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Forsmark site investigation

Geophysical borehole logging in borehole KFM06A, HFM20, HFM21, HFM22 and SP-logging in KFM01A and KFM04A

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Abstract

Geophysical borehole logging has been performed in boreholes KFM06A, HFM20, HFM21, HFM22, KFM01A and KFM04A, all boreholes situated in Forsmark, Sweden.

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

The logging in KFM06A was recorded from 100 m to 1,000 m, HFM20 was recorded from 0 to 301 m, HFM21 was recorded from 0 to 202 m and HFM22 was recorded from 0 to 222 m.

The Forsmark nuclear power plant, as well as the HVDC cable connecting Swedish electrical grid with the Finnish grid, is located close to the investigated area. In order to study possible effects by these installations on the electrical conditions in the bedrock, the boreholes KFM01A and KFM04A was measured by SP-logging. The SP-logs was recorded from 100 m to 1,000 m in both boreholes.

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 6.

Sammanfattning

Geofysisk borrhålsloggning har genomförts i borrhålen KFM06A, HFM20, HFM21, HFM22, KFM01A och KFM04A i Forsmark.

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 KFM06A från 100 m till 1 000 m, HFM20 mättes från 0 till 301 m, HFM21 mättes från 0 till 202 m och HFM22 mättes från 0 till 222 m.

Båda kärnkraftverket i Forsmark och HVDC-kabeln mellan Sverige och Finland är belägna nära undersökningsområdet. För att undersöka dessa installationers möjliga påverkan på de elektriska förhållanden i berggrunden utfördes SP-loggning i borrhålen KFM01A och KFM04A från 100 m till 1 000 m.

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

Processerade loggar presenteras i Appendix 1 till 6.

Contents

1 Introduction

This document reports the results gained by the geophysical borehole logging in boreholes KFM06A, HFM20, HFM21 and HFM22, which is one of the activities performed within the site investigation in Forsmark. The work was carried out in accordance with activity plan AP PF 400-04-85 (SKB internal controlling document) for boreholes KFM06A, HFM20, HFM21 and HFM22. In Table 1-1 controlling documents for performing this activity are listed.

Furthermore complementary SP-logging has been performed in boreholes KFM01A and KFM04A.

All measurements were conducted by RAMBØLL during the period November 2 to 5, 2004. All boreholes were recorded from Top Of Casing (TOC) to the bottom of the borehole. The technical data from the boreholes are shown in Table 1-2. The locations of the boreholes are shown in Figure 1-1.

The delivered raw and processed data have been inserted in the database of SKB (SICADA).

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

Activity plan	Number	Version
Geofysisk borrhålsloggning i KFM06A, HFM20, HFM21 och HFM22	AP PF 400-04-85	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för geofysisk borrhålsloggning	SKB MD 221.002	1.0
Metodbeskrivning för krökningsmätning av hammar- och kärnborrhål	SKB MD 224.001	1.0

Table 1-2. Technical data from core boreholes KFM06A and percussion drilled boreholes HFM20, HFM21 and HFM22.

Boreholes parameter	KFM06A	HFM20	HFM21	HFM22
Co-ordinates	X: 6699732.88	X: 6700187.50	X: 6700125.57	X: 6700456.18
(RT90)	Y: 1632442.51	Y: 1630776.68	Y: 1631074.05	Y: 1631217.64
Elevation	Z: 4.1	Z: 2.97	Z: 3.98	Z: 1.54
(RHB70)				
Inclination (from horizontal)	–60.25°	–85.45°	–58.48°	–58.85°
Azimuth	300.92°	354.41°	88.81°	90.08°
Length	1,000.64 m	301 m	202 m	222 m
Borehole diameter	Ø 76 mm (100.30–1,000 m)	Ø 139 mm	Ø 139 mm	Ø 140 mm
Casing	0–102.1 m	0–12.03 m	0–12.03 m	0–12.03 m
Cleaning level	Level 2	Level 1	Level 1	Level 1

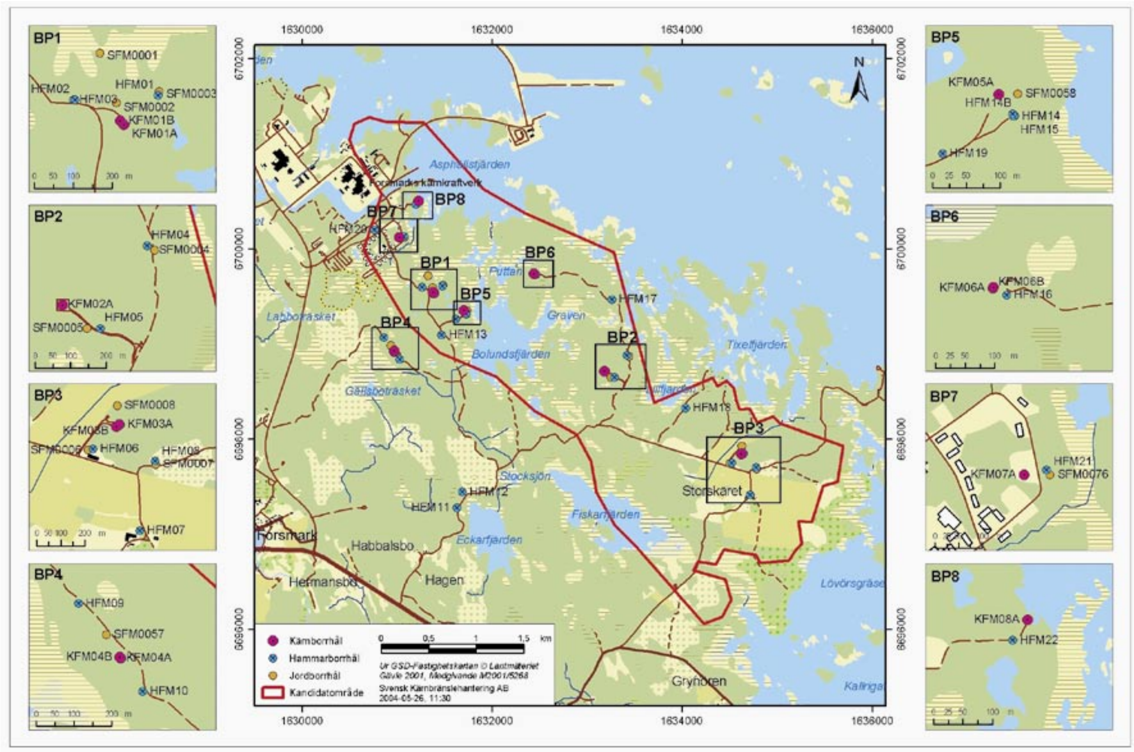

Figure 1-1. *General overview over the Forsmark areas. Borehole KFM06A is located at drill site BP6.*

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 deviation of the borehole (azimuth and inclination) as well as to determine the length marks in the core drilled borehole, KFM06A.

This field report describes the equipment used as well the measurement procedures. Geophysical borehole logging data is presented in graphs as a function of depth in drawing no. 1.1 for borehole KFM06A in Appendix 1, drawing no. 2.1 for borehole HFM20 in Appendix 2, drawing no. 3.1 for borehole HFM21 in Appendix 3 and drawing no. 4.1 for borehole HFM22 in Appendix 4.

The Forsmark nuclear power plant, as well as the HVDC cable connecting Swedish electrical grid with the Finnish grid, is located close to the investigated area. In order to study possible effects by these installations on the electrical conditions in the bedrock, the boreholes KFM01A and KFM04A was measured by SP-logging. The SP-logs was recorded from 100 m to 1,000 m in both boreholes. The complementary SP-logging performed in borehole KFM01A and KFM04A is presented in drawing no 5.1 and 6.1 in Appendix 5 and 6. The SP-logs is presented with the previous reported borehole logging data recorded in the boreholes. KFM01A was logged by RAMBØLL in April 2003 and January 2004 /SKB P-03-103/. KFM04A was logged by RAMBØLL in November 2003 /SKB P-04-144/.

3 Equipment

The geophysical borehole logging program in all boreholes was performed with 6 multi tool probes and resulted in a suite of 19 log types, listed in Table 5-1.

In borehole KFM01A and KFM04A only tool 8044 has been used.

The tools and recorded logs are listed in Table 3-1.

Table 3-1. Logging tools and logs recorded in KFM06A, HFM20, HFM21, HFM22, KFM01A and KFM04A.

Tool	Recorded logs	Dimension	Source detector spacing and type	Tool position in borehole
Century 8044 Normal resistivity, fluid temperature and fluid resistivity.	Normal resistivity (16 & 64 inch), single point resistance, fluid resistivity, fluid temperature and natural gamma.	237×5.3 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, 10 cm 1-arm calliper.	307×5.6 cm	20.3 cm 125 mCi Cs137	Sidewall. Gamma source focused.
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 & S-wave velocity picking, compensated P-wave travel-time and natural gamma.	283.2×5.1 cm	Near 2 ft. Far 3 ft.	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 and dip.	246×4 cm		Centralized.

4 Execution

4.1 General

In general the measurement procedures follow the SKB method description (MD 221.002, SKB internal controlling document). The logging program was executed in the period November 2 to 5, 2004. All relevant logging events were described in the daily report sheets delivered to SICADA.

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. The cleaning was done according to SKB cleaning level 2 (SKB internal controlling document SKB MD 600.004) before arriving at the site. Furthermore, all equipment was wiped with alcohol before it was lowered into the boreholes.

A function test of the deviation measurements in the HiRAT tool was performed before arriving at the site, following SKB internal controlling document SKB MD 224.001.

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 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 tools was in general 10 m/min for the used log runs.

4.2 Nonconformities

The logging has been performed in accordance with the activity plan AP PF 400-04-85.

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 in Appendix 1, no. 2.1 in Appendix 2, no. 3.1 in Appendix 3, no. 4.1 in Appendix 4, no. 5.1 in Appendix 5 and in no. 6.1 in Appendix 6 are presented in Table 5-1.

Table 5-1. Logs presented in drawings no. 1.1–6.1 in Appendices 1–4.

Log	Log name short	Unit	Tool
Fluid temperature	TEMP(FL)	deg C	8044
Fluid resistivity	RES(FL)	ohm-m	8044
Normal resistivity 16 inch	RES(16N)	ohm-m	8044
Normal resistivity 64 inch	RES(64N)	ohm-m	8044
Lateral resistivity	LATERAL	ohm-m	8044
Single point resistance	SPR	Ohm	8044
Self Potential	SP	mV	8044
Magnetic susceptibility	MAGSUSCEP	SI*10^{-5}	8622
Caliper, 1-arm	CALIPER1	mm	9030
Gamma-gamma density	DENSITY	kg/m3	9030
Focused guard log resistivity, 140 cm	RES(MG)	ohm-m	9030
Natural gamma	GAM(NAT)	µR/h	9030
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 Orientation, 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. 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.

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 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). 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. 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 KFM06A

In order to obtain an exact depth calibration in borehole KFM06A, 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 KFM06A, between all logruns, the obtained reference mark correlation is transferred to the other logs.

The complete log suite for borehole KFM06A is presented as composite log sheets in drawing no. 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 KFM06A.

Reference mark	HIRAT recorded
152	152
200	200.06
250	250.1
301	301.19
350	350.22
400	400.29
450	450.34
500	500.39
550	550.44
600	600.49
648	648.53
700	700.56
750	750.64
800	800.69
850	850.74
950	950.89
980	980.87

5.5 Borehole HFM20

Using the bottom of the casing and 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 5-4.

Table 5-4. Gamma events in borehole HFM20.

Events	Depths
Top event	27.43
Bottom event	280

The complete log suite for borehole HFM20 is presented as composite log sheet in drawing no. 2.1 in Appendix 2. The logs presented in drawing no. 2.1 are listed in Table 5-1.

5.6 Borehole HFM21

Using the bottom of the casing and 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.

Table 5-5. Gamma events in borehole HFM21.

Events	Depths
Top event	28.53
Bottom event	165.74

The complete log suite for borehole HFM21 is presented as composite log sheet in drawing no. 3.1 in Appendix 3. The logs presented in drawing no. 3.1 are listed in Table 5-1.

5.7 Borehole HFM22

Using the bottom of the casing and the natural gamma from the 8044 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 5-6.

Table 5-6. Shift correction value in borehole HFM22.

Tool	Shift correction value
8044	0
8622	0.16
9030	0.06
9072	0.06
9310	0.16
HiRAT	0.36

The complete log suite for borehole HFM22 is presented as composite log sheet in drawing no. 4.1 in Appendix 4. The logs presented in drawing no. 4.1 are listed in Table 5-1.

5.8 Borehole KFM01A

In order to obtain an exact depth calibration in borehole KFM01A, the reference track marks made while drilling are used. 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 KFM01A, between all logruns, the obtained reference mark correlation is transferred to the other logs.

The new depth scale was made for the logging results performed earlier in the borehole. The new depth scale was applied to the results from the SP-logging, giving a perfect match between the previous recorded logs and the SP-log.

The complete log suite for borehole KFM01A is presented as composite log sheets in drawing no. 5.1 in Appendix 5. The logs presented in drawing no. 5.1 are listed in Table 5-1.

5.9 Borehole KFM04A

In order to obtain an exact depth calibration in borehole KFM04A, the reference track marks made while drilling are used. 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 KFM04A, between all logruns, the obtained reference mark correlation is transferred to the other logs.

The new depth scale was made for the logging results performed earlier in the borehole. The new depth scale was applied to the results from the SP-logging, giving a perfect match between the previous recorded logs and the SP-log.

The complete log suite for borehole KFM04A is presented as composite log sheets in drawing no. 6.1 in Appendix 6. The logs presented in drawing no. 6.1 are listed in Table 5-1.

6 Data delivery

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

The delivered data have been inserted in the database (SICADA) of SKB.

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
KFM06A	8044	Down	KFM06A_11-03-04_12-55_8044C_.02_1.41_ 995.32_ORIG.log	Start Depth: 1.41 m. End Depth: 995.32 m
KFM06A	8622	Down	KFM06A_11-03-04_18-14_8622C_.02_1.33_ 994.80_ORIG.log	Start Depth: 1.33 m. End Depth: 994.8 m
KFM06A	8622	Up	KFM06A_11-03-04_18-41_8622C_.02_3.46_ 997.97_ORIG.log	Start Depth: 997.97 m. End Depth: 3.46 m
KFM06A	9030	Up	KFM06A_11-04-04_08-40_9030CA_.02_ 78.98_999.14_ORIG.log	Start Depth: 999.14 m. End Depth: 78.98 m
KFM06A	9072	Up	KFM06A_11-04-04_11-01_9072C_.02_4.42_ 998.16_ORIG.log	Start Depth: 998.16 m. End Depth: 4.42 m
KFM06A	9310	Up	KFM06A_11-03-04_16-34_9310C2_.10_-2.70_ 995.70_ORIG.log	Start Depth: 995.7 m. End Depth: –2.7 m
KFM06A	HiRAT	Up	KFM06A_HiRAT_90_pixels_up_run2.HED	Start Depth: 1,000 m. End Depth: 0 m
HFM20	8044	Down	HFM20_11-02-04_15-46_8044C_.02_0.28_ 299.42_ORIG.log	Start Depth: 0.28 m. End Depth: 299.42 m
HFM20	8622	Up	HFM20_11-02-04_19-58_8622C_.02_0.94_ 300.09_ORIG.log	Start Depth: 300.09 m. End Depth: 0.94 m
HFM20	9030	Up	HFM20_11-02-04_18-31_9030CA_.10_0.50_ 300.70_ORIG.log	Start Depth: 300.7 m. End Depth: 0.5 m
HFM20	9072	Up	HFM20_11-02-04_17-38_9072C_.10_0.20_ 300.80_ORIG.log	Start Depth: 300.8 m. End Depth: 0.2 m
HFM20	9310	Up	HFM20_11-02-04_16-48_9310C2_.10_-0.10_ 299.90_ORIG.log	Start Depth: 299.9 m. End Depth: –0.1 m
HFM20	HiRAT	Up	HFM20_HiRAT_90_pixels_up_run2.HED	Start Depth: 300 m. End Depth: 0 m
HFM21	8044	Down	HFM21_11-04-04_16-32_8044C_.02_0.28_ 200.37_ORIG.log	Start Depth: 0.28 m. End Depth: 200.37 m
HFM21	8622	Up	HFM21_11-04-04_19-34_8622C_.02_1.03_ 200.65_ORIG.log	Start Depth: 200.65 m. End Depth: 1.03 m
HFM21	9030	Up	HFM21_11-04-04_18-30_9030CA_.02_3.44_ 200.93_ORIG.log	Start Depth: 200.93 m. End Depth: 3.44 m
HFM21	9072	Up	HFM21_11-04-04_17-47_9072C_.02_2.33_ 201.11_ORIG.log	Start Depth: 201.11 m. End Depth: 2.33 m
HFM21	9310	Up	HFM21_11-04-04_17-14_9310C2_.02_1.25_ 200.13_ORIG.log	Start Depth: 200.13 m. End Depth: 1.25 m

Borehole	Probe	Log direction	WellCAD File	Description
HFM21	HiRAT	Up	HFM21_HiRAT_90_pixels_up_run2.HED	Start Depth: 200 m. End Depth: 0 m
HFM22	8044	Down	HFM22_11-02-04_10-56_8044C_.02_0.28_ 217.83_ORIG.log	Start Depth: 0.28 m. End Depth: 217.83 m
HFM22	8622	Up	HFM22_11-02-04_14-04_8622C_.02_0.36_ 215.72_ORIG.log	Start Depth: 215.72 m. End Depth: 0.36 m
HFM22	9030	Up	HFM22_11-02-04_13-27_9030CA_.02_0.66_ 214.58_ORIG.log	Start Depth: 214.58 m. End Depth: 0.66 m
HFM22	9072	Up	HFM22_11-02-04_12-03_9072C_.02_0.60_ 214.64_ORIG.log	Start Depth: 214.64 m. End Depth: 0.6 m
HFM22	9310	Up	HFM22_11-02-04_12-40_9310C2_.02_0.30_ 213.89_ORIG.log	Start Depth: 213.89 m. End Depth: 0.3 m
HFM22	HiRAT	Up	HFM22_HiRAT_90_pixels_up_run2.HED	Start Depth: 215 m. End Depth: 0 m
KFM01A	8044	Down	KFM01A_11-05-04_10-41_8044C_.02_0.28_ 998.02_ORIG.log	Start Depth: 0.28 m. End Depth: 998.02 m
KFM01A	8044	Up	KFM01A_11-05-04_11-08_8044C_.02_4.97_ 1000.09_ORIG.log	Start Depth: 1,000.09 m. End Depth: 4.97 m
KFM04A	8044	Down	KFM04A_11-05-04_08-14_8044C_.02_0.28_ 995.50_ORIG.log	Start Depth: 0.28 m. End Depth: 995.5 m
KFM04A	8044	Up	KFM04A_11-05-04_08-45_8044C_.02_2.85_ 1000.77_ORIG.log	Start Depth: 1,000.77 m. End Depth: 2.85 m

Table 6-2. Drawing files in WellCad format.

Borehole	Drawing	Drawing version	WellCad file
KFM06A	1.1	0	KFM06A_Presentation.WCL
HFM20	2.1	0	HFM20_Presentation.WCL
HFM21	3.1	0	HFM21_Presentation.WCL
HFM22	4.1	0	HFM22_Presentation.WCL
KFM01A	5.1	2	KFM01A_Presentation.WCL
		1 (January 2004)	
		0 (April 2003)	
KFM04A	6.1	1	KFM04A_Presentation.WCL
		0 (Nov. 2003)	

Table 6-3. Data files in excel for each borehole. Files in SICADA format.

Sheet	Comment
"Borehole"_GP040 – Caliper logging.xls	
"Borehole"_GP041 – 3-D caliper.xls	
"Borehole"_GP060 – Fluid temperature and resistivity logging.xls	
"Borehole"_GP090 – Density logging.xls	
"Borehole"_GP110 – Magnetic susceptibility logging.xls	
"Borehole"_GP120 – Natural gamma logging.xls	
"Borehole"_GP150 – Single point resistance logging.xls	
"Borehole"_GP160 – Resistivity, normal 1.6 m (64 in).xls	
"Borehole"_GP161 – Resistivity, focused 140 cm.xls	
"Borehole"_GP162 – Resistivity, focused 300 cm.xls	
"Borehole"_GP163 – Resistivity, lateral 1.6-0.1 m.xls	
"Borehole"_GP164 – Resistivity, normal 0.4 m (16 in).xls	
"Borehole"_GP175 – Fullwave sonic.xls	
"Borehole"_GP180 – Self potential logging.xls	Included for borehole KFM06A, KFM01A and KFM04A
"Borehole"_GP830 – Acoustic televiewer.xls	

Appendix 1

Borehole KFM06A. Drawing no. 1.1. Borehole logs

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

Northing: 6699732.88m Easting: 1632442.51m Elevation: 4.10m, RHB70

Diameter:	77.3mm
Reaming Diameter:	200mm
Outer Casing:	
Inner Casing:	
Borehole Length:	1000.64m
Cone:	
Inclination at ground surface:	-60.25°
Azimuth:	300.92°
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
SP	Self Potential	8044	mV

Rev.	Date	Drawn by	Control	Approved
0	2004-11-08	JRI	UTN	UTN

Job	Scale
360210A	1:500

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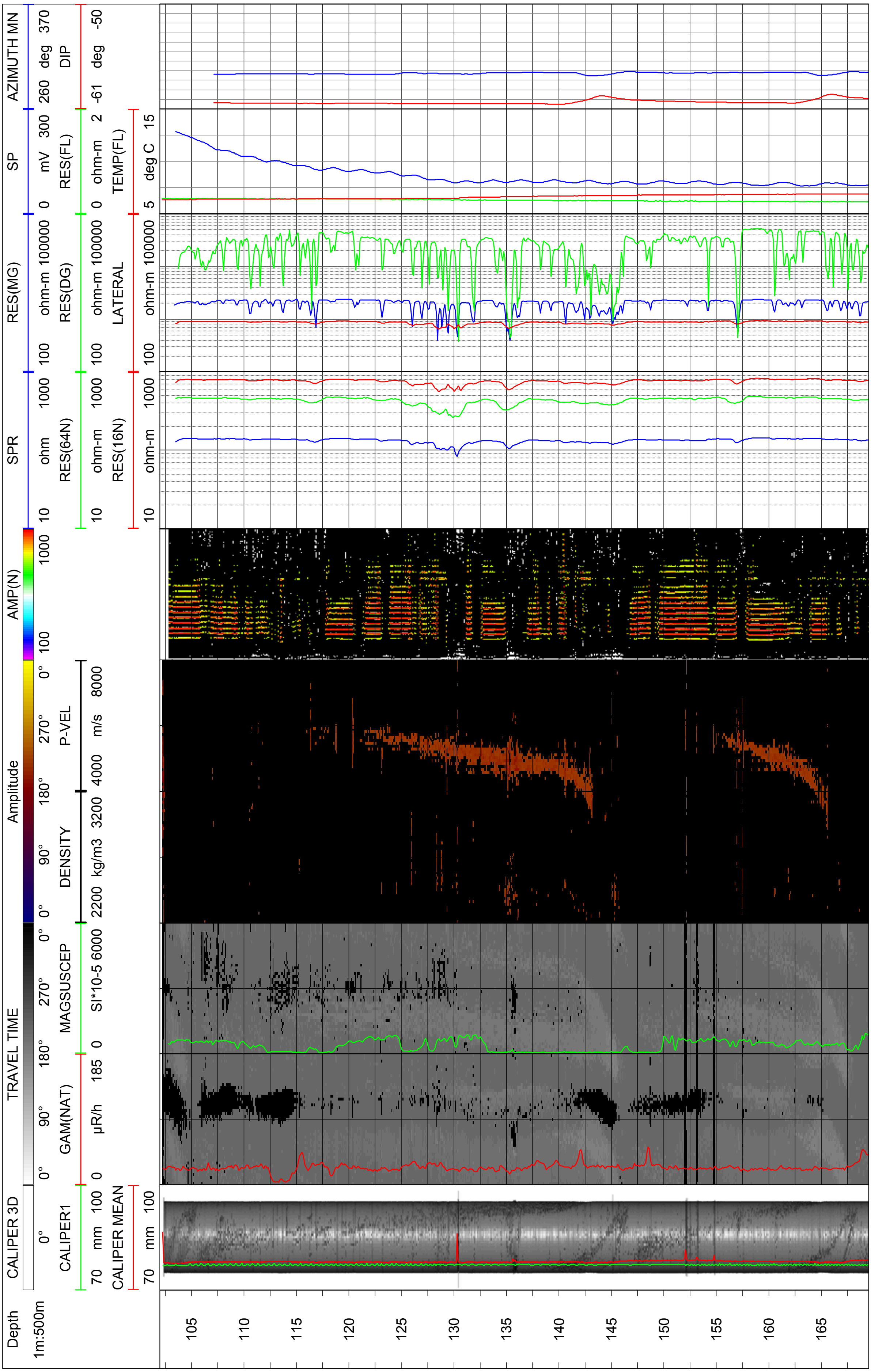
SKB geophysical borehole logging
Borehole KFM06A. Forsmark

