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Forsmark site investigation

Geophysical borehole logging in borehole KFM01A, HFM01 and HFM02

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RAMBØLL

June 2004

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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.

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Summary

According to a request from Svensk Kärnbränslehantering AB, geophysical borehole logging has been performed in the boreholes KFM01A, HFM01 and HFM02, all situated in Forsmark, Sweden. The logging in KFM01A have been recorded from 100 m to 1,000 m, HFM01 from top of casing (TOC) to 200 m and HFM02 from TOC to 100 m.

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

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

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1 Introduction

According to a request from Svensk Kärnbränslehantering, geophysical borehole logging has been performed in the boreholes KFM01A, HFM01 and HFM02, all situated in Forsmark area, see Figures 1-1 and 1-2. The borehole KFM01A is a telescope borehole, implying that the upper part, 0–100 m, is percussion drilled and the remaining part, 100–1,000 m, is cored drilled. HFM01 and HFM02 are percussion drilled boreholes.

Geophysical logging in the percussion drilled part of KFM01A as well as in HFM01 and HFM02 has been conducted by Malå Geoscience /1/. A third percussion drilled borehole, HFM03 (30 m) has also been logged by Malå Geoscience /1/. The relogging of HFM01 and HFM02 was made to provide the possibility to compare the results from the two logging operators.

In borehole KFM01A logging data was recorded from 100 to 1,000 m. This cored drilled part of the borehole has a diameter of 76 mm and a slight inclination of c. 84.7 degrees from horizontal. In borehole HFM01 the logs were performed from 0 m to 200 m. The diameter is 140 mm and the inclination c. 77.5 degrees from horizontal. In borehole HFM02 the logs were performed from 0 m to 100 m. The diameter is 137 mm and the inclination c. 87.8 degrees from horizontal.

The logging program has been executed by RAMBØLL. The fieldwork was executed during the period 24–30 April 2003 in accordance with the instructions and guidelines from SKB (Activity plan AP PF 400-03-03, SKB internal controlling document). The work has been carried out in accordance with RAMBØLLs guidelines and standards for logging operations.

In January 2004, KFM01A was re-logged with the sonic log since the results from the first logging were judged to be of poor quality. At the same time, complementary logging of normal resistivity and single point resistance (probe Century 8044) was performed.

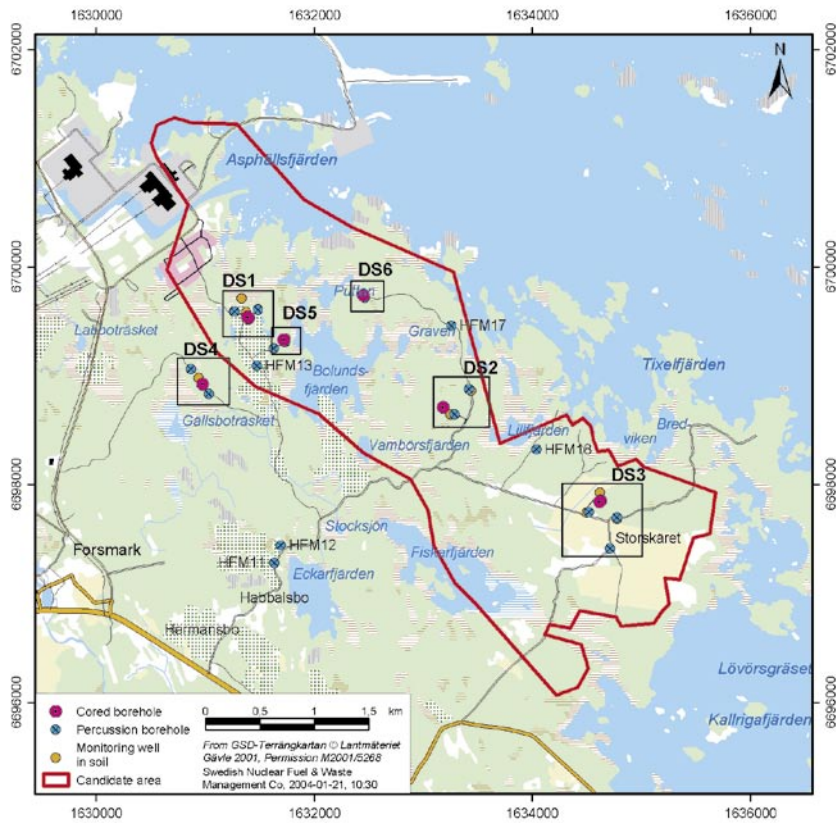


Figure 1-1. Drill sites in the Forsmark area. The boreholes KFM01A, HFM01 and HFM02 are located at drill site 1 (see Figure 1-2).

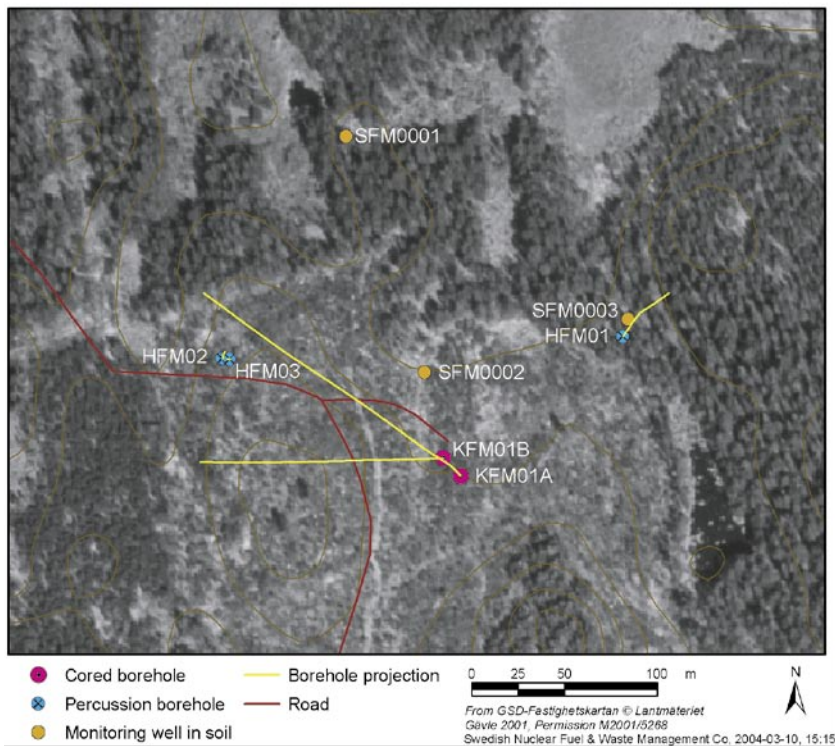


Figure 1-2. Drill site 1 in Forsmark.

2 Equipment and logging programme

The geophysical borehole logging programme in all three boreholes was performed with 6 multi tool probes, see Table 2-1, and resulted in a suite of 17 log types, listed in Table 4-1, (see Section 4.1). In KFM01A, logging was also performed with the Century 8044 probe (normal resistivity and single point resistivity).

Table 2-1. Logging tools and logs recorded (Century 8044 in KFM01A only).

Tool	Recorded logs	Dimension	Source Detector Spacing	Source type
Century 9042 Fluid resistivity and temperature.	Fluid resistivity, fluid temperature, fluid delta temperature, natural gamma.	203×4.1 cm		
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, 15 cm 1-arm caliper.	307×5.6 cm	20.3 cm	125 mCi Cs137
Century 9072 3 m focused guard.	Natural gamma, 3 m focused guard log resistivity.	310×6.4 cm		
Century 9310/9320 Sonic	Full wave form travelttime providing P and S-wave velocity picking, compensated P-wave travelttime, cement bond location, natural gamma.	300×6.1 cm	Near 91.4 cm, far 121.9 cm.	
RG 25 112 000 HIRAT* Acoustic televiewer	Full waveform acoustic amplitude and travelttime, 360° orientated acoustic image, 360° very high resolution caliper. Borehole azimuth and dip and natural gamma.	246×4 cm		
Century 8044 Normal resistivity, Lateral, Single point resistance, fluid temperatur and fluid resistivity.	Normal resistivity (16 and 64 inch), single point resistance, fluid temperatur, fluid resistivity and natural gamma.	237×5.3 cm		

3 Execution

In general the measurement procedures follow the SKB method description MD 221.002, version 1.0 (“Metodbeskrivning för geofysisk borrhålsloggning”). The logging programme in borehole HFM02 was executed 2003-04-24, in borehole HFM01 2003-04-25 and in borehole KFM01A 2003-04-25–30. The complementary logging in KFM01A was carried out 2004-01-13 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 logging equipment was cleaned according to SKB method description MD 600.004, version 1.0 (“Metodbeskrivning för rengöring av borrhålsutrustning och viss markbaserad utrustning”) before arriving at the site. Before logging the wire and logging tools were also cleaned at the site using alcohol. The applied logging tools were calibrated before arriving at the site, except tool 8622, which was calibrated at site, just before logging in borehole HFM02.

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 9030, 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 stop automatically 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 tools was in general 10 m/min for the used log runs, except the HiRAT Acoustic tool where the speed was 2 m/min, and with a sample interval of 2 mm.

4 Results

4.1 Presentation

Table 4-1 lists the logs presented in Appendix 1 to 3. The logs have not been filtered during logging or presentation.

Table 4-1. Logs presented in Appendix 1 to 3.

