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Äspö Hard Rock Laboratory

BIPS, radar and Flexit in KA2051A01, KA3007A01, KJ0044F01 and KJ0050F01

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Keywords: BIPS, RAMAC, Radar, TV, Deviation logging, Flexit.

Abstract

This report includes the data gained in geophysical logging operations performed within the extension of the Äspö HRL. The logging operations presented here includes BIPS in the core-drilled boreholes KA2051A01, KA3007A01, KJ0044F01 and KJ0050F01. The borehole radar (RAMAC) and Flexit deviation survey are performed in KA2051A01, KA3007A01 and KJ0050F01.

All measurements were conducted by Malå Geoscience AB in June 2011.

The objective of the radar surveys is to achieve information on the rock mass around the borehole. Borehole radar is used to investigate the nature and the structure of the rock mass enclosing the boreholes.

The objective of the BIPS logging is to achieve information of the borehole including occurrence of rock types as well as determination of fracture distribution and orientation.

The objective of the deviation measurement is to achieve information on borehole coordinates as well as dip and azimuth along the borehole length.

This report describes the equipment used as well as the measurement procedures and data gained. For the BIPS surveys, the results are presented as images. Radar data is presented in radargrams and the identified reflectors are listed.

The borehole radar data quality from KA2051A01, KA3007A01 and KJ0050F01 is relatively good. It is mainly the conductive formation water that makes the radar wave to attenuate, which decreases the penetration and reduces the ability for the radar to identify structures.

The borehole radar measurements resulted in KA2051A01 in 7 identified radar reflectors. Corresponding figures for KA3007A01 are 8 and for KJ0050F01 2 identified reflectors.

The basic conditions of the BIPS logging for geological mapping and orientation of structures are satisfying for the boreholes in this project, although induced affects from the drilling on the borehole walls limit the visibility.

The deviation survey with the Flexit system is presented as list of data including positioning and other sensor data from the system for every 3 metre along the boreholes.

Sammanfattning

Denna rapport omfattar geofysiska loggningar inom Äspö Utbyggnadsprojekt. Mätningarna som presenteras här omfattar borrhålsradarmätningar (RAMAC), BIPS-loggningar och Flexit avvikelsemätningar. Alla mätningar är utförda av Malå Geoscience AB under juni 2011.

Syftet med radarmätningarna är att samla information om bergmassan runt borrhålet. Borrhålsradar används till att karakterisera bergets egenskaper och strukturer i bergmassan närmast borrhålet.

Syftet med BIPS-loggningen är att skaffa information om borrhålet inkluderande förekommande bergarter och bestämning av sprickors fördelning och deras orientering.

Syftet med krökningsmätningarna är att mäta lutning och riktning och därmed få fram koordinater för punkter längs med borrhålet.

Rapporten beskriver utrustningen som använts liksom mätprocedurer och en beskrivning och tolkning av data som erhållits. För BIPS-loggningen presenteras data som plottar längs med borrhålet. Radardata presenteras i radargram och en lista över tolkade radarreflektorer ges. Krökningsmätningen presenteras som en lista med lägesdata.

Borrhålsradardata från KA2051A01, KA3007A01 and KJ0050F01 var relativt bra. Det är främst det konduktiva formationsvattnet som reducerar penetrationen och därmed minskar möjligheterna att identifiera strukturer. Totalt har 7 radarreflektorer identifierats i KA2051A01. Motsvarande siffror för KA3007A011 är 8 och för KJ0050F01 2 identifierade reflektorer (ej orienterade).

BIPS-bilderna visar att förutsättningarna för geologisk kartering och sprickorientering är goda för samtliga borrhål, även om det finns svärtningar på borrhålsväggen som försämrar kvalitén på bilderna.

Avvikelsemätningen med Flexit systemet presenteras som en lista med lägesdata och annan sensorinformation för varje 3 meter längs borrhålen.

Contents

1 Introduction

This report presents the data gained in geophysical logging operations, which is one of the activities performed within the extension of the Äspö HRL. The logging operations presented here includes borehole radar (RAMAC), BIPS and Flexit deviation measurements.

The work was carried out in accordance with activity plan AP TUDP002-11-017. In Table 1-1 the controlling documents for performing this activity are listed. Both the activity plan and method descriptions are SKB's internal controlling documents.

This report includes measurements in the boreholes listed in Table 1-2.

All measurements were conducted by Malå Geoscience AB in-between 8 and 20 June 2011. The investigation site and location of the borehole are shown in Figure 1-1.

The used investigation techniques comprised:

- Borehole radar measurements (Malå Geoscience AB's RAMAC system) with dipole and directional radar antennas
- Borehole TV logging with the so-called BIP-system (Borehole Image Processing System), which is a high resolution, side viewing, colour borehole TV system
- Borehole deviation equipment (Flexit SmartTool from Flexit AB), measuring azimuth, inclination (dip), tool face (gravity and magnetic) and magnetic dip.

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

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

Activity plan	**Number**	**Version**
Äspö utbyggnad, DP1-Karakterisering-BIPS, radar och Flexit av KA2051A01, KA3007A01 samt BH3	AP TD TUDP002-11-017	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för TV-loggning med BIPS	SKB MD 222.006	2.0
Metodbeskrivning för borrhålsradar	SKB MD 252.020	4.0
Metodbeskrivning för krökningsmätning av hammar- och kärnborrhål	SKB MD 224.001	3.0
Metodinstruktion för rengöring av borrhålsutrustning och viss markbaserad utrustning	SKB MD 600.004	1.0

Table 1-2. Technical data for the boreholes and performed surveys.

Performed surveys	**KA2051A01**	**KA3007A01**	**KJ0044F01**	**KJ0050F01**
BIPS	X	X	X	X
Radar 20MHz dipol	X	X		X
Radar directional	X	X		X
Flexit deviation survey	X	X		X
Borehole parameter				
Inclination at TOC	–35.01	–14.35	–4.22	–4.8
Bearing at TOC	86.62	22.16	78.05	52.17
Length (m)	319.84	227.76	17.26	46.79
Casing (m)	3.10	3.04	2.17	2.22
Borehole diameter (mm)	76.0	75.8	116.0	75.0

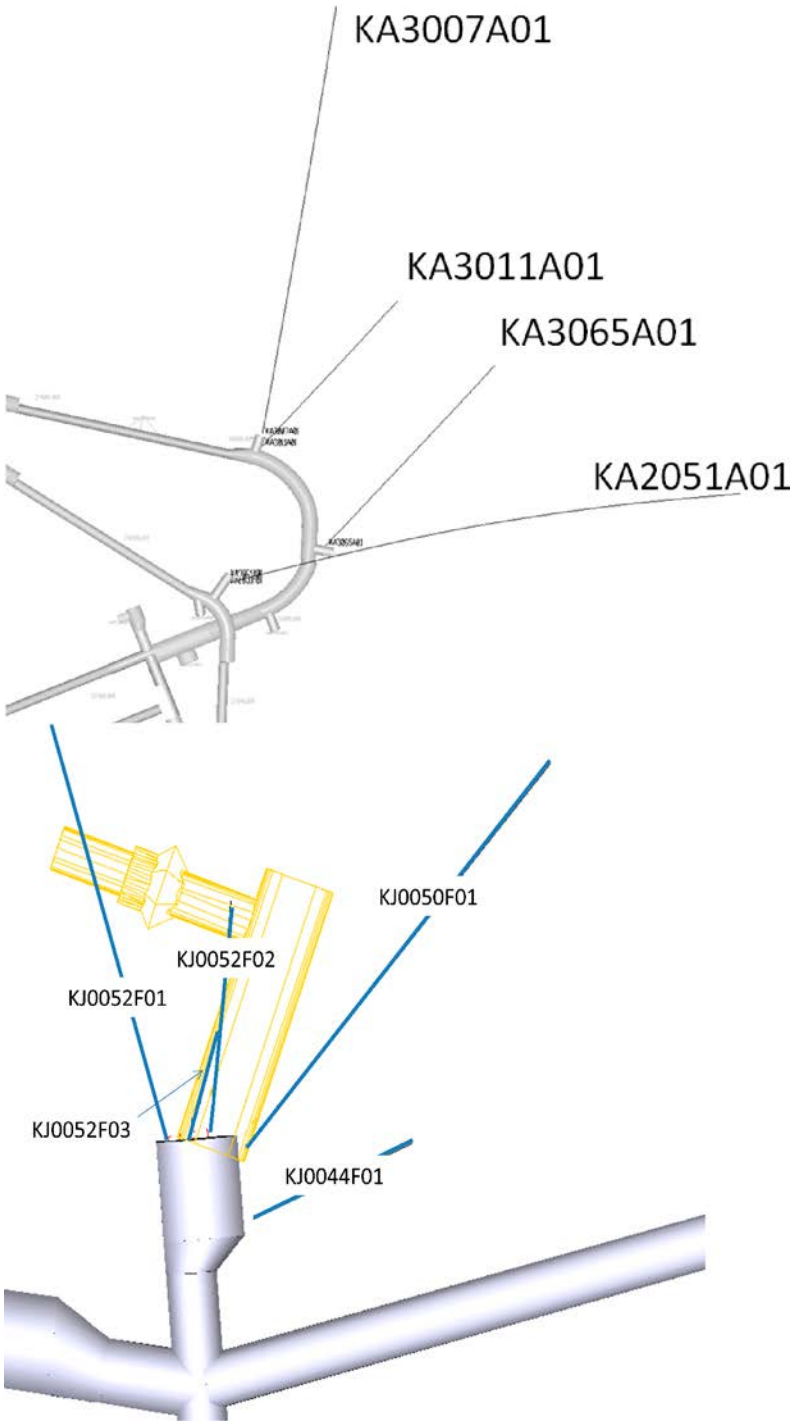


Figure 1-1. *Map of the location of the boreholes at Äspö HRL. Location of boreholes KA2051A01 and KA3007A01 above and location of borehole KJ0050F01 below.*

2 Objective and scope

The objective of the radar and BIPS surveys is to achieve information on the borehole conditions (borehole wall) as well as on the rock mass around the borehole. Borehole radar is engaged to investigate the nature and the structure of the rock mass enclosing the boreholes, and borehole TV for geological surveying of the borehole including determination of rock types as well as fracture distribution and orientation.

The objective of deviation logging is to achieve information of the borehole coordinates as well as dip and azimuth along the entire borehole length.

This report describes the equipment used for the radar, BIPS and deviation surveys as well as the measurement procedures and data gained. For the BIPS survey, the result is presented as images. Radar data is presented in radargrams and the identified reflectors are listed. The deviation measurements are presented as lists of data (coordinates etc).

3 Equipment

3.1 Radar measurements RAMAC

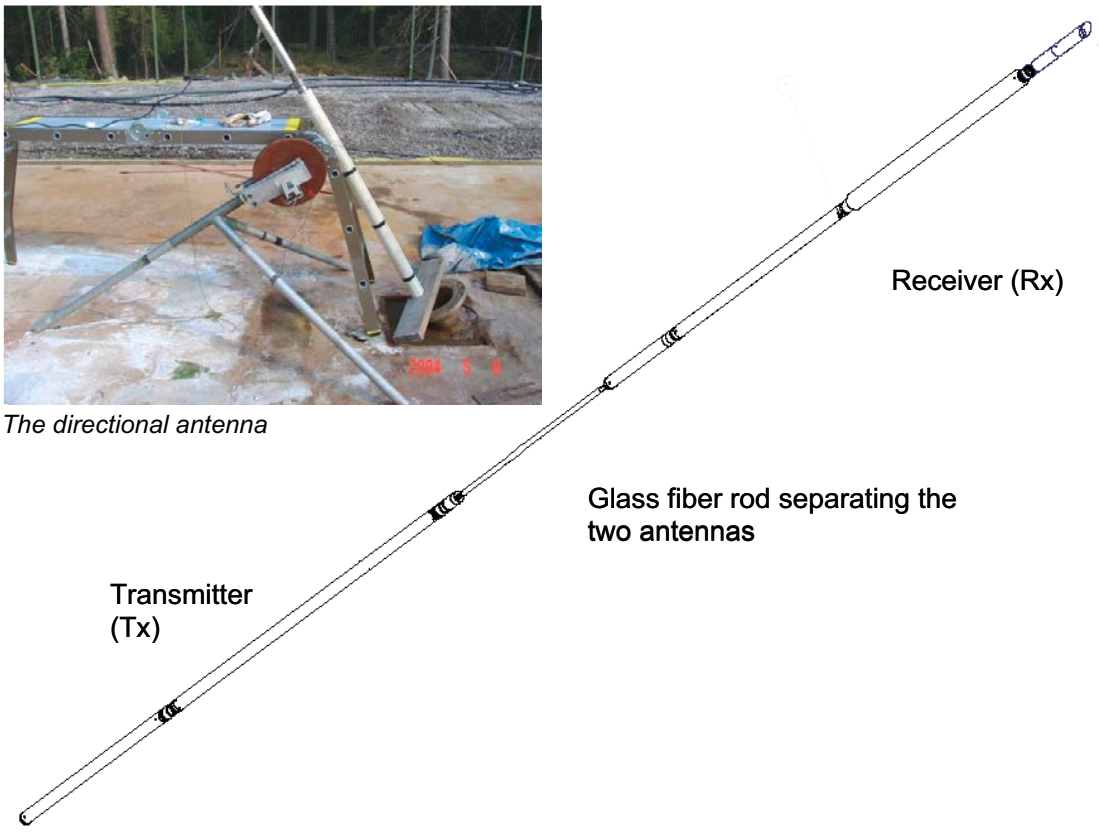
The RAMAC GPR system owned by SKB is a fully digital GPR system where emphasis has been laid on fast survey speed and easy field operation. The system operates dipole and directional antennas (see Figure 3-1). A system description is given in the SKB internal controlling document SKB MD 252.021.

The borehole radar system consists of a transmitter and a receiver antenna. During operation an electromagnetic pulse, within the frequency range of 20 MHz up to 60 MHz, is emitted into the bedrock. Once a feature, e.g. a water-filled fracture, with sufficiently different electrical properties is encountered, the pulse is reflected back to the receiver and recorded.

3.2 TV-Camera, BIPS

The BIPS 1500 system used is owned by SKB and described in SKB internal controlling document SKB MD 222.005. The BIPS method for borehole logging produces a digital scan of the borehole wall. In principle, a standard CCD video camera is installed in the probe in front of a conical mirror (see Figure 3-2). An acrylic window covers the mirror part and the borehole image is reflected through the window and displayed on the cone, from where it is recorded. During the measuring operation, pixel circles are grabbed with a resolution of 360 pixels/circle.

The system orientates the BIPS images according to two alternative methods, either using a compass (vertical boreholes) or with a gravity sensor (inclined boreholes).



The directional antenna

Figure 3-1. *Example of a borehole radar antenna.*

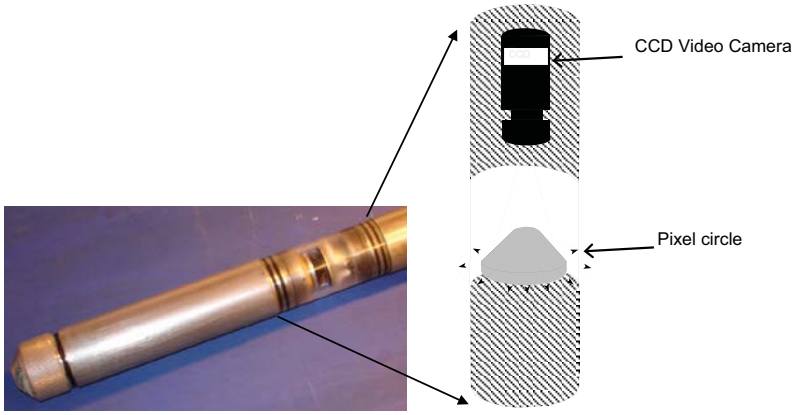


Figure 3-2. *The BIP-system. Illustration of the conical mirror scanning.*

3.3 Deviation measurements, Flexit SmartTool

The deviation measurements were carried out with the Flexit SmartTool Deviation equipment, Figure 3-3. The system is based on station readings.

The system consist of a borehole probe (SensIT) including 3-component magnetometers and accelerometers, measuring a number of different parameters. Table 3-1 describe the delivered parameters. Inside the probe the radio link is also built in were all data is downloaded after the end of the survey. The probe is controlled during the measurement either by an external PC and the software package called MeasureIT or a data pad StoreIT. For processing and reporting data the PC software MeasureIT and DisplayIT are used.

In the Flexit SmartTool system there is a magnetic integrity check to detect magnetic disturbance in the survey measurements. Magnetic disturbance results in incorrect/inaccurate azimuth values. The operator can select the average values for these parameters in the MeasureIT software and run a magnetic integrity check and if necessary change or delete azimuth values. If the azimuth value is changed the new added value by the operator is interpolated from the nearby station readings.

For more information and technical specification visit www.flexit.se.

Table 3-1. Flexit SmartTool result tables.

Dip	Inclination of the borehole at the position for reading
Azimuth:	Direction of the borehole at the position for reading.
Easting, Northing and Elevation:	Co-ordinate of the borehole at the position for reading.
Mag. Field:	Strength of earth's magnetic field.
Mag. Dip:	Inclination of earth's magnetic field.
Grav. Field:	Indicates if the probe was moved during recording at that station.
Status:	Indicates if the azimuth value at the reading station was disturbed or changed by the operator. If the azimuth value has been edited or the magnetic integrity check have indicated a magnetic disturbance at the reading station a number higher than 1 is printed in the status field.
Updown:	Shows the distance the actual reading station is above or below the planned straight line for the borehole given the starting direction.
Left/Right:	Shows the distance the actual reading station is left or right the planned straight line for the borehole given the starting direction.
Short Fall:	Shows the amount the actual point falls short of the planned survey point.

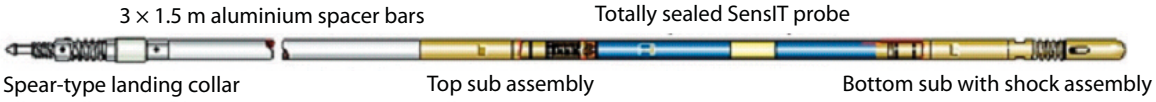


Figure 3-3. *The FlexIT SmartTool-system. Illustration of the set-up in the borehole.*

4 Execution

4.1 General

4.1.1 RAMAC Radar

The measurements in KA2051A01, KA3007A01 and KJ0050F01 were carried out with dipole radar antennas, with a frequency of 20 MHz. Measurements were also carried out with a directional antenna, with a central frequency of 60 MHz.

During logging the dipole antennas (transmitter and receiver) were lowered continuously into the borehole and data were recorded on a field PC along the measured interval. The measurement with the directional antenna was made step wise, with a short pause for each measurement occasion. The antennas (transmitter and receiver, both for dipole and directional) were kept at a fixed separation by glass fibre rods according to Table 4-1, 4-2 and 4-3. See also Figures 3-1 and 4-1.

All measurements were performed in accordance with the instructions and guidelines from SKB (internal document SKB MD 252.020). All cleaning of the antennas and cable was performed according to the internal document SKB MD 600.004 before the logging operation.

The functionality of the directional antenna was tested before measurements at SKB's workshop in Oskarshamn. This was performed by measurements in the air, where the receiver antenna and the transmitter antenna are placed apart. While transmitting and measuring the receiver antenna is turned around and by that giving the direction from the receiver antenna to the transmitter antenna. The difference in direction is measured by compass and the result difference achieved from the directional antenna was approximately 4 degrees. This can be considered to be good due to the disturbed environment, with metallic objects etc at the test site.

For more information on system settings used in for the surveyed boreholes see Table 4-1 to 4-3 below.