Presentation

Filename:
KFM06A_Presentation.wcl

Drawing no.:
1.1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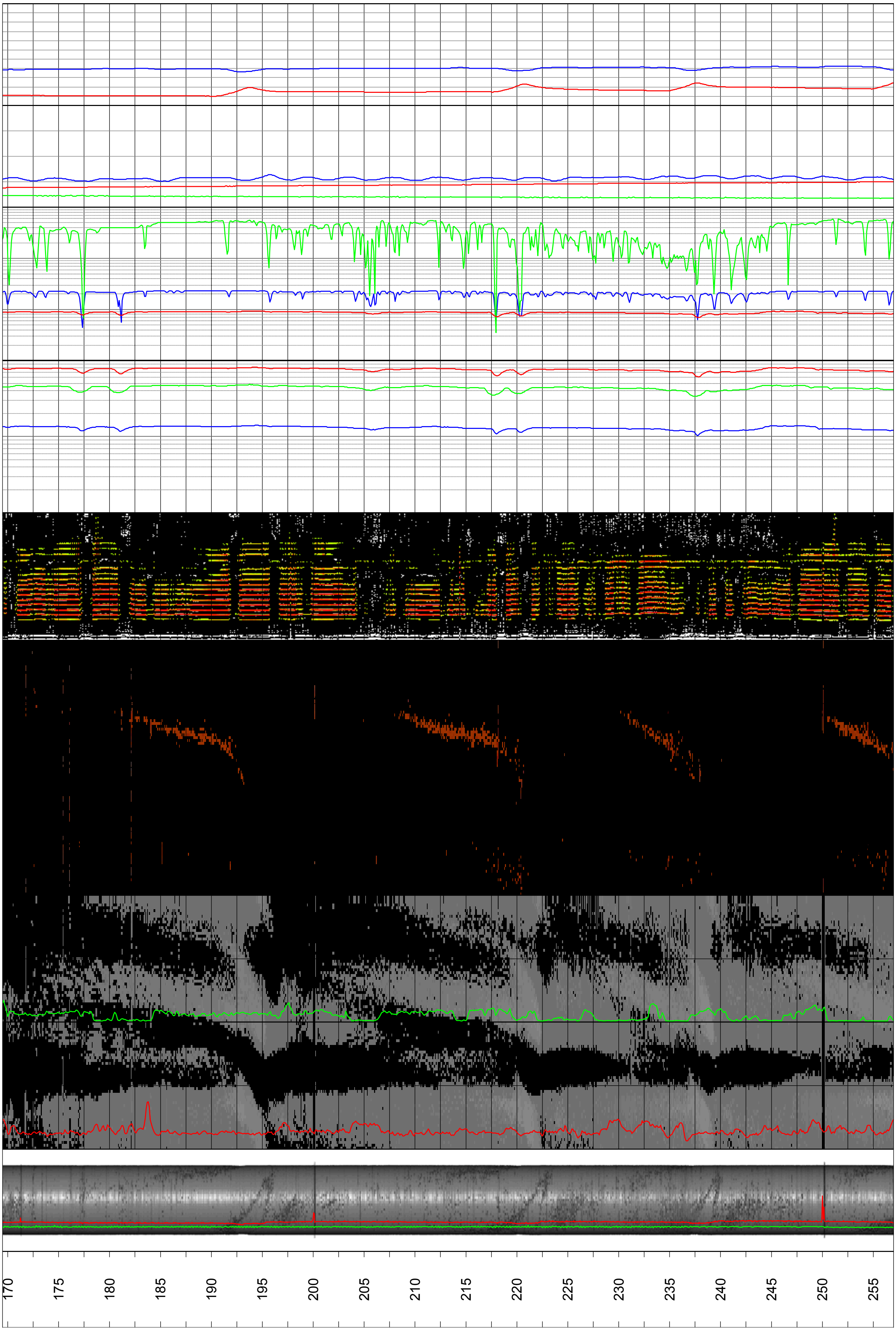
1m:500m
CALIPER 3D
0°
CALIPER1
70 mm 100
CALIPER MEAN
70 mm 100
TRAVEL TIME
0° 90° 180° 270° 0°
GAM(NAT)
0 µR/h 185
MAGSUSCEP
0 SI*10-5 6000
Amplitude
0° 90° 180° 270° 0°
DENSITY
2200 kg/m3 3200
P-VEL
4000 m/s 8000
AMP(N)
100 1000
SPR
10 ohm 1000
RES(64N)
10 ohm-m 1000
RES(16N)
10 ohm-m 1000
RES(MG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
LATERAL
100 ohm-m 100000
SP
0 mV 300
RES(FL)
0 ohm-m 2
TEMP(FL)
5 deg C 15
AZIMUTH MN
260 deg 370
DIP
-61 deg -50
105
110
115
120
125
130
135
140
145
150
155
160
165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210
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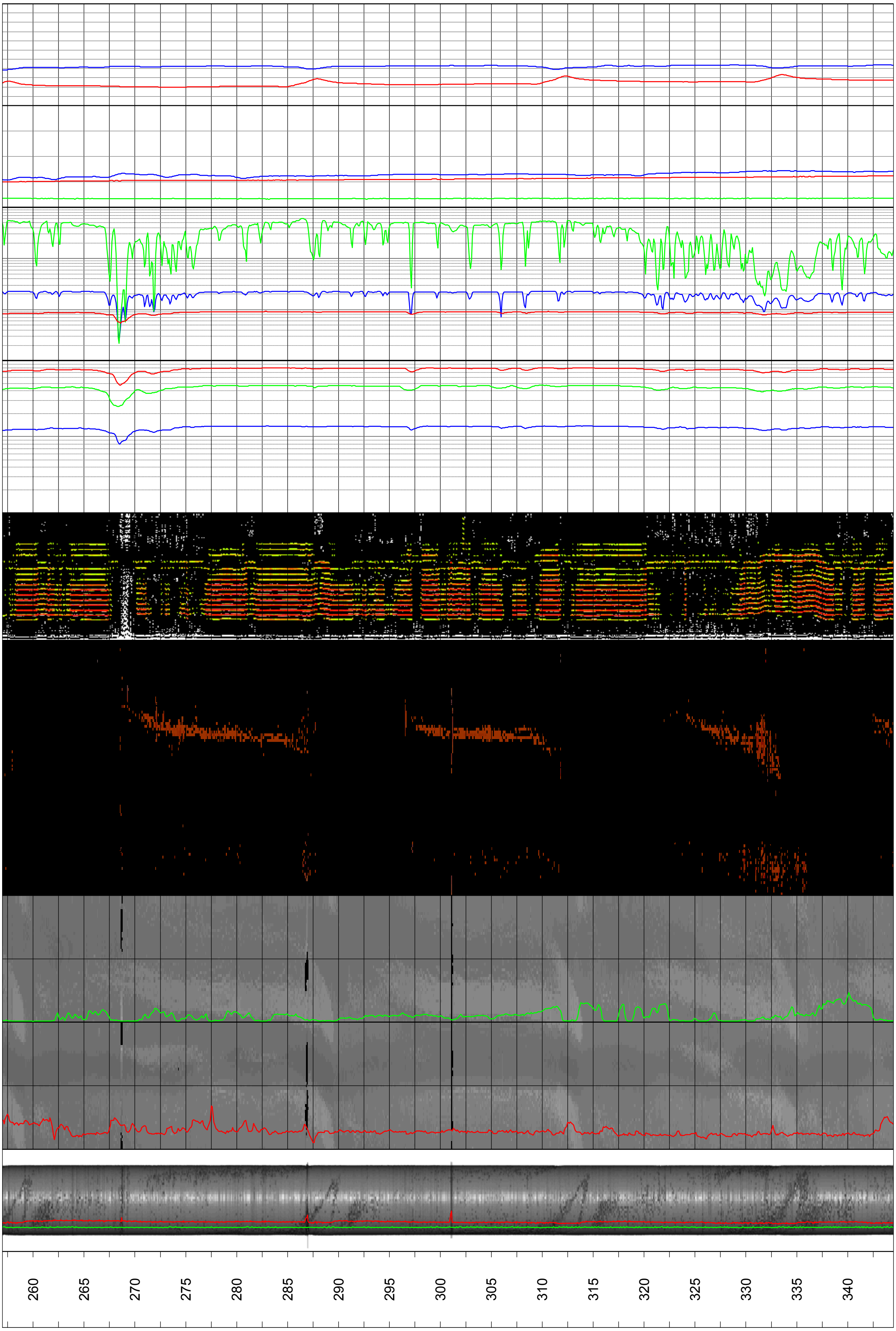
220
225
230
235
240
245
250
255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265
270
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280
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290
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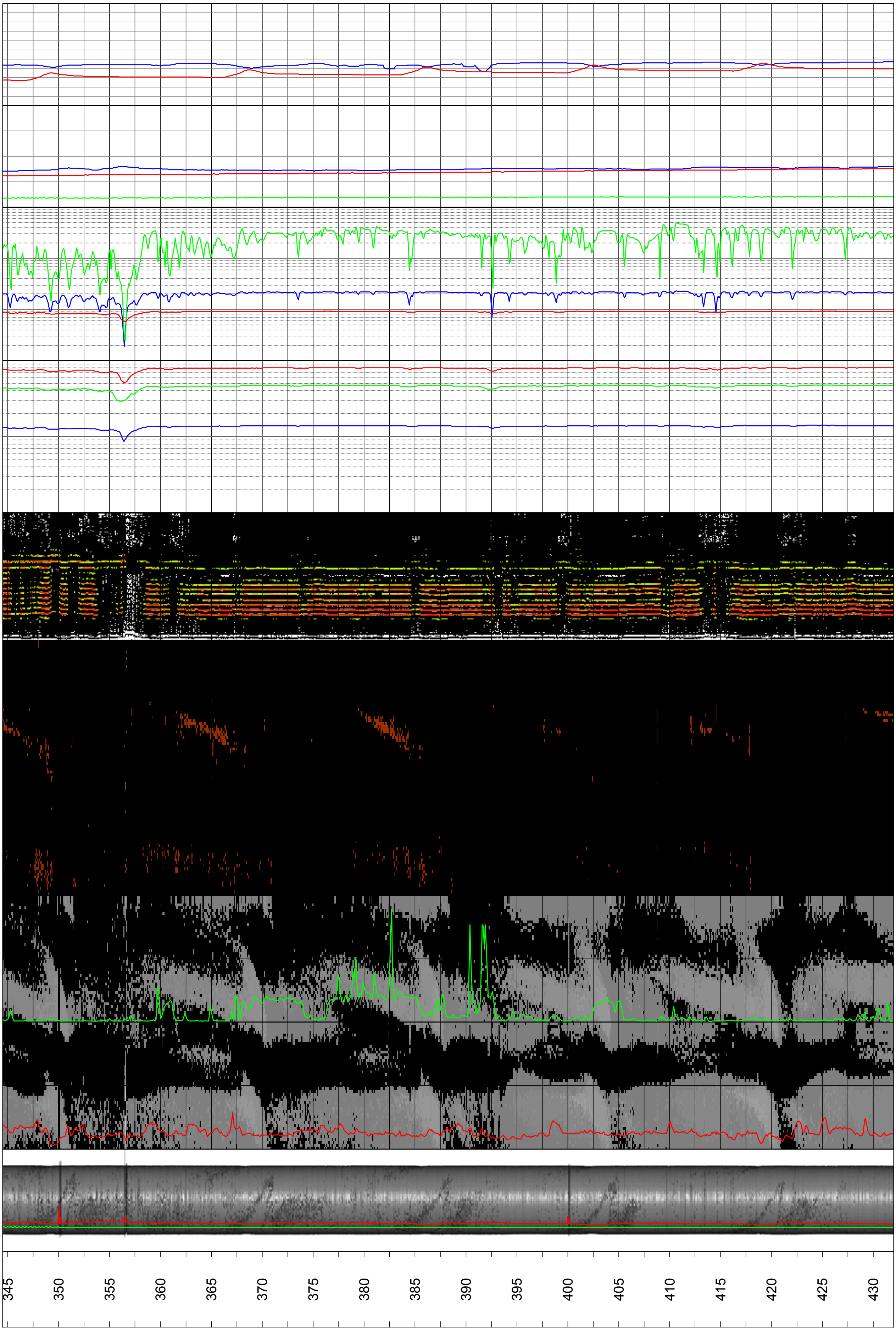
300
305
310
315
320
325
330
335
340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355
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395
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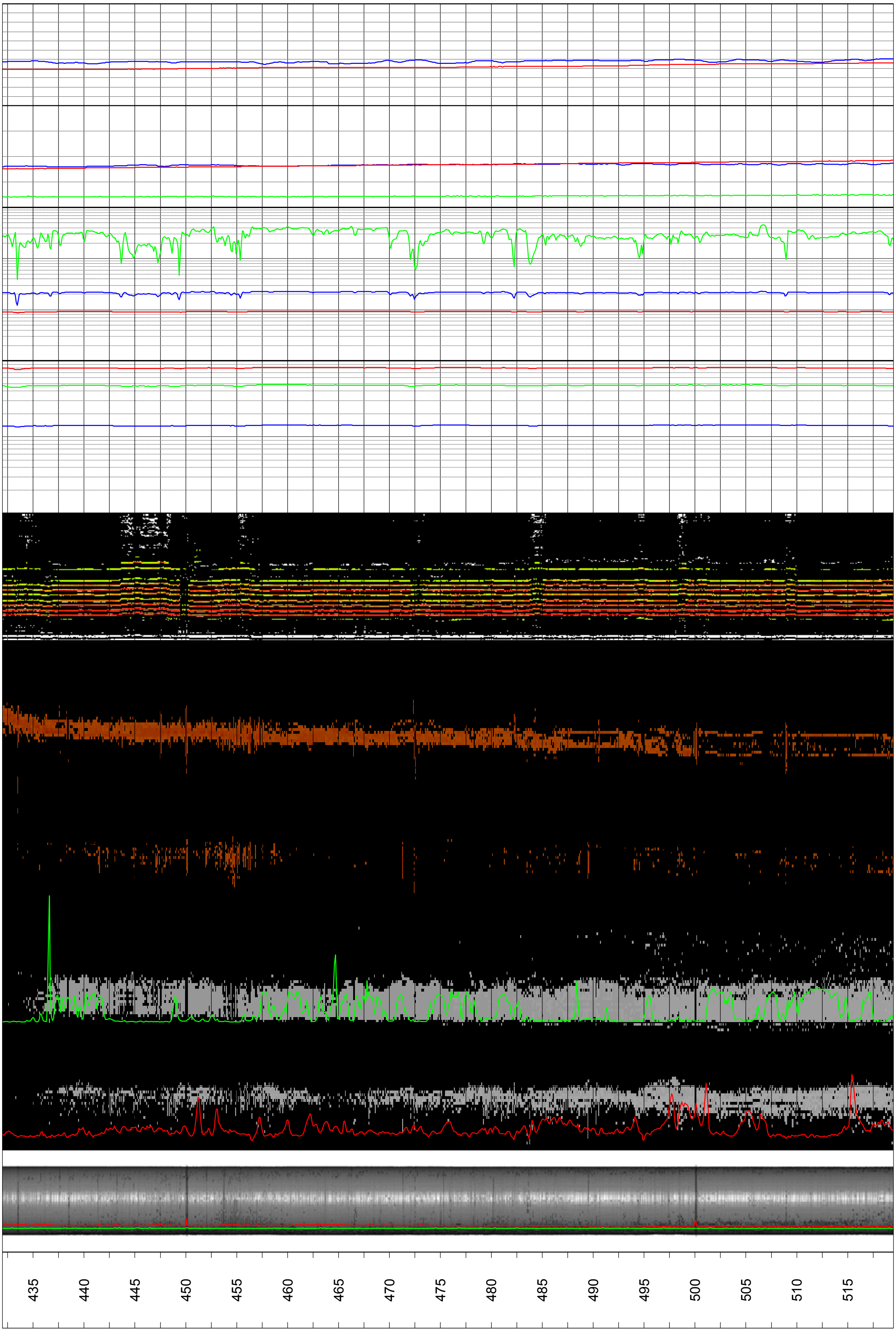
420
425
430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445
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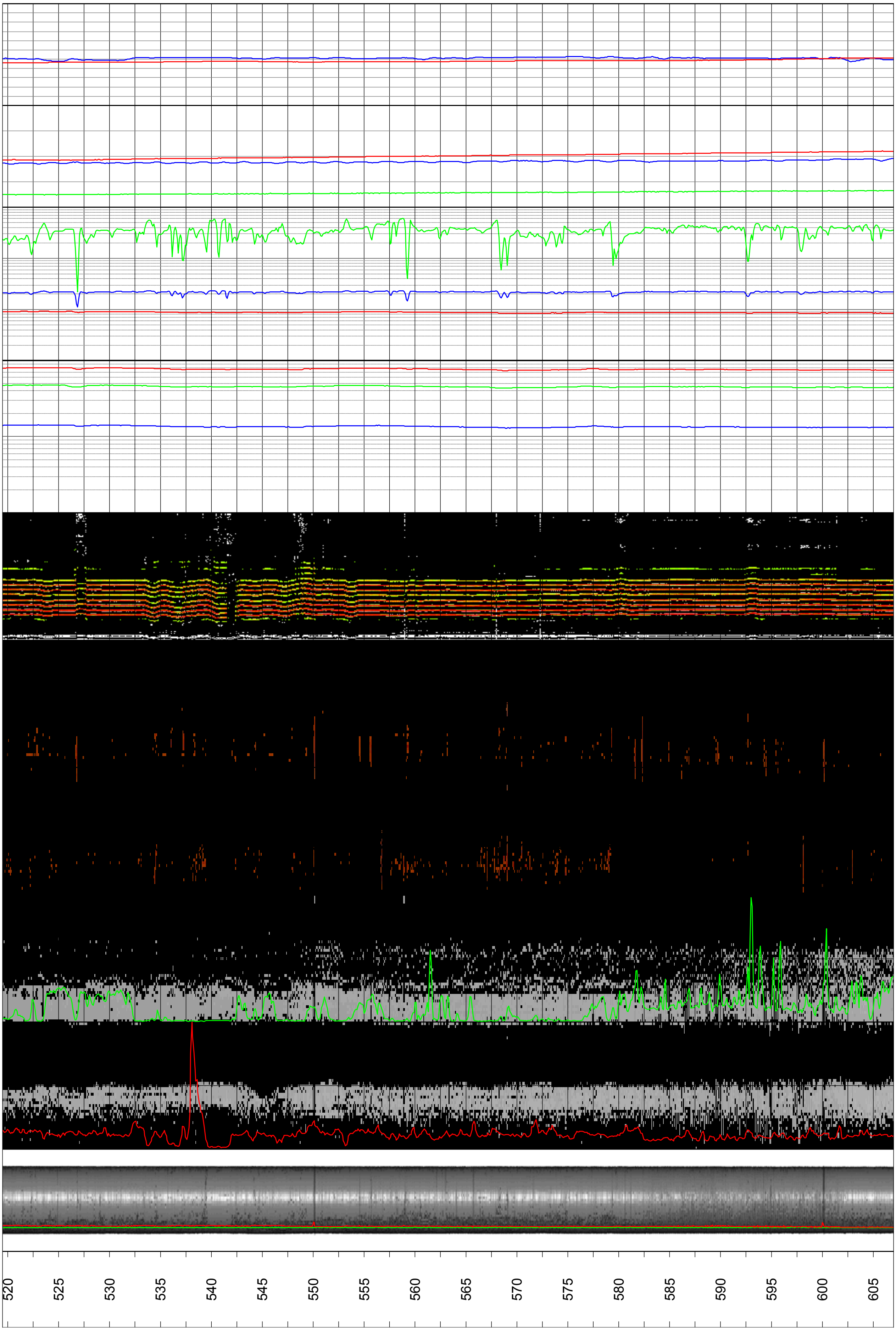
455
460
465
470
475
480
485
490
495
500
505
510
515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575
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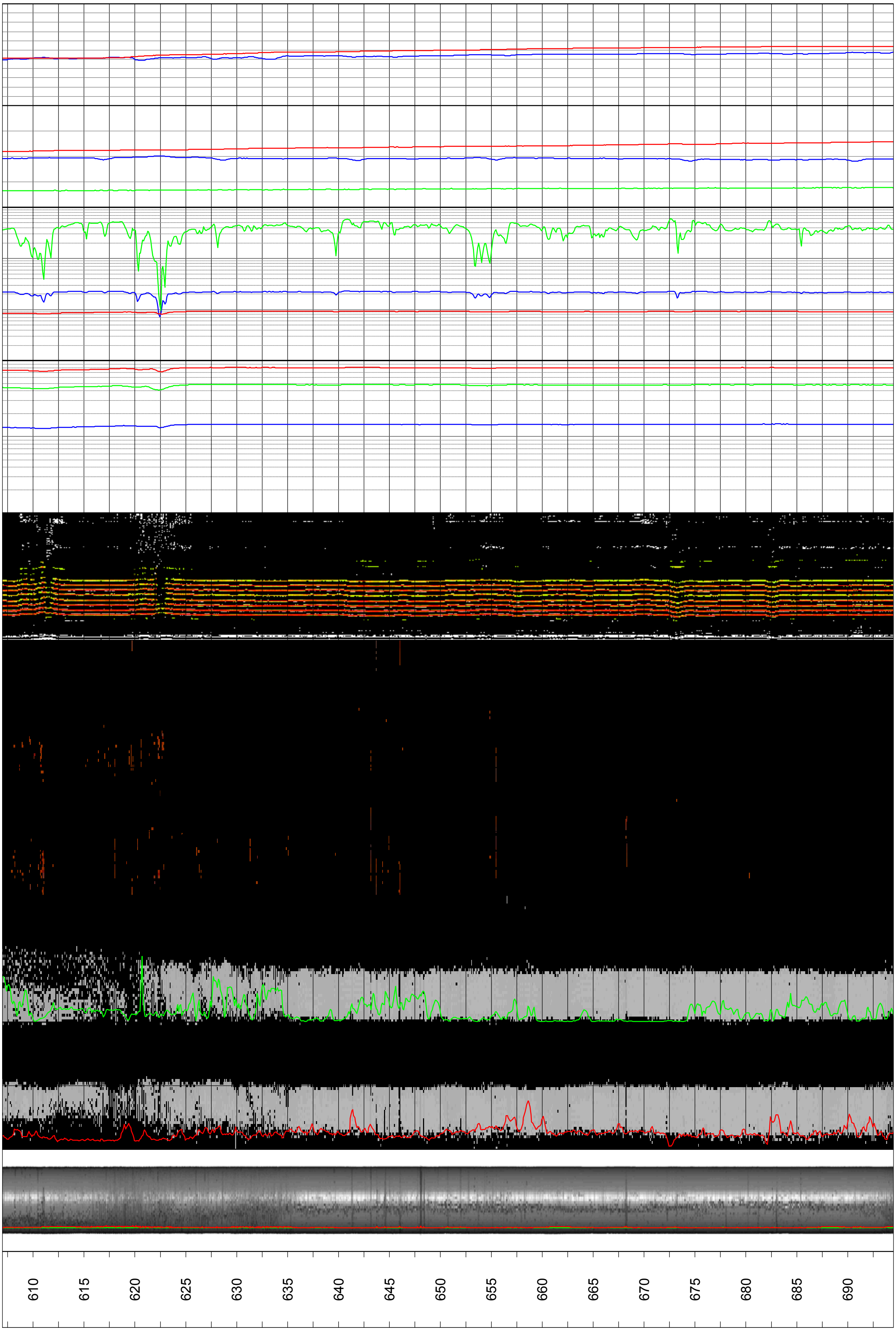
595
600
605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615
620
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630
635
640
645
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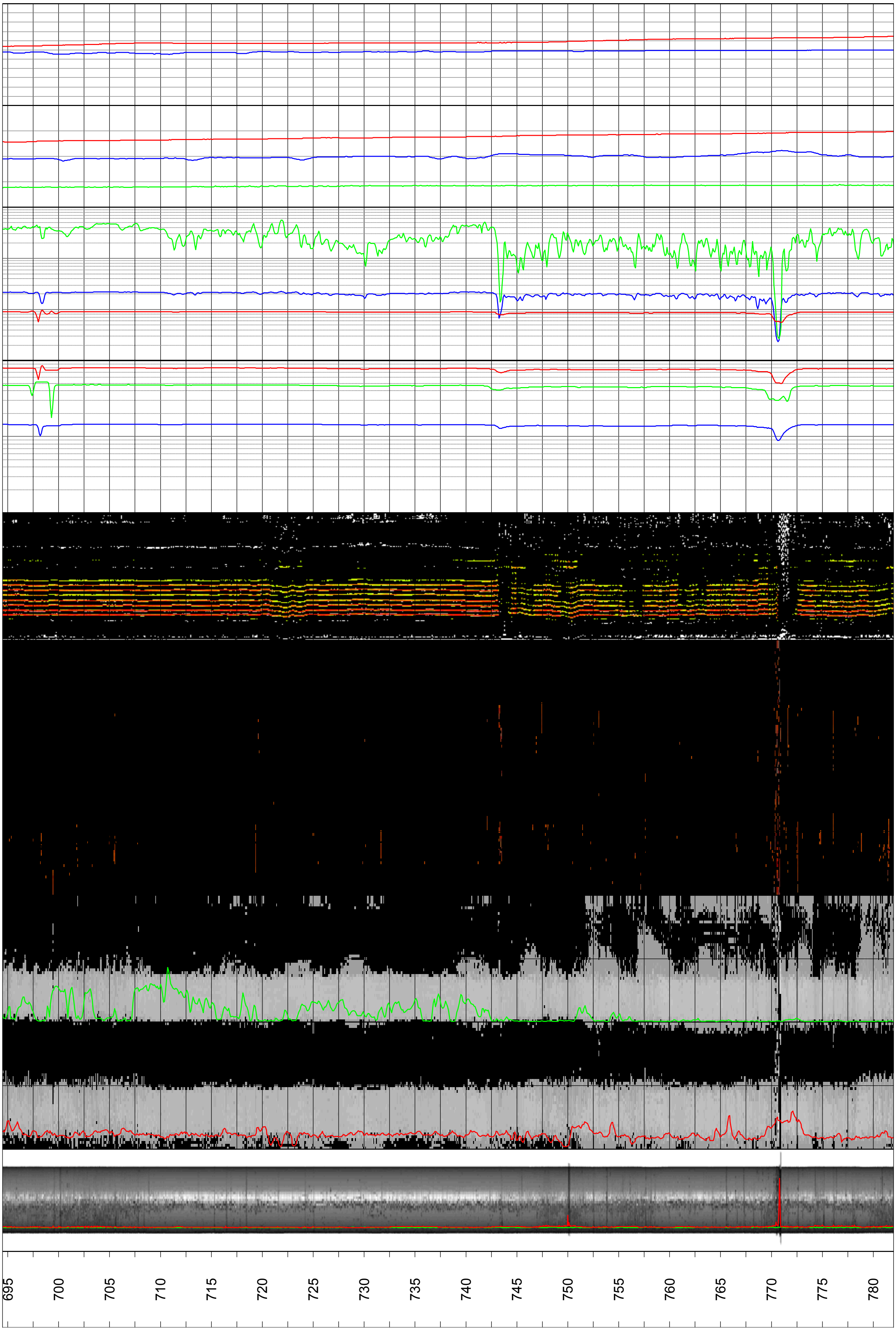
665
670
675
680
685
690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700
705
710
715
720
725
730
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745
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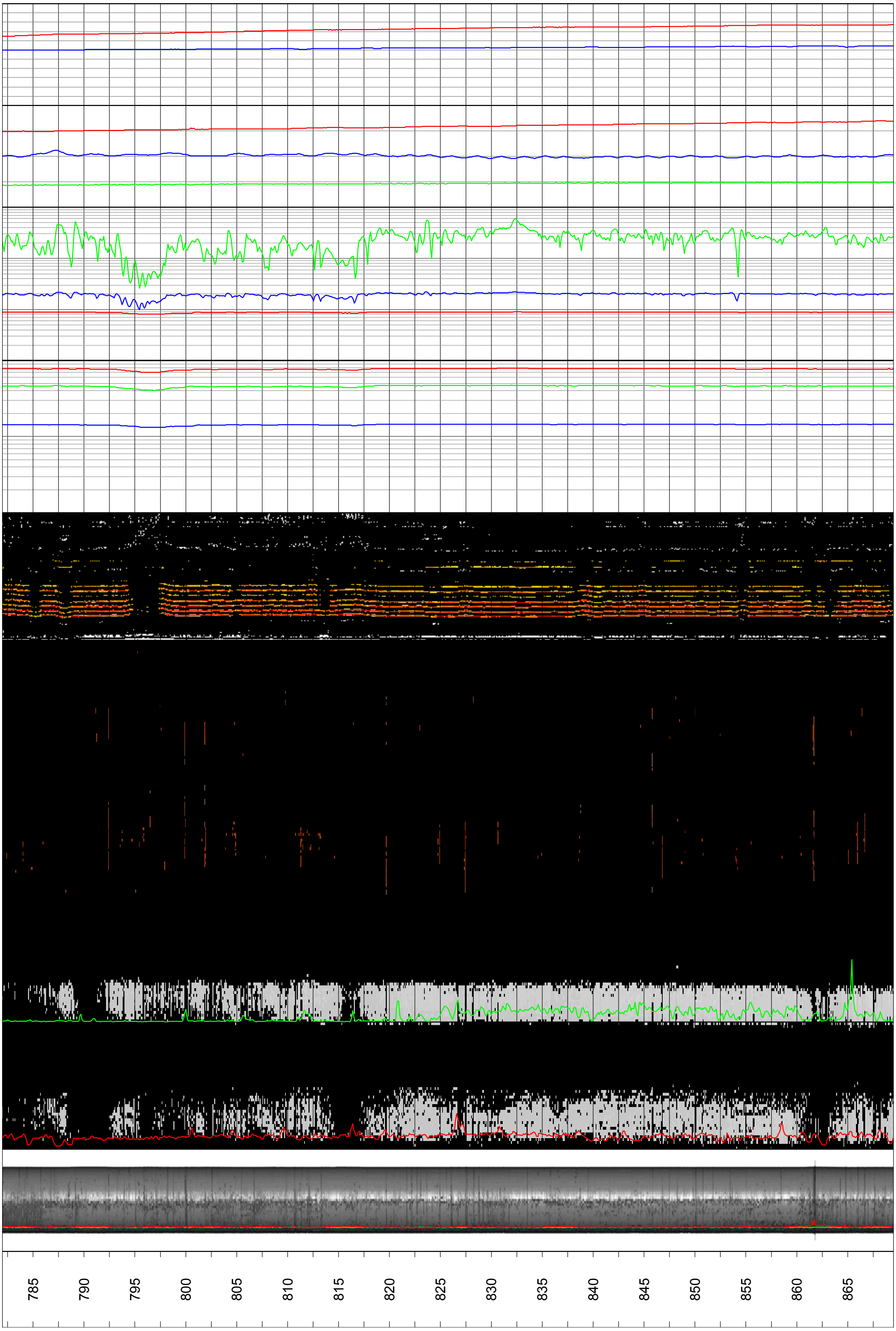
755
760
765
770
775
780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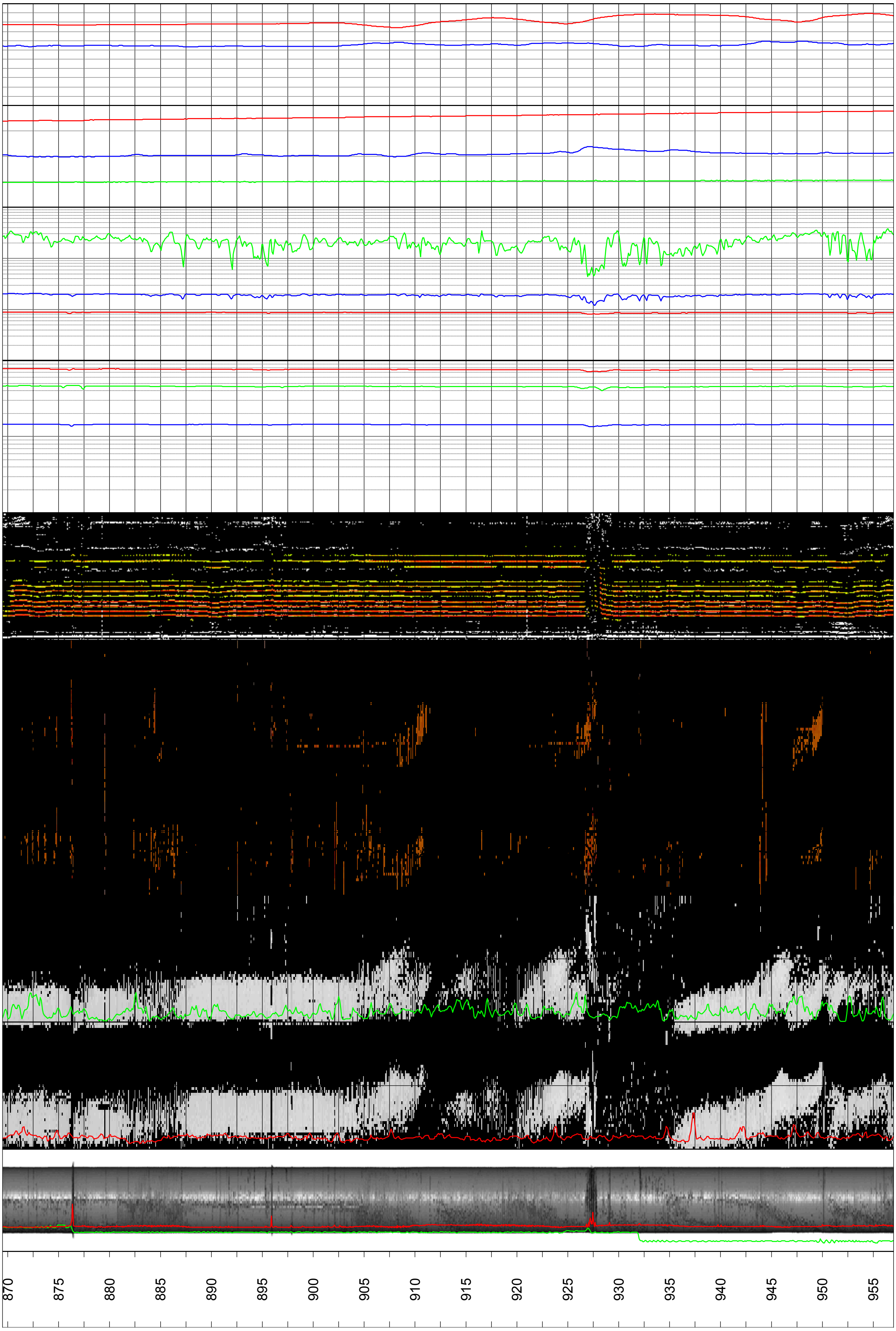
790
795
800
805
810
815
820
825
830
835
840
845
850
855
860
865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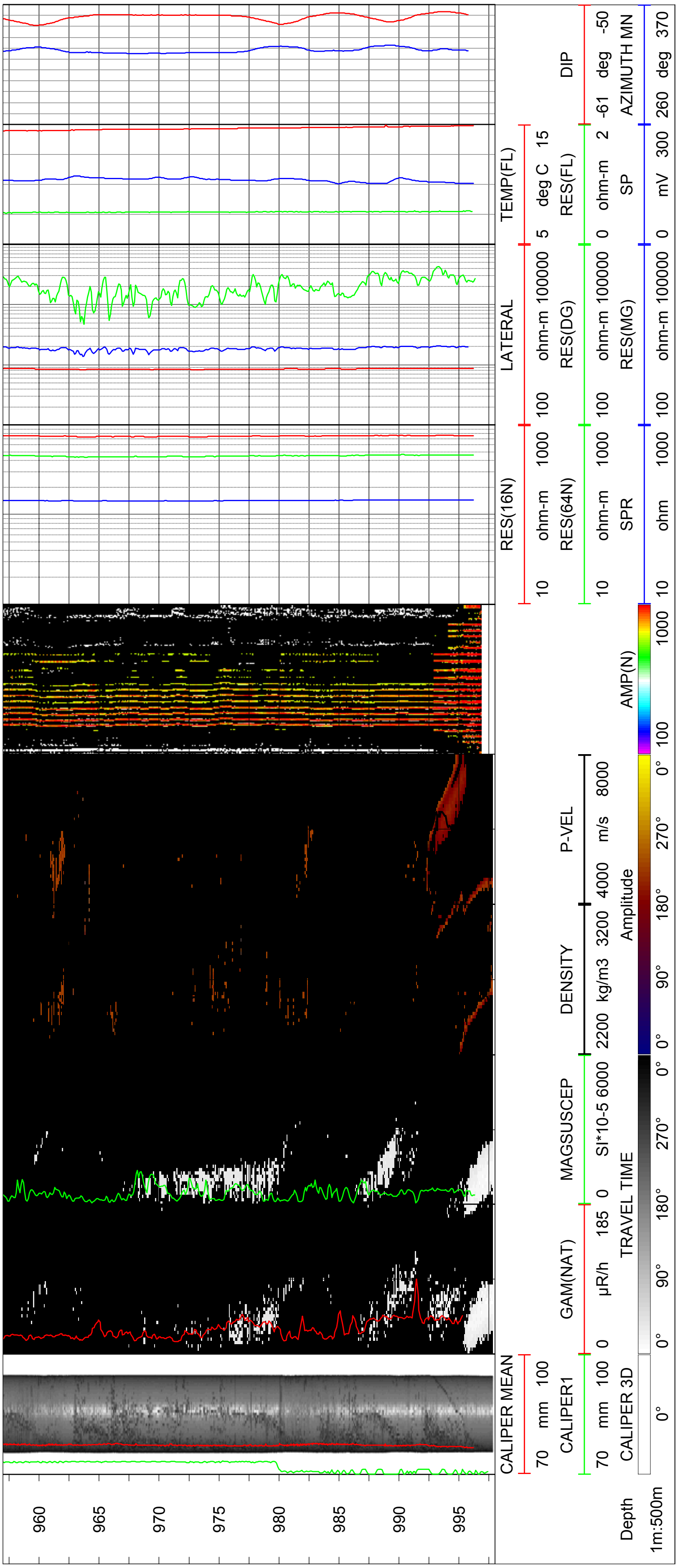
875
880
885
890
895
900
905
910
915
920
925
930
935
940
945
950
955