Log	Log name short	Unit	Tool
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	9042
Fluid resistivity	RES(FL)	ohm-m	9042
Focused guard log resistivity, 300 cm	RES(DG)	ohm-m	9072
P-wave velocity	P-VEL	m/s	9310/9320
Full wave form, near receiver	AMP(N)	μs	9310/9320
Full wave form, far receiver	AMP(F)	μs	9310/9320
Magnetic susceptibility	MAGSUSCEP	SI*10-5	8622
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 lateral	DIP	deg	HiRAT
360° orientated acoustic travel time	TRAVEL TIME	100 ns	HiRAT
360° orientated acoustic travel time	AMPLITUDE	–	HiRAT
Normal resistivity 16 inch (KFM01A only)	RES(16N)	ohm-m	8044
Normal resistivity 64 inch (KFM01A only)	RES(64N)	ohm-m	8044
Lateral resistivity (KFM01A only)	LATERAL	ohm-m	8044
Single point resistivity (KFM01A only)	SPR	ohm	8044

4.2 Calculated curves

4.2.1 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 4-2. 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 4-2. International Geomagnetic Reference Field (IGRF2000) components.

Location	
Latitude (North)	60 deg 23 min 32 sec
Longitude (East)	18 deg 11 min 19 sec
Elevation	0.02 km
Date of interest	2003-04-29
Magnetic field components	
Declination (east)	3 deg 58 min
Inclination (down)	73 deg 08 min

4.2.2 Conversion of the magnetic susceptibility

The magnetic susceptibility was converted for CGS units to SI units by multiplying the CGS value by 4π .

4.2.3 Conversion of natural gamma log

The natural gamma log was converted from CPS to $\mu\text{R/h}$ by multiplying by the constant 0.077. This constant was computed from the logs previously performed in borehole KLX02 located in Oskarshamn.

4.3 Borehole KFM01A

In order to obtain an exact depth calibration in borehole KFM01A, the track marks made while drilling 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 108.27 m in the HiRAT file is used as the marker at depth 110 m. The HiRAT tool is therefore shifted 1.73 m down. The same correction value is used for the whole borehole.

Table 4-3. The reference marks in the borehole, the recorded track marks from the HiRAT and the corrected depths.

Reference mark	HIRAT recorded	HIRAT after shift
110	108.27	110.00
150	148.31	150.04
200	198.33	200.06
250	248.38	250.11
300	298.40	300.13
350	348.42	350.15
400	398.48	400.21
500	498.52	500.25
550	548.53	550.26
600	598.57	600.30
650	648.59	650.32
700	698.59	700.32
750	748.62	750.35
800	798.62	800.35

Using the natural gamma from the HiRAT as reference, the natural gamma logs from the other probes are aligned to the same depth, and the shift correction value for the other tools is found. These values are shown in Table 4-4.

Table 4-4. Shift correction values in borehole KFM01A.

Tool	Shift correction value
8044	1.60 m down
8622	0.56 m down
9030	1.27 m down
9030. Medium guard	1.52 m down
9072	1.38 m down
9310	1.31 m down
HiRAT	1.73 m down

There is a minor difference, about 1.5 m/km, in the depth registration between up- and down runs. To compensate for this the logs recorded downward are stretched. The stretch value is found by means of comparison of the gamma logs. This is done to the following logs: 8622, 9042 and 9310.

The complete log suite for borehole KFM01A is presented as composite log sheets in Appendix 1 (Drawing no 1.1). The logs presented are listed in Table 4-1.

4.4 Borehole HFM01

Using the natural gamma from the 9042 as reference, the natural gamma logs from the other probes are aligned to the same depth, and the shift correction value for the other tools is found. These values are shown in Table 4-5.

Table 4-5. Shift correction values in borehole HFM01.

Tool	Shift correction value
8622	0.3 m up
9030	0.31 m up
9030. Medium guard	0.06 m up
9042	0
9072	0.2 m up
9320	0.15 m down
HiRAT	0.15 m down

The complete log suite for borehole HFM01 is presented as composite log sheets in Appendix 2 (Drawing no 2.1). The logs presented are listed in Table 4-1.

The inclination (dip) and azimuth from the HiRAT probe are presented in Drawing nos 2.2 and 2.3 as Bull's Eye plot and Vertical profile.

4.5 Borehole HFM02

Using the natural gamma from the 9042, the natural gamma logs from the other probes are aligned to the same depth, and the shift correction value for the other tools is found. These values are shown in Table 4-6.

Table 4-6. Shift correction values in borehole HFM02.

Tool	Shift correction value
8622	0
9030	0.52 m up
9030. Medium guard	0.27 m up
9042	0
9072	0.37 m up
9320	0.17 m up
HiRAT	0.09 m up

The complete log suite for borehole HFM01 is presented as composite log sheets in Appendix 3 (Drawing no 3.1). The logs presented are listed in Table 4-1.

5 Data delivery

Apart from the present report, a comprehensive field report was delivered to SKB /1/. The field report presents the work carried out during the main logging campaign and 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, 9310 and HiRAT shall not be calibrated). The complementary logging made in January 2004 is reported in the present report.

The raw-data from the measurements, recorded in Century and Robertson format, see Table 5-1, 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 (Table 5-1).

The processed files were delivered in both WellCAD, Table 5-2, and as excel files in SICADA format, Table 5-3. The different excel sheets (one for each log) in SICADA format are listed in Table 5-4.

The Sicada reference to the data from the logging operations is field note no Forsmark 133.

Table 5-1. Recorded log files in Century or Robertson format used for processing.

Borehole	Probe	Log direction	WellCAD File
KFM01A	8044	Down	KFM01A_01-13-04_11-30_8044C_.02_3.70_1000.23_ORIG.log.WCL
KFM01A	8622	Down	KFM01A_04-30-03_07-28_8622C_.10_0.00_998.90_ORIG.wcl
KFM01A	9030	Up	KFM01A_04-28-03_13-8_9030CA_.10_93.80_999.70_ORIG.wcl
KFM01A	9042	Down	KFM01A_04-25-03_13-02_9042C_.10_0.10_1000.30_ORIG.wcl
KFM01A	9072	Up	KFM01A_04-29-03_17-34_9072C_.10_89.70_1001.00_ORIG.wcl
KFM01A	9310	Up	KFM01A_01-13-04_13-34_9310C2_.02_322.36_999.68_ORIG.log.WCL
KFM01A	HiRAT	Up	KFM01A_HiRAT_up_120_run1.wcl
HFM01	8622	Up	HFM01_04-25-03_08-33_8622C_.10_-0.30_196.30_ORIG.wcl
HFM01	9030	Up	HFM01_04-25-03_09-59_9030CA_.10_0.20_196.90_ORIG.wcl
HFM01	9042	Down	HFM01_04-24-03_17-47_9042C_.10_0.10_198.80_ORIG.wcl
HFM01	9072	Up	HFM01_04-25-03_09-11_9072C_.10_0.00_196.90_ORIG.wcl
HFM01	9320	Up	HFM01_04-24-03_19-17_9320C2_.02_0.44_196.47_ORIG.wcl
HFM01	HiRAT	Up	HFM01_HiRAT_up_180_run1.wcl
HFM02	8622	Down	HFM02_04-24-03_11-59_8622C_.10_15.80_99.40_ORIG.wcl
HFM02	9030	Up	HFM02_04-24-03_13-07_9030CA_.10_0.50_99.60_ORIG.wcl
HFM02	9042	Down	HFM02_04-24-03_10-46_9042C_.10_0.10_99.90_ORIG.wcl
HFM02	9072	Up	HFM02_04-24-03_12-34_9072C_.10_0.30_99.70_ORIG.wcl
HFM02	9320	Up	HFM02_04-24-03_14-04_9320C2_.02_0.40_99.02_ORIG.wcl
HFM02	HiRAT	Up	HFM02_HiRAT_up_180_run1.wcl

Table 5-2. Drawing files in WellCad format.

Borehole	Drawing	WellCad file
KFM01A	1.1	KFM01A_Presentation.WCL
KFM01A	1.2	KFM01A_Deviation.WCL
KFM01A	1.3	KFM01A_Deviation.WCL
HFM01	2.1	HFM01_Presentation.WCL
HFM01	2.2	HFM01_Deviation.WCL
HFM01	2.3	HFM01_Deviation.WCL
HFM02	3.1	HFM02_Presentation.WCL
HFM02	3.2	HFM02_Deviation.WCL
HFM02	3.3	HFM02_Deviation.WCL

Table 5-3. Data files in excel, in SICADA format.

Borehole	Excel file
KFM01A	KFM01A_data.xls
HFM01	HFM01_data.xls
HFM02	HFM02_data.xls

Table 5-4. Sheets included in the excel files, in SICADA format.

Sheet	Borehole	Other
Acoustic televiewer	KFM01A, HFM01, HFM02	See description of "total magnetic field" and "magnetic inclination" below.
Focused resistivity 140 cm	KFM01A, HFM01, HFM02	
Focused resistivity 300 cm	KFM01A, HFM01, HFM02	
Fullwave sonic	KFM01A, HFM01, HFM02	column: v_velocity (shear wave), not interpreted from the recorded data.
Caliper1	KFM01A, HFM01, HFM02	
Caliper mean	KFM01A, HFM01, HFM02	From Acoustic televiewer.
Fluid resistivity	KFM01A, HFM01, HFM02	
Fluid Temperature	KFM01A, HFM01, HFM02	
Density	KFM01A, HFM01, HFM02	
Resistivity	KFM01A, HFM01, HFM02	
Natural gamma	KFM01A, HFM01, HFM02	
Self potential	Not recorded	
Single point resistivity	KFM01A	
Magnetic susceptibility	KFM01A, HFM01, HFM02	

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.

6 References

- /1/ **Nielsen U T, Ringgaard J, 2003.** Geophysical borehole logging in borehole KFM01A, HFM01 and HFM02. Rambøll Report 20030520utnaa.

