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Oskarshamn site investigation

Quantitative mapping of fracture minerals in Laxemar

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Abstract

The campaign includes quantitative fracture mineral mapping of PFL anomalies in boreholes KLX03, KLX10, KLX10C, KLX11F, KLX15A, KLX16A, KLX17A, KLX19A, and KLX26B.

The purpose of the activity is to obtain quantitative data of fracture minerals from a large number of fractures within borehole sections characterised by anomalous flow rates (PFL anomalies). This was done by mapping parameters from which fracture mineral volumes can be determined. This provided quantitative data of different fracture-filling minerals within the investigation site. This data is important when modelling the evolution of groundwater chemistry as well as transport of radionuclides.

Parameters recorded during the mapping were the measured thickness of fracture filling minerals, as well as coverage estimations based on comparison charts. The recording of these parameters underwent calibration during the campaign.

During the campaign a total of 1,913 fractures and 25 crush zones underwent quantitative mapping of fracture minerals. Out of the total number of fractures, 1,837 contained fracture filling minerals.

Sammanfattning

Aktiviteten inkluderar kvantitativ sprickmineralkartering av PFL anomalier i borrhålen KLX03, KLX10, KLX10C, KLX11F, KLX15A, KLX16A, KLX17A, KLX19A, samt KLX26B.

Syftet med aktiviteten är att erhålla kvantitativa data över sprickmineral från en stor mängd sprickor inom borrhålssektioner karakteriserade av flödesanomalier, s.k. PFL anomalier. Detta utfördes genom att kartera tjocklek och täckningsgrad på sprickmineralsbeläggningar. Aktiviteten genererar kvantitativa data över olika sprickfyllnadsmineral inom platsundersökningen. Kvantitativa data är i sin tur mycket viktig för modellering av utvecklingen av grundvattenkemi såväl som transport av radionuklider.

Parametrarna som karterades var mätning av mineralbeläggningstjocklek samt uppskattning av beläggningsgrad, vilken baserades på jämförelser med referensdiagram. Förkalibrering av karteringsparametrarna genomfördes under uppdraget.

Totalt 1 913 sprickor samt 25 krosszoner genomgick kvantitativ sprickmineralkartering under aktiviteten. Av det totala antalet sprickor, innehöll 1 837 sprickmineral.

Contents

1 Introduction

This document reports the data gained by the *Quantitative mapping of fractures in Laxemar*, which is one of the activities performed within the site investigation at *Oskarshamn*. The work was carried out in accordance with activity plan SKB PS 400-07-061. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents.

This activity concerns quantitative drill core mapping of fracture minerals. Fracture filling minerals are assumed to be available for reaction with flowing groundwater. For the purpose of the study, hydraulically conductive fracture zones were specifically targeted as these are of great interest for modelling of groundwater chemistry evolution in and around the repository. Radionuclides that are potentially released from the repository will also encounter fracture minerals and therefore their nature and quantity is of great interest concerning modelling of radionuclide transport. The activity was performed during August–December 2007.

The activity includes quantitative mapping of fracture minerals in boreholes KLX03, KLX10, KLX10C, KLX11F, KLX15A, KLX16A, KLX17A, KLX19A, and KLX26B. All boreholes have previously undergone standard boremap mapping.

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

Activity plan	Number	Version
Kvantitativ kartering av sprickmineral Oskarshamn	AP PS 400-07-061	1.0
Method descriptions	**Number**	**Version**
Instruktion: Regler för bergarters benämningar vid platsunder-sökning I Oskarshamn	SKB MD 132.004	1.0
Method Description for Boremap mapping	SKB MD 143.006	2.0
Nomenklatur vid Boremapkartering	SKB MD 143.008	2.0
Metodbeskrivning för kvantitativ kartering av sprickmineral	SKB MD 143.009	1.0
Mätsystembeskrivning för Boremap	SKB MD 146.005	1.0
Instruktion för längdkalibrering vid undersökningar i kärnborrhål	SKB MD 620.010	2.0

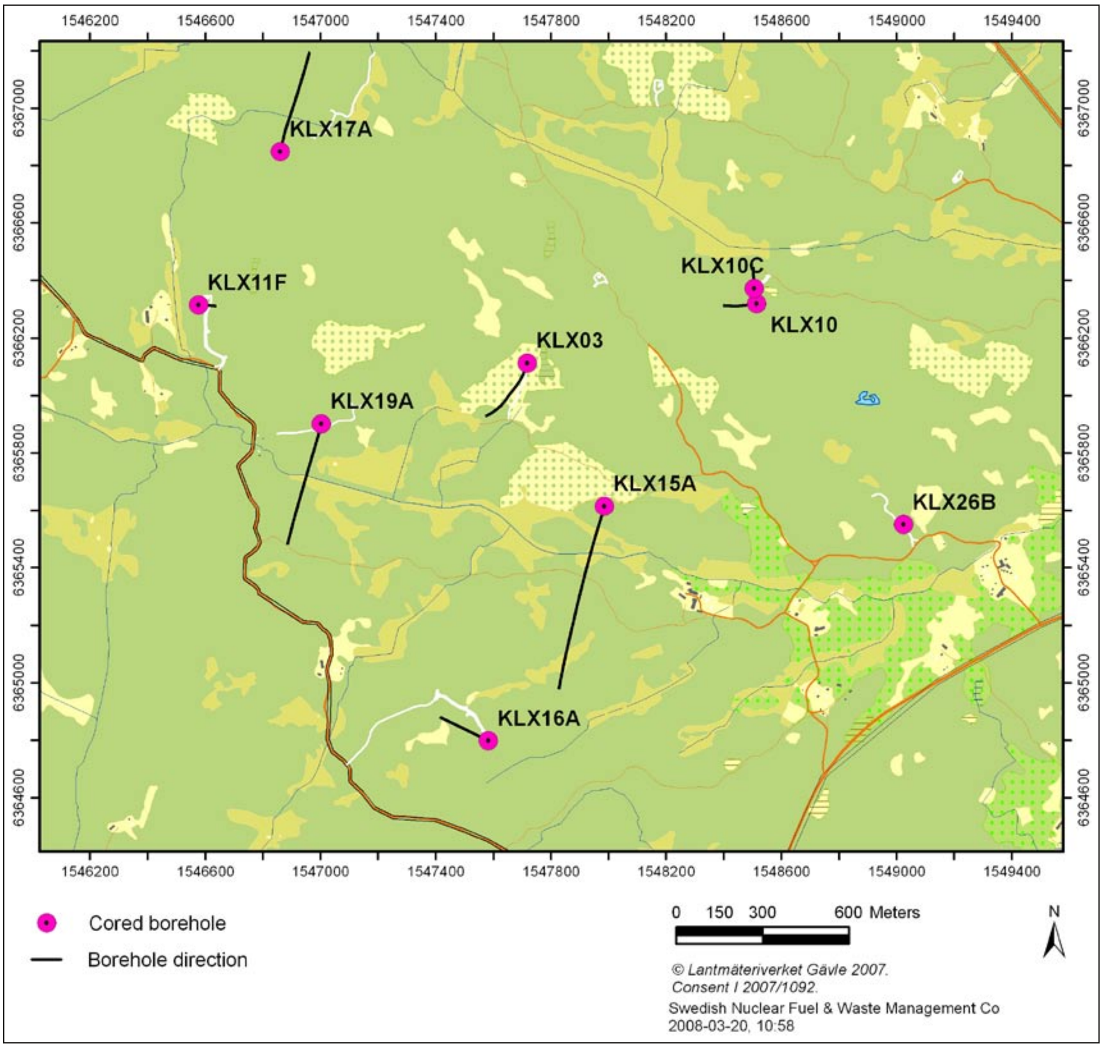


Figure 1-1. *Location of the boreholes included in this activity.*

2 Objective and scope

The campaign includes quantitative fracture mineral mapping of PFL anomalies in boreholes KLX03, KLX10, KLX10C, KLX11F, KLX15A, KLX16A, KLX17A, KLX19A, and KLX26B.

The purpose of the work is to obtain quantitative data of fracture minerals from a high number of fractures. This is done by performing a second mapping, focused on quantifying fracture minerals, of drill cores that were previously mapped according to conventional Boremap mapping. During the quantitative mapping the mineral coverage percentage of the fracture surface and thickness of fracture minerals were measured in the drill core. This provides quantitative data of different fracture-filling minerals within the investigation site. This data is important when modelling the evolution of groundwater chemistry as well as transport of radionuclides.

Choices of boreholes and core sections to be investigated in the campaign are based on hydraulic measurements in the borehole. Flow anomalies are mapped as well as the adjacent rock. Surrounding rock is limited to one meter above and below the flow anomaly interval. Each such section is called a PFL anomaly.

Parameters measured; the volume of different fracture filling minerals is determined based on measurements and calibrated estimations.

3 Equipment

3.1 Description of equipment/interpretation tools

During mapping the following equipment was used;

- Scale loupe with 10X magnification and equipped with a 0.1mm interval scale bar.
- Comparison charts for visual estimation of cover percentages.
- Tungsten carbide scriber for testing mineral hardness.
- 10% hydrochloric acid.
- Digital camera (minimum resolution requirement 2,832×2,128 dpi).

The mapping was executed in localities specifically adapted for the purpose, equipped with mapping stages for core boxes as well as lighting corresponding to daylight.

All data obtained during the mapping was recorded in Boremap version 4003 (or later) software.

Image analysis was performed using MapInfo Professional version 9.0.

4 Execution

4.1 General

The quantitative mapping was performed using both drill core and BIPS information. Only open fractures with aperture > 0 and crush zones were mapped within each PFL anomaly. The minerals of interest in the campaign were calcite, chlorite, clay minerals, hematite and pyrite. Other minerals were excluded from the mapping as they were regarded to be of minor importance.

Each open fracture was mapped with regard to fracture minerals present. Minerals belonging to the wall rock were excluded. When mapping an open fracture, each of the two fracture surfaces was treated separately. The order in which the minerals are mapped is determined by their relative position on the fracture surface. Mineral 1 is the mineral regarded to have the uppermost position on the fracture surface (disregarding up/down in the borehole), i.e. partially or completely covering the fracture surface including other fracture-filling minerals on the surface. Mineral 2 is the mineral interpreted to be the next in order according to these criteria. Up to four minerals were mapped in this manner for each fracture surface. For each mineral an estimation of the coverage was made. This was done through visual comparisons with mathematically accurate charts specifically developed for this purpose. The coverage is expressed as a percentage of the entire fracture surface. Two different coverage parameters were recorded; surface coverage and total coverage. Surface coverage is the visual percentage of the fracture surface that is covered by the particular mineral. Total coverage is an estimation of the total percentage of the fracture that is covered by the mineral. This is commonly greater than the surface coverage as fracture mineral fills often overlap each other. Mineral thickness was measured for each mineral using a scale loupe. This process is repeated for each mineral present on the fracture surface.

Some minerals present on the fracture surfaces were, however, treated in a different manner from the process described above. This occurred when the mineral appeared as visually separate, well developed discrete crystals on the fracture surface. Mapping surface coverage percentage and thickness for such minerals was determined to be less than satisfactory. Instead these fracture minerals were mapped as "spot minerals". Parameters mapped and recorded for spot minerals were crystal size, frequency (crystals/cm^2) and mineral thickness. In the campaign, pyrite was the only mineral regularly mapped as a "spot mineral".

Each crush zone was treated as a set of fractures. One parameter that was mapped was the number of fractures constituting the crush zone. This was estimated from core and BIPS. By performing coverage estimations and thickness measurements of fracture minerals on all the fractures present (if possible) within the crush zones, averages of these parameters could be calculated. These averages were then used to represent all fractures within the crush zone.

The activity were performed according to the method description SKB MD 143.009, SKB internal document.

4.2 Preparations

4.2.1 Basis for selecting drill core sections

The basis for selecting the drill core sections to be mapped is outlined in Appendix 1.

4.2.2 Image analysis

Image analysis was carried out on surface coverage percentages and mineral thicknesses. The purpose of this was to increase the accuracy of the mapping method by using the image analysis results as a form of precalibration. A random selection of fractures was made from three boreholes. These fractures were first mapped in accordance with the quantitative mapping method. Image analysis of visible coverage percentages was then done by photographing fracture surfaces and subsequently performing analysis of these photographs in Mapinfo Professional 9.0 (Figure 4-1). Accurate coverage percentages were thus obtained for each mineral. These results could then be compared to those from the mapping (Appendix 3). This process improved the accuracy of the estimations of coverage percentages as the random selection of fractures yielded fracture surfaces of different character which helped familiarise the mappers with the varying occurrence habits of fracture filling minerals.

For the purpose of analysing mineral thicknesses, the fractures selected for image analysis were mapped in accordance with the quantitative mapping method. Subsequently these fractures were cut perpendicular to the fracture surface using a rock saw. The exposed cutting surface, on which a cross-section of any fracture mineral fills was visible, was then photographed (Figure 4-2). The photographs were analysed in Mapinfo Professional 9.0, whereby average thicknesses of each fracture mineral exposed along the cut surface were obtained. This data was then used to compare the analytical data with those recorded during mapping of the same fractures. The incomplete results are presented in Appendix 4.

4.2.3 Hematite pigmentation

Analysis of mineral mixes consisting of hematite + chlorite/calcite/clay minerals was carried out by Isochron GeoConsulting at the University of Gothenburg. The purpose of this was to obtain better knowledge of the content of hematite in such mineral mixes. A range of different fracture fills with varying appearances and containing hematite as well as other minerals was selected. Analysis of these revealed that very little hematite can cause strong coloration of other minerals. Results from the analysis showed that no pure hematite was encountered in the mineral fills (Appendix 5). Instead, hematite only occurred as a pigmentation of other minerals. Hematite content did not exceed 2% in any of the hematite pigmented mineral mixes analysed. For the purpose of the activity, it was thus decided not to map pure hematite but rather to map minerals that were pigmented by hematite. Hematite pigmented chlorite, calcite and clay minerals were therefore added to the mineral list as additions to the existing list comprising calcite, chlorite, clay minerals and pyrite.

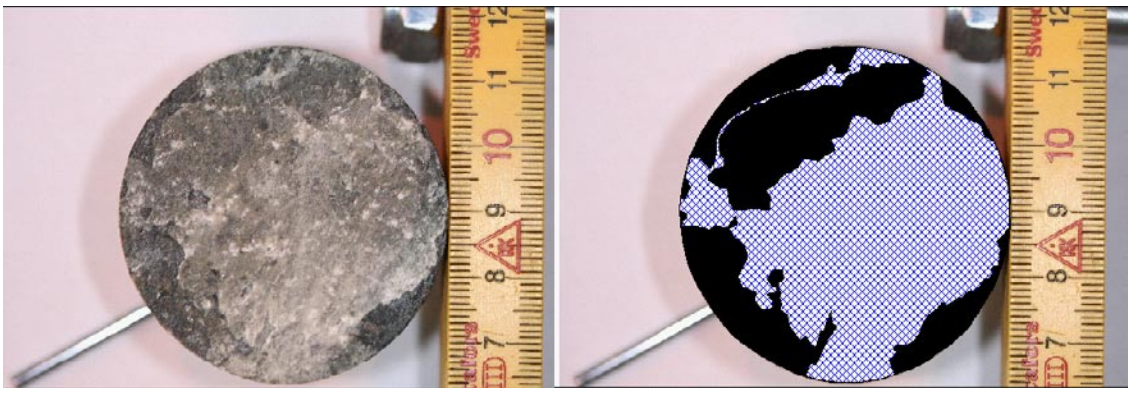


Figure 4-1. *Image analysis of fracture surface coverage (KLX03 Adjusted sec up 405.33 m). The visible calcite coverage on the fracture surface (left picture) was estimated to 70%. Image analysis (right picture) yielded an absolute visible calcite coverage (cross hatched) of 63%.*

Figure 4-2. *Photographed cross-section of core with visible fracture minerals.*

4.3 Data handling/post processing

The mapping is performed on-line on the SKB network, thus ensuring highest possible data security. Before every break (> 15 mins) a back-up of the mapping is saved on the local disk. An internal routine in the Boremap software performs quality checks before the data is exported to and archived in SKB's database SICADA. Personnel from SKB also perform spot test controls and regular quality revisions. All primary data is stored in SICADA and only these data are used for subsequent interpretation and modelling.

4.4 Nonconformities

The main nonconformity with respect to the activity plan concerned missing core sections during the mapping. This was generally a result of either core loss during drilling, crush zones with the majority of core pieces missing, or sampling. Of these sampling was the most significant as core samples often tend to be localised in anomalies such as crush zones that coincide with PFL anomalies. Nonconformities arising from missing core pieces and sections are listed in Appendix 2.

Some core boxes containing sections listed for mapping in the activity plan were unavailable during the mapping. These sections are also listed in Appendix 2.

The results from the image thickness analyses turned out less than satisfactory due to complications during the preparations. During cutting of the fractures, the mineral fills were damaged and partially to extensively lost form the fracture surface due to vibrations from the cutting process. No satisfying alternative solution was found due to time constraints and therefore analysis of mineral thicknesses was aborted before completion.

