P-04-240

Oskarshamn site investigation

Geophysical borehole logging in borehole HLX17, HLX18 and HLX19

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September 2004

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Keywords: Geophysical logging.

Summary

Geophysical borehole logging has been performed in boreholes HLX17, HLX18 and HLX19, situated in Laxemar, Oskarshamn, Sweden.

The objective of the surveys is to determine physical properties of the rock mass around the borehole in order to interpret rock types, quantify the fracture frequency and localise possible deformation zones in the rock. The geophysical logging is also used to measure changes in physical properties in the borehole fluid.

The logging in the holes was done between the lengths:

HLX17 0 to 202 m

HLX18 0 to 181 m

HLX19 0 to 202 m

The present report comprises a description of the equipment used, the performed logging program, the fieldwork, delivery of data and the results.

Sammanfattning

Geofysisk borrhålsloggning har utförts i borrhål HLX17, HLX18 och HLX19, vilka ligger i Laxemar, Oskarshamn, Sverige.

Syftet med loggningarna är att mäta bergets fysikaliska egenskaper för att kunna tolka bergarter, kvantifiera sprickfrekvensen och att lokalisera möjliga deformationszoner. Geofysisk loggning används även för att mäta borrhålsvätskans fysikaliska egenskaper.

Loggningen i hålen utfördes mellan längderna:

HLX17 0 till 202 m

HLX18 0 till 181 m

HLX19 0 till 202 m

Rapporten beskriver använd utrustning, genomfört loggningsprogram, fältarbete, dataleverans och erhållna resultat.

Contents

1 Introduction

This document reports the data gained in August 2004 in Laxemar, Oskarshamn. The geophysical borehole logging operations presented here include boreholes HLX17, HLX18 and HLX19.

All measurements were conducted by RAMBØLL during the period August 25 to 26, 2004 in accordance with the instructions and guidelines from SKB Activity plan AP PS 400-04-067. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB internal controlling documents.

All boreholes were recorded from Top Casing (TOC) to the bottom of the borehole. The technical data from the boreholes are shown in Table 1-2.

Table 1-1. Controlling documents for the performance of the activity.

Activity plan	Number	Version
Geophysical borehole logging in borehole HLX17, HLX18 and HLX19	AP PS 400-04-067	1.0
Method descriptions	**Number**	**Version**
Instruktion för rengöring av borrhålsutrustning och viss markbaserad utrustning..	SKB MD 600.004	1.0
Metodbeskrivning för krökningsmätning av hammar- och kärnborrhål..	SKB MD 224.001	1.0

Table 1-2. Technical data from core boreholes HLX17, HLX18 and HLX19.

Boreholes parameter	HLX17	HLX18	HLX19
Co-ordinates	6365951,51 N	6365919,12 N	6365757.87 N
(RT90)	1550040,75 E	1550067,64 E	1550090.86 E
Elevation	3,35 m	4,04 m	5.951 m
(RHB70)			
Azimuth (Bearing)	310,9°	135,9°	130,04 °
Inclination (from horizontal)	–59,05°	–57,6°	–57.89°
Length	202,2 m	181,2 m	202,2 m
Casing	0–8,94 m 168/160 mm	0–14,94 m 168/160 mm	0–11.94 m 168/160 mm
	8,94–9,03. 168/147 mm	14,94–15,03 168/147 mm	11.94–12.03 m 168/147 mm
Borehole diameter	190 mm (0–9,12 m)	190 mm (0–15,12 m)	190 mm (0–12,12 m)
	139 mm (9,12–202,2 m)	139 mm (15,12–181,2 m)	137 mm (12,12–202,2 m)
Cleaning level	Level 1	Level 1	Level 1

The locations of the boreholes are shown in Figure 1-1.

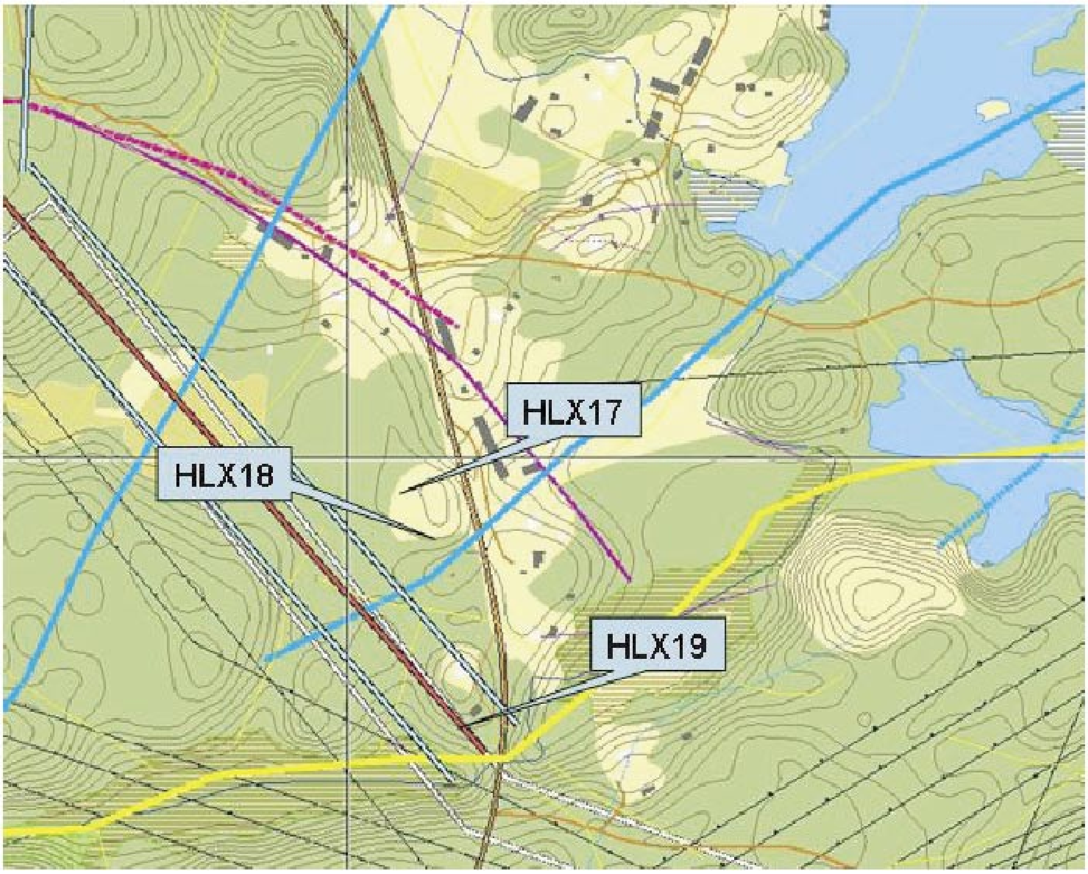

Figure 1-1. Location of HLX17, HLX18 and HLX19 in Laxemar subarea.

The data from the activity was stored in the SICADA database, see Table 1-3.

Table 1-3. Data references.

