P-05-58

Revised April 2006

Forsmark site investigation

RAMAC and BIPS logging in borehole KFM08B

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March 2005

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ISSN 1651-4416
SKB P-05-58

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Keywords: BIPS, RAMAC, Radar, TV, Forsmark, AP PF 400-04-47.

Reading instruction

The revised version of the report (April 2006) contains a recalculation of the directional radar data. The calculated angles now conforms with the right-hand rule, and they now are measured clockwise.

Abstract

This report includes the data gained in geophysical logging operations performed within the site investigation at Forsmark. The logging operations presented here includes BIPS logging and borehole radar measurements (RAMAC) in the core-drilled borehole KFM08B. All measurements were conducted by Malå Geoscience AB/RAYCON during February 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.

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 borehole radar data quality from KFM08B was good, but in some minor 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. The borehole radar measurements resulted in a number of identified radar reflectors. 79 reflectors were identified, and 22 of them oriented.

The basic conditions of the BIPS logging for geological mapping and orientation of structures are satisfying. Mud covering the lower most part of the borehole walls however limits the visibility.

Sammanfattning

Denna rapport omfattar geofysiska loggningar inom platsundersökningsprogrammet för Forsmark. Mätningarna som presenteras här omfattar BIPS- och radarloggningar i borrhål KFM08B. Alla mätningar är utförda av Malå Geoscience AB/RAYCON under februari 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.

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.

Borrhålsradardata från KFM08B var bra, 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. 79 radarreflektorer har identifierats, varav 22 är orienterade.

BIPS bilderna visar att förutsättningarna för geologisk kartering och sprickorientering är goda. Det är dock en del lösa mineralpartiklar i vattnet som lägger sig på liggsidan i borrhålet och på så sätt försämrar kvalitén på bilderna.

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 Forsmark. The logging operations presented here includes borehole radar (RAMAC) and TV-logging (BIPS) in the core-drilled borehole KFM08B. The work was carried out in accordance with Addition to Activity plan AP PF 400-04-47. In Table 1-1 the controlling documents for performing this activity are listed. Both activity plan and method descriptions are internal controlling documents of SKB.

This report includes measurements from 0 to approximately 200 m in borehole KFM08B. The borehole is drilled with an inclination of 60° from the horizontal, a bearing of 270° and a diameter of approximately 76 mm.

All measurements were conducted by Malå Geoscience AB/RAYCON during February 2005. The 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 antennas.
- Borehole TV logging with the so-called BIPS-system (Borehole Image Processing System), which is a high resolution, side viewing, colour borehole TV system.

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

Activity plan	Number	Version
Tillägg till Aktivitetsplan AP PF 400-04-47 (Borrhålsmätning med BIPS och radar i teleskopborrhålen KFM05A och KFM06A (100–1,000 m) samt KFM06B)	Tillägg till AP PF 400-04-47 med avseende på KFM08B	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	1.0

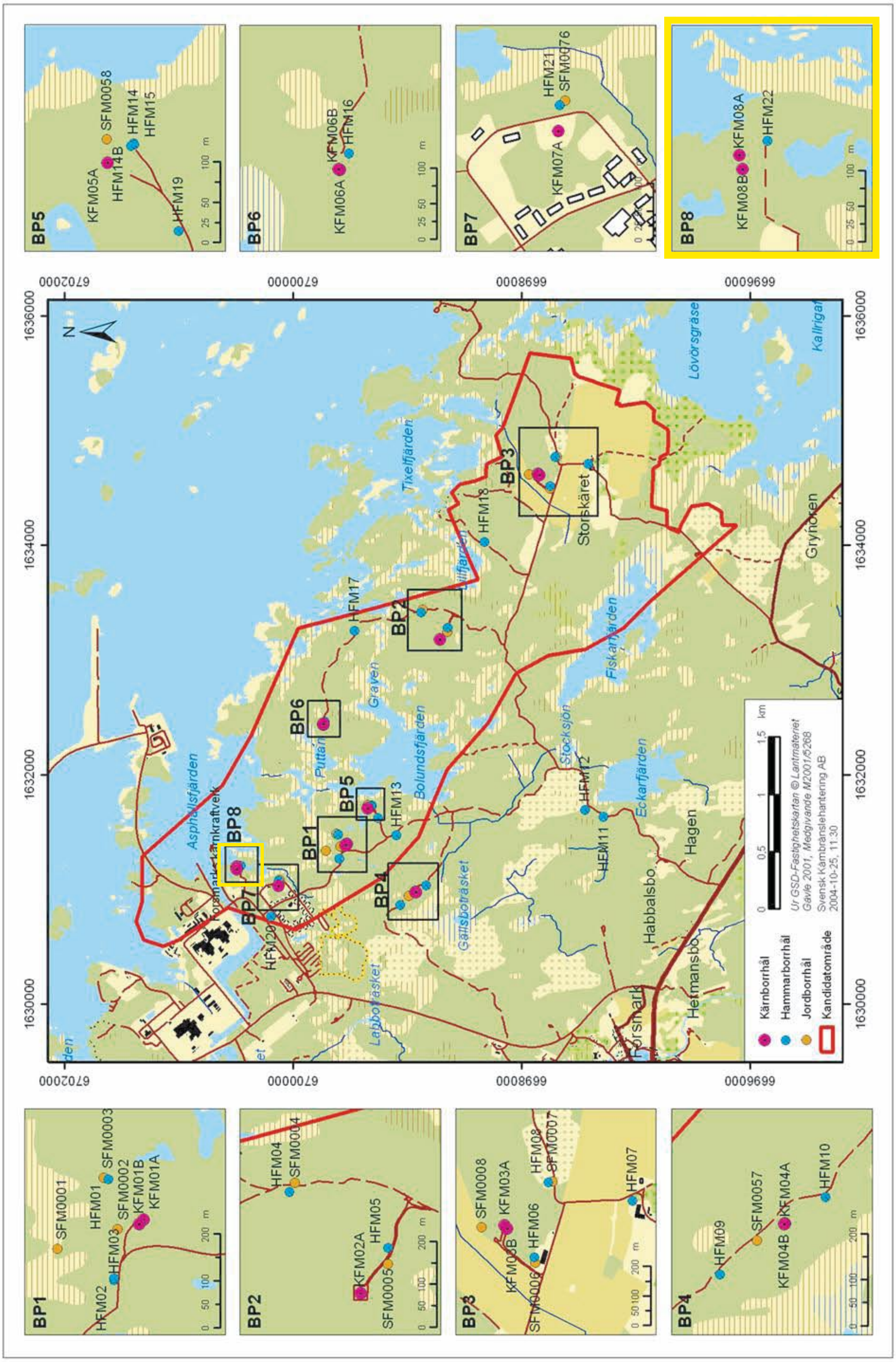


Figure 1-1. General overview over the Forsmark area with the location of the borehole KFM08B.

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 fracture distribution and orientation.

This report describes the equipment used as well 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.

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.

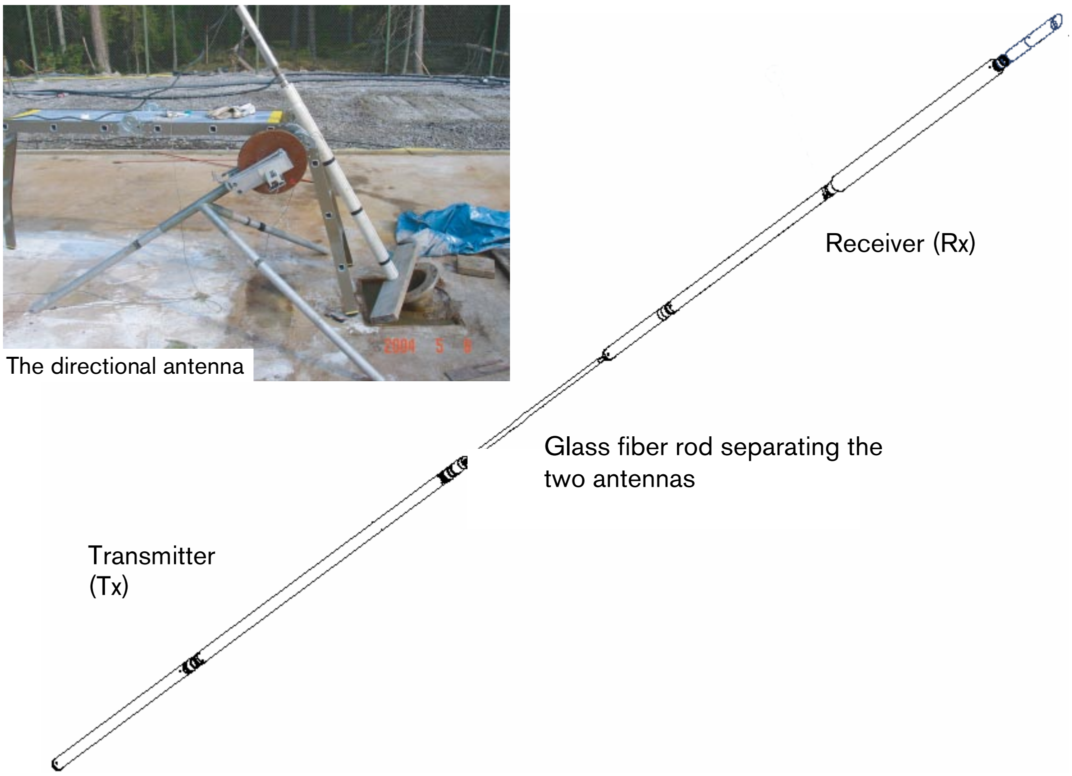


Figure 3-1. *Example of a borehole radar antenna.*

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, a circle of pixels is 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).