Geophysical borehole logging, borehole KFM01A

Borehole No. KFM01A


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

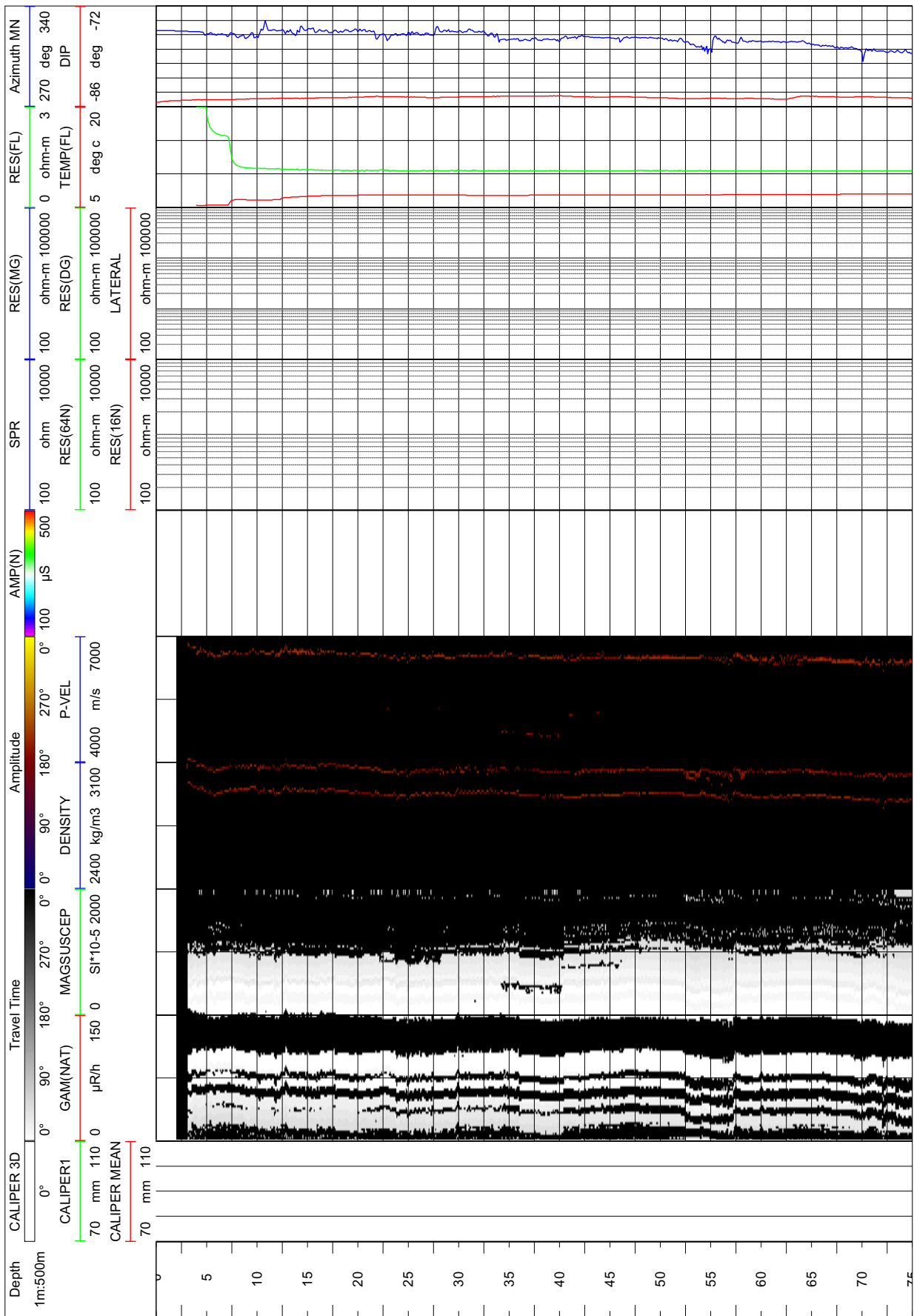
Northing: 6699529.813m Easting: 1631397.160m Elevation: 3.125m, RHB70

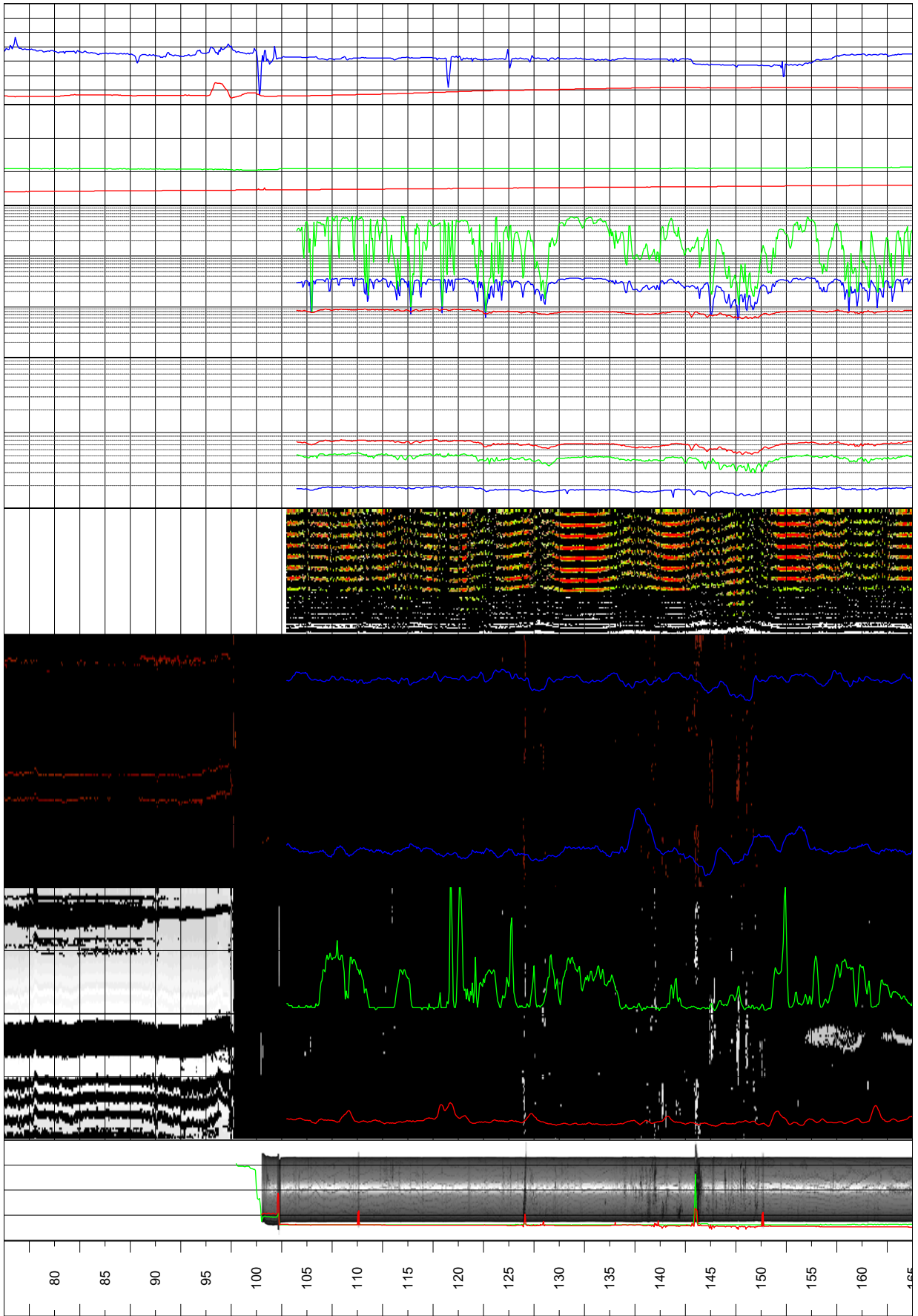
Diameter: 76mm
 Reaming Diameter: 251mm
 Outer Casing: 208mm
 Inner Casing: 200m
 Borehole Length: 1001.45m
 Cone:
 Inclination at ground surface: -84.734°
 Azimuth: 318.352°
 Comments:

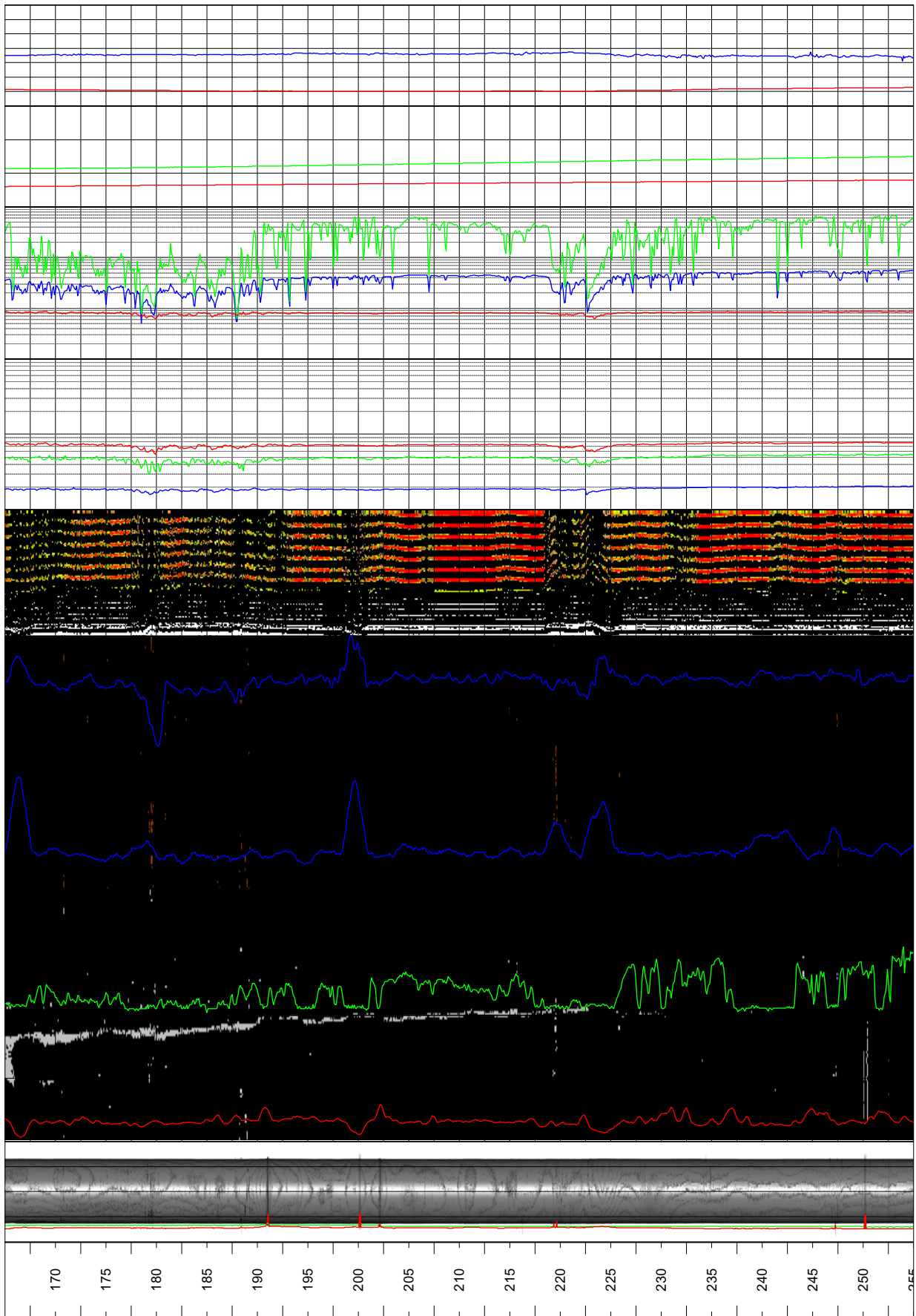
Borehole logging programme

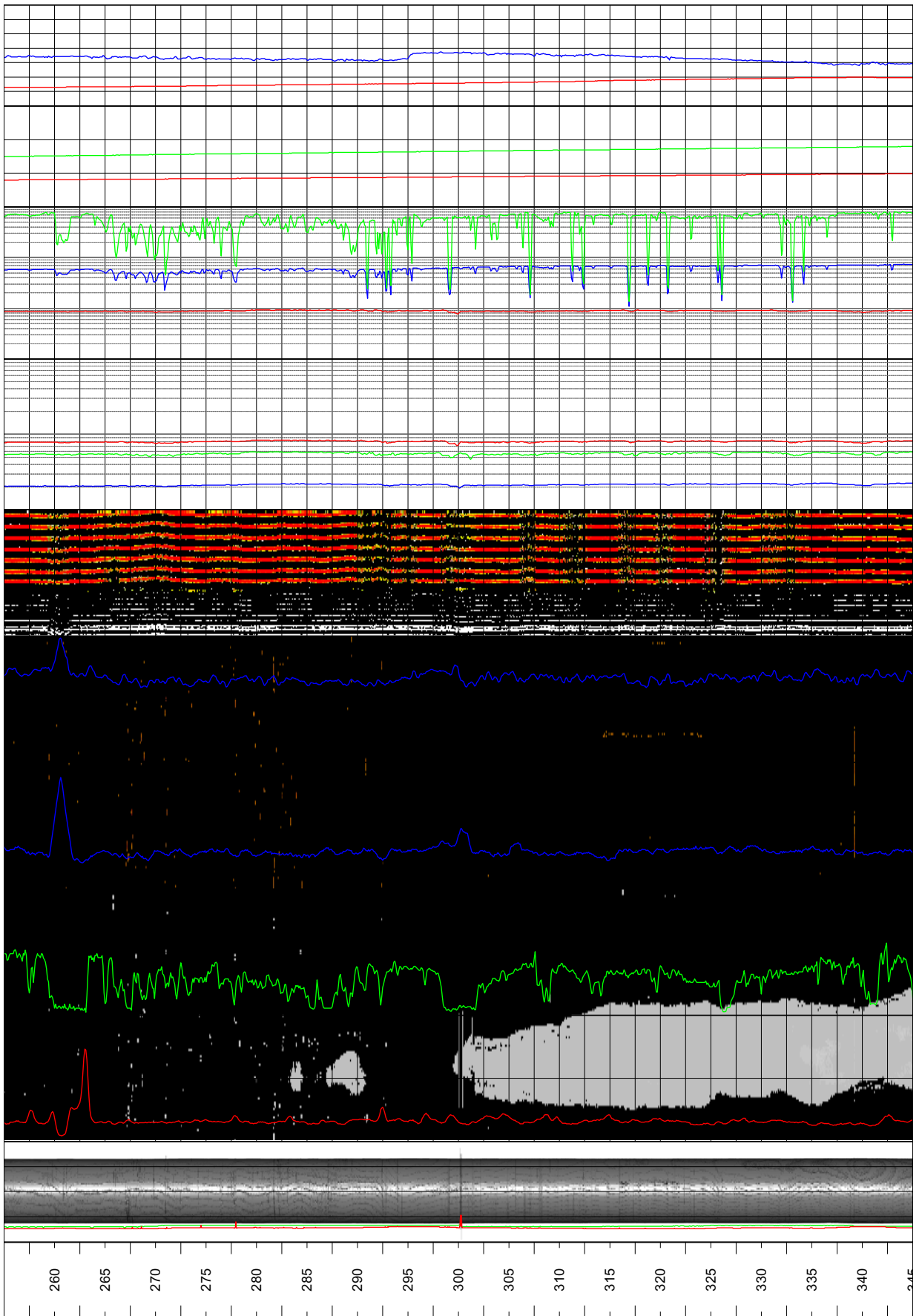
Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030	mm
DENSITY	Gamma-gamma density	9030	kg/m ³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9030	µR/h
TEMP(FL)	Fluid temperature	9042/9044	deg C
RES(FL)	Fluid resistivity	9042/9044	ohm-m
RES(DG)	Focused guard log resistivity, 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

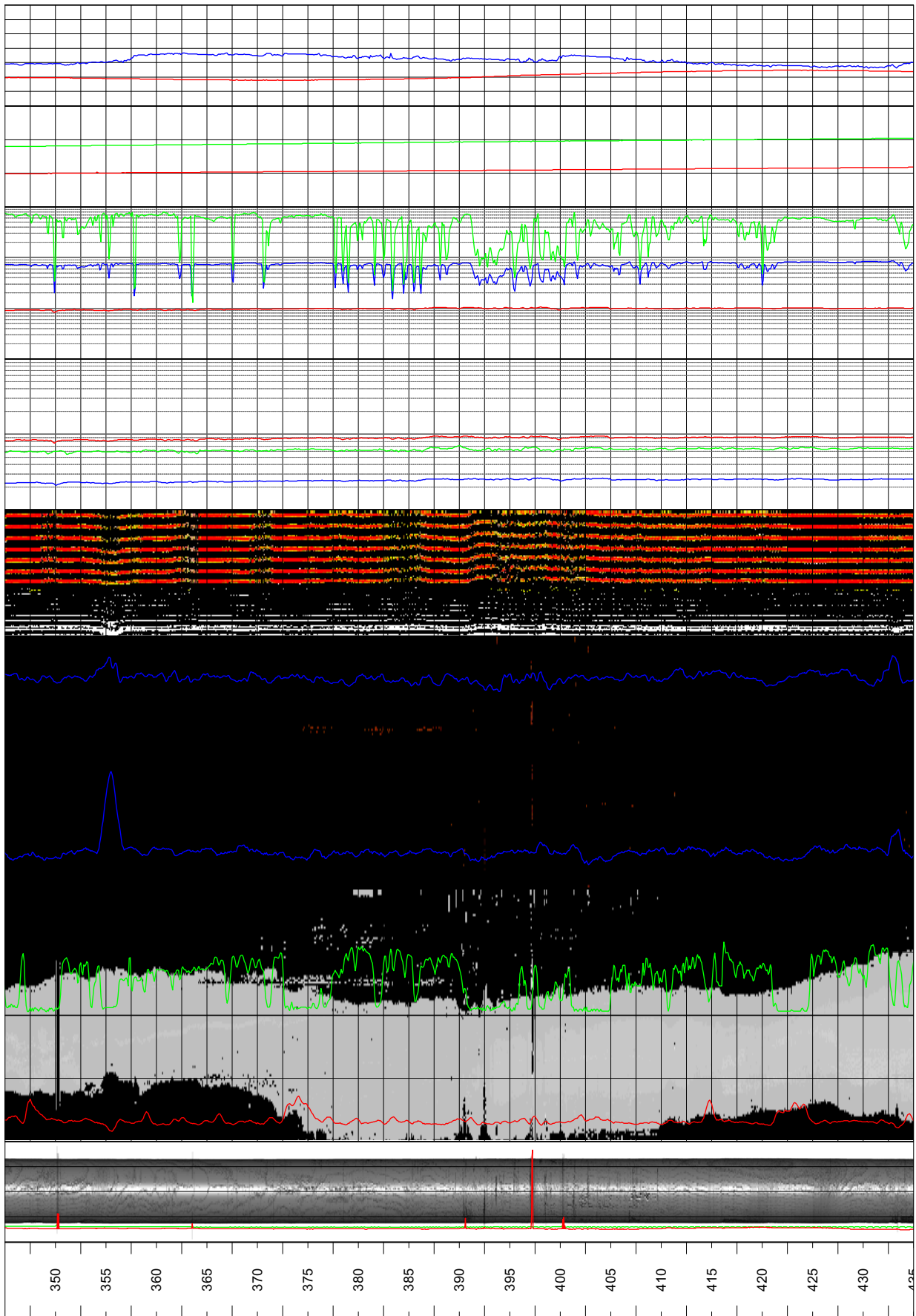
Rev. 0	Date 2003-01-26	Drawn by JRI	Control UTN	Approved UTN	 <p>Dansk Geo-servEx a/s DGE, Håndværkervej 11, 2970 Hørsholm, Phone +45 70 10 34 00, Fax +45 39 16 39 90 RAMBØLL, Bredevej 2, DK-2830 Virum, Phone +45 45 98 60 00, Fax +45 45 98 67 00</p>
Job 360210A	Scale 1:500				
<p>SKB geophysical borehole logging Borehole KFM01A Forsmark</p> <hr/> <p>Presentation</p>					Filename: KFM01A_Presentation.wcl Drawing no.: 1.1

