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Oskarshamn site investigation

Drilling and completion in boreholes KAV01, KLX01 and KBH03 during 2003 and 2004

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February 2009

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Keywords: Core drilling, Bedrock, Reaming, Rinsing, Telescope hole.

Abstract

KAV01 and KLX01 were drilled before the site investigation in Oskarshamn. The boreholes were located so that they were of interest for the site investigation and an activity plan was formulated to upgrade the boreholes so that they could be incorporated in the site investigation database.

Boreholes KAV01 and KLX01 were subjected to rinsing, reaming, and borehole completion so that the holes would meet the standard for the site investigation.

KAV01 is located on the island of Ävrö in the Simpevarp subarea of the Oskarshamn site investigation whereas KLX01 is in the Laxemar subarea.

KBH03 is located on the island of Hålö in the Simpevarp subarea of the site investigation area. The borehole was originally planned as a 750 meter cored borehole with a telescopic section. After completion of the percussion drilled telescopic section of borehole KBH03 a decision was taken not to proceed with the core drilling. The planned cored part of the hole was therefore not drilled.

Sammanfattning

KAV01 och KLX01 borrades före platsundersökningen i Oskarshamn. Borrhålen var placerade så att de var av intresse för platsundersökningen och en aktivitetsplan skapades för att uppgradera borrhålen så att de skulle kunna innefattas i databasen för platsundersökningen.

Borrhål KAV01 och KLX01 rensades, rymdes upp och försågs med installationer så att hålen kunde användas inom platsundersökningen.

KAV01 ligger på Ävrö i delområde Simpevarp inom Oskarshamns platsundersökning medan borrhål KLX01 ligger i delområde Laxemar.

KBH03 är placerad på Hålö i delområde Simpevarp inom Oskarshamns platsundersökning. Borrhålet planerades ursprungligen som ett 750 meter långt kärnborrhål med teleskopdel. Efter att den hammarborrade teleskopdelen i KBH03 färdigställts togs ett beslut att inte fortsätta med kärnborrningen. Den planerade kärnborrningen utfördes därför inte.

Contents

1 Introduction

SKB, the Swedish Nuclear Fuel & Waste Management Company, performs site investigations in order to evaluate the feasibility of locating a deep repository for spent nuclear fuel /1 and 2/. The investigations are performed in two Swedish municipalities: Östhammar and Oskarshamn.

The boreholes KAV01 and KLX01 had been drilled prior to the site investigation /3/. A series of measures including drilling, reaming and completion were made to upgrade the two boreholes for use in the site investigation programme.

Borehole KBH03 was drilled as part of the site investigation. The borehole was originally planned as a cored borehole to a length of 750 m. The hole was however discontinued after percussion drilling of the telescopic section and no core drilling was made.

Borehole KLX01 is located in the Laxemar subarea whereas KAV01 and KBH03 are located in the Simpevarp subarea of the investigation area in Oskarshamn. The borehole locations are shown in Figure 1-1.

All drilling related operations in KLX01 and KAV01 were performed according to a specific activity plan, AP PS 400-03-042. The drilling of KBH03 is described in activity plan AP PS-400-03-095. The activity plans in turn refer to a number of method descriptions, see Table 1-1 and 1-2.

Table 1-1. Controlling documents for the performance of the activity AP PS 400-03-042.

Activity plan	**Number**	**Version**
Kompletterande insatser I KAV01 och KLX01	AP PS 400-03-042	1.0*
Method descriptions	**Number**	**Version**
Metodbeskrivning för kärnborrning	SKB MD 620.003	1.0

* One amendment to the activity plan AP PS 400-03-042 exists.

Table 1-2. Controlling documents for the performance of the activity AP PS 400-03-095.

Activity plan	**Number**	**Version**
Kärnborrning KBH03	AP PS 400-03-095	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för kärnborrning	SKB MD 620.003	1.0
Metodbeskrivning för hammarborrning	SKB MD 610.003	1.0
Metodbeskrivning för hydrauliska enhålstrester	SKB MD 321.003	1.0
Metodbeskrivning för registrering och provtagning av spolvattenparametrar samt borrkax under kärnborrning	SKB MD 640.001	1.0
Metodbeskrivning för vattenprovtagning, pumptest och tryckmätning i samband med wireline-borrning	SKB MD 321.002	1.0
Instruktion för längdmarkering i kärnborrhål	SKB MD 620.009	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 ansättning av hammar- och kärnborrhål	SKB MD 600.002	1.0
Instruktion för hantering och provtagning av borrkärna	SKB MD 143.007	1.0
Metodbeskrivning för krökningsmätning av hammar- och kärnborrhål	SKB MD 224.001	1.0