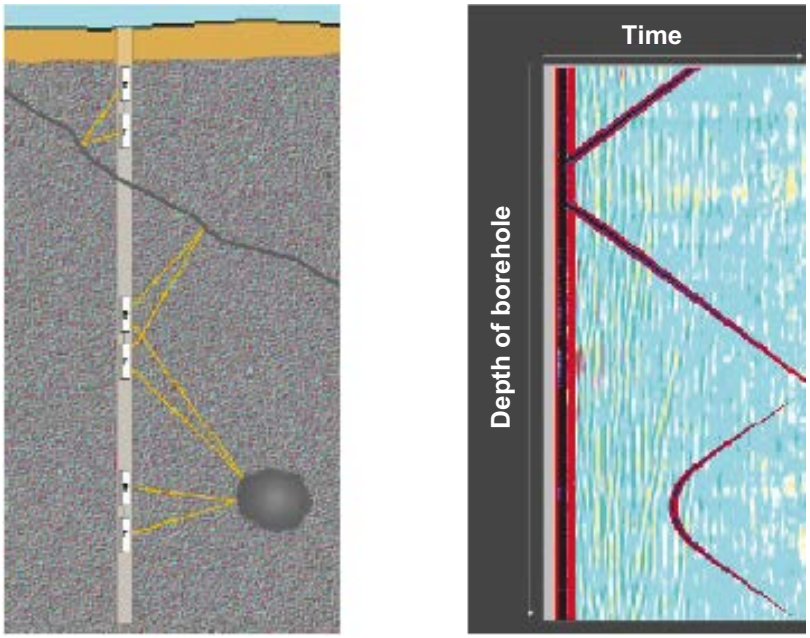


Figure 4-1. *The principle of radar borehole reflection survey and an example of result.*

Table 4-1. Radar logging information from KA2051A01.

Site: Äspö HRL **BH: KA2051A01** **Type: Directional/Dipole** **Operator: CG**	**Logging company: MALÅ Geoscience** **Equipment: SKB RAMAC** **Manufacturer: MALÅ Geoscience**	
	Directional Antenna	**20 MHz**
Logging date:	2011-06-18	2011-06-18
Reference:	TOC	TOC
Sampling frequency (MHz):	615	239
Number of samples:	512	518
Number of stacks:	32	Auto
Signal position:	410.5	–1.42
Logging from (m):	8.40	6.25
Logging to (m):	308.4	310.25
Trace interval (m):	0.5	0.25
Antenna separation (m):	5.73	10.05

Table 4-2. Radar logging information from KA3007A01.

Site: Äspö HRL **BH: KA3007A01** **Type: Directional/Dipole** **Operator: CG**	**Logging company: MALÅ Geoscience** **Equipment: SKB RAMAC** **Manufacturer: MALÅ Geoscience**	
	Directional Antenna	**20 MHz**
Logging date:	2011-06-08	2011-06-09
Reference:	TOC	TOC
Sampling frequency (MHz):	615	239
Number of samples:	512	518
Number of stacks:	32	Auto
Signal position:	410.5	–1.42
Logging from (m):	8.4	11.25
Logging to (m):	213.4	211.75
Trace interval (m):	0.5	0.25
Antenna separation (m):	5.73	10.05

Table 4-3. Radar logging information from KJ0050F01.

Site: Äspö HRL **BH: KJ0050F01** **Type: Directional/Dipole** **Operator: CG**	**Logging company: MALÅ Geoscience** **Equipment: SKB RAMAC** **Manufacturer: MALÅ Geoscience**	
	Directional Antenna	**20 MHz**
Logging date:	2011-06-20	2011-06-20
Reference:	TOC	TOC
Sampling frequency (MHz):	615	239
Number of samples:	512	518
Number of stacks:	32	Auto
Signal position:	410.5	–1.42
Logging from (m):	3.40	6.25
Logging to (m):	40.9	39.5
Trace interval (m):	0.5	0.25
Antenna separation (m):	5.73	10.05

4.1.2 BIPS

All measurements were performed in accordance with the instructions and guidelines from SKB (internal document SKB MD 222.006). All cleaning of the probe and cable was performed according to the internal document SKB MD 600.004 before the logging operation.

During the measurement, a pixel circle with a resolution of 360 pixels/circle was used and the digital circles were stored at every 1 mm on a MO-disc in the surface unit. The maximum speed during data collection was 1.5 m/minute.

A gravity sensor based on an air bulb in an alcohol liquid was used to measure the orientation of the images in the logged boreholes.

In order to control the quality of the system, calibration measurements were performed in a test pipe before logging and after logging. Figure 4-2 shows the results of the test logging performed before and after the logging campaign in June 2011. The results showed no difference regarding the colours and focus of the images. Results of the test loggings were included in the delivery of the raw data.

The BIPS logging information is found in the header presented in Appendix 4–7 in this report.

4.1.3 Deviation measurements

The deviation measurements were carried out according to the instructions and guidelines from SKB (internal document SKB MD 224.001). All cleaning of the probe and cable was performed according to the internal document SKB MD 600.004 before the logging operation.

During the logging a measurement was performed for each 3 m. The logging was carried out in two directions, both from the surface measuring to the bottom of the borehole and a second run measuring from the bottom of the borehole up to the surface.

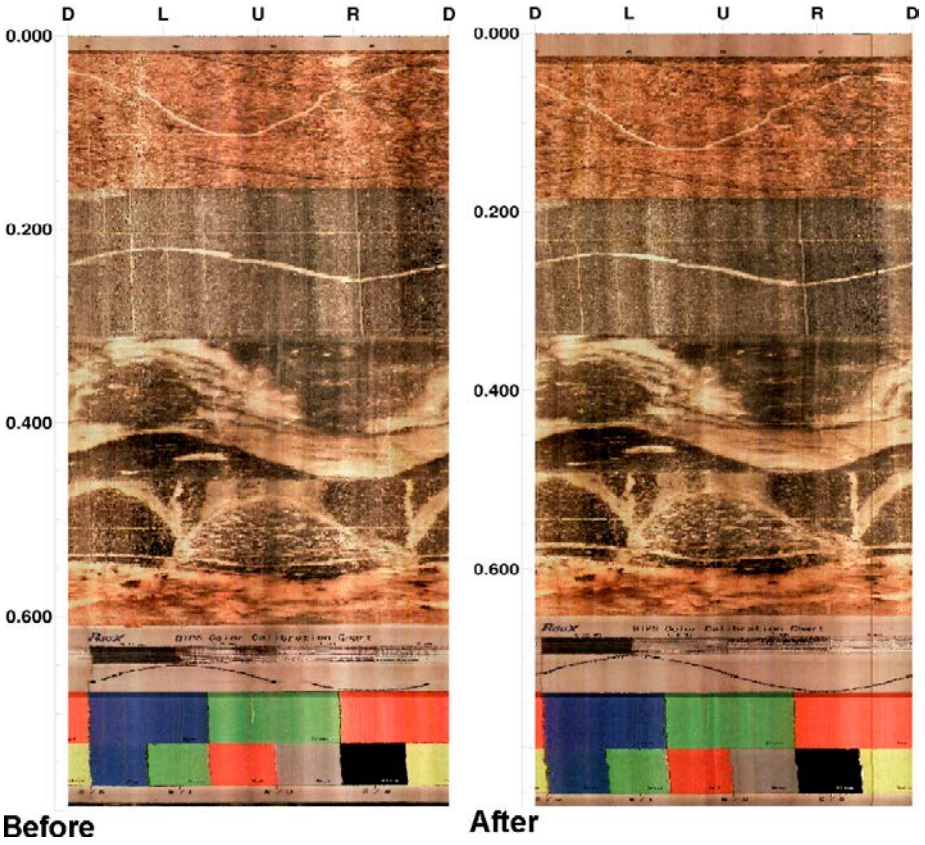


Figure 4-2. *Results from logging in the test pipe before and after the logging campaign in June, 2011.*

4.1.4 Length measurements

During logging of the RAMAC, BIPS and Flexit systems the length measuring wheel on the push rig was used for length controlling of the survey. For an accurate length control the length recording was adjusted regularly for every 50 metre by calculating the number of the 2 metre long aluminium rods.

4.2 Analyses and Interpretation

4.2.1 Radar

The result from radar measurements is most often presented in the form of a radargram where the position of the probes is shown along one axis and the radar wave propagation and reflection is shown along the other axis. The amplitude of the received signal is shown in the radargram with a grey scale where black colour corresponds to large positive signals and white colour to large negative signals. Grey colour corresponds to no reflected signals.

The presented data in this report is adjusted for the measurement point of the antennas. The measurement point is defined to be the central point between the transmitter and the receiver antenna.

The two basic patterns to interpret in borehole measurements are point and plane reflectors. In the reflection mode, borehole radar essentially gives a high-resolution image of the rock mass, showing the geometry of plane structures which may or may not, intersect the borehole (contact between layers, thin marker beds, fractures) or showing the presence of local features around the borehole (cavities, lenses etc).

The distance to a reflecting object or plane is determined by measuring the difference in arrival time between the direct and the reflected pulse. The basic assumption is that the speed of propagation is the same everywhere.

There are several ways to determine the radar wave propagation velocity. Each of them has its advantages and its disadvantages. For this logging campaign the velocity determination earlier performed during the Oskarshamn site investigation is used between KLX07A and KLX07B. The velocity measurement was performed by keeping the transmitter fixed in one borehole while moving the receiver downwards in the second borehole. The velocity measurement was performed with the 20 MHz antennas in boreholes KLX07A and KLX07B (Gustafsson and Gustafsson 2005).

The result is plotted in Figure 4-3 and the calculation shows a velocity varying between 110 and 117 m/micro seconds. The lower velocities most probably represent a fracture zone in the length interval 40 to 60 m.

The visualization of data is made with ReflexWin, a Windows based processing software for filtering and analysis of borehole radar data. The processing steps are shown in Table 4-4. It should be observed that the processing steps in Table 4-4 below refer to Appendix 1 in this report. The filters applied affect the whole borehole length and are not always suitable in all parts, depending on the geological conditions and conductivity of the borehole fluid. During interpretation further processing can be done, most often in form of bandpass filtering. This filtering can be applied just in parts of the borehole, where needed.

For the interpretation of the intersection angle between the borehole axis and the planes visible on the radargrams the RadinterSKB software has been used. The interpreted intersection points and intersection angles of the detected structures are presented in Table 5-1 to 5-3 and are also visible on the radargrams in Appendices 1–3.

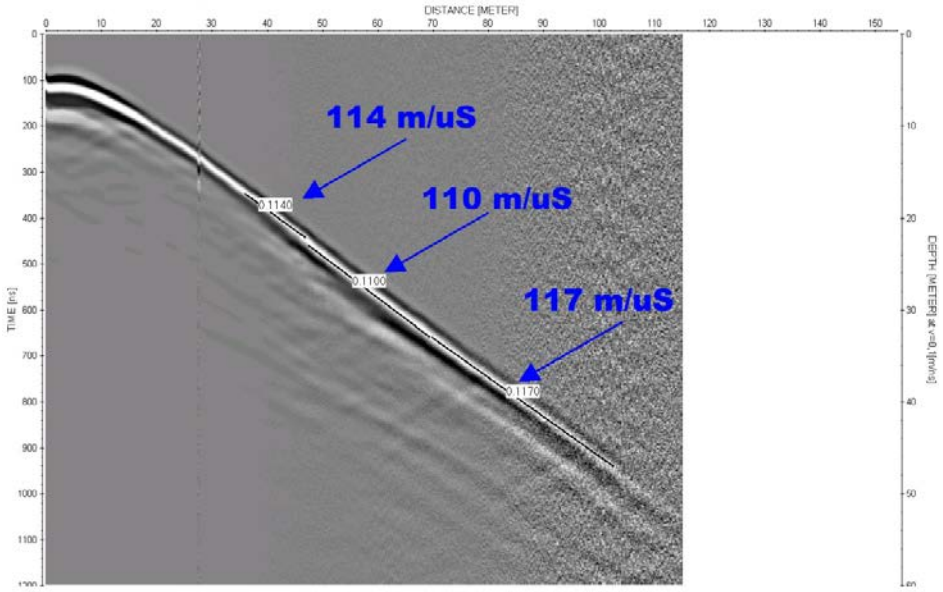


Figure 4-3. Results from velocity measurements (Gustafsson and Gustafsson 2005).

Table 4-4. Processing steps for borehole radar data.

Site: Äspö HRL **BH: KA2051A01, KA3007A01 and KJ0050F01** **Type: Directional/Dipole** **Interpret: CG**	**Logging company: MALÅ Geoscience AB** **Equipment: SKB RAMAC** **Manufacturer: MALÅ Geoscience**

	Directional Antenna	**20 MHz**
Processing:	Move start time (–38 samples) DC shift (300–511) Time gain (start 76 lin 222 exp 1) (FIR)	Move start time (–66.8) DC shift (300–500) Gain (start 72 lin 4.3 exp 0.1)

4.2.2 BIPS

The visualization of data is made with BDPP, a Windows based processing software for filtering, presentation and analysis of BIPS data. As no fracture mapping of the BIPS image is performed, the raw data was delivered on a CD-ROM together with printable pictures in *.pdf format before the field crew left the investigation site.

The printed results were delivered with measured length, together with adjusted length according to the length marks visible in the BIPS image. For printing of the BIPS images the printing software BIPP from RaaX was used.

4.2.3 Deviation measurements

The resulting data from the deviation measurements were corrected relatively to the magnetic North, 2.53 degrees east of RT90 North for the presentation in Appendices 8 to 10. For delivery to Sicada the azimuth was delivered relatively to magnetic North.

4.3 Nonconformities

No nonconformities occurred during the logging in June 2011.

5 Results

The results from the BIPS measurements were delivered as raw data (*.bip-files) on CD-ROM disks and MO-disks to SKB together with printable BIPS pictures in *.pdf format before the field crew left the investigation site. The information of the measurements was registered in Sicada, and the digital data on CD and MO disks were stored by SKB.

The RAMAC radar data was delivered as raw data file format *.rd3 (dipole antennas) or *.rd5 (directional antenna) for with corresponding information files (file format *.rad) whereas the data processing steps and results are presented in this report. Relevant information, including the interpretation presented in this report, was inserted into the SKB database Sicada.

The results from the deviation measurement were delivered to SKB in form of raw Flexit files and Excel-files, and also presented in Appendices 8–10 in this report. Each reading station lenght is referred from TOC in the appendices.

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

5.1 RAMAC logging

The results of the interpretation of the radar measurements are presented in Tables 5-1 to 5-6. Radar data is also visualized in Appendices 1–3. It should be remembered that the images in Appendices 1–3 are only a composite picture of all events 360 degrees around the borehole, and do not reflect the orientation of the structures.

Only the larger clearly visible structures are interpreted in RadinterSKB. An overview of the boreholes is given in Figures 5-1 to 5-3 below. A number of minor structures also exist but are not interpreted as indicated in Appendices 1–3. Often a number of structures can be noticed, but most probably lying so close to each other that it is impossible to distinguish one from the other. It should also be pointed out that reflections interpreted will always get an intersection point with the borehole axis, but being located further away. They may in some cases not reach the borehole.

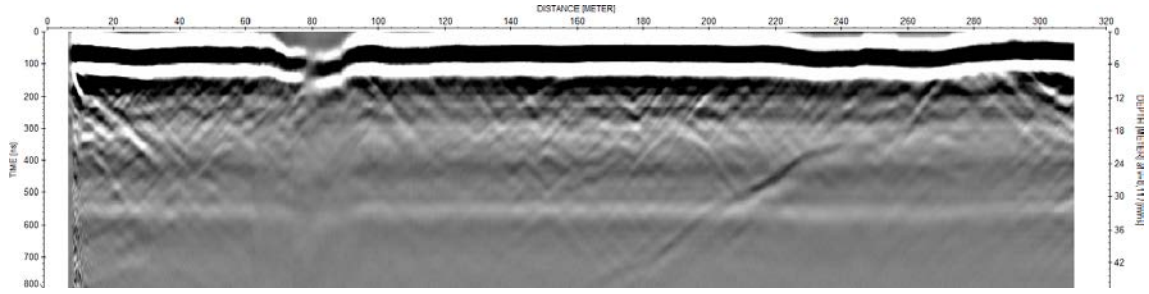


Figure 5-1. *Overview (20 MHz data) of the radar data for the borehole KA2051A01.*

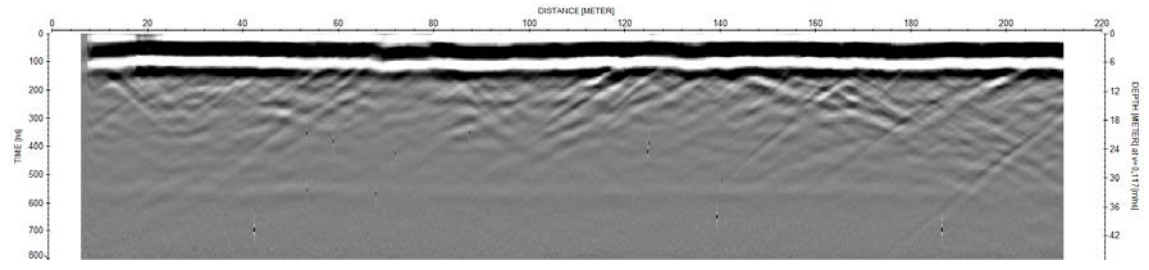


Figure 5-2. *Overview (20 MHz data) of the radar data for the borehole KA3007A01.*

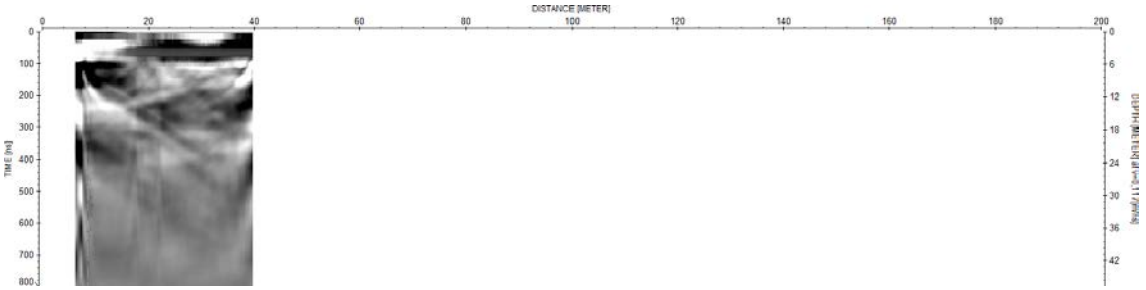


Figure 5-3. *Overview (20 MHz data) of the radar data for the borehole KJ0050F01.*

The data quality from KA2051A01 (as seen in Appendix 1) is good. The borehole intersects with several high conductivity zones. The position of the zones is clearly visible on the radargram by a delay of the first arrival over the zones. A conductive environment makes the radar wave to attenuate, which decreases the penetration. This conductive environment of course also reduces the possibility to distinguish and interpret possibly structures in the rock which otherwise could give a reflection.

The effect of a conductive environment is also seen in the directional antenna which makes it more difficult to interpret the direction to the identified structures.

Table 5-1 to Table 5-3 summarises the interpretation of radar data from KA2051A01, KA3007A01 and KJ0050F01. In the tables the borehole length and intersection angle to the identified structures are listed.

The direction to the reflector (object) is also given for structures that was possible to determine. As seen some radar reflectors in Tables 5-1 and 5-2 are marked with ±, which indicates an uncertainty in the interpretation of direction. The direction can in these cases be ± 180 degrees. The definition for direction to the reflector (object) is defined in Figure 5-4. As the borehole inclination is less than 85° the direction to object is calculated using gravity roll. The direction to object and the intersection angle are recalculated to strike and dip, also given in the tables. The plane strike is the angle between line of the plane's cross-section with the surface and the Magnetic North direction. It counts clock-wise and can be between 0 and 359 degrees. A strike of 0 degrees implies a dip to the east while a strike of 180 degrees implies a dip to the west. The plane dip is the angle between the plane and the surface. It can vary between 0 and 90 degrees.

Table 5-1. Interpretation of radar reflectors from the dipole antenna 20 MHz and the directional antenna 60 MHz in borehole KA2051A01.

Radinter model information (Directional and dipole antennas)							
Site: Äspö HRL. Borehole name: KA2051A01. Nominal velocity (m/µs): 117.0							
Name	**Intersection length**	**Intersection angle**	**RadInter direction to object (gravity roll)**	**Dip 1**	**Strike 1**	**Dip 2**	**Strike 2**
1	71.2	45					
2	76.3	49	18±	85	354	21	130
3	170.6	28	303	82	294		
4	198.5	53	48	84	190		
5	215.1	41	24	82	359		
6	284.2	24	309±	75	296	45	250
7	283.2	45	315	87	311		

Table 5-2. Interpretation of radar reflectors from the dipole antenna 20 MHz and the directional antenna 60 MHz in borehole KA3007A01.

