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Keywords: Geophysics, Rock unit, Borehole, Deformation zone, Fractures, Alteration.

Abstract

This report contains geological single-hole interpretation of the cored borehole KLX13A and the percussion boreholes HLX39 and HLX41 at Laxemar. The interpretation combines the geological core mapping, interpreted geophysical logs and borehole radar measurements to identify rock units and possible deformation zones in the boreholes.

The geological single-hole interpretation shows that two rock units (RU1–RU2) occur in KLX13A. In general, borehole KLX13A is dominated by Ävrö granite (501044). Subordinate rock types comprise occurrences of fine-grained diorite-gabbro (505102), fine-grained granite (511058), pegmatite (501061), diorite/gabbro (501033) and very sparse occurrences of granite (501058). Seven possible deformation zones are identified in KLX13A (DZ1–DZ7).

One rock unit (RU1) occurs in HLX39. In general, the percussion borehole HLX39 is dominated by Ävrö granite (501044). Subordinate rock types comprise occurrences of diorite/gabbro (501033), fine-grained granite (511058), fine-grained diorite-gabbro (505102) and pegmatite (501061). One possible deformation zone is identified in HLX39 (DZ1).

The single-hole interpretation shows that borehole HLX41 is dominated by Ävrö granite (501044) which constitutes one rock unit (RU1). Subordinate rock types comprise occurrences of fine-grained granite (511058), diorite/gabbro (501033), fine-grained diorite-gabbro (505102) and pegmatite (501061). There is no possible deformation zone in HLX41.

Sammanfattning

Denna rapport behandlar geologisk enhålstolkning av kärnborrhålet KLX13A och hammarborrhålen HLX39 och HLX41 i Laxemar. Den geologiska enhålstolkningen syftar till att utifrån den geologiska karteringen, tolkade geofysiska loggar och borrhålsradarmätningar identifiera olika litologiska enheters fördelning i borrhålen samt möjliga deformationszoners läge och utbredning.

Den geologiska enhålstolkningen visar att KLX13A kan delas in i två litologiska enheter (RU1–RU2). Generellt sett domineras borrhålet av Ävrögranit (501044). Finkornig diorit-gabbro (505102), finkornig granit (511058), pegmatit (501061) och diorit/gabbro (501033) förekommer som underordnade bergarter, samt mycket sparsamt även granit (501058). Sju möjliga deformationszoner har identifierats i KLX13A (DZ1–DZ7).

En litologisk enhet (RU1) förekommer i hammarborrhål HLX39. Borrhålet domineras av Ävrögranit (501044). Diorit/gabbro (501033), finkornig granit (511058), finkornig diorit-gabbro (505102) och pegmatit (501061) förekommer som underordnade bergarter. En möjlig deformationszon har identifierats i HLX39 (DZ1).

Den geologiska enhålstolkningen visar att hammarborrhål HLX41 domineras av Ävrögranit (501044). Finkornig granit (511058), diorit/gabbro (501033), finkornig diorit-gabbro (505102) och pegmatit (501061) förekommer som underordnade bergarter. Inga möjliga deformationszoner har identifierats i HLX41.

Contents

1 Introduction

Much of the primary geological and geophysical borehole data stored in the SKB database Sicada need to be integrated and synthesized before they can be used for modeling in the 3D-CAD system Rock Visualization System (RVS). The end result of this procedure is a geological single-hole interpretation, which consists of integrated series of different loggings and accompanying descriptive documents (SKB MD 810.003 v.3.0, SKB internal controlling document).

This document reports the results gained by the geological single-hole interpretation of boreholes KLX13A, HLX39 and HLX41 at Laxemar (Figure 1-1), which is one of the activities performed within the site investigation at Oskarshamn. The work was carried out in accordance with Activity Plan AP PS 400-06-127. The controlling documents for performing this activity are listed in Table 1-1. Both Activity Plan and Method Description are SKB's internal controlling documents. Rock type nomenclature that has been used is shown in Table 1-2.

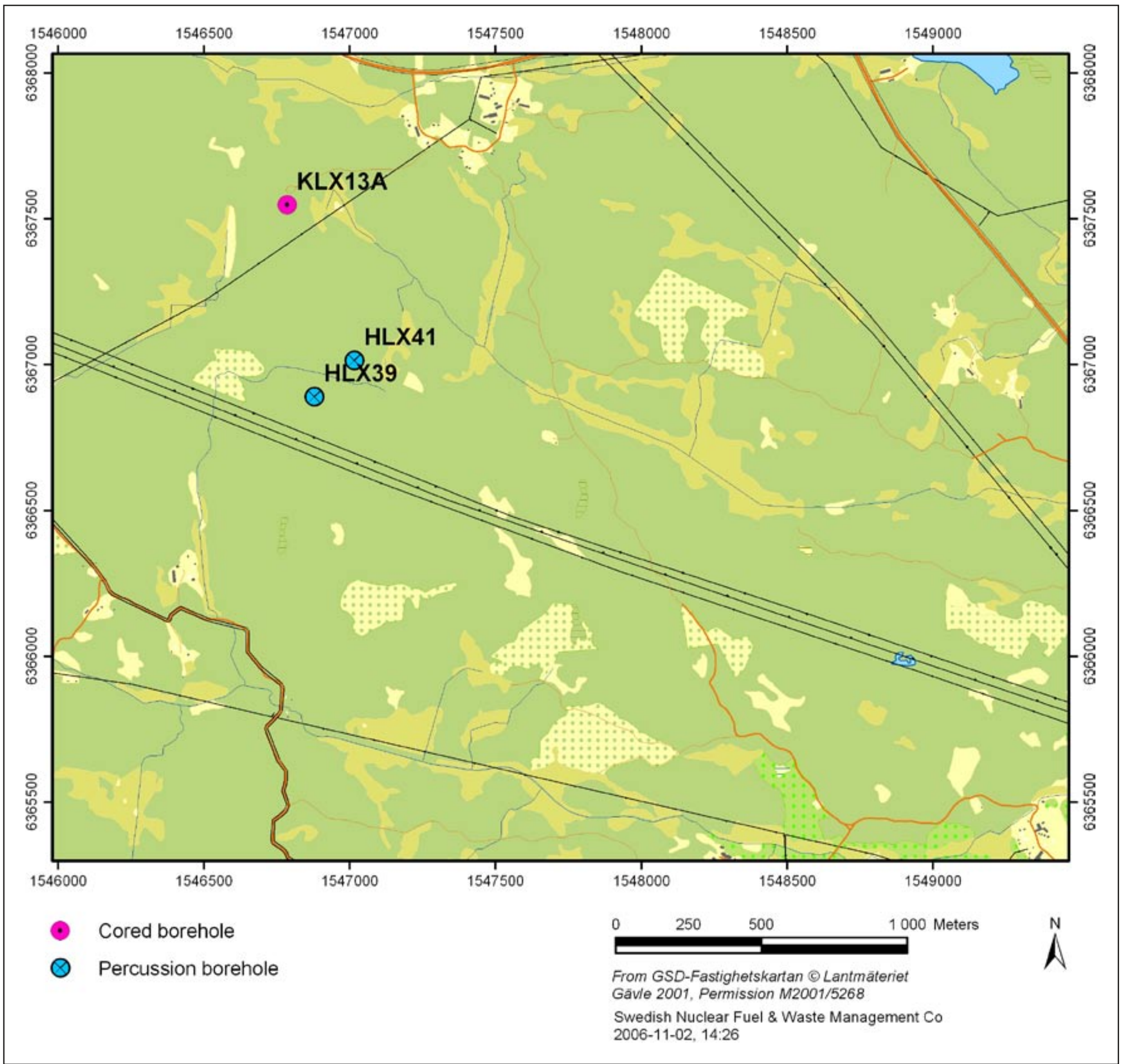


Figure 1-1. *Map showing the position of the cored borehole KLX13A and the percussion drilled boreholes HLX39 and HLX41.*

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

Activity Plan	Number	Version
Geologisk enhålstolkning av KLX13A, HLX39 och HLX41	AP PS 400-06-127	1.0
Method Description	**Number**	**Version**
Metodbeskrivning för geologisk enhålstolkning	SKB MD 810.003	3.0

Table 1-2. Rock type nomenclature for the site investigation at Oskarshamn.

Rock type	Rock code	Rock description
Dolerite	501027	Dolerite
Fine-grained Götemar granite	531058	Granite, fine- to medium-grained, ("Götemar granite")
Coarse-grained Götemar granite	521058	Granite, coarse-grained, ("Götemar granite")
Fine-grained granite	511058	Granite, fine- to medium-grained
Pegmatite	501061	Pegmatite
Granite	501058	Granite, medium- to coarse-grained
Ävrö granite	501044	Granite to quartz monzodiorite, generally porphyritic
Quartz monzodiorite	501036	Quartz monzonite to monzodiorite, equigranular to weakly porphyritic
Diorite/gabbro	501033	Diorite to gabbro
Fine-grained dioritoid	501030	Intermediate magmatic rock
Fine-grained diorite-gabbro	505102	Mafic rock, fine-grained
Sulphide mineralization	509010	Sulphide mineralization
Sandstone	506007	Sandstone

Original data from the reported activity are stored in the primary database Sicada, where they are traceable by the Activity Plan number (AP PS 400-06-127). Only data in SKB's 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 data revisions entail a revision of the P-report. Minor data revisions are normally presented as supplements, available at www.skb.se.