Depth
1m:500m
960
965
970
975
980
985
990
995
CALIPER MEAN
70 mm 100
CALIPER1
70 mm 100
CALIPER 3D
0°
GAM(NAT)
0 µR/h 185
MAGSUSCEP
0 SI*10-5 6000
TRAVEL TIME
0° 90° 180° 270° 0°
DENSITY
2200 kg/m3 3200
Amplitude
0° 90° 180° 270° 0°
P-VEL
4000 m/s 8000
AMP(N)
100 1000
RES(16N)
10 ohm-m 1000
RES(64N)
10 ohm-m 1000
SPR
10 ohm 1000
LATERAL
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
RES(MG)
100 ohm-m 100000
TEMP(FL)
5 deg C 15
RES(FL)
0 ohm-m 2
SP
0 mV 300
DIP
-61 deg -50
AZIMUTH MN
260 deg 370

Appendix 2

Borehole HFM20. Drawing no. 2.1. Borehole logs

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

Northing: 6700187.50m Easting: 1630776.68m Elevation: 2.97m , RHB70

Diameter:	135mm
Reaming Diameter:	
Outer Casing:	168mm
Inner Casing:	160mm
Borehole Length:	301m
Cone:	
Inclination at ground surface:	-85.45°
Azimuth:	354.41°
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
SP	Self Potential	8044	mV

Rev.	Date	Drawn by	Control	Approved
0	2004-11-30	JRI	UTN	UTN

Job 360210A

Scale 1:500

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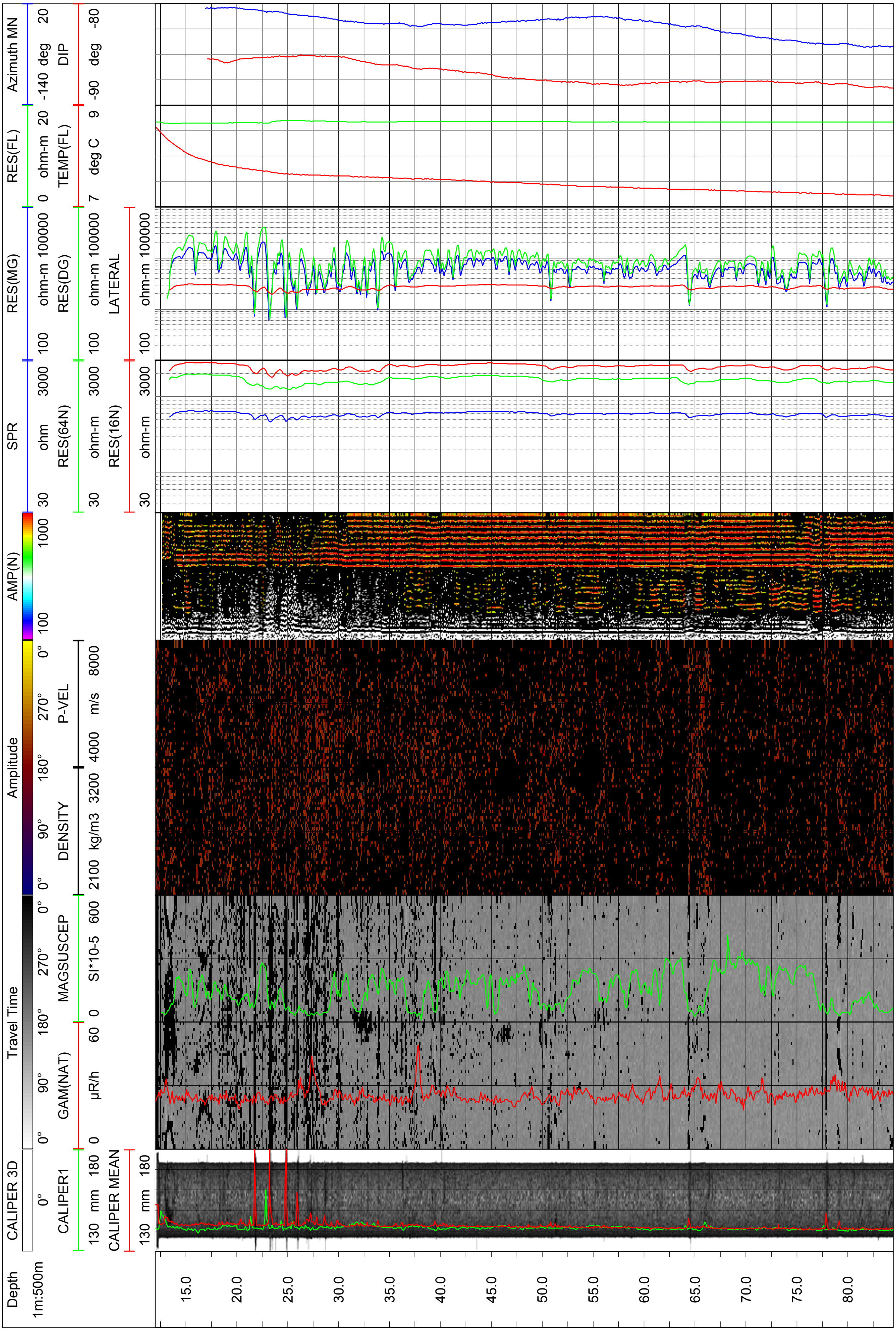
SKB geophysical borehole logging

Borehole HFM20. Forsmark.

