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Oskarshamn site investigation

RAMAC and BIPS logging in boreholes KLX07A, KLX07B, HLX34 and HLX35 and deviation logging in boreholes KLX07B, HLX34 and HLX35

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September 2005

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Keywords: BIPS, RAMAC, radar, TV.

Reading instruction

For revision no 1 of this report a recalculation of the directional radar data has been done. The strike angle between the line of the plane's cross-section with the surface and the Magnetic North direction was earlier counted counter-clockwise but it is now recalculated as such it counts clockwise, Figures 5-3 and 5-4. New values for strike and dip are therefore updated in Tables 5-5 and 5-6.

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) and BIPS logging in the core drilled boreholes KLX07A and KLX07B and in the percussion drilled boreholes HLX34 and HLX35. In the boreholes KLX07B, HLX34 and HLX35 also deviation measurements were carried out. All measurements were conducted by Malå Geoscience AB/RAYCON during July 2005.

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 KLX07A, KLX07B, HLX34 and HLX35 was relatively satisfying, but in some 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 approximately 264 identified radar reflectors in KLX07A and of these 54 were orientated (strike/dip). The corresponding figures for KLX07B are 48 and 11. In HLX34 36 radar reflectors and in HLX35 46 reflectors were identified.

The conditions in the boreholes for the BIPS logging was for the time of logging in general satisfying. This resulted in good images from the BIPS camera and geological mapping and orientation of structures is possible. The discoloring effect from the drilling is the only concern and it is only KLX07A that partly is effected between 100 m and 500 m. Another occurrence are scratches along the borehole wall. This scratches is probably from some of the equipment that have been attached to the drill rods. The other boreholes in this report are of very good quality with clean water and no mud coverage which result in very good images.

Sammanfattning

Denna rapport omfattar geofysiska loggningar inom platsundersökningsprogrammet för Oskarshamn. Mätningarna som presenteras här omfattar borrhålsradarmätningar (RAMAC) och BIPS-loggningar i kärnborrhålen KLX07A och KLX07B och i hammarborrhålen HLX34 och HLX35. I borrhålen KLX07B, HLX34 och HLX35 genomfördes även avvikelsemätningar, s k krökningsmätningar. Alla mätningar är utförda av Malå Geoscience AB/RAYCON under juli 2005.

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 avvikelsemätningarna är att få fram koordinater samt lutning och riktning 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. Avvikelsemätningen presenteras som en lista med lägesdata.

Borrhålsradardata från KLX07A, KLX07B, HLX34 och HLX35 var relativt tillfredställande, men i delar av sämre kvalité troligen till stor del beroende på en konduktiv miljö. En konduktiv miljö minskar möjligheterna att identifiera strukturer från borrhålsradardata. Dock har 264 radarreflektorer identifierats i KLX07A och av dessa har 54 orienterats (med strykning/stupning). Motsvarande siffror för KLX07B är 48 och 11. I HLX34 har 36 radarreflektorer identifierats och i HLX35 46 reflektorer.

BIPS data för hammarborrhålen är av bra kvalitet. Data från KLX07A är behäftade med de vanliga svärtningarna från borrrören. Det är främst partiet från 100 m ner till 500 m där detta fenomen är påtagligt. En annan effekt i borrhålet är repningar på borrhålsväggen som är tydliga i BIPS bilderna. I borrhål KLX07B respektive HLX34 och HLX35 saknas helt svärtningar på väggen och bra vattenkvalité vilket ger bra BIPS-bilder.

Contents

1 Introduction

This document reports 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 directional radar (RAMAC) measurements in the core drilled boreholes KLX07A and KLX07B and in the percussion drilled boreholes HLX34 and HLX35.

In KLX07B, HLX34 and HLX35 also deviation measurements were carried out.

The work was carried out in accordance with activity plan AP PS 400-05-050. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents.

This report includes measurements from 0 to 830 m in KLX07A, from 0 to 195 m in KLX07B, from 0 to 150 m in HLX34 and from 0 to 145 m in HLX35.

The borehole KLX07A are percussion drilled with a diameter of 198 mm down to 100.3 m, from there the borehole is core drilled with a diameter of 76 mm. The borehole KLX07B is core drilled with a diameter of 76 mm. The percussion drilled boreholes HLX34 and HLX35 are drilled with diameter of 137 and 140 mm respectively.

All measurements were conducted by Malå Geoscience AB/RAYCON during July 2005. 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 internal controlling documents).

Activity plan	Number	Version
Borrhålsradar och BIPS KLX07A, KLX07B, HLX34 och HLX35	AP PS 400-05-050	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

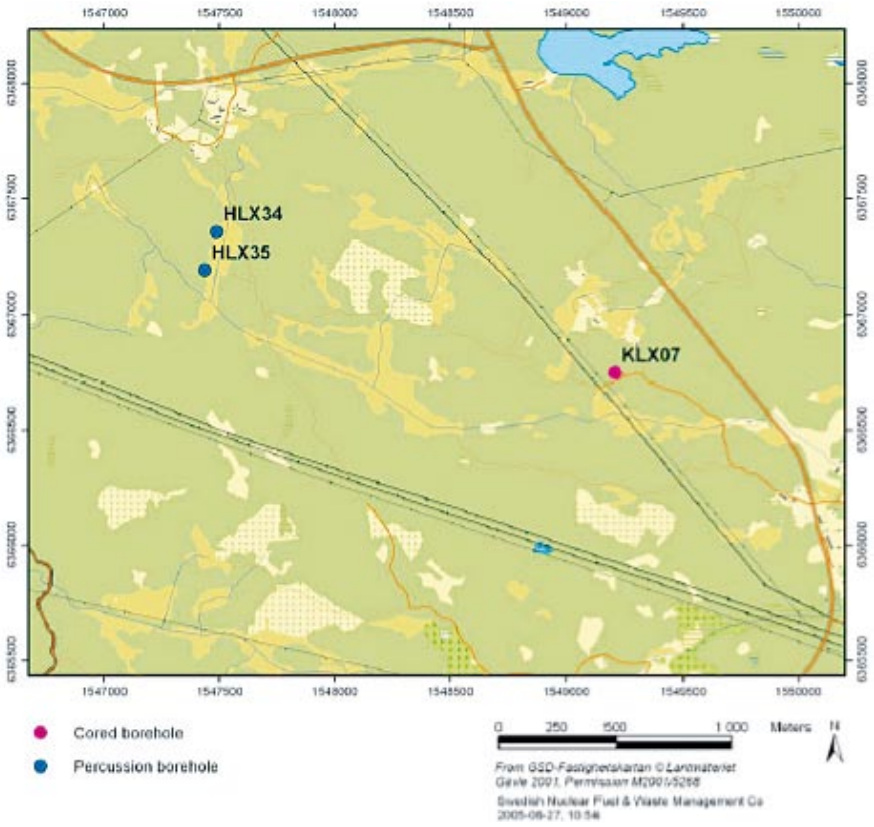


Figure 1-1. *General overview over the Laxemar subarea in Oskarshamn with the location of the boreholes KLX07A, KLX07B, HLX34 and HLX35.*

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.

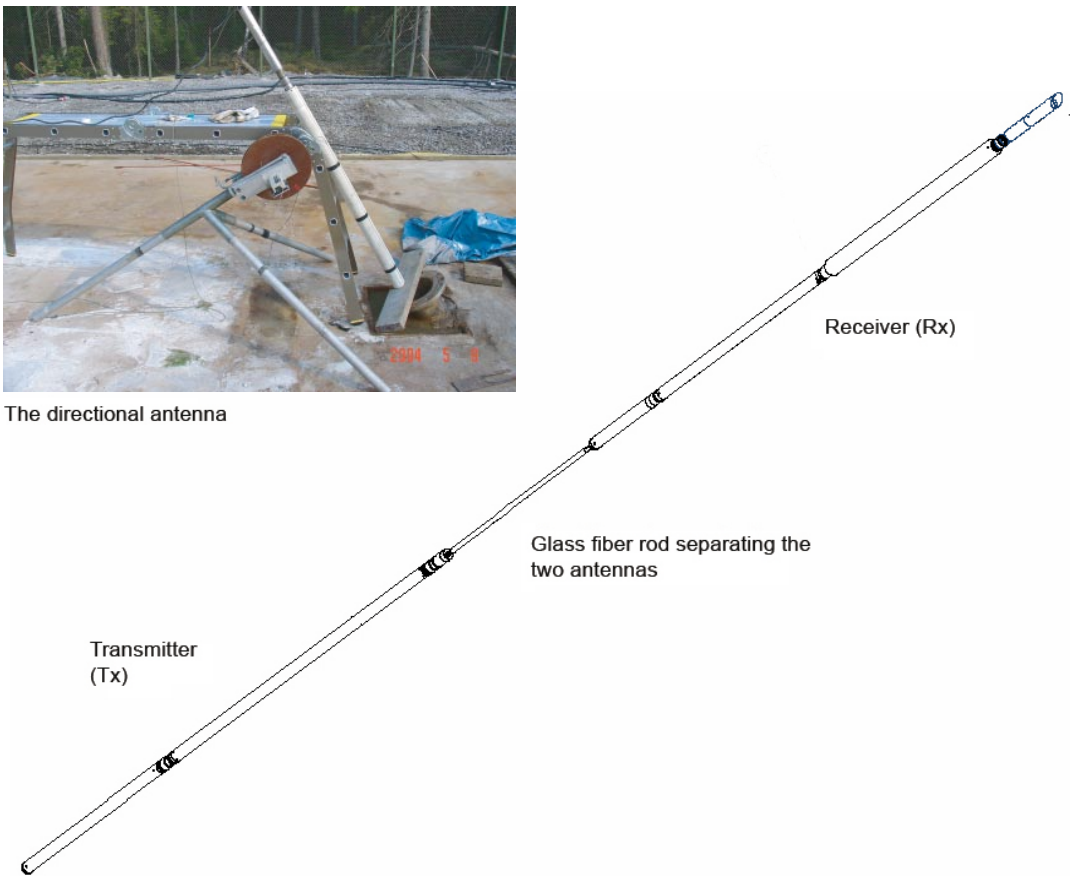


Figure 3-1. *Example of a borehole radar antenna.*

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.

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

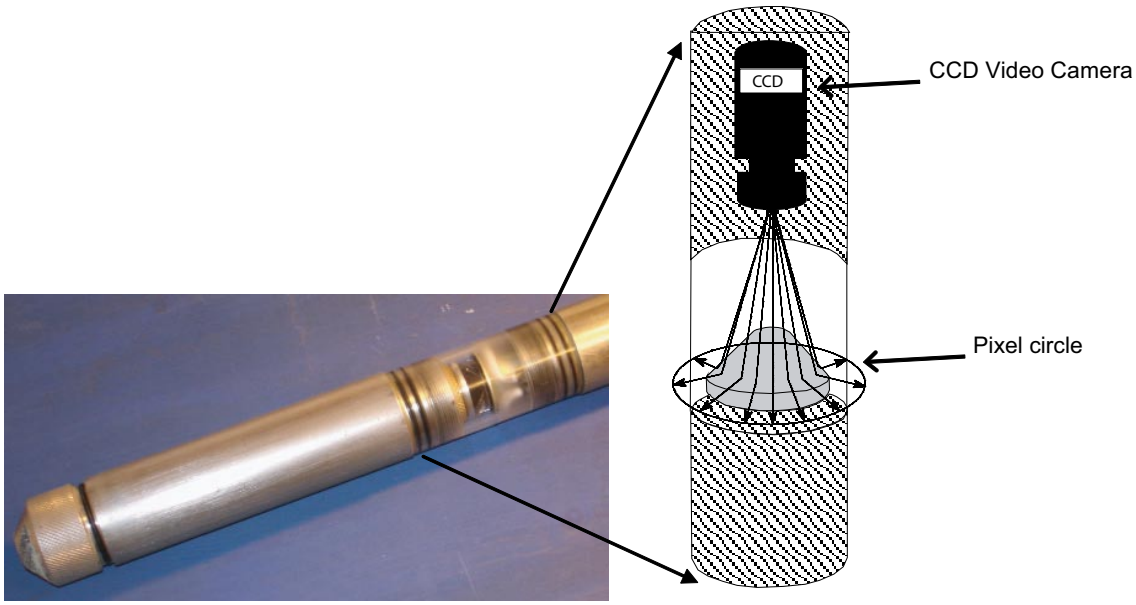


Figure 3-2. *The BIP-system, Illustration of the conical mirror scanning.*

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 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.

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.

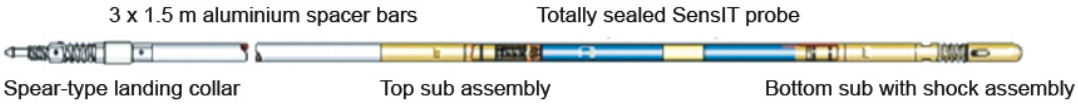


Figure 3-3. *The FlexIT SmartTool-system, Illustration of the set-up in the borehole.*

4 Execution

4.1 General

4.1.1 RAMAC Radar

The measurements in KLX07A, KLX07B, HLX34 and HLX35 were carried out with dipole radar antennas, with frequencies of 250, 100 and 20 MHz. In KLX07A and KLX07B measurements were also carried out using the 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 is made step wise, with a short pause for each measurement occasion. The antennas (transmitter and receiver, both for dipole and directional) are kept at a fixed separation by glass fiber rods according to Table 4-1. See also Figure 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 KLX07A and KLX07B. 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 about 6 degrees. This can be considered to be good due to the disturbed environment, with metallic objects etc at the test site. See also Figure 4-2.

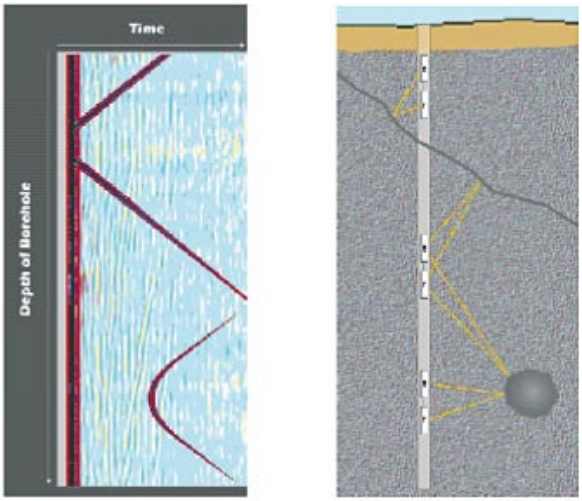


Figure 4-1. *The principle of radar borehole reflection survey and an example of result.*

Figure 4-2. *Test of the functionality of the directional antenna at drill site KLX07, Laxemar. The receiver antenna is mounted on the roof of the container and the transmitters held by a tripod.*

For more information on system settings used in the investigation of KLX07A, KLX07B, HLX34 and HLX35, see Tables 4-1 to 4-4 below.

Table 4-1. Radar logging information from KLX07A.

Site:	**Oskarshamn**	**Logging company:**	**RAYCON**		
BH:	**KLX07A**	**Equipment:**	**SKB RAMAC**		
Type:	**Directional / Dipole**	**Manufacturer:**	**MALÅ GeoScience**		
Operator:	**CG**	**Antenna**			
		Directional	**250 MHz**	**100 MHz**	**20 MHz**
Logging date:		05-07-07 and 05-07-08	05-07-08	05-07-08	05-07-09
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:		410.51	–0.34	–0.35	1.40
Logging from (m):		103.4	1.5	2.6	6.25
Logging to (m):		826.4	829.6	834.3	825.8
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 KLX07B.

Site:	**Oskarshamn**	**Logging company:**	**RAYCON**		
BH:	**KLX07B**	**Equipment:**	**SKB RAMAC**		
Type:	**Directional / Dipole**	**Manufacturer:**	**MALÅ GeoScience**		
Operator:	**CG**	**Antenna**			
		Directional	**250 MHz**	**100 MHz**	**20 MHz**
Logging date:		05-07-07	05-07-08	05-07-08	05-07-09
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:		410.51	–0.34	–0.35	1.40
Logging from (m):		13.4	1.5	2.6	6.25
Logging to (m):		191.4	197.3	197.0	192.9
Trace interval (m):		0.5	0.1	0.2	0.25
Antenna separation (m):		5.73	2.4	3.9	10.05

Table 4-3. Radar logging information from HLX34.

Site:	**Oskarshamn**	**Logging company:**	**RAYCON**		
BH:	**HLX34**	**HLX34Equipment:**	**SKB RAMAC**		
Type:	**Dipole**	**Manufacturer:**	**MALÅ GeoScience**		
Operator:	**CG**	**Antenna**			
		250 MHz	**100 MHz**	**20 MHz**	
Logging date:		05-07-21	05-07-21	05-07-21	
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:		–0.34	–0.35	–1.40	
Logging from (m):		1.5	2.6	6.25	
Logging to (m):		149.5	148.8	144.25	
Trace interval (m):		0.1	0.2	0.25	
Antenna separation (m):		2.4	3.9	10.05	

Table 4-4. Radar logging information from HLX35.

Site:	Oskarshamn	Logging company:	RAYCON	
BH:	HLX34	HLX34Equipment:	SKB RAMAC	
Type:	Dipole	Manufacturer:	MALÅ GeoScience	
Operator:	CG	Antenna		
		250 MHz	100 MHz	20 MHz
Logging date:		05-07-20	05-07-20	05-07-20
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:		–0.34	–0.35	–1.40
Logging from (m):		1.5	2.6	6.25
Logging to (m):		146.5	146.6	141.25
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 was used to measure the orientation of the images in the boreholes KLX07A, KLX07B, HLX34 and HLX35.

In order to control the quality of the system, calibration measurements were performed in a test pipe before logging and after logging. Figures 4-3 and 4-4 correspond to the test logging performed before and after the logging of KLX07A, KLX07B, HLX34 and HLX35. 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 5 to 9 in this report.

4.1.3 Deviation measuremnts

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 were 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 up to the surface. For the operation in the borehole 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 m by the actual marks on the logging cable.

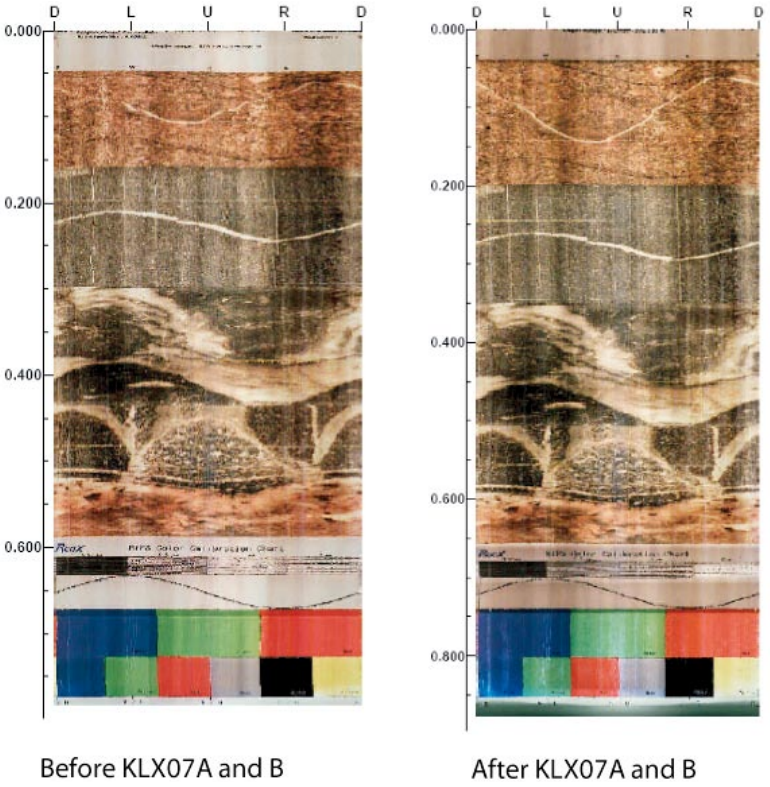


Figure 4-3. *Results from logging in the test pipe before and after the logging campaign in July 6th to 9th, 2005.*

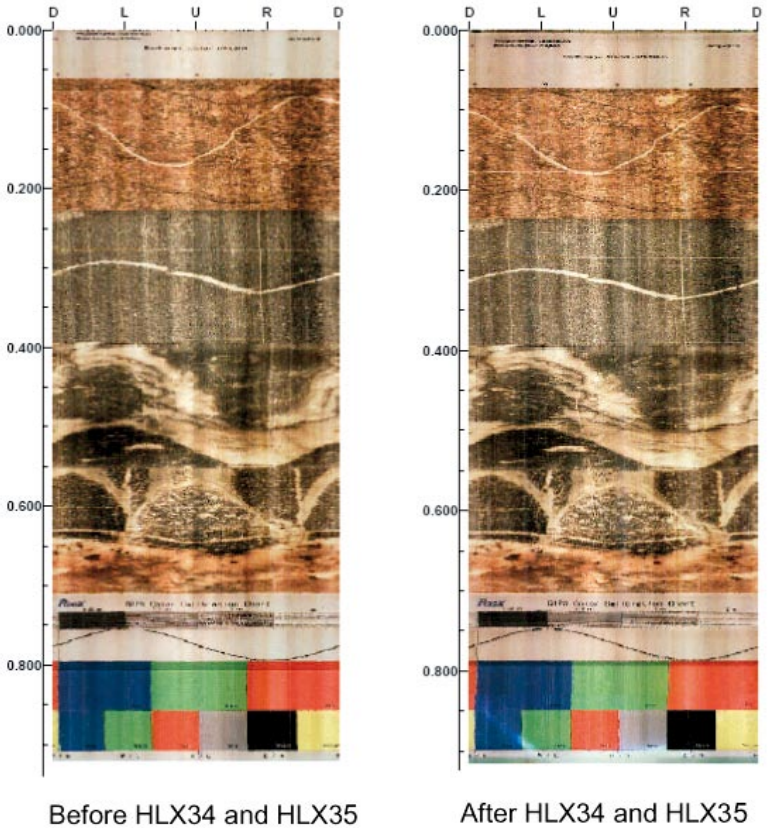


Figure 4-4. *Results from logging in the test pipe before and after the logging campaign in July 19th to 21st, 2005.*

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 5 to 9. 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 m 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 propagation 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 the 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. In this logging campaign the velocity determination was performed by keeping the transmitter fixed in one borehole (KLX07A) while moving the receiver downwards in nearby borehole (KLX07B). The velocity measurement was performed with the 20 MHz antennas.

The result is plotted in Figure 4-5 and the calculation shows a velocity varying between 110 and 117 m/micro seconds. The lower velocities most probably represent a 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 Table 4-5 to 4-8. It should be observed that the processing steps in Table 4-5 to 4-8 below refer to Appendix 1 to 4 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 the Tables 5-5 to 5-8 and are also visible on the radargrams in Appendices 1 to 4.

Table 4-5. Processing steps for borehole radar data from KLX07A.

Site:	**Oskarshamn**	**Logging company:**	**RAYCON**		
BH:	**KLX07A**	**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 (–25)	Move start time (–41)	Move start time (–80)
		DC shift (400–511)	DC shift (200–230)	DC shift (490–540)	DC shift (1,900–2,100)
		Time gain (start 80 lin 150 exp 5)	Gain (Start 10 lin 0.5 exp 1.66)	Gain (Start 40 lin 1 exp 1)	Gain (Start 100 lin 6.2 exp 0.17)
		(FIR)			

Table 4-6. Processing steps for borehole radar data from KLX07B.

Site:	**Oskarshamn**	**Logging company:**	**RAYCON**		
BH:	**KLX07B**	**Equipment:**	**SKB RAMAC**		
Type:	**Directional/Dipole**	**Manufacturer:**	**MALÅ GeoScience**		
Interpret:	**JG**	**Antenna**			
		Directional	**250 MHz**	**100 MHz**	**20 MHz**
Processing:		Move start time (–49 samples)	Move start time (–25)	Move start time (–40.8)	Move start time (–79.5)
		DC shift (400–511)	DC shift (200–230)	DC shift (490–540)	DC shift (1,900–2,100)
		Time gain (start 75 lin 100 exp 5)	Gain (Start 15 lin 1.15 exp 1.44)	Gain (Start 39 lin 2.99 exp 0.49)	Gain (Start 120 lin 4.3 exp 0.2)
		(FIR)			

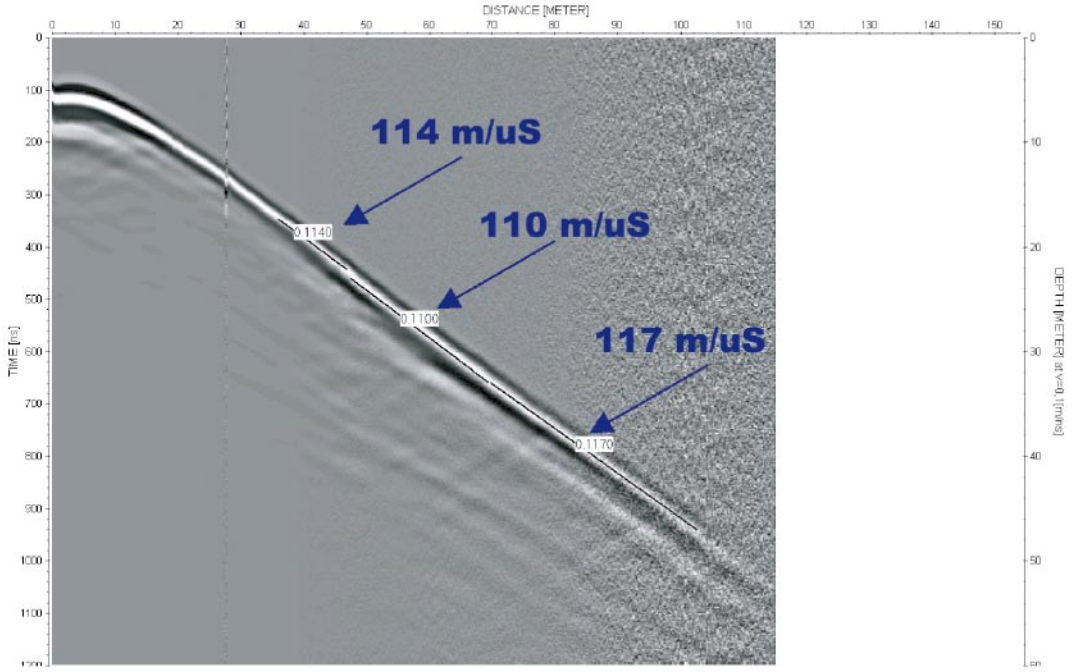


Figure 4-5. *Results from velocity measurements in KLX07B with 100 MHz dipole antennas.*

Table 4-7. Processing steps for borehole radar data from HLX34.

Site:	**Oskarshamn**	**Logging company:**	**RAYCON**	
BH:	**HLX34**	**Equipment:**	**SKB RAMAC**	
Type:	**Dipole**	**Manufacturer:**	**MALÅ GeoScience**	
Interpret:	**JG**	**Antenna**		
		250 MHz	**100 MHz**	**20 MHz**
Processing:		Move start time (–23)	Move start time (–47)	Move start time (–92)
		DC removal (190–220)	DC removal (490–530)	DC removal (1,900–2,100)
		Gain (Start 10 linear 0 exp 3)	Gain (Start 40 linear 1 exp 0.73)	Gain (Start 140 linear 4.8. exp 0.17)

Table 4-8. Processing steps for borehole radar data from HLX35.

Site:	**Oskarshamn**	**Logging company:**	**RAYCON**	
BH:	**HLX35**	**Equipment:**	**SKB RAMAC**	
Type:	**Dipole**	**Manufacturer:**	**MALÅ GeoScience**	
Interpret:	**JG**	**Antenna**		
		250 MHz	**100 MHz**	**20MHz**
Processing:		Move start time (–19)	Move start time (–43)	Move start time (–81)
		DC removal (190–220)	DC removal (490–530)	DC removal (1,900–2,100)
		Gain (Start 10 linear 0.08 exp 2.8)	Gain (Start 45 linear 0.64 exp 0.92)	Gain (Start 140 linear 2.1. exp 0.25)

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 according to the magnetic north, 2.33 degrees east in RT90.

4.3 Nonconformities

No nonconformities occurred during the logging operation with the radar- or BIPS equipment.

The deviation measurements was planned to be carried out in two directions, both up and down the boreholes. However during the logging of HLX35, the deviation measurement was only saved for the measurement up from the borehole because of a mistake by the logging engineer.

For revision no 1 of this report a recalculation of the directional radar data has been done. The strike angle between the line of the plane’s cross-section with the surface and the Magnetic North direction was earlier counted counter-clockwise but it is now recalculated as such it counts clockwise, Figures 5-3 and 5-4. New values for strike and dip are therefore updated in Tables 5-5 and 5-6.

5 Results

The results from the BIPS measurements for KLX07A, KLX07B, HLX34 and HLX35 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 or *.rd5) for KLX07A, KLX07B, HLX34 and HLX35 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.

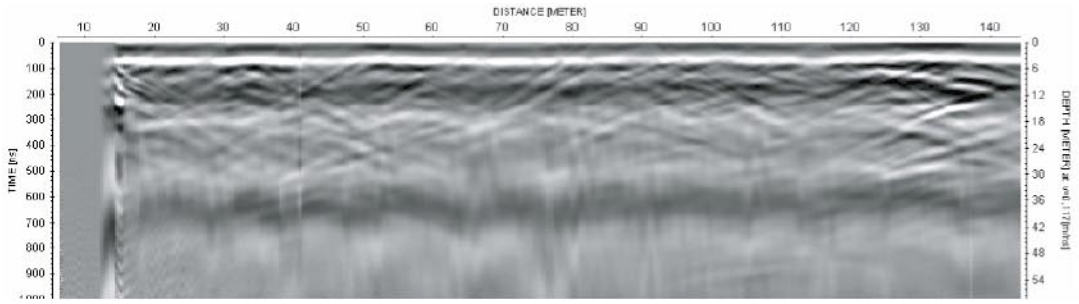
The results from the deviation measurement were delivered to SKB in form of raw Flexit files and Excel-files, and also presented in Appendices 9 to 11 in this report. Each reading station depth are referred from TOC in the appendices.

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

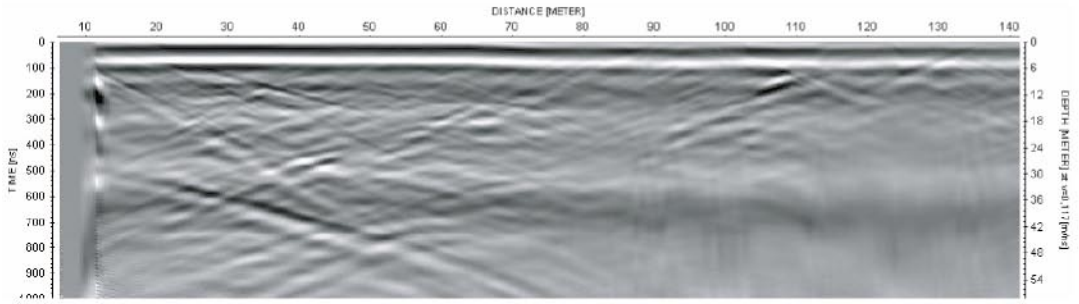
5.1 RAMAC logging

The results of the interpretation of the radar measurements are presented in Tables 5-1 to 5-8. Radardata is also visualized in Appendices 1 to 4. It should be remembered that the images in Appendices 1 to 4 are only a composite picture of all events 360 degrees around the borehole, and do not reflect the orientation of the structures.

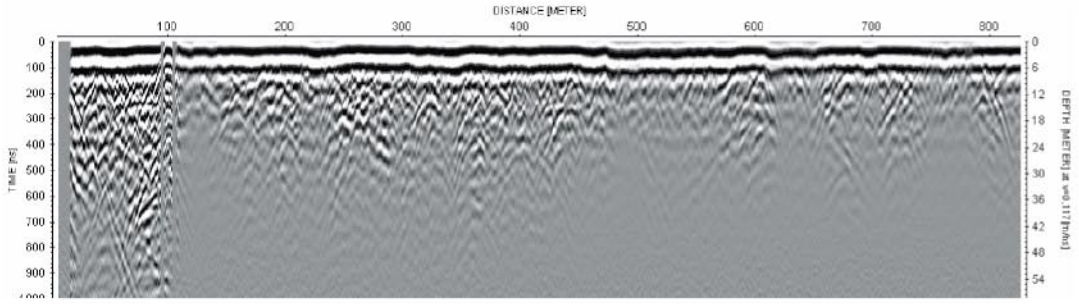
Only the larger clearly visible structures are interpreted in RadinterSKB. Overviews of the four different boreholes are given in Figure 5-1 below. A number of minor structures also exist, indicated in Appendices 1 to 4. Often a number of structures can be noticed, but most probably lying so close to each other that it is impossible to distinguish one from the other (see Figure 5-2). Larger structures parallel to the borehole are also indicated in Appendices 1 to 4. 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.



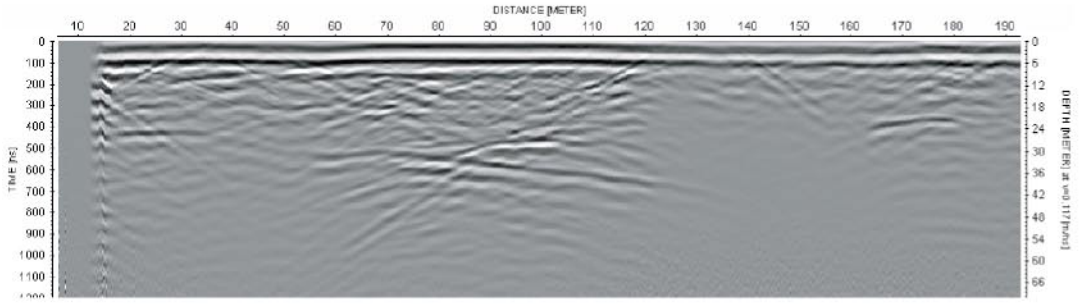
HLX34



HLX35



KLX07A



KLX07B

Figure 5-1. *An overview (20 MHz data) of the radar data for the four different boreholes; HLX34, HLX35, KLX07A and KLX07B. Observe that the length (x-scale) differs between the different boreholes.*

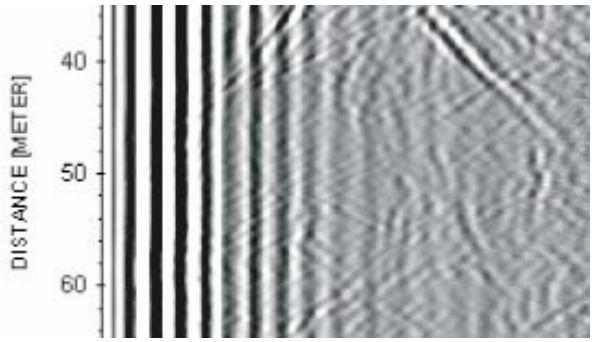


Figure 5-2. *Example of data from HLX35 where a number of structures are seen but lying so close to each other, that one can not be distinguished from the other.*

In Appendix 1 and 2 also other boreholes can be identified. For instance in the data from KLX07B, the boreholes KLX07A and KLX02 are clearly identified in the uppermost part of the borehole. Observe that the structures identified (see Appendix 2) appear as quite crooked lines, this is due to the fact that the velocity of the rock is not constant between the boreholes, see also Figure 4-5. The boreholes KLX07A and KLX02 can also be identified in the data for the directional antenna measured in KLX07B. The resulting directions from RadInterSKB is in well accordance to the real directions between the boreholes. In RadInterSKB the resulting direction from KLX07B to KLX02 was approximately 30 degrees and to KLX07A approximately 180 degrees defined from Magnetic North.

The data quality from KLX07A, KLX07B, HLX34 and HLX35, (as seen in Appendices 1 to 4) is relatively satisfying, but in parts also of lower quality due to more conductive conditions. A conductive environment makes the radar wave to attenuate, which decreases the penetration. This is for instance seen very clearly in the 250 MHz data from HLX34 from 70 m depth. This conductive environment of course also reduces the possibility to distinguish and interpret possibly structures in the rock which otherwise could give a reflection.

This effect is also seen in the directional antenna for KLX07A and KLX07B, 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 especially in the data from KLX07A, (250 and 100 MHz data) for the first 100 m, where the borehole diameter is larger.

As also seen in Appendices 1 to 4 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 Table 5-1 to 5-4 below the distribution of identified structures along the borehole are listed for KLX07A, KLX07, HLX34 and HLX35.

Table 5-1. Identified structures as a function of depth in KLX07A.

Depth (m)	No of structures
–100	15
100–150	12
150–200	16
200–250	22
250–300	16
300–350	19
350–400	20
400–450	21
450–500	16
500–550	14
550–600	16
600–650	16
650–700	16
700–750	13
750–800	23
800–850	9

Table 5-2. Identified structures as a function of depth in KLX07B.

Depth (m)	No of structures
–20	4
20–40	3
40–60	1
60–80	5
80–100	7
100–120	8
120–140	5
140–160	5
160–180	6
180–200	4
200–	1

Table 5-3. Identified structures as a function of depth in HLX34.

Depth (m)	No of structures
–20	1
20–40	6
40–60	8
60–80	6
80–100	4
100–120	4
120–140	3
140–160	3
160–180	–
180–	1

Table 5-4. Identified structures as a function of depth in HLX35.

Depth (m)	No of structures
–20	7
20–40	3
40–60	8
60–80	6
80–100	5
100–120	3
120–140	11
140–	4

Tables 5-5 to 5-8 summarises the interpretation of radar data from KLX07A, KLX07B, HLX34 and HLX35. For KLX07A and KLX07B the direction to the reflector is also given. As seen some radar reflectors in Table 5-5 and 5-6 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 (the plane) is defined in Figure 5-3 and 5-4. If the borehole inclination is less than 85° the direction to object is calculated using gravity roll (Figure 5-3). If the borehole is near vertical (> 85 degrees) the direction to object is calculated using magnetic roll (Figure 5-4). The direction to object and the intersection angle are recalculated to strike and dip, also given in Tables 5-5 and 5-6. 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 structure 5 in Table 5-5 and Appendix 1. To this structure, most likely, also structure 5x belongs.

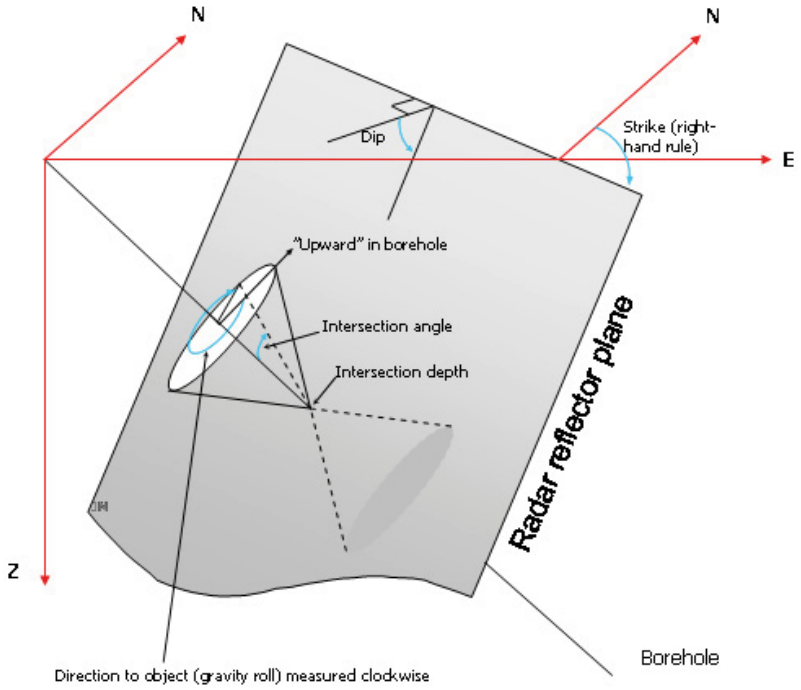


Figure 5-3. *Definition of intersection angle, direction to object using gravity roll, dip and strike using the right hand rule as presented in Table 5-5.*

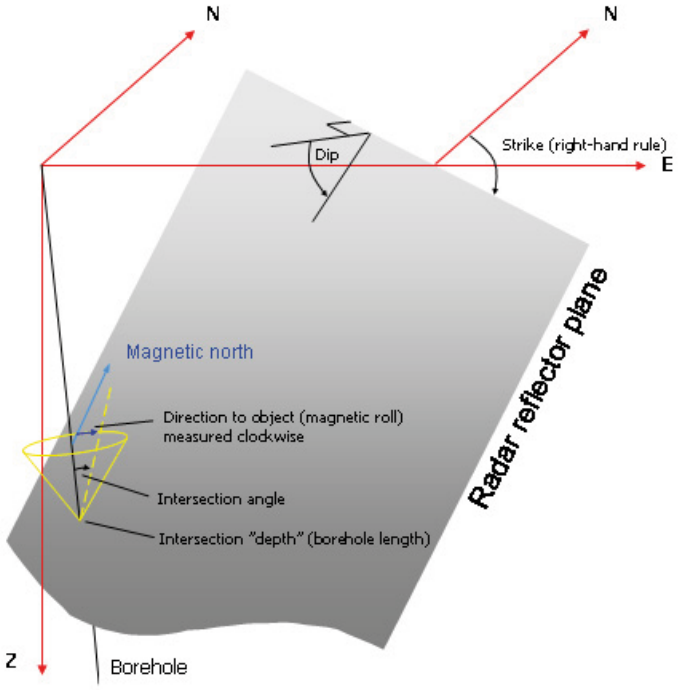


Figure 5-4. *Definition of intersection angle, direction to object using magnetic roll, dip and strike using the right hand rule as presented in Table 5-6.*

Table 5-5. Interpretation of radar reflectors from the dipole antennas 250, 100 and 20 MHz, and the directional antenna 60 MHz in borehole KLX07A.

