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Oskarshamn site investigation

RAMAC, BIPS and deviation logging in boreholes KLX17A and HLX43

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January 2007

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

This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the authors and do not necessarily coincide with those of the client.

A pdf version of this document can be downloaded from www.skb.se

Abstract

This report includes the data gained in geophysical logging operations performed within the site investigation at Oskarshamn. The logging operations presented here includes borehole radar (RAMAC), BIPS and deviation logging in the core drilled borehole KLX17A and in the percussion drilled borehole HLX43. All measurements were conducted by Malå Geoscience AB/RAYCON during November and December 2006.

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 survey, the result is presented as images. Radar data is presented in radargrams and the identified reflectors are listed. The deviation measurement is presented as a list of data.

The borehole radar data quality from KLX17A and HLX43 was satisfying to relatively good, but in parts of lower quality due to more conductive conditions. This conductive environment of course reduces the possibility to distinguish and interpret possible structures in the rock mass which otherwise could give a reflection. However, the borehole radar measurements resulted in 178 identified radar reflectors in KLX17A and of these 16 were orientated (strike/dip). In HLX43 20 structures were identified.

The images from the BIPS survey in KLX17A was not of the best quality. Mud covering the lower part of the borehole limits the visibility. However in HLX43 the water quality is of very high quality and resulted in perfect images.

Sammanfattning

Denna rapport omfattar geofysiska loggningar inom platsundersökningsprogrammet för Oskarshamn. Mätningarna som presenteras här omfattar borrhålsradarmätningar (RAMAC), och BIPS-loggningar i kärnborrhålet KLX17A och i hammarborrhålet HLX43. I alla borrhål genomfördes även avvikelsemätningar, s.k. krökningsmätningar. Alla mätningar är utförda av Malå Geoscience AB/RAYCON under november och december 2006.

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 KLX17A och HLX43 var tillfredställande till relativt bra, men bitvis med sämre djuppenetration troligen till stor del beroende på en konduktiv miljö. En konduktiv miljö minskar möjligheterna att identifiera strukturer från borrhålsradardata. Dock har 178 radarreflektorer identifierats i KLX17A och av dessa har 16 orienterats (med strykning/stupning). I HLX43 identifierades 20 strukturer.

BIPS mätningarna i KLX17A är inte av bästa kvalitet. Borrkax täcker borrhålsväggens nedre kant och försämrar kvalitén på bilderna väsentligt. I HLX43 är dock vattenkvalitén bra och BIPS bilderna utmärkta.

Contents

1 Introduction

This report presents the data gained in geophysical logging operations, which is one of the activities performed within the site investigation at Oskarshamn. The logging operations presented here includes borehole radar (RAMAC) and BIPS in the core drilled borehole KLX17A and in the percussion drilled borehole HLX43. In both boreholes deviation measurements were also carried out.

The work was carried out in accordance with activity plan AP PS 400-06-136. 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 from 0 to 694 m in KLX17A. The borehole was core drilled with a diameter of 76 mm. The measurements in HLX43 was made from 0 to 167 m. The borehole was percussion drilled with a diameter of 140 mm.

All measurements were conducted by Malå Geoscience AB/RAYCON during November and December 2006. The investigation site and location of the boreholes is 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
Borrhålsradar, BIPS och Flexit-mätning i KLX17A och HLX43.	AP PS 400-06-136	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för TV-loggning med BIPS	SKB MD 222.006	1.0
Metodbeskrivning för borrhålsradar	SKB MD 252.020	2.0
Metodbeskrivning för krökningsmätning av hammar- och kärnborrhål	SKB MD 224.001	1.0

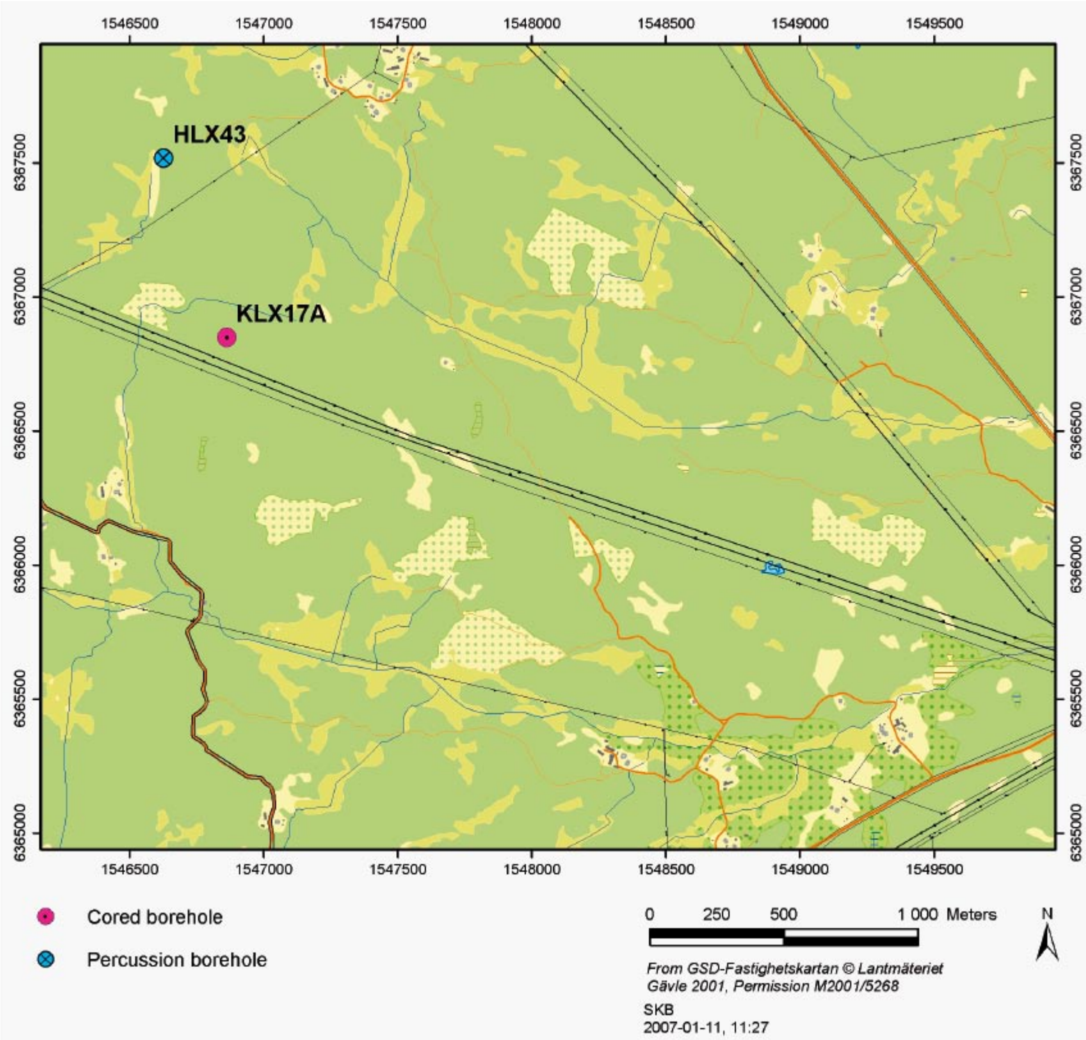


Figure 1-1. *Map of the location of the boreholes KLX17A and HLX43 in the Laxemar subarea, Oskarshamn.*

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 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 250 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 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.

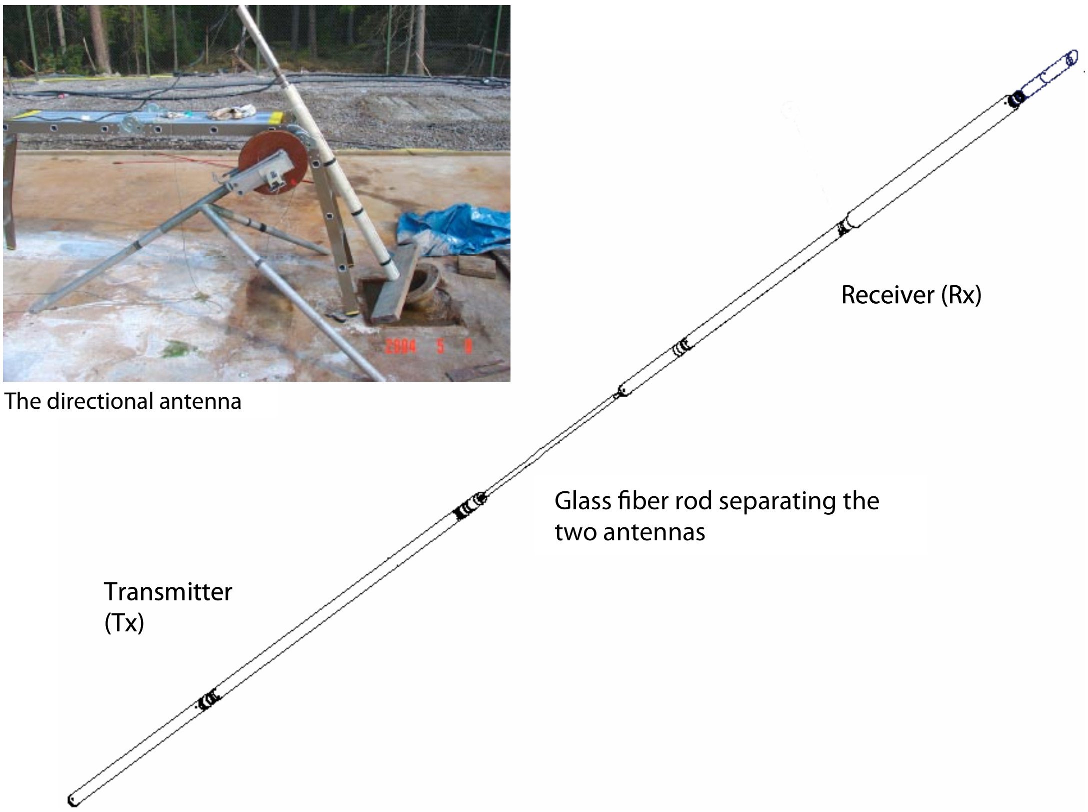


Figure 3-1. *Example of a borehole radar antenna.*

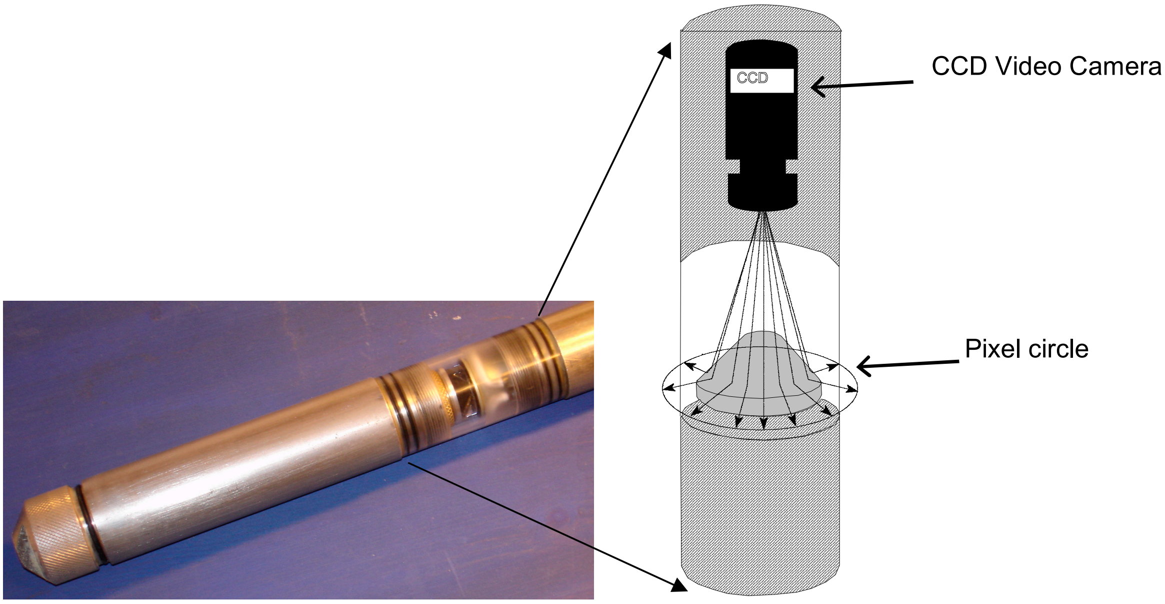


Figure 3-2. *The BIP-system. Illustration of the conical mirror scanning.*

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

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 are 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 this 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.

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

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 symbol with more than two "hands" is visible 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

4 Execution

4.1 General

4.1.1 RAMAC Radar

The measurements in KLX17A and HLX43 were carried out with dipole radar antennas, with frequencies of 250, 100 and 20 MHz. In KLX17A 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 fiber rods according to Tables 4-1 and 4-2. See also Figures 3-1 and 4-1.

All measurements were performed in accordance with the instructions and guidelines from SKB (internal document 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 in KLX17A. 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 10 degrees. This can be considered to be satisfying due to the disturbed environment, with metallic objects etc at the test site.

For more information on system settings used in the investigation of KLX17A and HLX43 see Tables 4-1 and 4-2 below.

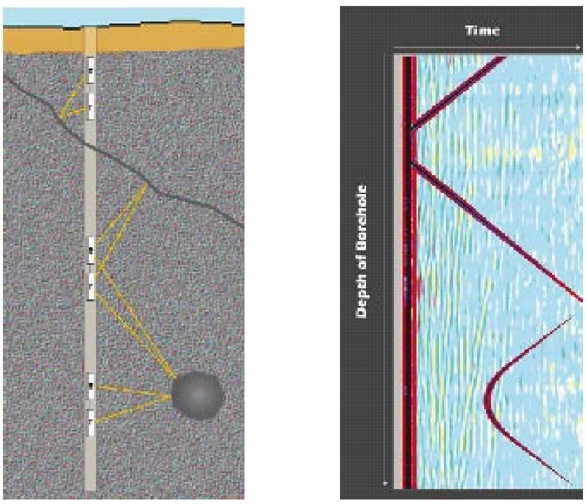


Figure 4-1. *The principle of radar borehole reflection survey and an example of result.*

Table 4-1. Radar logging information from KLX17A.

Site:	Oskarshamn	Logging company:	MALÅ GeoScience/RAYCON		
BH:	KLX17A	Equipment:	SKB RAMAC		
Type:	Directional/Dipole	Manufacturer:	MALÅ GeoScience		
Operator:	CG	Antenna			
		Directional	250 MHz	100 MHz	20 MHz
Logging date:		2006-11-29	2006-11-29	2006-11-29	2006-11-29
Reference:		T.O.C.	T.O.C.	T.O.C.	T.O.C.
Sampling frequency (MHz):		615	2,424	891	239
Number of samples:		512	619	518	518
Number of stacks:		32	Auto	Auto	Auto
Signal position:		410.5	–0.36	–0.36	–1.42
Logging from (m):		69.4	1.5	2.6	6.25
Logging to (m):		683.9	696.8	695.4	691.65
Trace interval (m):		0.5	0.1	0.2	0.25
Antenna separation (m):		5.73	2.4	3.9	10.05

Table 4-2. Radar logging information from HLX43.

Site:	Oskarshamn	Logging company:	MALÅ GeoScience/RAYCON	
BH:	HLX43	Equipment:	SKB RAMAC	
Type:	Dipole	Manufacturer:	MALÅ GeoScience	
Operator:	CG	Antenna		
		250 MHz	100 MHz	20 MHz
Logging date:		2006-12-01	2006-12-01	2006-12-01
Reference:		T.O.C.	T.O.C.	T.O.C.
Sampling frequency (MHz):		2,424	891	239
Number of samples:		619	518	518
Number of stacks:		Auto	Auto	Auto
Signal position:		–0.36	–0.36	–1.42
Logging from (m):		1.5	2.6	6.25
Logging to (m):		168.2	167.2	163.2
Trace interval (m):		0.1	0.2	0.25
Antenna separation (m):		2.4	3.9	10.05

4.1.2 BIPS

All measurements were performed in accordance with the instructions and guidelines from SKB (internal document 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 a air bulb in a alcohol liquid was used to measure the orientation of the images in the boreholes KLX17A and HLX43.

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 November and December 2006. 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 for every single borehole presented in Appendices 3 and 4 in this report.

4.1.3 Deviation measurements

The deviation measurements were carried out according to the instructions and guidelines from SKB (internal document 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. For the operation in the core drilled boreholes the RAMAC/BIPS winch installed in the container was used together with the standard length measuring devices. For an accurate depth control the length recording was adjusted regularly for every 50 metre by the actual marks on the logging cable. In the percussion drilled boreholes the dummy winch was used for the logging. No depth control is possible for the measuring wheel due to lack off reference marks on the logging cable. Maximum depth error for the measuring wheel is 0.5%.

Before KLX17A **After HLX43**

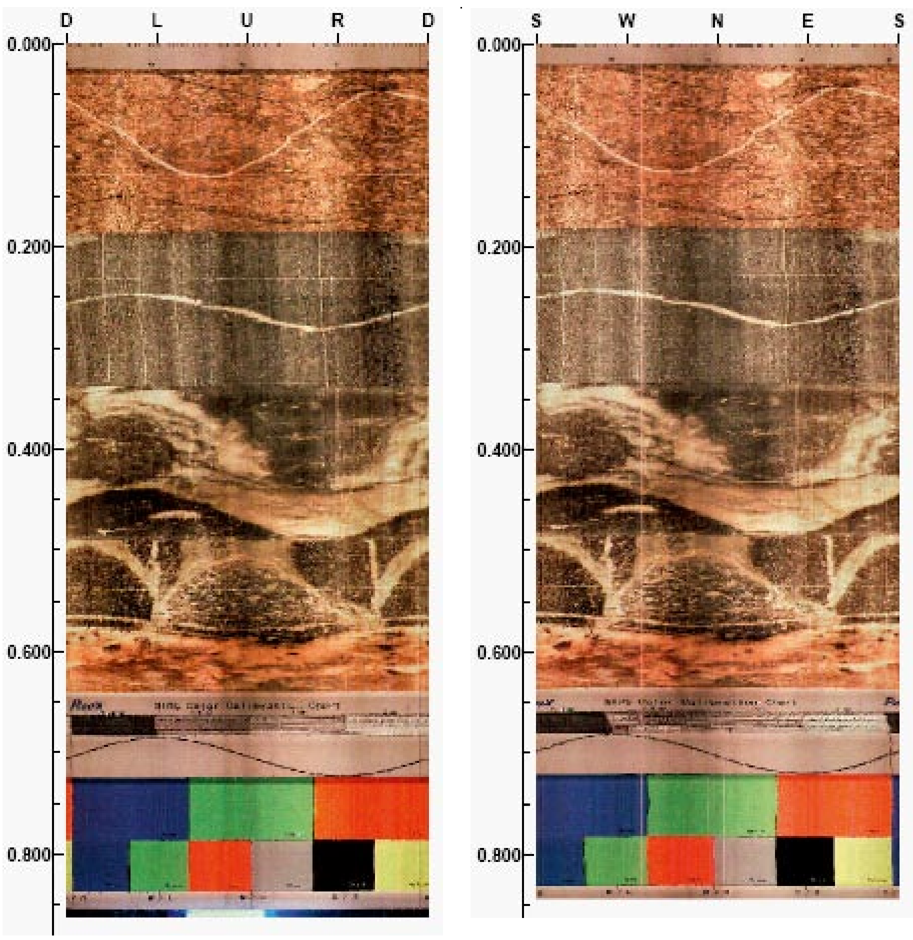


Figure 4-2. *Results from logging in the test pipe before and after the logging campaign in November and December, 2006.*

4.1.4 Length measurements

During logging the depth recording for the RAMAC systems is taken care of by a measuring wheel mounted on the cable winch. The logging is measured from TOC (Top of Casing). The length is adjusted to the bottom of casing when visible in the BIPS image.

During the BIPS logging in core drilled boreholes, where the reference marks in the borehole wall is visible on the image, the position where the depth mark is visible is marked with scotch tape on the logging cable. During BIPS logging the measured length was adjusted to true length according to depth mark visible in the BIPS image. The adjusted true length is marked with red in the image plot together with the non-adjusted measured length. The non-adjusted length is marked with black as seen in Appendices 3 and 4. The tape marks on the logging cable are then used for controlling the RAMAC measurement.

The experience we have from earlier measurements with dipole antennas in the core drilled boreholes in Forsmark and Oskarshamn for the radar logging is that the depth divergence is less than 100 cm in the deepest parts of a 1,000 metre deep borehole.

The depth divergence is taken into account in the resulting tables in Chapter 5.

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 was performed between KLX07A and KLX07B by keeping the transmitter fixed in one borehole while moving the receiver downwards in a nearby borehole. The velocity measurement was performed with the 20 MHz antennas in boreholes KLX07A and KLX07B /1/.

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 depth 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 Tables 4-3 and 4-4. It should be observed that the processing steps in Tables 4-3 and 4-4 below refer to Appendices 1 and 2 in this report. The filters applied affect the whole borehole length and are

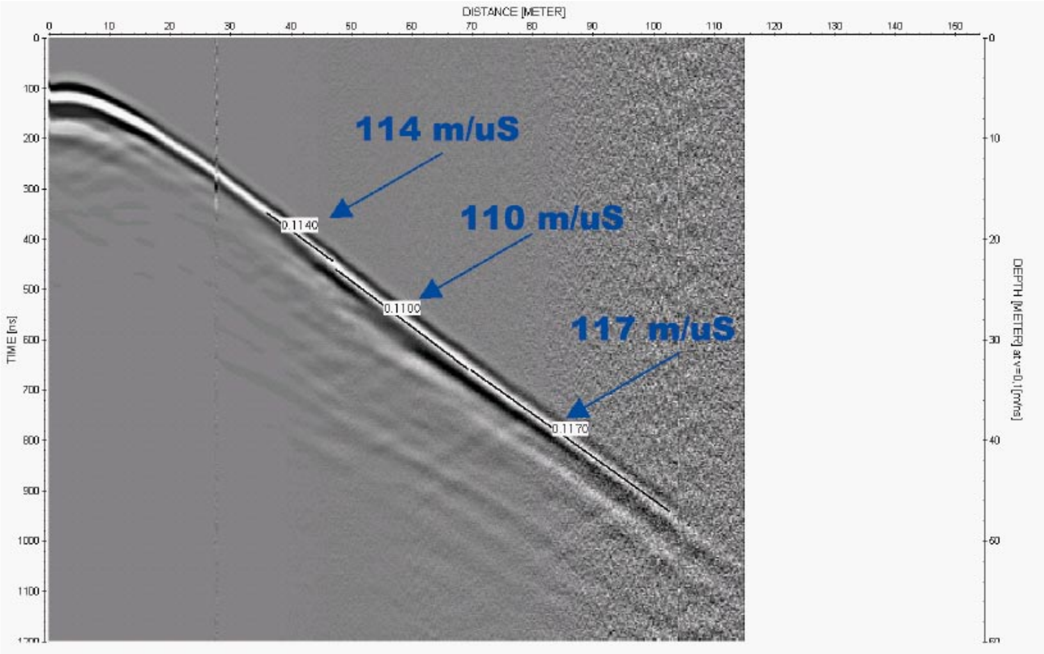


__Figure 4-3.__ Results from velocity measurements /1/.

Table 4-3. Processing steps for borehole radar data from KLX17A.

