P-04-144

Forsmark site investigation

Geophysical borehole logging in borehole KFM04A, KFM06A, HFM10, HFM11, HFM12 and HFM13

Uffe Torben Nielsen, Jørgen Ringgaard
RAMBØLL

June 2004

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

ISSN 1651-4416
SKB P-04-144

Forsmark site investigation

Geophysical borehole logging in borehole KFM04A, KFM06A, HFM10, HFM11, HFM12 and HFM13

Uffe Torben Nielsen, Jørgen Ringgaard
RAMBØLL

June 2004

Keywords: Geophysical logging, AP PF 400-03-89, Field note no Forsmark 301.

This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the authors and do not necessarily coincide with those of the client.

A pdf version of this document can be downloaded from www.skb.se

Summary

According to a request from Svensk Kärnbränslehantering AB, AP PF 400-03-89 /1/, geophysical borehole logging has been performed in borehole KFM04A, KFM06A, HFM10, HFM11, HFM12 and HFM13, all situated in Forsmark, Sweden. The logging in KFM04A was recorded from 0 m to 1000 m, KFM06A, HFM10, HFM11, HFM12 and HFM13 was recorded from 0 to the bottom of the borehole, between 100 and 200 m.

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

The processing of the data includes removing of spikes, negative data and data in the casing. All data are stretched. In boreholes without depth markers the data are stretched and shifted using one gamma event in the top of the borehole and one in the bottom. In boreholes with depth markers, all data are stretched to each marker

The logging data were delivered to SKB on CDs, the raw data in Century or Robertson format and the processed data in WellCad and Excel format.

Contents

1 Introduction

This document reports the data gained in November 2003 in Forsmark. The geophysical borehole logging operations presented include the boreholes KFM04A, KFM06A, HFM10, HFM11, HFM12 and HFM13, see Figure 1-1.

KFM04A and KFM06A are telescope boreholes, implying that the upper part, 0–100 m, is percussion drilled with a larger diameter and the remaining, major part of the borehole is core drilled. The core drilled part of the boreholes, 100–1000 m, has a diameter of c 76 mm. At the time of logging, only the upper part of KFM06A was completed. HFM10 –13 are percussion drilled with a diameter of c160 mm. All boreholes were recorded from ground level to the bottom of the borehole. The technical data from the boreholes are shown in Table 1-1.

The measurements were conducted by RAMBØLL during the period November 21–27 2003 in accordance with the instructions and guidelines from SKB (activity plan AP PF 400-03-89 and method description MD 221.002, SKB internal controlling documents).

Table 1-1. Technical data from the cored boreholes KFM04A and KFM06A (uppermost, percussion drilled part) and the percussion boreholes HFM10, HFM11, HFM12 and HFM13.

Boreholes Parameter	KFM04A	KFM06A	HFM10	HFM11	HFM12	HFM13
Co-ordinates	6698921.7 N	6699732.9 N	6698834.7 N	6697280 N	6697446.4 N	6699093.6 N
(RT90)	1630978.9 E	1632442.3 E	1631037.1 E	1631634 E	1631695.6 E	1631474.4 E
Elevation (RHB70)	8.771 m	4.1 m	4.986 m	7.559 m	7.025 m	5.687 m
Azimuth	45.24°	45°	92.93°	60°	245°	51°
Inclination at ground surface	60.08°	60°	68.7°	50°	49°	58.8°
Length	1001.42 m	95 m	150 m	182.35 m	209.5 m	175.6 m
Casing	108 m	15 m	13 m	12 m	14.9 m	14.9 m
Cleaning level	Level 2	Level 2	Level 2	Level 1	Level 1	Level 2
Borehole diameter	76 mm	160 mm	160 mm	160 mm	160 mm	160 mm

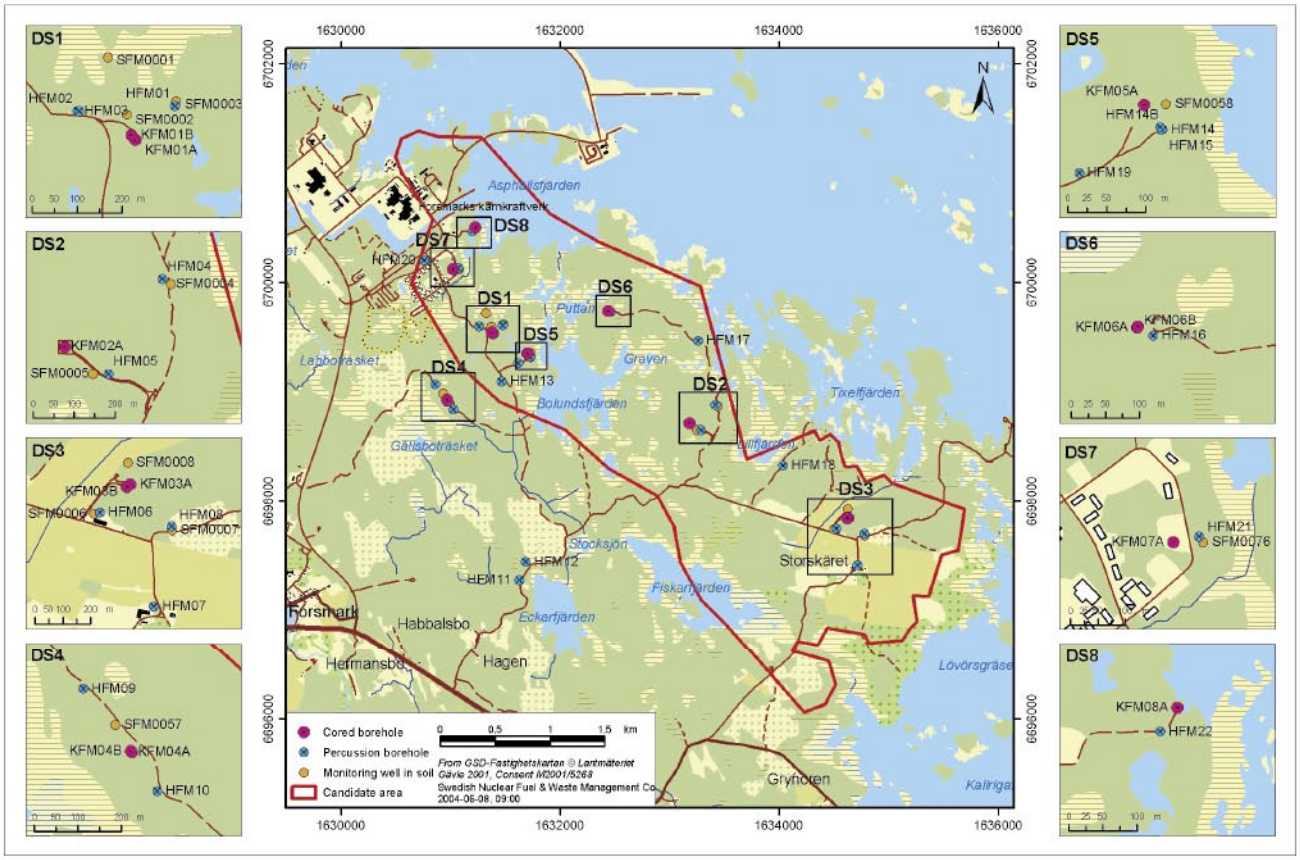


Figure 1-1. *Drill sites at Forsmark. KFM04A and HFM10 are located at drill site 4 and KFM06A at drill site 6. HFM11 and HFM12 are drilled NW of Eckarfjärden on the Eckarfjärden deformation zone and HFM13 on an inferred lineament SW of drill site 5.*

2 Objective and scope

The objective of the surveys 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. Also the deviation of the borehole is determined.

This report describes the equipment used as well the measurement procedures. Geophysical borehole logging data are presented in Appendix 1 to 6.

3 Equipment

The geophysical borehole logging programme in all boreholes was performed with 6 multi tool probes and resulted in a suite of 21 log types, listed in Table 5-1 (se Section 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 9030 Gamma density	Gamma density, natural gamma, 140 cm focused guard log resistivity, 10 cm 1-arm calliper	307·5.6 cm	20.3 cm 125 mCi Cs137	Sidewall Gamma source focused
Century 9044 Normal resistivity and Single point resistance	Fluid Conductivity, Fluid Temperature, Normal resistivity (16 and 64 inch), single point resistance and natural gamma.	237·5.3 cm		–
Century 9072 3 m focused guard	3 m focused guard log resistivity and natural gamma	310·6.4 cm		–
Century 9310 Sonic	Full wave form travel-time providing P and S-wave velocity picking, compensated P-wave travel-time and natural gamma	300·6.1 cm	Near 91.4 cm. Far 121.9 cm.	Centralized
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/dip and natural gamma	246·4 cm		Centralized

4 Execution

In general the measurement procedures follow the SKB method description MD 221.002, Version 1.0 (“Metodbeskrivning för geofysisk borrhålsloggning”). The logging programme was executed in the period November 21–27, 2003. All relevant logging events were described in the daily report sheets.

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 according to the SKB method description MD 600.004, Version 1.0 (“Metodbeskrivning för rengöring av borrhålsutrustning och viss markbaserad utrustning”) before arriving at the site.

For control, each log run is normally recorded both in downward and in upward direction using the down run as a repeat section. For logging tools 9030 and 9310, a repeat section is made in upward direction. 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 using Century equipment.

All data was recorded with max10 cm sample interval. The speed of the logging tools was in general 10 m/min for the used log runs, except for the HiRAT Acoustic tool where the speed was 2.4 m/min.

5 Results

5.1 Presentation

Table 5-1 lists the logs presented in Appendix 1 to 6. The logs have not been filtered during logging or presentation.

Table 5-1. Logs presented in Appendix 1 to 6.

Log	Log name short	Unit	Tool
Magnetic susceptibility	MAGSUSCEP	SI*10–5	8622
Caliper, 1-arm	CALIPER1	mm	9030
Gamma-gamma density	DENSITY	kg/m^3	9030
Focused guard log resistivity, 140 cm	RES(MG)	ohm–m	9030
Natural gamma	GAM(NAT)	µR/h	9030
Fluid temperature	TEMP(FL)	deg C	9044
Fluid resistivity	RES(FL)	ohm–m	9044
Normal resistivity 16 inch	RES(16N)	ohm–m	9044
Normal resistivity 64 inch	RES(64N)	ohm–m	9044
Lateral resistivity	LATERAL	ohm–m	9044
Single point resistance	SPR	ohm	9044
Focused guard log resistivity, 300 cm	RES(DG)	ohm–m	9072
P-wave velocity	P-VEL	m/s	9310
Full wave form, near receiver	AMP(N)	µs	9310
Full wave form, far receiver	AMP(F)	µs	9310
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 Orientations, alignment and stretch of logs

5.2.1 Orientation of images

The orientation of the results from the HiRAT Acoustic tool, are done after recording. The orientation is done using the raw data from the magnetometers and accelerometers, where spikes and disturbed data are deleted or filtered away.

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. When applicable, overlapping data from the topmost-recorded file is always used (overlapping data are never the mean value from two log runs).

5.2.3 Alignment of data

In order to obtain an exact depth 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 HiRAT Acoustic tool. The depths from the track marks and from the HiRAT tool are used to make a new depth scale in WellCAD. All log files are shifted using the new depth scale.

5.2.4 Stretch of logs

There is a minor difference in the used winch between up- and down runs in the depth registration. The size of the defect is about 1.5 m/km. To compensate for this the logs are stretched using a new depth scale for each tool. The depth scale is established 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 depth scale is added to the log.

5.2.5 Removing of data

The processing of the data includes removing of spikes, negative values and data in the casing. The caliper logs, azimuth and dip have not been removed in the casing.

5.2.6 Repicking of sonic log

The sonic velocity is normally calculated using an automatic picking routine in the sonic tool, 9310. In inclined boreholes the routine is often picking the wrong arrivals, due to so-called “road noise”. Therefore all sonic logs have been manually repicked in WellCAD using the full wave signal.

5.3 Calculated log curves

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

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 1000.
Focused guard log resistivity, 140 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	–
Normal resistivity 16 inch	–
Normal resistivity 64 inch	–
Lateral resistivity	–
Single point resistance	–
Focused guard log resistivity, 300 cm	–
P-wave velocity	The P-VEL is calculated using the difference in distance between the far and near receiver divided by the difference between the first arrival from the far and near signal. (121.9 cm–91.4 cm)/(Time(far) – Time(near)).
Full wave form, near receiver	–
Full wave form, far receiver	–
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 acoustical televiewer, the fluid temperature, fluid velocity and the internal travel time in the acoustical televiewer.
Borehole azimuth magnetic north	See 5.3.1
Borehole Inclination from lateral	See 5.3.1
360° orientated acoustic travel time	–
360° orientated acoustic travel time	–

5.3.1 Calculation of coordinates

To convert the measured azimuth and inclination to grid-coordinates, one needs to take into account the magnetic declination at the site at the time of data acquisition. The actual declination was found by means of the current International Geomagnetic Reference Field (IGRF), see Table 5-3. The actual values can be found below. Disturbances from solar storms etc were not taken into account. By means of the “Radius of Curvature” method implemented in WellCad, the azimuth and inclination were converted to northing, easting and TVD coordinates relative to the top of the borehole (top of casing, TOC). In the same calculation, the magnetic declination was added. Finally, the relative coordinates were added to the given TOC-coordinates (XYZ) in RT90 2.5 gon W and RH70B.

Table 5-3. International Geomagnetic Reference Field (IGRF2000) components.

Location	
Latitude (North)	60 deg 23 min 18 sec
Longitude (East)	18 deg 11 min 22 sec
Elevation	0.00 km
Date of interest	2003-11-23
Magnetic field components	
Declination (east)	4 deg 2 min
Inclination (down)	73 deg 8 min

5.4 Borehole KFM04A

In order to obtain an exact depth calibration, as described in 5.2.3, the track marks are used. The connection between the track marks and the logs is obtained from the HiRAT Acoustic tool.

To obtain a common depth reference point, the track mark at 128.43 m in the HiRAT file is used as the marker at depth 119 m. The HiRAT tool is therefore shifted 9.43 m up. The same correction value is used for the whole boring.

The reference mark made in the borehole, the recorded track marks from the HiRAT and the corrected depth are observed in the following depths, Table 5-4.

Due to recording error, the raw data from the sonic log have been stretched in the interval from 0 to 500 m, using the natural gamma from the HiRAT as reference.

Table 5-4. The reference mark made in the borehole, the recorded track marks form the HiRAT and the corrected depth.

Reference mark	HiRAT recorded	HiRAT after shift
119.00	128.43	119.000
150.00	159.47	150.040
200.00	209.51	200.080
250.00	259.47	250.040
300.00	309.55	300.120
350.00	359.61	350.180
400.00	409.68	400.250
450.00	459.7	450.270
500.00	509.75	500.320
550.00	559.84	550.410
600.00	609.87	600.440
650.00	659.9	650.470
700.00	710.02	700.590
750.00	760.06	750.630
800.00	810.2	800.770
850.00	860.28	850.850
900.00	910.22	900.790
950.00	960.39	950.960

A new depth scale is made using the corrected depth shown in Table 5-4. The new depth scale is applied to the HiRAT file. In this way a perfect match between given depths of the reference marks and the recorded data is obtained. By means of alignment of the observed gamma events in Table 5-5, between all log runs, the obtained reference mark correlation is transferred to the other logs.

Table 5-5. Gamma events in borehole KFM04A.

Events	Depths (m)
Top event	113.7
Mid event	532
Bottom event	996.6

The complete log suite for borehole KFM04A is presented as composite log sheets in Appendix 1 (Drawing no 5.1.). The logs presented are listed in Table 5-1.

5.5 Borehole KFM06A

Using the natural gamma from the 9044 as reference, the natural gamma logs from the other probes are aligned to the same depth. A new depth scale is added to each log and the logs are stretched using the events shown in Table 5-6.

Table 5-6. Gamma events in borehole KFM06A.

Events	Depths (m)
Top event	13
Bottom event	88

The complete log suite for borehole KFM06A is presented as composite log sheets in Appendix 2 (Drawing no 6.1.). The logs presented are listed in Table 5-1.