RADINTER MODEL INFORMATION
(20, 100 and 250 MHz Dipole Antennas and directional antenna)

Site: Oskarshamn
Borehole name: KLX07A
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	29.4	51					
2	30.1	69					
222	31.1	38					
224	21.6	37					
3	32.7	40					
223	42.5	37					
4	56.0	48					
5	65.1	39					
6	67.7	67					
7	71.7	69					
5x	74.0	28					
11	77.2	64					
8	89.4	57					
9	92.9	53					
12	97.8	43					
10	104.1	53					
13	115.5	65	294	53	227		
14	118.9	52					
15	120.7	62					
16	122.7	66					
19	134.5	40					
17	134.8	55	321±	71	230	24	314
18	136.5	52					
20	140.9	56					
21	142.5	45					
22	144.5	42					
23	147.8	45					
24	152.1	55					
240	157.0	59	216	23	203		
25	167.5	22					
26	168.1	32					
25x	170.6	21					
241	171.0	39	324±	86	226	28	351
28	172.6	56					
29	173.1	56					
27	174.4	61	24±	67	265	19	217
30	175.5	42					
32	185.8	47					
34	188.9	60					
31	191.6	24					
226	192.1	33					

RADINTER MODEL INFORMATION
(20, 100 and 250 MHz Dipole Antennas and directional antenna)

Site: Oskarshamn
Borehole name: KLX07A
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
33	192.6	44	30±	82	274	21	164
35	198.7	37					
36	200.2	39					
40	204.2	52					
37	206.0	39					
38	207.8	41					
41	210.0	31					
39	210.2	41					
46x	210.7	25	6	75	78		
228	215.5	28					
46	216.3	27	6	79	78		
42	216.4	44					
44	221.0	52					
43	221.4	43					
45	225.2	41					
225	226.4	18					
47	228.8	45					
48	232.1	43					
49	233.7	43					
50	235.5	53					
51	241.4	54					
52	241.8	59					
53	243.7	63					
54	245.9	56					
55	252.1	40					
57	252.1	68					
55x	254.2	50					
227	257.5	58					
56	259.7	47					
59	263.3	43	231±	36	174	79	291
58x	268.7	46					
58	269.4	44					
60	266.8	45					
61	276.4	42					
62	280.0	42	189	10	117		
62x	280.9	34	189	16	103		
64	284.4	43					
65	285.0	48					
66	290.6	61	345±	71	247	14	286
67	296.7	64					
68	300.3	61	198±	17	227	67	264
70	307.0	37	12	85	88		
69	310.2	63					

RADINTER MODEL INFORMATION
(20, 100 and 250 MHz Dipole Antennas and directional antenna)

Site: Oskarshamn
Borehole name: KLX07A
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
71	311.6	48	183	3	218		
242	311.9	71	147	27	278		
229	313.3	57					
72	313.6	56					
73	318.3	43					
74	319.4	78					
230	324.2	32					
77	326.8	52					
76	327.1	38	69	75	306		
75	327.9	46					
80x	336.5	12					
78	338.1	70					
87	338.6	39					
243	341.3	60	246±	39	211	60	290
79	341.7	37					
80	348.6	41	252	50	195		
83	353.0	24					
81	360.5	49					
82	365.6	64					
84	368.4	32					
89	369.1	25					
85	373.5	35					
90	375.3	50	9	83	267		
91	378.3	64					
97	378.3	33					
92	379.9	24					
96	383.0	51					
88	384.0	21					
104	384.3	58					
93	388.2	44					
94	389.2	56	171±	12	285	76	257
101	393.3	71					
99	393.4	23	78	80	327		
95	394.6	40					
98	396.3	47					
100	398.7	48					
103	400.3	59					
102	405.9	36					
108	406.0	52					
105	408.5	46					
106	410.5	37	186±	10	111	83	88
111	411.3	51					
107	413.9	66					

RADINTER MODEL INFORMATION
(20, 100 and 250 MHz Dipole Antennas and directional antenna)

Site: Oskarshamn
Borehole name: KLX07A
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
245	414.4	48	18	84	275		
231	414.6	47					
109	424.4	53					
232	424.0	61					
110	425.2	49					
244	427.6	58	54±	66	291	34	214
112	430.2	60					
113	432.3	58					
114	434.3	56	342	78	252		
115	437.7	41					
118	440.7	59					
117	441.9	70					
119	444.4	51					
233	448.1	46					
120	451.2	62					
121	454.6	56					
122	455.9	51	252	44	210		
123	459.7	61	81±	53	297	46	221
124	463.7	67					
125	464.1	60					
126	466.9	46					
131	472.5	73					
127	473.0	52					
128	478.1	42					
129	479.5	33					
130	481.0	72					
234	482.1	58					
132	486.2	33					
133	488.1	45					
134	493.8	50					
135	502.0	54					
136	504.6	54	42±	75	288	28	207
137	505.9	59					
138	514.5	57					
140	520.3	57					
139	520.9	37	213	24	177		
141	528.8	49					
142	531.6	49					
143	533.5	51					
235	534.1	77					
246	534.2	65	207±	18	221	61	274
144	542.6	58					
145	544.1	69					

RADINTER MODEL INFORMATION
(20, 100 and 250 MHz Dipole Antennas and directional antenna)

Site: Oskarshamn
Borehole name: KLX07A
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
146	549.0	54					
147	551.8	53					
148	555.5	59					
150	557.7	56					
249	560.1	75	204±	25	248	52	269
149	560.4	40	339	85	245		
151	562.6	51					
152	567.0	47					
153	571.6	53					
154	573.7	44	207±	19	157	80	279
155	579.3	47					
156	581.9	50	165	11	13		
157	585.6	62					
159	593.9	58					
236	595.8	81					
158	596.7	47					
160	595.8	53					
162	602.1	53					
161x	605.5	23					
161	608.6	21					
163	610.3	40					
237	612.7	24					
164	617.6	40					
167	617.9	46					
165x	621.3	37					
165	623.4	28	6	82	85		
166	626.2	58					
168	637.8	80					
169	639.2	76					
170	640.6	71					
171	645.3	59					
172	646.7	74					
174	648.8	76					
173	650.1	51	189	7	143		
175x	651.0	21					
175	655.8	48					
176	659.5	53					
177	661.4	48					
178x	667.8	39					
178	668.8	43					
179	675.0	36					
181	677.7	42					
180	679.8	36					

RADINTER MODEL INFORMATION
(20, 100 and 250 MHz Dipole Antennas and directional antenna)

Site: Oskarshamn
Borehole name: KLX07A
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
182	686.6	62					
184x	690.6	18					
183	693.5	48					
251	696.9	36					
184	697.0	30	228	43	154		
184xx	697.6	24	222	42	145		
185	707.8	59	306	61	230		
186	713.9	44	315±	76	228	30	345
188	715.5	34					
187	717.3	52	15	78	269		
189	723.4	41					
190	725.0	42	225±	30	176	75	290
250	730.5	45	60±	70	300	40	182
191	735.4	47					
192	737.5	46					
193	740.2	44					
238	740.9	35					
194	745.9	55					
194x	747.8	39	6	87	264		
196	750.9	43					
195	751.2	31	15	84	92		
248	753.7	28	132	43	5		
197	758.9	29	6	79	85		
197x	756.3	37					
198	757.1	47					
204	762.9	57					
199	764.1	49					
200	765.4	51					
201	770.0	60					
202	772.2	57	174±	5	300	72	256
203	773.4	61					
206	776.6	46					
208	782.9	42	192±	14	121		
209	783.5	45					
207	779.2	45					
247x	784.7	35					
210	786.7	44					
211	787.4	76					
212	790.1	46					
247	790.4	25	198	30	113		
214	795.6	30					
213	795.7	47					
215	805.6	56					

RADINTER MODEL INFORMATION
(20, 100 and 250 MHz Dipole Antennas and directional antenna)

Site: Oskarshamn
Borehole name: KLX07A
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
216	807.4	55	315±	66	234	26	324
217	811.3	39					
239	812.4	45					
218	813.1	51					
219	820.9	18	309	85	33		
220	826.5	60					
221x	829.9	27					
221	832.8	23	303	89	209		

Table 5-6. Interpretation of radar reflectors from the dipole antennas 250, 100 and 20 MHz, and the directional antenna 60 MHz in borehole KLX07B.

RADINTER MODEL INFORMATION
(20, 100 and 250 MHz Dipole Antennas and directional antenna)

Site: Oskarshamn
Borehole name: KLX07B
Nominal velocity (m/µs): 117.0

Name	Intersection depth	Intersection angle	RadInter Direction to object (magnetic roll)	Dip 1	Strike 1	Dip 2	Strike 2
43	0.4	33					
1	13.1	22					
36	13.1	81					
4	25.6	50	168	41	258		
2	28.7	74	303±	19	33	19	213
3x	39.2	37					
3	40.9	40	318	50	48		
37	60.7	52					
38	61.5	36					
9	73.5	32					
8	74.5	61					
12	76.3	46					
10	81.4	60					
5	83.7	23					
7	83.8	48					
6	92.0	17	51	73	141		
16	94.0	36					
15	95.3	42					
11	97.3	35					
18	100.2	51					
14	103.2	38					
44	107.4		294				
17	109.5	73	33±	20	123	20	303
13	112.5	32	54	56	144		

RADINTER MODEL INFORMATION (20, 100 and 250 MHz Dipole Antennas and directional antenna)							
Site:		**Oskarshamn**					
Borehole name:		**KLX07B**					
Nominal velocity (m/µs):		**117.0**					
Name	**Intersection depth**	**Intersection angle**	**RadInter Direction to object (magnetic roll)**	**Dip 1**	**Strike 1**	**Dip 2**	**Strike 2**
42	116.6	57					
6x	117.7	10	48	80	138		
19	118.5	59	6±	28	96	28	276
20x	127.6	78					
39	128.8	56					
20	130.2	61	156	30	246		
21	131.3	60					
22	139.5	48					
23	142.6	65					
24	143.5	80					
41	148.1	78					
25	152.8	57					
26	158.1	53					
27	160.3	61					
28	162.6	46					
29	163.9	51					
30	166.9	61					
31	168.2	74					
32	176.7	60					
33	188.8	48	177±	40	267	40	87
45	190.3	13	348	77	78		
40	191.5	74					
35	198.8	31					
34	201.1	53					

Table 5-7. Interpretation of radar reflectors from the dipole antennas 250, 100 and 20 MHz, in borehole HLX34.

RADINTER MODEL INFORMATION (20, 100 and 250 MHz Dipole Antennas)			
Site:	**Oskarshamn**		
Borehole name:	**HLX34**		
Nominal velocity (m/µs):	**117.0**		
Object type	**Name**	**Intersection depth**	**Intersection angle**
PLANE	29	12.8	61
PLANE	1	22.4	73
PLANE	2	26.6	57
PLANE	2x	28.1	60
PLANE	33	34.0	26
PLANE	4	35.2	56
PLANE	5	36.7	62
PLANE	3	41.5	22
PLANE	7	45.0	60
PLANE	6	47.1	70

RADINTER MODEL INFORMATION (20, 100 and 250 MHz Dipole Antennas)			
Site:		**Oskarshamn**	
Borehole name:		**HLX34**	
Nominal velocity (m/µs):		**117.0**	
Object type	**Name**	**Intersection depth**	**Intersection angle**
PLANE	8	51.7	54
PLANE	9	53.0	56
PLANE	12	56.1	85
PLANE	10	57.1	50
PLANE	30	58.6	69
PLANE	11	60.6	55
PLANE	15	71.2	70
PLANE	13	71.7	60
PLANE	13x	71.7	48
PLANE	17	73.8	53
PLANE	14	75.2	49
PLANE	27	83.6	56
PLANE	16	86.4	57
PLANE	32	88.6	76
PLANE	18	95.3	49
PLANE	19	105.6	34
PLANE	20	110.3	68
PLANE	21	111.1	31
PLANE	22	116.6	25
PLANE	23	124.8	41
PLANE	25	137.8	81
PLANE	24	139.1	59
PLANE	26	142.1	52
PLANE	34	145.8	48
PLANE	28	155.6	41
PLANE	31	199.0	28

Table 5-8. Interpretation of radar reflectors from the dipole antennas 250, 100 and 20 MHz, in borehole HLX35.

RADINTER MODEL INFORMATION (20, 100 and 250 MHz Dipole Antennas)			
Site:		**Oskarshamn**	
Borehole name:		**HLX35**	
Nominal velocity (m/µs):		**117.0**	
Object type	**Name**	**Intersection depth**	**Intersection angle**
PLANE	37	–70.9	25
PLANE	38	–2.1	55
PLANE	39	–1.8	69
PLANE	36	–1.0	58
PLANE	2	2.7	26
PLANE	3	3.7	53
PLANE	1	14.2	46
PLANE	4	31.9	66
PLANE	5	33.8	56
PLANE	13	38.9	34
PLANE	14	40.8	63

RADINTER MODEL INFORMATION
(20, 100 and 250 MHz Dipole Antennas)

Site:	**Oskarshamn**
Borehole name:	**HLX35**
Nominal velocity (m/µs):	**117.0**

Object type	Name	Intersection depth	Intersection angle
PLANE	6	41.2	65
PLANE	42	41.7	42
PLANE	9	48.1	46
PLANE	8	50.3	47
PLANE	7	51.3	64
PLANE	10	57.2	24
PLANE	12	57.7	53
PLANE	15	60.7	53
PLANE	16	63.6	55
PLANE	10x	63.7	18
PLANE	11	65.4	16
PLANE	19	69.8	67
PLANE	17	72.1	52
PLANE	22	85.3	66
PLANE	21	90.0	46
PLANE	20	93.8	49
PLANE	20x	95.9	45
PLANE	23	97.5	56
PLANE	24	105.3	43
PLANE	18	109.5	11
PLANE	43	119.3	42
PLANE	25	121.2	57
PLANE	28x	123.9	47
PLANE	26	124.2	41
PLANE	28	125.0	61
PLANE	27	126.5	48
PLANE	29	129.3	57
PLANE	41	132.2	43
PLANE	30	132.6	45
PLANE	33	136.9	36
PLANE	40	139.5	30
PLANE	32	141.2	46
PLANE	31	142.7	73
PLANE	35	152.9	54
PLANE	34	154.3	63

In Appendices 1 to 4, 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 5-9 to 5-12.

Table 5-9. Borehole length intervals in KLX07A with decreased amplitude for the 250 MHz antenna.

Length (m)	Length (m)
0–80	335–350
115	375–390
130	400
140	450–465
155	475–495
165	525–535
170–180	550
185	560
205	610–630
220–230	645–655
235	690–700
245	745
290	755–765
315	785
325	

Table 5-10. Borehole length intervals in KLX07B with decreased amplitude for the 250 MHz antenna.

Length (m)	Length (m)
0–20	115–120
25–30	130
40–45	165–170
50–60	180–190
90	

Table 5-11. Borehole length intervals in HLX34 with decreased amplitude for the 250 MHz antenna.

Length (m)	Length (m)
25	95
35	105–115
45	120
55–60	130
65–75	140–145
85	

Table 5-12. Borehole length intervals in HLX35 with decreased amplitude for the 250 MHz antenna.

Length (m)	Length (m)
70–100	135
115–125	140

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 5-13 below.

Table 5-13. Some important structures in KLX07A, KLX07B, HLX34 and HLX35.

Borehole	KLX07A	KLX07B	HLX34	HLX35
Structures	5, 8, 10, 18, 25, 25x, 53, 55, 55x, 56, 64, 80, 85, 90, 110, 113, 122, 149, 151, 165, 165x, 180, 186, 194x, 195, 198, 208, 219, 221, 221x, 222, 223, 227, 231, 232 and 244	2, 3, 6, 6x, 7, 11, 13 and 20	3, 9, 13, 18, 19, 20, 21, 24 and 34	1, 2, 9, 10, 18, 25, 28x, 32, 37 and 41

Observe that it is 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 angle will most often give a increased amplitude than a larger angle, and by that a more clear structure.

5.2 BIPS logging

The BIPS pictures from KLX07A, KLX07B, HLX34 and HLX35 are presented in Appendices 5 to 8.

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 in KLX07A. For the other boreholes the marks on the logging cable at 110 m and 150 m were used for adjustment of the depth.

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.

Very good images was recorded in HLX34 and fracture mapping and geological interpretation is easy to perform.

In HLX35 the water quality was slightly worse compared with the images from HLX34 but still the mapping is possibly to perform.

The logging in KLX07A was performed in two different runs due to the difference in borehole diameter. The first run was logged from 11 m down to 97 m. In this part the borehole diameter is 200 mm and the camera probe was equipped with 165 mm centralisers. The water is of good quality but the images are influenced by the large borehole diameter and the effect of smaller centralisers. In the mid part of the images the light from the camera

in combination of a darker background gives a poor visibility. This borehole diameters is the upper limit where the camera can be used. The manufacturer recommend the use of the camera in boreholes of maximum 200 mm. Larger borehole diameters will absorb to much of the light specially when the rock is dark.

In the core drilled part of the borehole KLX07A the images is effected by the induced discolouring on the walls caused by the drilling. This is most obvious between 100 m down to 500 m. Another occurrence are scratches along the borehole wall. These scratches are probably from some of the equipments that have been attached to the drill rods, Figure 5-5.

Images from KLX07B is of perfect quality and no discolouring effect from the drill rod occur on the walls.

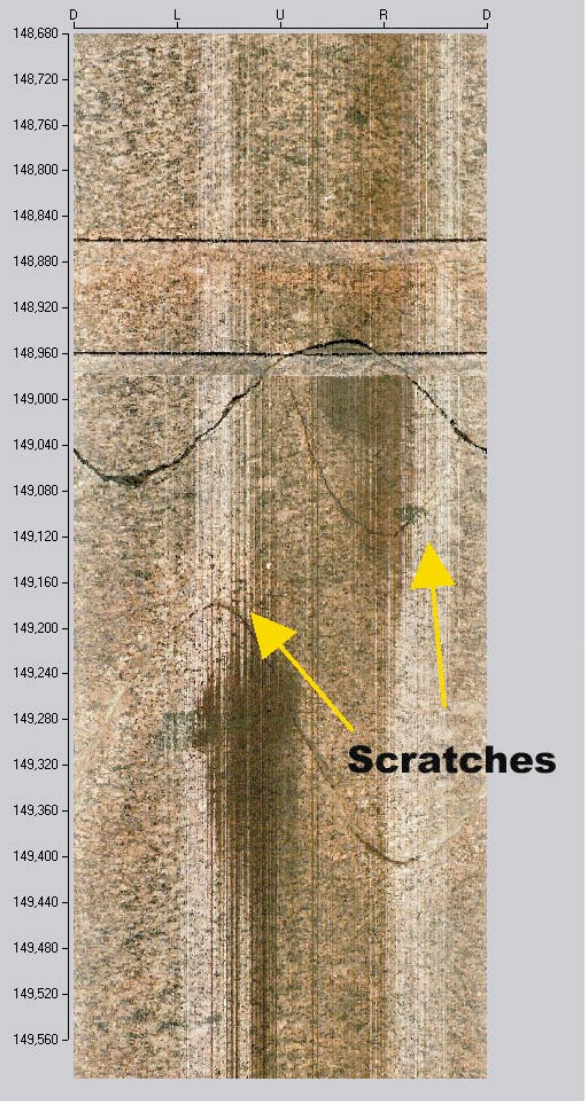
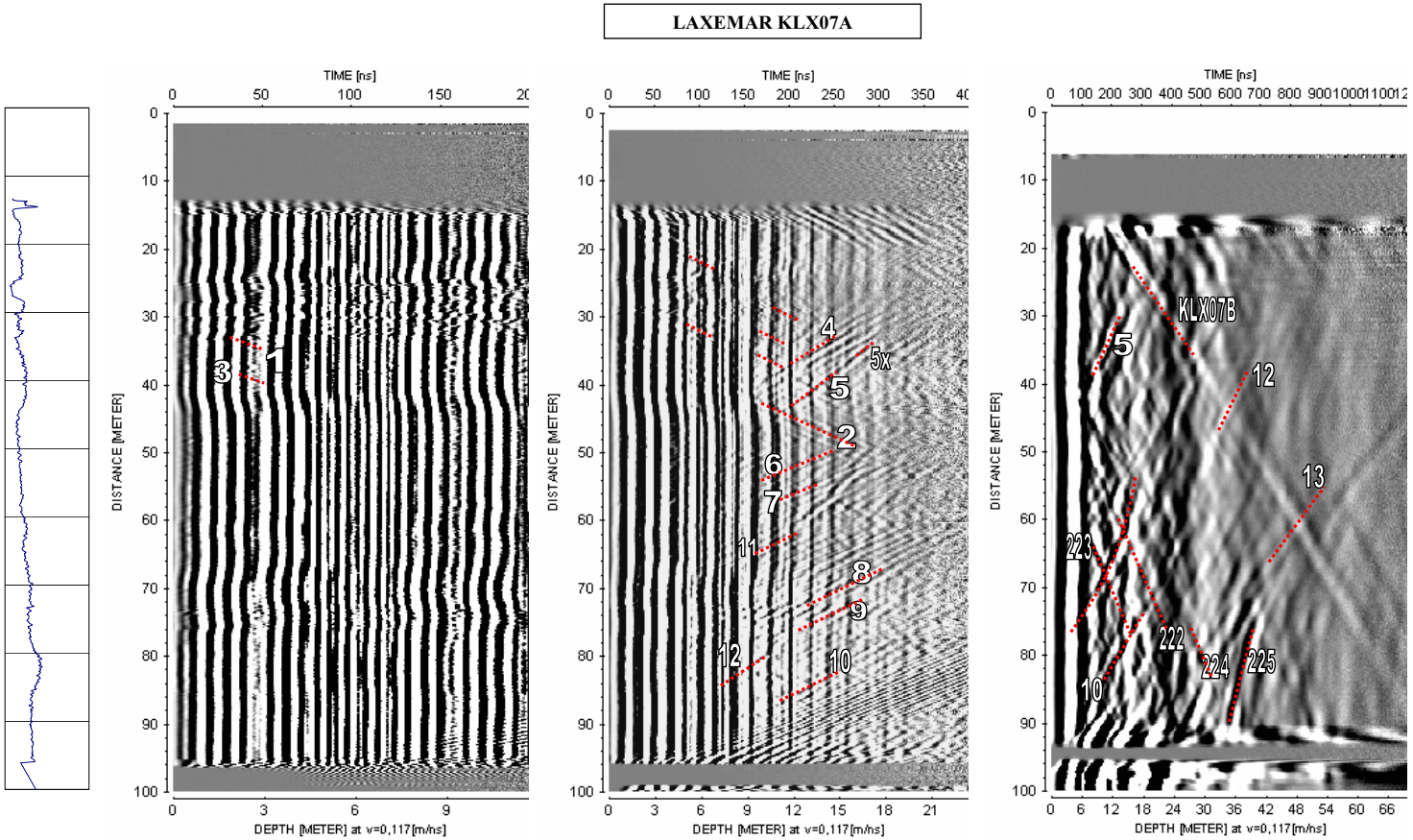
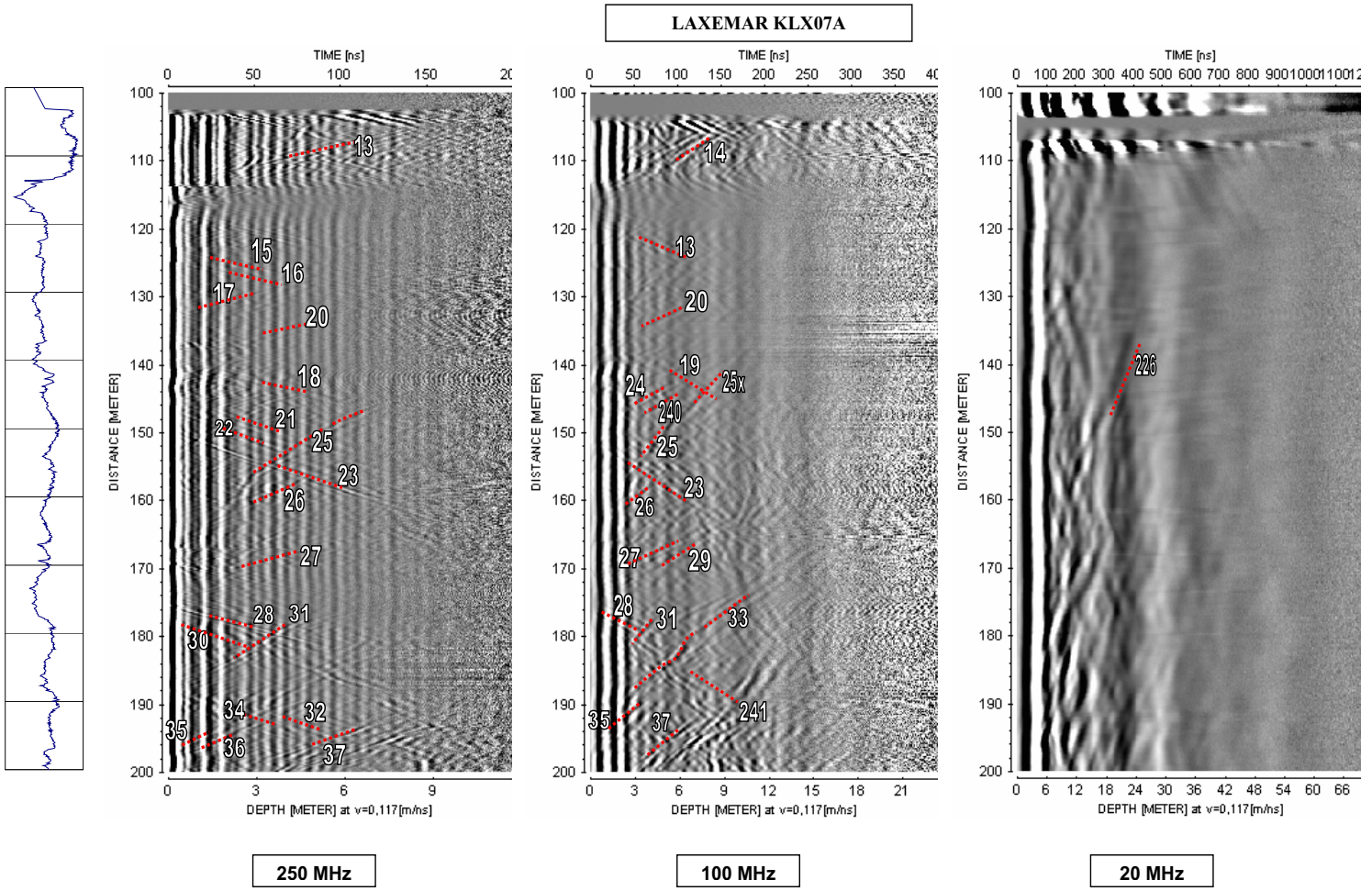


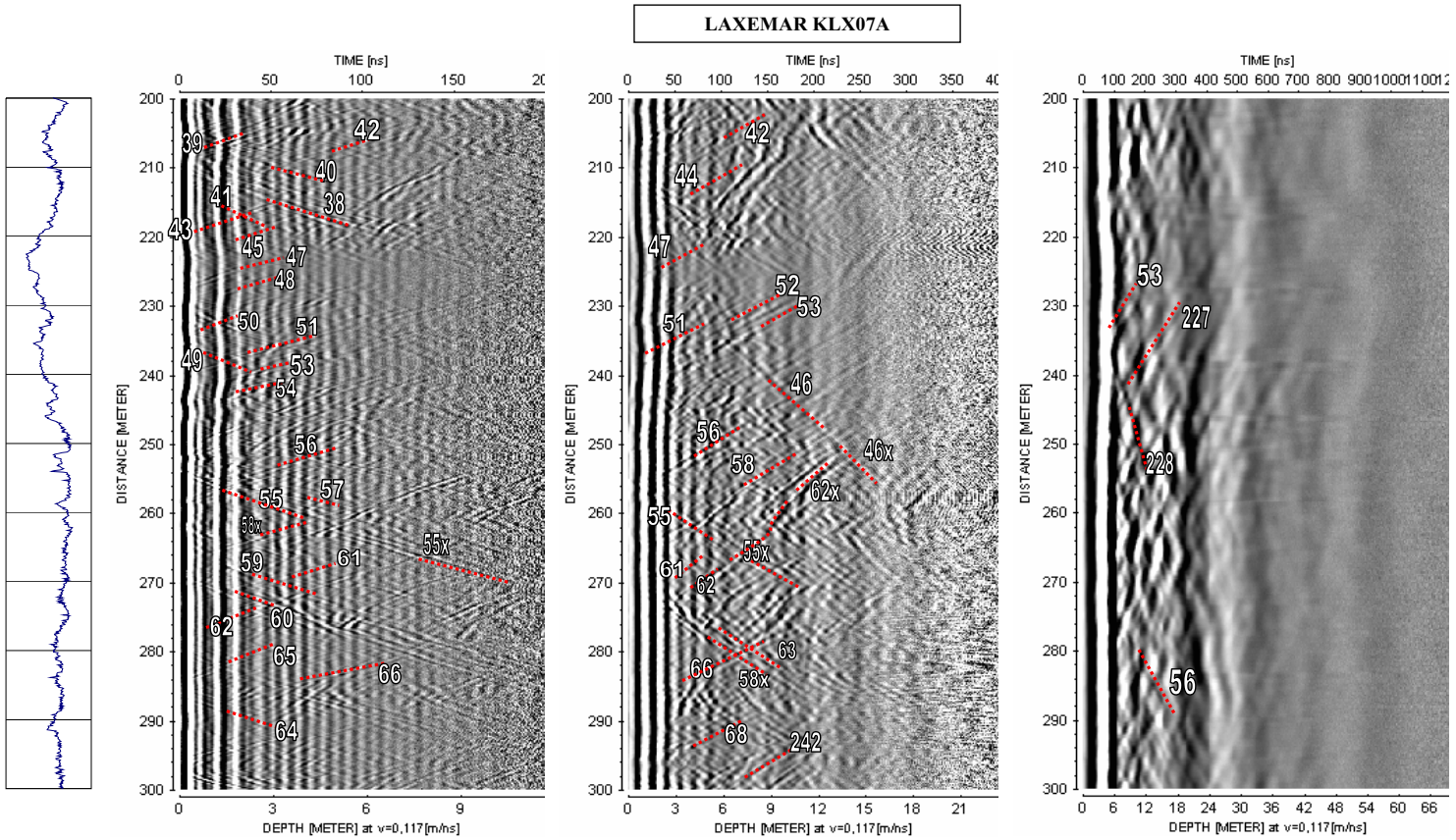
Figure 5-5. *Images showing scratches on the borehole wall.*

Radar logging in KLX07A, 0 to 830 m dipole antennas 250, 100 and 20 MHz



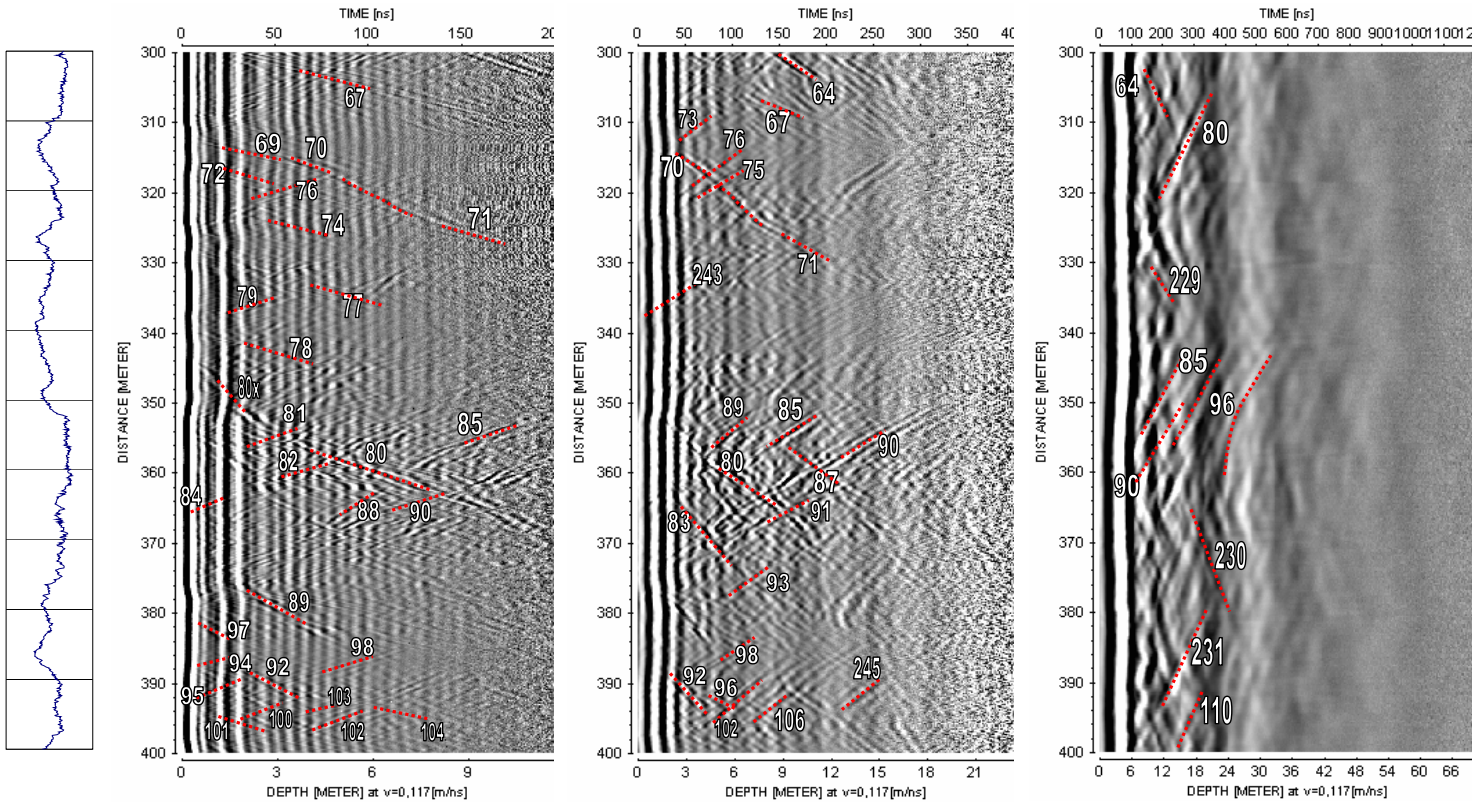

LAXEMAR KLX07A
TIME [ns]
DISTANCE [METER]
DEPTH [METER] at v=0,117[m/ns]
250 MHz
100 MHz
20 MHz

