P-04-234

Oskarshamn site investigation

Drilling of two percussion boreholes, HLX13 and HLX14

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December 2004

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Keywords: Percussion drilling, Flushing water well, Soil, Bedrock.

Summary

Drilling of percussion holes is required as a supplement to the drilling of deep cored holes. In general, the percussion holes serve two principal purposes: water supply for core drilling and as investigation boreholes to shallow depth.

Boreholes HLX13 and HLX14 were drilled for supply of flushing water for core drilling in the Laxemar subarea.

Borehole HLX13 did not yield enough water and a second percussion hole was drilled close by but in a different direction. The new hole was called HLX14 and it did yield sufficient amounts of water.

The drilling was performed by contractor Sven Andersson in Uppsala AB in February and March 2004.

Supportive means to the drilling operations were given from SKB personnel regarding planning, coordination, infrastructure, sampling and on-site measurements.

A summary of data from boreholes HLX13 and HLX14 is given in Table 0-1.

Lengths in the boreholes are given as metres below “top of casing”.

Table 0-1. Technical summary.

	HLX13	HLX14
Easting RT90	1547690	1547692
Northing RT90	6366953	6366960
Elevation (m.a.s.l) RH70	17.39	17.11
Azimuth (0–360)	184	90
Dip (0–90)	–58	–69
Drilling dates	040224–040226	040308–040311
Casing depth	11.85 m	11.9 m
Casing inner diameter (mm)	160	160
Hole diameter (mm)	140.0	139.0
Length (m)	200.2	115.9
Water yield	3 l/min	60 l/min

Sammanfattning

Hammarborrhål borras i allmänhet för två olika ändamål: dels för vattenförsörjning vid kärnborrning och dels för att möjliggöra undersökningar i ytligare berggrund.

Borrhålen HLX13 och HLX14 utfördes som spolvattenbrunnar inför kärnborrningen inom delområde Laxemar. HLX13 gav inte tillräckliga mängder vatten och ett andra borrhål utfördes i närheten men i en annan riktning. Det nya hålet kallades HLX14 och gav tillräckliga mängder vatten.

Borrningen utfördes på entreprenad av Sven Andersson i Uppsala AB under februari och mars 2004. SKB personal utförde planering och koordinering av aktiviteten samt vissa stödinsatser vid borrning tex borrplatsanläggning, provtagningar och mätningar.

En sammanfattning av data från borrhål HLX13 och HLX14 ges i tabell 0-1.

Borrhålslängder anges som meter under foderrörets överkant.

Tabell 0-1. Teknisk sammanfattning.

	HLX13	HLX14
Öst RT90	1547690	1547692
Nord RT90	6366953	6366960
Elevation (m.a.s.l) RH70	17.39	17.11
Riktning (0–360)	184	90
Lutning (0–90)	–58	–69
Datum för borrning	040224–040226	040308–040311
Foderrörslängd	11.85 m	11.9 m
Foderrör innerdiameter (mm)	160	160
Hål diameter (mm)	140.0	139.0
Längd (m)	200.2	115.9
Vattenmängd	3 l/min	60 l/min

Contents

1 Introduction

SKB performs site investigations in order to evaluate the feasibility of locating a deep repository for high level radioactive waste /1/ in two Swedish municipalities: Östhammar and Oskarshamn.

This report will describe the drilling of the two percussion holes, HLX13 and HLX14, and the measurements performed during the drilling phase. The holes were drilled in the Laxemar subarea of the Oskarshamn site investigation /2/. The location of the boreholes is shown in Figure 1-1. The decision to drill HLX13 and HLX14 is included in SKB ID 1021608 (2004-02-17). A notification according to the Environmental Code was issued to the regional authorities, SKB ID 1032089.