Subactivity	Database	Field note number
Geophysical logging in HLX17, HLX18 and HLX19	SICADA	FN 445

2 Objective and scope

The objective of the surveys is to both receive information of the borehole itself, and from the rock mass around the borehole. Geophysical borehole logging was used to measure changes in physical properties in the borehole fluid and the bedrock surrounding the boreholes. Optical televiewer was used for determination of the deviation of the borehole (azimuth and inclination).

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 1.1–1.3 for borehole HLX17, drawing no 2.1–2.3 for borehole HLX18 and drawing no 3.1–3.3 for borehole HLX19.

3 Equipment

The geophysical borehole logging program in all boreholes was performed with 6 multi tool probes and resulted in a suite of 17 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 in HLX17, HLX18 and HLX19.

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 and 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 and 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 25 110 004 OPTV Optical televiewer	360° RGB digital orientated optical image Borehole azimuth and dip.	260×5.8 cm		Centralized

4 Execution

In general the measurement procedures follow the SKB method description (MD 221.002, SKB internal controlling documents). The logging program in all boreholes was executed in the period August 25–26, 2004.

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 cleaned according to SKB cleaning level 1 (MD 600.004, SKB internal controlling documents) before arriving at the site.

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.

Optical televiewer was used for determination of the deviation of the borehole (azimuth and inclination) instead of the planned acoustic televiewer.

4.1 Nonconformities

No nonconformities have been reported.

5 Results

5.1 Presentation

All relevant logging events were described in the daily report sheet which was delivered separately. A functional test of the OPTV tool for deviations measurements was made prior to employing the tool, following the routines normally used for the HiRAT tool (SKB MD 224.001).

The logs have not been filtered during logging or presentation. The logs presented in drawing number 1.1 in Appendix 1 are listed in Table 5-1.

Table 5-1. Logs presented in drawings number 1.1, 2.1 and 3.1 in Appendix 1.

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
Magnetic susceptibility	MAGSUSCEP	SI*10^{-5}	8622
Caliper, 1-arm	CALIPER1	mm	9030
Gamma-gamma density	DENSITY	kg/m^3	9030
Focused guard log resistivity, 140 cm	RES(MG)	ohm-m	9030
Natural gamma	GAM(NAT)	µR/h	9030
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
Borehole azimuth magnetic north	AZIMUTH MN	deg	OPTV
Borehole Inclination from horizontal	DIP	deg	OPTV

5.2 Orientations, alignment and stretch of logs

5.2.1 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).

5.2.2 Stretch of logs

There is a minor difference in the used winch between up- and down runs in the depth registration. The size of this difference is about 1.5 m/km.

To compensate for this, the logs are stretched using gamma events from the down run of the 8044 tool. Gamma events from each tool are matched with the same gamma events from the 8044 tool and a new depth scale for the individual tools is created.

5.2.3 Removing of data

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

5.2.4 Repicking of sonic log

The sonic velocity is normally calculated using an automatic picking routine in the 9310 sonic tool. 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.
Borehole azimuth magnetic north	See 5.3.1
Borehole Inclination from lateral	See 5.3.1

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.

Model: IGRF2000

Latitude: 57 deg, 24 min, 58 sec

Longitude: 16 deg, 38 min, 16 sec

Elevation: 0.028 km

Date of Interest: 25/8/2004 and 26/8/2004

D(+ East)(deg)

3d 25m

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.

5.4 Borehole HLX17

Using the bottom of the casing and the natural gamma from the 8044 tool 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 5-3.

The complete log suite for borehole HLX17 is presented as composite log sheet in drawing number 1.1 in Appendix 1. The logs presented on drawing number 1.1 are listed in Table 5-1.

Table 5-3. Gamma events in borehole HLX17.

Events	Depths
Top event	11.93
Bottom event	186.35

5.5 Borehole HLX18

Using the bottom of the casing and the natural gamma from the 8044 tool 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 HLX18.

Events	Depths
Top event	16.8
Bottom event	163.6

The complete log suite for borehole HLX18 is presented as composite log sheet in drawing number 2.1 in Appendix 2. The logs presented on drawing number 2.1 are listed in Table 5-1.

5.6 Borehole HLX19

Using the bottom of the casing and the natural gamma from the 8044 tool 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 HLX19 is presented as composite log sheet in drawing number 3.1 in Appendix 3. The logs presented on drawing number 3.1 are listed in Table 5-1.

Table 5-5. Gamma events in borehole HLX19.

Events	Depths
Top event	9.7
Bottom event	162.1

6 Data delivery

Logging data from the measurements, recorded in Century and Robertson format, were delivered 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 processed files shown on the drawings have been delivered as WellCAD files, Table 6-2, and as excel files in SICADA format, Table 6-3. The different excel sheets (one for each log) in SICADA format are listed in Table 6-4.

All data has been entered into the SKB SICADA database under field note no 445.

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

Borehole	Probe	Log direction	WellCAD File	Description
HLX17	8044	Down	HLX17_08-26-04_09-15_8044C_.02_0.24_201.57_ORIG.log	Start Depth: 0.24 m. End Depth: 201.57 m
HLX17	8622	Up	HLX17_08-26-04_12-10_8622C_.02_1.19_202.38_ORIG.log	Start Depth: 202.38 m. End Depth: 1.19 m
HLX17	9030	Up	HLX17_08-26-04_11-36_9030CA_.02_1.39_202.48_ORIG.log	Start Depth: 202.48 m. End Depth: 1.39 m
HLX17	9072	Up	HLX17_08-26-04_10-10_9072C_.02_1.35_202.62_ORIG.log	Start Depth: 202.62 m. End Depth: 1.35 m
HLX17	9310	Up	HLX17_08-26-04_10-49_9310C2_.02_1.23_201.57_ORIG.log	Start Depth: 201.57 m. End Depth: 1.23 m
HLX17	DOPTV	Up	HLX17_DOPTV_360pixels_2mm_up_run2.HED	Start Depth: 200 m. End Depth: 0 m
HLX18	8044	Down	HLX18_08-25-04_16-25_8044C_.02_0.24_180.51_ORIG.log	Start Depth: 0.24 m. End Depth: 180.51 m
HLX18	8622	Up	HLX18_08-25-04_18-59_8622C_.02_1.07_181.27_ORIG.log	Start Depth: 181.27 m. End Depth: 1.07 m
HLX18	9030	Up	HLX18_08-25-04_17-49_9030CA_.02_1.29_181.23_ORIG.log	Start Depth: 181.23 m. End Depth: 1.29 m
HLX18	9072	Up	HLX18_08-25-04_17-07_9072C_.02_1.15_181.41_ORIG.log	Start Depth: 181.41 m. End Depth: 1.15 m
HLX18	9310	Up	HLX18_08-25-04_18-23_9310C2_.02_0.98_180.41_ORIG.log	Start Depth: 180.41 m. End Depth: 0.98 m
HLX18	DOPTV	Up	HLX18_DOPTV_360pixels_2mm_up_run2.HED	Start Depth: 179.34 m. End Depth: 0 m
HLX19	8044	Down	HLX19_08-26-04_14-20_8044C_.02_0.32_201.23_ORIG.log	Start Depth: 0.32 m. End Depth: 201.23 m
HLX19	8622	Up	HLX19_08-26-04_17-14_8622C_.02_1.23_201.77_ORIG.log	Start Depth: 201.77 m. End Depth: 1.23 m
HLX19	9030	Up	HLX19_08-26-04_16-02_9030CA_.02_1.63_201.93_ORIG.log	Start Depth: 201.93 m. End Depth: 1.63 m
HLX19	9072	Up	HLX19_08-26-04_16-40_9072C_.02_1.29_201.95_ORIG.log	Start Depth: 201.95 m. End Depth: 1.29 m
HLX19	9310	Up	HLX19_08-26-04_15-16_9310C2_.02_0.66_199.06_ORIG.log	Start Depth: 199.06 m. End Depth: 0.66 m
HLX19	DOPTV	Up	HLX19_DOPTV_360pixels_2mm_up_run2.HED	Start Depth: 200 m. End Depth: 0 m

Table 6-2. Drawing files in WellCad format.