LAXEMAR KLX07A

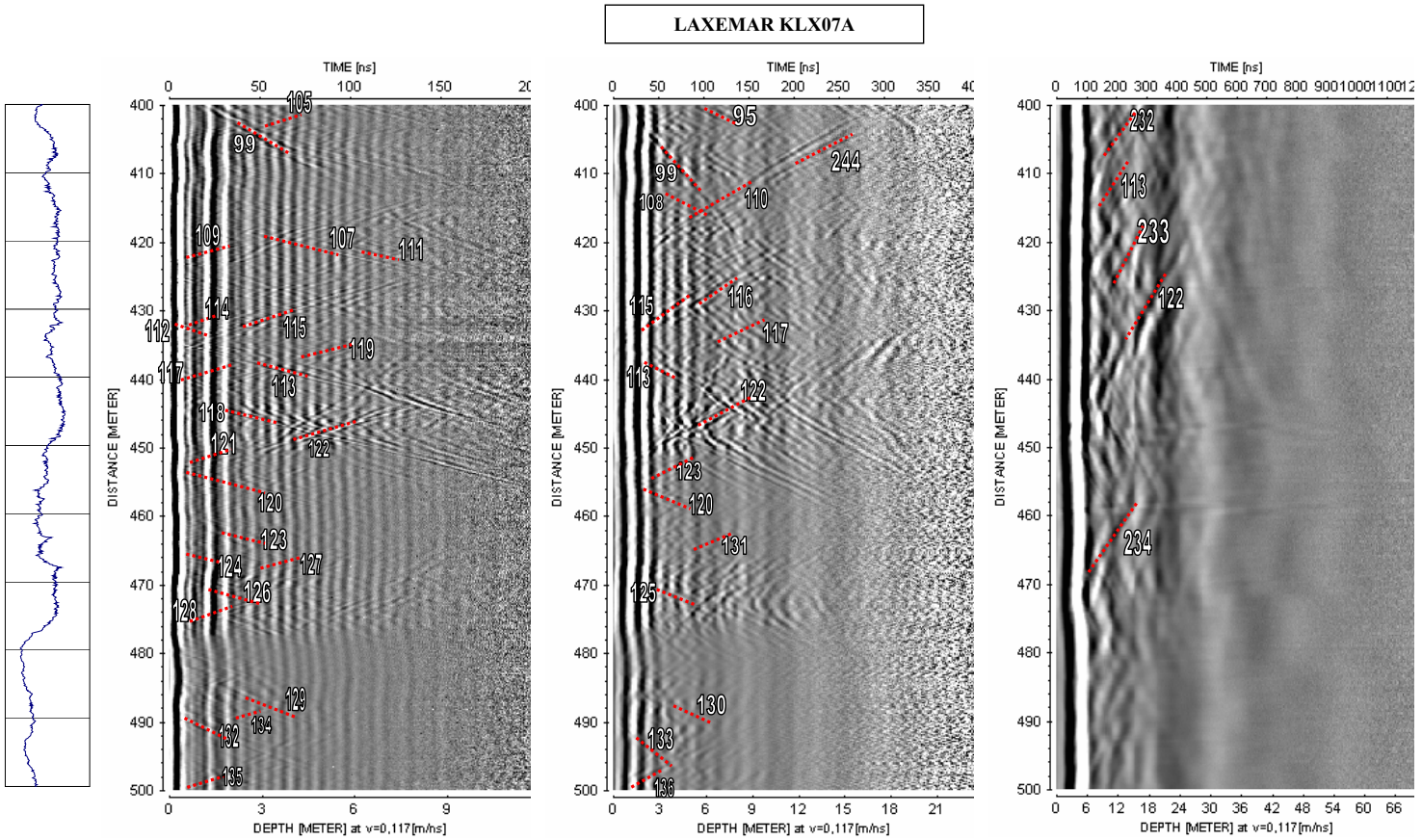


250 MHz | **100 MHz** | **20 MHz**

LAXEMAR KLX07A

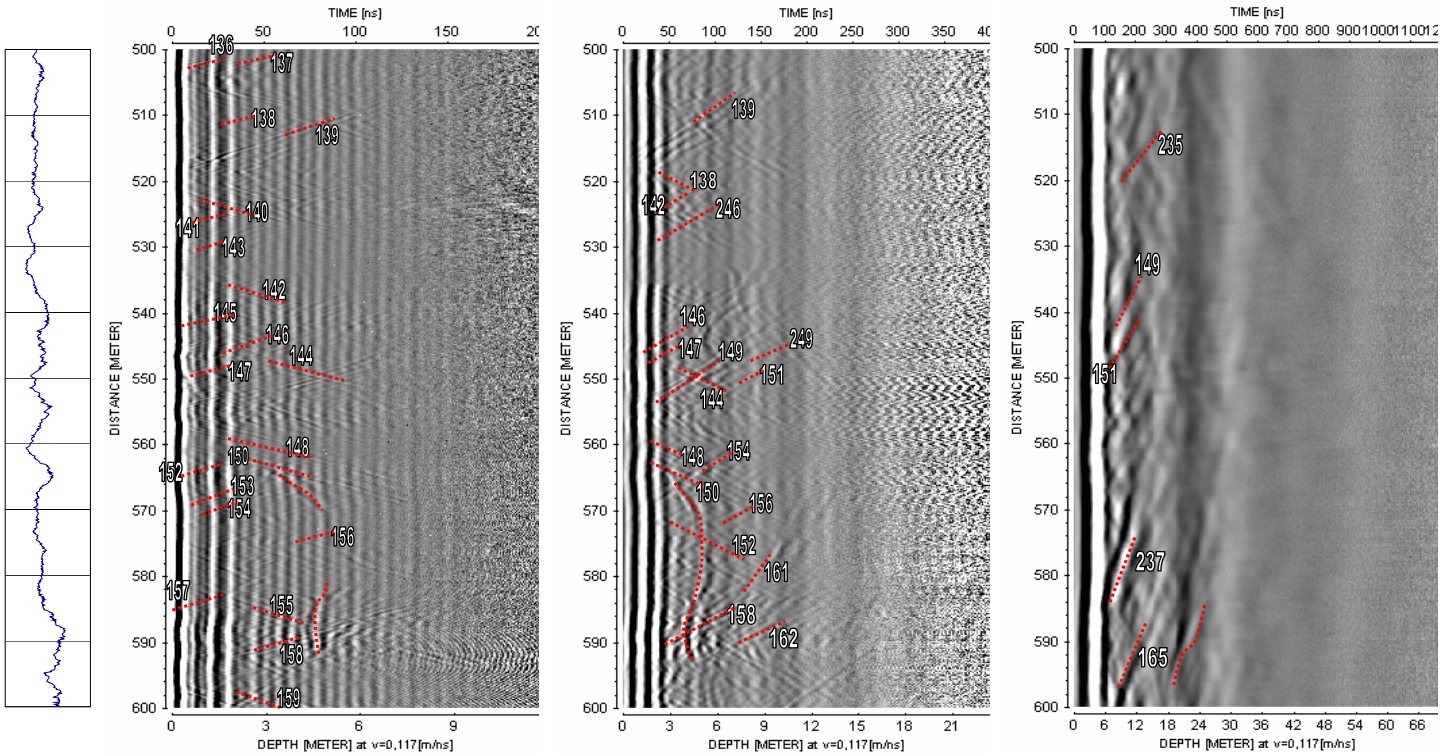


LAXEMAR KLX07A



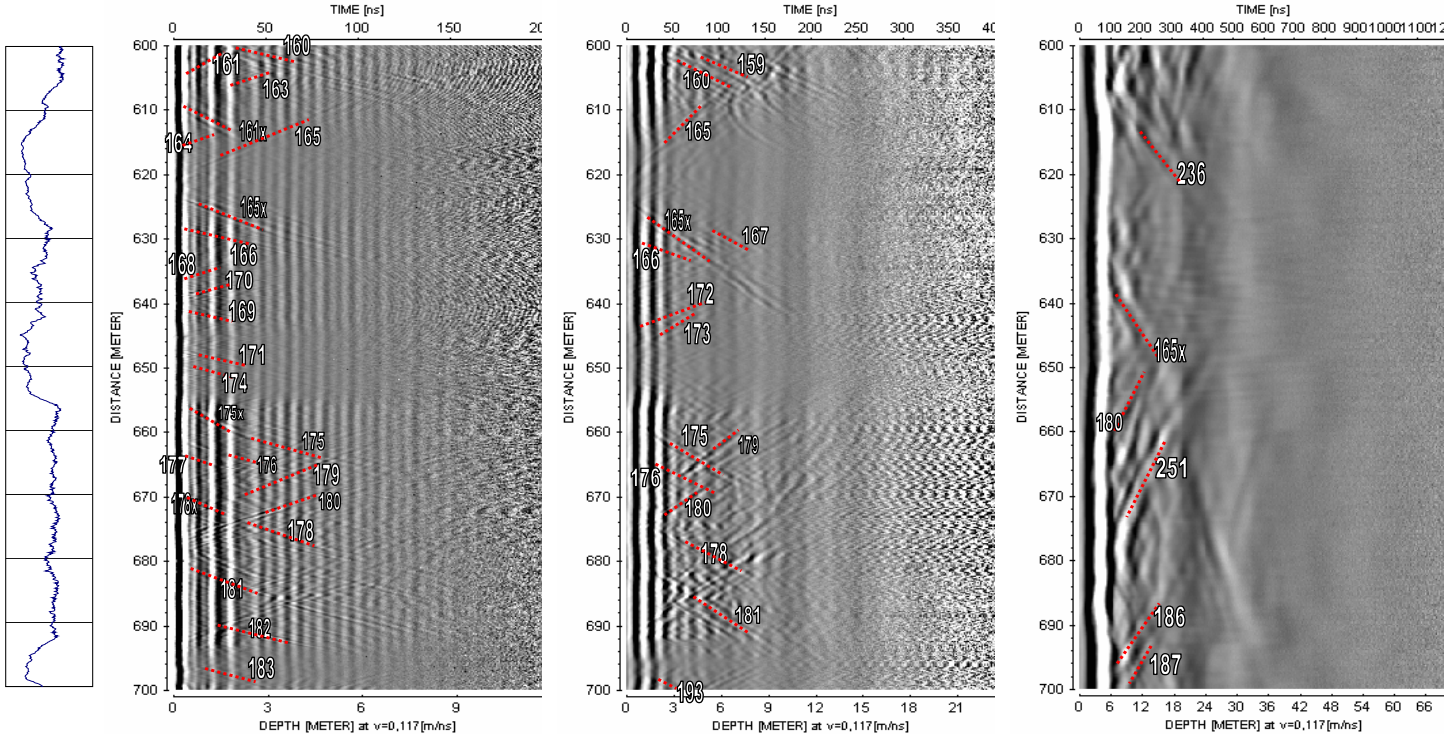
250 MHz **100 MHz** **20 MHz**

LAXEMAR KLX07A



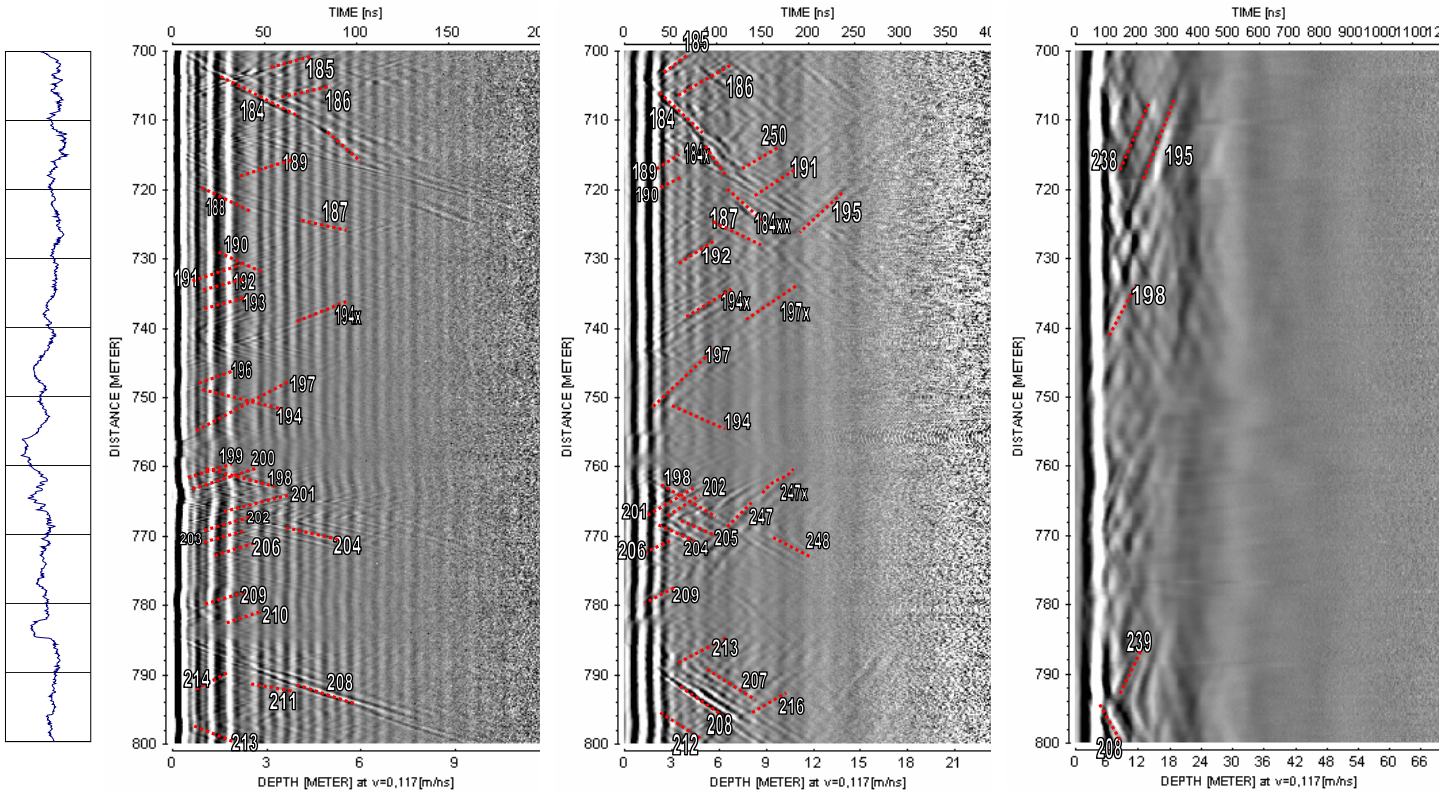
250 MHz **100 MHz** **20 MHz**

LAXEMAR KLX07A



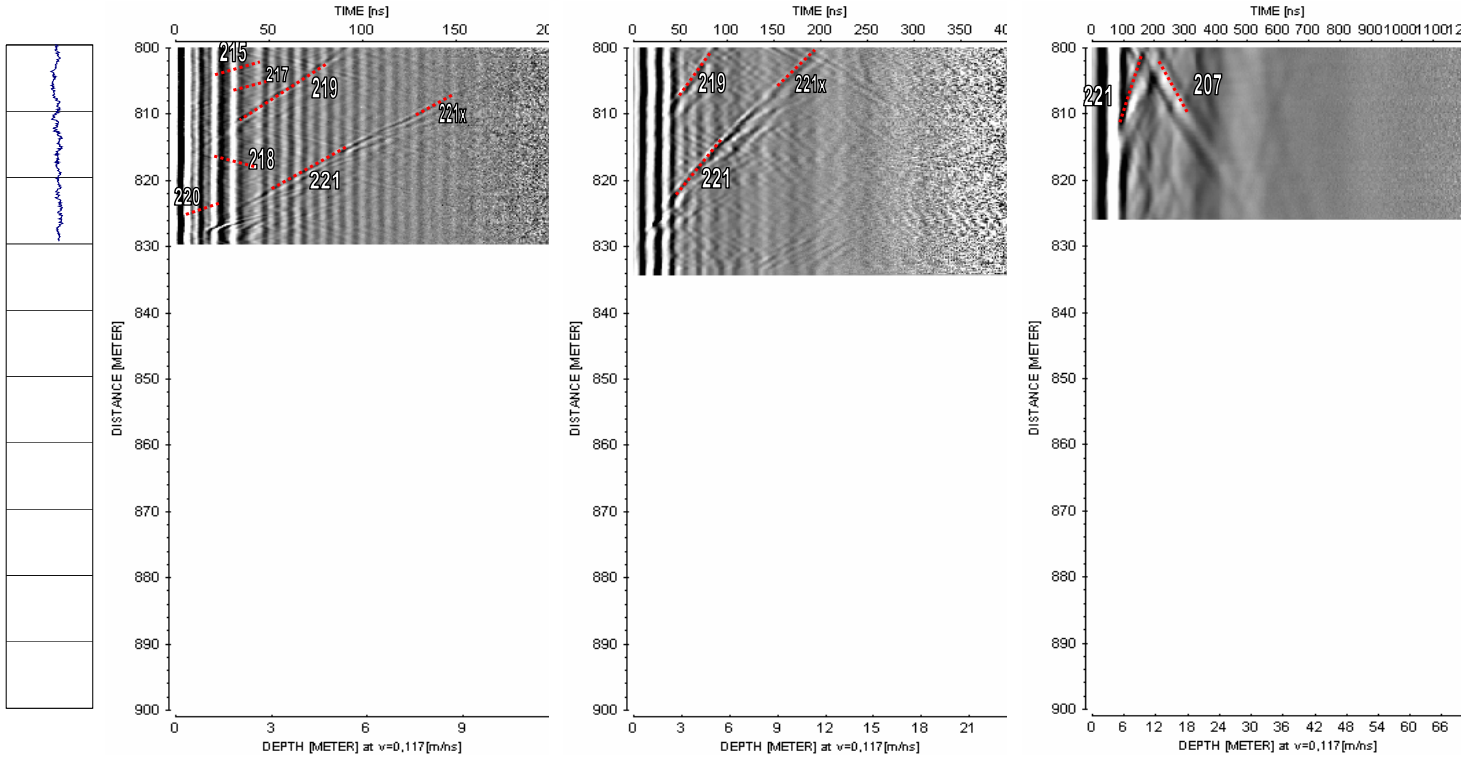
250 MHz **100 MHz** **20 MHz**

LAXEMAR KLX07A



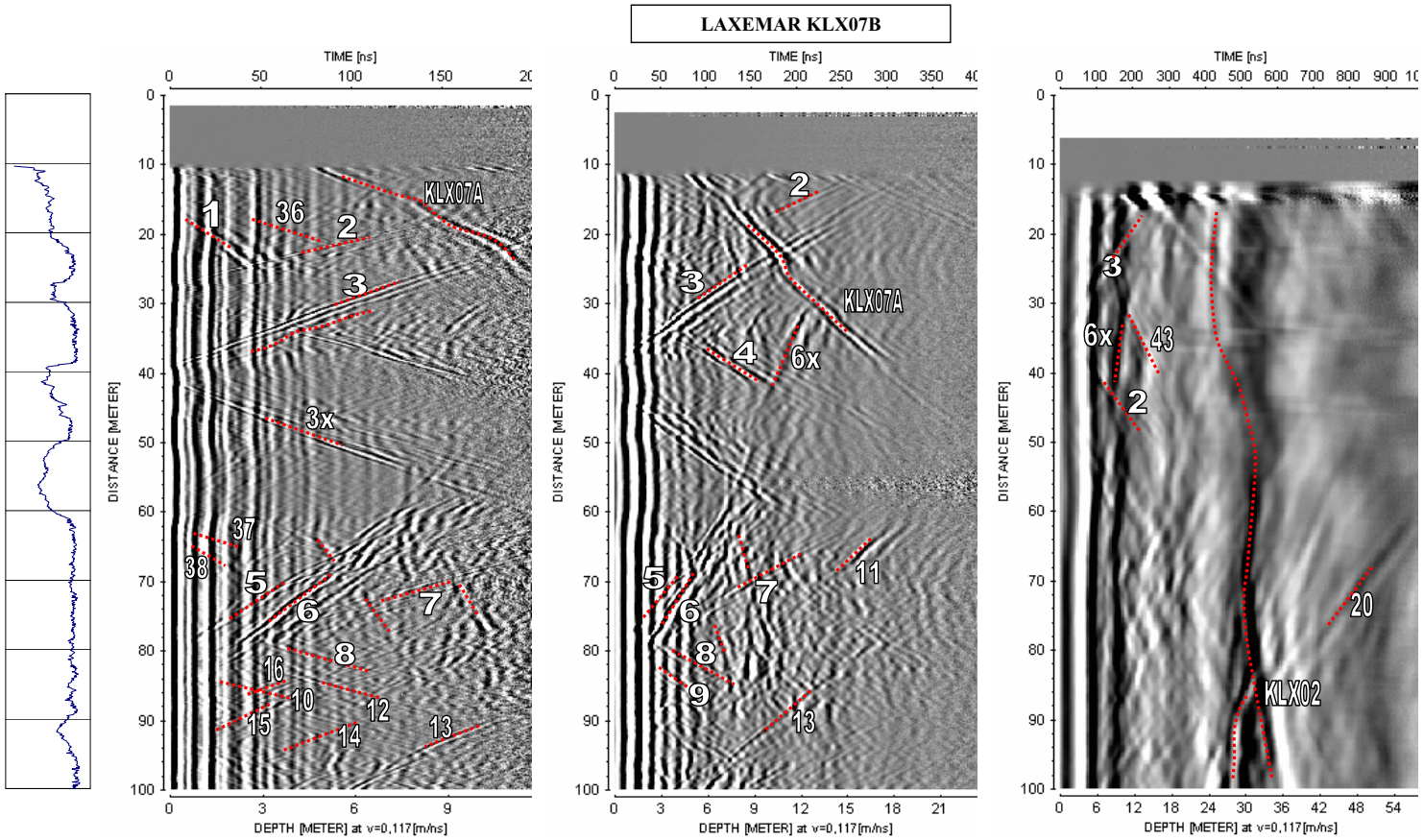
250 MHz **100 MHz** **20 MHz**

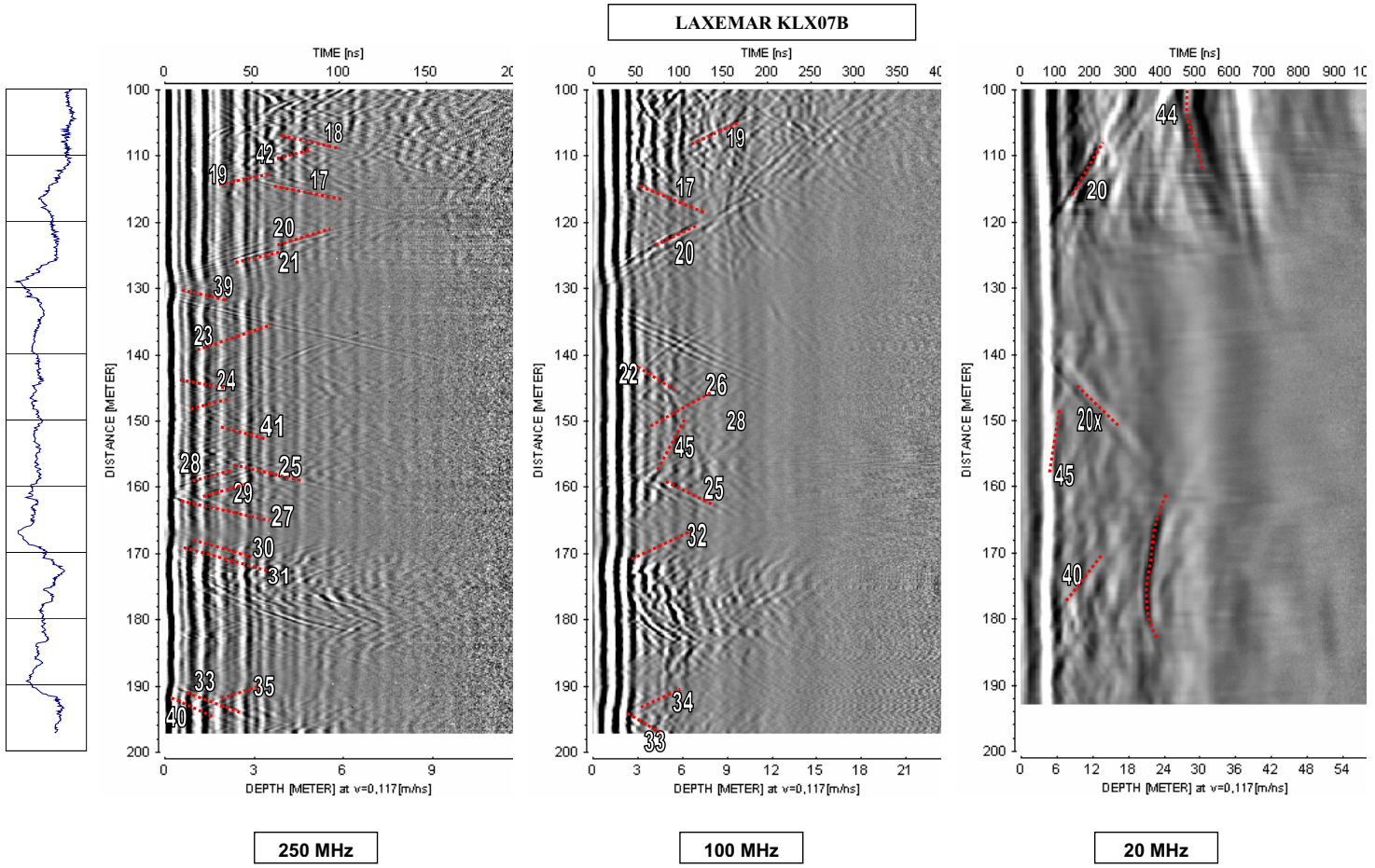
LAXEMAR KLX07A



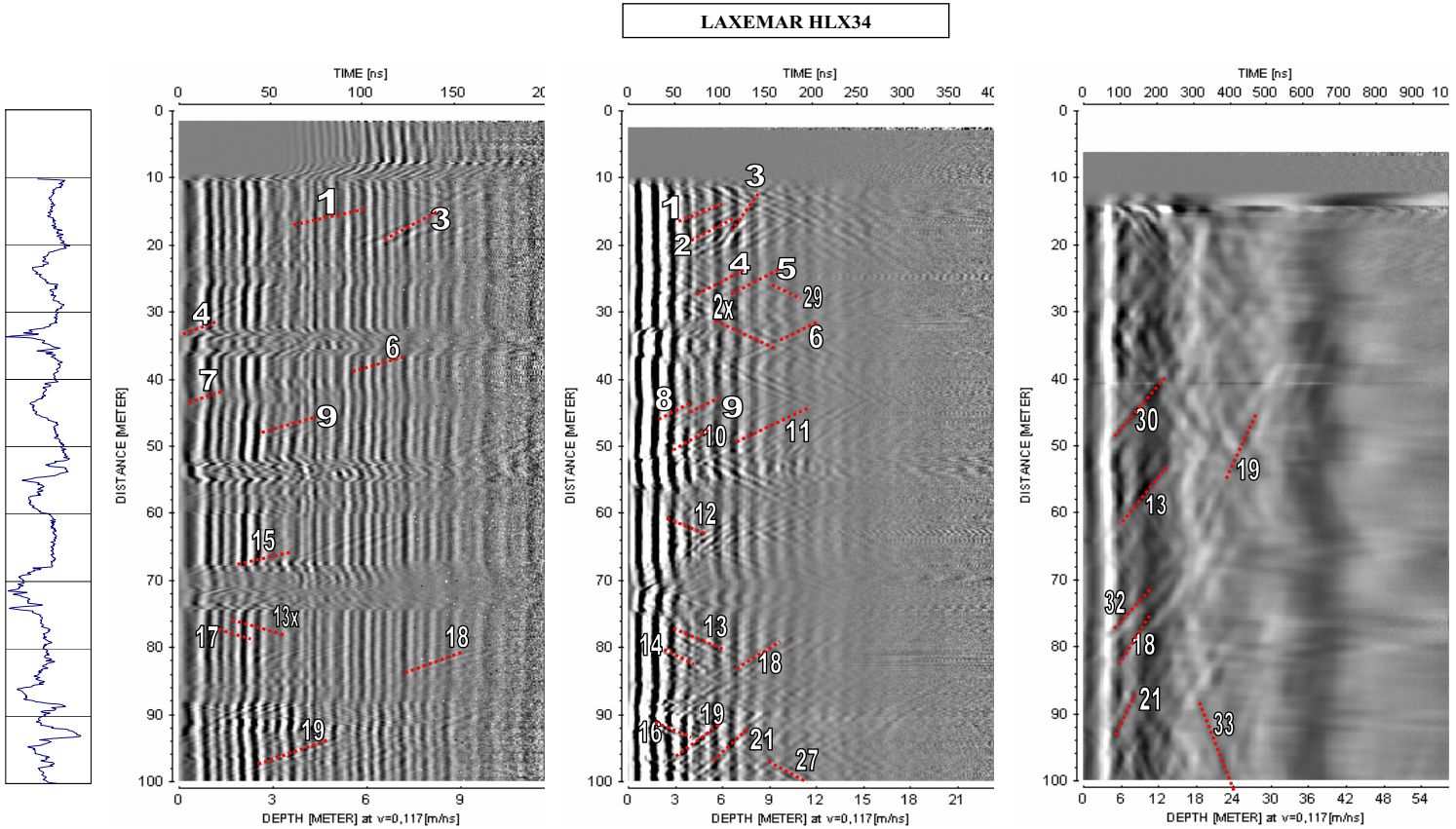
250 MHz | **100 MHz** | **20 MHz**

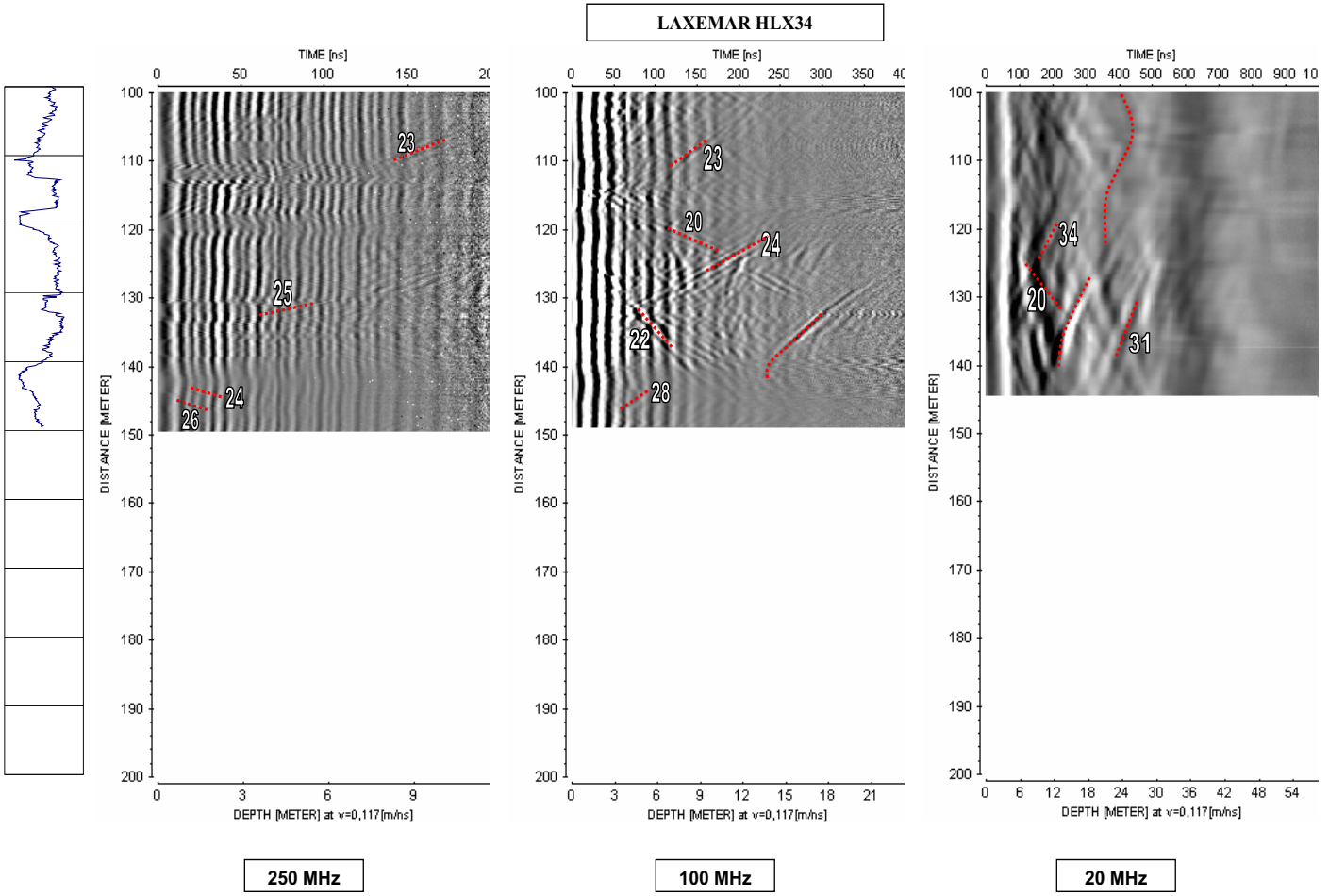
Radar logging in KLX07B, 0 to 195 m dipole antennas 250, 100 and 20 MHz



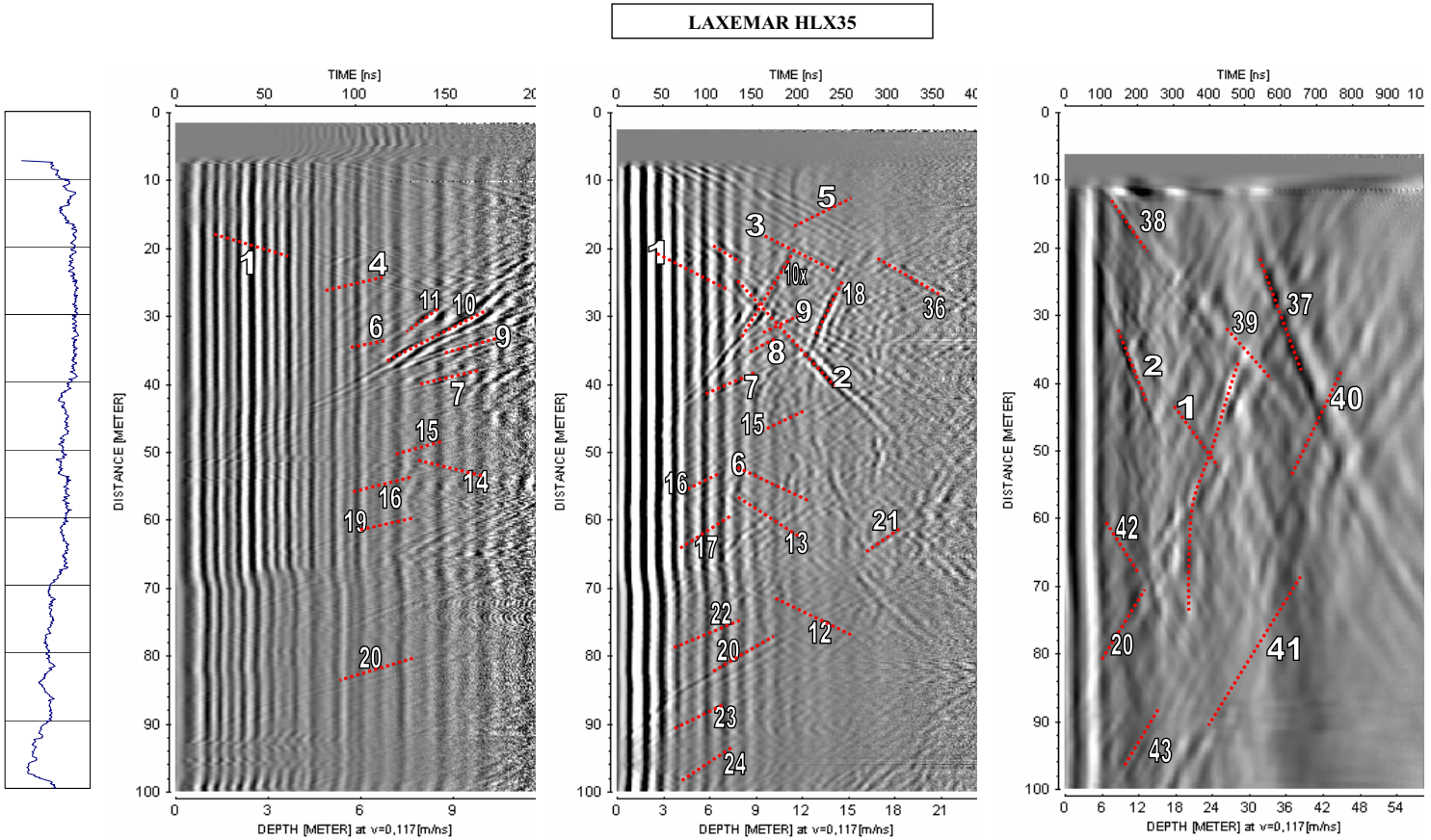

LAXEMAR KLX07B
TIME [ns]
DISTANCE [METER]
DEPTH [METER] at v=0,117[m/ns]
250 MHz
100 MHz
20 MHz

Radar logging in HLX34, 0 to 145 m dipole antennas 250, 100 and 20 MHz

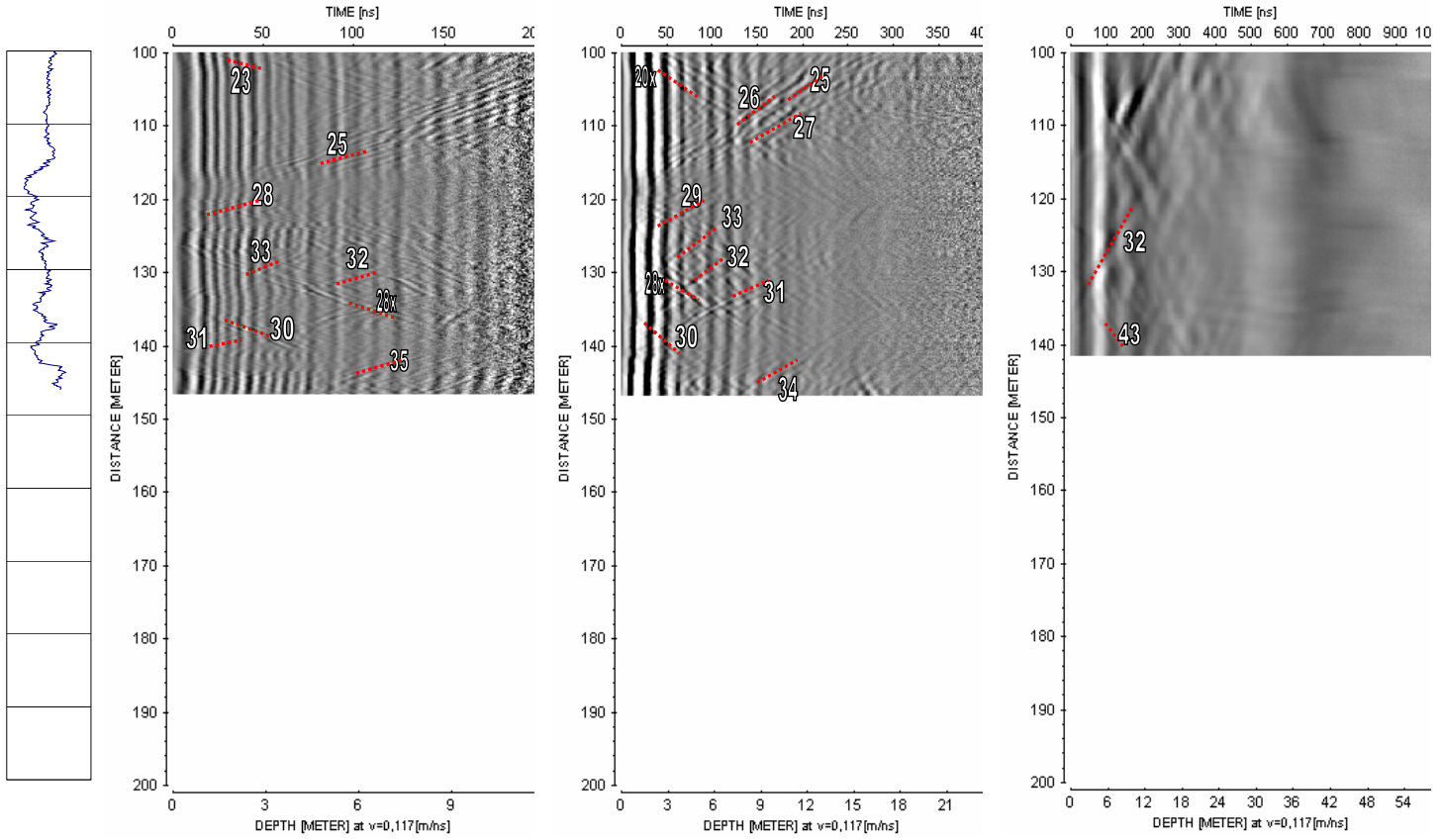



LAXEMAR HLX34
TIME [ns]
DISTANCE [METER]
DEPTH [METER] at v=0,117[m/ns]
23
25
24
26
20
22
28
34
31
250 MHz
100 MHz
20 MHz

Radar logging in HLX35, 0 to 145 m dipole antennas 250, 100 and 20 MHz



LAXEMAR HLX35



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

Appendix 5

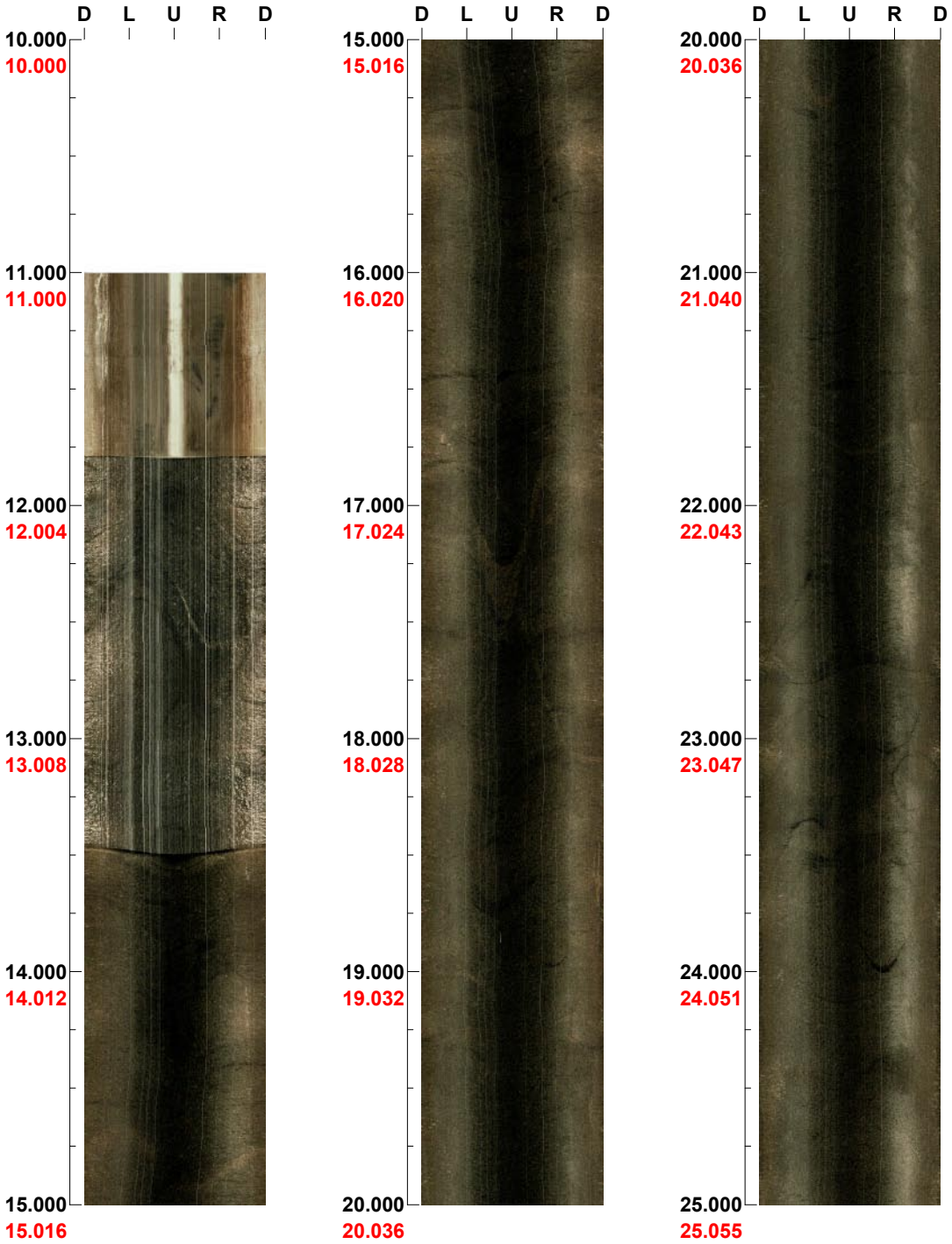
BIPS logging in KLX07A, 11 to 832 m

Project name: Laxemar

Image file	**: c:\work\r5446s~1\klx07a\bips\klx07a11.bip**
BDT file	**: c:\work\r5446s~1\klx07a\bips\klx07a11.bdt**
Locality	**: LAXEMAR**
Bore hole number	**: KLX07A**
Date	**: 05/07/07**
Time	**: 10:34:00**
Depth range	**: 11.000 - 97.106 m**
Azimuth	**: 174**
Inclination	**: -60**
Diameter	**: 198.0 mm**
Magnetic declination	**: 0.0**
Span	**: 4**
Scan interval	**: 0.25**
Scan direction	**: To bottom**
Scale	**: 1/25**
Aspect ratio	**: 125 %**
Pages	**: 6**
Color	**:**  **+0 +0 +0**