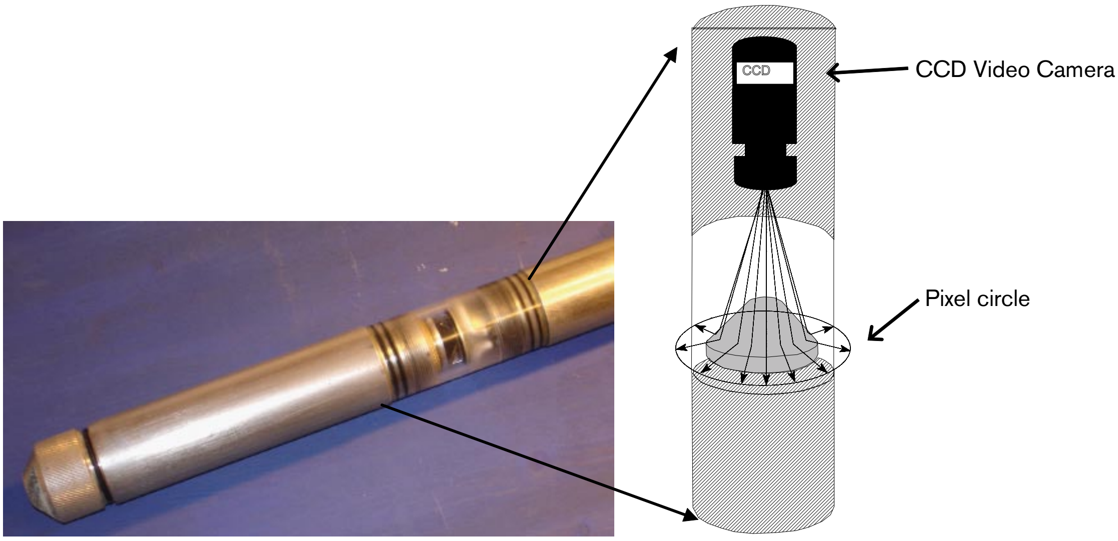


Figure 3-2. *The BIPS-probe. To the right an illustration of the conical mirror scanning.*

4 Execution

4.1 General

4.1.1 RAMAC Radar

The measurements in KFM08B were carried out with dipole radar antennas, with frequencies of 250, 100 and 20 MHz. The directional antenna was also used, 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) 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 KFM08B. This is done 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 measured by compass and the result achieved from the directional antenna was about 6°. This can be considered as very good due to the disturbed environment, with metallic objects etc at the test site.

For more information on system settings used in the investigation of KFM08B see Table 4-1.

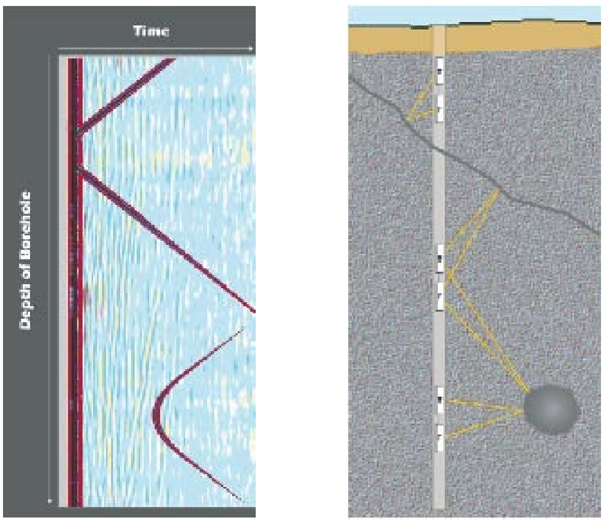


Figure 4-1. The principle of radar borehole reflection survey and an example of result.

Table 4-1. Radar logging information from KFM08B.

Site:	**Forsmark**	**Logging company:**	**RAYCON**		
BH:	**KFM08B**	**Equipment:**	**SKB RAMAC**		
Type:	**Directional/Dipole**	**Manufacturer:**	**MALÅ GeoScience**		
Operator:	**CG**	**Antenna**			
		Directional	**250 MHz**	**100 MHz**	**20 MHz**
	Logging date:	05-02-09	05-02-10	05-02-10	05-02-10
	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:	390.48	–0.31	–0.37	–1.40
	Logging from (m):	3.4	1.5	2.6	6.25
	Logging to (m):	188.4	198.3	197.6	193.2
	Trace interval (m):	0.5	0.25	0.2	0.1
	Antenna separation (m):	5.73	1.9	2.9	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 circle of pixels 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.

In order to control the quality of the system, calibration measurements were performed in a test pipe before logging the first borehole and after logging the last one. Figure 4-2 corresponds to the test pipe logging before and after the logging activity comprising KFM08B and KFM06B in February 2005. The results showed no difference regarding the colours and focus of the images. Results of the test loggings were included in the delivery of the raw data.

The BIPS logging information is found in the header presented in Appendix 2 in this report.

4.1.3 Length measurements

During logging the depth recording for the RAMAC and BIPS systems is taken care of by a measuring wheel mounted on the cable winch.

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 which is marked with black as seen in Appendix 2. The tape marks on the logging cable are then used for controlling the RAMAC measurement.

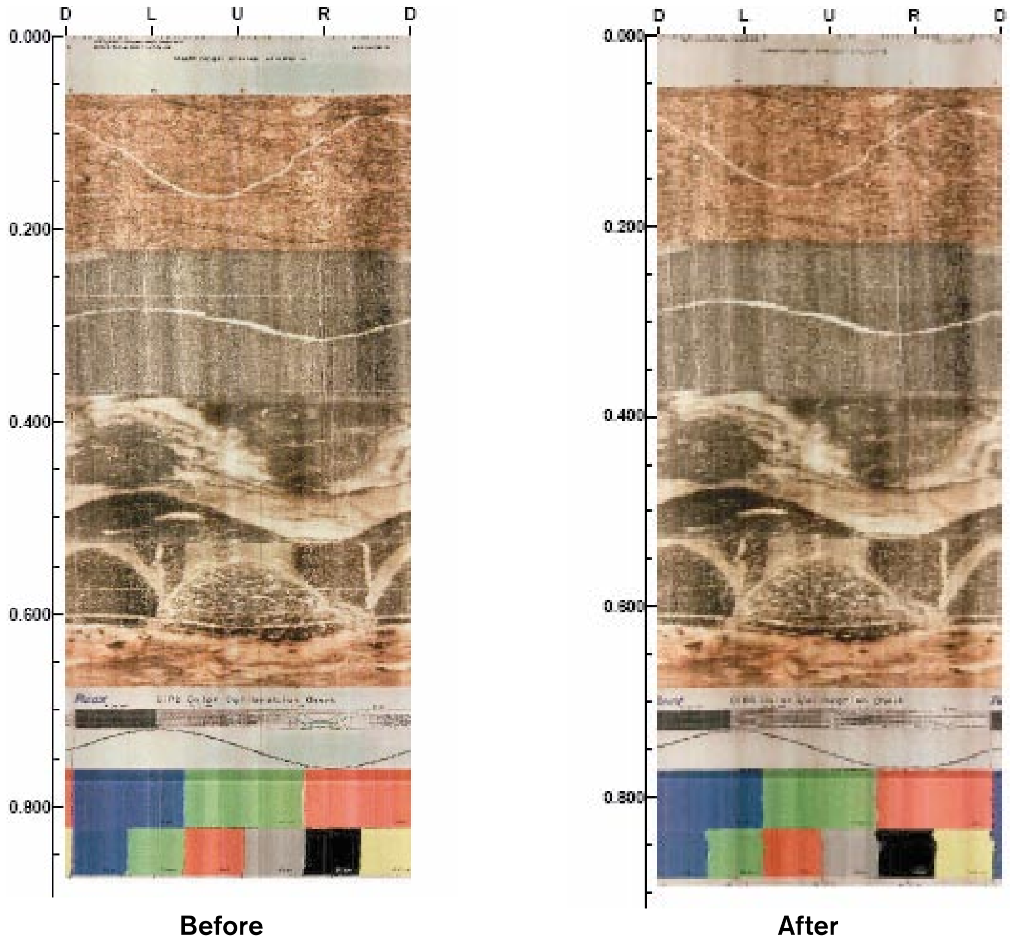


Figure 4-2. Results from logging in the test pipe before and after the logging campaign in February (05-02-09 to 05-02-11).