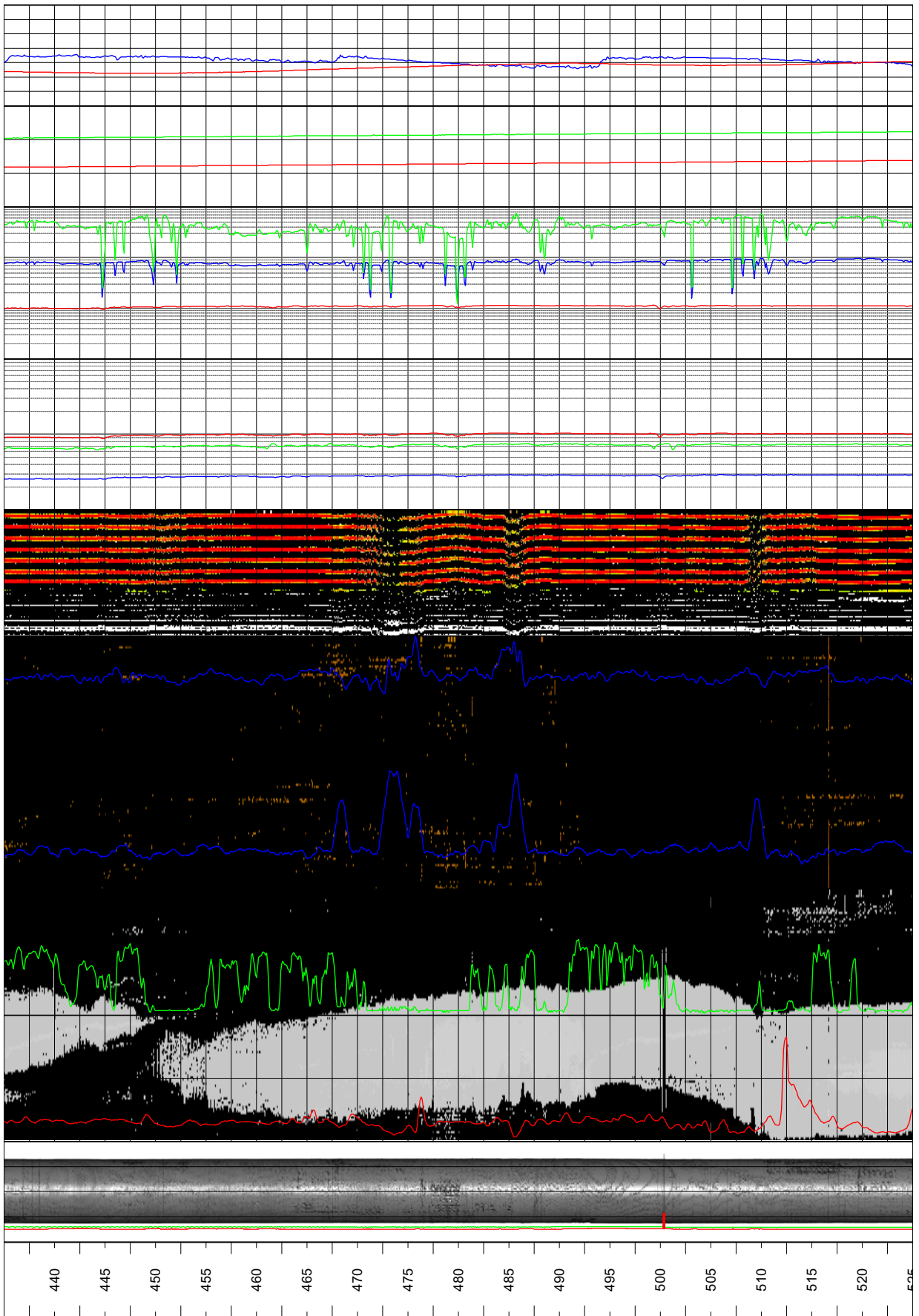


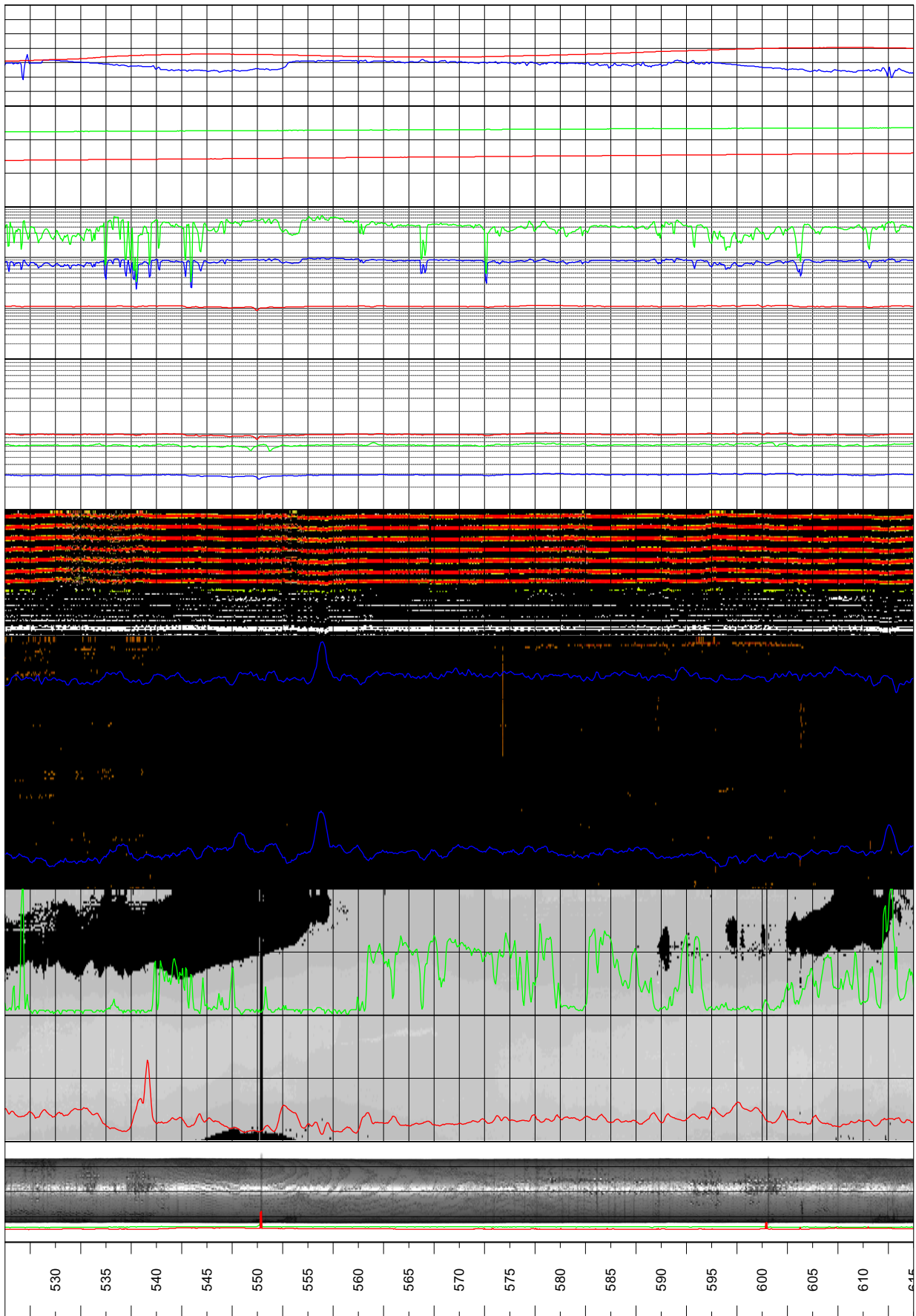


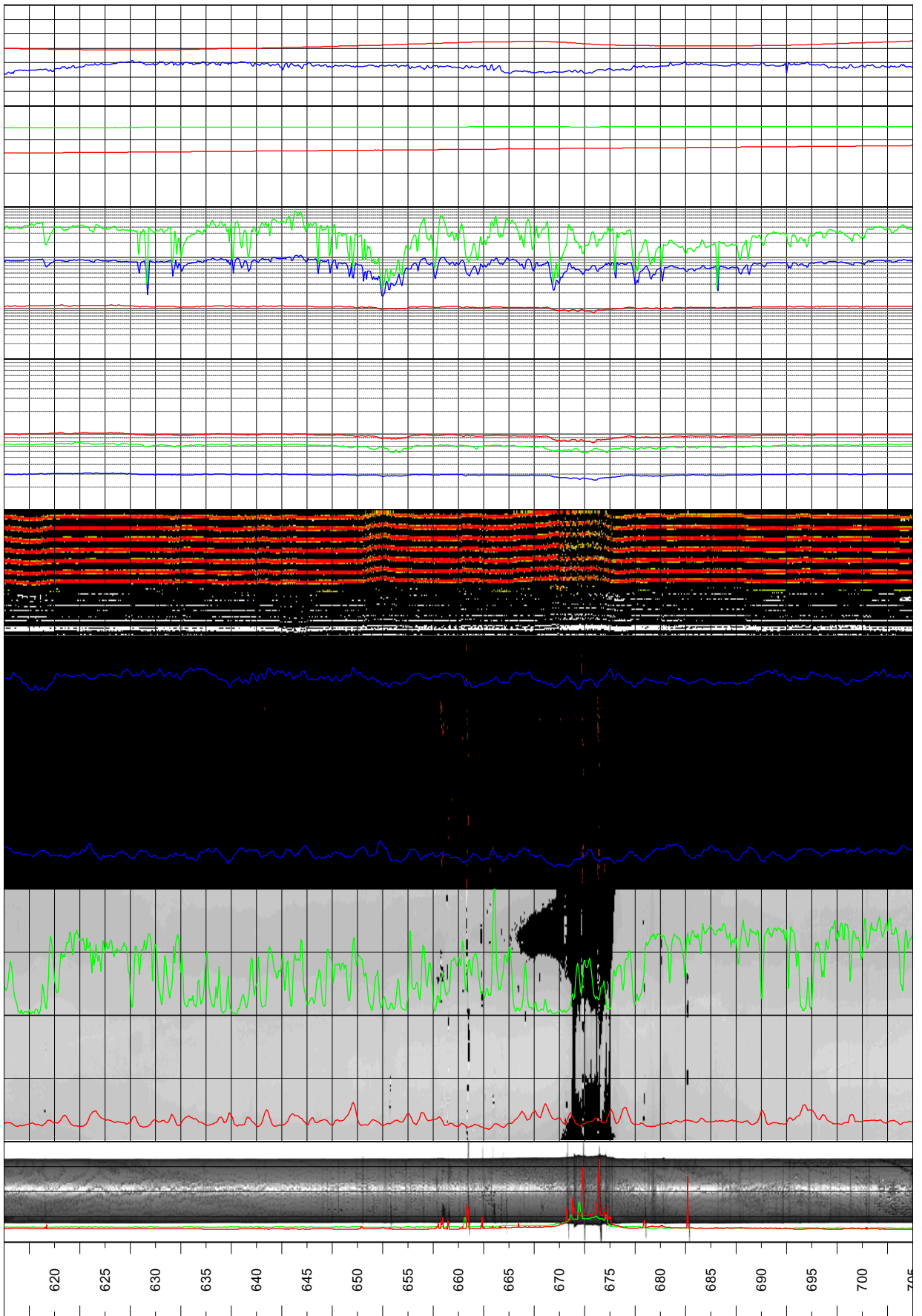


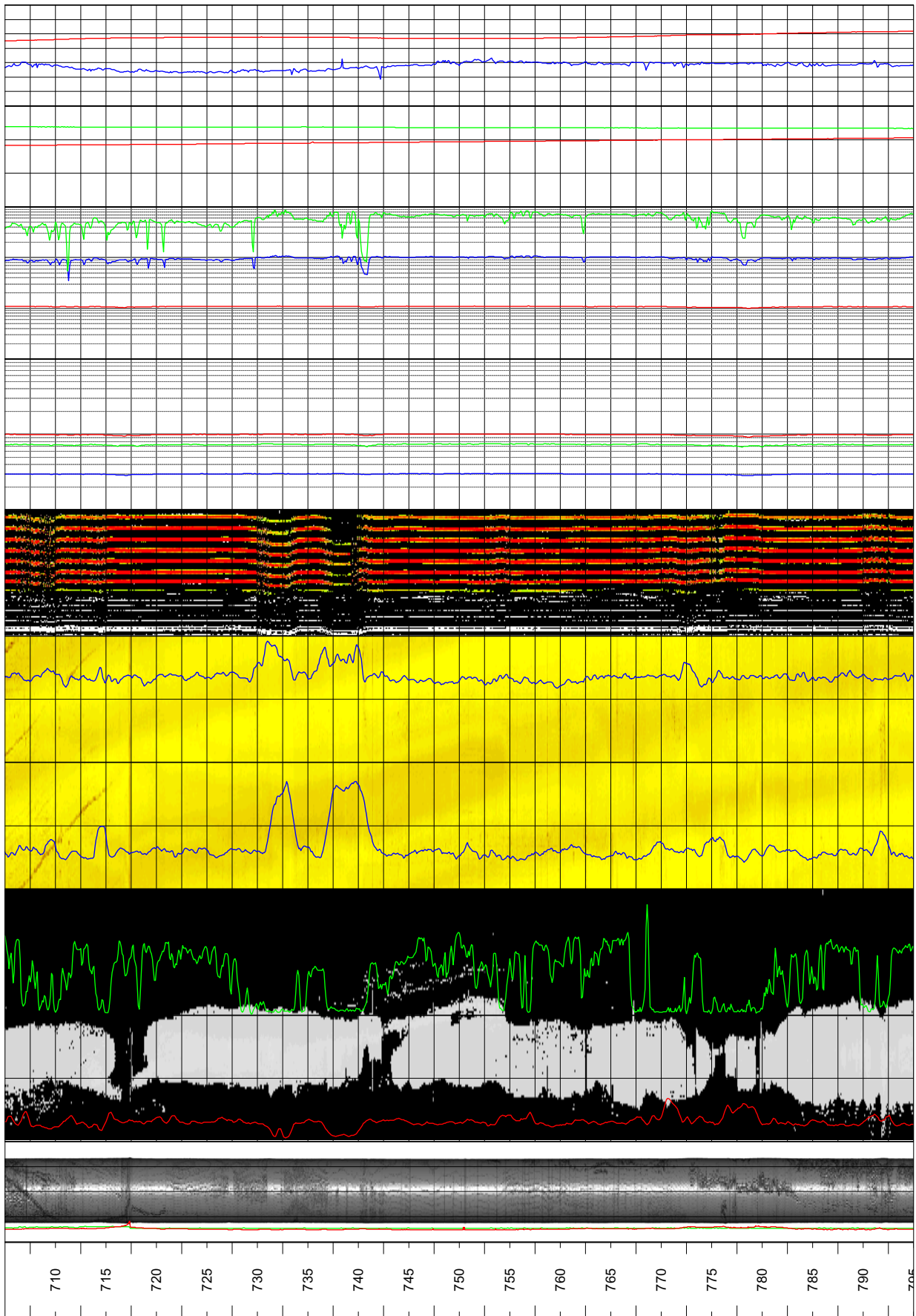


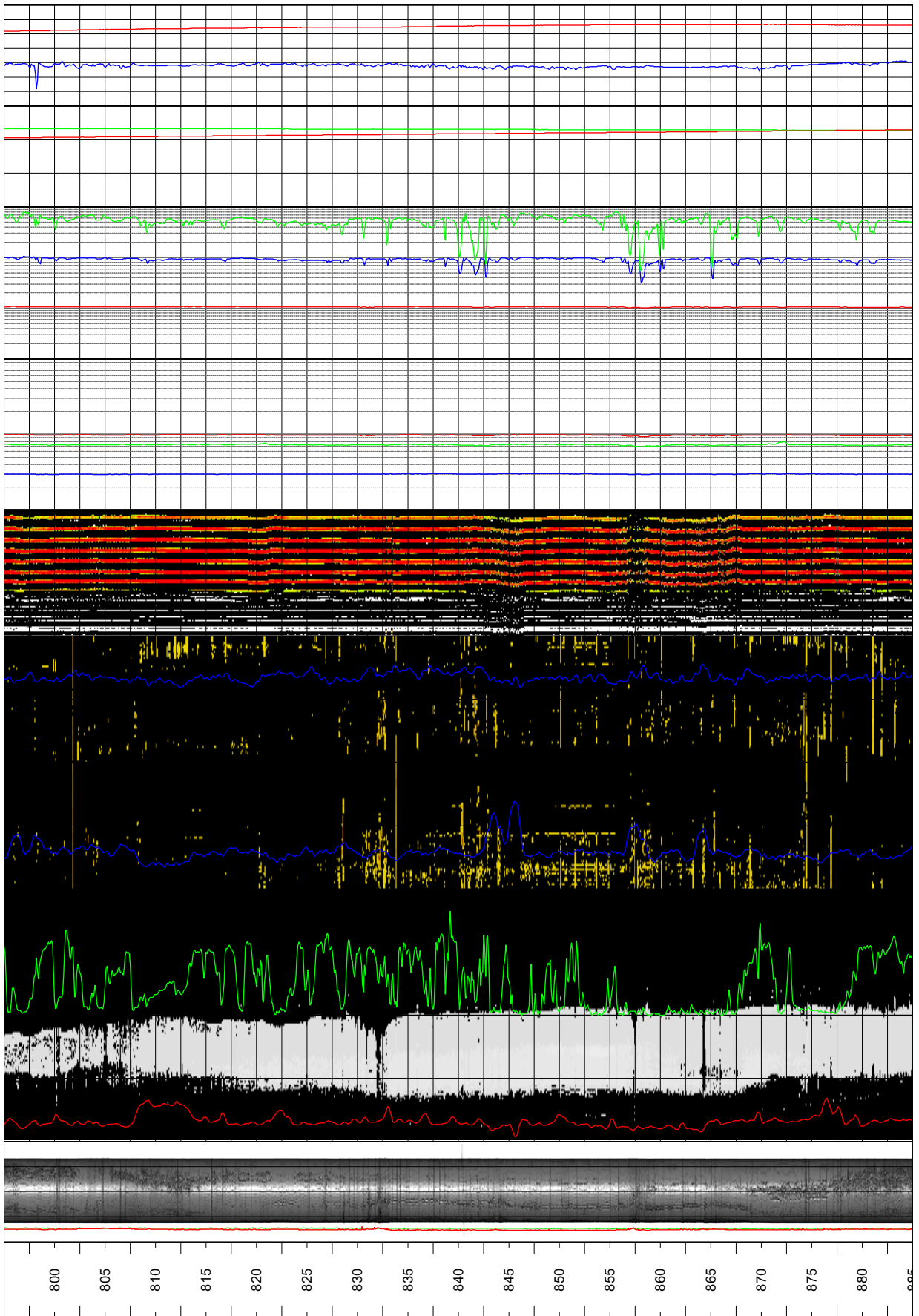


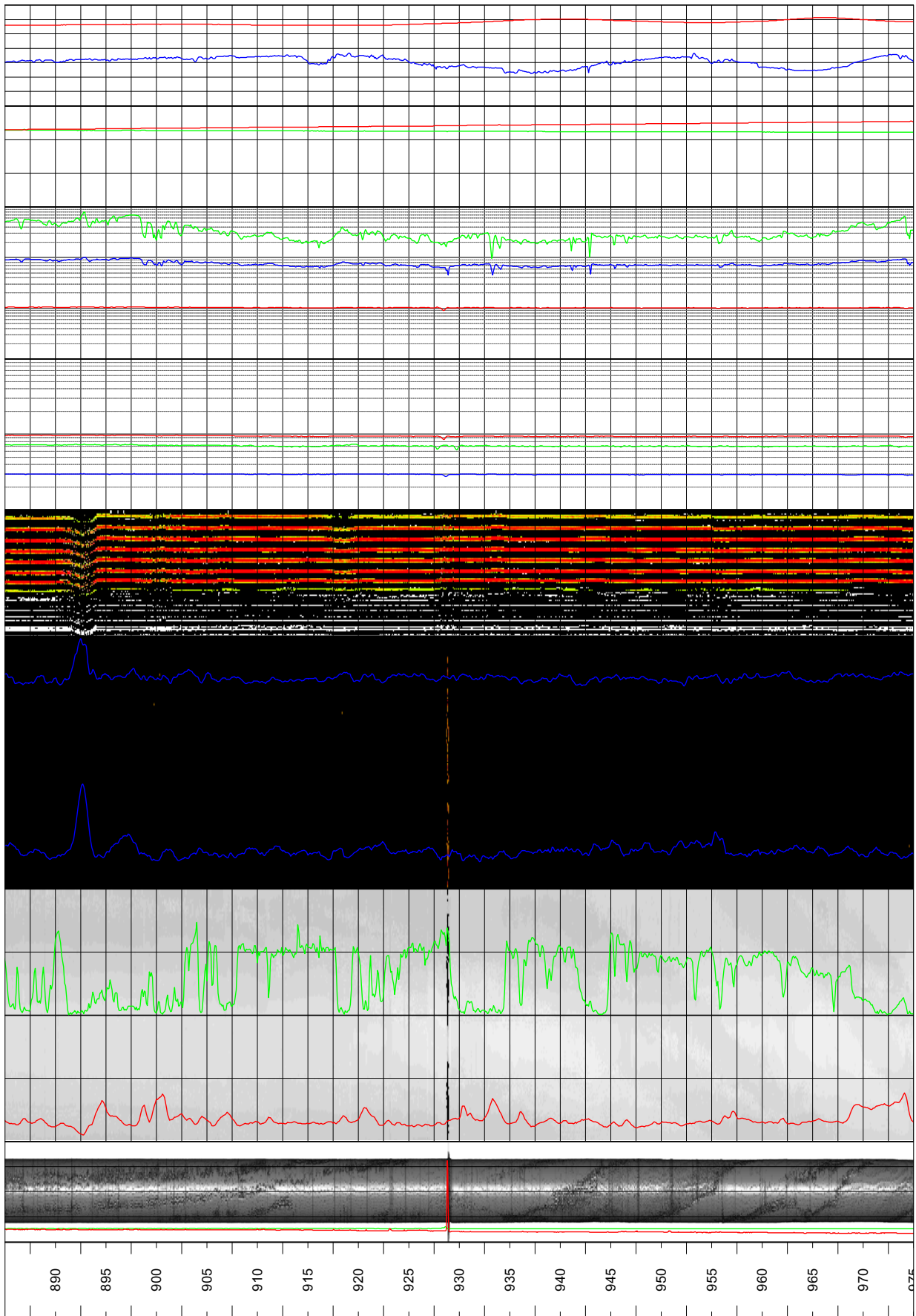


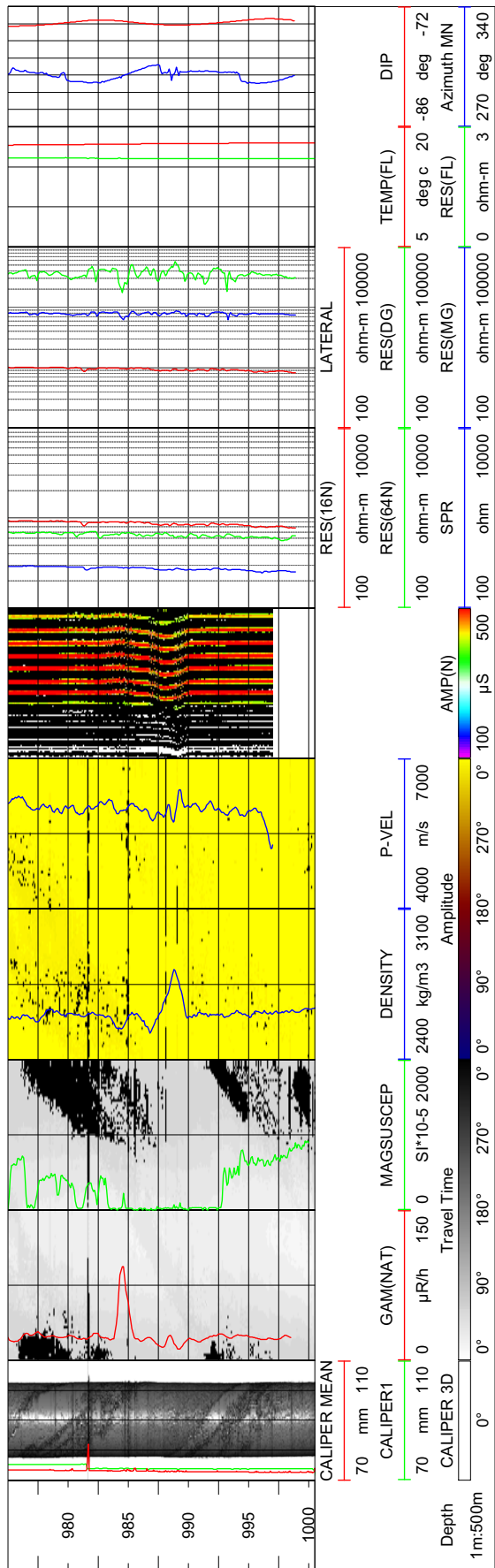












Geophysical borehole logging, borehole HFM01

Borehole No. HFM01


Co-ordinates in RT90 2,5 gon V 0:-15. RHB70

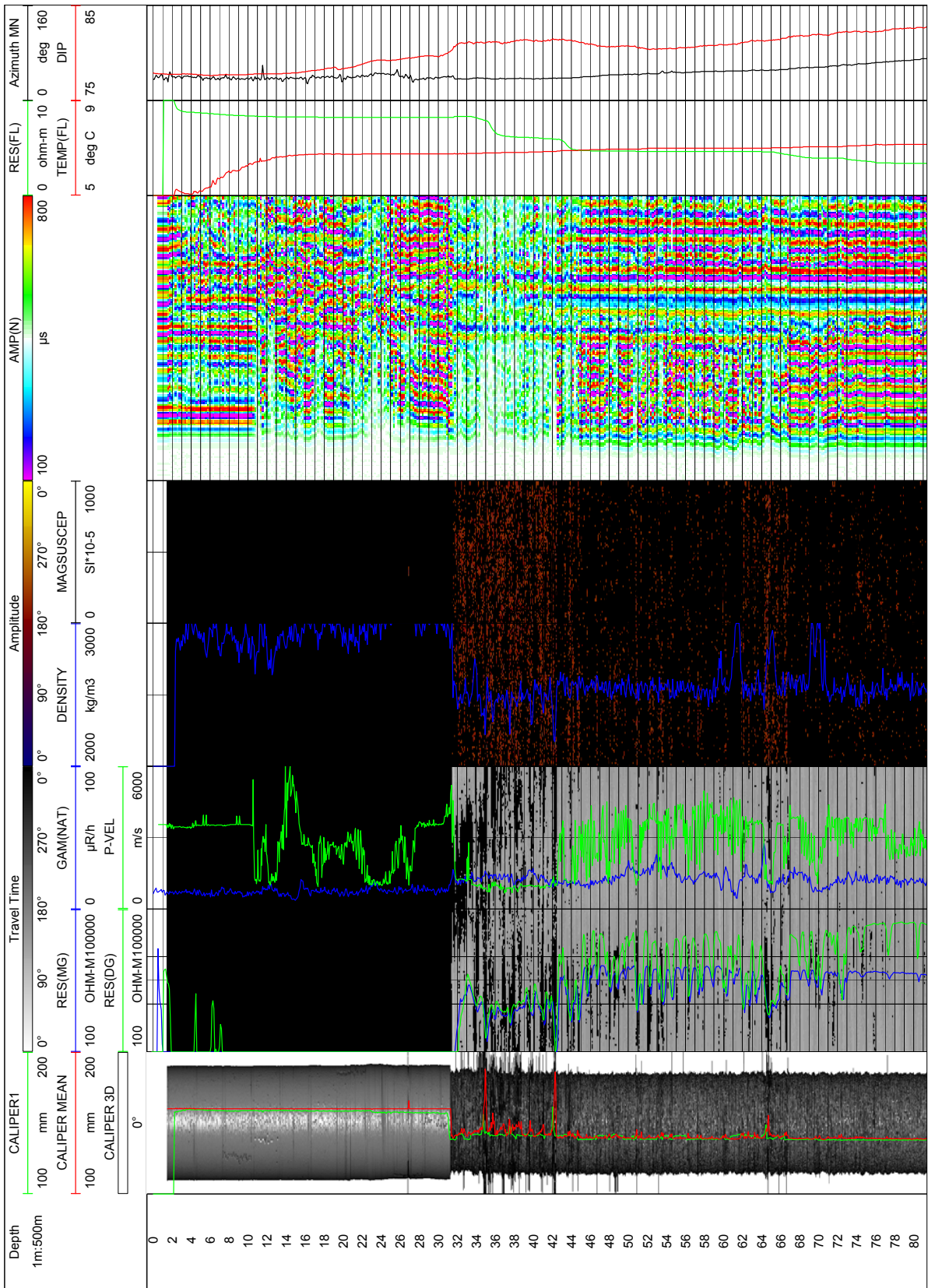
X: 6699605.181 Y: 1631484.552 Z: 1.731

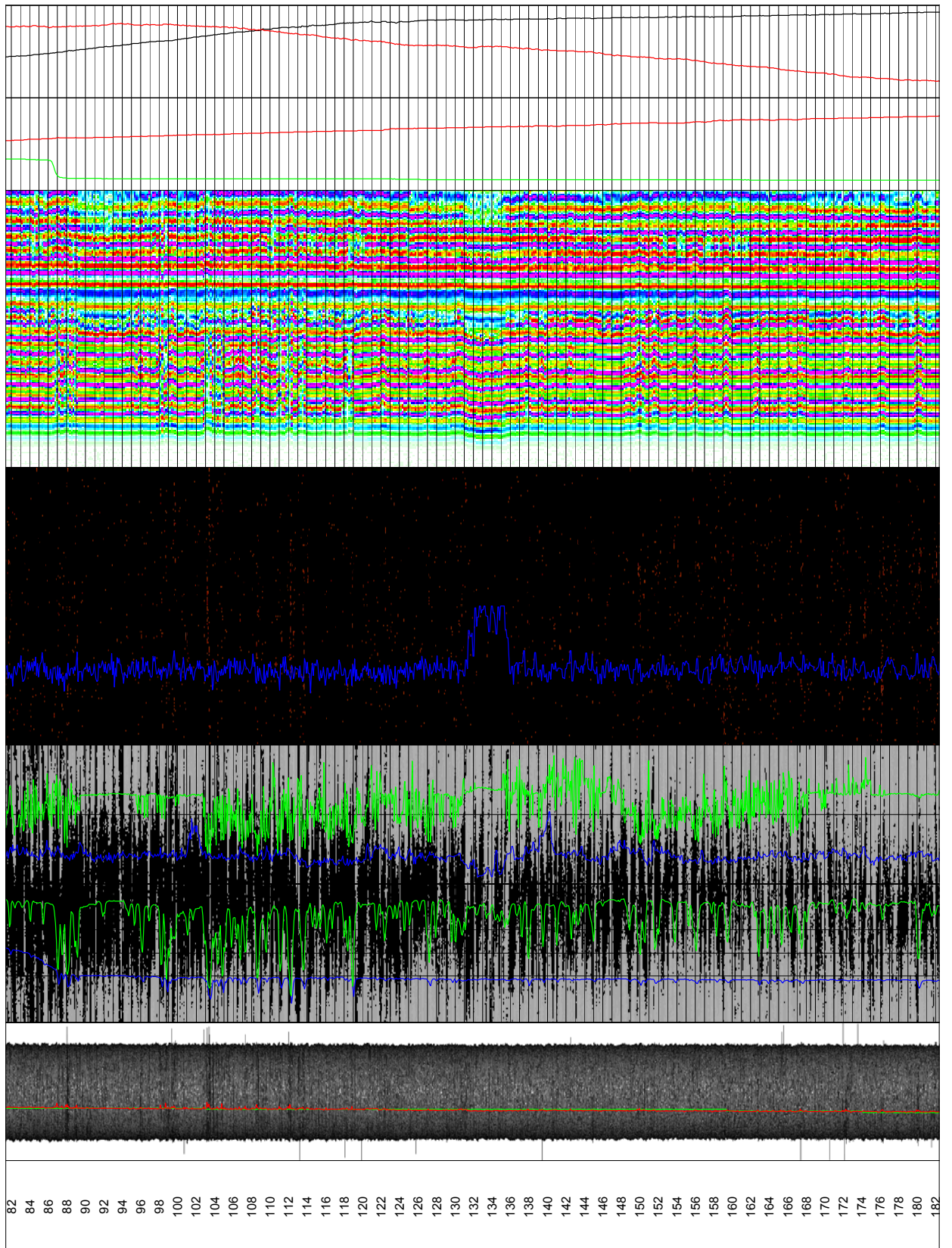
Diametre: 140 mm from 31.90 m to 200.20 m
 Reaming Diametre: 160 mm from 0 til 31.90 m