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

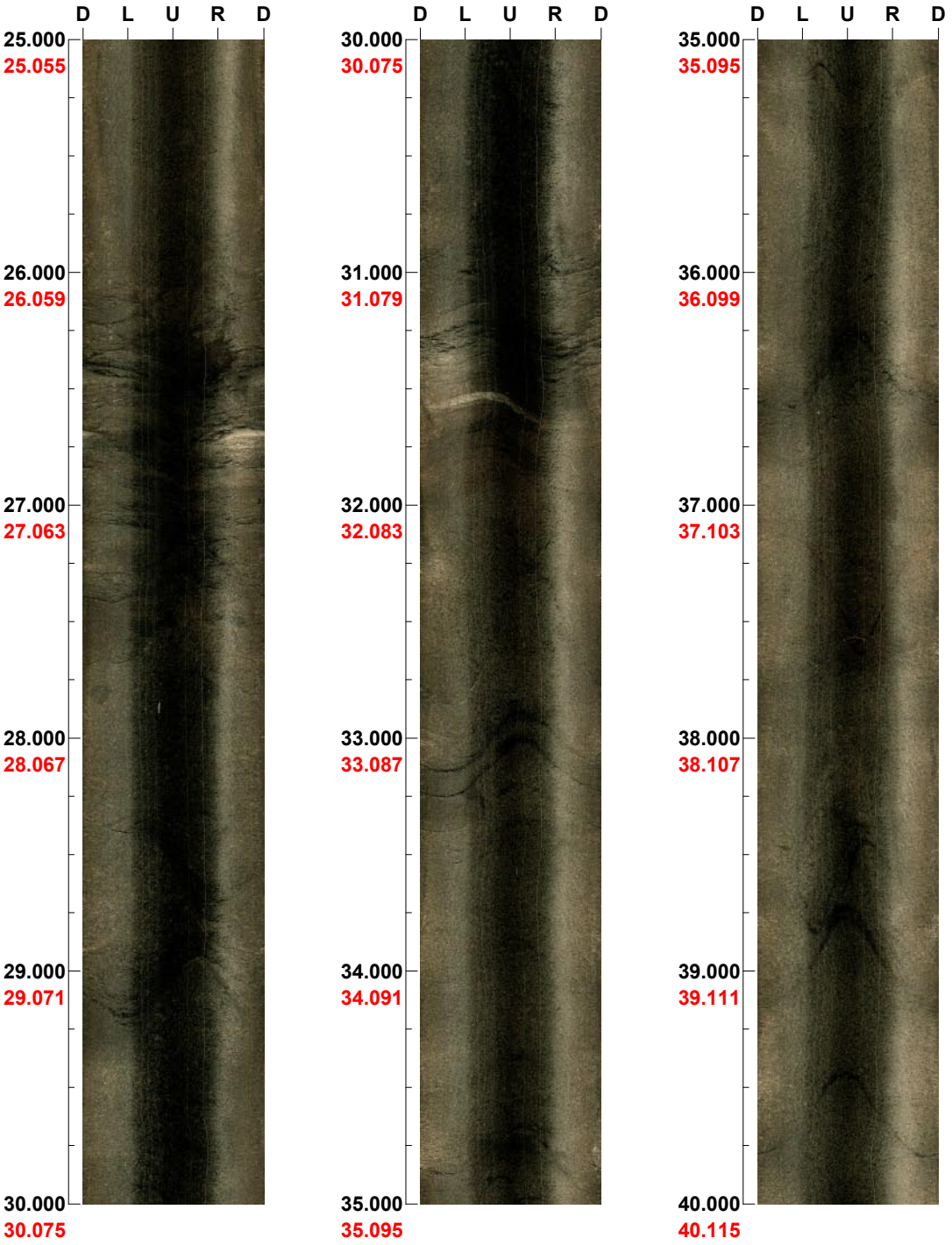
Depth range: 10.000 - 25.000 m



(1 / 6) **Scale: 1/25** **Aspect ratio: 125 %**

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

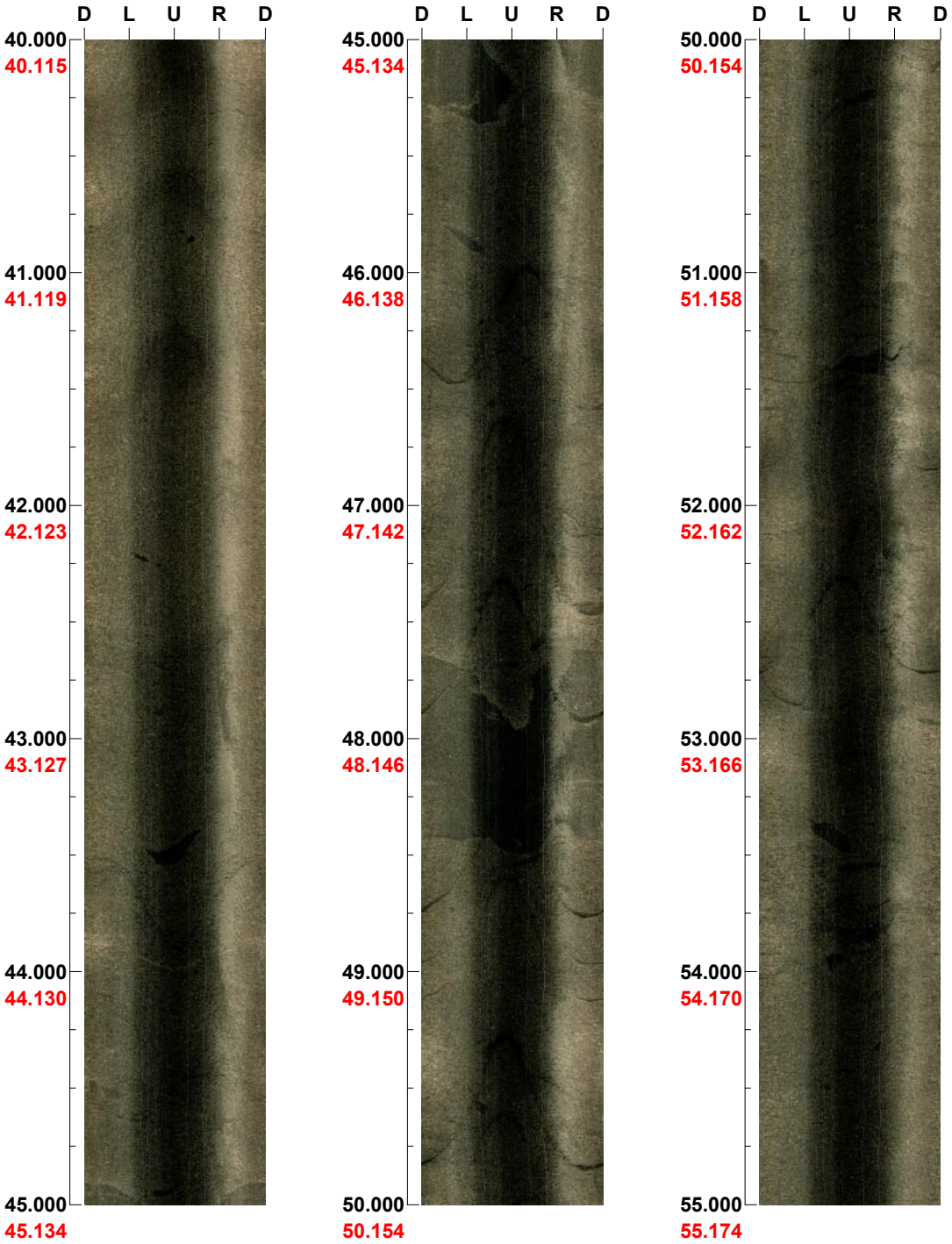
Depth range: 25.000 - 40.000 m



(2 / 6) **Scale: 1/25** **Aspect ratio: 125 %**

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

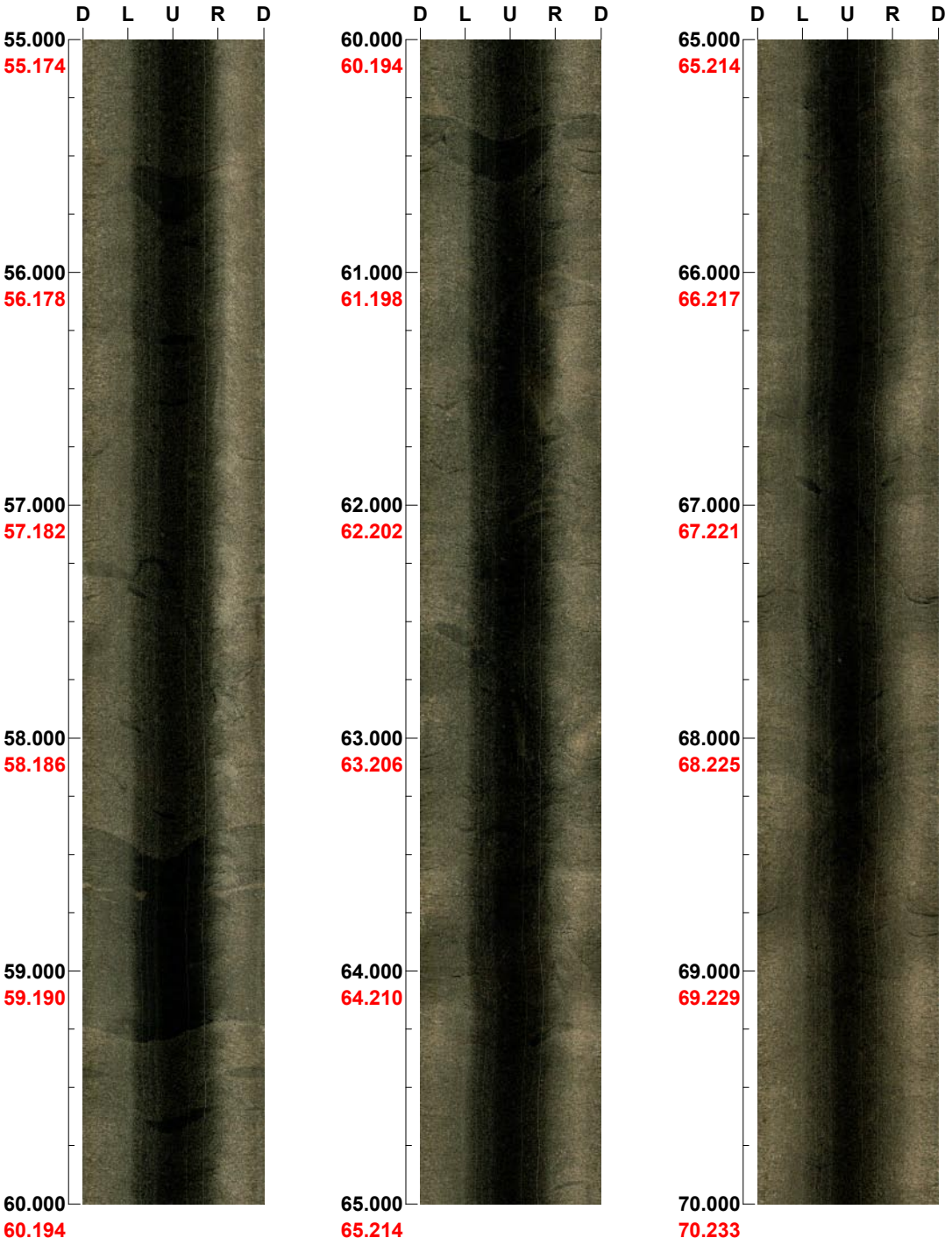
Depth range: 40.000 - 55.000 m



(3 / 6) **Scale: 1/25** **Aspect ratio: 125 %**

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

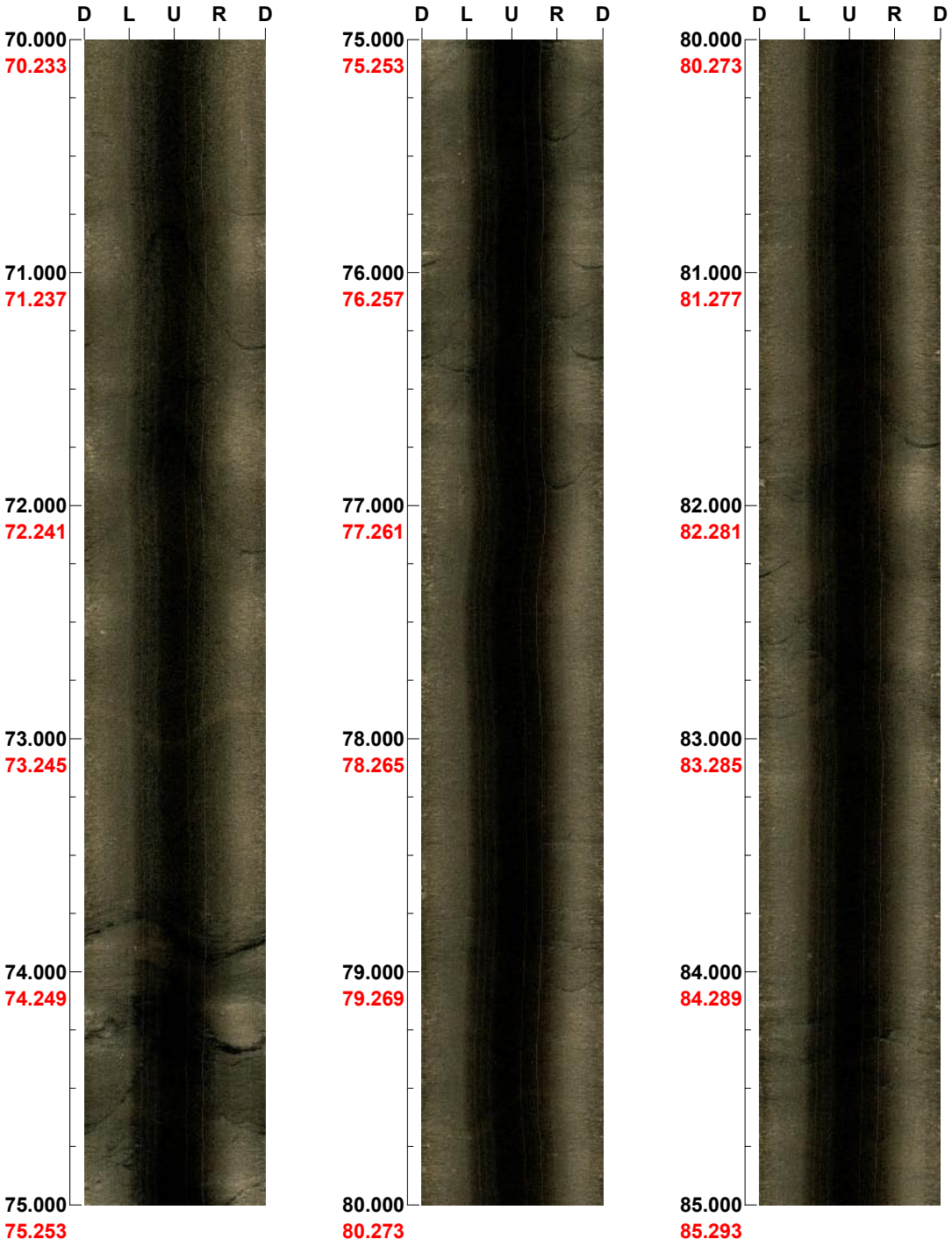
Depth range: 55.000 - 70.000 m



(4 / 6) **Scale: 1/25** **Aspect ratio: 125 %**

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

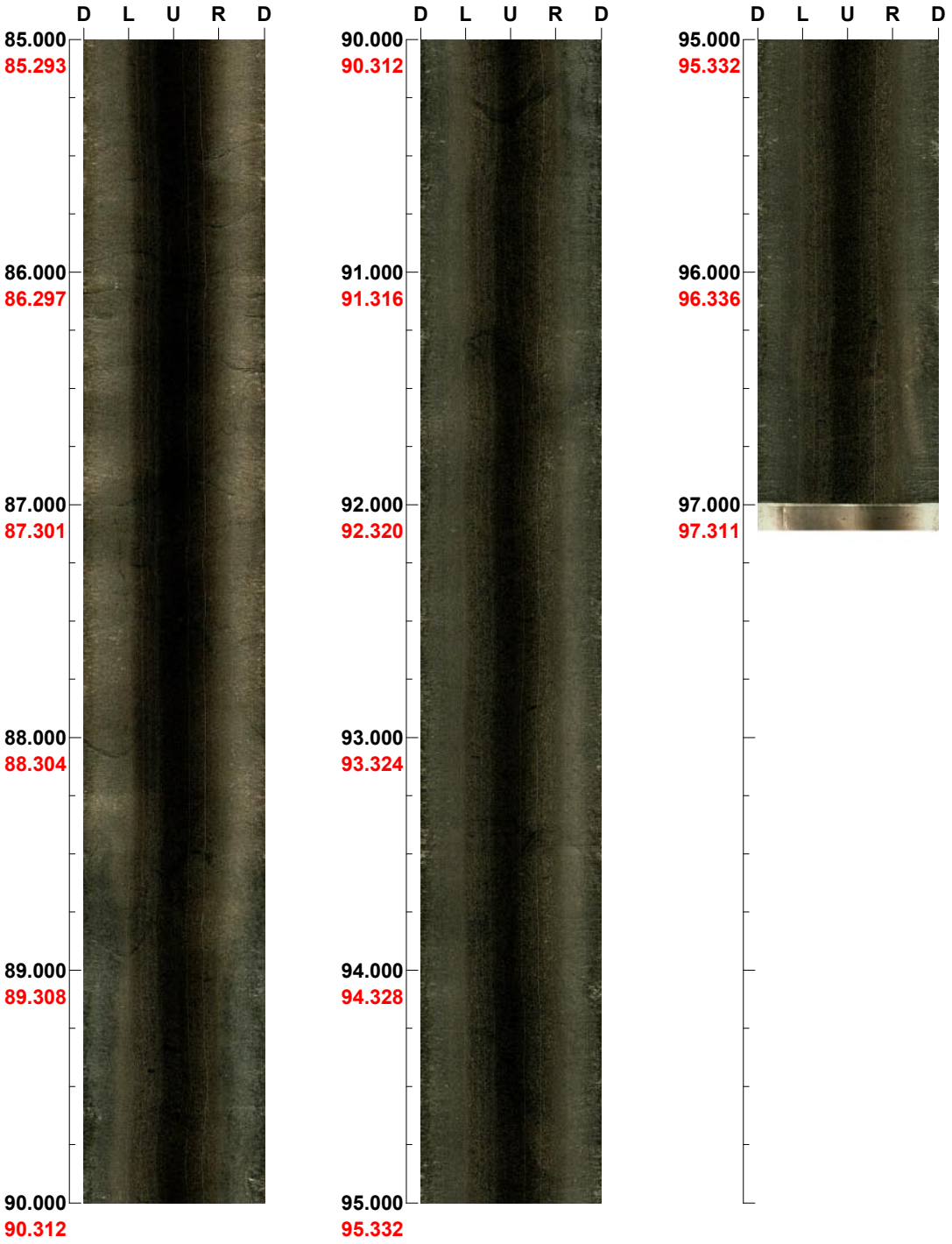
Depth range: 70.000 - 85.000 m



(5 / 6) **Scale: 1/25** **Aspect ratio: 125 %**

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 85.000 - 97.106 m



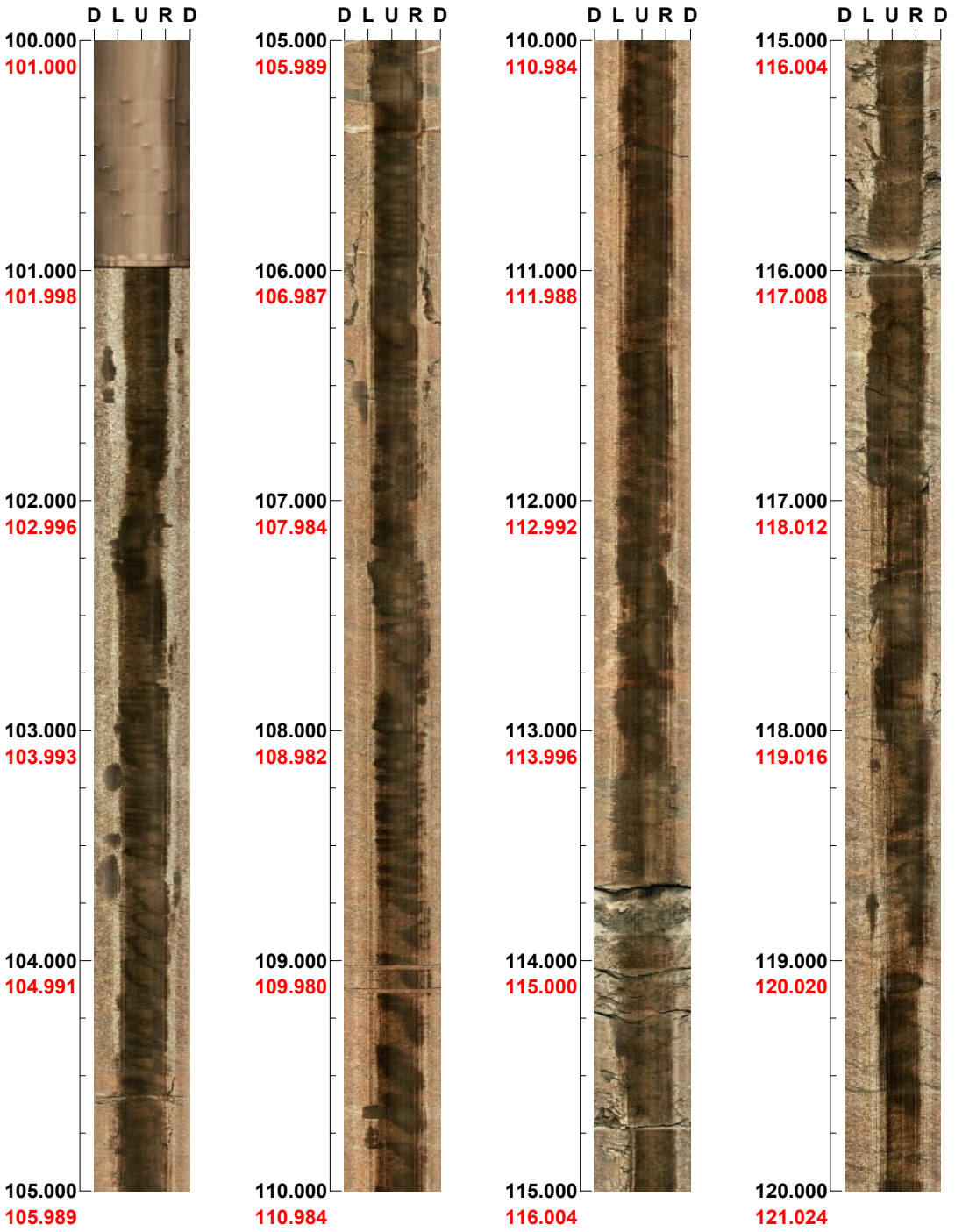
(6 / 6) **Scale: 1/25** **Aspect ratio: 125 %**

Project name: Laxemar

Image file	**: c:\work\r5446s~1\klx07a\bips\klx07a_1.bip**
BDT file	**: c:\work\r5446s~1\klx07a\bips\klx07a_1.bdt**
Locality	**: LAXEMAR**
Bore hole number	**: KLX07A**
Date	**: 05/07/06**
Time	**: 15:45:00**
Depth range	**: 100.000 - 831.500 m**
Azimuth	**: 174**
Inclination	**: -60**
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	**: 20**
Color	**:**  **+0 +0 +0**

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

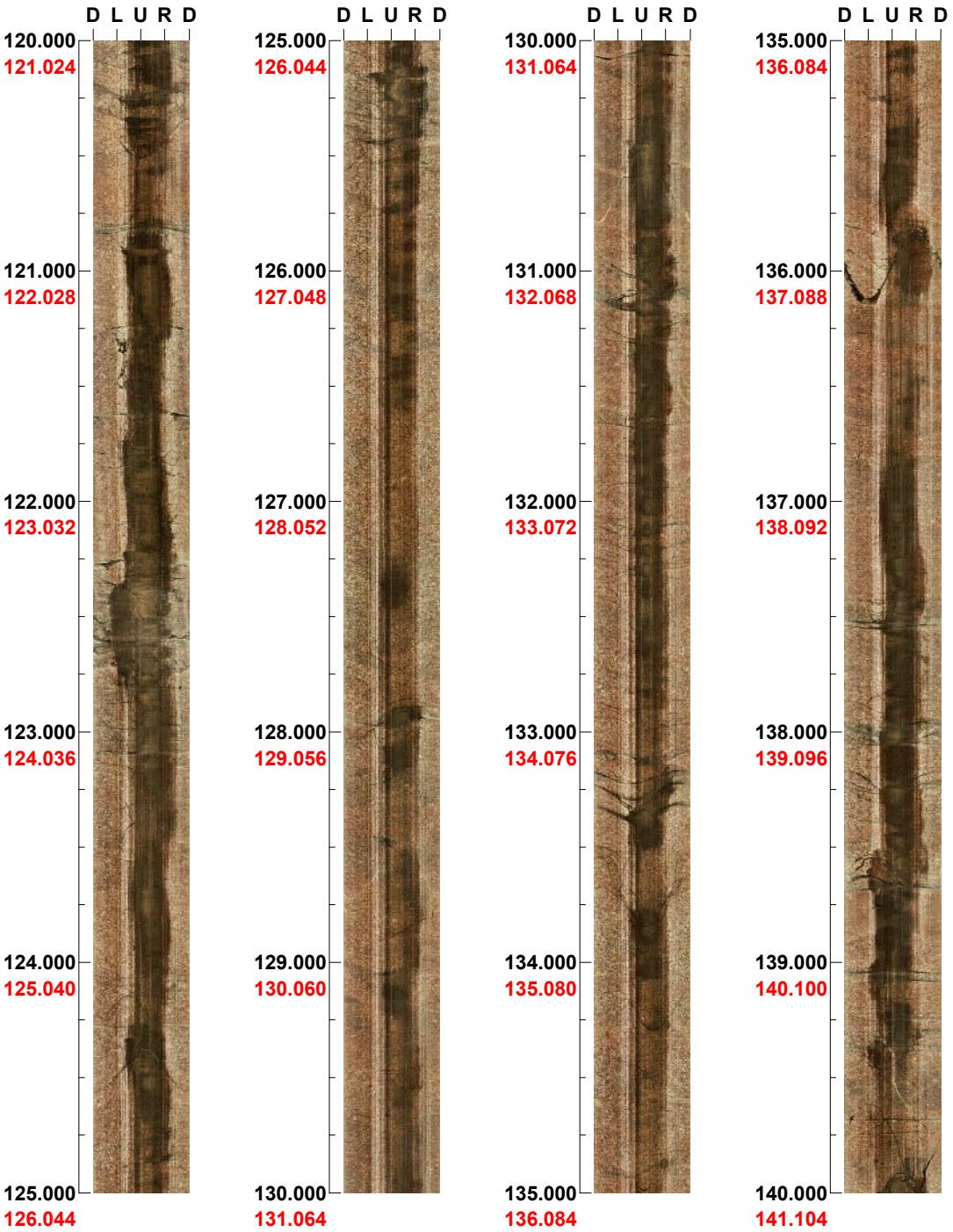
Depth range: 100.000 - 120.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

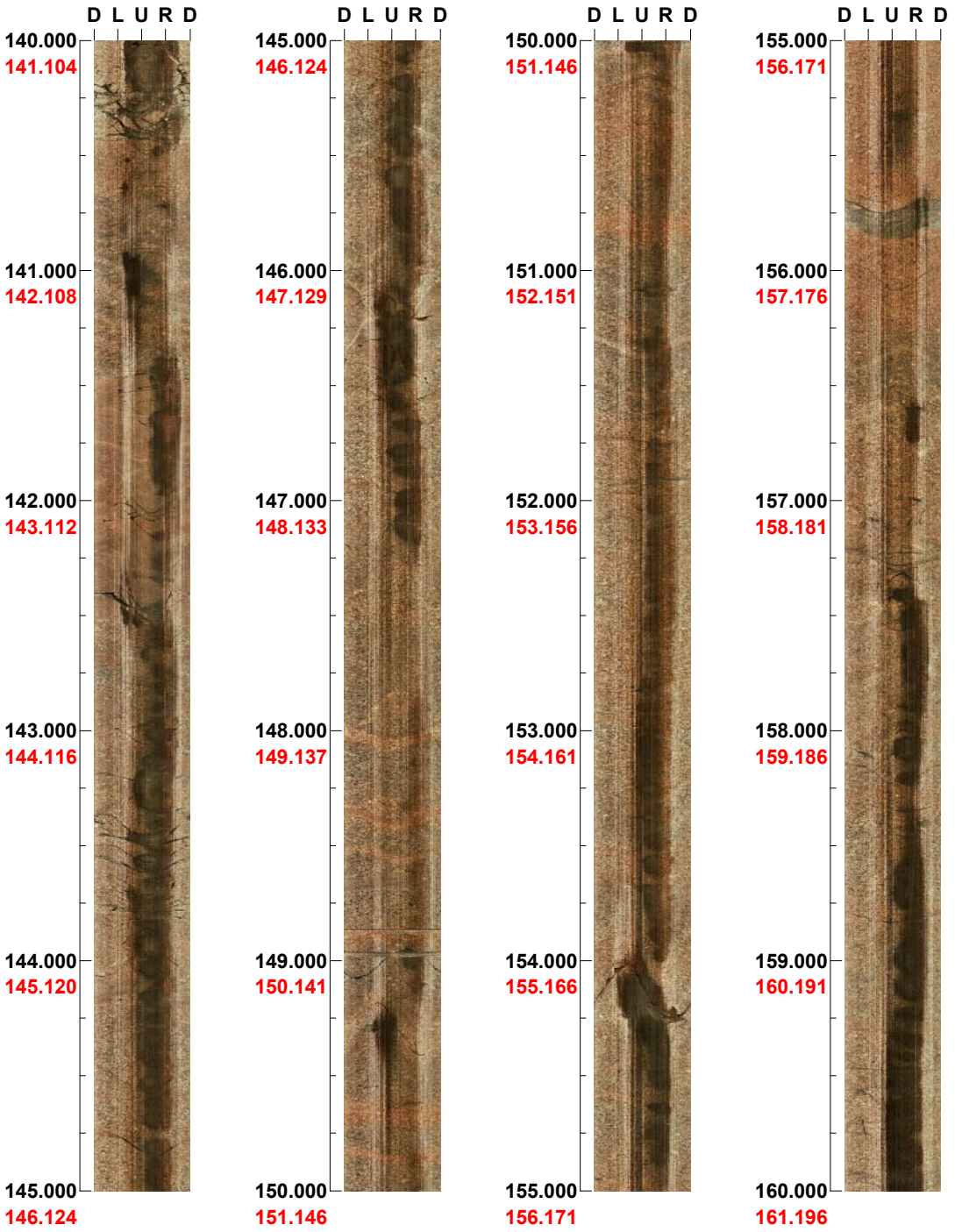
Depth range: 120.000 - 140.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 140.000 - 160.000 m



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

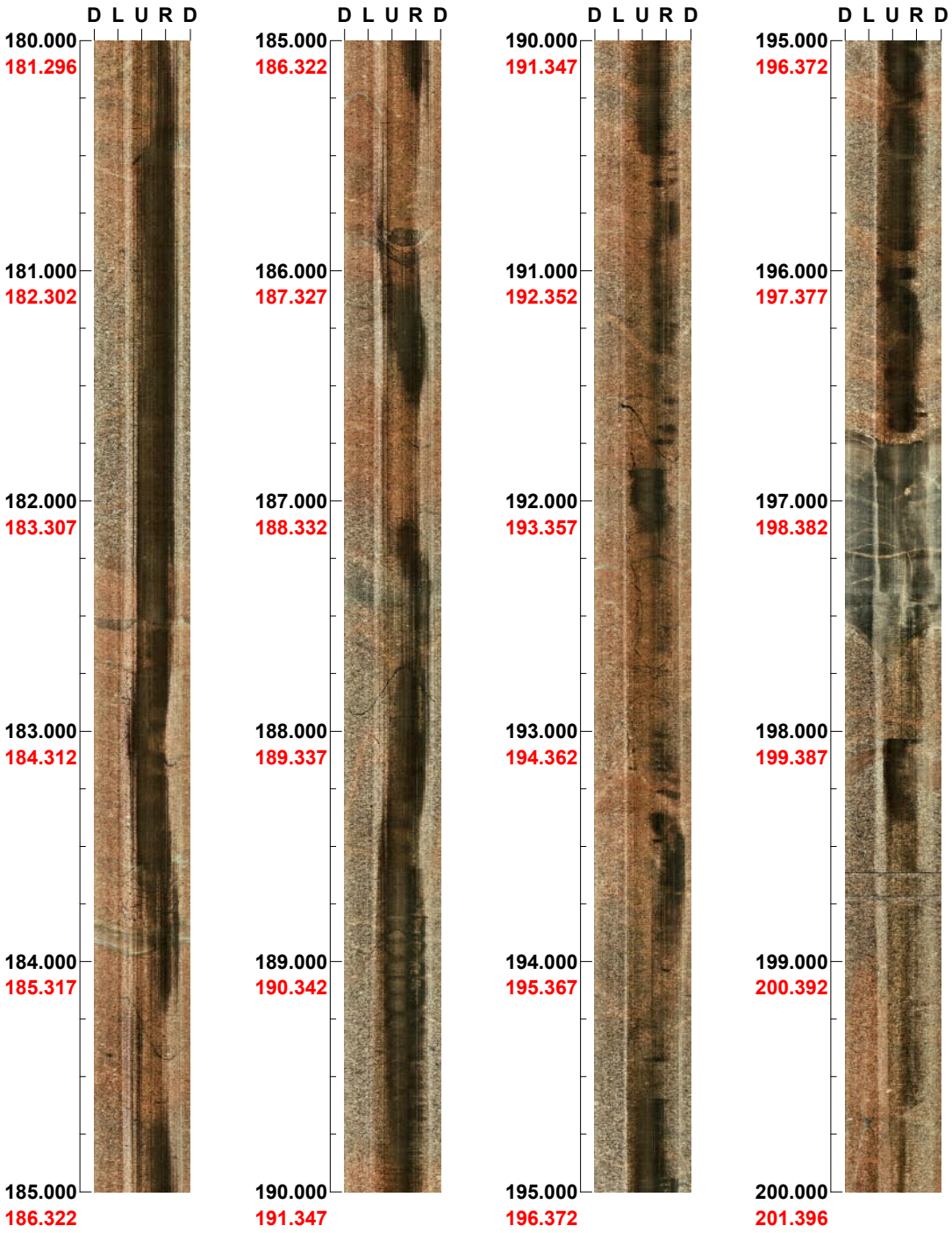
Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 160.000 - 180.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

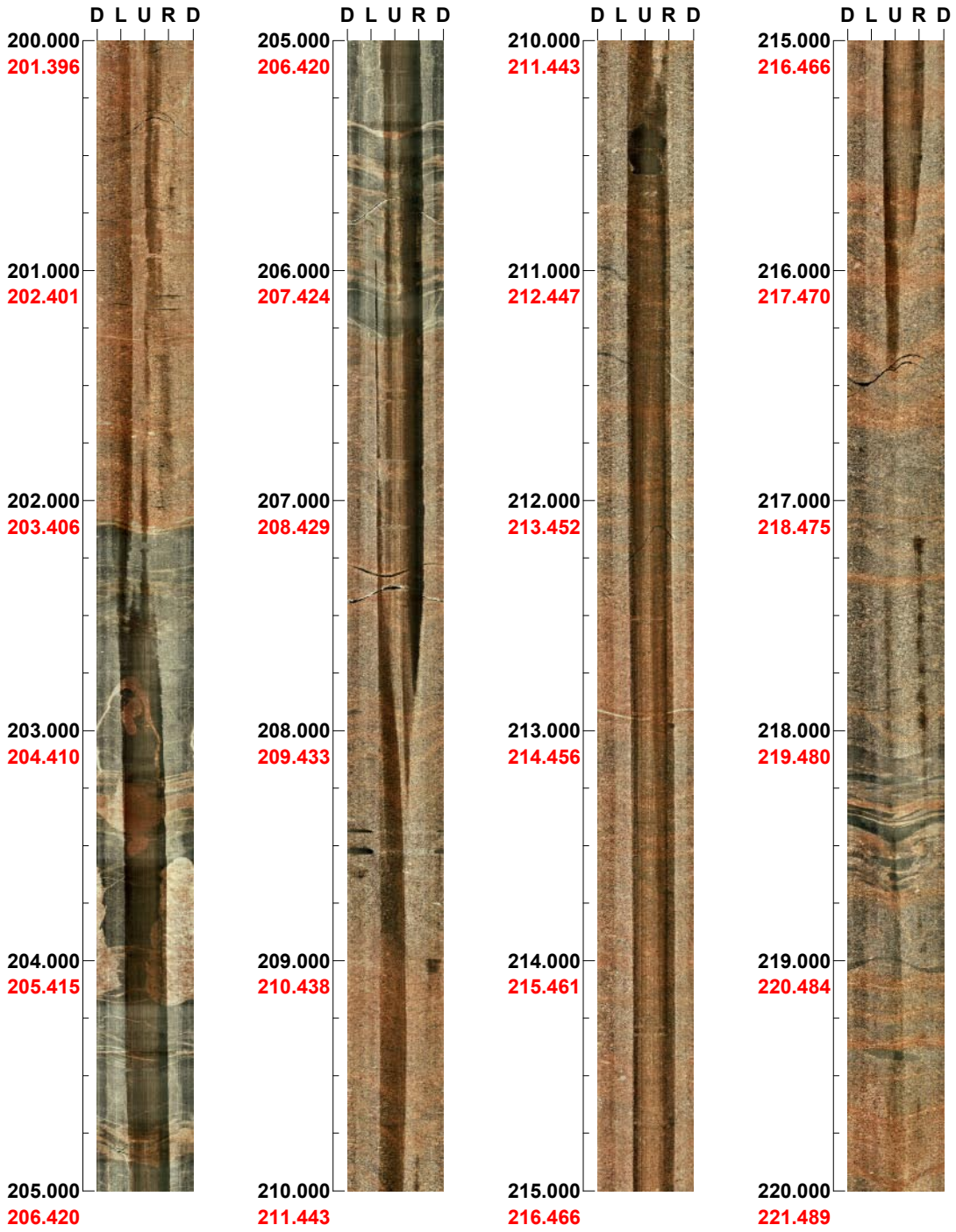
Depth range: 180.000 - 200.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 200.000 - 220.000 m



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

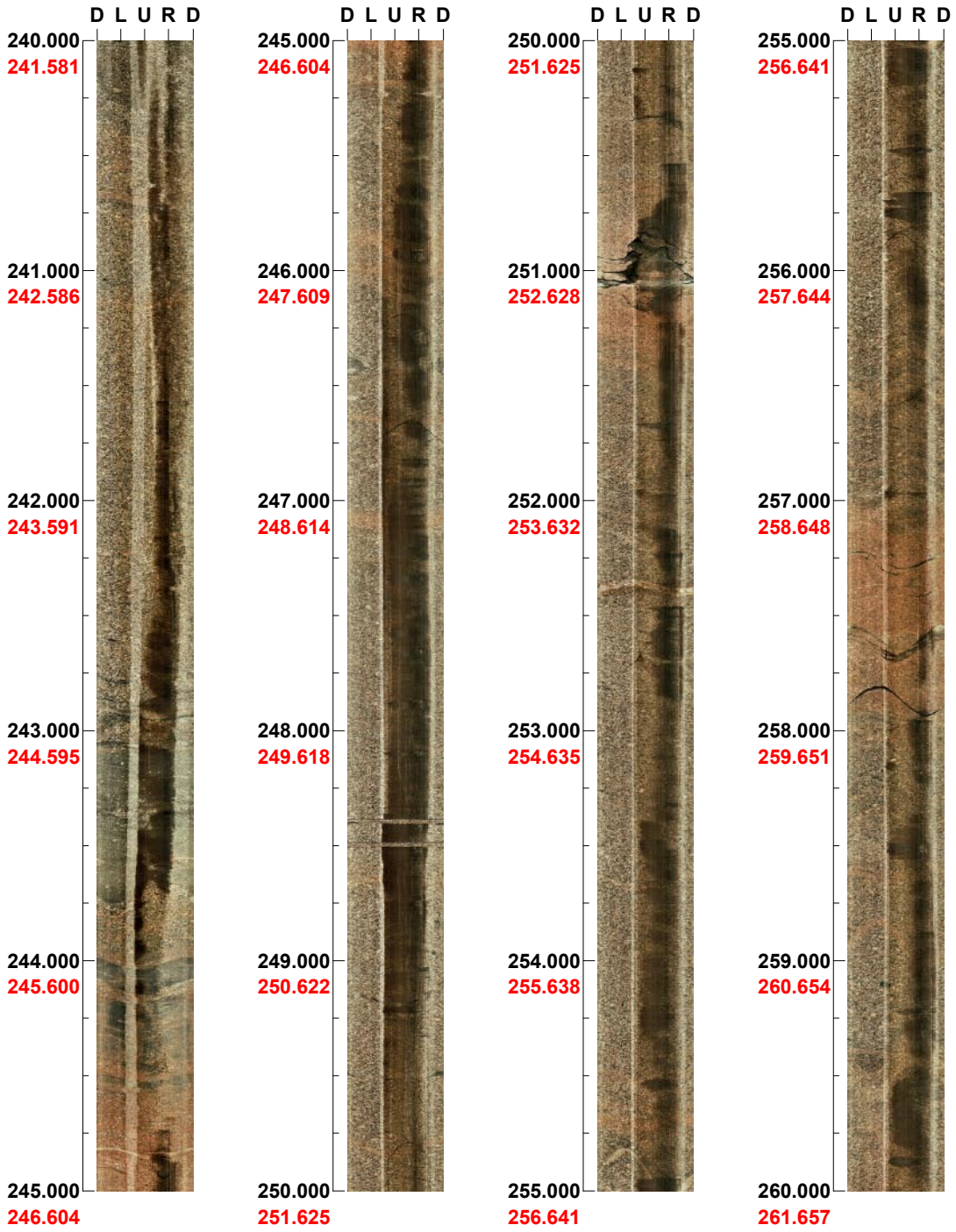
Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 220.000 - 240.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 240.000 - 260.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 260.000 - 280.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 280.000 - 300.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 300.000 - 320.000 m