5 Results

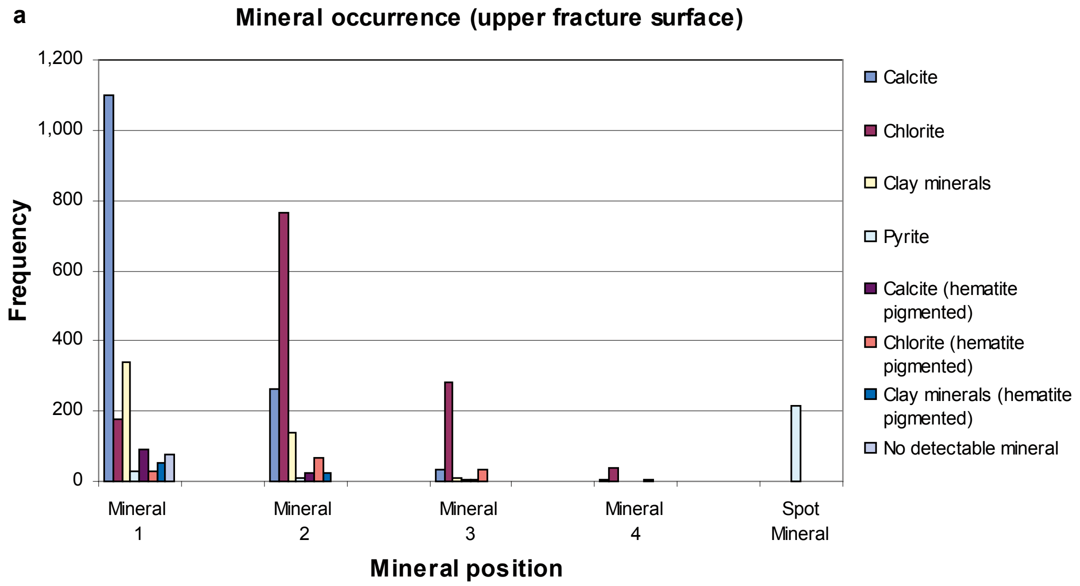
A total of 1,913 fractures and 25 crush zones underwent quantitative mapping of fracture minerals during the campaign. Of the fractures, 1,837 contained fracture filling minerals.

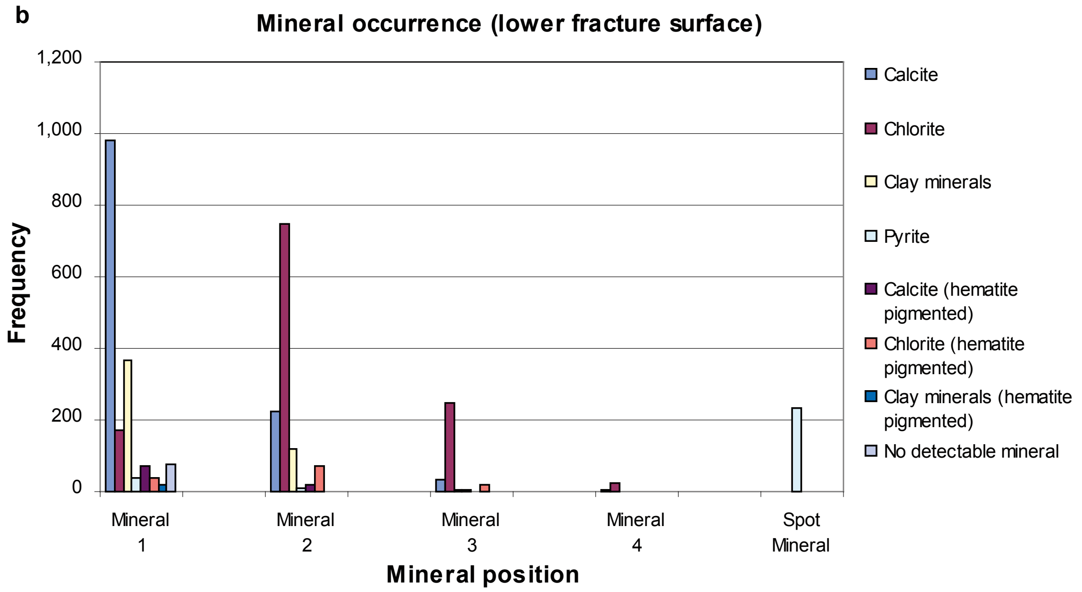
The data obtained during the activity highlight differences between minerals regarding the parameters recorded during mapping. Basic plots of mineral occurrences in different mineral positions (Figure 5-1) show differences in occurrence habits between the mapped minerals. Most minerals display a decreasing trend being most common in position 1 and least common in position 4. Exceptions to this are chlorite and hematite pigmented chlorite, which are most common in mineral position 2.

Regarding mineral coverage percentages, minor patterns can be discerned. For most of the mapped minerals, Visible and Total coverage curves (Figure 5-2) are relatively similar. The obvious exception to this is chlorite which has a distinctive peak in the number of total coverage percentages > 90%.

A plot of the frequency of mineral volumes within different volume intervals (Figure 5-3) determines that all mapped minerals display overall decreasing trends in terms of frequency with increasing volume.

Original data from the reported activity is stored in the primary database SICADA. Data are traceable in SICADA by means of the Activity plan number (AP PS 400-07-061). Only data in databases are accepted for further interpretation and modelling. The data presented in this report are regarded as copies of the original data. Data in the databases may be revised if needed. Such revisions will not necessarily result in a revision of the P-report, although the normal procedure is that major revisions entail a revision of the P-report. Minor revisions are normally presented as supplements, available at www.skb.se.





Figur 5-1. *Mineral distributions based on mineral position on the upper (a) and lower (b) fracture surface.*

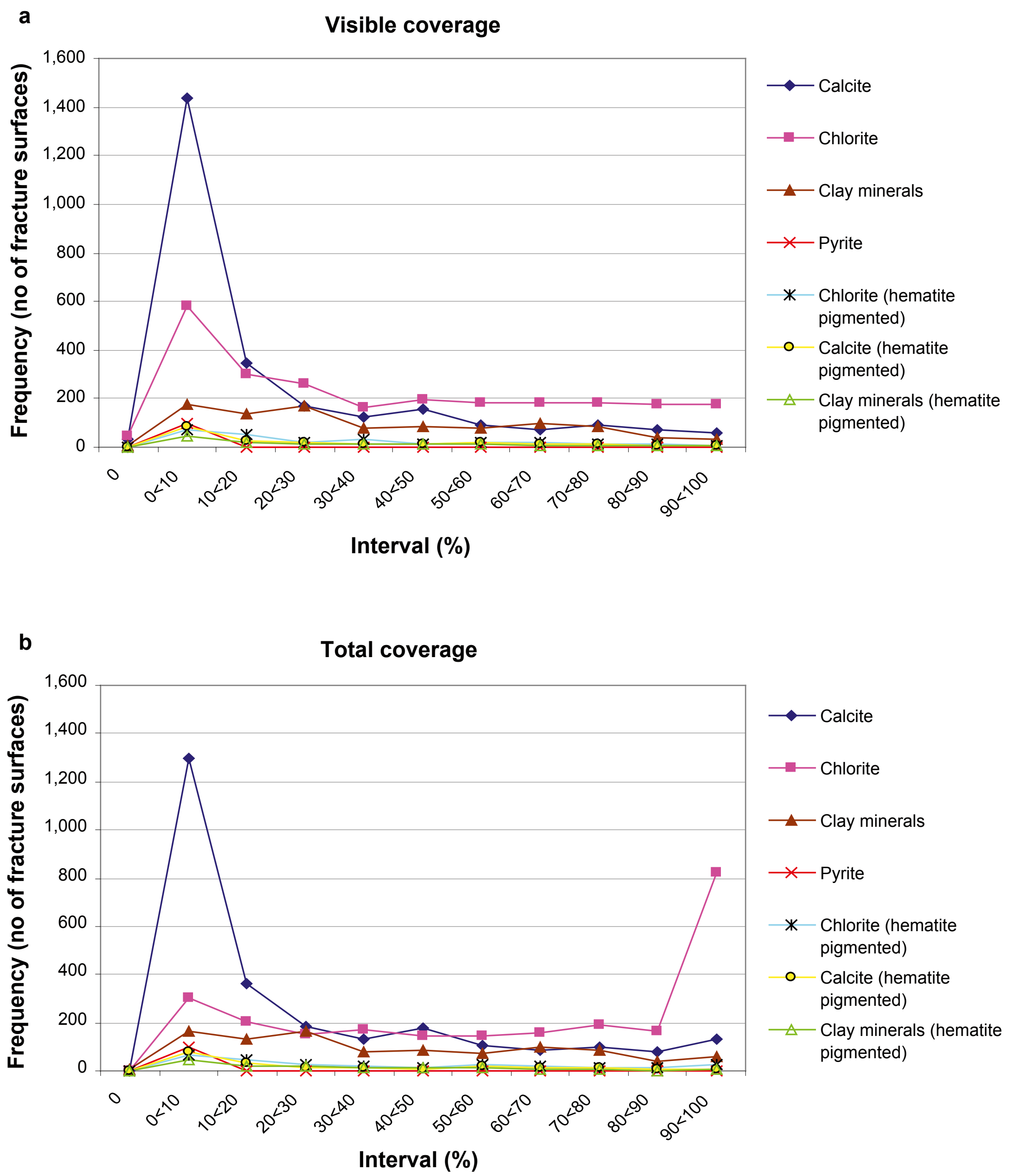


Figure 5-2. *Plots of the mapped minerals and their distribution of visible (a) and total (b) coverage percentages. Coverage percentages are divided into intervals with frequency representing the total number of fractures with a coverage percentage within that interval.*

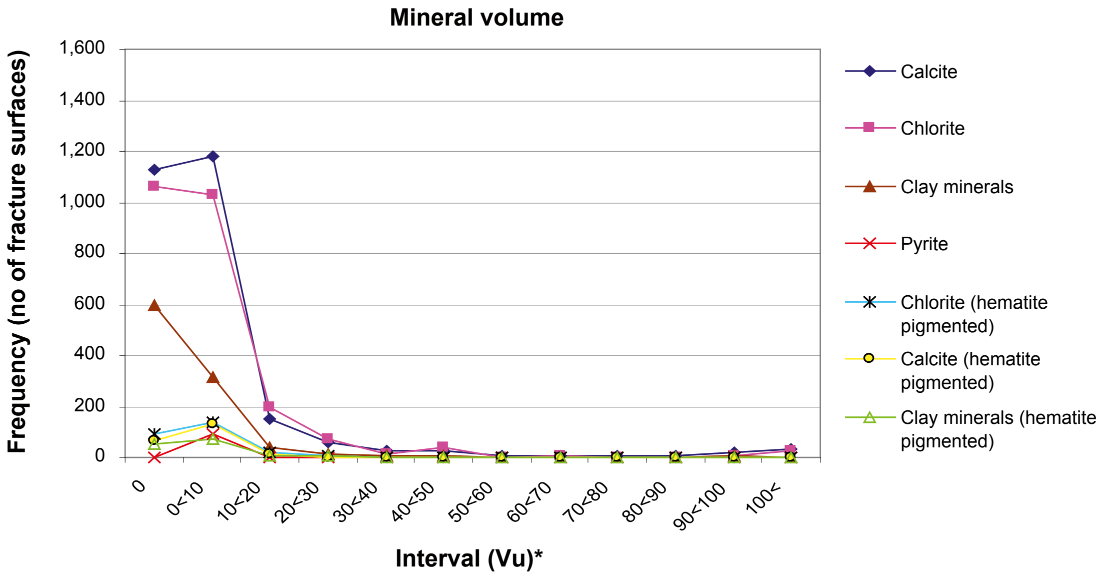


Figure 5-3. *Distribution of minerals in terms of volume. The volume is split into intervals with the frequency representing the total number of fracture surfaces with a mineral volume within that interval. *Vu (Volumetric unit) = Mineral thickness (mm) • Total Coverage (%)*

Appendix 1

Oskarshamn site investigation

Quantitative mapping of fracture minerals in Laxemar

Basis for selecting drill core sections

Martin Löfgren, Kemakta Konsult AB

January 2007

Abstract

It has previously been proposed in a motivation document /1/ to investigate fracture minerals of open fractures by way of drill core mapping. This document describes the planning of the campaign, in terms of selecting drill core sections to be mapped. The document was written after the completion of the campaign. Results from the campaign are delivered elsewhere.

In the campaign drill core sections associated with hydraulic flow anomalies previously detected by the Posiva difference flow meter, also called Posiva Flow Log (PFL), were mapped. In addition, smaller lengths of drill core sections distant from such anomalies were mapped for comparison. A drill core section associated with a PFL anomaly is in this document called a PFL section and comprises the rock surrounding the anomaly by one metre at each side.

In the motivation document /1/ it was suggested to map 400 PFL sections as well as 50 m of drill core distant from any PFL anomaly. This would comprise the maximum drill core length of 850 m. To meet the terms of the motivation document it was initially planned to map 415 PFL sections as well as 104 m of drill core distant from any PFL anomaly. This would in total comprise a drill core length of about 725 m. Due to practical reasons, mainly concerning the fact that the site investigation program came to an end before all boreholes could be mapped, there was a need to reduce the campaign. This resulted in a campaign comprising the mapping of 321 PFL sections and in total about 550 m of drill core. This document describes both the drill core sections initially planned to be mapped and the sections that were eventually mapped.

Out of the 321 PFL sections mapped, 272 sections are found within the area of interest for repository layout studies, the so-called Laxemar focused area. 49 PFL sections located in a peripheral area to the south of the focused area were investigated for comparison. In the table below the numbers of PFL sections from different elevation ranges that were mapped are shown. Also the numbers for PFL anomalies mapped in different transmissivity ranges are shown.

In addition to the PFL sections, 71 m of drill core distant from any PFL anomaly was mapped in the campaign.

Number of mapped PFL-sections in different elevation and transmissivity ranges.

	E > –100 m.a.s.l.	–100 ≥ E ≥ –300 m.a.s.l.	–300 > E ≥ –600 m.a.s.l.	E < –600 m.a.s.l.	T < 10^{-8} m²/s	10^{-8} ≤ T ≤ 10^{-6} m²/s	T > 10^{-6} m²/s
KLX10	0	17	30	4	12	31	8
KLX10C	25	0	0	0	13	11	1
KLX15A	6	29	0	0	9	22	4
KLX26B	17	0	0	0	7	9	1
KLX17A	0	11	13	0	12	9	3
KLX03	0	0	10	18	8	18	2
KLX11F	23	0	0	0	4	17	2
KLX15A	0	14	11	2	13	14	0
KLX19A	0	12	27	3	21	19	2
KLX16A	12	34	3	0	12	32	5
Total	**83**	**117**	**94**	**27**	**111**	**182**	**28**

Content

1 Introduction

1.1 Introduction to the campaign

This campaign concerns drill core mapping of fracture minerals, mainly in association of hydraulically conductive fractures or fracture systems. These fracture minerals are assumed to be available for reactions with flowing groundwater and are thus of great interest for the modelling of groundwater chemistry in and around the repository during its evolution. Also radionuclides that potentially are released from the repository will encounter these fracture minerals, wherefore their nature is of interest when modelling radionuclide transport.

It has previously been proposed in a motivation document /1/ to investigate the fracture minerals in association with in total 400 PFL anomalies at the Laxemar site. These anomalies are detected with the Posiva difference flow meter and should correspond to hydraulically conductive fractures or fracture zones. Out of the 400 PFL anomalies, about 300 should according to the motivation document be found within the area of interest for repository layout studies and for focused investigation. About 100 anomalies should be investigated in the peripheral area for comparison.

As it turned out, the timeframe available for the investigations did not allow for investigating the full set of 400 PFL anomalies but only 321. The drill core sections finally chosen to be mapped are found in the Activity plan (AP PS 400-07-061) of the campaign, as well as in this present document. In this document, boreholes that were initially planned to be mapped but later needed to be disregarded are marked as “excluded”. If it in the future, for some reason, is decided to expand the presently performed campaign to that of the initially planned, the work done in the initial planning has been made accessible in this document.

The performance of the mapping is not described here but in the Method description (SKB MD 143.009). Generally the campaign aims at delivering information concerning the occurrence, thickness and coverage of different fracture minerals. Elsewhere it is intended to treat the data statistically with the aim at delivering input data in form of probability functions to safety assessment modelling.

1.2 The Laxemar site, rock domains and core drilled boreholes

Figure A1-1 shows the central part of the Laxemar subarea and most of the boreholes drilled at the site. The dotted blue line coarsely shows the area of interest for the repository layout studied in Laxemar (Layout D1 central and west alternative) reported in /2/. This area generally correspond to the so called “focused area” defined in the Laxemar Site Description Model 2.1 /3/. However, comparing to the area of interest for the D1 layout studies, the north-eastern line in /3/ is somewhat shifted to the south, as is coarsely shown by the yellow dotted line in Figure A1-1.

Figure A1-2 shows the two main repository layouts as defined in the D1 design studies /2/. To the left is the central alternative at 500 m depth and to the right the west alternative at 500 m depth.

Figure A1-3 shows the “focused area” defined in the Laxemar Site Description Model 2.1 /3/, as encircled by the dotted black line.

The main area, as encircled by the blue dotted line in Figure A1-1, consists of three major rock domains at repository depth, RSMA, RSMD, and RSMM. In addition there are two minor rock domains in the area, RSMB and RSMBA /2/. The rock domains at the depth of 500 m are shown in Figure A1-4.

For comparison, a somewhat more detailed map of the rock domains at the surface is shown in Figure A1-5.