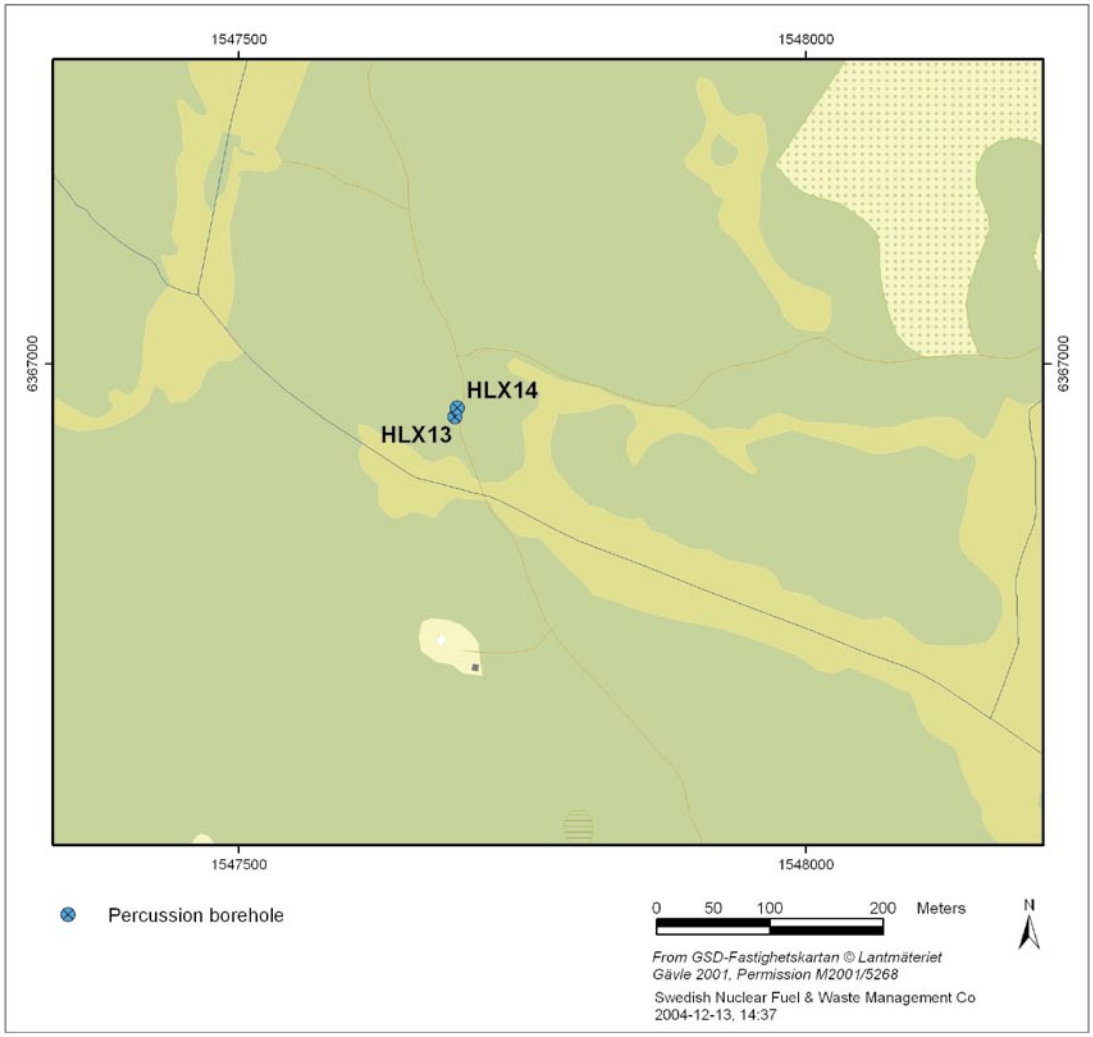


Figure 1-1. *Location of boreholes HLX13 and HLX14 in the Laxemar subarea of the Oskarshamn site investigation.*

The drilling and all related on-site operations were performed according to a specific Activity Plan (AP PS 400-04-016). Reference is given in the activity plan to procedures in the SKB Method Description for Percussion Drilling (SKB MD 610.003, Version 1.0) and other relevant method instructions for handling of chemicals, surveying and evaluation of cuttings. The controlling documents for the activity are listed in Table 1-1.

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

Activity plan	Number	Version
Hammarborrning av spolvattenbrunn HLX13.	AP PS 400-04-016	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för hammarborrning.	SKB MD 610.003	1.0
Metodbeskrivning för undersökning av borrkax.	SKB MD 142.001	1.0
Instruktion för rengöring av borrhålsutrustning och viss markbaserad utrustning.	SKB MD 600.004	1.0
Instruktion för användning av kemiska produkter och material vid borrning och undersökningar.	SKB MD 600.006	1.0
Instruktion för borrplatsanläggning.	SKB MD 600.005	1.0
Instruktion för spolvattenhantering.	SKB MD 620.007	1.0
Instruktion för utsättning och inmätning av borrhål.	SKB MD 600.002	1.0

Activity plans and method descriptions are SKB internal documents.