Radinter model information (Directional and dipole antennas)							
Site: Äspö HRL. Borehole name: KA3007A01. Nominal velocity (m/µs): 117.0							
Name	**Intersection length**	**Intersection angle**	**RadInter direction to object (gravity roll)**	**Dip 1**	**Strike 1**	**Dip 2**	**Strike 2**
1	63.6	49					
2	73.9	51	9	67	282		
3	123.6	30	240	57	32		
4	124.3	56	216	49	70		
5	149.4	31					
6	175.4	63	93±	76	124	78	68
7	209.2	39	243	60	40		
8	231.4	54	93	76	133		

Table 5-3. Interpretation of radar reflectors from the dipole antenna 20 MHz and the directional antenna 60 MHz in borehole KJ0050F01.

Radinter model information (Directional and dipole antennas)							
Site: Äspö HRL. Borehole name: KJ0050F01. Nominal velocity (m/µs): 117.0							
Name	**Intersection length**	**Intersection angle**	**RadInter direction to object (gravity roll)**	**Dip 1**	**Strike 1**	**Dip 2**	**Strike 2**
1	56.3	21					
2	9.7	47					

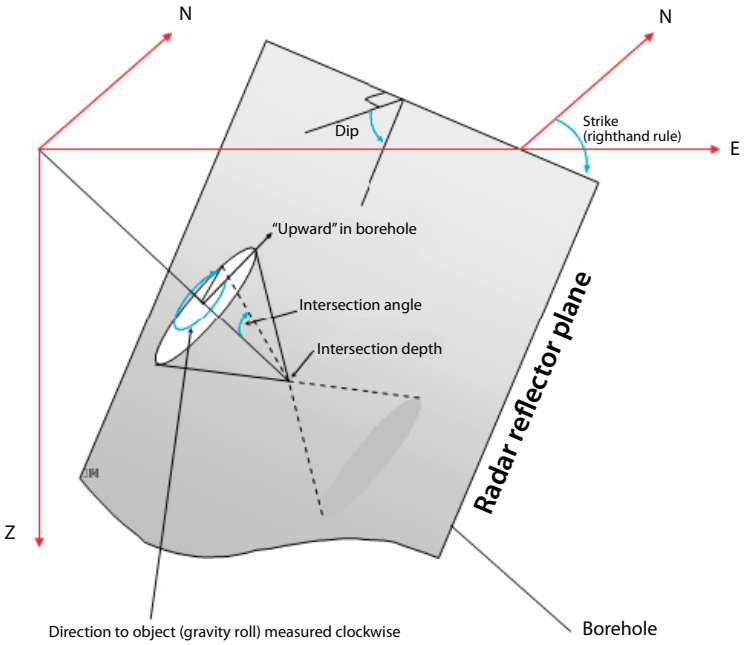


Figure 5-4. *Definition of intersection angle, direction to object using gravity roll, dip and strike using the right hand rule as presented in Table 5-1 to 5-3.*

In Appendices 1–3, the amplitude of the first arrival is plotted against the depth, for the 20 MHz dipole antennas. The amplitude variation along the borehole indicates changes of the electrical conductivity of the volume of rock surrounding the borehole. A decrease in this amplitude may indicate fracture zones, clay or rock volumes with higher water content, i.e. increases in electric conductivity. Sections in the boreholes with a decrease in amplitude are shown in Table 5-4 to Table 5-5. For the borehole KJ0050F01 there was no big decrease in amplitude along the borehole.

Table 5-4. Borehole length intervals in KA2051A01 with decreased amplitude for the 20 MHz antenna.

Length (m)
24–28
64–92
104–108
224–244
258–272

Table 5-5. Borehole length intervals in KA3007A01with decreased amplitude for the 20 MHz antenna.

Length (m)
72–82
132–136

Finally, the structures considered as the most important (clear in the radargram, identified with several antenna frequencies, stretching out far from the borehole wall etc) are listed in Table 5-6 below.

Table 5-6. Some important structures in the boreholes.

Borehole	KA2051A01	KA3007A01	KJI0050F01
Structures	1, 2, 5, and 6	1, 2, 4, and 7	1

Observe that it can be very difficult to classify different structures in an objective manner, along a borehole. This is due to the fact that the water quality (the conductivity) amongst others varies along the borehole length and by that reason affects the results of the radar logging, by for instance attenuating the radar waves differently. Also the intersection angle of the identified structures affects the amplitude on the resulting radargram. Small intersection angles will most often give an increased amplitude compared to larger intersection angles, and by that a more clear structure. Another factor to consider is the long distance (10.05 m) in-between the 20 MHz transmitter (Tx) and receiver (Rx) antenna. Tiny structures intersecting the borehole with high attenuation result in a wide anomaly over a distance that is equal to the Tx and Rx distance.

5.2 BIPS logging

The BIPS pictures from KA2051A01, KA3007A01, KJ0044F01 and KJ0050F01 are presented in Appendices 4–7.

In order to control the quality of the system, calibration measurements were performed in a test pipe before and after the logging. The resulting images displayed with no difference regarding the colours and focus of the images. Results of the test loggings were included in the delivery of the raw data.

To get the best possible length accuracy, the BIPS images are adjusted by using the push rods as reference.

The error in the length recording depends mainly on the tension of the cable and error of the length readings from the measuring wheel. The adjusted length is showed in red colour and the recording length have black colour in the printouts.

The BIPS images in the core drilled part of the borehole show good quality along the borehole. Small amount of discouloring effect of the borehole walls make the geological mapping easy, although induced affects from the drilling on the borehole walls limit the visibility.

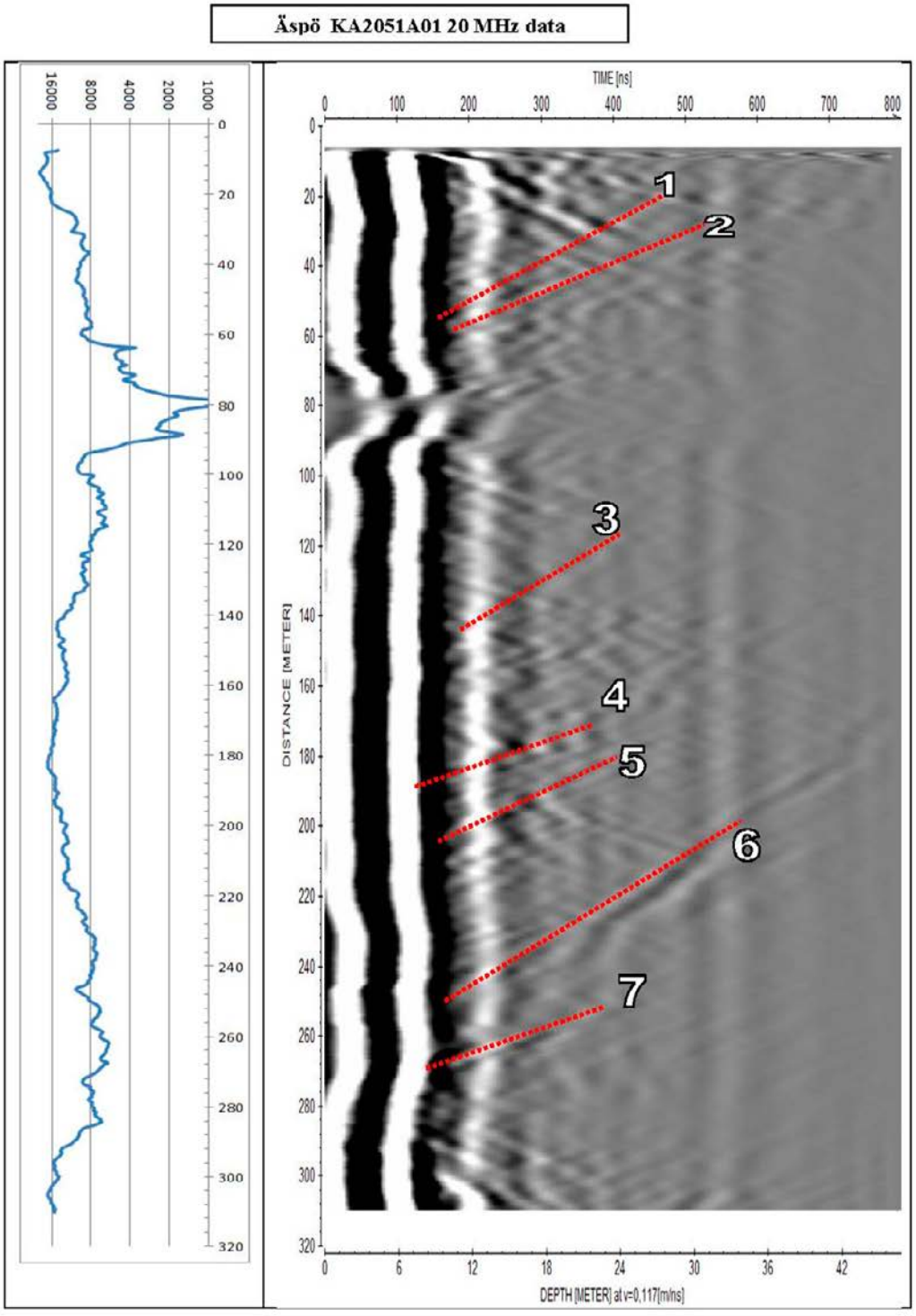
References

SKB's (Svensk Kärnbränslehantering AB) publications can be found at www.skb.se/publications.

Gustafsson J, Gustafsson C, 2005. Oskarshamn site investigation. RAMAC and BIPS logging in boreholes KLX07A, KLX07B, HLX34 and HLX35 and deviation logging in boreholes KLX07B, HLX34 and HLX35. SKB P-05-231, Svensk Kärnbränslehantering AB.

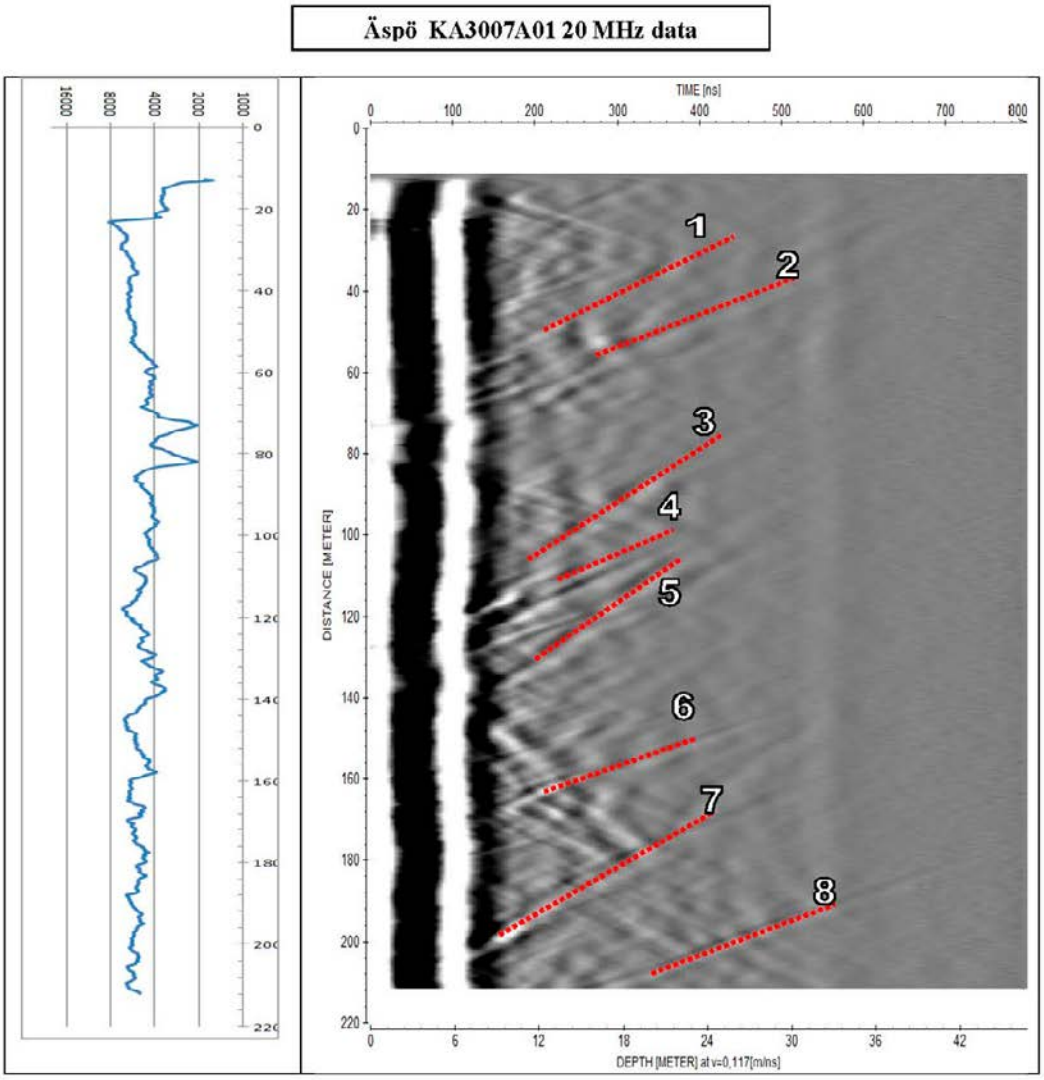
Appendix 1

Radar logging in KA2051A01, 6.2 to 310.2 m, dipole antenna 20 MHz



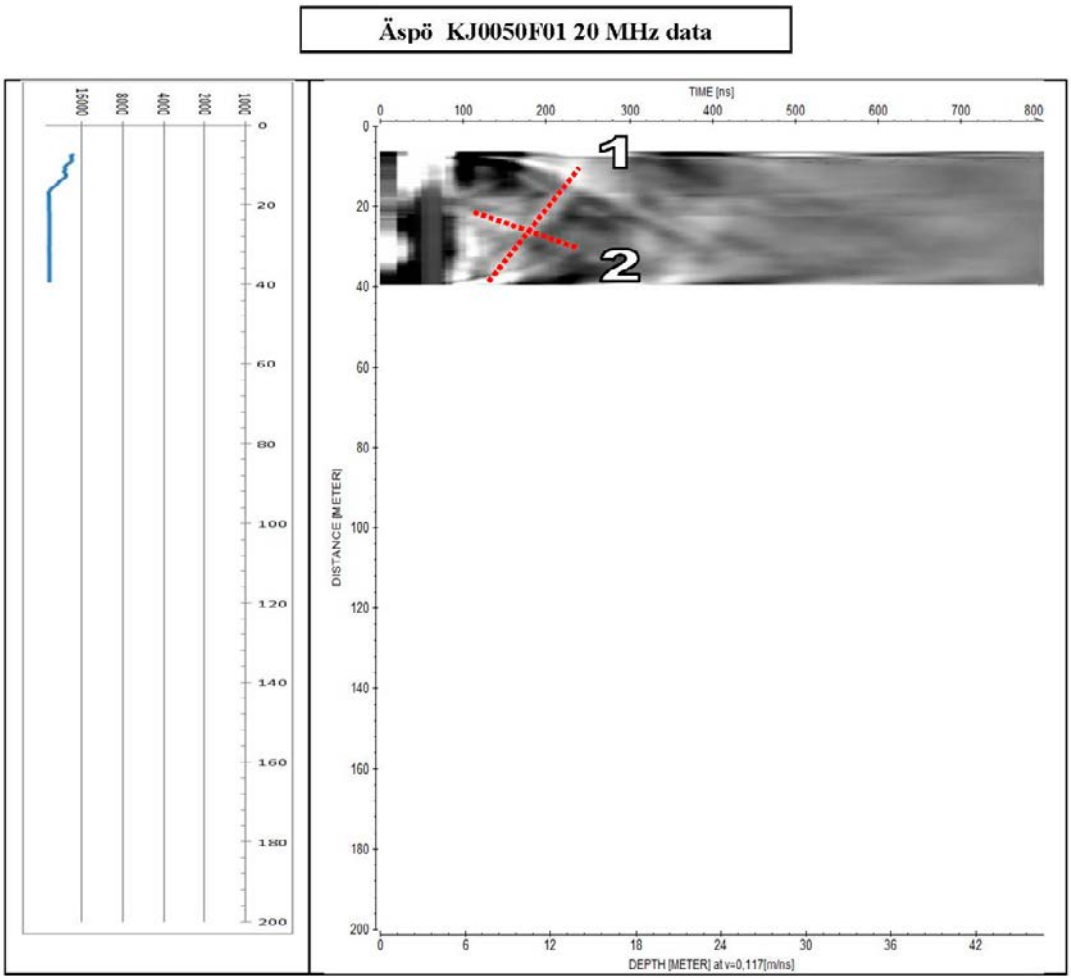
Appendix 2

Radar logging in KA3007A01, 11.2 to 211.7 m, dipole antenna 20 MHz



Appendix 3

Radar logging in KJ0050F01, 6.2 to 39.5 m, dipole antenna 20 MHz



Appendix 4

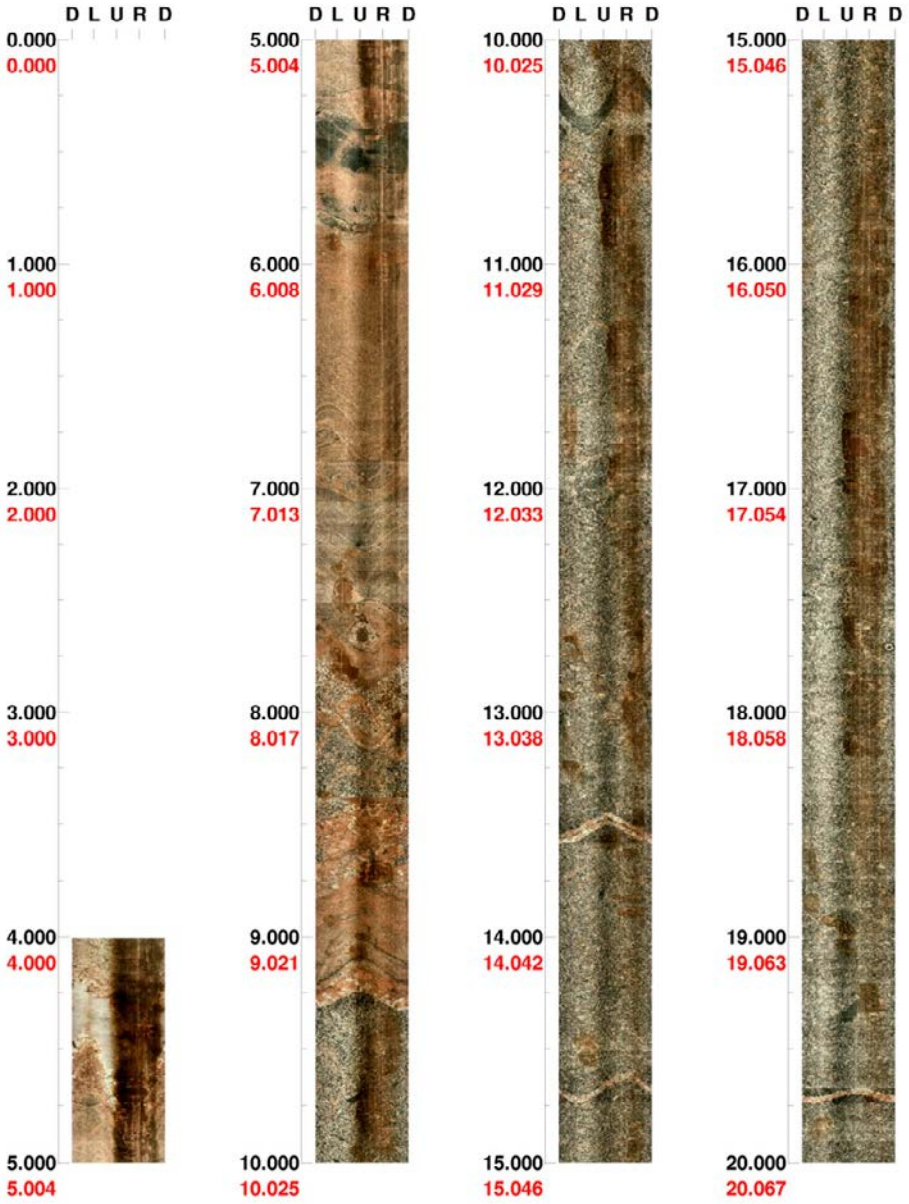
BIPS logging in KA2051A01, 4.0 to 318.3 m