2 Objective and scope

A geological single-hole interpretation is carried out in order to identify and to describe briefly the characteristics of major rock units and possible deformation zones within a borehole. The work involves an integrated interpretation of data from the geological mapping of the borehole (Boremap), different borehole geophysical logs and borehole radar data. The geological mapping of the cored boreholes involves a documentation of the character of the bedrock in the drill core. This work component is carried out in combination with an inspection of the oriented image of the borehole walls that is obtained with the help of the Borehole Image Processing *S*ystem (BIPS). The geological mapping of the percussion boreholes focuses more attention on an integrated interpretation of the information from the geophysical logs and the BIPS images. For this reason, the results from the percussion borehole mapping are more uncertain. The interpretations of the borehole geophysical and radar logs are available when the single-hole interpretation is performed. The result from the geological single-hole interpretation is presented in a WellCad plot. The work reported here concerns stage 1 in the single-hole interpretation, as defined in the Method Description.

3 Data used for the geological single-hole interpretation

The following data have been used in the single-hole interpretation of boreholes KLX13A, HLX39 and HLX41:

- Boremap data (including BIPS and geological mapping data) /2, 3/.
- Generalized geophysical logs and their interpretation /4, 5/.
- Radar data and their interpretation /6/.

As a basis for the geological single-hole interpretation a combined WellCad plot consisting of the above mentioned data sets were used. An example of a WellCad plot used during the geological single-hole interpretation is shown in Figure 3-1. The plot consists of nine main columns and several subordinate columns. These include nine main:

1: Length along the borehole

2: Boremap data

2.1: Rock type

2.2: Rock type < 1 m

2.3: Rock type structure

2.4: Rock structure intensity

2.5: Rock type texture

2.6: Rock type grain size

2.7: Structure orientation

2.8: Rock alteration

2.9: Rock alteration intensity

2.10: Crush

3: Generalized geophysical data

3.1: Silicate density

3.2: Magnetic susceptibility

3.3: Natural gamma radiation

3.4: Estimated fracture frequency

4: Unbroken fractures

4.1: Primary mineral

4.2: Secondary mineral

4.3: Third mineral

4.4: Fourth mineral

4.5: Alteration, dip direction

5: Broken fractures

5.1: Primary mineral

5.2: Secondary mineral

5.3: Third mineral

5.4: Fourth mineral

5.5: Aperture (mm)

5.6: Roughness

5.7: Surface

5.8: Slickenside

5.9: Alteration, dip direction

6: Crush zones

6.1: Piece (mm)

6.2: Sealed network

6.3: Core loss

7: Fracture frequency

7.1: Sealed fractures

7.2: Open fractures

8: BIPS

9: Length along the borehole

The geophysical logs are described below:

Magnetic susceptibility: The rock has been classified into sections of low, medium, high, and very high magnetic susceptibility. The susceptibility is strongly connected to the magnetite content in the different rock types.

Natural gamma radiation: The rock has been classified into sections of low, medium, and high natural gamma radiation. Low radiation may indicate mafic rock types and high radiation may indicate younger, fine-grained granite or pegmatite.

Possible alteration: This parameter has not been used in the geological single-hole interpretation in the area.

Silicate density: This parameter indicates the density of the rock after subtraction of the magnetic component. It provides general information on the mineral composition of the rock types, and serves as a support during classification of rock types.

Estimated fracture frequency: This parameter provides an estimate of the fracture frequency along 5 m sections, calculated from short and long normal resistivity, SPR, P-wave velocity as well as focused resistivity 140 and 300. The estimated fracture frequency is based on a statistical connection after a comparison has been made between the geophysical logs and the mapped fracture frequency. The log provides an indication of sections with low and high fracture frequencies.

Close inspection of the borehole radar data was carried out during the interpretation process, especially during the identification of possible deformation zones. The occurrence and orientation of radar anomalies within the possible deformation zones are commented upon in the text that describes these zones.

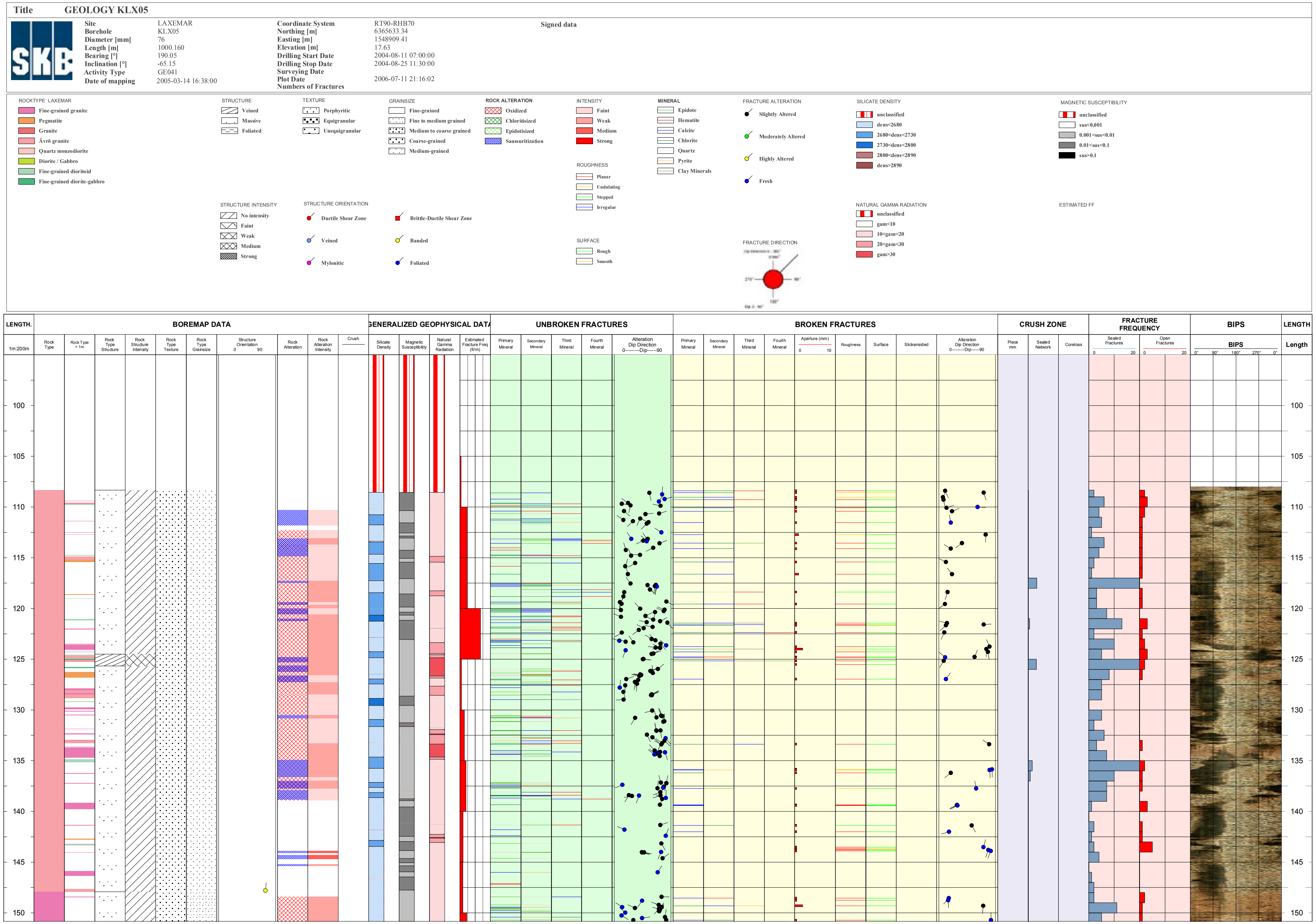


Figure 3-1. *Example of WellCad plot (from borehole KLX05 in Laxemar) used as a basis for the single-hole interpretation.*

4 Execution

4.1 General

The geological single-hole interpretation has been carried out by a group of geoscientists consisting of both geologists and geophysicists. All data to be used (see Chapter 3) are visualized side by side in a borehole document extracted from the software WellCad. The working procedure is summarized in Figure 4-1 and in the text below.

The first step in the working procedure is to study all types of data (rock type, rock alteration, silicate density, natural gamma radiation, etc) related to the character of the rock type and to merge sections of similar rock types, or sections where one rock type is very dominant, into rock units (minimum length of c. 5 m). Each rock unit is defined in terms of the borehole length interval and provided with a brief description for inclusion in the WellCad plot. This includes a brief description of the rock types affected by the possible deformation zone. The confidence in the interpretation of a rock unit is made on the following basis: 3 = high, 2 = medium and 1 = low.