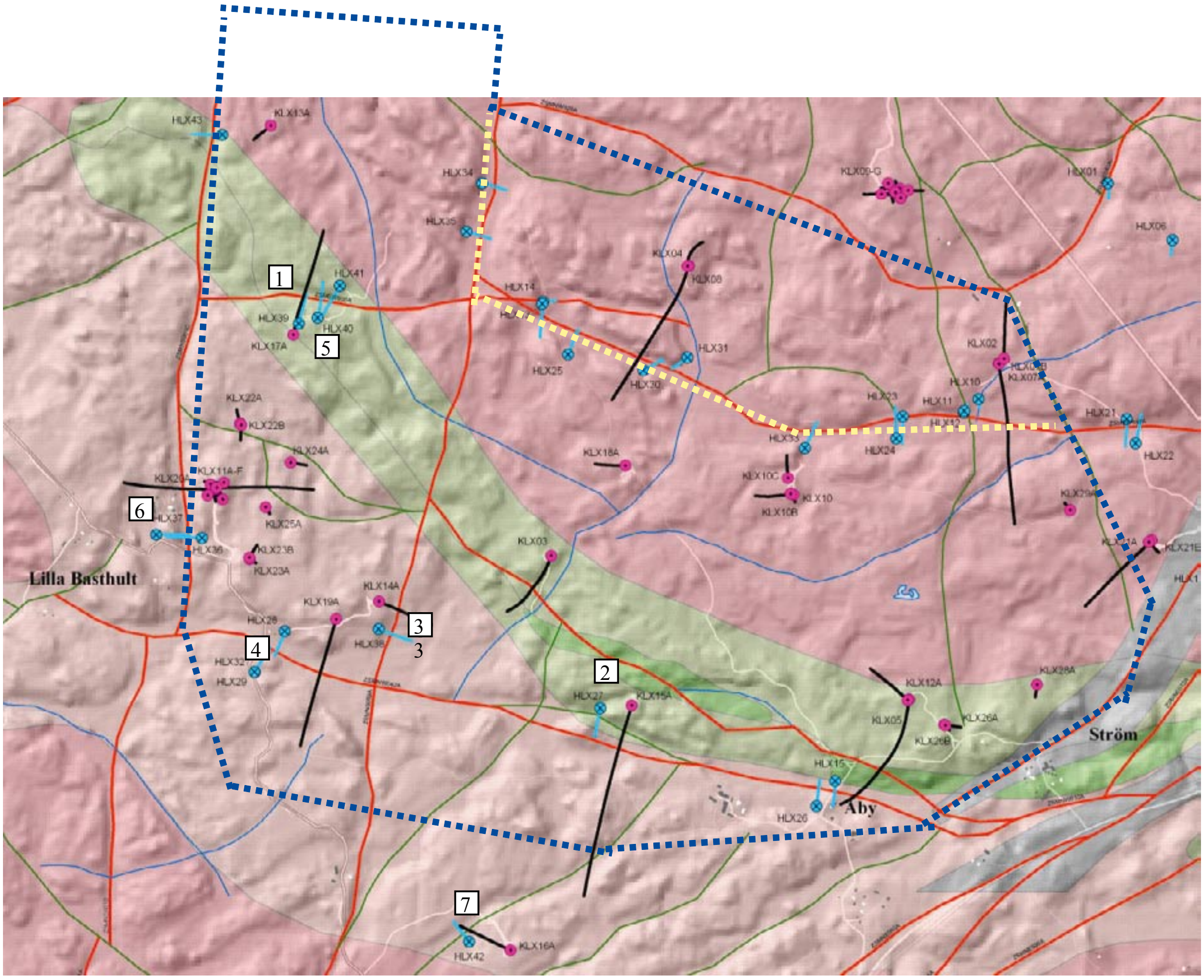


Figure A1-1. Area within Laxemar of main interest for the campaign.

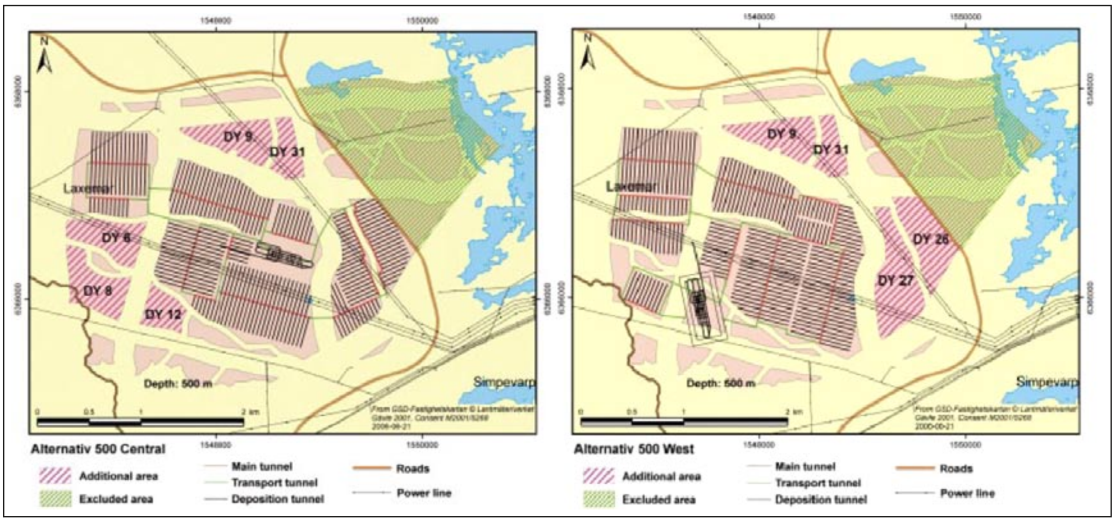


Figure A1-2. The main alternatives in the D1 repository layout studies. Images taken from /2/.

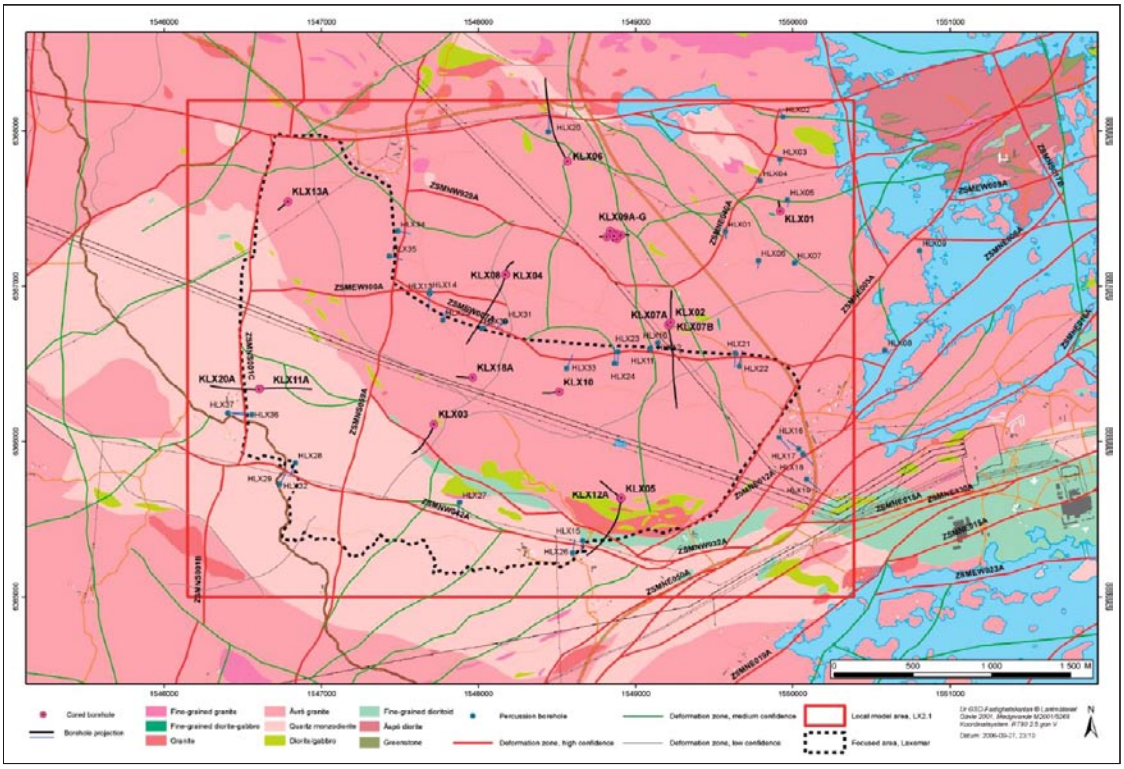


Figure A1-3. *The focused area, as defined in Laxemar SDM 2.1. Image taken from /3/.*

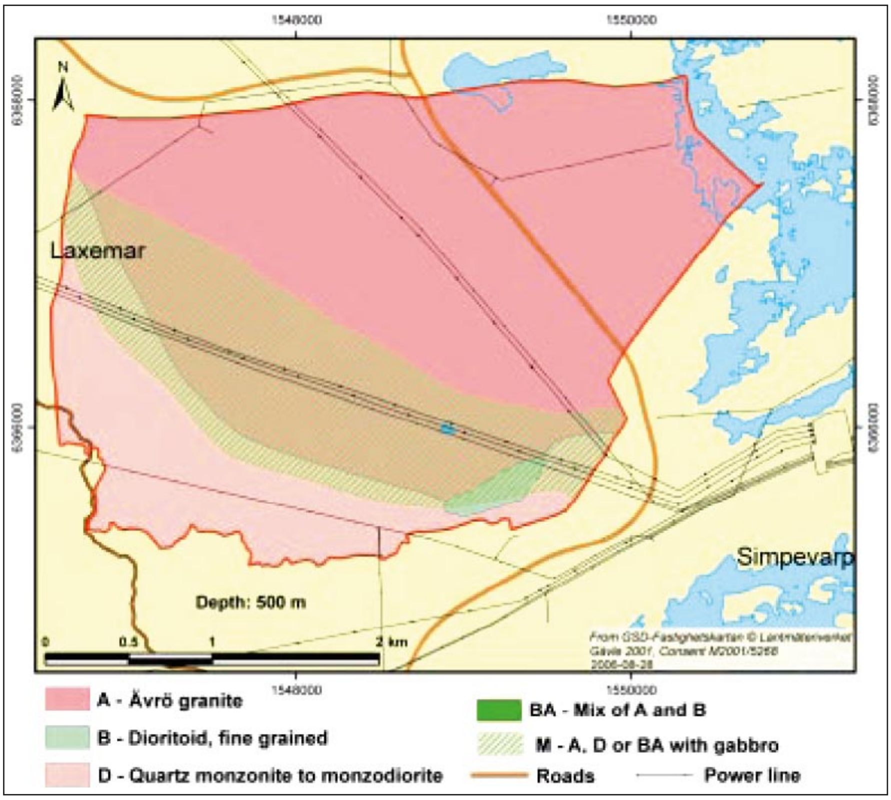


Figure A1-4. *Rock domains at the depth of 500 m. Image taken from /2/.*

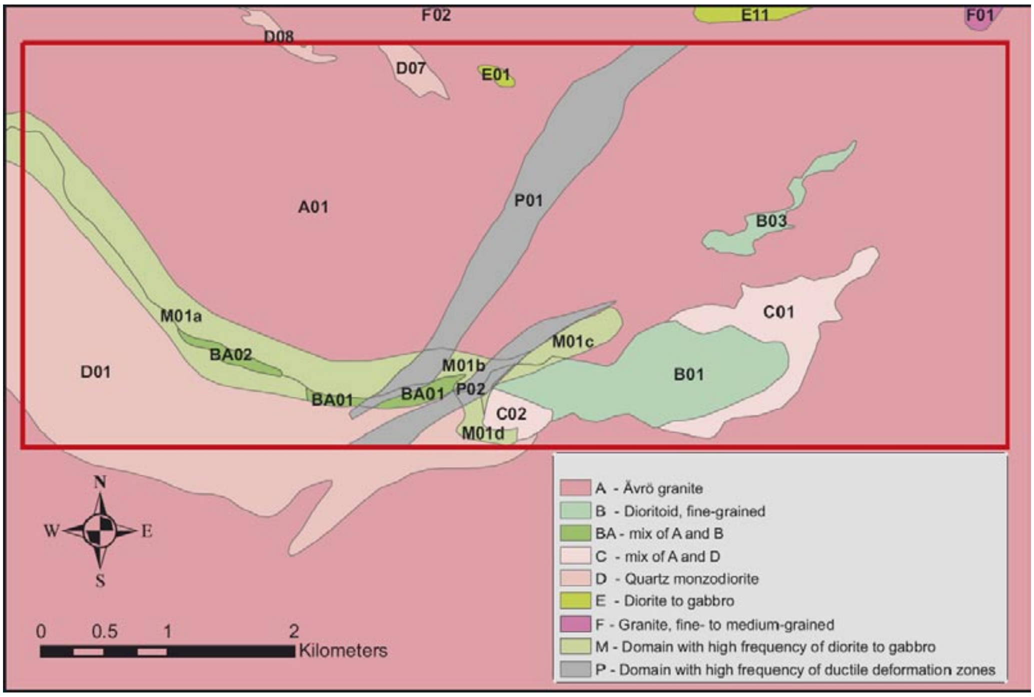


Figure A1-5. *Rock domains at surface. Image taken from /4/.*

1.3 Some definitions and clarifications

1.3.1 Approximate elevation

In the planning of the campaign, the elevation of a drill core section was approximated from the borehole length, elevation at the surface, and dip of the borehole at the surface. In this document the term approximated elevation is therefore used. In reality the boreholes may be curved, making the approximated elevation somewhat over- or underestimated. This error is deemed acceptable for the purpose of planning the campaign. In reports handling the results, it is recommended to use exact coordinates. In this document m.a.s.l. and mbsl are used as units of elevation, which are abbreviations for "metres above sea level" and "metres below sea level", respectively.

1.3.2 PFL anomalies and PFL sections

The choice of boreholes and drill core sections to be investigated in this campaign is largely based on hydraulic measurements with the Posiva difference flow meter. This tool can detect flow anomalies with a vertical resolution of 0.1 m. In this document, a 2 m long drill core section that is comprised of the rock surrounding a PFL anomaly, by one metre at each side, is called a PFL section. Of course, if the spacing between two investigated PFL anomalies is less than 2 m, the overlapping drill core was not mapped twice and therefore the total length of mapped drill core is less than the product of the number of investigated PFL sections and 2 m.

Concerning PFL anomalies, many of them are in the hydrogeological background reports marked as uncertain. As stated in the reports, e.g. /5/:

"Some fracture-specific results were rated to be "uncertain"... The criterion of "uncertain" was in most cases a minor flow rate (< 30 mL/h). In some cases fracture anomalies were unclear, since the distance between them was less than one metre."

However, for this present campaign fractures of low hydraulic conductivity are of great importance and should therefore not be excluded. Furthermore, closely spaced anomalies are being handled by mapping drill core sections large enough to including the closely spaced anomalies. Therefore, in this campaign no distinctions are made on beforehand between PFL anomalies marked as uncertain or not in the background documents. In the subsequent analysis, however, it is recommended to investigate whether this decision affects the obtained data.

1.4 Expected nonconformities

It this planning of this work, it was not checked whether the drill core sections suggested suffer from drill core loss or loss of BIPS image. If this was the case, there was an option to exclude the drill core section from the campaign. However, it was on beforehand judged that the loss of mapped PFL section should be small in the context of the entire campaign. This was also confirmed during the process of mapping.

2 Horizontal spatial representativity of boreholes

For this campaign it was proposed to perform investigations within the main area in the rock domains RSMA, RSMD, and RSMM. It was intended to equally divide the number of PFL anomalies investigated on the three rock domains.

To achieve adequate spatial representativity it was proposed to investigate more that one borehole in each rock domain. Furthermore, the investigated boreholes should be sufficiently distant from each other. Both short and long core drilled boreholes should be investigated, if needed, to achieve sufficient vertical spatial representativity. Short and long boreholes may be chosen even if drilled from the same drill site if only vertical spatial representativity is sought.

For the rock domain RSMA it was initially planned to investigate boreholes KLX10, KLX10C and KLX13A. Borehole KLX13A was later excluded from the campaign. For the rock domain RSMD it was initially planned to investigate boreholes KLX11F, KLX15A (lower part), KLX19A, and KLX20A. Borehole KLX20A was later excluded from the campaign. For rock domain RSMM it was planned to investigate boreholes KLX03, KLX15A (upper part), KLX17A, and KLX26B. All of these boreholes were mapped in the campaign.

For the peripheral area it was initially planned to investigate KLX16A in the Laxemar subarea and KSH02 in the Simpevarp subarea. Borehole KSH02 was later excluded from the campaign.

All boreholes in the Laxemar subarea mentioned above are encircled by solid rings in Figure A2-1. Green rings mark boreholes that were mapped and red rings mark boreholes that were excluded.

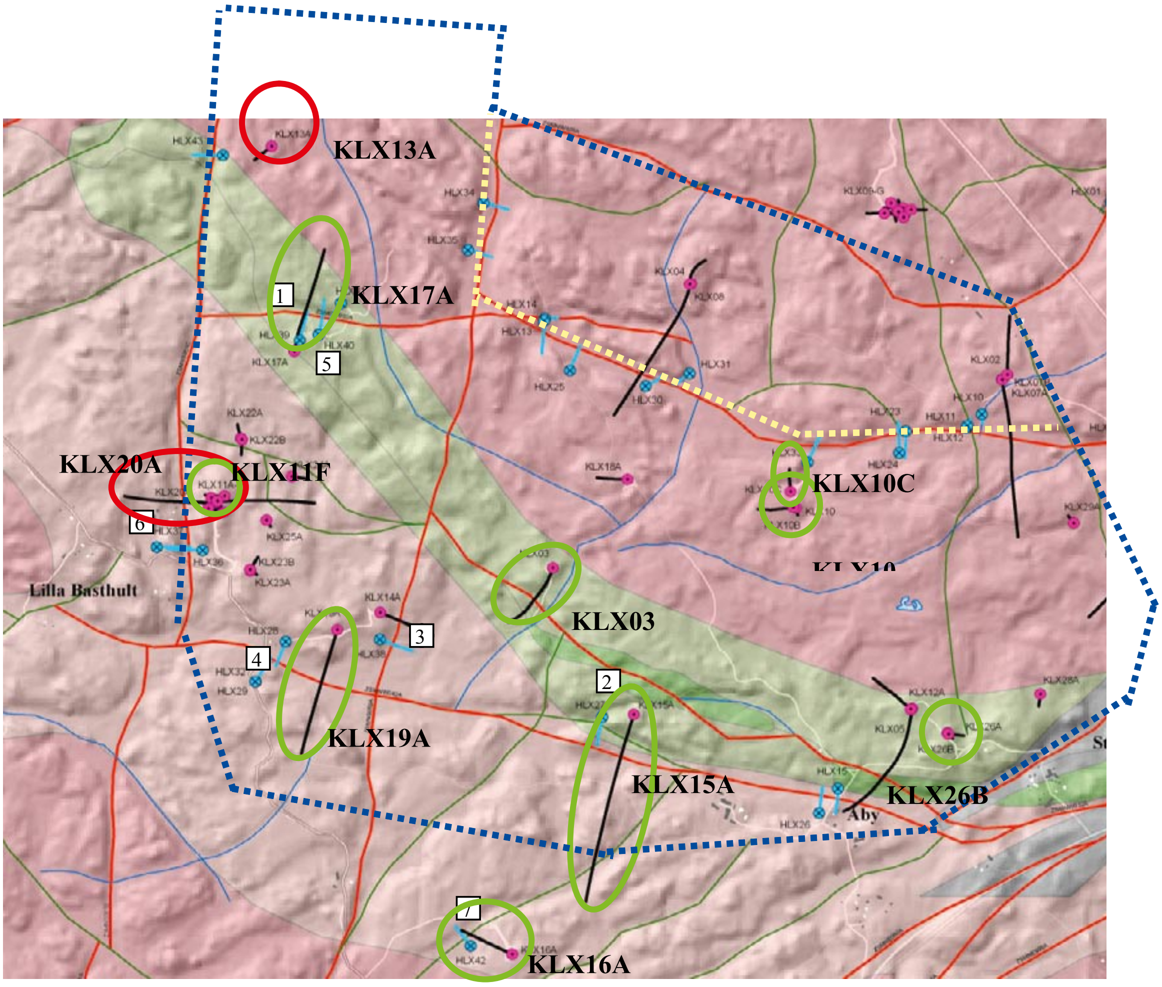


Figure A2-1. *Suggested boreholes to be investigated.*

3 Vertical spatial representativity of drill core sections

According to the motivation document /1/, out of the suggested PFL anomalies located within the focused area, about half should be distributed between the elevation 300 and 600 mbsl (meter below sea level), and half should be distributed at elevations above 300 mbsl.