No marks are performed during the drilling in this borehole, KFM08B. For the depth adjustments we have used older marks on the logging cable from previous logging activities. The experience from one year of logging is that the marks on the logging cable is very good and differs very little compared with the results from core-drilled boreholes. We have used marks at 110 and 150 m on the logging cable for depth adjustments of the BIPS results.

The experience we have from earlier measurements with dipole antennas in the core-drilled boreholes of 1,000 m length in Forsmark and Oskarshamn for the radar logging is that the depth divergence is less than 50 cm in the deepest parts of these boreholes.

The results from KFM08B, i.e. the depth to identified structures, are corrected according to the presumed depth divergence. The correction is done by a change in the radar information file, *.rad. As the measured borehole is less than 200 m long, the depth divergence was less than 20 cm in the deepest parts of the borehole.

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 color corresponds to the large positive signals and white color to large negative signals. Grey color 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 project the velocity determination was performed by keeping the transmitter fixed in the borehole while moving the receiver downwards in the borehole. The result is plotted in Figure 4-3 and the calculation shows a velocity of 128 m/µs. The velocity measurement was performed with the 100 MHz antenna /1/.

The visualization of data in Appendix 1 is made with ReflexWin, a Windows based processing software for filtering and analysis of borehole radar data. The processing steps are shown in Table 4-2. It should be observed that the processing steps below refer to the Appendix 1. 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.

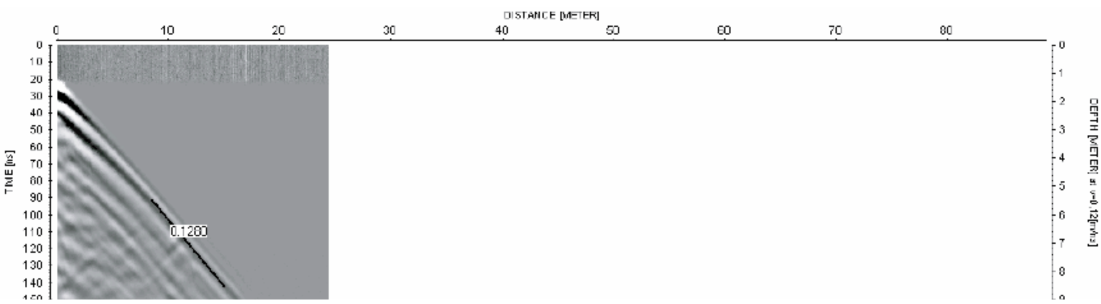


Figure 4-3. *Results from velocity measurements in HFM03 /1/.*

The software RadInter SKB, is used for the interpretation of the intersection angle between the borehole axis and the planes visible on the radargrams. The interpreted intersection points and intersection angles of the detected structures are presented in the Tables 5-1 and 5-2 and are also visible on the radargrams in Appendix 1.

Table 4-2. Processing steps for borehole radar data from KFM08B.

Site:	**Forsmark**		**Logging company:**	**RAYCON**	
BH:	**KFM08B**		**Equipment:**	**SKB RAMAC**	
Type:	**Directional/Dipole**		**Manufacturer:**	**MALÅ GeoScience**	
Interpret:	**JA**		**Antenna**		
		Directional	**250 MHz**	**100 MHz**	**20 MHz**
Processing:		DC removal	DC removal	DC removal	DC removal
		(414–511)	(170–240)	(380–500)	(1,600–2,030)
		Move start time	Move start time	Move start time	Move start time
		(–40)	(–19.4)	(–87.6)	(–110.2)
		Gain	Gain	Gain	Gain
		(from 68, linear 100, exp 1)	(from 26, linear 1.2, exp 1.2)	(from 100, linear 1, exp 0.6)	(from 115, linear 2.4, exp 015)
		Delete mean trace			

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.

For printing of the BIPS images the printing software BIPP from RaaX was used.

4.3 Nonconformities

No nonconformities during the reported logging activity.

The revised version of the report (April 2006) contains a recalculation of the directional radar data. The calculated angles now conforms with the right-hand rule, and they now are measured clockwise.

5 Results

The results from the BIPS measurements in KFM08B were delivered as raw data (*.bip-files) 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 CD-ROM's stored by SKB.

The RAMAC radar data for KFM08B was delivered as raw data (file format *.rd3 or *.rd5) with corresponding information files (file format *.rad) on CD-ROM's to SKB before the field crew left the investigation site, 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.

5.1 RAMAC logging

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

Only the larger clearly visible structures are interpreted in RadinterSKB. A number of minor structures or other also exist. 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. Parallel structures can also be identified, especially in the 20 MHz data.

The data quality from KFM08B, (as seen in Appendix 1) is very good, but in some parts 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 in the 250 MHz data around 175 m depth. A conductive environment of course also reduces the possibility to distinguish and interpret possibly structures in the rock which otherwise could give a reflection.

As also seen in Appendix 1 the resolution and penetration of radar waves depend on the antenna frequency used. Low antenna frequency gives less resolution but higher penetration rate 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 below, the distribution of identified structures along the boreholes KFM08B is showed.

Table 5-1. Identified structures as a function of depth in KFM08B.

Depth (m)	No of structures
–20	4
20–40	8
40–60	8
60–80	11
80–100	6
100–120	7
120–140	6
140–160	6
160–180	10
180–200	6
200–	7

Table 5-2 summarises the interpretation of radar data from KFM08B. In the table the depth and intersection angle to the identified structures are listed. As seen some radar reflectors are marked with ±, which indicates an uncertainty in the interpretation of direction. The direction can in these cases be ± 180°. The direction to the object (the plane) is defined in Figure 5-1. This direction and the intersection angle are also given as strike and dip.

Observe that a structure can have several different angles, if the structure is undulating, and thereby also different intersection depths. This is seen for structure 58 in Table 5-2. To this structure, most likely, also structure 58× belongs.

Table 5-2. Interpretation of radar reflectors from dipole antennas 20, 100 and 250 MHz and the directional antenna in borehole KFM08B.

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

Site: Forsmark
Borehole name: KFM08B
Nominal velocity (m/μs): 128.0

Name	Intersection depth	Intersection angle	Object direction	Dip 1	Strike 1	Dip 2	Strike 2
1	–88.3	7					
66	–63.2	23					
3	–21.4	16	327	77	149		
2	–18.5	20					
4	7.0	64					
5	21.3	62	174±	3	83	64	358
6	25.8	58					
7	27.2	64	333±	54	349	15	46
69	28.9	20					
8	30.3	65					
9	31.4	71	162±	14	28	53	354
10	33.1	59					
12	39.2	21					
12×	40.4	24					

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

Site: Forsmark
Borehole name: KFM08B
Nominal velocity (m/μs): 128.0

Name	Intersection depth	Intersection angle	Object direction	Dip 1	Strike 1	Dip 2	Strike 2
15	42.9	33					
14	43.3	71					
11	49.4	8					
13	49.8	35					
19	52.9	66					
65	54.4	14					
29	58.7	19					
18	60.7	66					
17	62.2	35					
16	62.3	67	327±	52	347	18	44
73	66.0	54	36	64	24		
29×	69.4	22	318	87	143		
21	71.1	44					
23	74.0	56					
22	74.2	35	342	84	347		
17×	74.3	15					
28	75.2	32					
24	78.4	65					
26	81.5	61					
58×	83.6	11					
25	83.6	59	51	59	32		
72	90.6	21	327	83	151		
30	93.1	71					
27	96.2	36	45	78	37		
27×	102.4	24					
31	105.6	66					
32	107.5	75	327±	46	350	22	23
35	108.7	26	24	87	203		
20	109.0	11	354	68	175		
36×	113.6	31	18	88	17		
38	115.5	21					
34	120.0	18					
39	123.7	33					
36	126.8	18					
58	129.3	21	147±	42	134	85	151
64	131.8	48					
42	135.9	37					
37	142.2	18	339	79	162		
44	143.8	77					
33	149.0	9					
45	151.5	56					
40	156.2	16					