All data were stored in the SICADA database for Oskarshamn. The field note numbers for entry into SICADA are given in Table 1-2.

Table 1-2. Data references.

Subactivity	Database	Field note number
Drilling HLX13	SICADA	FN 251
Drilling HLX14	SICADA	FN 294
Air lift pumping test HLX13 and HLX14	SICADA	FN 277

2 Equipment and methods

In this chapter descriptions are given of the drilling equipment, the technique and equipment for gap injection of the borehole casings and of the instrumentation used for deviation measurements performed after completion of drilling. Also the equipment used for measurements and sampling during drilling is briefly described.

Drilling, completion and deviation measurements were made by contractor Sven Andersson, Uppsala AB.

2.1 Drilling equipment

Drilling of the two percussion boreholes was made with a Puntel percussion drilling machine supplied with accessories.

The drilling machine was equipped with separate engines for transportation and power supplies. For the raising of water and drill cuttings from the borehole, a 27 bar diesel air-compressor, type Atlas-Copco XRVS 455 Md was used. The DTH drillhammer was of type Secoroc 5”, lowered into the borehole by a Driconeq 114 mm pipe string.

2.2 Equipment for measurements and sampling during drilling

Flow measurements during drilling were performed using measuring a graded vessel and a stop watch. Measurement of the drilling penetration rate was done manually.

Samples of soil and drill cuttings were collected in sampling pots. Water flow measurements are typically made at 100 and 200 metres length or where noticeable changes in water flow occur.

3 Execution

The work was performed in accordance with SKB MD 610.003, Version 1.0 (Method Description for Percussion Drilling, SKB internal document) and consisted of:

- preparations,
- drilling through overburden,
- gap injection techniques and equipment,
- percussion drilling in hard rock,
- sampling and measurements,
- borehole completion,
- data handling,
- environmental control.

3.1 Preparations

The preparation stage included the Contractor's functional control of his equipment. The machinery and chemicals used have to comply with SKB MD 600.006, Version 1.0 (Method Instruction for Chemical Products and Materials, SKB internal document).

The equipment was cleaned in accordance with SKB MD 600.004, Version 1.0 (Method Instruction for Cleaning Borehole Equipment and certain Ground-based Equipment, SKB internal document).

3.2 Drilling through overburden

The terrain encountered in the Laxemar subarea of investigation consists of gently undulating bedrock surface with low to moderate relief. The crystalline rock basement frequently outcrops or subcrops in the higher terrain and is covered with unconsolidated soil in the more shallow parts.

Excentric percussion drilling with 200 mm diameter ("ODEX 160") was made through the unconsolidated soil and fractured near-surface bedrock.

3.3 Gap injection techniques and equipment

In order to prevent surface water and shallow groundwater to infiltrate into deeper parts of the borehole, the gap between the borehole wall and the casings was grouted with cement, see Figure 3-1.

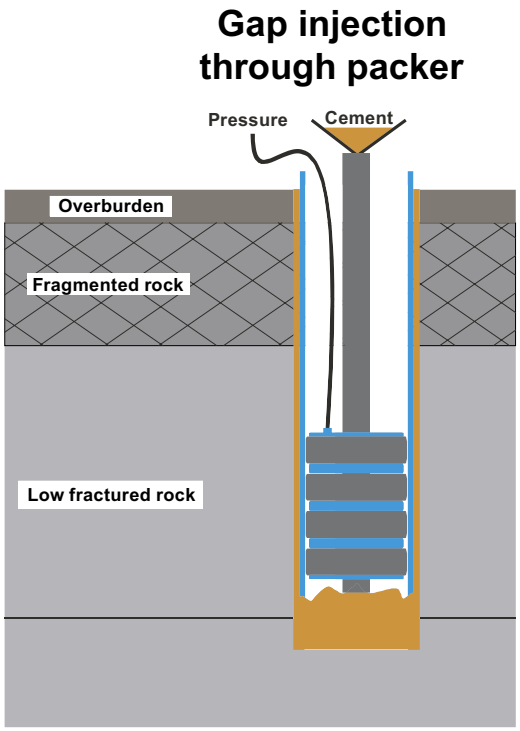


Figure 3-1. *Gap injection technique.*

A packer was installed at the bottom of the cased section. The concrete introduced through the packer and allowed to flow up between the casing and the bedrock wall. A reference sample of the cement paste was kept cool and dark on the surface to ensure that drilling was not resumed until the mixture had hardened.