In the planning of the campaign it was proposed that rock volume above 300 mbsl should be divided into two subdivisions 1) elevation above 100 mbsl and 2) elevation between 100 and 300 mbsl. The investigated PFL sections should be fairly equally divided on the two subdivisions. Furthermore, it was proposed that a few PFL sections below 600 mbsl should be investigated for comparison.

For the peripheral area, about half of the mapped PFL sections should be distributed above the elevation –300 m.a.s.l. and half between –300 and –600 m.a.s.l. according to /1/.

3.1 Basis for selecting PFL anomalies

3.1.1 Transmissivity

It has been suggested as a possibility to choose PFL anomalies based on their transmissivity. Therefore, three transmissivity subdivisions were assigned: low transmissivity ($T < 10^{-8}$ m^2/s), medium transmissivity ($10^{-8} \leq T \leq 10^{-6}$ m^2/s), and high transmissivity ($T > 10^{-6}$ m^2/s). However, it was later judged that choosing PFL anomalies based on their transmissivity would likely induce a bias in the data selection. Therefore, it was decided against including the transmissivity as a basis for choosing PFL sections. Even so, when presenting the selected PFL sections the transmissivity of the associated flow anomaly is accounted for in this document.

3.1.2 Fracture orientation, rock type, fracture frequency, etc

Based on a similar reasoning as for transmissivity, it was decided against basing the choice of PFL anomalies on the fracture orientation, rock type and fracture frequency of the host rock, etc. This was to done in order to reduce the risk of inducing bias in the data selection.

3.1.3 Basis for reduction of data points

In this campaign a few hundred PFL sections were investigated out of the many thousands at the site. Even if reducing the discussion to the boreholes suggested for the campaign in Chapter 2 (see Figure A2-1), these boreholes feature well over one thousand anomalies. Therefore, data reduction was required. To not reduce the possibility of studying the local variability between closely spaced fractures, it was decided that when necessary the borehole should be divided into 20 m long sections and that whole sections should be included or discarded.

4 Rock domain RSMA

For rock domain RSMA, boreholes KLX10 and KLX10C were mapped. Initially it was also planned to map borehole KLX13A but due to practical reasons the borehole was excluded from the campaign. In total 76 PFL sections were mapped, and the basis for the selection is accounted for in Sections 4.1 and 4.2. The distribution of the 76 PFL anomalies, in terms of borehole, elevation, and transmissivity ranges is shown in Table A4-1.

The PFL-sections initially suggested in KLX13A, but later excluded from the campaign, are accounted for in subsection 4.3.

4.1 KLX10

The long boreholes KLX10 was selected on the basis that it is located in the centre of rock domain RSMA. In the Posiva difference flow logging /6/ KLX10 was logged between the borehole lengths 92–850 m and the shallowest PFL anomaly found was located at the borehole length 103 m. Therefore, the borehole was chosen to represent rock at the elevations between 100 and 300 mbsl and also below 300 mbsl.

In total 191 PFL anomalies were measured in the borehole, whereof 181 are located above the elevation 500 mbsl. Therefore, it was judged that above this elevation data reduction was needed. In accordance with the reasoning in subsection 3.1.3, this was done by dividing the borehole above –500 m.a.s.l. into 20 m sections (based on elevation). PFL anomalies from the elevations 100 to 120 mbsl, 200 to 220 mbsl, 300 to 320 mbsl, and 400 to 420 mbsl were included in the data selection. Below 500 mbsl, no data reduction was performed and all PFL anomalies were included in the campaign (see Figure A4-1 and Table A4-2 below). In total 51 PFL anomalies were selected.

In Figure A4-1 the location of the 51 selected and 141 discarded PFL anomalies in KLX10 are shown together with their transmissivities. Numerical values of locations and transmissivities of the selected PFL anomalies are shown in Table A4-2. The colour codes of the table represent the transmissivity subdivisions of subsection 3.1.1. The colour codes represents the following: tanned = low transmissivity ($T < 10^{-8}$ m^2/s), yellow = medium transmissivity ($10^{-8} \leq T \leq 10^{-6}$ m^2/s), green = high transmissivity ($T > 10^{-6}$ m^2/s). The approximate elevation on the x-axis was obtained as described in subsection 1.3.1.

In addition to the selected PFL sections, the drill core section 490–500 m (borehole length) was chosen to represent drill core at least 5 m distant from any PFL-anomaly. This section is marked by grey colour in Table A4-2.

Table A4-1. Distribution of selected PFL anomalies in rock domain RSMA.

	E > –100 m.a.s.l.	–100 ≥ E ≥ –300 m.a.s.l.	–300 > E ≥ –600 m.a.s.l.	E < –600 m.a.s.l.	$T < 10^{-8}$ m^2/s	$10^{-8} \leq T \leq 10^{-6}$ m^2/s	$T > 10^{-6}$ m^2/s
KLX10	0	17	30	4	12	31	8
KLX10C	25	0	0	0	13	11	1
Total	**25**	**17**	**30**	**4**	**25**	**42**	**9**

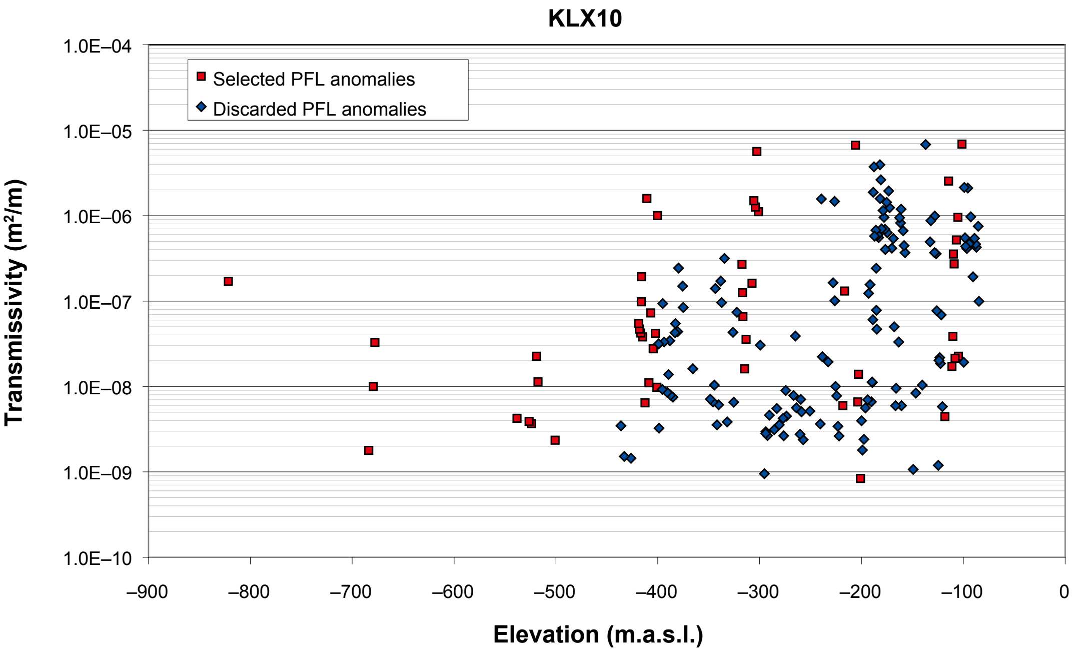


Figure A4-1. Selected and discarded PFL anomalies in KLX10.

Table A4-2. Selected drill core sections in KLX10.

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m²/s)	Rock domain
KLX10	118.9	120.9	119.9	–101.2	6.88E–006	RSMA
KLX10	122.4	130.9	123.4	–104.7	2.25E–008	RSMA
			124.0	–105.3	9.54E–007	RSMA
			125.5	–106.8	5.17E–007	RSMA
			126.8	–108.1	2.13E–008	RSMA
			127.7	–109.0	2.71E–007	RSMA
			128.4	–109.7	3.54E–007	RSMA
			129.0	–110.3	3.85E–008	RSMA
			129.9	–111.2	1.71E–008	RSMA
KLX10	132.1	134.1	133.1	–114.3	2.54E–006	RSMA
KLX10	135.7	137.7	136.7	–117.9	4.43E–009	RSMA
KLX10	218.9	223.6	219.9	–200.8	8.36E–010	RSMA
			221.9	–202.8	1.39E–008	RSMA
			222.6	–203.5	6.59E–009	RSMA
KLX10	223.8	225.8	224.8	–205.7	6.67E–006	RSMA
KLX10	234.7	238.2	235.7	–216.6	1.31E–007	RSMA
			237.2	–218.1	5.95E–009	RSMA
KLX10	319.4	327.8	320.4	–301.0	1.11E–006	RSMA
			322.0	–302.6	5.63E–006	RSMA
			323.5	–304.1	1.26E–006	RSMA
			324.9	–305.5	1.49E–006	RSMA
			326.8	–307.3	1.61E–007	RSMA
KLX10	331.7	337.7	332.7	–313.2	3.56E–008	RSMA
			334.1	–314.6	1.60E–008	RSMA
			335.8	–316.3	6.55E–008	RSMA
			336.2	–316.7	1.25E–007	RSMA

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Rock domain
			336.7	–317.2	2.69E–007	RSMA
KLX10	418.9	425.2	419.9	–400.1	1.00E–006	RSMA
			420.5	–400.7	9.79E–009	RSMA
			422.0	–402.2	4.18E–008	RSMA
			424.2	–404.4	2.75E–008	RSMA
KLX10	425.6	433.3	426.6	–406.8	7.25E–008	RSMA
			428.5	–408.7	1.10E–008	RSMA
			430.5	–410.7	1.58E–006	RSMA
			432.3	–412.5	6.41E–009	RSMA
KLX10	433.7	439.5	434.7	–414.9	3.80E–008	RSMA
			435.8	–416.0	1.92E–007	RSMA
			436.0	–416.2	9.78E–008	RSMA
			436.4	–416.6	4.21E–008	RSMA
			437.7	–417.8	4.68E–008	RSMA
			438.5	–418.6	5.44E–008	RSMA
KLX10	490.0	500.0	No PFL-anomaly			RSMA
KLX10	519.8	521.8	520.8	–500.6	2.35E–009	RSMA
KLX10	536.7	540.2	537.7	–517.5	1.13E–008	RSMA
			539.2	–519.0	2.25E–008	RSMA
KLX10	543.2	545.2	544.2	–524.0	3.66E–009	RSMA
KLX10	545.4	547.4	546.4	–526.2	3.88E–009	RSMA
KLX10	557.4	559.4	558.4	–538.1	4.23E–009	RSMA
KLX10	697.5	701.1	698.5	–677.7	3.26E–008	RSMA
			700.0	–679.2	9.98E–009	RSMA
KLX10	703.4	705.4	704.4	–683.6	1.78E–009	RSMA
KLX10	841.9	843.9	842.9	–821.6	1.70E–007	RSMA

4.2 KLX10C

The short borehole KLX10C was chosen as a complement to KLX10, to represent the rock volume above the elevations 100 mbsl. All 25 PFL anomalies detected in the PFL flow logging /7/ in the borehole length interval 10–139 m were included in the selected data set for the campaign (see Figure A4-2 and Table A4-3 below).

In Figure A4-2 the location of the 25 selected PFL anomalies in KLX10C are shown together with their transmissivities. The numerical values of the locations and transmissivities of the selected PFL anomalies are shown in Table A4-3. The colour codes are the same as in Table A4-2.

In addition to the selected PFL sections, the drill core section 68–78 m (borehole length) was chosen to represent drill core at least 5 m distant from any PFL-anomaly.

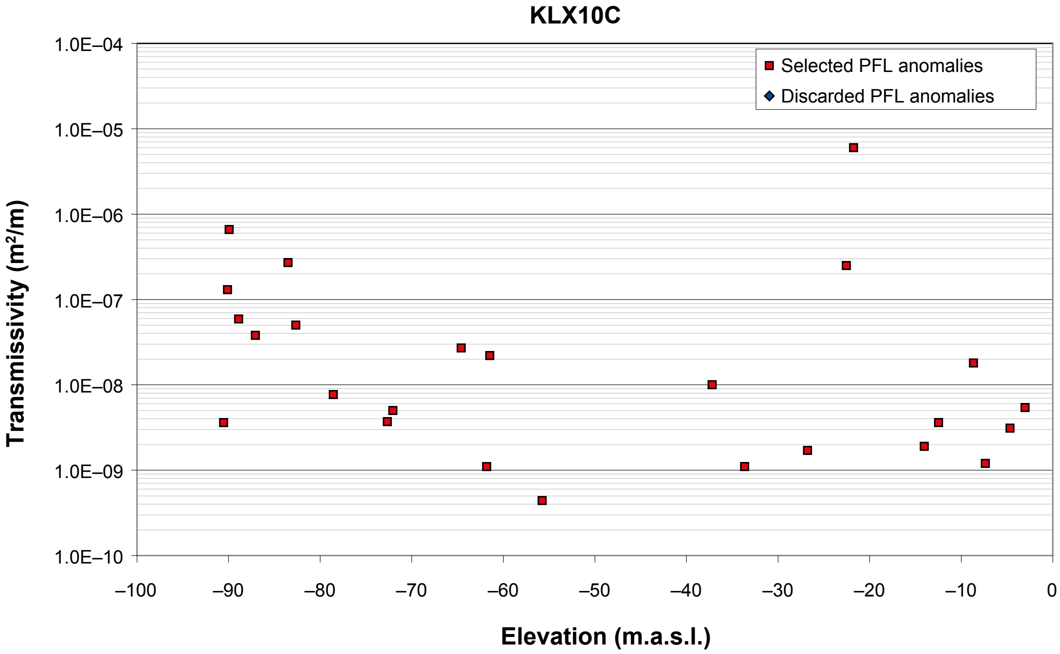


Figure A4-2. *Location and transmissivity of PFL anomalies in KLX10C.*

Table A4-3. Selected drill core sections in KLX10C.

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Rock domain
KLX10C	22.0	250	23.0	–3.0	5.40E–09	RSMA
			24.9	–4.7	3.10E–09	RSMA
KLX10C	27.0	30.5	28.0	–7.4	1.20E–09	RSMA
			29.5	–8.7	1.80E–08	RSMA
KLX10C	32.9	36.7	33.9	–12.5	3.60E–09	RSMA
			35.7	–14.0	1.90E–09	RSMA
KLX10C	43.6	46.5	44.6	–21.8	6.00E–06	RSMA
			45.5	–22.5	2.50E–07	RSMA
KLX10C	49.4	51.4	50.4	–26.8	1.70E–09	RSMA
KLX10C	57.3	59.3	58.3	–33.6	1.10E–09	RSMA
KLX10C	61.4	63.4	62.4	–37.2	1.00E–08	RSMA
KLX10C	68.0	78.0	No PFL-anomaly			RSMA
KLX10C	82.8	84.8	83.8	–55.8	4.40E–10	RSMA
KLX10C	89.4	91.8	90.4	–61.5	2.20E–08	RSMA
			90.8	–61.8	1.10E–09	RSMA
KLX10C	93.0	95.0	94.0	–64.6	2.70E–08	RSMA
KLX10C	101.6	104.3	102.6	–72.1	5.00E–09	RSMA
			103.3	–72.7	3.70E–09	RSMA
KLX10C	109.1	111.1	110.1	–78.6	7.70E–09	RSMA
KLX10C	113.8	116.8	114.8	–82.6	5.00E–08	RSMA
			115.8	–83.5	2.70E–07	RSMA
KLX10C	118.9	124.9	119.9	–87.1	3.80E–08	RSMA
			122.0	–88.9	5.90E–08	RSMA
			123.2	–89.9	6.60E–07	RSMA
			123.4	–90.1	1.30E–07	RSMA
			123.9	–90.5	3.60E–09	RSMA

4.3 KLX13A – excluded borehole

The text below describes the initial planning of drill core selection. Later on the entire borehole was excluded from the campaign. The rational for excluding the particular borehole is that it is located in the most northern part of the focused area, while much layout work presently focuses on the southern part.

The borehole KLX13A was initially chosen as it distant from borehole KLX10, but still within the area of interest for the repository layout D1 (see Figure A1-2). In the flow logging /8/, 155 PFL anomalies were detected between the borehole lengths 94–588 m. Data reduction was made by dividing the borehole in 20 m sections (based on elevation). PFL anomalies from the elevations 80 to 100 mbsl, 180 to 200 mbsl, 280 to 300 mbsl, 380 to 400 mbsl, and 480 to 500 mbsl were initially included in the data selection.