Project name: Äspö HRL

Image file	: d:\work\r5911s~1\bips\ka2051~1.bip
BDT file	: d:\work\r5911s~1\bips\ka2051~1.bdt
Locality	: ASPO HRL
Bore hole number	: KA2051A1
Date	: 11/06/10
Time	: 10:46:00
Depth range	: 4.000 - 318.315 m
Azimuth	: 87
Inclination	: -35
Diameter	: 76.0 mm
Magnetic declination	: 0.0
Span	: 4
Scan interval	: 0.25
Scan direction	: To bottom
Scale	: 1/25
Aspect ratio	: 175 %
Pages	: 17
Color	:  +0 +0 +0

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 0.000 - 20.000 m



(1 / 16) Scale: 1/25 Aspect ratio: 175 %

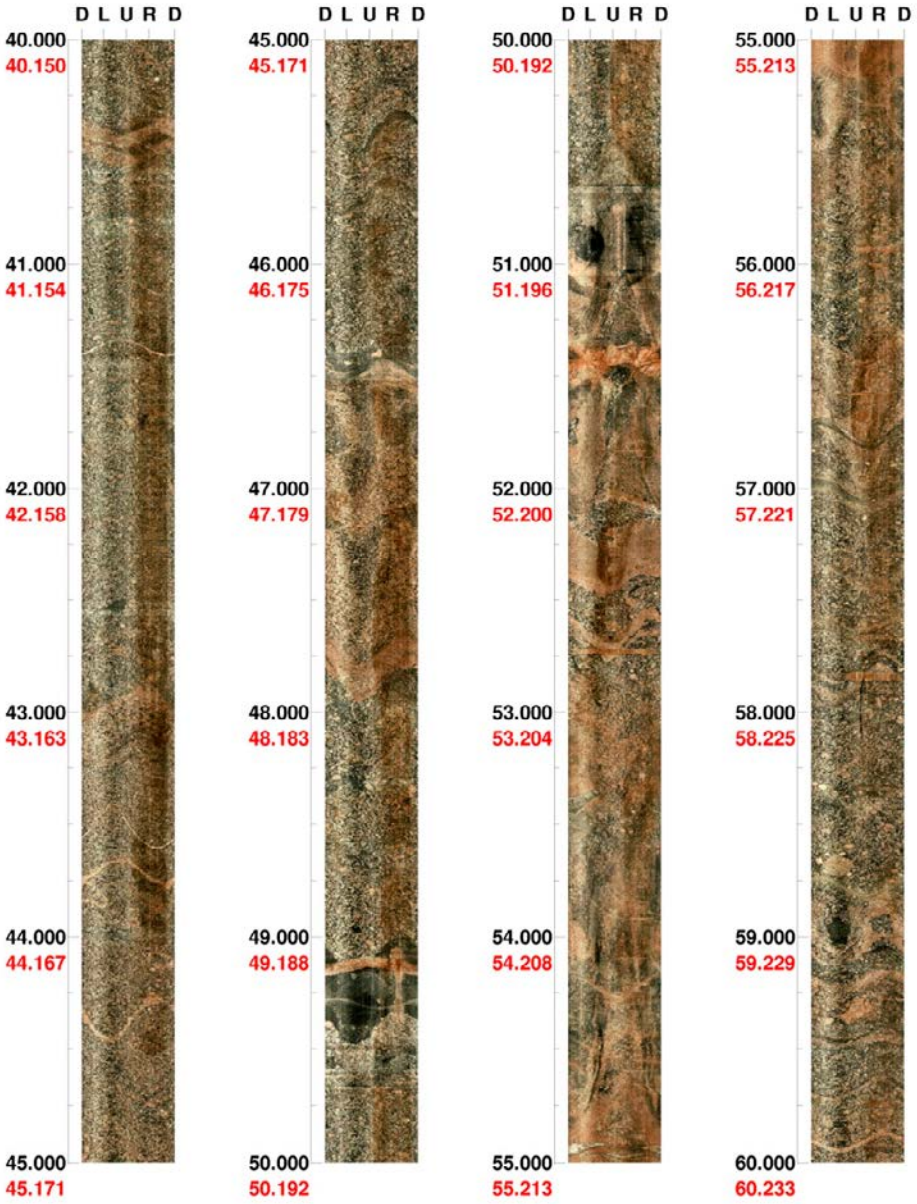
Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 20.000 - 40.000 m

(2 / 16) Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 40.000 - 60.000 m



(3 / 16) Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 60.000 - 80.000 m

(4 / 16) Scale: 1/25 Aspect ratio: 175 %

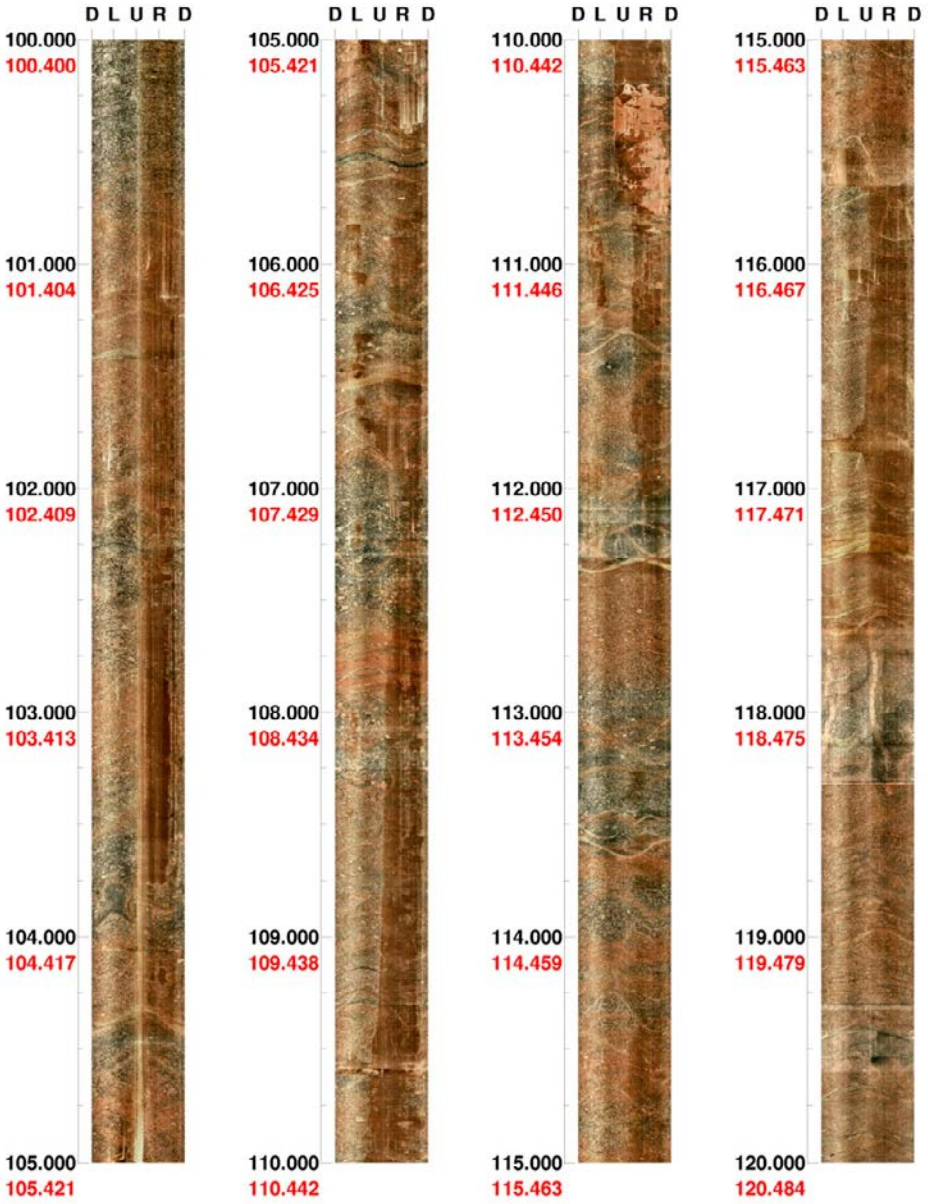
Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 80.000 - 100.000 m

(5 / 16 Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 100.000 - 120.000 m



(6 / 16) Scale: 1/25 Aspect ratio: 175 %

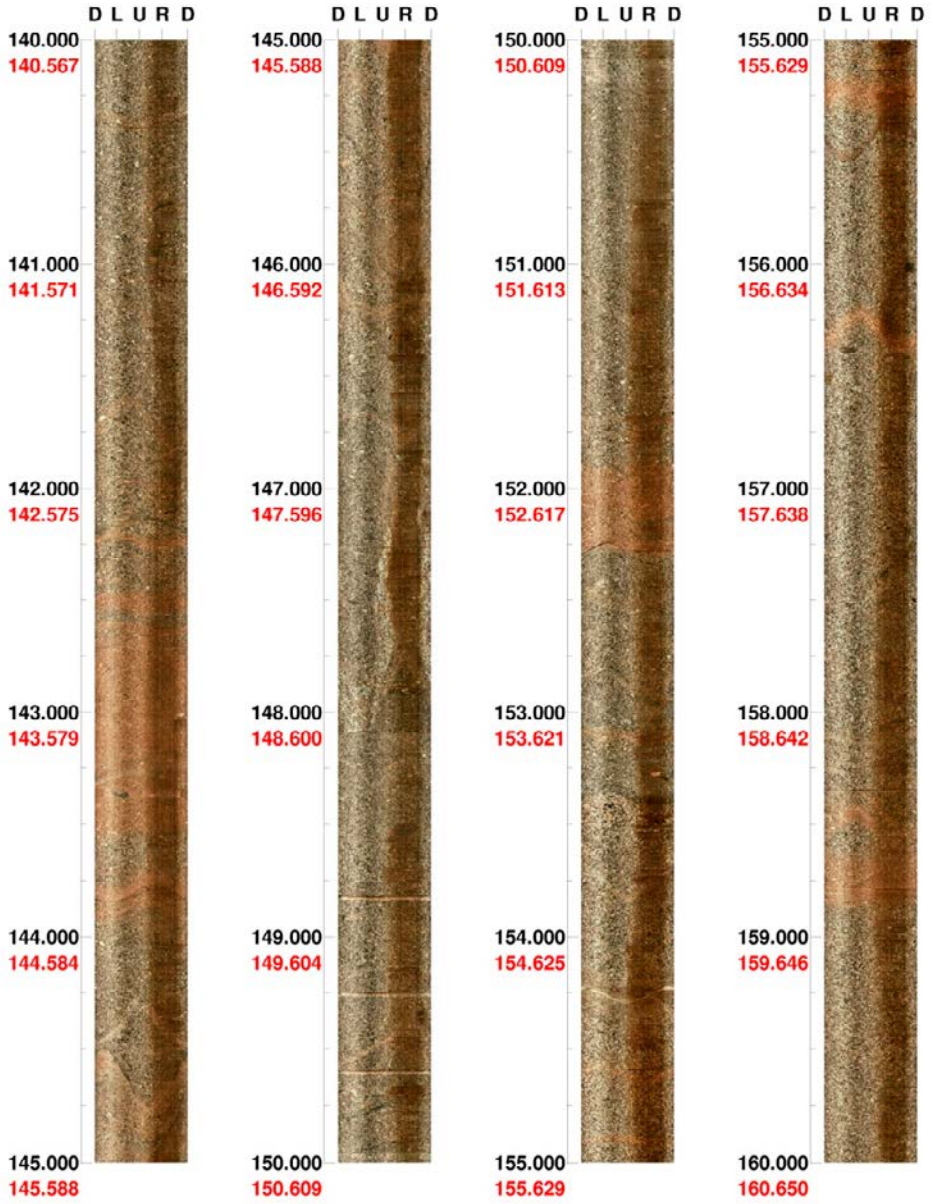
Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 120.000 - 140.000 m

(7 / 16) Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

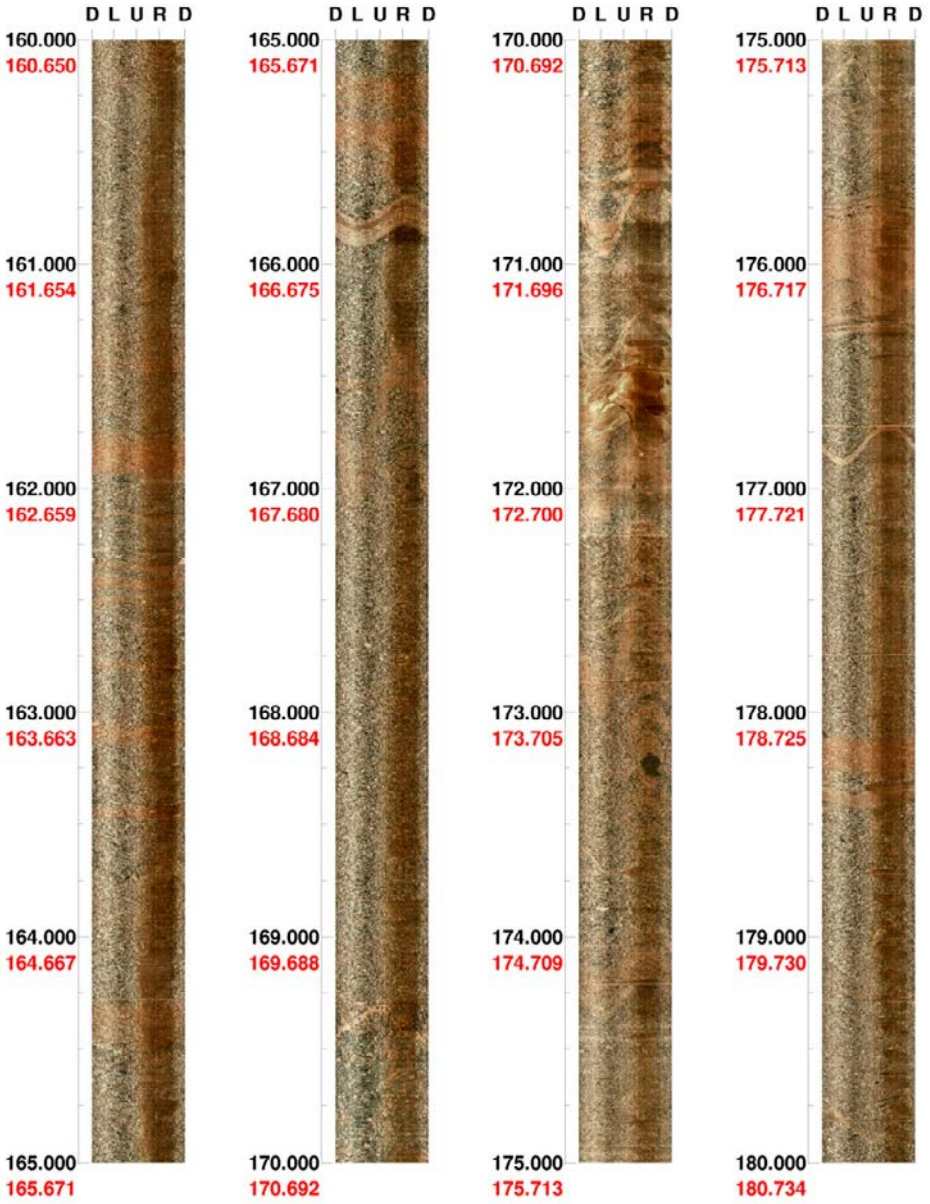
Depth range: 140.000 - 160.000 m



(8 / 16) Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

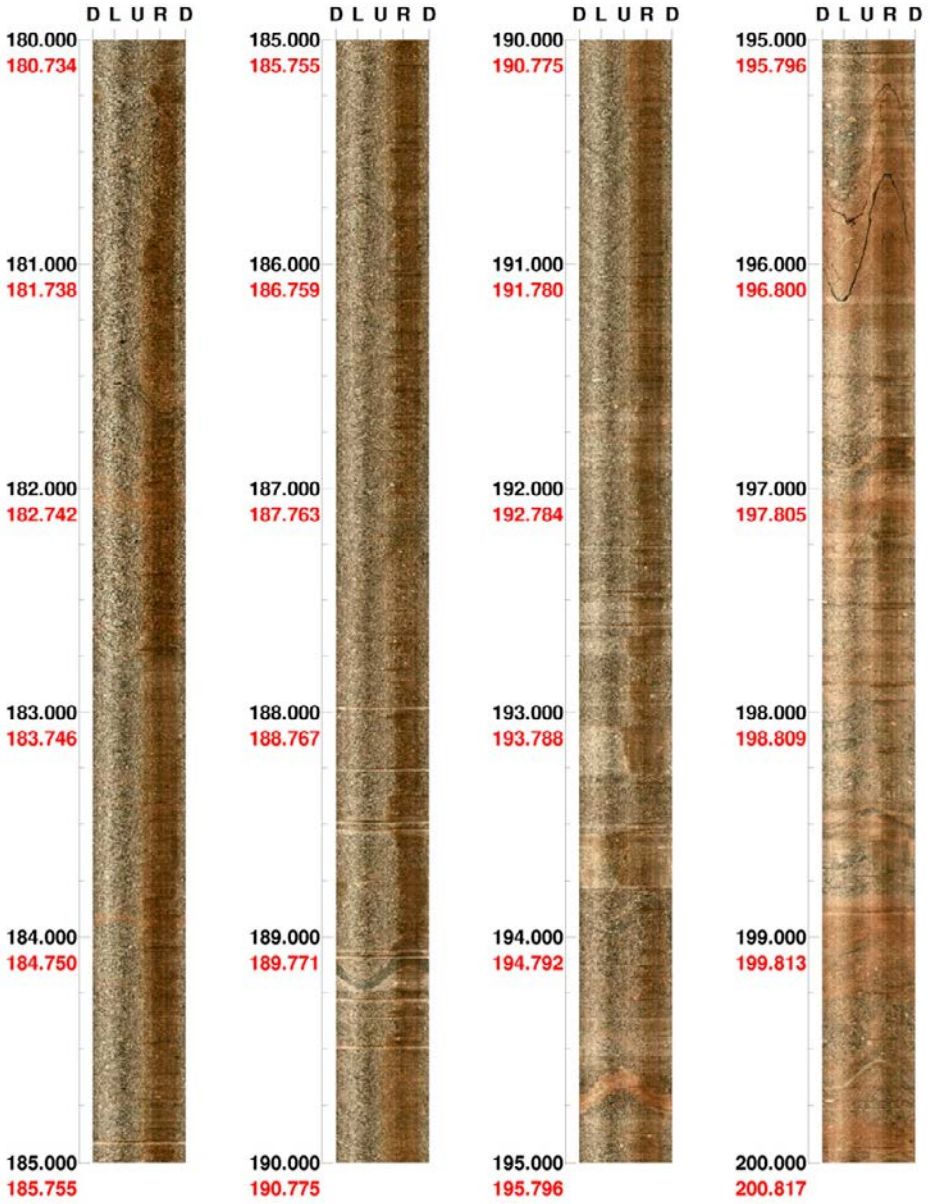
Depth range: 160.000 - 180.000 m



(9 / 16) Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 180.000 - 200.000 m



(10/ 16) Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 200.000 - 220.000 m

(11 /16) Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 220.000 - 240.000 m