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

Site: Forsmark
Borehole name: KFM08B
Nominal velocity (m/µs): 128.0

Name	Intersection depth	Intersection angle	Object direction	Dip 1	Strike 1	Dip 2	Strike 2
46	157.4	52					
48	160.8	43					
47	163.0	47	204	14	263		
20×	163.8	6					
50	165.3	75					
49	169.4	48					
54	170.5	15					
70	170.6	34					
51	174.8	53					
52	176.0	59					
63	179.8	61					
53	186.4	14					
62	187.2	71					
43×	189.9	15	330	77	152		
56	190.6	58					
55	192.2	46	15	72	12		
61	198.8	52					
43	212.6	11	345	70	166		
59	234.3	16					
41	238.9	10					
71	253.0	22	0	80	182		
60	268.6	17					
67	342.1	14					
68	394.2	13					

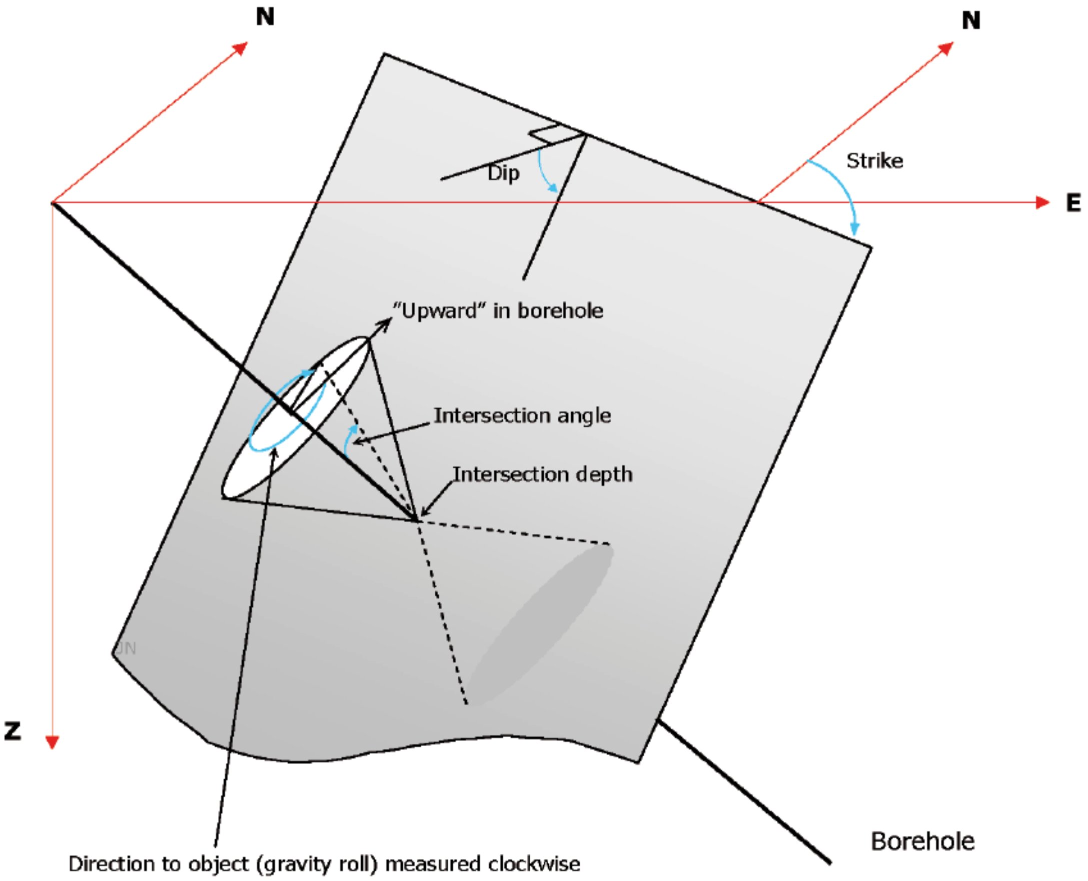


Figure 5-1. *Definition of direction to object, intersection angle, strike and dip as presented in Table 5-2.*

In Appendix 1, 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 Table 5-3.

Table 5-3. Borehole length intervals in KFM08B with decreased amplitude for the 250 MHz antenna.

Depth (m)
30
120
135
155
170–185

In the 20 MHz data (see Figure 5-2) reflections from the nearby borehole KFM08A clearly appears.

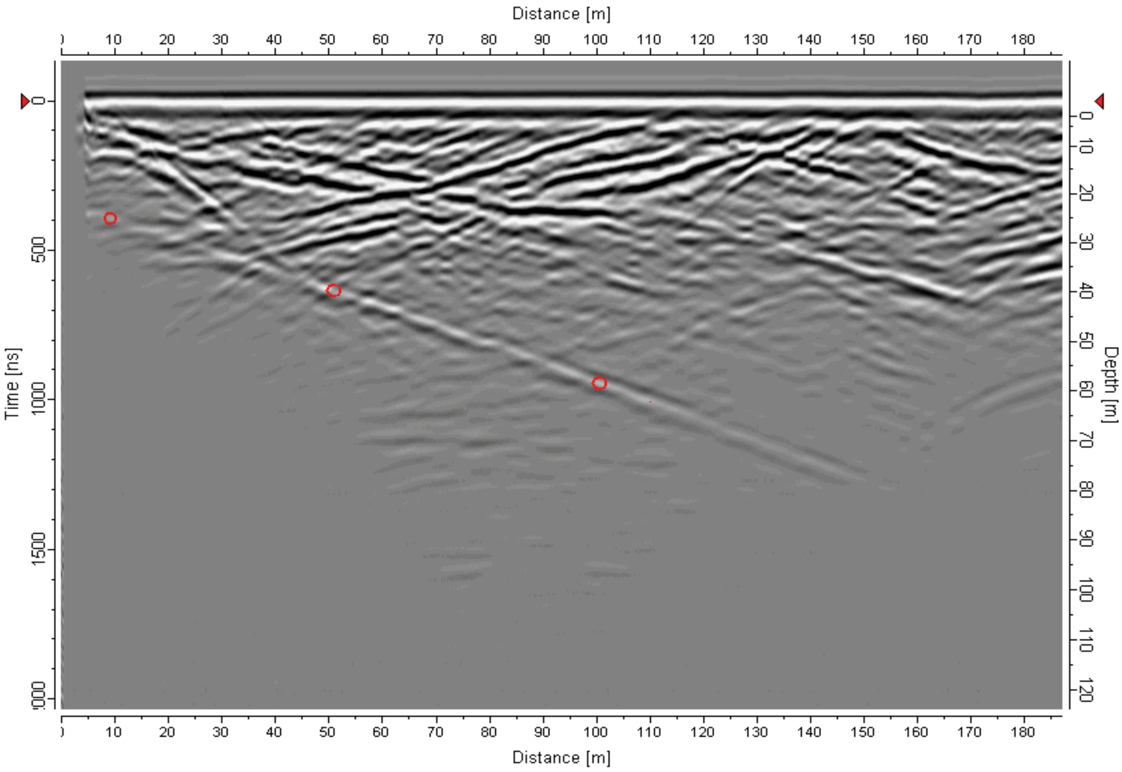
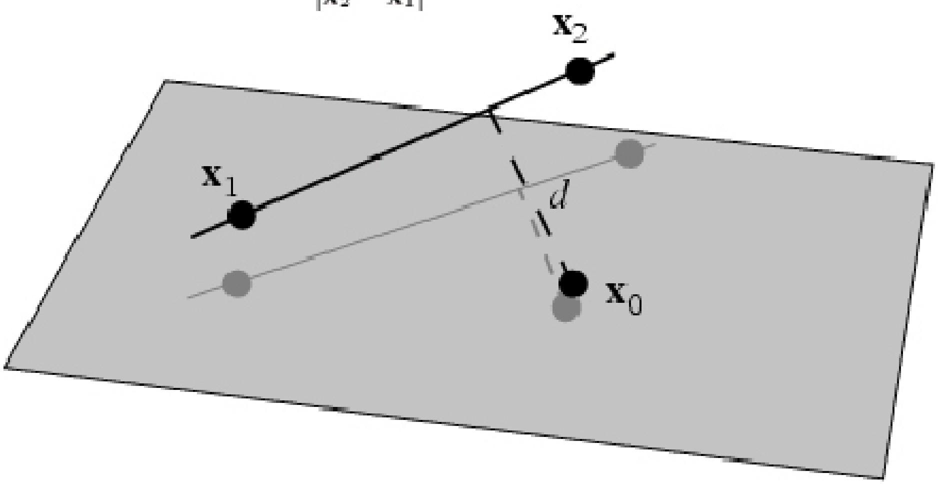


Figure 5-2. *Radar data measured with the 20 MHz dipole antenna. The reflection from the nearby hole KFM08A is clearly observed. The three positions in the borehole (10, 50 and 100 m) at which the comparison is performed, are indicated by red circles.*

It is verified that the reflections originates from KFM08A by calculating the distance *d* from the three-dimensional vector equation (taken from /2/):

$$d = \frac{|(\mathbf{x}_2 - \mathbf{x}_1) \times (\mathbf{x}_1 - \mathbf{x}_0)|}{|\mathbf{x}_2 - \mathbf{x}_1|}.$$



in which x_1, x_2 are two arbitrary points in KFM08A and x_0 denotes a position of the dipole antenna in KFM08B.

