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Oskarshamn site investigation

Geophysical borehole logging in boreholes KLX08, HLX30, HLX31 and HLX33

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November 2005

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Abstract

Geophysical borehole logging has been performed in boreholes KLX08, HLX30, HLX31 and HLX33 all situated in Laxemar in Oskarshamn, 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.

The logging in KLX08 was recorded from 12 m to 990, HLX30 was recorded from 9 m to 163 m, HLX31 was recorded from 9 m to 133 m and HLX33 from 9 m to 202 m.

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 to 4.

Sammanfattning

Geofysisk borrhålsloggning har genomförts i borrhålen KLX08, HLX30, HLX31 och i HLX33 i delområde Laxemar, Oskarshamn.

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

Den geofysiska borrhålsloggningen genomfördes i KLX08 från 12 m till 990 m, i HLX30 från 9 m till 163 m, i HLX31 från 9 m till 133 m och i HLX33 från 9 m till 202 m.

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

Processerade loggar presenteras i Appendix 1 till 4.

Contents

1 Introduction

This document reports the results gained by the geophysical borehole logging in boreholes KLX08, HLX30, HLX31 and HLX33, which is one of the activities performed within the site investigation at Oskarshamn. The work was carried out in accordance with activity plan AP PS 400-05-059 (SKB internal controlling document). In Table 1-1 controlling documents for performing this activity are listed.

All measurements were conducted by RAMBØLL during the period October 25 to 28 2005. The borehole was recorded from Top Of Casing (TOC) to the bottom of the borehole. The technical data from the boreholes is shown in Table 1-2. The location of the boreholes is shown in Figure 1-1.

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

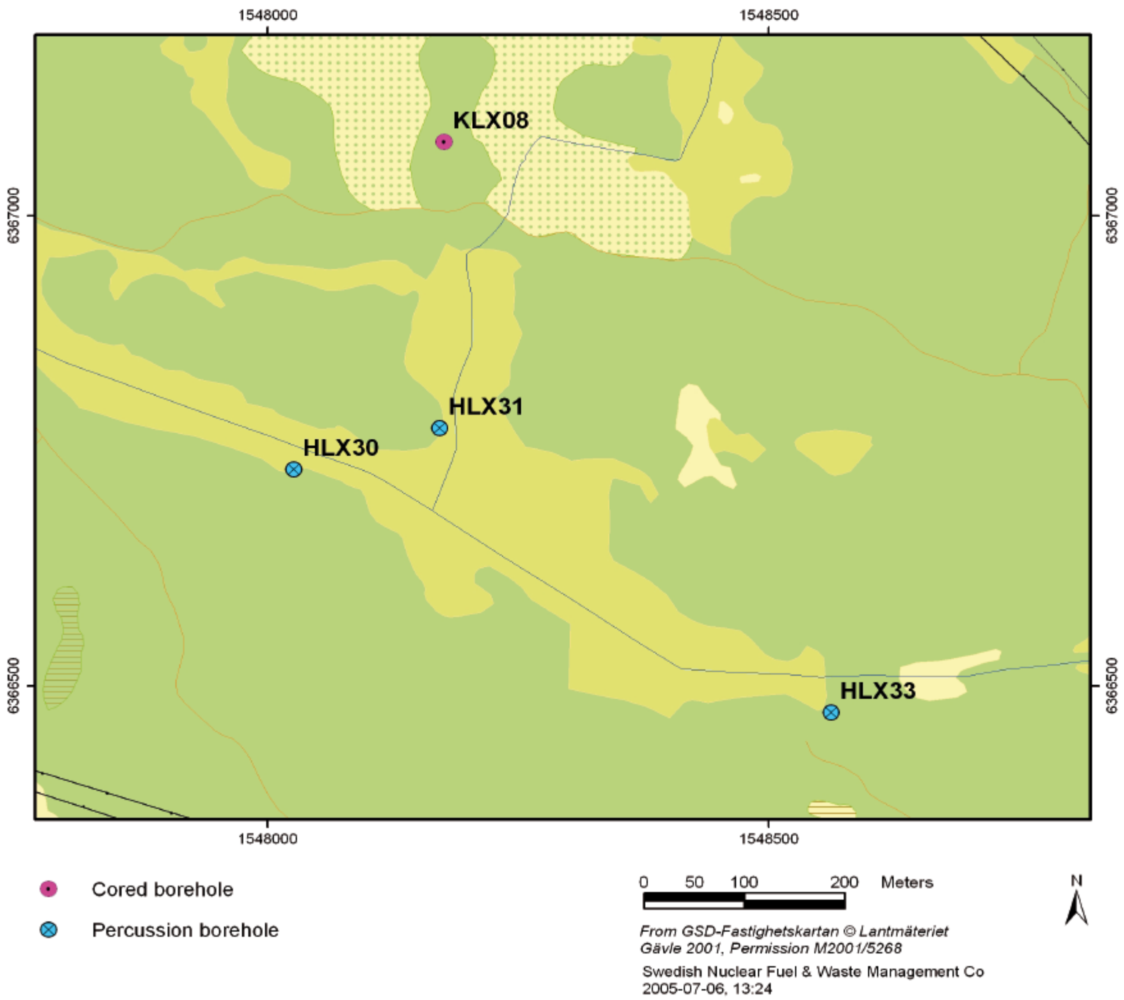

Figure 1-1. *Overview over borehole KLX08, HLX30, HLX31 and HLX33 in the Laxemar subarea.*

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

Activity plan	Number	Version
Geofysisk borrhålsloggning i KLX08, HLX30, HLX31 och HLX33.	AP PS 400-05-059	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för geofysisk borrhålsloggning.	SKB MD 221.002	2.0
Metodbeskrivning för krökningsmätning av hammar- och kärnborrhål.	SKB MD 224.001	1.0

Table 1-2. Technical data for the boreholes.

Borehole parameter	KLX08	HLX30	HLX31	HLX33
Co-ordinates (RT90)	X: 6367079.103 Y: 1548176.713	X: 6366730.734 Y: 1548026.729	X: 6366774.513 Y: 1548172.268	X: 6366471.744 Y: 1548562.705
Elevation (RHB70)	Z: 24.314	Z: 12.184	Z: 12.162	Z: 12.201
Inclination (from horizontal)	–60.2522°	–60.763°	–58.758°	–58.763°
Azimuth	199.1724°	55.816°	231.772°	21.769°
Length	1, 000.41 m[1]	163.40 m	133.20 m	202.10 m
Borehole diameter	Ø 343 mm (0.00–12.2 m) Ø 197 mm (12.2–100.2 m) Ø 165 mm (100.2–100.3 m) Ø 86 mm (100.3–101.01 m) Ø 76 mm (101.01–1,000.41 m)	Ø 190 mm (0.00–9.10 m) Ø 139 mm (9.10–163.4 m)	Ø 190 mm (0.00–9.1 m) Ø 139 mm (9.1–133.2 m)	Ø 190 mm (0.00–9.1 m) Ø 139 mm (9.1–202.1 m)
Casing	Ø 323/310 mm casing (0.3–12.2 m) Ø 208/200 mm casing (0.0–12.2 m) Cone from 96.25–100.85 (Ø100/ Ø 80 mm).	Ø 168/160 mm casing (0–8.94 m) Ø 168/147 mm casing (8.94–9.03 m)	Ø 168/160 mm casing (0–8.94 m) Ø 168/147 mm casing (8.94–9.03 m)	Ø 168/160 mm casing (0–8.94 m) Ø 168/147 mm casing (8.94–9.03 m)
Cleaning level	Level 2	Level 1	Level 1	Level 1

[1] Abandoned PFL-probe with upper end at 991.92 m.

2 Objective and scope

The objective of the survey is to both receive information of the borehole itself, and from the rock mass around the borehole. Geophysical borehole logging was used to measure changes in physical properties in the borehole fluid and the bedrock surrounding the boreholes. Acoustic televiewer was used for determination of the 360° caliper in borehole KLX08 and HLX31, the azimuth and inclination in borehole HLX31 and to determine the length marks in the core-drilled borehole, KLX08.

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 in drawing no 1.1 for borehole KLX08 in Appendix 1, drawing no 2.1 for borehole HLX30 in Appendix 2, drawing no 3.1 for borehole HLX31 in Appendix 3 and drawing no 4.1 for borehole HLX33 in Appendix 4.

3 Equipment

The geophysical borehole logging program in KLX08 was performed with up to 8 multi tool probes and resulted in a suite of 19 log types, listed in Table 5-1. The tools and recorded logs are listed in Table 3-1.

Table 3-1. Logging tools and logs recorded.

Tool	Recorded logs	Dimension	Source detector spacing and type	Tool position in borehole	Tool used in borehole
Century 8144 Normal resistivity	Normal resistivity (16 and 64 inch), single point resistance and natural gamma.	237·5.3 cm			Not used in HLX30 and HLX31
Century 8622 Magnetic susceptibility.	Magnetic susceptibility, natural gamma.	203·4.1 cm			All boreholes
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.	Not used in HLX30
Century 9042 Fluid temperatur and fluid resistivity	Fluid temperatur, fluid resistivity and natural gamma.	137·4.1 cm			All boreholes
Century 9072 3 m focused guard.	3 m focused guard log resistivity and natural gamma.	310·6.4 cm			All boreholes
Century 9139 Compensated gamma density.	Compensated Gamma density, natural gamma, 140 cm focused guard log resistivity, 1-arm caliper.	380.3·5.6 cm	20.3 cm 125 m 200 mCi Cs137	Sidewall. Gamma source focused.	Not used in HLX31 and HLX33
Century 9310 Sonic.	Full wave form travel-time providing P and S-wave velocity picking, compensated P-wave travel-time and natural gamma.	300·6.0 cm	Near 91.4 cm Far 121.9 cm	Centralized.	All boreholes
RG 25 112 000 HiRAT. Acoustic televiewer.	Full waveform acoustic amplitude and travel-time, 360° orientated acoustic image, 360° very high resolution caliper, borehole azimuth and dip and natural gamma.	246·4 cm		Centralized.	Only KLX08 and HLX31

4 Execution

4.1 General

In general the measurement procedures follow the SKB method description (MD 221.002, SKB internal controlling document). The logging program was executed in the period October 25 to 28, 2005. All relevant logging events are described in the daily report sheets delivered to SICADA and are traceable by the activity number.

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

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

For control, each log run is normally recorded both in down and in upward direction using the down run as a repeat section. For logging density tool 9030 and 9139 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 using Century equipment, except tool 9310.

All data was recorded with max.10 cm sample interval. The speed of the logging for the 9030 and 9139 tool were 5 m/min, for the 8622 tool 20 m/min and for all other tools 10 m/min.

4.2 Nonconformities

For borehole KLX08 due to disturbance of the cone between 96.25 and 100.85 and bad data in the wider part of the borehole (198 mm) between 12.2 and 100.85 m data has been skipped in that part.

The Normal resistivity 16" (RES16) and Normal resistivity 64" (RES64), LATERAL and SPR log have not been recorded in borehole HLX30 and HLX31.

The 140 cm focused resistivity log, RES(MG), has not been recorded in borehole HLX30.

5 Results

5.1 Presentation

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

Logs presented in drawings no 1.1–4.1 are presented in Table 5-1.

Table 5-1. Logs presented in drawings no 1.1 through 4.1 in Appendices 1 to 4.

