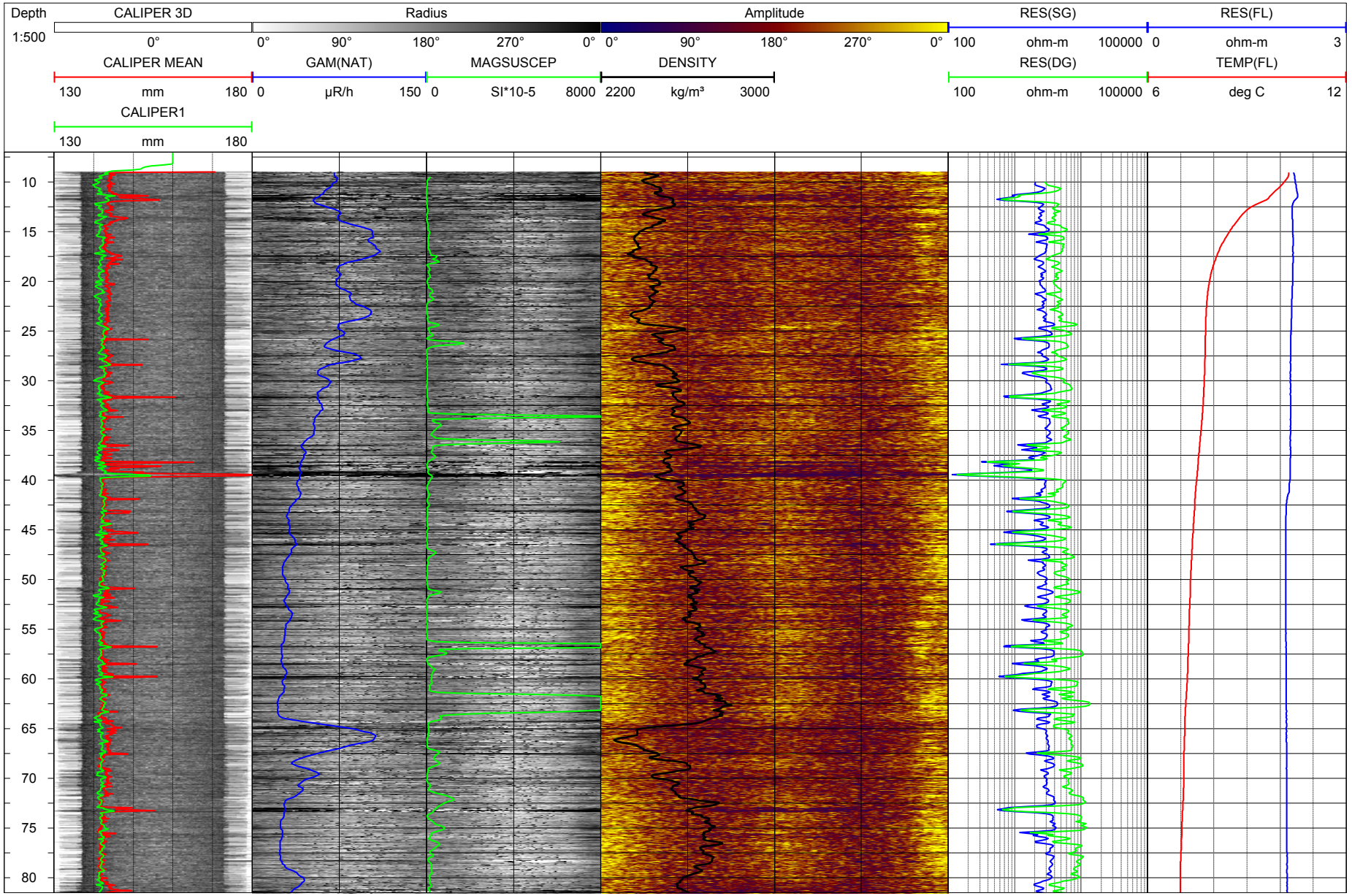
Rambøll. Bredevej 2, DK-2830 Virum
Phone + 45 45 98 60 00, Fax + 45 45 98 67 00