The second step in the working procedure is to identify possible deformation zones by visual inspection of the results of the geological mapping (fracture frequency, fracture mineral, aperture, alteration, etc) in combination with the geophysical logging and radar data. The section of each identified possible deformation zone is defined in terms of the borehole length interval and provided with a brief description for inclusion in the WellCad plot. The confidence in the interpretation of a possible deformation zone is made on the following basis: 3 = high, 2 = medium and 1 = low.

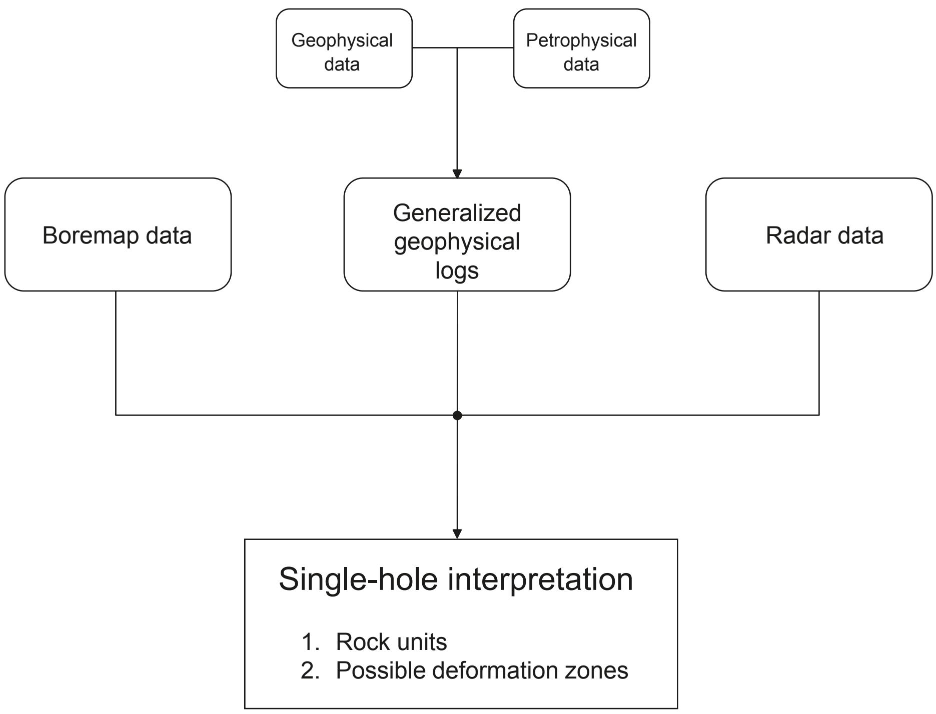
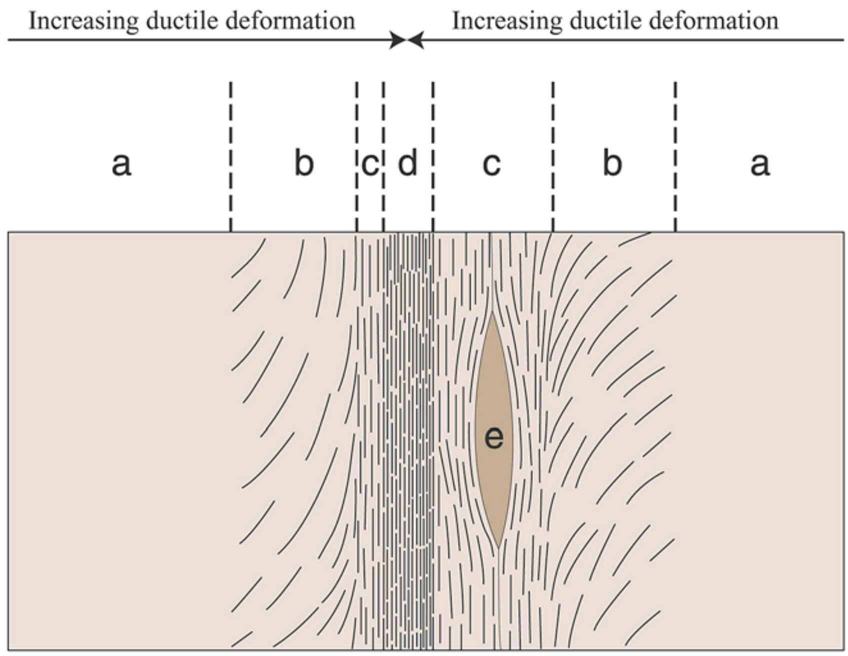


Figure 4-1. *Schematic block-scheme of single-hole interpretation.*

Inspection of BIPS images is carried out whenever it is judged necessary during the working procedure. Furthermore, following definition of rock units and deformation zones, with their respective confidence estimates, the drill cores are inspected in order to check the selection of the boundaries between these geological entities. If judged necessary, the location of these boundaries is adjusted.

Possible deformation zones that are ductile or brittle in character have been identified primarily on the basis of occurrence of protomylonitic to mylonitic foliation and the frequency of fractures, respectively, according to the recommendations in /1/. Both the transitional parts and the core part have been included in each zone (Figures 4-2 to 4-4). The fracture/m values in Figure 4-4 may serve only as examples. The frequencies of open and sealed fractures have been assessed in the identification procedure, and the character of the zone has been described accordingly. Partly open fractures are included together with open fractures in the brief description of each zone. The presence of bedrock alteration, the occurrence and, locally, inferred orientation of radar reflectors, the resistivity, SPR, P-wave velocity, caliper and magnetic susceptibility logs have all assisted in the identification of primarily the brittle structures.



a. Wallrock - undeformed to weakly deformed hostrock.
b. Transition zone - protomylonite. Weakly to strongly deformed hostrock.
c. Core - mylonite. Strongly deformed hostrock.
d. Core - ultramylonite. Intensely deformed hostrock.
e. Tectonic lens - rock with minor deformation within the shearzone

Figure 4-2. *Schematic example of a ductile shear zone. Homogeneous rock which is deformed under low- to medium-grade metamorphic conditions (after /1/).*

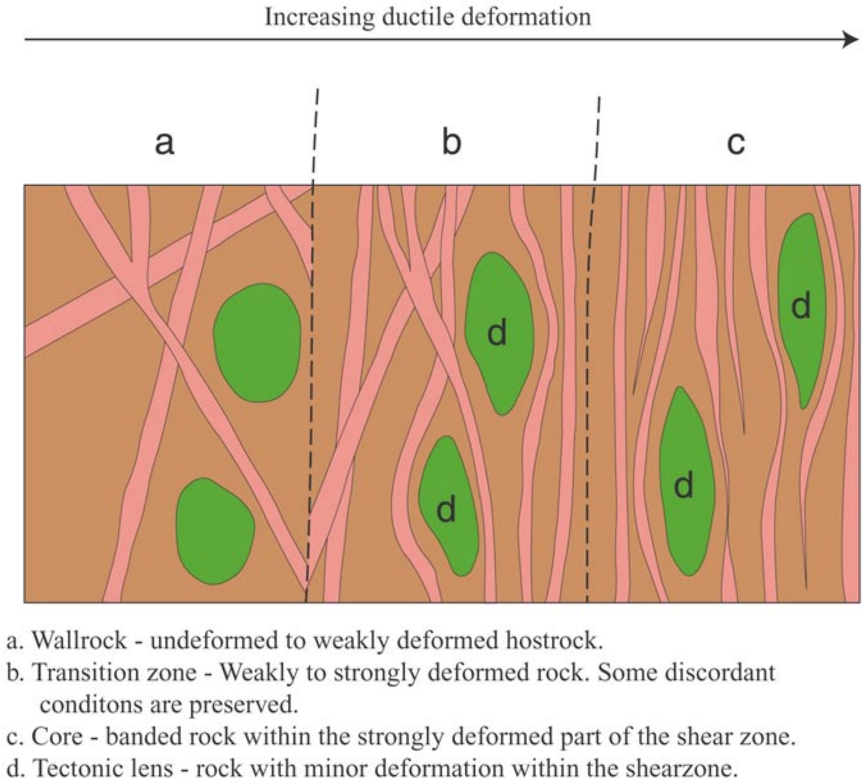


Figure 4-3. *Schematic example of a ductile shear zone. Heterogeneous rock which is deformed under low- to high-grade metamorphic conditions (after /1/).*