Site:	**Oskarshamn**	**Logging company:**	**MALÅ GeoScience/RAYCON**		
BH:	**KLX17A**				
		Equipment:	**SKB RAMAC**		
Type:	**Directional/Dipole**	**Manufacturer:**	**MALÅ GeoScience**		
Interpret:	**JG**	**Antenna**			
		Directional	**250 MHz**	**100 MHz**	**20 MHz**
Processing:		Move start time (–52 samples)	Move start time (–20)	Move start time (–49.8)	Move start time (–10)1.5
		DC shift (400–510)	DC shift (190–230)	DC shift (470–530)	DC shift (1,800–2,000)
		Time gain (start 84 lin 100 exp 5)	Gain (start 16 lin 1.4 exp 0.9)	Gain (start 32 lin 1.4 exp 0.6)	Gain (start 44 lin 6.2 exp 0.07)
		(FIR)			

Table 4-4. Processing steps for borehole radar data from HLX43.

Site:	**Oskarshamn**	**Logging company:**	**MALÅ GeoScience/RAYCON**	
BH:	**HLX43**			
		Equipment:	**SKB RAMAC**	
Type:	**Dipole**	**Manufacturer:**	**MALÅ GeoScience**	
Interpret:	**JG**	**Antenna**		
		250 MHz	**100 MHz**	**20 MHz**
Processing:		Move start time (–19.7)	Move start time (–36.58)	Move start time (–99.7)
		DC removal (190–230)	DC removal (470–530)	DC removal (1,800–2,000)
		Gain (start 19 lin 1 exp 1)	Gain (start 51 lin 3 exp 0.3)	Gain (start 96 lin 3 exp 0.2)

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 the Tables 5-3 and 5-4 and are also visible on the radargrams in Appendices 1 and 2.

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 5 and 6. For delivery to SICADA the azimuth was delivered relatively to magnetic North.

4.3 Nonconformities

No nonconformities occurred during the logging campaign in November and December, 2006.

5 Results

The results from the BIPS measurements for KLX17A and HLX43 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 and VHS tapes stored by SKB.

The RAMAC radar data was delivered as raw data (file format *.rd3 (dipole antennas) or *.rd5 (directional antenna)) for KLX17A and HLX43 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 5 and 6 in this report. Each reading station depth are referred from T.O.C. 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 5-7. Radar data is also visualized in Appendices 1 and 2. It should be remembered that the images in Appendices 1 and 2 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 are given in Figure 5-1 below. A number of minor structures also exist but not interpreted as indicated in the Appendices. 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. Larger structures parallel to the borehole, if present, are also indicated in the Appendices. An example of a large structure, stretching from approximately from 280 to 440 m, is given in Figure 5-2. It should also be pointed out that reflections interpreted will always get an intersection point with the borehole, but being located further away. They may in some cases not reach the borehole.

The data quality from KLX17A and HLX43, (as seen in Appendices 1 and 2) is relatively good, but in parts of lower quality due to more conductive conditions. This is seen in both boreholes, for example in the lower part of KLX17A (500 to 700 m). 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. In parts with an increased conductivity and thereby a decreased depth penetration most often only the edges of structures can be distinguished, giving an intersection angle of 90 degrees. This is especially seen for the 250 MHz data from HLX43.

The effect of a conductive environment is also seen in the directional antenna for KLX17A, which makes it more difficult to interpret the direction to the identified structures.

Further on, depending on the size of the borehole, the conductivity and the antenna frequency, so called ringing can be achieved, which again makes the interpretation of single structures quite complicated. This is seen in the data from KLX17A, (250 and 100 MHz data) for the first 60 m, where the borehole diameter is larger. See also Figure 5-3.

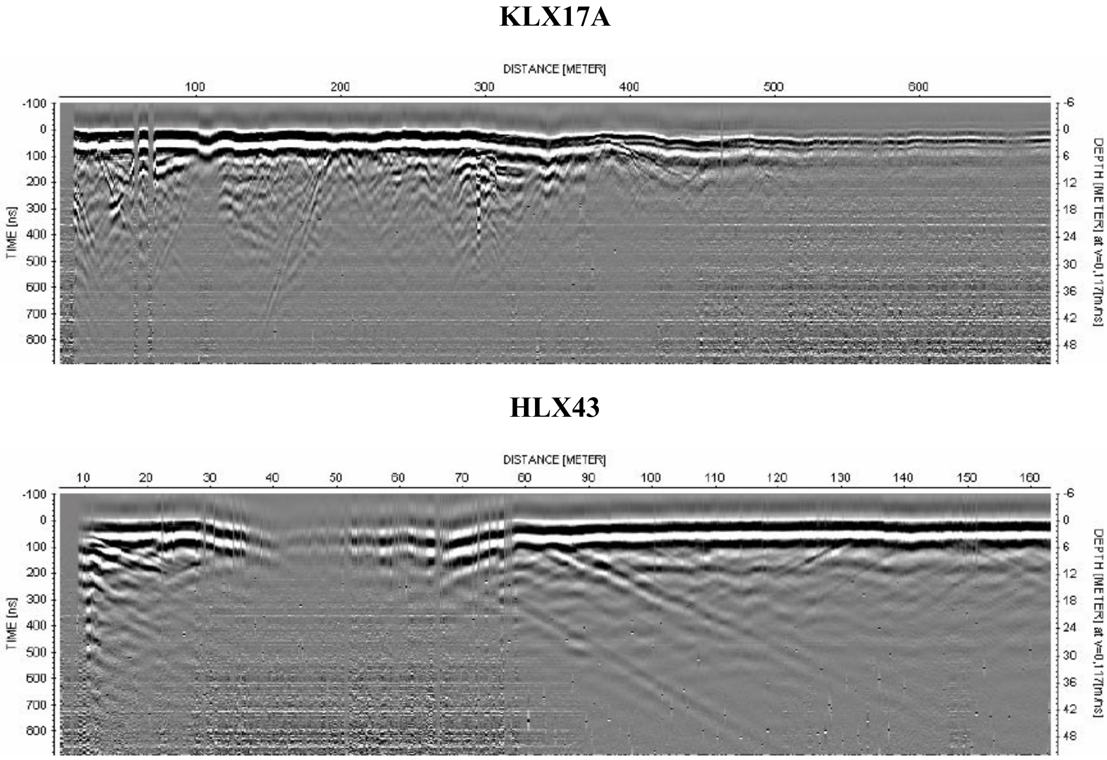


Figure 5-1. An overview (20 MHz data) of the radar data for the boreholes KLX17A and HLX43. Observe that the length (x-scale) differs between the different boreholes.

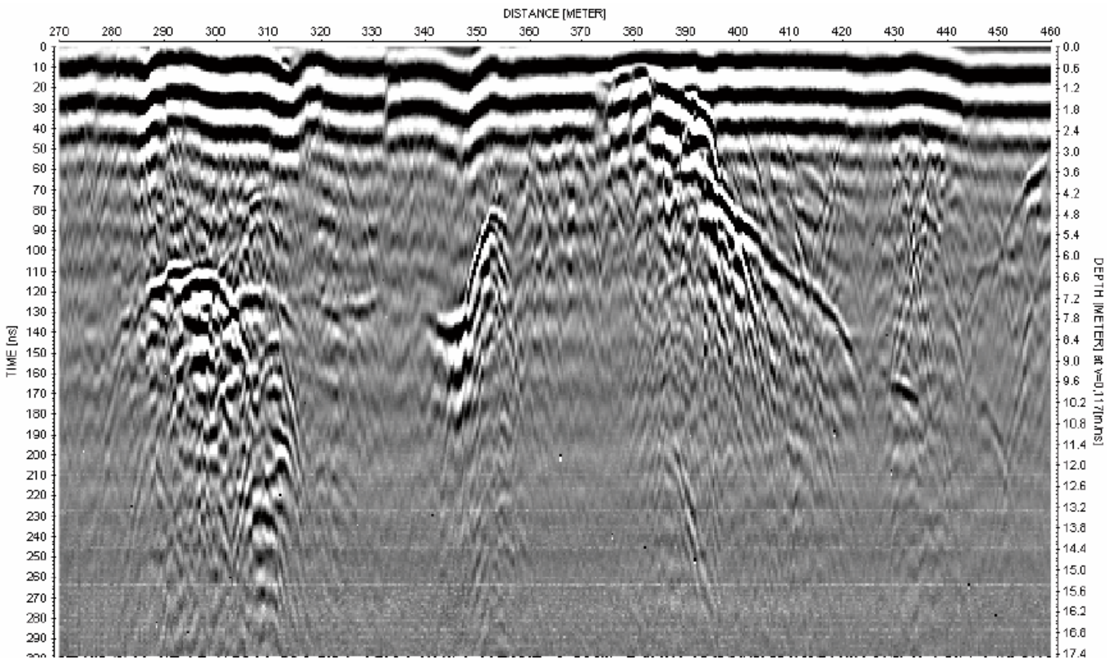


Figure 5-2. A detail from KLX17A with a clear structure which most probably stretches from 280 to 440 m borehole length.

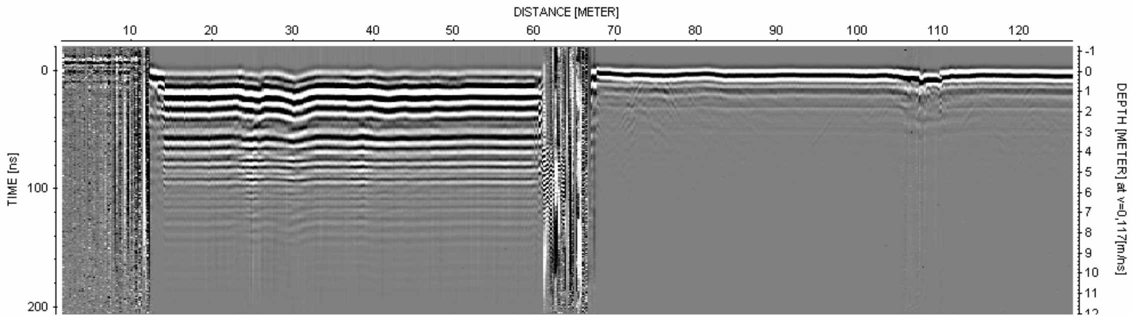


Figure 5-3. *Example of raw data from KLX17A (250 MHz data). The effect of the two different borehole diameters are clearly seen, in the amount of so called ringing, in the upper part compared to the lower part of the borehole.*

As also seen in Appendices 1 and 2 the resolution and penetration of radar waves depend on the antenna frequency used. Low antenna frequency gives less resolution but higher penetration depth compared to a higher frequency. If structures can be identified with all three antenna frequencies, it can probably be explained by that the structure is quite significant.

In Tables 5-1 and 5-2 below the distribution of identified structures along the borehole are listed for KLX17A and HLX43.

Table 5-1. Identified structures as a function of depth in KLX17A.

Depth (m)	No. of structures
–50	2
50–100	9
100–150	19
150–200	16
200–250	16
250–300	18
300–350	12
350–400	14
400–450	11
450–500	12
500–550	11
550–600	10
500–650	15
650–700	13
700–	1

Table 5-2. Identified structures as a function of depth in HLX43.

Depth (m)	No. of structures
–20	2
20–40	1
40–60	2
60–80	5
80–100	1
100–120	1
120–140	2
140–160	4
160–	2

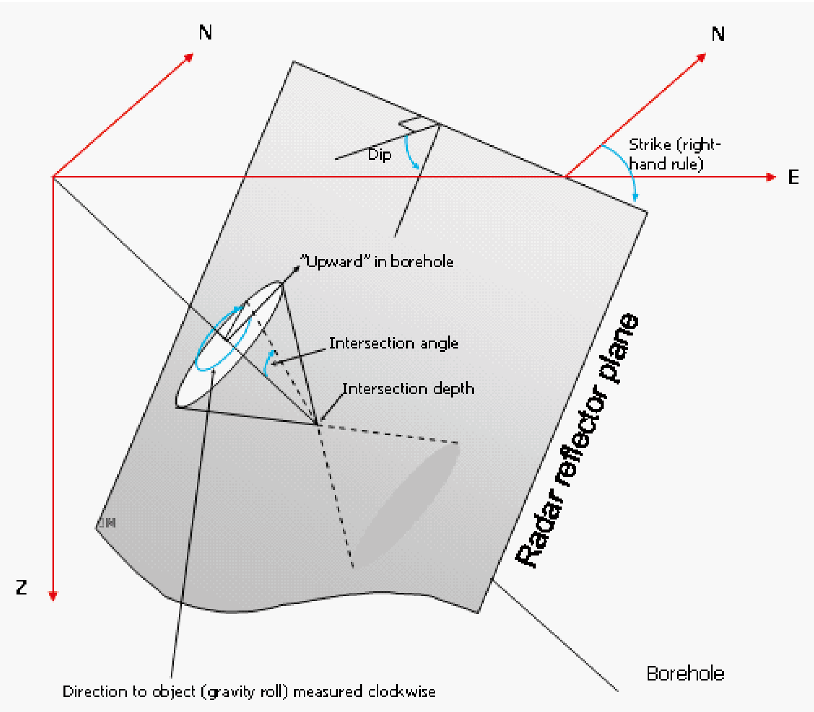


Figure 5-4. *Definition of intersection angle, direction to object using gravity roll, dip and strike using the right hand rule as presented in Table 5-3.*

Tables 5-3 and 5-4 summarises the interpretation of radar data from KLX17A and HLX43. The direction to the reflector (object) is also given for the borehole KLX17A. As seen some radar reflectors in Table 5-3 are marked with ±, which indicates an uncertainty in the interpretation of direction. The direction can in these cases be ±180 degrees. The 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 Table 5-3. The plane strike is the angle between line of the plane's cross-section with the surface and the Magnetic North direction. It counts clockwise 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.

Observe that a structure can have several different angles, if the structure is undulating, and thereby also different intersection depths is given. This is seen for instance for structure 12 in Table 5-3 and Appendix 1. To this structure, most likely, also structure 12x belongs.

Table 5-3. Interpretation of radar reflectors from the dipole antennas 250, 100 and 20 MHz, and the directional antenna 60 MHz in borehole KLX17A.

Radinter model information (Directional antenna)							
Site:		Oskarshamn					
Borehole name:		KLX17A					
Nominal velocity (m/μs):		117.0					
Name	**Intersection depth**	**Intersection angle**	**RadInter direction to object (gravity roll)**	**Dip 1**	**Strike 1**	**Dip 2**	**Strike 2**
1	22.5	63					
2	22.8	70					
17	58.2	56					
3	72.8	77					
4	74.8	60					
5	76.7	61					
7	78.6	63					
6	80.4	77					
11	82.5	53					
9	91.4	48					
8	98.6	21					
12x	101.0	61					
12	103.3	33					
18	104.1	32					
13	105.2	71					
14	106.4	65					
15	112.8	69					
16	115.2	75					
20	117.6	72					
170	119.6	50					
19	124.0	64					
22	133.2	67					
21	133.9	74					
24	141.5	76					
23	143.1	74					
25	137.5	70					
30	140.7	60					
27	146.0	60					
28	146.1	82					
26	147.1	55					
29	151.9	68					
168	152.1	48					
10	153.1	8	114	71	209		
171	155.8	68					
32	164.2	33					
31	166.8	68					
42	169.4	78					
33	169.9	27					
173	174.1	75					
176	174.8	14	294 ±	89	40	66	206
34	183.6	84					

Radinter model information
(Directional antenna)

Site:	**Oskarshamn**
Borehole name:	**KLX17A**
Nominal velocity (m/μs):	**117.0**

Name	Intersection depth	Intersection angle	RadInter direction to object (gravity roll)	Dip 1	Strike 1	Dip 2	Strike 2
36	192.0	67					
37	194.0	79					
35	194.7	46					
38	195.4	61	192 ±	6	17	57	108
172	197.3	69					
40	200.0	79					
39	200.4	59					
172x	201.8	69					
41	208.1	64					
43	212.4	61					
44	214.6	68					
46	222.7	72	294 ±	39	79	27	141
45	223.1	56					
47	225.0	51					
48	230.5	75					
52	234.3	75					
49	235.1	53					
50	236.9	62					
51	238.5	71					
174	246.3	63					
53	247.4	22					
55	250.4	75					
54	251.5	42					
57	254.0	55					
56	257.3	62					
59	266.8	43					
58	269.3	53	285 ±	48	60	36	165
60	270.7	60					
61	273.3	61					
62	281.0	50					
64	281.0	60					
63	283.4	51					
65	283.5	58					
67	278.7	65					
68	286.2	54					
66	287.2	41					
70	296.0	56					
69	298.9	52					
71	307.6	71					
72	310.5	65					
73	315.4	65					
74	320.7	61					
75	322.4	59					

Radinter model information (Directional antenna)							
Site:		**Oskarshamn**					
Borehole name:		**KLX17A**					
Nominal velocity (m/μs):		**117.0**					
Name	**Intersection depth**	**Intersection angle**	**RadInter direction to object (gravity roll)**	**Dip 1**	**Strike 1**	**Dip 2**	**Strike 2**
77	324.2	50					
79	332.0	68					
76	334.2	73					
78	336.2	71					
80	341.8	66					
81	343.8	50					
82	347.5	67					
83	350.7	56					
84	354.2	68					
92	354.7	75					
85	356.5	86					
96	359.0	9	291 ±	88	216	71	207
88	360.0	74					
91	364.6	37	18	83	118		
86	368.9	65					
87	371.2	49					
90	379.3	61					
89	387.8	52					
95	393.3	33					
93	393.9	70					
94	397.7	62					
98	401.3	34					
97	401.5	47	39	71	132		
98x	403.6	51					
100	409.9	38					
99	411.5	52					
175	422.7	45					
101	423.7	73					
102	426.2	71	51 ±	45	124	23	58
103	431.6	59					
104	436.1	38					
105	444.1	47					
106	452.5	61					
107	452.8	54					
108	456.8	57					
109	458.8	64					
110	465.5	46					
115	467.2	66	183 ±	5	89	55	104
111	471.2	47					
165	476.0	63					
113	477.1	55					
112	479.0	55					
114	483.0	45					

Radinter model information
(Directional antenna)

Site:	**Oskarshamn**
Borehole name:	**KLX17A**
Nominal velocity (m/μs):	**117.0**

Name	Intersection depth	Intersection angle	RadInter direction to object (gravity roll)	Dip 1	Strike 1	Dip 2	Strike 2
116	495.1	44					
117	502.6	58					
123	503.4	30					
118	513.2	75					
119	514.8	72					
120	517.1	68	342 ±	58	92	11	143
121	522.2	55	345 ±	67	92	10	215
122	526.6	60					
125	540.6	63					
124	543.4	67					
128	549.2	62					
126	549.5	55					
127	553.4	56					
129	557.5	46	258	44	36		
130	562.1	54					
133	564.7	64	33 ±	52	117	17	48
131	564.7	76					
132	571.9	80					
135	573.9	49					
137	579.3	54					
136	585.0	52					
138	590.3	60					
139	603.6	64	150 ±	16	152	56	86
166	606.4	46					
169	606.6	45					
140	608.7	56					
141	610.0	57					
142	615.1	46	75 ±	60	153	46	30
143	620.4	48					
147	625.3	44					
144	625.8	47					
145	630.2	44					
146	633.2	43					
150	635.3	50					
167	641.8	41					
148	645.9	39					
149	649.3	46					
153	650.0	70					
151	651.5	53					
152	654.0	51					
154	659.7	41					
155	667.6	31					
163	669.3	46					

Radinter model information (Directional antenna)							
Site:		**Oskarshamn**					
Borehole name:		**KLX17A**					
Nominal velocity (m/μs):		**117.0**					
Name	**Intersection depth**	**Intersection angle**	**RadInter direction to object (gravity roll)**	**Dip 1**	**Strike 1**	**Dip 2**	**Strike 2**
157	671.2	27					
156	672.0	42					
158	674.0	32					
161	686.8	76					
159	687.1	45					
160	693.7	29					
164	698.4	34					
162	700.3	37					
160	693.7	29					
164	698.4	34					
162	700.3	37					
160	693.7	29					
164	698.4	34					
162	700.3	37					

Table 5-4. Interpretation of radar reflectors from the dipole antennas 250, 100 and 20 MHz, in borehole HLX43.

Radinter model information (20, 100 and 250 MHz Dipole Antennas)			
Site:		**Oskarshamn**	
Borehole name:		**HLX43**	
Nominal velocity (m/μs):		**117.0**	
Reflector type	**Name**	**Intersection depth**	**Intersection angle**
PLANE	1	5.7	64
PLANE	2	14.6	57
PLANE	3	33.5	39
PLANE	19	50.3	53
PLANE	4	54.3	73
PLANE	5	66.8	61
PLANE	6	70.6	64
PLANE	20	73.0	45
PLANE	18	74.7	71
PLANE	7	79.9	68
PLANE	8	91.7	67
PLANE	9	117.3	78
PLANE	10	120.3	90
PLANE	11	130.4	27
PLANE	13	142.6	52
PLANE	12	143.6	35
PLANE	15	149.8	64
PLANE	14	151.4	60
PLANE	16	168.3	56
PLANE	17	177.3	44

In Appendices 1 and 2, the amplitude of the first arrival is plotted against the depth, for the 250 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 increases in water content, i.e. increases in electric conductivity. The decrease in amplitude is shown in Tables 5-5 and 5-6.

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. A small intersection angle will most often give an increased amplitude compared to a larger intersection angle, and by that a more clear structure.

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 5-7 below.

Table 5-5. Borehole length intervals in KLX17A with decreased amplitude for the 250 MHz antenna.

Length (m)	Length (m)
25	420–430
70–75	440–485
105–115	505
130–140	510–525
175	535
185	545
195–205	555
220–225	565–575
245	585
265–290	590
310–315	650
335–350	660–670
395	

Table 5-6. Borehole length intervals in HLX43 with decreased amplitude for the 250 MHz antenna.

Length (m)	Length (m)
30– 75	110– 115
80– 90	150
95	155

Table 5-7. Some important structures in KLX17A and HLX43.

Borehole	KLX17A	HLX43
Structures	1, 8, 10, 38, 91, 96, 102, 105, 112, 170, 172, 172x and 176	1, 3, 13, 14, 19 and 20

5.2 BIPS logging

The BIPS pictures from KLX17A and HLX43 are presented in Appendices 3 and 4.

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 depth accuracy, the BIPS images are adjusted to the reference mark on the cable for the logging.