Log	Log name short	Unit	Tool	Recorded/ calculated in borehole
Fluid temperature	TEMP(FL)	deg C	9042	All
Fluid resistivity	RES(FL)	ohm-m	9042	All
Normal resistivity 16 inch	RES(16N)	ohm-m	8144	KLX08, HLX33
Normal resistivity 64 inch	RES(64N)	ohm-m	8144	KLX08, HLX33
Lateral resistivity	LATERAL	ohm-m	8144	KLX08, HLX33
Single point resistance	SPR	Ohm	8144	KLX08, HLX33
Magnetic susceptibility	MAGSUSCEP	$SI \cdot 10^{-5}$	8622	All
Caliper, 1-arm	CALIPER1	mm	9030	KLX08, HLX31, HLX33
Caliper, 1-arm	CALIPER1	mm	9139	KLX08, HLX30
Gamma-gamma density	DENSITY	kg/m^3	9030	KLX08, HLX31, HLX33
Gamma-gamma density	DENSITY	kg/m^3	9139	KLX08, HLX30
Focused guard log resistivity, 140 cm	RES(MG)	ohm-m	9030	KLX08, HLX31, HLX33
Focused guard log resistivity, 127 cm	RES(SG)	ohm-m	9139	KLX08, HLX30
Natural gamma	GAM(NAT)	μR/h	9030	KLX08, HLX31, HLX33
Natural gamma	GAM(NAT)	μR/h	9072	HLX30
Focused guard log resistivity, 300 cm	RES(DG)	ohm-m	9072	All
P-wave velocity	P-VEL	m/s	9310	All
Full wave form, near receiver	AMP(N)	μs	9310	All
Full wave form, far receiver	AMP(F)	μs	9310	All
Caliper, high resolution. 360°	CALIPER 3D	mm	HiRAT	KLX08, HLX31
High resolution 1D Caliper	CALIPER MEAN	mm	HiRAT	KLX08, HLX31
Borehole azimuth magnetic north	AZIMUTH MN	Deg	HiRAT	HLX31
Borehole Inclination from horizontal	DIP	Deg	HiRAT	HLX31
360° orientated acoustic travel time	TRAVEL TIME	100 ns	HiRAT	KLX08, HLX31
360° orientated acoustic travel time	AMPLITUDE	–	HiRAT	KLX08, HLX31

5.2 Orientation, alignment and stretch of logs

5.2.1 Orientation of images

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

5.2.2 Overlapping data

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

5.2.3 Alignment of data

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

5.2.5 Removing of data

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

5.2.6 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 1,000.
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	–
Self-potential	–
Focused guard log resistivity, 300 cm	–
P-wave velocity	The P-VEL velocity is calculated using the difference in distance between the far and near receiver divided by the time 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 acoustic televiewer, the fluid temperature, fluid velocity and the internal travel time in the acoustic 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 in borehole HLX31

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). 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. In the same calculation, the magnetic declination was added. Finally, the relative coordinates were added to the given coordinate in RT90 for the top of the borehole. The coordinates were calculated from 5 m below the casing bottom.

5.4 Borehole KLX08

In order to obtain an exact depth calibration in borehole KLX08, the reference track marks made while drilling are used. The correlation between the track marks and the logs is obtained from the HiRAT Acoustic tool.

The reference track marks in the borehole and the recorded track marks from the HiRAT are observed in the following 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 depth scale. 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 KLX08, between all logruns, the obtained reference mark correlation is transferred to the other logs.

The complete log suite for borehole KLX08 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.

Table 5-3. The reference track marks in the borehole and the recorded track marks form the HiRAT in borehole KLX08.

Reference mark	HIRAT recorded
111.00	108.80
150.00	147.89
200.00	197.98
250.00	248.05
300.00	298.19
350.00	348.27
400.00	398.35
450.00	448.47
500.00	498.58
550.00	548.63
600.00	598.75
650.00	648.87
700.00	698.92
750.00	749.06
800.00	799.16
850.00	849.23
900.00	899.36
950.00	949.50
980.00	979.54

5.5 Borehole HLX30

Using the natural gamma from the 9072 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 5-4.

The complete log suite for borehole HLX30 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.

Table 5-4. Gamma events in borehole HLX30.

Events	Depths
Top event	19.07
Bottom event	143.20

5.6 Borehole HLX31

Using the natural gamma from the HiRAT 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 5-5.

The complete log suite for borehole HLX31 is presented as composite log sheet in drawing 3.1 in Appendix 3. The logs presented in drawing no 3.1 are listed in Table 5-1.

Table 5-5. Gamma events in borehole HLX31.

Events	Depths
Top event	10.8
Bottom event	No events

5.7 Borehole HLX33

Using the natural gamma from the 9030 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 5-6.

The complete log suite for borehole HLX33 is presented as composite log sheet in drawing no 4.1 in Appendix 4. The logs presented in drawing no 4.1 are listed in Table 5-1.

Table 5-6. Gamma events in borehole HLX33.

Events	Depths
Top event	57.48
Bottom event	197.93

6 Data delivery

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

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

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

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

Borehole	Probe	Log direction	WellCAD File	Description
KLX08	8144	Down	KLX08_10-26-05_07-56_8144C_.02_10.91_989.74_ORIG.log	Start Depth: 10.91 m. End Depth: 989.74 m
KLX08	8622	Up	KLX08_10-25-05_19-52_8622C_.02_-1.90_582.93_ORIG.log	Start Depth: 582.93 m. End Depth: –1.9 m
KLX08	8622	Up	KLX08_10-25-05_19-24_8622C_.02_571.04_991.04_ORIG.log	Start Depth: 991.04 m. End Depth: 571.04 m
KLX08	9030	Up	KLX08_10-26-05_11-15_9030CA_.02_4.73_991.40_ORIG.log	Start Depth: 991.4 m. End Depth: 4.73 m
KLX08	9042	Down	KLX08_10-25-05_14-10_9042C_.02_0.22_999.72_ORIG.log	Start Depth: 0.22 m. End Depth: 999.72 m
KLX08	9072	Up	KLX08_10-25-05_17-16_9072C_.02_3.78_994.78_ORIG.log	Start Depth: 994.78 m. End Depth: 3.78 m
KLX08	9139	Up	KLX08_10-27-05_09-33_9139A_.02_-1.01_710.03_ORIG.log	Start Depth: 710.03 m. End Depth: –1.01 m
KLX08	9139	Up	KLX08_10-26-05_20-15_9139A_.02_695.37_990.70_ORIG.log	Start Depth: 990.7 m. End Depth: 695.37 m
KLX08	9310	Up	KLX08_10-27-05_14-24_9310C2_.10_74.00_214.10_ORIG.log	Start Depth: 214.1 m. End Depth: 74 m
KLX08	9310	Up	KLX08_10-27-05_13-22_9310C2_.10_191.30_677.50_ORIG.log	Start Depth: 677.5 m. End Depth: 191.3 m
KLX08	9310	Up	KLX08_10-27-05_12-37_9310C2_.10_635.30_990.90_ORIG.log	Start Depth: 990.9 m. End Depth: 635.3 m
KLX08	HiRAT	Up	KLX08_HiRAT_90PIXELS_UP_RUN2.HED	Start Depth: 990 m. End Depth: 0 m
HLX30	8622	Up	HLX30_10-28-05_14-14_8622C_.10_-0.30_162.60_ORIG.log	Start Depth: 162.6 m. End Depth: –0.3 m
HLX30	9042	Down	HLX30_10-28-05_11-05_9042C_.02_4.82_162.68_ORIG.log	Start Depth: 4.82 m. End Depth: 162.68 m
HLX30	9072	Up	HLX30_10-28-05_11-42_9072C_.02_-0.29_162.28_ORIG.log	Start Depth: 162.28 m. End Depth: –0.29 m
HLX30	9139	Up	HLX30_10-28-05_12-58_9139A_.02_-0.11_161.83_ORIG.log	Start Depth: 161.83 m. End Depth: –0.11 m
HLX30	9310	Up	HLX30_10-28-05_13-45_9310C2_.10_-0.20_161.40_ORIG.log	Start Depth: 161.4 m. End Depth: –0.2 m
HLX31	8622	Up	HLX31_10-28-05_09-14_8622C_.02_3.06_132.53_ORIG.log	Start Depth: 132.53 m. End Depth: 3.06 m

Borehole	Probe	Log direction	WellCAD File	Description
HLX31	9030	Up	HLX31_10-28-05_09-34_9030CA_.02_6.50_131.70_ ORIG.log	Start Depth: 131.7 m. End Depth: 6.5 m
HLX31	9042	Down	HLX31_10-28-05_08-01_9042C_.02_0.22_132.71_ ORIG.log	Start Depth: 0.22 m. End Depth: 132.71 m
HLX31	9072	Up	HLX31_10-28-05_08-49_9072C_.02_2.92_132.55_ ORIG.log	Start Depth: 132.55 m. End Depth: 2.92 m
HLX31	9310	Up	HLX31_10-28-05_10-20_9310C2_.10_0.00_131.50_ ORIG.log	Start Depth: 131.5 m. End Depth: 0 m
HLX31	HiRAT	Up	HLX31_90pixels_up_run1.HED	Start Depth: 130 m. End Depth: 0 m
HLX33	8144	Down	HLX33_10-27-05_16-19_8144C_.02_0.28_204.62_ ORIG.log	Start Depth: 0.28 m. End Depth: 204.62 m
HLX33	8622	Up	HLX33_10-27-05_18-50_8622C_.02_3.21_201.47_ ORIG.log	Start Depth: 201.47 m. End Depth: 3.21 m
HLX33	9030	Up	HLX33_10-27-05_17-45_9030CA_.02_-5.68_200.29_ ORIG.log	Start Depth: 200.29 m. End Depth: –5.68 m
HLX33	9042	Down	HLX33_10-27-05_15-42_9042C_.02_0.22_202.52_ ORIG.log	Start Depth: 0.22 m. End Depth: 202.52 m
HLX33	9072	Up	HLX33_10-27-05_17-04_9072C_.02_3.26_202.02_ ORIG.log	Start Depth: 202.02 m. End Depth: 3.26 m
HLX33	9310	Up	HLX33_10-27-05_19-23_9310C2_.10_1.20_201.20_ ORIG.log	Start Depth: 201.2 m. End Depth: 1.2 m

Table 6-2. Drawing files in WellCad format.

Borehole	Drawing	WellCad file
KLX08	1.1	KLX08_Presentation.WCL
HLX30	2.1	HLX30_Presentation.WCL
HLX31	3.1	HLX31_Presentation.WCL
HLX33	4.1	HLX33_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	Included for borehole KLX08 and HLX31
“Borehole”_TEMP(FL)_RES(FL)_GP060 – Fluid temperature and resistivity logging.xls	
“Borehole”_DENSITY_GP090 – Density logging.xls	
KLX08_DENSITY_9030_GP090 – Density logging.xls	KLX08. Tool 9030
KLX08_DENSITY_9139_GP090 – Density logging.xls	KLX08. Tool 9139
“Borehole”_MAGSUSCEP_GP110 – Magnetic susceptibility logging.xls	
“Borehole”_GAM(NAT)_GP120 – Natural gamma logging.xls	
“Borehole”_SPR_GP150 – Single point resistance logging.xls	Not included for borehole HLX30 and HLX31
“Borehole”_RES(64N)_GP160 – Resistivity, normal 1.6 m (64 in).xls	Not included for borehole HLX30 and HLX31
“Borehole”_RES(MG)_GP161 – Resistivity, focused 140 cm.xls	Not included for borehole HLX30
“Borehole”_RES(DG)_GP162 – Resistivity, focused 300 cm.xls	
“Borehole”_LATERAL_GP163 – Resistivity, lateral 1.6–0.1 m.xls	Not included for borehole HLX30 and HLX31
“Borehole”_RES(16N)_GP164 – Resistivity, normal 0.4 m (16 in).xls	Not included for borehole HLX30 and HLX31
“Borehole”_P-VEL_GP175 – Fullwave sonic.xls	

Appendix 1

Borehole KLX08, drawing no 1.1, borehole logs

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

Northing: 6367079.103 Easting: 1548176.713 Elevation: 24.314

Diameter:	76 mm
Reaming Diameter:	
Outer Casing:	
Inner Casing:	
Borehole Length:	991.92 m
Cone:	
Inclination at ground surface:	-60.2522 deg
Azimuth:	199.1724 deg
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030/9139	mm
DENSITY	Gamma-gamma density	9030/9139	kg/m³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9072	μR/h
TEMP(FL)	Fluid temperature	9042	deg C
RES(FL)	Fluid resistivity	9042	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9310	m/s
AMP(N)	Full wave form, near receiver	9310	μs
AMP(F)	Full wave form, far receiver	9310	μs
MAGSUSCEP	Magnetic susceptibility	8622	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT	deg
DIP	Borehole inclination from horizontal	HiRAT	deg
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	8144	ohm-m
RES(64N)	Normal resistivity 64 inch	8144	ohm-m
LATERAL	Lateral resistivity	8144	ohm-m
SPR	Single point resistivity	8144	ohm
SP	Self Potential	8144	mV
RES(SG)	Focused guard log resistivity, 12.8 cm	9139	ohm-m

