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Forsmark site investigation

BIPS logging in the boreholes HFK248, HFK249 and HFK250

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Keywords: BIPS, TV, Forsmark, AP PF 400-05-039.

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 in the percussion-drilled boreholes HFK248, HFK249 and HFK250. During the field activity the boreholes was denoted PFM000034, PFM000035 and PFM0000036, and the delivered field protocols refer to these ID-codes. All measurements were conducted by Malå Geoscience AB/RAYCON at May 11, 2005.

The boreholes were drilled 1999–2000 by Geosigma AB for the Forsmark power plant in order to produce drinking water. However, the water quality was not suitable for drinking water, and thus the boreholes were not used further.

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.

It was only in one of the boreholes that we could log to the bottom. The image quality was surprisingly good, even though the boreholes were drilled more than 5 years ago.

Sammanfattning

Denna rapport omfattar geofysiska loggningar inom platsundersökningsprogrammet för Forsmark. Mätningarna som presenteras här omfattar BIPS-loggningar i borrhålen HFK248, HFK249 and HFK250 (tidigare PFM000034, PFM000035 och PFM000036). Alla mätningar är utförda av Malå Geoscience AB/RAYCON den 11 maj 2005.

Hålen borrades 1999–2000 av Geosigma AB som dricksvattenbrunnar för Forsmarksverket. Eftersom vattenkvalitén inte var tillfredsställande har brunnarna inte använts vidare.

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.

Endast ett av borrhålen kunde loggas ner till botten. BIPS bilderna kvalitet var överraskande bra. Hålen borrades för drygt 23 år sedan, och det normala är att borrhålsväggarna blir mörka med åren.

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 a TV-logging (BIPS) in the percussion-drilled boreholes HFK248, HFK249 and HFK250. The work was carried out in accordance with Activity plan AP PF 400-05-039. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents.

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

Activity plan	**Number**	**Version**
BIPS loggning i FKA-hålen PFM000034, PFM000035, PFM000036, PFM000037	AP PF 400-05-039	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för TV- loggning med BIPS	SKB MD 222.006	1.0

This report includes measurements from 4 to 6 m in borehole HFK248 (previously denoted PFM000034), from 8 to 51 m in borehole HFK249 (previously denoted PFM000035) and from 3 to 25 m in borehole HFK250 (previously denoted PFM000036). The boreholes were drilled with a diameter of 154–160 mm.

Figure 1-1 shows a photography of one of the measuring sites, and Figure 1-2 shows a map with the locations of the boreholes.

The used investigation techniques comprised:

- Borehole TV logging with the so-called BIPS-system (Borehole Image Processing System), which is a high resolution, side viewing, colour borehole TV system.