Presentation

Filename:
HFM20_Presentation.wcl

Drawing no.:
2.1


Depth
1m:500m
CALIPER 3D
0°
CALIPER1
130 mm 180
CALIPER MEAN
130 mm 180
Travel Time
0° 90° 180° 270° 0°
GAM(NAT)
0 μR/h 60
MAGSUSCEP
0 SI*10-5 600
Amplitude
0° 90° 180° 270° 0°
DENSITY
2100 kg/m3 3200
P-VEL
4000 m/s 8000
AMP(N)
100 1000
SPR
30 ohm 3000
RES(64N)
30 ohm-m 3000
RES(16N)
30 ohm-m 3000
RES(MG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
LATERAL
100 ohm-m 100000
RES(FL)
0 ohm-m 20
TEMP(FL)
7 deg C 9
Azimuth MN
-140 deg 20
DIP
-90 deg -80
15.0
20.0
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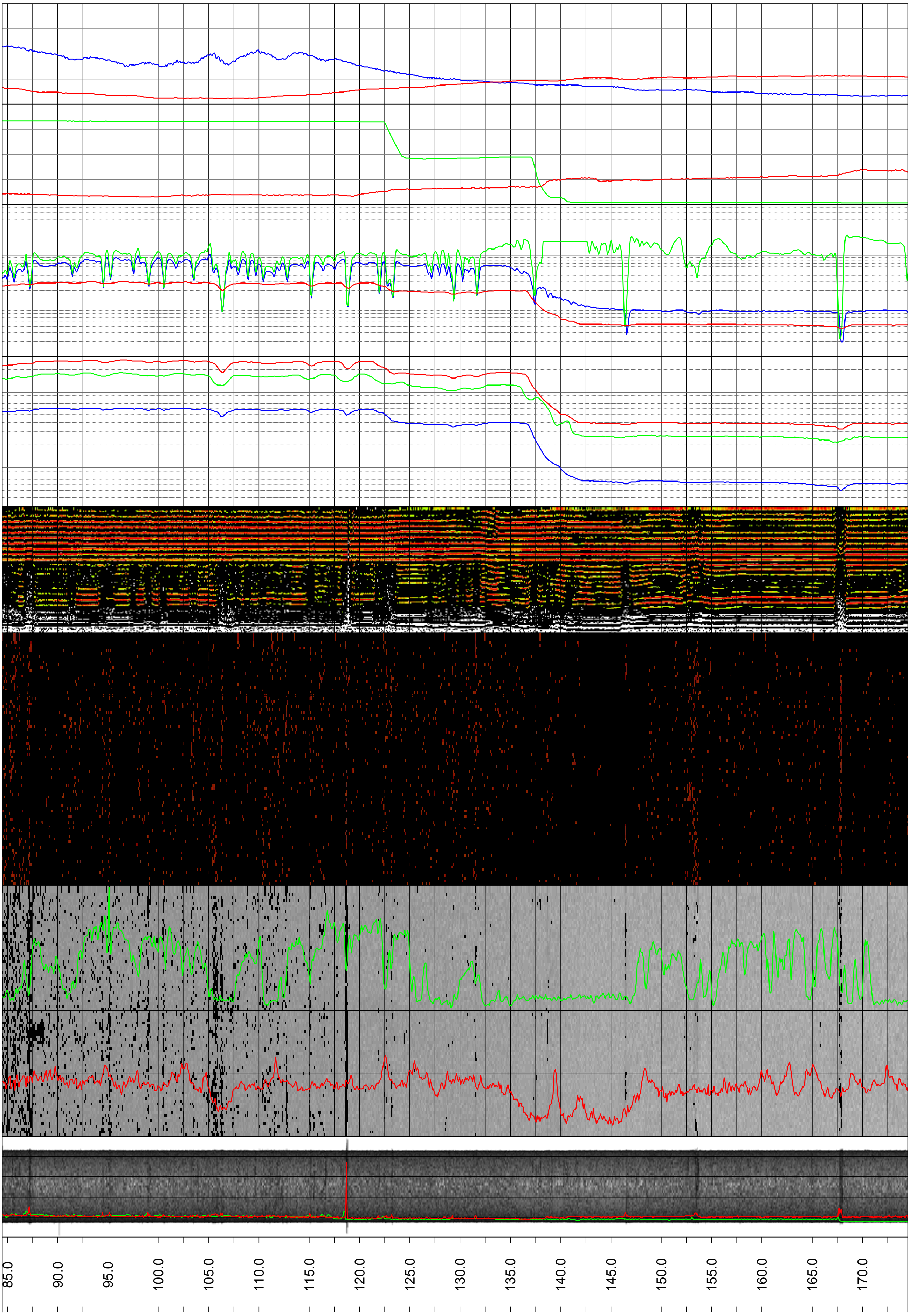
70.0
75.0
80.0


85.0
90.0
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100.0
105.0
110.0
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120.0
125.0
130.0
135.0
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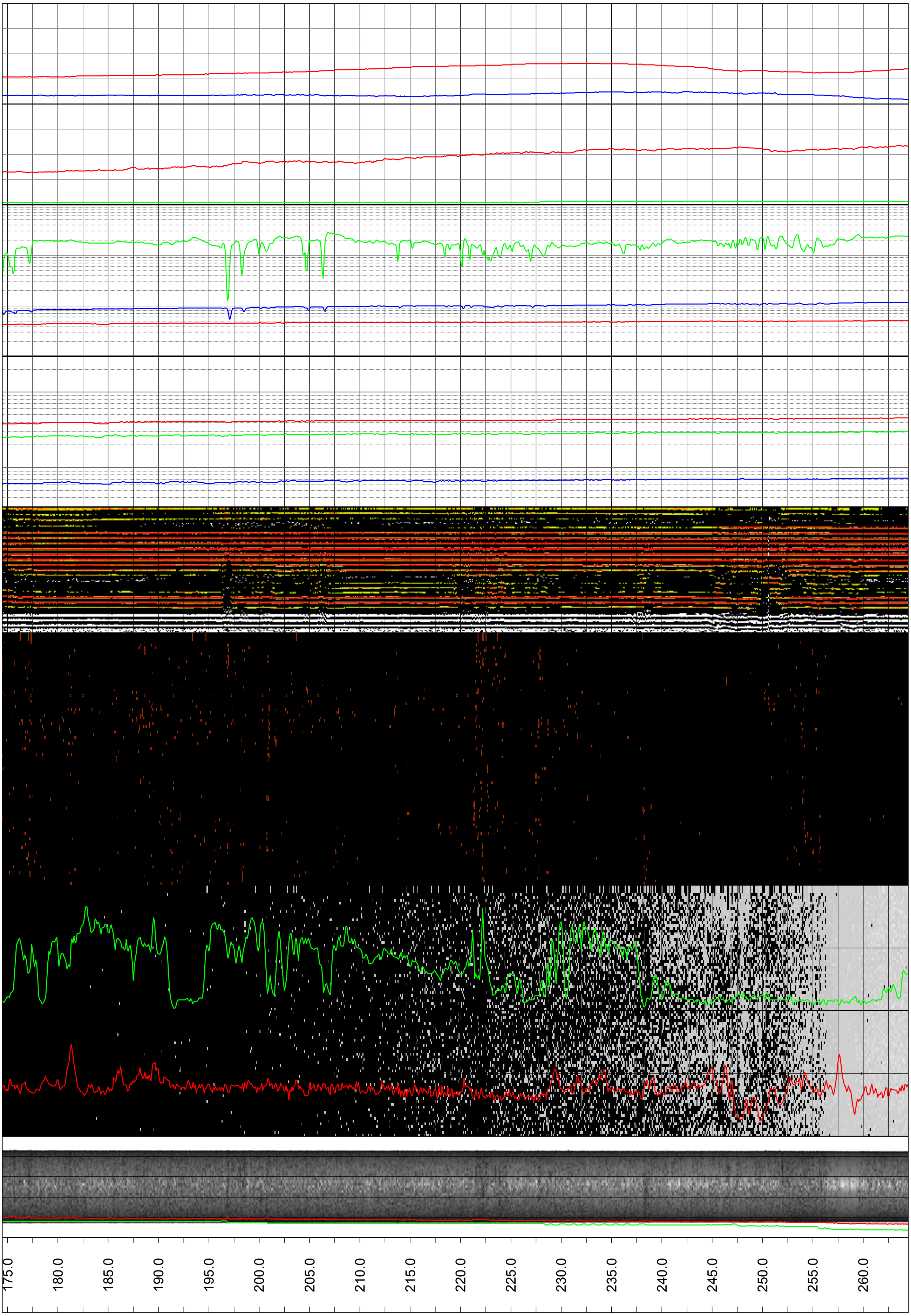
160.0
165.0
170.0


175.0
180.0
185.0
190.0
195.0
200.0
205.0
210.0
215.0
220.0
225.0
230.0
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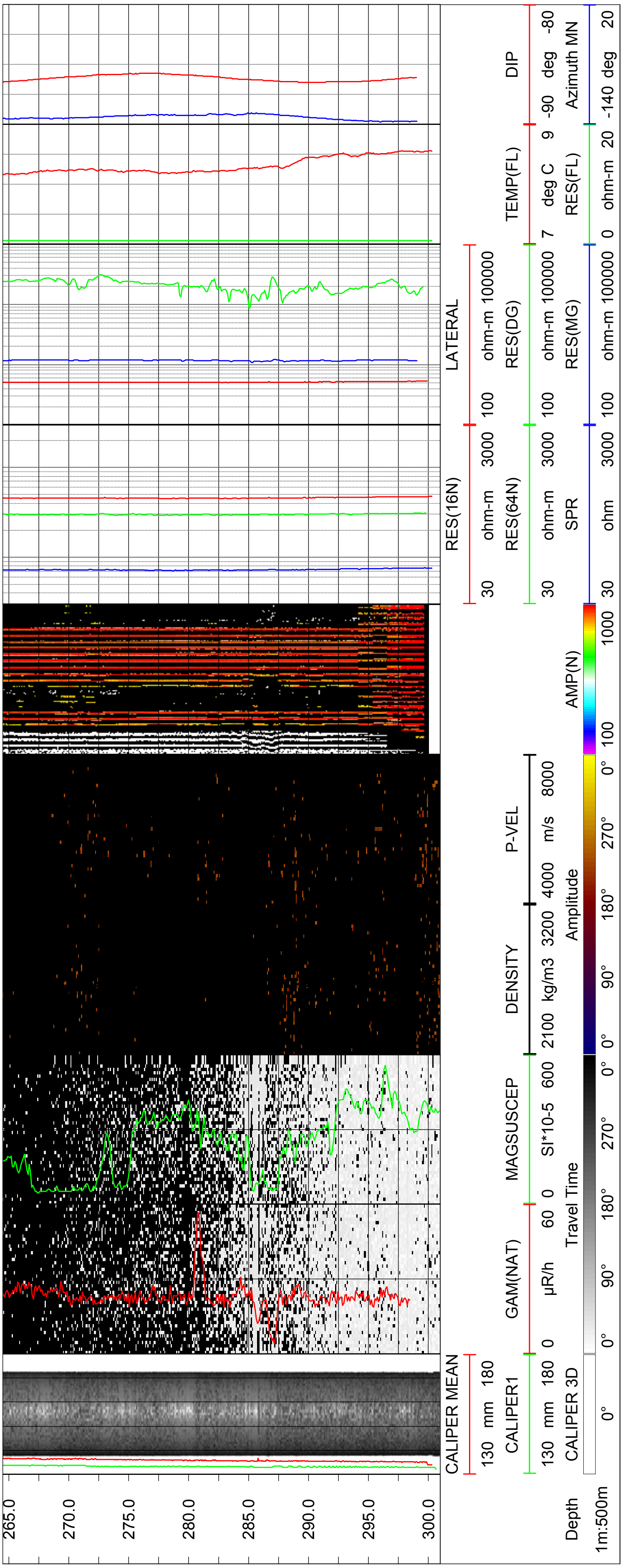
250.0
255.0
260.0



Depth
1m:500m
265.0
270.0
275.0
280.0
285.0
290.0
295.0
300.0
CALIPER MEAN
130 mm 180
CALIPER1
130 mm 180
CALIPER 3D
0°
GAM(NAT)
0 µR/h 60
MAGSUSCEP
0 SI*10-5 600
Travel Time
0° 90° 180° 270° 0°
DENSITY
2100 kg/m3 3200
P-VEL
4000 m/s 8000
Amplitude
0° 90° 180° 270° 0°
AMP(N)
100 1000
RES(16N)
30 ohm-m 3000
RES(64N)
30 ohm-m 3000
SPR
30 ohm 3000
LATERAL
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
RES(MG)
100 ohm-m 100000
TEMP(FL)
7 deg C 9
RES(FL)
0 ohm-m 20
DIP
-90 deg -80
Azimuth MN
-140 deg 20

Appendix 3

Borehole HFM21. Drawing no. 3.1. Borehole logs

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

Northing: 6700125.57m Easting: 1631074.05m Elevation: 3.98m , RHB70

Diameter:	137mm
Reaming Diameter:	
Outer Casing:	168mm
Inner Casing:	160mm
Borehole Length:	301m
Cone:	
Inclination at ground surface:	-58.48°
Azimuth:	88.81°
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
SP	Self Potential	8044	mV

Rev.	Date	Drawn by	Control	Approved
0	2004-12-01	JRI	UTN	UTN

Job	Scale
360210A	1:500

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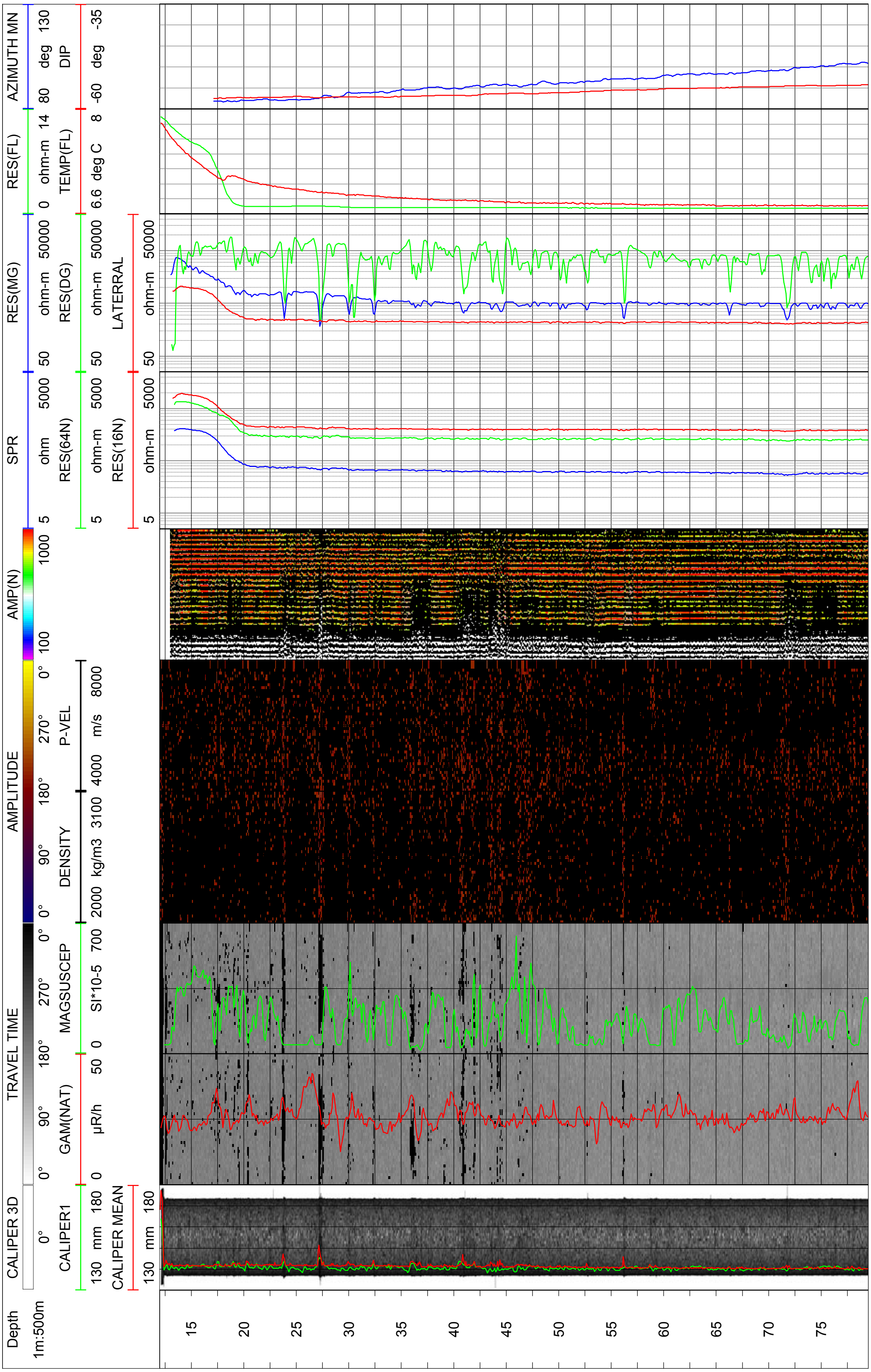
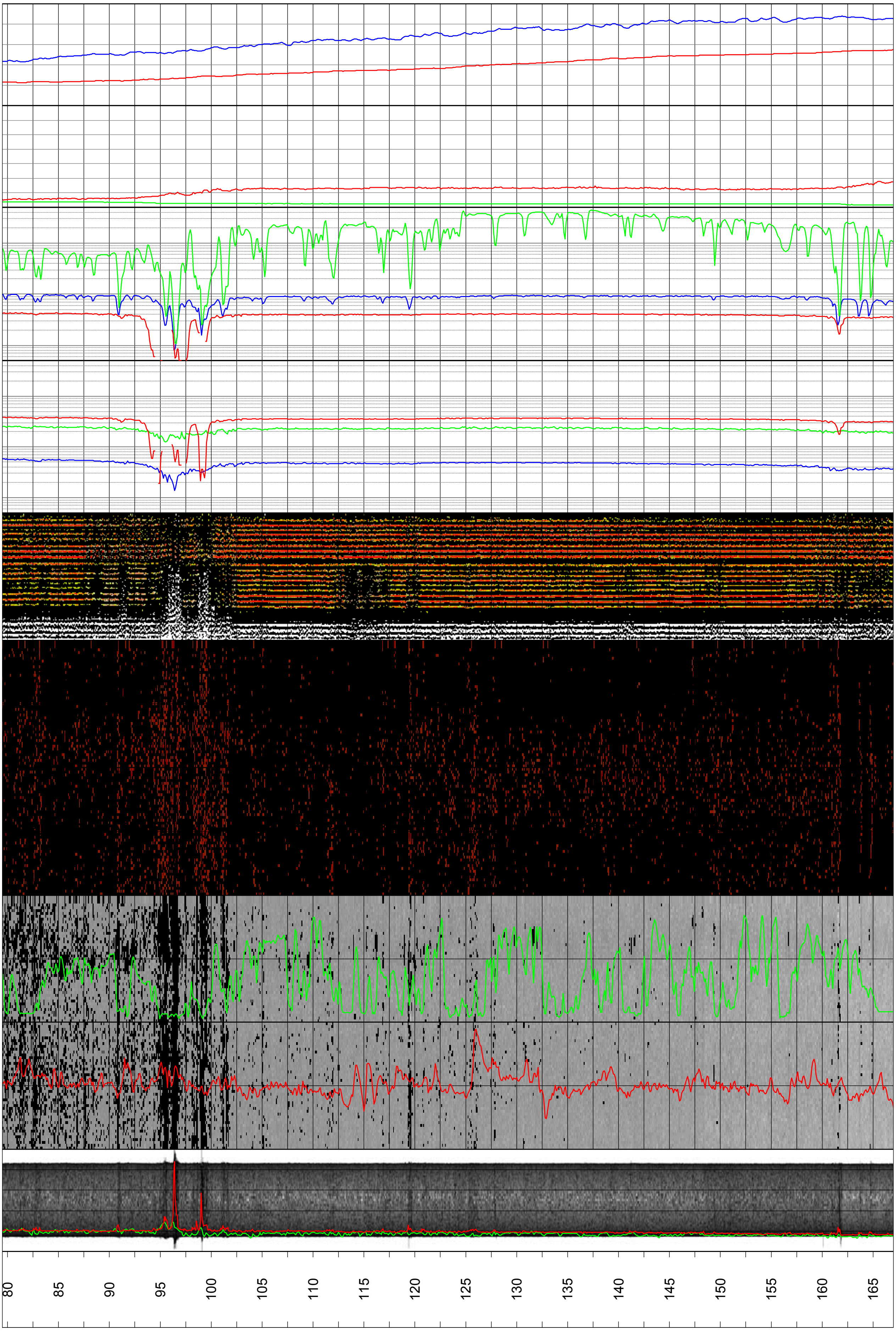
SKB geophysical borehole logging
Borehole HFM21. Forsmark.