Borehole	Drawing	WellCad file
HLX17	1.1	HLX17_Presentation.WCL
HLX17	1.2	HLX17_Deviation.WCL
HLX17	1.3	HLX17_Deviation.WCL
HLX18	2.1	HLX18_Presentation.WCL
HLX18	2.2	HLX18_Deviation.WCL
HLX18	2.3	HLX18_Deviation.WCL
HLX19	3.1	HLX19_Presentation.WCL
HLX19	3.2	HLX19_Deviation.WCL
HLX19	3.3	HLX19_Deviation.WCL

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

Borehole	Excel file
HLX17	HLX17_data.xls
HLX18	HLX18_data.xls
HLX19	HLX19_data.xls

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

Sheet	Other
Optical televiewer. Azimuth and DIP	
Focused resistivity 140 cm	
Focused resistivity 300 cm	
Fullwave sonic	column: v_velocity (shear wave), not interpreted from the recorded data
Caliper1	
Fluid resistivity	
Fluid Temperature	
Density	
Resistivity	
Natural gamma	
Self potential	
Single point resistivity	
Magnetic susceptibility	

Drawing No 1.1. HLX17. Borehole logs

Borehole No. HLX17

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

Northing: 6365951.51m Easting: 1550040.75m Elevation: 3.35m

Diameter:	139 mm
Reaming Diameter:	
Outer Casing:	168 mm
Inner Casing:	160 mm
Borehole Length:	202.2 m
Cone:	
Inclination at ground surface:	-59.5
Azimuth:	310.9
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	OPTV	deg
DIP	Borehole inclination from horizontal	OPTV	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

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0	2004-09-17	TVP	JRI	UTN

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Scale: 1:500

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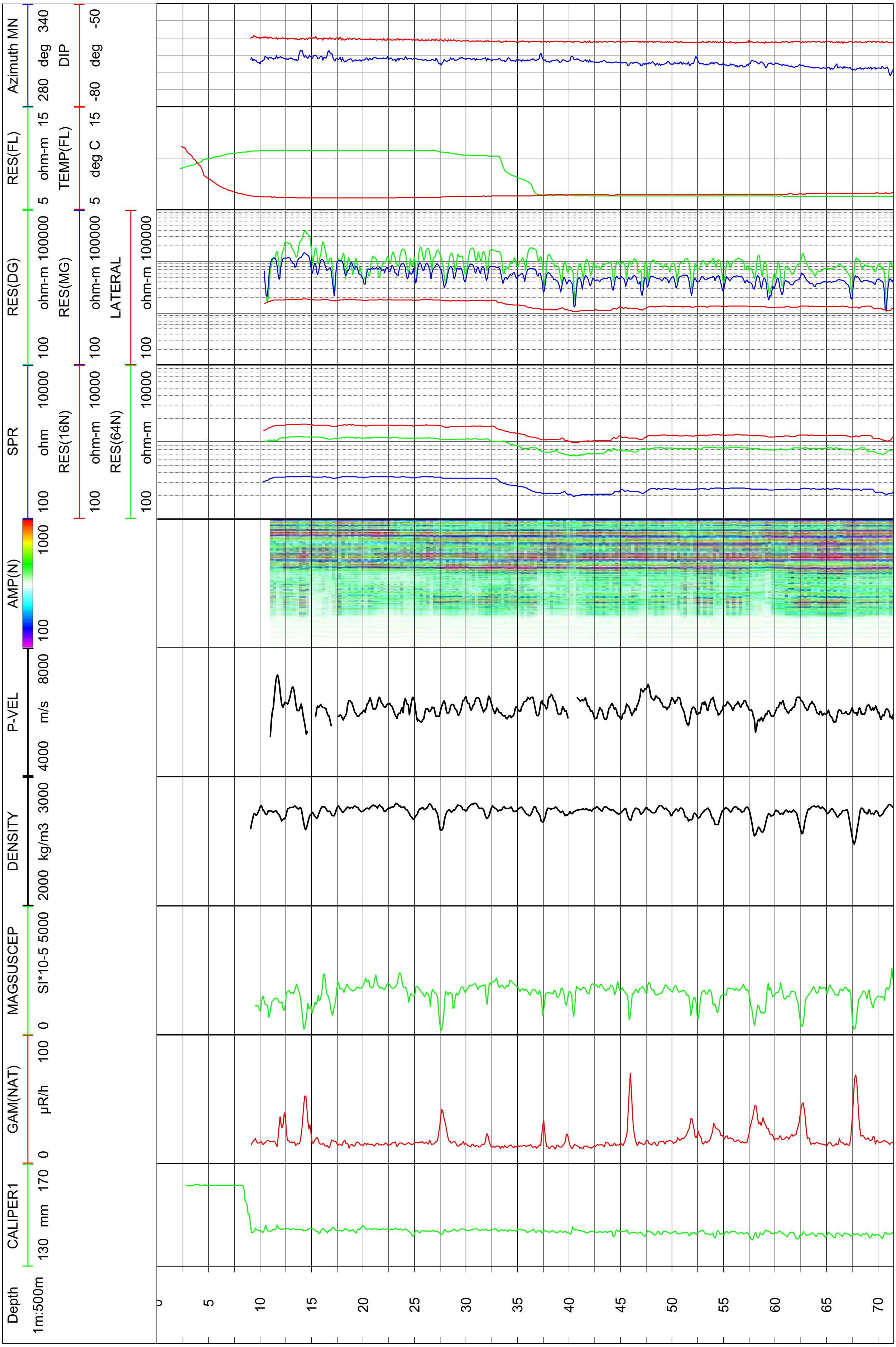
SKB geophysical borehole logging
Borehole HLX17