SKB geophysical borehole logging
Borehole HFR106

Presentation

Filename: HFR106_Presentation.wcl

Drawing no.: **2.1**


Depth
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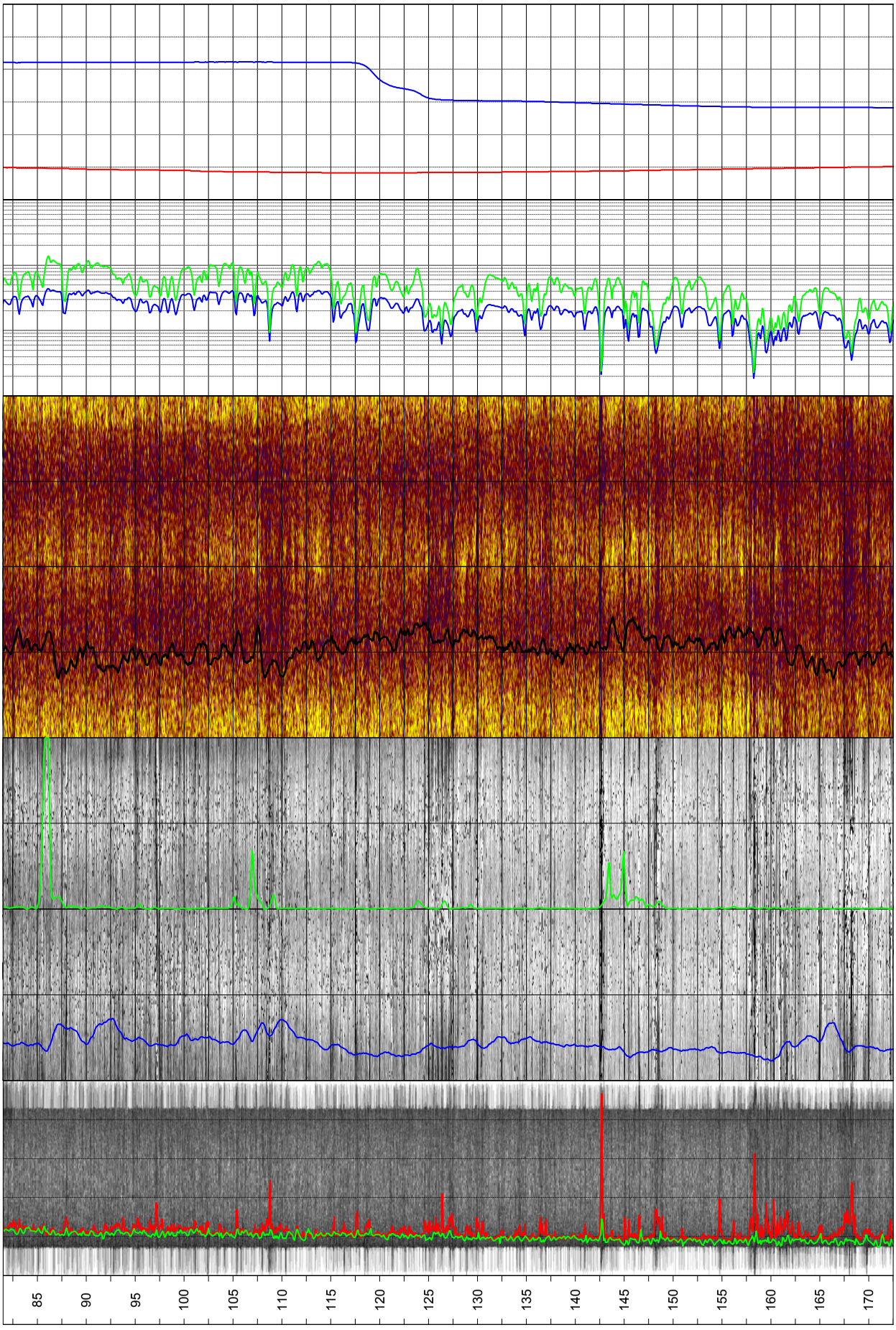
CALIPER 3D
0°
CALIPER MEAN
130 mm 180
CALIPER1
130 mm 180
Radius
0° 90° 180° 270° 0°
GAM(NAT)
0 µR/h 150
MAGSUSCEP
0 SI*10-5 8000
Amplitude
0° 90° 180° 270° 0°
DENSITY
2200 kg/m³ 3000
RES(SG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
RES(FL)
0 ohm-m 3
TEMP(FL)
6 deg C 12
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80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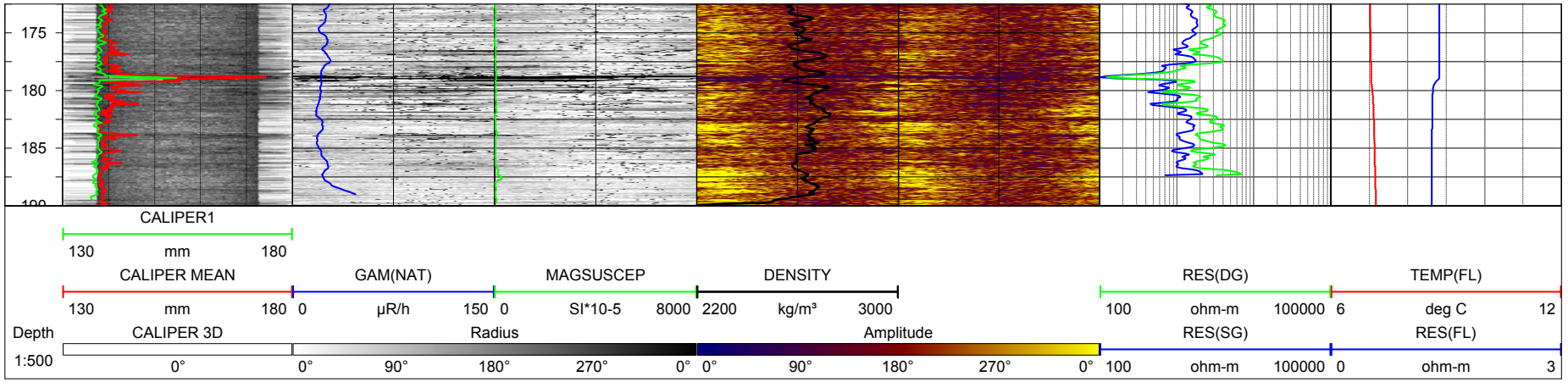
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180
185
CALIPER1
130 mm 180
CALIPER MEAN
130 mm 180
GAM(NAT)
0 µR/h 150
MAGSUSCEP
0 SI*10-5 8000
DENSITY
2200 kg/m³ 3000
RES(DG)
100 ohm-m 100000
TEMP(FL)
6 deg C 12
Depth
1:500
CALIPER 3D
0°
Radius
0° 90° 180° 270° 0°
Amplitude
0° 90° 180° 270° 0°
RES(SG)
100 ohm-m 100000
RES(FL)
0 ohm-m 3