Presentation

Filename:
HFM21_Presentation.wcl

Drawing no.:
3.2


Depth
1m:500m
15
20
25
30
35
40
45
50
55
60
65
70
75
CALIPER 3D
0°
CALIPER1
130 mm 180
CALIPER MEAN
130 mm 180
TRAVEL TIME
0° 90° 180° 270° 0°
GAM(NAT)
0 µR/h 50
MAGSUSCEP
0 SI*10-5 700
AMPLITUDE
0° 90° 180° 270° 0°
DENSITY
2000 kg/m3 3100
P-VEL
4000 m/s 8000
AMP(N)
100 1000
SPR
5 ohm 5000
RES(64N)
5 ohm-m 5000
RES(16N)
5 ohm-m 5000
RES(MG)
50 ohm-m 50000
RES(DG)
50 ohm-m 50000
LATERAL
50 ohm-m 50000
RES(FL)
0 ohm-m 14
TEMP(FL)
6.6 deg C 8
AZIMUTH MN
80 deg 130
DIP
-60 deg -35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90
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120
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135
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145
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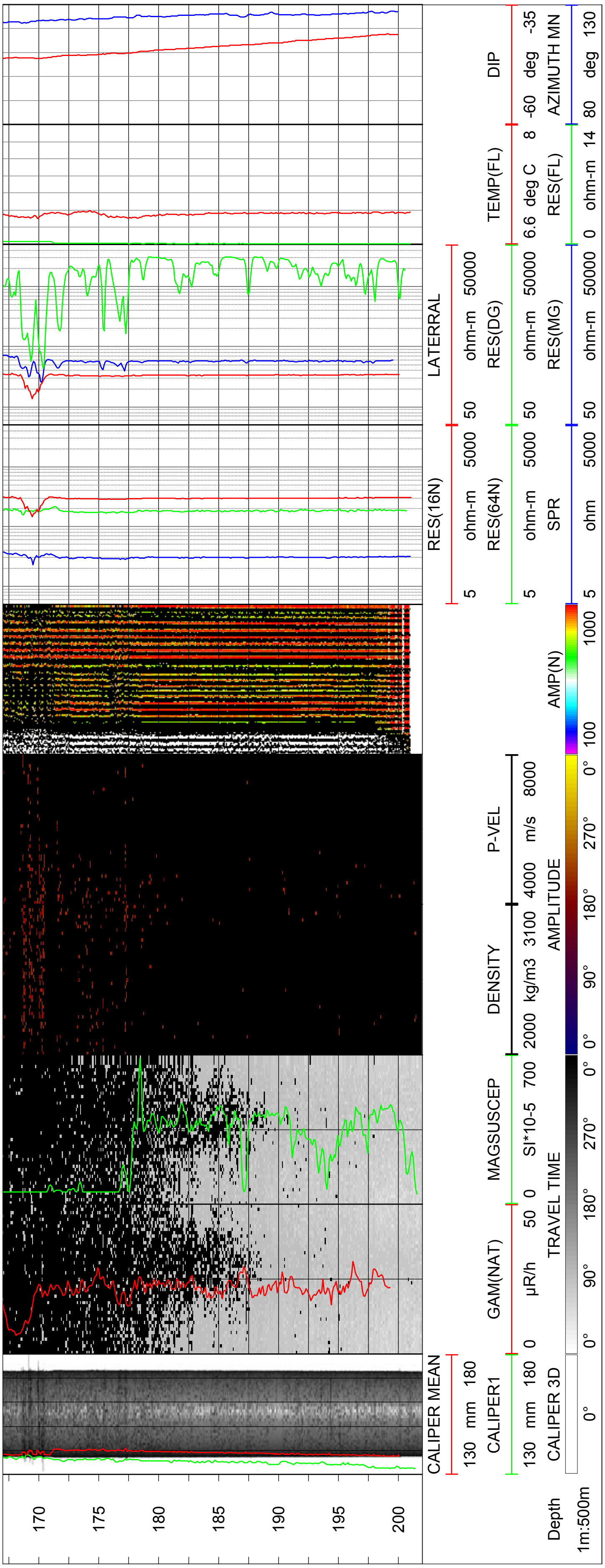
155
160
165


Depth
1m:500m
170
175
180
185
190
195
200
CALIPER MEAN
130 mm 180
CALIPER1
130 mm 180
CALIPER 3D
0°
GAM(NAT)
0 µR/h 50
MAGSUSCEP
0 SI*10-5 700
TRAVEL TIME
0° 90° 180° 270° 0°
DENSITY
2000 kg/m3 3100
P-VEL
4000 m/s 8000
AMPLITUDE
0° 90° 180° 270° 0°
AMP(N)
100 1000
RES(16N)
5 ohm-m 5000
RES(64N)
5 ohm-m 5000
SPR
5 ohm 5000
LATERRAL
50 ohm-m 50000
RES(DG)
50 ohm-m 50000
RES(MG)
50 ohm-m 50000
TEMP(FL)
6.6 deg C 8
RES(FL)
0 ohm-m 14
DIP
-60 deg -35
AZIMUTH MN
80 deg 130

Appendix 4

Borehole HFM22. Drawing no. 4.1. Borehole logs

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

Northing: 6700456.18m Easting: 1631217.64m Elevation: 1.54m, RHB70

Diameter:	136mm
Reaming Diameter:	200mm
Outer Casing:	168mm
Inner Casing:	160mm
Borehole Length:	222m
Cone:	
Inclination at ground surface:	-58.85°
Azimuth:	90.08°
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
SP	Self Potential	8044	mV

Rev.	Date	Drawn by	Control	Approved
0	2004-11-05	JRI	UTN	UTN

Job 360210A **Scale** 1:500

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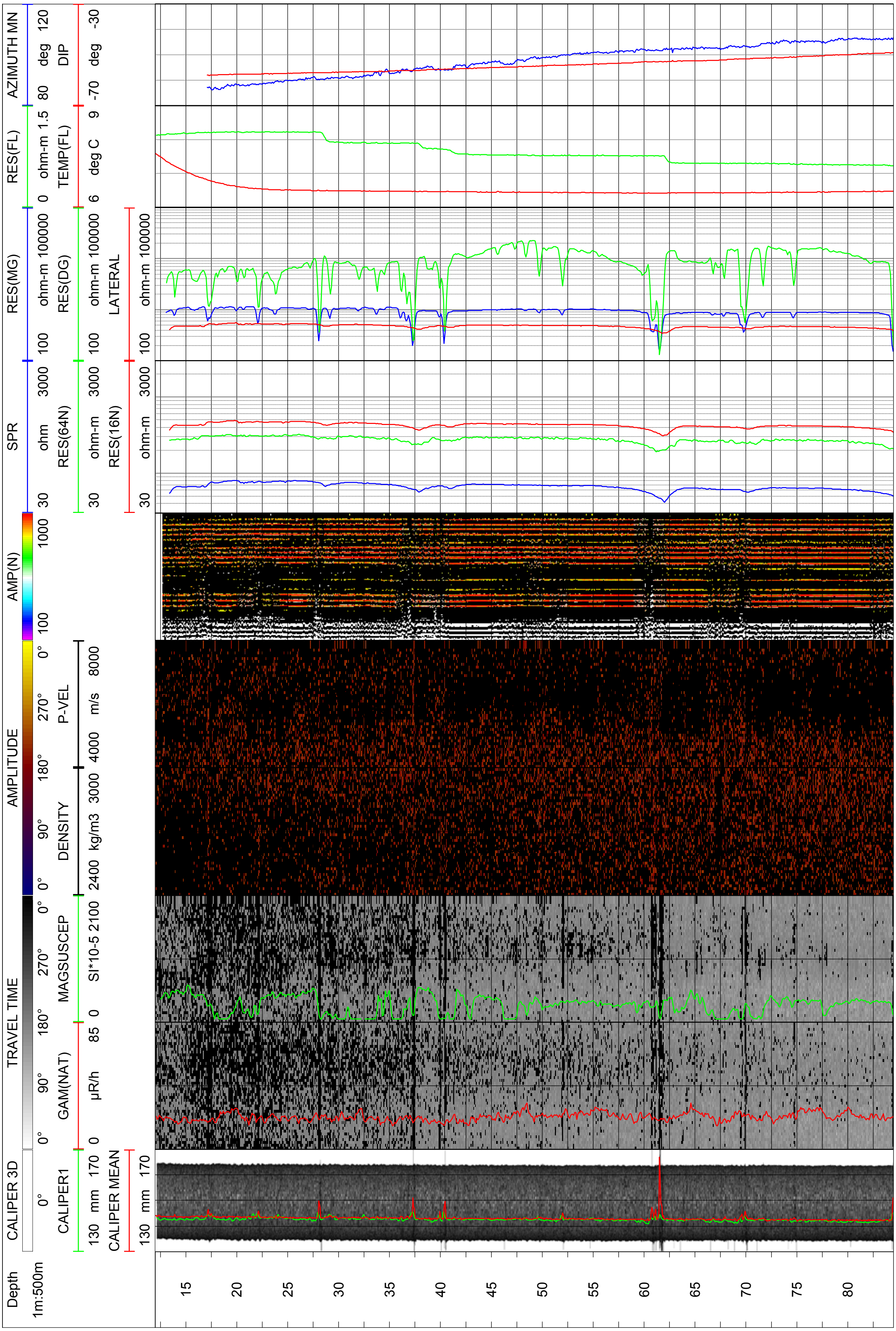
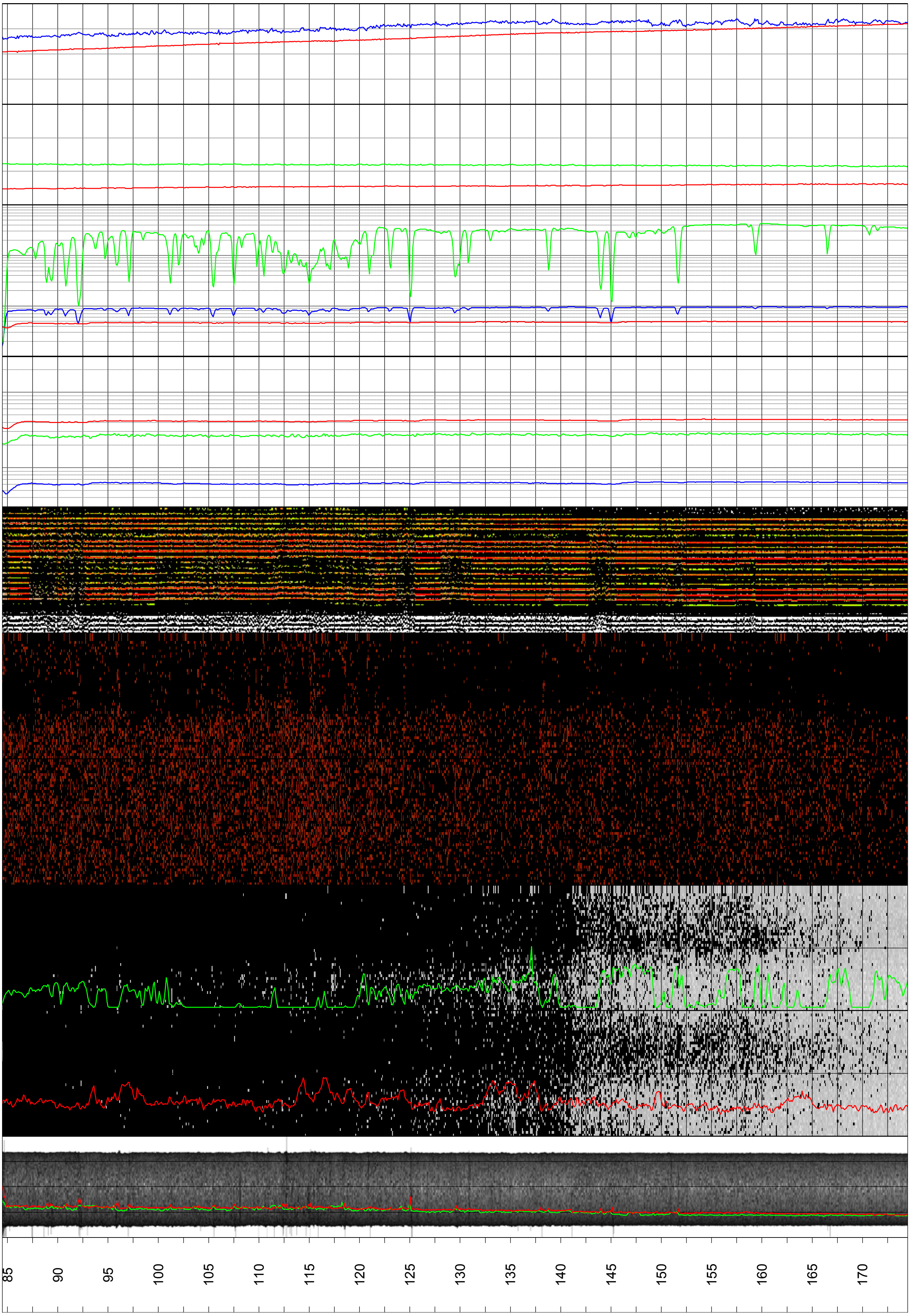
SKB geophysical borehole logging
HFM22. Forsmark

Presentation

Filename:
HFM22_Presentation.wcl

Drawing no.:
4.1


AZIMUTH MN
80 deg 120
DIP
-70 deg -30
RES(FL)
0 ohm-m 1.5
TEMP(FL)
6 deg C 9
RES(MG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
LATERAL
100 ohm-m 100000
SPR
30 ohm 3000
RES(64N)
30 ohm-m 3000
RES(16N)
30 ohm-m 3000
AMP(N)
100 1000
AMPLITUDE
0° 90° 180° 270° 0°
DENSITY
2400 kg/m3 3000
P-VEL
4000 m/s 8000
TRAVEL TIME
0° 90° 180° 270° 0°
MAGSUSCEP
0 SI*10-5 2100
GAM(NAT)
0 µR/h 85
CALIPER 3D
0°
CALIPER1
130 mm 170
CALIPER MEAN
130 mm 170
Depth
1m:500m
15
20
25
30
35
40
45
50
55
60
65
70
75
80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100
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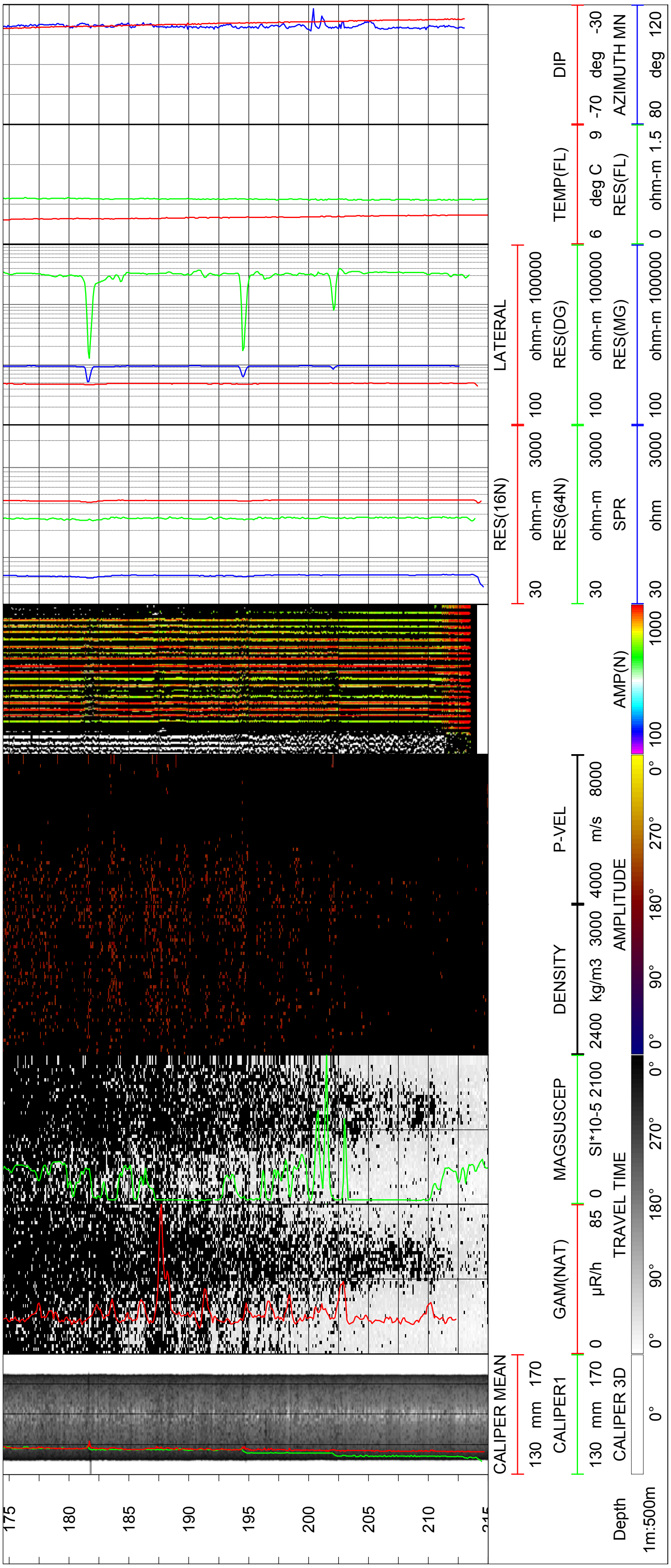
165
170



Depth
1m:500m
175
180
185
190
195
200
205
210
215
CALIPER MEAN
130 mm 170
CALIPER1
130 mm 170
CALIPER 3D
0°
GAM(NAT)
0 µR/h 85
MAGSUSCEP
0 SI*10-5 2100
TRAVEL TIME
0° 90° 180° 270° 0°
DENSITY
2400 kg/m3 3000
P-VEL
4000 m/s 8000
AMPLITUDE
0° 90° 180° 270° 0°
AMP(N)
100 1000
RES(16N)
30 ohm-m 3000
RES(64N)
30 ohm-m 3000
SPR
30 ohm 3000
LATERAL
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
RES(MG)
100 ohm-m 100000
TEMP(FL)
6 deg C 9
RES(FL)
0 ohm-m 1.5
DIP
-70 deg -30
AZIMUTH MN
80 deg 120

Appendix 5

Borehole KFM01A. Drawing no. 5.1. Borehole logs

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/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
SP	Self Potential	8044	mV

Rev.	Date	Drawn by	Control	Approved
1	2004-12-10	JRI	UTN	UTN

Job 360210A

Scale 1:500

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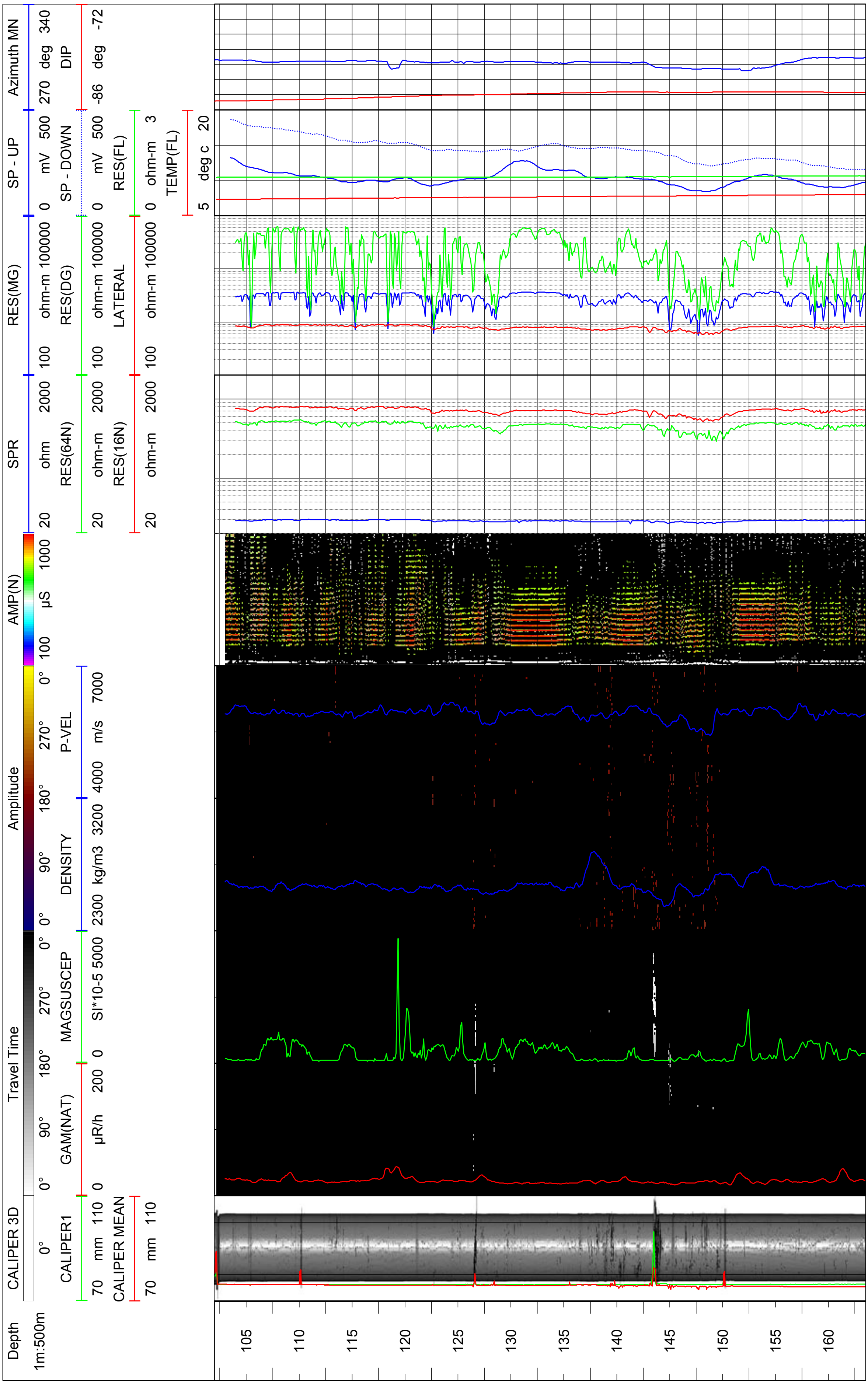
SKB geophysical borehole logging

Borehole KFM01A Forsmark

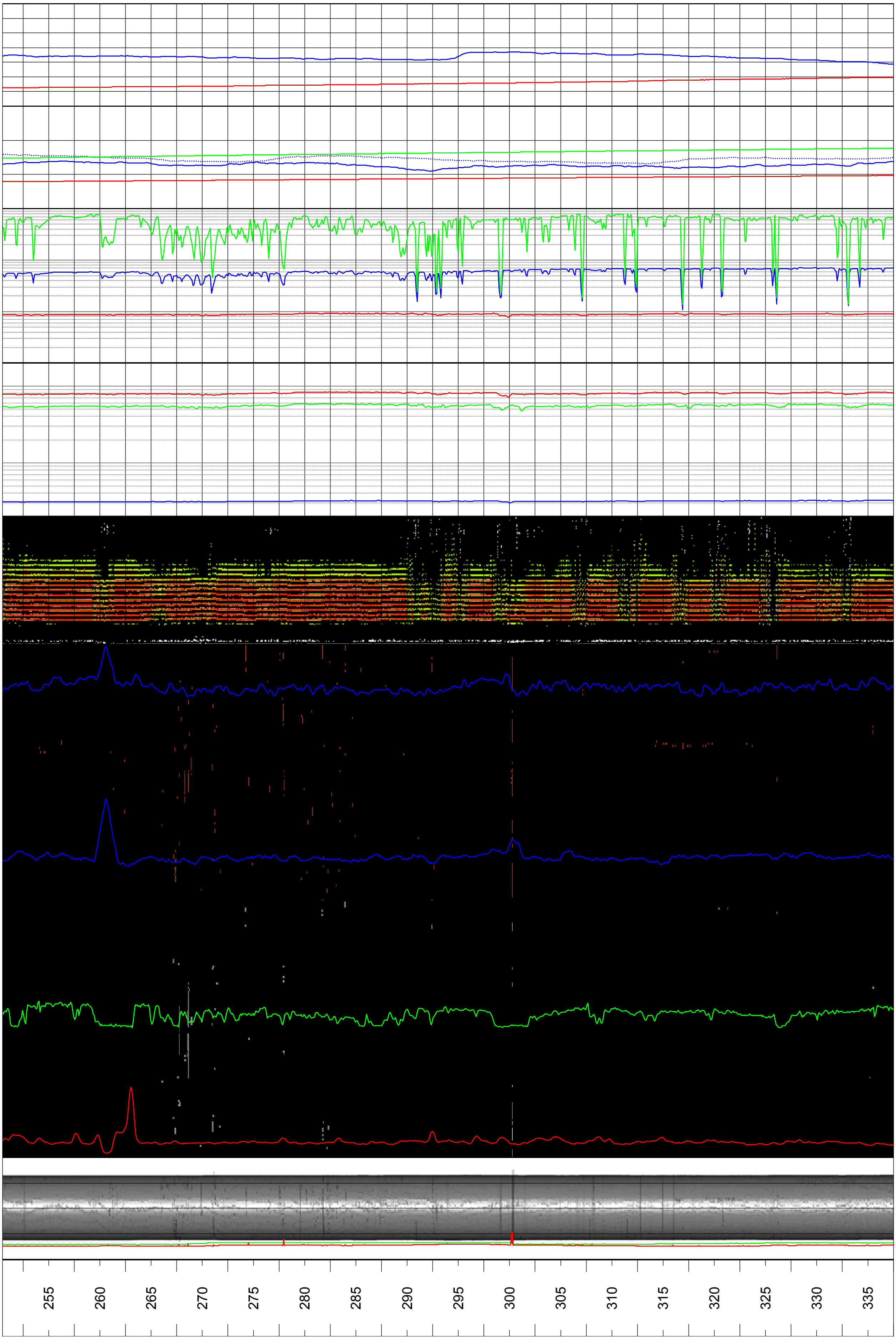
Presentation

Filename: KFM01A_Presentation_with_SP.wcl

Drawing no.: **5.1**


Depth
1m:500m
105
110
115
120
125
130
135
140
145
150
155
160
CALIPER 3D
0°
CALIPER1
70 mm 110
CALIPER MEAN
70 mm 110
Travel Time
0° 90° 180° 270° 0°
GAM(NAT)
0 µR/h 200
MAGSUSCEP
0 SI*10-5 5000
Amplitude
0° 90° 180° 270° 0°
DENSITY
2300 kg/m3 3200
P-VEL
4000 m/s 7000
AMP(N)
100 µS 1000
SPR
20 ohm 2000
RES(64N)
20 ohm-m 2000
RES(16N)
20 ohm-m 2000
RES(MG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
LATERAL
100 ohm-m 100000
SP - UP
0 mV 500
SP - DOWN
0 mV 500
RES(FL)
0 ohm-m 3
TEMP(FL)
5 deg c 20
Azimuth MN
270 deg 340
DIP
-86 deg -72