Presentation

Filename: HLX17_Presentation.wcl

Drawing no.: 1.1



Depth
1m:500m
CALIPER1
130 mm 170
GAM(NAT)
0 µR/h 100
MAGSUSCEP
0 SI*10-5 5000
DENSITY
2000 kg/m3 3000
P-VEL
4000 m/s 8000
AMP(N)
100 1000
SPR
100 ohm 10000
RES(16N)
100 ohm-m 10000
RES(64N)
100 ohm-m 10000
RES(DG)
100 ohm-m 100000
RES(MG)
100 ohm-m 100000
LATERAL
100 ohm-m 100000
RES(FL)
5 ohm-m 15
TEMP(FL)
5 deg C 15
Azimuth MN
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60
65
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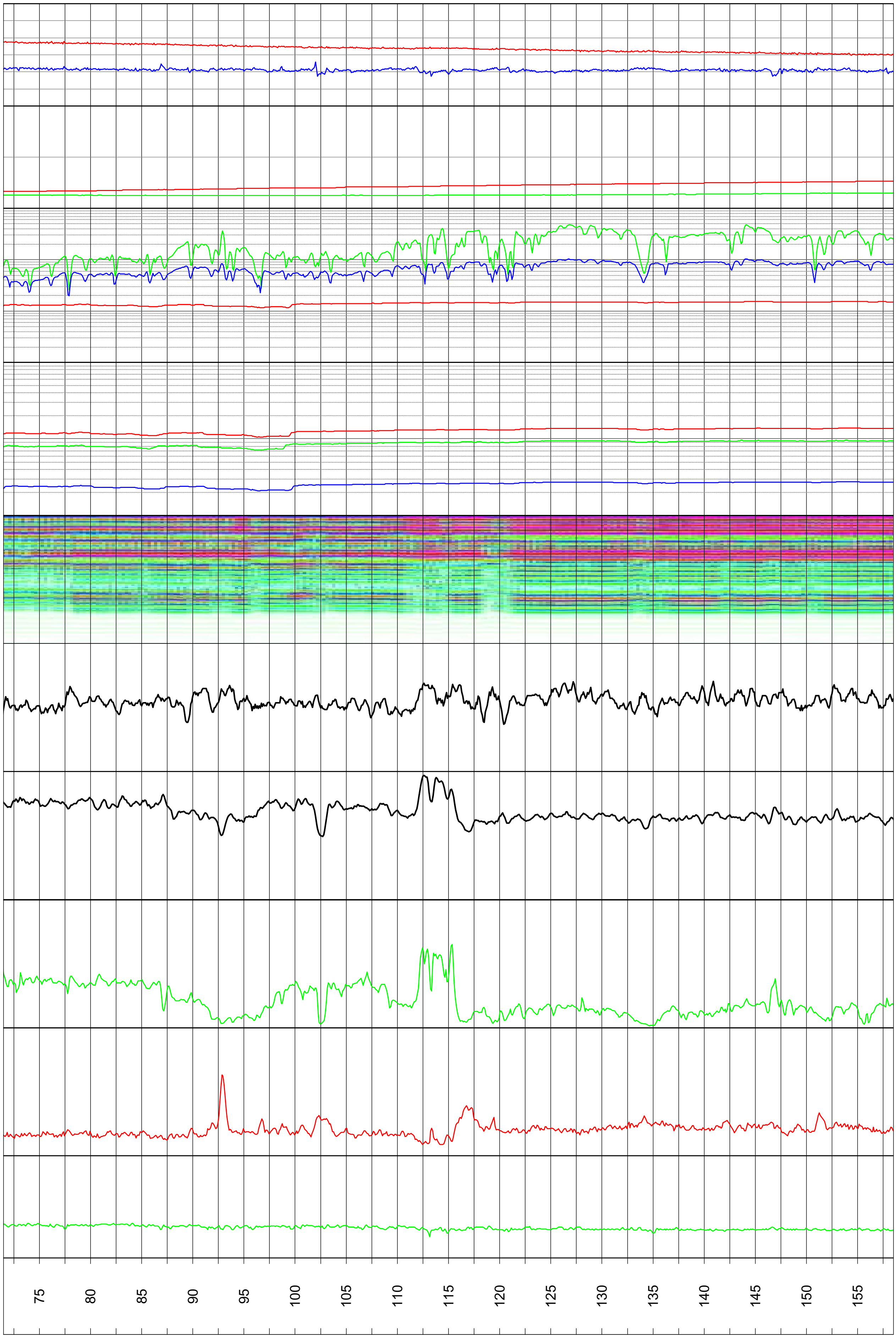
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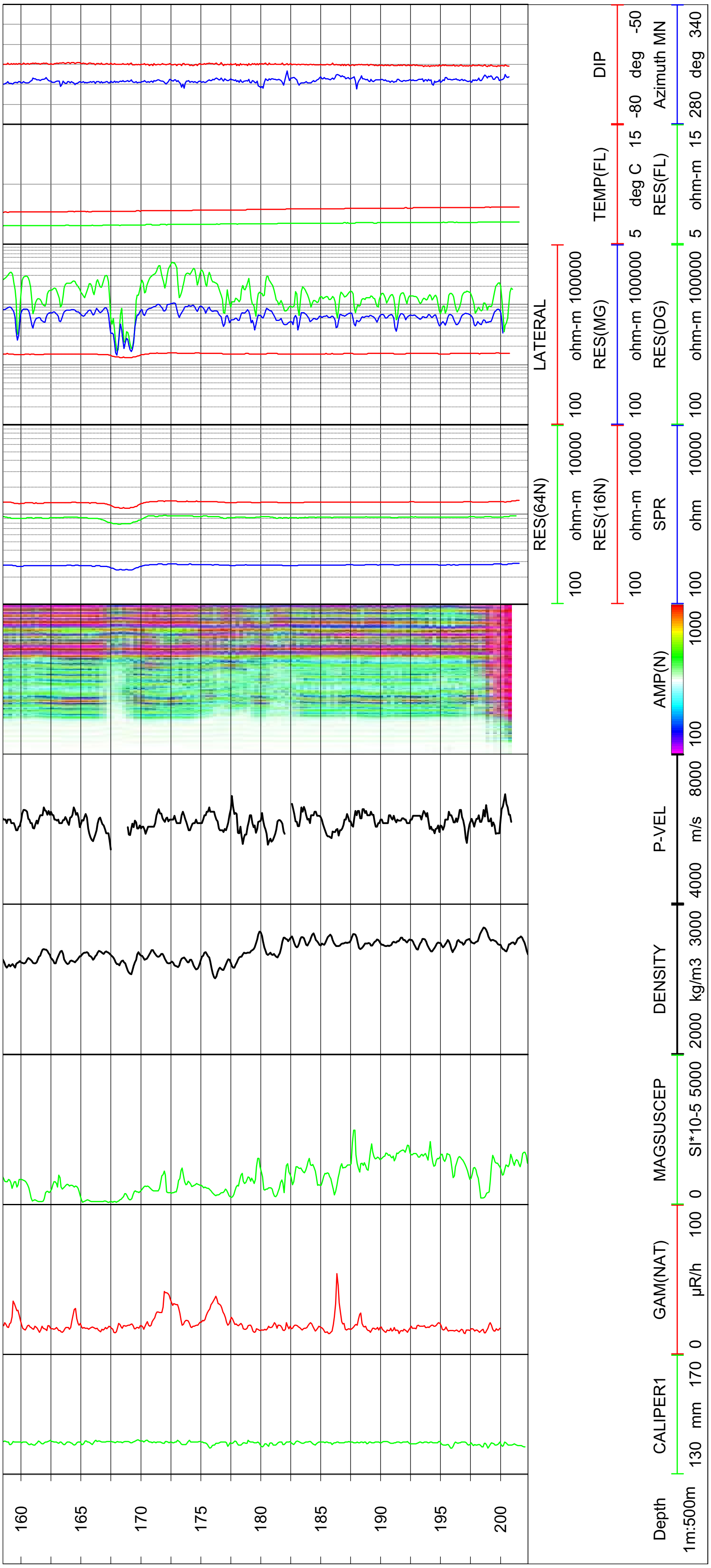
Depth
1m:500m
160
165
170
175
180
185
190
195
200
CALIPER1
130 mm 170
GAM(NAT)
0 µR/h 100
MAGSUSCEP
0 SI*10-5 5000
DENSITY
2000 kg/m3 3000
P-VEL
4000 m/s 8000
AMP(N)
100 1000
RES(64N)
100 ohm-m 10000
RES(16N)
100 ohm-m 10000
SPR
100 ohm 10000
LATERAL
100 ohm-m 100000
RES(MG)
100 ohm-m 100000
RES(DG)
100 ohm-m 100000
TEMP(FL)
5 deg C 15
RES(FL)
5 ohm-m 15
DIP
-80 deg -50
Azimuth MN
280 deg 340