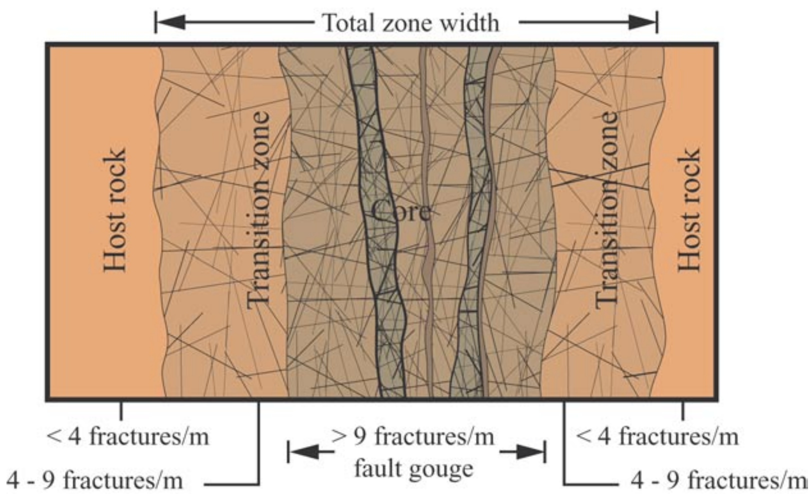


Figure 4-4. *Schematic example of a brittle deformation zone (after /1/).*

Since the frequency of fractures is of key importance for the definition of the possible deformation zones, a moving average plot for this parameter is shown for the cored borehole KLX13A (Figure 4-5). A 5 m window and 1 m steps have been used in the calculation procedure. The moving averages for open fractures alone, the total number of open fractures (open, partly open and crush), the sealed fractures alone, and the total number of sealed fractures (sealed and sealed fracture network) are shown in a diagram.

The occurrence and orientation of radar anomalies within these possible deformation zones are used during the identification of zones. Overview of the borehole radar measurement in KLX13A is shown in Figure 4-6, for HLX39 in Figure 4-7 and for HLX41 in Figure 4-8. In some cases, alternative orientations for oriented radar reflectors are presented. One of the alternatives is considered to be correct, but due to uncertainty in the interpretation of radar data, a decision concerning which of the alternatives that represent the true orientation cannot be made.

Orientations from directional radar are presented as strike/dip using the right-hand-rule method, e.g. 040/80 corresponds to a strike of N40°E and a dip of 80° to the SE.

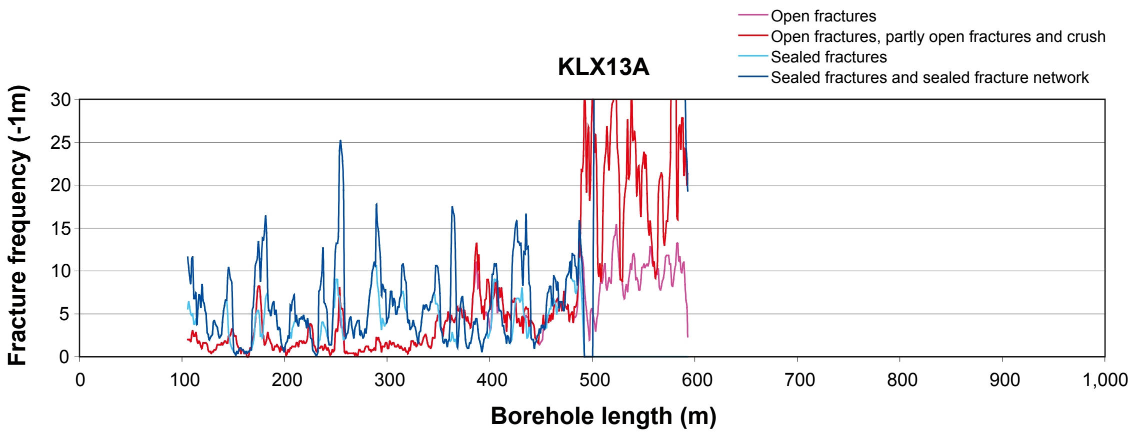


Figure 4-5. *Fracture frequency plot for KLX13A. Moving average with a 5 m window and 1 m steps.*

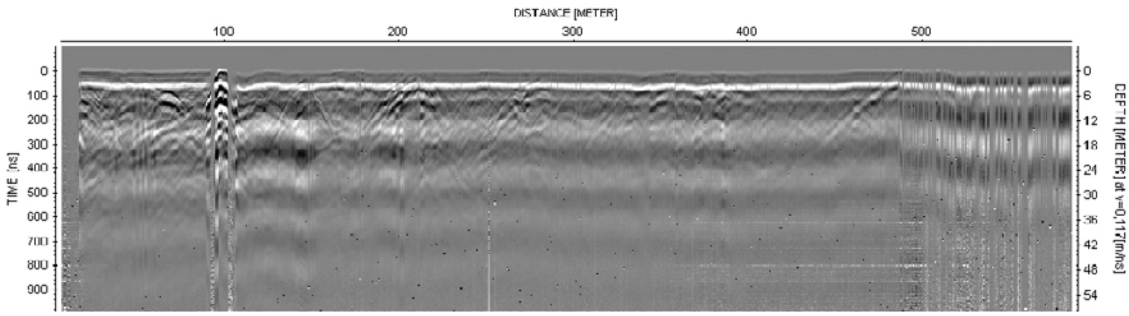


Figure 4-6. *Overview (20 MHz data) of the borehole radar measurement in KLX13A.*

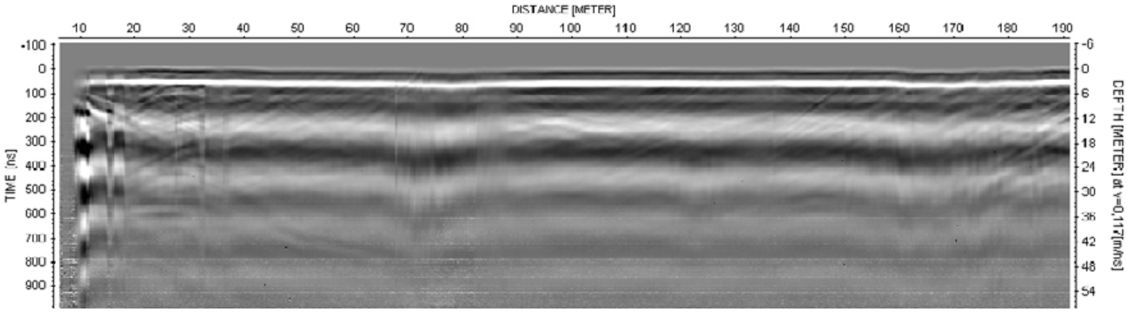


Figure 4-7. *Overview (20 MHz data) of the borehole radar measurement in HLX39.*

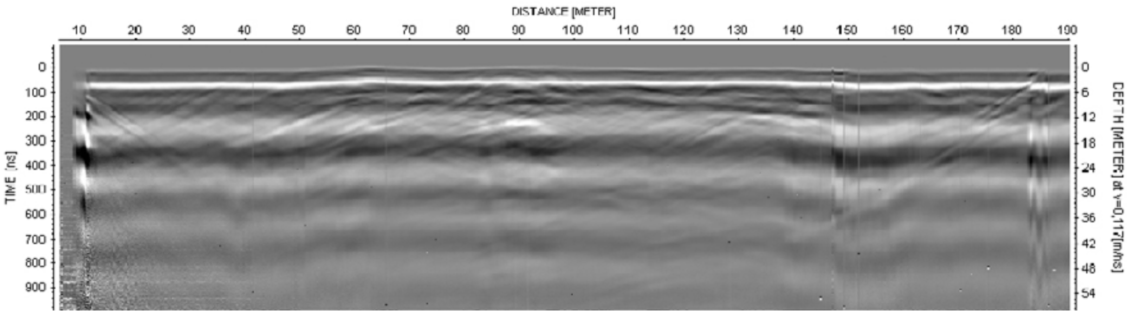


Figure 4-8. *Overview (20 MHz data) of the borehole radar measurement in HLX41.*

5 Results

The detailed result of the single-hole interpretation is presented as print-out from the software WellCad (Appendix 1 for KLX13A, Appendix 2 for HLX39 and Appendix 3 for HLX41).

5.1 KLX13A

Rock units

The borehole consists of two rock units (RU1 and RU2).

102.01–399.38 m

RU1: Dominated by Ävrögranite (501044). Diorite/gabbro (501033) occurs in scattered up to 35 m long sections, especially in the upper and lower part of the rock unit. Subordinate rock types comprise fine-grained granite (511058), fine-grained diorite-gabbro (505102), pegmatite (501061), and very sparse occurrence of granite (501058). The Ävrö granite has a density in the range 2,740–2,780 kg/m^3, and a magnetic susceptibility in the range 0.035–0.055 SI. Scattered up to 30 m long sections are characterized by faint to weak foliation. The section c. 340–399 m is characterized by an increased frequency of open fractures that is interpreted to be a transition zone, related to the underlying deformation zone DZ7. Confidence level = 3.