165
170
175
180
185
190
195
200
205
210
215
220
225
230
235
240
245
250



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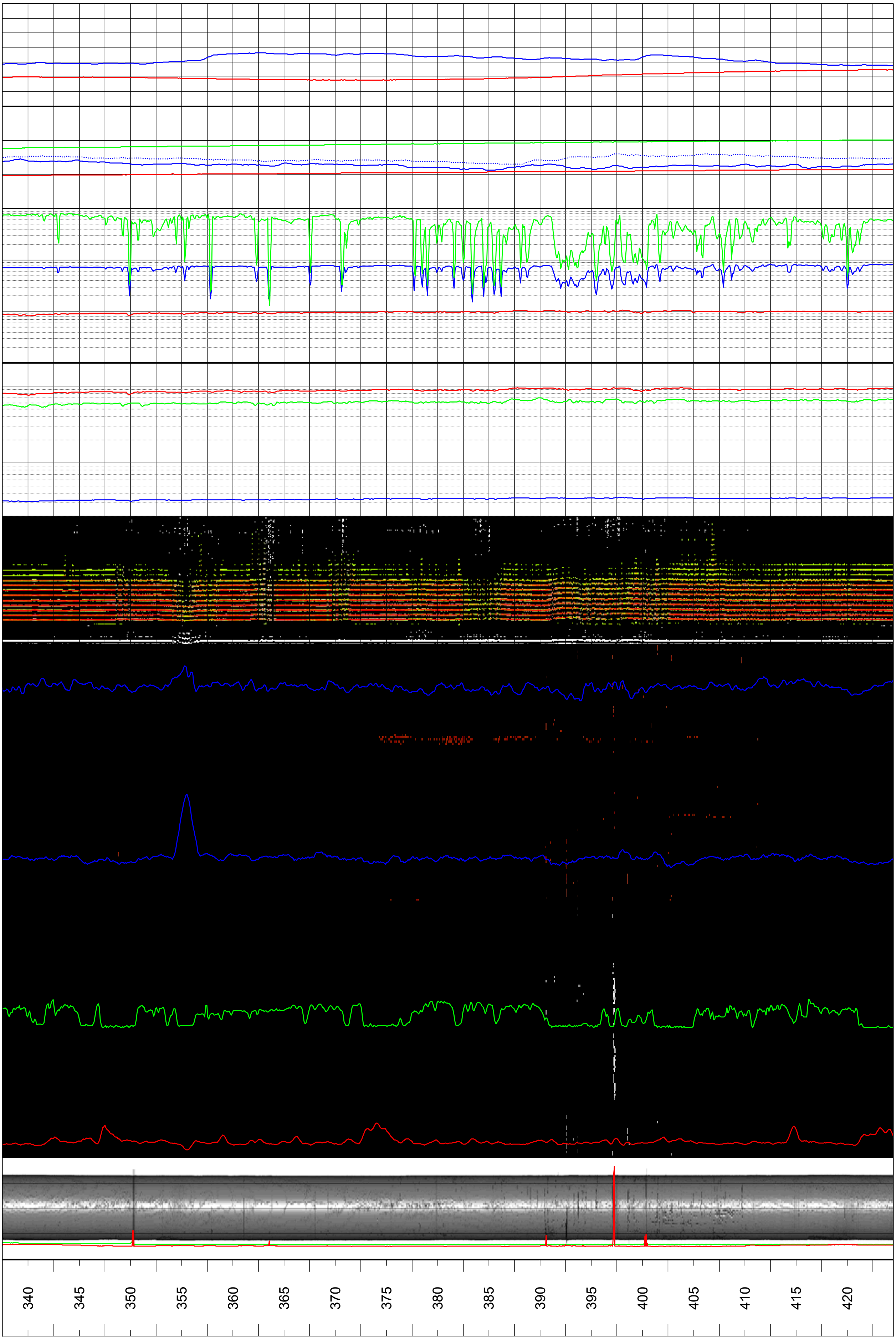
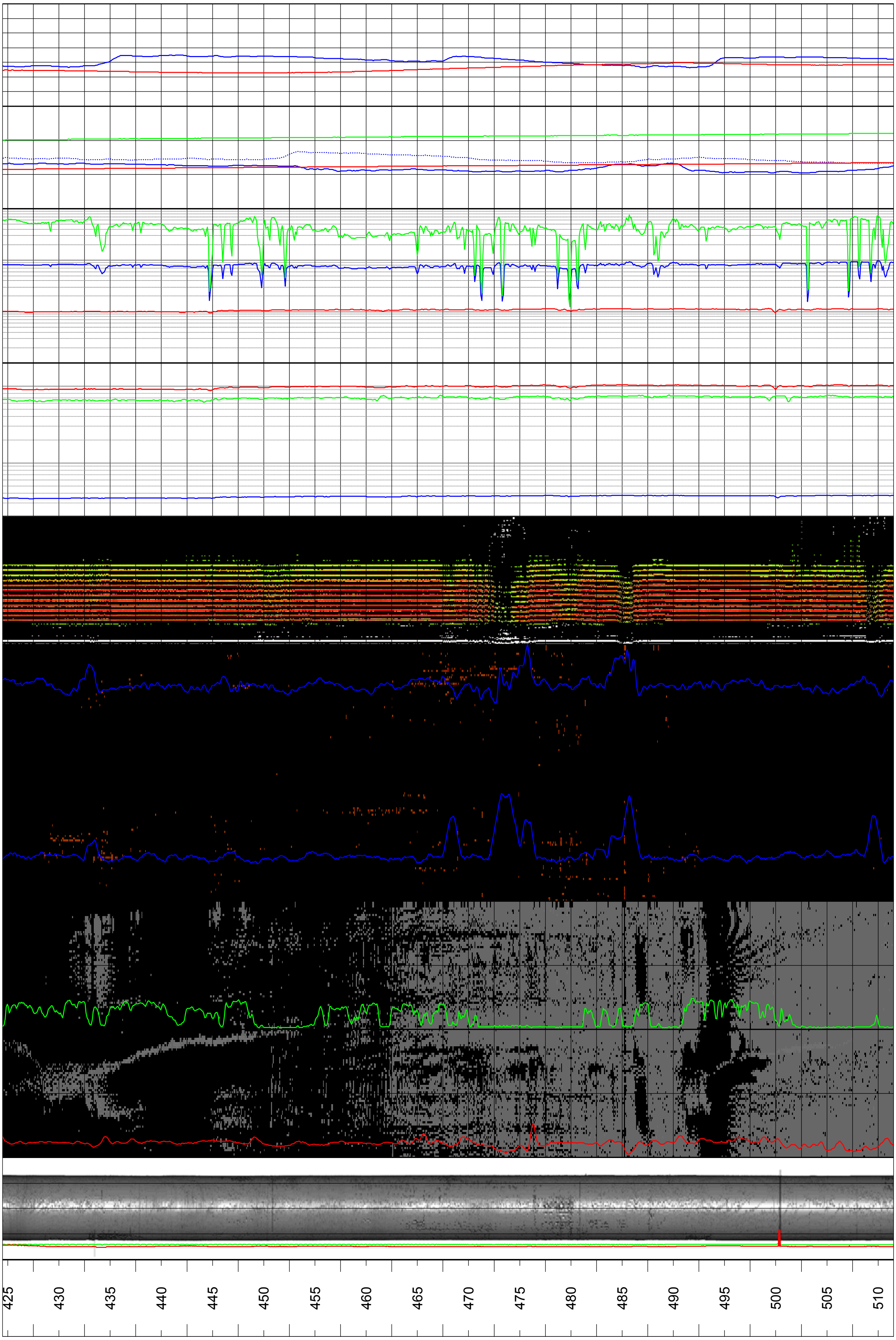
260
265
270
275
280
285
290
295
300
305
310
315
320
325
330
335


340
345
350
355
360
365
370
375
380
385
390
395
400
405
410
415
420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430
435
440
445
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455
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465
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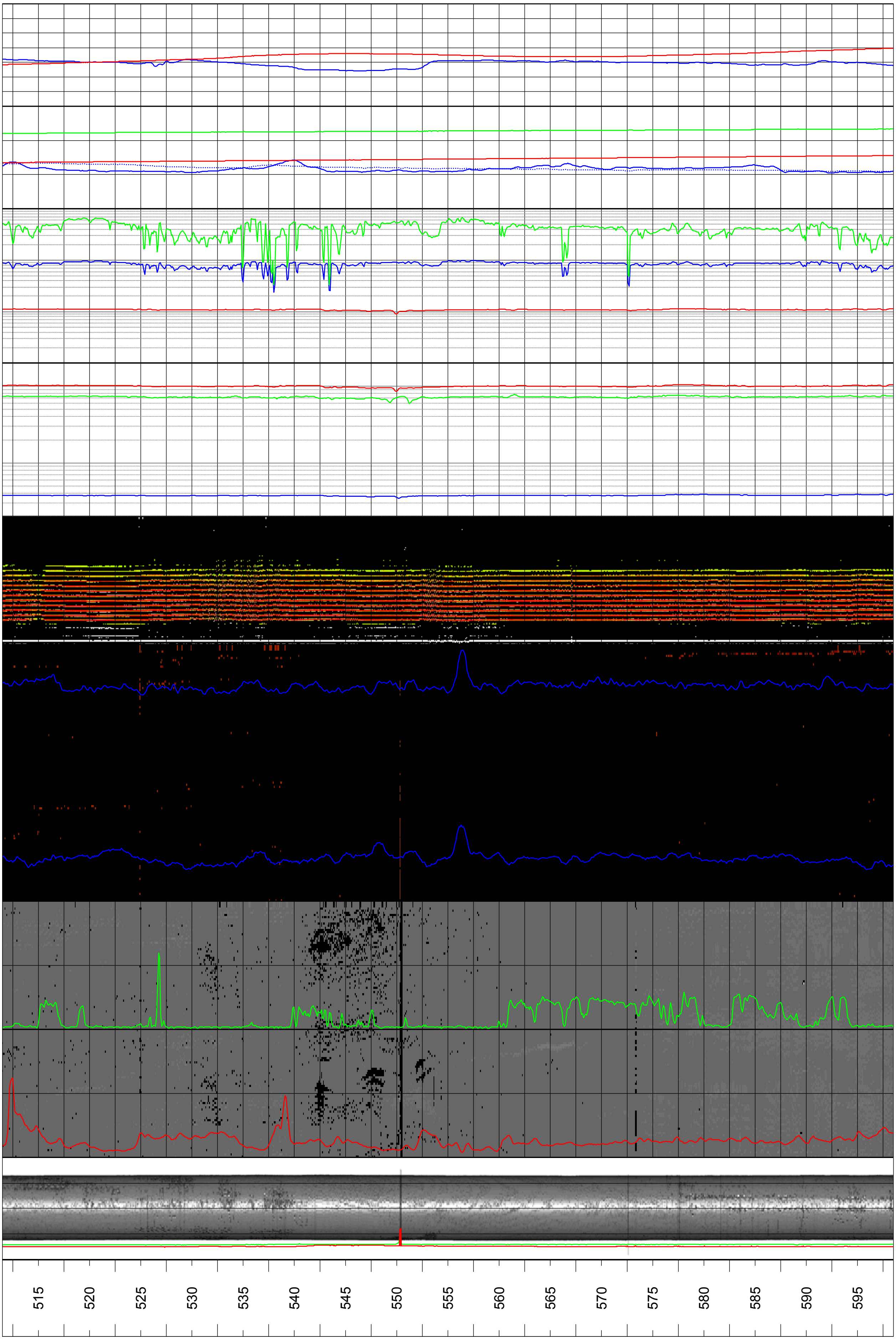
475
480
485
490
495
500
505
510


515
520
525
530
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540
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560
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570
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580
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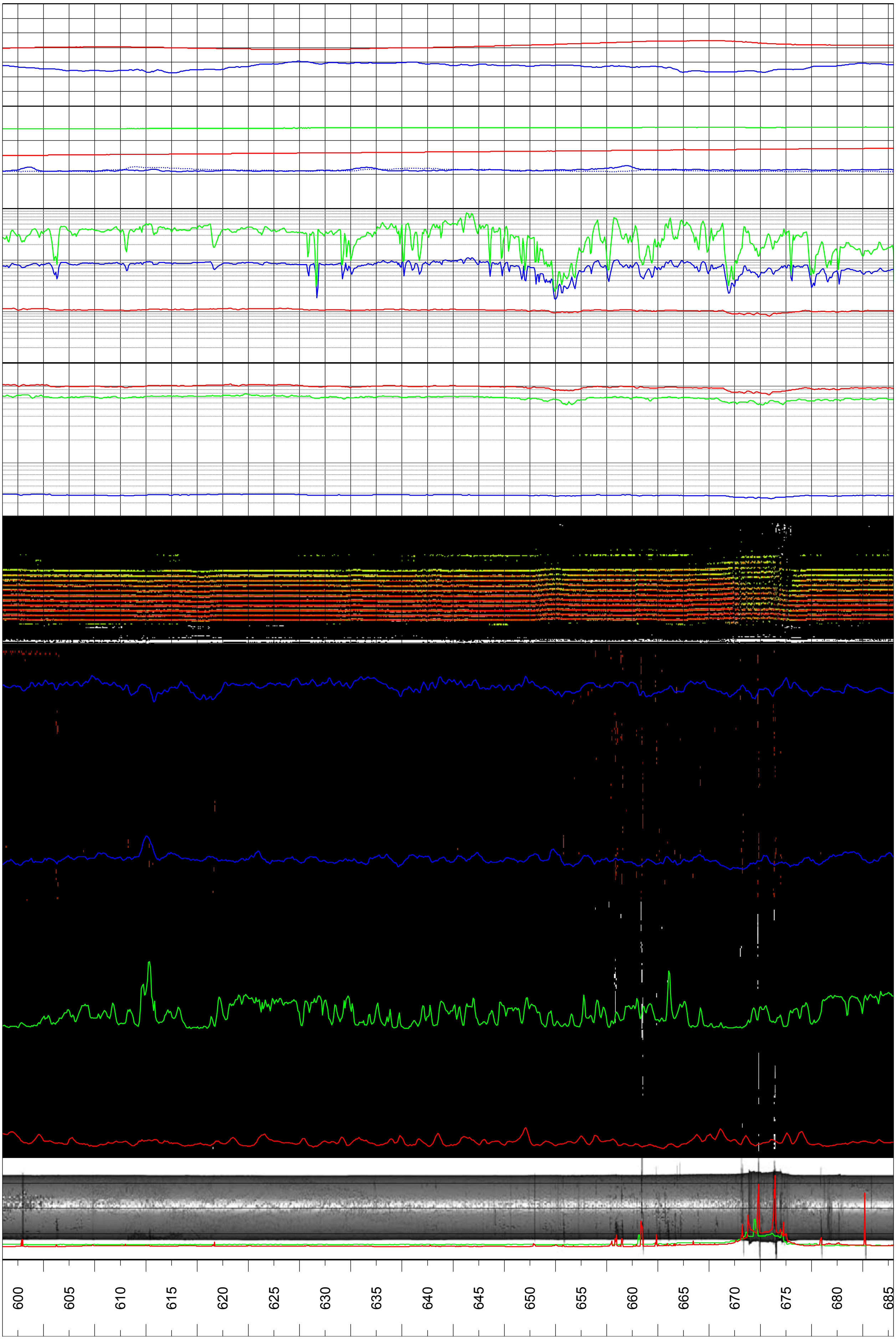
590
595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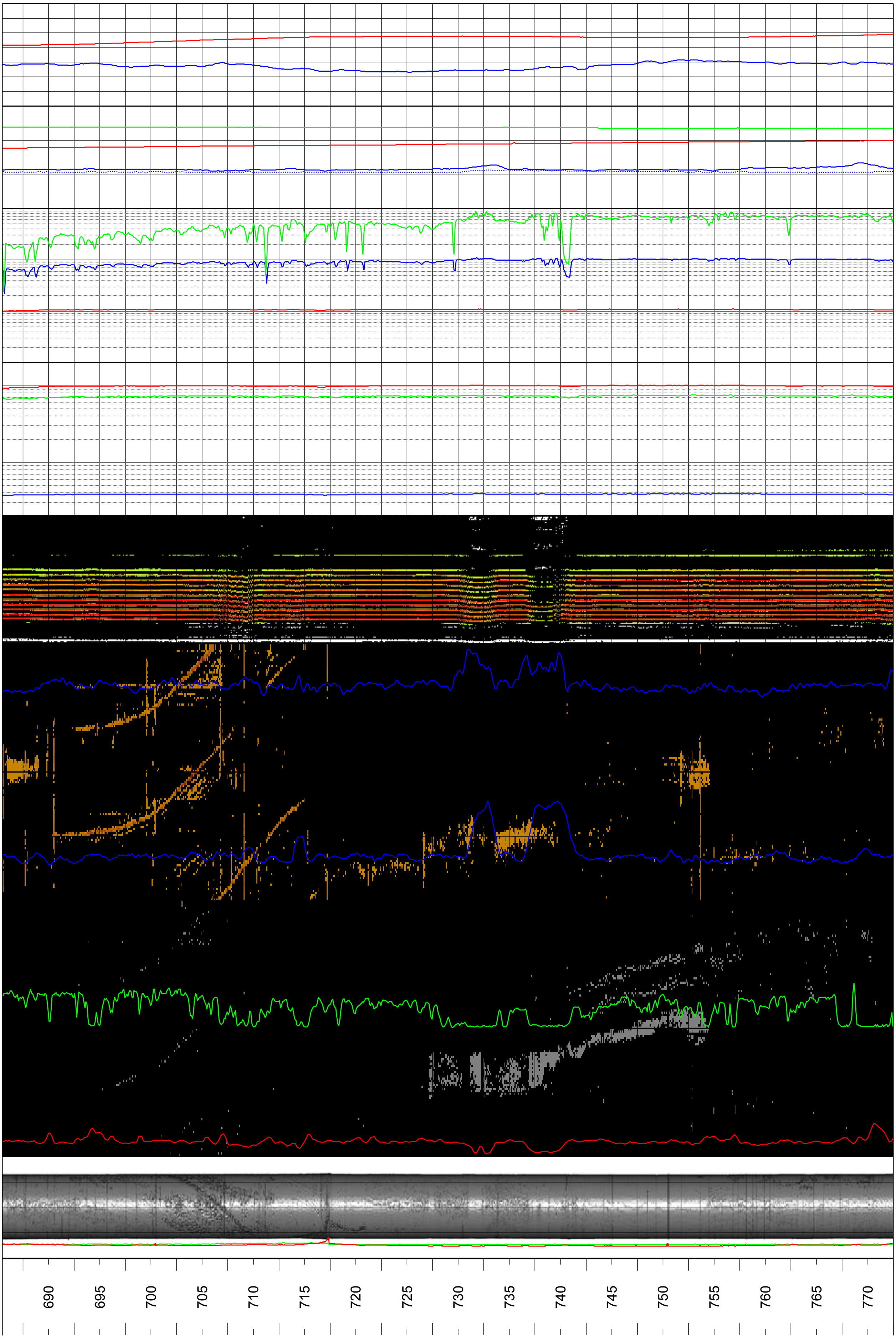
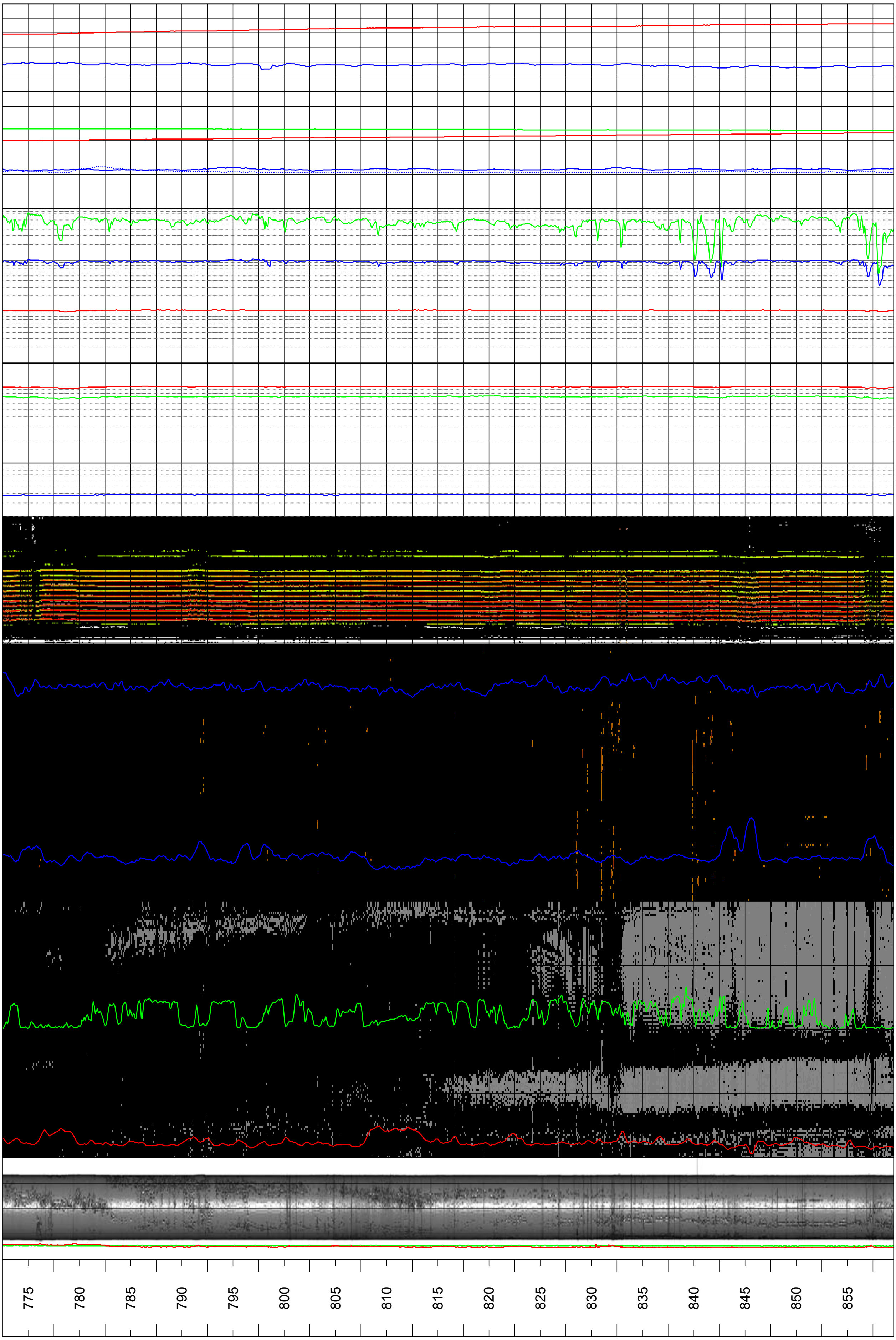
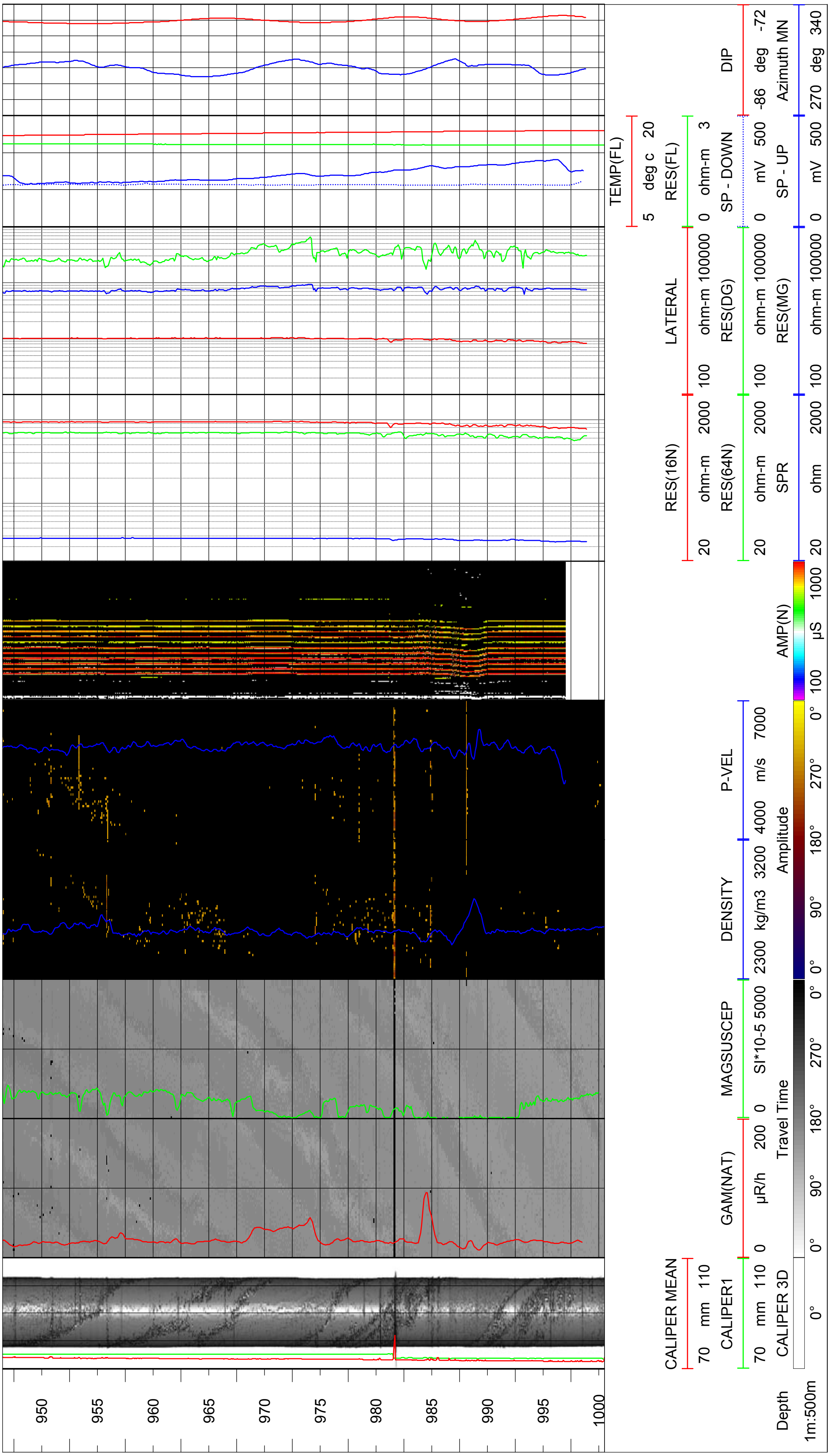
605
610
615
620
625
630
635
640
645
650
655
660
665
670
675
680
685