Drawing No 2.1. HLX18. Borehole logs

Borehole No. HLX18

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

Northing: 6365919.12 Easting: 1550067.64 Elevation: 4.04

Diameter:	139
Reaming Diameter:	
Outer Casing:	168
Inner Casing:	160
Borehole Length:	181.2
Cone:	
Inclination at ground surface:	-57.6
Azimuth:	135.9
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	OPTV	deg
DIP	Borehole inclination from horizontal	OPTV	deg
TRAVEL TIME	360 degrees orientated acoustic travel time	HiRAT	100 ns
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent
RES(16N)	Normal resistivity 16 inch	8044	ohm-m
RES(64N)	Normal resistivity 64 inch	8044	ohm-m
LATERAL	Lateral resistivity	8044	ohm-m
SPR	Single point resistivity	8044	ohm

Rev.	Date	Drawn by	Control	Approved
0	2004-09-24	TVP	UTN	UTN

Job 360210A

Scale 1:500

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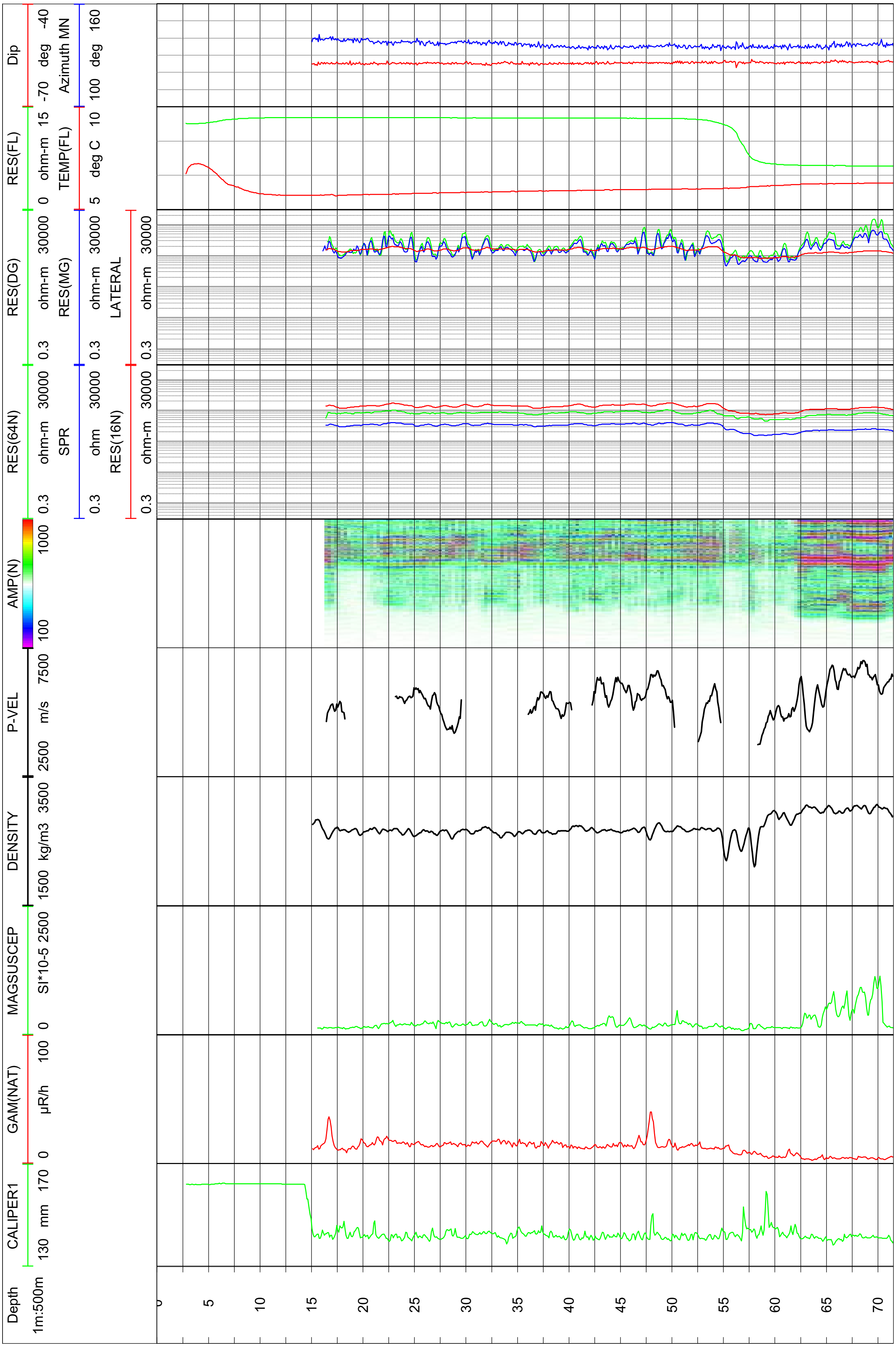
SKB geophysical borehole logging
Borehole HLX18