399.38–593.32 m

RU2: Totally dominated by Ävrö granite (501044). Subordinate rock types comprise diorite/gabbro (501033), fine-grained granite (511058), fine-grained diorite-gabbro (505102), and very sparse occurrence of granite (501058). The Ävrö granite in the section c. 399–455 m has a density in the range 2,740–2,780 kg/m^3, and 2,670–2,715 kg/m^3 in the section c. 455–593 m. The decreased density in the section c. 488–593 m is considered to be related to the alteration and reworking of the Ävrö granite in DZ7. Scattered up to 15 m long sections in the interval c. 399–485 m are characterized by faint to weak foliation. The section c. 399–488 m is characterized by an increased frequency of open fractures that is interpreted to be a transition zone, related to the underlying deformation zone DZ7. Confidence level = 3.

Possible deformation zones

Seven possible deformation zones have been recognised in KLX13A.

146.80–147.40 m.

DZ1: Brittle-ductile shear zone with increased frequency of sealed fractures and weak alteration. Single distinct low resistivity anomaly that coincides with strong gradient in the density. Decreased magnetic susceptibility. The host rock is dominated by Ävrö granite (501044). Subordinate rock types are diorite/gabbro (501033) and fine-grained granite (511058). Confidence level = 3.

173.20–177.45 m

DZ2: Brittle deformation zone characterized by increased frequency of open and sealed fractures, faint alteration, general decrease in bulk resistivity and partly decreased P-wave velocity. The section displays combination of strong positive and negative anomalies in the density, the natural gamma radiation and the magnetic susceptibility. One oriented radar reflector at 177.5 m

(153/37 or 330/50) and one non-oriented at 176.9 m with the angle 56° to borehole axis. Low radar amplitude at 172–176 m. The host rock is dominated by diorite/gabbro (501033). Subordinate rock type is fine-grained granite (511058). Confidence level = 3.

254.90–255.60 m

DZ3: Brittle-ductile shear zone (judged from core). Increased frequency of open and sealed fractures. One crush zone at 255.01–255.12 m and weak alteration. Single distinct low resistivity anomaly that coincides with decreased P-wave velocity and strong gradients in the density, the natural gamma radiation and the magnetic susceptibility. One oriented prominent radar reflector at 255.3 m (170/45 or 345/57) and one non-oriented at 255.5 m with the angle 66° to borehole axis. Low radar amplitude at 253–256 m. The host rock is dominated by fine-grained diorite-gabbro (505102). Subordinate rock type is fine-grained granite (511058). Confidence level = 3.

291.00–291.30 m

DZ4: Ductile shear zone. Increased frequency of sealed fractures, slight increase of open fractures and weak alteration. Single distinct low resistivity anomaly. The host rock is dominated by Ävrö granite (501044). Subordinate rock type is fine-grained granite (511058). Confidence level = 3.

348.75–349.50 m

DZ5: Brittle-ductile deformation zone. Increased frequency of sealed fractures and slight increase of open fractures with large apertures. Faint to weak alteration. Single distinct low resistivity anomaly that coincides with decreased P-wave velocity, decreased density, decreased magnetic susceptibility and caliper anomaly. One non-oriented radar reflector at 348.6 m with the angle 39° to borehole axis. The host rock is dominated by fine-grained granite (511058). Confidence level = 2.

384.00–388.20 m

DZ6: Brittle deformation zone characterized by increased frequency of open fractures with large apertures. Crush zone at 387.71–387.82 m. Several low resistivity anomalies, two caliper anomalies and intervals with decreased P-wave velocity. One oriented radar reflector at 385.5 m (150/14) and one non-oriented at 385.0 m with the angle 44° to borehole axis. The host rock is dominated by Ävrö granite (501044). Subordinate rock types are granite (501058) and fine-grained granite (511058). Confidence level = 2.

488.00–593.32 m

DZ7: Brittle deformation zone overprinting scattered sections of brittle-ductile shear zones in the upper part. Highly increased frequency of sealed fractures and open fractures with large apertures. 66 crush zones characterize the section. The whole deformation zone is dominated by medium alteration (red staining). Scattered sections of core loss. General decrease in the bulk resistivity and in the fluid resistivity. A large number of caliper anomalies (mainly concentrated at c. 493.5–504.5 m, 520.0–525.0 m and 550.0–559.0 m), a large number of intervals with decreased P-wave velocity. The entire section is characterized by decreased magnetic susceptibility, decreased density and increased natural gamma radiation. Eight non-oriented radar reflectors (38–77° to borehole axis) and three oriented radar reflectors occur within DZ7. The oriented reflectors are located at 493.2 m (214/54 or 025/58), 494.5 m 280/74) and at 521.3 m (304/44 or 119/31). There is very low radar amplitude from 492 m and throughout the deformation zone. The host rock is dominated by Ävrö granite (501044). Subordinate rock types are diorite/gabbro (501033), fine-grained granite (511058) and fine-grained diorite-gabbro (505102). Confidence level = 3.

5.2 HLX39

Rock units

The borehole consists of one rock unit (RU1).

6.10–198.79 m

RU1: Totally dominated by Ävrö granite (501044). Subordinate rock types comprise diorite/gabbro (501033), particularly in the sections c. 5–30 m and c.167–181 m, fine-grained granite (511058), fine-grained diorite-gabbro (505102) and pegmatite (501061). The Ävrö granite in the section c. 40–170 m has a density in the range 2,685–2,715 kg/m^3. Above and below this section the Ävrö granite is dominated by lower density in the range 2,620–2,650 kg/m^3. Confidence level = 3.

Possible deformation zones

One possible deformation zone has been recognised in HLX39.

75.0–85.0 m

DZ1: Brittle deformation zone characterized by increased frequency of open fractures and medium alteration. One crush zone at 76.86–77.11 m. General decrease in the bulk resistivity and in the magnetic susceptibility. Decreased density and a minor decrease in the P-wave velocity at c. 76.7 m. One radar reflector at 78.5 m with the angle 68° to borehole axis. The host rock is dominated by Ävrö granite (501044). Subordinate rock types are fine-grained diorite-gabbro (505102) and fine-grained granite (511058). Confidence level = 2.

5.3 HLX41

Rock units

The borehole consists of one rock unit (RU1).

6.10–199.25 m

RU1: Totally dominated by Ävrö granite (501044). Subordinate rock types comprise fine-grained granite (511058), diorite/gabbro (501033), fine-grained diorite-gabbro (505102) and pegmatite (501061). The Ävrö granite in the section c. 5–162 m is dominated by a density in the range 2,640–2,670 kg/m^3, and in the range 2,690–2,730 kg/m^3 in the section c. 170–199 m. The fine-grained granites in the section 57–99 m have untypically low natural gamma radiation in the range 10–15 µR/h. Confidence level = 3.

Possible deformation zones

No possible deformation zone has been recognised in HLX41.

6 Comments

The results from the geological single-hole interpretation of KLX13A, HLX39 and HLX41 are presented in a WellCad plot (Appendices 1–3). The WellCad plot consists of the following columns:

In data Boremap	1: Depth (Length along the borehole).
	2: Rock type.
	3: Rock alteration.
	4: Frequency of sealed fractures.
	5: Frequency of open and partly open fractures.
	6: Crush zones.
In data Geophysics	7: Silicate density.
	8: Magnetic susceptibility.
	9: Natural gamma radiation.
	10: Estimated fracture frequency.
Interpretations	11: Description: Rock unit.
	12: Stereogram for sealed fractures in rock unit (blue symbols).
	13: Stereogram for open and partly open fractures in rock unit (red symbols).
	14: Description: Possible deformation zone.
	15: Stereogram for sealed fractures in possible deformation zone (blue symbols).
	16: Stereogram for open and partly open fractures in possible deformation zone (red symbols).

7 References

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/2/ **Rauséus G, Mattsson K-J, Ehrenborg J, 2006.** Oskarshamn site investigation. Boremap mapping of core drilled borehole KLX13A. SKB P-06-255, Svensk Kärnbränslehantering AB.

/3/ **Sigurdsson O, 2007.** Oskarshamn site investigation. Simplified boremap mapping of percussion boreholes HLX38 on lineament NS059, HLX39, HLX40 and HLX41 on lineament EW900, HLX42 on lineament NE107 and HLX43 on lineament NS001. SKB P-06-266, Svensk Kärnbränslehantering AB.

/4/ **Mattsson H, Keisu M, 2006.** Oskarshamn site investigation. Interpretation of geophysical borehole measurements from KLX20A, KLX18A, KLX11B, KLX09B, KLX09D, KLX09F, HLX38, HLX39, HLX40 and HLX41. SKB P-06-292, Svensk Kärnbränslehantering AB.

/5/ **Mattsson H, Keisu M, Thunehed H, 2006.** Oskarshamn site investigation. Interpretation of geophysical borehole measurements from KLX13A, KLX14A, KLX22A, KLX22B, KLX23A, KLX23B, KLX24A, KLX25A, KLX26A and KLX26B. SKB P-06-317, Svensk Kärnbränslehantering AB.