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

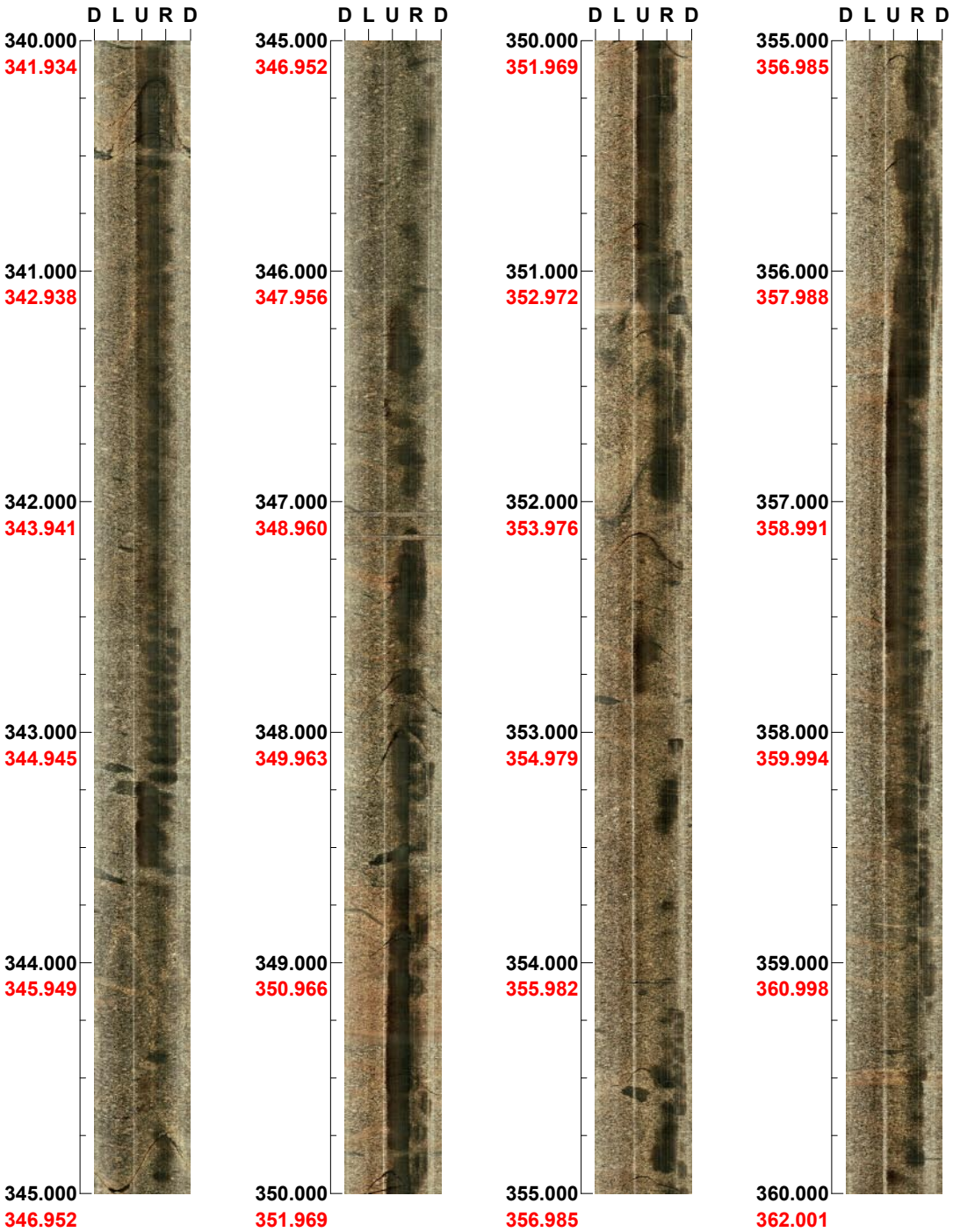
Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 320.000 - 340.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

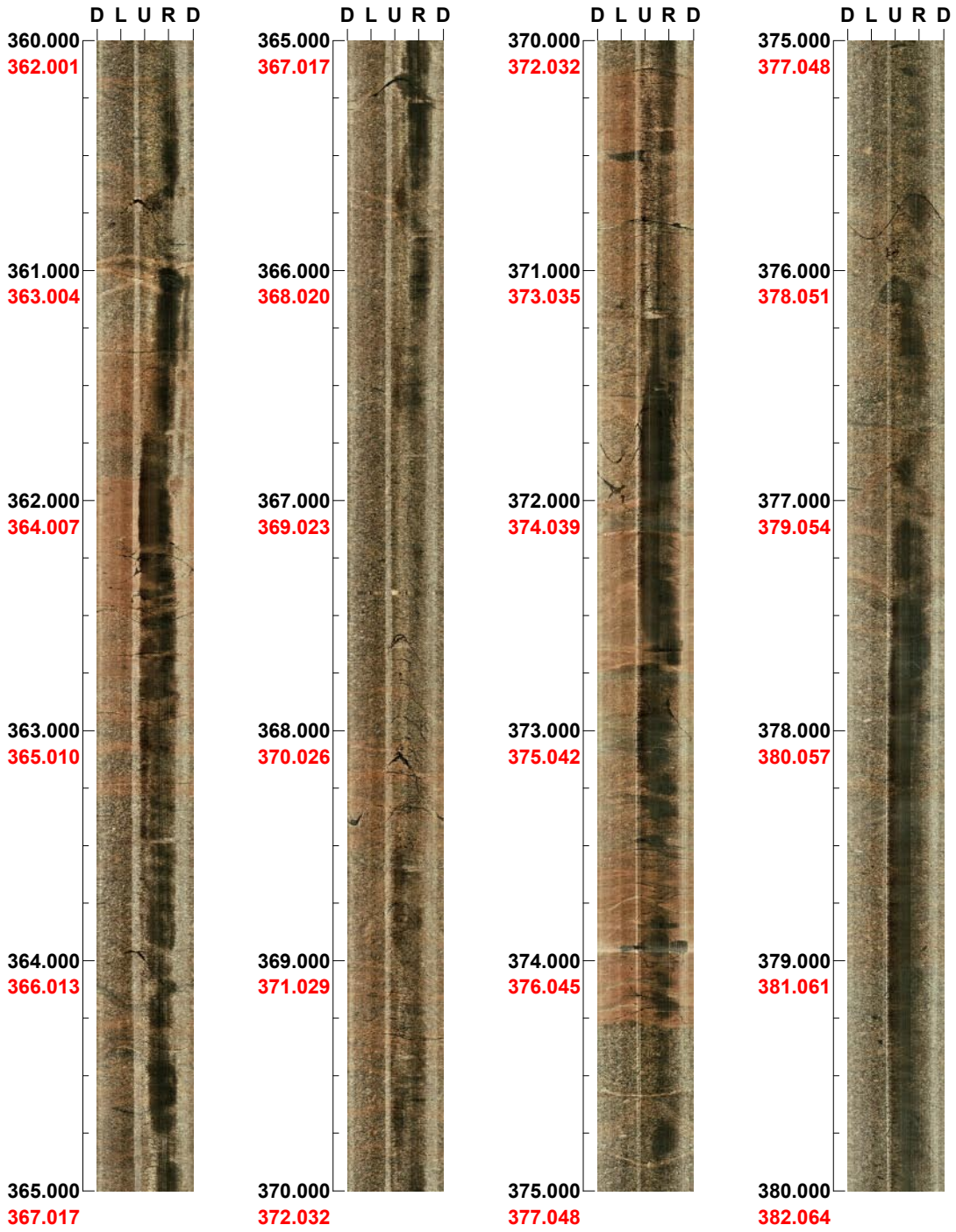
Depth range: 340.000 - 360.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

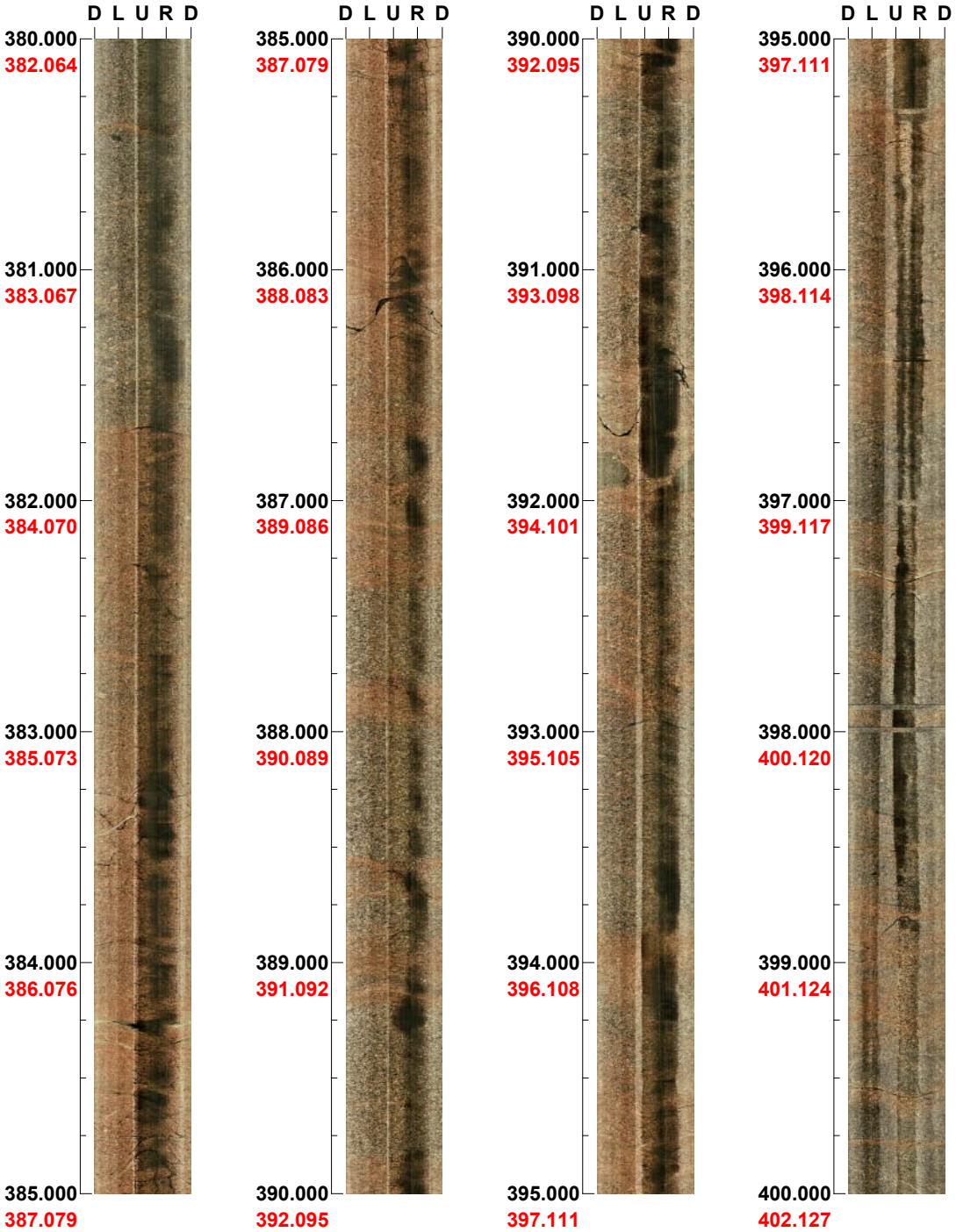
Depth range: 360.000 - 380.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 380.000 - 400.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 400.000 - 420.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 420.000 - 440.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 440.000 - 460.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 460.000 - 480.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 480.000 - 499.997 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 500.000 - 520.000 m

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

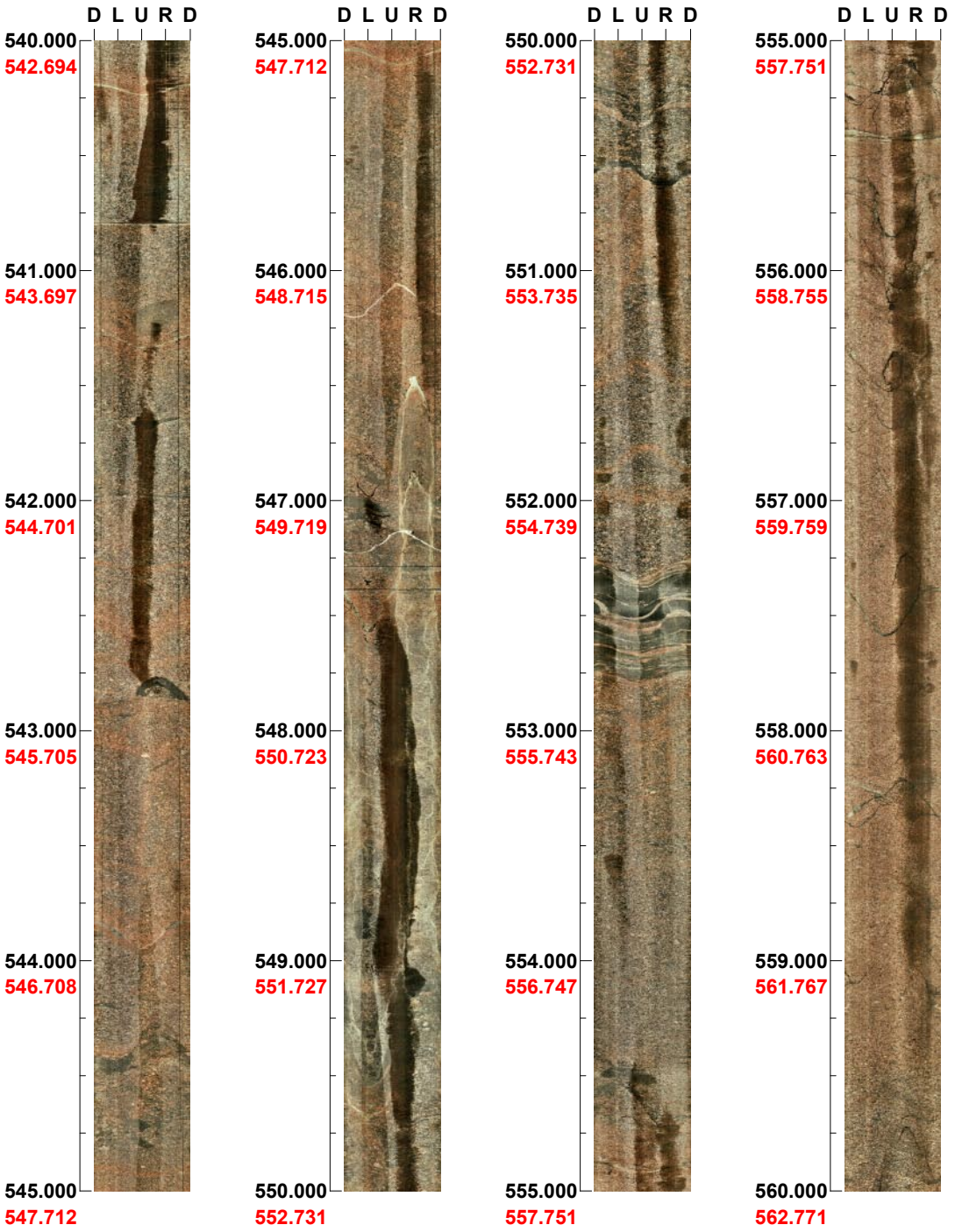
Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 520.000 - 540.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

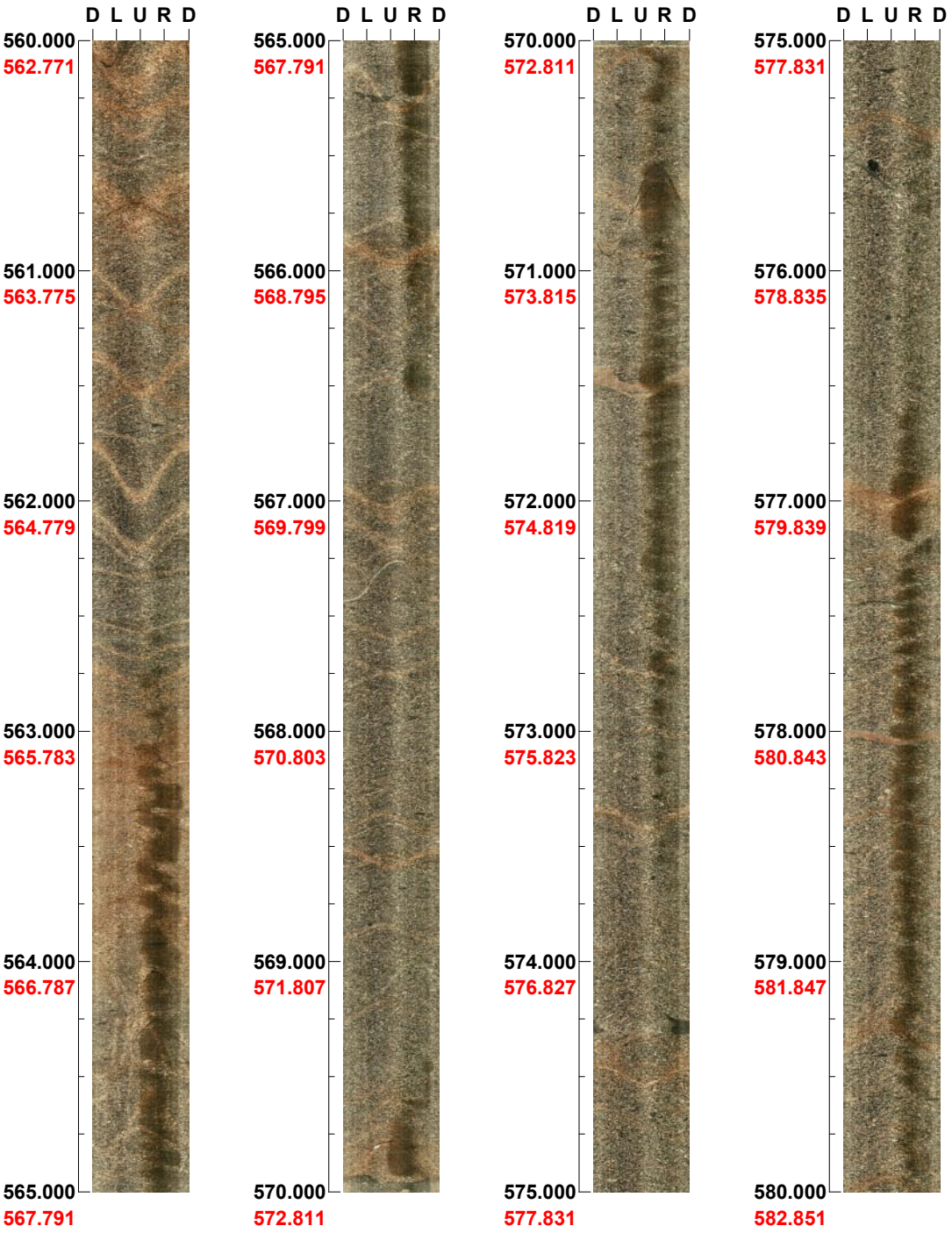
Depth range: 540.000 - 560.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

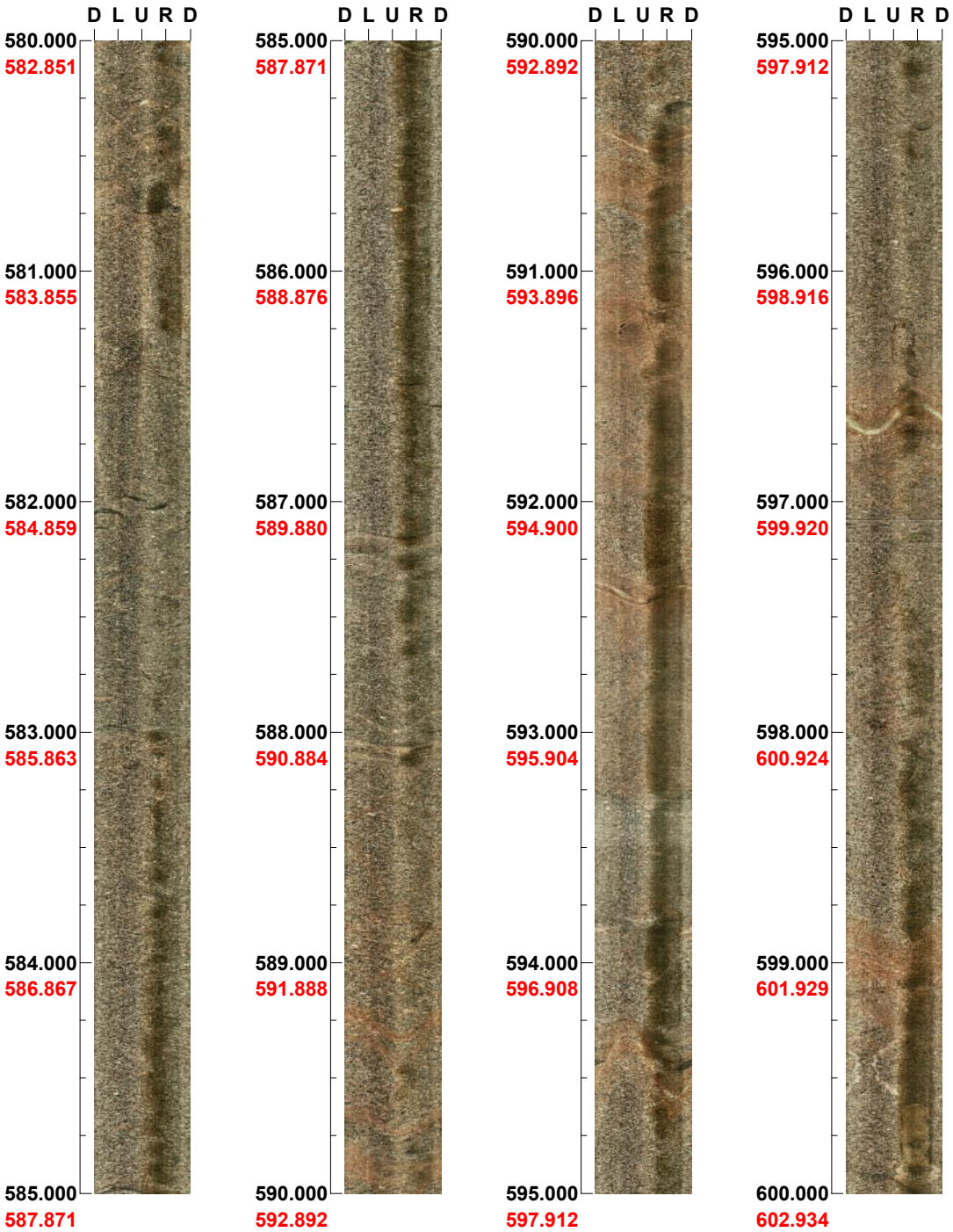
Depth range: 560.000 - 580.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

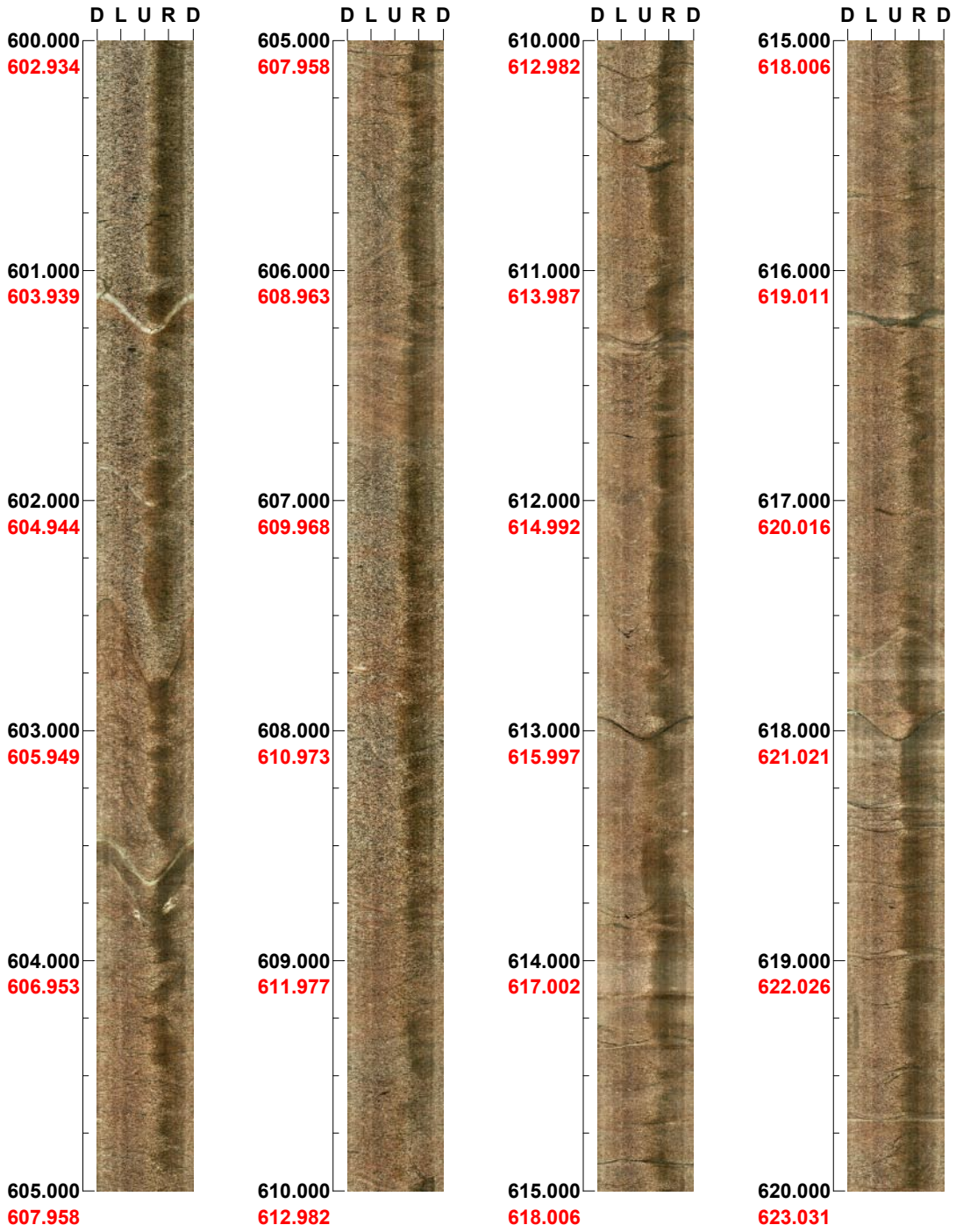
Depth range: 580.000 - 600.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

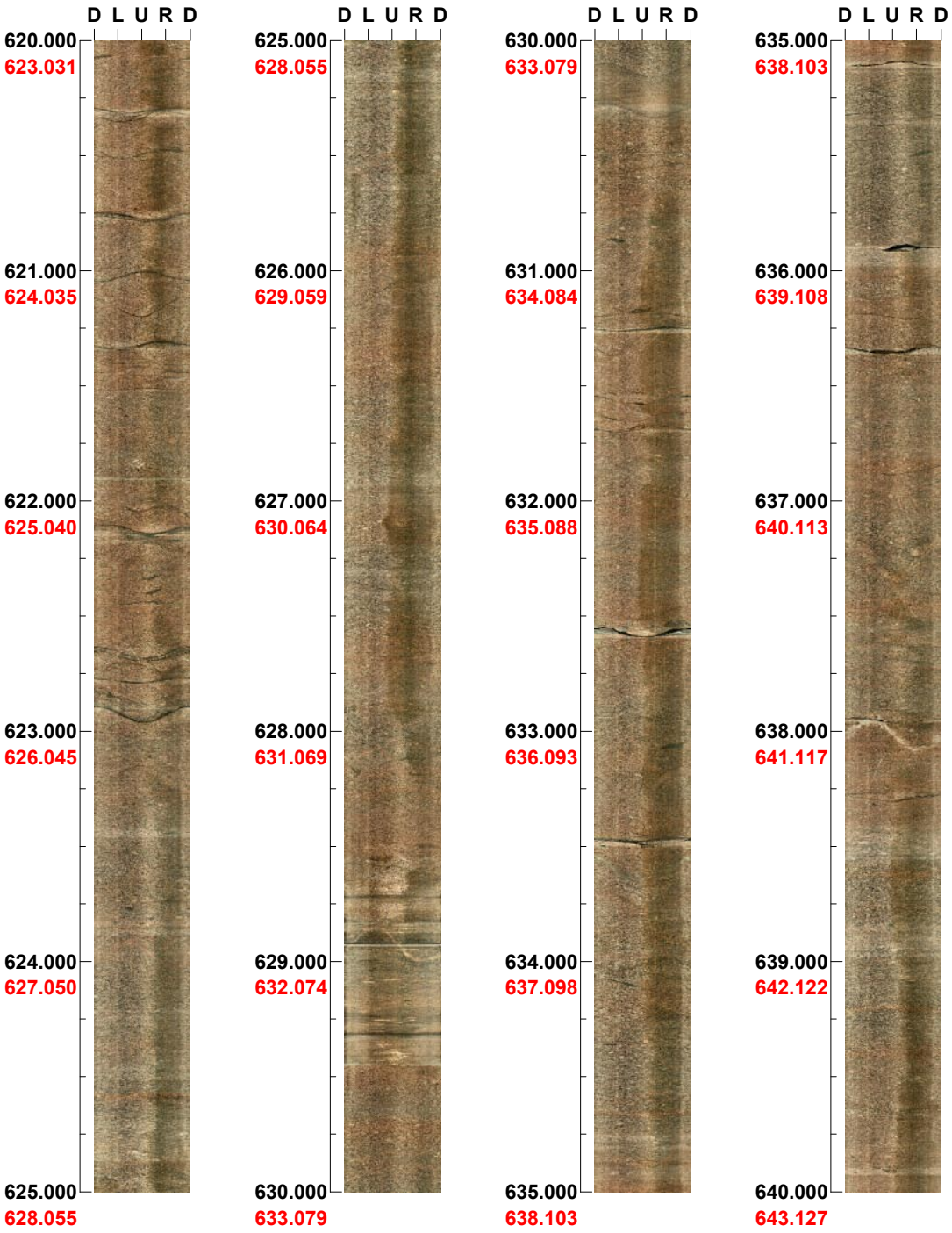
Depth range: 600.000 - 620.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 620.000 - 640.000 m



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

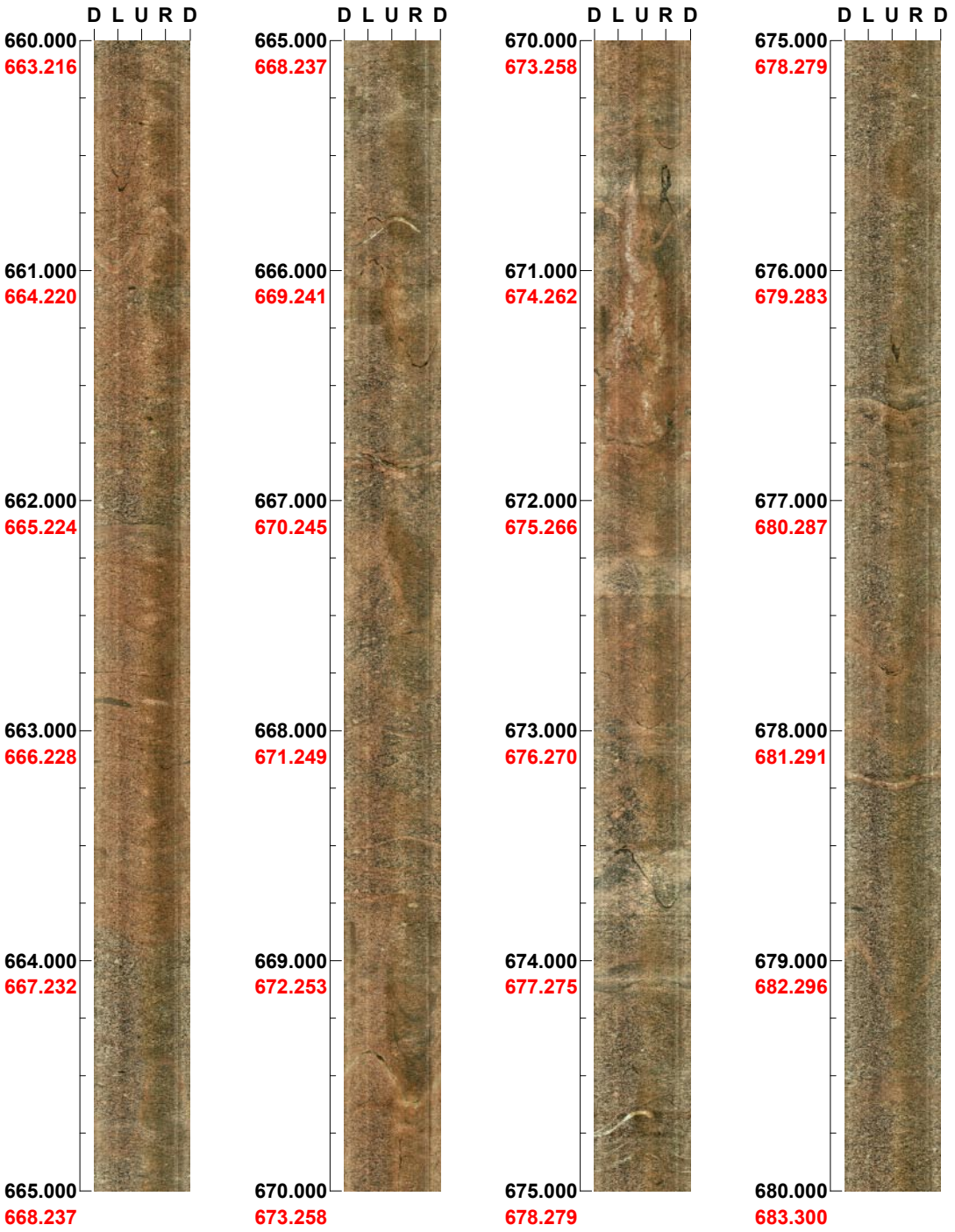
Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 640.000 - 660.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 660.000 - 680.000 m



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

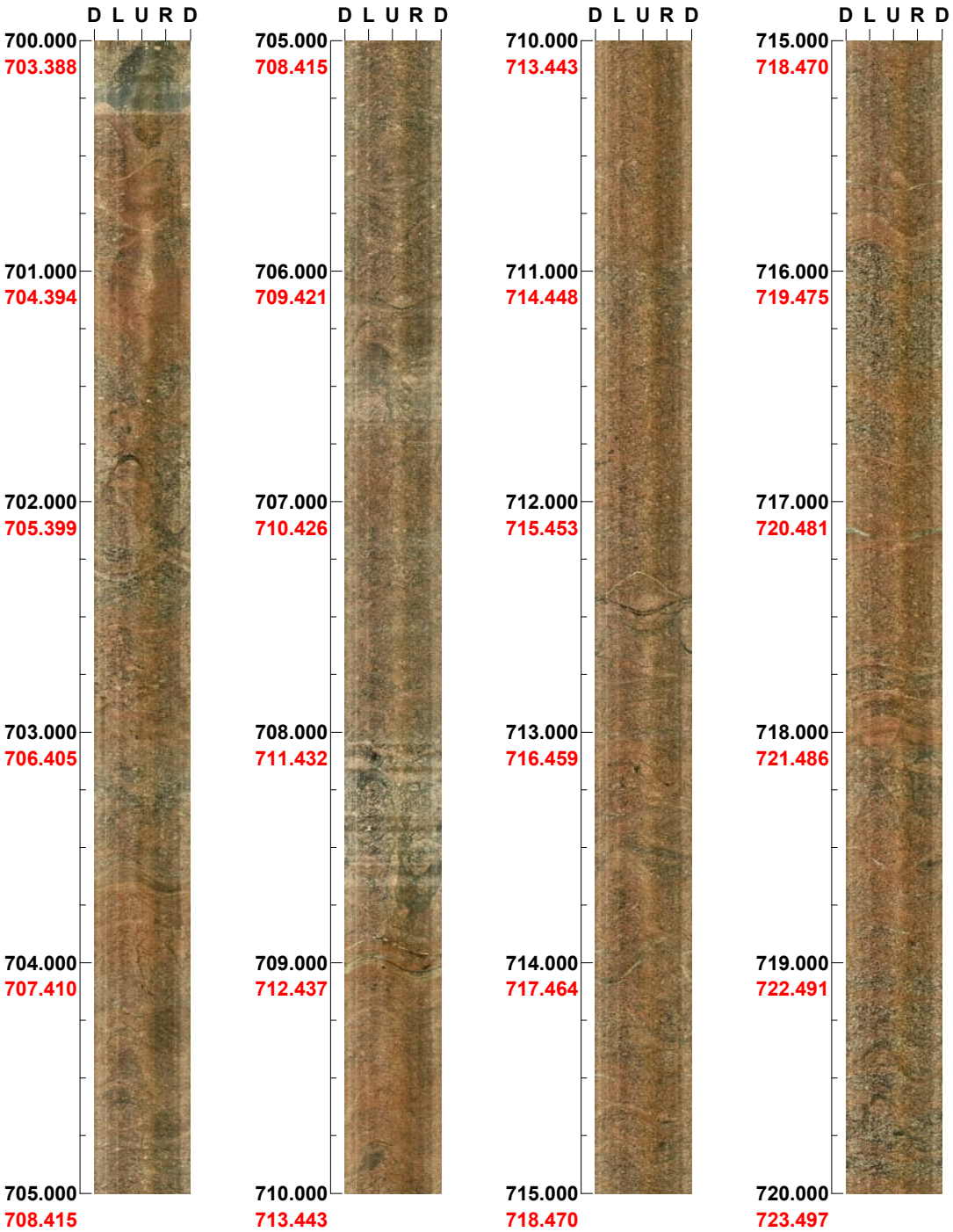
Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 680.000 - 700.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 700.000 - 720.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 720.000 - 740.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 740.000 - 760.000 m