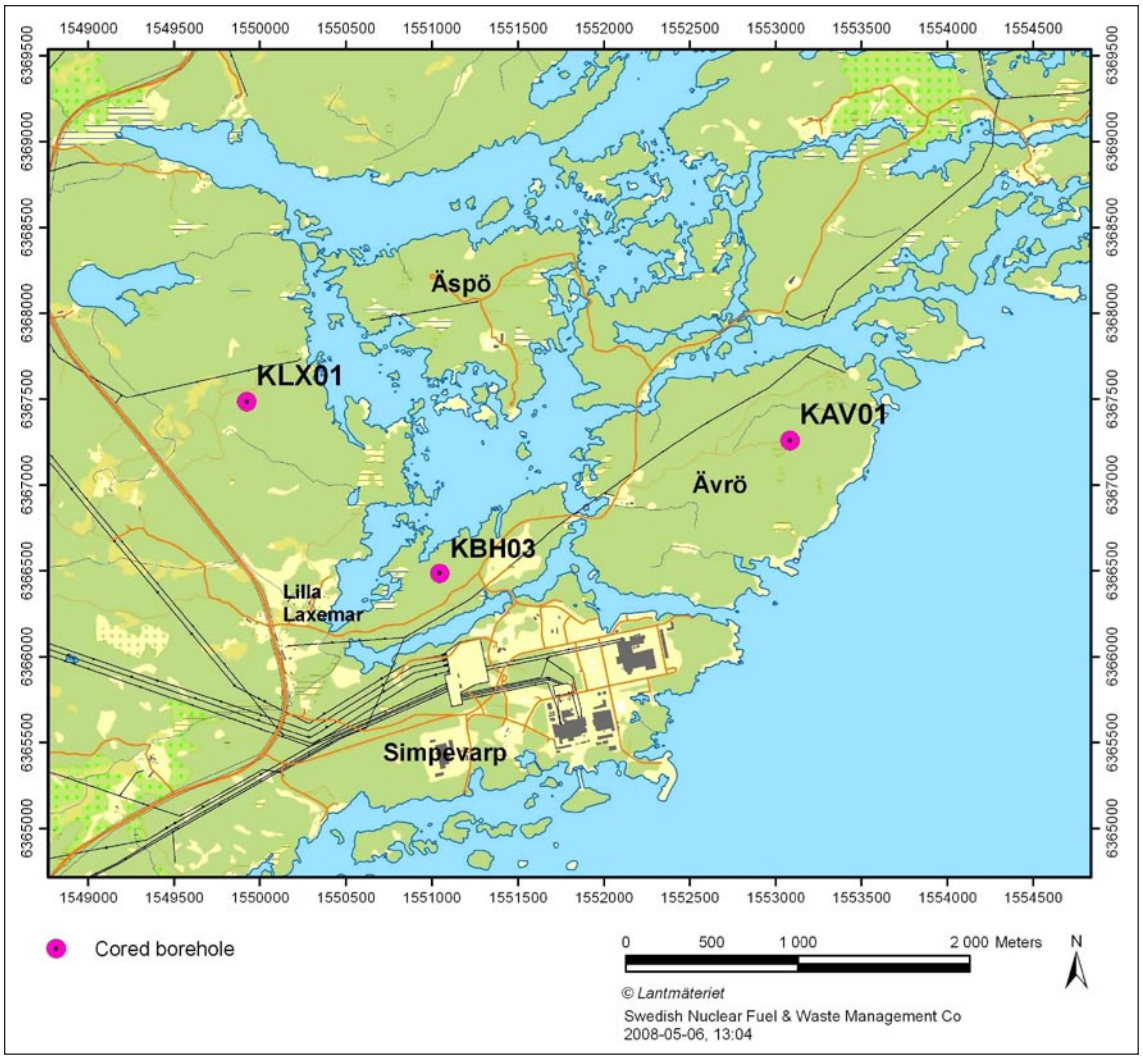


Figure 1-1. *Location of boreholes KLX01, KAV01 and KBH03 in the Oskarshamn site investigation area.*

The activity plans and method descriptions are SKB internal documents.

2 Objective and scope

This report will describe the methods employed and the results achieved during the drilling and completion in boreholes KLX01, KAV01 and KBH03 in 2003 and 2004.

2.1 KAV01 and KLX01

KAV01 and KLX01 were drilled before the site investigation started. The purpose of the activity was to upgrade the boreholes so that they could be used for further measurements within the site investigation in Oskarshamn. The activity was conducted from established drill sites and no notification for regulatory environmental purposes was made.

2.2 KBH03

Borehole KBH03 was initiated within the site investigation. The hole was planned as a cored borehole to a length of 750 m. The decision to drill KBH03 is given in SKB id 1020197, dated 2003-12-29, internal document. The main purpose was to give general information at depth of the geological conditions beneath the island of Hålö. The borehole was however discontinued after the percussion drilling of the telescopic section and no core drilling was made. The decision not to continue with the core drilling in KBH03 is given in SKB id 1021427, dated 2004-02-13, internal document.

The hole, KBH03, was planned as a “telescope hole”, which means that the upper, normally, 100 metre section of the hole has a wider diameter than the deeper core drilled part of the hole, see section 3.2 for further explanation of the SKB telescopic drilling method.

A notification in accordance with the Environmental Code was sent to the Regional Authorities 2003-05-21, SKB id 1014488, internal document. Information of the final coordinates and details regarding the return water handling was sent to the Regional Authorities on 2003-11-07, SKB id 1018722, internal documents. The local council was consulted regarding the location of the drill site.

3 Drilling history in KAV01 and KLX01

3.1 Drilling history in KAV01 and KLX01

The drilling history in KAV01 and KLX01 is summarised Table 3-1 and 3-2 respectively.

The drilling and the results from the drilling of KAV01 in 1977 are summarised in /4/. The geological results together with drilled lengths for the drilling in 1986 are given in /5/. No written references have been found specifically describing the third round of drilling in 1997 in KAV01. The third drilling was performed within a project aiming to develop a depth reference method. The test was however unsuccessful and was not published externally. It is however clear from Boremap mapping based on both drill core and BIPS-images done from 1998 that the borehole was core drilled to a length of 757.31 m. A BIPS report /6/ from 2004 mentions that the drilling from 744.60 to 757.31 m was made.

Core drilling in KLX01 is briefly mentioned in /3/ together with a summary of geoscientific results from the hole. Drilling was made in 1987 to a length of 702 m and subsequently deepened to 1,078 m in 1990. There is some confusion as to the exact lengths for the drilling in 1990, see comments below Table 3-2.

Table 3-1. Drilling history in KAV01.

Date	From (m)	To (m)	Hole diameter (mm)	Core diameter (mm)
1977-04-21–1977-05-16	0	502.20	56	42
1986-10-06–1986-11-16	502.20	744.60	56	42
1996-11-25–1996-11-27	744.60	757.31	56	42*

* Assumed diameter–the cores have not been located.

Table 3-2. Drilling history in KLX01.

Date	From (m)	To (m)	Hole diameter (mm)	Core diameter (mm)
1987-12-05–1987-12-15	0	101.30	155	62
1987-12-16–1988-02-05	101.30	702.11	76	62
1990-05-07–1990-08-04	702.1*	1077.5**	56	42

* The drill core starts at 702.88 m and ends at 1,077.99 according to PR 25-91-07 /7/. This also corresponds well to the lengths given in the core trays. The interval between 702.11 and 702.88 is thereby unaccounted for in terms of drill core. The BIPS image however shows the presence of granitic rock in this interval. A change in TOC and probably also drilling reference level was done on February 24, 1988 by increasing the casing length with 0.5 m. The bottom of the borehole at ca 702 m would then have become closer to 702.88 m below TOC. The reference level during drilling of the interval 702–1,078 m was however maintained at 16.81 m.a.s.l. i.e. the same level of TOC as was surveyed on February 6, 1988 after drilling to 702 m. This is deductible from records of hydrogeological recovery measurements done during drilling (the source here is from the Äspö HRL archive, document IU90/Br86, dated 1990-06-06) and Sicada data. Hydraulic tests done in mid-August 1990 i.e. after drilling was completed, indicate that the reference level for the hydraulic measurements were around 17.30 m.a.s.l. /8/. It is felt here that 702.1 m is a more correct value for the starting length of the second round of drilling that better corresponds to the drilling reference levels used in the first round of drilling in 1987 and the activities performed in 2003–2004.

** It is very likely that 1,077.99 m is the final length below TOC that existed after February 24, 1988 when the casing level was increased to around 16.81+0.50 m. The lengths given in the core boxes would therefore be 0.5 m too long. A survey done in 2001 shows that the TOC level was at 16.77 m.a.s.l. The casing must at some stage have been cut to the level that was measured in 2001. There is however no record in Sicada of changing the TOC a second time. The position of the casing at around 702.1 m from BIPS images taken in 2004 nevertheless strongly support the argument the start of the drilling in 1990 should be around 702.1 m rather that 702.8 m. In consequence, the final length of borehole KLX01 would then be 1,077.5 m.

The length of the telescopic section in KLX01 is also subject to some uncertainty. In Sicada the length is set at 101.30 m and in a 1990 hydrogeological report /8/ the length is stated to be 100.3 m. It is assumed here that the Sicada data are correct.

Technical problems and core jamming were frequent during the 1990 drillings /7/. Casing was left in borehole KLX01 after the drilling /8/. Unsuccessful attempts to remove and pull out the casing in KLX01 were done in 2001 and 2002 (pers. comm., SKB staff).

3.2 The SKB telescope drilling method – short overview

In brief, the telescope drilling method is based on the construction of a larger diameter hole (150–200 mm diameter) to a length of normally 100 metres followed by a cored section to full length. The larger diameter section can either be percussion drilled or reamed with a percussion bit after core drilling of a pilot hole.