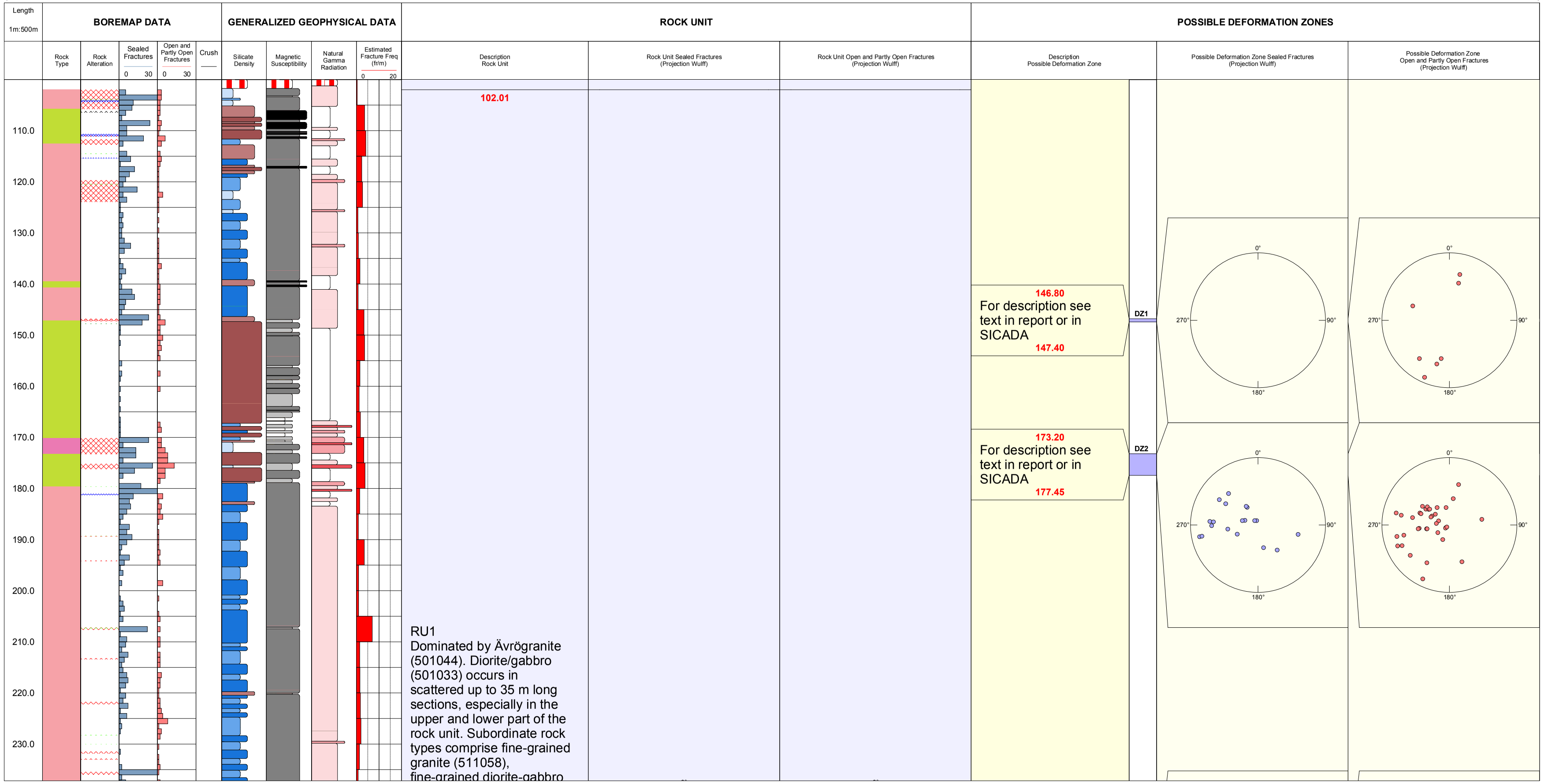
/6/ **Gustafsson J, Gustafsson C, 2006.** Oskarshamn site investigation. RAMAC, BIPS and deviation logging in boreholes KLX13A, KLX14A, KLX22A, KLX22B, KLX23A, KLX23B, KLX24A, KLX25A, KLX26A, KLX26B, HLX39 and HLX41. SKB P-06-260, Svensk Kärnbränslehantering AB.

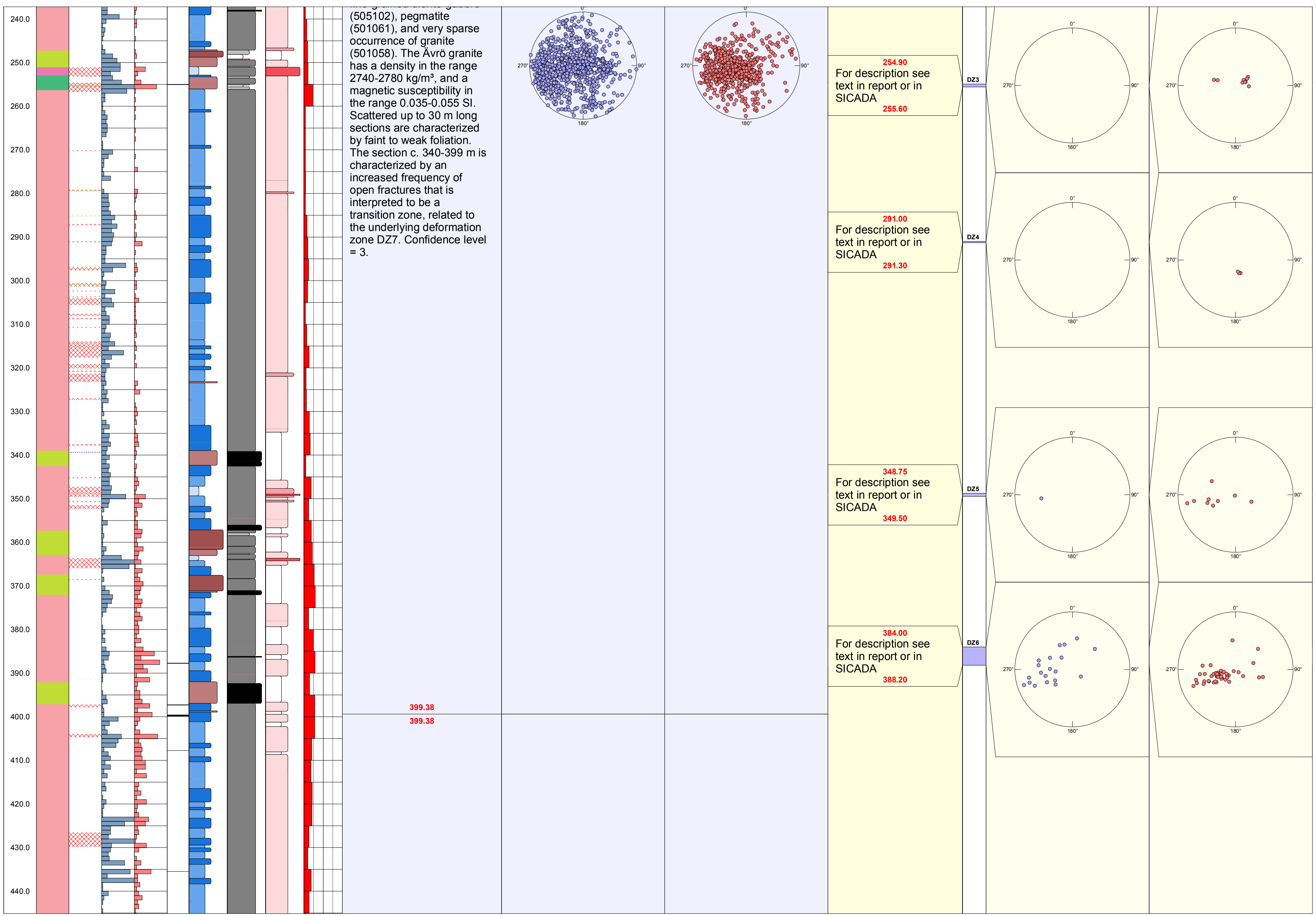
Appendix 1

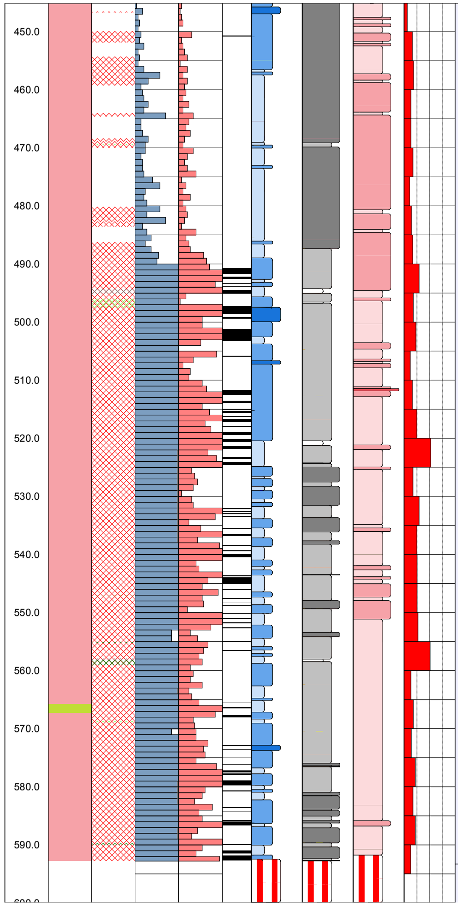
Geological single-hole interpretation of KLX13A