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

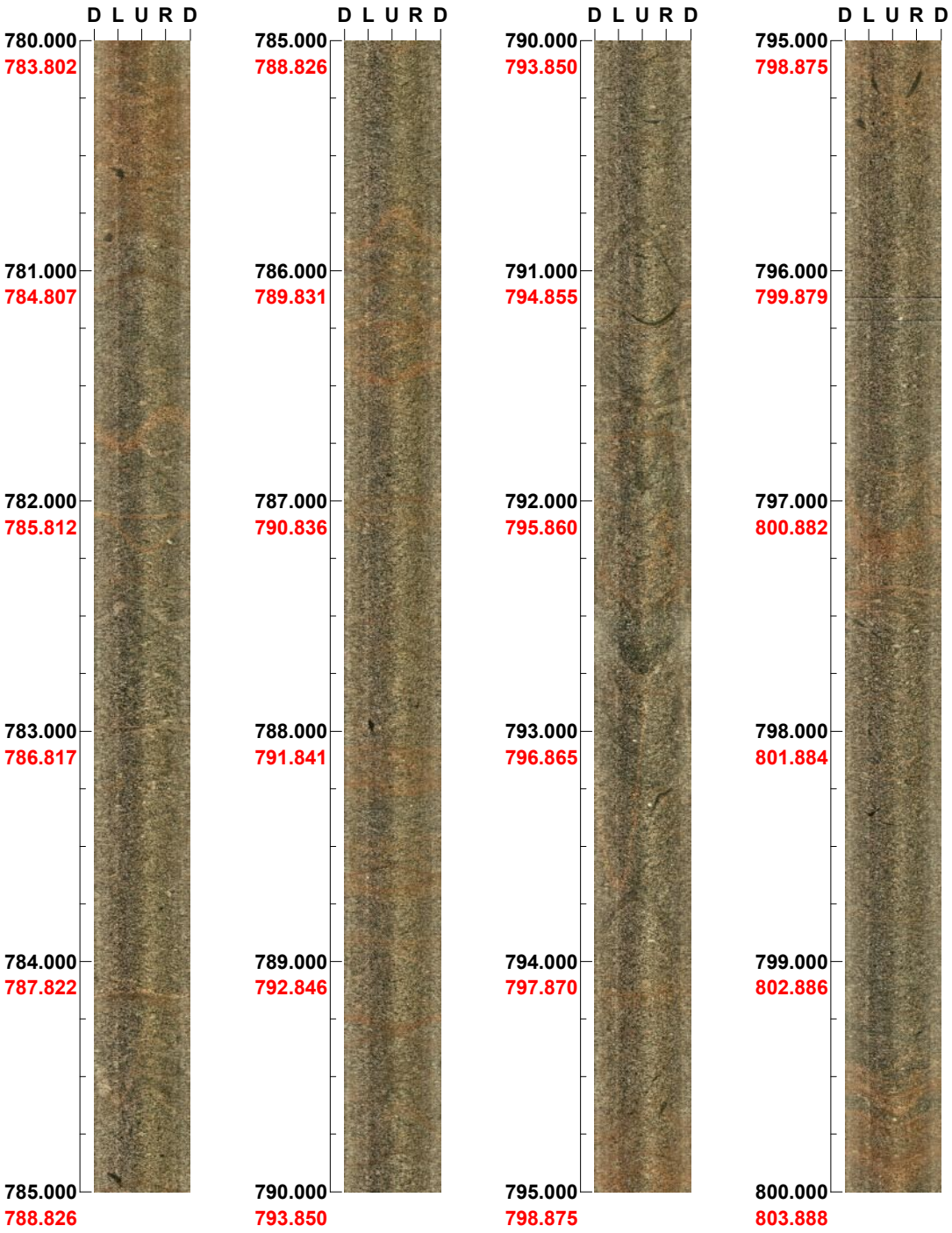
Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 760.000 - 780.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 780.000 - 800.000 m



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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 800.000 - 820.000 m

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

Project name: Laxemar
Bore hole No.: KLX07A **Azimuth: 174** **Inclination: -60**

Depth range: 820.000 - 831.698 m

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

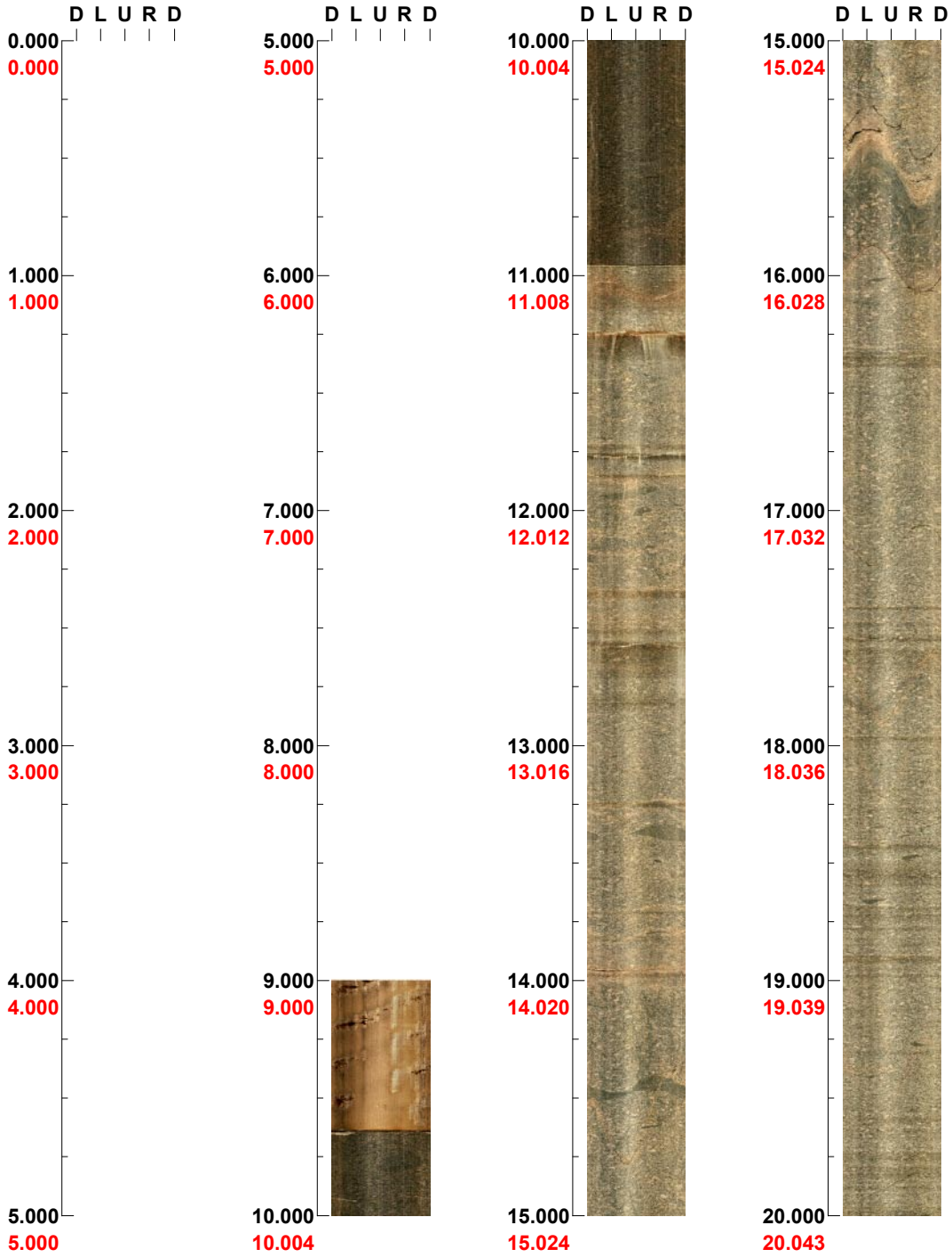
BIPS logging in KLX07B, 9 to 199 m

Project name: Laxemar

Image file	**: c:\work\r5446s~1\klx07b\bips\klx07b.bip**
BDT file	**: c:\work\r5446s~1\klx07b\bips\klx07b.bdt**
Locality	**: LAXEMAR**
Bore hole number	**: KLX07B**
Date	**: 05/07/07**
Time	**: 08:01:00**
Depth range	**: 9.000 - 199.320 m**
Azimuth	**: 174**
Inclination	**: -85**
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	**: 10**
Color	**:**  **+0 +0 +0**

Project name: Laxemar
Bore hole No.: KLX07B **Azimuth: 174** **Inclination: -85**

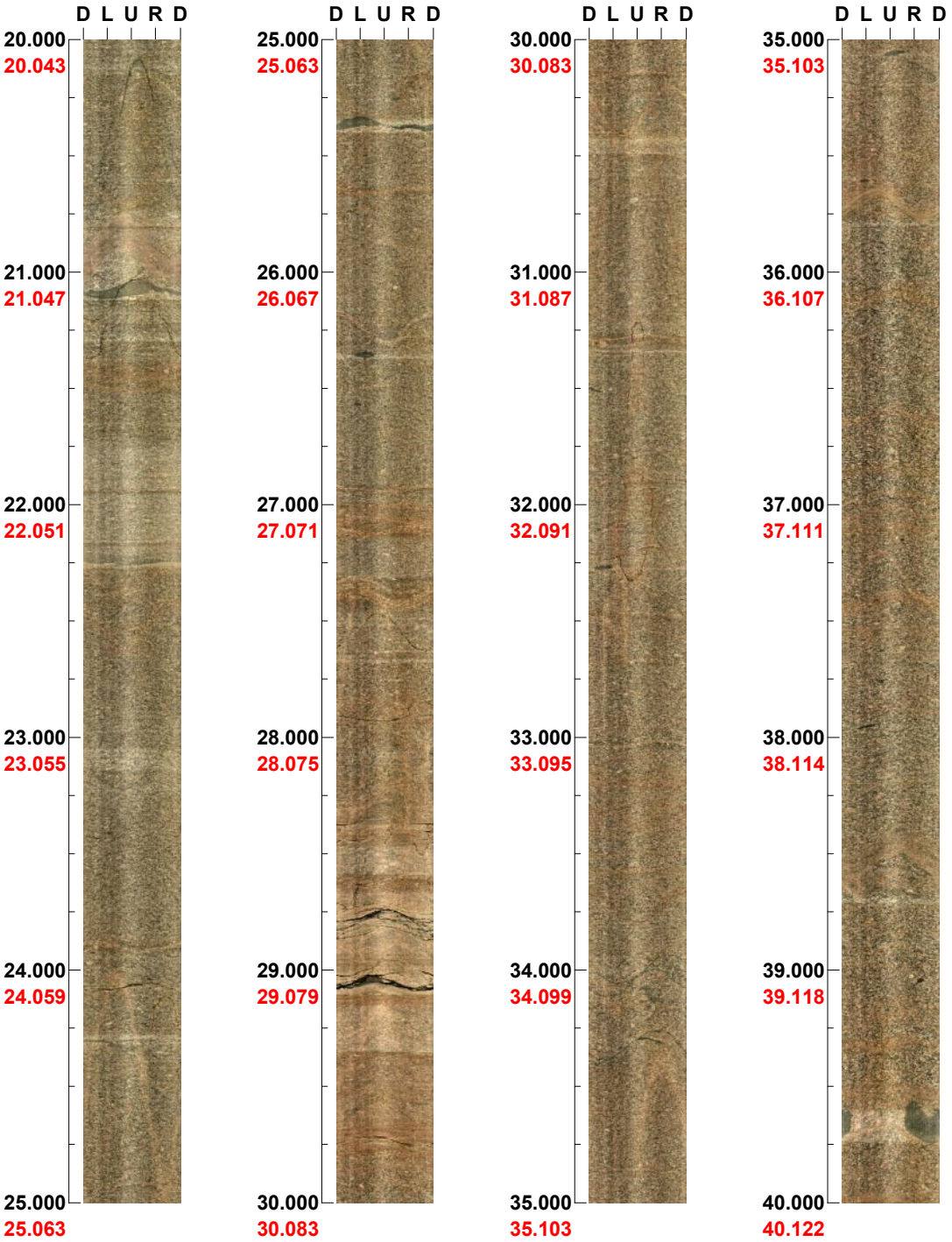
Depth range: 0.000 - 20.000 m



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

Project name: Laxemar
Bore hole No.: KLX07B **Azimuth: 174** **Inclination: -85**

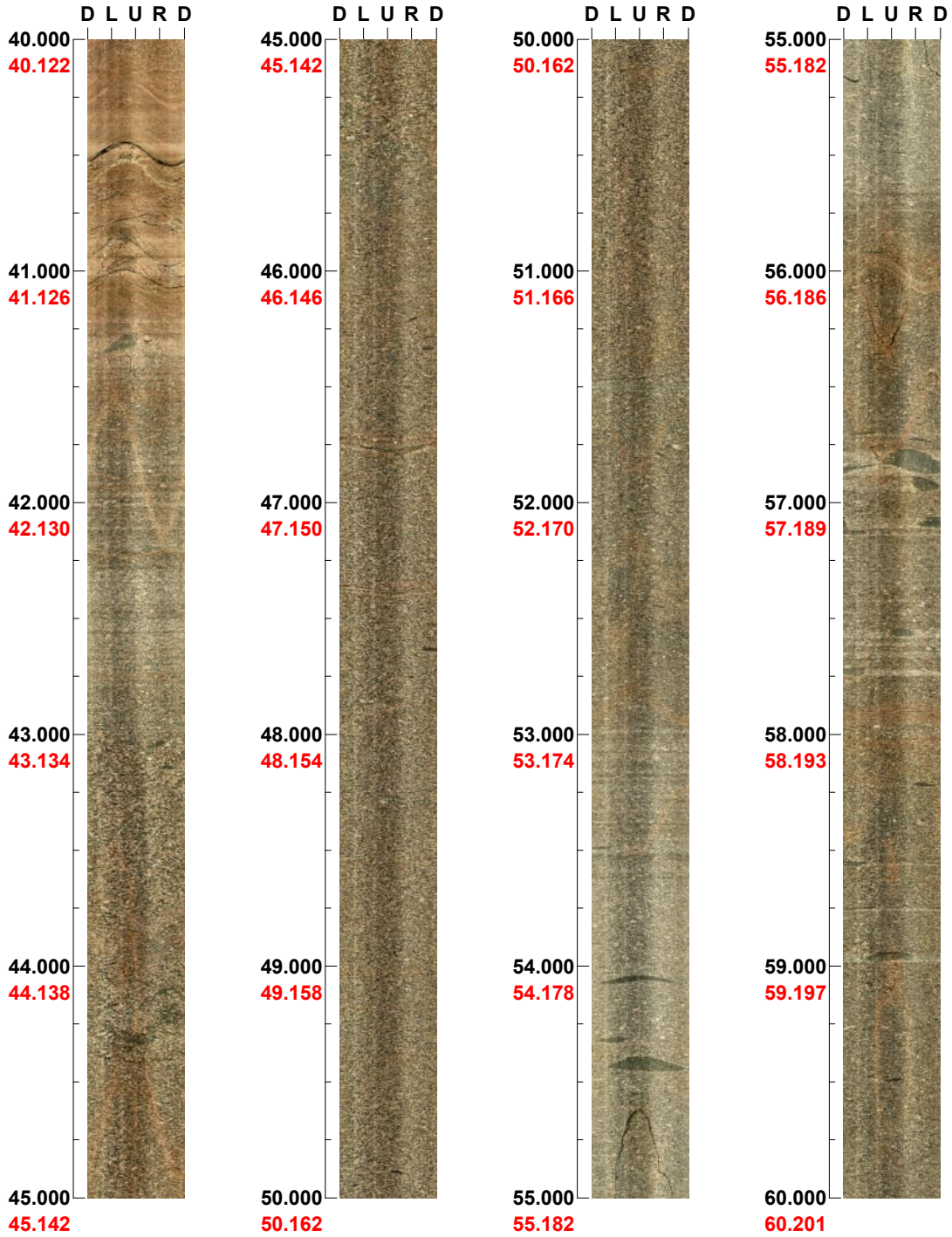
Depth range: 20.000 - 40.000 m



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

Project name: Laxemar
Bore hole No.: KLX07B **Azimuth: 174** **Inclination: -85**

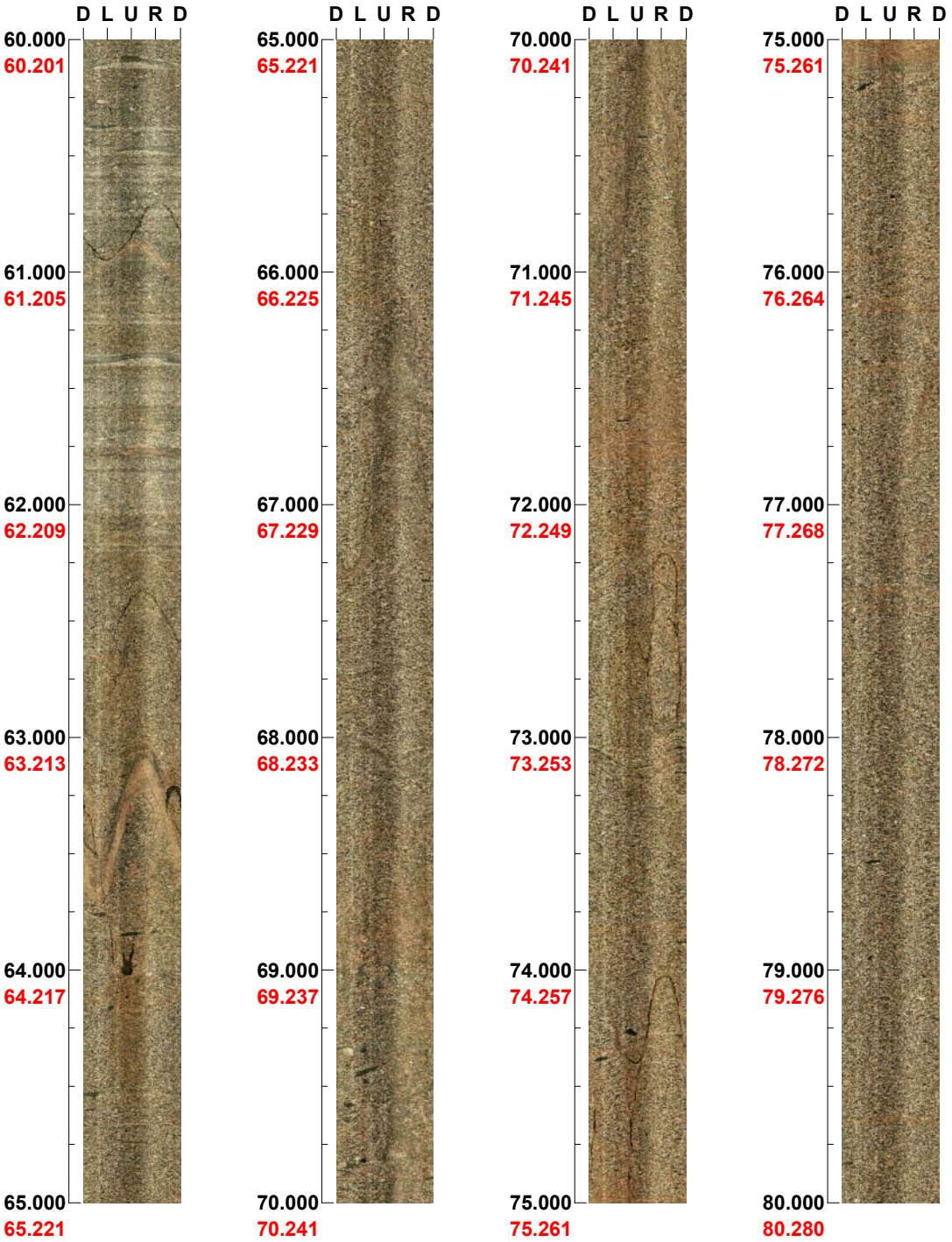
Depth range: 40.000 - 60.000 m



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

Project name: Laxemar
Bore hole No.: KLX07B **Azimuth: 174** **Inclination: -85**

Depth range: 60.000 - 80.000 m



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

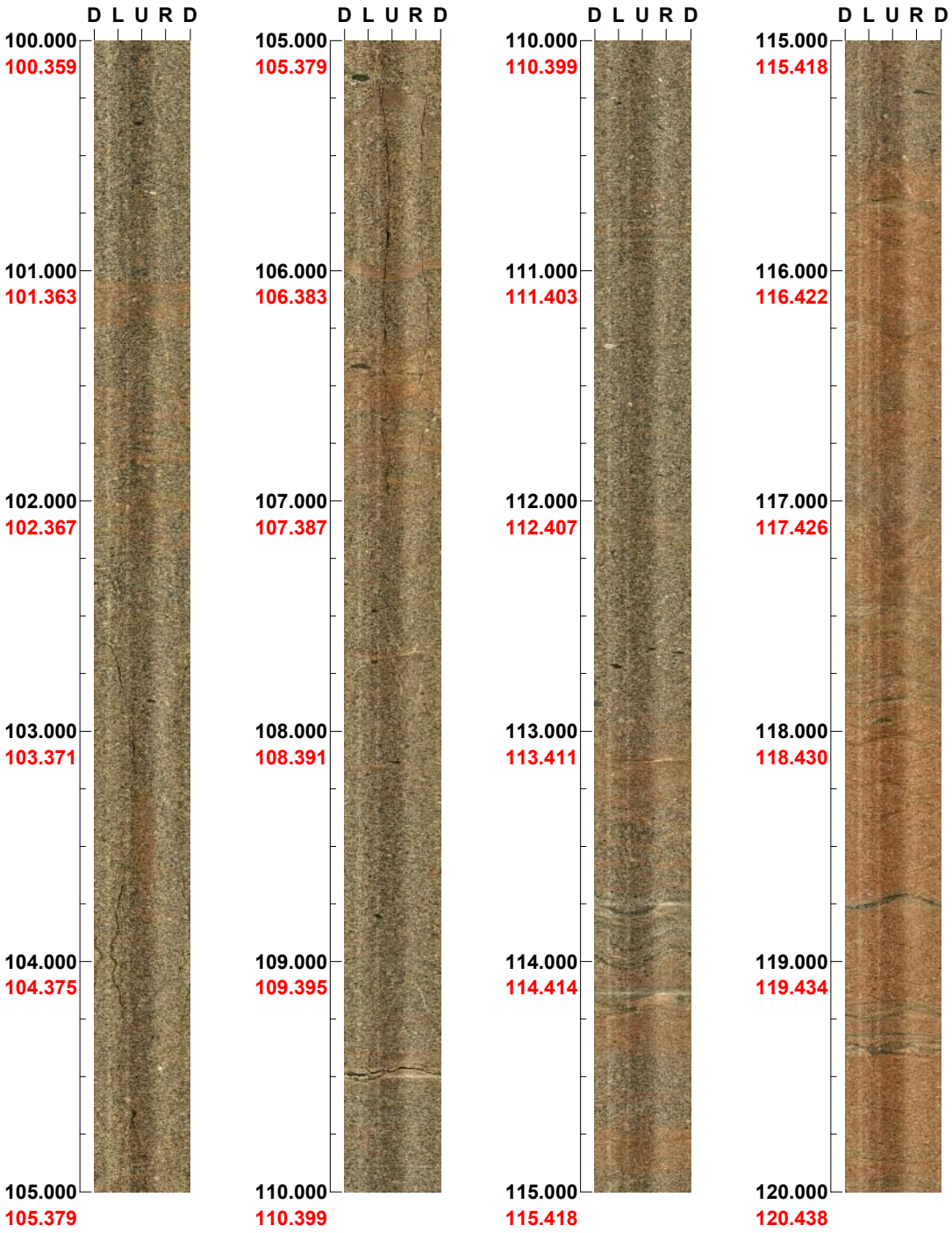
Project name: Laxemar
Bore hole No.: KLX07B **Azimuth: 174** **Inclination: -85**

Depth range: 80.000 - 100.000 m

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

Project name: Laxemar
Bore hole No.: KLX07B **Azimuth: 174** **Inclination: -85**

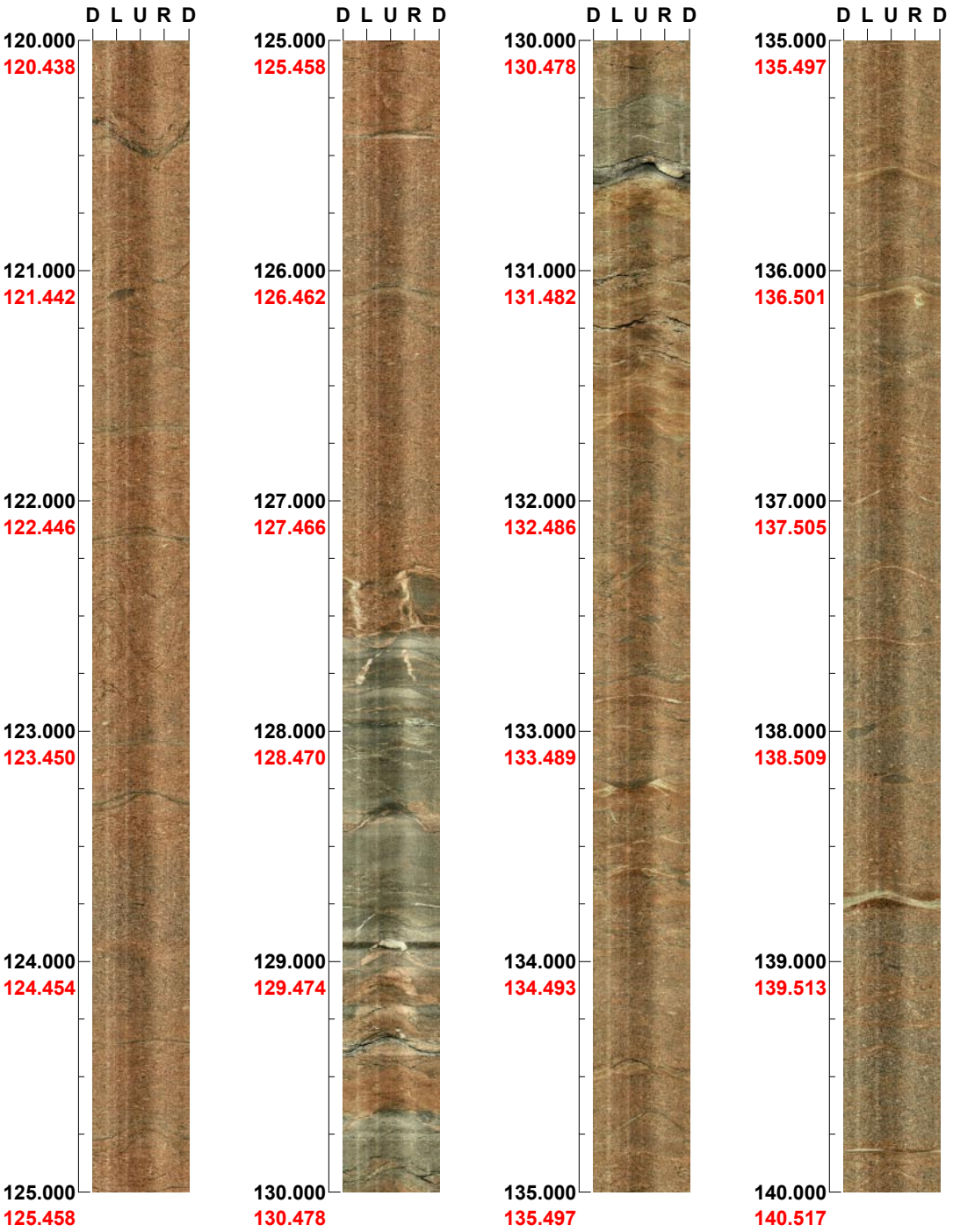
Depth range: 100.000 - 120.000 m



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

Project name: Laxemar
Bore hole No.: KLX07B **Azimuth: 174** **Inclination: -85**

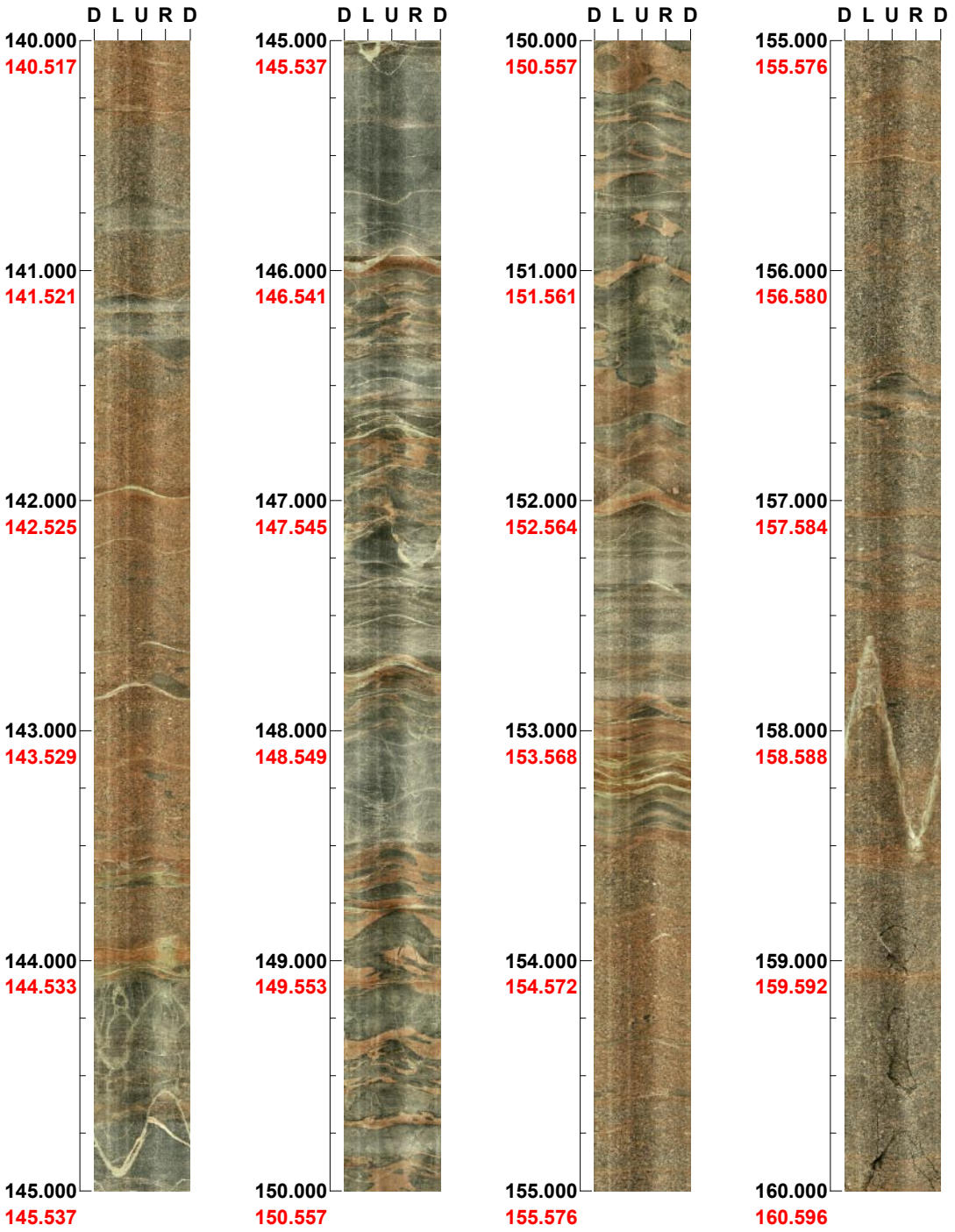
Depth range: 120.000 - 140.000 m



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

Project name: Laxemar
Bore hole No.: KLX07B **Azimuth: 174** **Inclination: -85**

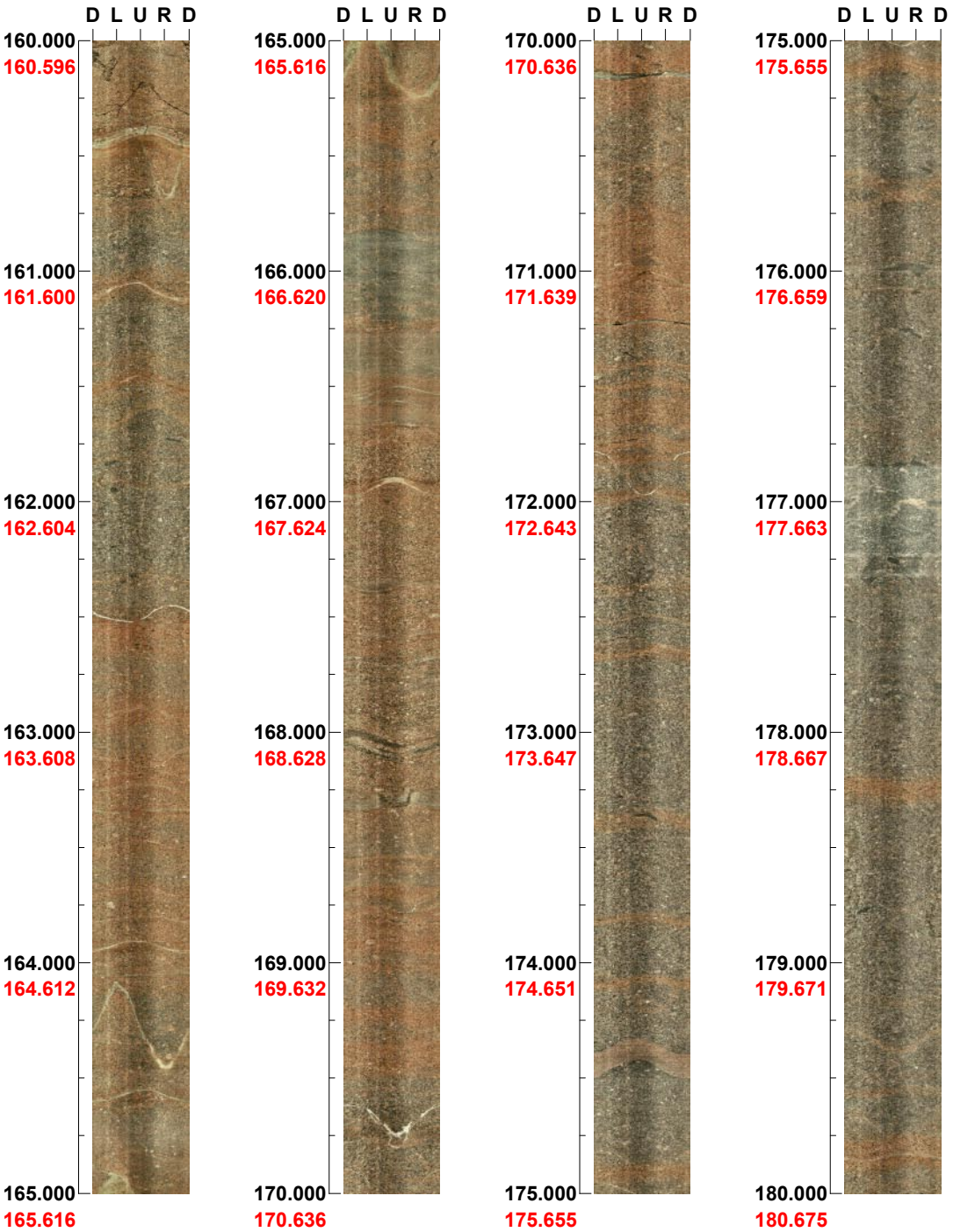
Depth range: 140.000 - 160.000 m



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

Project name: Laxemar
Bore hole No.: KLX07B **Azimuth: 174** **Inclination: -85**

Depth range: 160.000 - 180.000 m



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

Project name: Laxemar
Bore hole No.: KLX07B **Azimuth: 174** **Inclination: -85**

Depth range: 180.000 - 199.320 m

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

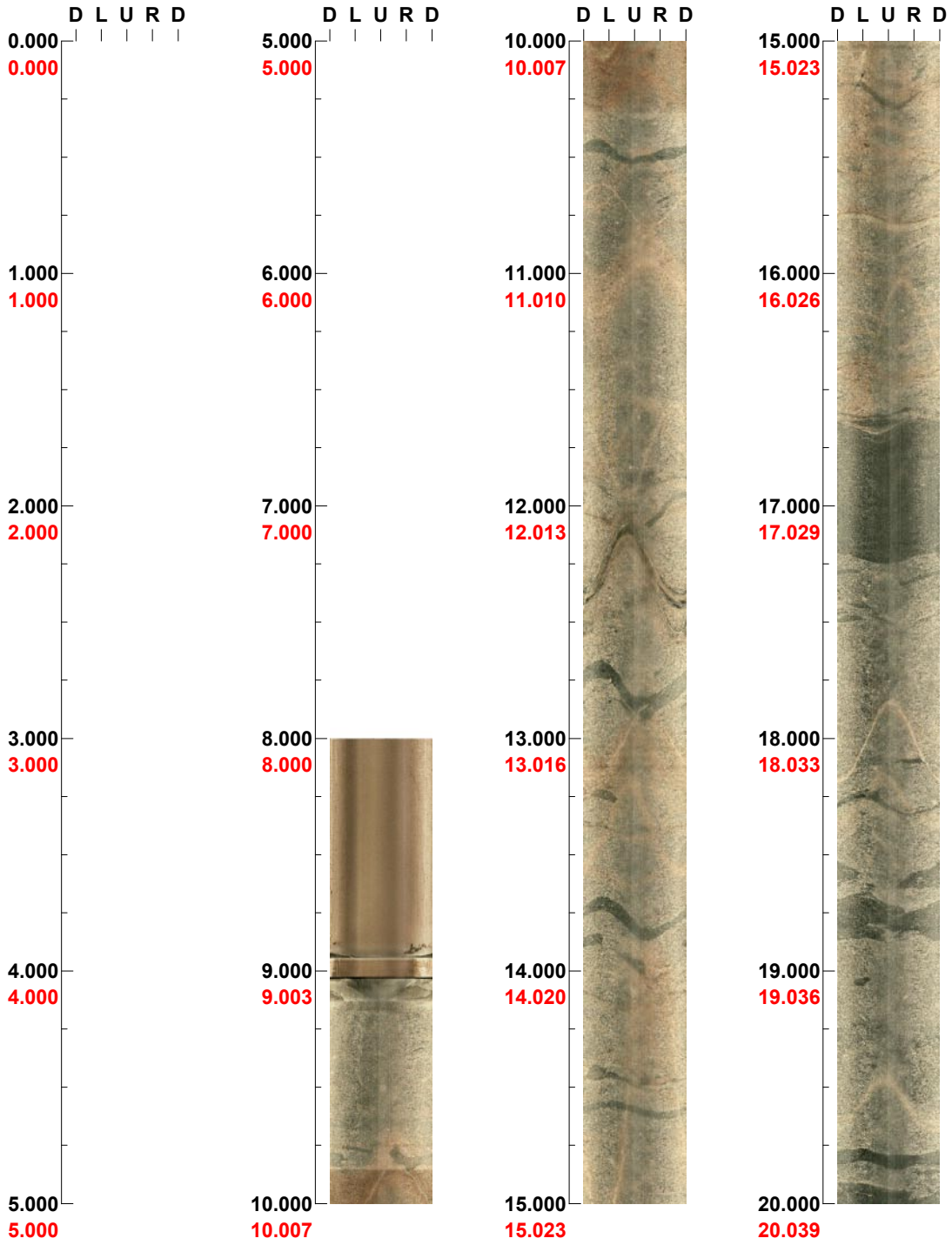
BIPS logging in HLX34, 8 to 132 m

Project name: Laxemar

Image file	**: c:\work\r5446s~1\hlx34\bips\hlx34a.bip**
BDT file	**: c:\work\r5446s~1\hlx34\bips\hlx34a.bdt**
Locality	**: LAXEMAR**
Bore hole number	**: HLX34**
Date	**: 05/07/20**
Time	**: 16:42:00**
Depth range	**: 8.000 - 150.470 m**
Azimuth	**: 101**
Inclination	**: -60**
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	**: 7**
Color	**: +0 +0 +0**