5.6 Borehole HFM10

Using the natural gamma from the 9044 as reference, the natural gamma logs from the other probes are aligned to the same depth. A new depth scale is added to each log and afterwards the logs are stretched using the events shown in Table 5-7.

Table 5-7. Gamma events in borehole HFM10.

Events	Depths (m)
Top event	8.5
Bottom event	145.5

The complete log suite for borehole HFM10 is presented as composite log sheets in Appendix 3 (Drawing no 2.1.). The logs presented are listed in Table 5-1.

5.7 Borehole HFM11

Using the natural gamma from the 9044 as reference, the natural gamma logs from the other probes are aligned to the same depth. A new depth scale is added to each log and afterwards the logs are stretched using the events shown in Table 5-8.

Table 5-8. Gamma events in borehole HFM11.

Events	Depths (m)
Top event	14.5
Bottom event	177.5

The complete log suite for borehole HFM11 is presented as composite log sheets in Appendix 4 (Drawing no 2.1.). The logs presented are listed in Table 5-1.

5.8 Borehole HFM12

Using the natural gamma from the 9044 as reference, the natural gamma logs from the other probes are aligned to the same depth. A new depth scale is added to each log and afterwards the logs are stretched using the events shown in Table 5-9.

Table 5-9. Gamma events in borehole HFM12.

Events	Depths (m)
Top event	6.9
Bottom event	197.3

The complete log suite for borehole HFM12 is presented as composite log sheets in Appendix 5 (Drawing no 3.1.). The logs presented are listed in Table 5-1.

5.9 Borehole HFM13

Using the natural gamma from the 9044 as reference, the natural gamma logs from the other probes are aligned to the same depth. A new depth scale is added to each log and afterwards the logs are stretched using the events shown in Table 5-10.

Table 5-10. Gamma events in borehole HFM13.

Events	Depths (m)
Top event	9.74
Bottom event	88.3

The complete log suite for borehole HFM13 is presented as composite log sheets in Appendix 6 (Drawing no 4.1.). The logs presented are listed in Table 5-1.

6 Data delivery

Apart from the present report, a comprehensive field report was delivered to SKB /1/. The field report comprises logging reports, processing logs, logging reference point descriptions and cleaning and probe sensor descriptions. The calibration values from the probes 8622, 9030 and 9072 are also included (probe 9320 and HiRAT shall not be calibrated).

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

The processed files were delivered in both WellCAD, Table 6-2, and as excel files in SICADA format, Table 6-3. The different excel sheets (one for each log) in SICADA format are listed in Table 6-4.

The Sicada reference to the data from the logging operations is field note no Forsmark 301.

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

Borehole	Probe	Log direction	WellCAD File
KFM04A	8622	Up	KFM04A_11-21-03_18-48_8622C_.04_12.05_1002.01_PROC.log
KFM04A	9030	Up	KFM04A_11-23-03_15-55_9030CA_.04_677.09_1002.09_ORIG.log
KFM04A	9030	Up	KFM04A_11-23-03_16-37_9030CA_.04_0.84_687.84_ORIG.log
KFM04A	9044	Down	KFM04A_11-24-03_07-38_9044C_.04_0.28_998.66_ORIG.log
KFM04A	9072	Up	KFM04A_11-23-03_18-20_9072C_.04_1.16_1000.97_ORIG.log
KFM04A	9310	Up	KFM04A_11-24-03_17-39_9310C2_.02_111.82_1000.93_ORIG.log
KFM04A	HiRAT	Up	KFM04A_HiRAT_120pixels_up_run2.HED
KFM04A	HiRAT	Up	KFM04A_HiRAT_120pixels_up_run3.HED
KFM06A	8622	Up	KFM06A_11-25-03_16-26_8622C_.02_0.30_99.48_ORIG.log
KFM06A	9030	Up	KFM06A_11-25-03_17-33_9030CA_.02_0.62_99.60_ORIG.log
KFM06A	9044	Down	KFM06A_11-25-03_15-43_9044C_.02_0.28_99.56_ORIG.log
KFM06A	9072	Up	KFM06A_11-25-03_16-55_9072C_.02_0.56_100.08_ORIG.log
KFM06A	9310	Up	KFM06A_11-25-03_19-54_9310C2_.02_0.12_98.78_ORIG.log
KFM06A	HiRAT	Up	KFM06A_HiRAT_360pixels_up_run3.HED
HFM10	8622	Up	HFM10_11-27-03_20-44_8622C_.02_0.34_149.03_ORIG.log
HFM10	9030	Up	HFM10_11-27-03_19-35_9030CA_.02_0.72_149.23_ORIG.log
HFM10	9044	Down	HFM10_11-27-03_16-39_9044C_.02_0.24_148.73_ORIG.log
HFM10	9072	Up	HFM10_11-27-03_20-13_9072C_.02_0.52_149.21_ORIG.log
HFM10	9310	Up	HFM10_11-27-03_18-51_9310C2_.02_0.44_148.31_ORIG.log
HFM10	HiRAT	Up	HFM10_HiRAT_180pixels_up_run2.HED

Borehole	Probe	Log direction	WellCAD File
HFM11	8622	Up	HFM11_11-27-03_14-55_8622C_.02_0.34_181.19_ORIG.log
HFM11	9030	Up	HFM11_11-27-03_13-35_9030CA_.02_0.38_181.57_ORIG.log
HFM11	9044	Down	HFM11_11-27-03_09-51_9044C_.02_0.24_194.32_ORIG.log
HFM11	9072	Up	HFM11_11-27-03_14-19_9072C_.02_0.48_182.05_ORIG.log
HFM11	9310	Up	HFM11_11-27-03_12-34_9310C2_.02_0.28_181.25_ORIG.log
HFM11	HiRAT	Up	HFM11_HiRAT_180pixels_up_run2.LGX
HFM12	8622	Up	HFM12_11-26-03_14-33_8622C_.10_-0.50_209.70_ORIG.log
HFM12	9030	Up	HFM12_11-26-03_15-26_9030CA_.02_27.40_207.40_ORIG.log
HFM12	9030	Up	HFM12_11-26-03_15-58_9030CA_.02_-0.26_30.79_ORIG.log
HFM12	9044	Down	HFM12_11-26-03_13-39_9044C_.10_0.10_208.30_ORIG.log
HFM12	9072	Up	HFM12_11-26-03_13-10_9072C_.10_-0.20_208.60_ORIG.log
HFM12	9310	Up	HFM12_11-26-03_17-54_9310C2_.02_-0.42_207.46_ORIG.log
HFM12	HiRAT	Up	HFM12_HiRAT_180pixels_up_run2.HED
HFM12	HiRAT	Up	HFM12_HiRAT_180pixels_up_run4.HED
HFM13	8622	Up	HFM13_11-21-03_10-01_8622C_.04_-0.04_178.83_ORIG.log
HFM13	9030	Up	HFM13_11-25-03_09-22_9030CA_.02_0.90_175.58_ORIG.log
HFM13	9044	Down	HFM13_11-25-03_08-23_9044C_.02_0.28_174.62_ORIG.log
HFM13	9072	Up	HFM13_11-21-03_10-43_9072C_.04_0.36_175.56_ORIG.log
HFM13	9310	Up	HFM13_11-21-03_14-18_9310C2_.02_0.50_174.26_ORIG.log
HFM13	HiRAT	Up	HFM13_HiRAT_180pixels_up_run3.LGX

Table 6-2. Drawing files in WellCad format

Borehole	Drawing	WellCad file
HFM10	1.1	HFM10_Presentation.WCL
HFM10	1.2	HFM10_Deviation.WCL
HFM10	1.3	HFM10_Deviation.WCL
HFM11	2.1	HFM11_Presentation.WCL
HFM11	2.2	HFM11_Deviation.WCL
HFM11	2.3	HFM11_Deviation.WCL
HFM12	3.1	HFM12_Presentation.WCL
HFM12	3.2	HFM12_Deviation.WCL
HFM12	3.3	HFM12_Deviation.WCL
HFM13	4.1	HFM13_Presentation.WCL
HFM13	4.2	HFM13_Deviation.WCL
HFM13	4.3	HFM13_Deviation.WCL
KFM04A	5.1	KFM04A _Presentation.WCL
KFM04A	5.2	KFM04A _Deviation.WCL
KFM04A	5.3	KFM04A _Deviation.WCL
KFM06A	6.1	KFM06A _Presentation.WCL
KFM06A	6.2	KFM06A _Deviation.WCL
KFM06A	6.3	KFM06A _Deviation.WCL

Table 6-3. Data files in excel, in SICADA format

Borehole	Excel file
HFM10	HFM10 _data.xls
HFM11	HFM11 _data.xls
HFM12	HFM12_data.xls
HFM13	HFM13 _data.xls
KFM04A	KFM04A_data.xls
KFM06A	KFM06A_data.xls

Table 6-4. Sheets included in the excel files, in SICADA format

Sheet	Other
Acoustic televiewer	See description of “total magnetic field” and “magnetic inclination” below
Focused resistivity 140 cm	
Focused resistivity 300 cm	
Fullwave sonic	column: v_velocity (shear wave), not interpreted from the recorded data
Caliper1	
Caliper Mean	Calculated using Fluid resistivity and Acoustic televiewer
Fluid resistivity	
Fluid Temperature	
Density	
Resistivity	
Natural gamma	
Single point resistivity	
Magnetic susceptibility	

Calculation of the total magnetic field

The data delivered in the “tot magn field” column, in the “Acoustic televiewer” sheet, was calculated as the square root of the sum of the 3 components, from the magnetometer in the HiRAT probe, squared.

Calculation of the magnetic inclination

The data delivered in the “magn_inclination” column, in the “Acoustic televiewer” sheet, was found by calculating the angle between the z component and the summarized vector of the x and y components from the magnetometer in the HiRAT probe.

The calculation do not include the inclination of the borehole, all boreholes are in the calculation defined to be vertical.

7 References

/1/ **Nielsen, U T, Ringgaard J, 2004.** Geophysical borehole logging in borehole KFM04A, KFM06A, HFM10, HFM11, HFM12 and HFM13. Rambøll Report 20040305utnaa.

Appendix 1

Geophysical borehole logging, borehole KFM04A

Borehole No. KFM04A

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

Northing: 6698921.744m Easting: 1630978.964m Elevation: 8.771m

Diameter:	77.3mm
Reaming Diameter:	
Outer Casing:	
Inner Casing:	200mm
Borehole Length:	1001.42
Cone:	
Inclination at ground surface:	-60.08°
Azimuth:	45.24°
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030	mm
DENSITY	Gamma-gamma density	9030	kg/m³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9030	µR/h
TEMP(FL)	Fluid temperature	9042/9044	deg C
RES(FL)	Fluid resistivity	9042/9044	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9320	m/s
AMP(N)	Full wave form, near receiver	9320	µs
AMP(F)	Full wave form, far receiver	9320	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
TRAVEL TIME	360 degrees orientated acoustic travel time	HiRAT	100 ns
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	9044	ohm-m
RES(64N)	Normal resistivity 64 inch	9044	ohm-m
LATERAL	Lateral resistivity	9044	ohm-m
SPR	Single point resistivity	9044	ohm

Rev.	Date	Drawn by	Control	Approved
1	2004-02-08	JRI	UTN	UTN

Job 360210A

Scale 1:500

DGE Dansk Geo-servEx a/s
DGE, Händværkersvinget 11, 2970 Hørsholm, Phone +45 70 10 34 00, Fax + 45 39 16 39 90
RAMBØLL. Bredevej 2, DK-2830 Virum, Phone + 45 45 98 60 00, Fax + 45 45 98 67 00