Table 5-4. Comparison of measured distance and expected theoretical distance between the radar antenna and the reflection point in KFM08A.

Borehole length	Measured distance (m)	Theoretical distance (m)
10	27	25.5
50	42	39.1
100	62	58.2

Table 5-4 compares the actual measured distance and the expected theoretical distance from the radar antenna to the nearby borehole KFM08A. It is seen that the agreement is acceptable.

5.2 BIPS logging

The BIPS pictures are presented in Appendix 2.

To get the best possible depth accuracy, the BIPS images are adjusted to the reference marks on the logging cable. Additionally the marks on the borehole wall created by the drill rig are visible on the BIPS screen. The recorded length is adjusted to these visible marks. In percussion drilled boreholes we use these marks on the cable as reference for the depth adjustment.

In order to control the quality of the system, calibration measurements were performed in a test pipe before logging the first borehole and after logging of the last borehole. The resulting images displayed no difference regarding the colours and focus of the images. Results of the test loggings were included in the delivery of the field data and are also presented in Figure 4-2 in this report.

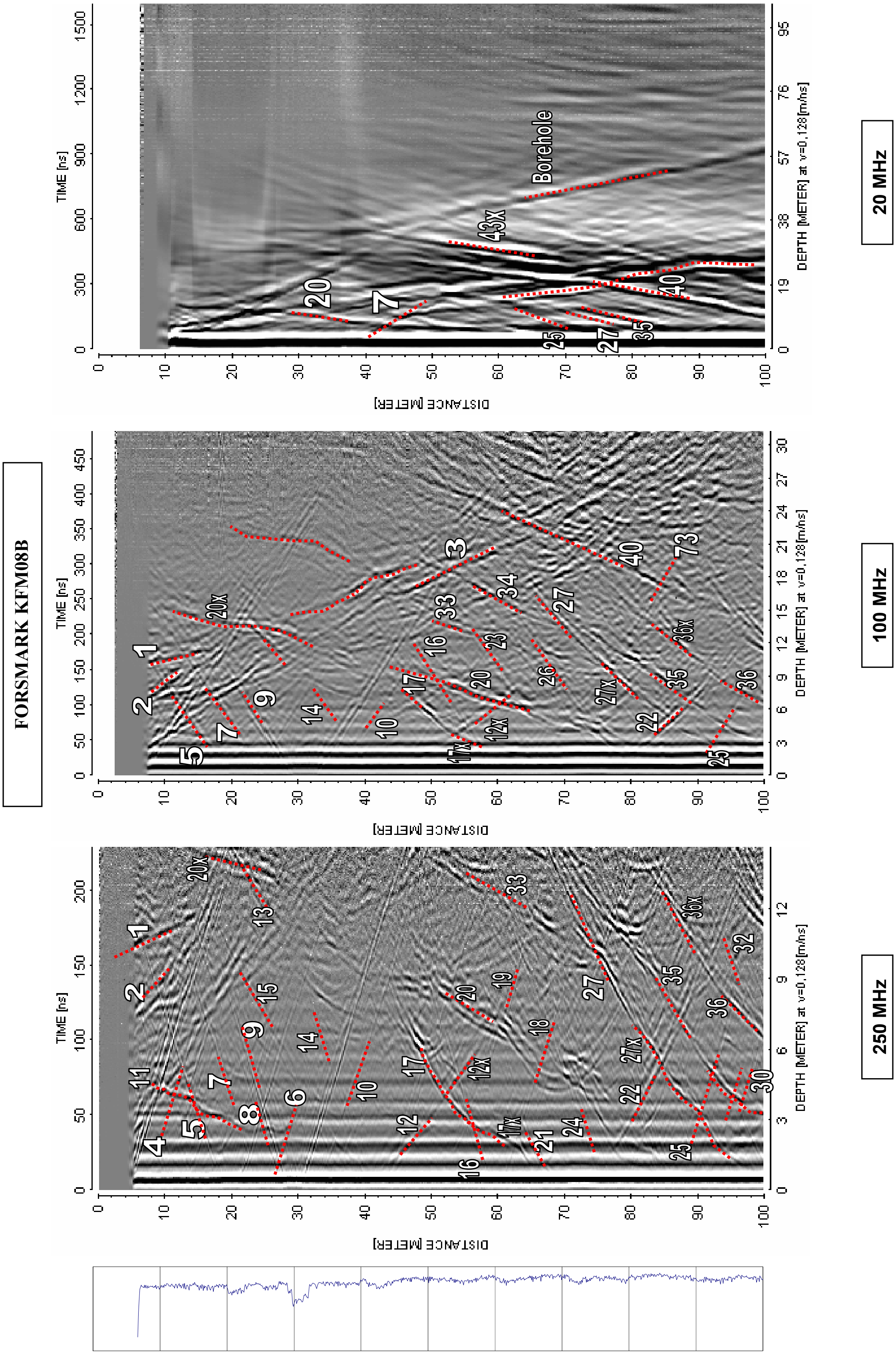
The BIPS images displays little discolouring effect from the drilling that is common in longer core drilled boreholes. The length of the borehole seems to be an important factor of this effect. Along the borehole there is mud that covers the lowermost part of the borehole wall that lowers the quality. This effect is more obvious in the end of the borehole.

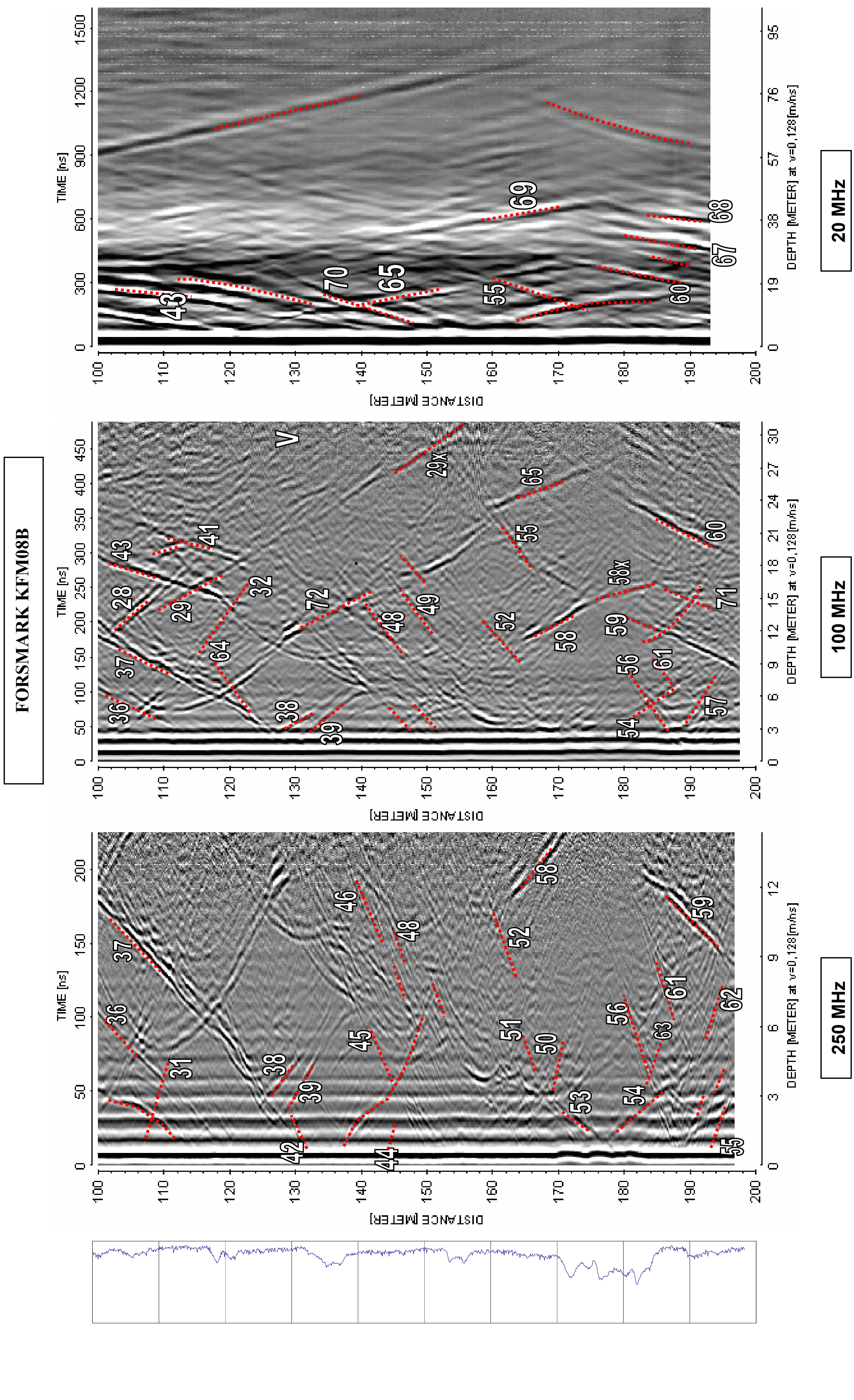
References

/1/ **Gustafsson C, Nilsson P, 2003.** Geophysical Radar and BIPS logging in borehole HFM01, HFM02, HFM03 and the percussion drilled part of KFM01A. SKB P-03-39. Svensk Kärnbränslehantering AB.