Figure 1-1. *The measurement container during transportation.*

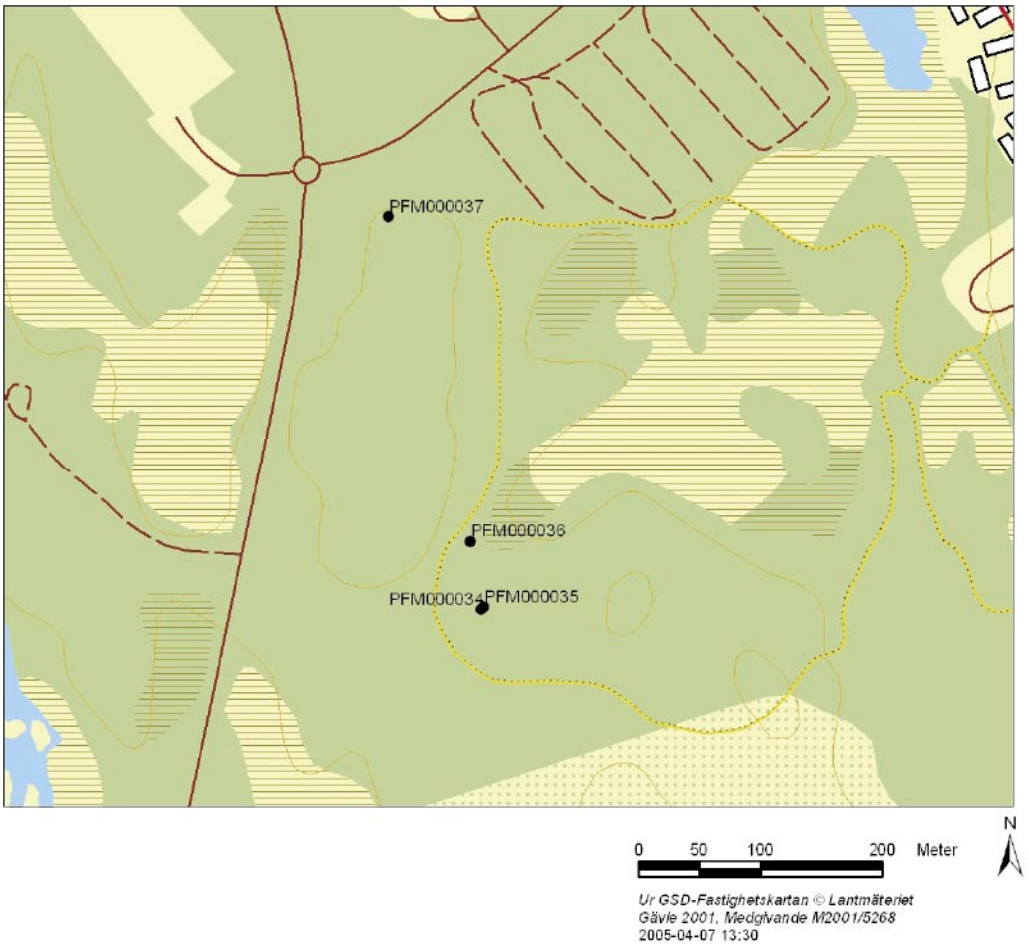


Figure 1-2. *Detailed map over the area SW of the residential area in Forsmark, with the three boreholes. Observe that the ID-codes are changed to HFK248-HFK250. The hole PFM000037 was not accessible.*

2 Objective and scope

The objective of the BIPS surveys is to achieve information on the borehole conditions (borehole wall). Borehole TV is engaged 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. The BIPS results are presented as images.

3 Equipment

3.1 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).