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

The images from the BIPS survey in KLX17A was not of best quality. Mud covering the lower part of the borehole limits the visibility. Fortunately the water quality along the borehole is of very good quality and make clear and sharp pictures on the walls that not are covered with mud. However, when 50% of the image is covered with light colored mud and the bedrock is of darker color the automatic iris function in the camera do not work in a proper way. The bright parts of the mud will make the visible parts of the darker bedrock walls to be slightly darker than they are in real, in other words under-exposed. This effect is more obvious in the 197 mm part of the borehole than the 76 mm part.

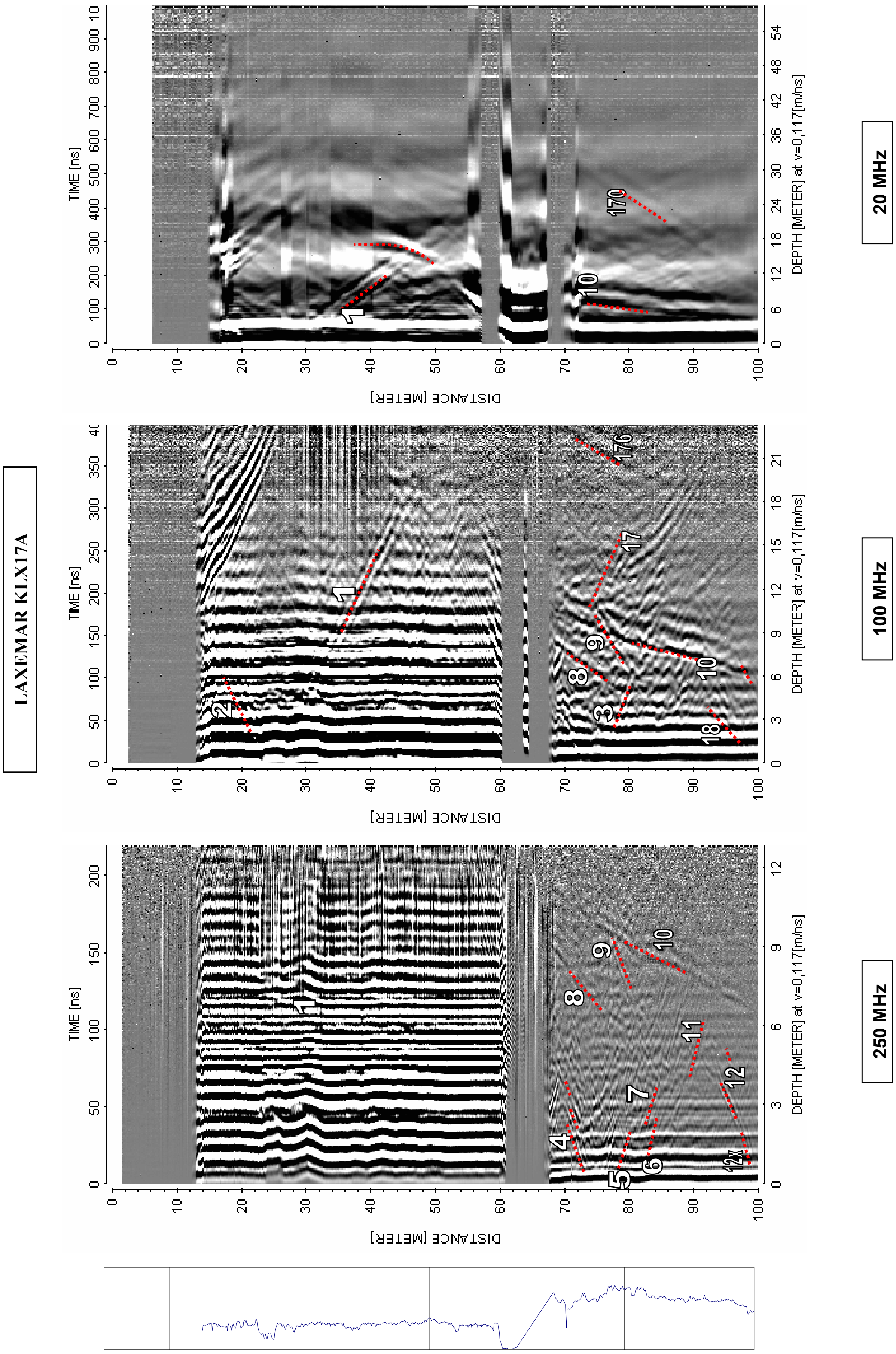
In HLX43 the water quality is of very high quality and resulted in perfect images.

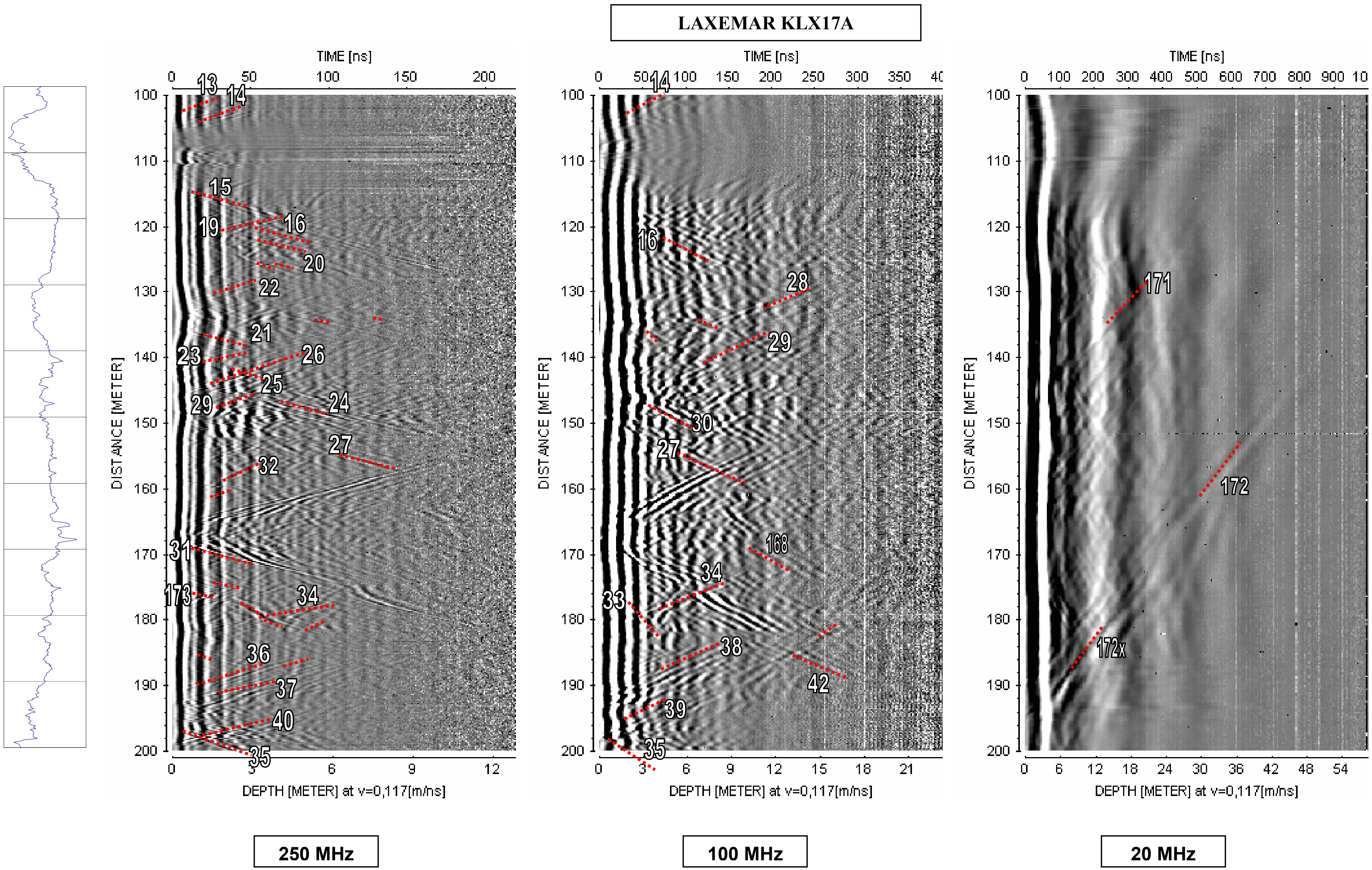
References

/1/ **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.

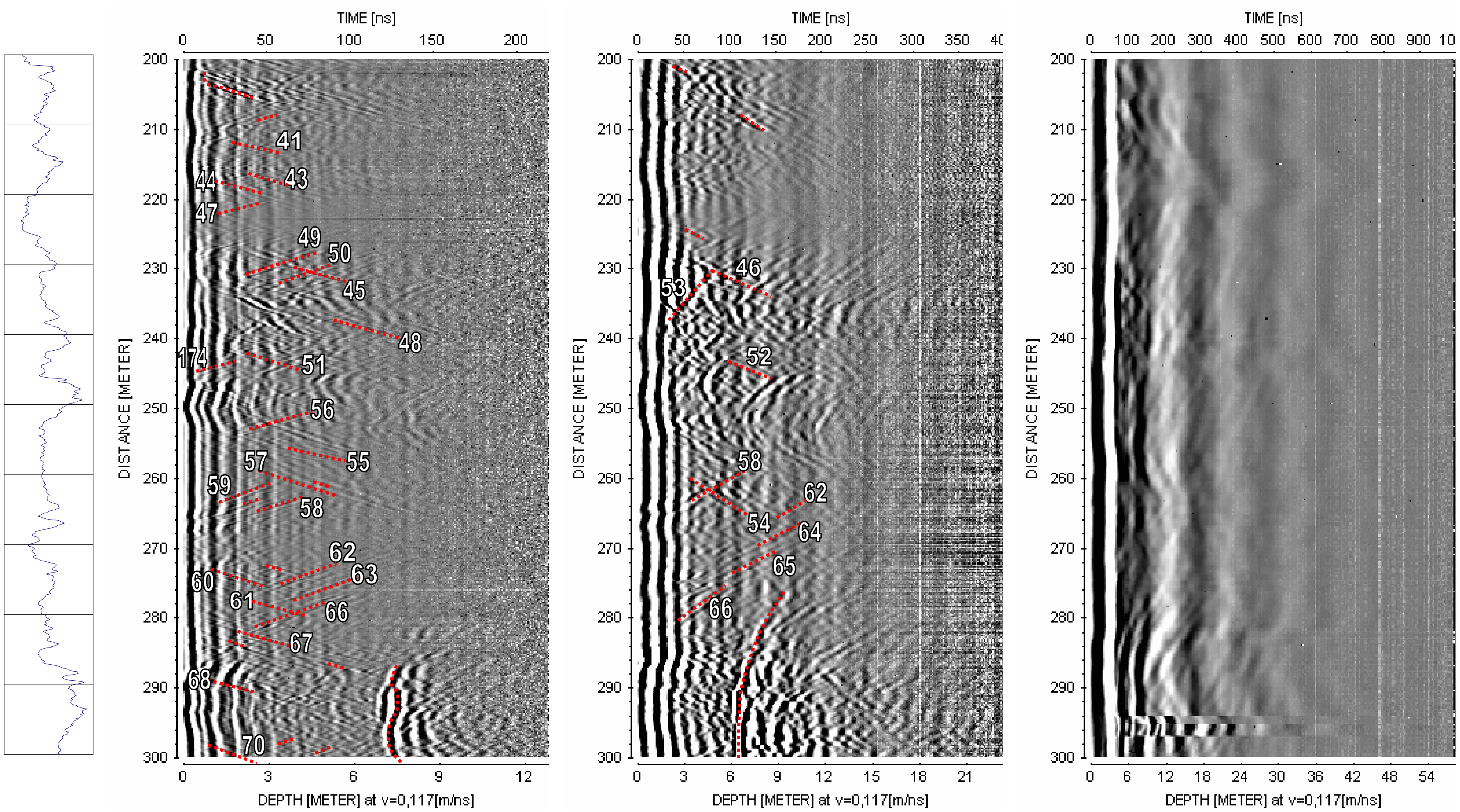
Appendix 1

Radar logging in KLX17A, 0 to 695 m, dipole antennas 250, 100 and 20 MHz



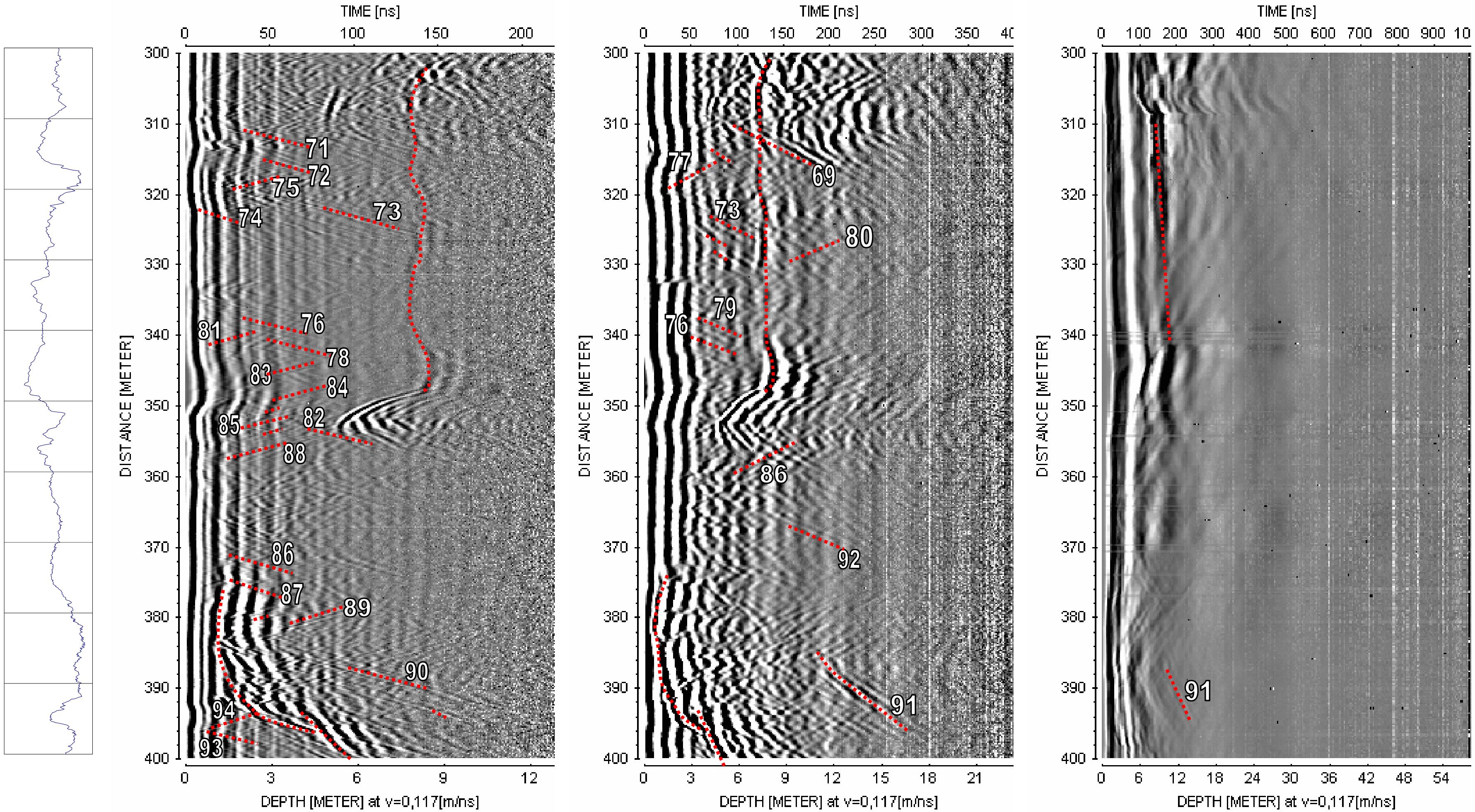

LAXEMAR KLX17A
TIME [ns]
DISTANCE [METER]
DEPTH [METER] at v=0,117[m/ns]
250 MHz
100 MHz
20 MHz