In Figure A4-3 the location of the 27 selected and 128 discarded PFL anomalies in KLX13A are shown together with their transmissivities. The numerical values of the locations and transmissivities of the selected PFL anomalies are shown in Table A4-4. The colour codes are the same as in Table A4-2.

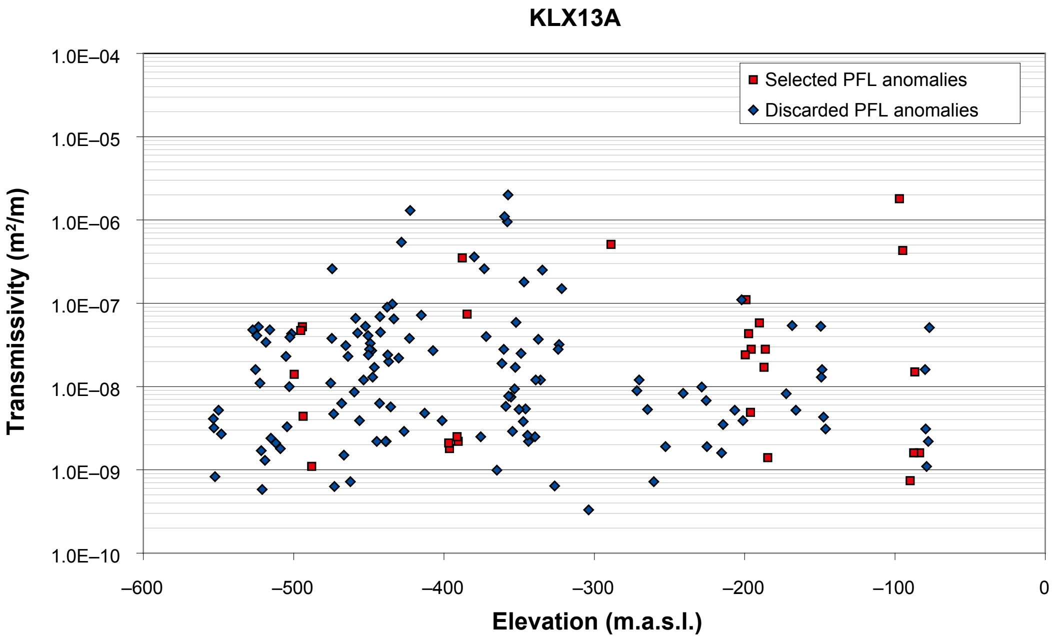


Figure A4-3. *Location and transmissivity of PFL anomalies in KLX13A.*

Table A4-4. PFL-anomalies in KLX13A initially selected but later on excluded from the campaign.

Borehole	Borehole length of PFL anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m²/s)	Rock domain
KLX13A	108.6	–83.4	1.60E–09	RSMA
KLX13A	111.9	–86.7	1.50E–08	RSMA
KLX13A	112.7	–87.5	1.60E–09	RSMA
KLX13A	115.0	–89.8	7.40E–10	RSMA
KLX13A	120.0	–94.7	4.30E–07	RSMA
KLX13A	122.3	–97.0	1.80E–06	RSMA
KLX13A	210.6	–184.5	1.40E–09	RSMA
KLX13A	212.3	–186.2	2.80E–08	RSMA
KLX13A	213.2	–187.1	1.70E–08	RSMA
KLX13A	216.2	–190.1	5.80E–08	RSMA
KLX13A	221.8	–195.6	2.80E–08	RSMA
KLX13A	222.3	–196.1	4.90E–09	RSMA
KLX13A	223.5	–197.3	4.30E–08	RSMA
KLX13A	225.2	–199.0	1.10E–07	RSMA
KLX13A	225.7	–199.5	2.40E–08	RSMA
KLX13A	315.9	–288.8	5.10E–07	RSMA
KLX13A	412.5	–384.6	7.40E–08	RSMA
KLX13A	415.7	–387.7	3.50E–07	RSMA
KLX13A	418.5	–390.5	2.20E–09	RSMA
KLX13A	419.2	–391.2	2.50E–09	RSMA
KLX13A	424.4	–396.3	1.80E–09	RSMA
KLX13A	424.9	–396.8	2.10E–09	RSMA
KLX13A	516.9	–488.0	1.10E–09	RSMA
KLX13A	522.6	–493.6	4.40E–09	RSMA
KLX13A	523.1	–494.1	5.20E–08	RSMA
KLX13A	524.2	–495.2	4.70E–08	RSMA
KLX13A	528.6	–499.6	1.40E–08	RSMA

5 Rock domain RSMM

For rock domain RSMM, all boreholes of the initial planning were mapped. The concerned boreholes are KLX03, KLX15A (upper part), KLX17A, and KLX26B. In total 104 PFL-sections were mapped, and the strategy for the drill core selection is accounted for below and in Section 5.1 to 5.4. The distribution of the 104 PFL anomalies, in terms of borehole, elevation, and transmissivity ranges is shown in Table A5-1.

The strategy behind the choice of boreholes was that KLX03 should be the main borehole, as it is situated in the centre of rock domain RSMM. KLX03 should be complemented by the short borehole KLX26B, which should represent the shallow rock above the elevation 100 mbsl. Additionally, in this rock domain there is a special interest to investigate certain sections of the boreholes KLX15A and KLX17A. Sections of these boreholes are candidates for being injection sections in cross-hole tracer tests with sorbing species that are being planned as a part of the Oskarshamn site investigation. As these sections are located between the elevations 100 and 300 mbsl, it is proposed that KLX15A and KLX17A should represent this elevation range. Rock below 300 mbsl should be represented by KLX03.

5.1 KLX03

KLX03 was chosen to represent the rock below the elevation 300 mbsl in rock domain RSMM. All PFL anomalies detected in the flow loggings /9/ below 300 mbsl were included, except for the two lower ones, which are situated in rock domain RSMD. In total 28 PFL anomalies were selected for the campaign (see Figure A5-1 and Table A5-2 below).

In Figure A5-1 the location of the 28 selected and 27 discarded PFL anomalies in KLX03 are shown together with their transmissivities. The numerical values of the locations and transmissivities of the selected PFL anomalies are shown in Table A5-2. The colour codes are the same as in Table A4-2.

In addition to the selected PFL sections, the drill core sections 175–185 m and 500–510 m (borehole length) were chosen to represent drill core at least 5 m distant from any PFL-anomaly.

Table A5-1. Distribution of selected PFL anomalies in rock domain RSMM.

	E > –100 m.a.s.l.	–100 ≥ E ≥ –300 m.a.s.l.	–300 > E ≥ –600 m.a.s.l.	E < –600 m.a.s.l.	T < 10^{-8} m²/s	10^{-8} ≤ T ≤ 10^{-6} m²/s	T > 10^{-6} m²/s
KLX15A	6	29	0	0	9	22	4
KLX26B	17	0	0	0	7	9	1
KLX17A	0	11	13	0	12	9	3
KLX03	0	0	10	18	8	18	2
Total	**23**	**40**	**23**	**18**	**36**	**58**	**10**

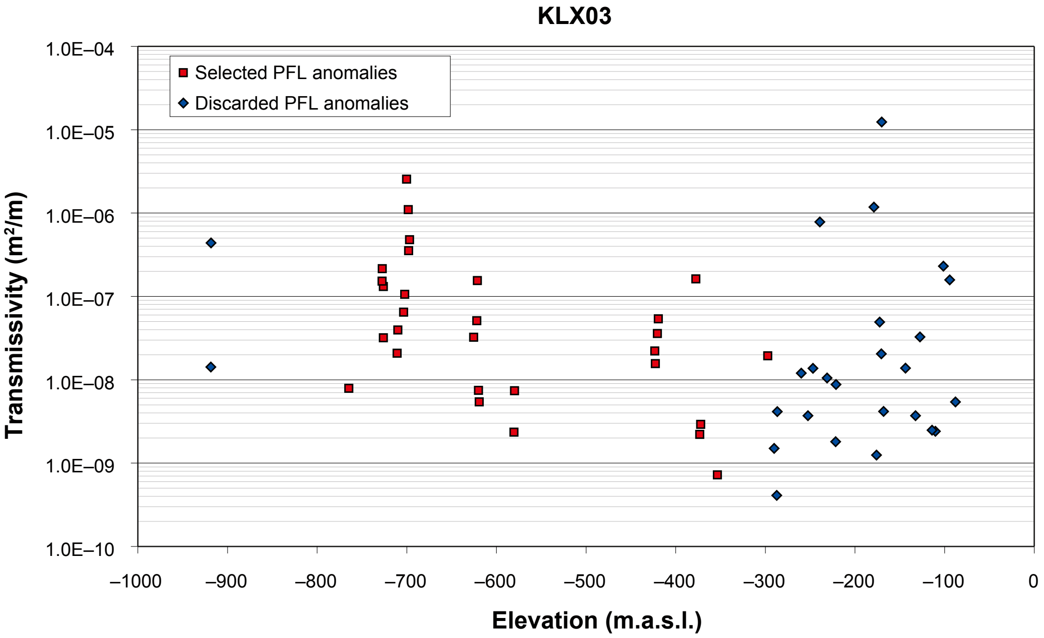


Figure A5-1. *Location and transmissivity of PFL anomalies in KLX03.*

Table A5-2. Selected drill core sections in KLX03.

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Rock domain
KLX03	175.0	185.0	No PFL anomaly			RSMM
KLX03	384.0	386.0	385.0	–353.3	7.23E–10	RSMM
KLX03	403.4	406.4	404.4	–372.0	2.91E–09	RSMM
			405.4	–373.0	2.21E–09	RSMM
KLX03	408.9	410.9	409.9	–377.3	1.62E–07	RSMM
KLX03	452.4	455.4	453.4	–419.3	5.37E–08	RSMM
			454.4	–420.3	3.58E–08	RSMM
KLX03	455.7	458.4	456.7	–422.5	1.56E–08	RSMM
			457.4	–423.2	2.21E–08	RSMM
KLX03	500.0	510.0	No PFL anomaly			RSMM
KLX03	618.4	621.1	619.4	–579.6	7.38E–09	RSMM
			620.1	–580.3	2.35E–09	RSMM
KLX03	659.2	664.0	660.2	–619.0	5.43E–09	RSMM
			661.2	–620.0	7.44E–09	RSMM
			662.4	–621.1	1.55E–07	RSMM
			663.0	–621.7	5.10E–08	RSMM
KLX03	665.7	667.7	666.7	–625.3	3.23E–08	RSMM
KLX03	739.8	745.1	740.8	–696.8	4.78E–07	RSMM
			741.8	–697.8	3.53E–07	RSMM
			742.3	–698.3	1.10E–06	RSMM
			744.1	–700.0	2.55E–06	RSMM
KLX03	745.4	748.7	746.4	–702.2	1.06E–07	RSMM
			747.7	–703.5	6.48E–08	RSMM
KLX03	753.3	756.1	754.3	–709.9	3.96E–08	RSMM
			755.1	–710.6	2.08E–08	RSMM
KLX03	770.0	773.6	771.0	–726.0	3.18E–08	RSMM
			771.1	–726.1	1.31E–07	RSMM
			772.3	–727.2	2.15E–07	RSMM
			772.6	–727.5	1.52E–07	RSMM
KLX03	810.0	812.0	811.0	–764.6	7.88E–09	RSMM

5.2 KLX26B

KLX26B was chosen to represent the rock above the elevation 100 mbsl in rock domain RSMM. All PFL anomalies detected in the flow loggings /10/ were included. In total 17 PFL anomalies were selected for the campaign (see Figure A5-2 and Table A5-3 below).

In Figure A5-2 the location of the 17 selected PFL anomalies in KLX26B are shown together with their transmissivities. The numerical values of locations and transmissivities of the selected PFL anomalies are shown in Table A5-3. The colour codes are the same as in Table A4-2.

Table A5-3. Selected drill core sections in KLX26B.

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Rock domain
KLX26B	16.9	18.9	17.9	0.3	8.80E–10	RSMM
KLX26B	19.4	24.0	20.4	–1.8	2.90E–09	RSMM
			21.3	–2.6	1.00E–09	RSMM
			23.0	–4.1	1.70E–08	RSMM
KLX26B	24.4	33.2	25.4	–6.2	4.30E–09	RSMM
			27.4	–7.9	2.40E–08	RSMM
			27.8	–8.2	4.20E–08	RSMM
			28.4	–8.8	3.90E–08	RSMM
			29.0	–9.3	6.30E–09	RSMM
			31.0	–11.0	4.40E–09	RSMM
			31.9	–11.8	3.40E–08	RSMM
			32.2	–12.1	2.80E–08	RSMM
KLX26B	35.6	37.6	36.6	–15.9	1.90E–06	RSMM
KLX26B	38.1	43.6	39.1	–18.0	6.00E–09	RSMM
			40.2	–19.0	3.40E–08	RSMM
			41.1	–19.8	1.80E–07	RSMM
			42.6	–21.1	2.70E–08	RSMM

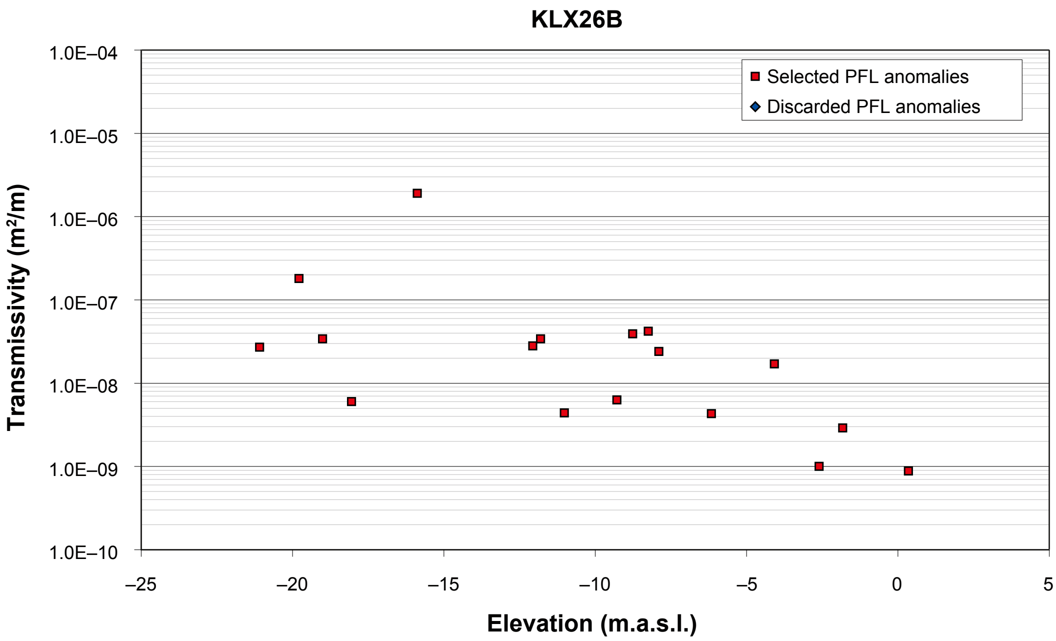


Figure A5-2. Location and transmissivity of PFL anomalies in KLX26B.

5.3 KLX15A

The upper 300 m (borehole length) or so of KLX15A is situated in rock domain RSMM while the lower part is situated in RSMD. For the selection there was a special focus on the borehole section 175–275 m, as this section is an alternative for performing injection of sorbing tracers in tracer tests that are being presently planned at the site. Therefore, all 15 PFL anomalies in the section were selected.

The PFL anomalies shallower than 175 m were so many (36) that data reduction was required. This was done by dividing the borehole into 20 m sections and only selecting PFL anomalies in every other section. This resulted in 20 selected PFL anomalies above 175 m borehole length. In total 35 PFL sections were selected for the campaign from rock domain RSMM in borehole KLX15A (see Figure A5-3 and Table A5-4 below).

In Figure A5-3 the location of the 35 selected and 15 discarded PFL anomalies in rock domain RSMM in KLX15A are shown together with their transmissivities. In addition, PFL anomalies in rock domain RSMD, below the borehole length 300 m, are shown. The numerical values of the locations and transmissivities of the selected PFL anomalies for rock domain RSMM are shown in Table A5-4. The colour codes are the same as in Table A4-2.

In addition to the selected PFL sections, the drill core section 95.9–98.9 m (borehole length) was chosen to represent drill core distant from any PFL-anomaly.

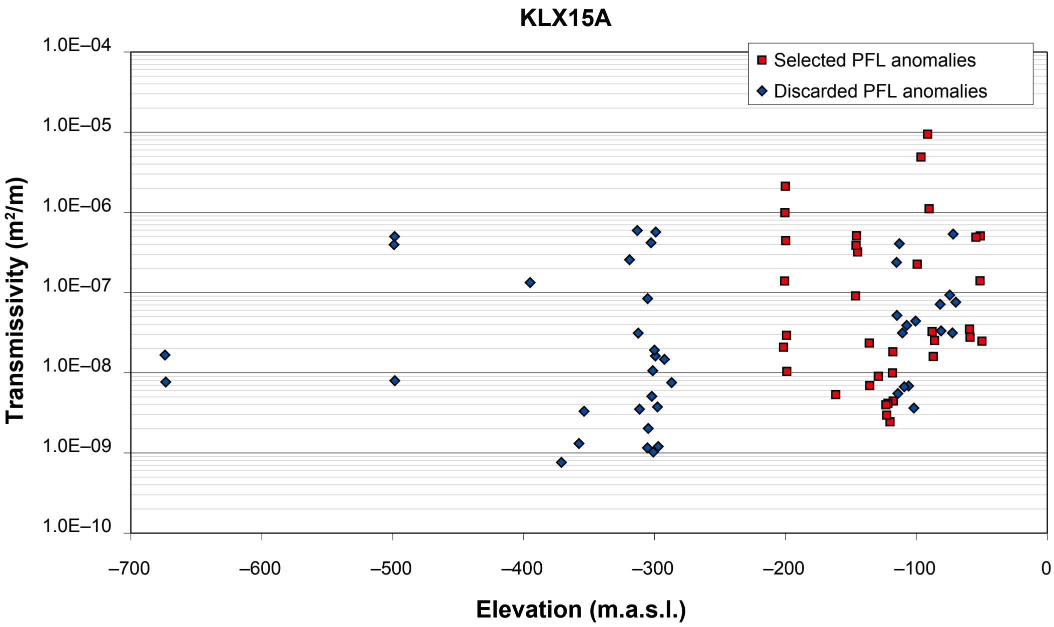


Figure A5-3. *Location and transmissivity of PFL anomalies in KLX15A.*

Table A5-4. Selected drill core sections in rock domain RSMM in borehole KLX15A.