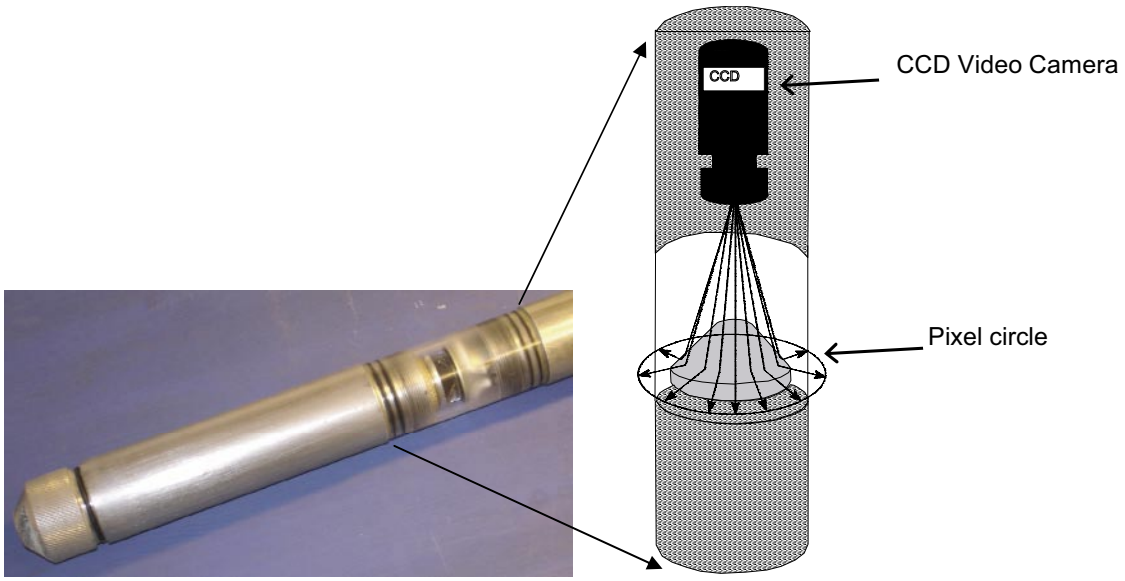


Figure 3-1. *The BIPS-system. To the right an illustration of the conical mirror scanning.*

4 Execution

4.1 General

4.1.1 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 4-1 corresponds to the test pipe logging before and after the logging campaign in May. 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 Appendix 2 in this report.

Technical data for the three boreholes are listed in Table 4-1.

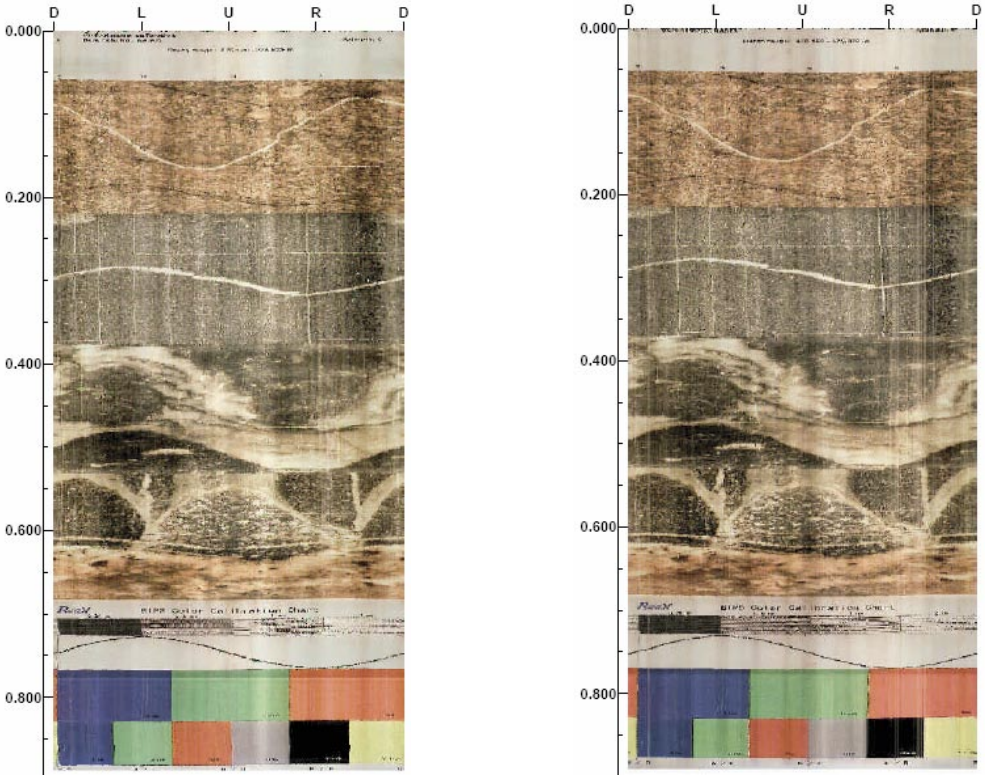


Figure 4-1. *Results from logging in the test pipe before and after the logging campaign in May 2005.*

Tabell 4-1. Technical data for HFK248, HFK249 and HFK250.