The main purpose of the upper large diameter section is to improve the removal of water from the hole by air-lift pumping in order to minimize the intrusion of foreign substances (flushing water and cuttings) to the surrounding bedrock. It also enables the use of submersible pumps for tests and to facilitate the installation of multi-packer systems for ground water pressure recordings.

After drilling 0–100 m, equipment for air-lift pumping is installed in the borehole. The air-lift pumping will create a pressure drawdown and help remove water and cuttings while core drilling between 100 metres and full planned length, see Figure 3-1. The effect of drawdown is dependent on the depth and capacity of major groundwater conductors.

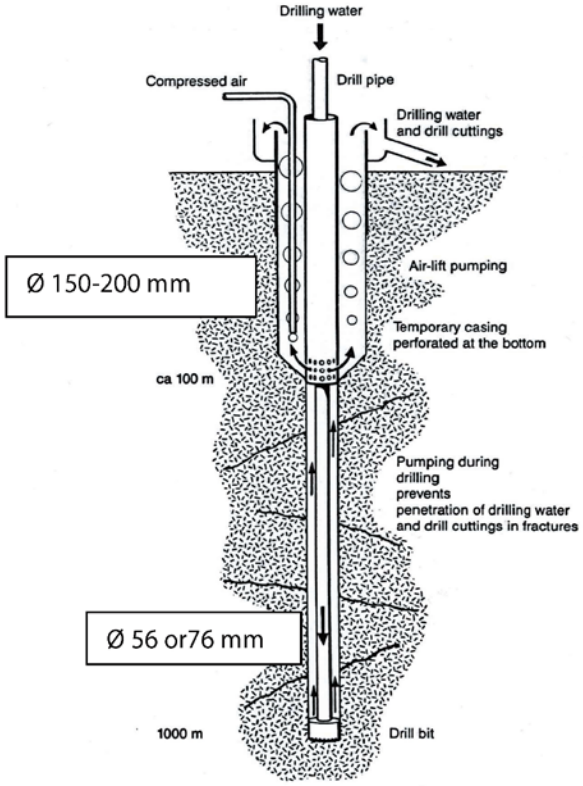


Figure 3-1. *A sketch of the telescopic drilling method with air-lift pumping for retrieval of drilling water and cuttings.*

4 Contractors and equipment

4.1 Contractors

The main contractor for drilling was Drillcon Core AB, with subcontractor for core drilling Suomen Malmi OY (SMOY) and subcontractor for percussion drilling Sven Andersson AB.

4.2 Percussion drilling equipment

KAV01

Reaming of the telescopic section was done with a Puntel MX1000 percussion drill rig with an Atlas Copco XRVS 455 Md air compressor. The down-the-hole (DTH) hammer was a Secoroc 165 mm for the first reaming and a 200 mm for the second reaming. The drill rods were Driqoneq 114 mm. The casing utilized was 168/160 mm (SS 2343, stainless).

KBH03

The equipment used was a Puntel MX1000 percussion drill rig with an Atlas Copco XRVS 455 Md air compressor. Overburden drilling was made with NO-X 280 mm equipment. The down-the-hole (DTH) hammer was a Secoroc 165 mm for the pilot borehole and the drill rods were Driqoneq 114 mm. Reamings were done with Secoroc DTH-hammers for 200 and 250 mm diameter. The casings utilized were 208/200 mm (SS 2343, stainless) and 324/320 mm (non stainless).

4.3 Core drilling equipment

KAV01

Reaming of the borehole wall in KAV01 was made with a Boyles B20 Atlas Copco Craelius fully hydraulic machine fitted with a modern and environmentally adapted diesel engine. Reaming from 56 mm hole diameter to 76 mm was made with a special made N-size reaming bit.

KLX01

Removal of casing and other borehole completion activities in KLX01 were made with a Hagby Onram 1000 electrically powered drill rig. The downhole equipment was lowered on WL-66, WL56-stem or 53 mm Alu-stem. Specialised cutting and fishing tools were used in addition to normal core drilling equipment.

The drill rig was fitted with a diesel power generator of 175 kW which would give a capacity for drilling to a depth of ca 1,500 m with N-size drilling.

4.3.1 Drilling monitoring system (DMS)

Logging with DMS was not made in KAV01 or KLX01 for this activity.

No core drilling was made in KBH03 hence was no logging made with DMS.

4.3.2 Deviation measurements

No deviation measurement or calculation of borehole trajectory was made for KAV01 as part of this activity plan.

No deviation measurement for KLX01 was made as part of the activity plan. A calculation of borehole trajectory (EG154) was made in 2007 based on deviation measurements from 1988. The calculation was however not made as part of the activity plan AP PS 400-03-042.

No deviation measurement was made in KBH03

4.3.3 Equipment for reaming reference slots in KAV01

In order to establish accurate and similar depth references for the various measurements that will be performed in the borehole, reference slots are reamed in the borehole wall.

The equipment has been developed by SKB and consists of a reaming tool that can be fitted to conventional drilling rods for 56 and 76 mm drilling equipment. The reaming tool is operated hydraulically from the surface, so that the cutters expand when the water pressure is increased.

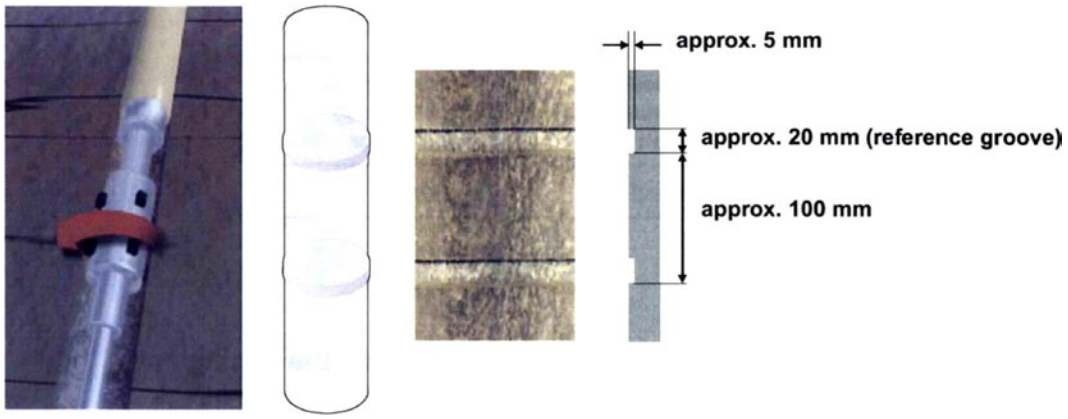


Figure 4-1. *The equipment for reaming of reference slots. To the left, the reaming tool with openings for the cutters is shown. The resulting reference slots are illustrated in the three pictures to the right.*

5 Drilling and completion in KAV01, KLX01 and KBH03-execution and results

The original data and results are stored in the SICADA database. Only the datasets in the database will be used for further interpretation and modelling. The data is traceable in SICADA by the Activity Plan number, AP PS 400-03-042 for boreholes KLX01 and KAV01. The data for borehole KBH03 is traceable in the database by the Activity Plan Number AP PS 400-03-095.

5.1 Drilling, reaming and completion work in KAV01

The operations started in June 2003 with establishing of the drill rig, running a drill stem to the full length of the borehole, 757.31 m, and flushing the hole.

Casing was subsequently drilled away to 5.20 m.