LAXEMAR KLX17A



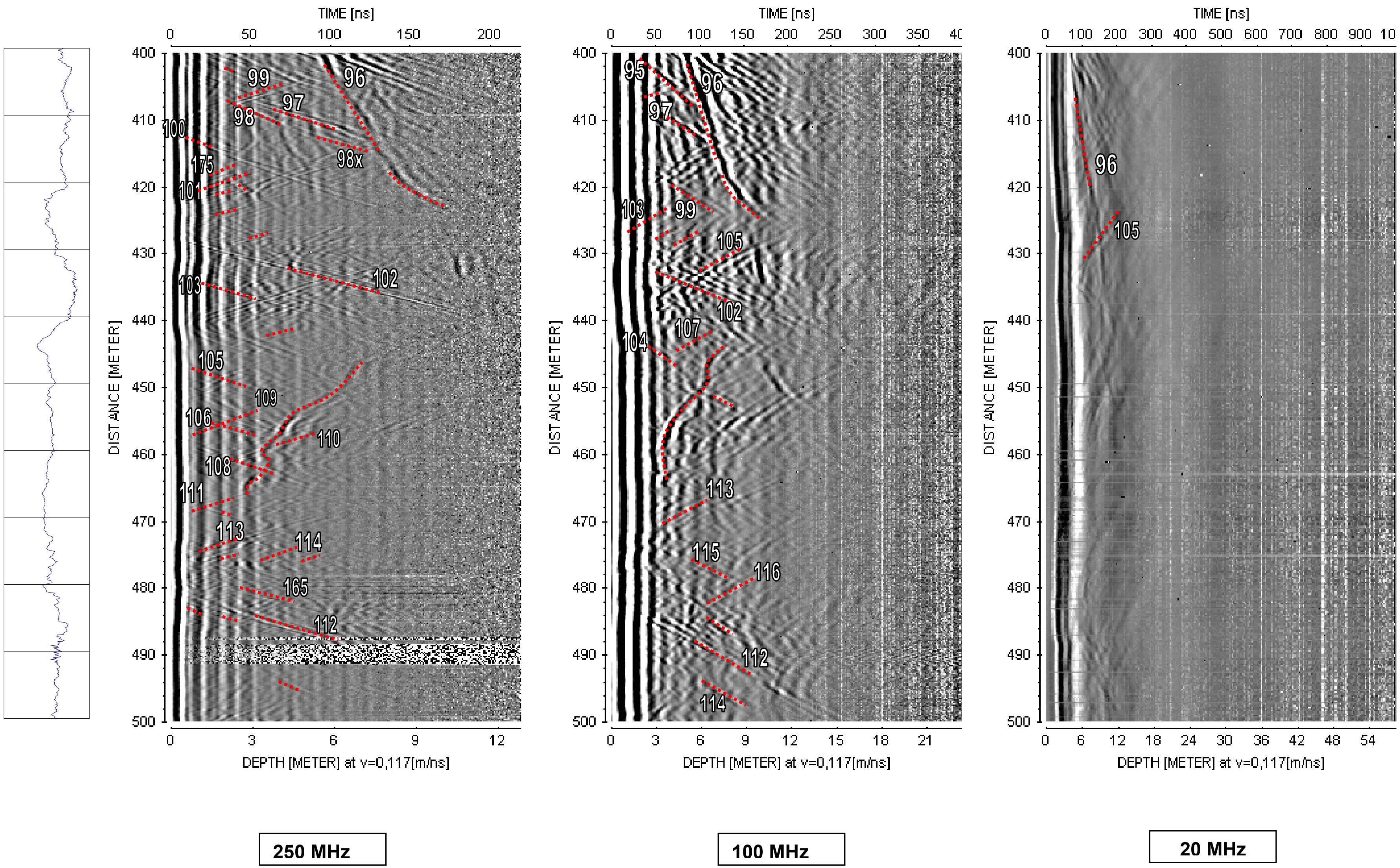
250 MHz **100 MHz** **20 MHz**

LAXEMAR KLX17A

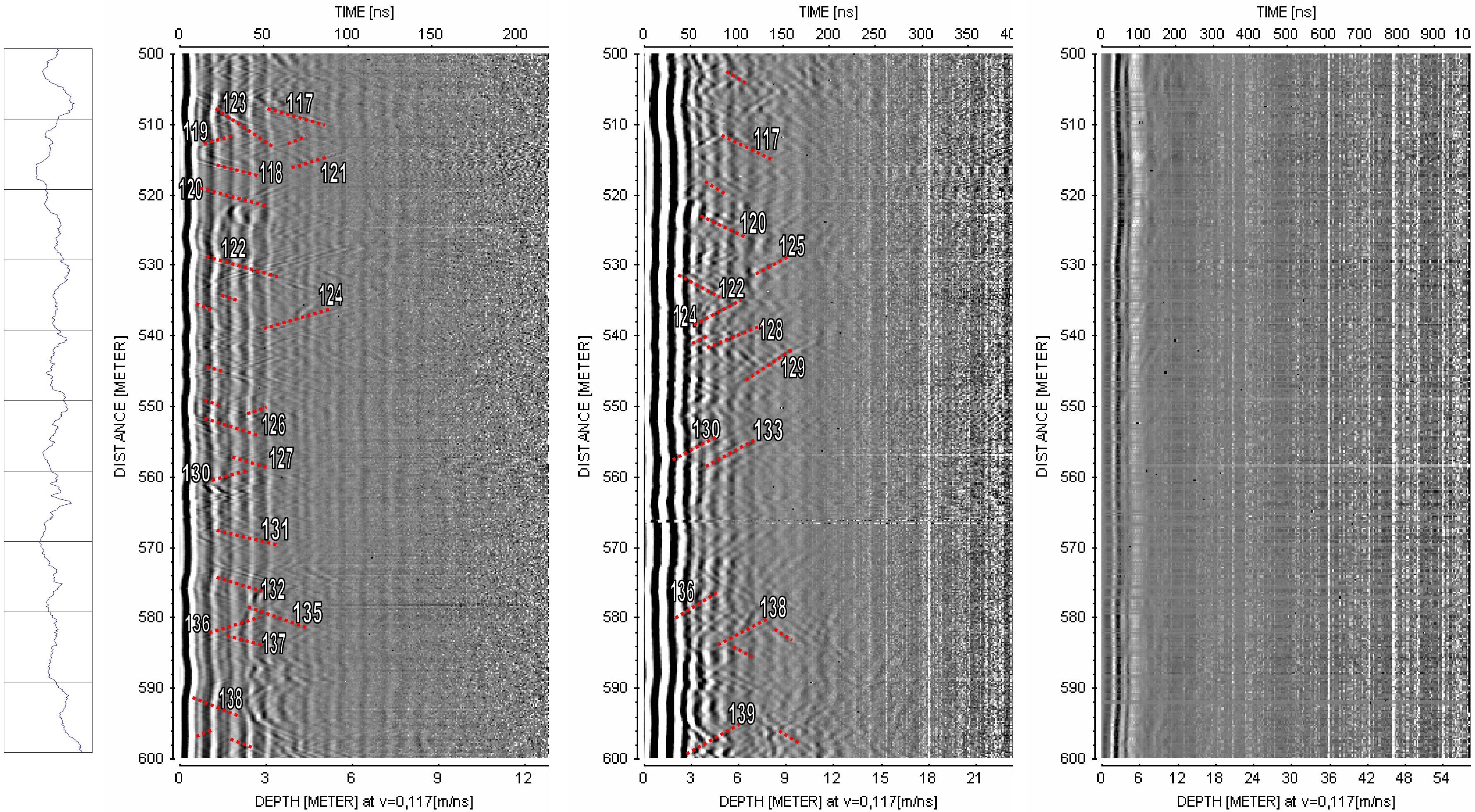


250 MHz **100 MHz** **20 MHz**

LAXEMAR KLX17A



LAXEMAR KLX17A

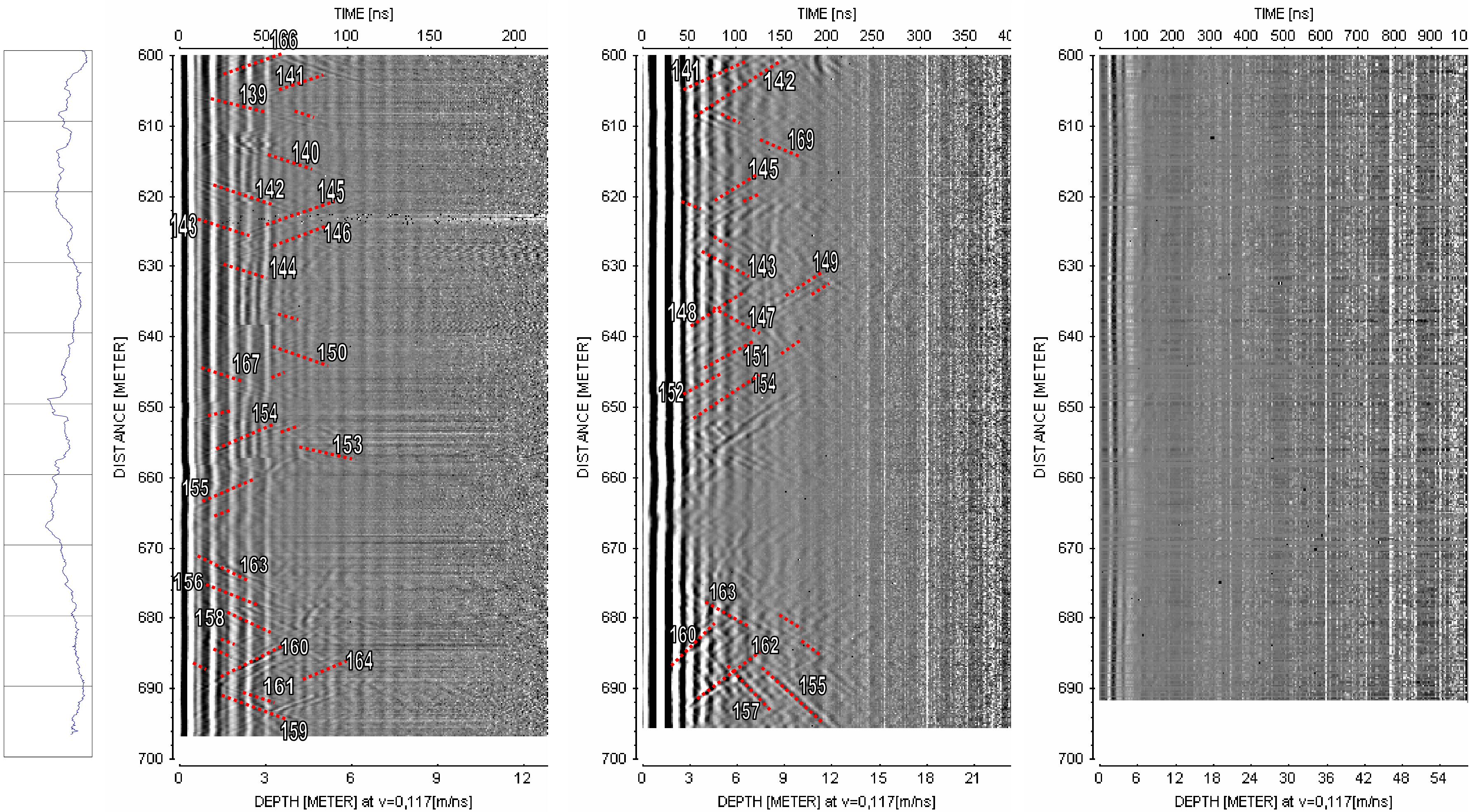


250 MHz

100 MHz

20 MHz

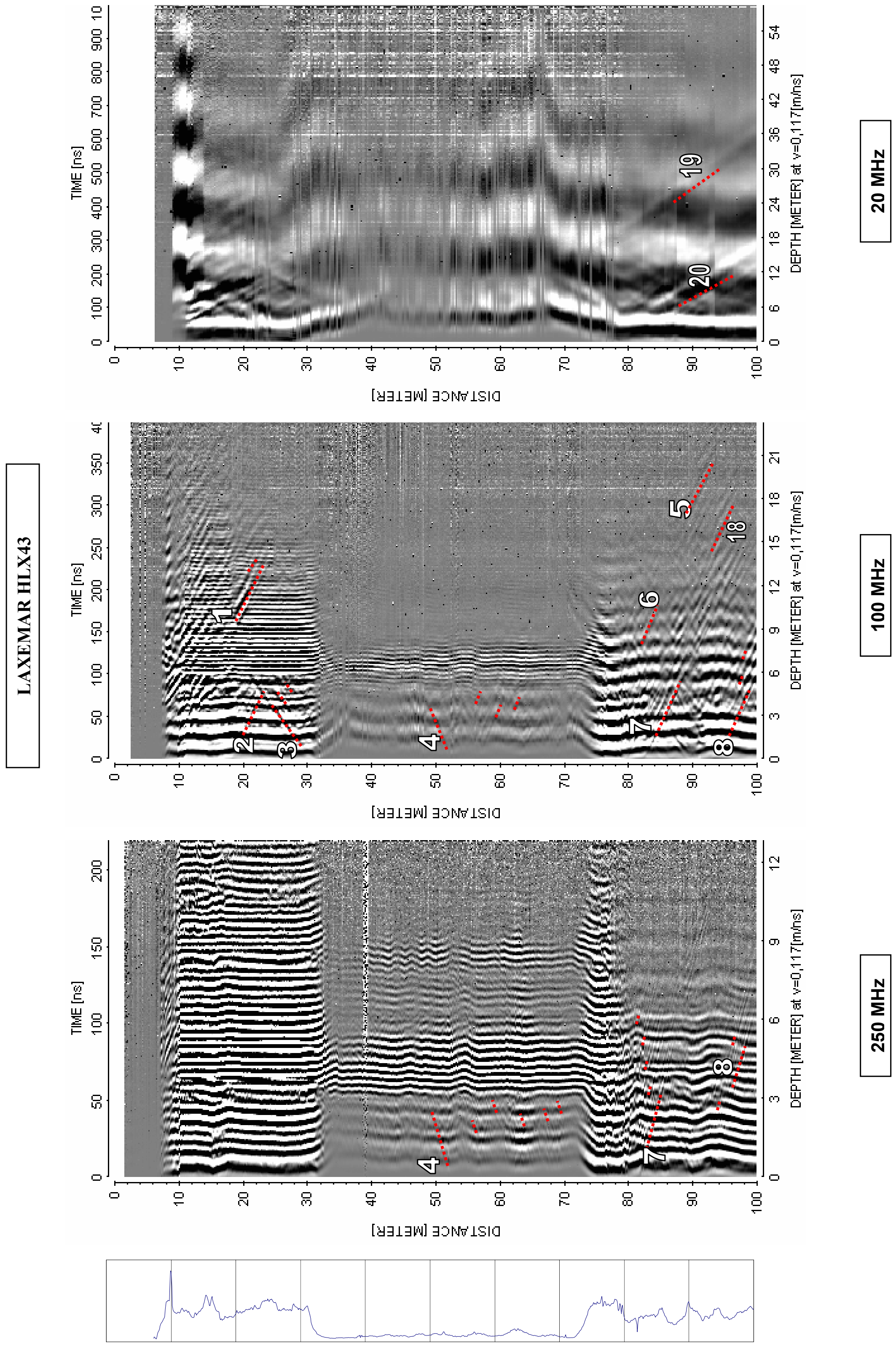
LAXEMAR KLX17A



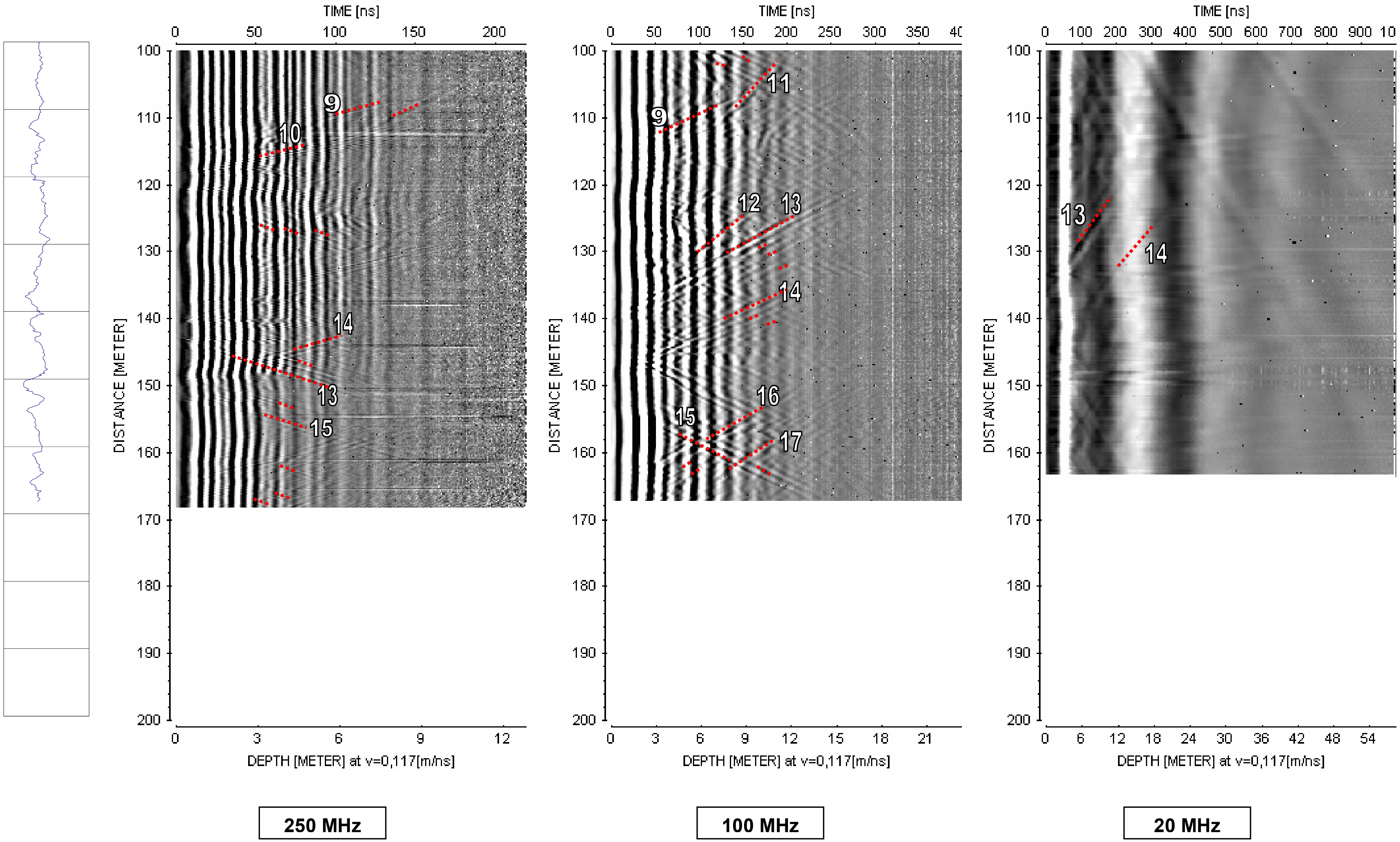
250 MHz **100 MHz** **20 MHz**

Appendix 2

Radar logging in HLX43, 0 to 167 m, dipole antennas 250, 100 and 20 MHz



LAXEMAR HLX43



BIPS logging in KLX17A, 66 to 697 m

Project name: Laxemar

Image file	: c:\work\r5582k~1\bips\klx17a_1.bip
BDT file	: c:\work\r5582k~1\bips\klx17a_1.bdt
Locality	: LAXEMAR
Bore hole number	: KLX17A
Date	: 06/11/29
Time	: 08:58:00
Depth range	: 11.000 - 61.789 m
Azimuth	: 11
Inclination	: -61
Diameter	: 197.0 mm
Magnetic declination	: 0.0
Span	: 4
Scan interval	: 0.25
Scan direction	: To bottom
Scale	: 1/25
Aspect ratio	: 70 %
Pages	: 3
Color	: +0 +0 +0

Project name: Laxemar

Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 11.000 - 31.000 m

(1 / 3) **Scale: 1/25** **Aspect ratio: 70 %**

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 31.000 - 51.000 m

(2 / 3) **Scale: 1/25** **Aspect ratio: 70 %**

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 51.000 - 61.789 m

(3 / 3) **Scale: 1/25** **Aspect ratio: 70 %**

Project name: Laxemar

Image file	: c:\work\r5582k~1\bips\klx17a_2.bip
BDT file	: c:\work\r5582k~1\bips\klx17a_2.bdt
Locality	: LAXEMAR
Bore hole number	: KLX17A
Date	: 06/11/28
Time	: 12:46:00
Depth range	: 66.000 - 499.998 m
Azimuth	: 11
Inclination	: -61
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	: 22
Color	: +0 +0 +0

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 60.000 - 80.000 m

D L U R D

60.000
60.000
61.000
61.000
62.000
62.000
63.000
63.000
64.000
64.000
65.000
65.000

D L U R D

65.000
65.000
66.000
66.000
67.000
67.051
68.000
68.103
69.000
69.154
70.000
70.206

D L U R D

70.000
70.206
71.000
71.257
72.000
72.308
73.000
73.360
74.000
74.411
75.000
75.440

D L U R D

75.000
75.440
76.000
76.441
77.000
77.442
78.000
78.443
79.000
79.444
80.000
80.444

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 80.000 - 100.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 100.000 - 120.000 m

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

Project name: Laxemar

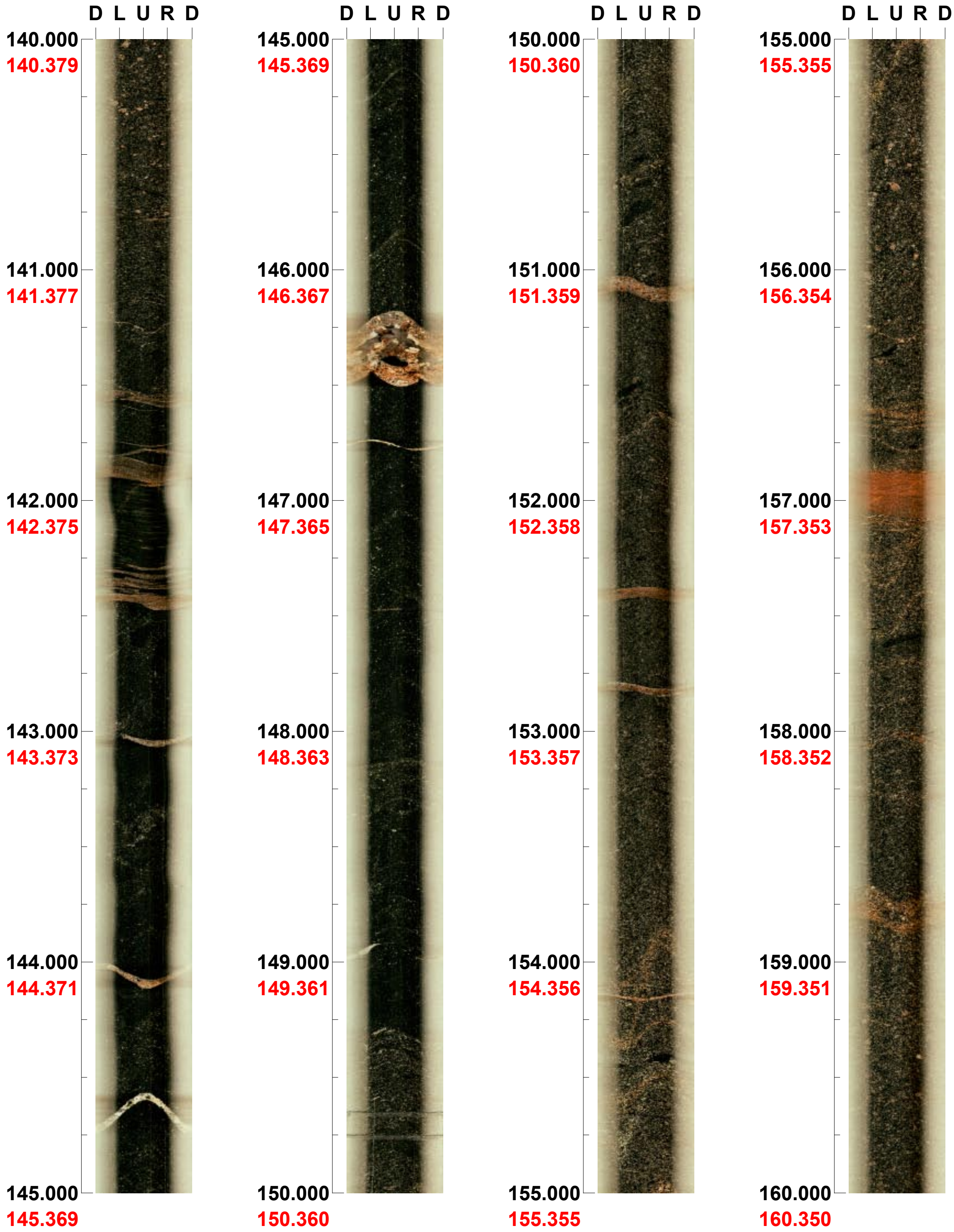
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 120.000 - 140.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 140.000 - 160.000 m



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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 160.000 - 180.000 m

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

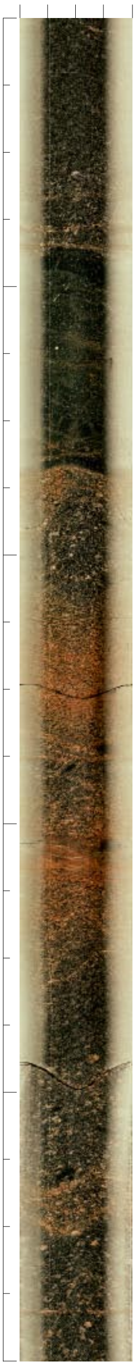
Project name: Laxemar

Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 180.000 - 200.000 m

D L U R D

180.000
180.330



181.000
181.329

182.000
182.328

183.000
183.327

184.000
184.326

185.000
185.325

D L U R D

185.000
185.325

186.000
186.324

187.000
187.323

188.000
188.322

189.000
189.321

190.000
190.320

D L U R D

190.000
190.320

191.000
191.319

192.000
192.318

193.000
193.317

194.000
194.316

195.000
195.315

D L U R D

195.000
195.315

196.000
196.314

197.000
197.313

198.000
198.312

199.000
199.311

200.000
200.310

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

Project name: Laxemar
Bore hole No.: KLX17A Azimuth: 11 Inclination: -61

Depth range: 200.000 - 220.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 220.000 - 240.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 240.000 - 260.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 260.000 - 280.000 m

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

Project name: Laxemar

Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 280.000 - 300.000 m

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

Project name: Laxemar

Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 300.000 - 320.000 m

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

Project name: Laxemar

Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 320.000 - 340.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A　　Azimuth: 11　　Inclination: -61

Depth range: 340.000 - 360.000 m

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

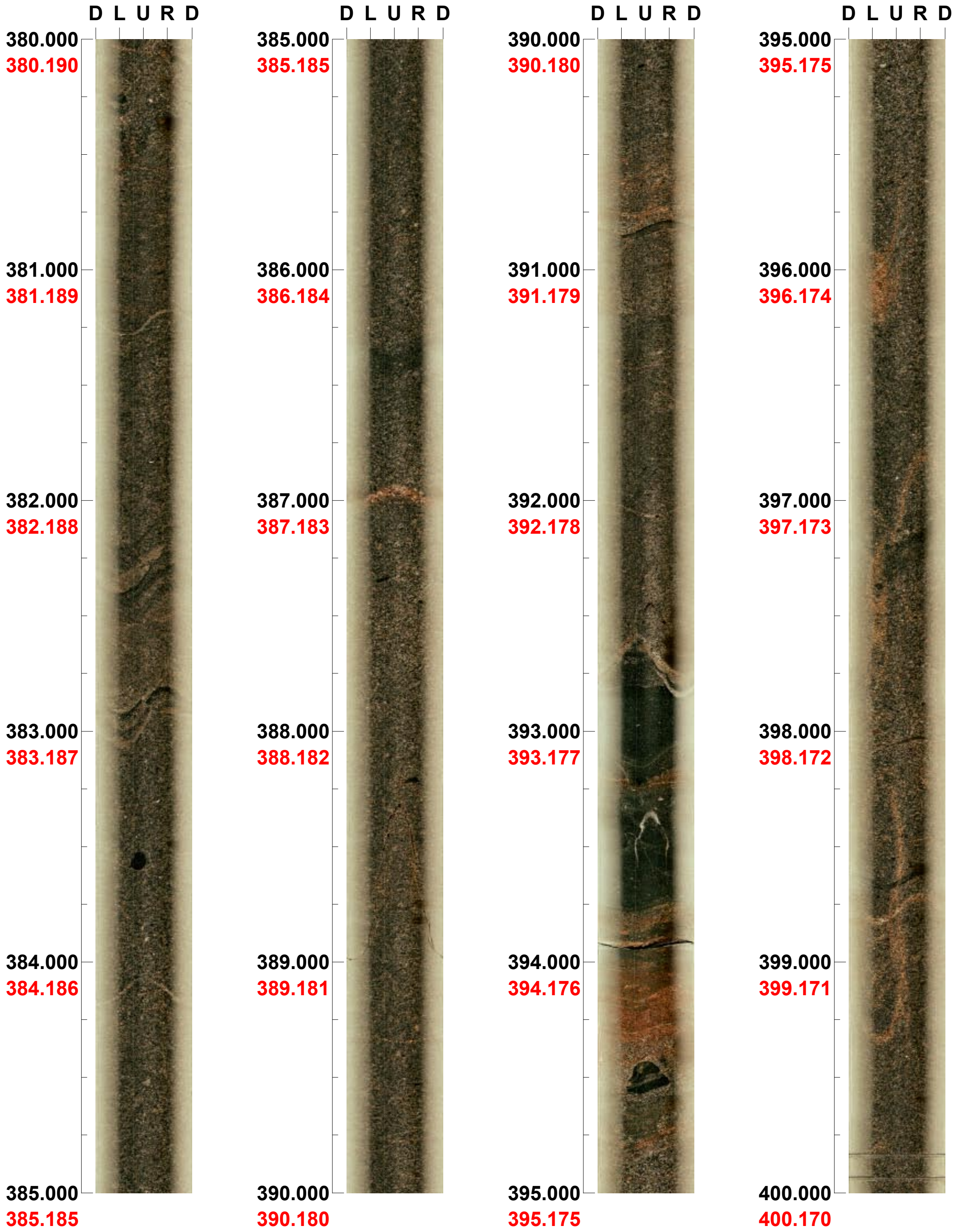
Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 360.000 - 380.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 380.000 - 400.000 m