Title	SINGLE HOLE INTERPRETATION KLX13A					
Site	LAXEMAR	Inclination [°]	-82.23	Elevation [m.a.s.l.]	24.08	Signed data
Borehole	KLX13A	Date of mapping	2006-09-06 11:38:00	Drilling Start Date	2006-03-23 12:30:00	
Diameter [mm]	76	Coordinate System	RT90-RHB70	Drilling Stop Date	2006-03-30 13:30:00	
Length [m]	595.850	Northing [m]	6367546.33	Surveying Date		
Bearing [°]	224.48	Easting [m]	1546787.41	Plot Date	2007-10-14 22:03:05	

ROCKTYPE LAXEMAR	ROCK ALTERATION	SILICATE DENSITY	SUSCEPTIBILITET	NATURAL GAMMA
Fine-grained granite	Oxidized	unclassified	unclassified	unclassified
Ävrö granite	Chloritisized	dens<2680	sus<0.001	gam<10
Diorite / Gabbro	Epidotisized	2680<dens<2730	0.001<sus<0.01	10<gam<20
Fine-grained diorite-gabbro	Silicification	2730<dens<2800	0.01<sus<0.1	20<gam<30
	Argillization	2800<dens<2890	sus>0.1	gam>30
	Saussuritization	dens>2890		

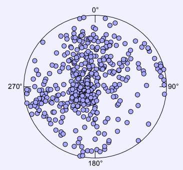


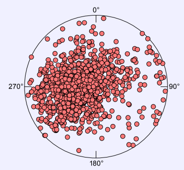

(505102), pegmatite (501061), and very sparse occurrence of granite (501058). The Ävrö granite has a density in the range 2740-2780 kg/m³, and a magnetic susceptibility in the range 0.035-0.055 SI. Scattered up to 30 m long sections are characterized by faint to weak foliation. The section c. 340-399 m is characterized by an increased frequency of open fractures that is interpreted to be a transition zone, related to the underlying deformation zone DZ7. Confidence level = 3.
399.38
399.38
254.90
For description see text in report or in SICADA
255.60
291.00
For description see text in report or in SICADA
291.30
348.75
For description see text in report or in SICADA
349.50
384.00
For description see text in report or in SICADA
388.20
DZ3
DZ4
DZ5
DZ6
240.0
250.0
260.0
270.0
280.0
290.0
300.0
310.0
320.0
330.0
340.0
350.0
360.0
370.0
380.0
390.0
400.0
410.0
420.0
430.0
440.0
0°
90°
180°
270°



RU2
Totally dominated by Ävrö granite (501044). Subordinate rock types comprise diorite/gabbro (501033), fine-grained granite (511058), fine-grained diorite-gabbro (505102), and very sparse occurrence of granite (501058). The Ävrö granite in the section c. 399-455 m has a density in the range 2740-2780 kg/m³, and 2670-2715 kg/m³ in the section c. 455-593 m. The decreased density in the section c. 488-593 m is considered to be related to the alteration and reworking of the Ävrö granite in DZ7. Scattered up to 15 m long sections in the interval c. 399-485 m are characterized by faint to weak foliation. The section c. 399-488 m is characterized by an increased frequency of open fractures that is interpreted to be a transition zone, related to the underlying deformation zone DZ7. Confidence level = 3.

593.32



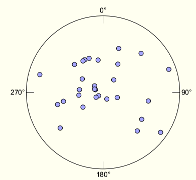


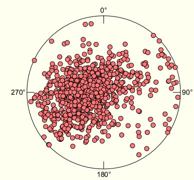
488.00

For description see text in report or in SICADA

593.32

DZ7





Appendix 2

Geological single-hole interpretation of HLX39

Title SINGLE HOLE INTERPRETATION HLX39

Site	LAXEMAR	**Inclination [°]**	-59.34	**Elevation [m.a.s.l.]**	27.04	**Signed data**
Borehole	HLX39	**Date of mapping**	2006-10-03 11:20:00	**Drilling Start Date**	2006-06-07 11:40:00	
Diameter [mm]	138	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2006-06-14 12:00:00	
Length [m]	199.300	**Northing [m]**	6366887.87	**Surveying Date**		
Bearing [°]	14.29	**Easting [m]**	1546880.48	**Plot Date**	2007-10-15 22:03:14	

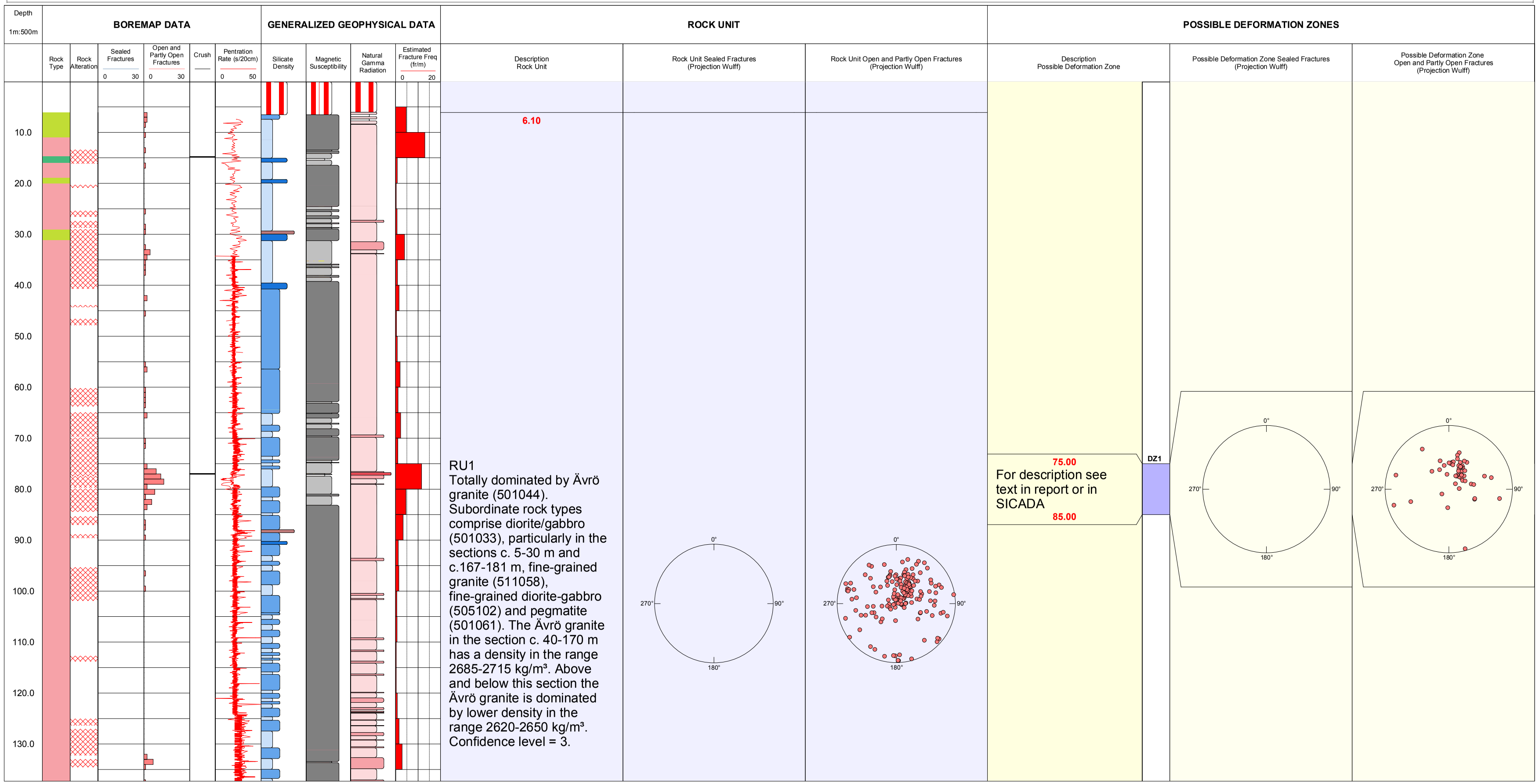
ROCKTYPE LAXEMAR
- Fine-grained granite
- Ävrö granite
- Diorite / Gabbro
- Fine-grained diorite-gabbro