3.4 Percussion drilling in hard rock

After allowing the cement to harden, drilling could continue and was performed to the full borehole length with conventional percussion drilling with a nominal diameter of 140 mm.

3.5 Sampling and measurements

Sampling and measurements done by the drill coordinators during drilling included:

- Samples of rock chip drill cuttings were taken along the holes. Three grab samples were taken over a length of three metres and collected to one sample. The samples were stored for later logging and analysis.
- Penetration rate (expressed as seconds per 20 cm) was manually recorded.
- Noticeable changes in water flow and colour of return water were recorded manually.

The water yield from the hole was estimated after the drilling phase was completed. The method employed was to blow compressed air through the drill stem and to measure the amount of return water during steady state conditions.

When the drilling was completed the hole was rinsed from drill cuttings by blowing air with the compressor at maximum capacity for 30 minutes.

Deviation measurements were not made in conjunction with drilling in the two holes.

3.6 Borehole completion

The boreholes were secured by mounting a lockable steel cap on the casing.

All equipment was removed, the site cleaned and a joint inspection was made by representatives from SKB and the Contractor to ensure that the site had been restored to satisfactory level.

3.7 Data handling

Data collected by the drill coordinators were reported in daily logs and other protocols and delivered to the Activity Leader. The information was entered to SICADA (SKB database) by database operators.

3.8 Environmental control

The SKB routine for environmental control (SDP-301, SKB internal document) was followed throughout the activity. A checklist was filled in and signed by the Activity Leader and filed in the SKB archive.

All waste generated during the establishment, drilling and completion phases have been removed and disposed of properly. Water effluent from drilling was allowed to infiltrate to the ground in accordance with an agreement with the environmental authorities. The water amounted to very small quantities.

Recovered drill cuttings were collected in a steel container. After completion of drilling, the container was removed from the site and emptied at an approved site.

4 Results

The main purpose for the boreholes was to provide a water supply for core drilling in the Laxemar subarea. As the first hole, HLX13, did not yield enough water a second hole, HLX14, was drilled.

All data were stored in the SICADA database for Oskarshamn. The field note numbers for entry into SICADA are given in Table 4-1.

Table 4-1. Data references.

Subactivity	Database	Field note number
Drilling HLX13	SICADA	FN 251
Drilling HLX14	SICADA	FN 294
Air lift pumping test HLX13 and HLX14	SICADA	FN 277

4.1 Borehole design

A summary of data from holes HLX13 and HLX14 are presented in Table 4-2.