Rev.	Date	Drawn by	Control	Approved
0	2005-11-16	JRI	UTN	UTN

Job	Scale
547310A	1:500

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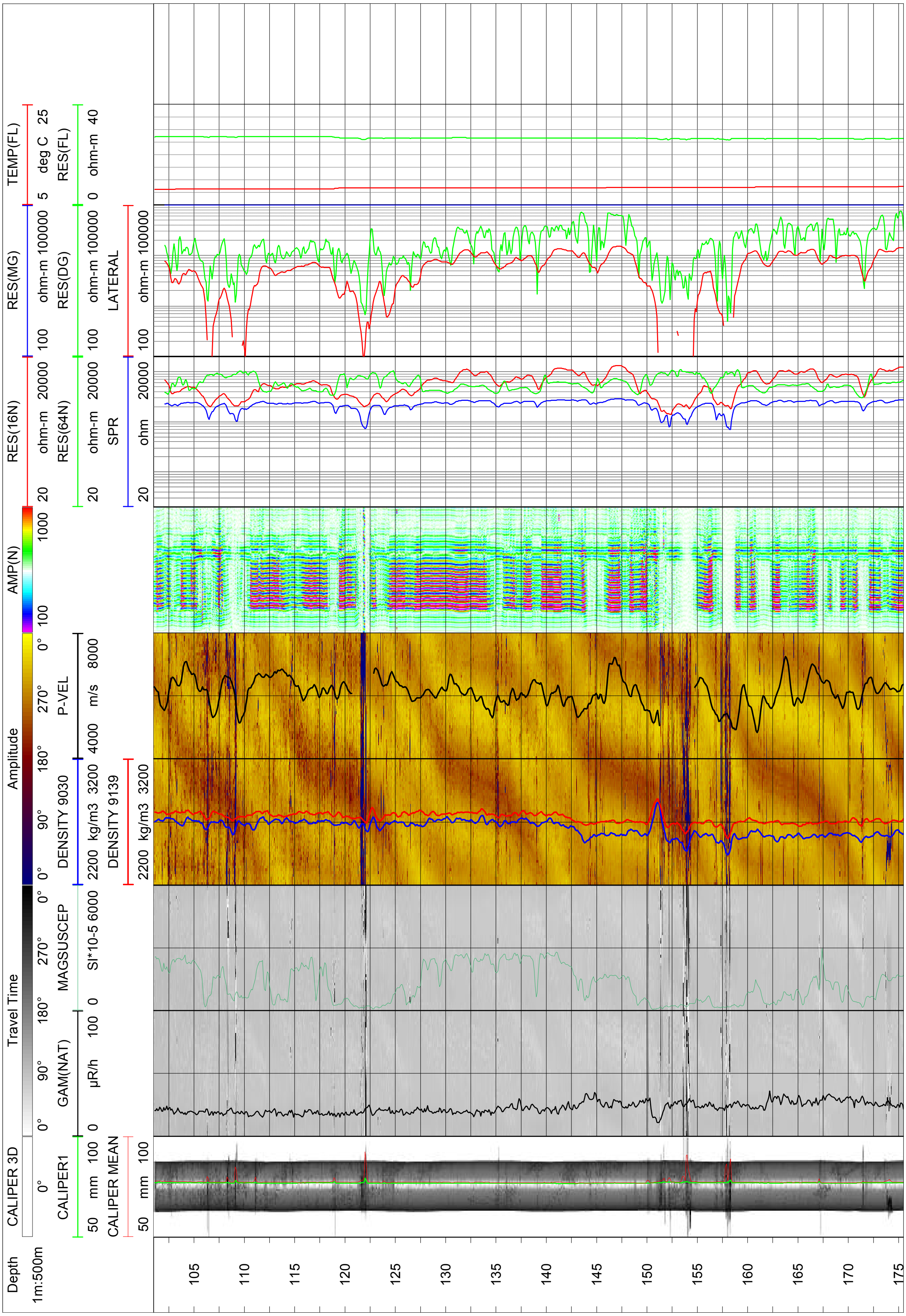
SKB geophysical borehole logging
Borehole KLX08