	HFK248 (PFM000034)	HFK249 (PFM000035)	HFK250 (PFM000036)
Coordinate (RT 90)	6699445 1630244	6699447 1630246	6699501 1630235
Drection	105º	105º	100º
Dip	–60º	–60º	–60º
Length	10	52	40
Casing	4.5	9	12

4.1.2 Length measurements

During the BIPS logging in core-drilled boreholes, were the reference marks in the borehole wall is visible on the image, the logging cable is marked with scotch tape. These tape marks are then used for controlling the RAMAC and BIPS measurements in percussion-drilled boreholes. For these boreholes no length adjustments are made due the very shallow depths, lack off reference marks and marks on the logging cable. The experience we have from earlier measurements with this equipment in the core-drilled boreholes in Forsmark and Oskarshamn is that the length divergence is less than 50 cm in the deeper parts (700–1,000 m) of the core drilled boreholes. In the present very short boreholes we estimate the length divergence to be less than 10 cm.

4.2 Analyses and Interpretation

4.2.1 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 made on the cable when logging core-drilled boreholes (where the length marks are visible in the BIPS image). For printing of the BIPS images the printing software BIPP from RaaX was used.

4.3 Nonconformities

Before starting the field activity, the boreholes were checked. During this check it was found out that the borehole HFK251 (PFM000037) was blocked close to the casing and logging was therefore canceled. We did not manage to log to the bottom in boreholes HFK248 and HFK250.

5 Results

The results from the BIPS measurements in HFK248, HFK249 and HFK250 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.

5.1 BIPS logging

The BIPS pictures are presented in Appendix 1, 2 and 3.

Due to the shallow logging depths and lack of reference marks on the logging cable at this depths no depth adjustment is performed on presented results in this report.

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 4-1 in this report.

Data quality is relatively good for geological mapping in all three boreholes. In borehole HFK249 the visibility is limited due to mud partly covering the borehole wall.

Appendix 1

BIPS logging in HFK248, 4 to 6.1 m

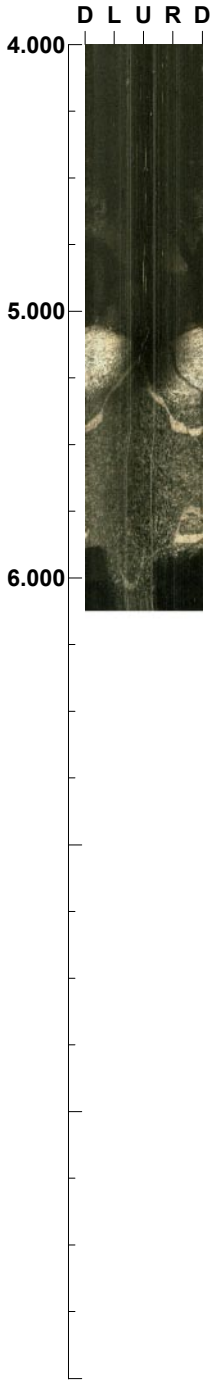
Project name: Forsmark

Image file	**: c:\work\r5399s~1\bips\fkabor~1\pfm00034.bip**
BDT file	**: c:\work\r5399s~1\bips\fkabor~1\pfm00034.bdt**
Locality	**: FORSMARK**
Bore hole number	**: PFM00034**
Date	**: 05/05/11**
Time	**: 17:23:00**
Depth range	**: 4.000 - 6.120 m**
Azimuth	**: 105**
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	**: 1**
Color	**:**  **+0 +0 +0**

Appendix 1. HFK248

Project name: Forsmark
Bore hole No.: PFM00034 **Azimuth: 105** **Inclination: -60**