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

Project name: Laxemar

Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 400.000 - 420.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 420.000 - 440.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

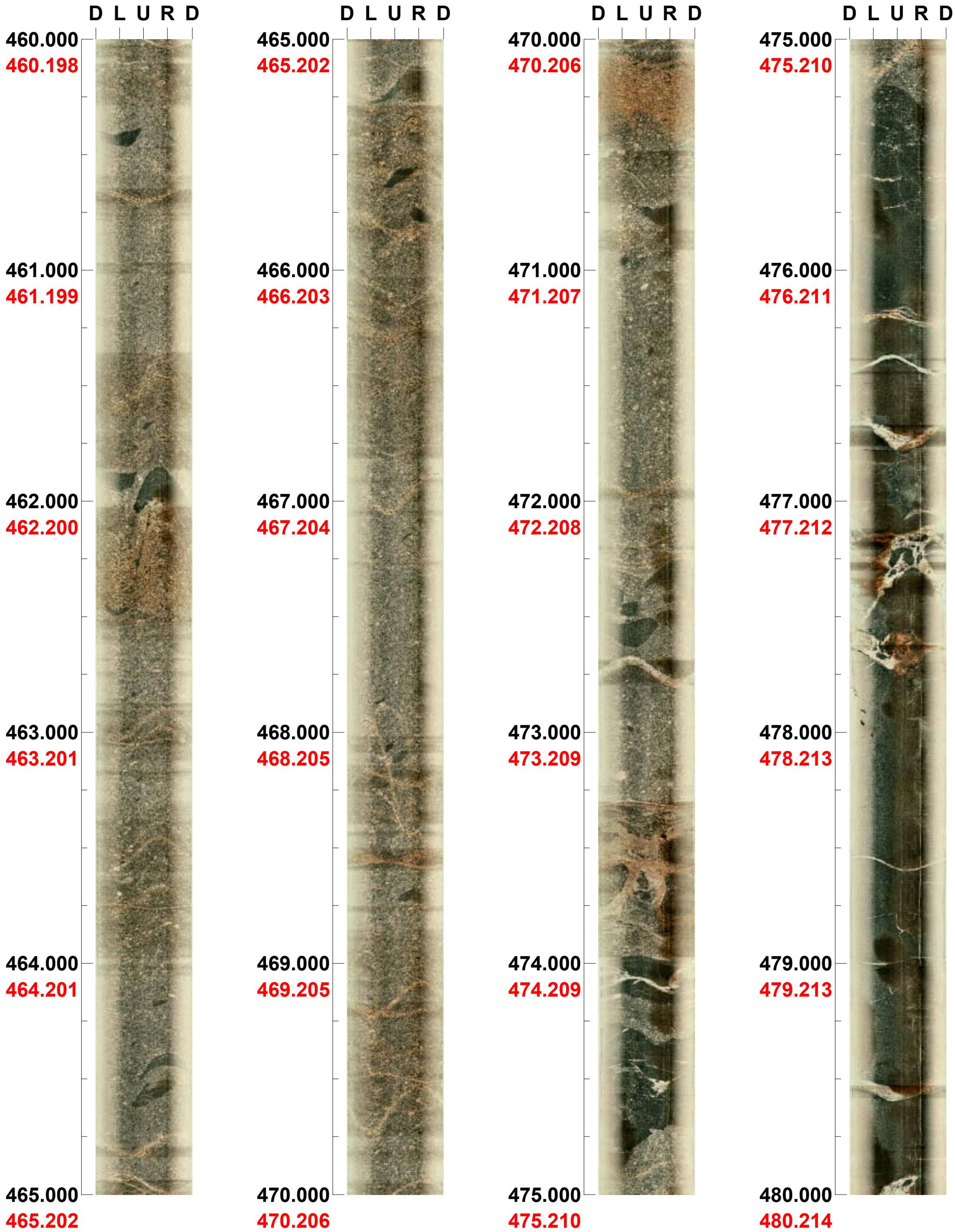
Depth range: 440.000 - 460.000 m

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

Project name: Laxemar

Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 460.000 - 480.000 m



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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 480.000 - 499.998 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 500.000 - 520.000 m

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

Project name: Laxemar

Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 520.000 - 540.000 m

D L U R D

520.000
520.182
521.000
521.179
522.000
522.177
523.000
523.175
524.000
524.172
525.000
525.170

D L U R D

525.000
525.170
526.000
526.167
527.000
527.165
528.000
528.163
529.000
529.160
530.000
530.158

D L U R D

530.000
530.158
531.000
531.155
532.000
532.153
533.000
533.151
534.000
534.148
535.000
535.146

D L U R D

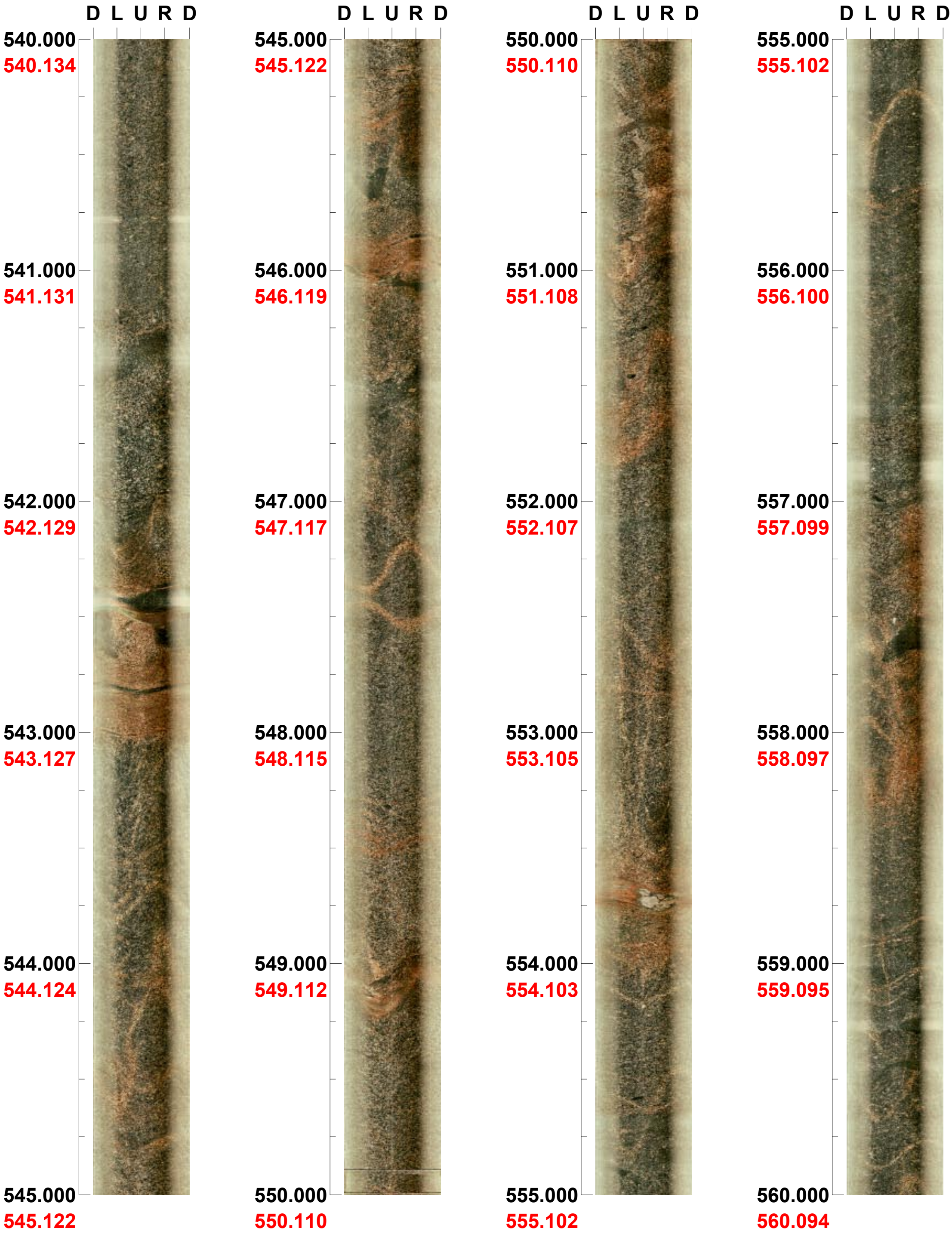
535.000
535.146
536.000
536.143
537.000
537.141
538.000
538.139
539.000
539.136
540.000
540.134

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

Project name: Laxemar

Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 540.000 - 560.000 m



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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

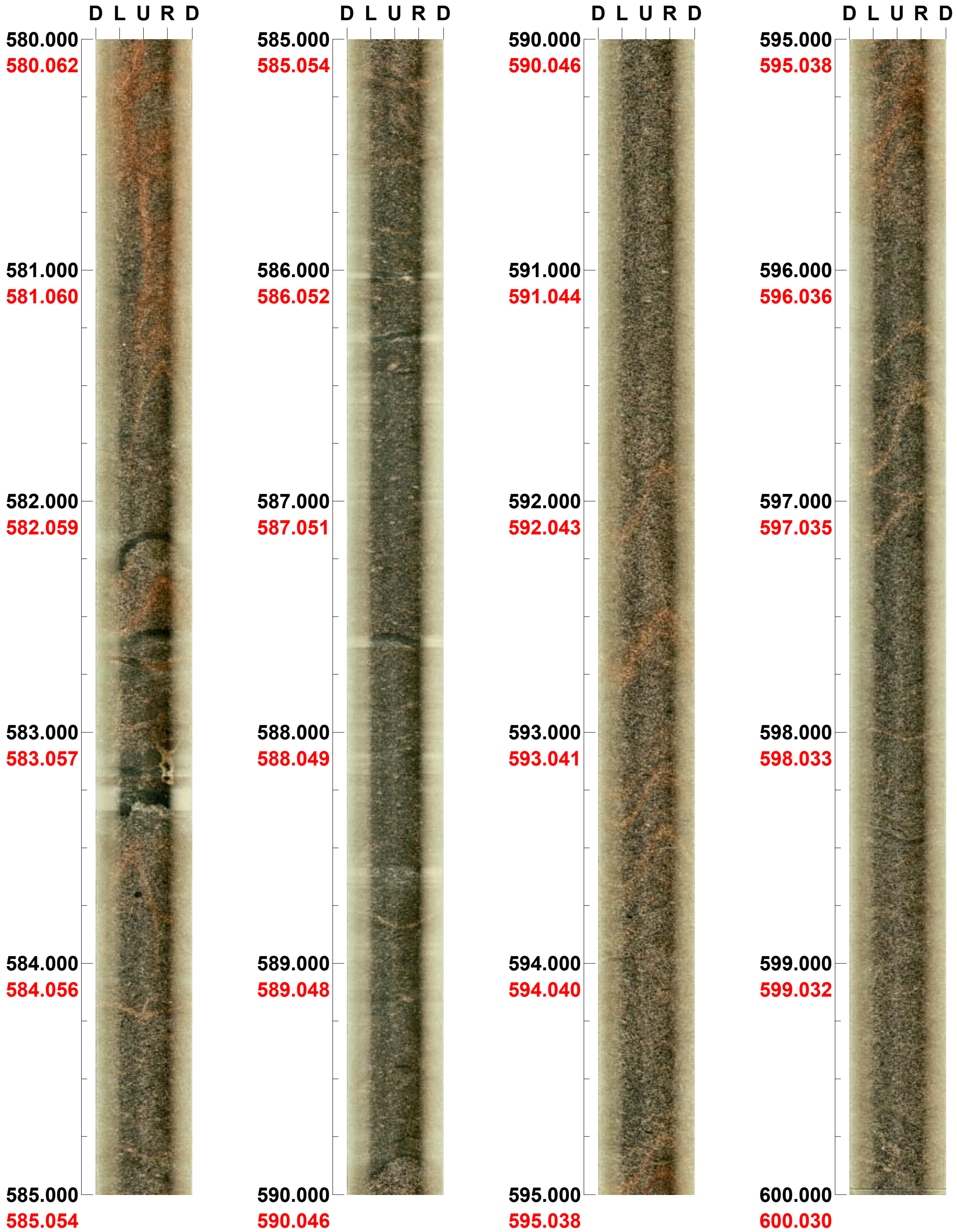
Depth range: 560.000 - 580.000 m

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

Project name: Laxemar

Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

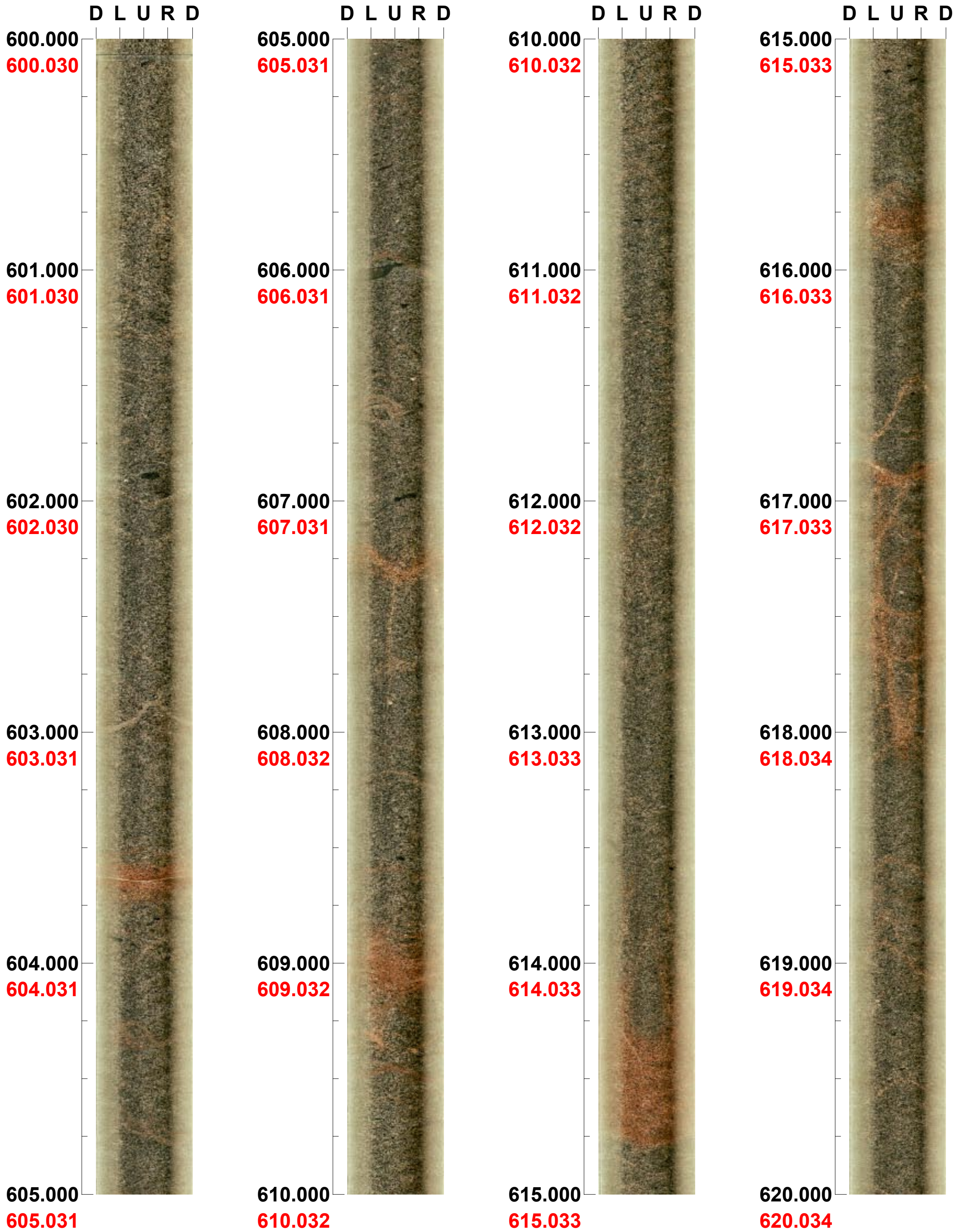
Depth range: 580.000 - 600.000 m



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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 600.000 - 620.000 m



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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 620.000 - 640.000 m

D L U R D

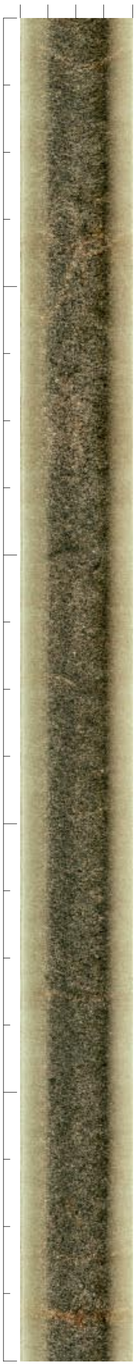
620.000
620.034
621.000
621.034
622.000
622.034
623.000
623.035
624.000
624.035
625.000
625.035

D L U R D

625.000
625.035
626.000
626.035
627.000
627.035
628.000
628.036
629.000
629.036
630.000
630.036

D L U R D

630.000
630.036
631.000
631.036
632.000
632.036
633.000
633.037
634.000
634.037
635.000
635.037



D L U R D

635.000
635.037
636.000
636.037
637.000
637.037
638.000
638.038
639.000
639.038
640.000
640.038

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 640.000 - 660.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 660.000 - 680.000 m

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

Project name: Laxemar
Bore hole No.: KLX17A **Azimuth: 11** **Inclination: -61**

Depth range: 680.000 - 696.780 m

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

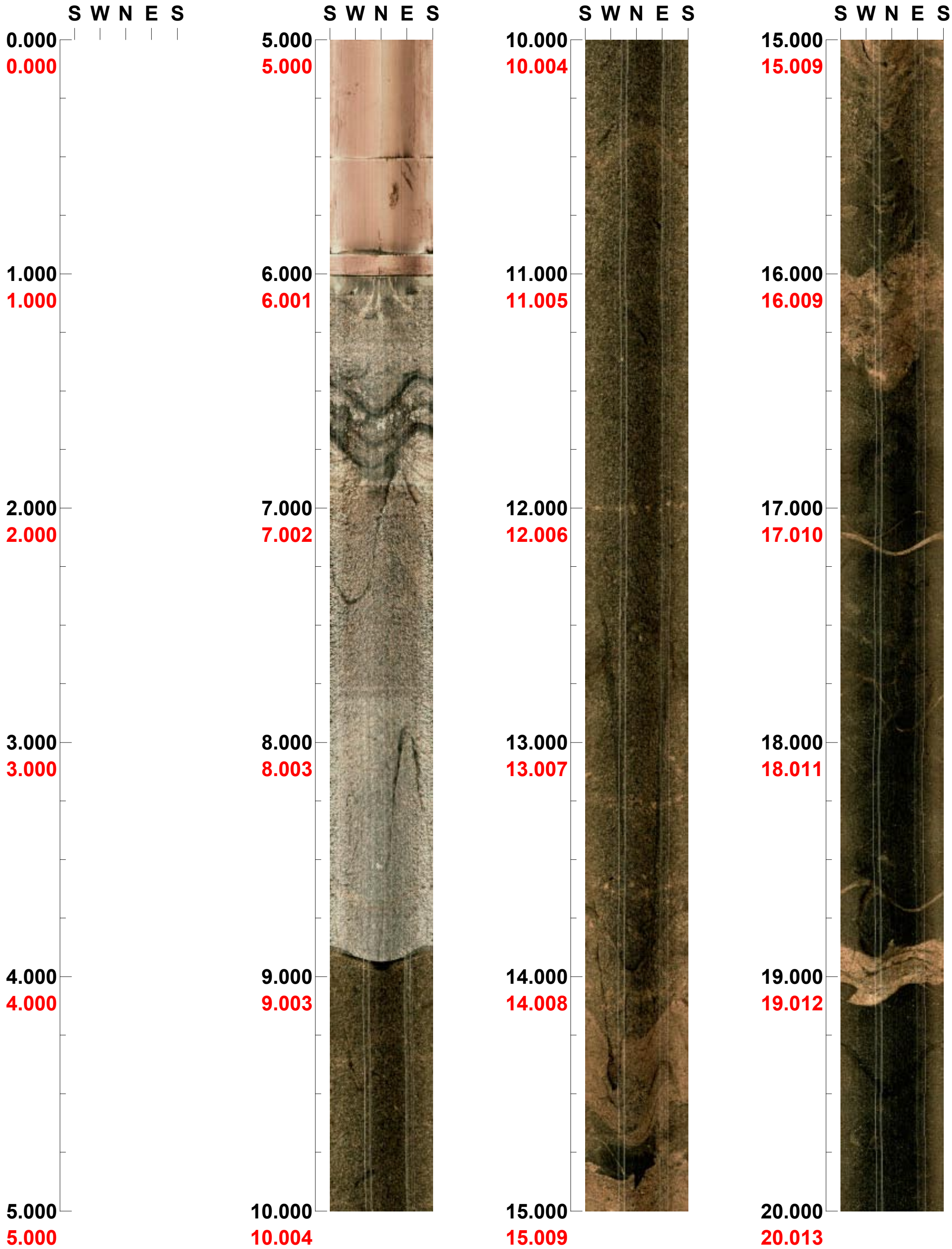
BIPS logging in HLX43, 5 to 170 m

Project name: Laxemar

Image file	: c:\work\r5582k~1\bips\hlx43.bip
BDT file	: c:\work\r5582k~1\bips\hlx43.bdt
Locality	: LAXEMAR
Bore hole number	: HLX43
Date	: 06/11/30
Time	: 16:54:00
Depth range	: 5.000 - 169.845 m
Azimuth	: 0
Inclination	: -50
Diameter	: 140.0 mm
Magnetic declination	: 0.0
Span	: 4
Scan interval	: 0.25
Scan direction	: To bottom
Scale	: 1/25
Aspect ratio	: 100 %
Pages	: 9
Color	: +0 +0 +0