Reaming of depth reference slots was made on June 26, 2003 at the intervals given in Table 5-1. The depth reference slots are used for depth calibration of down-hole equipment for subsequent investigations in the hole. The presence of the depth reference slots have been confirmed by caliper log measurements.

The remaining casing between 5.20 and 11.74 m was removed by drilling and the hole was inspected with a down-hole camera.

Reaming of the borehole wall from 56 mm to 76 mm diameter was done to 70 m length on June 30, 2003.

Attempts at geophysical measurement were made in early July as part of a separate activity (AP PS 400-03-031), the geophysical wireline equipment could not go beneath ca 440 m.

Rinsing and running of a dummy up and down the hole was made by the drilling contractor SMOY in early August. A packer was emplaced at 75 m length in order to stop drill cuttings and cement to enter the deeper parts of the borehole during planned reaming and casing grouting.

The core drilling rig was removed in early August and a percussion drill rig was established on the drill site in mid-August.

Reaming of the borehole to a diameter of first 165 mm and then to 200 mm was done between August 20 and 25. Casing, 168/160 mm, was emplaced to 68.00 m length and grouted. A total of 890 kg of concrete was used. No measurements or sampling were done during the percussion drilling and reaming of the telescopic section in KAV01

The percussion rig was replaced by the core drill rig in mid-September.

Installation of the conical steel guide was done by reaming the hole to 76 mm diameter to a length of 70.04 m.

Table 5-1. Depth reference slots (m) in KAV01.

100.00	451.00
150.00	500.00
200.00	550.00
250.00	600.00
300.00	650.00
350.00	700.00
400.00	

Rinsing and water flushing was done along the entire length of the borehole. No nitrogen lifting was done in the borehole.

A technical drawing of KAV01 is given in Figure 5-1.

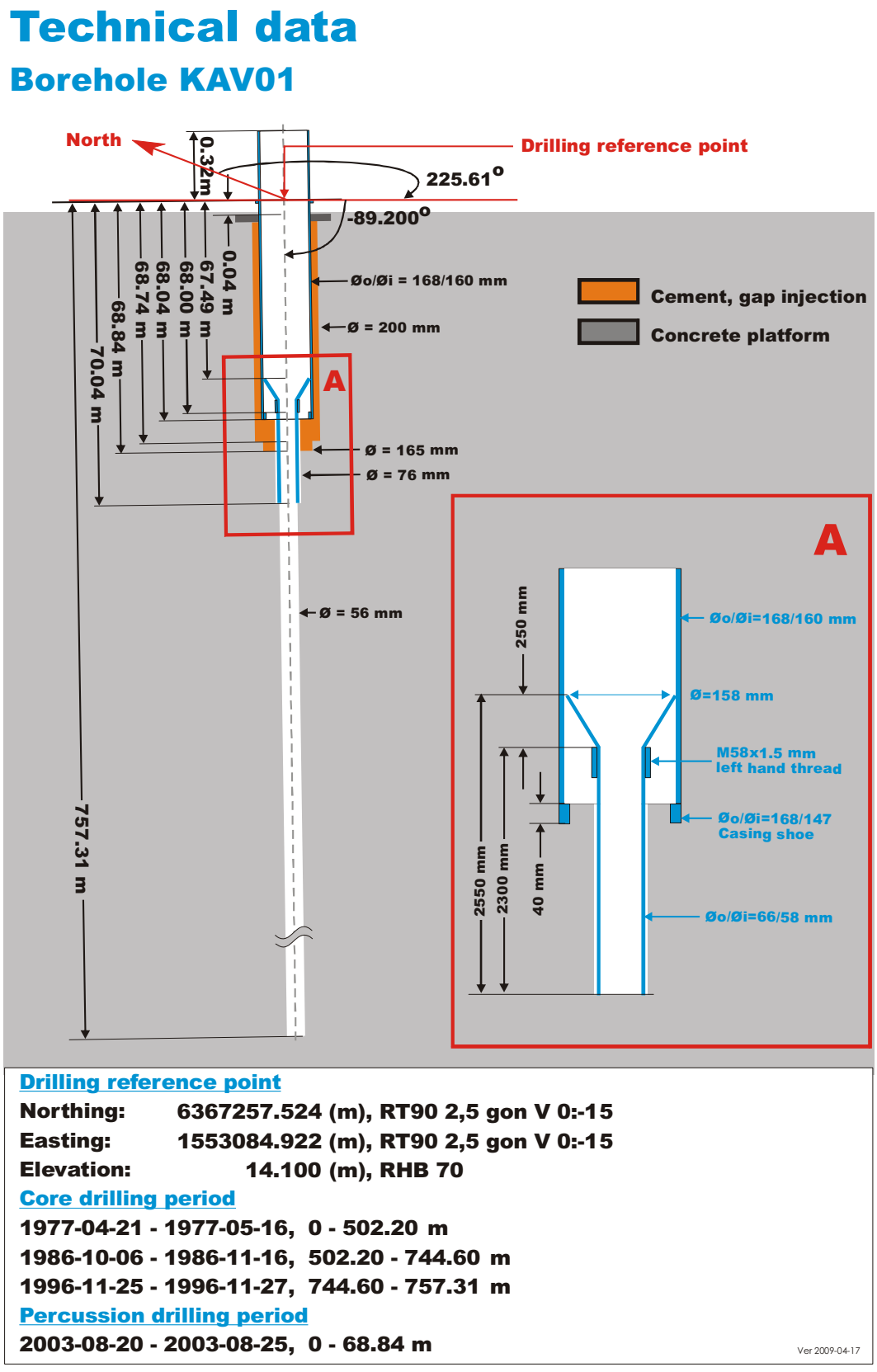


Figure 5-1. *Technical drawing, KAV01.*

5.2 Rinsing, casing pulling and completion work in KLX01 2003 and 2004

At the onset of the activity in July 2003 a 74/67 mm inner casing was standing in the borehole from the ground surface level to an unknown depth.

Rinsing of the hole inside the 74/67 mm casing was done with a 66 mm drill string between July 1 and 3, 2003. The objective was to remove the casing in KLX01 by pulling and pushing with an Onram 1000 rig. No success was achieved by this method. A down-hole camera was also used for investigation, but the water was too muddy to give any visibility.

A magnetic susceptibility logging was made on August 11. The lower end of the casing was established at 702 m.

The inner supportive casing in the telescopic section was removed in August from the borehole together with rubber tubing and remains of a packer, see Figure 5-2.

Between August 12 and September 4 the casing was removed to 268.3 m. Slots were cut in the casing from the inside with a casing cutter. The cutter was lowered with a 53 mm aluminium stem. The casing was cut first with 100 m interval. As this interval proved to be too great the distance between cuts was diminished. The casing was then pulled up by with an inside grappling fishing tool. The fishing tool was a left-threaded taper tap (Hagby tap) fitted on 76 mm left-threaded steel drill stem. The casing was pulled with a jack and also with an upwards hitting stem hammer. Very limited success was achieved with this method. Most of the casting remains in the borehole, see Figure 5-5. The casing remaining in the borehole is cut at the following intervals: 270, 280, 300, 400, 500 and 600 m length.