(12 / 16) Scale: 1/25 Aspect ratio: 175 %

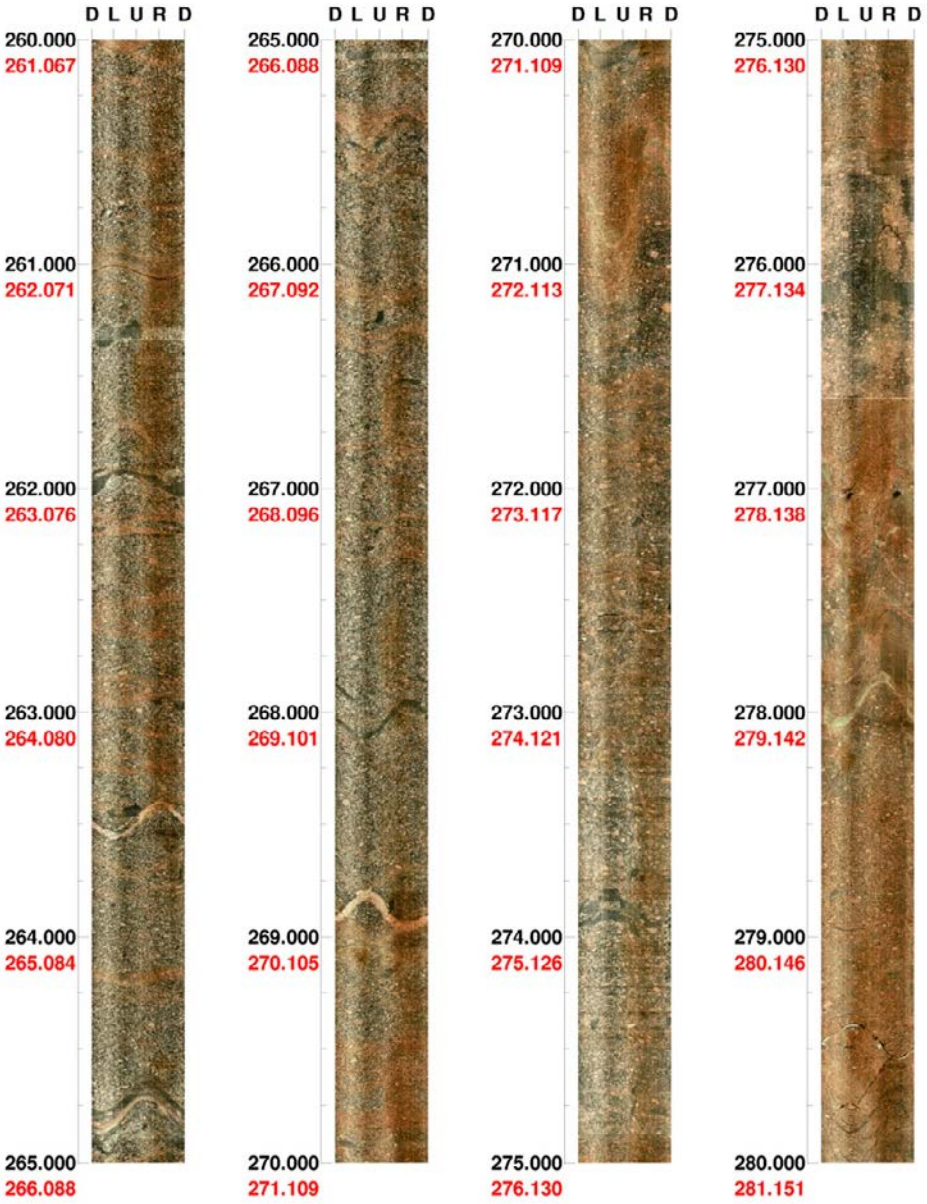
Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 240.000 - 260.000 m

(13 / 16) Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 260.000 - 280.000 m



(14 / 16) Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 280.000 - 300.000 m

(15 / 16) Scale: 1/25 Aspect ratio: 175 %

Project name: Äspö HRL
Bore hole No.: KA2051A1 Azimuth: 87 Inclination: -35

Depth range: 300.000 - 318.315 m

(16 / 16) Scale: 1/25 Aspect ratio: 175 %

Appendix 5

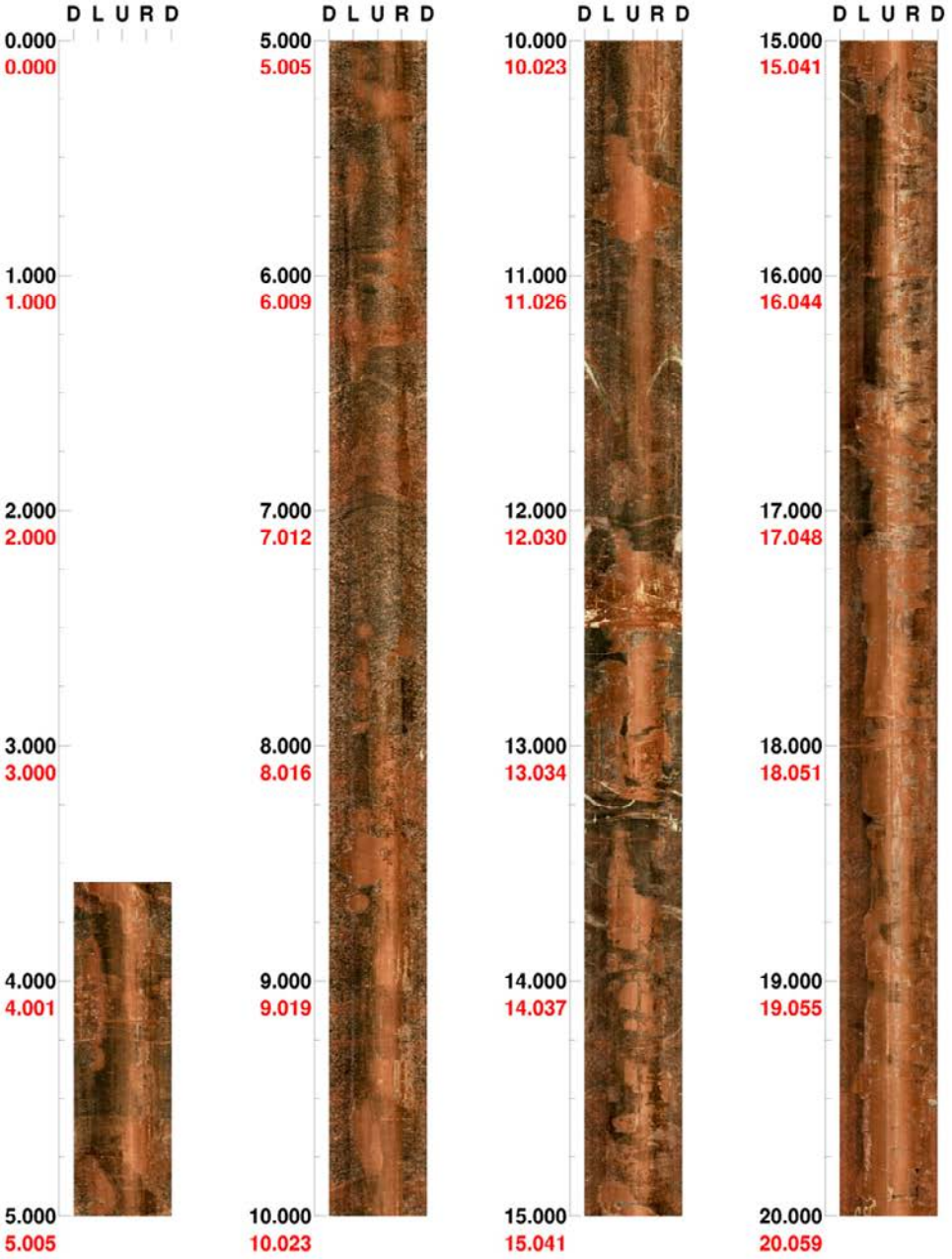
BIPS logging in KA3007A01, 3.6 to 218.0 m

Project name: AP TDPRAS1004-11-022

Image file	: d:\work\r5911s~1\bips\ka3007~1.bip
BDT file	: d:\work\r5911s~1\bips\ka3007~1.bdt
Locality	: ASPO HRL
Bore hole number	: KA307A01
Date	: 11/06/08
Time	: 10:23:00
Depth range	: 3.580 - 217.979 m
Azimuth	: 22
Inclination	: -14
Diameter	: 76.0 mm
Magnetic declination	: 0.0
Span	: 4
Scan interval	: 0.25
Scan direction	: To bottom
Scale	: 1/25
Aspect ratio	: 175 %
Pages	: 11
Color	: +0 +0 +0

Bore hole No.: KA307A01 **Azimuth: 22** **Inclination: -14**

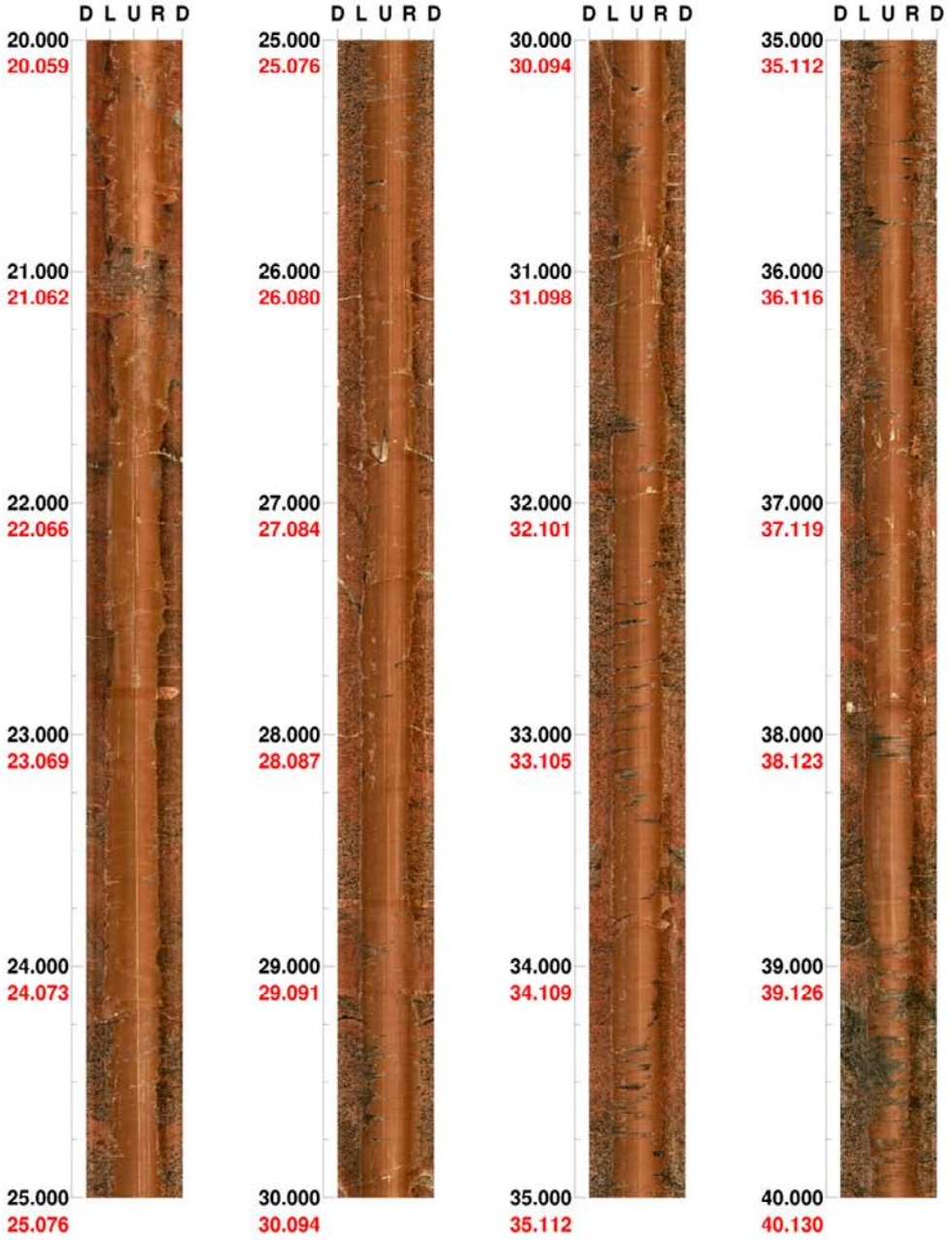
Depth range: 0.000 - 20.000 m



(1 / 11) **Scale: 1/25** **Aspect ratio: 175 %**

Bore hole No.: KA307A01 Azimuth: 22 Inclination: -14

Depth range: 20.000 - 40.000 m



(2 / 11) Scale: 1/25 Aspect ratio: 175 %

Bore hole No.: KA307A01 Azimuth: 22 Inclination: -14

Depth range: 40.000 - 60.000 m

(3 / 11) Scale: 1/25 Aspect ratio: 175 %

Bore hole No.: KA307A01 Azimuth: 22 Inclination: -14

Depth range: 60.000 - 80.000 m

(4 / 11) Scale: 1/25 Aspect ratio: 175 %

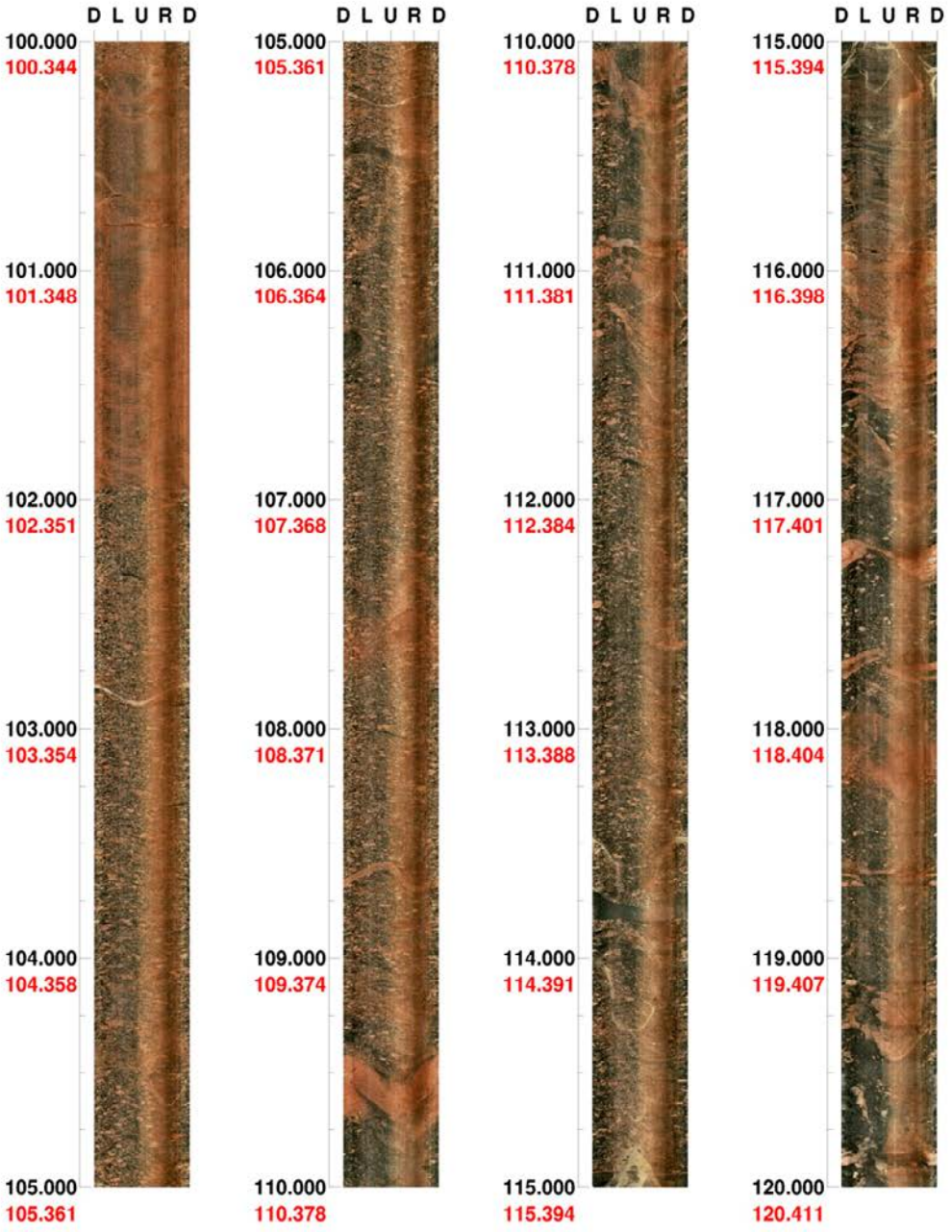
Bore hole No.: KA307A01 Azimuth: 22 Inclination: -14