Depth range: 4.000 - 6.120 m



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

Appendix 2

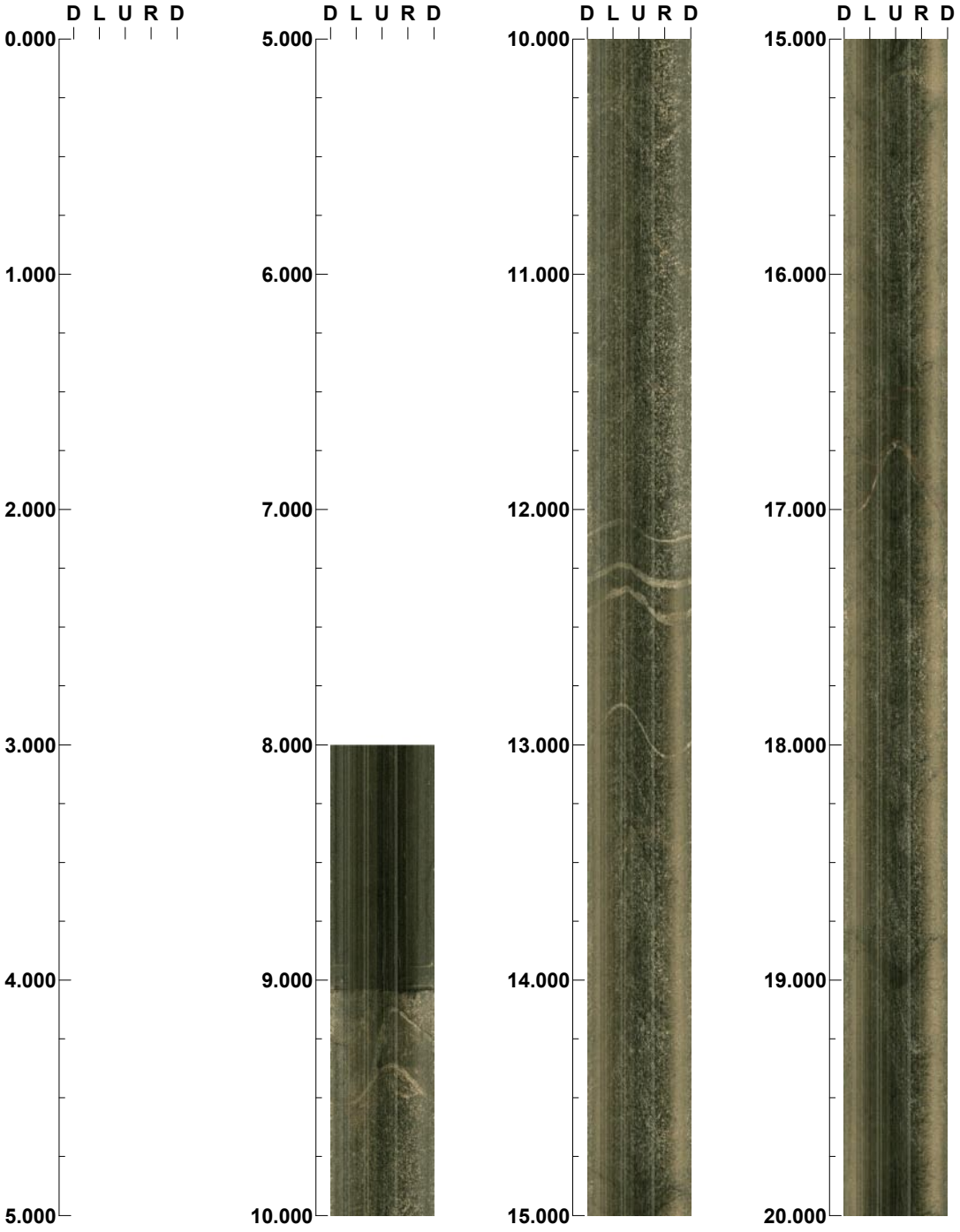
BIPS logging in HFK249, 8 to 51.5 m

Project name: Forsmark

Image file	**: c:\work\r5399s~1\bips\fkabor~1\pfm00035.bip**
BDT file	**: c:\work\r5399s~1\bips\fkabor~1\pfm00035.bdt**
Locality	**: FORSMARK**
Bore hole number	**: PFM00035**
Date	**: 05/05/11**
Time	**: 16:38:00**
Depth range	**: 8.000 - 51.504 m**
Azimuth	**: 105**
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	**: 3**
Color	**: +0 +0 +0**