/2/ **Weisstein E W.** Point-Line Distance – 3-Dimensional. From MathWorld – A Wolfram Web Resource. http://mathworld.wolfram.com/Point-LineDistance3-Dimensional.html.

Radar logging in KFM08B, 0 to 196 m, dipole antennas 250, 100 and 20 MHz




FORSMARK KFM08B
250 MHz
100 MHz
20 MHz
TIME [ns]
DISTANCE [METER]
DEPTH [METER] at v=0,128[m/ns]

Appendix 2

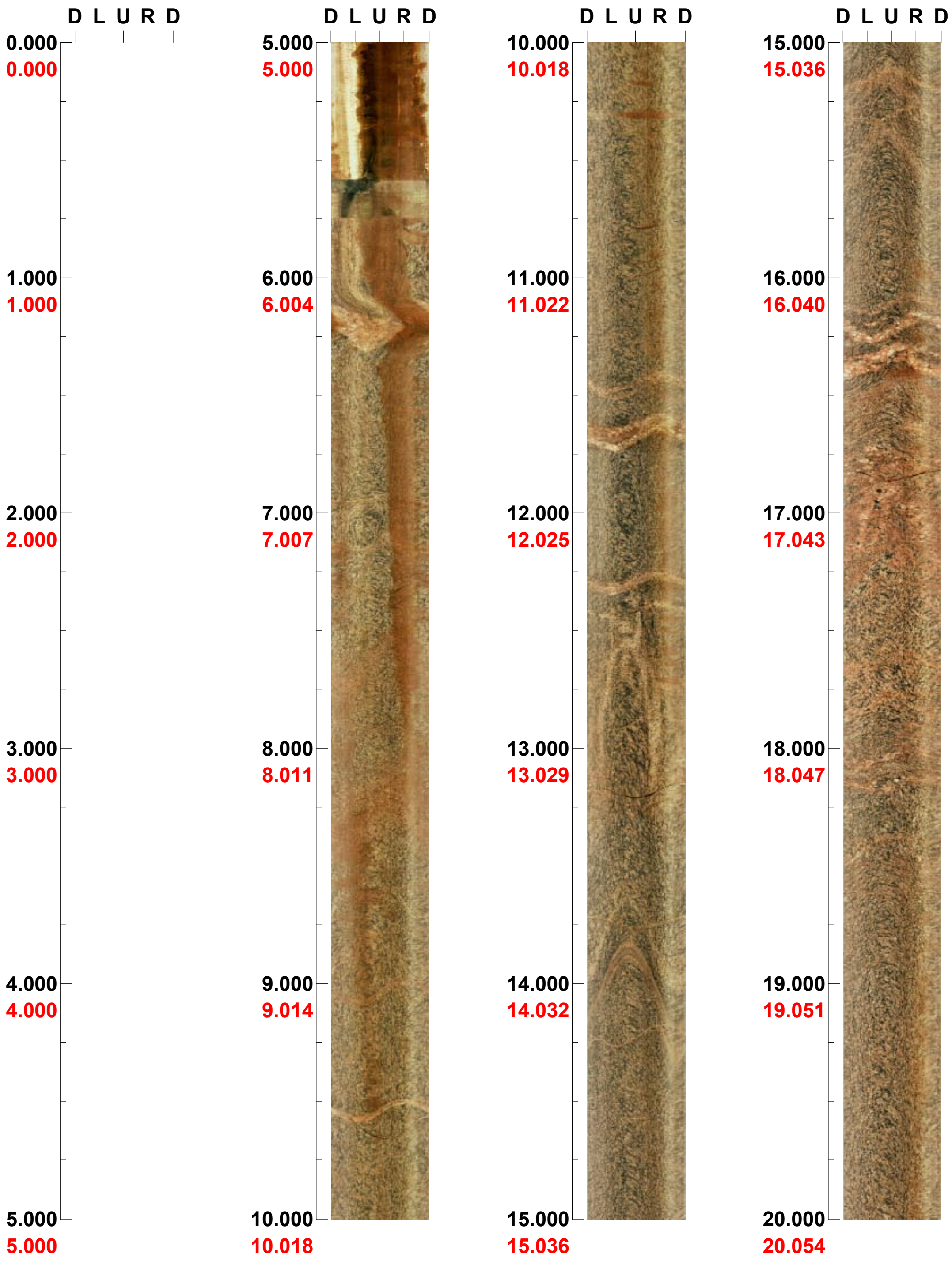
BIPS logging in KFM08B, 5 to 199 m

Project name: Forsmark

Image file	: c:\work\r5282s~1\kfm08b\bips\kfm08b.bip
BDT file	: c:\work\r5282s~1\kfm08b\bips\kfm08b.bdt
Locality	: FORSMARK
Bore hole number	: KFM08B
Date	: 05/02/10
Time	: 09:06:00
Depth range	: 5.000 - 199.146 m
Azimuth	: 270
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	: 10
Color	: +0 +0 +0

Project name: Forsmark
Bore hole No.: KFM08B **Azimuth: 270** **Inclination: -60**

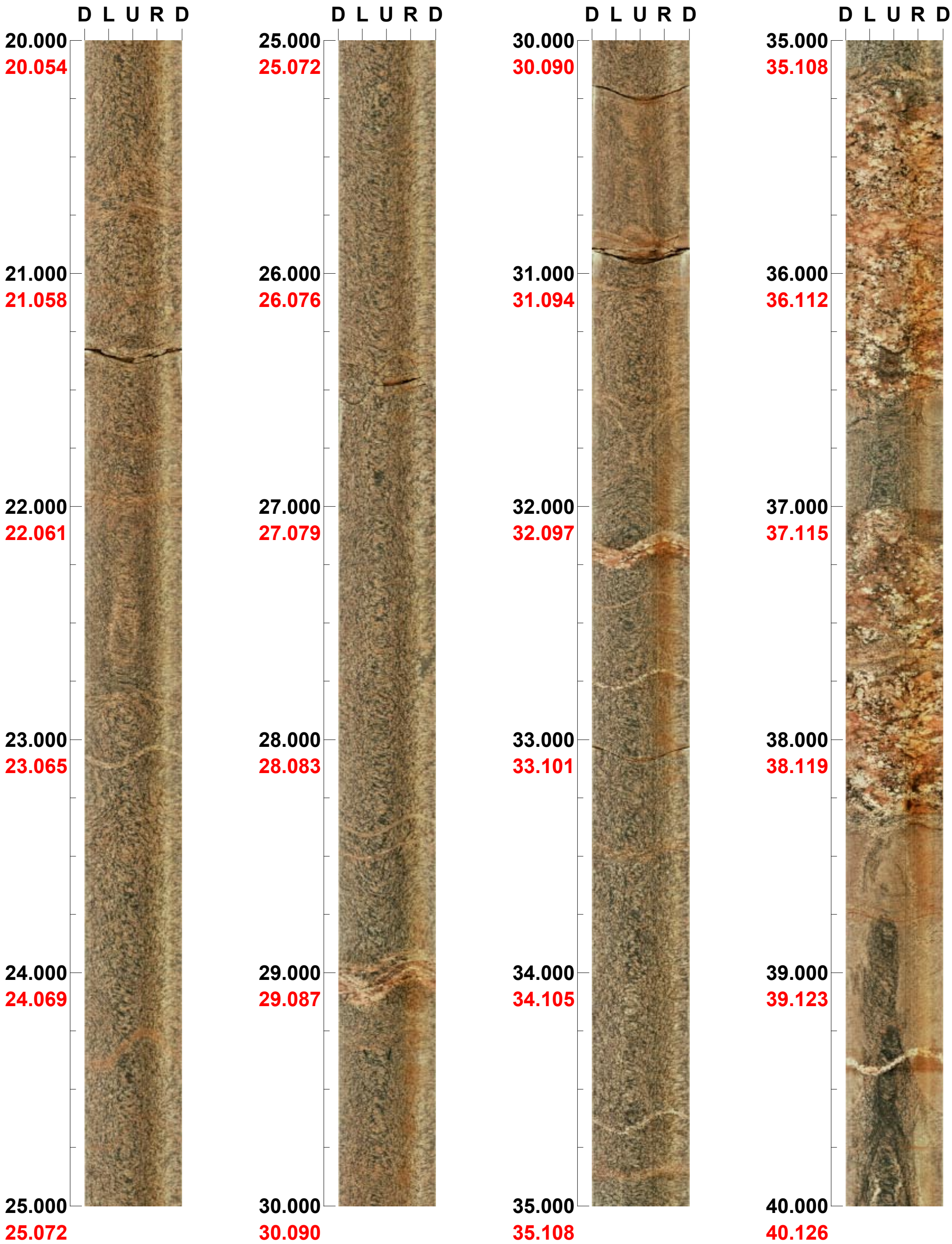
Depth range: 0.000 - 20.000 m



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

Project name: Forsmark
Bore hole No.: KFM08B **Azimuth: 270** **Inclination: -60**