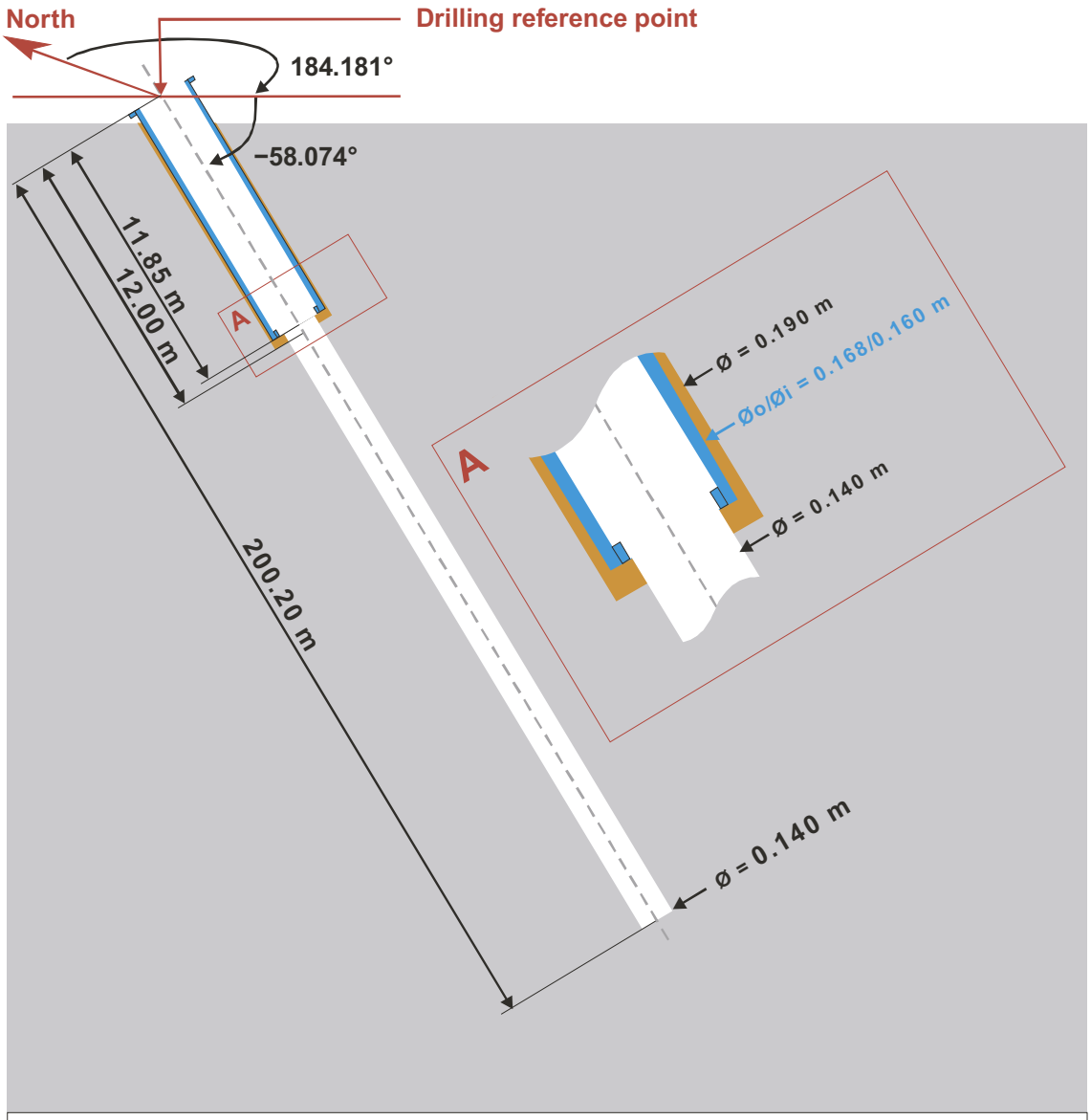
Table 4-2. Geometric and technical data for boreholes HLX13 and HLX14.

Parameter	HLX13		HLX14	
Drilling period	From 2004-02-24 to 2004-02-26		From 2004-03-08 to 2004-03-11	
Borehole inclination (starting point) (0 to –90)	–58.07°		–68.65	
Borehole azimuth (0–360)	184.2°		89.9°	
Borehole length	200.20 m		115.90 m	
Soil depth	0.7 m		1.2 m	
Drill bit diameter	0.140 m		0.139 m	
Starting point coordinates (system RT90/RHB70)	Northing: 6366953.00 m Easting: 1547690.42 m Elevation: 17.391 m.a.s.l.		Northing: 6366960.81 m Easting: 1547692.57 m Elevation: 17.113 m.a.s.l.	
Water yield (interval)	3 l/min (12–200.2 m)		60 l/min (12–112.9 m)	
Borehole diameter	0–12.00 m	200 mm	0–12.00 m	200 mm
(interval) (diameter mm)	12.00–200.2 m	140 mm	12.00–115.9 m	139 mm
Casing diameter	0–11.78	$Ø_o$ = 168	0–11.81 m	$Ø_o$ = 168
(interval) (diameter mm)	11.78–11.85 m	$Ø_i$ = 160 $Ø_o$ = 168 $Ø_i$ = 147	11.81–11.90 m	$Ø_i$ = 160 $Ø_o$ = 168 $Ø_i$ = 147

The design of each borehole is illustrated in drawings in Figures 4-1 and 4-2.