Depth range: 80.000 - 100.000 m

(5 / 11) Scale: 1/25 Aspect ratio: 175 %

Bore hole No.: KA307A01 Azimuth: 22 Inclination: -14

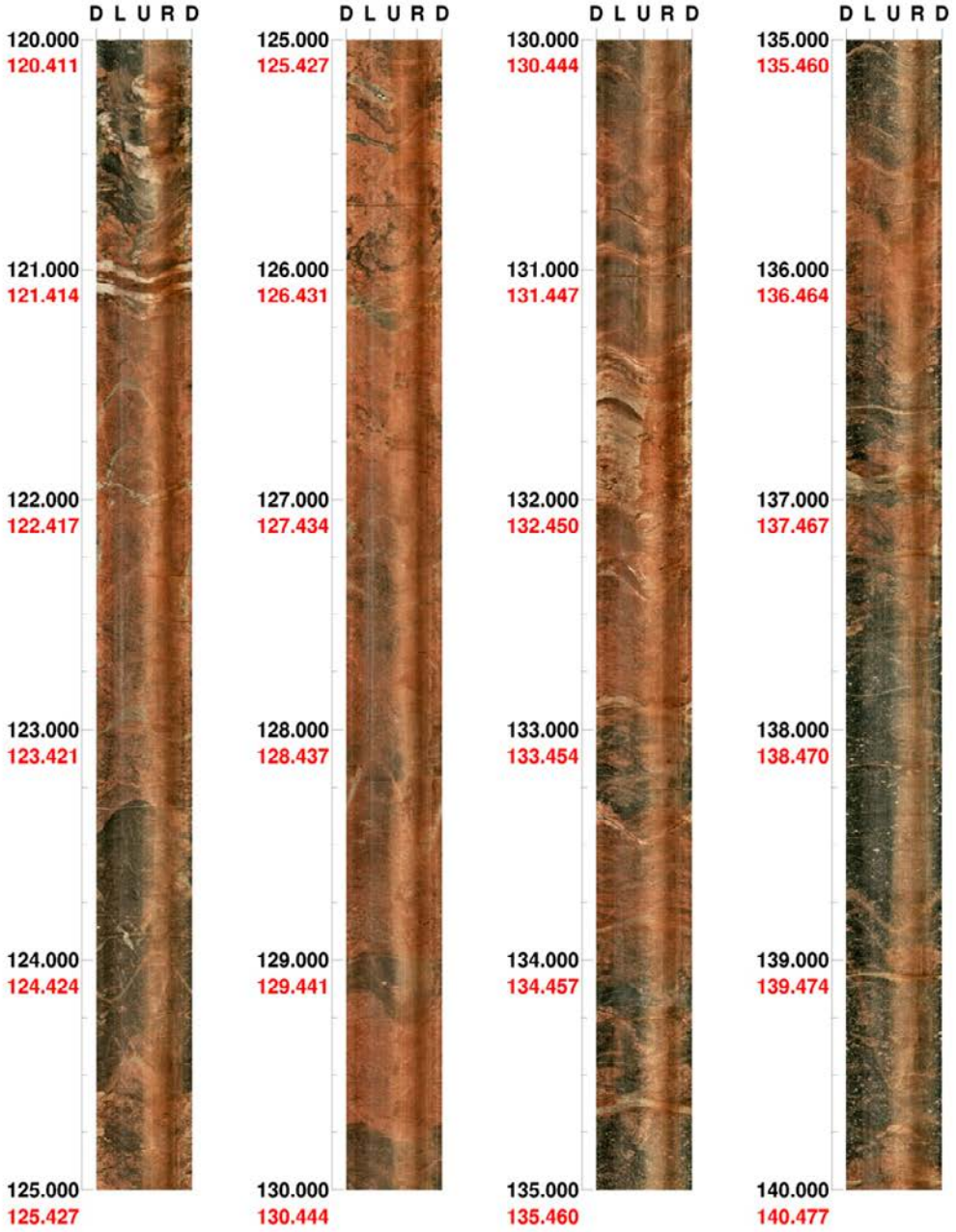
Depth range: 100.000 - 120.000 m



(6 / 11) Scale: 1/25 Aspect ratio: 175 %

Bore hole No.: KA307A01 Azimuth: 22 Inclination: -14

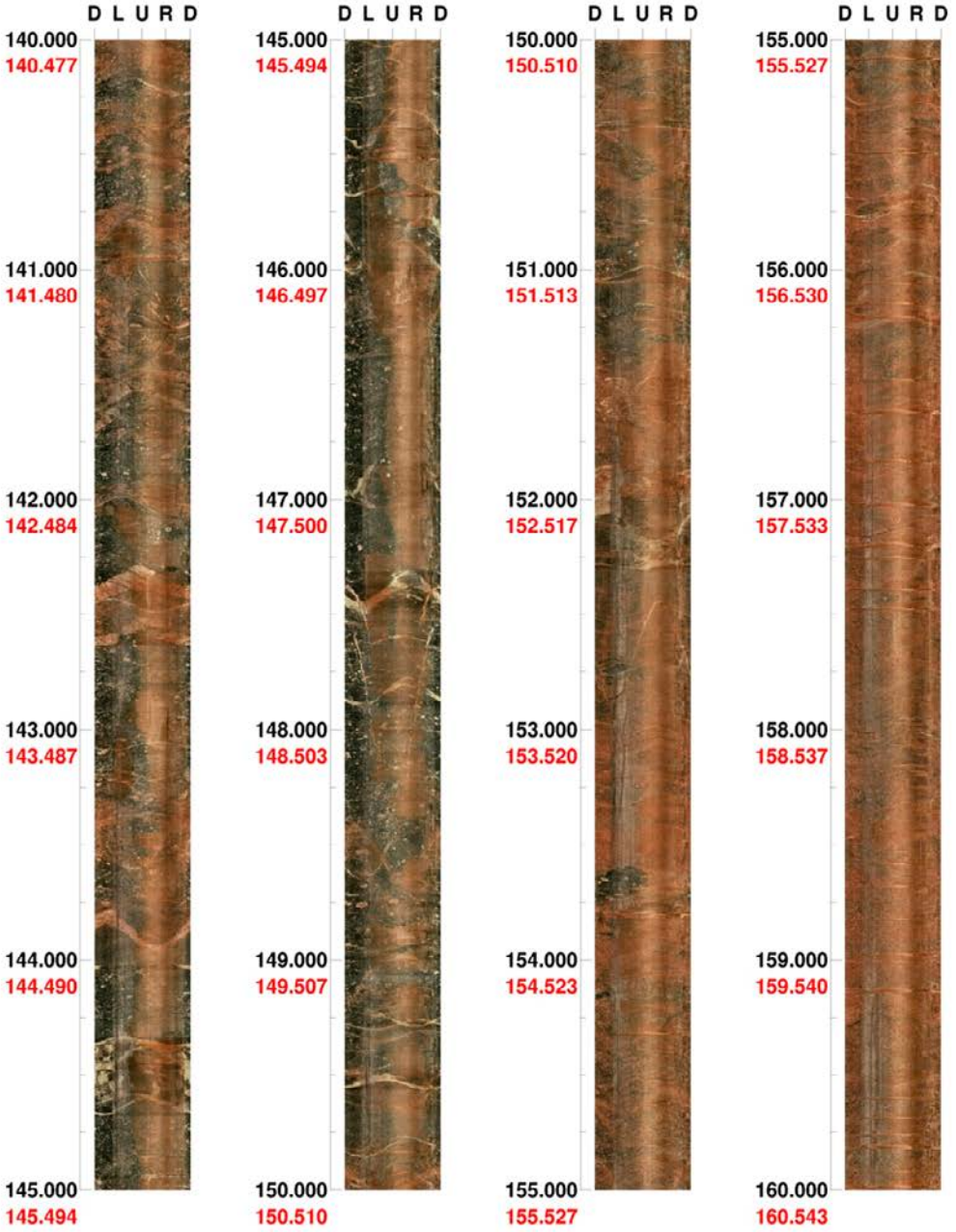
Depth range: 120.000 - 140.000 m



(7 / 11) Scale: 1/25 Aspect ratio: 175 %

Bore hole No.: KA307A01 Azimuth: 22 Inclination: -14

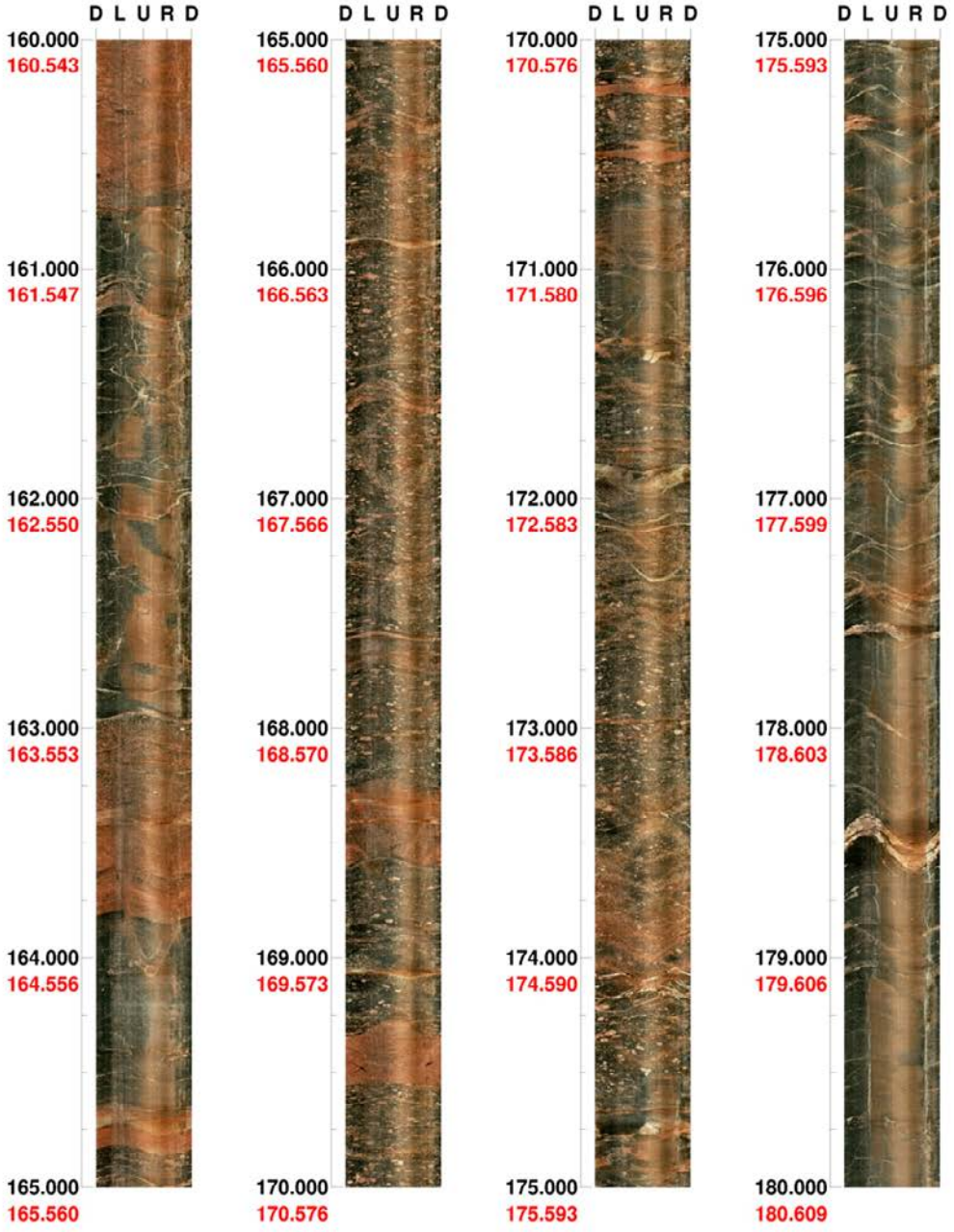
Depth range: 140.000 - 160.000 m



(8 / 11) Scale: 1/25 Aspect ratio: 175 %

Bore hole No.: KA307A01 Azimuth: 22 Inclination: -14

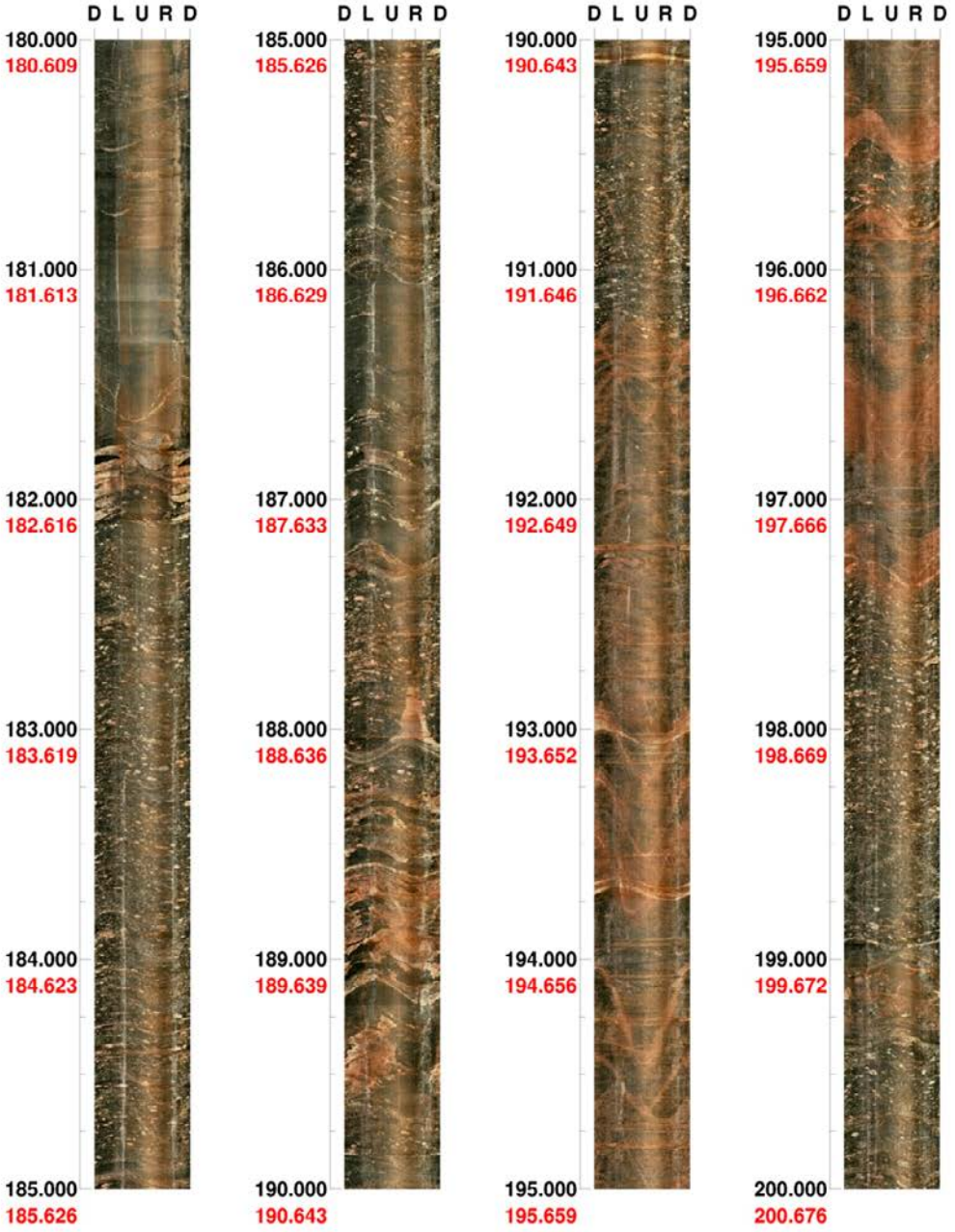
Depth range: 160.000 - 180.000 m



(9 / 11) Scale: 1/25 Aspect ratio: 175 %

Bore hole No.: KA307A01 Azimuth: 22 Inclination: -14

Depth range: 180.000 - 200.000 m



(10 / 11) Scale: 1/25 Aspect ratio: 175 %

Bore hole No.: KA307A01 Azimuth: 22 Inclination: -14

Depth range: 200.000 - 217.979 m

(11/ 11) Scale: 1/25 Aspect ratio: 175 %

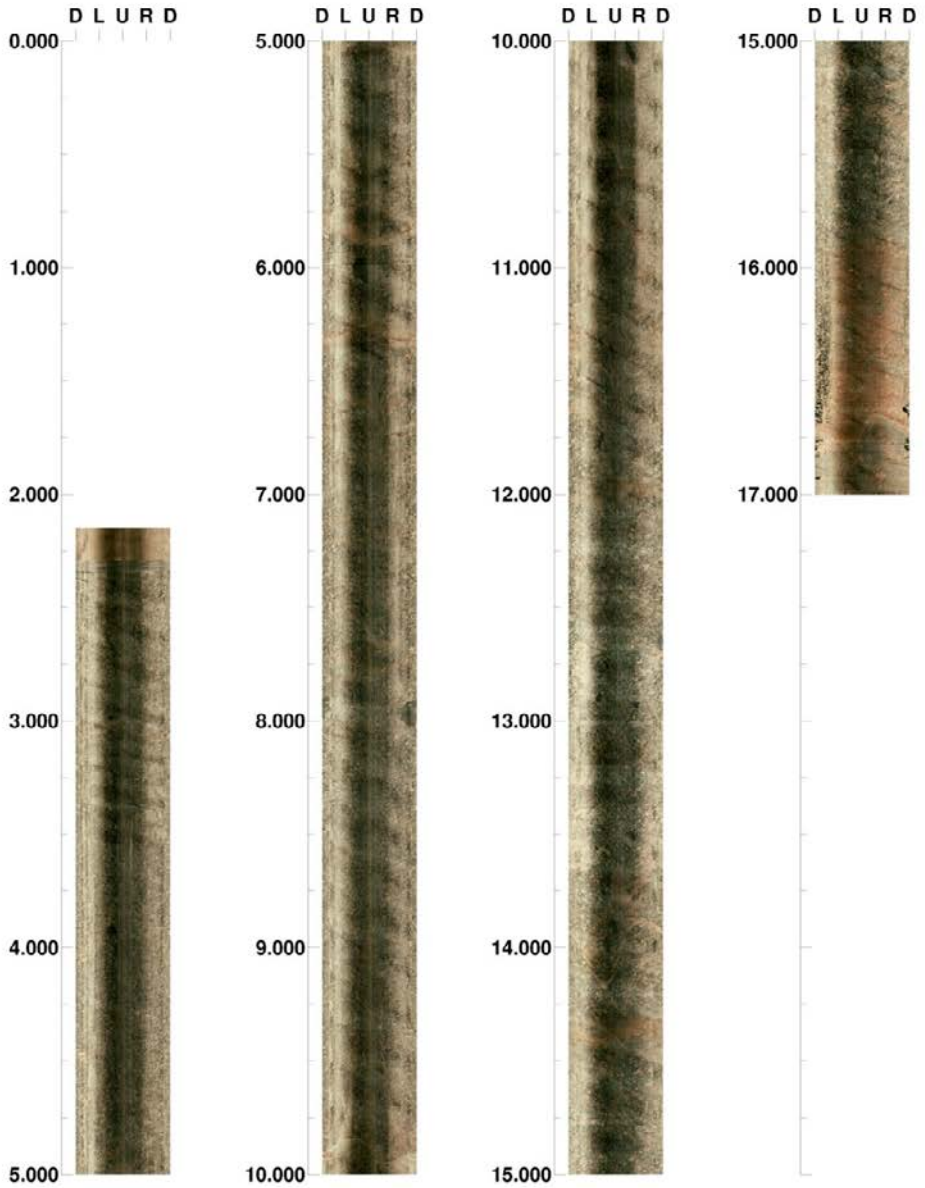
BIPS logging in KJ0044F01, 2.1 to 17.0 m

Project name: AP TDPRAS1004-11-022

Image file	: d:\work\r5911s~1\bips\kj0044~1.bip
BDT file	:
Locality	: ASPO HRL
Bore hole number	: KJ044F01
Date	: >0/01/01
Time	: 01:24:00
Depth range	: 2.146 - 17.000 m
Azimuth	: 0
Inclination	: -90
Diameter	: 76.0 mm
Magnetic declination	: 0.0
Span	: 4
Scan interval	: 0.25
Scan direction	: To entrance
Scale	: 1/25
Aspect ratio	: 175 %
Pages	: 1
Color	: +0 +0 +0

Project name: AP TDPRAS1004-11-022
Bore hole No.: KJ044F01 Azimuth: 0 Inclination: -90

Depth range: 0.000 - 17.000 m



(1 / 1) Scale: 1/25 Aspect ratio: 175 %

Appendix 7

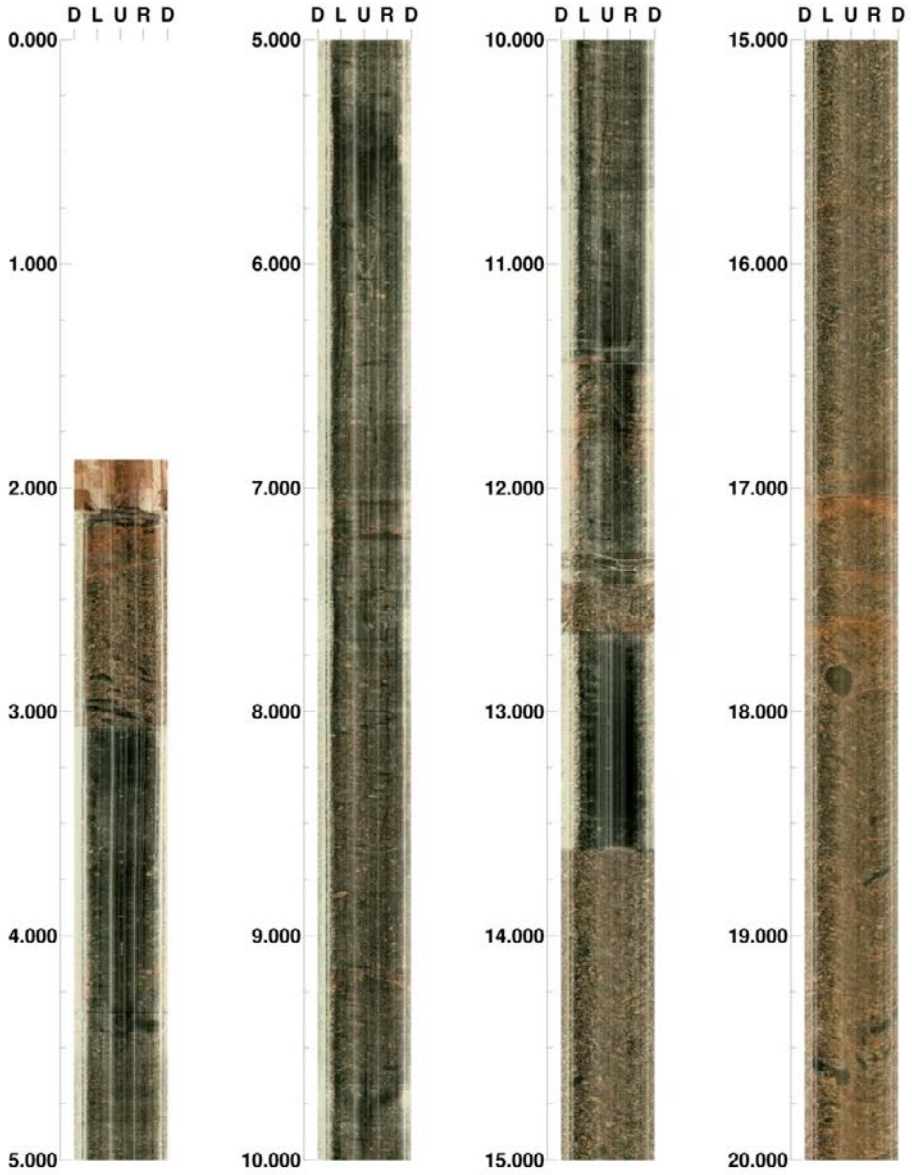
BIPS logging in KJ0050F01, 1.9 to 46.3 m