Project name: Laxemar
Bore hole No.: HLX34 **Azimuth: 101** **Inclination: -60**

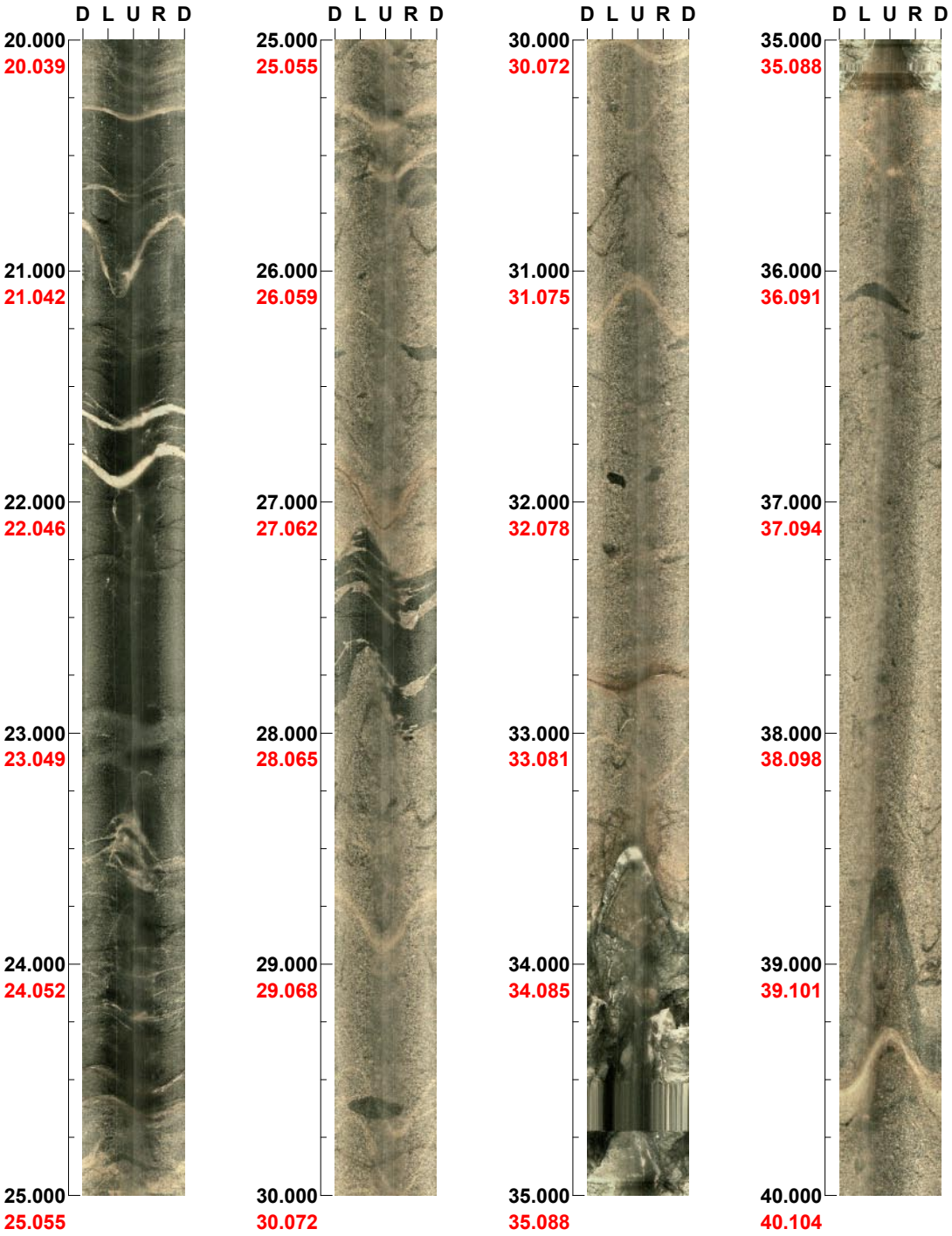
Depth range: 0.000 - 20.000 m



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

Project name: Laxemar
Bore hole No.: HLX34 **Azimuth: 101** **Inclination: -60**

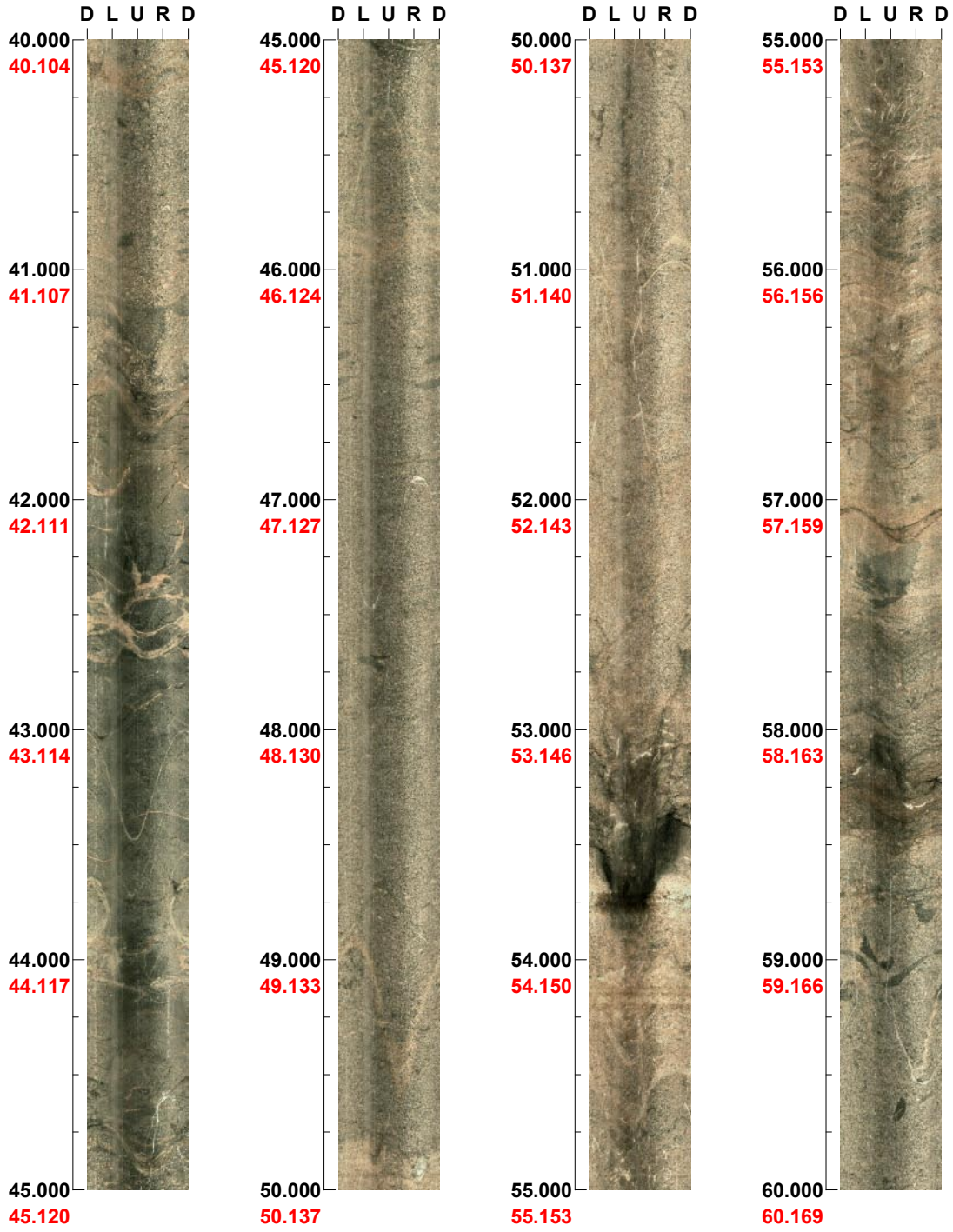
Depth range: 20.000 - 40.000 m



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

Project name: Laxemar
Bore hole No.: HLX34 **Azimuth: 101** **Inclination: -60**

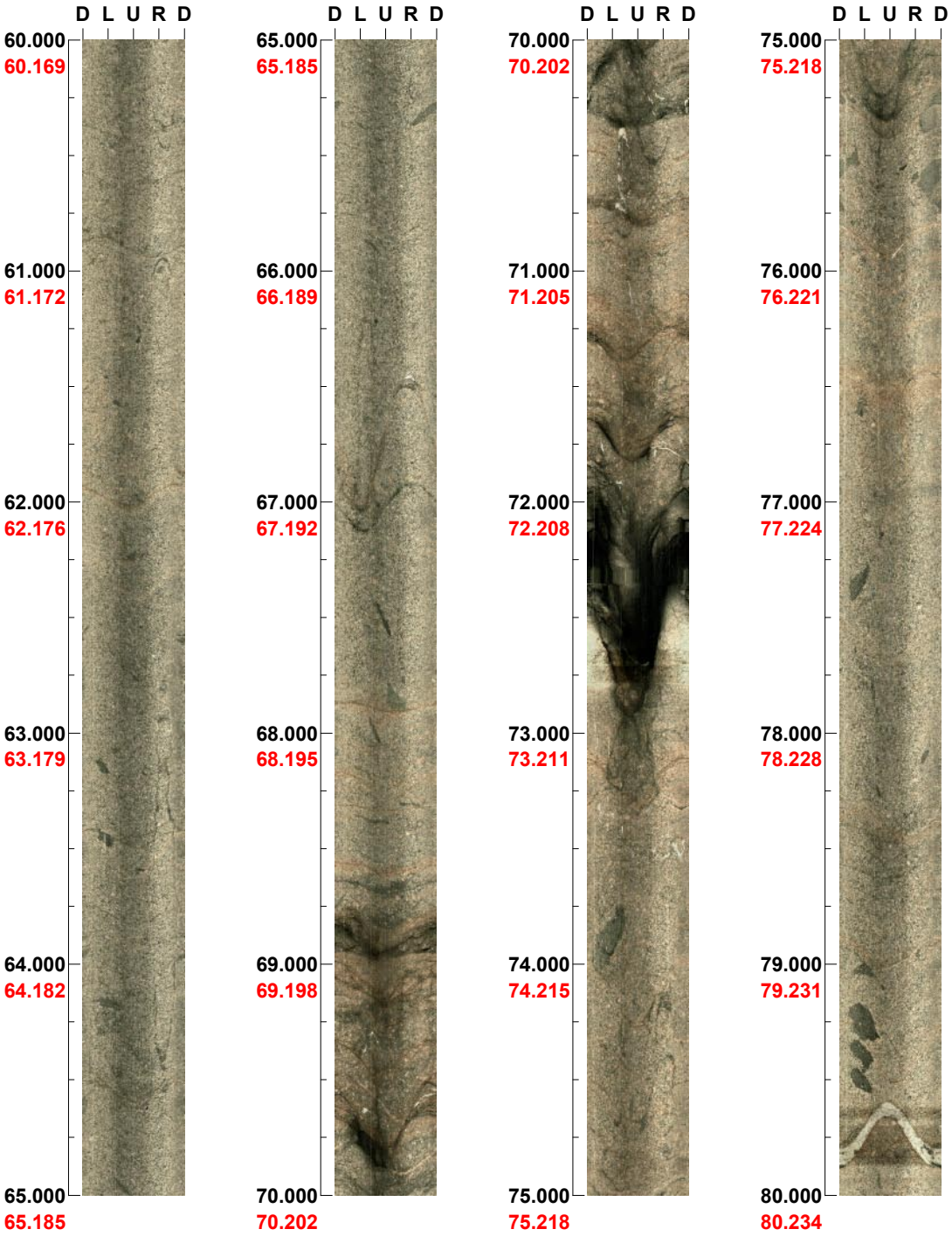
Depth range: 40.000 - 60.000 m



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

Project name: Laxemar
Bore hole No.: HLX34 **Azimuth: 101** **Inclination: -60**

Depth range: 60.000 - 80.000 m



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

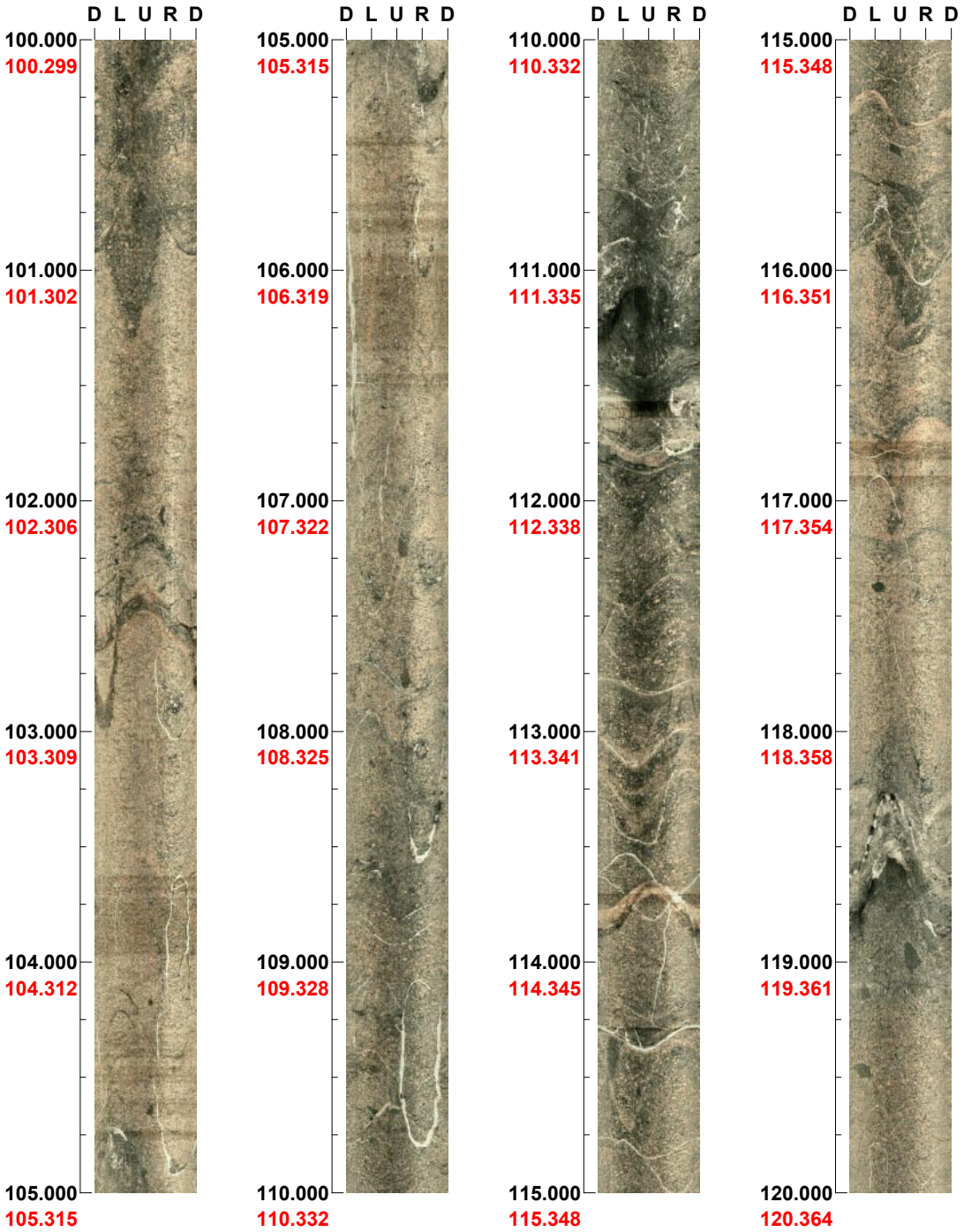
Project name: Laxemar
Bore hole No.: HLX34 **Azimuth: 101** **Inclination: -60**

Depth range: 80.000 - 100.000 m

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

Project name: Laxemar
Bore hole No.: HLX34 **Azimuth: 101** **Inclination: -60**

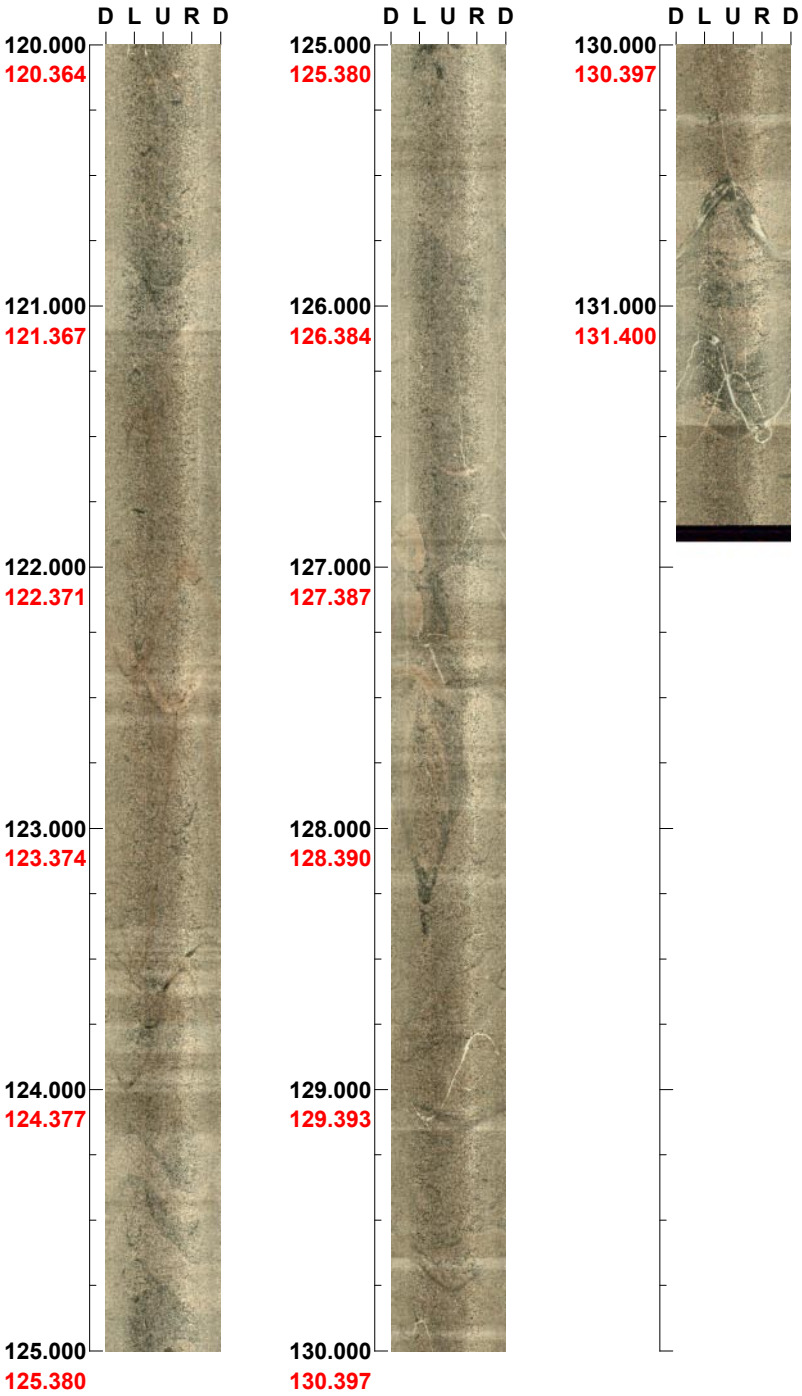
Depth range: 100.000 - 120.000 m



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

Project name: Laxemar
Bore hole No.: HLX34 **Azimuth: 101** **Inclination: -60**

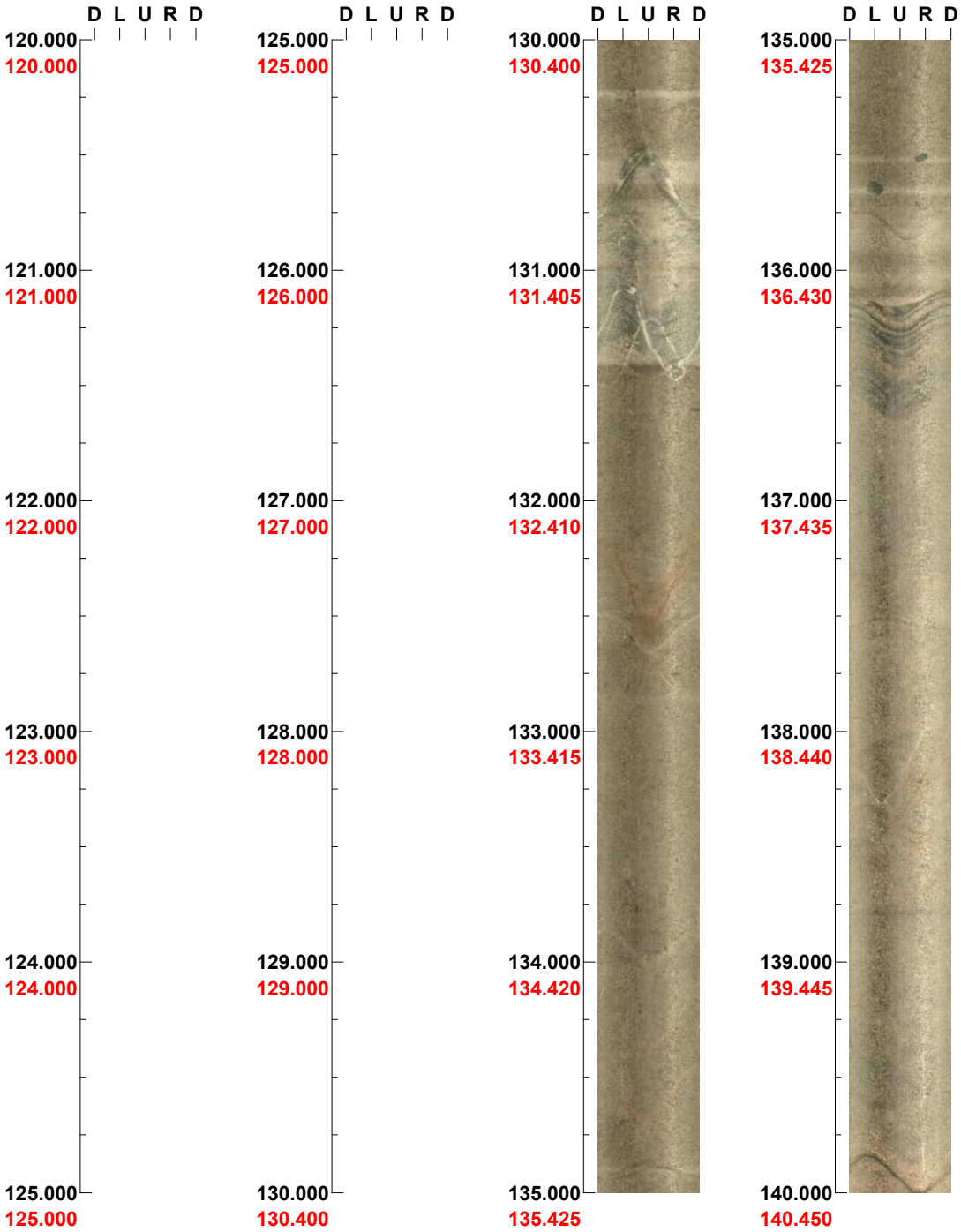
Depth range: 120.000 - 131.901 m



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

Project name: Laxemar
Bore hole No.: HLX34 **Azimuth: 101** **Inclination: -60**

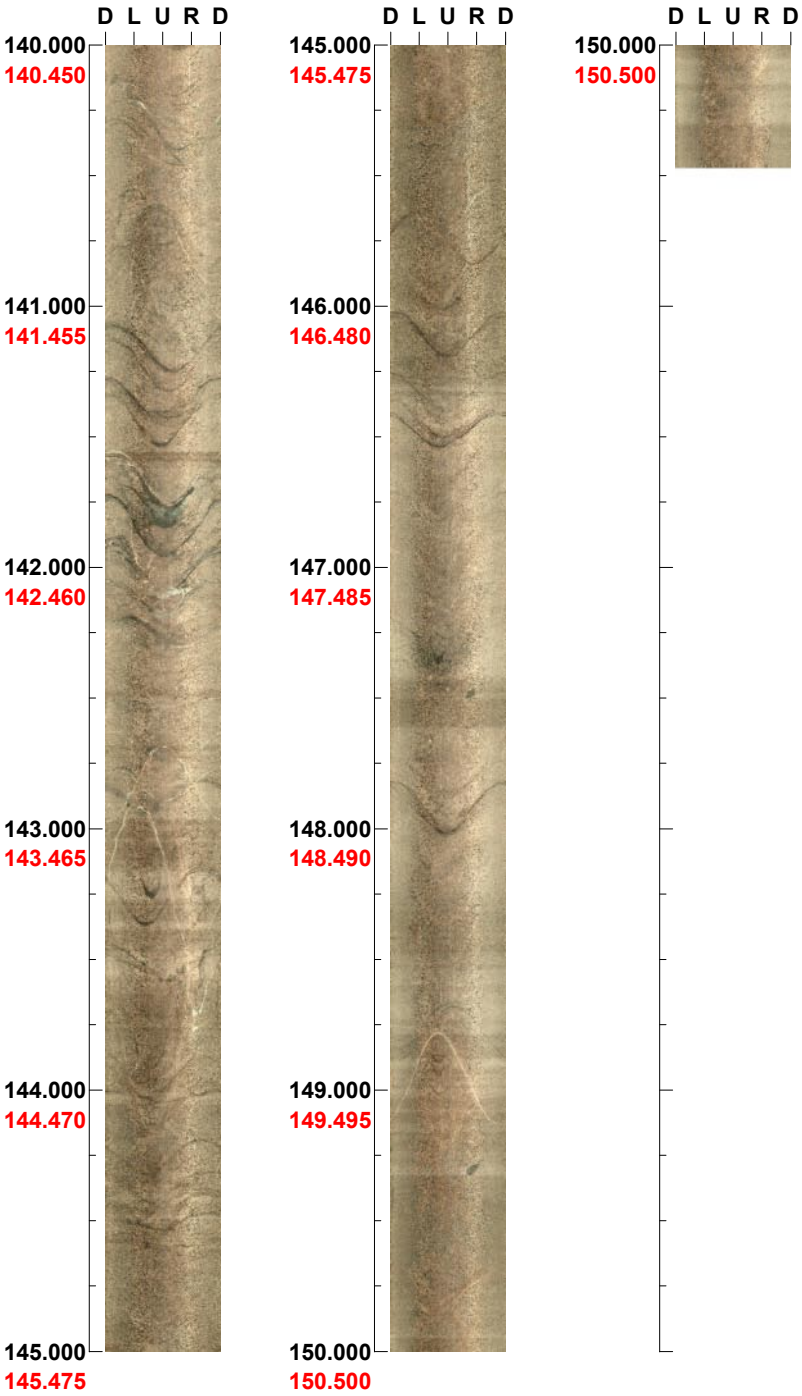
Depth range: 120.000 - 140.000 m



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

Project name: Laxemar
Bore hole No.: HLX34 **Azimuth: 101** **Inclination: -60**

Depth range: 140.000 - 150.470 m



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

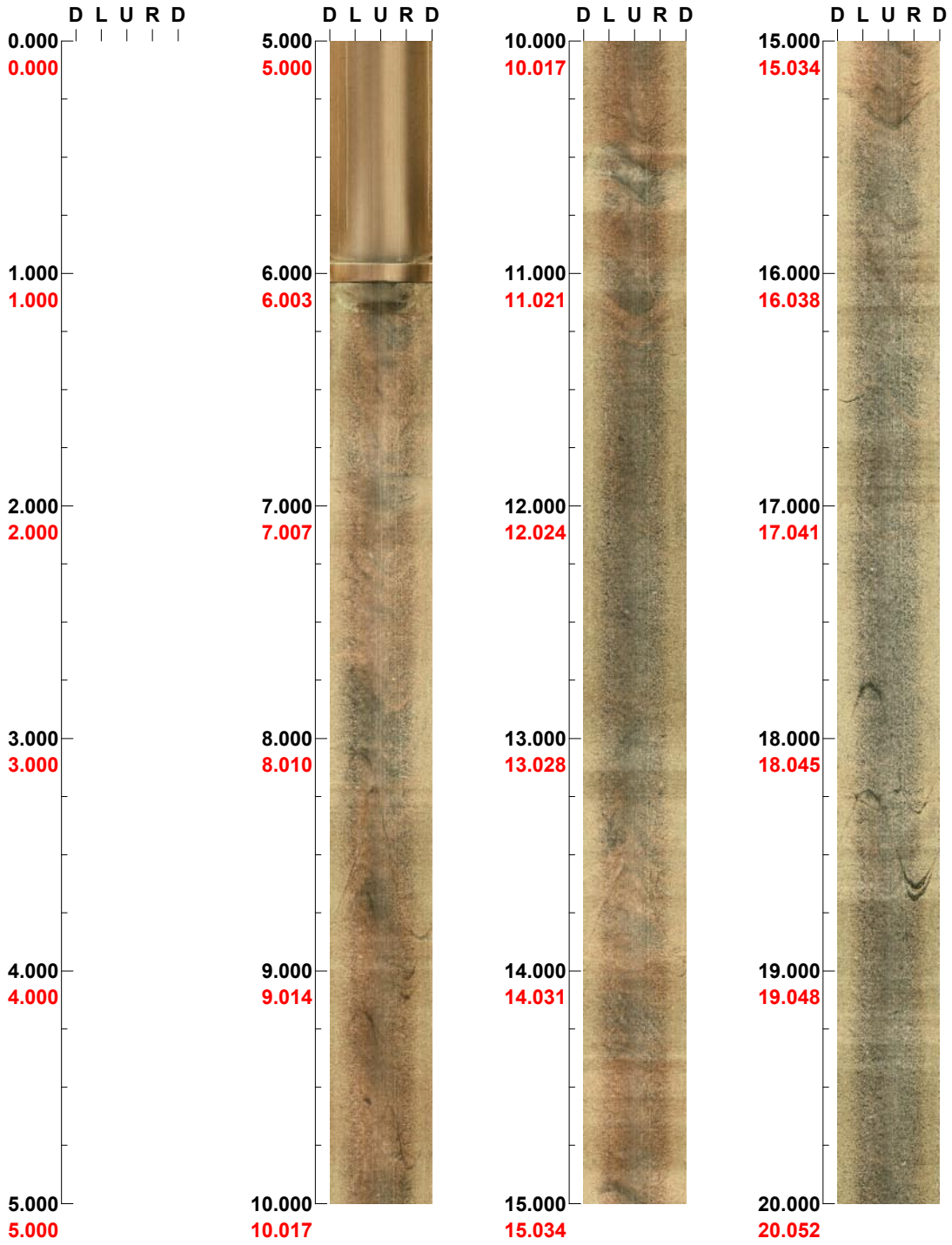
BIPS logging in HLX35, 5 to 150 m

Project name: Laxemar

Image file	: c:\work\r5446s~1\hlx35\bips\hlx35.bip
BDT file	: c:\work\r5446s~1\hlx35\bips\hlx35.bdt
Locality	: LAXEMAR
Bore hole number	: HLX35
Date	: 05/07/20
Time	: 08:44:00
Depth range	: 5.000 - 150.459 m
Azimuth	: 102
Inclination	: -60
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	: 8
Color	: +0 +0 +0

Project name: Laxemar
Bore hole No.: HLX35 **Azimuth: 102** **Inclination: -60**

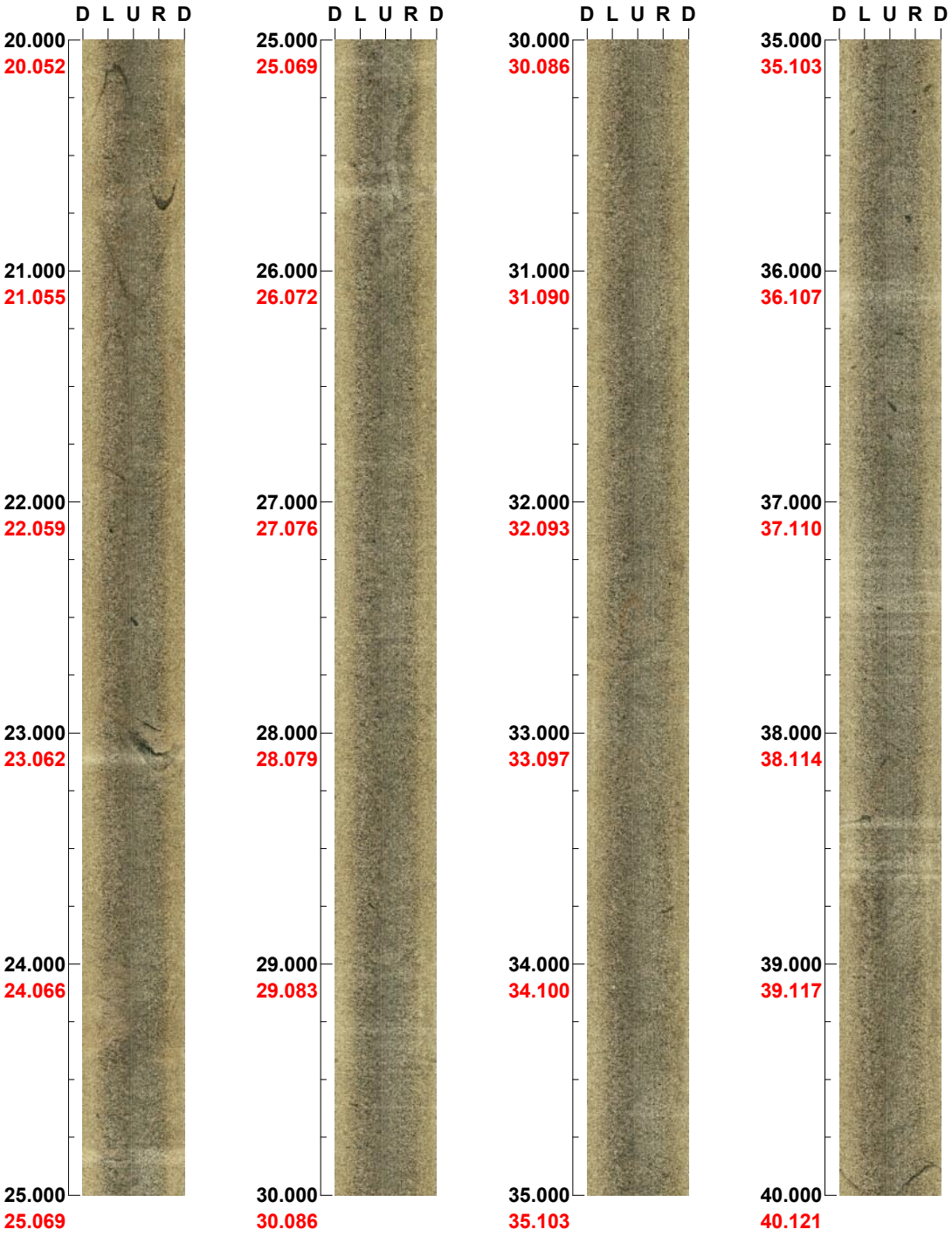
Depth range: 0.000 - 20.000 m



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

Project name: Laxemar
Bore hole No.: HLX35 **Azimuth: 102** **Inclination: -60**

Depth range: 20.000 - 40.000 m



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

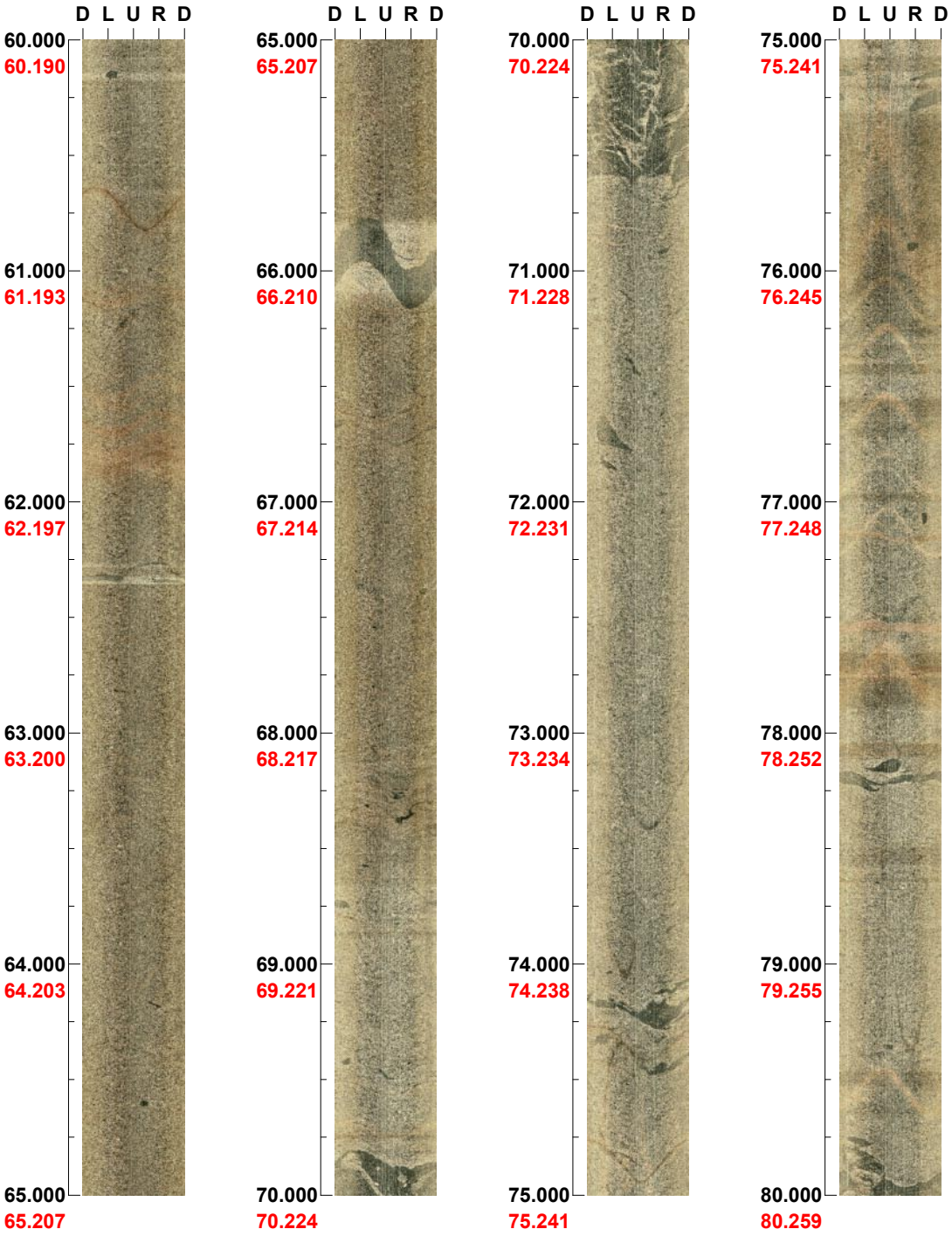
Project name: Laxemar
Bore hole No.: HLX35 **Azimuth: 102** **Inclination: -60**