Figure 5-2. *Tubing removed from the telescopic section (0–101.3 m) in KLX01 during July–August 2003.*

In January–February 2004 there were sporadic and unsuccessful attempts clear the borehole below 700 m. Trials were made with 53 mm Alu-stem and with 56 mm equipment.

In May 2004 a supportive casing was installed to around 270 m. The borehole was mechanically rinsed and flushed with water with 56 mm equipment to full drilled length. Nitrogen lifting was done on May 20. A dummy was run in the hole on May 23. It got stuck at 760 m but was recovered two days later with a special tool. All the supportive casing was removed after some difficulty.

On May 28, 2004 a BIPS-measurement (digital borehole image) was made in selected intervals from 269 to 735 m, see Table 5-2. No sign of the upper limit of the casing could be seen in the image from 269.00 to 306.00 m. The cuts in the casing was made in four places, an clear example from 399.92 m is given in Figure 5-3. The lower position of the casing at ca 702 m can be inferred in Figure 5-4.

The boreholes were secured by mounting of lockable steel caps fastened to the concrete pad. All equipment was removed, the site cleaned and inspected by representatives from SKB and the contractor to ensure that the site had been satisfactorily restored.

A technical drawing of KLX01 is given in Figure 5-5.

Nonconformities in KLX01
Reaming of depth reference slots was not possible to do because of the presence of the drill stem from 268–702 m, see also section 5-6.

Table 5-2. BIPS measurement sections in KLX01 2004-05-28.

Section start (m)	Section stop (m)
269.00	306.00
397.00	403.00
497.00	503.40
597.00	603.00
697.00	735.00

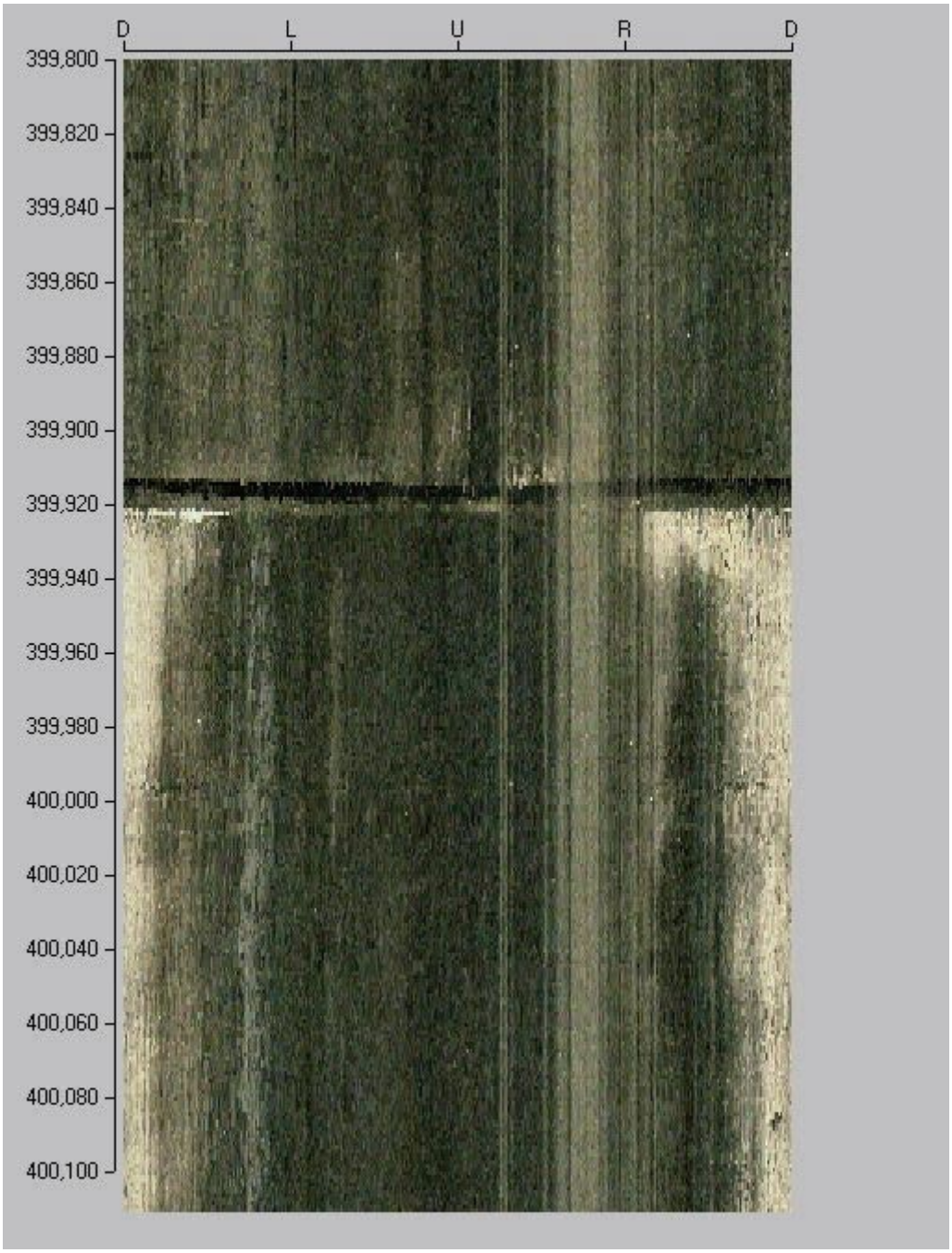


Figure 5-3. *BIPS image from 399.80 to 400.10 m. A cut in the casing can be clearly seen at 399.92 m.*