Technical data

Borehole HLX13



Drilling reference point

Northing:	**6366953.000 (m), RT90 2,5 gon V 0:-15**
Easting:	**1547690.420 (m), RT90 2,5 gon V 0:-15**
Elevation:	**17.391 (m), RHB 70**

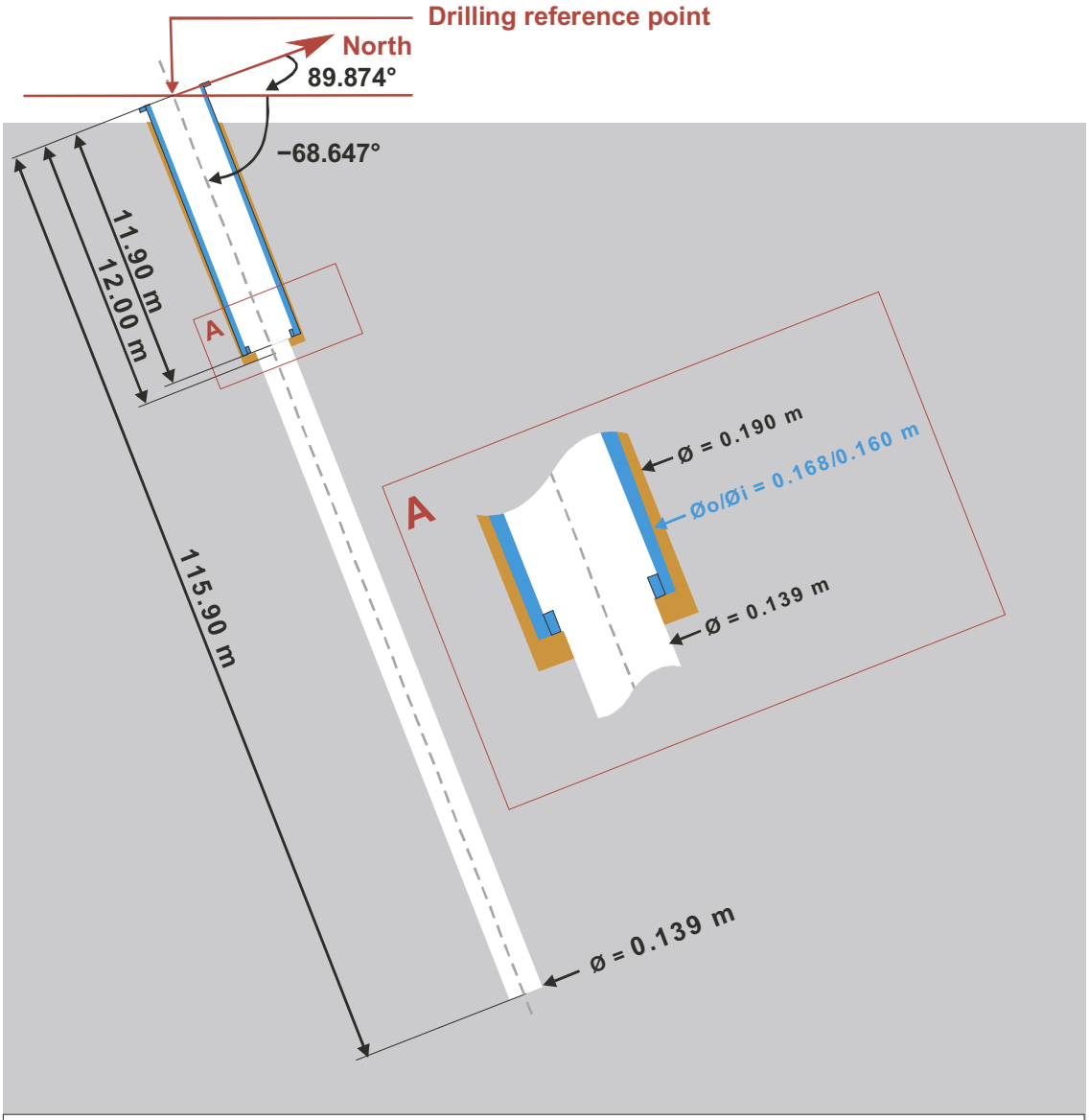
Drilling period

Drilling start date:	**2004-02-24**
Drilling stop date:	**2004-02-26**

Figure 4-1. *Technical data for borehole HLX13.*

Technical data

Borehole HLX14



Drilling reference point

Northing:	**6366960.813(m), RT90 2,5 gon V 0:-15**
Easting:	**1547692.570 (m), RT90 2,5 gon V 0:-15**
Elevation:	**17.113 (m), RHB 70**