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m²/s)	Rock domain
KFM15A	78.2	82.1	79.2	–49.6	2.47E–08	RSMM
			80.9	–50.9	5.09E–07	RSMM
			81.1	–51.1	1.40E–07	RSMM
KFM15A	83.9	85.9	84.9	–54.2	4.90E–07	RSMM
KFM15A	89.5	91.9	90.5	–58.7	2.77E–08	RSMM
			90.9	–59.0	3.50E–08	RSMM
KFM15A	95.9	98.9	No PFL anomaly			RSMM
KFM15A	122.7	127.0	123.7	–85.6	2.53E–08	RSMM
			124.9	–86.6	1.59E–08	RSMM
			126.0	–87.5	3.25E–08	RSMM
KFM15A	127.8	131.3	128.8	–89.7	1.11E–06	RSMM
			130.3	–91.0	9.41E–06	RSMM
KFM15A	135.5	137.5	136.5	–96.0	4.89E–06	RSMM
KFM15A	139.0	141.0	140.0	–98.8	2.26E–07	RSMM
KFM15A	161.6	164.2	162.6	–117.1	4.44E–09	RSMM
			162.9	–117.4	1.82E–08	RSMM
			163.2	–117.6	9.93E–09	RSMM
KFM15A	164.5	170.4	165.5	–119.5	2.44E–09	RSMM
			167.5	–121.1	4.16E–09	RSMM
			168.8	–122.1	2.95E–09	RSMM
			169.4	–122.6	3.98E–09	RSMM
KFM15A	175.6	177.6	176.6	–128.5	9.00E–09	RSMM
KFM15A	183.7	186.1	184.7	–135.0	6.92E–09	RSMM
			185.1	–135.3	2.34E–08	RSMM
KFM15A	195.1	199	196.1	–144.3	3.20E–07	RSMM
			197.1	–145.1	5.11E–07	RSMM
			197.5	–145.4	3.88E–07	RSMM
			198.0	–145.8	9.09E–08	RSMM
KFM15A	215.6	217.6	216.6	–160.9	5.33E–09	RSMM
KFM15A	261.4	266.7	262.4	–198.0	1.04E–08	RSMM
			262.9	–198.4	2.92E–08	RSMM
			263.6	–198.9	4.43E–07	RSMM
			263.9	–199.2	2.11E–06	RSMM
			264.3	–199.5	9.90E–07	RSMM
			264.6	–199.7	1.39E–07	RSMM
			265.7	–200.6	2.08E–08	RSMM

5.4 KLX17A

For the selection of PFL anomalies in KLX17A there was a special focus on the borehole section 184–218 m (borehole length), as this section is an alternative for performing injection of sorbing tracers in tracer tests that are being presently planned. Therefore, all 11 PFL anomalies detected in the flow logging /11/ in the section were selected. In addition there was a need to select drill core representing the deeper part of the rock, between 300 and 600 mbsl, as only 10 PFL anomalies in this range were located in borehole KLX03. Therefore, all 13 PFL anomalies identified in the flow logging between 300 and 600 mbsl were selected. In total 24 PFL sections were selected for the campaign (see Figure A5-4 and Table A5-5 below).

In Figure A5-4 the location of the 24 selected and 23 discarded PFL anomalies in KLX17A are shown together with their transmissivities. The numerical values of the locations and transmissivities of the selected PFL anomalies are shown in Table A5-5. The colour codes are the same as in Table A4-2.

Table A5-5. Selected drill core sections in KLX17A.

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Rock domain
KLX17A	183.3	187.1	184.3	–134.1	2.00E–07	RSMM
			186.1	–135.7	1.20E–08	RSMM
KLX17A	189.8	194.7	190.8	–139.8	2.90E–09	RSMM
			191.4	–140.3	7.00E–07	RSMM
			193.1	–141.8	6.90E–09	RSMM
			193.7	–142.3	2.70E–09	RSMM
KLX17A	199.3	201.3	200.3	–148.1	9.60E–08	RSMM
KLX17A	206.6	208.6	207.6	–154.5	2.50E–08	RSMM
KLX17A	214.2	218.7	215.2	–161.2	4.10E–09	RSMM
			217.1	–162.9	4.00E–09	RSMM
			217.7	–163.4	5.90E–09	RSMM
KLX17A	409.2	411.2	410.2	–332.3	7.50E–09	RSMM
KLX17A	413.8	417.0	414.8	–336.3	5.90E–09	RSMM
			416.0	–337.4	1.50E–08	RSMM
KLX17A	419.9	427.0	420.9	–341.7	6.80E–06	RSMM
			422.6	–343.2	6.70E–07	RSMM
			423.4	–343.9	2.80E–07	RSMM
			424.4	–344.7	2.70E–08	RSMM
			426.0	–346.1	1.40E–09	RSMM
KLX17A	427.9	429.9	428.9	–348.7	3.20E–06	RSMM
KLX17A	430.6	432.6	431.6	–351.1	4.30E–06	RSMM
KLX17A	464.5	466.5	465.5	–380.8	1.20E–09	RSMM
KLX17A	667.6	669.6	668.6	–559.0	1.30E–09	RSMM
KLX17A	678.6	680.6	679.6	–568.7	2.40E–09	RSMM

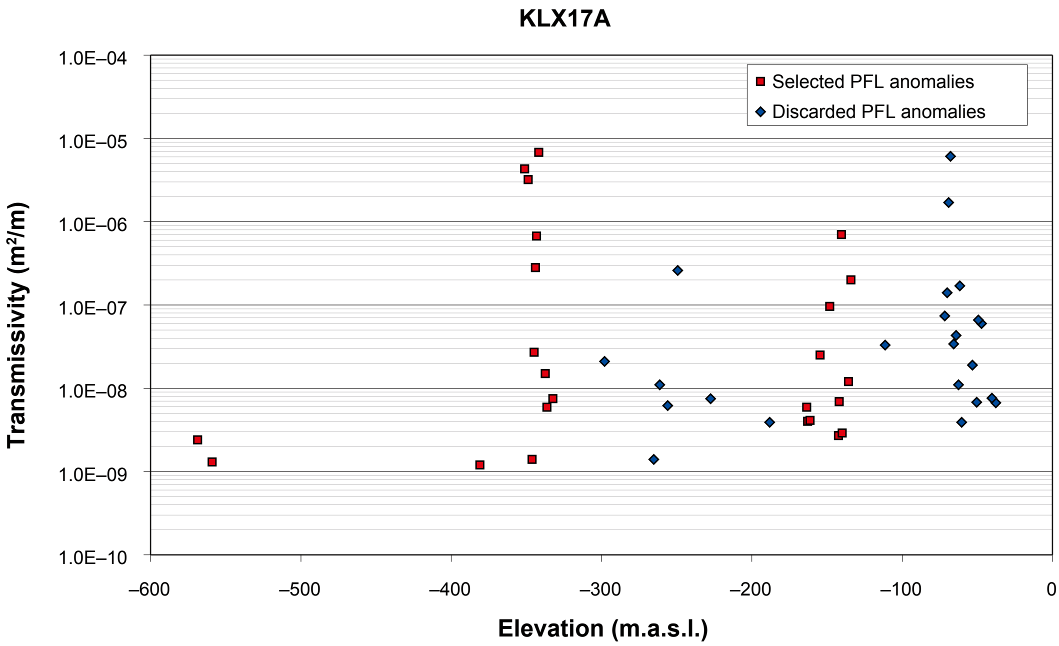


Figure A5-4. *Location and transmissivity of PFL anomalies in KLX17A.*

6 Rock domain RSMD

For rock domain RSMD it was initially proposed to investigate boreholes KLX11F, KLX15A (lower part), KLX19A, and KLX20A. However, due to practical reasons borehole KLX20A was excluded from the campaign. The rational for excluding the particular borehole was that the borehole is located outside the focused area at repository depth.

In total 92 PFL sections were mapped, and the basis for their selection is accounted for in section 6.1 to 6.3. The distribution of the selected PFL anomalies, in terms of borehole, elevation, and transmissivity ranges is shown in Table A6-1.

The strategy behind the choice of boreholes was that boreholes KLX19A and KLX15A should be the main boreholes of rock domain RSMD. These boreholes should be complemented by the short borehole KLX11F, which should represent the shallow rock above the elevation 100 mbsl.

The PFL sections initially planned in KLX20A, but later excluded from the campaign, are accounted for in subsection 6.4.

6.1 KLX19A

KLX19A was chosen to represent the rock below the elevation 100 mbsl in rock domain RSMD. All PFL anomalies detected in the flow loggings /12/ below 100 mbsl were included. In total 42 PFL anomalies were selected for the campaign (see Figure A6-1 and Table A6-2 below).

In Figure A6-1 the location of the 42 selected and 18 discarded PFL anomalies in KLX19A are shown together with their transmissivities. The numerical values of the locations and transmissivities of the selected PFL anomalies are shown in Table A6-2. The colour codes are the same as in Table A4-2.

In addition to the selected PFL sections, the drill core sections 180–190 m and 550–560 m (borehole length) were chosen to represent drill core at least 5 m distant from any PFL anomaly.

Table A6-1. Distribution of selected PFL anomalies in rock domain RSMD.

	$E > -100$ m.a.s.l.	$-100 \geq E \geq -300$ m.a.s.l.	$-300 > E \geq -600$ m.a.s.l.	$E < -600$ m.a.s.l.	$T < 10^{-8}$ m^2/s	$10^{-8} \leq T \leq 10^{-6}$ m^2/s	$T > 10^{-6}$ m^2/s
KLX11F	23	0	0	0	4	17	2
KLX15A	0	14	11	2	13	14	0
KLX19A	0	12	27	3	21	19	2
Total	**23**	**26**	**38**	**5**	**38**	**50**	**4**

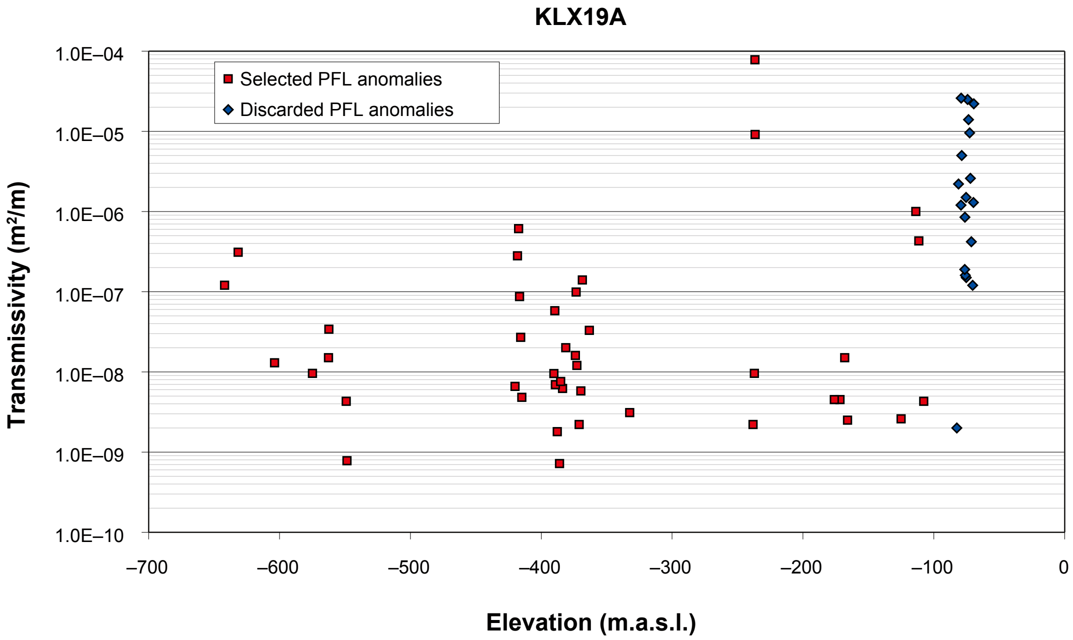


Figure A6-1. *Location and transmissivity of PFL anomalies in KLX19A.*

Table A6-2. Selected drill core sections in KLX19A.

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Rock domain
KLX19A	146.2	148.2	147.2	–107.7	4.30E–09	RSMD
KLX19A	150.6	152.6	151.6	–111.4	4.30E–07	RSMD
KLX19A	153.3	155.3	154.3	–113.7	1.00E–06	RSMD
KLX19A	166.6	168.6	167.6	–124.9	2.60E–09	RSMD
KLX19A	180.0	190.0	No PFL anomaly			RSMD
KLX19A	215.1	217.1	216.1	–166.0	2.50E–09	RSMD
KLX19A	217.5	219.5	218.5	–168.0	1.50E–08	RSMD
KLX19A	221.9	223.9	222.9	–171.7	4.50E–09	RSMD
KLX19A	227.0	229.0	228.0	–176.0	4.50E–09	RSMD
KLX19A	298.5	302.3	299.5	–236.5	9.10E–06	RSMD
			299.7	–236.7	7.80E–05	RSMD
			300.1	–237.0	9.60E–09	RSMD
			301.3	–238.0	2.20E–09	RSMD
KLX19A	411.8	413.8	412.8	–332.4	3.10E–09	RSMD
KLX19A	448.3	450.3	449.3	–363.2	3.30E–08	RSMD
KLX19A	454.5	462.8	455.5	–368.5	1.40E–07	RSMD
			456.9	–369.7	5.80E–09	RSMD
			458.4	–370.9	2.20E–09	RSMD
			460.4	–372.6	1.20E–08	RSMD
			461.2	–373.3	9.90E–08	RSMD
			461.8	–373.8	1.60E–08	RSMD
KLX19A	469.6	471.6	470.6	–381.3	2.00E–08	RSMD
KLX19A	472.5	477.1	473.5	–383.7	6.20E–09	RSMD
KLX19A	477.2	482.2	475.2	–385.1	7.60E–09	RSMD
			476.1	–385.9	7.20E–10	RSMD
			478.2	–387.7	1.80E–09	RSMD
			479.9	–389.1	6.90E–09	RSMD
			480.5	–389.6	5.80E–08	RSMD

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Rock domain
			481.2	–390.2	9.50E–09	RSMD
KLX19A	509.2	515.2	510.2	–414.8	4.80E–09	RSMD
			511.2	–415.6	2.70E–08	RSMD
			512.2	–416.5	8.70E–08	RSMD
			513.2	–417.3	6.10E–07	RSMD
			514.2	–418.1	2.80E–07	RSMD
KLX19A	515.3	517.3	516.3	–419.9	6.60E–09	RSMD
KLX19A	550.0	560.0	No PFL anomaly			RSMD
KLX19A	667.2	669.9	668.2	–548.4	7.80E–10	RSMD
			668.9	–549.0	4.30E–09	RSMD
KLX19A	683.5	685.8	684.5	–562.2	3.40E–08	RSMD
			684.8	–562.5	1.50E–08	RSMD
KLX19A	698.4	700.4	699.4	–574.8	9.60E–09	RSMD
KLX19A	732.6	734.6	733.6	–603.8	1.30E–08	RSMD
KLX19A	765.4	767.4	766.4	–631.5	3.10E–07	RSMD
KLX19A	777.7	779.7	778.7	–641.9	1.20E–07	RSMD

6.2 KLX11F

KLX11F was chosen to represent the rock above the elevation 100 mbsl in rock domain RSMD. All PFL anomalies detected in the flow loggings below 100 mbsl were included. In total 23 PFL anomalies were selected for the campaign (see Figure A6-2 and Table A6-3 below).

In Figure A6-2 the location of the 23 selected PFL anomalies in KLX11F are shown together with their transmissivities. The numerical values of the locations and transmissivities of the selected PFL anomalies are shown in Table A6-3. The colour codes are the same as in Table A4-2.

In addition to the selected PFL sections, the drill core sections 15.9–22.9 m and 56.7–60.7 m (borehole length) were chosen to represent drill core at least 5 m distant from any PFL anomaly.

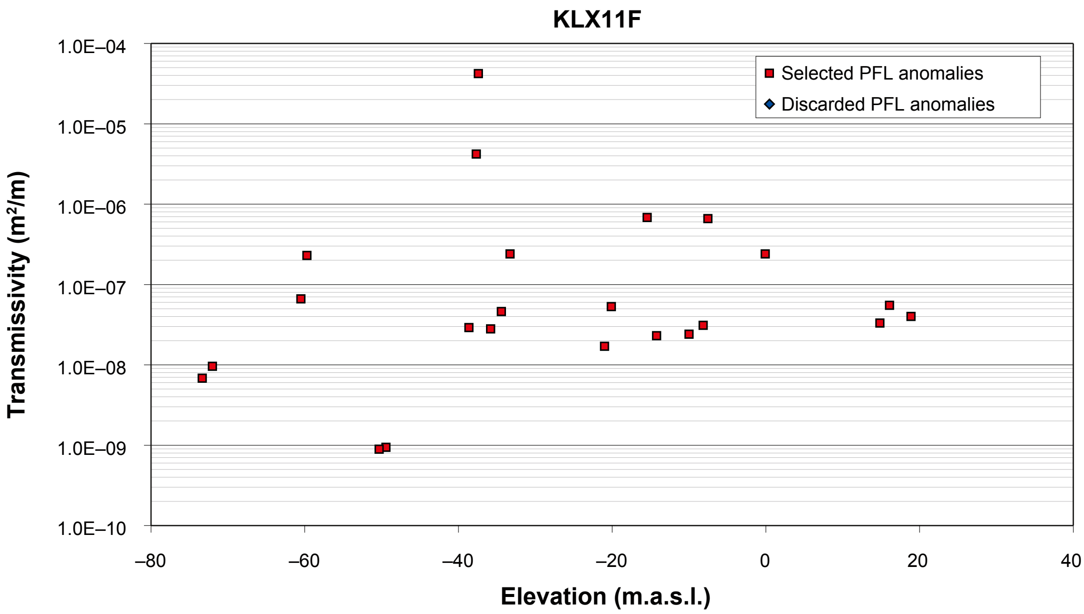


Figure A6-2. Location and transmissivity of PFL anomalies in KLX11F.