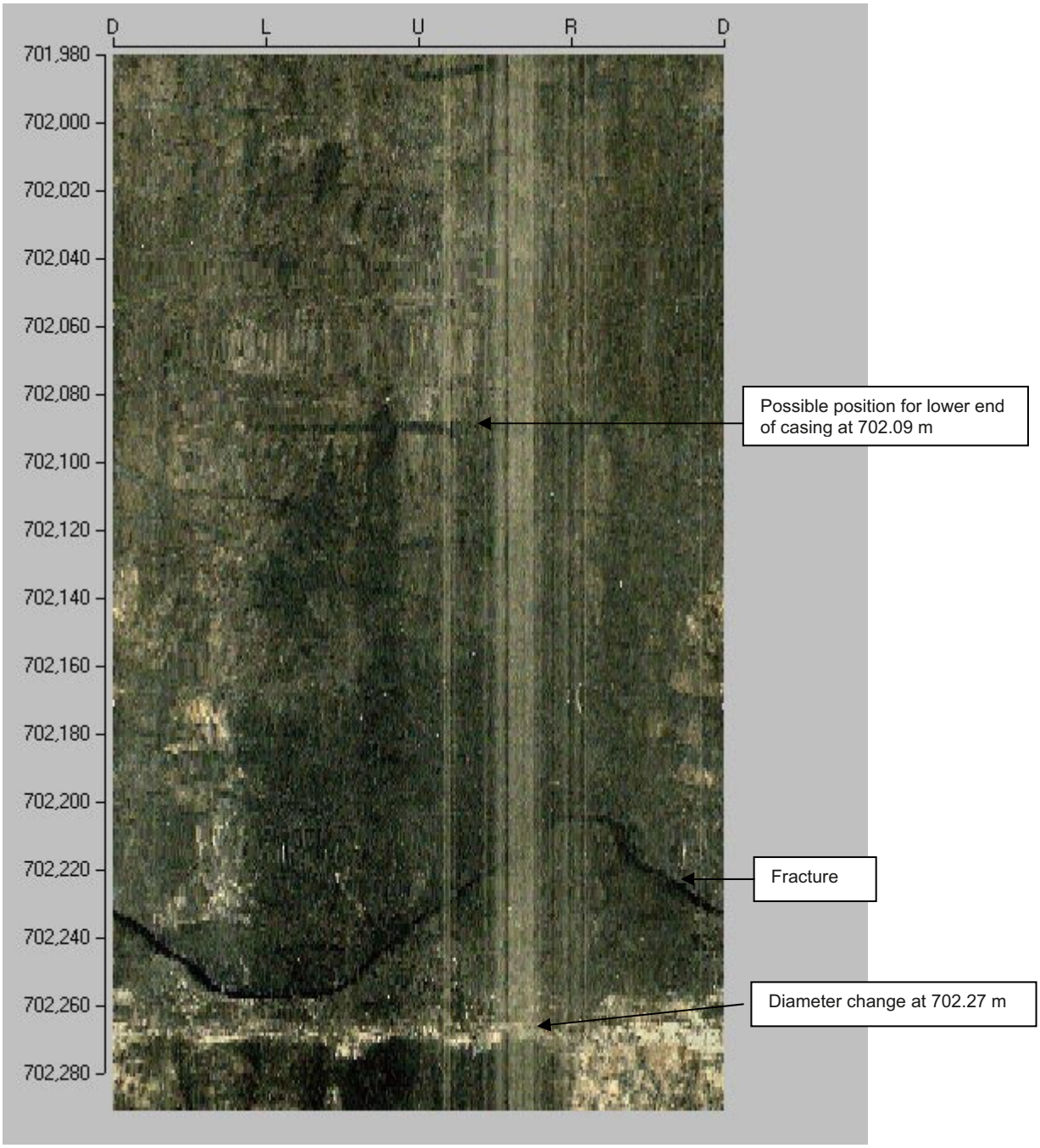
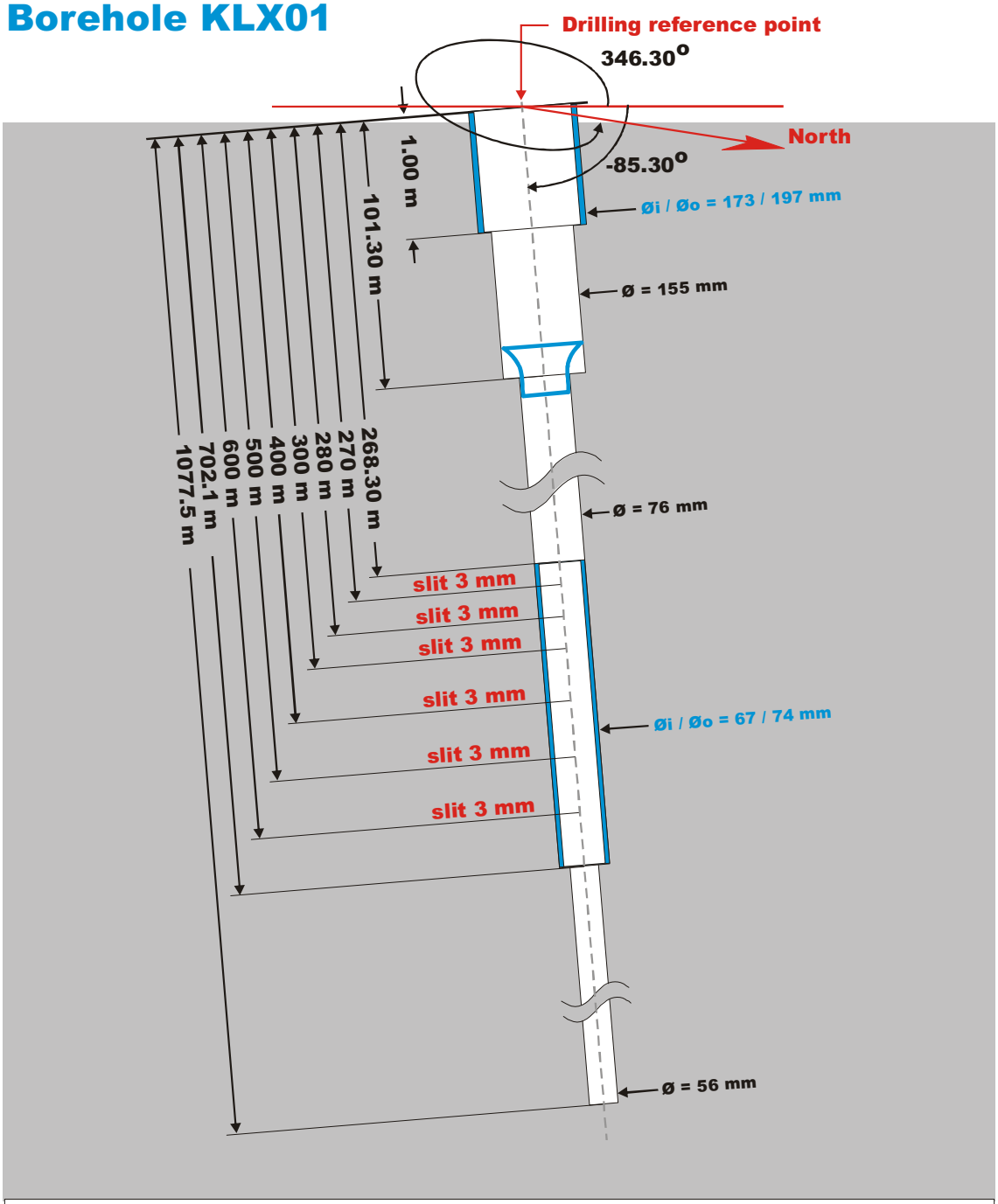


Figure 5-4. *BIPS image of the interval 701.98–702.28 m. The lower end of the casing is here interpreted at 702.09 m where a faint horizontal line can be seen. The sinusoidal shape of a fracture can be seen between 702.20–702.25. A change of diameter is interpreted at 702.27. It is likely that the casing has stood on this edge at some stage.*

Technical data

Borehole KLX01



Drilling reference point

Northing: 6367485.52 (m), RT90 2,5 gon V 0:-15

Easting: 1549923.09 (m), RT90 2,5 gon V 0:-15

Elevation: 16.77 (m), RHB 70

Drilling period

1987-12-05 - 1988-02-05, 0 - 702.1 m

1990-05-07 - 1990-08-04, 702.1 - 1077.5 m

Ver 2009-01-19

Figure 5-5. *Technical drawing, KLX01.*

5.3 Drilling, measurements and results in the telescopic section 0–100.43 m of KBH03

Drilling, reaming and casing grouting (gap injection) were made from January 27 to February 13, 2004.

5.3.1 Preparations

A cement pad for emplacement of drill rig, fuel container and compressor was built. A suitable area was cleared and levelled for establishing of a drill site. Cleaning of all DTH (down-the-hole) equipment was done with a high-capacity steam cleaner.

5.3.2 Drilling and casing installation

The construction of the upper telescope section (0–100.43 metres) of KBH03 was made in steps as shown in Figure 5-6 and described below.