 Outer Casing: 204 mm
 Inner Casing: 160 mm
 Borehole Length: 200.20 m
 Cone: -
 Inclination at ground surface: -77.513 deg
 Azimuth: 34.061 deg
 Comments:

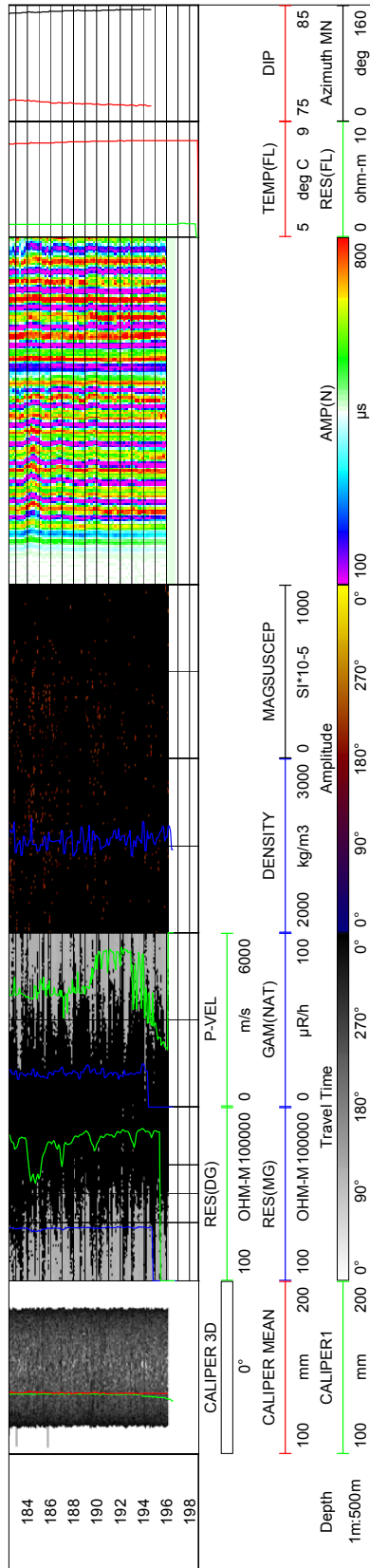
Borehole logging programme

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	deg C
RES(FL)	Fluid resistivity	9042	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 lateral	HiRAT	deg
TRAVEL TIME	360 degrees orientated acoustic travel time	HiRAT	100 ns
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT	-

Rev. 0	Date 2003 - 05 - 23	Drawn by JRI	Control UTN	Approved UTN	 <p>DGE RAMBOLL <small>Dansk Geo-servEx