Presentation

Filename: HLX18_Presentation.wcl

Drawing no.: 2.1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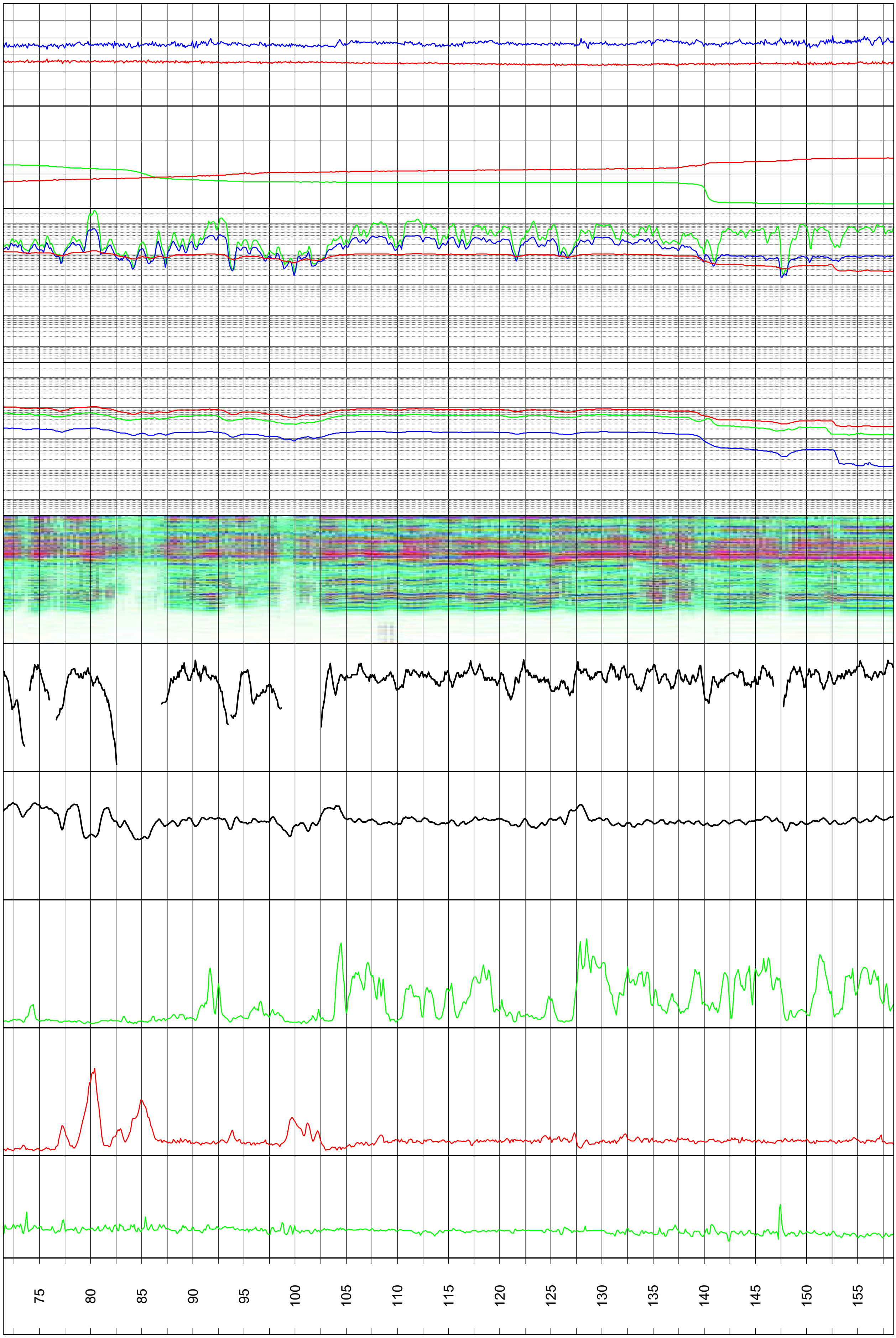
-70 deg -40
Azimuth MN
100 deg 160
RES(FL)
0 ohm-m 15
TEMP(FL)
5 deg C 10
RES(DG)
0.3 ohm-m 30000
RES(MG)
0.3 ohm-m 30000
LATERAL
0.3 ohm-m 30000
RES(64N)
0.3 ohm-m 30000
SPR
0.3 ohm 30000
RES(16N)
0.3 ohm-m 30000
AMP(N)
100 1000
P-VEL
2500 m/s 7500
DENSITY
1500 kg/m3 3500
MAGSUSCEP
0 SI*10-5 2500
GAM(NAT)
0 µR/h 100
CALIPER1
130 mm 170
Depth
1m:500m
5 10 15 20 25 30 35 40 45 50 55 60 65 70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80
85
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95
100
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110
115
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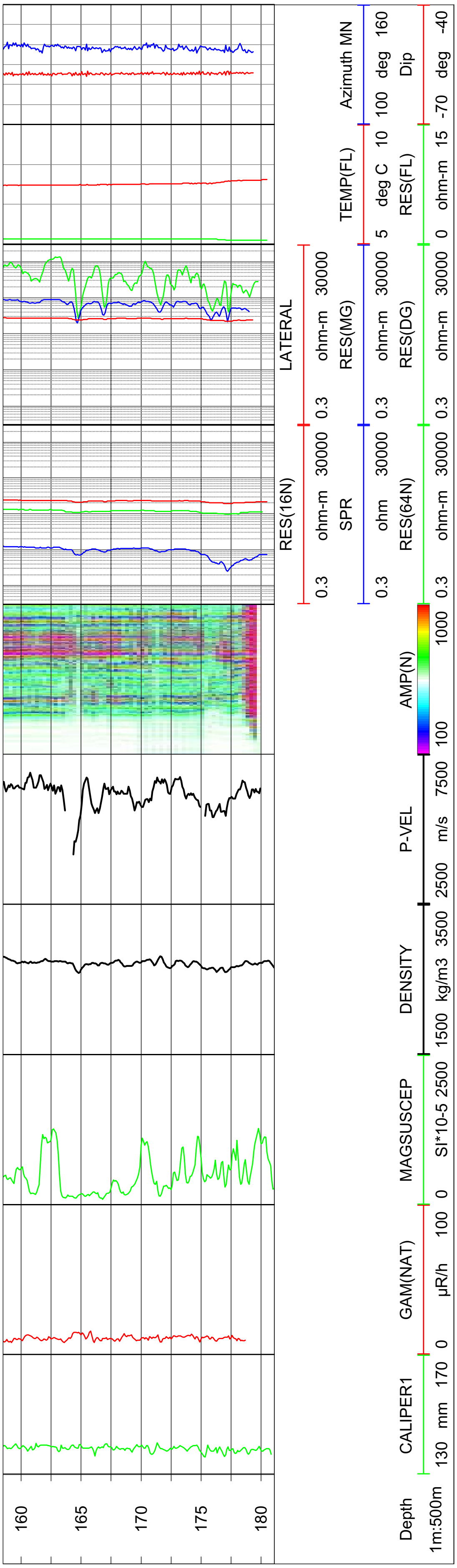
125
130
135
140
145
150
155


Depth
1m:500m
160
165
170
175
180
CALIPER1
130 mm 170
GAM(NAT)
0 µR/h 100
MAGSUSCEP
0 SI*10-5 2500
DENSITY
1500 kg/m3 3500
P-VEL
2500 m/s 7500
AMP(N)
100
1000
RES(16N)
0.3 ohm-m 30000
SPR
0.3 ohm 30000
RES(64N)
0.3 ohm-m 30000
LATERAL
0.3 ohm-m 30000
RES(MG)
0.3 ohm-m 30000
RES(DG)
0.3 ohm-m 30000
TEMP(FL)
5 deg C 10
RES(FL)
0 ohm-m 15
Azimuth MN
100 deg 160
Dip
-70 deg -40