Drilling was done by Sven Andersson AB and consisted of the following items:

- Drilling was made to 12.00 metres length with NO-X 280 mm equipment. This gave a hole diameter of 346 mm and left a casing (324/310 mm diameter) to a length of 12.00 metres.
- Inner supportive casing for guidance for the drill string was mounted.
- A pilot percussion hole was drilled to a depth of 100.43 metres with 5” DTH-hammer (nominal diameter 165 mm).
- Reaming to diameter 254 mm was done to 24.97 metres.
- Stainless casing of 208x4 mm was installed from 0 to 24.97 metres.
- Casing grouting (gap injection) with low alkali cement based concrete (500 kg or 800 litres) was made for both sets of casing. The outer casing was cut along the ground surface at 10 cm below the drilling reference level.
- After the concrete had hardened the borehole was rinsed and flushed to remove loose concrete and water. The water tightness of the casing grouting and the casing was tested by manual plumbing the hole on February 3. No increase of the water table could be measured over a half-hour after air-lifting and rinsing the entire borehole with compressed air.
- A total consumption of hammer oil was 15 litres was noted for the percussion drilling.

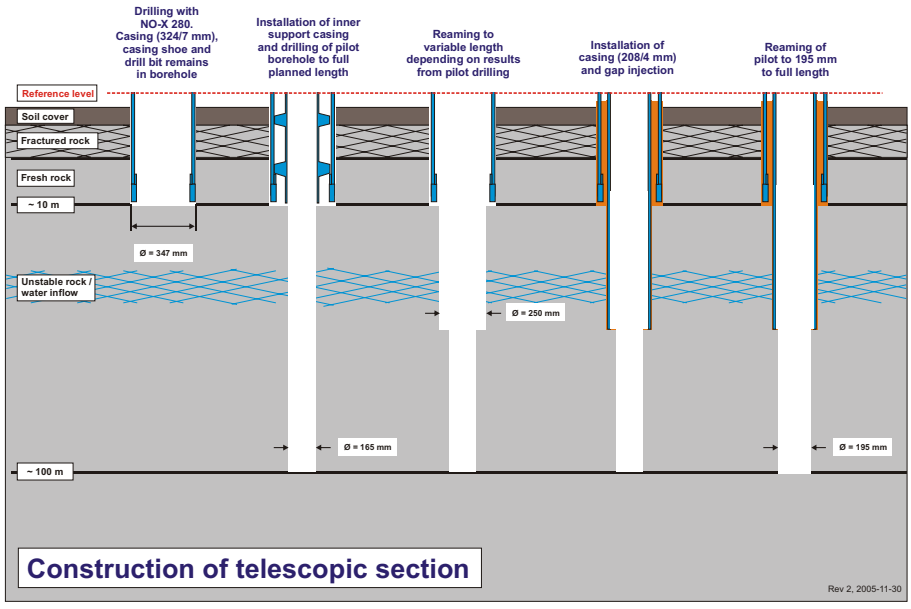


Figure 5-6. *Construction of the telescopic section. The cement for casing grouting is introduced between the casing and the rock wall. The drill bit acts as a barrier so that cement does not enter the pilot hole.*

Technical data from KBH03 is given in Figure 5-7.

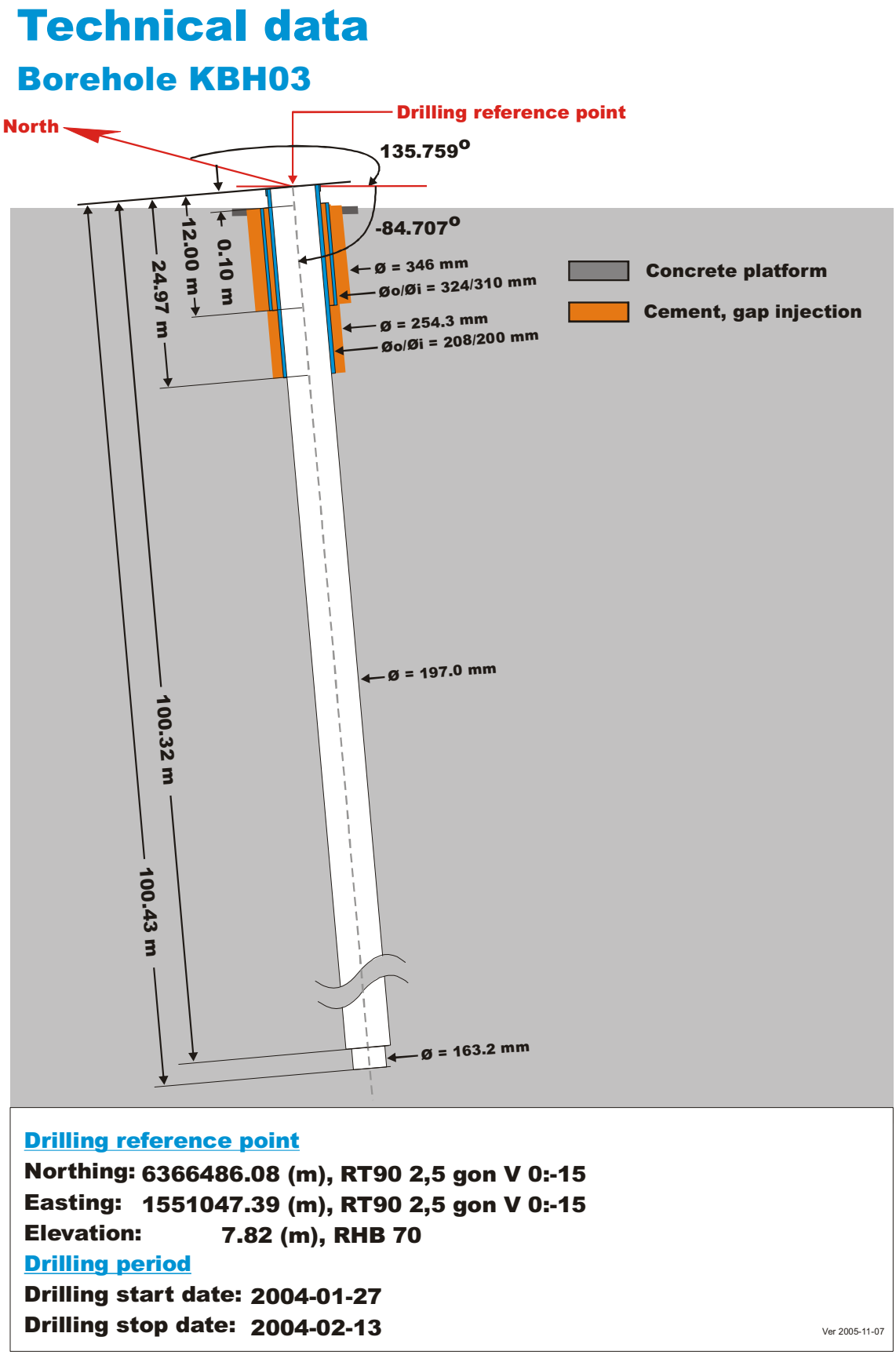


Figure 5-7. *Technical drawing, KBH03.*

5.3.3 Measurements and sampling during drilling of the telescopic section

Sampling and measurements done during drilling of the telescopic section included:

- The percussion drilling progress was monitored by a contracted geologist. Drill cuttings samples were collected every metre and a preliminary geological logging including measurement of magnetic susceptibility was made.
- Penetration rate (expressed as seconds per 20 cm) was recorded automatically and observation of changes in water flow was noted.