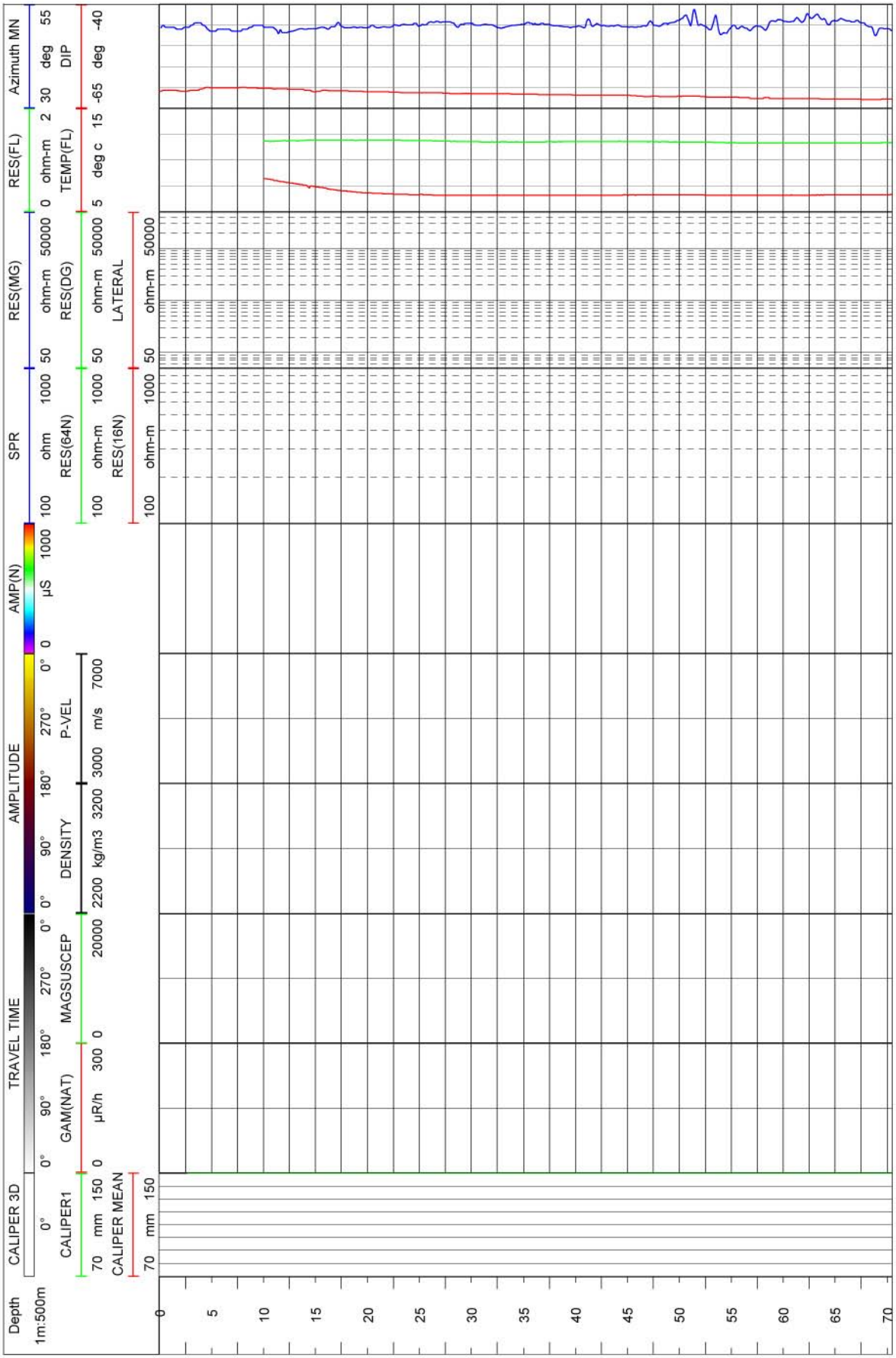
SKB geophysical borehole logging

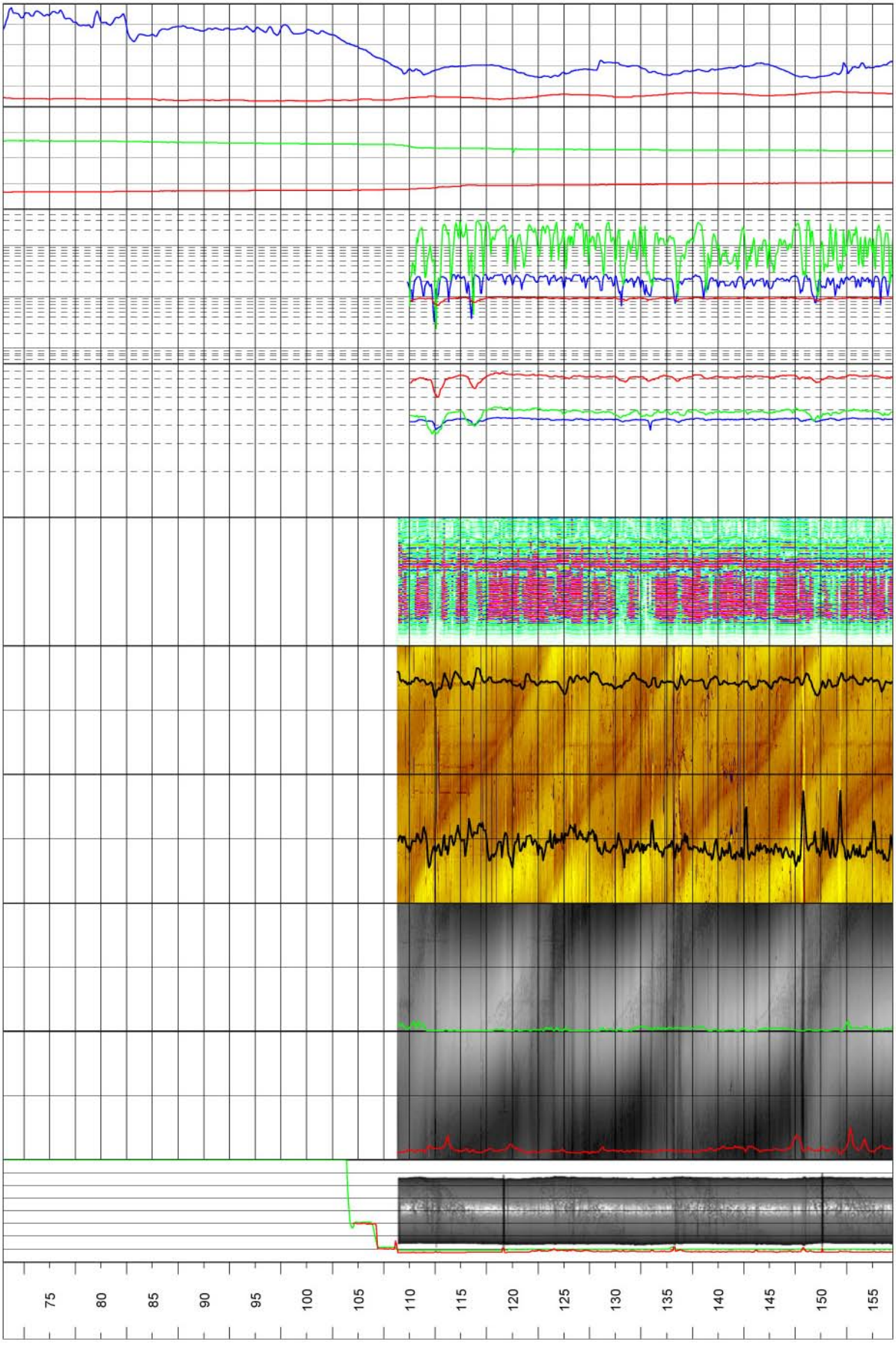
Borehole KFM04A. Forsmark

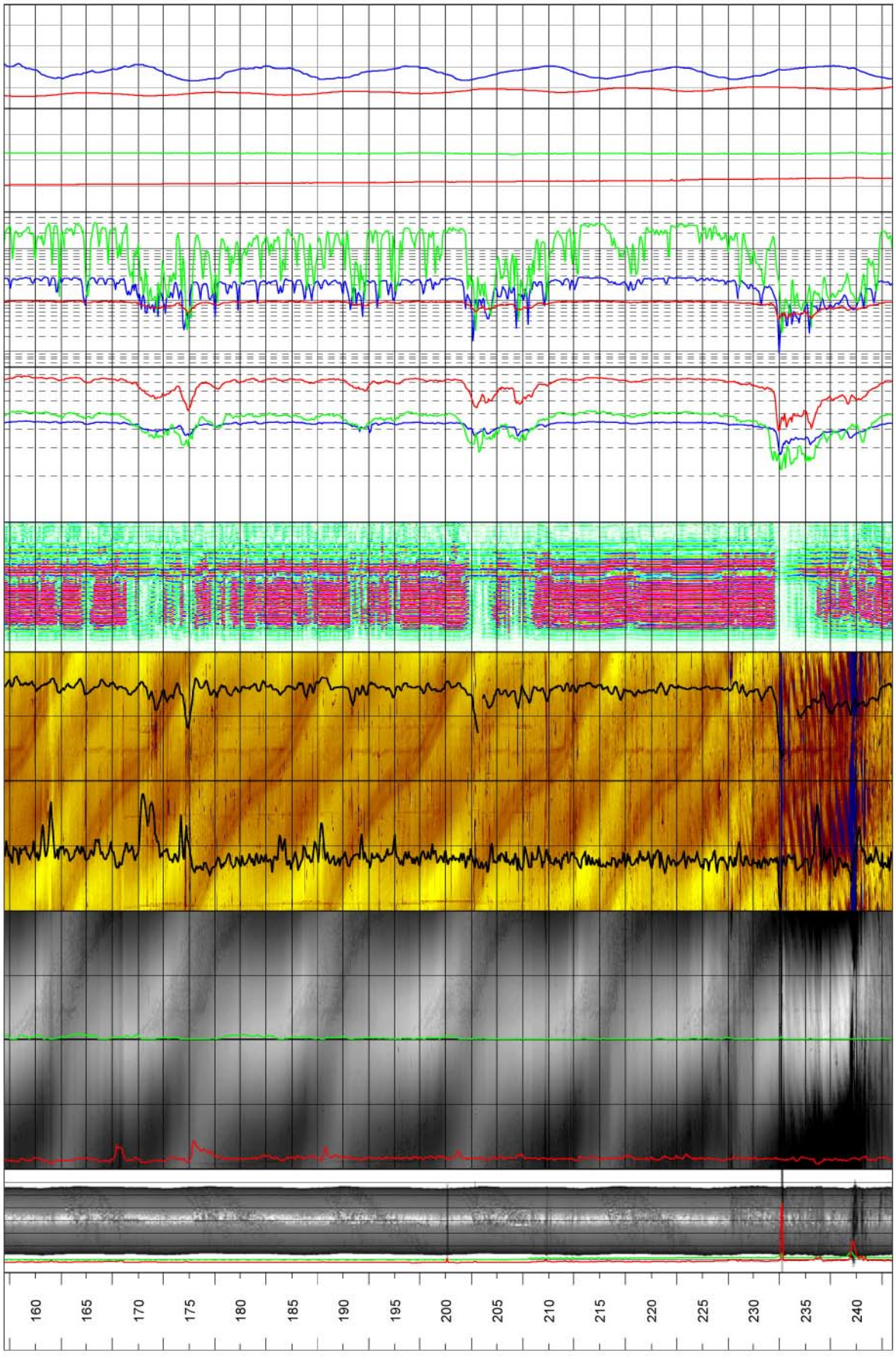
Presentation

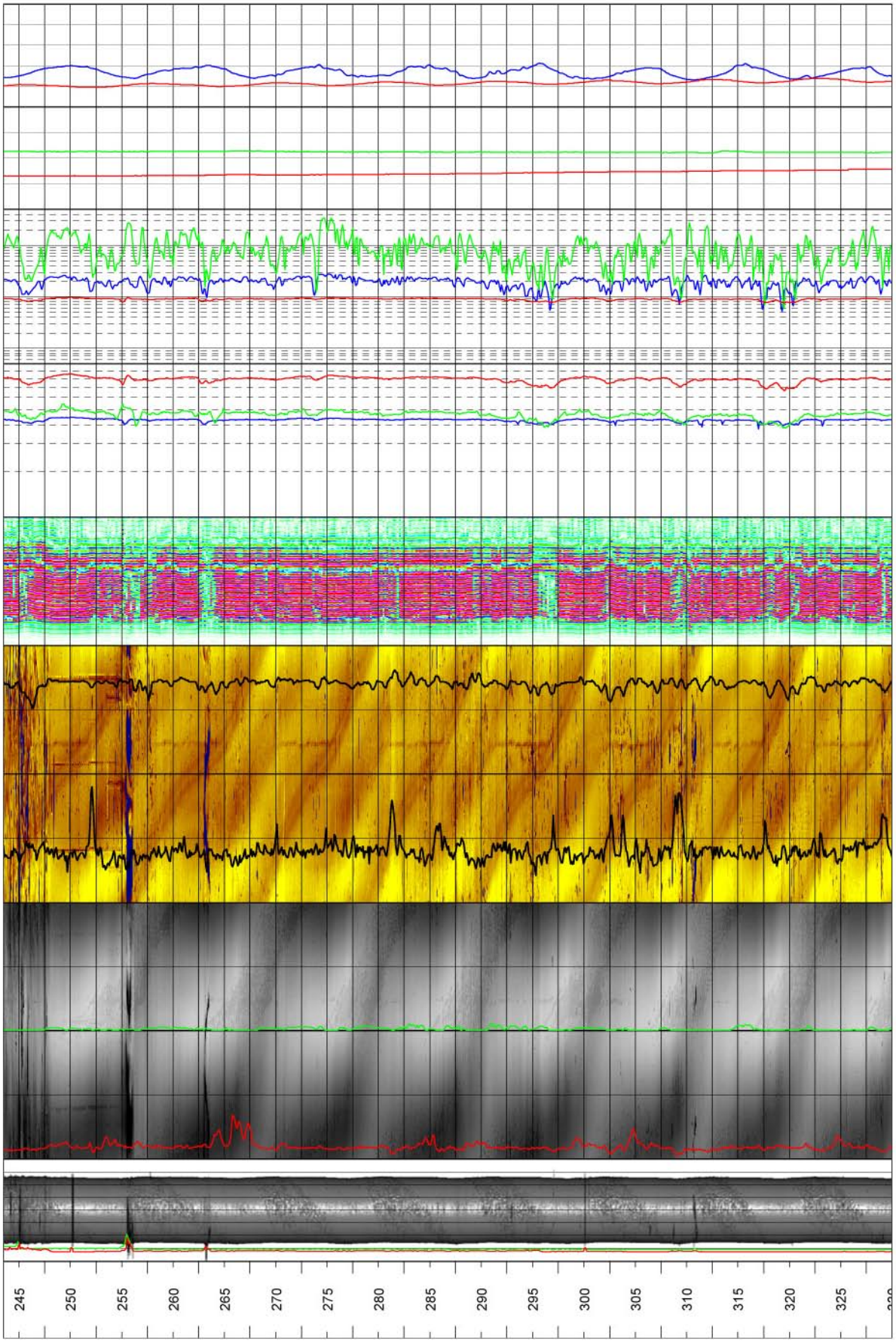
Filename: KFM04A_Presentation.wcl

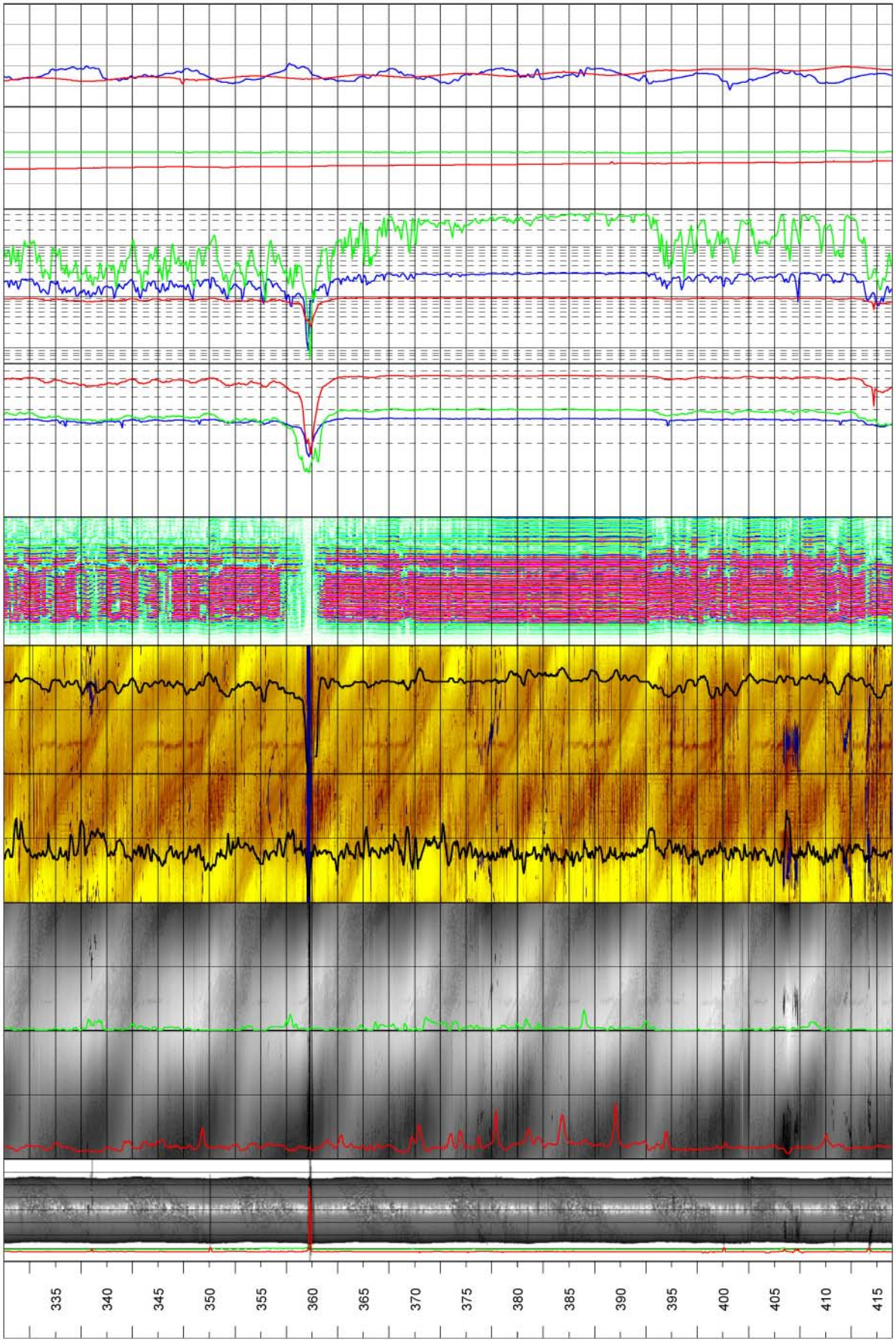
Drawing no.: **5.1**

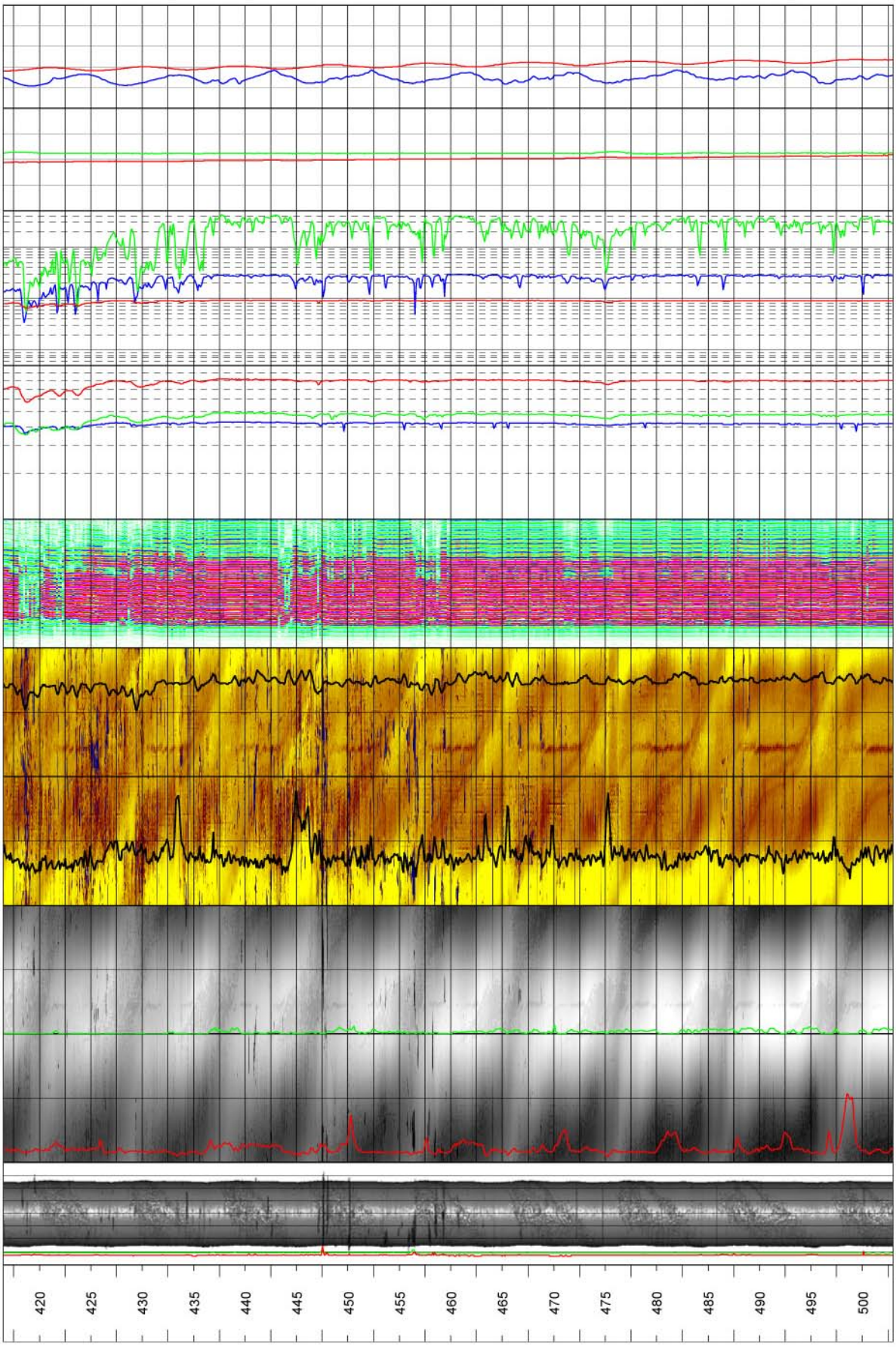

Depth
1m:500m
CALIPER 3D
0° 0° 90° 180° 270° 0°
CALIPER1
70 mm 150
CALIPER MEAN
70 mm 150
TRAVEL TIME
GAM(NAT)
0 µR/h 300
MAGSUSCEP
0 20000
AMPLITUDE
0° 90° 180° 270° 0°
DENSITY
2200 kg/m3 3200
P-VEL
3000 m/s 7000
AMP(N)
0° 0 µS 1000
SPR
100 ohm 1000
RES(64N)
100 ohm-m 1000
RES(16N)
100 ohm-m 1000
LATERAL
100 ohm-m 50000
RES(MG)
50 ohm-m 50000
RES(DG)
50 ohm-m 50000
RES(FL)
0 ohm-m 2 30
TEMP(FL)
5 deg c 15 -65
Azimuth MN
deg 55
DIP
deg -40
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