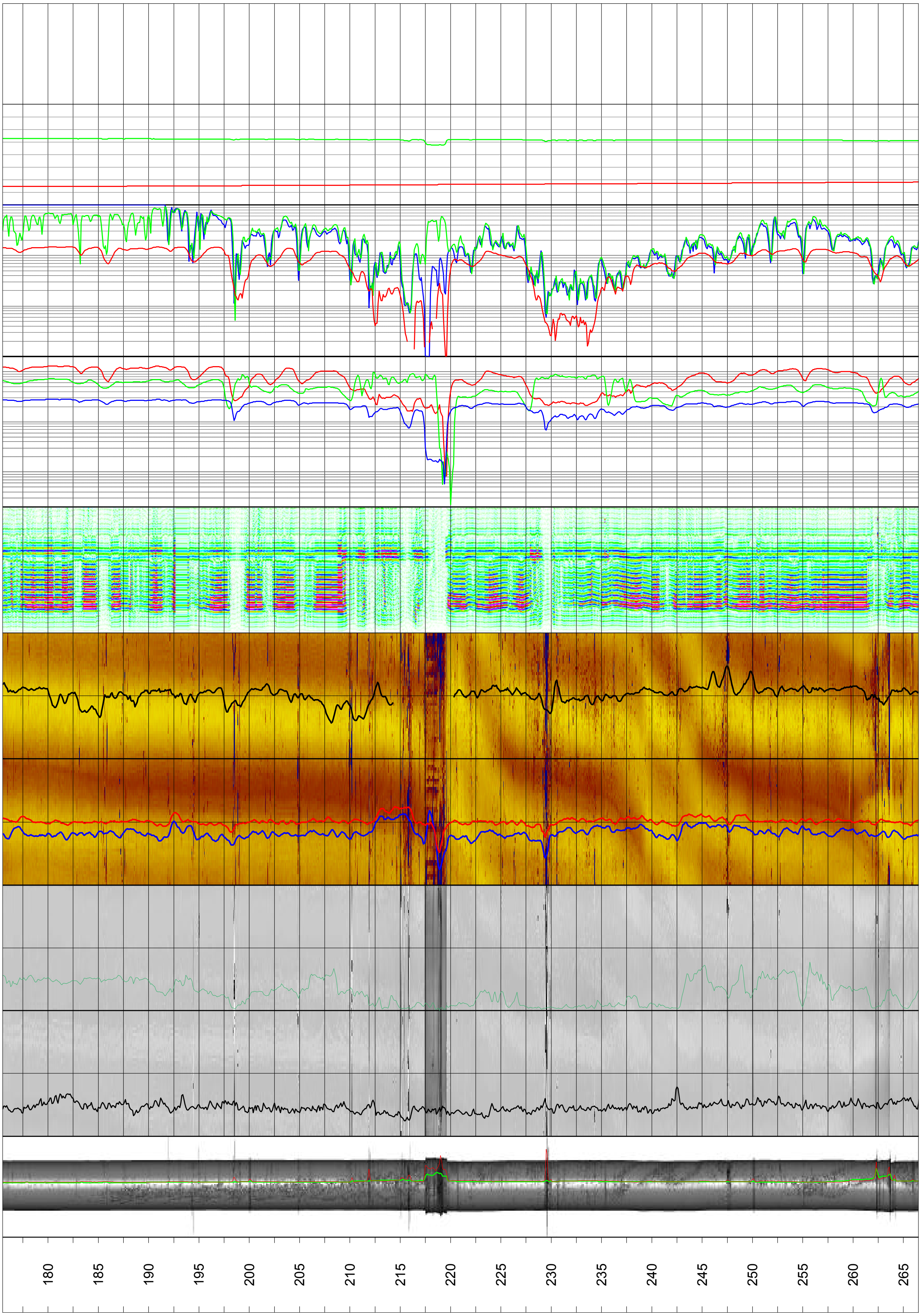
Presentation

Filename:
KLX08_Presentation.wcl

Drawing no.:
1.1



Depth
1m:500m
CALIPER 3D
CALIPER1
50 mm 100
CALIPER MEAN
50 mm 100
Travel Time
0° 90° 180° 270° 0°
GAM(NAT)
0 µR/h 100
MAGSUSCEP
0 SI*10-5 6000
Amplitude
0° 90° 180° 270° 0°
DENSITY 9030
2200 kg/m3 3200
DENSITY 9139
2200 kg/m3 3200
P-VEL
4000 m/s 8000
AMP(N)
100 1000
RES(16N)
20 ohm-m 20000
RES(64N)
20 ohm-m 20000
SPR
20 ohm 20000
RES(MG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
LATERAL
100 ohm-m 100000
TEMP(FL)
5 deg C 25
RES(FL)
0 ohm-m 40
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175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260
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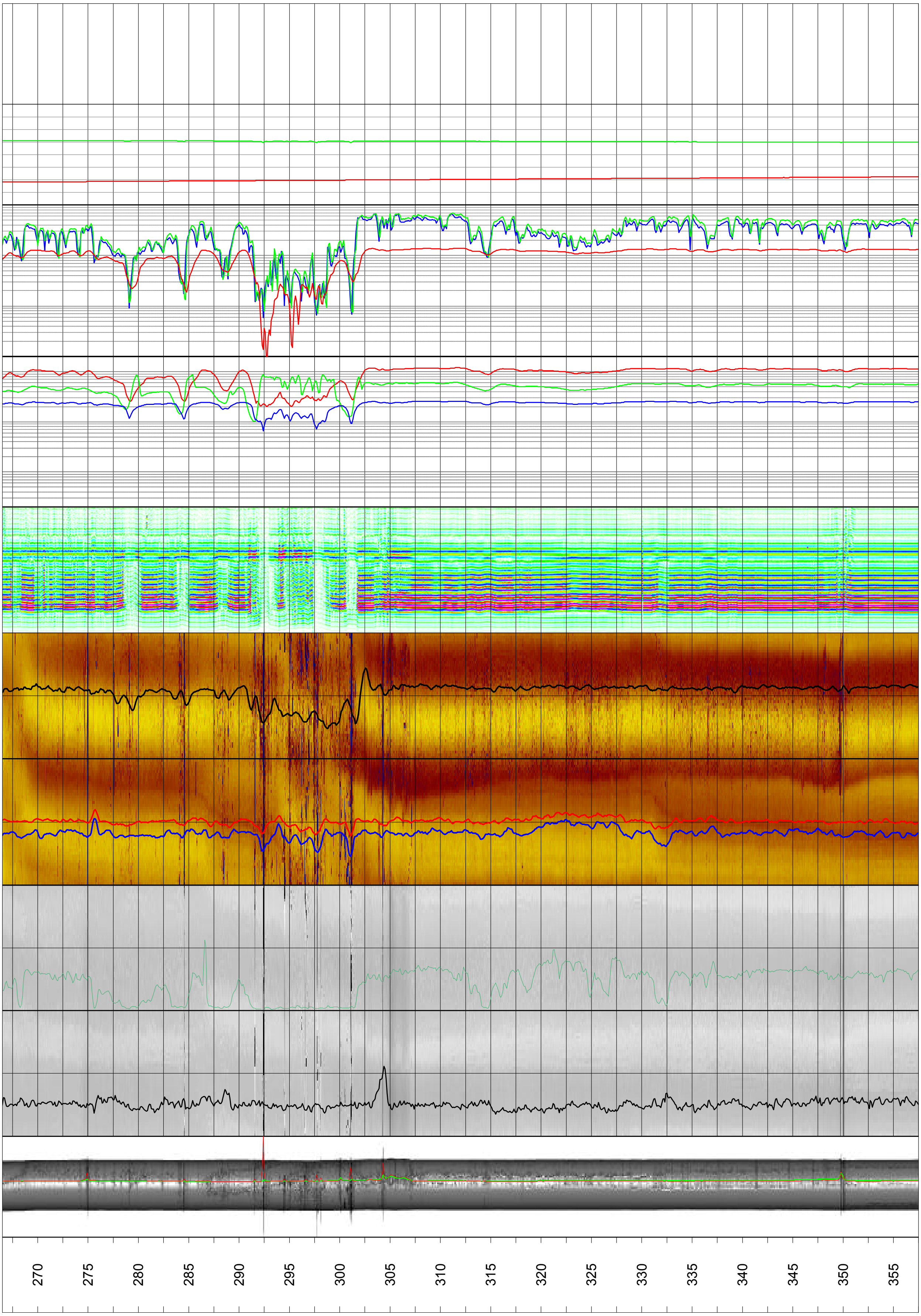
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345
350
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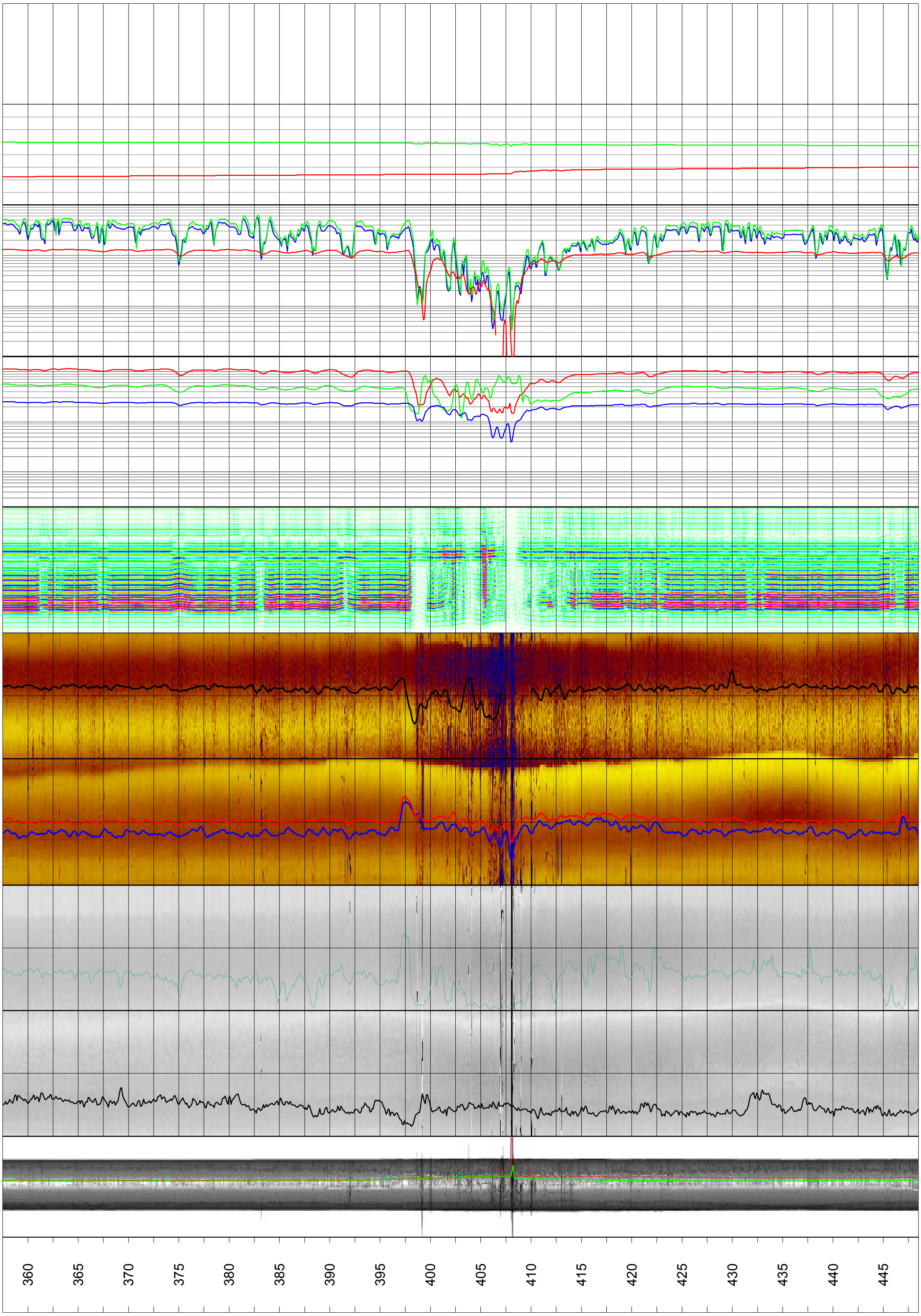