Appendix 3

Borehole HFM07. Drawing no. 3.1. Borehole logs

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

Northing: 6697416.25m Easting: 1634715.69m Elevation: 5.78m, RHB70

Diameter:	139.6 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:	-84.52°
Azimuth:	342.32°
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9139/FDSB	mm
DENSITY	Compensated Densisty log	9139/FDSB	kg/m³
RES(SG)	Focused guard log resistivity, 128 cm	9139/FDSB	ohm-m
GAM(NAT)	Natural gamma	9072/NGAM	µR/h
TEMP(FL)	Fluid temperature	9042/TCME	deg C
RES(FL)	Fluid resistivity	9042/TCME	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072/TCME	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/MSUS	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT/BHTV	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT/BHTV	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT/BHTV	deg
DIP	Borehole inclination from horizontal	HiRAT/BHTV	deg
RADIUS	360 degrees orientated acoustic radius	HiRAT/BHTV	mm
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT/BHTV	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent

Rev.	Date	Drawn by	Control	Approved
1	2009-11-03	JRI	UTN	UTN

Job: 547310A

Scale: 1:500

RAMBØLL

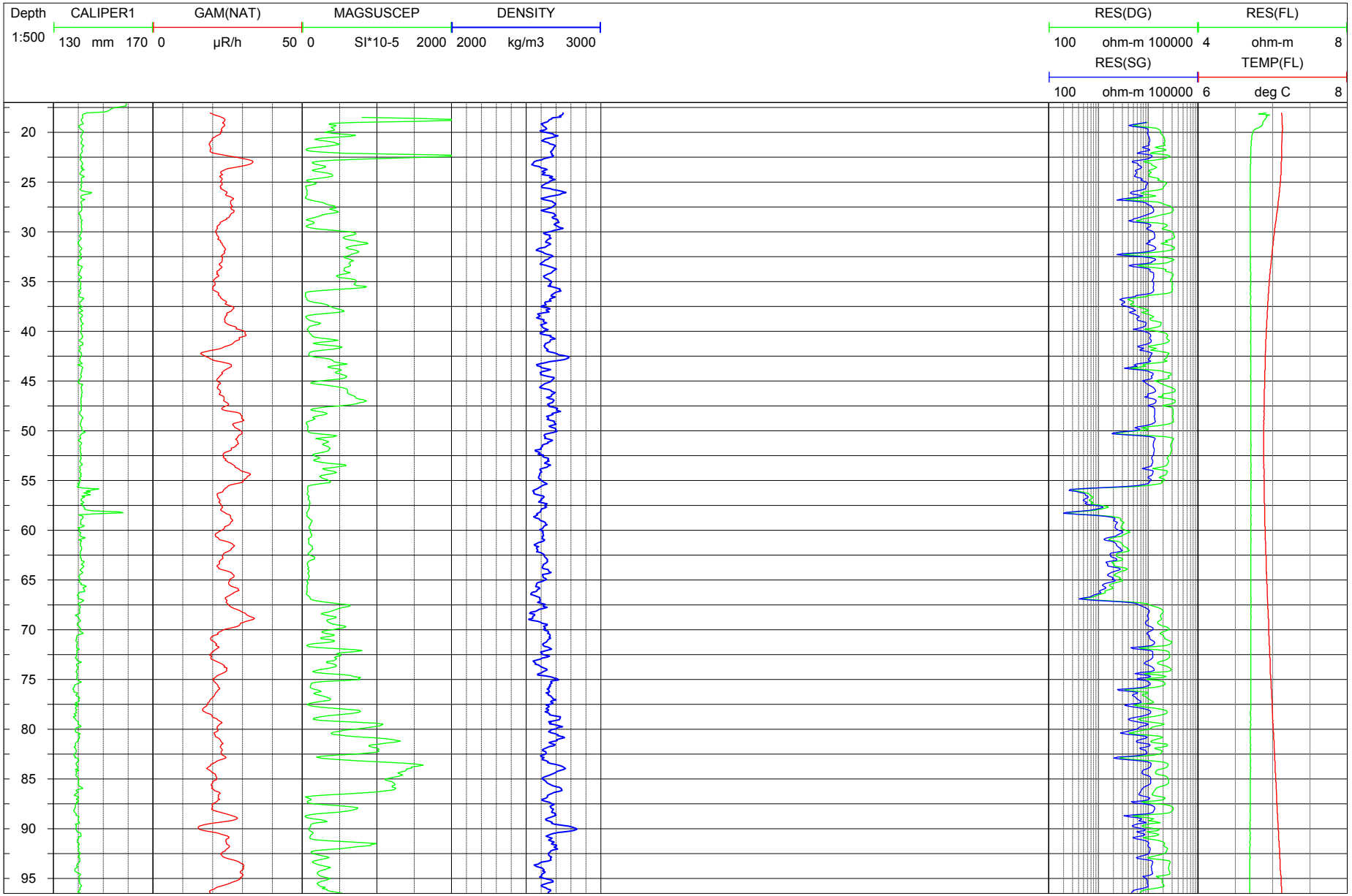
Rambøll. Bredevej 2, DK-2830 Virum
Phone + 45 45 98 60 00, Fax + 45 45 98 67 00

SKB geophysical borehole logging
Borehole HFM07

Presentation

Filename: HFM07_Presentation_Sep_2009.wcl

Drawing no.: **3.1**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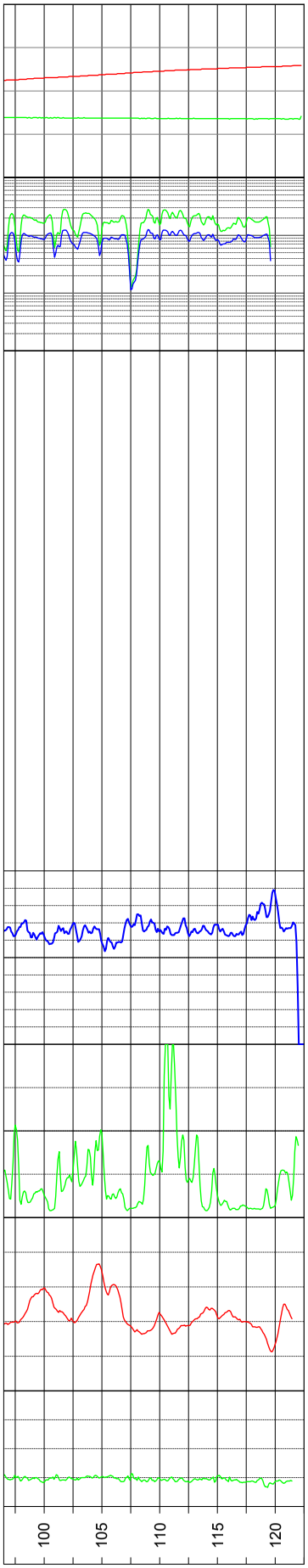
1:500
CALIPER1
130 mm 170
GAM(NAT)
0 µR/h 50
MAGSUSCEP
0 SI*10-5 2000
DENSITY
2000 kg/m3 3000
RES(DG)
100 ohm-m 100000
RES(FL)
4 ohm-m 8
RES(SG)
100 ohm-m 100000
TEMP(FL)
6 deg C 8
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95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110
115
120