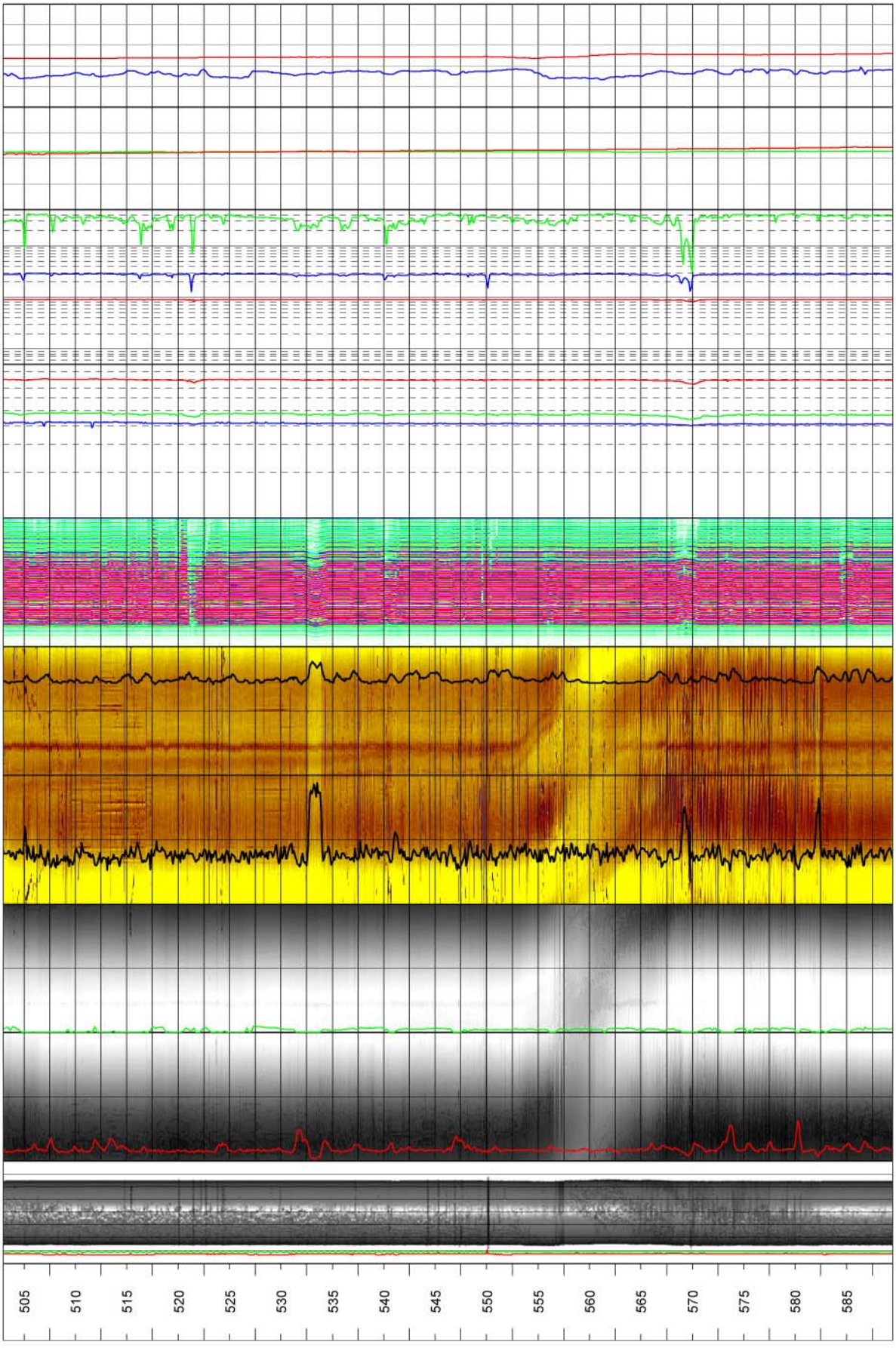

75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155

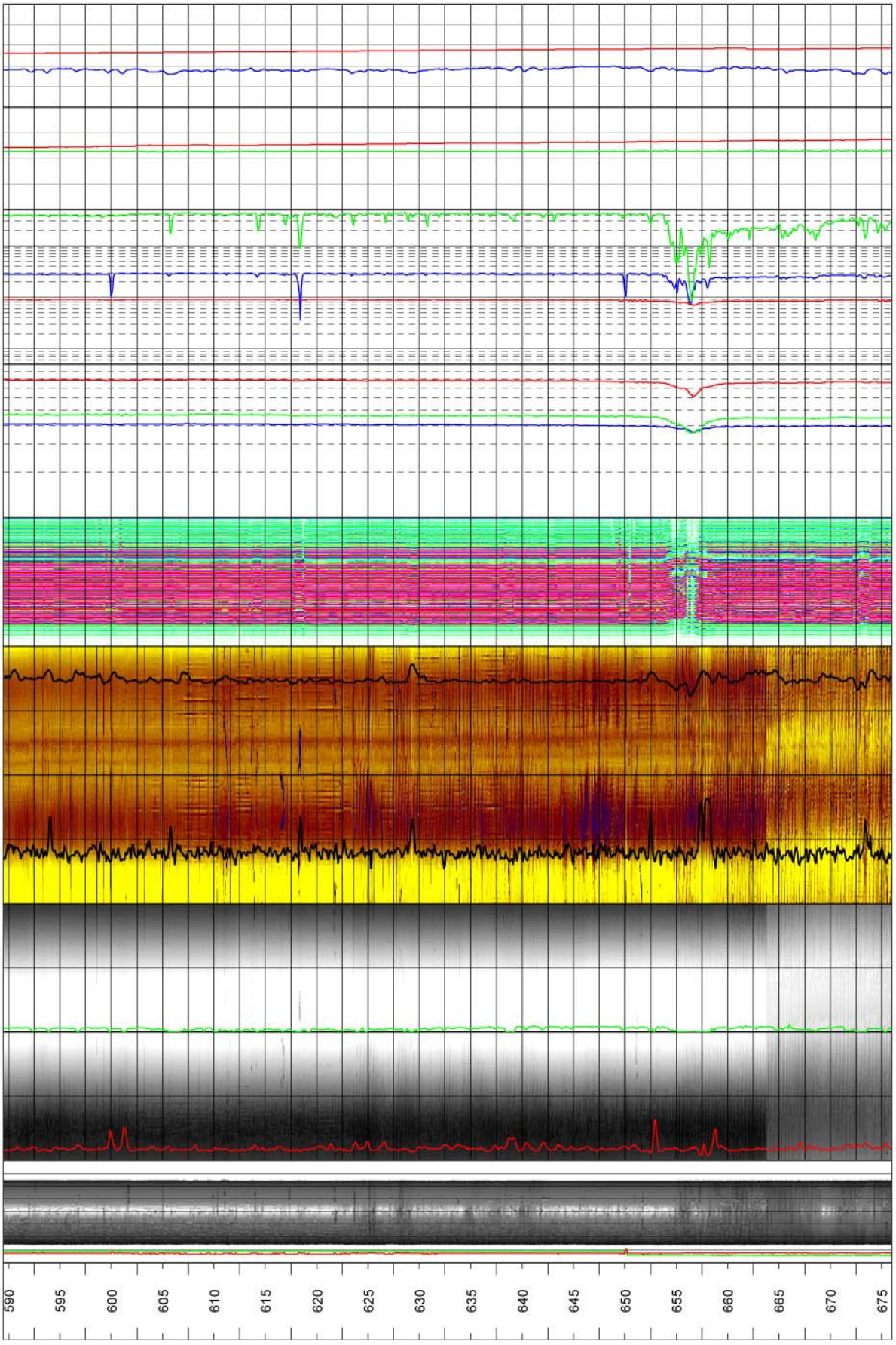

160
165
170
175
180
185
190
195
200
205
210
215
220
225
230
235
240

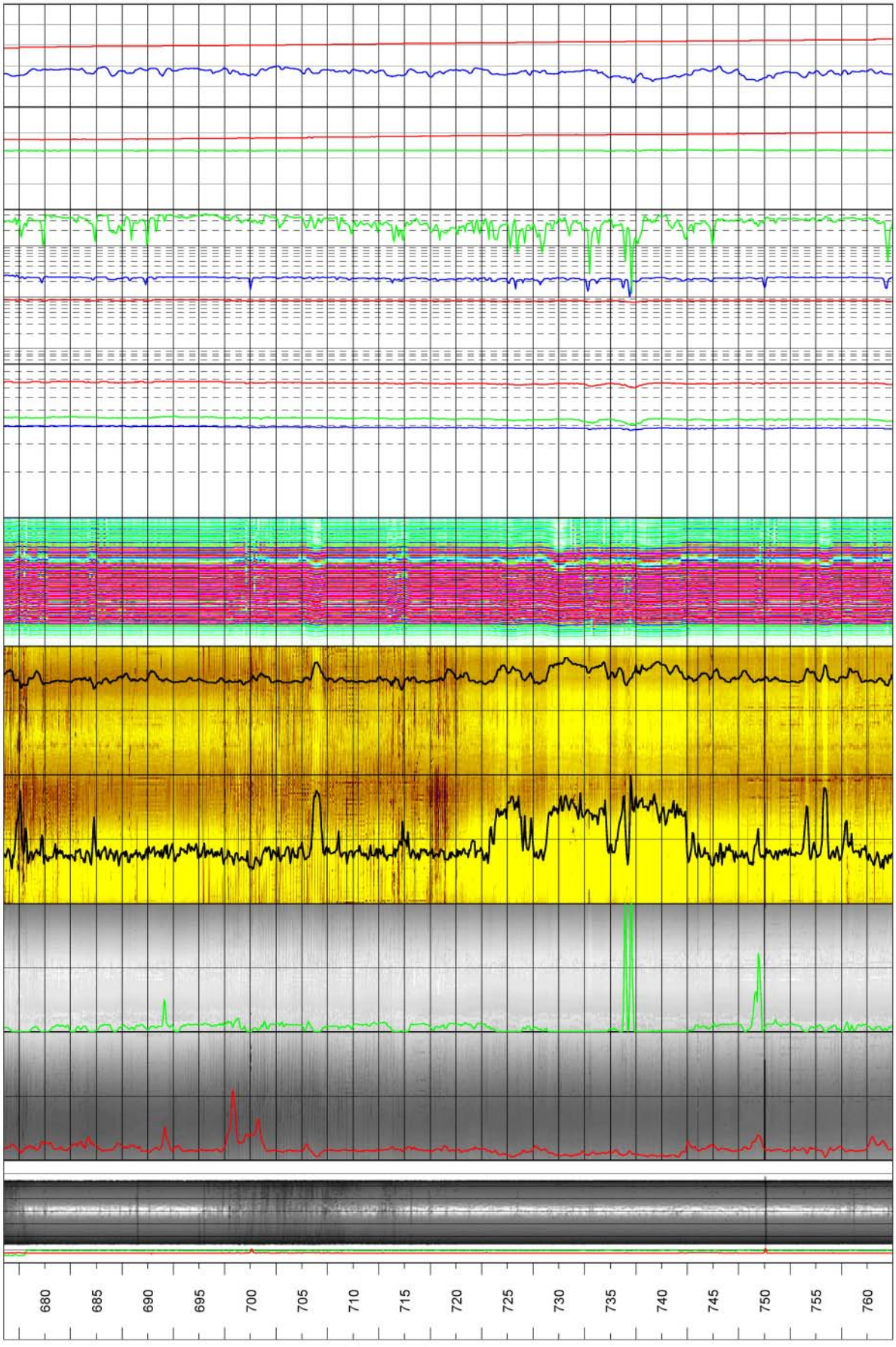

245
250
255
260
265
270
275
280
285
290
295
300
305
310
315
320
325


335
340
345
350
355
360
365
370
375
380
385
390
395
400
405
410
415

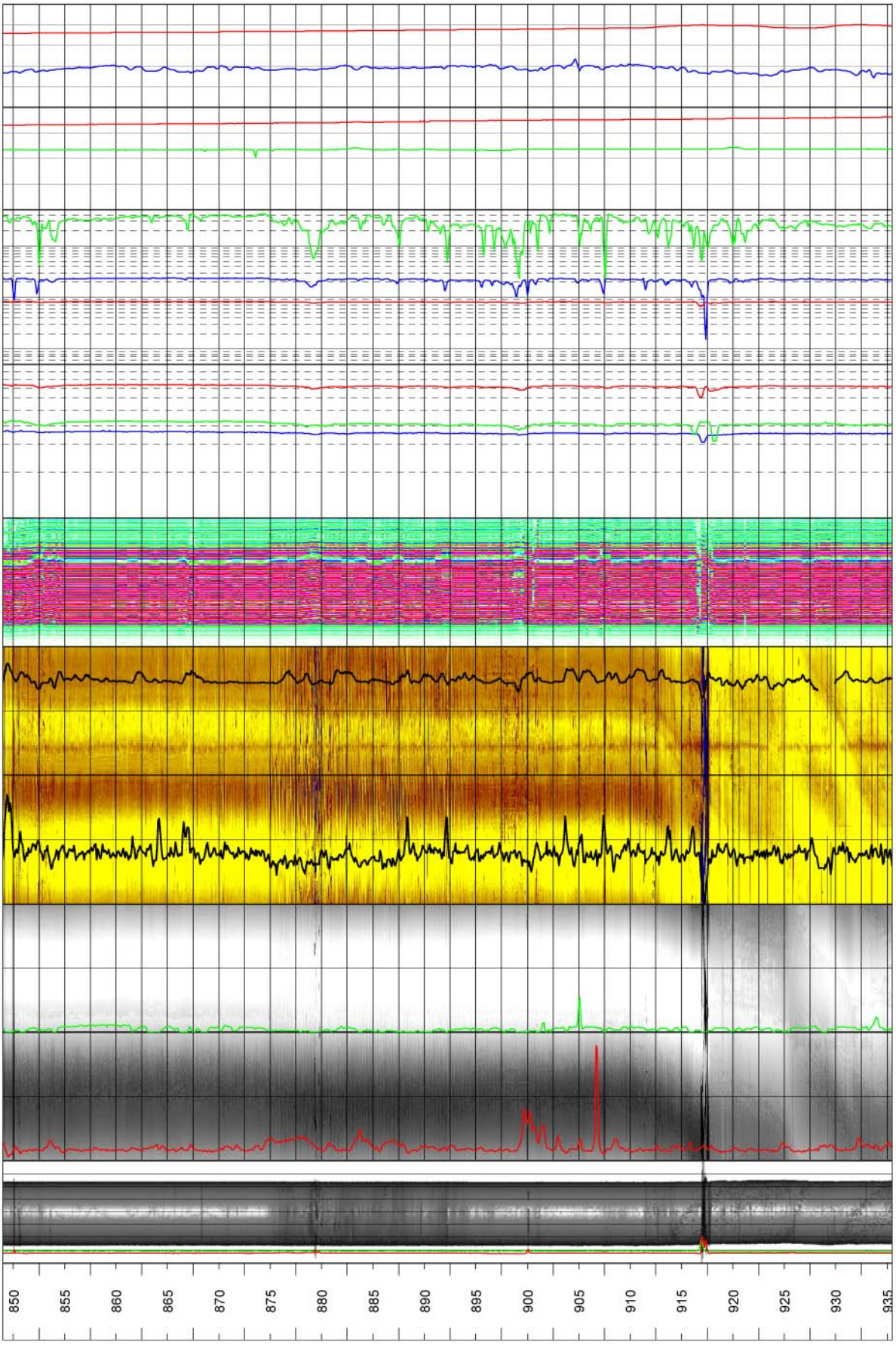

420
425
430
435
440
445
450
455
460
465
470
475
480
485
490
495
500

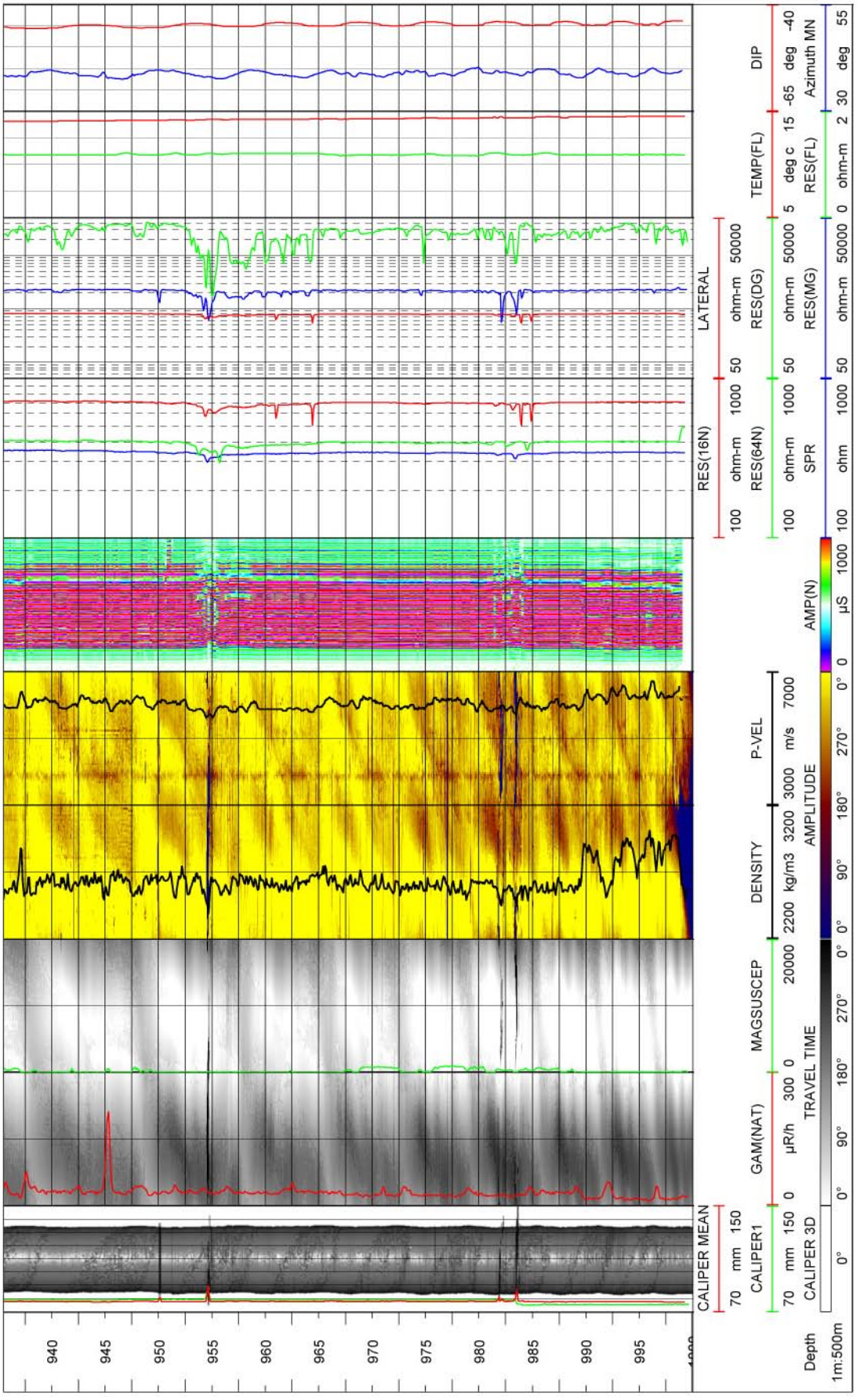

505
510
515
520
525
530
535
540
545
550
555
560
565
570
575
580
585


590
595
600
605
610
615
620
625
630
635
640
645
650
655
660
665
670
675


680
685
690
695
700
705
710
715
720
725
730
735
740
745
750
755
760


765
770
775
780
785
790
795
800
805
810
815
820
825
830
835
840
845


850
855
860
865
870
875
880
885
890
895
900
905
910
915
920
925
930
935


Depth
1m:500m
940
945
950
955
960
965
970
975
980
985
990
995
CALIPER MEAN
70 mm 150
CALIPER1
70 mm 150
CALIPER 3D
0° 0° 90° 180° 270° 0°
GAM(NAT)
0 µR/h 300
TRAVEL TIME
0 90° 180° 270° 0°
MAGSUSCEP
0 20000
DENSITY
2200 kg/m3 3200
AMPLITUDE
3000 m/s 7000
P-VEL
0° 90° 180° 270° 0°
AMP(N)
0 µS 1000
RES(16N)
100 ohm-m 1000
RES(64N)
100 ohm-m 1000
SPR
100 ohm 1000
LATERAL
50 ohm-m 50000
RES(DG)
50 ohm-m 50000
RES(MG)
50 ohm-m 50000
TEMP(FL)
5 deg c 15
RES(FL)
0 ohm-m 2
DIP
-65 deg -40
Azimuth MN
30 deg 55

Appendix 2

Geophysical borehole logging, borehole KFM06A

Borehole No. KFM06A

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

Northing: 6699732.9m Easting: 1632442.3m Elevation: 4.1m, RHB70

Diameter: 160mm
Reaming Diameter:
Outer Casing:
Inner Casing:
Borehole Length: 100m
Cone:
Inclination at ground surface:
Azimuth:
Comments:

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030	mm
DENSITY	Gamma-gamma density	9030	kg/m³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9030	µR/h
TEMP(FL)	Fluid temperature	8044	deg C
RES(FL)	Fluid resistivity	8044	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
TRAVEL TIME	360 degrees orientated acoustic travel time	HiRAT	100 ns
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	8044	ohm-m
RES(64N)	Normal resistivity 64 inch	8044	ohm-m
LATERAL	Lateral resistivity	8044	ohm-m
SPR	Single point resistivity	8044	ohm

Rev.	Date	Drawn by	Control	Approved
0	2004-02-09	JRI	UTN	UTN

Job 360210A

Scale 1:500

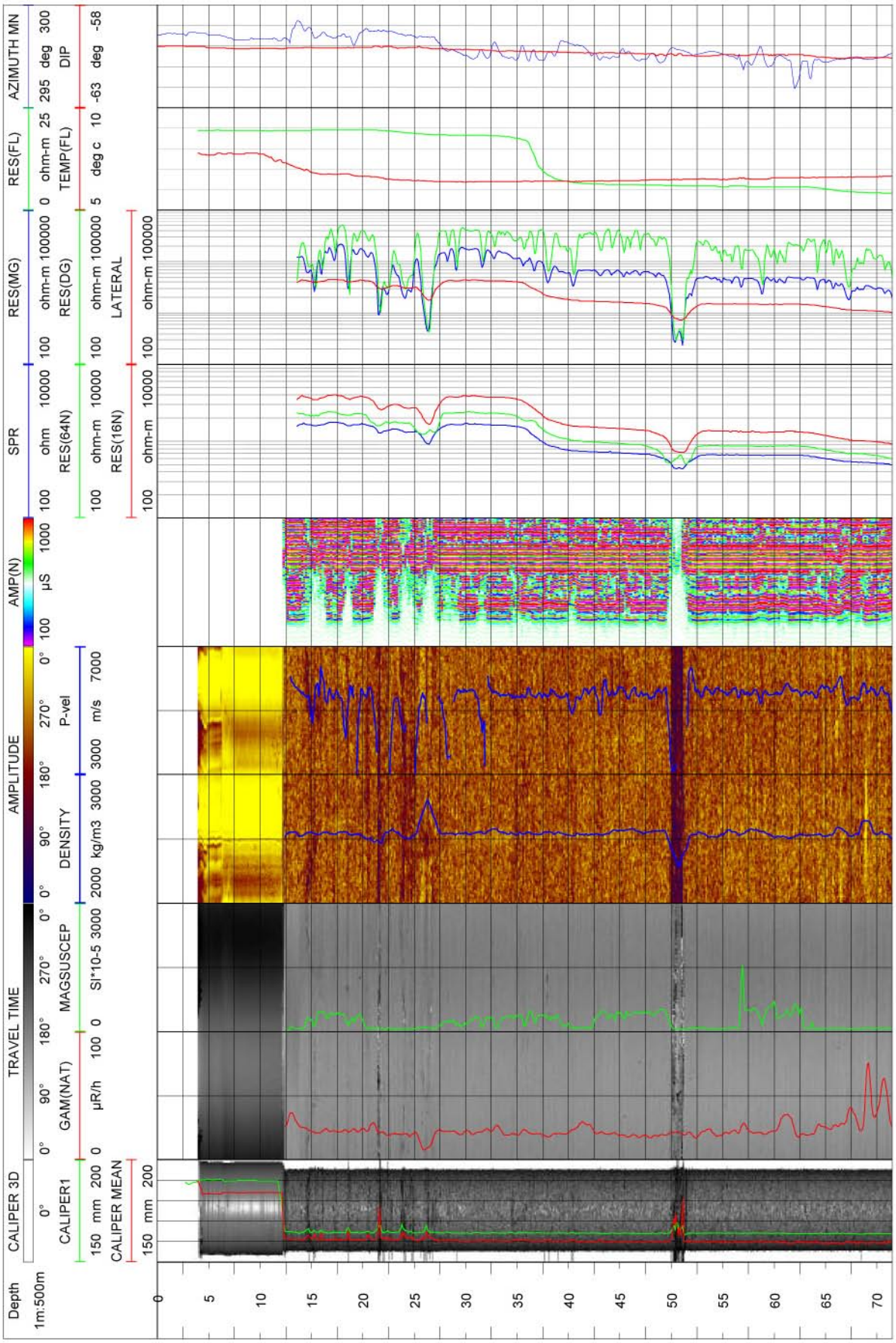
DGE, Håndværkersvinget 11, 2970 Hørsholm, Phone +45 70 10 34 00, Fax + 45 39 16 39 90
RAMBØLL. Bredevej 2, DK-2830 Virum, Phone + 45 45 98 60 00, Fax + 45 45 98 67 00

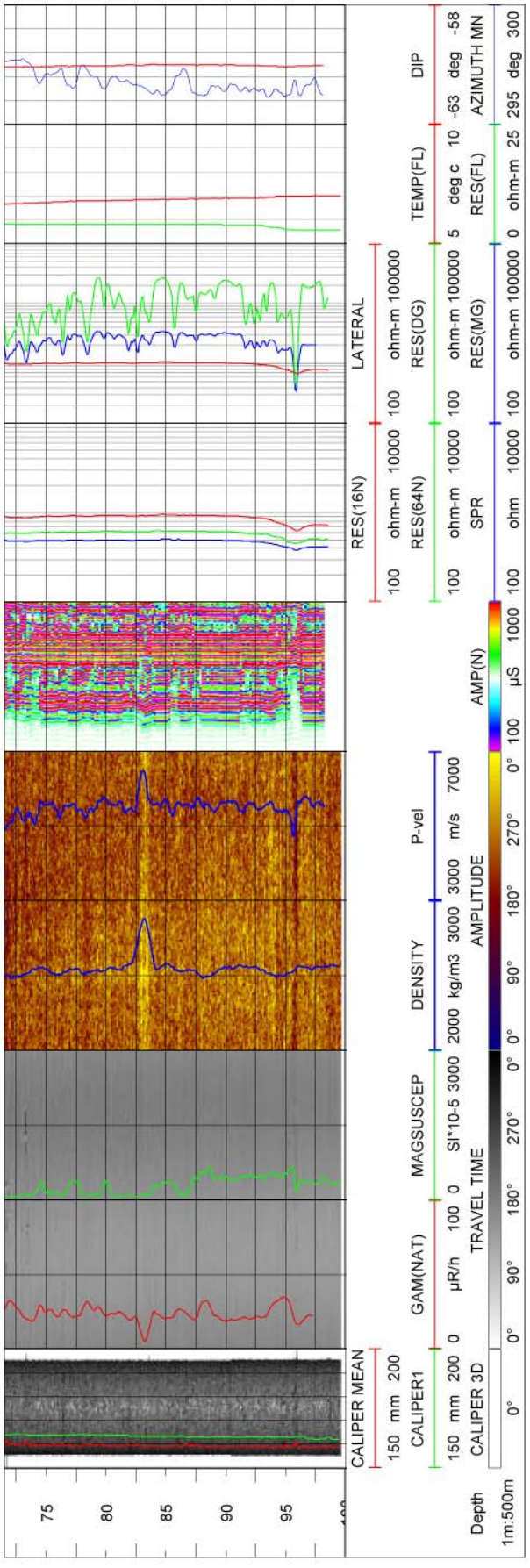
SKB geophysical borehole logging
Borehole KFM06A

Presentation

Filename: KFM06A_Presentation.wcl

Drawing no.: **6.1**


Depth
1m:500m
CALIPER 3D
0° 90° 180° 270° 0°
CALIPER1
150 mm 200
CALIPER MEAN
150 mm 200
TRAVEL TIME
GAM(NAT)
0 µR/h 100
MAGSUSCEP
0 SI*10-5 3000
AMPLITUDE
0° 90° 180° 270° 0°
DENSITY
2000 kg/m3 3000
P-vel
3000 m/s 7000
AMP(N)
100 µS 1000
SPR
100 ohm 10000
RES(64N)
100 ohm-m 10000
RES(16N)
100 ohm-m 10000
RES(MG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
LATERAL
100 ohm-m 100000
RES(FL)
0 ohm-m 25
TEMP(FL)
5 deg c 10
AZIMUTH MN
295 deg 300
DIP
-63 deg -58
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70