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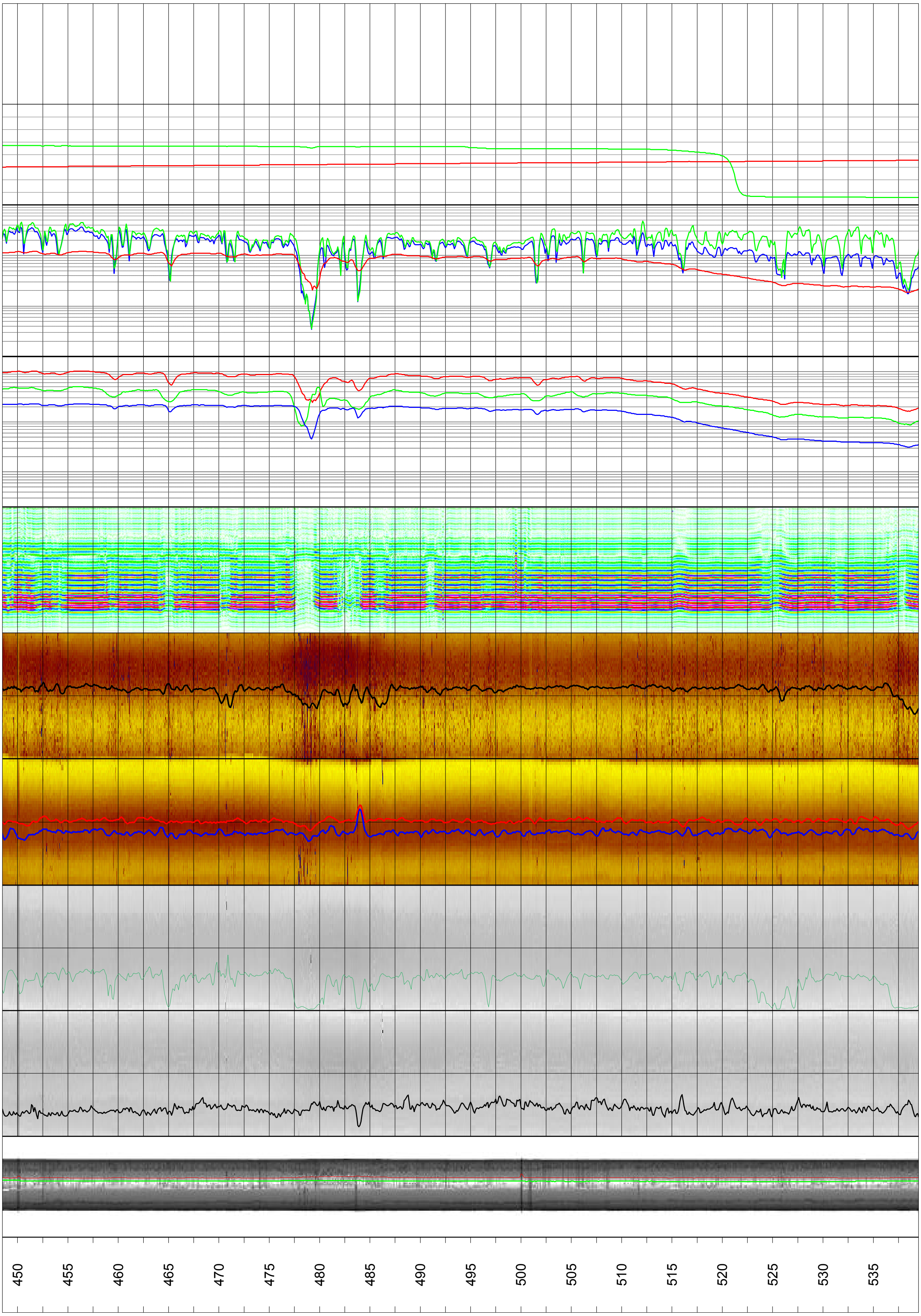
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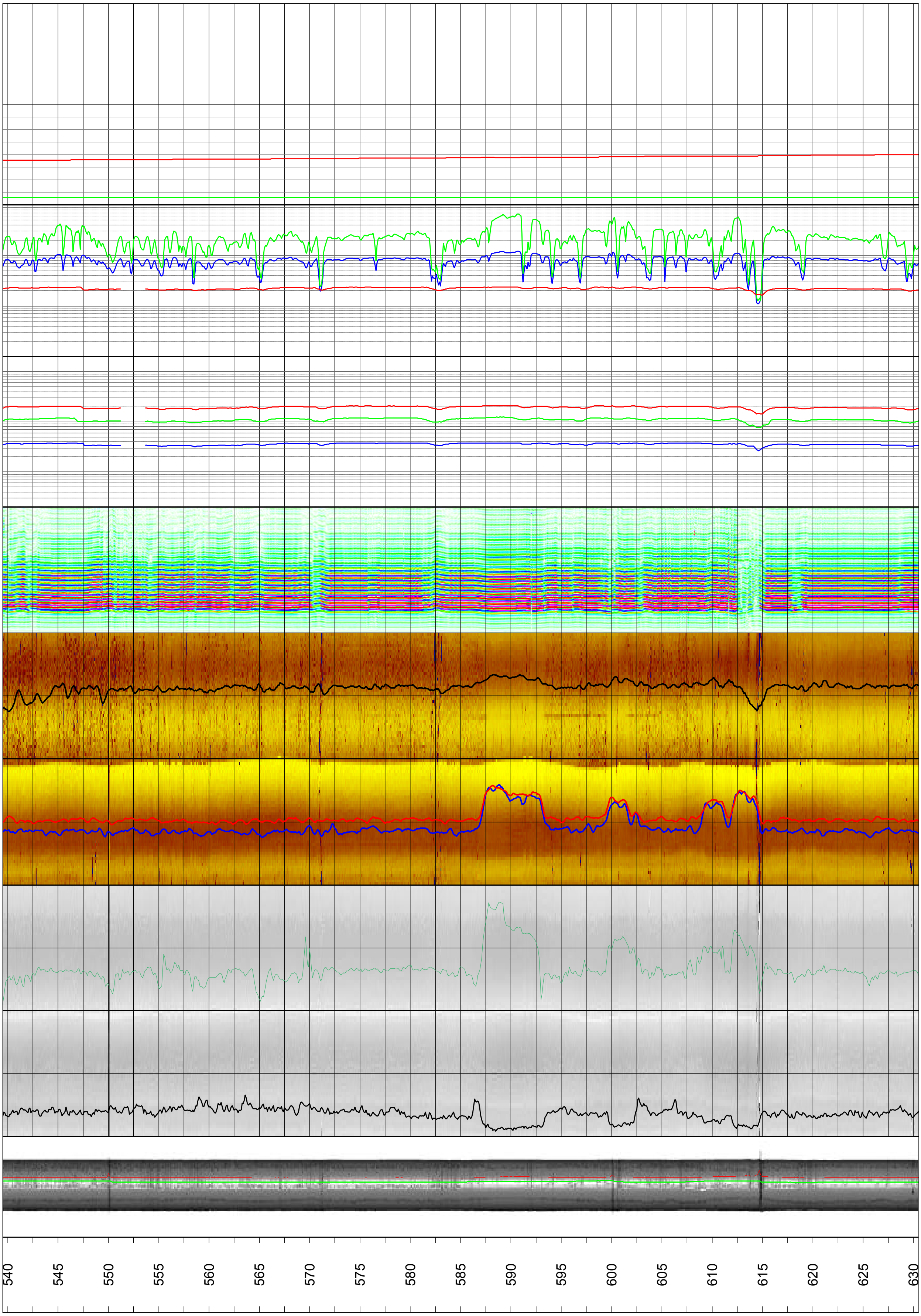
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625
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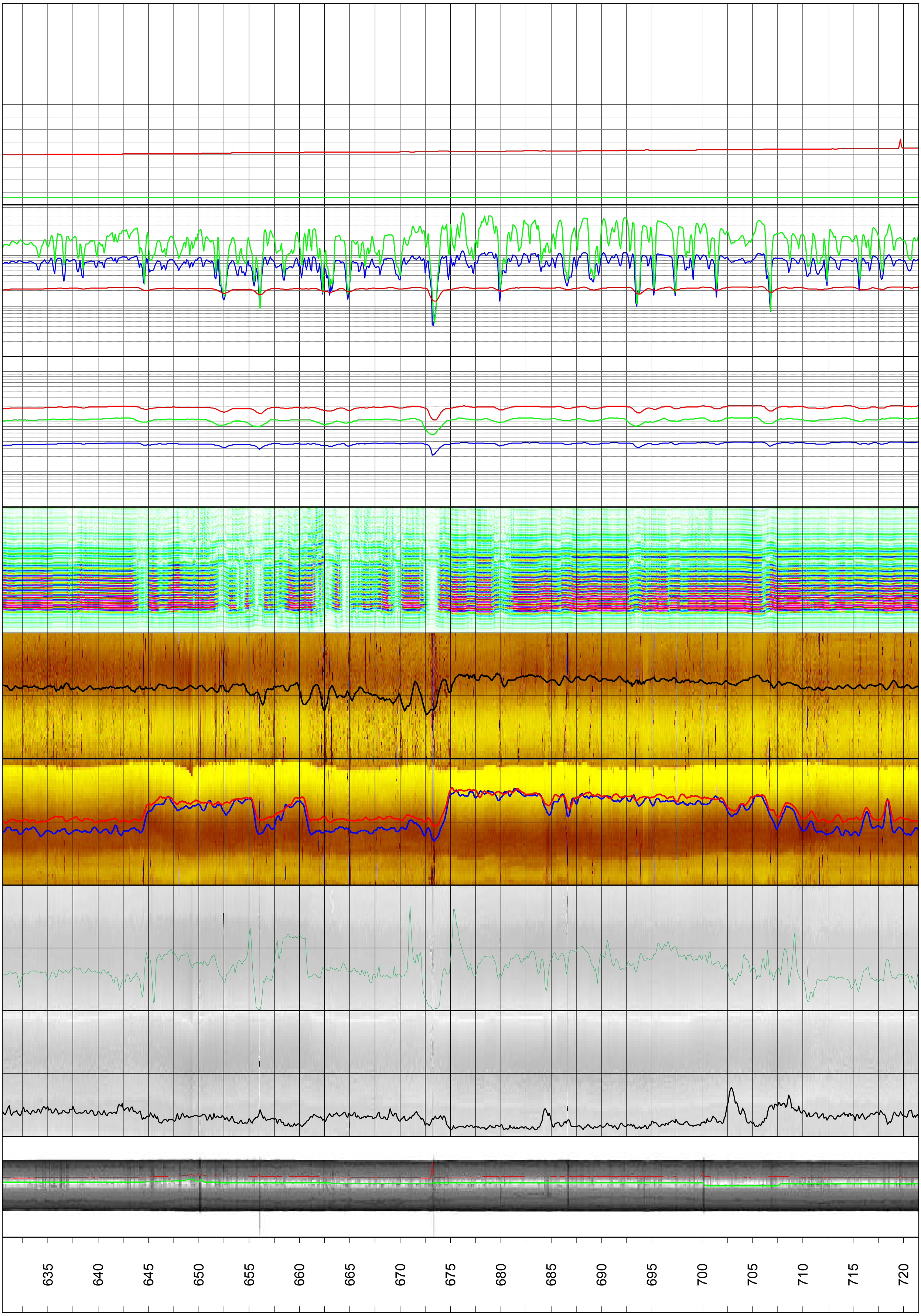
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645
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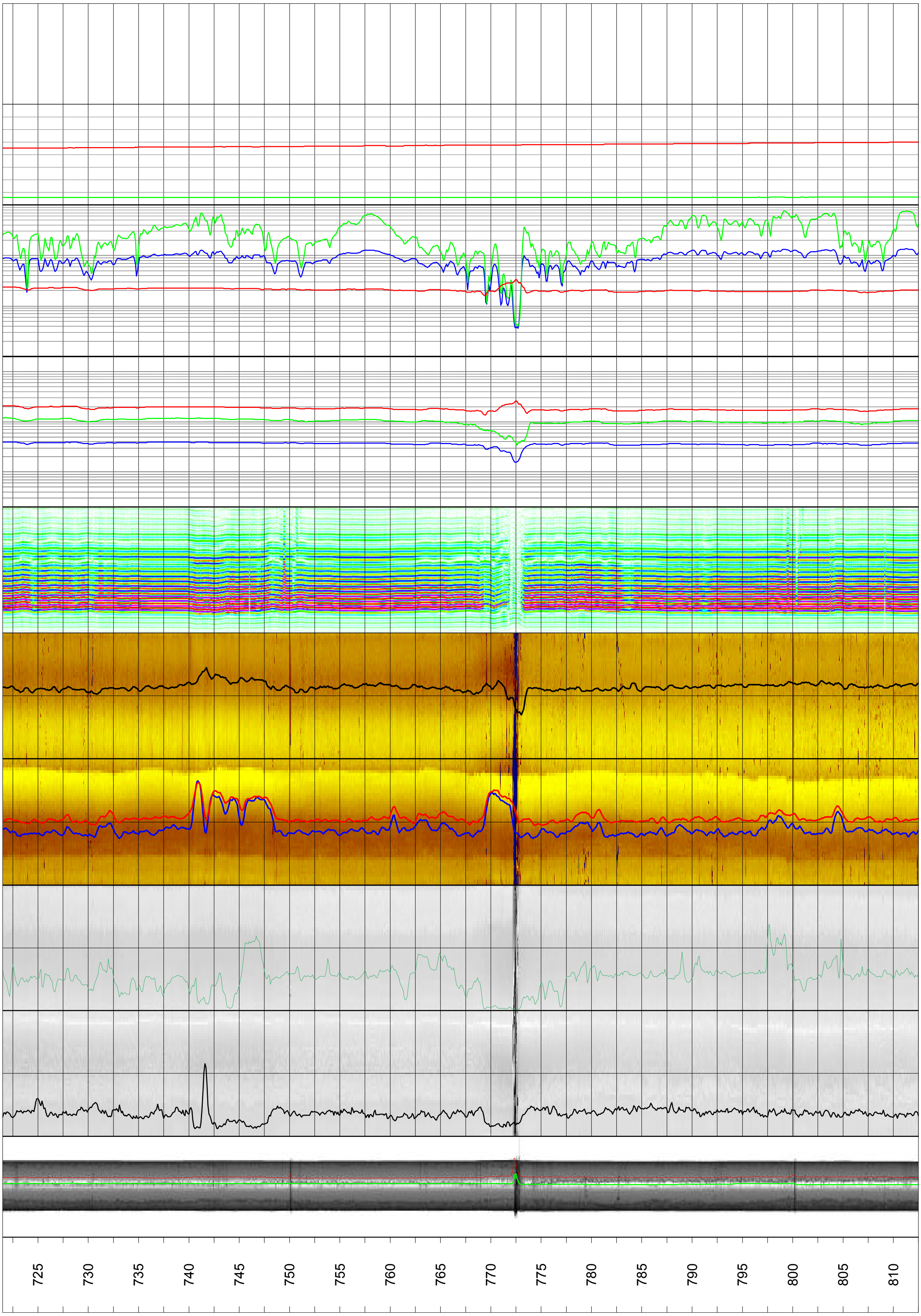
685
690
695
700
705
710
715
720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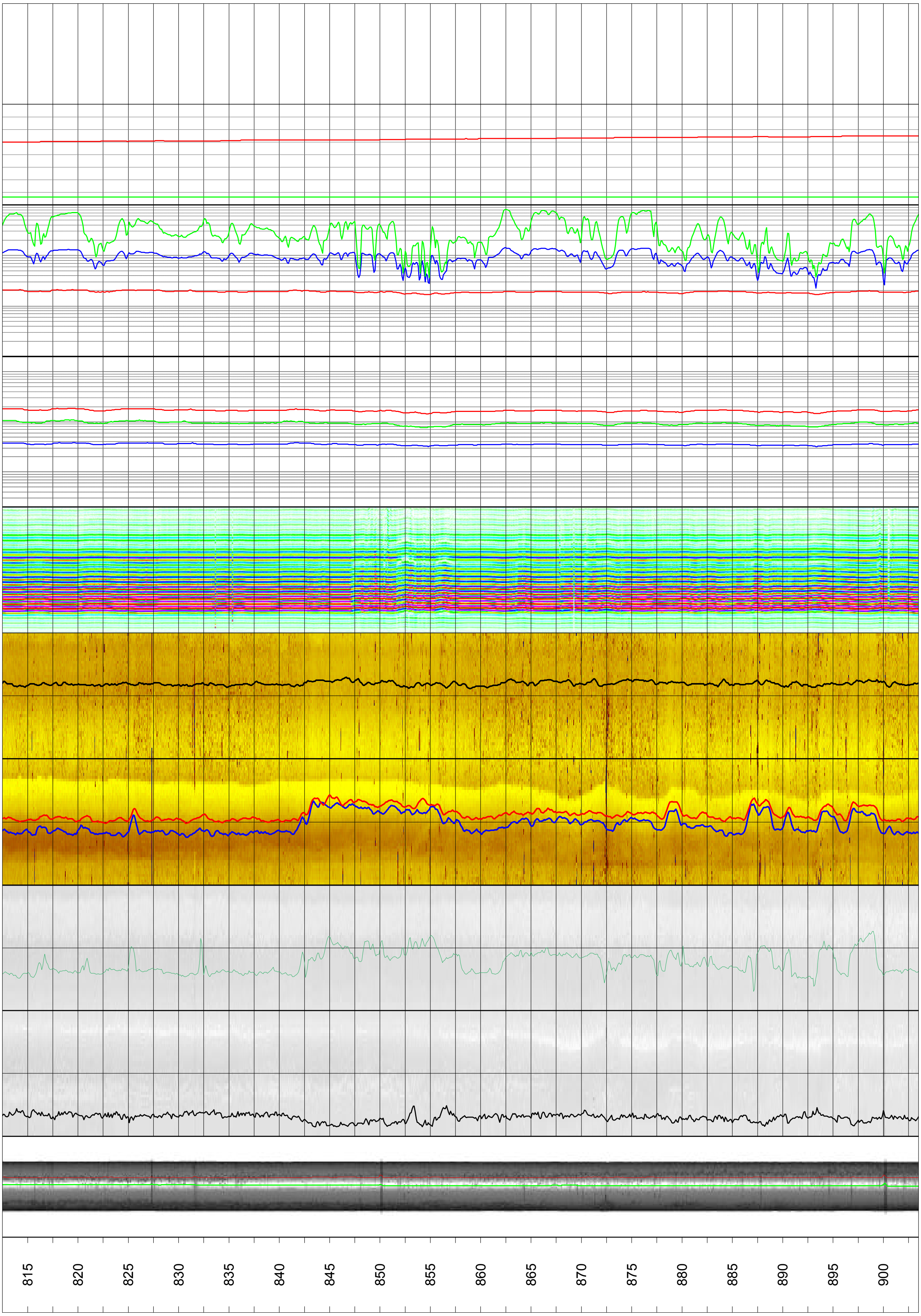
745
750
755
760
765
770
775
780
785
790
795
800
805
810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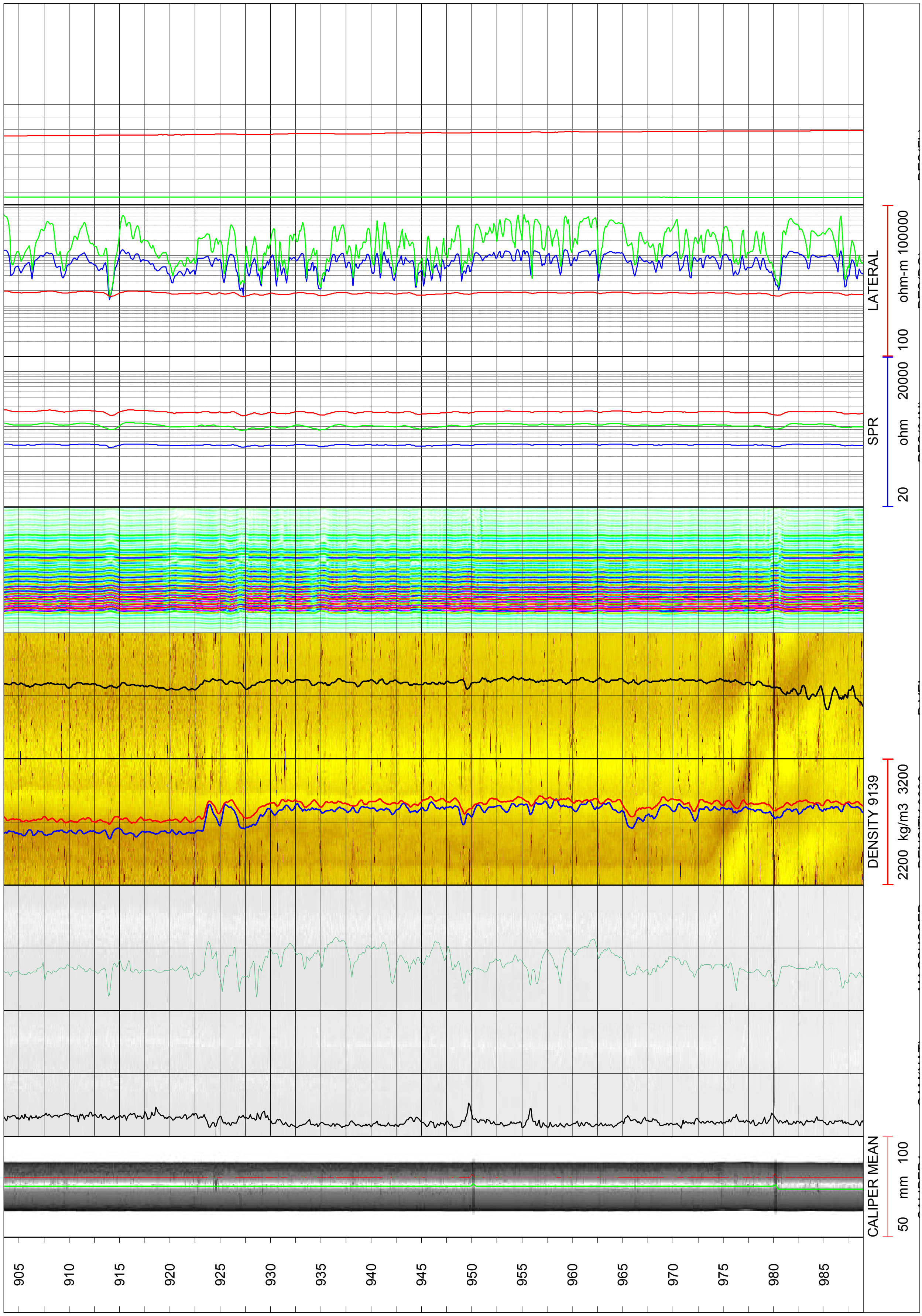
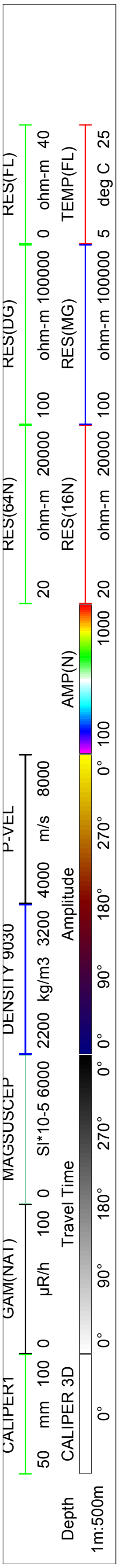
820
825
830
835
840
845
850
855
860
865
870
875
880
885
890
895
900