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
940
945


950
955
960
965
970
975
980
985
990
995
1000
Depth
1m:500m
CALIPER MEAN
70 mm 110
CALIPER1
70 mm 110
CALIPER 3D
0°
GAM(NAT)
0 µR/h 200
MAGSUSCEP
0 SI*10-5 5000
Travel Time
0° 90° 180° 270° 0°
DENSITY
2300 kg/m3 3200
P-VEL
4000 m/s 7000
Amplitude
0° 90° 180° 270° 0°
AMP(N)
100 µS 1000
RES(16N)
20 ohm-m 2000
RES(64N)
20 ohm-m 2000
SPR
20 ohm 2000
LATERAL
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
RES(MG)
100 ohm-m 100000
TEMP(FL)
5 deg c 20
RES(FL)
0 ohm-m 3
SP - DOWN
0 mV 500
SP - UP
0 mV 500
DIP
-86 deg -72
Azimuth MN
270 deg 340

Appendix 6

Borehole KFM04A. Drawing no. 6.1. Borehole logs

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	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
SP	Self Potential	8044	mV

Rev.	Date	Drawn by	Control	Approved
2	2004-12-10	JRI	UTN	UTN

Job	Scale
360210A	1:500

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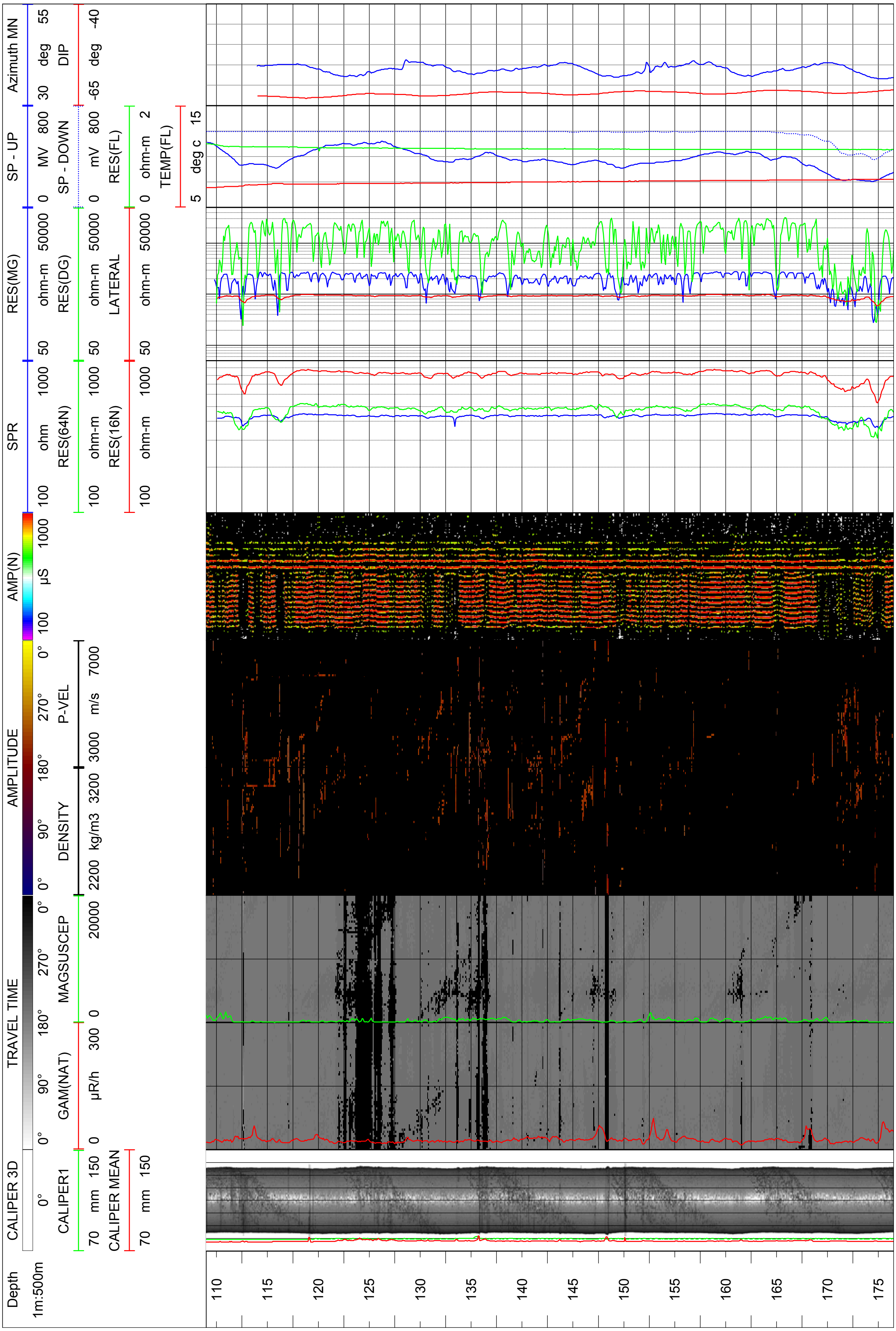
SKB geophysical borehole logging
Borehole KFM04A. Forsmark