Depth
1m:500m
CALIPER 3D
0° 0° 90° 180° 270° 0°
TRAVEL TIME
CALIPER1
150 mm 200
CALIPER MEAN
150 mm 200
GAM(NAT)
0 µR/h 100
MAGSUSCEP
0 SI*10-5 3000
DENSITY
2000 kg/m3 3000
AMPLITUDE
P-vel
3000 m/s 7000
AMP(N)
0° 0° 90° 180° 270° 0°
100 µS 1000
RES(16N)
100 ohm-m 10000
RES(64N)
100 ohm-m 10000
SPR
100 ohm 10000
LATERAL
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
RES(MG)
100 ohm-m 100000
TEMP(FL)
5 deg c 10
RES(FL)
0 ohm-m 25
DIP
-63 deg -58
AZIMUTH MN
295 deg 300
75
80
85
90
95

Appendix 3

Geophysical borehole logging, borehole HFM10

Borehole No. HFM10

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

Northing: 6698834.785 Easting: 1631037.188m Elevation: 4.986m, RHB70

Diameter:	139.3mm
Reaming Diameter:	
Outer Casing:	168.0mm
Inner Casing:	160.0mm
Borehole Length:	150.00m
Cone:	
Inclination at ground surface:	-68.70
Azimuth:	92.93
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030	mm
DENSITY	Gamma-gamma density	9030	kg/m³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9030	µR/h
TEMP(FL)	Fluid temperature	9042/9044	deg C
RES(FL)	Fluid resistivity	9042/9044	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9320	m/s
AMP(N)	Full wave form, near receiver	9320	µs
AMP(F)	Full wave form, far receiver	9320	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
TRAVEL TIME	360 degrees orientated acoustic travel time	HiRAT	100 ns
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	9044	ohm-m
RES(64N)	Normal resistivity 64 inch	9044	ohm-m
LATERAL	Lateral resistivity	9044	ohm-m
SPR	Single point resistivity	9044	ohm

Rev.	Date	Drawn by	Control	Approved
1	2004-02-05	TVP	JRI	UTN

Job 360210A

Scale 1:500

DGE Dansk Geo-servEx a/s
DGE, Håndværkersvinget 11, 2970 Hørsholm, Phone +45 70 10 34 00, Fax + 45 39 16 39 90
RAMBØLL. Bredevej 2, DK-2830 Virum, Phone + 45 45 98 60 00, Fax + 45 45 98 67 00

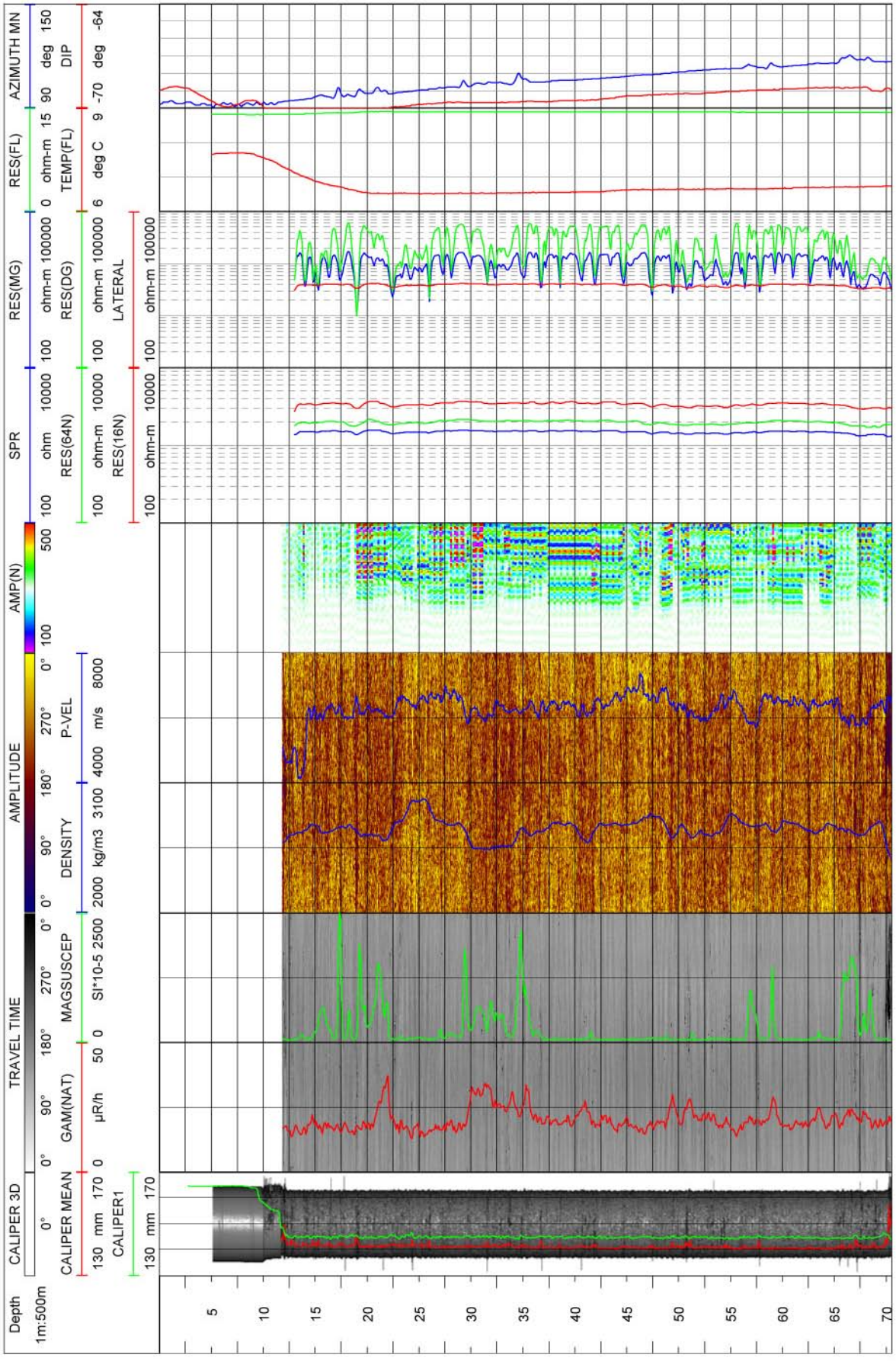
SKB geophysical borehole logging

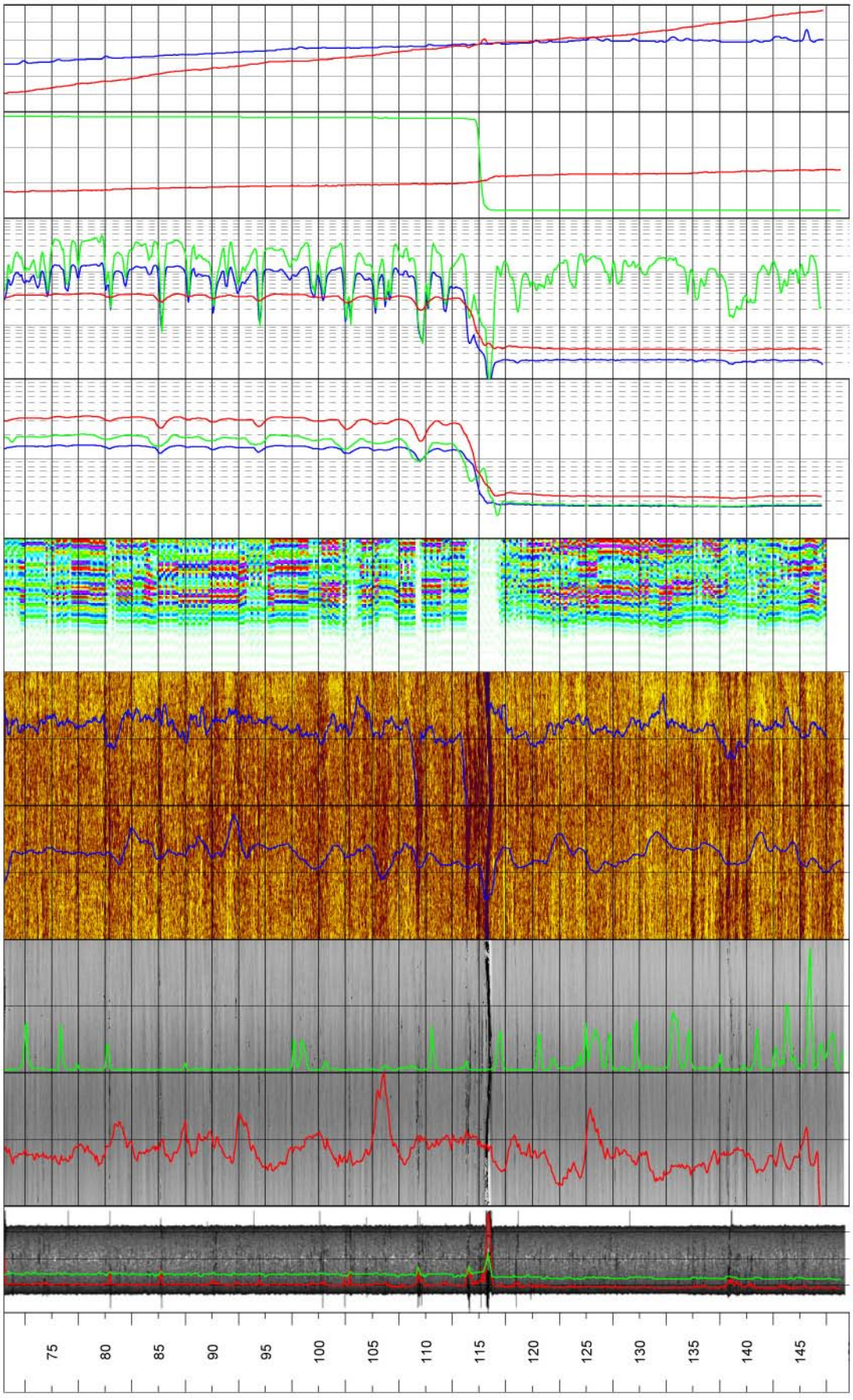
Borehole HFM10 Forsmark

Presentation

Filename: HFM10_Presentation.wcl

Drawing no.: **2.1**


Depth
1m:500m
CALIPER 3D
0° 0° 90° 180° 270° 0°
CALIPER MEAN
130 mm 170
CALIPER1
130 mm 170
TRAVEL TIME
GAM(NAT)
0 µR/h 50
MAGSUSCEP
0 SI*10-5 2500
AMPLITUDE
0° 90° 180° 270° 0°
DENSITY
2000 kg/m3 3100
P-VEL
4000 m/s 8000
AMP(N)
100 500
SPR
100 ohm 10000
RES(64N)
100 ohm-m 10000
RES(16N)
100 ohm-m 10000
RES(MG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
LATERAL
100 ohm-m 100000
RES(FL)
0 ohm-m 15
TEMP(FL)
6 deg C 9
AZIMUTH MN
90 deg 150
DIP
-70 deg -64
5
10
15
20
25
30
35
40
45
50
55
60
65
70


75
80
85
90
95
100
105
110
115
120
125
130
135
140
145

Appendix 4

Geophysical borehole logging, borehole HFM11

Borehole No. HFM11

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

Northing: 6697283.402m Easting: 1631636.333m Elevation: 7.559m, RHB70

Diameter:	138.8mm
Reaming Diameter:	
Outer Casing:	168.3mm
Inner Casing:	160.3mm
Borehole Length:	182.35m
Cone:	
Inclination at ground surface:	-49°
Azimuth:	63.5°
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030	mm
DENSITY	Gamma-gamma density	9030	kg/m³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9030	µR/h
TEMP(FL)	Fluid temperature	9042/9044	deg C
RES(FL)	Fluid resistivity	9042/9044	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9320	m/s
AMP(N)	Full wave form, near receiver	9320	µs
AMP(F)	Full wave form, far receiver	9320	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
TRAVEL TIME	360 degrees orientated acoustic travel time	HiRAT	100 ns
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	9044	ohm-m
RES(64N)	Normal resistivity 64 inch	9044	ohm-m
LATERAL	Lateral resistivity	9044	ohm-m
SPR	Single point resistivity	9044	ohm

Rev.	Date	Drawn by	Control	Approved
1	2004-01-05	JRI	TVP	UTN

Job 360210A

Scale 1:500

DGE Dansk Geo-servEx a/s
DGE, Håndværkersvinget 11, 2970 Hørsholm, Phone +45 70 10 34 00, Fax + 45 39 16 39 90
RAMBØLL. Bredevej 2, DK-2830 Virum, Phone + 45 45 98 60 00, Fax + 45 45 98 67 00