LATERAL
ohm-m 100000
100
SPR
ohm
20000
20
DENSITY 9139
2200 kg/m3 3200
CALIPER MEAN
50 mm 100
905
910
915
920
925
930
935
940
945
950
955
960
965
970
975
980
985


Depth
1m:500m
CALIPER1
50 mm 100
CALIPER 3D
0°
GAM(NAT)
0 µR/h 100
Travel Time
0° 90° 180° 270° 0°
MAGSUSCEP
0 SI*10-5 6000
DENSITY 9030
2200 kg/m3 3200
Amplitude
0° 90° 180° 270° 0°
P-VEL
4000 m/s 8000
AMP(N)
100 1000
RES(64N)
20 ohm-m 20000
RES(16N)
20 ohm-m 20000
RES(DG)
100 ohm-m 100000
RES(MG)
100 ohm-m 100000
RES(FL)
0 ohm-m 40
TEMP(FL)
5 deg C 25

Borehole HLX30, drawing no 2.1, borehole logs

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

Northing: 6366730.734 Easting: 1548026.729 Elevation: 12.184

Diameter:	139 mm
Reaming Diameter:	
Outer Casing:	
Inner Casing:	
Borehole Length:	163.40 m
Cone:	
Inclination at ground surface:	-60.763 deg
Azimuth:	55.816 deg
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030/9139	mm
DENSITY	Gamma-gamma density	9030/9139	kg/m³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9072	µR/h
TEMP(FL)	Fluid temperature	9042	deg C
RES(FL)	Fluid resistivity	9042	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9310	m/s
AMP(N)	Full wave form, near receiver	9310	µs
AMP(F)	Full wave form, far receiver	9310	µs
MAGSUSCEP	Magnetic susceptibility	8622	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT	deg
DIP	Borehole inclination from horizontal	HiRAT	deg
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	8144	ohm-m
RES(64N)	Normal resistivity 64 inch	8144	ohm-m
LATERAL	Lateral resistivity	8144	ohm-m
SPR	Single point resistivity	8144	ohm
SP	Self Potential	8144	mV
RES(SG)	Focused guard log resistivity, 12.8 cm	9139	ohm-m

Rev.	Date	Drawn by	Control	Approved
0	2005-11-28	UTN	JRI	UTN

Job: 547310A

Scale: 1:500

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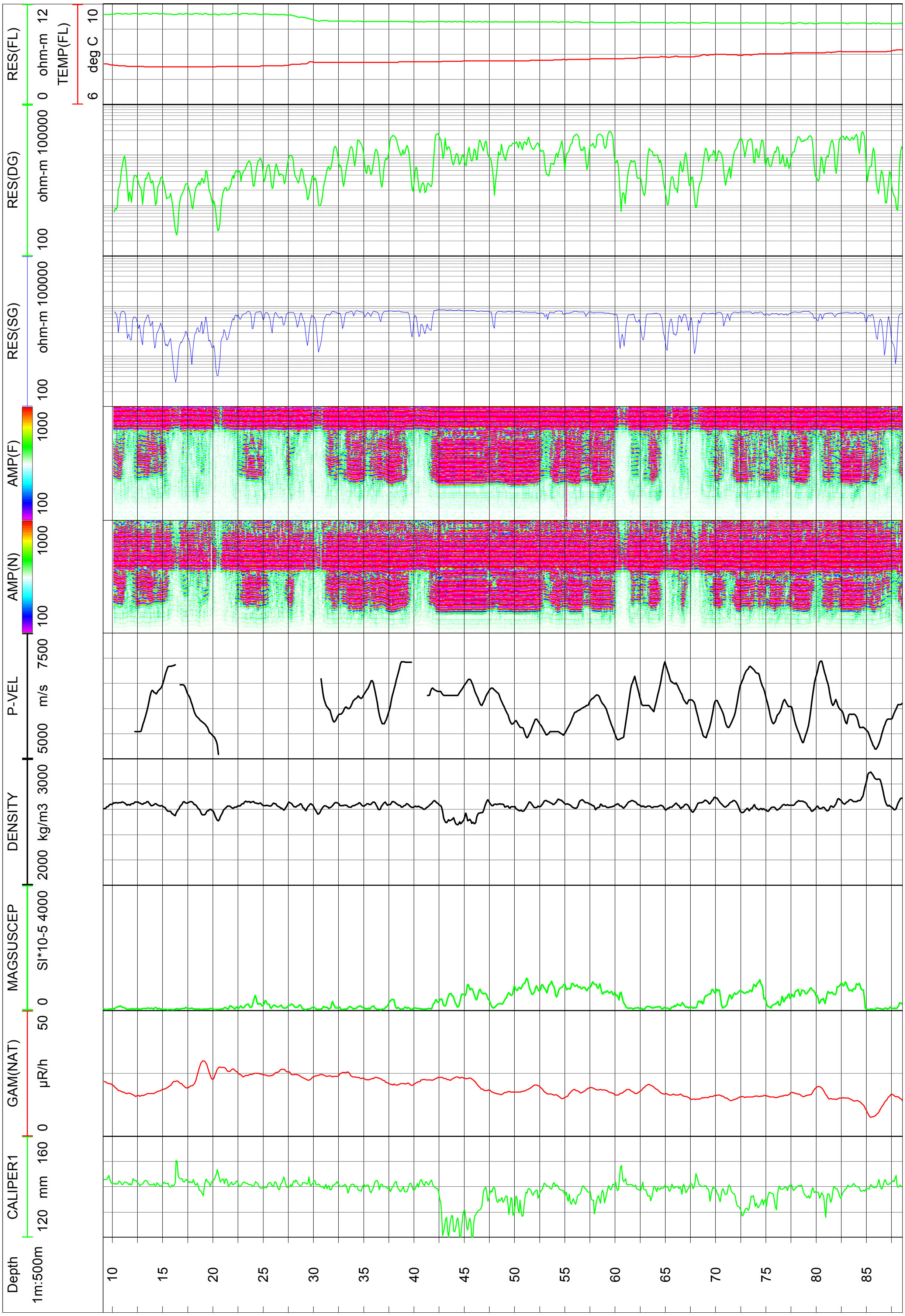
SKB geophysical borehole logging
Borehole HLX30