Depth range: 20.000 - 40.000 m



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

Project name: Forsmark
Bore hole No.: KFM08B **Azimuth: 270** **Inclination: -60**

Depth range: 40.000 - 60.000 m

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

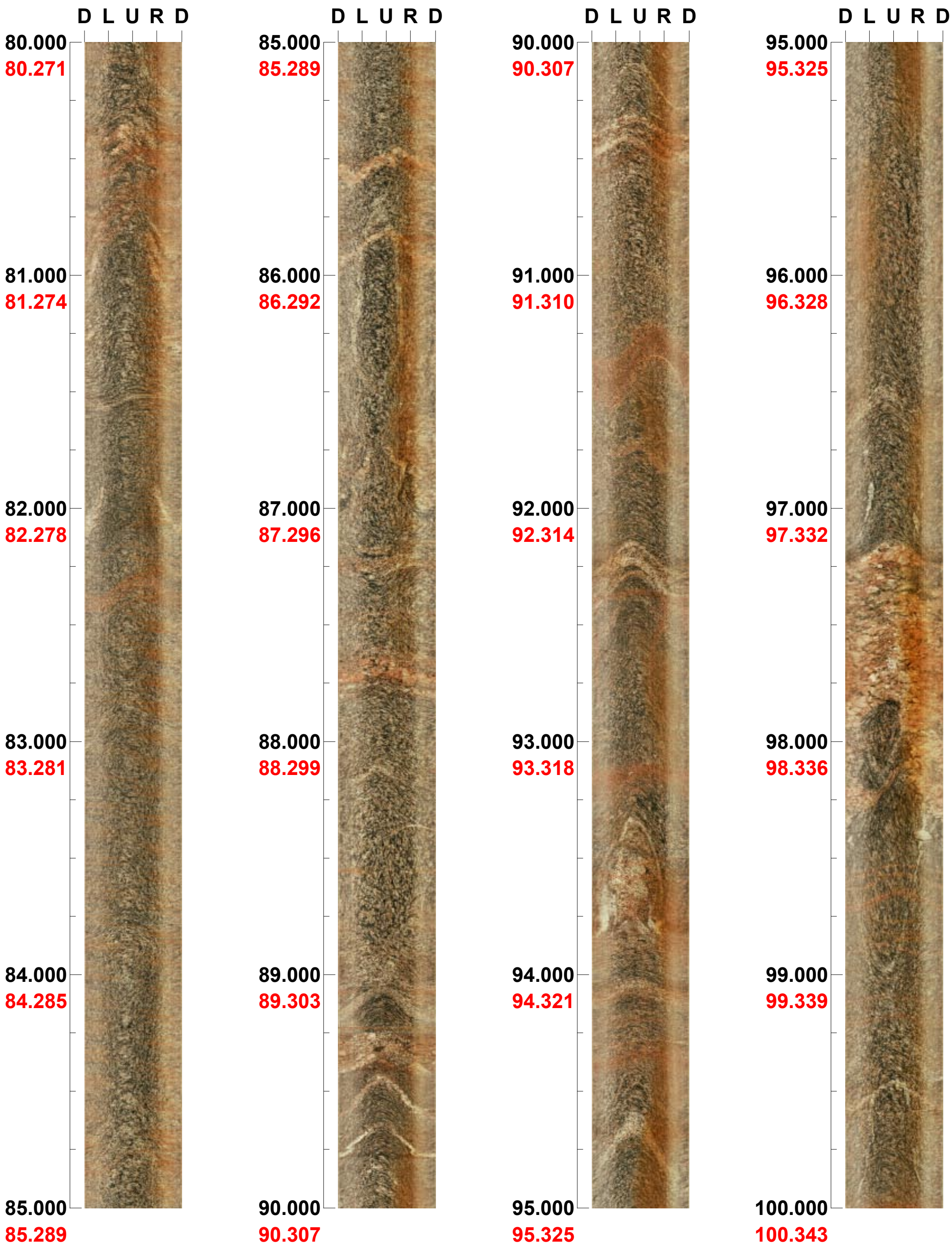
Project name: Forsmark
Bore hole No.: KFM08B **Azimuth: 270** **Inclination: -60**

Depth range: 60.000 - 80.000 m

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

Project name: Forsmark
Bore hole No.: KFM08B **Azimuth: 270** **Inclination: -60**

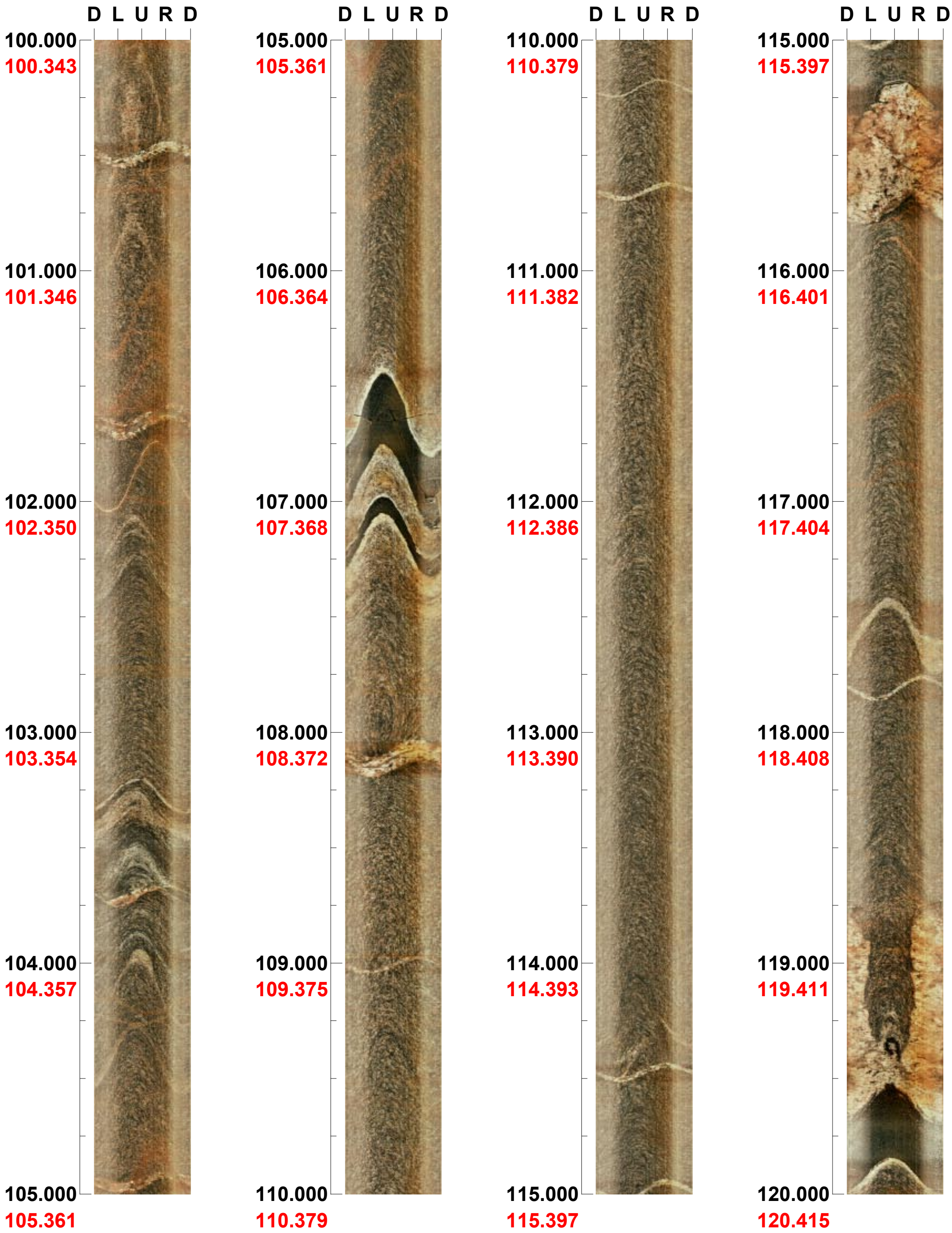
Depth range: 80.000 - 100.000 m



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

Project name: Forsmark
Bore hole No.: KFM08B **Azimuth: 270** **Inclination: -60**