Drilling period

Drilling start date:	**2004-03-08**
Drilling stop date:	**2004-03-11**

Figure 4-2. *Technical data for borehole HLX14.*

4.2 Hydrogeological results

Drilling 0–12 metre

The concrete seal was tested by blowing compressed air in the hole and measuring the amount of in-flowing water. As no water could be measured in either hole, the tightness of the gap injection was considered to be sufficient.

Drilling 12 m to full depth

No significant changes of inflow of water were noted in HLX13. At 112.9 metres and at full hole depth the inflow of water was measured at 3 litres per minute.

Two levels of water inflow were noted in HLX14 at 24.6–25.6 and 106.9–109.9 metres. Their individual yield was not measured. The total inflow at full hole depth was 60 litres per minute.

The borehole was rinsed from cuttings and water when drilling had been done to full depth by blowing compressed air through the drill stem (air lift pumping test). The specific capacity (Q_s) was estimated by assuming that the drawdown of the water table extended to the hole bottom. The specific capacity is calculated by dividing the yield (m^3/s) with the hole length (m). The results are given in Table 4-3.

Table 4-3. Hydrogeological results from HLX13 and HLX14.

Borehole	From (m)	To (m)	Water yield (L/min)	Specific capacity (m^2/s)
HLX13	12.00	200.20	3	2.7×10^{-7}
HLX14	12.00	112.9	60	9.6×10^{-6}

4.3 Geological summary

HLX13 is dominated by Ävrö Granite with one section of fine-grained dioritoide between ca 80 and 110 metres.

HLX14 consists of Ävrö Granite with two intercalations of fine-grained dioritoide at 40 and 60 metres respectively.

The results from the preliminary geological mapping are presented in Appendices 1 and 2.

4.4 Consumption of oil and chemicals

Small amounts of hammer oil and compressor oil enter the holes during drilling but are continuously retrieved by air flushing during drilling. After the drilling is completed, only minor remainders of the products are left in the borehole.

No consumption of compressor oil (Schuman 46) was noted.

Consumption of hammer oil (Preem Hydra 46) was 10 litres per hole.

Consumption of cement paste amounted to 80 litres (72 kg) per hole.

4.5 Nonconformities

No nonconformities are registered for the holes.

5 References

/1/ SKB, 2001. Platsundersökningar. Undersökningsmetoder och generellt genomförandeprogram SKB R-01-10, Svensk Kärnbränslehantering AB.

/2/ SKB, 2001. Geovetenskapligt program för platsundersökning vid Simpevarp. SKB R-01-44, Svensk Kärnbränslehantering AB.

WellCad plot HLX13 – Geology and drill penetration rate

Title	PERCUSSION BOREHOLE HLX13		Appendix 1
Site	LAXEMAR	Coordinate System	RT90-RHB70
Borehole	HLX13	Northing [m]	6366953.00
Diameter [mm]	140	Easting [m]	1547690.42
Length [m]	200.200	Elevation [m.a.s.l.]	17.39
Bearing [°]	184.18	Drilling Start Date	2004-02-24 12:00:00
Inclination [°]	-58.06	Drilling Stop Date	2004-02-26 18:50:00
Date of mapping	2004-05-07 00:00:00	Plot Date	2004-12-26 21:02:59