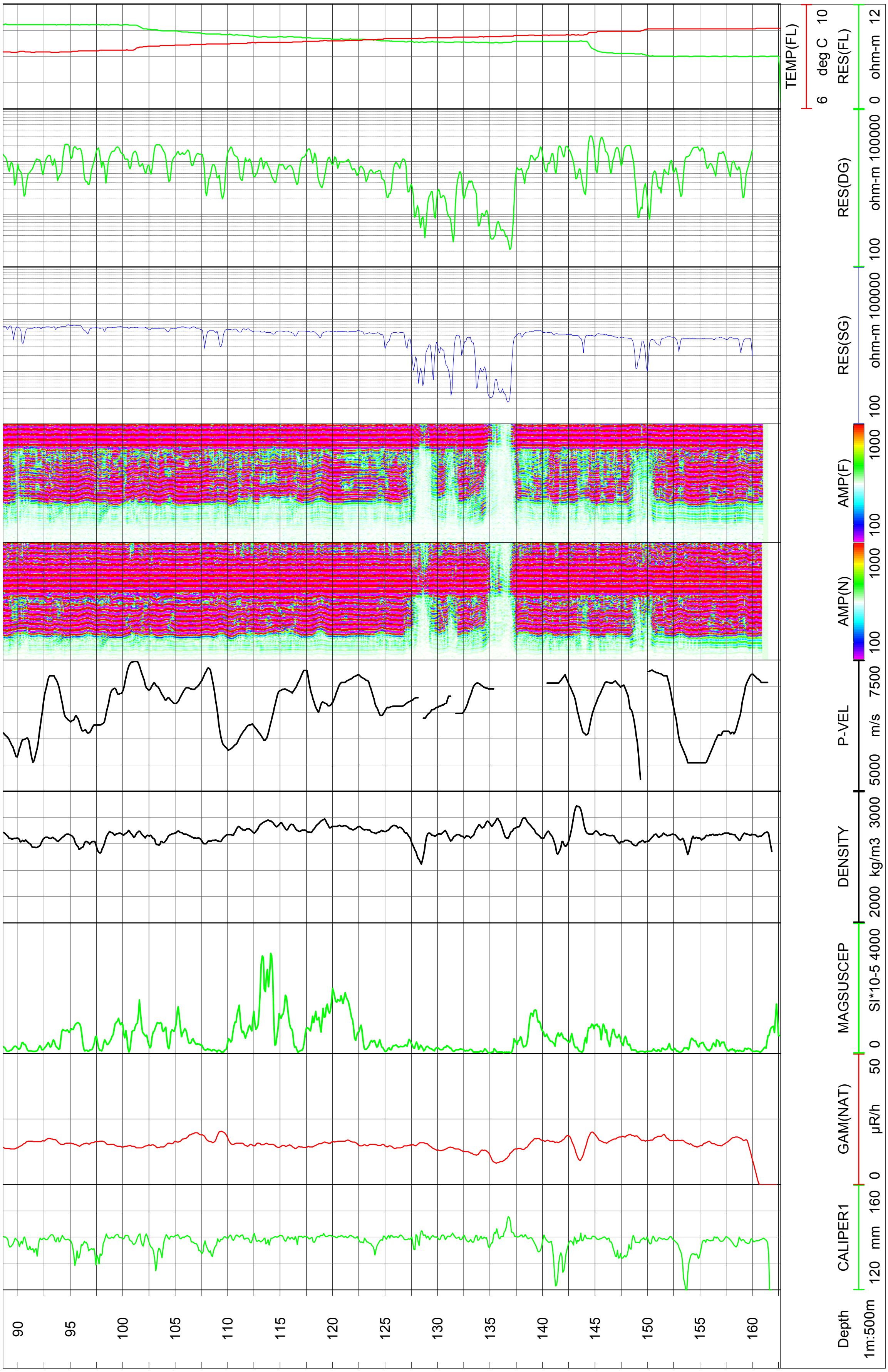
Presentation

Filename:
HLX30_Presentation

Drawing no.:
2.1



RES(FL)
ohm-m
0
12
TEMP(FL)
deg C
6
10
RES(DG)
ohm-m
100
100000
RES(SG)
ohm-m
100
100000
AMP(F)
100
1000
AMP(N)
100
1000
P-VEL
m/s
5000
7500
DENSITY
kg/m3
2000
3000
MAGSUSCEP
SI*10-5
0
4000
GAM(NAT)
µR/h
0
50
CALIPER1
mm
120
160
Depth
1m:500m
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85


Depth
1m:500m
CALIPER1
120 mm 160
GAM(NAT)
0 µR/h 50
MAGSUSCEP
0 SI*10-5 4000
DENSITY
2000 kg/m3 3000
P-VEL
5000 m/s 7500
AMP(N)
100 1000
AMP(F)
100 1000
RES(SG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
TEMP(FL)
6 deg C 10
RES(FL)
0 ohm-m 12
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160

Appendix 3

Borehole HLX31, drawing no 3.1, borehole logs

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

Northing: 6366774.513m Easting: 1547172.268m Elevation: 12.162m, RHB70

Diameter:	139mm
Reaming Diameter:	
Outer Casing:	168mm
Inner Casing:	160mm
Borehole Length:	133.2m
Cone:	
Inclination at ground surface:	-58.758°
Azimuth:	231.772°
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030/9139	mm
DENSITY	Gamma-gamma density	9030/9139	kg/m³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9072	µR/h
TEMP(FL)	Fluid temperature	9042	deg C
RES(FL)	Fluid resistivity	9042	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9310	m/s
AMP(N)	Full wave form, near receiver	9310	µs
AMP(F)	Full wave form, far receiver	9310	µs
MAGSUSCEP	Magnetic susceptibility	8622	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT	deg
DIP	Borehole inclination from horizontal	HiRAT	deg
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	8144	ohm-m
RES(64N)	Normal resistivity 64 inch	8144	ohm-m
LATERAL	Lateral resistivity	8144	ohm-m
SPR	Single point resistivity	8144	ohm
SP	Self Potential	8144	mV
RES(SG)	Focused guard log resistivity, 12.8 cm	9139	ohm-m

Rev.	Date	Drawn by	Control	Approved
0	2005-11-28	JRI	UTN	UTN

Job: 547310A

Scale: 1:500

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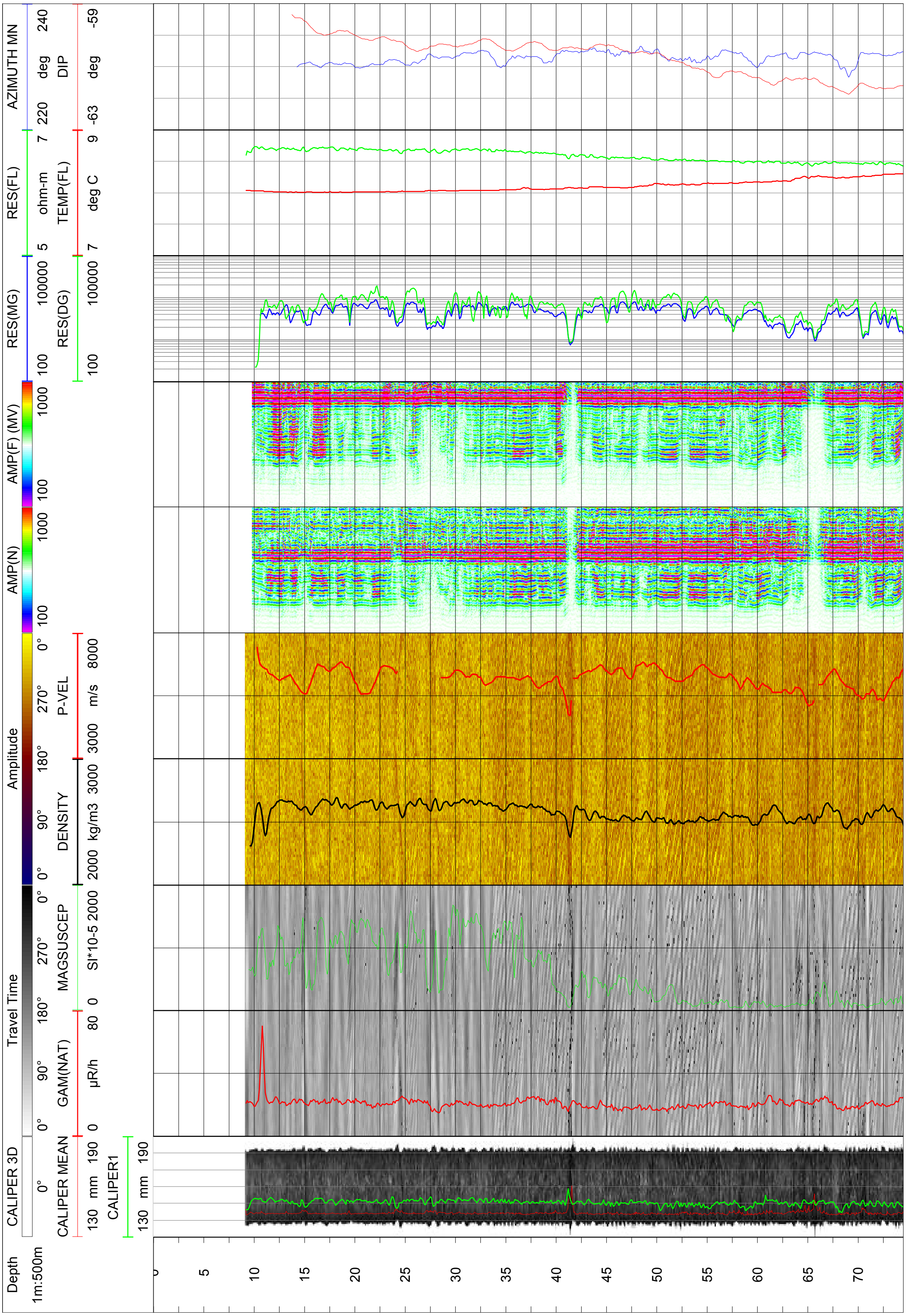
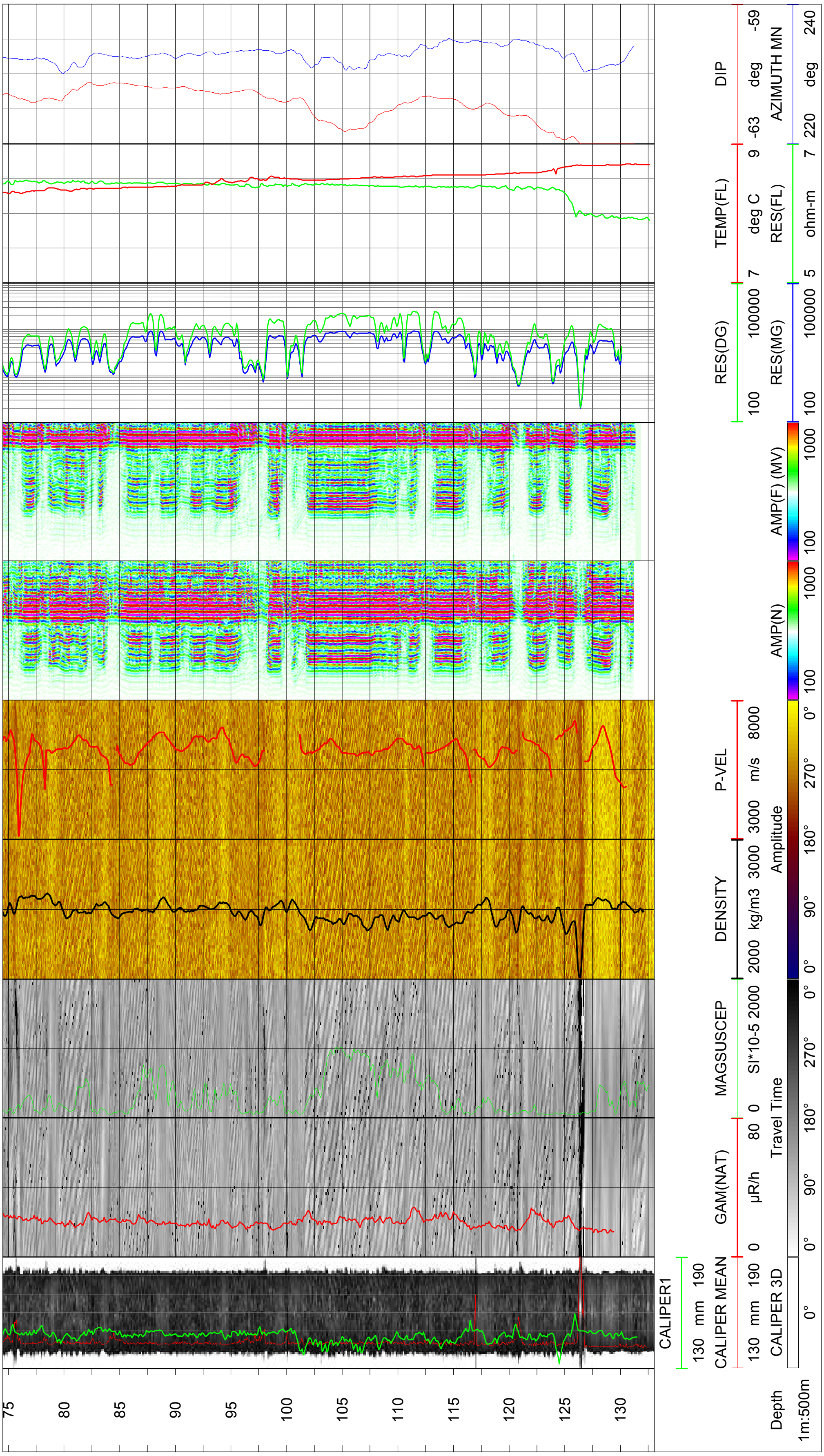
Borehole HLX31.