The preliminary geological results with penetration rate and magnetic susceptibility as measured on the cuttings are presented in Figure 5-8.

The depth to bedrock from top of casing (TOC) is between 0.1 and 1.1 m. The geological logging show granitic cuttings from the start, i.e. from 0.1 m, although it is noted that concrete fragments do occur. The drill crew has however noted that the rock surface starts at 1.1 m below the drilling reference level.

No water inflow could be measured over the entire length of the telescopic section after percussion drilling of the pilot borehole (nominal diameter 165 mm).

The results from the preliminary geological logging, measurements of magnetic susceptibility in the drill cuttings and water flow during drilling are given in Figure 5-3.

No water samples were collected in the telescopic section in KBH03.

5.3.4 Completion work

A decision, SKB id 1021427, internal document, was taken not to core drill in KBH03. The decision not to core drill give rise to several other non-compliances compared to the intentions of the activity plan AP PS 400-03-042, see also section 5.6.

The drill site was cleared of equipment and the borehole was secured by mounting of lockable steel caps fastened to the concrete pad. The site cleaned and inspected by representatives from SKB and the contractor to ensure that it had been satisfactorily restored.

5.4 Data handling

Data collected by the drilling contractor and the SKB 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.

5.5 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. The return water from drilling was pumped from the drill site to an emission point and there allowed to infiltrate to the ground in accordance with an agreement with the environmental authorities.

An environmental monitoring well, SSM000015, was drilled close to KBH03. As no core drilling was done in KBH03 water samples were taken for environmental monitoring purposes. The technical data for well SSM000015 is given in /9/.

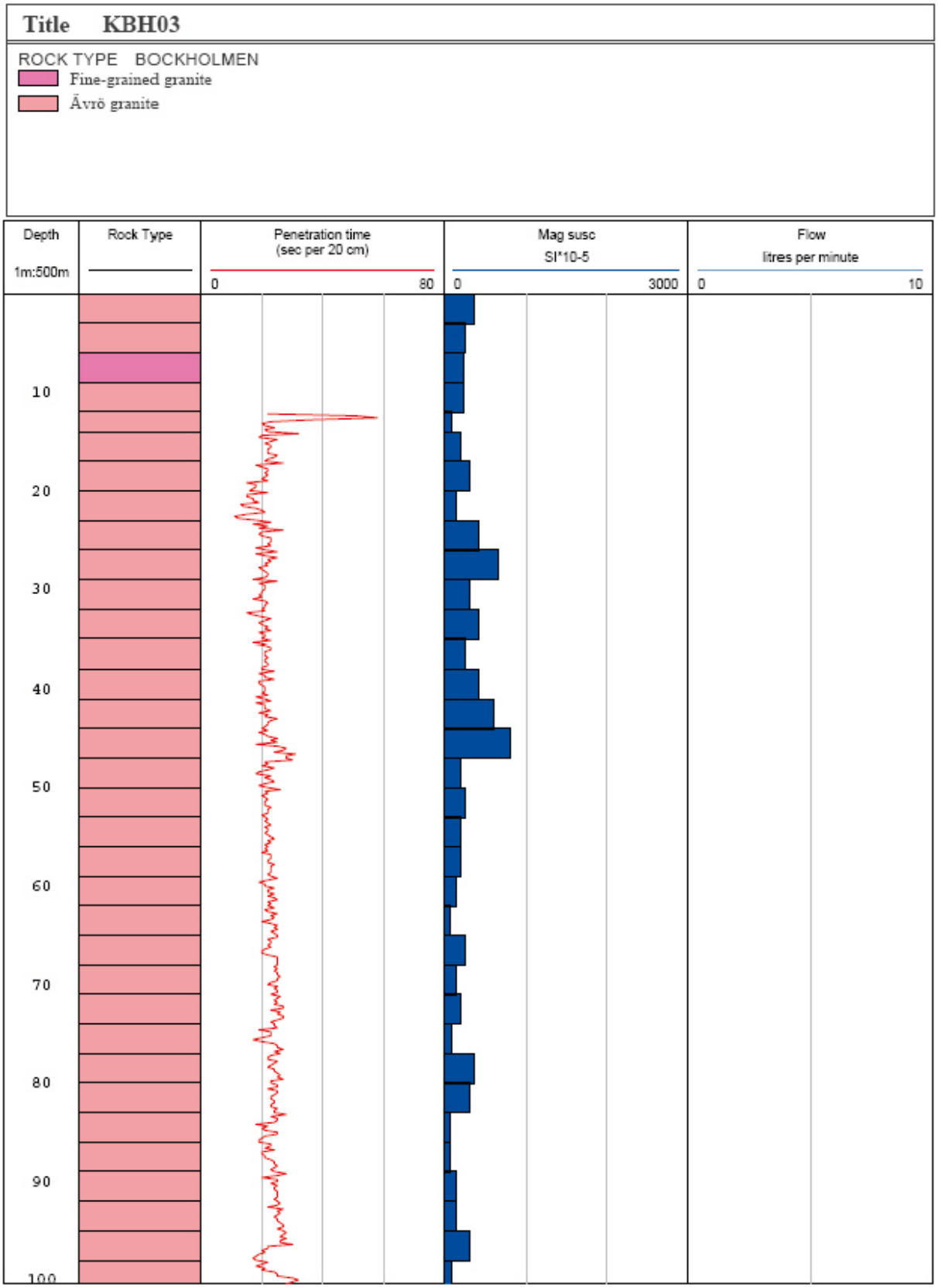


Figure 5-8. *Geological results based on preliminary logging of drill cuttings and penetration rate from percussion drilling of KBH03.*

5.6 Nonconformities

KAV01

A nonconformity that relates to the drilling borehole completion activity (AP PS 400-03-042) was compiled after the geophysical logging in KAV01 (AP PS 400-03-031). Geophysical logging could not be done below 443 m probably due to rock fall-out in borehole wall.

KLX01

No formal nonconformity was written. The casing remaining in the borehole was substantially longer than was presumed in the activity plan AP PS 400-03-042. The original assumption was that the casing extended to little over 100 m from the surface. The casing was however found to extend to about 700 m. All the casing could not be removed and the original goal with activity had to be adjusted so that casing remains in the borehole between 268 and 702 m.

No reaming of depth reference slots was made in KLX01. The activity plan assumes that reference slots should be reamed in the upper 700 m of the boreholes with WL76 or N-size equipment and that the lower part of the borehole from 702 to 1,078 m should be reamed with 53 mm aluminium drill stem suited for 56 mm diameter boreholes. The reaming of reference slots could not be made as the casing in the interval down to 702 meters could not be removed.

KBH03

No core drilling was done in KBH03. The decision not to core drill gave rise to several other non-compliances compared to the intentions of the activity plan AP PS 400-03-042.

A nonconformity was noted by the drilling contractor during the percussion drilling in KBH03. The diameter of the new drill bit (199 mm) was too large too enable effective drilling of concrete inside the casing (inner diameter 200 mm). Rinsing of concrete inside the casing resulted in damage of the drill bit.

6 References

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