Appendix 3

Drawing No 3.1. HLX19. Borehole logs

Borehole No. HLX19

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

Northing: 6365757.88m   Easting: 1550090.87m   Elevation: 5.95m

Diameter:	139 mm
Reaming Diameter:	
Outer Casing:	168mm
Inner Casing:	160mm
Borehole Length:	202.2m
Cone:	
Inclination at ground surface:	-57.9
Azimuth:	130.0
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	OPTV	deg
DIP	Borehole inclination from horizontal	OPTV	deg
TRAVEL TIME	360 degrees orientated acoustic travel time	HiRAT	100 ns
AMPLITUDE	360 degrees orientated acoustic amplitude	HiRAT	-
THORIUM	Spectral gamma, Thorium component	9080	PPM
URANIUM	Spectral gamma, Uranium component	9080	PPM
POTASSIUM	Spectral gamma, Potassium component	9080	percent
RES(16N)	Normal resistivity 16 inch	8044	ohm-m
RES(64N)	Normal resistivity 64 inch	8044	ohm-m
LATERAL	Lateral resistivity	8044	ohm-m
SPR	Single point resistivity	8044	ohm

Rev.	Date	Drawn by	Control	Approved
0	2004-09-28	TVP	UTN	UTN

Job: 360210A   Scale: 1:500

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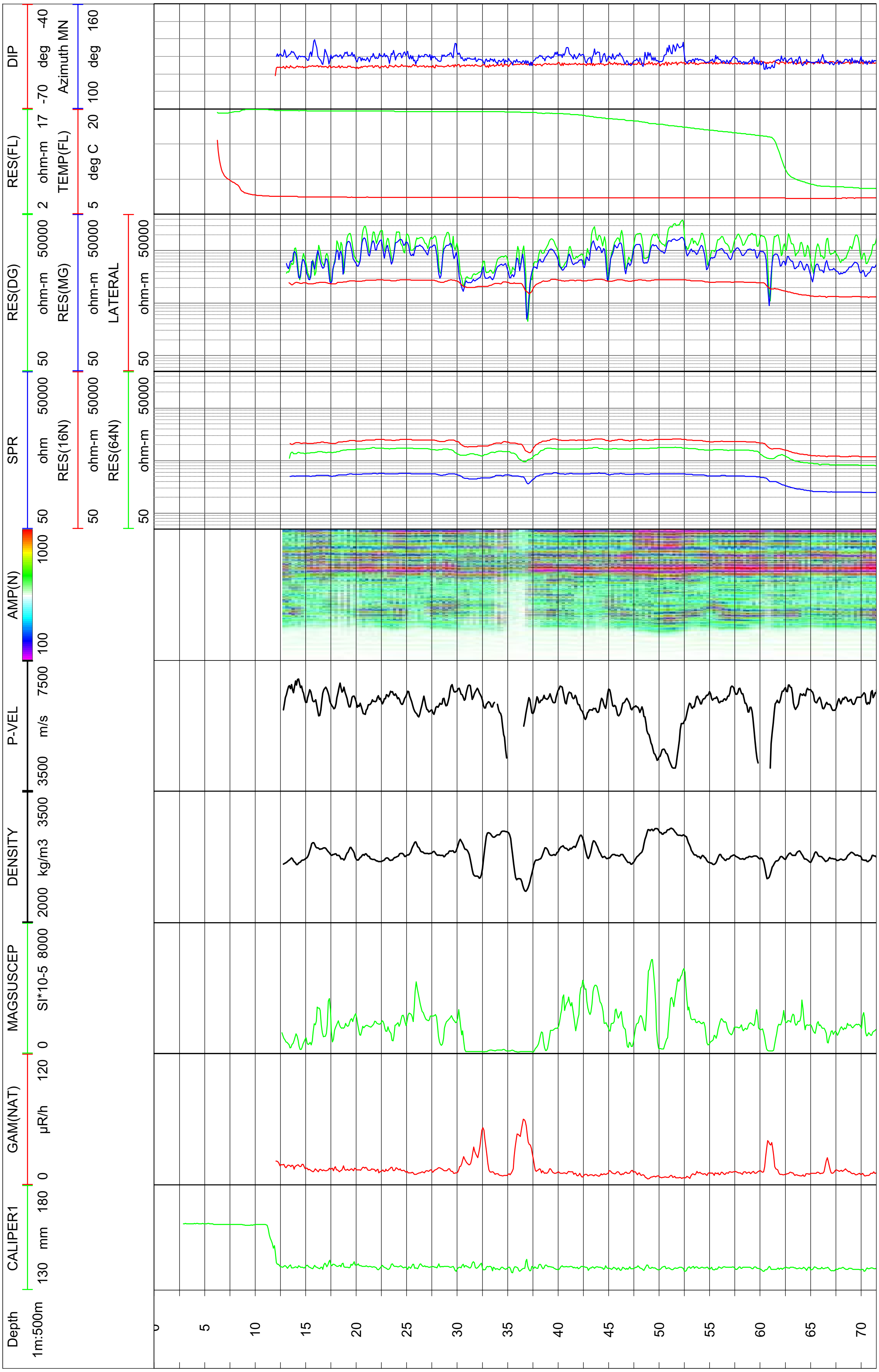
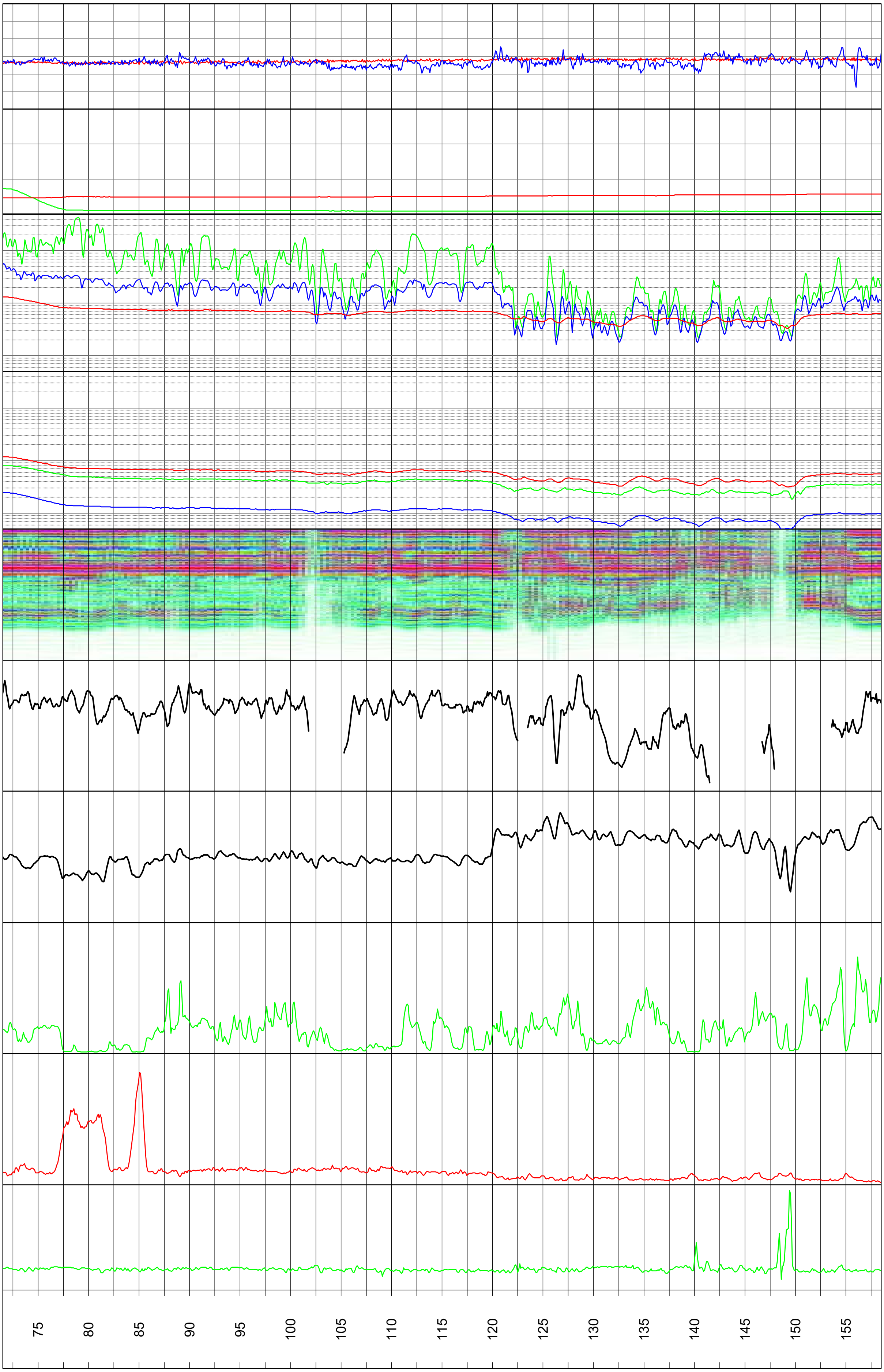
SKB geophysical borehole logging
Borehole HLX19