Project name: Laxemar
Bore hole No.: HLX43 **Azimuth: 0** **Inclination: -50**

Depth range: 0.000 - 20.000 m



(1 / 9) **Scale: 1/25** **Aspect ratio: 100 %**

Project name: Laxemar

Bore hole No.: HLX43 **Azimuth: 0** **Inclination: -50**

Depth range: 20.000 - 40.000 m

(2 / 9) **Scale: 1/25** **Aspect ratio: 100 %**

Project name: Laxemar
Bore hole No.: HLX43 **Azimuth: 0** **Inclination: -50**

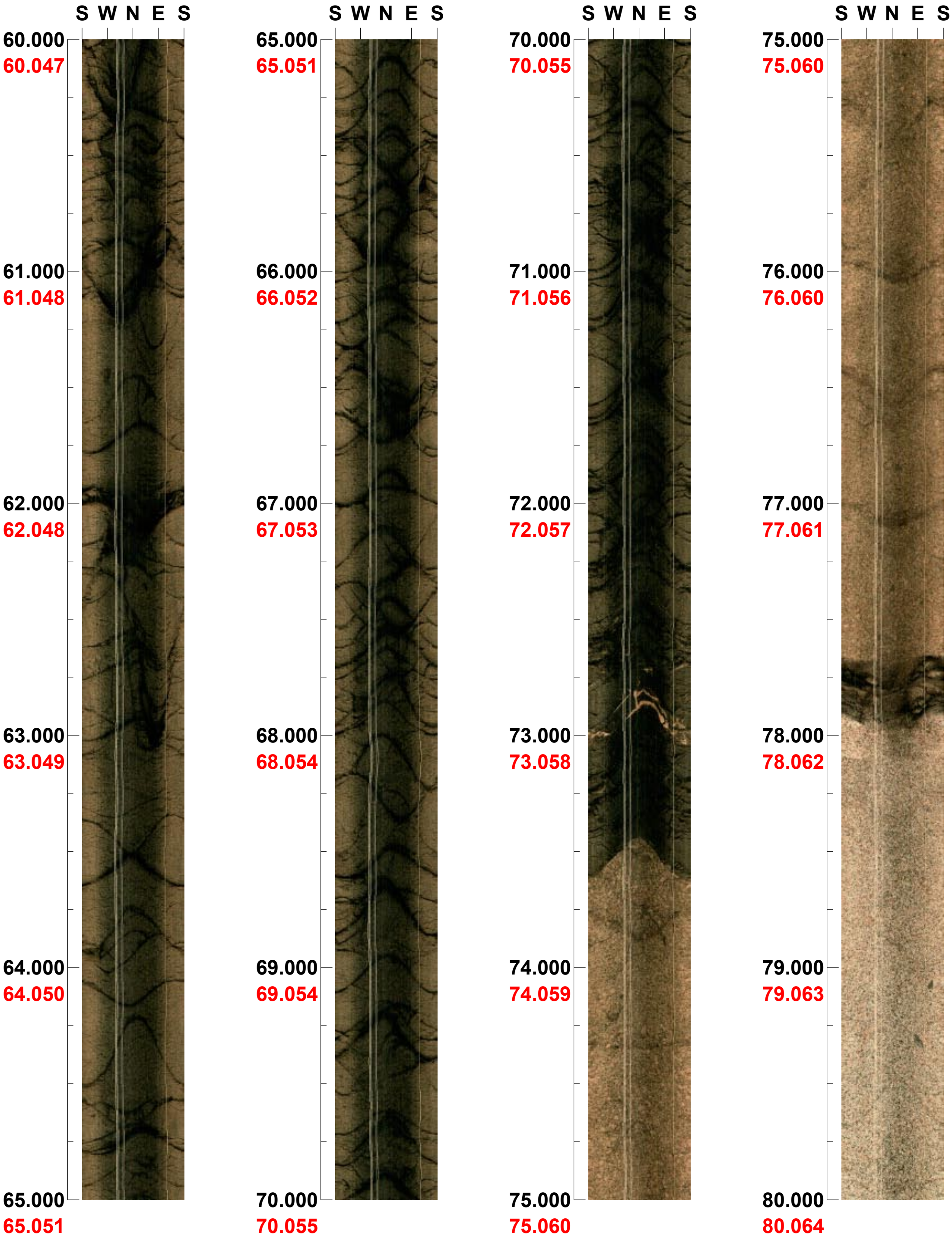
Depth range: 40.000 - 60.000 m

(3 / 9) Scale: 1/25 Aspect ratio: 100 %

Project name: Laxemar

Bore hole No.: HLX43 **Azimuth: 0** **Inclination: -50**

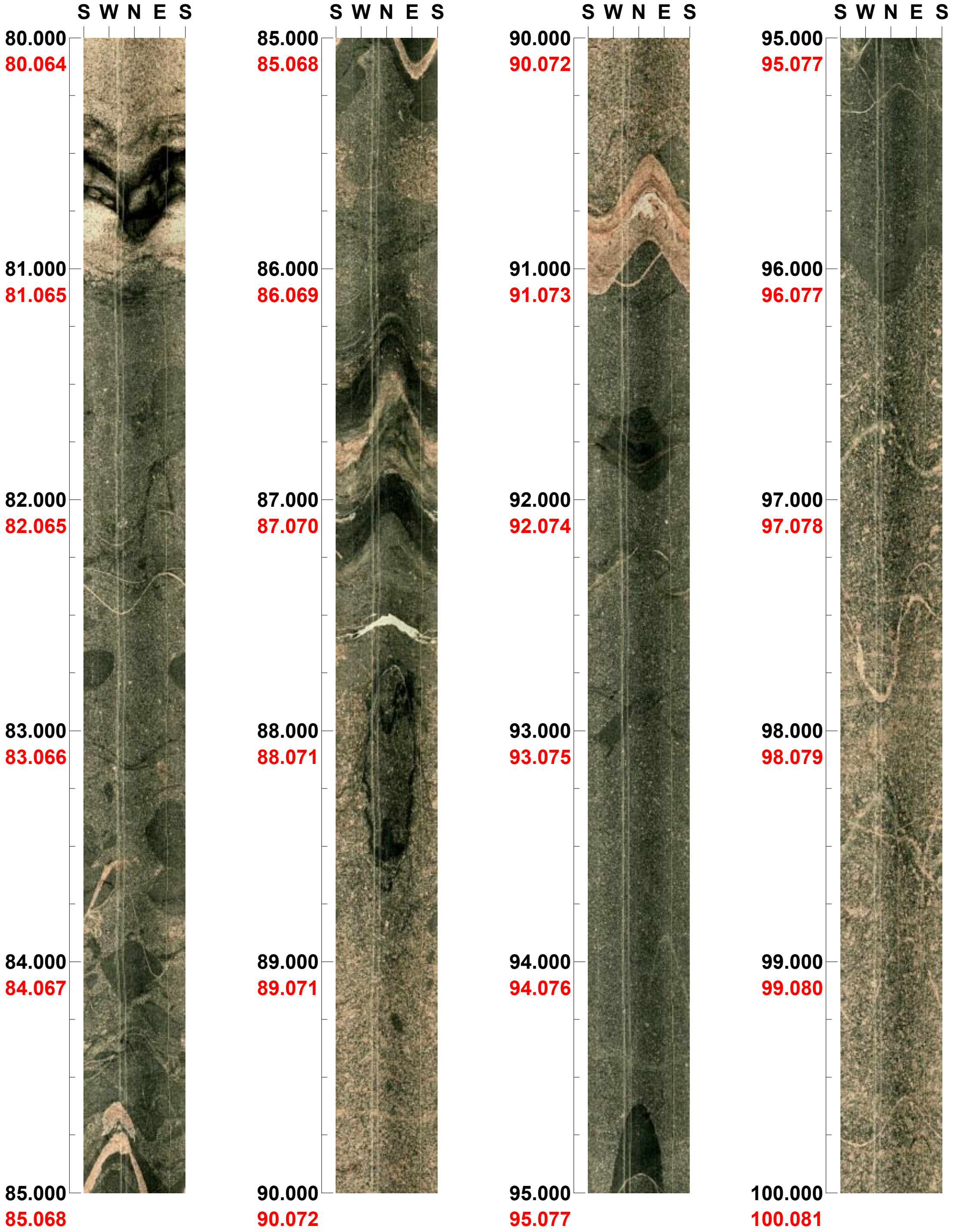
Depth range: 60.000 - 80.000 m



(4 / 9) **Scale: 1/25** **Aspect ratio: 100 %**

Project name: Laxemar
Bore hole No.: HLX43 **Azimuth: 0** **Inclination: -50**

Depth range: 80.000 - 100.000 m

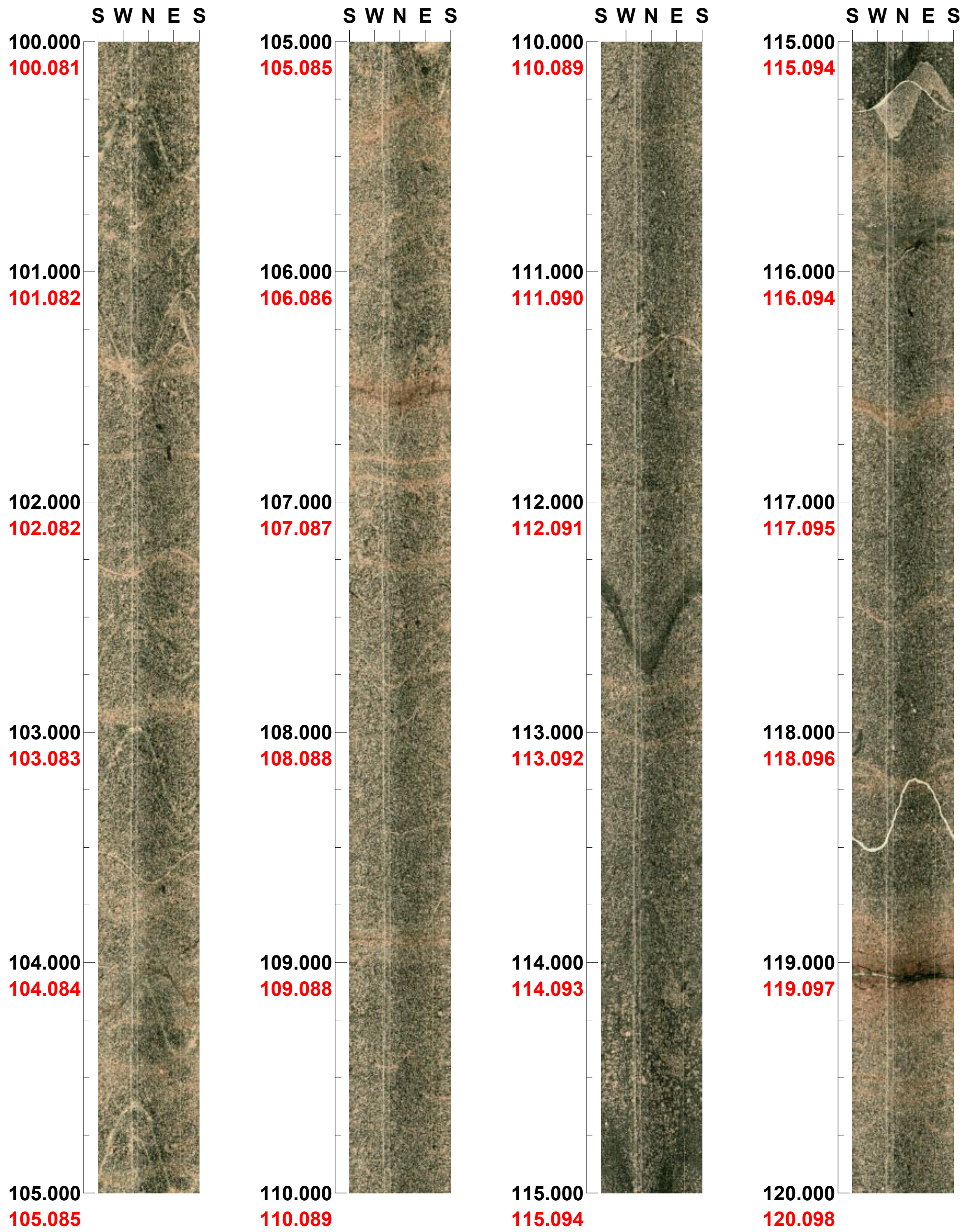


(5 / 9) **Scale: 1/25** **Aspect ratio: 100 %**

Project name: Laxemar

Bore hole No.: HLX43 **Azimuth: 0** **Inclination: -50**

Depth range: 100.000 - 120.000 m

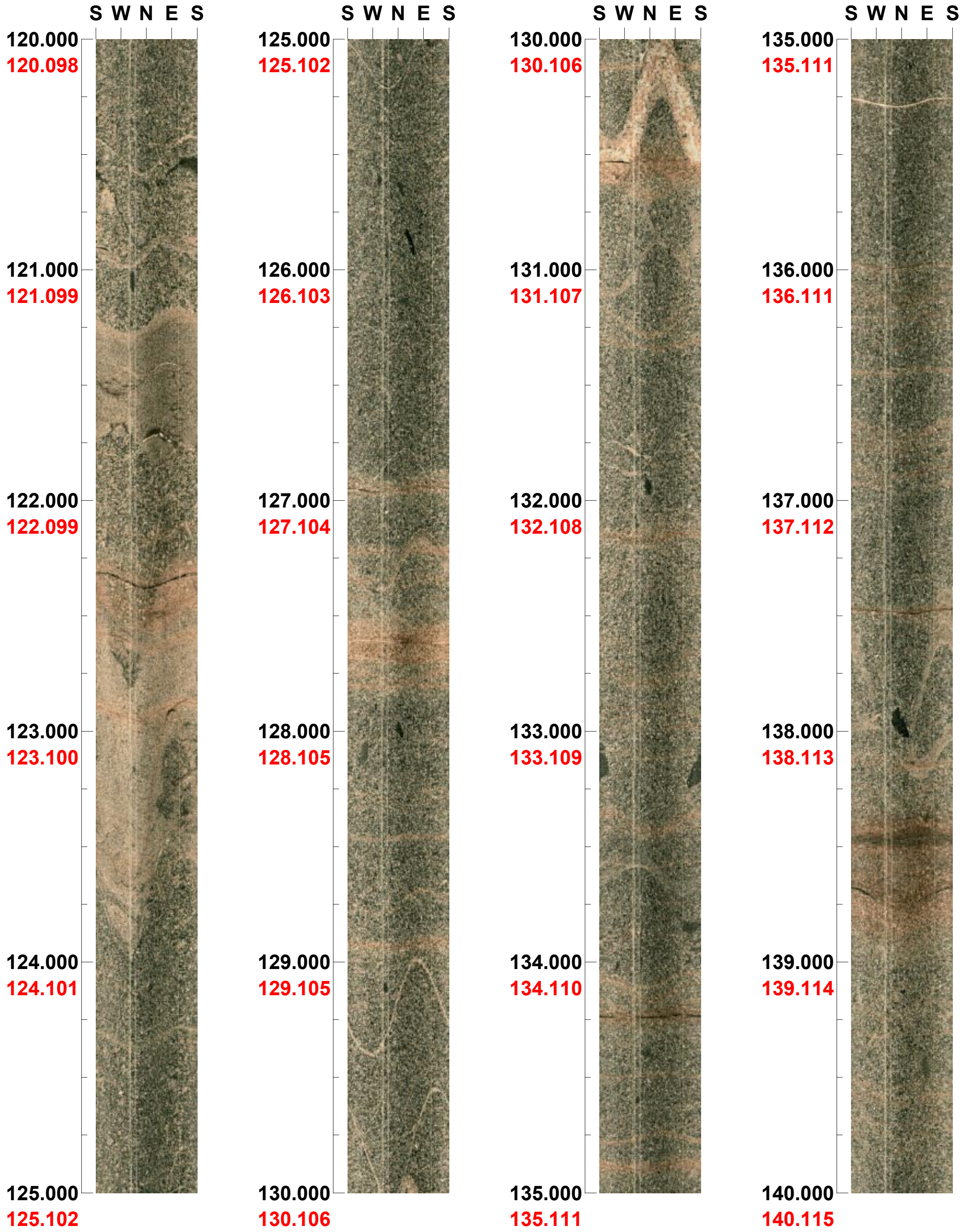


(6 / 9) **Scale: 1/25** **Aspect ratio: 100 %**

Project name: Laxemar

Bore hole No.: HLX43 **Azimuth: 0** **Inclination: -50**

Depth range: 120.000 - 140.000 m

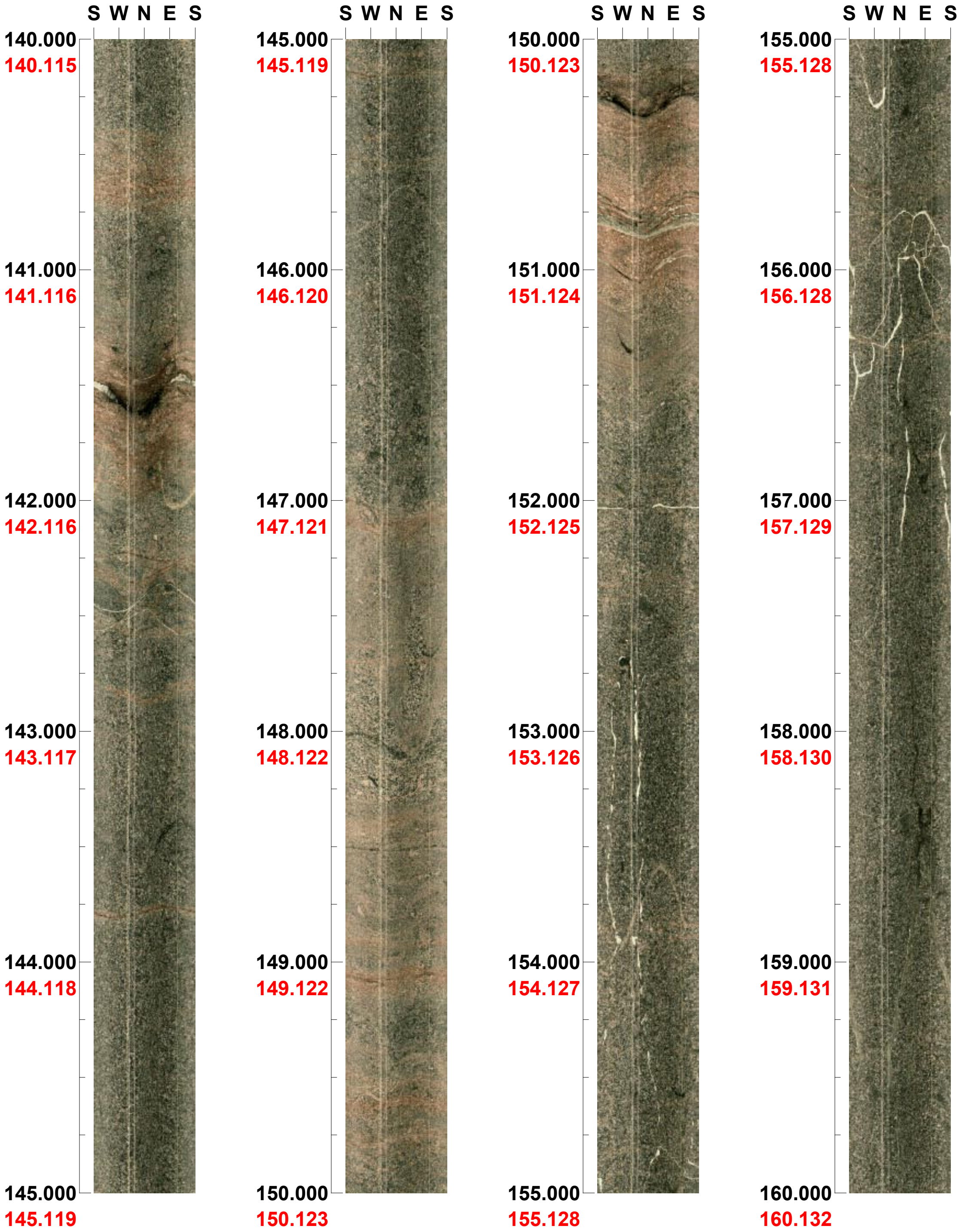


(7 / 9) **Scale: 1/25** **Aspect ratio: 100 %**

Project name: Laxemar

Bore hole No.: HLX43 **Azimuth: 0** **Inclination: -50**

Depth range: 140.000 - 160.000 m

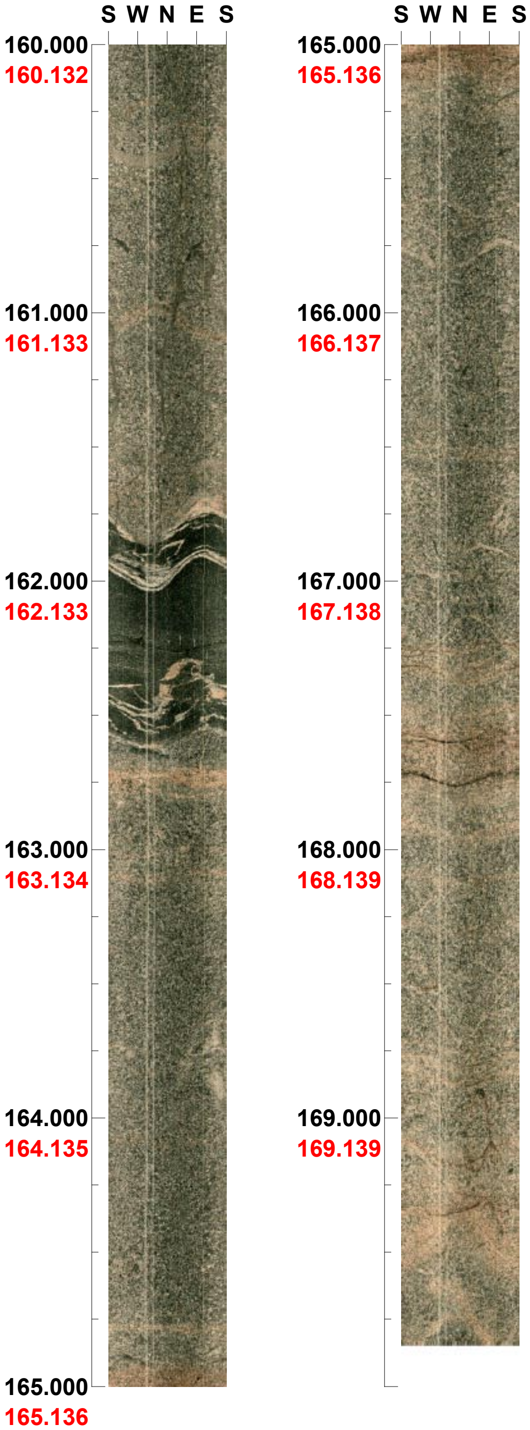


(8 / 9) **Scale: 1/25** **Aspect ratio: 100 %**

Project name: Laxemar

Bore hole No.: HLX43 **Azimuth: 0** **Inclination: -50**

Depth range: 160.000 - 169.845 m



(9 / 9) **Scale: 1/25** **Aspect ratio: 100 %**

Appendix 5

Deviation logging in KLX17A, 0 to 696 m

Laxemar

Survey name:	**KLX17A**
Survey date:	30/11/2007 15:17:17
Project:	PLU
Location:	Laxemar
Country:	Sweden
Survey company:	Mala GeoScience AB / RAYCON
Surveyed by:	Christer Gustafsson
Survey type:	STANDARD
Operating conditions:	
General comments:	
Client name:	SKB
Client ID number:	APPS 400-06-136
Client reference:	Leif Stenberg
Drill company:	
Drill rig:	
Drill diameter:	76
Survey direction:	INTO hole
Survey run on:	Wireline
Magnetic Var.:	2,6 degrees East of North

FLEXIT

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:	49000	2000	nano Tesla
Magnetic dip:	70	2	Degrees

SURVEY	Actual start	End of survey	Difference
Station:	0,0	696,0	696,0
East:	1546862,09	1546978,28	116,19
North:	6366848,75	6367185,45	336,70
Elevation:	27,63	-569,36	-596,99
Dip:	-61,62	-56,26	5,36
Azimuth:	11,21	14,86	3,65

OFFSETS at end
Offsets relative to: ACTUAL START
26,66 metres upwards
48,52 metres right
3,04 metres shortfall

Printed on: 2007-01-24 14:00:37

Page 1 of 8

FLEXIT: SmartTool drillhole survey result table.