Project name: AP TDPRAS1004-11-022

Image file	: d:\work\r5911s~1\bips\kj0050~1.bip
BDT file	:
Locality	: ASPO HRL
Bore hole number	: KJ050F01
Date	: >0/01/01
Time	: 01:24:00
Depth range	: 1.871 - 46.300 m
Azimuth	: 0
Inclination	: -90
Diameter	: 76.0 mm
Magnetic declination	: 0.0
Span	: 4
Scan interval	: 0.25
Scan direction	: To entrance
Scale	: 1/25
Aspect ratio	: 175 %
Pages	: 3
Color	: +0 +0 +0

Project name: AP TDPRAS1004-11-022
Bore hole No.: KJ050F01 Azimuth: 0 Inclination: -90

Depth range: 0.000 - 20.000 m



(1 / 3) Scale: 1/25 Aspect ratio: 175 %

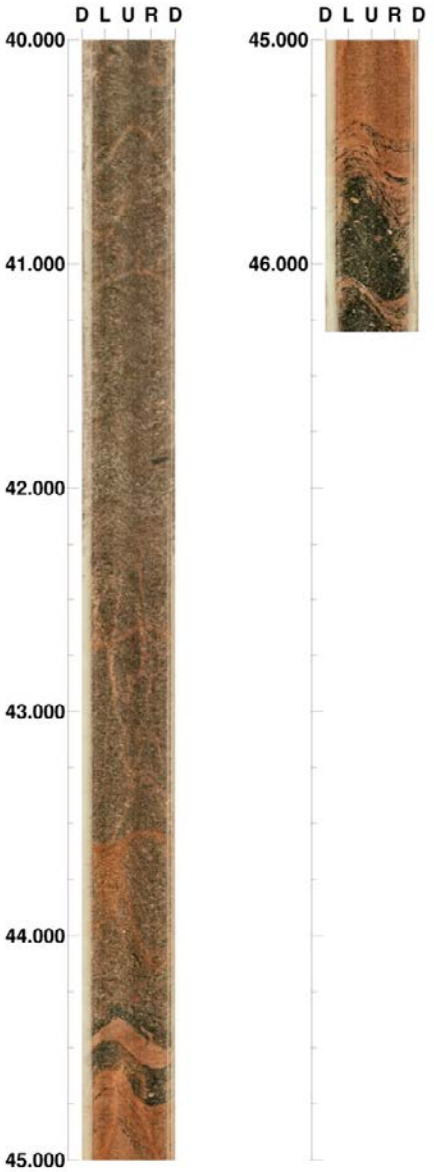
Project name: AP TDPRAS1004-11-022
Bore hole No.: KJ050F01 Azimuth: 0 Inclination: -90

Depth range: 20.000 - 40.000 m

(2 / 3) Scale: 1/25 Aspect ratio: 175 %

Project name: AP TDPRAS1004-11-022
Bore hole No.: KJ050F01 Azimuth: 0 Inclination: -90

Depth range: 40.000 - 46.300 m



(3 / 3) Scale: 1/25 Aspect ratio: 175 %

Deviation logging in KA2051A01, 0 to 315 m

Survey name:	**KA2051 IN**
Survey date:	18/06/2011 17:41:39
Project:	DP1 Karakterisering
Location:	Äspö HRL

Country:	Sweden
Survey company:	Malå GeoScience
Surveyed by:	Christer Gustafsson
Survey type:	STANDARD
Operating conditions:	
General comments:	AP TUDP002-11-017
Client name:	SKB
Client ID number:	
Client reference:	Leif Stenberg
Drill company:	
Drill rig:	
Drill diameter:	76
Survey direction:	INTO hole
Survey run on:	Wireline
Magnetic Var.:	2,53 degrees East of North

Conventions	
Linear units:	Metres
Angular units:	Degrees
Temperature units:	Centigrade
Co-ordinate system:	0 North
Elevation positive	Up
Dip origin:	0 Horizontal
Dip positive:	Up

Magnetic Integrity Check (MagIC)			
	Mid value	± limit	
Field strength:	49700	1000	nano Tesla
Magnetic dip:	71	1.5	Degrees

SURVEY	Actual start	End of survey	Difference
Station:	0,0	315,0	315,0
East:	0,00	255,45	255,45
North:	0,00	49,33	49,33
Elevation:	0,00	-176,90	-176,90
Dip:	-35,05	-33,36	1,69
Azimuth:	73,88	84,74	10,86

OFFSETS at end
Offsets relative to: ACTUAL START
3,98 metres upwards
23,54 metres right
1,29 metres shortfall

Printed on: 2011-10-02 13:16:17

FLEXIT: SmartTool drillhole survey result table.

Survey name: KA2051A01

Survey data: 18/06/2011 17:41:39

Printed on 2011-10-02 13:16:17

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	ToolRoll	MagToolFa	DLS	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	Degrees	Degrees	deg./m	*	Metres	Metres	Metres
0	-35,05	73,88	0	0	0	50328	71,42	0,995568	220,42	17,74	0	16	0	0	0
3	-34,67	73,85	2,36	0,68	-1,71	50238	70,9	1,002327	214,45	11,09	0,126	0	0,01	0	0
6	-34,75	73,92	4,73	1,37	-3,42	50374	70,95	1,00085	252,52	49,19	0,033	0	0,03	0	0
9	-34,76	74,28	7,1	2,04	-5,13	49356	70,64	1,00048	251,62	47,88	0,099	0	0,04	0,01	0
12	-34,75	75,25	9,48	2,69	-6,84	49770	69,39	1,000742	250,66	45,3	0,266	2	0,06	0,05	0
15	-34,77	73,46	11,86	3,36	-8,55	49381	70,22	1,000745	250,69	46,44	0,49	0	0,07	0,07	0
18	-34,77	74,25	14,22	4,04	-10,27	49218	69,48	1,000988	249,43	44,2	0,216	2	0,09	0,07	0
21	-34,72	74,58	16,6	4,7	-11,97	49454	70,23	1,000206	249,94	45,69	0,092	0	0,1	0,09	0
24	-34,71	75	18,98	5,35	-13,68	49001	69,61	1,000903	249,88	44,83	0,115	0	0,12	0,13	0
27	-34,74	74,93	21,36	5,99	-15,39	49049	70,29	1,000691	248,74	44,54	0,022	0	0,14	0,18	0
30	-34,73	75,18	23,74	6,63	-17,1	49349	70,07	1,00084	248,52	44,04	0,069	0	0,15	0,23	0
33	-34,75	74,91	26,12	7,26	-18,81	49157	69,86	1,000404	248,77	44,02	0,074	0	0,17	0,28	0
36	-34,73	73,8	28,5	7,93	-20,52	49813	70,93	1,000658	248,3	44,95	0,304	0	0,19	0,3	0
39	-34,7	74,9	30,87	8,59	-22,23	49464	70,55	1,00087	248,56	44,71	0,302	0	0,2	0,32	0
42	-34,7	74,5	33,25	9,24	-23,94	49568	70,43	1,000715	249,38	45,38	0,11	0	0,22	0,35	0
45	-34,68	74,58	35,63	9,9	-25,64	49440	70,64	1,000946	249,31	45,58	0,023	0	0,24	0,38	0
48	-34,66	74,67	38,01	10,55	-27,35	50387	70,61	1,000483	249,74	45,99	0,026	0	0,26	0,41	0
51	-34,67	75,7	40,39	11,19	-29,06	49918	71,38	1,000662	248,75	45,94	0,282	0	0,28	0,47	0
54	-34,6	75,2	42,78	11,81	-30,76	50222	71,16	1,000915	249,78	46,72	0,139	0	0,3	0,54	0
57	-34,6	74,82	45,17	12,44	-32,47	50388	71,24	1,00084	249,93	46,99	0,104	0	0,32	0,58	-0,01
60	-34,6	76,24	47,56	13,06	-34,17	49484	70,99	1,000835	249,09	45,8	0,39	0	0,35	0,66	-0,01
63	-34,6	75,69	49,95	13,66	-35,87	49983	70,42	1,000515	249,75	45,75	0,151	0	0,37	0,75	-0,01
66	-34,6	75,45	52,34	14,28	-37,58	49741	71,23	1,000709	249,05	46,07	0,066	0	0,39	0,82	-0,01

FLEXIT: SmartTool drillhole survey result table.

Survey name: KA2051A01

Survey data: 18/06/2011 17:41:39

Printed on 2011-10-02 13:16:17

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	ToolRoll	MagToolFa	DLS	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	Degrees	Degrees	deg./m	*	Metres	Metres	Metres
69	-34,52	75,42	54,74	14,9	-39,28	49741	71,27	1,000734	249,21	46,32	0,027	0	0,42	0,89	-0,01
72	-34,49	75,7	57,13	15,51	-40,98	49737	71,27	1,000714	250,26	47,37	0,078	0	0,45	0,96	-0,01
75	-34,53	75,86	59,53	16,12	-42,68	49715	71,26	1,000578	249,27	46,35	0,046	0	0,47	1,04	-0,01
78	-34,56	76,13	61,92	16,72	-44,38	49659	71,19	1,000951	248,95	45,92	0,075	0	0,5	1,13	-0,01
81	-34,55	76,21	64,32	17,31	-46,08	49645	71,17	1,0008	249,46	46,42	0,023	0	0,52	1,23	-0,02
84	-34,53	76,19	66,72	17,9	-47,78	49649	71,16	1,000715	249,23	46,17	0,009	0	0,55	1,33	-0,02
87	-34,52	76,38	69,12	18,49	-49,48	49655	71,15	1,000602	249,81	46,74	0,052	0	0,58	1,43	-0,02
90	-34,48	76,39	71,53	19,07	-51,18	49665	71,16	1,000958	249,37	46,33	0,012	0	0,6	1,54	-0,02
93	-34,45	76,42	73,93	19,65	-52,88	49689	71,16	1,000859	249,71	46,68	0,013	0	0,63	1,65	-0,02
96	-34,45	76,31	76,33	20,23	-54,57	49752	71,11	1,000455	249,86	46,77	0,03	0	0,66	1,76	-0,03
99	-34,43	76,64	78,74	20,81	-56,27	49726	71,16	1,000519	249,7	46,67	0,091	0	0,69	1,87	-0,03
102	-34,41	76,54	81,15	21,38	-57,97	49766	71,14	1,000943	249,56	46,51	0,028	0	0,73	1,99	-0,03
105	-34,37	76,55	83,56	21,96	-59,66	49759	71,12	1,00041	250,39	47,33	0,013	0	0,76	2,1	-0,03
108	-34,37	76,68	85,96	22,53	-61,35	49716	71,07	1,000575	249,76	46,63	0,036	0	0,79	2,22	-0,03
111	-34,49	76,68	88,37	23,1	-63,05	49741	71,13	1,000947	247,95	44,86	0,04	0	0,82	2,34	-0,04
114	-34,45	76,71	90,78	23,67	-64,75	49761	71,09	1,00069	249,28	46,16	0,015	0	0,85	2,46	-0,04
117	-34,47	76,81	93,19	24,24	-66,45	49714	71,11	1,000709	249,3	46,19	0,028	0	0,88	2,59	-0,04
120	-34,52	76,53	95,59	24,81	-68,15	49758	71,1	1,000844	249,06	45,93	0,078	0	0,91	2,71	-0,05
123	-34,49	77,18	98	25,37	-69,84	49659	71,09	1,000662	249,15	46	0,179	0	0,93	2,84	-0,05
126	-34,47	77,12	100,41	25,92	-71,54	49755	70,82	1,000845	250	46,53	0,017	0	0,96	2,98	-0,05
129	-34,45	77,32	102,82	26,47	-73,24	49749	71,11	1,000613	250,24	47,13	0,055	0	0,99	3,12	-0,06
132	-34,42	76,26	105,23	27,03	-74,94	50624	69,92	1,000719	250,52	45,93	0,292	0	1,02	3,25	-0,06
135	-34,4	77,8	107,64	27,59	-76,63	49694	70,84	1,000858	251,28	47,84	0,424	0	1,05	3,38	-0,06

FLEXIT: SmartTool drillhole survey result table.

Survey name: KA2051A01

Survey data: 18/06/2011 17:41:39

Printed on 2011-10-02 13:16:17

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	ToolRoll	MagToolFa	DLS	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	Degrees	Degrees	deg./m	*	Metres	Metres	Metres
138	-34,35	78,45	110,07	28,1	-78,33	49646	70,8	1,000819	249,9	46,43	0,18	0	1,08	3,57	-0,07
141	-34,31	78,24	112,49	28,6	-80,02	49741	70,67	1,00092	250,4	46,78	0,059	0	1,12	3,76	-0,07
144	-34,28	78,66	114,92	29,1	-81,71	49839	70,74	1,000939	250,05	46,52	0,116	0	1,15	3,96	-0,08
147	-34,26	78,86	117,35	29,58	-83,4	49716	70,69	1,000784	249,73	46,14	0,055	0	1,19	4,17	-0,09
150	-34,24	78,81	119,79	30,06	-85,09	49532	70,37	1,000373	250,11	46,14	0,016	0	1,23	4,38	-0,1
153	-34,19	79	122,22	30,54	-86,77	49893	71,08	1,000642	249,91	46,83	0,055	0	1,26	4,6	-0,1
156	-34,17	79,17	124,66	31,01	-88,46	49496	70,58	1,000731	250,46	46,77	0,047	0	1,3	4,82	-0,11
159	-34,14	79,2	127,1	31,47	-90,14	49765	70,88	1,000685	249,76	46,45	0,014	0	1,34	5,05	-0,12
162	-34,09	79,05	129,54	31,94	-91,83	49728	70,38	1,001186	250,22	46,3	0,045	0	1,39	5,28	-0,13
165	-34,06	79,41	131,98	32,41	-93,51	49772	70,79	1,000663	250,02	46,62	0,1	0	1,43	5,51	-0,14
168	-34,01	80,16	134,42	32,85	-95,18	49804	70,72	1,000709	250,45	46,98	0,208	0	1,48	5,77	-0,15
171	-33,97	79,77	136,87	33,28	-96,86	49604	70,72	1,000898	250,28	46,81	0,108	0	1,52	6,03	-0,16
174	-34	79,83	139,32	33,72	-98,54	49592	70,88	1,000812	249,7	46,43	0,019	0	1,57	6,29	-0,17
177	-34,02	80,19	141,77	34,15	-100,22	49639	70,6	1,000892	249,77	46,15	0,1	0	1,62	6,55	-0,19
180	-34	80,16	144,22	34,58	-101,89	49638	70,63	1,000391	249,87	46,29	0,01	0	1,66	6,83	-0,2
183	-33,96	80,61	146,67	34,99	-103,57	49538	70,54	1,00052	250,27	46,59	0,125	0	1,71	7,11	-0,21
186	-33,97	80,03	149,13	35,41	-105,25	49684	70,77	1,00053	249,72	46,32	0,16	0	1,76	7,39	-0,23
189	-33,96	80,98	151,58	35,82	-106,92	49382	70,59	1,000674	249,93	46,32	0,263	0	1,81	7,67	-0,24
192	-33,94	80,3	154,04	36,23	-108,6	49466	70,66	1,000771	249,95	46,43	0,188	0	1,85	7,97	-0,26
195	-33,94	80,44	156,49	36,64	-110,27	49319	70,8	1,000878	250,07	46,72	0,039	0	1,9	8,25	-0,27
198	-33,96	80,45	158,94	37,05	-111,95	49465	70,68	1,000376	250,5	47	0,006	0	1,95	8,53	-0,28
201	-33,91	80,76	161,4	37,46	-113,62	49922	70,89	1,000703	250,82	47,59	0,087	0	2	8,82	-0,3
204	-33,92	80,32	163,85	37,87	-115,3	49790	70,92	1,00049	250,25	47,05	0,122	0	2,05	9,11	-0,31

FLEXIT: SmartTool drillhole survey result table.

Survey name: KA2051A01

Survey data: 18/06/2011 17:41:39

Printed on 2011-10-02 13:16:17

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	ToolRoll	MagToolFa	DLS	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	Degrees	Degrees	deg./m	*	Metres	Metres	Metres
207	-33,89	80,86	166,31	38,28	-116,97	49815	70,96	1,000665	250,06	46,92	0,15	0	2,1	9,4	-0,33
210	-33,9	80,54	168,77	38,68	-118,65	49950	70,95	1,001072	249,97	46,82	0,089	0	2,15	9,7	-0,34
213	-33,92	80,72	171,22	39,08	-120,32	49520	70,83	1,000825	249,65	46,35	0,05	0	2,2	9,99	-0,36
216	-33,91	80,57	173,68	39,49	-121,99	49633	70,37	1,000349	249,91	46,04	0,042	0	2,25	10,29	-0,37
219	-33,96	82,01	176,14	39,87	-123,67	49654	70,79	1,000683	249,78	46,44	0,399	0	2,29	10,61	-0,39
222	-33,96	82,13	178,61	40,21	-125,34	49937	71,09	1,000498	249,88	46,91	0,033	0	2,34	10,96	-0,41
225	-33,97	82,2	181,07	40,55	-127,02	49933	71,12	1,000384	249,8	46,86	0,02	0	2,38	11,32	-0,43
228	-33,95	81,59	183,53	40,9	-128,7	49829	70,66	1,000464	250,05	46,54	0,169	0	2,42	11,67	-0,45
231	-33,96	81,44	186	41,27	-130,37	49521	70,13	1,000898	249,99	45,83	0,042	0	2,47	12	-0,47
234	-33,95	81,1	188,45	41,64	-132,05	49283	69,94	1,000644	250,06	45,66	0,094	0	2,51	12,32	-0,49
237	-33,96	80,83	190,91	42,04	-133,72	49376	69,44	1,000532	250,12	45,1	0,075	2	2,56	12,62	-0,5
240	-33,96	81,4	193,37	42,42	-135,4	49584	69,37	1,000867	250,09	44,99	0,158	2	2,6	12,94	-0,52
243	-33,95	81,79	195,83	42,78	-137,07	49416	69,8	1,000667	249,93	45,38	0,108	0	2,65	13,27	-0,54
246	-33,94	81,35	198,29	43,15	-138,75	49154	69,65	1,000693	249,99	45,25	0,122	0	2,69	13,6	-0,56
249	-33,92	82,39	200,76	43,5	-140,42	49625	70,32	1,00095	250,73	46,83	0,288	0	2,74	13,95	-0,58
252	-33,83	82,91	203,23	43,82	-142,1	49876	70,9	1,000542	250,44	47,29	0,147	0	2,78	14,33	-0,6
255	-33,81	82,56	205,7	44,13	-143,77	49797	70,61	1,000673	250,21	46,7	0,097	0	2,83	14,71	-0,63
258	-33,77	82,91	208,17	44,45	-145,43	49667	70,8	1,000848	249,97	46,71	0,098	0	2,88	15,1	-0,65
261	-33,76	83,06	210,65	44,75	-147,1	49719	70,81	1,000752	250,1	46,86	0,042	0	2,93	15,49	-0,68
264	-33,75	83,94	213,13	45,04	-148,77	49954	70,46	1,000711	249,17	45,53	0,244	0	2,98	15,91	-0,71
267	-33,75	83,58	215,61	45,31	-150,43	49601	70,57	1,00069	249,89	46,38	0,1	0	3,02	16,34	-0,74
270	-33,69	83,89	218,09	45,58	-152,1	49769	71	1,00082	250	47,03	0,088	0	3,07	16,76	-0,77
273	-33,65	83,88	220,57	45,85	-153,76	49629	70,7	1,000892	249,98	46,67	0,013	0	3,12	17,2	-0,8

FLEXIT: SmartTool drillhole survey result table.