Presentation

Filename:
HLX31_Presentation.wcl

Drawing no.:
3.1


Depth
1m:500m
CALIPER 3D
0°
CALIPER MEAN
130 mm 190
CALIPER1
130 mm 190
Travel Time
0° 90° 180° 270° 0°
GAM(NAT)
0 µR/h 80
MAGSUSCEP
0 SI*10-5 2000
Amplitude
0° 90° 180° 270° 0°
DENSITY
2000 kg/m3 3000
P-VEL
3000 m/s 8000
AMP(N)
100 1000
AMP(F) (MV)
100 1000
RES(MG)
100 100000
RES(DG)
100 100000
RES(FL)
5 ohm-m 7
TEMP(FL)
7 deg C 9
AZIMUTH MN
220 deg 240
DIP
-63 deg -59
5
10
15
20
25
30
35
40
45
50
55
60
65
70



Depth
1m:500m
75
80
85
90
95
100
105
110
115
120
125
130
CALIPER1
130 mm 190
CALIPER MEAN
130 mm 190
CALIPER 3D
0°
GAM(NAT)
0 µR/h 80
MAGSUSCEP
0 SI*10-5 2000
Travel Time
0° 90° 180° 270° 0°
DENSITY
2000 kg/m3 3000
P-VEL
3000 m/s 8000
Amplitude
0° 90° 180° 270° 0°
AMP(N)
100 1000
AMP(F) (MV)
100 1000
RES(DG)
100 100000
RES(MG)
100 100000
TEMP(FL)
7 deg C 9
RES(FL)
5 ohm-m 7
DIP
-63 deg -59
AZIMUTH MN
220 deg 240

Appendix 4

Borehole HLX33, drawing no 4.1, borehole logs

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

Northing: 6366471.744 Easting: 1548562.705 Elevation: 12.201

Diameter:	139 mm
Reaming Diameter:	
Outer Casing:	
Inner Casing:	
Borehole Length:	202.10 m
Cone:	
Inclination at ground surface:	-58.763 deg
Azimuth:	21.769 deg
Comments:	

Borehole logging programme

Name	Description	Tool	Unit
CALIPER1	Caliper, 1-arm	9030/9139	mm
DENSITY	Gamma-gamma density	9030/9139	kg/m³
RES(MG)	Focused guard log resistivity, 140cm	9030	ohm-m
GAM(NAT)	Natural gamma	9072	µR/h
TEMP(FL)	Fluid temperature	9042	deg C
RES(FL)	Fluid resistivity	9042	ohm-m
RES(DG)	Focused guard log resistivity, 300cm	9072	ohm-m
P-VEL	P-wave velocity	9310	m/s
AMP(N)	Full wave form, near receiver	9310	µs
AMP(F)	Full wave form, far receiver	9310	µs
MAGSUSCEP	Magnetic susceptibility	8622	SI*10-5
CALIPER 3D	Caliper, high resolution 360 degrees	HiRAT	mm
CALIPER MEAN	High resolution 1D caliper	HiRAT	mm
AZIMUTH MN	Borehole azimuth magnetic north	HiRAT	deg
DIP	Borehole inclination from horizontal	HiRAT	deg
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	8144	ohm-m
RES(64N)	Normal resistivity 64 inch	8144	ohm-m
LATERAL	Lateral resistivity	8144	ohm-m
SPR	Single point resistivity	8144	ohm
SP	Self Potential	8144	mV
RES(SG)	Focused guard log resistivity, 12.8 cm	9139	ohm-m

Rev.	Date	Drawn by	Control	Approved
0	2005-11-28	UTN	JRI	UTN

Job	Scale
547310A	1:500

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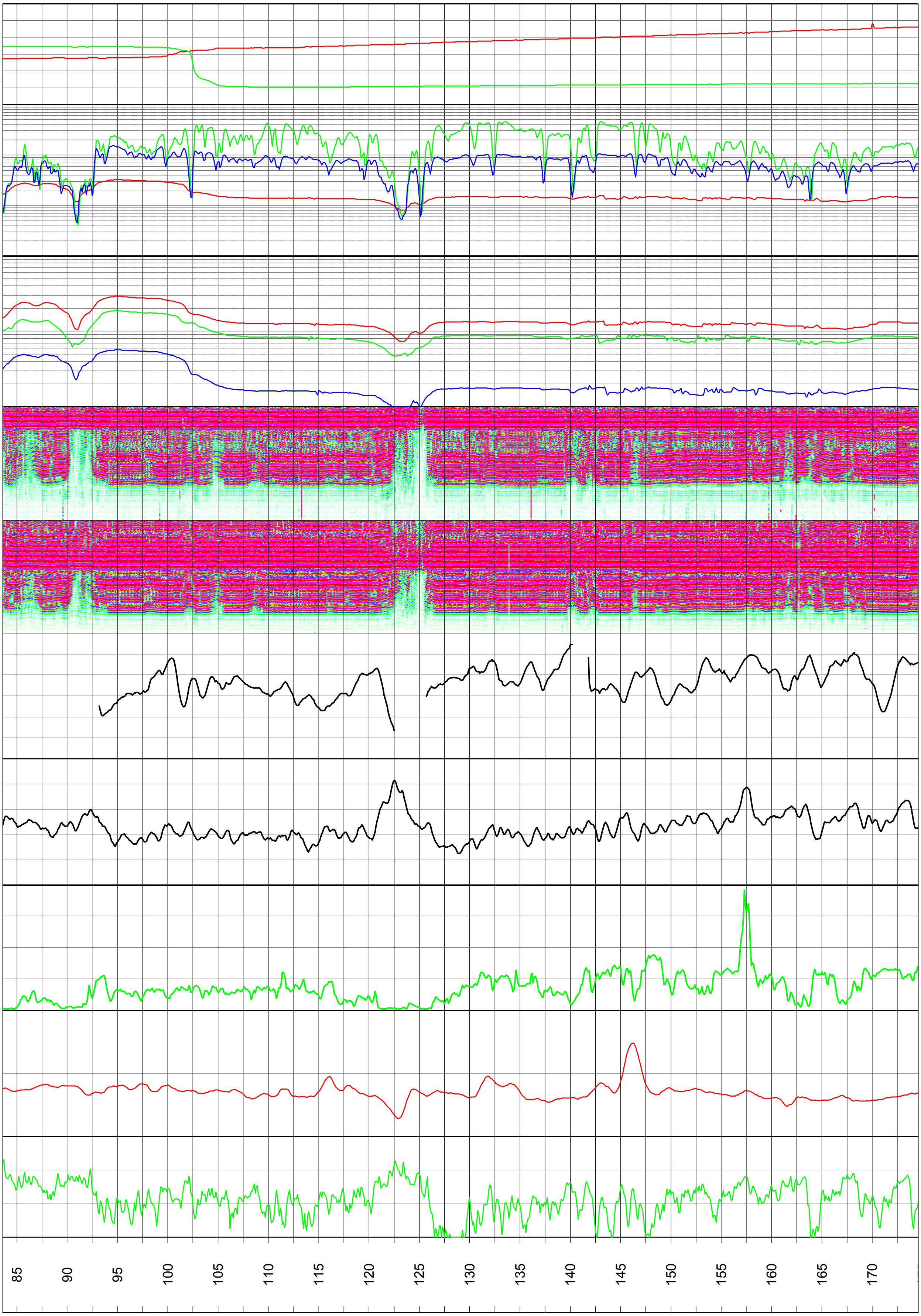
Borehole HLX33

Presentation

Filename:
HLX33_Presentation.wcl

Drawing no.:
4.1


TEMP(FL) 6 deg C 10
RES(FL) 0 ohm-m 30
LATERAL 100 ohm-m 100000
RES(DG) 100 ohm-m 100000
RES(MG) 100 ohm-m 100000
RES(16N) 100 ohm-m 10000
RES(64N) 100 ohm-m 10000
SPR 100 ohm 10000
AMP(F) 100 1000
AMP(N) 100 1000
P-VEL 5000 m/s 8000
DENSITY 2000 kg/m3 3000
MAGSUSCEP 0 SI*10-5 4000
GAM(NAT) 0 µR/h 50
CALIPER1 130 mm 160
Depth 1m:500m
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80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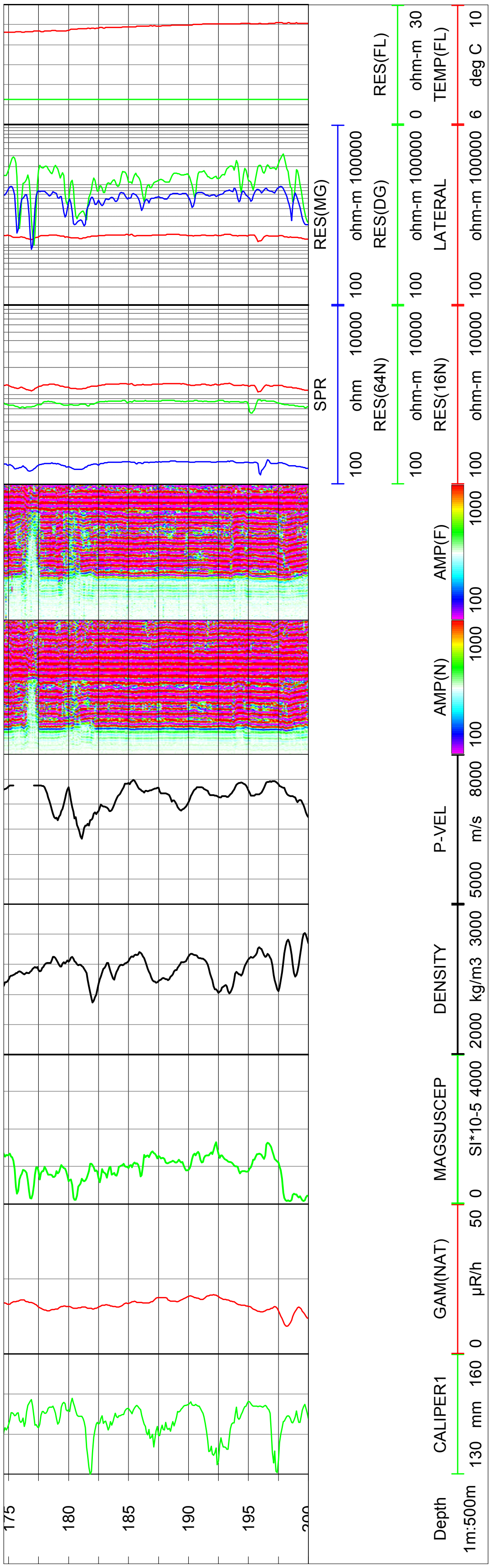
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170


Depth
1m:500m
175
180
185
190
195
200
CALIPER1
130 mm 160
GAM(NAT)
0 µR/h 50
MAGSUSCEP
0 SI*10-5 4000
DENSITY
2000 kg/m3 3000
P-VEL
5000 m/s 8000
AMP(N)
100 1000
AMP(F)
100 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 30
TEMP(FL)
6 deg C 10