Presentation

Filename: HLX19_Presentation.wcl

Drawing no.: **3.1**


Depth
1m:500m
5 10 15 20 25 30 35 40 45 50 55 60 65 70
CALIPER1
130 mm 180
GAM(NAT)
0 µR/h 120
MAGSUSCEP
0 SI*10-5 8000
DENSITY
2000 kg/m3 3500
P-VEL
3500 m/s 7500
AMP(N)
100 1000
SPR
50 ohm 50000
RES(16N)
50 ohm-m 50000
RES(64N)
50 ohm-m 50000
RES(DG)
50 ohm-m 50000
RES(MG)
50 ohm-m 50000
LATERAL
50 ohm-m 50000
RES(FL)
2 ohm-m 17
TEMP(FL)
5 deg C 20
DIP
-70 deg -40
Azimuth MN
100 deg 160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80
85
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95
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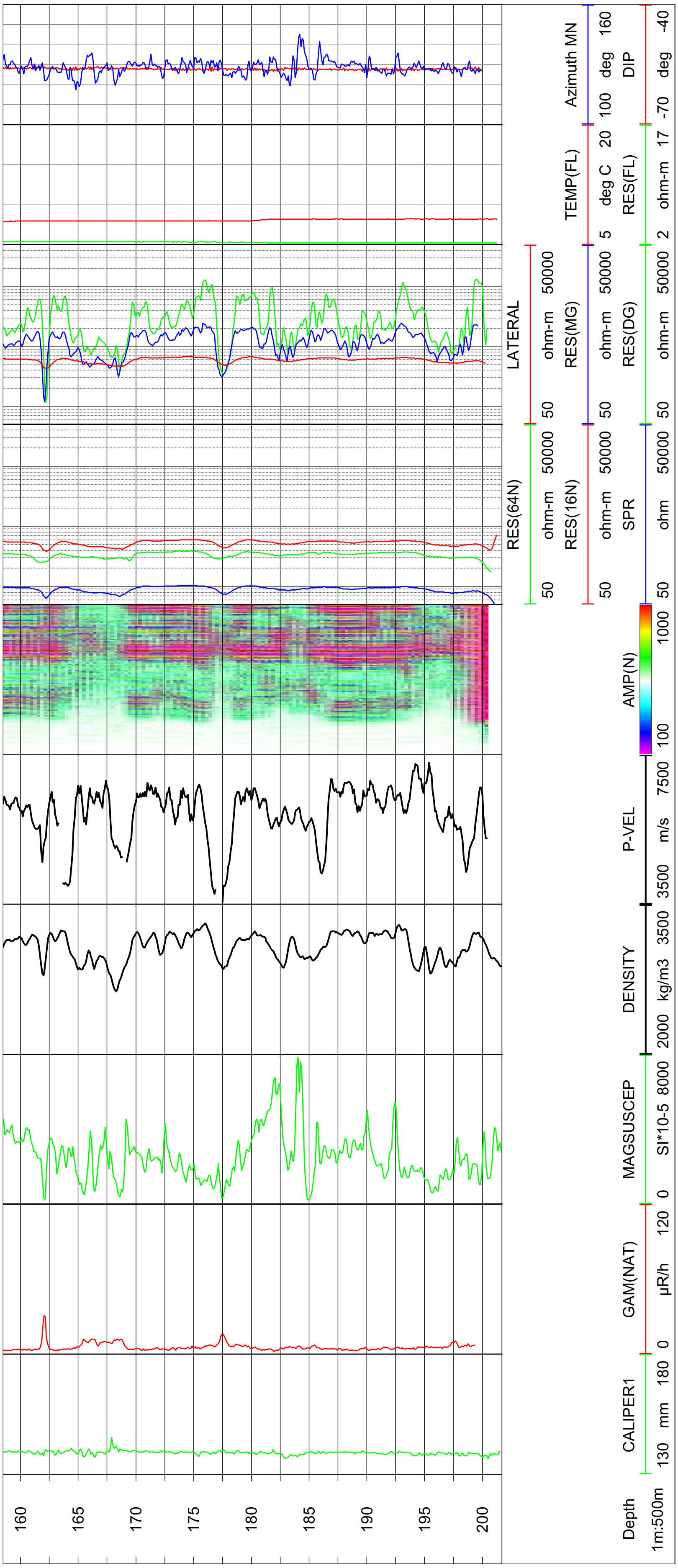
105
110
115
120
125
130
135
140
145
150
155


Depth
1m:500m
160
165
170
175
180
185
190
195
200
CALIPER1
130 mm 180
GAM(NAT)
0 µR/h 120
MAGSUSCEP
0 SI*10-5 8000
DENSITY
2000 kg/m3 3500
P-VEL
3500 m/s 7500
AMP(N)
100 1000
RES(64N)
50 ohm-m 50000
RES(16N)
50 ohm-m 50000
SPR
50 ohm 50000
LATERAL
50 ohm-m 50000
RES(MG)
50 ohm-m 50000
RES(DG)
50 ohm-m 50000
TEMP(FL)
5 deg C 20
RES(FL)
2 ohm-m 17
Azimuth MN
100 deg 160
DIP
-70 deg -40