ROCKTYPE LAXEMAR

Ävrö granite

Fine-grained dioritoid

SOIL

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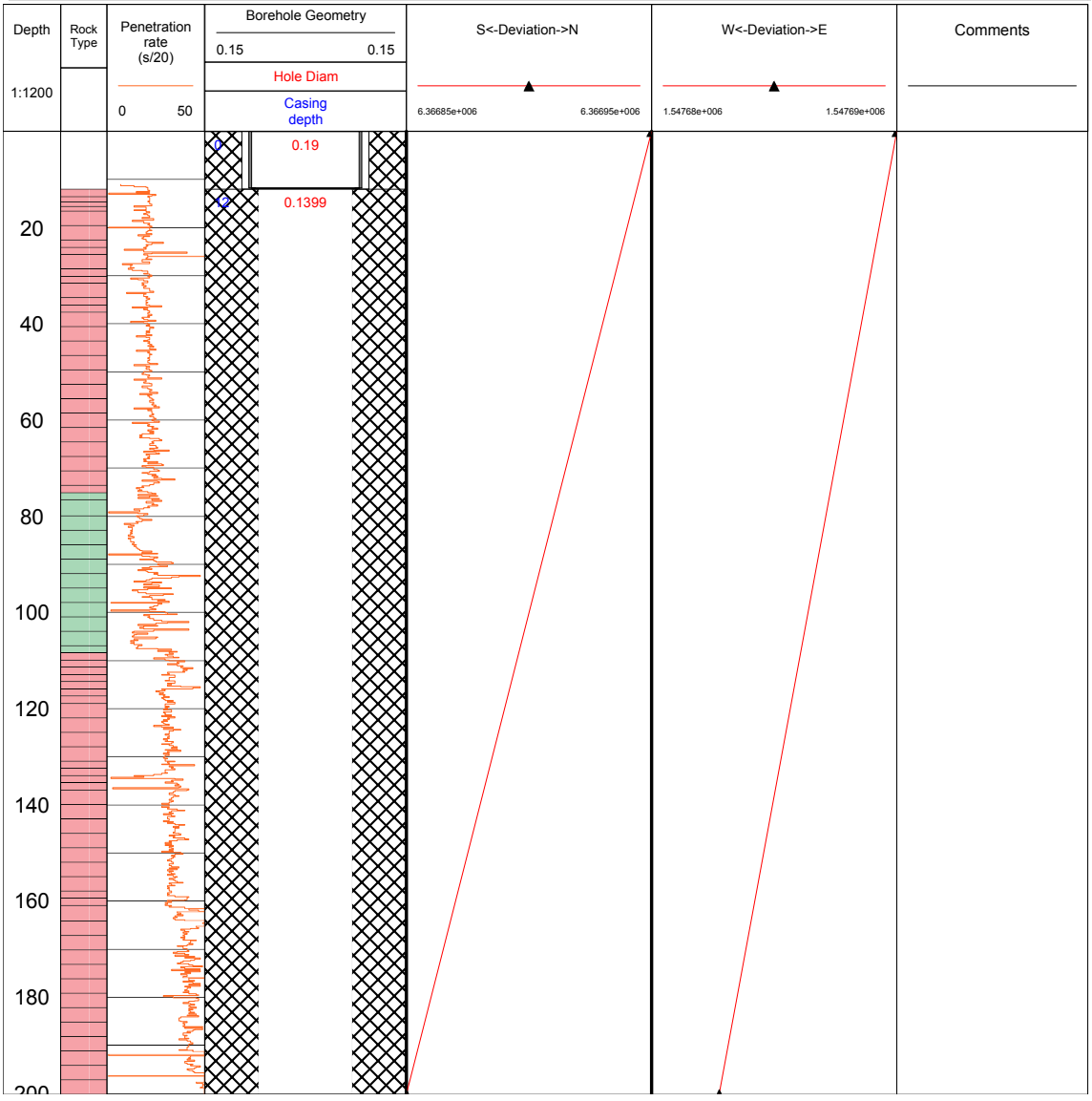

WellCad plot HLX14 – Geology and drill penetration rate

Title	PERCUSSION BOREHOLE HLX14		Appendix 2
Site	LAXEMAR	Coordinate System	RT90-RHB70
Borehole	HLX14	Northing [m]	6366960.81
Diameter [mm]	139	Easting [m]	1547692.57
Length [m]	115.900	Elevation [m.a.s.l.]	17.11
Bearing [°]	89.87	Drilling Start Date	2004-03-08 10:00:00
Inclination [°]	-68.64	Drilling Stop Date	2004-03-11 10:00:00
Date of mapping	2004-06-01 00:00:00	Plot Date	2004-12-26 21:02:59

ROCKTYPE LAXEMAR

Ävrö granite

Fine-grained dioritoid

SOIL

SCRIPT NAME A4_HammarBorrHål_SIMPEVARP_Eng_Log_2003-03-28_[SICADA].sql