Survey name : KLX17A

Survey date : 30/11/2007 15:17:17

Printed on 2007-01-24 14:00:49

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	*	Metres	Metres	Metres
0,0	-61,62	11,21	1546862,09	6366848,75	27,63	30705	70,52	1,000862	✍✍	0,00	0,00	0,00
3,0	-61,45	10,88	1546862,36	6366850,15	24,99	52324	72,27	0,996956	✍✍	0,00	0,00	0,00
6,0	-61,39	10,50	1546862,63	6366851,56	22,36	49299	69,39	0,997313	✍	0,01	-0,02	0,00
9,0	-61,35	10,27	1546862,89	6366852,98	19,73	49453	72,37	0,997100	✍	0,03	-0,04	0,00
12,0	-61,28	12,05	1546863,17	6366854,39	17,09	48861	70,36	0,997905	✍	0,04	-0,04	0,00
15,0	-61,39	12,82	1546863,48	6366855,80	14,46	48534	70,21	0,997879	✍	0,06	-0,01	0,00
18,0	-60,98	12,29	1546863,79	6366857,21	11,83	49348	70,44	0,979551	✍	0,08	0,03	0,00
21,0	-61,41	13,16	1546864,11	6366858,62	9,20	49391	70,46	0,998574	✍	0,10	0,06	0,00
24,0	-61,48	11,60	1546864,42	6366860,02	6,57	50053	70,14	0,998830	✍	0,11	0,09	0,00
27,0	-61,40	13,44	1546864,73	6366861,42	3,93	49880	70,52	1,002271	✍	0,12	0,13	0,00
30,0	-61,22	12,52	1546865,05	6366862,82	1,30	47336	69,43	1,001902	✍	0,14	0,17	0,00
33,0	-61,32	13,03	1546865,37	6366864,23	-1,33	49396	71,15	0,997514	✍	0,15	0,21	0,00
36,0	-61,41	12,66	1546865,69	6366865,63	-3,96	50668	70,42	0,997103	✍	0,17	0,25	0,00
39,0	-61,37	11,60	1546865,99	6366867,03	-6,60	47940	70,86	0,997745	✍	0,18	0,27	0,00
42,0	-61,30	10,71	1546866,27	6366868,45	-9,23	49743	70,57	0,996773	✍	0,19	0,27	0,00
45,0	-61,30	13,91	1546866,58	6366869,85	-11,86	48631	71,14	0,996910	✍	0,21	0,30	0,00
48,0	-61,10	12,25	1546866,91	6366871,26	-14,49	49068	70,65	0,996819	✍	0,23	0,35	0,00
51,0	-61,13	10,57	1546867,19	6366872,68	-17,11	49428	70,37	0,997094	✍	0,26	0,35	0,00
54,0	-61,20	11,73	1546867,47	6366874,10	-19,74	49786	71,39	0,997145	✍	0,28	0,35	0,00
57,0	-61,17	10,52	1546867,75	6366875,52	-22,37	49353	70,89	0,997551	✍	0,30	0,35	0,00
60,0	-60,05	10,21	1546868,02	6366876,97	-24,99	50046	70,93	0,998578	✍	0,35	0,33	0,00
63,0	-60,65	8,35	1546868,25	6366878,43	-27,59	50641	70,31	1,001865	✍	0,42	0,28	-0,01
66,0	-60,93	9,38	1546868,48	6366879,88	-30,21	49788	70,46	1,001736	✍	0,46	0,22	-0,01
69,0	-60,97	9,60	1546868,72	6366881,32	-32,83	48958	69,72	1,001657	✍	0,50	0,17	-0,01
72,0	-60,97	10,25	1546868,97	6366882,75	-35,46	50084	70,56	1,002032	✍	0,53	0,14	-0,01
75,0	-60,96	10,67	1546869,24	6366884,18	-38,08	49965	70,44	1,001693	✍	0,56	0,12	-0,01
78,0	-60,99	12,16	1546869,52	6366885,61	-40,70	49380	69,93	1,001669	✍	0,60	0,13	-0,01
81,0	-60,99	11,60	1546869,82	6366887,03	-43,33	47890	68,13	1,001323	✍	0,63	0,14	-0,01
84,0	-61,03	11,55	1546870,12	6366888,46	-45,95	50151	71,10	1,001532	✍	0,66	0,15	-0,01
87,0	-61,04	11,42	1546870,40	6366889,88	-48,58	50034	70,45	1,001823	✍	0,69	0,16	-0,01
90,0	-61,04	11,55	1546870,69	6366891,30	-51,20	49788	70,80	1,001614	✍	0,72	0,17	-0,01
93,0	-61,03	12,39	1546871,00	6366892,73	-53,82	49577	70,29	1,001751	✍	0,75	0,19	-0,01
96,0	-61,04	12,21	1546871,30	6366894,14	-56,45	50184	70,60	1,001378	✍	0,78	0,21	-0,01
99,0	-60,96	12,50	1546871,62	6366895,57	-59,07	50452	70,47	1,001973	✍	0,82	0,24	-0,01

Survey name : KLX17A

Survey date : 30/11/2007 15:17:17

Printed on 2007-01-24 14:00:49

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	*	Metres	Metres	Metres
102,0	-60,97	11,93	1546871,92	6366896,99	-61,70	50370	70,69	1,001655	✍	0,85	0,27	-0,01
105,0	-60,98	11,95	1546872,23	6366898,41	-64,32	51103	70,46	1,001573	✍	0,88	0,29	-0,01
108,0	-60,92	11,29	1546872,52	6366899,84	-66,94	51221	70,15	1,001808	✍	0,92	0,30	-0,01
111,0	-60,94	11,51	1546872,81	6366901,27	-69,56	50999	70,13	1,001478	✍	0,95	0,30	-0,01
114,0	-60,89	10,05	1546873,08	6366902,70	-72,19	51120	70,83	1,001737	✍	0,99	0,29	-0,01
117,0	-60,89	13,60	1546873,38	6366904,13	-74,81	49872	69,71	1,001839	✍	1,03	0,31	-0,01
120,0	-60,92	17,60	1546873,77	6366905,53	-77,43	50412	70,57	1,001744	✍	1,06	0,42	-0,01
123,0	-60,89	19,07	1546874,23	6366906,92	-80,05	49369	69,25	1,001537	✍	1,09	0,60	-0,02
126,0	-60,91	20,14	1546874,72	6366908,29	-82,67	49319	69,41	1,001762	✍	1,11	0,81	-0,03
129,0	-60,85	21,84	1546875,24	6366909,65	-85,29	48127	69,13	1,001624	✍	1,13	1,06	-0,04
132,0	-60,82	22,81	1546875,80	6366911,01	-87,91	47661	70,38	1,001844	✍	1,15	1,34	-0,05
135,0	-60,85	23,60	1546876,37	6366912,35	-90,53	47522	67,19	1,001740	✍✍	1,16	1,65	-0,07
138,0	-60,84	22,60	1546876,95	6366913,70	-93,15	49261	69,15	1,001631	✍	1,17	1,95	-0,08
141,0	-60,87	21,85	1546877,50	6366915,05	-95,77	48743	68,10	1,001955	✍	1,19	2,23	-0,09
144,0	-60,88	21,60	1546878,04	6366916,40	-98,39	48145	70,71	1,002003	✍	1,21	2,49	-0,11
147,0	-60,87	23,76	1546878,60	6366917,75	-101,01	47993	70,64	1,001948	✍	1,22	2,78	-0,12
150,0	-60,84	23,60	1546879,19	6366919,09	-103,63	48208	67,15	1,001609	✍✍	1,23	3,10	-0,14
153,0	-60,80	22,60	1546879,76	6366920,44	-106,25	49024	69,84	1,001702	✍	1,24	3,40	-0,15
156,0	-60,77	21,24	1546880,31	6366921,79	-108,87	48943	68,83	1,001581	✍	1,27	3,67	-0,16
159,0	-60,74	21,86	1546880,85	6366923,16	-111,49	48746	68,75	1,001497	✍	1,29	3,94	-0,18
162,0	-60,72	21,46	1546881,39	6366924,52	-114,11	49485	68,65	1,002005	✍	1,31	4,20	-0,19
165,0	-60,68	20,08	1546881,91	6366925,89	-116,72	49954	69,93	1,001658	✍	1,34	4,45	-0,20
168,0	-60,68	21,08	1546882,43	6366927,27	-119,34	49276	69,51	1,002080	✍	1,38	4,68	-0,21
171,0	-60,64	23,65	1546882,99	6366928,63	-121,95	49136	68,62	1,001785	✍	1,40	4,97	-0,22
174,0	-60,63	23,40	1546883,57	6366929,98	-124,57	48481	69,77	1,001840	✍	1,42	5,28	-0,24
177,0	-60,64	23,10	1546884,15	6366931,33	-127,18	48388	70,25	1,002037	✍	1,45	5,59	-0,25
180,0	-60,62	21,95	1546884,72	6366932,69	-129,80	48382	70,91	1,001817	✍	1,47	5,88	-0,27
183,0	-60,61	23,92	1546885,29	6366934,04	-132,41	48657	69,25	1,001856	✍	1,50	6,18	-0,28
186,0	-60,59	23,51	1546885,88	6366935,39	-135,02	48887	69,37	1,001942	✍	1,52	6,50	-0,30
189,0	-60,60	21,89	1546886,45	6366936,75	-137,64	49312	70,01	1,001411	✍	1,55	6,79	-0,31
192,0	-60,60	21,36	1546886,99	6366938,12	-140,25	49833	70,43	1,001919	✍	1,58	7,06	-0,33
195,0	-60,58	24,40	1546887,57	6366939,48	-142,86	47865	69,64	1,001757	✍	1,61	7,35	-0,34
198,0	-60,55	21,60	1546888,14	6366940,83	-145,48	51268	72,32	1,001871	✍✍✍	1,63	7,65	-0,36
201,0	-60,55	20,49	1546888,67	6366942,21	-148,09	48184	69,83	1,001944	✍	1,67	7,91	-0,37

Survey name : KLX17A

Survey date : 30/11/2007 15:17:17

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Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	*	Metres	Metres	Metres
204,0	-60,53	23,32	1546889,22	6366943,58	-150,70	48715	70,06	1,001987	✍	1,70	8,18	-0,38
207,0	-60,52	25,96	1546889,84	6366944,92	-153,31	47799	68,94	1,001869	✍	1,73	8,52	-0,40
210,0	-60,46	19,13	1546890,40	6366946,28	-155,93	49294	71,55	1,002121	✍	1,76	8,81	-0,41
213,0	-60,49	19,16	1546890,89	6366947,68	-158,54	49300	71,57	1,001725	✍	1,80	9,02	-0,42
216,0	-60,44	25,40	1546891,45	6366949,04	-161,15	48809	69,93	1,001970	✍	1,84	9,30	-0,44
219,0	-60,42	23,76	1546892,06	6366950,39	-163,76	48912	70,71	1,002171	✍	1,87	9,64	-0,46
222,0	-60,44	30,92	1546892,74	6366951,70	-166,37	49123	69,71	1,001996	✍	1,87	10,05	-0,48
225,0	-60,46	37,63	1546893,58	6366952,93	-168,98	44941	68,11	1,001861	✍	1,83	10,63	-0,54
228,0	-60,45	32,10	1546894,42	6366954,14	-171,59	47664	66,52	1,001706	✍	1,78	11,23	-0,60
231,0	-60,43	24,80	1546895,12	6366955,44	-174,20	47575	68,19	1,001959	✍	1,78	11,66	-0,63
234,0	-60,39	22,63	1546895,72	6366956,79	-176,81	47232	69,47	1,001977	✍	1,81	11,98	-0,65
237,0	-60,40	24,58	1546896,31	6366958,15	-179,41	47103	68,38	1,002020	✍	1,85	12,30	-0,67
240,0	-60,33	21,86	1546896,90	6366959,51	-182,02	47448	68,35	1,001997	✍	1,88	12,61	-0,69
243,0	-60,27	21,60	1546897,45	6366960,89	-184,63	47674	69,45	1,002010	✍	1,93	12,88	-0,70
246,0	-60,29	21,70	1546898,00	6366962,28	-187,23	47288	67,65	1,001855	✍	1,98	13,15	-0,71
249,0	-60,21	21,60	1546898,55	6366963,66	-189,84	49759	70,57	1,002183	✍	2,03	13,42	-0,72
252,0	-60,17	22,60	1546899,11	6366965,04	-192,44	47439	70,16	1,001621	✍	2,08	13,70	-0,74
255,0	-60,10	24,49	1546899,70	6366966,41	-195,04	48408	68,51	1,001760	✍	2,13	14,02	-0,75
258,0	-60,06	25,03	1546900,33	6366967,77	-197,64	48471	68,44	1,001605	✍	2,17	14,37	-0,77
261,0	-60,02	25,32	1546900,97	6366969,13	-200,24	48318	67,82	1,002078	✍	2,21	14,73	-0,80
264,0	-59,97	24,31	1546901,60	6366970,49	-202,84	48057	67,66	1,002086	✍	2,26	15,09	-0,82
267,0	-59,92	19,60	1546902,16	6366971,88	-205,44	49544	69,79	1,002108	✍	2,32	15,37	-0,83
270,0	-59,85	19,35	1546902,66	6366973,30	-208,03	48364	70,22	1,002137	✍	2,40	15,58	-0,84
273,0	-59,84	19,89	1546903,17	6366974,72	-210,63	49544	68,75	1,002191	✍	2,48	15,80	-0,85
276,0	-59,82	21,21	1546903,70	6366976,13	-213,22	48716	68,88	1,001933	✍	2,56	16,05	-0,86
279,0	-59,82	20,92	1546904,24	6366977,54	-215,81	48094	69,78	1,001746	✍	2,63	16,31	-0,87
282,0	-59,82	17,72	1546904,74	6366978,96	-218,41	48673	69,12	1,001758	✍	2,71	16,52	-0,88
285,0	-59,83	30,09	1546905,34	6366980,33	-221,00	47455	63,90	1,001963	✍	2,76	16,85	-0,90
288,0	-59,74	19,79	1546905,98	6366981,70	-223,60	48722	70,18	1,002152	✍	2,82	17,21	-0,92
291,0	-59,71	20,70	1546906,50	6366983,12	-226,19	48938	70,93	1,002115	✍	2,90	17,44	-0,94
294,0	-59,69	21,58	1546907,05	6366984,53	-228,78	47918	70,09	1,002591	✍	2,98	17,70	-0,95
297,0	-59,65	24,20	1546907,64	6366985,92	-231,37	48333	69,08	1,002110	✍	3,05	18,01	-0,96
300,0	-59,66	23,14	1546908,25	6366987,31	-233,96	48096	69,13	1,002054	✍	3,12	18,34	-0,98
303,0	-59,59	23,21	1546908,84	6366988,71	-236,54	48948	68,96	1,002025	✍	3,20	18,65	-1,00

FLEXIT: SmartTool drillhole survey result table.

Survey name : KLX17A
Survey date : 30/11/2007 15:17:17

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Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	*	Metres	Metres	Metres
306,0	-59,57	25,94	1546909,47	6366990,09	-239,13	48114	69,49	1,001936	✍	3,27	19,00	-1,02
309,0	-59,57	24,91	1546910,13	6366991,46	-241,72	47319	70,47	1,001905	✍	3,34	19,38	-1,05
312,0	-59,60	23,22	1546910,75	6366992,85	-244,31	45928	68,40	1,001778	✍	3,41	19,71	-1,07
315,0	-59,57	22,60	1546911,34	6366994,24	-246,89	49125	70,34	1,002143	✍	3,49	20,02	-1,08
318,0	-59,54	21,60	1546911,91	6366995,65	-249,48	49474	70,21	1,001836	✍	3,57	20,31	-1,10
321,0	-59,51	24,19	1546912,50	6366997,05	-252,06	47922	69,51	1,002045	✍	3,65	20,62	-1,12
324,0	-59,50	23,13	1546913,11	6366998,45	-254,65	48993	69,69	1,001960	✍	3,73	20,95	-1,13
327,0	-59,44	24,90	1546913,73	6366999,84	-257,23	48091	69,38	1,002032	✍	3,81	21,28	-1,15
330,0	-59,43	24,10	1546914,36	6367001,23	-259,82	48201	69,51	1,001837	✍	3,89	21,63	-1,18
333,0	-59,40	21,60	1546914,96	6367002,64	-262,40	47458	67,81	1,002128	✍✍	3,98	21,94	-1,19
336,0	-59,33	25,34	1546915,57	6367004,04	-264,98	47751	69,11	1,002031	✍	4,06	22,27	-1,21
339,0	-59,29	24,60	1546916,21	6367005,43	-267,56	47876	68,59	1,001921	✍	4,15	22,63	-1,24
342,0	-59,25	25,80	1546916,87	6367006,81	-270,14	46133	68,39	1,001828	✍	4,23	23,00	-1,26
345,0	-59,21	23,60	1546917,51	6367008,21	-272,72	43186	70,01	1,002042	✍✍	4,32	23,36	-1,28
348,0	-59,20	24,06	1546918,13	6367009,61	-275,29	43817	70,46	1,002158	✍	4,41	23,70	-1,30
351,0	-59,16	23,60	1546918,75	6367011,02	-277,87	51487	69,32	1,002264	✍✍	4,50	24,03	-1,32
354,0	-59,16	24,03	1546919,37	6367012,42	-280,45	49928	66,50	1,002288	✍	4,60	24,37	-1,34
357,0	-59,14	25,52	1546920,01	6367013,82	-283,02	50438	65,28	1,002458	✍	4,69	24,73	-1,37
360,0	-59,13	25,90	1546920,68	6367015,21	-285,60	48758	67,30	1,002181	✍	4,78	25,11	-1,39
363,0	-59,09	23,23	1546921,32	6367016,61	-288,17	49202	68,39	1,001677	✍	4,87	25,47	-1,42
366,0	-59,05	20,91	1546921,90	6367018,04	-290,75	49293	69,23	1,001913	✍	4,98	25,76	-1,43
369,0	-59,04	21,84	1546922,46	6367019,47	-293,32	48931	69,34	1,002461	✍	5,09	26,03	-1,45
372,0	-59,03	21,49	1546923,03	6367020,91	-295,89	48851	69,33	1,001891	✍	5,21	26,31	-1,46
375,0	-59,02	21,09	1546923,59	6367022,35	-298,46	48573	69,31	1,002036	✍	5,32	26,58	-1,48
378,0	-59,00	17,94	1546924,11	6367023,80	-301,03	49076	70,08	1,002074	✍	5,44	26,80	-1,49
381,0	-59,00	19,94	1546924,61	6367025,26	-303,61	49080	69,64	1,002135	✍	5,57	27,01	-1,50
384,0	-59,01	19,22	1546925,13	6367026,72	-306,18	49108	70,03	1,002025	✍	5,69	27,24	-1,51
387,0	-58,97	18,80	1546925,63	6367028,18	-308,75	49067	69,83	1,001996	✍	5,82	27,45	-1,52
390,0	-58,94	16,00	1546926,09	6367029,66	-311,32	49661	70,14	1,002010	✍	5,95	27,61	-1,53
393,0	-58,93	14,49	1546926,50	6367031,15	-313,89	49388	70,20	1,002559	✍	6,08	27,72	-1,53
396,0	-58,89	17,32	1546926,93	6367032,64	-316,46	49246	70,24	1,001973	✍	6,22	27,85	-1,54
399,0	-58,88	17,57	1546927,39	6367034,12	-319,03	49218	69,79	1,001963	✍	6,35	28,02	-1,54
402,0	-58,87	18,25	1546927,87	6367035,59	-321,60	49053	69,98	1,002144	✍	6,49	28,20	-1,55
405,0	-58,85	17,24	1546928,34	6367037,07	-324,16	49177	70,25	1,002156	✍	6,62	28,38	-1,56