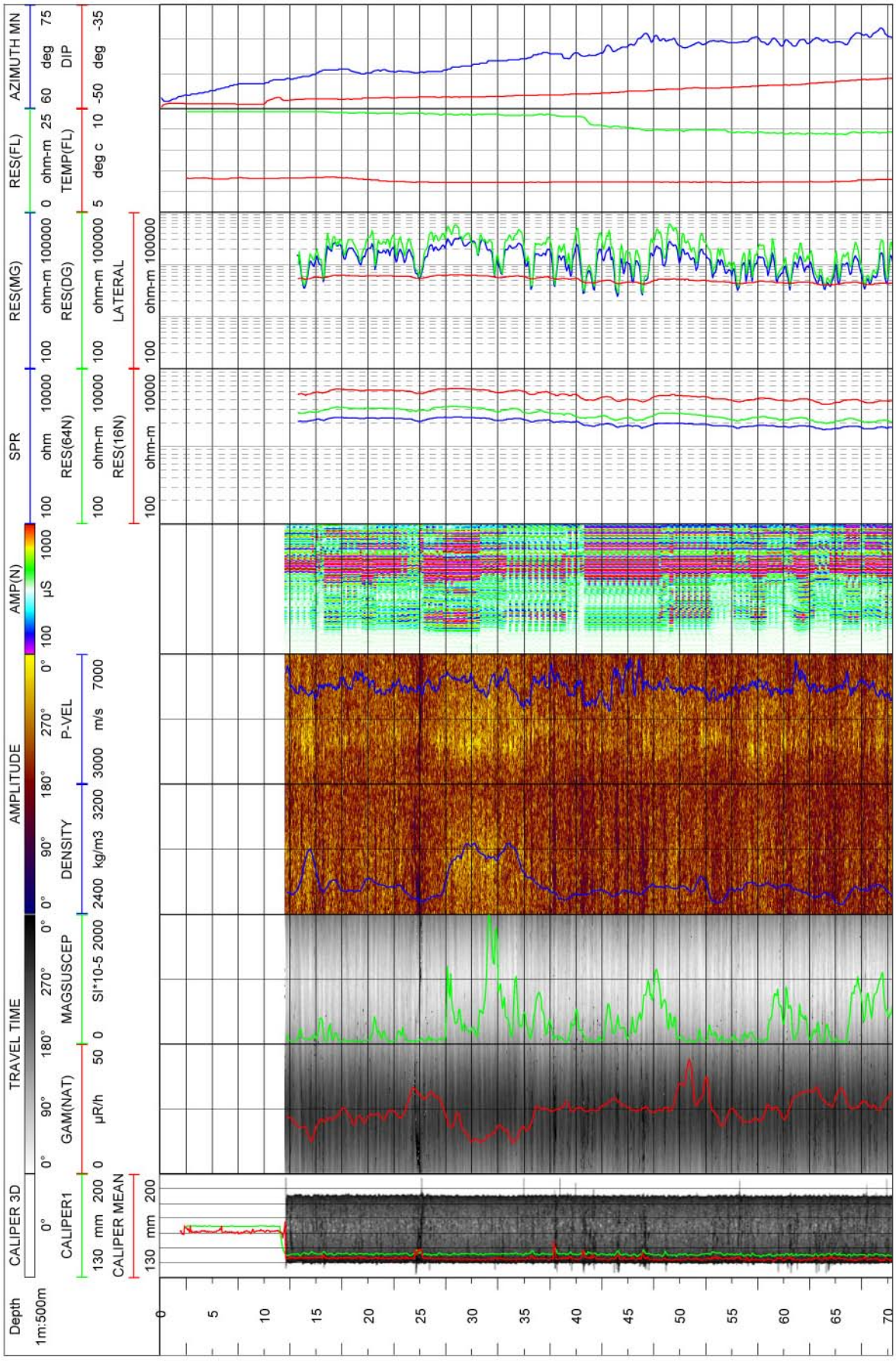
SKB geophysical borehole logging

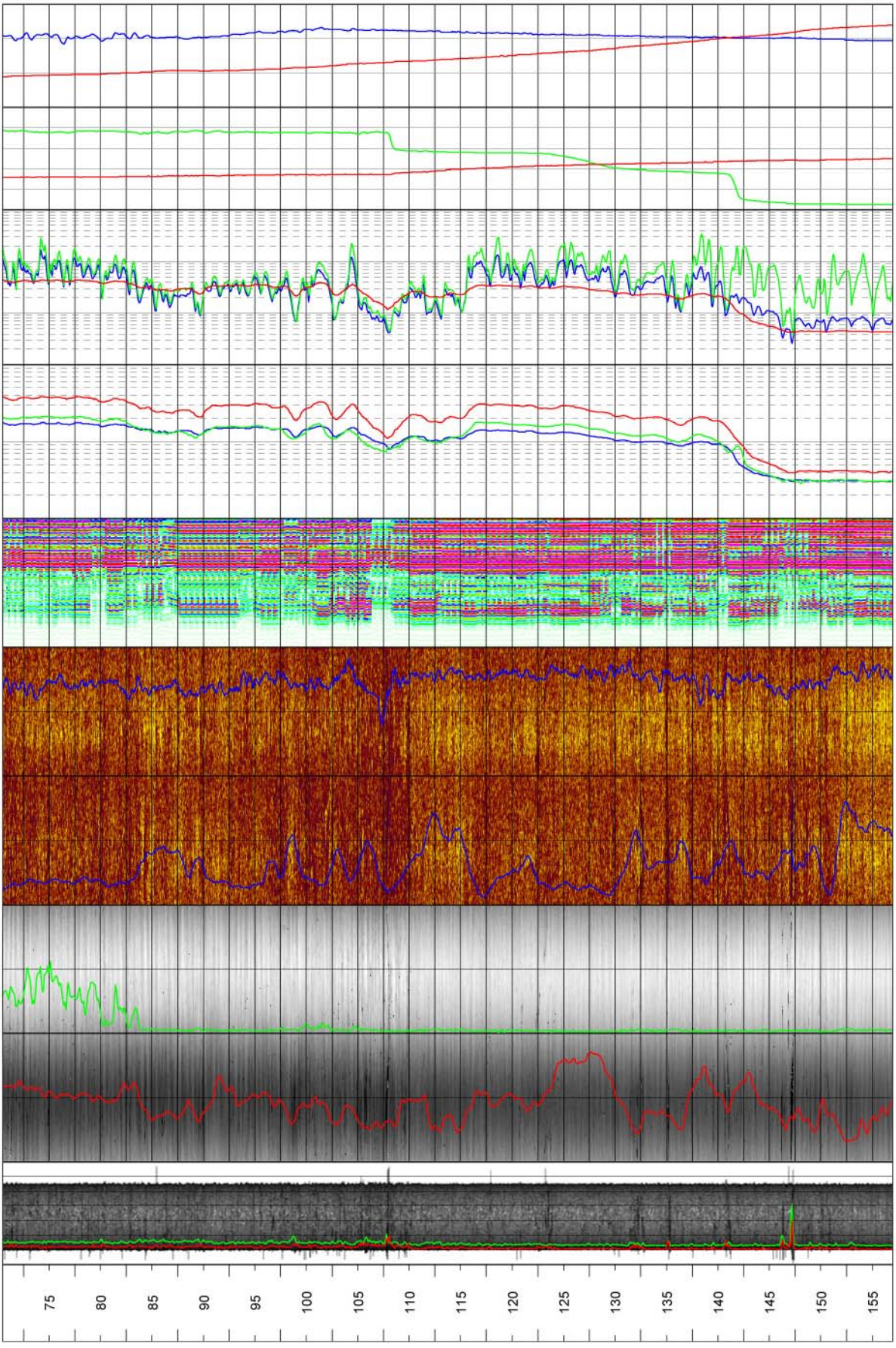
Borehole HFM11 Forsmark

Presentation

Filename: HFM11_Presentation.wcl

Drawing no.: **2.1**


Depth
1m:500m
CALIPER 3D
0° 90° 180° 270° 0°
CALIPER1
130 mm 200
CALIPER MEAN
130 mm 200
TRAVEL TIME
0° 90° 180° 270° 0°
GAM(NAT)
0 µR/h 50
MAGSUSCEP
0 SI*10-5 2000
AMPLITUDE
0° 90° 180° 270° 0°
DENSITY
2400 kg/m3 3200
P-VEL
3000 m/s 7000
AMP(N)
100 µS 1000
SPR
100 ohm 10000
RES(64N)
100 ohm-m 10000
RES(16N)
100 ohm-m 10000
RES(MG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
LATERAL
100 ohm-m 100000
RES(FL)
0 ohm-m 25 60
TEMP(FL)
5 deg c 10 -50
AZIMUTH MN
75 deg -35
DIP
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70


75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155

Appendix 5

Geophysical borehole logging, borehole HFM12

Borehole No. HFM12

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

Northing: 6697446.459m Easting: 1631695.671m Elevation: 7.025m, RHB70

Diameter:	135.3mm
Reaming Diameter:	
Outer Casing:	168.3mm
Inner Casing:	160.3mm
Borehole Length:	209.5m
Cone:	
Inclination at ground surface:	-49°
Azimuth:	245°
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030	mm
DENSITY	Gamma-gamma density	9030	kg/m³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9030	µR/h
TEMP(FL)	Fluid temperature	9042/9044	deg C
RES(FL)	Fluid resistivity	9042/9044	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9320	m/s
AMP(N)	Full wave form, near receiver	9320	µs
AMP(F)	Full wave form, far receiver	9320	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
TRAVEL TIME	360 degrees orientated acoustic travel time	HiRAT	100 ns
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	9044	ohm-m
RES(64N)	Normal resistivity 64 inch	9044	ohm-m
LATERAL	Lateral resistivity	9044	ohm-m
SPR	Single point resistivity	9044	ohm

Rev.	Date	Drawn by	Control	Approved
0	2004-02-05	JRI	TVP	UTN

Job 360210A

Scale 1:500

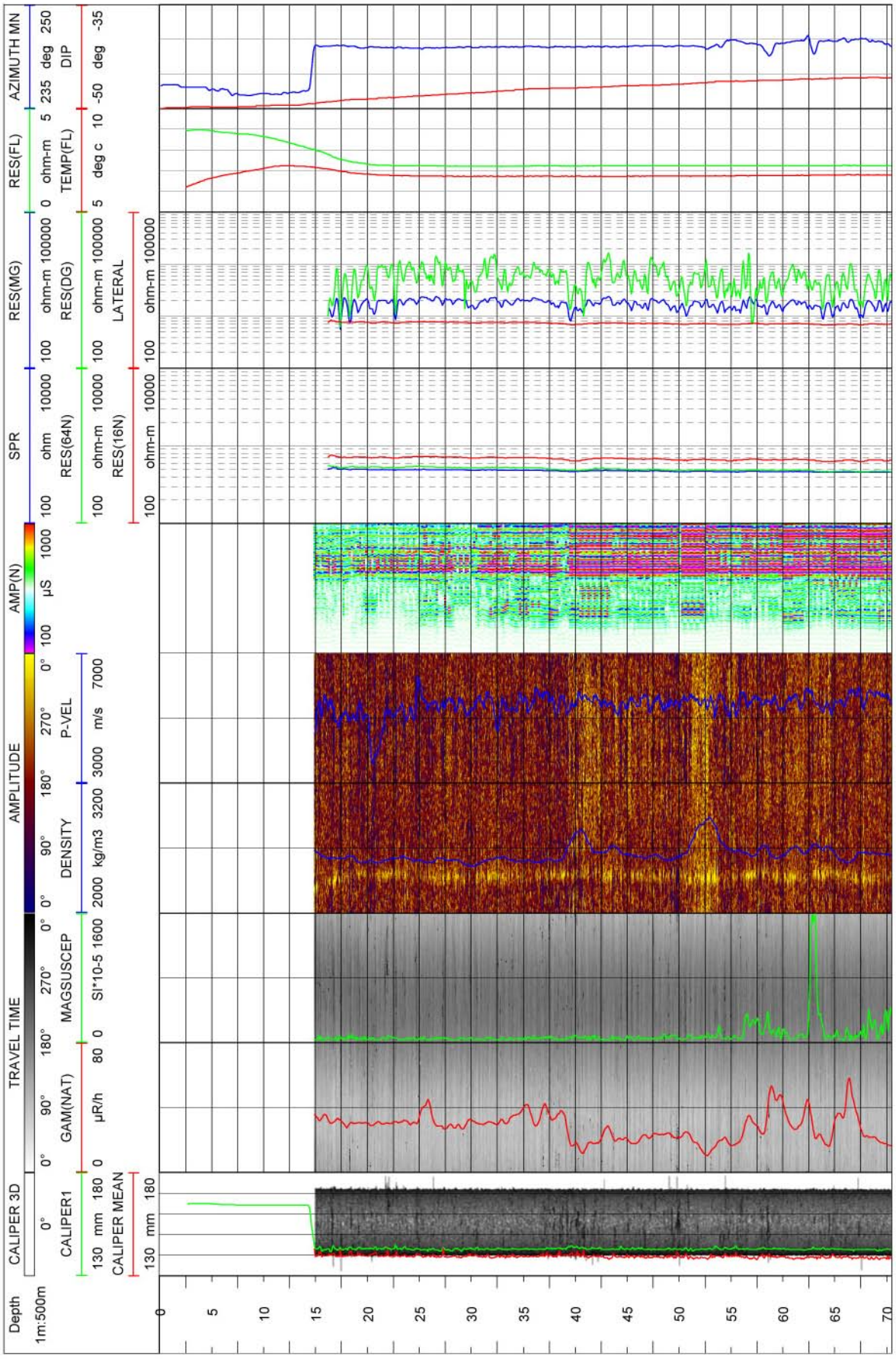
DGE Dansk Geo-servEx a/s
DGE, Håndværkersvinget 11, 2970 Hørsholm, Phone +45 70 10 34 00, Fax + 45 39 16 39 90
RAMBØLL. Bredevej 2, DK-2830 Virum, Phone + 45 45 98 60 00, Fax + 45 45 98 67 00

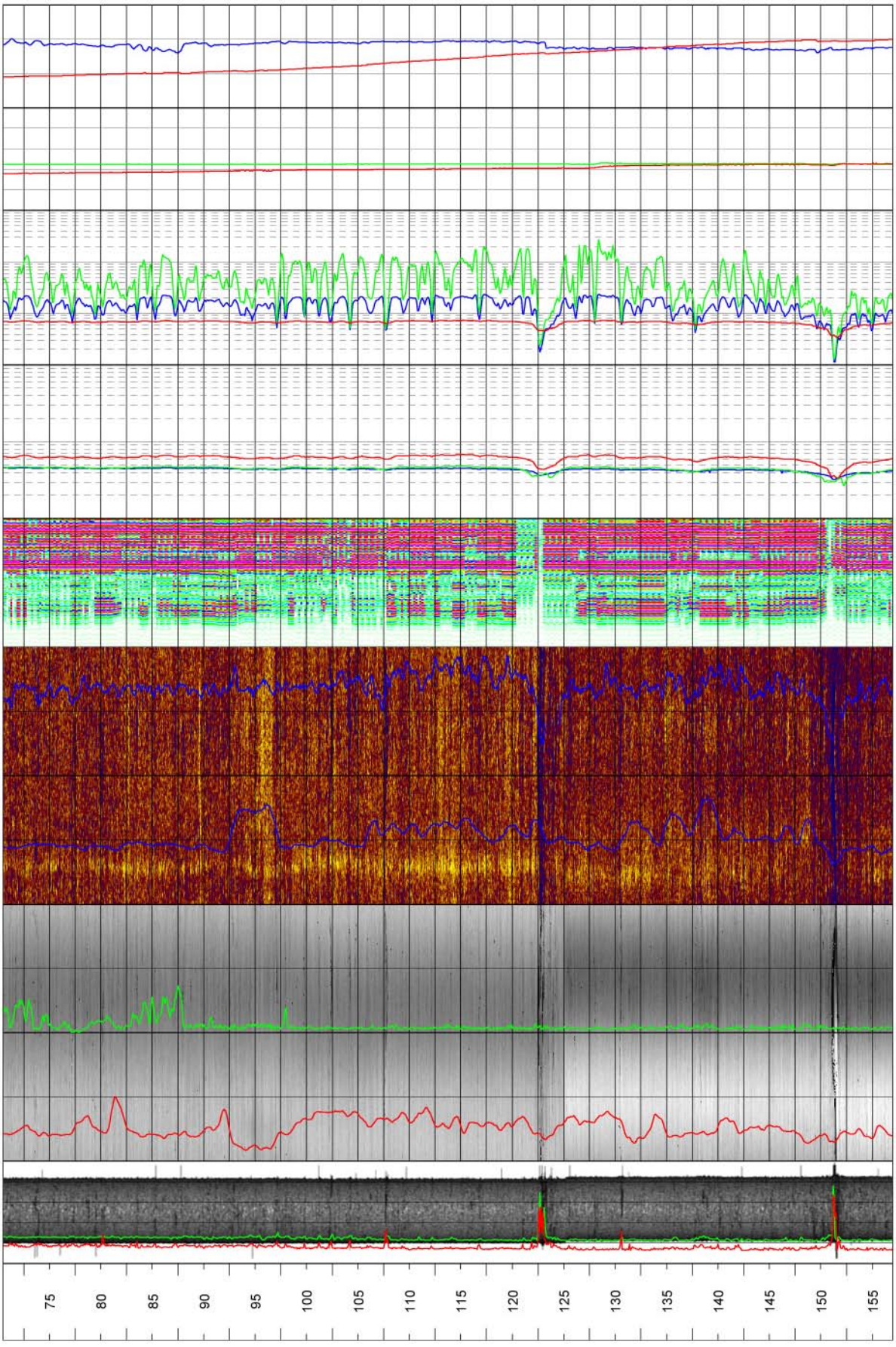
SKB geophysical borehole logging
Borehole HFM12 Forsmark