Project name: Forsmark
Bore hole No.: PFM00035 **Azimuth: 105** **Inclination: -60**

Depth range: 0.000 - 20.000 m



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

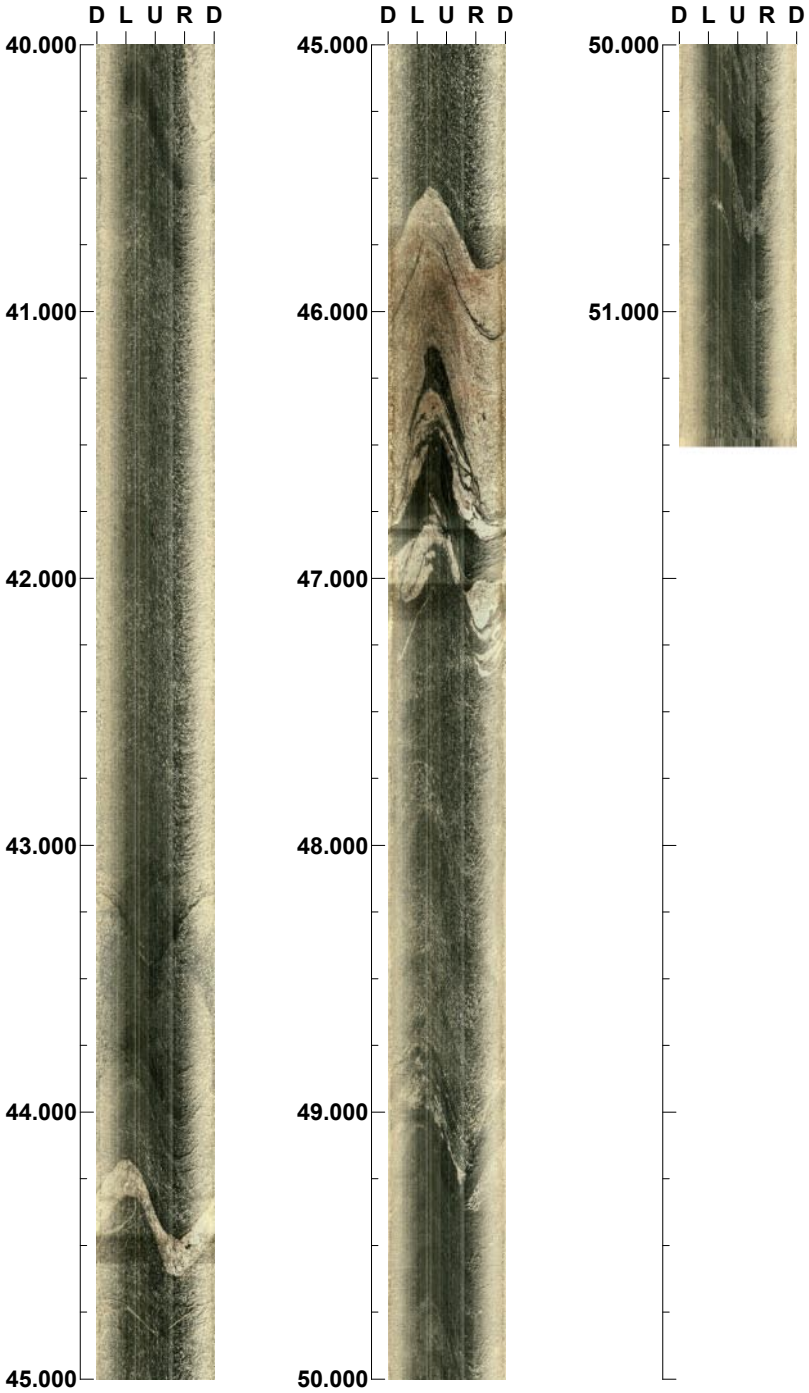
Project name: Forsmark
Bore hole No.: PFM00035 **Azimuth: 105** **Inclination: -60**