Presentation

Filename:
KFM04A_Presentation_with_SP.wcl

Drawing no.:
6.1



Depth
1m:500m
CALIPER 3D
0°
CALIPER1
70 mm 150
CALIPER MEAN
70 mm 150
TRAVEL TIME
0° 90° 180° 270° 0°
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)
100 µS 1000
SPR
100 ohm 1000
RES(64N)
100 ohm-m 1000
RES(16N)
100 ohm-m 1000
RES(MG)
50 ohm-m 50000
RES(DG)
50 ohm-m 50000
LATERAL
50 ohm-m 50000
SP - UP
0 MV 800
SP - DOWN
0 mV 800
RES(FL)
0 ohm-m 2
TEMP(FL)
5 deg c 15
Azimuth MN
30 deg 55
DIP
-65 deg -40
110
115
120
125
130
135
140
145
150
155
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165
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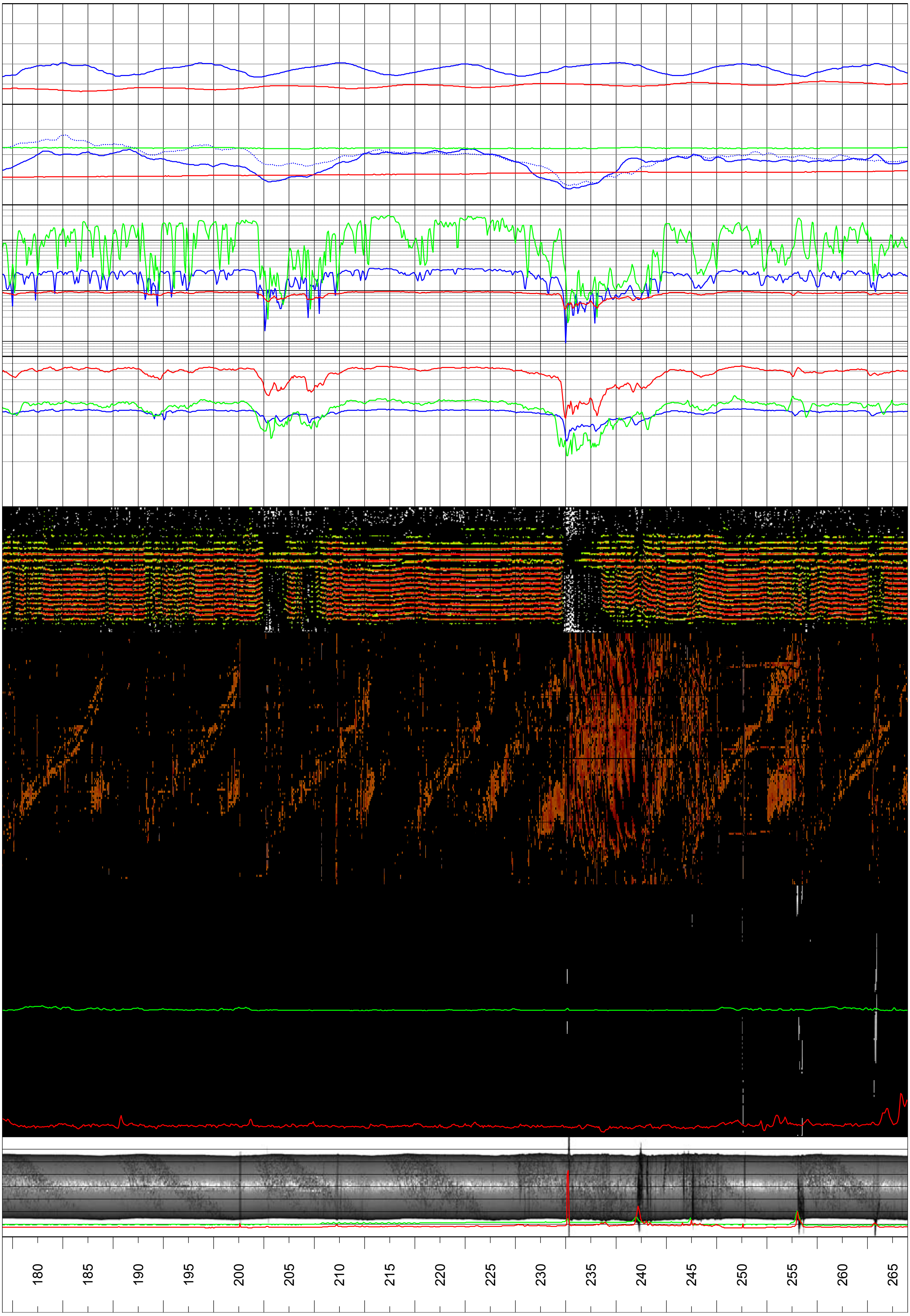
175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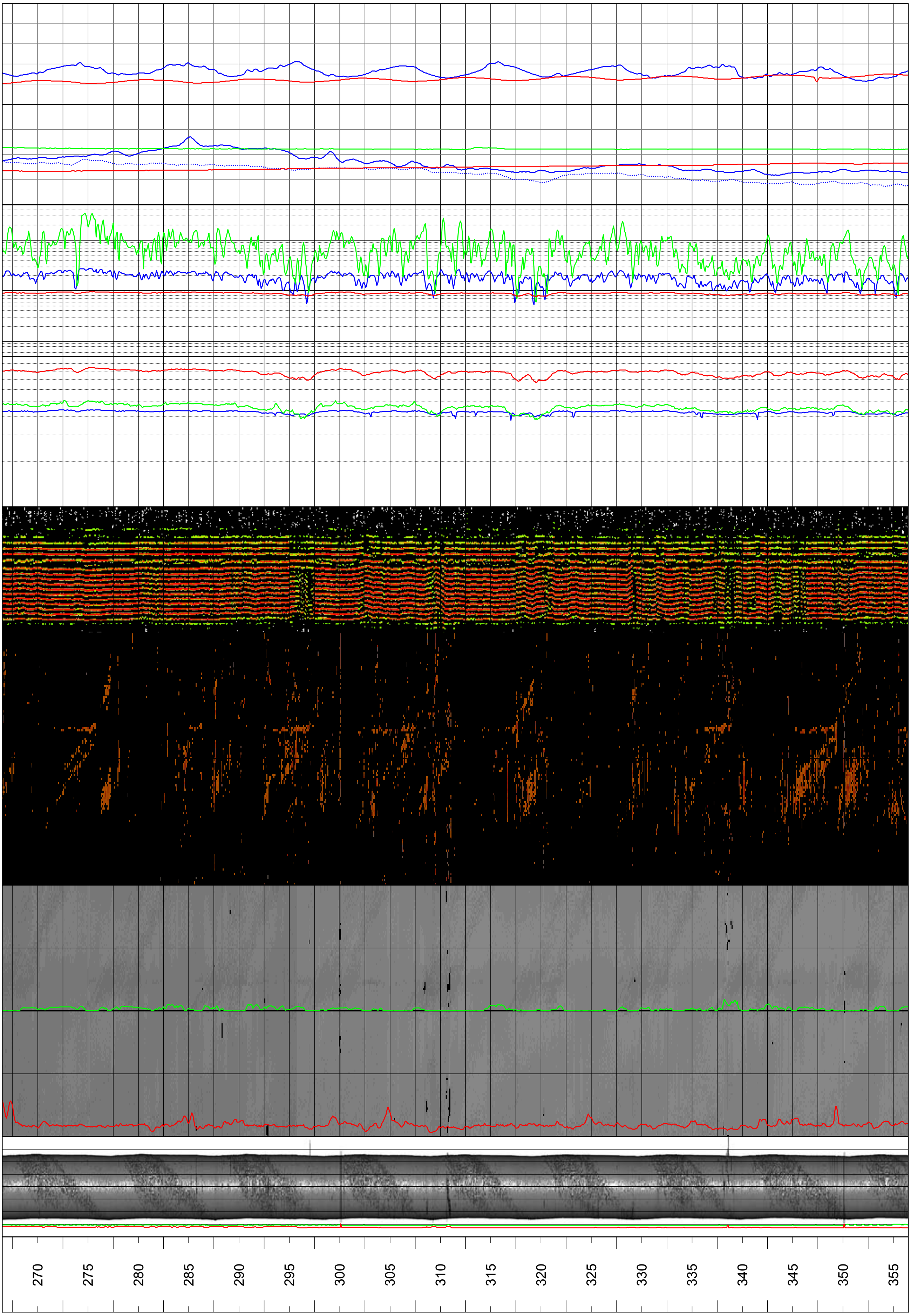
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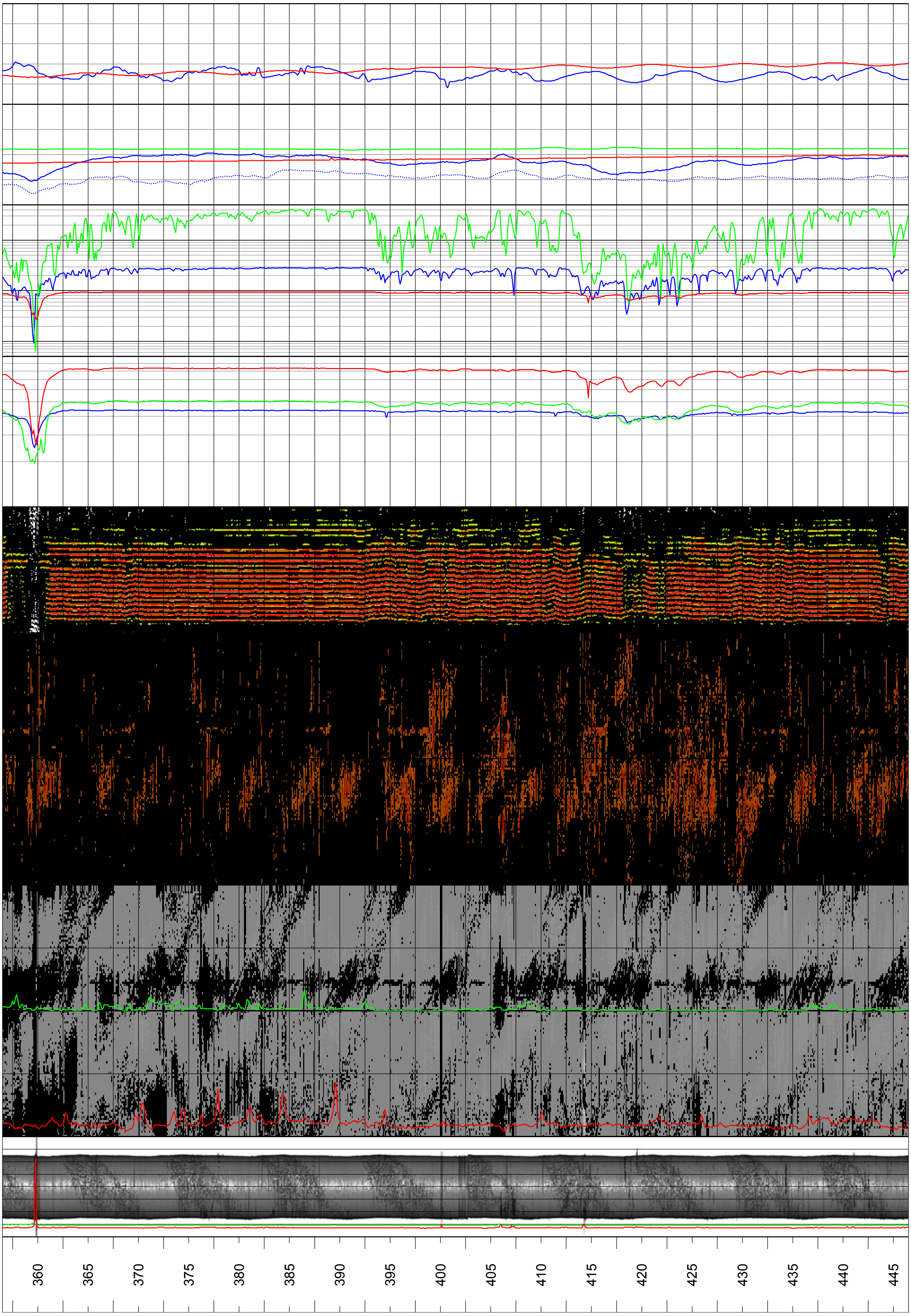
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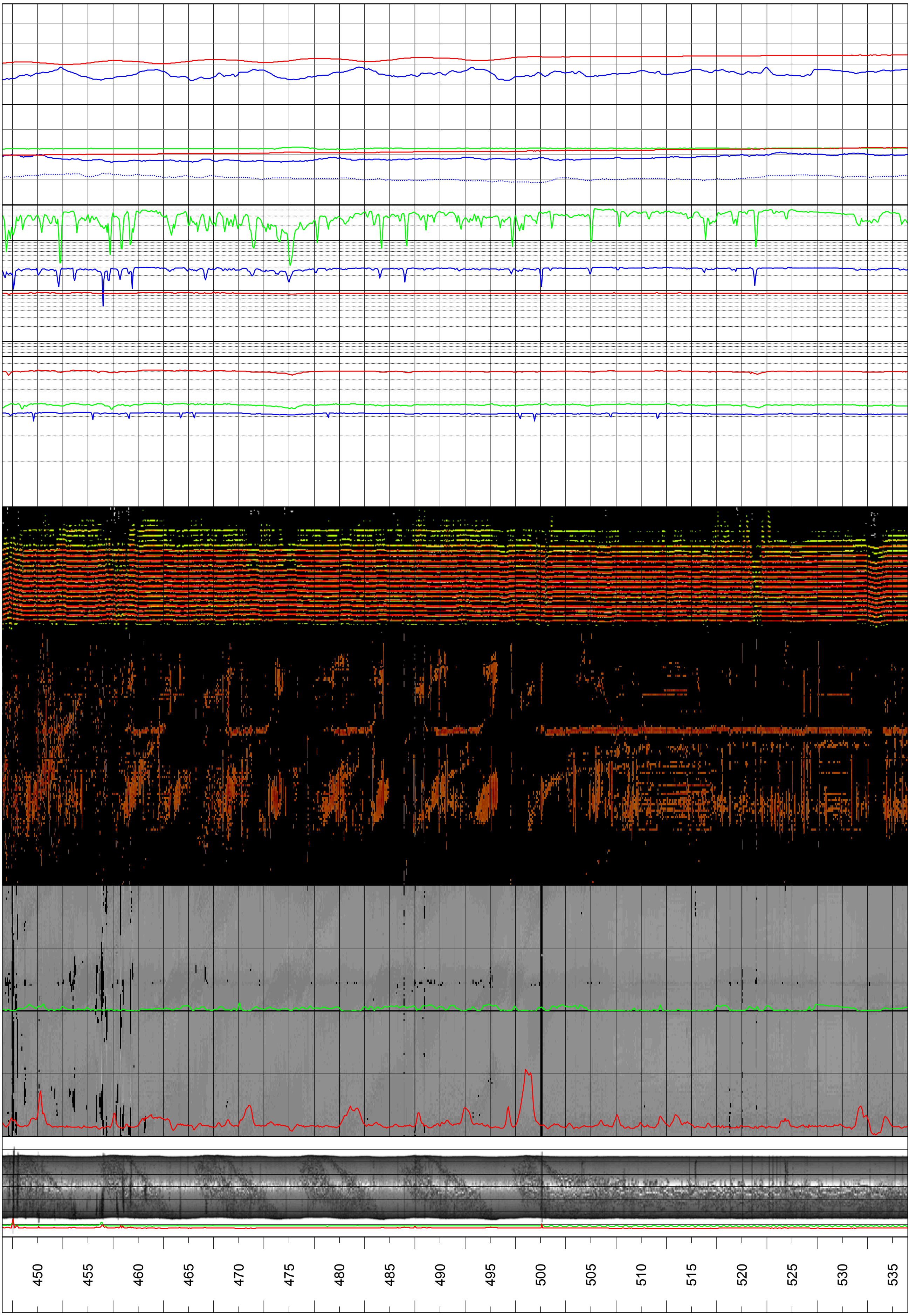
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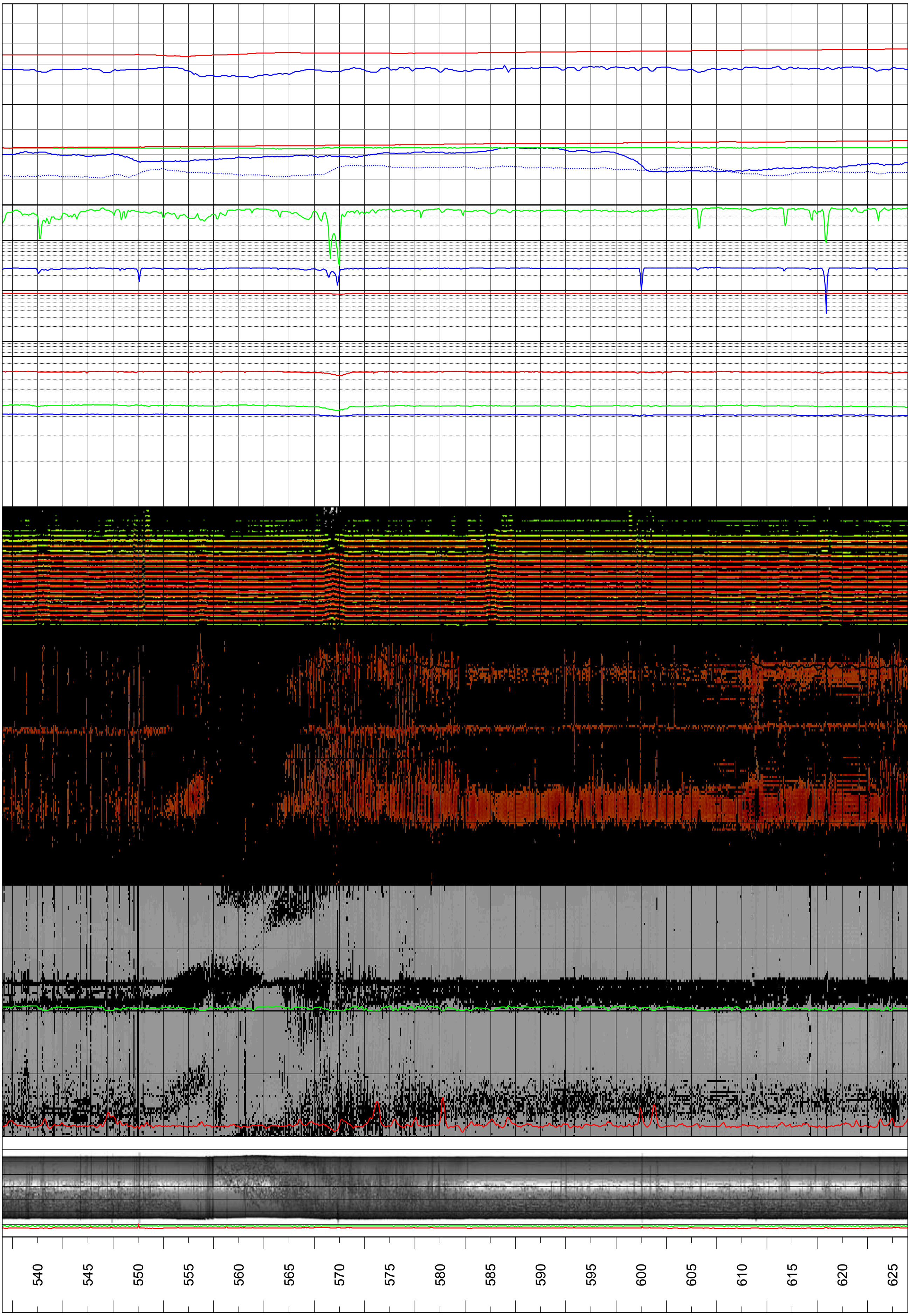
535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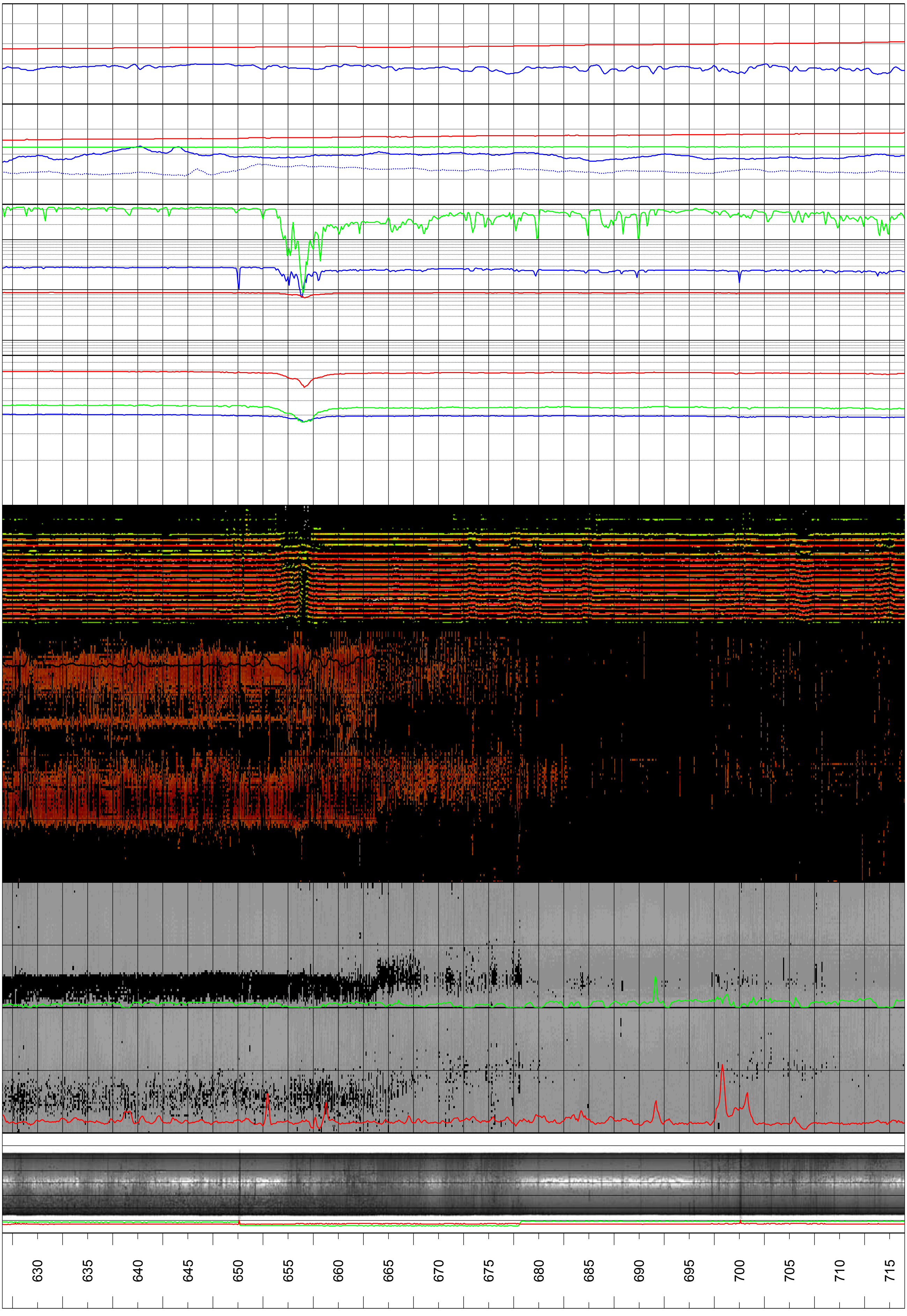
620
625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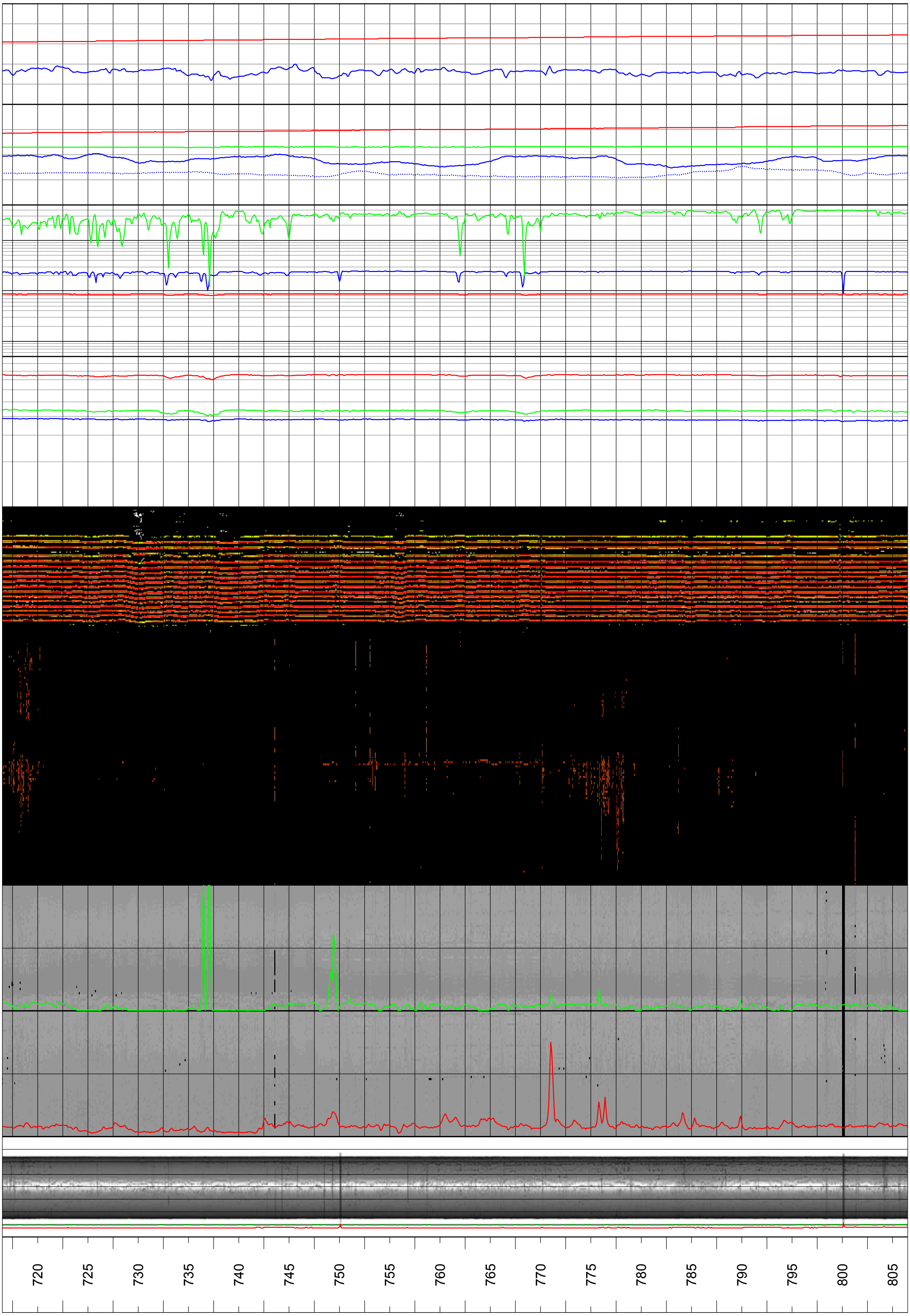
710
715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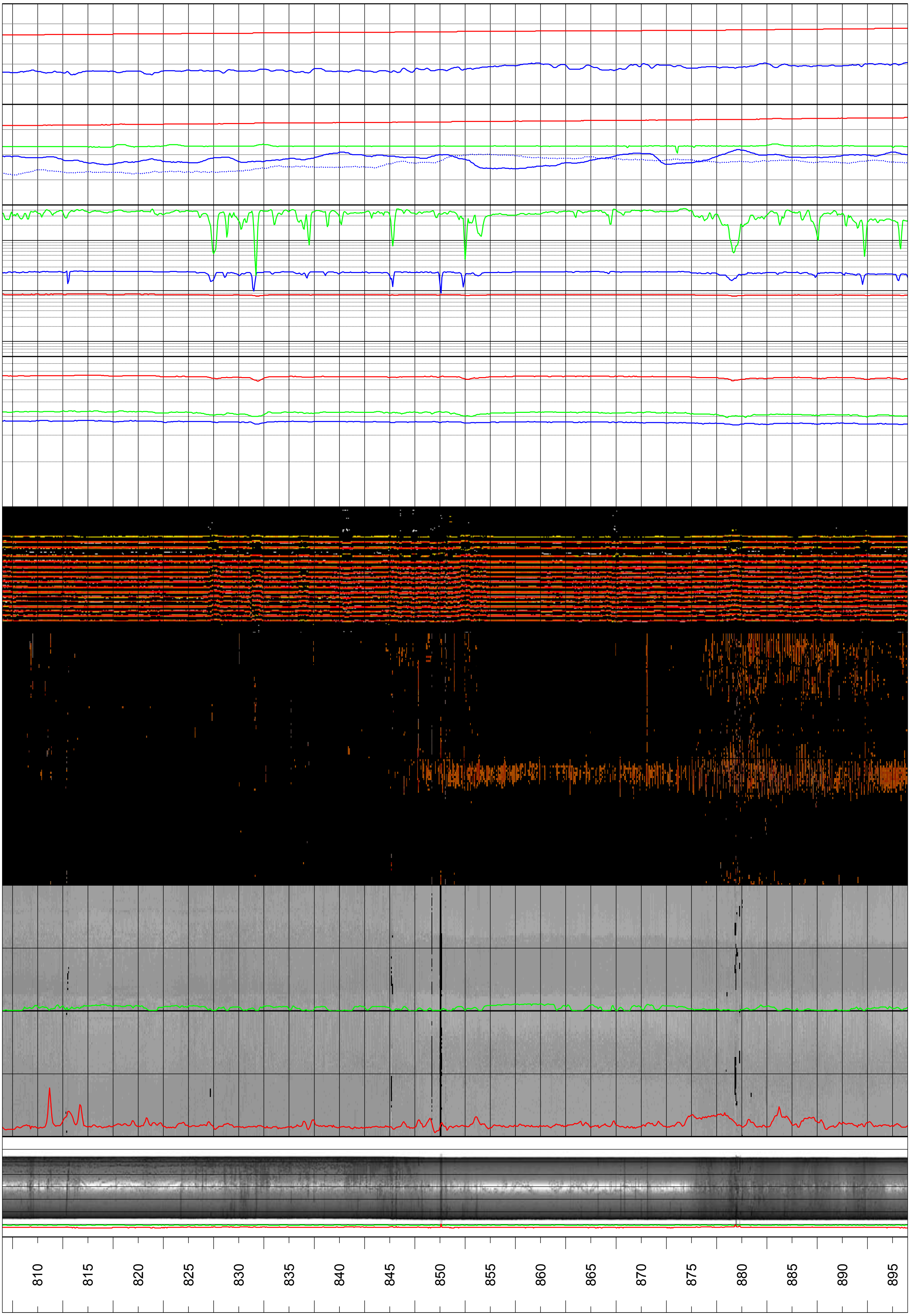
800
805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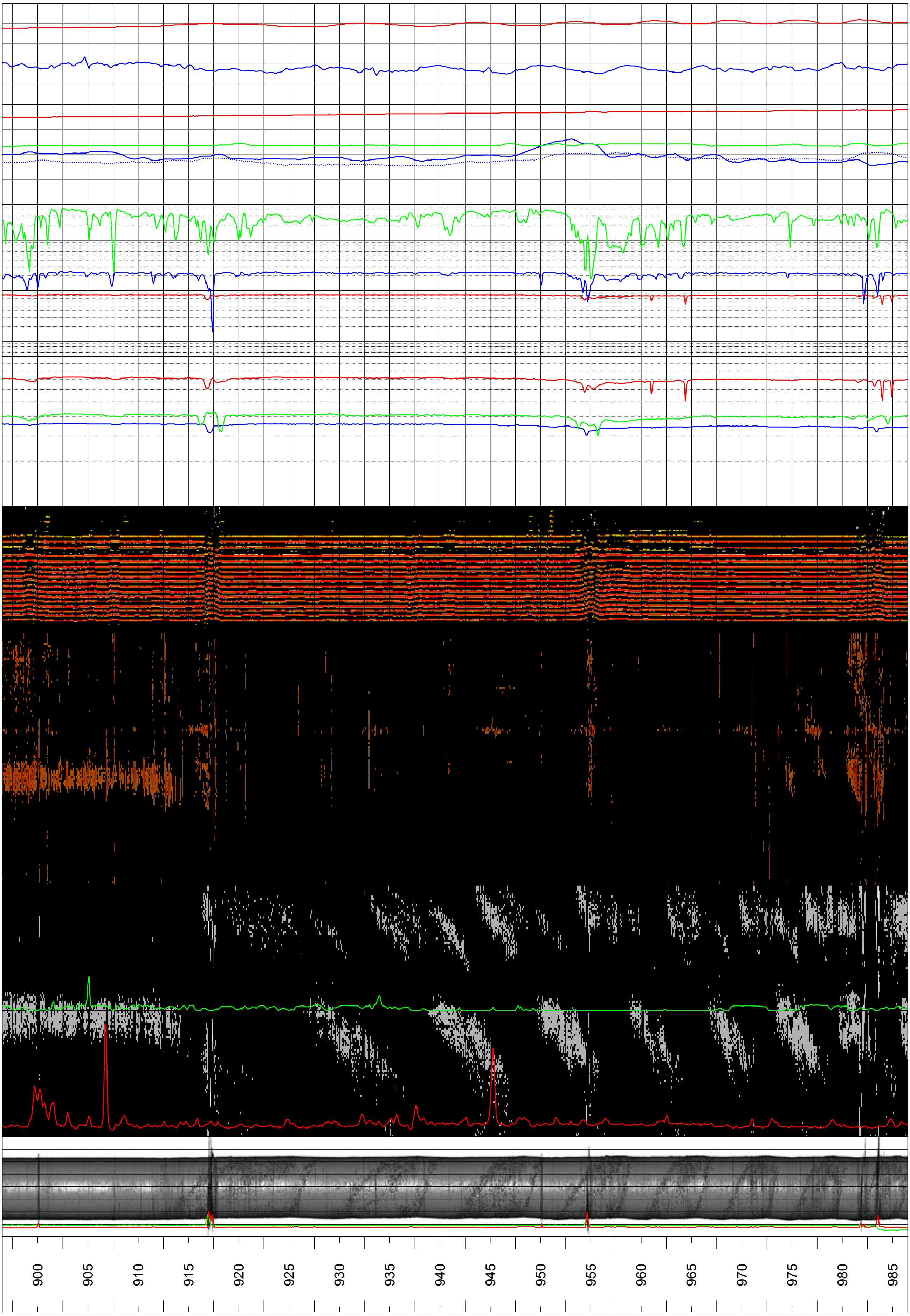
895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955
960
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970
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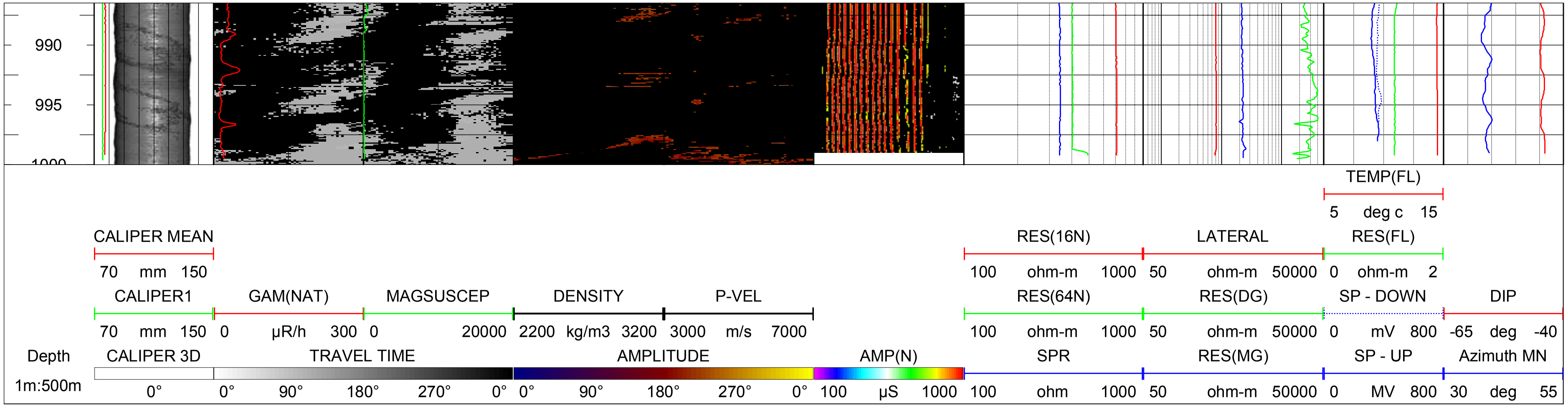
980
985



990
995
TEMP(FL)
5 deg c 15
CALIPER MEAN
70 mm 150
RES(16N)
100 ohm-m 1000
LATERAL
50 ohm-m 50000
RES(FL)
0 ohm-m 2
CALIPER1
70 mm 150
GAM(NAT)
0 μR/h 300
MAGSUSCEP
0 20000
DENSITY
2200 kg/m3 3200
P-VEL
3000 m/s 7000
RES(64N)
100 ohm-m 1000
RES(DG)
50 ohm-m 50000
SP - DOWN
0 mV 800
DIP
-65 deg -40
Depth
1m:500m
CALIPER 3D
0°
TRAVEL TIME
0° 90° 180° 270° 0°
AMPLITUDE
0° 90° 180° 270° 0°
AMP(N)
100 μS 1000
SPR
100 ohm 1000
RES(MG)
50 ohm-m 50000
SP - UP
0 MV 800
Azimuth MN
30 deg 55