Depth range: 40.000 - 60.000 m

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

Project name: Laxemar
Bore hole No.: HLX35 **Azimuth: 102** **Inclination: -60**

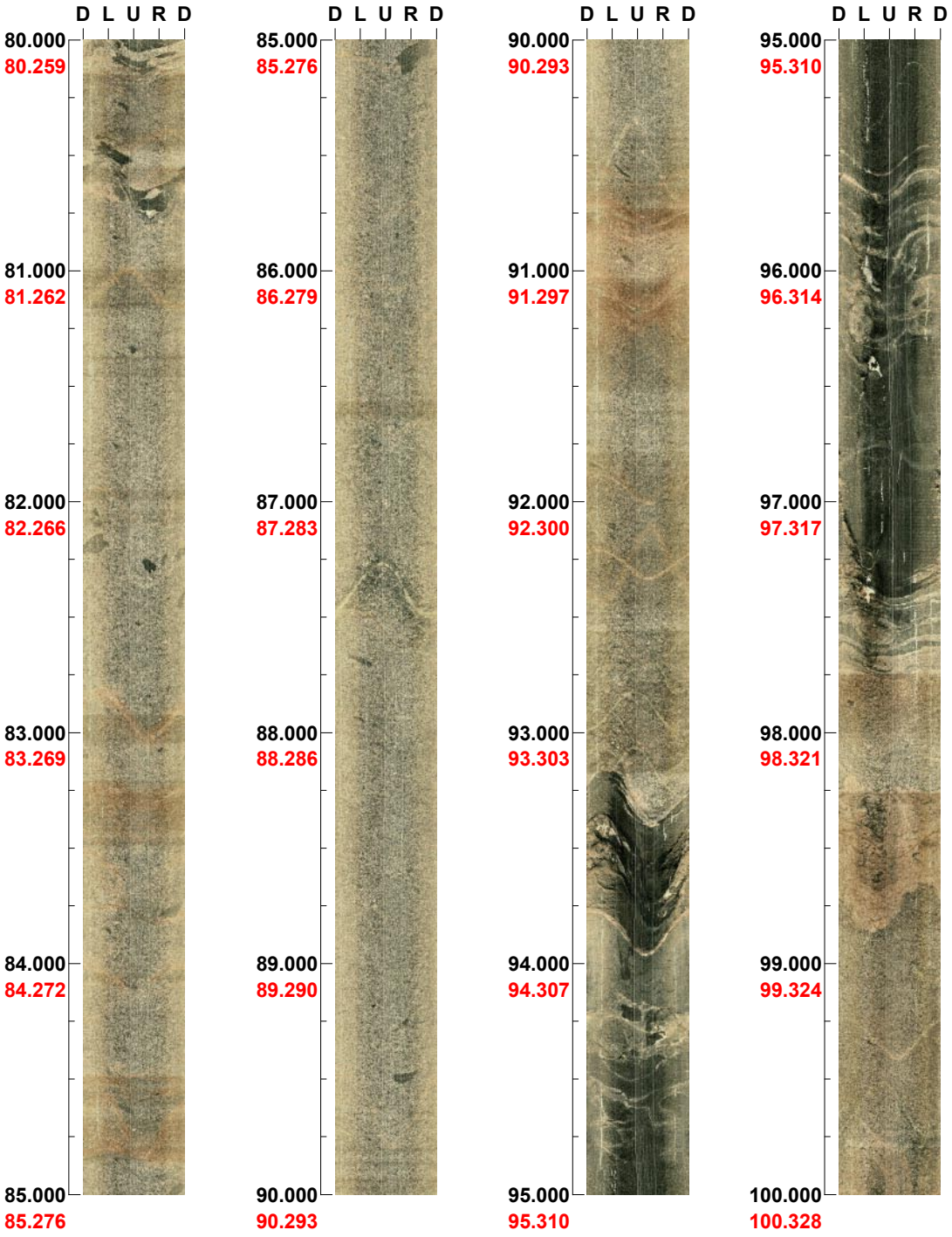
Depth range: 60.000 - 80.000 m



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

Project name: Laxemar
Bore hole No.: HLX35 **Azimuth: 102** **Inclination: -60**

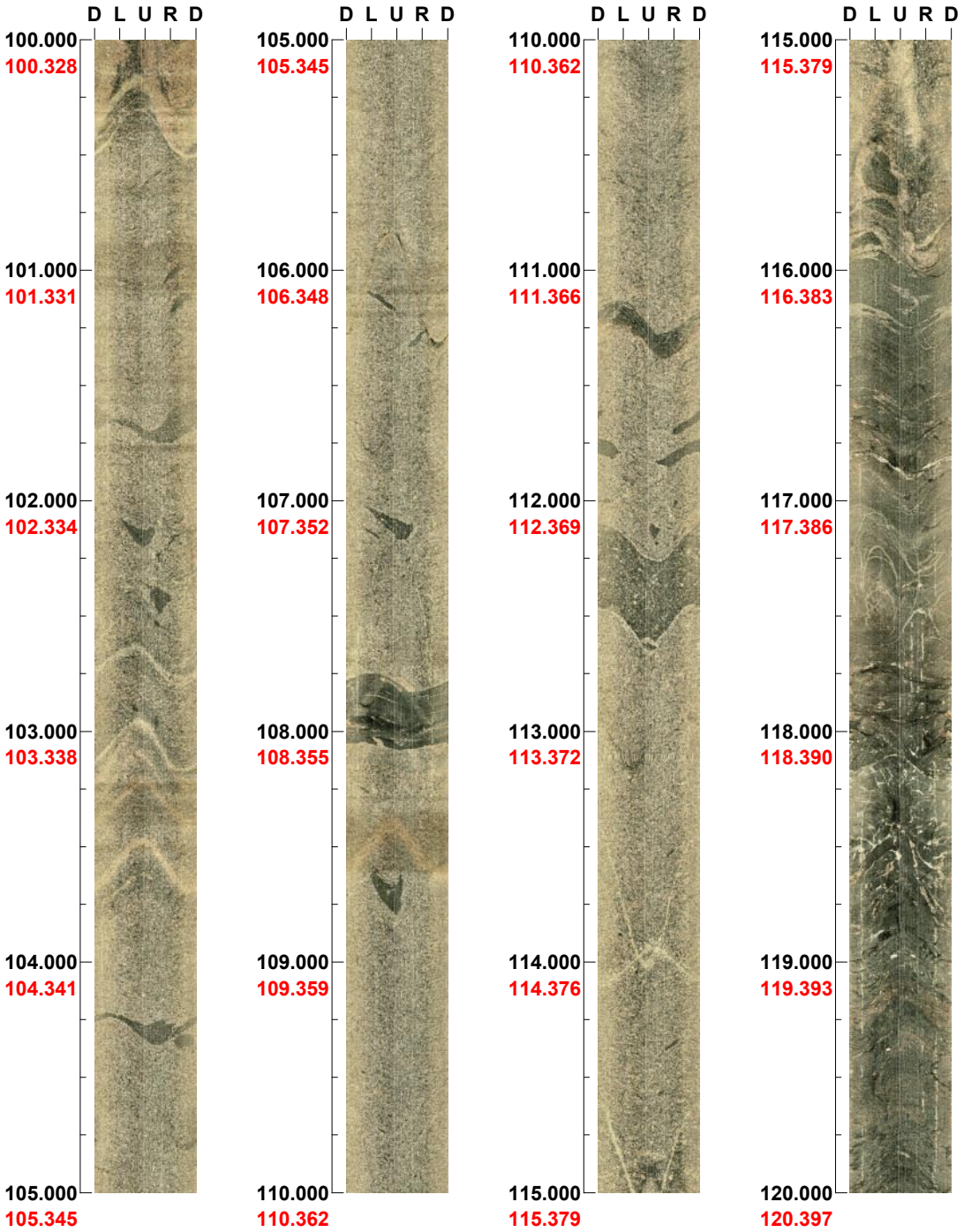
Depth range: 80.000 - 100.000 m



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

Project name: Laxemar
Bore hole No.: HLX35 **Azimuth: 102** **Inclination: -60**

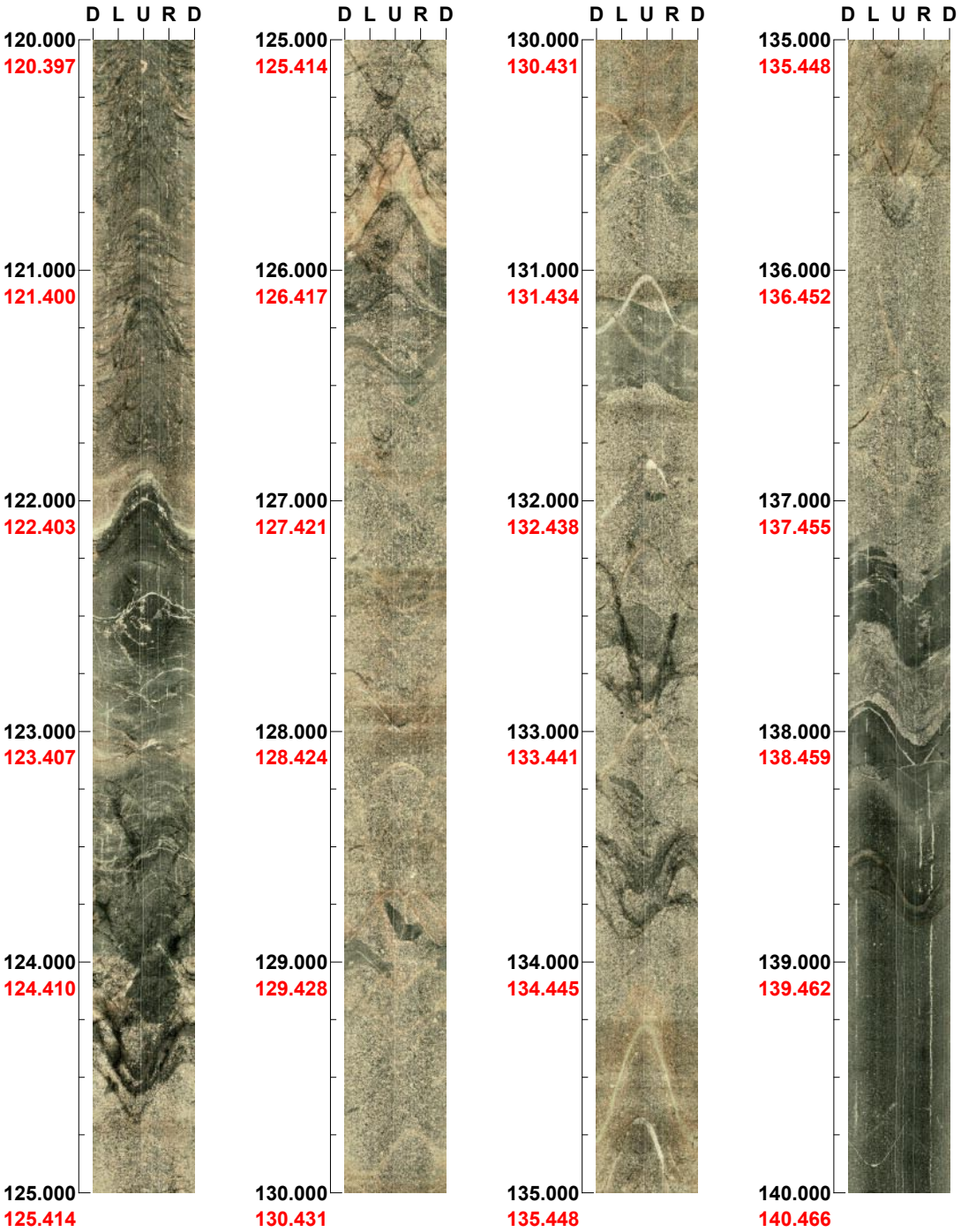
Depth range: 100.000 - 120.000 m



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

Project name: Laxemar
Bore hole No.: HLX35 **Azimuth: 102** **Inclination: -60**

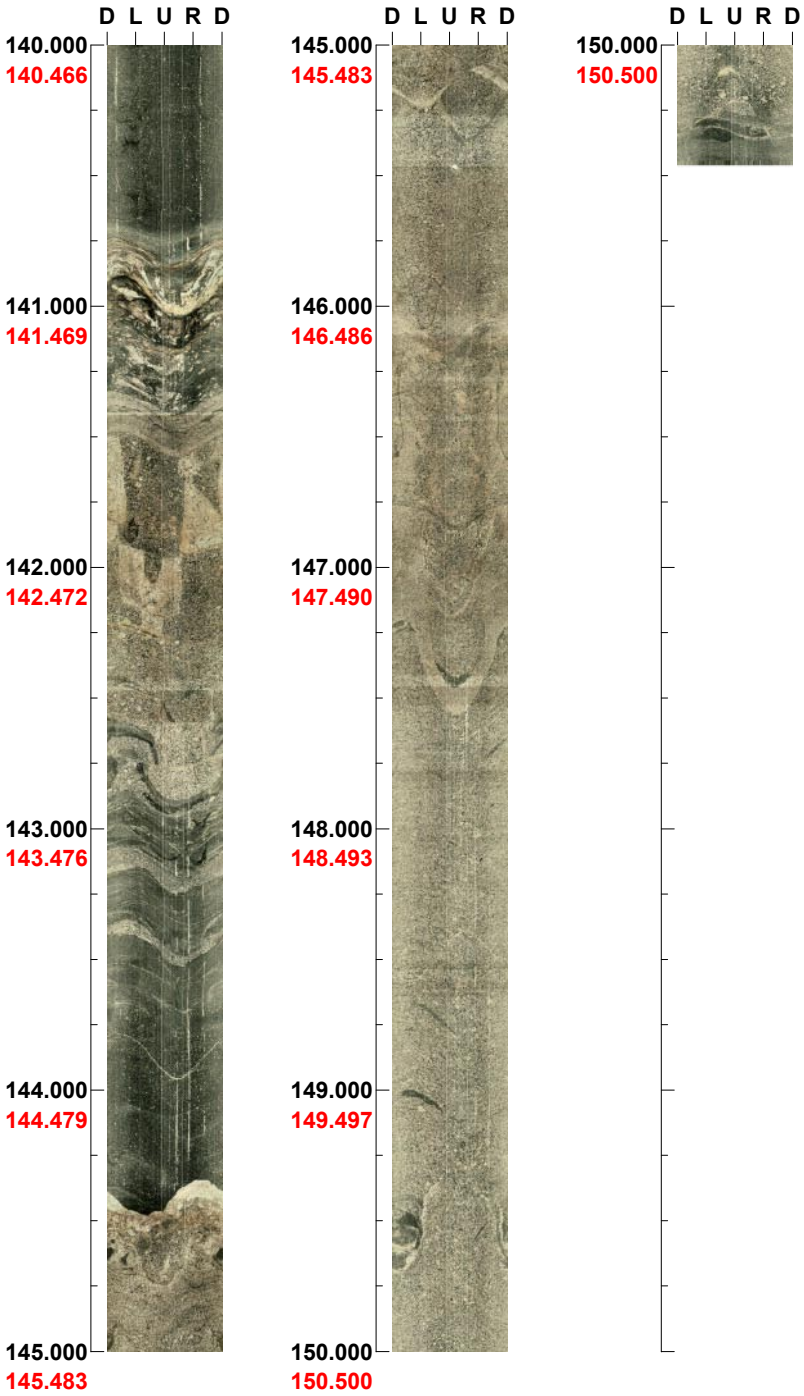
Depth range: 120.000 - 140.000 m



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

Project name: Laxemar
Bore hole No.: HLX35 **Azimuth: 102** **Inclination: -60**

Depth range: 140.000 - 150.459 m



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

Appendix 9

Deviation logging in KLX07B, 0 to 198 m

New MeasureIT files

Survey name:	**KLX07B in**
Survey date:	09/07/2005 12:18:04
Project:	PLU
Location:	Laxemar

Country:	Sweden
Survey company:	Mala GeoScience / RAYCON
Surveyed by:	Christer Gustafsson
Survey type:	STANDARD
Operating conditions:	
General comments:	
Client name:	SKB
Client ID number:	
Client reference:	Leif Stenberg
Drill company:	
Drill rig:	Core drilling
Drill diameter:	76
Survey direction:	INTO hole
Survey run on:	Wireline
Magnetic Var.:	2,33 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:	71.5	1.5	Degrees

SURVEY	Actual start	End of survey	Difference
Station:	0,0	198,0	198,0
East:	1549206,76	1549208,54	1,78
North:	6366753,14	6366735,95	-17,19
Elevation:	18,38	-178,86	-197,24
Dip:	-85,23	-84,78	0,45
Azimuth:	174,33	175,85	1,52

OFFSETS at end
Offsets relative to: ACTUAL START
0,81 metres upwards
0,07 metres left
0,00 metres shortfall

Printed on: 2005-09-09 02:01:24

Survey name : KLX07B in
Survey date : 09/07/2005 12:18:04
Printed on 2005-09-09 02:01:36

Station Metres	Dip Degrees	Azimuth Degrees	Easting Metres	Northing Metres	Elevation Metres	Mag.Field nT	Mag.Dip Degrees	Grav.Field G	Status *	UpDown Metres	LeftRight Metres	Shortfall Metres
0,0	-85,23	174,33	1549206,76	6366753,14	18,38	42620	70,70	1,001214	✍✍	0,00	0,00	0,00
3,0	-85,23	174,33	1549206,78	6366752,89	15,39	42633	70,70	1,001145	✍✍	0,00	0,00	0,00
6,0	-85,11	174,33	1549206,81	6366752,64	12,40	50479	66,70	1,000655	✍✍	0,00	0,00	0,00
9,0	-85,16	174,33	1549206,83	6366752,38	9,41	50687	70,00	1,001614	✍	0,01	0,00	0,00
12,0	-85,19	173,13	1549206,86	6366752,13	6,42	51041	71,29	1,001207	✍	0,01	0,00	0,00
15,0	-85,18	172,09	1549206,89	6366751,88	3,43	49894	70,44	1,000914	✍	0,01	-0,01	0,00
18,0	-85,17	172,61	1549206,93	6366751,63	0,44	50124	70,70	1,001243	✍	0,02	-0,02	0,00
21,0	-85,17	172,71	1549206,96	6366751,38	-2,55	49876	70,83	1,001418	✍	0,02	-0,03	0,00
24,0	-85,16	172,10	1549206,99	6366751,13	-5,53	50069	71,01	1,001186	✍	0,02	-0,03	0,00
27,0	-85,17	172,38	1549207,03	6366750,88	-8,52	50127	71,24	1,000932	✍	0,02	-0,04	0,00
30,0	-85,17	172,45	1549207,06	6366750,63	-11,51	50081	71,41	1,000988	✍	0,03	-0,05	0,00
33,0	-85,11	172,83	1549207,09	6366750,38	-14,50	49846	71,41	1,000471	✍	0,03	-0,06	0,00
36,0	-85,07	171,47	1549207,13	6366750,12	-17,49	49947	71,54	1,000774	✍	0,04	-0,07	0,00
39,0	-85,00	172,17	1549207,16	6366749,87	-20,48	49851	71,52	1,000212	✍	0,05	-0,08	0,00
42,0	-84,98	171,99	1549207,20	6366749,61	-23,47	49923	71,41	1,000298	✍	0,06	-0,09	0,00
45,0	-84,96	172,95	1549207,23	6366749,35	-26,46	49491	71,14	0,999968	✍	0,07	-0,10	0,00
48,0	-84,99	172,49	1549207,27	6366749,08	-29,45	49715	71,17	1,000466	✍	0,09	-0,11	0,00
51,0	-84,93	174,32	1549207,30	6366748,82	-32,43	49752	71,10	0,999518	✍	0,10	-0,11	0,00
54,0	-84,95	173,03	1549207,33	6366748,56	-35,42	49592	70,82	1,000344	✍	0,12	-0,11	0,00
57,0	-84,92	172,64	1549207,36	6366748,30	-38,41	49606	70,94	0,999955	✍	0,13	-0,12	0,00
60,0	-84,89	173,96	1549207,39	6366748,03	-41,40	49602	70,90	1,000434	✍	0,15	-0,13	0,00
63,0	-85,09	174,05	1549207,42	6366747,77	-44,39	49768	71,27	0,999756	✍	0,16	-0,13	0,00
66,0	-84,90	172,74	1549207,45	6366747,51	-47,38	49691	71,12	1,000047	✍	0,17	-0,13	0,00
69,0	-84,86	173,33	1549207,48	6366747,25	-50,36	50129	71,33	0,999802	✍	0,19	-0,14	0,00
72,0	-85,03	174,67	1549207,51	6366746,98	-53,35	49927	71,03	0,999545	✍	0,20	-0,14	0,00
75,0	-85,00	173,35	1549207,54	6366746,72	-56,34	49760	71,19	1,000019	✍	0,22	-0,14	0,00
78,0	-84,92	174,76	1549207,56	6366746,46	-59,33	49707	71,42	1,000385	✍	0,23	-0,14	0,00
81,0	-84,99	177,01	1549207,58	6366746,20	-62,32	49744	71,29	0,998996	✍	0,24	-0,14	0,00
84,0	-84,95	173,70	1549207,60	6366745,94	-65,31	49719	70,98	1,000160	✍	0,26	-0,13	0,00
87,0	-85,09	174,22	1549207,63	6366745,68	-68,30	49617	71,08	1,000006	✍	0,27	-0,13	0,00
90,0	-85,02	174,69	1549207,66	6366745,42	-71,28	49468	71,25	1,000119	✍	0,28	-0,13	0,00
93,0	-85,14	173,47	1549207,68	6366745,17	-74,27	49972	71,49	0,999929	✍	0,28	-0,13	0,00
96,0	-85,03	173,79	1549207,71	6366744,91	-77,26	49705	71,20	1,000344	✍	0,29	-0,14	0,00

Survey name : KLX07B in
Survey date : 09/07/2005 12:18:04
Printed on 2005-09-09 02:01:36

Station Metres	Dip Degrees	Azimuth Degrees	Easting Metres	Northing Metres	Elevation Metres	Mag.Field nT	Mag.Dip Degrees	Grav.Field G	Status *	UpDown Metres	LeftRight Metres	Shortfall Metres
99,0	-84,97	173,73	1549207,74	6366744,65	-80,25	49651	70,90	1,000189	✍	0,30	-0,14	0,00
102,0	-84,96	173,72	1549207,77	6366744,39	-83,24	49702	71,04	0,999658	✍	0,32	-0,14	0,00
105,0	-84,99	173,95	1549207,80	6366744,13	-86,23	49616	71,18	0,999672	✍	0,33	-0,14	0,00
108,0	-85,00	173,72	1549207,82	6366743,87	-89,22	49618	71,34	1,000262	✍	0,34	-0,15	0,00
111,0	-85,17	174,39	1549207,85	6366743,61	-92,20	49919	71,12	0,999090	✍	0,35	-0,15	0,00
114,0	-85,09	175,51	1549207,87	6366743,36	-95,19	50110	71,42	0,999329	✍	0,36	-0,14	0,00
117,0	-85,16	173,54	1549207,90	6366743,10	-98,18	49968	71,57	1,000209	✍	0,36	-0,14	0,00
120,0	-85,10	173,23	1549207,93	6366742,85	-101,17	49791	71,79	1,000120	✍	0,37	-0,15	0,00
123,0	-85,00	173,23	1549207,96	6366742,59	-104,16	49844	71,65	1,000199	✍	0,38	-0,15	0,00
126,0	-85,04	173,58	1549207,99	6366742,33	-107,15	49756	71,55	1,000333	✍	0,39	-0,16	0,00
129,0	-85,22	173,87	1549208,02	6366742,08	-110,14	49925	71,92	1,000004	✍	0,39	-0,16	0,00
132,0	-84,97	174,07	1549208,04	6366741,83	-113,13	49870	72,16	1,000683	✍	0,40	-0,16	0,00
135,0	-84,99	174,30	1549208,07	6366741,57	-116,12	49895	71,42	1,000228	✍	0,41	-0,16	0,00
138,0	-84,99	174,96	1549208,09	6366741,30	-119,11	49630	70,51	1,000705	✍	0,42	-0,16	0,00
141,0	-85,00	175,00	1549208,12	6366741,04	-122,09	49602	70,41	1,000327	✍	0,44	-0,16	0,00
144,0	-84,98	176,57	1549208,14	6366740,78	-125,08	50384	72,02	0,999937	✍	0,45	-0,15	0,00
147,0	-85,00	175,92	1549208,15	6366740,52	-128,07	50374	71,87	1,000262	✍	0,46	-0,14	0,00
150,0	-84,97	175,51	1549208,17	6366740,26	-131,06	50155	71,73	0,999890	✍	0,47	-0,14	0,00
153,0	-84,90	175,19	1549208,19	6366740,00	-134,05	50033	72,03	1,000052	✍	0,49	-0,13	0,00
156,0	-84,94	173,53	1549208,22	6366739,73	-137,04	49577	70,82	1,000726	✍	0,50	-0,13	0,00
159,0	-84,88	173,42	1549208,25	6366739,47	-140,02	49352	70,65	1,000084	✍	0,52	-0,13	0,00
162,0	-84,83	173,35	1549208,28	6366739,20	-143,01	49930	70,90	1,000655	✍	0,54	-0,14	0,00
165,0	-84,80	173,42	1549208,31	6366738,93	-146,00	49779	71,49	1,000576	✍	0,56	-0,14	0,00
168,0	-84,81	174,36	1549208,34	6366738,66	-148,99	50196	71,99	1,000315	✍	0,58	-0,15	0,00
171,0	-84,78	174,88	1549208,37	6366738,39	-151,97	49647	71,27	1,000247	✍	0,61	-0,14	0,00
174,0	-84,77	175,15	1549208,39	6366738,12	-154,96	49558	70,63	1,000072	✍	0,63	-0,14	0,00
177,0	-84,75	174,29	1549208,42	6366737,84	-157,95	49822	71,41	1,000412	✍	0,65	-0,14	0,00
180,0	-84,79	175,73	1549208,44	6366737,57	-160,94	49509	69,97	1,000353	✍	0,68	-0,14	0,00
183,0	-84,77	177,35	1549208,46	6366737,30	-163,92	49107	70,34	1,000135	✍	0,70	-0,13	0,00
186,0	-84,91	178,03	1549208,47	6366737,03	-166,91	49582	71,45	0,999549	✍	0,72	-0,11	0,00
189,0	-84,82	175,90	1549208,48	6366736,76	-169,90	49831	71,82	0,999806	✍	0,74	-0,10	0,00
192,0	-84,83	174,71	1549208,50	6366736,49	-172,89	50089	72,18	1,000658	✍	0,76	-0,09	0,00
195,0	-84,80	178,01	1549208,52	6366736,22	-175,88	49515	71,21	1,000028	✍	0,78	-0,08	0,00

Survey name : KLX07B in
Survey date : 09/07/2005 12:18:04

Printed on 2005-09-09 02:01:36

Station Metres	Dip Degrees	Azimuth Degrees	Easting Metres	Northing Metres	Elevation Metres	Mag.Field nT	Mag.Dip Degrees	Grav.Field G	Status *	UpDown Metres	LeftRight Metres	Shortfall Metres
198,0	-84,78	175,85	1549208,54	6366735,95	-178,86	49720	71,05	1,000183	✍	0,81	-0,07	0,00

Appendix 10

Deviation logging in HLX34, 0 to 147 m

New MeasureIT files

Survey name:	**HLX34 in**
Survey date:	20/07/2005 15:34:18
Project:	PLU
Location:	Laxemar

Country:	Sweden
Survey company:	Mala GeoScience / RAYCON
Surveyed by:	Christer Gustafsson
Survey type:	STANDARD
Operating conditions:	
General comments:	
Client name:	SKB
Client ID number:	
Client reference:	Leif Stenberg
Drill company:	
Drill rig:	
Drill diameter:	140
Survey direction:	INTO hole
Survey run on:	Wireline
Magnetic Var.:	2,33 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:	49600	1000	nano Tesla
Magnetic dip:	71.4	1.5	Degrees

SURVEY	Actual start	End of survey	Difference
Station:	0,0	147,0	147,0
East:	1547489,56	1547568,54	78,98
North:	6367355,13	6367336,33	-18,80
Elevation:	14,29	-108,13	-122,42
Dip:	-59,97	-53,37	6,60
Azimuth:	101,07	103,56	2,49

OFFSETS at end
Offsets relative to: ACTUAL START
8,97 metres upwards
3,28 metres right
0,41 metres shortfall

Printed on: 2005-09-09 01:46:49

Survey name : HLX34 in

Survey date : 20/07/2005 15:34:18

Printed on 2005-09-09 01:47:15

Station Metres	Dip Degrees	Azimuth Degrees	Easting Metres	Northing Metres	Elevation Metres	Mag.Field nT	Mag.Dip Degrees	Grav.Field G	Status *	UpDown Metres	LeftRight Metres	Shortfall Metres
0,0	-59,97	101,07	1547489,56	6367355,13	14,29	50415	72,36	1,001848	✍	0,00	0,00	0,00
3,0	-59,68	101,07	1547491,04	6367354,84	11,70	50706	72,87	0,999454	✍✍	0,01	0,00	0,00
6,0	-59,86	101,07	1547492,52	6367354,55	9,10	50330	72,29	0,999896	✍	0,02	0,00	0,00
9,0	-59,71	100,96	1547494,00	6367354,26	6,51	50187	71,75	0,997944	✍	0,03	0,00	0,00
12,0	-59,41	102,00	1547495,49	6367353,95	3,93	49587	71,14	0,997556	✍	0,05	0,01	0,00
15,0	-59,20	101,42	1547496,99	6367353,64	1,35	49742	71,99	0,997490	✍	0,08	0,03	0,00
18,0	-59,05	105,80	1547498,49	6367353,28	-1,23	50549	71,65	0,997557	✍	0,13	0,09	0,00
21,0	-58,96	99,79	1547499,99	6367352,94	-3,80	50536	71,63	0,997258	✍	0,17	0,14	0,00
24,0	-58,67	104,00	1547501,51	6367352,62	-6,37	48207	71,35	0,997411	✍✍	0,23	0,16	0,00
27,0	-58,38	102,00	1547503,04	6367352,27	-8,93	51236	70,12	0,997985	✍✍	0,31	0,22	-0,01
30,0	-58,33	103,22	1547504,57	6367351,92	-11,48	49524	71,52	0,997115	✍	0,39	0,26	-0,01
33,0	-58,36	101,20	1547506,11	6367351,59	-14,04	49196	71,71	0,997329	✍	0,48	0,29	-0,01
36,0	-58,34	103,55	1547507,65	6367351,25	-16,59	49260	71,35	0,997560	✍	0,56	0,33	-0,01
39,0	-58,12	101,68	1547509,19	6367350,91	-19,14	49453	71,67	0,998242	✍	0,65	0,37	-0,01
42,0	-58,03	101,58	1547510,74	6367350,59	-21,69	50252	71,57	0,998800	✍	0,75	0,38	-0,01
45,0	-57,85	100,51	1547512,31	6367350,28	-24,23	49413	71,79	0,998094	✍	0,86	0,38	-0,01
48,0	-57,78	101,08	1547513,88	6367349,98	-26,77	49238	71,25	0,998167	✍	0,97	0,38	-0,02
51,0	-57,50	103,40	1547515,44	6367349,64	-29,30	49460	71,49	0,998209	✍	1,09	0,41	-0,02
54,0	-57,11	102,87	1547517,02	6367349,28	-31,83	49012	71,78	0,997601	✍	1,23	0,47	-0,02
57,0	-57,22	101,22	1547518,61	6367348,94	-34,35	50125	71,56	0,998782	✍	1,38	0,49	-0,03
60,0	-56,99	104,35	1547520,20	6367348,58	-36,87	49290	71,53	0,998776	✍	1,52	0,54	-0,03
63,0	-56,83	105,22	1547521,79	6367348,16	-39,38	49352	71,52	0,998991	✍	1,68	0,65	-0,04
66,0	-56,69	103,70	1547523,38	6367347,75	-41,89	49011	72,13	0,998412	✍	1,85	0,75	-0,04
69,0	-56,45	102,34	1547524,99	6367347,38	-44,39	49946	71,88	0,998450	✍	2,02	0,80	-0,05
72,0	-56,01	101,35	1547526,62	6367347,03	-46,89	50245	71,85	0,998799	✍	2,22	0,83	-0,06
75,0	-55,88	103,00	1547528,26	6367346,68	-49,37	49171	71,73	0,998213	✍	2,43	0,86	-0,06
78,0	-55,70	105,56	1547529,90	6367346,26	-51,85	50042	72,24	0,997980	✍	2,65	0,95	-0,07
81,0	-55,56	104,77	1547531,53	6367345,82	-54,33	49440	71,39	0,998266	✍	2,87	1,07	-0,08
84,0	-55,34	102,93	1547533,18	6367345,41	-56,80	49235	71,43	0,998046	✍	3,10	1,16	-0,09
87,0	-55,35	101,79	1547534,85	6367345,05	-59,27	49501	71,63	0,998089	✍	3,34	1,19	-0,10
90,0	-55,45	103,41	1547536,51	6367344,68	-61,74	49962	71,38	0,997930	✍	3,58	1,24	-0,11
93,0	-55,40	102,59	1547538,17	6367344,29	-64,21	49246	71,64	0,998983	✍	3,82	1,30	-0,12
96,0	-55,50	103,88	1547539,83	6367343,90	-66,68	49353	71,73	0,999385	✍	4,05	1,36	-0,13

Survey name : HLX34 in
Survey date : 20/07/2005 15:34:18

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Station Metres	Dip Degrees	Azimuth Degrees	Easting Metres	Northing Metres	Elevation Metres	Mag.Field nT	Mag.Dip Degrees	Grav.Field G	Status *	UpDown Metres	LeftRight Metres	Shortfall Metres
99,0	-55,34	104,12	1547541,48	6367343,49	-69,15	49191	71,91	0,999231	✍	4,29	1,45	-0,14
102,0	-55,22	104,45	1547543,13	6367343,07	-71,61	49296	71,47	0,999345	✍	4,53	1,54	-0,16
105,0	-54,99	104,40	1547544,80	6367342,64	-74,07	49014	71,86	0,999273	✍	4,79	1,64	-0,17
108,0	-54,97	105,00	1547546,46	6367342,21	-76,53	49051	71,77	0,999288	✍	5,04	1,75	-0,18
111,0	-54,83	104,09	1547548,13	6367341,77	-78,99	49477	72,30	0,999291	✍	5,31	1,86	-0,19
114,0	-54,74	105,40	1547549,80	6367341,33	-81,44	49260	71,88	0,998881	✍	5,57	1,97	-0,21
117,0	-54,43	104,59	1547551,48	6367340,88	-83,88	48782	71,76	0,998847	✍	5,85	2,09	-0,22
120,0	-54,38	106,13	1547553,17	6367340,42	-86,32	49470	71,90	0,998798	✍	6,14	2,22	-0,24
123,0	-54,15	107,47	1547554,84	6367339,91	-88,76	49408	71,71	0,998508	✍	6,43	2,39	-0,26
126,0	-54,05	105,54	1547556,53	6367339,41	-91,19	49208	72,05	0,998974	✍	6,73	2,56	-0,28
129,0	-54,01	106,22	1547558,23	6367338,93	-93,61	49417	72,05	0,999209	✍	7,04	2,71	-0,30
132,0	-53,92	105,68	1547559,92	6367338,45	-96,04	49440	71,92	0,999327	✍	7,34	2,86	-0,32
135,0	-53,90	103,77	1547561,63	6367338,00	-98,46	46721	71,11	0,999457	✍	7,66	2,97	-0,34
138,0	-53,84	104,43	1547563,35	6367337,57	-100,89	49475	71,76	0,998956	✍	7,97	3,06	-0,35
141,0	-53,65	102,98	1547565,07	6367337,15	-103,31	49898	71,52	0,999080	✍	8,30	3,15	-0,37
144,0	-53,57	103,04	1547566,81	6367336,75	-105,72	49707	71,49	0,999195	✍	8,63	3,21	-0,39
147,0	-53,37	103,56	1547568,54	6367336,33	-108,13	49857	71,69	0,999533	✍	8,97	3,28	-0,41

Appendix 11

Deviation logging in HLX35, 0 to 147 m

New MeasureIT files

Survey name:	**HLX35 out**
Survey date:	20/07/2005 14:01:11
Project:	PLU
Location:	Laxemar

Country:	Sweden
Survey company:	Mala GeoScience / RAYCON
Surveyed by:	Christer Gustafsson
Survey type:	STANDARD
Operating conditions:	
General comments:	
Client name:	SKB
Client ID number:	
Client reference:	Leif Stenberg
Drill company:	
Drill rig:	
Drill diameter:	140
Survey direction:	INTO hole
Survey run on:	Wireline
Magnetic Var.:	2,33 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:	49600	1000	nano Tesla
Magnetic dip:	71.4	1.5	Degrees

SURVEY	Actual start	End of survey	Difference
Station:	0,0	147,0	147,0
East:	1547437,79	1547515,86	78,07
North:	6367194,79	6367173,56	-21,23
Elevation:	14,44	-108,10	-122,54
Dip:	-60,36	-52,62	7,74
Azimuth:	102,22	105,95	3,73

OFFSETS at end
Offsets relative to:
ACTUAL START
9,60 metres upwards
4,22 metres right
0,54 metres shortfall

Printed on: 2005-09-09 02:05:39

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Survey name : HLX35 out

Survey date : 20/07/2005 14:01:11

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Station Metres	Dip Degrees	Azimuth Degrees	Easting Metres	Northing Metres	Elevation Metres	Mag.Field nT	Mag.Dip Degrees	Grav.Field G	Status *	UpDown Metres	LeftRight Metres	Shortfall Metres
0,0	-60,36	102,22	1547437,79	6367194,79	14,44	50135	71,83	0,999327	✍	0,00	0,00	0,00
3,0	-60,38	102,22	1547439,24	6367194,47	11,84	50242	72,05	0,999116	✍	0,00	0,00	0,00
6,0	-60,68	102,22	1547440,68	6367194,16	9,22	50250	71,54	1,001338	✍	-0,01	0,00	0,00
9,0	-60,53	102,86	1547442,12	6367193,84	6,61	50165	71,67	0,997715	✍	-0,02	0,01	0,00
12,0	-60,66	103,79	1547443,55	6367193,50	4,00	49959	71,69	0,999823	✍	-0,04	0,04	0,00
15,0	-60,29	103,55	1547444,99	6367193,15	1,39	50025	71,47	1,001001	✍	-0,04	0,07	0,00
18,0	-59,94	104,04	1547446,44	6367192,80	-1,21	49561	71,57	1,000080	✍	-0,03	0,12	0,00
21,0	-59,74	104,33	1547447,90	6367192,43	-3,81	49434	71,55	0,999430	✍	0,00	0,17	0,00
24,0	-59,57	105,07	1547449,37	6367192,04	-6,40	49522	71,38	0,999579	✍	0,03	0,23	0,00
27,0	-59,48	104,42	1547450,84	6367191,66	-8,98	49693	71,46	1,000248	✍	0,07	0,30	0,00
30,0	-59,32	105,35	1547452,32	6367191,26	-11,57	49561	71,40	0,999901	✍	0,12	0,37	0,00
33,0	-59,17	105,79	1547453,79	6367190,85	-14,14	49657	71,02	1,001179	✍	0,18	0,46	-0,01
36,0	-58,96	105,54	1547455,28	6367190,44	-16,72	49777	71,32	0,999958	✍	0,24	0,55	-0,01
39,0	-58,79	104,95	1547456,78	6367190,03	-19,28	49825	71,46	0,999977	✍	0,32	0,63	-0,01
42,0	-58,69	105,11	1547458,28	6367189,62	-21,85	49934	71,48	1,000025	✍	0,40	0,71	-0,01
45,0	-58,44	104,15	1547459,79	6367189,23	-24,41	49952	71,88	0,999787	✍	0,49	0,78	-0,01
48,0	-58,19	104,35	1547461,32	6367188,84	-26,96	49733	71,78	0,998945	✍	0,60	0,83	-0,02
51,0	-57,94	103,13	1547462,86	6367188,46	-29,51	49490	72,06	0,999989	✍	0,72	0,87	-0,02
54,0	-57,87	106,32	1547464,40	6367188,06	-32,05	49464	71,10	1,000145	✍	0,85	0,94	-0,02
57,0	-57,65	105,60	1547465,94	6367187,62	-34,59	49488	71,22	0,999773	✍	0,98	1,05	-0,03
60,0	-57,51	105,47	1547467,49	6367187,19	-37,12	49786	71,64	0,999790	✍	1,12	1,14	-0,03
63,0	-57,35	104,94	1547469,05	6367186,76	-39,65	49561	71,46	1,000106	✍	1,27	1,23	-0,04
66,0	-57,21	104,50	1547470,62	6367186,35	-42,17	49741	71,43	0,998691	✍	1,43	1,30	-0,04
69,0	-57,09	103,14	1547472,20	6367185,96	-44,69	49388	71,46	0,999103	✍	1,60	1,34	-0,05
72,0	-56,71	107,43	1547473,78	6367185,53	-47,20	49400	71,22	0,998527	✍	1,78	1,43	-0,06
75,0	-56,45	107,28	1547475,36	6367185,04	-49,71	49032	71,34	0,999758	✍	1,97	1,58	-0,06
78,0	-56,26	106,75	1547476,94	6367184,55	-52,21	49207	71,35	0,999005	✍	2,17	1,72	-0,08
81,0	-56,08	106,89	1547478,54	6367184,07	-54,70	49338	71,40	1,000065	✍	2,39	1,85	-0,09
84,0	-55,81	105,29	1547480,16	6367183,60	-57,18	49274	71,21	0,998982	✍	2,61	1,96	-0,10
87,0	-55,51	107,78	1547481,78	6367183,12	-59,66	49803	71,38	0,999290	✍	2,86	2,09	-0,11
90,0	-55,22	107,75	1547483,40	6367182,60	-62,13	50554	72,15	0,998991	✍	3,11	2,26	-0,12
93,0	-54,94	104,21	1547485,05	6367182,13	-64,59	50614	70,95	0,998848	✍✍	3,38	2,37	-0,14
96,0	-54,85	104,25	1547486,73	6367181,70	-67,04	50273	71,32	0,999082	✍	3,67	2,43	-0,15

Survey name : HLX35 out

Survey date : 20/07/2005 14:01:11

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Station Metres	Dip Degrees	Azimuth Degrees	Easting Metres	Northing Metres	Elevation Metres	Mag.Field nT	Mag.Dip Degrees	Grav.Field G	Status *	UpDown Metres	LeftRight Metres	Shortfall Metres
99,0	-54,75	105,78	1547488,40	6367181,26	-69,49	49867	71,33	0,999616	✍	3,96	2,51	-0,17
102,0	-54,55	104,85	1547490,07	6367180,80	-71,94	49374	71,75	0,998422	✍	4,25	2,61	-0,18
105,0	-54,53	106,16	1547491,75	6367180,33	-74,39	49596	71,65	0,998975	✍	4,55	2,71	-0,20
108,0	-54,36	106,75	1547493,42	6367179,84	-76,83	49703	71,58	0,999117	✍	4,86	2,84	-0,22
111,0	-54,23	105,63	1547495,10	6367179,35	-79,26	48839	71,91	0,998449	✍	5,17	2,96	-0,24
114,0	-54,03	106,19	1547496,79	6367178,87	-81,69	49090	69,67	0,998444	✍	5,49	3,07	-0,26
117,0	-53,94	104,12	1547498,50	6367178,41	-84,12	49808	71,62	0,998289	✍	5,82	3,16	-0,28
120,0	-53,67	104,53	1547500,21	6367177,97	-86,54	49638	71,65	0,999180	✍	6,16	3,23	-0,30
123,0	-53,42	104,40	1547501,94	6367177,52	-88,95	49751	71,72	0,998082	✍	6,52	3,30	-0,32
126,0	-53,39	105,14	1547503,67	6367177,07	-91,36	49825	71,57	1,000451	✍	6,88	3,37	-0,34
129,0	-53,15	106,15	1547505,40	6367176,58	-93,77	49841	71,69	0,998401	✍	7,25	3,48	-0,37
132,0	-52,96	107,13	1547507,12	6367176,07	-96,16	49756	71,41	0,998484	✍	7,62	3,62	-0,39
135,0	-52,73	108,74	1547508,85	6367175,51	-98,56	49658	71,64	0,999298	✍	8,01	3,80	-0,42
138,0	-52,71	104,59	1547510,59	6367174,99	-100,94	50130	71,59	0,998667	✍	8,40	3,94	-0,45
141,0	-52,66	106,23	1547512,34	6367174,51	-103,33	50036	72,03	0,998130	✍	8,80	4,04	-0,48
144,0	-52,60	103,94	1547514,10	6367174,03	-105,71	50001	72,02	0,998467	✍	9,20	4,13	-0,51
147,0	-52,62	105,95	1547515,86	6367173,56	-108,10	49500	71,58	0,998793	✍	9,60	4,22	-0,54