Depth range: 20.000 - 40.000 m

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

Project name: Forsmark
Bore hole No.: PFM00035 **Azimuth: 105** **Inclination: -60**

Depth range: 40.000 - 51.504 m



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

Appendix 3

BIPS logging in HFK250, 3.5 to 25.5 m

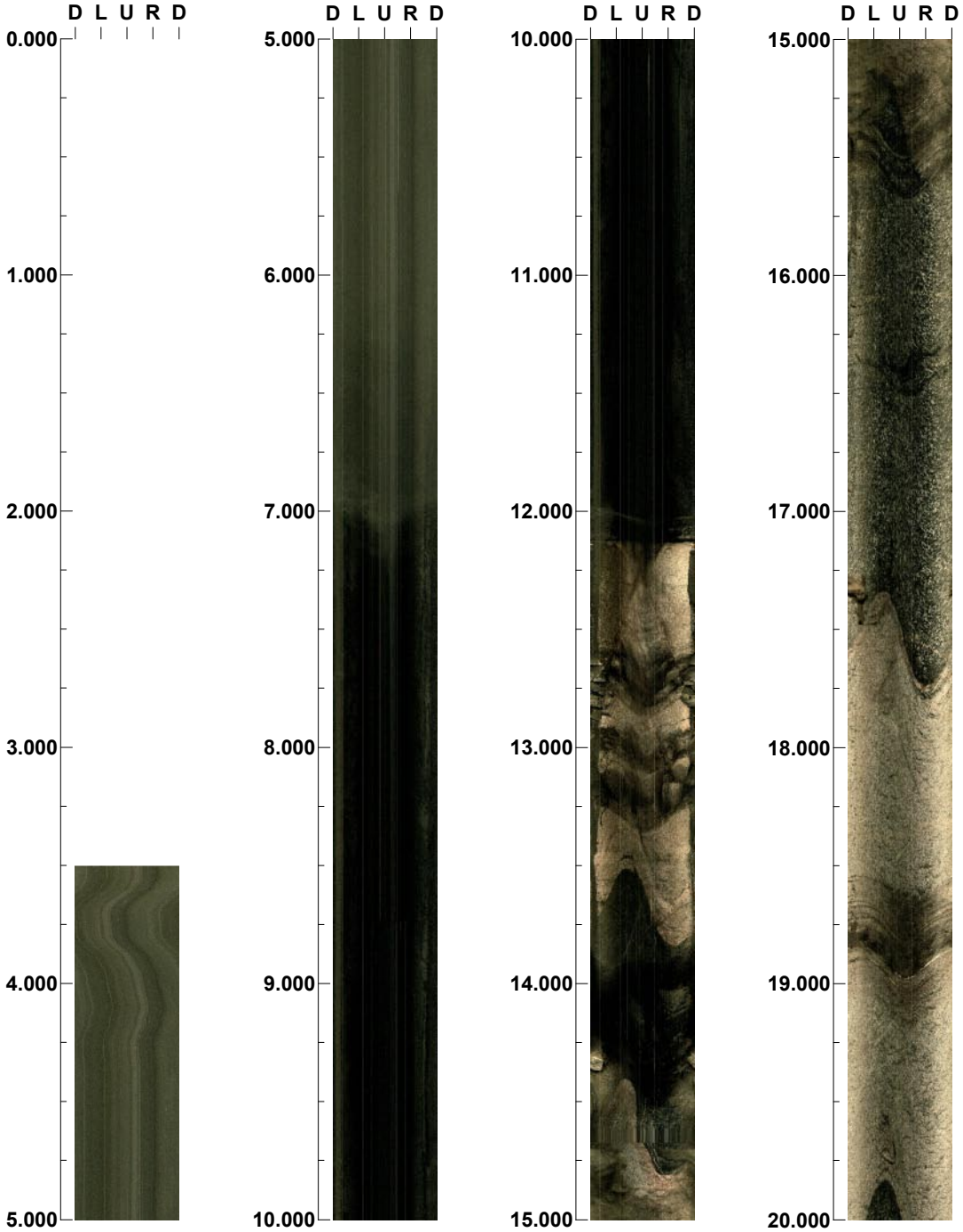
Project name: Forsmark

Image file	**: c:\work\r5399s~1\bips\fkabor~1\pfm00036.bip**
BDT file	**: c:\work\r5399s~1\bips\fkabor~1\pfm00036.bdt**
Locality	**: FORSMARK**
Bore hole number	**: PFM00036**
Date	**: 05/05/11**