Table A6-3. Selected drill core sections in KLX11F.

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Rock domain
KLX11F	5.3	7.3	6.3	18.9	4.00E–08	RSMD
KLX11F	8.5	11.9	9.5	16.1	5.50E–08	RSMD
			10.9	14.9	3.30E–08	RSMD
KLX11F	15.9	22.9	No PFL anomaly			RSMD
KLX11F	26.9	28.9	27.9	–0.1	2.40E–07	RSMD
KLX11F	35.4	38.1	36.4	–7.5	6.60E–07	RSMD
			37.1	–8.2	3.10E–08	RSMD
KLX11F	38.2	40.2	39.2	–10.0	2.40E–08	RSMD
KLX11F	43.0	46.4	44.0	–14.2	2.30E–08	RSMD
			45.4	–15.4	6.80E–07	RSMD
KLX11F	49.7	52.7	50.7	–20.1	5.30E–08	RSMD
			51.7	–21.0	1.70E–08	RSMD
KLX11F	56.7	60.7	No PFL anomaly			RSMD
KLX11F	64.7	72.8	65.7	–33.3	2.40E–07	RSMD
KLX11F	83.1	86.1	67.0	–34.4	4.60E–08	RSMD
KLX11F	94.8	97.7	68.6	–35.8	2.80E–08	RSMD
KLX11F	108.8	112.3	70.4	–37.4	4.20E–05	RSMD
			70.7	–37.7	4.20E–06	RSMD
			71.8	–38.6	2.90E–08	RSMD
KLX11F	83.1	86.1	84.1	–49.4	9.40E–10	RSMD
			85.1	–50.3	8.90E–10	RSMD
KLX11F	94.8	97.7	95.8	–59.7	2.30E–07	RSMD
			96.7	–60.5	6.60E–08	RSMD
KLX11F	108.8	112.3	109.8	–72.0	9.60E–09	RSMD
			111.3	–73.3	6.80E–09	RSMD

6.3 KLX15A

The upper 300 m (borehole length) or so of KLX15A is situated in rock domain RSMM while the lower part is situated in RSMD. All PFL-anomalies detected in rock domain RSMD were selected for the campaign. In total 27 PFL sections were selected for the campaign from rock domain RSMD in borehole KLX15A (see Figure A6-3 and Table A6-4 below).

In Figure A6-3 the location of the 27 selected PFL anomalies in rock domain RSMD in KLX15A are shown together with their transmissivities. In addition, PFL anomalies in rock domain RSMM, above the borehole length 300 m, are shown. The numerical values of the locations and transmissivities of the selected PFL anomalies for rock domain RSMD are shown in Table A6-4. The colour codes are the same as in Table A4-2.

In addition to the selected PFL sections, the drill core section 95.9–98.9 m (borehole length) was chosen to represent drill core distant from any PFL-anomaly.

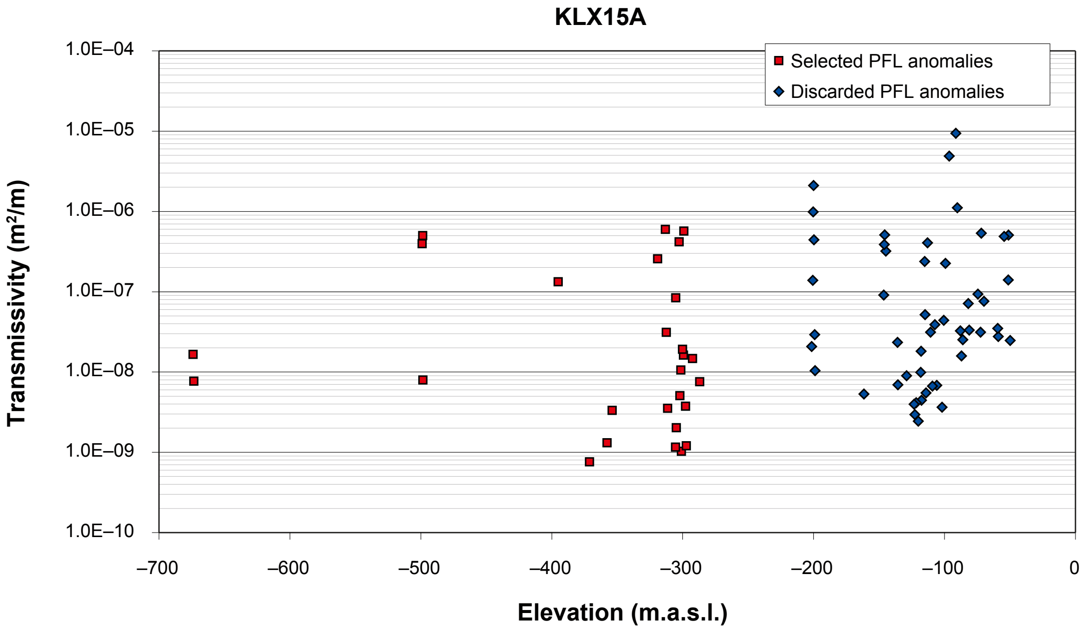


***Figure A6-3.** Location and transmissivity of PFL anomalies in KLX15A.*

Table A6-4. Selected drill core sections in rock domain RSMD in borehole KLX15A.

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Rock domain
KFM15A	369.8	371.8	370.8	–285.8	7.55E–09	RSMD
KFM15A	376.5	378.5	377.5	–291.2	1.47E–08	RSMD
KFM15A	382.3	391.1	383.3	–295.9	1.20E–09	RSMD
			384.1	–296.5	3.75E–09	RSMD
			385.6	–297.7	5.70E–07	RSMD
			386	–298.1	1.62E–08	RSMD
			386.8	–298.7	1.92E–08	RSMD
			387.9	–299.6	1.03E–09	RSMD
			388.4	–300.0	1.06E–08	RSMD
			389.3	–300.7	5.08E–09	RSMD
			390.1	–301.4	4.17E–07	RSMD
KFM15A	391.7	394.5	392.7	–303.5	2.02E–09	RSMD
			393.2	–303.9	8.39E–08	RSMD
			393.5	–304.1	1.16E–09	RSMD
KFM15A	399.9	404.0	400.9	–310.1	3.52E–09	RSMD
			402.1	–311.1	3.12E–08	RSMD
			403	–311.8	5.96E–07	RSMD
KFM15A	409.2	411.2	410.2	–317.7	2.57E–07	RSMD
KFM15A	451.9	453.9	452.9	–352.3	3.32E–09	RSMD
KFM15A	456.7	458.7	457.7	–356.1	1.31E–09	RSMD
KFM15A	473.2	475.2	474.2	–369.5	7.61E–10	RSMD
KFM15A	502.6	504.6	503.6	–393.3	1.33E–07	RSMD
KFM15A	629.7	632.4	630.7	–496.3	7.96E–09	RSMD
			630.9	–496.4	5.00E–07	RSMD
			631.4	–496.8	3.95E–07	RSMD
KFM15A	844.8	847.6	845.8	–670.5	7.68E–09	RSMD
			846.6	–671.2	1.66E–08	RSMD

6.4 KLX20A – excluded borehole

The text below describes the initial planning of drill core selection. Later on the entire borehole was excluded from the campaign. The rational for excluding the particular borehole is that it is located outside the focused area at repository depth.

In the flow logging /13/, 55 PFL anomalies were detected. Out of these anomalies the 18 anomalies below 150 mbsl were selected in the initial planning (see Figure A6-4 and Table A6-5 below).

In Figure A6-4 the location of the 18 selected and 37 discarded PFL anomalies in KLX20A are shown together with their transmissivities. The numerical values of the locations and transmissivities of the selected PFL anomalies are shown in Table A6-5. The colour codes are the same as in Table A4-2.

Table A6-5. PFL-anomalies in KLX20A initially selected but later on excluded from the campaign.

Borehole	Borehole length (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Rock domain
KLX20A	261.3	–172.6	8.50E–09	RSMD
KLX20A	262.2	–173.3	3.40E–09	RSMD
KLX20A	264.4	–175.0	1.10E–07	RSMD
KLX20A	265.6	–175.9	2.70E–08	RSMD
KLX20A	267.7	–177.5	4.40E–09	RSMD
KLX20A	268.5	–178.1	1.10E–06	RSMD
KLX20A	268.9	–178.4	3.70E–07	RSMD
KLX20A	269.4	–178.8	1.30E–07	RSMD
KLX20A	276.9	–184.5	1.70E–09	RSMD
KLX20A	278	–185.4	2.90E–08	RSMD
KLX20A	279.9	–186.8	1.40E–08	RSMD
KLX20A	280.5	–187.3	1.20E–08	RSMD
KLX20A	284.1	–190.0	7.20E–08	RSMD
KLX20A	285.6	–191.2	5.90E–10	RSMD
KLX20A	286.4	–191.8	6.90E–08	RSMD
KLX20A	288.5	–193.4	6.40E–10	RSMD
KLX20A	289.7	–194.3	7.00E–09	RSMD
KLX20A	290.4	–194.8	5.90E–10	RSMD

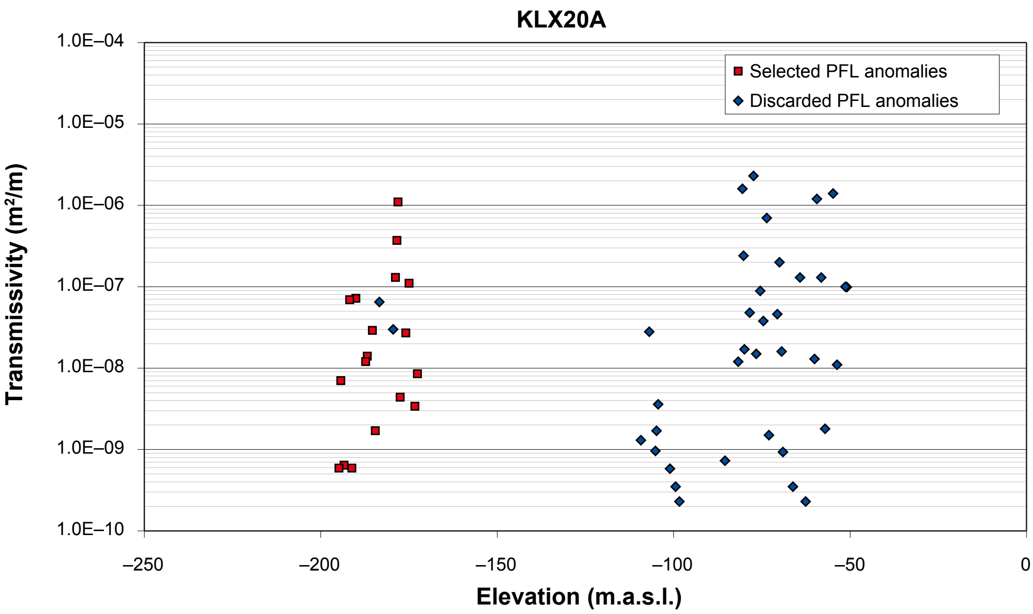


Figure A6-4. Location and transmissivity of PFL anomalies in KLX20A.

7 Peripheral boreholes

In the motivation document /1/ it was suggested that 100 PFL-sections should be logged in peripheral boreholes, for comparison. In the initial planning borehole KLX16A were chosen from the Laxemar subarea and borehole KSH02 from the Simpevarp subarea. However, later on borehole KSH02 was excluded from the campaign.

In total 49 PFL-sections were mapped, and the strategy for the drill core selection is accounted for in Section 7.1. The distribution of the 49 PFL anomalies, in terms of borehole, elevation, and transmissivity ranges is shown in Table A7-1.

The PFL-sections initially suggested in KSH02, but later excluded from the campaign, are accounted for in subsection 7.2.

7.1 KLX16A

KLX16F was chosen to represent the rock peripheral to the Laxemar focused area. The borehole is located in the southern part of rock domain RSMD. In total 78 PFL anomalies were detected in the flow logging /14/. Data reduction was performed below the borehole length 200 m in accordance with the strategy described in subsection 3.1.3. In total 49 PFL anomalies were selected for the campaign (see Figure A7-1 and Table A7-2 below).

In Figure A7-1 the location of the 49 selected and 29 discarded PFL anomalies in KLX16A are shown together with their transmissivities. The numerical values of the locations and transmissivities of the selected PFL anomalies are shown in Table A7-2. The colour codes are the same as in Table A4-2.

7.2 KSH02 – excluded borehole

The text below describes the initial planning of drill core selection. Later on the entire borehole was excluded from the campaign. The rational for excluding the particular borehole is that it is located outside the Laxemar subarea.

In the flow logging /15/, 82 PFL anomalies were detected. Data reduction was performed in accordance with the strategy described in subsection 3.1.3. In total 49 PFL anomalies were selected for the campaign in the initial planning (see Figure A7-2 and Table A7-3 below).

In Figure A7-2 the location of the 49 selected and 33 discarded PFL anomalies in KSH02 are shown together with their transmissivities. The numerical values of the locations and transmissivities of the selected PFL anomalies are shown in Table A7-3. The colour codes are the same as in Table A4-2.

Table A7-1. Distribution of selected PFL sections in peripheral boreholes.

	$E > -100$ m.a.s.l.	$-100 \geq E \geq -300$ m.a.s.l.	$-300 > E \geq -600$ m.a.s.l.	$E < -600$ m.a.s.l.	$T < 10^{-8}$ m²/s	$10^{-8} \leq T \leq 10^{-6}$ m²/s	$T > 10^{-6}$ m²/s
KLX16A	12	34	3	0	12	32	5
Total	**12**	**34**	**3**	**0**	**12**	**32**	**5**

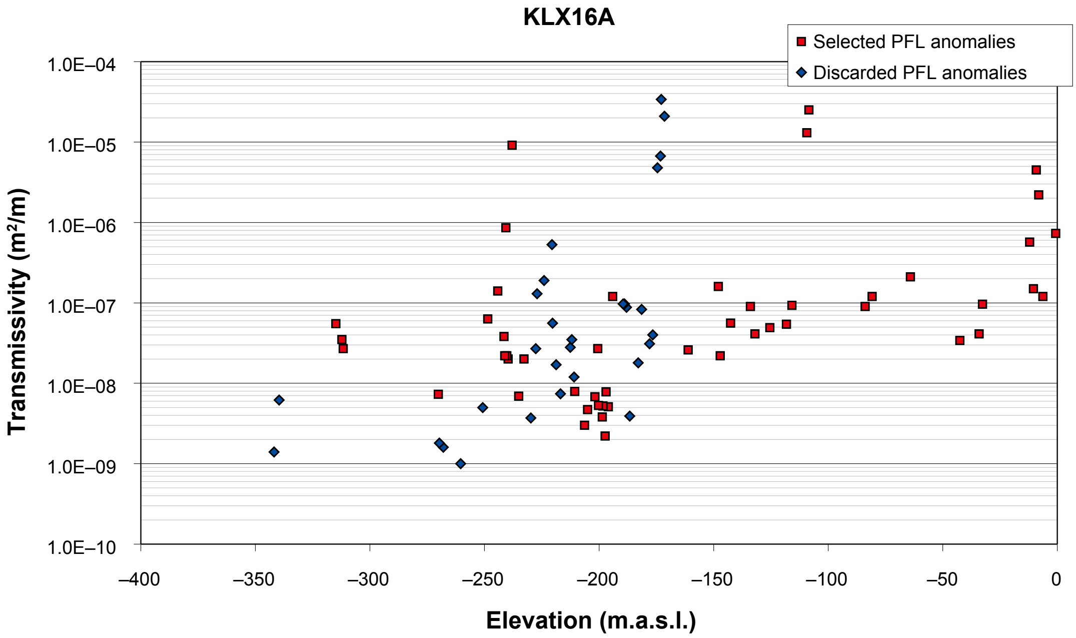


Figure A7-1. *Location and transmissivity of PFL anomalies in KLX16A.*

Table A7-2. Selected drill core sections in KLX16A.