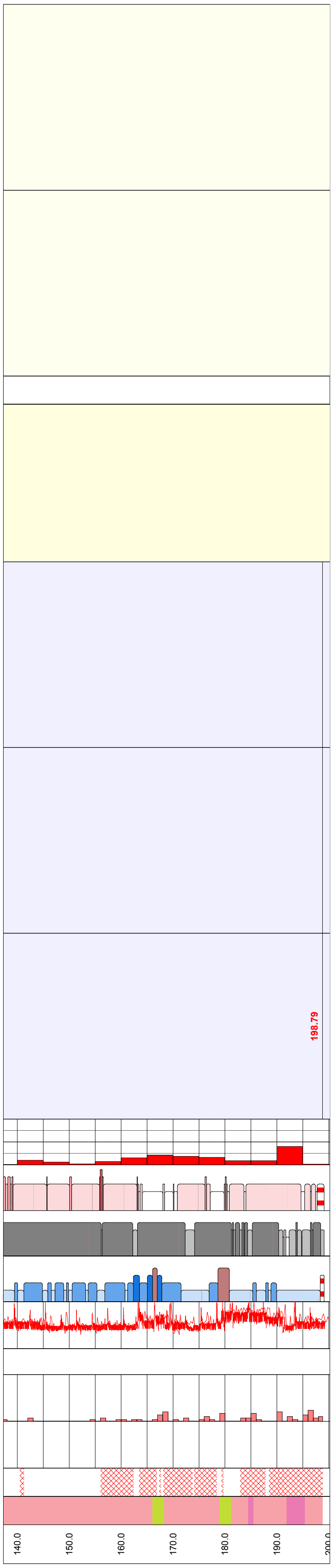
ROCK ALTERATION
- Oxidized

SILICATE DENSITY
- unclassified
- dens<2680
- 2680<dens<2730
- 2730<dens<2800
- 2800<dens<2890

SUSCEPTIBILITET
- unclassified
- sus<0.001
- 0.001<sus<0.01
- 0.01<sus<0.1

NATURAL GAMMA
- unclassified
- gam<10
- 10<gam<20
- 20<gam<30
- gam>30




198.79
140.0
150.0
160.0
170.0
180.0
190.0
200.0

Appendix 3

Geological single-hole interpretation of HLX41

Title SINGLE HOLE INTERPRETATION HLX41

Site	LAXEMAR	**Inclination [°]**	-59.14	**Elevation [m.a.s.l.]**	21.80	**Signed data**
Borehole	HLX41	**Date of mapping**	2006-10-11 15:26:00	**Drilling Start Date**	2006-05-22 12:00:00	
Diameter [mm]	139	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2006-06-01 11:00:00	
Length [m]	199.500	**Northing [m]**	6367013.20	**Surveying Date**		
Bearing [°]	208.29	**Easting [m]**	1547017.61	**Plot Date**	2007-10-15 22:03:14	

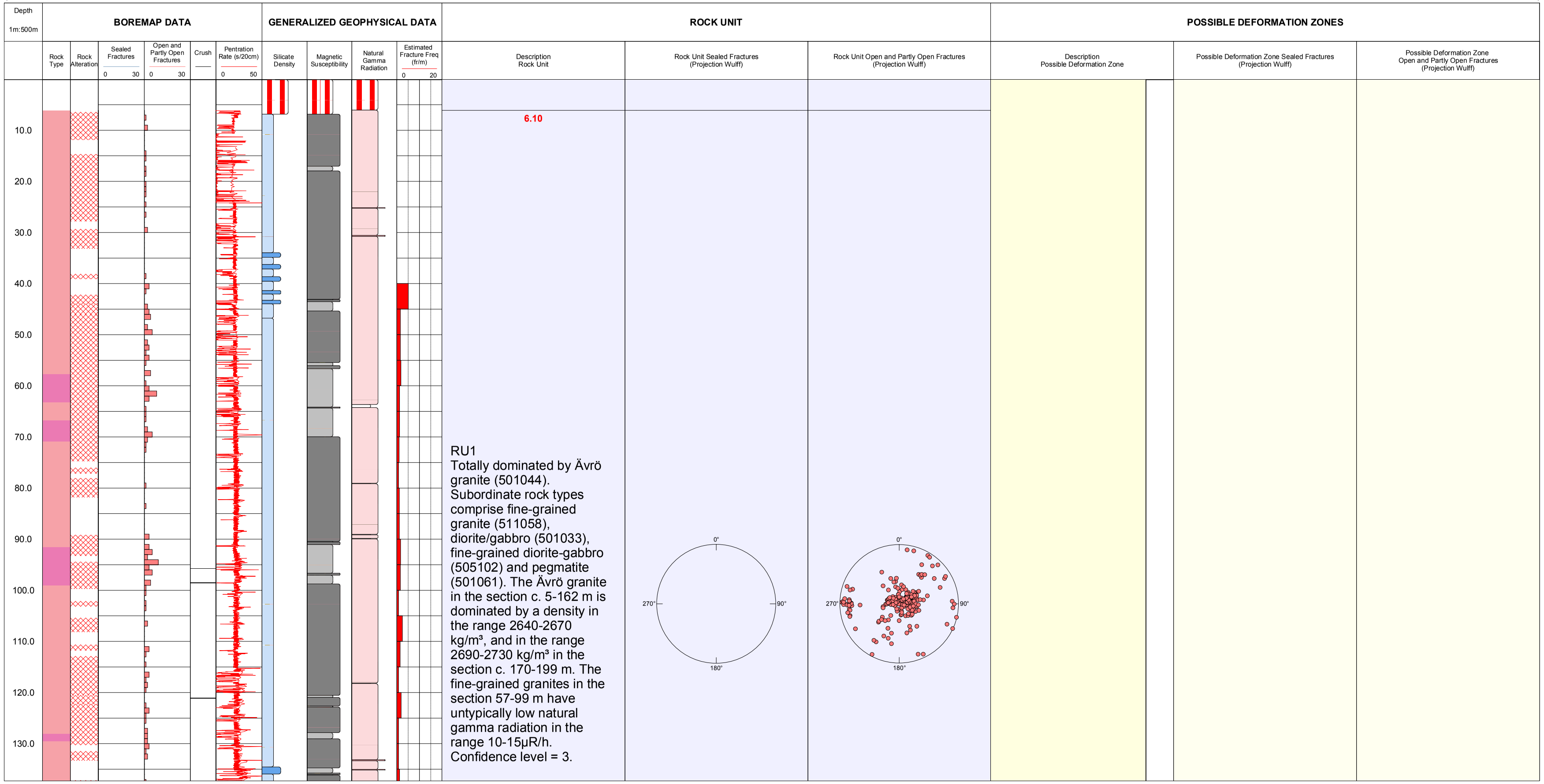
ROCKTYPE LAXEMAR
- Fine-grained granite
- Ävrö granite
- Diorite / Gabbro

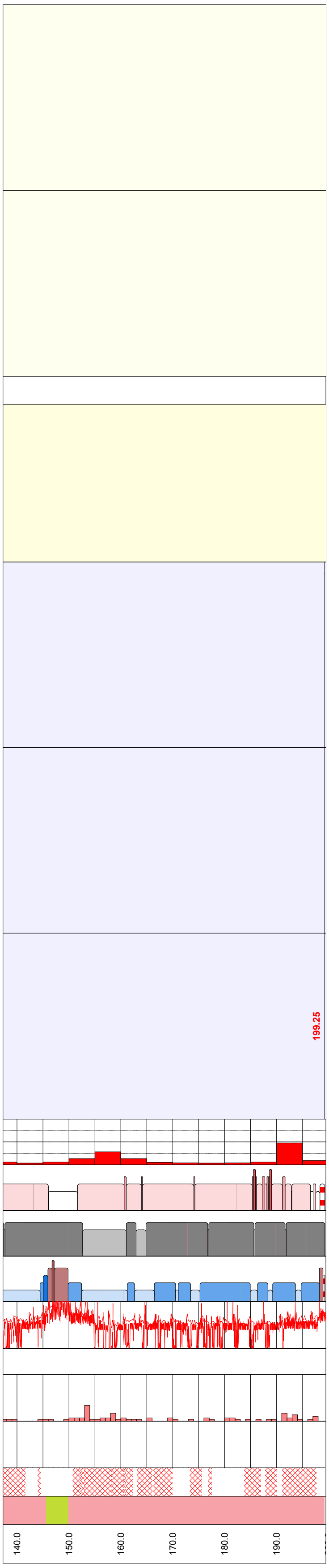
ROCK ALTERATION
- Oxidized

SILICATE DENSITY
- unclassified
- dens<2680
- 2680<dens<2730
- 2730<dens<2800
- 2800<dens<2890
- dens>2890

SUSCEPTIBILITET
- unclassified
- 0.001<sus<0.01
- 0.01<sus<0.1

NATURAL GAMMA
- unclassified
- gam<10
- 10<gam<20
- 20<gam<30
- gam>30





199.25
140.0
150.0
160.0
170.0
180.0
190.0