Survey name : KLX17A

Survey date : 30/11/2007 15:17:17

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Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	*	Metres	Metres	Metres
408,0	-58,85	19,12	1546928,82	6367038,55	-326,73	48937	69,60	1,001722	✍	6,76	28,56	-1,57
411,0	-58,84	13,34	1546929,26	6367040,03	-329,30	49650	70,94	1,002164	✍	6,90	28,70	-1,58
414,0	-58,81	20,54	1546929,71	6367041,52	-331,87	48767	69,24	1,002312	✍	7,03	28,85	-1,58
417,0	-58,78	17,90	1546930,22	6367042,99	-334,43	48902	69,38	1,002313	✍	7,17	29,07	-1,59
420,0	-58,78	18,91	1546930,71	6367044,46	-337,00	48648	69,69	1,002307	✍	7,31	29,27	-1,60
423,0	-58,79	20,85	1546931,24	6367045,92	-339,56	50813	70,80	1,002039	✍	7,44	29,50	-1,62
426,0	-58,79	20,75	1546931,79	6367047,38	-342,13	50430	70,49	1,002329	✍	7,57	29,76	-1,63
429,0	-58,77	20,40	1546932,34	6367048,83	-344,69	49316	69,63	1,002478	✍	7,70	30,01	-1,64
432,0	-58,77	18,97	1546932,86	6367050,30	-347,26	49299	69,59	1,001981	✍	7,83	30,24	-1,66
435,0	-58,75	18,81	1546933,37	6367051,77	-349,82	49184	69,80	1,002190	✍	7,97	30,45	-1,67
438,0	-58,75	18,60	1546933,87	6367053,24	-352,39	49247	70,37	1,001962	✍	8,11	30,65	-1,68
441,0	-58,72	20,16	1546934,38	6367054,71	-354,95	48725	69,97	1,002646	✍	8,24	30,87	-1,69
444,0	-58,68	22,94	1546934,96	6367056,16	-357,52	47353	70,56	1,001667	✍	8,37	31,15	-1,70
447,0	-58,68	23,39	1546935,57	6367057,59	-360,08	49220	69,40	1,002204	✍	8,50	31,48	-1,72
450,0	-58,65	23,24	1546936,19	6367059,03	-362,64	49055	68,80	1,002040	✍	8,62	31,80	-1,74
453,0	-58,63	22,42	1546936,79	6367060,47	-365,20	47845	68,73	1,002397	✍	8,75	32,12	-1,76
456,0	-58,60	21,82	1546937,38	6367061,91	-367,77	48304	68,38	1,002217	✍	8,88	32,41	-1,78
459,0	-58,58	22,85	1546937,97	6367063,36	-370,33	47989	68,38	1,002604	✍	9,01	32,72	-1,80
462,0	-58,54	22,14	1546938,57	6367064,81	-372,89	48271	69,36	1,002162	✍	9,15	33,02	-1,82
465,0	-58,52	21,36	1546939,15	6367066,26	-375,44	48202	69,96	1,002191	✍	9,29	33,31	-1,83
468,0	-58,51	23,71	1546939,75	6367067,71	-378,00	48181	69,40	1,002801	✍	9,42	33,62	-1,85
471,0	-58,51	22,84	1546940,37	6367069,15	-380,56	48283	69,49	1,002161	✍	9,55	33,94	-1,87
474,0	-58,48	20,60	1546940,95	6367070,60	-383,12	49688	70,90	1,002216	✍	9,69	34,23	-1,89
477,0	-58,41	20,54	1546941,50	6367072,07	-385,67	50230	72,42	1,002077	✍	9,84	34,48	-1,91
480,0	-58,39	21,17	1546942,06	6367073,54	-388,23	49654	71,45	1,002437	✍	9,99	34,75	-1,92
483,0	-58,34	17,48	1546942,58	6367075,03	-390,78	48645	70,49	1,001923	✍	10,15	34,97	-1,93
486,0	-58,31	19,16	1546943,08	6367076,52	-393,34	48368	69,95	1,002328	✍	10,31	35,16	-1,94
489,0	-58,26	18,28	1546943,59	6367078,01	-395,89	48725	69,70	1,002408	✍	10,47	35,37	-1,96
492,0	-58,23	17,87	1546944,08	6367079,52	-398,44	48635	70,15	1,002308	✍	10,64	35,56	-1,97
495,0	-58,19	18,71	1546944,57	6367081,02	-400,99	49352	70,70	1,002251	✍	10,80	35,75	-1,98
498,0	-58,12	15,93	1546945,04	6367082,53	-403,54	49398	70,89	1,002149	✍	10,98	35,92	-1,99
501,0	-58,07	17,98	1546945,51	6367084,04	-406,09	49016	70,51	1,002382	✍	11,15	36,08	-2,00
504,0	-58,00	17,97	1546946,00	6367085,55	-408,63	49802	70,36	1,002111	✍	11,33	36,27	-2,01
507,0	-57,95	19,88	1546946,51	6367087,06	-411,17	49333	70,37	1,001845	✍	11,51	36,48	-2,02

FLEXIT: SmartTool drillhole survey result table.

Survey name : KLX17A

Survey date : 30/11/2007 15:17:17

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Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	*	Metres	Metres	Metres
510,0	-57,91	17,65	1546947,02	6367088,57	-413,72	48835	70,48	1,002428	✍	11,69	36,69	-2,03
513,0	-57,85	19,28	1546947,53	6367090,08	-416,26	49216	70,10	1,002221	✍	11,87	36,89	-2,05
516,0	-57,77	16,07	1546948,01	6367091,60	-418,80	50086	71,81	1,002568	✍	12,06	37,07	-2,06
519,0	-57,66	19,40	1546948,50	6367093,13	-421,33	48738	70,22	1,002727	✍	12,26	37,26	-2,07
522,0	-57,54	20,43	1546949,05	6367094,64	-423,87	48885	69,87	1,002264	✍	12,45	37,50	-2,09
525,0	-57,47	19,70	1546949,60	6367096,15	-426,40	48755	70,80	1,002254	✍	12,65	37,75	-2,10
528,0	-57,37	19,65	1546950,15	6367097,67	-428,92	48775	69,73	1,002281	✍	12,85	37,98	-2,12
531,0	-57,26	19,29	1546950,69	6367099,20	-431,45	49201	70,02	1,002291	✍	13,06	38,22	-2,14
534,0	-57,21	18,41	1546951,21	6367100,74	-433,97	49275	70,68	1,002374	✍	13,28	38,43	-2,15
537,0	-57,16	19,43	1546951,74	6367102,28	-436,49	48995	70,22	1,002340	✍	13,50	38,65	-2,17
540,0	-57,13	19,30	1546952,28	6367103,81	-439,01	48524	69,89	1,002412	✍	13,72	38,88	-2,18
543,0	-57,11	18,64	1546952,81	6367105,35	-441,53	48963	70,60	1,002576	✍	13,94	39,10	-2,20
546,0	-57,11	15,95	1546953,29	6367106,91	-444,05	49248	70,89	1,002164	✍	14,17	39,27	-2,21
549,0	-57,05	17,70	1546953,76	6367108,47	-446,57	49132	70,47	1,002862	✍	14,40	39,43	-2,23
552,0	-57,04	18,39	1546954,27	6367110,02	-449,09	49224	70,39	1,002121	✍	14,63	39,63	-2,24
555,0	-57,01	22,24	1546954,84	6367111,55	-451,60	48760	68,53	1,002110	✍	14,85	39,89	-2,26
558,0	-56,99	21,15	1546955,44	6367113,07	-454,12	49104	68,72	1,002569	✍	15,07	40,18	-2,28
561,0	-56,97	16,62	1546955,97	6367114,61	-456,64	49592	70,71	1,002409	✍	15,29	40,40	-2,30
564,0	-56,92	19,30	1546956,47	6367116,17	-459,15	49072	70,50	1,002455	✍	15,53	40,59	-2,32
567,0	-56,94	19,43	1546957,02	6367117,71	-461,67	49428	70,53	1,002119	✍	15,76	40,83	-2,33
570,0	-56,91	19,44	1546957,56	6367119,26	-464,18	49044	70,71	1,002462	✍	15,99	41,06	-2,35
573,0	-56,92	20,95	1546958,13	6367120,79	-466,69	48376	70,55	1,002266	✍	16,22	41,32	-2,37
576,0	-56,92	17,72	1546958,67	6367122,34	-469,21	49224	71,01	1,001965	✍	16,45	41,55	-2,39
579,0	-56,85	18,31	1546959,17	6367123,90	-471,72	49395	70,62	1,002695	✍	16,69	41,74	-2,41
582,0	-56,85	20,60	1546959,72	6367125,44	-474,23	48557	69,74	1,002245	✍	16,92	41,98	-2,42
585,0	-56,83	19,64	1546960,29	6367126,99	-476,74	49258	70,01	1,002708	✍	17,15	42,23	-2,44
588,0	-56,83	21,50	1546960,86	6367128,52	-479,25	48687	69,96	1,002579	✍	17,38	42,50	-2,47
591,0	-56,82	17,67	1546961,41	6367130,07	-481,76	49339	70,61	1,002295	✍	17,62	42,74	-2,48
594,0	-56,78	17,74	1546961,91	6367131,63	-484,28	49351	70,63	1,002279	✍	17,86	42,92	-2,50
597,0	-56,74	18,01	1546962,42	6367133,20	-486,78	49571	70,46	1,002414	✍	18,11	43,11	-2,52
600,0	-56,75	18,21	1546962,93	6367134,76	-489,29	49408	70,47	1,002313	✍	18,35	43,31	-2,53
603,0	-56,75	17,45	1546963,43	6367136,33	-491,80	49443	70,45	1,002382	✍	18,59	43,50	-2,55
606,0	-56,72	17,91	1546963,93	6367137,90	-494,31	49269	70,20	1,002392	✍	18,84	43,69	-2,56
609,0	-56,69	17,67	1546964,43	6367139,46	-496,82	49383	70,06	1,002573	✍	19,09	43,88	-2,58

FLEXIT: SmartTool drillhole survey result table.

Survey name : KLX17A

Survey date : 30/11/2007 15:17:17

Printed on 2007-01-24 14:00:50

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	*	Metres	Metres	Metres
612,0	-56,68	18,10	1546964,94	6367141,03	-499,32	49364	70,16	1,002327	✍	19,34	44,07	-2,60
615,0	-56,67	17,96	1546965,45	6367142,60	-501,83	49409	70,27	1,002081	✍	19,58	44,26	-2,61
618,0	-56,65	17,64	1546965,95	6367144,17	-504,34	49398	70,37	1,002502	✍	19,83	44,45	-2,63
621,0	-56,63	16,43	1546966,44	6367145,75	-506,84	49316	70,62	1,002283	✍	20,09	44,62	-2,65
624,0	-56,61	17,58	1546966,92	6367147,32	-509,35	49142	70,21	1,002369	✍	20,34	44,79	-2,66
627,0	-56,58	17,17	1546967,41	6367148,90	-511,85	49439	70,47	1,002448	✍	20,59	44,96	-2,68
630,0	-56,57	16,87	1546967,90	6367150,48	-514,36	49398	70,56	1,002333	✍	20,85	45,13	-2,69
633,0	-56,58	17,57	1546968,39	6367152,06	-516,86	49086	70,48	1,002580	✍	21,11	45,30	-2,71
636,0	-56,56	16,74	1546968,87	6367153,64	-519,36	49403	70,54	1,002373	✍	21,36	45,47	-2,72
639,0	-56,53	16,59	1546969,35	6367155,22	-521,87	49517	70,57	1,002383	✍	21,62	45,63	-2,74
642,0	-56,56	17,44	1546969,83	6367156,80	-524,37	49311	70,25	1,002540	✍	21,88	45,80	-2,76
645,0	-56,52	17,11	1546970,32	6367158,38	-526,87	49210	70,41	1,002616	✍	22,14	45,97	-2,77
648,0	-56,52	15,77	1546970,79	6367159,97	-529,38	49459	70,40	1,002412	✍	22,40	46,12	-2,79
651,0	-56,53	17,37	1546971,26	6367161,56	-531,88	49244	70,37	1,002433	✍	22,66	46,28	-2,80
654,0	-56,51	16,53	1546971,75	6367163,14	-534,38	49352	70,36	1,002164	✍	22,92	46,44	-2,82
657,0	-56,49	16,87	1546972,22	6367164,73	-536,88	49223	69,47	1,002268	✍	23,18	46,60	-2,83
660,0	-56,46	17,55	1546972,71	6367166,31	-539,38	49572	70,05	1,002708	✍	23,44	46,78	-2,85
663,0	-56,43	15,65	1546973,19	6367167,90	-541,88	49719	70,73	1,002275	✍	23,70	46,93	-2,87
666,0	-56,43	16,60	1546973,65	6367169,49	-544,38	50336	71,29	1,002761	✍	23,97	47,07	-2,88
669,0	-56,43	15,79	1546974,11	6367171,08	-546,88	49705	71,08	1,002213	✍	24,23	47,22	-2,90
672,0	-56,42	16,28	1546974,57	6367172,68	-549,38	49601	70,85	1,002402	✍	24,50	47,36	-2,91
675,0	-56,41	16,45	1546975,03	6367174,27	-551,88	49327	70,34	1,002328	✍	24,76	47,51	-2,93
678,0	-56,38	16,53	1546975,51	6367175,86	-554,38	49478	70,44	1,002632	✍	25,03	47,66	-2,94
681,0	-56,35	17,49	1546975,99	6367177,45	-556,88	49370	70,17	1,002105	✍	25,30	47,83	-2,96
684,0	-56,34	15,65	1546976,47	6367179,04	-559,37	49477	70,64	1,002413	✍	25,57	47,98	-2,98
687,0	-56,34	16,36	1546976,92	6367180,64	-561,87	49418	70,54	1,002535	✍	25,84	48,12	-2,99
690,0	-56,34	16,02	1546977,39	6367182,24	-564,37	49477	70,52	1,002284	✍	26,11	48,27	-3,01
693,0	-56,32	15,78	1546977,84	6367183,84	-566,87	49439	70,45	1,002658	✍	26,38	48,40	-3,02
696,0	-56,26	14,86	1546978,28	6367185,45	-569,36	49194	71,42	1,002362	✍	26,66	48,52	-3,04

Appendix 6

Deviation logging in HLX43, 0 to 168 m

New MeasureIT files

FLEXIT

Survey name:	**HLX43**
Survey date:	30/11/2007 20:39:55
Project:	PLU
Location:	Laxemar

Country:	Sweden		
Survey company:	Mala GeoScience AB / RAYCON		
Surveyed by:	Christer Gustafsson		
Survey type:	STANDARD		
Operating conditions:			
General comments:			
Client name:	SKB		
Client ID number:	APPS 400-06-136		
Client reference:	Leif Stenberg		
Drill company:			
Drill rig:			
Drill diameter:	76	Survey run on:	Wireline
Survey direction:	INTO hole	Magnetic Var.:	2,6 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:	49900	2000	nano Tesla
Magnetic dip:	71	2	Degrees

SURVEY	Actual start	End of survey	Difference
Station:	0,0	168,0	168,0
East:	1546626,60	1546527,06	-99,54
North:	6367517,45	6367518,37	0,92
Elevation:	24,20	-110,92	-135,12
Dip:	-50,76	-58,22	-7,46
Azimuth:	268,55	271,00	2,45

OFFSETS at end
Offsets relative to:
ACTUAL START
8,44 metres downwards
3,44 metres right
0,42 metres shortfall

Printed on: 2007-01-25 11:30:33

Page 1 of 3

FLEXIT: SmartTool drillhole survey result table.

Survey name : HLX43

Survey date : 30/11/2007 20:39:55

Printed on 2007-01-25 11:34:14

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	*	Metres	Metres	Metres
0,0	-50,76	268,55	1546626,60	6367517,45	24,20	49556	71,24	0,997106	✍	0,00	0,00	0,00
3,0	-50,31	268,00	1546624,69	6367517,39	21,89	48484	71,97	0,999984	✍	0,01	-0,01	0,00
6,0	-50,21	267,27	1546622,77	6367517,32	19,58	49575	70,96	0,997685	✍	0,04	-0,04	0,00
9,0	-50,43	267,66	1546620,86	6367517,23	17,27	48653	70,59	0,997381	✍	0,06	-0,08	0,00
12,0	-50,62	267,00	1546618,95	6367517,14	14,96	49115	70,64	0,996336	✍	0,07	-0,12	0,00
15,0	-50,69	267,00	1546617,06	6367517,04	12,64	48042	70,00	0,999886	✍	0,08	-0,17	0,00
18,0	-50,92	268,00	1546615,16	6367516,96	10,31	48657	70,72	1,002386	✍	0,07	-0,20	0,00
21,0	-51,28	269,85	1546613,28	6367516,92	7,98	48670	71,82	1,001865	✍	0,06	-0,19	0,00
24,0	-51,45	270,07	1546611,40	6367516,92	5,63	49050	71,93	1,001762	✍	0,02	-0,14	0,00
27,0	-51,52	269,54	1546609,54	6367516,92	3,29	49328	71,71	1,002176	✍	-0,02	-0,10	0,00
30,0	-51,67	269,00	1546607,67	6367516,89	0,93	47400	71,05	1,001531	✍✍	-0,06	-0,08	0,00
33,0	-51,77	268,03	1546605,82	6367516,84	-1,42	48646	72,16	1,001732	✍	-0,11	-0,08	0,00
36,0	-51,81	268,47	1546603,96	6367516,79	-3,78	48692	71,83	1,001690	✍	-0,16	-0,09	0,00
39,0	-51,75	270,37	1546602,10	6367516,77	-6,13	48619	71,48	1,002154	✍	-0,22	-0,06	0,00
42,0	-51,87	270,42	1546600,25	6367516,78	-8,49	48615	71,50	1,001631	✍	-0,27	0,00	-0,01
45,0	-51,85	269,80	1546598,40	6367516,79	-10,85	48527	71,60	1,002204	✍	-0,33	0,05	-0,01
48,0	-51,89	269,13	1546596,54	6367516,77	-13,21	48500	71,39	1,002201	✍	-0,39	0,08	-0,01
51,0	-51,96	269,86	1546594,69	6367516,75	-15,57	48397	71,32	1,001743	✍	-0,45	0,11	-0,01
54,0	-52,01	271,70	1546592,85	6367516,78	-17,94	48456	71,45	1,001948	✍	-0,52	0,18	-0,01
57,0	-52,09	271,93	1546591,00	6367516,84	-20,30	48610	71,38	1,001984	✍	-0,59	0,28	-0,01
60,0	-52,05	273,28	1546589,16	6367516,92	-22,67	48553	71,17	1,002169	✍	-0,66	0,41	-0,02
63,0	-52,05	271,38	1546587,32	6367516,99	-25,03	48325	71,34	1,001447	✍	-0,73	0,54	-0,02
66,0	-52,15	273,69	1546585,48	6367517,08	-27,40	48523	70,94	1,001548	✍	-0,81	0,66	-0,02
69,0	-52,29	270,58	1546583,64	6367517,14	-29,77	48348	71,31	1,001204	✍	-0,89	0,78	-0,03
72,0	-52,35	272,13	1546581,81	6367517,19	-32,15	49157	71,20	1,001096	✍	-0,97	0,87	-0,03
75,0	-52,39	269,95	1546579,98	6367517,22	-34,52	48843	71,16	1,001118	✍	-1,06	0,95	-0,03
78,0	-52,38	269,11	1546578,15	6367517,21	-36,90	48964	71,09	1,000911	✍	-1,14	0,98	-0,03
81,0	-52,39	269,47	1546576,31	6367517,18	-39,28	47824	70,71	1,000282	✍	-1,23	1,00	-0,03
84,0	-52,56	270,00	1546574,49	6367517,17	-41,66	47155	71,99	1,000402	✍✍	-1,32	1,04	-0,04
87,0	-52,74	270,15	1546572,67	6367517,18	-44,04	48098	70,42	1,000437	✍	-1,42	1,09	-0,04
90,0	-52,83	270,46	1546570,85	6367517,19	-46,43	46662	72,13	0,999685	✍	-1,52	1,15	-0,04
93,0	-53,07	271,00	1546569,05	6367517,21	-48,82	46120	71,06	0,999654	✍✍	-1,64	1,21	-0,04
96,0	-53,23	269,82	1546567,25	6367517,22	-51,22	49254	70,87	0,998854	✍	-1,76	1,27	-0,05
99,0	-53,34	270,54	1546565,45	6367517,23	-53,63	49042	70,43	0,997942	✍	-1,90	1,32	-0,05

Survey name : HLX43

Survey date : 30/11/2007 20:39:55

Printed on 2007-01-25 11:34:14

Station	Dip	Azimuth	Easting	Northing	Elevation	Mag.Field	Mag.Dip	Grav.Field	Status	UpDown	LeftRight	Shortfall
Metres	Degrees	Degrees	Metres	Metres	Metres	nT	Degrees	G	*	Metres	Metres	Metres
102,0	-53,65	271,16	1546563,67	6367517,25	-56,04	49020	70,77	0,996524	✍	-2,04	1,40	-0,05
105,0	-53,76	271,09	1546561,89	6367517,29	-58,46	49485	70,77	0,996379	✍	-2,20	1,47	-0,06
108,0	-54,06	271,22	1546560,13	6367517,33	-60,88	48943	71,23	0,996292	✍	-2,36	1,56	-0,07
111,0	-54,16	271,00	1546558,37	6367517,36	-63,31	47071	71,27	0,996148	✍✍	-2,54	1,63	-0,07
114,0	-54,61	271,01	1546556,62	6367517,39	-65,75	49013	70,81	0,996442	✍	-2,73	1,71	-0,08
117,0	-54,91	271,97	1546554,89	6367517,43	-68,20	49195	70,74	0,996456	✍	-2,94	1,80	-0,09
120,0	-55,10	270,42	1546553,17	6367517,47	-70,66	49612	69,92	0,996135	✍	-3,17	1,88	-0,10
123,0	-55,40	272,21	1546551,46	6367517,51	-73,12	48951	70,52	0,996357	✍	-3,40	1,96	-0,11
126,0	-55,76	272,85	1546549,77	6367517,58	-75,60	49263	71,15	0,996317	✍	-3,66	2,08	-0,12
129,0	-56,11	271,89	1546548,09	6367517,65	-78,08	49776	70,48	0,996404	✍	-3,93	2,19	-0,14
132,0	-56,40	271,52	1546546,42	6367517,70	-80,58	48348	70,56	0,996204	✍	-4,22	2,28	-0,15
135,0	-56,71	271,10	1546544,77	6367517,74	-83,08	48097	71,01	0,996329	✍	-4,53	2,36	-0,17
138,0	-56,88	272,94	1546543,13	6367517,80	-85,59	48677	71,33	0,997366	✍	-4,85	2,46	-0,19
141,0	-57,12	272,00	1546541,49	6367517,87	-88,11	47765	71,56	0,997865	✍✍	-5,17	2,57	-0,21
144,0	-57,35	272,07	1546539,87	6367517,93	-90,63	47372	71,29	0,998583	✍	-5,52	2,67	-0,23
147,0	-57,49	271,55	1546538,26	6367517,98	-93,16	49573	71,49	0,998448	✍	-5,87	2,76	-0,25
150,0	-57,44	273,40	1546536,65	6367518,05	-95,69	49049	70,90	0,998375	✍	-6,22	2,87	-0,27
153,0	-57,34	271,88	1546535,03	6367518,12	-98,22	48122	71,51	0,998783	✍	-6,57	2,99	-0,29
156,0	-57,58	272,00	1546533,42	6367518,18	-100,74	46929	72,63	0,998916	✍✍	-6,92	3,08	-0,32
159,0	-57,91	273,07	1546531,82	6367518,25	-103,28	48402	71,07	0,999808	✍	-7,29	3,19	-0,34
162,0	-57,97	271,47	1546530,23	6367518,31	-105,82	48202	71,20	0,996492	✍	-7,67	3,30	-0,37
165,0	-58,10	271,00	1546528,64	6367518,35	-108,37	48710	70,93	0,997037	✍	-8,05	3,37	-0,39
168,0	-58,22	271,00	1546527,06	6367518,37	-110,92	49547	70,92	0,997766	✍	-8,44	3,44	-0,42