Time	**: 15:24:00**
Depth range	**: 3.500 - 25.536 m**
Azimuth	**: 100**
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	**: 2**
Color	**:**  **+0 +0 +0**

Appendix 3. HFK250

Project name: Forsmark
Bore hole No.: PFM00036 **Azimuth: 100** **Inclination: -60**

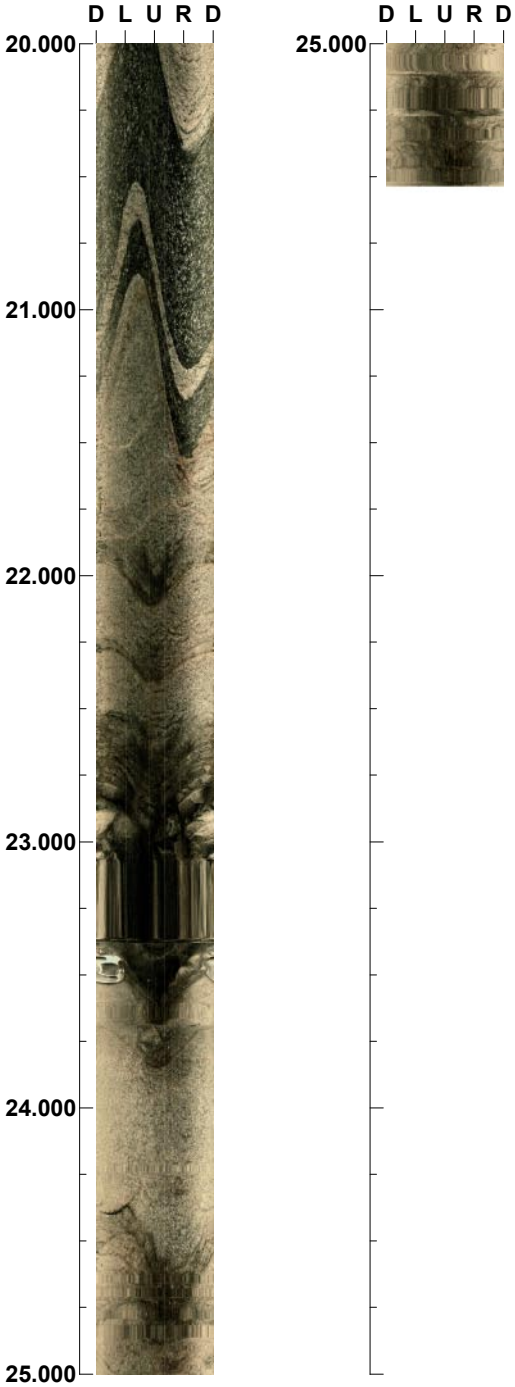
Depth range: 0.000 - 20.000 m



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

Project name: Forsmark
Bore hole No.: PFM00036 **Azimuth: 100** **Inclination: -60**

Depth range: 20.000 - 25.536 m



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