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m²/s)	Rock domain
KLX16A	20.5	22.5	21.5	–0.6	7.30E–07	RSMD
KLX16A	26.7	35.1	27.7	–6.2	1.20E–07	RSMD
			29.7	–8.1	2.20E–06	RSMD
			30.9	–9.1	4.50E–06	RSMD
			32.3	–10.4	1.50E–07	RSMD
			34.1	–12.0	5.70E–07	RSMD
KLX16A	55.8	59.4	56.8	–32.6	9.60E–08	RSMD
			58.4	–34.1	4.10E–08	RSMD
KLX16A	66.7	68.7	67.7	–42.5	3.40E–08	RSMD
KLX16A	90.5	92.5	91.5	–64.1	2.10E–07	RSMD
KLX16A	109.0	111.0	110.0	–80.8	1.20E–07	RSMD
KLX16A	112.3	114.3	113.3	–83.8	9.00E–08	RSMD
KLX16A	139.4	142.4	140.4	–108.4	2.50E–05	RSMD
			141.4	–109.3	1.30E–05	RSMD
KLX16A	147.6	149.6	148.6	–115.8	9.30E–08	RSMD
KLX16A	150.2	152.2	151.2	–118.2	5.40E–08	RSMD
KLX16A	158.2	160.2	159.2	–125.4	4.90E–08	RSMD
KLX16A	165.4	167.4	166.4	–131.9	4.10E–08	RSMD
KLX16A	167.6	169.6	168.6	–133.9	9.00E–08	RSMD
KLX16A	177.1	179.1	178.1	–142.5	5.60E–08	RSMD
KLX16A	182.1	185.0	183.1	–147.1	2.20E–08	RSMD
			184.0	–147.9	1.60E–07	RSMD
KLX16A	197.6	199.6	198.6	–161.1	2.60E–08	RSMD
KLX16A	233.9	235.9	234.9	–194.0	1.20E–07	RSMD
KLX16A	236.0	244.5	237.0	–195.9	5.10E–09	RSMD
			238.1	–196.9	7.80E–09	RSMD

Borehole	Adjusted Secup (m)	Adjusted Seclow (m)	Borehole length PFL-anomaly (m)	~ Elevation (m.a.s.l.)	Transmissivity (m²/s)	Rock domain
			238.6	–197.3	2.20E–09	RSMD
			239.6	–198.3	5.20E–09	RSMD
			239.9	–198.5	3.80E–09	RSMD
			241.8	–200.2	5.30E–09	RSMD
			242.1	–200.5	2.70E–08	RSMD
			243.5	–201.8	6.80E–09	RSMD
KLX16A	246.0	249.5	247.0	–205.0	4.70E–09	RSMD
			248.5	–206.3	3.00E–09	RSMD
KLX16A	252.2	254.2	253.2	–210.6	7.90E–09	RSMD
KLX16A	276.7	278.7	277.7	–232.8	2.00E–08	RSMD
KLX16A	279.2	281.2	280.2	–235.0	6.90E–09	RSMD
KLX16A	282.4	288.3	283.4	–237.9	9.10E–06	RSMD
			285.3	–239.7	2.00E–08	RSMD
			285.9	–240.2	2.20E–08	RSMD
			286.4	–240.7	8.60E–07	RSMD
			286.9	–241.1	2.20E–08	RSMD
			287.3	–241.5	3.80E–08	RSMD
KLX16A	289.3	291.3	290.3	–244.2	1.40E–07	RSMD
KLX16A	294.1	296.1	295.1	–248.5	6.30E–08	RSMD
KLX16A	317.9	319.9	318.9	–270.1	7.30E–09	RSMD
KLX16A	363.7	366.4	364.7	–311.6	2.70E–08	RSMD
			365.4	–312.2	3.50E–08	RSMD
KLX16A	367.3	369.3	368.3	–314.9	5.50E–08	RSMD

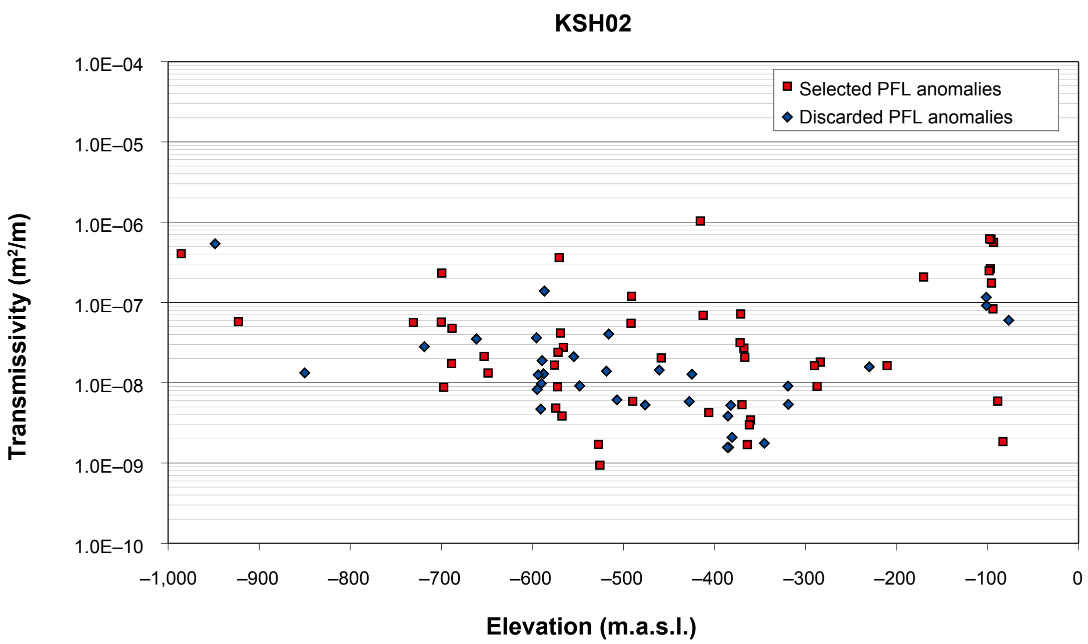


***Figure A7-2.** Location and transmissivity of PFL anomalies in KSH02.*

Table A7-3. PFL-anomalies in KSH02 initially selected but later on excluded from the campaign.

Borehole	Borehole length (m)	~ Elevation (m.a.s.l.)	Transmissivity (m^2/s)	Subarea
KSH02	89.0	–82.9	1.84E–09	Simpevarp
KSH02	94.8	–88.7	5.89E–09	Simpevarp
KSH02	99.5	–93.4	5.60E–07	Simpevarp
KSH02	100.1	–94.0	8.28E–08	Simpevarp
KSH02	101.6	–95.5	1.74E–07	Simpevarp
KSH02	102.0	–95.9	6.12E–07	Simpevarp
KSH02	103.0	–96.9	2.62E–07	Simpevarp
KSH02	103.8	–97.7	6.16E–07	Simpevarp
KSH02	104.2	–98.0	2.47E–07	Simpevarp
KSH02	176.6	–170.2	2.07E–07	Simpevarp
KSH02	216.8	–210.2	1.63E–08	Simpevarp
KSH02	290.5	–283.6	1.81E–08	Simpevarp
KSH02	294.0	–287.1	8.99E–09	Simpevarp
KSH02	296.8	–289.9	1.63E–08	Simpevarp
KSH02	367.3	–360.1	3.44E–09	Simpevarp
KSH02	368.6	–361.4	2.99E–09	Simpevarp
KSH02	371.0	–363.8	1.69E–09	Simpevarp
KSH02	373.6	–366.4	2.07E–08	Simpevarp
KSH02	374.7	–367.5	2.70E–08	Simpevarp
KSH02	376.8	–369.6	5.33E–09	Simpevarp
KSH02	378.2	–371.0	7.19E–08	Simpevarp
KSH02	378.8	–371.6	3.15E–08	Simpevarp
KSH02	413.4	–406.0	4.23E–09	Simpevarp
KSH02	419.6	–412.2	6.91E–08	Simpevarp
KSH02	422.8	–415.4	1.03E–06	Simpevarp
KSH02	465.9	–458.3	2.03E–08	Simpevarp
KSH02	497.3	–489.6	5.85E–09	Simpevarp
KSH02	498.4	–490.7	1.19E–07	Simpevarp
KSH02	499.1	–491.4	5.49E–08	Simpevarp
KSH02	533.4	–525.6	9.40E–10	Simpevarp
KSH02	535.0	–527.2	1.70E–09	Simpevarp
KSH02	573.8	–565.8	2.76E–08	Simpevarp
KSH02	575.2	–567.2	3.85E–09	Simpevarp
KSH02	577.0	–569.0	4.16E–08	Simpevarp
KSH02	578.3	–570.3	3.62E–07	Simpevarp
KSH02	579.6	–571.6	2.39E–08	Simpevarp
KSH02	580.3	–572.3	8.89E–09	Simpevarp
KSH02	582.1	–574.1	4.84E–09	Simpevarp
KSH02	583.5	–575.5	1.66E–08	Simpevarp
KSH02	656.8	–648.5	1.32E–08	Simpevarp
KSH02	661.1	–652.8	2.12E–08	Simpevarp
KSH02	696.6	–688.1	4.76E–08	Simpevarp
KSH02	697.0	–688.5	1.73E–08	Simpevarp
KSH02	705.8	–697.3	8.76E–09	Simpevarp
KSH02	707.7	–699.2	2.32E–07	Simpevarp
KSH02	708.4	–699.9	5.68E–08	Simpevarp
KSH02	739.2	–730.6	5.63E–08	Simpevarp
KSH02	932.1	–922.7	5.76E–08	Simpevarp
KSH02	995.2	–985.6	4.04E–07	Simpevarp

8 References

/1/ **Löfgren M, 2007.** Oskarshamn kompletterande undersökningar. Statistisk och kvantitativ kartering av sprickmineral. Företagsinternt PM. Dokument ID 1075135. Svensk Kärnbränslehantering AB.

/2/ **Janson T, Magnusson J, Bergvall M, Olsson R, Cuisiat F, Skurtveit E, Grimstad E, 2006.** Final repository for spent nuclear fuel. Underground design Laxemar Layout D1. SKB R-06-36, Svensk Kärnbränslehantering AB.

/3/ **SKB, 2006.** Preliminary site description Laxemar stage 2.1. Feedback for completion of the site investigation including input from safety assessment and repository engineering. SKB R-06-110, Svensk Kärnbränslehantering AB.

/4/ **Wahlgren C-H, Hermanson J, Forssberg O, Curtis P, Triumf C-A, Drake H, Tullborg E-L, 2006.** Geological description of rock domains and deformation zones in the Simpevarp and Laxemar subareas. Preliminary site description Laxemar subarea – version 1.2. SKB R-05-69, Svensk Kärnbränslehantering AB.

/5/ **Pöllänen J, Sokolnicki M, 2004.** Difference flow logging in borehole KFM03A. Forsmark site investigation. SKB P-04-189, Svensk Kärnbränslehantering AB.

/6/ **Sokolnicki M, 2007.** Difference flow logging of borehole KLX10 Subarea Laxemar. Oskarshamn site investigation. SKB P-06-58, Svensk Kärnbränslehantering AB.

/7/ **Väisäsvaara J, Leppänen H, Kristiansson S, Pöllänen J, 2006.** Difference flow logging of boreholes KLX09G, KLX10B and KLX10C Subarea Laxemar. Oskarshamn site investigation. SKB P-06-229, Svensk Kärnbränslehantering AB.

/8/ **Väisäsvaara J, Pekkanen J, 2007.** Difference flow logging of borehole KLX13A Subarea Laxemar. Oskarshamn site investigation. SKB P-06-245, Svensk Kärnbränslehantering AB.

/9/ **Rouhiainen P, Pöllänen J, Sokolnicki M, 2005.** Difference flow logging of borehole KLX03. Subarea Laxemar. Oskarshamn site investigation. SKB P-05-67, Svensk Kärnbränslehantering AB.

/10/ **Pöllänen J, 2007.** Difference flow logging of boreholes KLX26A and KLX26B Subarea Laxemar. Oskarshamn site investigation. SKB P-07-72, Svensk Kärnbränslehantering AB.

/11/ **Pöllänen J, Kristansson S, 2007.** Difference flow logging of borehole KLX17A Subarea Laxemar. Oskarshamn site investigation. SKB P-07-34, Svensk Kärnbränslehantering AB.

/12/ **Rouhiainen P, Pöllänen J, Sokolnicki M, 2005.** Difference flow logging of borehole KLX03. Subarea Laxemar. Oskarshamn site investigation. SKB P-05-67, Svensk Kärnbränslehantering AB.

/13/ **Kristiansson S, 2007.** Difference flow logging of borehole KLX20A Subarea Laxemar. Oskarshamn site investigation. SKB P-06-183, Svensk Kärnbränslehantering AB.

/14/ **Väisäsvaara J, 2007.** Difference flow logging in borehole KLX16A Subarea Laxemar. Oskarshamn site investigation. SKB P-07-87, Svensk Kärnbränslehantering AB.

/15/ **Rouhiainen P, Pöllänen J, 2003.** Difference flow measurements in borehole KSH02 at Simpevarp. Oskarshamn site investigation. SKB P-03-110, Svensk Kärnbränslehantering AB.

Appendix 2

Nonconformities from selected drill core sections

Borehole	PFL section (adjusted length in m) secup	seclow	Cause of data loss
KLX03 (No PFL)	175.0	185.0	Unavailable core boxes
KLX03	408.9	410.9	Fracture at 410.040 removed
KLX03	455.7	458.4	Crush at 457.332 missing in core due to sampling
KLX03	659.2	664.0	Fractures at 662.166, 662.315 missing in core due to sampling
KLX03	665.7	667.7	Fractures at 666.410, 666.596, 666.616 missing in core due to sampling
KLX03	739.8	745.1	Fractures at 739.900, 740.757, 744.001, 744.006 missing in core due to sampling
KLX10	132.1	134.1	Fracture at 132.998 missing in core due to sampling
KLX10	519.8	521.8	Fracture at 520.360 missing in core due to sampling
KLX10	697.5	701.0	Fractures at 700.470, 700.525, 700.530, 700.970, 700.971 missing in core due to sampling
KLX10	841.9	843.9	Unavailable core boxes
KLX10C	43.6	46.5	Core loss at 44.433–44.492, Fracture at 45.262 missing in core due to sampling
KLX11F	5.3	7.3	Fracture at 6.634 missing in core due to sampling
KLX11F	8.5	11.9	Fractures at 9.578, 11.573 missing in core due to sampling
KLX11F (No PFL)	15.9	22.9	Fracture at 17.352 missing in core due to sampling
KLX11F	49.7	52.7	Fractures at 52.400, 52.524 missing in core due to sampling
KLX11F	64.7	72.8	Crush at 70.235–70.360 missing in core due to sampling
KLX15A	127.8	131.3	Fracture at 128.801 missing due to sampling, crush at 130.220 missing due to sampling
KLX15A	215.6	217.6	Fractures at 216.569, 216.580, 216.620 missing in core due to core loss
KLX15A	629.7	632.4	Fractures at 631.358, 631.305, 631.307 missing in core due to sampling
KLX17A	199.3	201.3	Fractures at 200.123, 200.151, 200.218, 200.244, 200.349 missing in core due to sampling
KLX17A	419.9	427.0	Crush at 423.295–423.370 missing in core due to sampling, fractures at 426.189, 426.196, 426.199, 426.231, 426.310 missing in core due to sampling
KLX17A	430.6	432.6	Fractures at 431.492, 431.519, 431.523, 431.626 missing in core due to sampling
KLX19A	298.5	302.3	Core loss at 299.616–299.737, 301.307–301.528
KLX19A	411.8	413.8	Fracture at 412.844 missing in core due to sampling
KLX19A	448.3	450.3	Crush at 449.455–449.495 missing in core due to sampling, fractures at 449.514, 449.607, 449.636 missing in core due to sampling

Appendix 3

Image analysis of mineral coverage

Image analysis of visible coverage					
Borehole	Adj sec up	Mineral*	Estimated coverage (%)	Analytical coverage (%)	Note
KLX03	405.33	Chlorite	30	37.0	
		Calcite	70	63.0	
KLX03	406.12	Chlorite	15	12.0	
		Calcite	85	88.0	
KLX03	504.178	Chlorite	96	95.2	
		Calcite	3	4.3	
		Pyrite	1	0.5	
KLX03	662.65	Chlorite	60	70.0	
		Calcite	10	7.3	
		Clay minerals	30	23.0	
KLX03	663.186	Calcite	15	13.4	
KLX03	665.438	Chlorite	55	54.0	No PFL
		Calcite	5	1.0	
KLX03	666.086	Chlorite (hem)	90	95.0	
		Chlorite	10	5.0	
KLX03	746.03	Calcite	80	82.0	
KLX03	772.973	Calcite	2	2.5	
		Chlorite	15	16.5	
KLX03	774.31	Chlorite	5	3.25	No PFL
		Chlorite (hem)	15	20.0	
KLX10	125.787	Calcite	60	59.6	
		Chlorite	37	39.0	
KLX10	130.147	Calcite	70	81.0	
KLX10	123.722	Calcite	30	25.7	
		Chlorite	3	3.4	
KLX10	333.204	Calcite	1	0.8	
		Chlorite	15	9.3	
KLX10	429.587	Chlorite	50	44.7	
		Clay minerals	15	13.1	
KLX10	430.35	Chlorite	30	25.2	
KLX10	435.551	Calcite	10	11.9	
		Chlorite (hem)	55	57.6	
		Chlorite	35	30.5	
KLX10	704.999	Calcite	1	0.66	
		Chlorite	20	14.9	
KLX10	703.934	Clay minerals	20	24.9	No PFL
		Clay minerals (hem)	80	75.8	
KLX10	539.101	Calcite	3	4.8	
		Chlorite	10	10.1	

* (hem) means the mineral is impregnated with hematite

Appendix 4

Image analysis of mineral thickness

Image analysis of fracture mineral thickness

Borehole	Adj sec up	Mineral	Measured thickness (mm)	Analytical thickness (mm)
KLX03	406.12	Chlorite	0.2	0.175
KLX03	504.178	Calcite	0.5	0.378
KLX03	662.65	Calcite	0.2	0.22
KLX03	663.186	Calcite	0.3	0.309
KLX03	665.438	Chlorite	0.2	0.194
		Calcite	0.3	0.369
KLX03	746.03	Calcite	0.1	0.096
KLX03	774.31	Chlorite	0.1	0.054

Appendix 5

Analysis of hematite-impregnated minerals

Sample ID	Hematite content (area–%) *	FeO (normalised) **
H1	0.4–0.7	7–13%
H2	1.2–1.9	4–17%
H3	0.4–0.6	5–11%
H4	0.6–0.8	8–18%
H5	0.3–0.6	7–13%

* The hematite content was calculated by running two profiles across the sample at 50x magnification. Each profile consisted of approximately 15 area measurements where the hematite content was estimated. Area measurements consisted of a combination of manual analysis and BSE-intensity mapping over the surface. Hematite was generally associated with chlorite and analysis of these grains (generally < spot size) yielded chlorite + hematite. In these cases BSE-intensity was lower than for pure hematite and was therefore counted as c. 20% hematite or 30–50% hematite depending on the addition of Fe to the chlorite analysis. Due to this the average hematite content for each sample is presented as a range, depending on what hematite content is designated in the mixed analysis.

** A chemoanalysis (normalised to 100%) was also executed for each area measurement. The column presents the average FeO content as a range depending on what hematite content is designated in the mixed analysis.