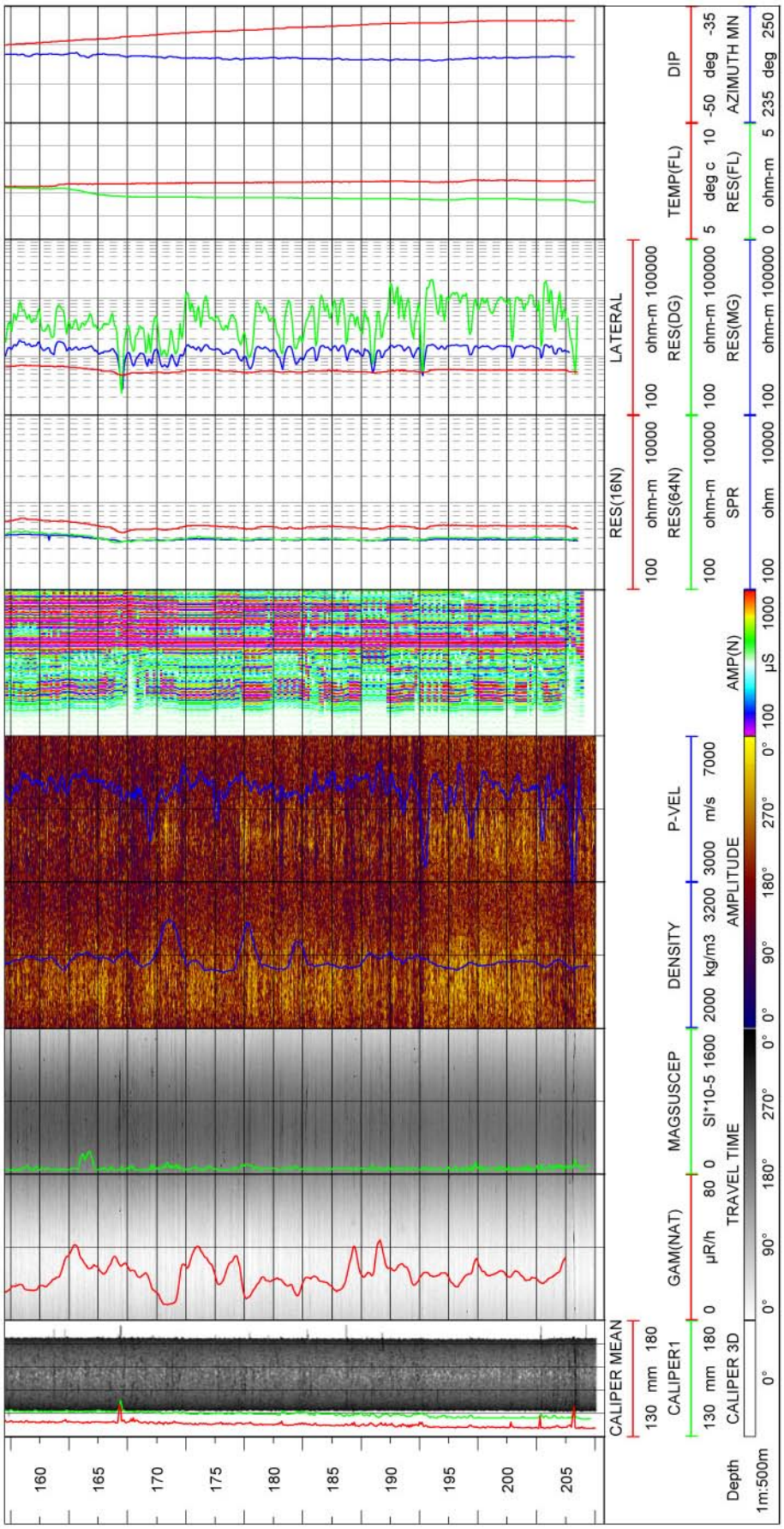
Presentation

Filename: HFM12_Presentation.wcl

Drawing no.: **3.1**


Depth
1m:500m
CALIPER 3D
0° 0° 90° 180° 270° 0°
CALIPER1
130 mm 180
CALIPER MEAN
130 mm 180
TRAVEL TIME
AMPLITUDE
AMP(N)
0° 90° 180° 270° 0°
GAM(NAT)
0 µR/h 80
MAGSUSCEP
0 SI*10-5 1600
DENSITY
0° 90° 180° 270° 0°
2000 kg/m3 3200
P-VEL
100 µS 1000
3000 m/s 7000
SPR
RES(64N)
100 ohm 10000
RES(16N)
100 ohm-m 10000
RES(MG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
LATERAL
100 ohm-m 100000
RES(FL)
0 ohm-m 5
TEMP(FL)
5 deg c 10
AZIMUTH MN
235 deg 250
DIP
-50 deg -35
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70


75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155


Depth
1m:500m
160
165
170
175
180
185
190
195
200
205
CALIPER 3D
0° 0° 90° 180° 270° 0° 0° 90° 180° 270° 0° 100 µS 1000
TRAVEL TIME
AMPLITUDE
AMP(N)
CALIPER1
130 mm 180
CALIPER MEAN
130 mm 180
GAM(NAT)
0 µR/h 80
MAGSUSCEP
0 SI*10-5 1600
DENSITY
2000 kg/m3 3200
P-VEL
3000 m/s 7000
RES(16N)
100 ohm-m 10000
RES(64N)
100 ohm-m 10000
SPR
100 ohm 10000
LATERAL
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
RES(MG)
100 ohm-m 100000
TEMP(FL)
5 deg c 10
RES(FL)
0 ohm-m 5
DIP
-50 deg -35
AZIMUTH MN
235 deg 250

Appendix 6

Geophysical borehole logging, borehole HFM13

Borehole No. HFM13

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

Northing: 6699093.678 Easting: 1631474.404 m Elevation: 5.687 m

Diameter:	135 mm
Reaming Diameter:	-
Outer Casing:	188 mm
Inner Casing:	160 mm
Borehole Length:	175.6 m
Cone:	-
Inclination at ground surface:	- 58.8 deg
Azimuth:	51 deg
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030	mm
DENSITY	Gamma-gamma density	9030	kg/m³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9030	µR/h
TEMP(FL)	Fluid temperature	9042/9044	deg C
RES(FL)	Fluid resistivity	9042/9044	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9320	m/s
AMP(N)	Full wave form, near receiver	9320	µs
AMP(F)	Full wave form, far receiver	9320	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
TRAVEL TIME	360 degrees orientated acoustic travel time	HiRAT	100 ns
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	9044	ohm-m
RES(64N)	Normal resistivity 64 inch	9044	ohm-m
LATERAL	Lateral resistivity	9044	ohm-m
SPR	Single point resistivity	9044	ohm

Rev.	Date	Drawn by	Control	Approved
1	2004-02-08	UTN	JRI	UTN

Job 360210A

Scale 1:500

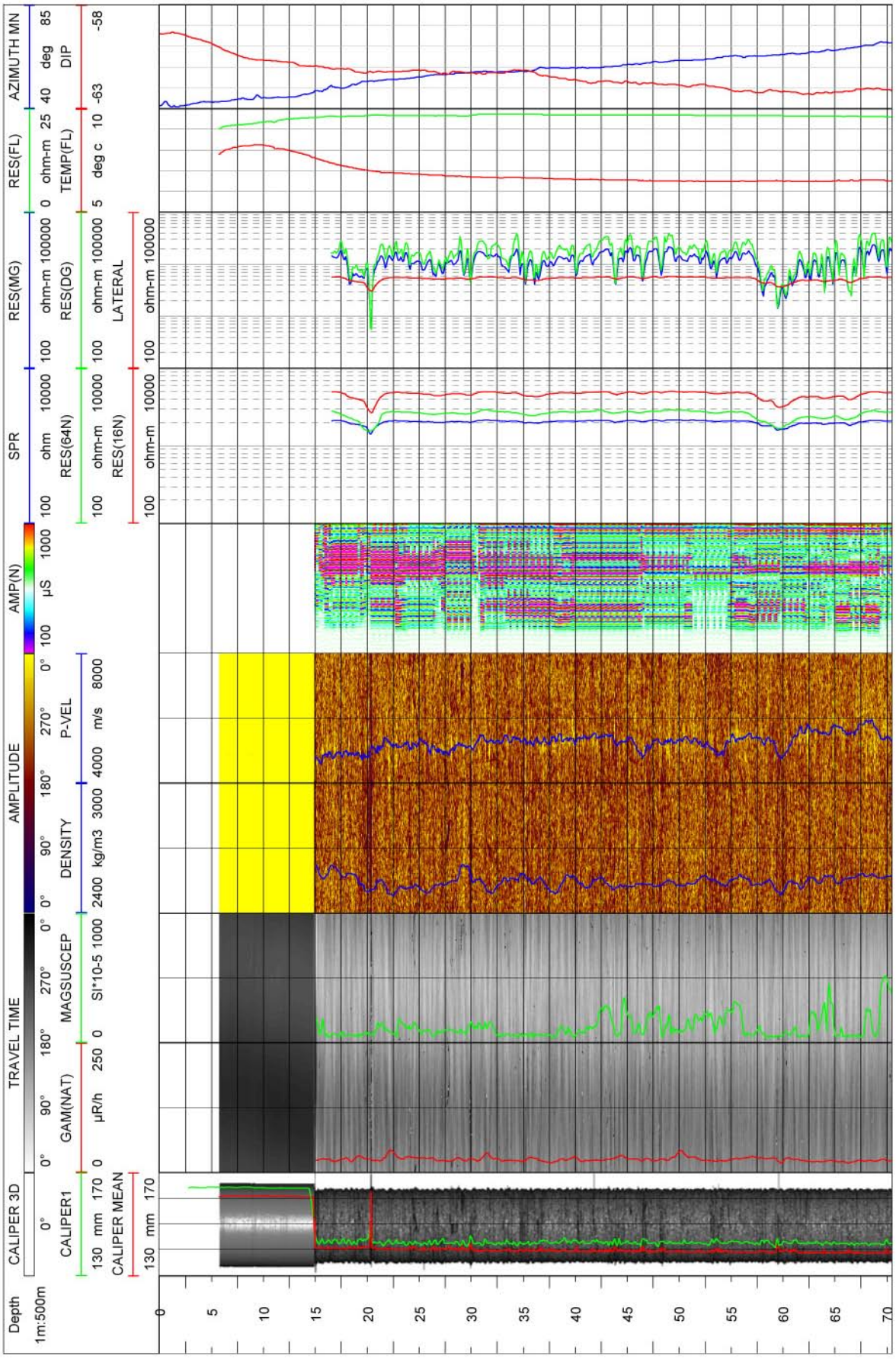
DGE Dansk Geo-servEx a/s
DGE, Håndværkersvinget 11, 2970 Hørsholm, Phone +45 70 10 34 00, Fax + 45 39 16 39 90
RAMBØLL. Bredevej 2, DK-2830 Virum, Phone + 45 45 98 60 00, Fax + 45 45 98 67 00

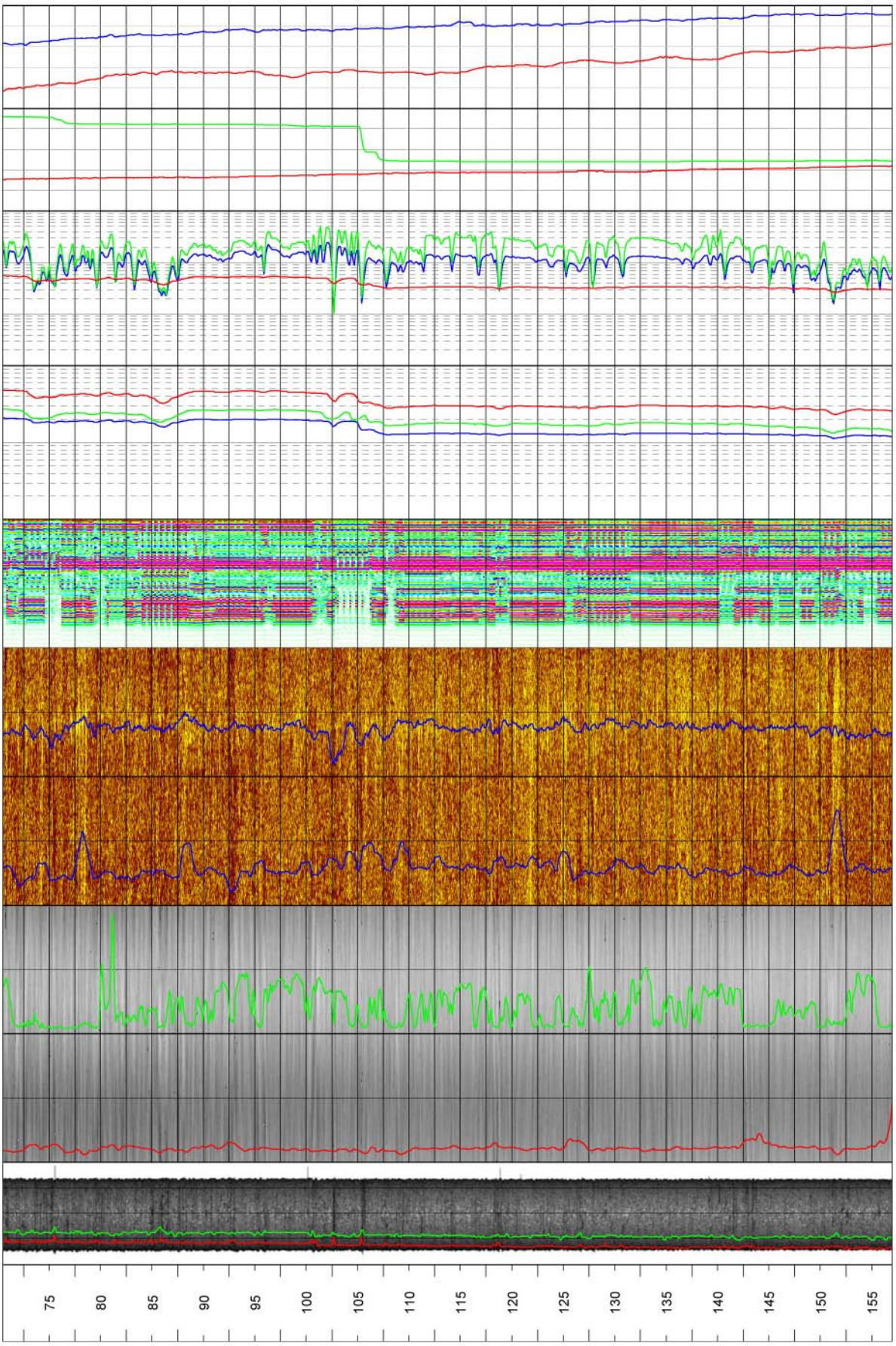
SKB geophysical borehole logging
Borehole HFM13. Forsmark

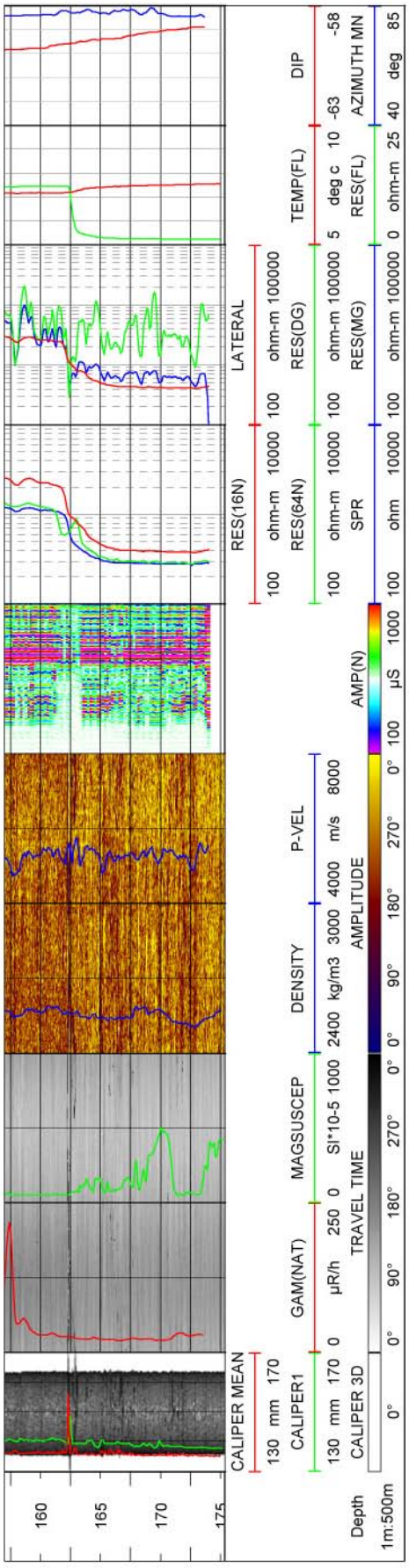
Presentation

Filename: HFM13_Presentation.wcl

Drawing no.: **4.1**


Depth
1m:500m
CALIPER 3D
CALIPER1
CALIPER MEAN
TRAVEL TIME
GAM(NAT)
MAGSUSCEP
AMPLITUDE
DENSITY
P-VEL
AMP(N)
SPR
RES(64N)
RES(16N)
RES(MG)
RES(DG)
LATERAL
RES(FL)
TEMP(FL)
AZIMUTH MN
DIP


75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155


Depth
1m:500m
160
165
170
175
CALIPER 3D
0° 0° 90° 180° 270° 0°
CALIPER1
130 mm 170
CALIPER MEAN
130 mm 170
GAM(NAT)
0 µR/h 250
TRAVEL TIME
0° 0° 90° 180° 270° 0°
MAGSUSCEP
0 SI*10-5 1000
DENSITY
2400 kg/m3 3000
AMPLITUDE
0° 0° 90° 180° 270° 0°
P-VEL
4000 m/s 8000
AMP(N)
0° 100 µS 1000
RES(16N)
100 ohm-m 10000
RES(64N)
100 ohm-m 10000
SPR
100 ohm 10000
LATERAL
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
RES(MG)
100 ohm-m 100000
TEMP(FL)
5 deg c 10
RES(FL)
0 ohm-m 25
DIP
-63 -58
AZIMUTH MN
40 deg 85