Survey name: KA2051A01

Survey data: 18/06/2011 17:41:39

Printed on 2011-10-02 13:16:17

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	ToolRoll	MagToolFa	DLS	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	Degrees	Degrees	deg./m	*	Metres	Metres	Metres
276	-33,64	84,16	223,05	46,11	-155,43	49741	71,04	1,000669	250,32	47,43	0,078	0	3,17	17,64	-0,84
279	-33,55	84,02	225,54	46,36	-157,09	49620	71,01	1,000766	250,53	47,61	0,048	0	3,23	18,08	-0,87
282	-33,53	84,14	228,03	46,62	-158,74	49691	71,24	1,000629	250,15	47,53	0,034	0	3,28	18,52	-0,9
285	-33,46	84,19	230,52	46,88	-160,4	49688	71,23	1,000698	250,7	48,08	0,027	0	3,34	18,97	-0,94
288	-33,38	84,24	233,01	47,13	-162,05	49720	71,23	1,001023	250,73	48,13	0,031	0	3,4	19,42	-0,97
291	-33,38	84,26	235,5	47,38	-163,7	49711	71,18	1,00054	250,11	47,46	0,006	0	3,47	19,87	-1,01
294	-33,38	84,31	237,99	47,63	-165,35	49681	71,2	1,000971	249,99	47,36	0,014	0	3,53	20,32	-1,04
297	-33,35	84,33	240,49	47,88	-167	49640	71,29	1,000895	249,6	47,09	0,012	0	3,6	20,78	-1,08
300	-33,37	84,38	242,98	48,12	-168,65	49679	71,33	1,000768	249,57	47,1	0,015	0	3,66	21,23	-1,11
303	-33,34	84,36	245,47	48,37	-170,3	49711	71,36	1,000781	250,08	47,65	0,01	0	3,73	21,69	-1,15
306	-33,33	84,36	247,97	48,61	-171,95	49753	71,38	1,000672	250,05	47,66	0,004	0	3,79	22,14	-1,18
309	-33,34	84,47	250,46	48,86	-173,6	49793	71,39	1,000685	249,84	47,45	0,031	0	3,86	22,6	-1,22
312	-33,37	84,68	252,96	49,1	-175,25	49828	71,37	1,0004	249,63	47,21	0,059	0	3,92	23,07	-1,26
315	-33,36	84,74	255,45	49,33	-176,9	49861	71,38	1,000719	251,32	48,92	0,017	0	3,98	23,54	-1,29

Deviation logging in KA3007A01, 0 to 216 m

Survey name:	**KA3007A01**
Survey date:	09/06/2011 20:20:53
Project:	DP1 Karakterisering
Location:	Äspö HRL

Country:	Sweden
Survey company:	Malå GeoScience
Surveyed by:	Christer Gustafsson
Survey type:	STANDARD
Operating conditions:	
General comments:	AP TUDP002-11-017
Client name:	SKB
Client ID number:	
Client reference:	Leif Stenberg
Drill company:	
Drill rig:	
Drill diameter:	76
Survey direction:	INTO hole
Survey run on:	Wireline
Magnetic Var.:	2,53 degrees East of North

Conventions	
Linear units:	Metres
Angular units:	Degrees
Temperature units:	Centigrade
Co-ordinate system:	0 North
Elevation positive	Up
Dip origin:	0 Horizontal
Dip positive:	Up

Magnetic Integrity Check (MagIC)	Mid value	± limit	
Field strength:	49700	1000	nano Tesla
Magnetic dip:	71	1.5	Degrees

SURVEY	Actual start	End of survey	Difference
Station:	0,0	216,0	216,0
East:	0,00	33,59	33,59
North:	0,00	206,54	206,54
Elevation:	0,00	-53,50	-53,50
Dip:	-14,86	-13,81	1,05
Azimuth:	9,53	8,56	-0,97

OFFSETS at end
Offsets relative to: ACTUAL START
1,96 metres upwards
1,07 metres left
0,03 metres shortfall

Printed on: 2011-10-02 14:12:34

FLEXIT: SmartTool drillhole survey result table.

Survey name: KA3007A01

Survey data: 09/06/2011 20:20:53

Printed on 2011-10-02 14:12:34

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	ToolRoll	MagToolFa	DLS	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	Degrees	Degrees	deg./m	*	Metres	Metres	Metres
0	-14,86	9,53	0	0	0	51612	69,54	1,001032	333,05	148,91	0	17	0	0	0
3	-14,91	9,57	0,48	2,86	-0,77	50033	71	1,000934	328,02	145,27	0,02	0	0	0	0
6	-14,83	9,84	0,97	5,72	-1,54	49926	71,16	1,000623	326,72	143,9	0,091	0	0	0,01	0
9	-14,83	9,84	1,47	8,57	-2,31	49926	71,16	1,000671	326,72	143,9	0,001	0	0	0,03	0
12	-14,77	9,95	1,96	11,43	-3,07	49972	71,35	1,0008	328,72	145,89	0,041	0	0	0,04	0
15	-14,78	9,91	2,46	14,29	-3,84	50040	71,36	1,001244	334,42	151,61	0,014	0	0,01	0,06	0
18	-14,76	9,75	2,96	17,15	-4,6	50127	71,38	1,000872	335,72	152,97	0,052	0	0,01	0,08	0
21	-14,75	10,08	3,46	20,01	-5,37	50040	71,35	1,000658	336,2	153,32	0,106	0	0,02	0,1	0
24	-14,75	10,32	3,97	22,86	-6,13	49929	71,3	1,001423	336,31	153,33	0,077	0	0,02	0,13	0
27	-14,75	9,57	4,47	25,72	-6,9	49853	71,36	1,001106	336,04	153,36	0,242	0	0,03	0,15	0
30	-14,74	10,06	4,97	28,58	-7,66	49824	71,32	1,000559	337,37	154,49	0,158	0	0,04	0,17	0
33	-14,71	10,14	5,48	31,43	-8,42	49852	71,28	1,000807	335,06	152,14	0,028	0	0,04	0,2	0
36	-14,68	11	6,01	34,29	-9,18	48722	70,44	1,001038	336,6	153,19	0,277	0	0,05	0,25	0
39	-14,67	9,59	6,53	37,14	-9,94	50094	71,37	1,000668	337,38	154,69	0,455	0	0,06	0,29	0
42	-14,67	9,86	7,02	40	-10,7	50038	71,24	1,000672	336,97	154,16	0,087	0	0,07	0,3	0
45	-14,65	9,94	7,52	42,86	-11,46	49977	71,29	1,001087	336,85	154,02	0,026	0	0,08	0,32	0
48	-14,65	9,5	8,01	45,72	-12,22	49963	71,43	1,000828	336,98	154,34	0,142	0	0,09	0,33	0
51	-14,68	10,14	8,5	48,58	-12,98	49960	71,15	1,000882	335,85	152,92	0,207	0	0,1	0,34	0
54	-14,69	10,72	9,03	51,44	-13,74	50111	71,33	1,00116	335,07	151,94	0,187	0	0,11	0,39	0
57	-14,7	9,08	9,53	54,29	-14,5	49958	71,29	1,000958	335,34	152,83	0,529	0	0,12	0,41	0
60	-14,68	9,71	10	57,16	-15,26	49940	71,11	1,000825	333,44	150,66	0,203	0	0,13	0,4	0
63	-14,68	9,7	10,49	60,02	-16,02	50025	71,36	1,000724	334,45	151,72	0,004	0	0,14	0,41	0
66	-14,68	9,36	10,97	62,88	-16,78	49936	71,25	1,000841	333,38	150,76	0,11	0	0,15	0,41	0

FLEXIT: SmartTool drillhole survey result table.

Survey name: KA3007A01

Survey data: 09/06/2011 20:20:53

Printed on 2011-10-02 14:12:34

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	ToolRoll	MagToolFa	DLS	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	Degrees	Degrees	deg./m	*	Metres	Metres	Metres
69	-14,56	9,33	11,44	65,74	-17,54	49695	71,13	1,000105	302,27	119,64	0,043	0	0,16	0,4	0
72	-14,55	9,11	11,91	68,61	-18,29	50245	71,22	1,000207	293,44	110,91	0,071	0	0,18	0,38	0
75	-14,5	8,98	12,36	71,48	-19,05	50229	71,25	1,000305	289,07	106,6	0,045	0	0,19	0,36	0
78	-14,45	9,36	12,83	74,35	-19,8	50063	71,2	1,000163	286,12	103,5	0,124	0	0,21	0,34	0
81	-14,42	9,61	13,3	77,21	-20,54	49779	71,09	1,00071	281,8	99,06	0,082	0	0,24	0,34	0
84	-14,4	10	13,8	80,07	-21,29	49796	71,04	1,000574	280,76	97,87	0,126	0	0,26	0,35	0
87	-14,39	9,64	14,3	82,94	-22,04	49761	71,41	1,000512	279,85	97,16	0,116	0	0,28	0,37	0
90	-14,39	9,18	14,77	85,8	-22,78	49857	71,36	1,000615	279,31	96,78	0,149	0	0,31	0,36	0
93	-14,37	9,11	15,23	88,67	-23,53	50111	71,51	1,000256	281,93	99,45	0,024	0	0,33	0,34	0
96	-14,38	9,05	15,69	91,54	-24,27	50127	71,49	1,000534	285,23	102,78	0,02	0	0,36	0,32	0
99	-14,37	9,31	16,15	94,41	-25,02	50099	71,31	1,0004	284,83	102,25	0,084	0	0,38	0,3	0
102	-14,35	8,88	16,61	97,28	-25,76	50356	71,27	1,000774	282,02	99,6	0,139	0	0,41	0,28	0
105	-14,36	9,21	17,07	100,15	-26,5	50012	71,43	1,000474	283,79	101,27	0,107	0	0,44	0,25	0
108	-14,31	8,83	17,53	103,02	-27,25	50174	71,48	1,000377	283,8	101,43	0,124	0	0,46	0,23	0
111	-14,33	9,62	17,99	105,89	-27,99	50163	71,52	1,000354	285,33	102,67	0,255	0	0,49	0,21	0
114	-14,32	8,79	18,46	108,76	-28,73	50376	71,69	1,000526	287,26	104,94	0,268	0	0,52	0,2	0
117	-14,3	9,06	18,91	111,63	-29,47	50391	71,36	1,000243	287,41	104,93	0,087	0	0,55	0,16	-0,01
120	-14,36	9,26	19,37	114,5	-30,22	50394	71,47	1,000125	286,91	104,37	0,068	0	0,58	0,15	-0,01
123	-14,35	9,27	19,84	117,37	-30,96	50399	71,47	1,000183	286,91	104,37	0,003	0	0,6	0,13	-0,01
126	-14,32	9,3	20,31	120,24	-31,7	50345	71,32	1,000178	282,96	100,39	0,014	0	0,63	0,12	-0,01
129	-14,31	9,38	20,78	123,11	-32,44	50392	71,27	1,000454	285,68	103,06	0,026	0	0,66	0,11	-0,01
132	-14,31	9,28	21,25	125,98	-33,19	50344	71,26	1,000599	286,63	104,05	0,032	0	0,69	0,1	-0,01
135	-14,28	9,26	21,72	128,85	-33,93	50371	71,29	1,000579	283,49	100,93	0,012	0	0,72	0,09	-0,01

FLEXIT: SmartTool drillhole survey result table.

Survey name: KA3007A01

Survey data: 09/06/2011 20:20:53

Printed on 2011-10-02 14:12:34

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	ToolRoll	MagToolFa	DLS	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	Degrees	Degrees	deg./m	*	Metres	Metres	Metres
138	-14,28	9,37	22,19	131,71	-34,67	50312	71,25	1,000391	285,45	102,84	0,036	0	0,75	0,08	-0,01
141	-14,27	9,16	22,66	134,58	-35,41	50236	71,16	1,000461	285,65	103,1	0,068	0	0,78	0,06	-0,01
144	-14,25	9,12	23,12	137,45	-36,14	50242	71,1	1,000518	282,58	100,04	0,016	0	0,81	0,04	-0,01
147	-14,21	8,95	23,58	140,33	-36,88	50264	71,17	1,000508	284,35	101,89	0,056	0	0,84	0,02	-0,01
150	-14,14	9,02	24,03	143,2	-37,62	50109	71,13	1,000644	283,47	100,98	0,032	0	0,88	-0,01	-0,01
153	-14,12	9,06	24,49	146,07	-38,35	50047	71,11	1,000367	283,56	101,05	0,016	0	0,92	-0,03	-0,01
156	-14,1	9,21	24,95	148,94	-39,08	50105	71,07	1,000306	285,72	103,14	0,049	0	0,96	-0,05	-0,01
159	-14,1	9,02	25,41	151,82	-39,81	50105	71,13	1,000554	279,26	96,77	0,061	0	1	-0,08	-0,01
162	-14,01	8,9	25,86	154,69	-40,54	50066	71,09	1,00058	270,64	88,19	0,049	0	1,04	-0,1	-0,01
165	-14	8,81	26,31	157,57	-41,27	50030	71,2	1,000541	264,39	81,99	0,029	0	1,08	-0,14	-0,01
168	-13,99	8,61	26,75	160,45	-41,99	49997	71,24	1,001069	263,26	80,94	0,065	0	1,13	-0,18	-0,01
171	-14,02	8,28	27,18	163,33	-42,72	50005	71,03	1,00082	266,77	84,55	0,107	0	1,17	-0,24	-0,01
174	-13,98	8,63	27,61	166,2	-43,44	49972	71,01	1,000885	264,3	81,94	0,114	0	1,22	-0,29	-0,01
177	-13,97	8,62	28,04	169,08	-44,17	49989	70,99	1,001148	260,06	77,71	0,006	0	1,26	-0,34	-0,01
180	-13,95	8,64	28,48	171,96	-44,89	49997	71	1,00098	263,71	81,35	0,01	0	1,31	-0,38	-0,01
183	-13,86	8,75	28,92	174,84	-45,61	50067	71,2	1,001225	245,94	63,57	0,045	0	1,36	-0,42	-0,01
186	-13,86	8,54	29,36	177,72	-46,33	49958	71,08	1,001709	240,05	57,74	0,068	0	1,41	-0,47	-0,01
189	-13,81	8,25	29,79	180,6	-47,05	50110	71,18	1,001653	230,67	48,48	0,095	0	1,47	-0,53	-0,02
192	-13,83	8,15	30,2	183,48	-47,76	50060	71,47	1,00138	222,67	40,56	0,033	0	1,52	-0,59	-0,02
195	-13,79	8,26	30,62	186,37	-48,48	49976	71,1	1,001089	210,6	28,4	0,038	0	1,58	-0,66	-0,02
198	-13,83	8,34	31,04	189,25	-49,2	49890	70,91	1,001272	193,57	11,31	0,03	0	1,63	-0,72	-0,02
201	-13,85	8,36	31,46	192,13	-49,91	49899	71,08	1,000808	172,35	350,11	0,01	0	1,68	-0,78	-0,02
204	-13,82	8,28	31,88	195,02	-50,63	49838	71,15	1,000271	159,12	336,92	0,028	0	1,74	-0,85	-0,02

FLEXIT: SmartTool drillhole survey result table.

Survey name: KA3007A01

Survey data: 09/06/2011 20:20:53

Printed on 2011-10-02 14:12:34

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	ToolRoll	MagToolFa	DLS	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	Degrees	Degrees	deg./m	*	Metres	Metres	Metres
207	-13,8	8,34	32,3	197,9	-51,35	49838	71,13	1,000425	159,14	336,92	0,021	0	1,79	-0,91	-0,02
210	-13,82	8,45	32,73	200,78	-52,06	49960	71	1,000011	156,98	334,69	0,036	0	1,85	-0,97	-0,02
213	-13,8	8,54	33,16	203,66	-52,78	49847	71,02	0,999846	152,79	330,47	0,03	0	1,9	-1,02	-0,02
216	-13,81	8,56	33,59	206,54	-53,5	49850	71,03	1,000087	152,8	330,48	0,007	0	1,96	-1,07	-0,03

Deviation logging in KJ0050F01, 0 to 45 m

Survey name:	**KJ0050F01_in**
Survey date:	19/06/2011 15:33:22
Project:	DP1 Karakterisering
Location:	Äspö HRL

Country:	Sweden
Survey company:	Malå GeoScience
Surveyed by:	Christer Gustafsson
Survey type:	STANDARD
Operating conditions:	
General comments:	AP TUDP002-11-017
Client name:	SKB
Client ID number:	
Client reference:	Leif Stenberg
Drill company:	
Drill rig:	
Drill diameter:	76
Survey direction:	INTO hole
Survey run on:	Wireline
Magnetic Var.:	2,53 degrees East of North

Conventions	
Linear units:	Metres
Angular units:	Degrees
Temperature units:	Centigrade
Co-ordinate system:	0 North
Elevation positive	Up
Dip origin:	0 Horizontal
Dip positive:	Up

Magnetic Integrity Check (MagIC)			
	Mid value	± limit	
Field strength:	49700	1000	nano Tesla
Magnetic dip:	71	1.5	Degrees

SURVEY	Actual start	End of survey	Difference
Station:	0,0	45,0	45,0
East:	0,00	30,03	30,03
North:	0,00	33,35	33,35
Elevation:	0,00	-3,25	-3,25
Dip:	-4,65	-3,24	1,41
Azimuth:	42,89	40,94	-1,95

OFFSETS at end
Offsets relative to: ACTUAL START
0,40 metres upwards
0,69 metres left
0,01 metres shortfall

Printed on: 2011-10-02 14:43:06

FLEXIT: SmartTool drillhole survey result table.

Survey name: KJ0050F01

Survey data: 19/06/2011 15:33:22

Printed on 2011-10-02 14:43:06

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	ToolRoll	MagToolFa	DLS	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	Degrees	Degrees	deg./m	*	Metres	Metres	Metres
0	-4,65	42,89	0	0	0	49141	70,55	1,0006	164,39	331,19	0	0	0	0	0
3	-4,82	41,77	2,01	2,21	-0,25	49076	70,41	1,0001	81,43	248,41	0,376	0	0	-0,03	0
6	-4,61	40,84	3,99	4,46	-0,49	49372	70,63	1,0014	173,97	341,37	0,316	0	-0,01	-0,11	0
9	-4,58	41,7	5,96	6,7	-0,73	49012	70,22	1,0007	152,44	319,31	0,286	0	-0,01	-0,2	0
12	-4,51	40,82	7,93	8,95	-0,97	49320	70,3	1,0002	170,61	337,79	0,293	0	0	-0,28	0
15	-4,55	42,62	9,92	11,18	-1,21	48733	69,85	1,0006	347,13	153,5	0,598	0	0,01	-0,34	0
18	-4,5	41,48	11,92	13,4	-1,45	49117	70,06	1,0002	73,55	240,38	0,379	0	0,01	-0,39	0
21	-4,3	42,66	13,93	15,63	-1,68	48898	69,85	1,001	137,2	303,58	0,398	0	0,03	-0,43	-0,01
24	-4,12	42,87	15,96	17,82	-1,9	48830	70,21	1,0005	160,39	326,99	0,093	0	0,05	-0,44	-0,01
27	-3,99	42,99	18	20,01	-2,11	48562	70,01	1,0018	209,73	16,17	0,059	1	0,08	-0,43	-0,01
30	-3,87	42,71	20,03	22,21	-2,31	48500	70,17	1,0017	228,22	34,86	0,101	1	0,12	-0,44	-0,01
33	-3,78	42,98	22,07	24,4	-2,51	48425	69,99	1,0009	174,46	340,9	0,094	1	0,16	-0,44	-0,01
36	-3,62	42,65	24,1	26,6	-2,71	48088	70,13	1,0016	205,14	11,78	0,122	1	0,21	-0,44	-0,01
39	-3,5	40,78	26,1	28,83	-2,89	49382	71,04	1,0013	190,5	358,28	0,624	0	0,27	-0,5	-0,01
42	-3,37	41,34	28,06	31,09	-3,07	49338	70,98	1,0021	222,59	30,19	0,191	0	0,33	-0,6	-0,01
45	-3,24	40,94	30,03	33,35	-3,25	49502	71,22	1,0001	159,66	327,54	0,14	0	0,4	-0,69	-0,01