a/s DGE, Håndværkervingen 11, 2970 Hersholm, Phone +45 70 10 34 00, Fax + 45 39 16 39 90 RAMBOLL, Bredevej 2, DK-2830 Virum, Phone + 45 45 98 60 00, Fax + 45 45 98 67 00</small></p>
Job 360210A	Scale 1:500				
<hr/> <h2>SKB geophysical borehole logging</h2> <h3>Borehole HFM01 Forsmark</h3> <hr/>					
				Filename: HFM01_Presentation.wcl Drawing no.: 2.1	







Geophysical borehole logging, borehole HFM02

Borehole No. HFM02


Co-ordinates in RT90 2,5 gon V =:-15. RHB70

X: 6699593.212 Y: 1631268.674 Z: 3.053

Diametre: 137 mm from 25.4 m to 100 m
 Reaming Diametre: 160 mm from 0 to 25.4 m
 Outer Casing: 204 mm
 Inner Casing: 160 mm
 Borehole Length: 100 m
 Cone: -
 Inclination at ground surface: -87.787 deg
 Azimuth: 6.516 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	deg C
RES(FL)	Fluid resistivity	9042	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 lateral	HiRAT	deg
TRAVEL TIME	360 degrees orientated acoustic travel time	HiRAT	100 ns
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT	-

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Job 360210A	Scale 1:500				
<hr/> <h2>SKB geophysical borehole logging</h2> <h3>Borehole HFM02 Forsmark</h3> <hr/>					Filename: HFM02_Presentation.wcl Drawing no.: 3.1