Depth range: 100.000 - 120.000 m



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

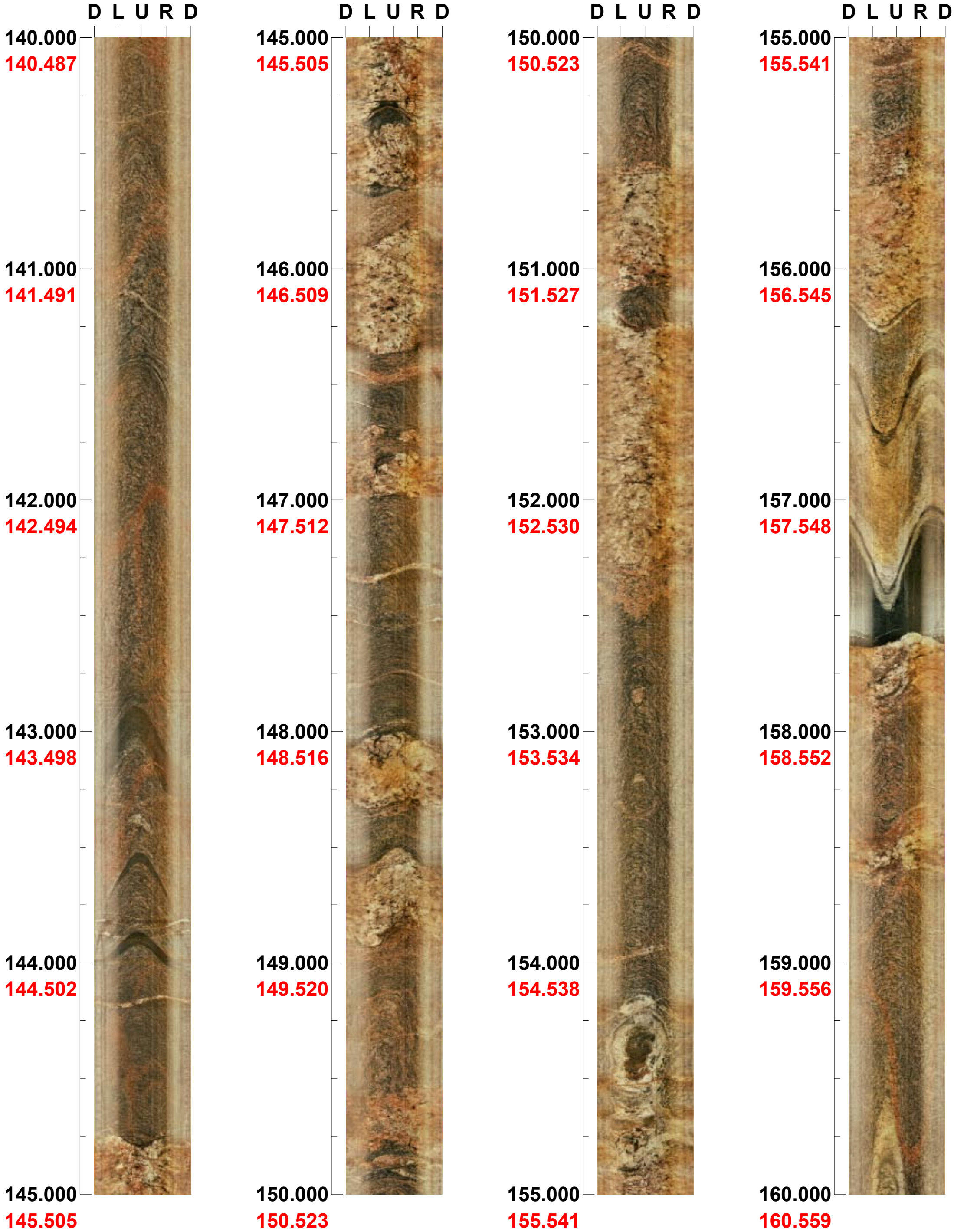
Project name: Forsmark
Bore hole No.: KFM08B **Azimuth: 270** **Inclination: -60**

Depth range: 120.000 - 140.000 m

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

Project name: Forsmark
Bore hole No.: KFM08B **Azimuth: 270** **Inclination: -60**

Depth range: 140.000 - 160.000 m



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

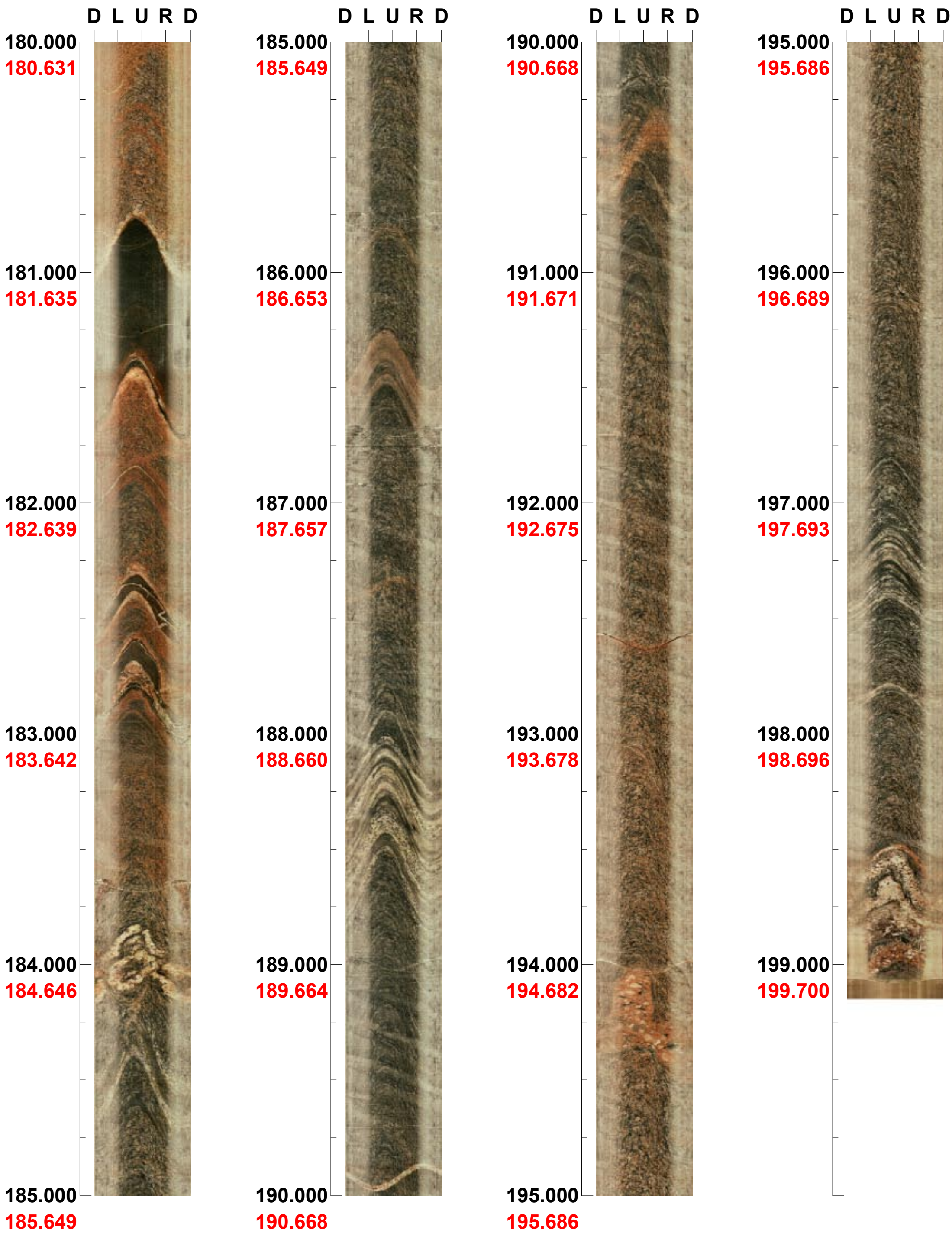
Project name: Forsmark
Bore hole No.: KFM08B **Azimuth: 270** **Inclination: -60**

Depth range: 160.000 - 180.000 m

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

Project name: Forsmark
Bore hole No.: KFM08B **Azimuth: 270** **Inclination: -60**

Depth range: 180.000 - 199.146 m



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