P-05-38

Oskarshamn site investigation

Geological single-hole interpretation of KLX03, HLX26 and HLX27

Seje Carlsten, Geosigma AB

Peter Hultgren, Svensk Kärnbränslehantering AB

Håkan Mattsson, GeoVista AB

Roy Stanfors, Roy Stanfors Consulting

Carl-Henric Wahlgren, Geological Survey of Sweden

July 2006

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

ISSN 1651-4416
SKB P-05-38

Oskarshamn site investigation

Geological single-hole interpretation of KLX03, HLX26 and HLX27

Seje Carlsten, Geosigma AB

Peter Hultgren, Svensk Kärnbränslehantering AB

Håkan Mattsson, GeoVista AB

Roy Stanfors, Roy Stanfors Consulting

Carl-Henric Wahlgren, Geological Survey of Sweden

July 2006

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

Abstract

This report contains geological single-hole interpretations of the cored borehole KLX03 and the percussion boreholes HLX26 and HLX27 at Laxemar. The interpretation combines the geological core mapping, interpreted geophysical logs and borehole radar measurements to identify rock units (RU) and possible deformation zones (DZ) in the boreholes.

The geological single-hole interpretation shows that KLX03 is divided into four rock units (RU1–RU4). In general, the upper 620 m of the borehole is dominated by Ävrö granite and the lower part of the borehole down to 1,000 m is dominated by quartz monzodiorite. One possible deformation zone has been identified in KLX03 (DZ1).

One rock unit occurs in percussion borehole HLX26 (RU1). The rock unit is totally dominated by quartz monzodiorite. One possible deformation zone has been identified in HLX26 (DZ1).

Percussion borehole HLX27 is totally dominated by quarts monzodiorite, which constitutes one rock unit (RU1). One possible deformation zone has been identified in HLX27 (DZ1).

Sammanfattning

Denna rapport behandlar geologisk enhålstolkning av kärnborrhålet KLX03 samt hammarborrhålen HLX26 och HLX27 i Laxemar. Den geologiska enhålstolkningen syftar till att utifrån den geologiska karteringen, tolkade geofysiska loggar och borrhålsradarmätningar identifiera olika litologiska enheter (RU) och möjliga deformationszoner (DZ).

Geologisk enhålstolkning visar att det i KLX03 finns fyra litologiska enheter (RU1–RU4). Generellt sett dominerar Ävrögranit i de övre 620 m av borrhålet, medan resterande del av borrhålet ner till 1,000 m domineras av kvartsmonzodiorit. En möjlig deformationszon har identifierats i KLX03 (DZ1).

En litologisk enhet är identifierad i hammarborrhål HLX26 (RU1), vilken domineras av kvartsmonzodiorit. En möjlig deformationszon har identifierats i HLX26 (DZ1).

Hammarborrhål HLX27 domineras av kvartsmonzodiorit vilken utgör en litologisk enhet (RU1). En möjlig deformationszon har identifierats i HLX27 (DZ1).

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, SKB internal controlling document).

This document reports the results gained by the geological single-hole interpretation of the cored borehole KLX03 and the percussion drilled boreholes HLX26 and HLX27 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 400-04-108. 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.

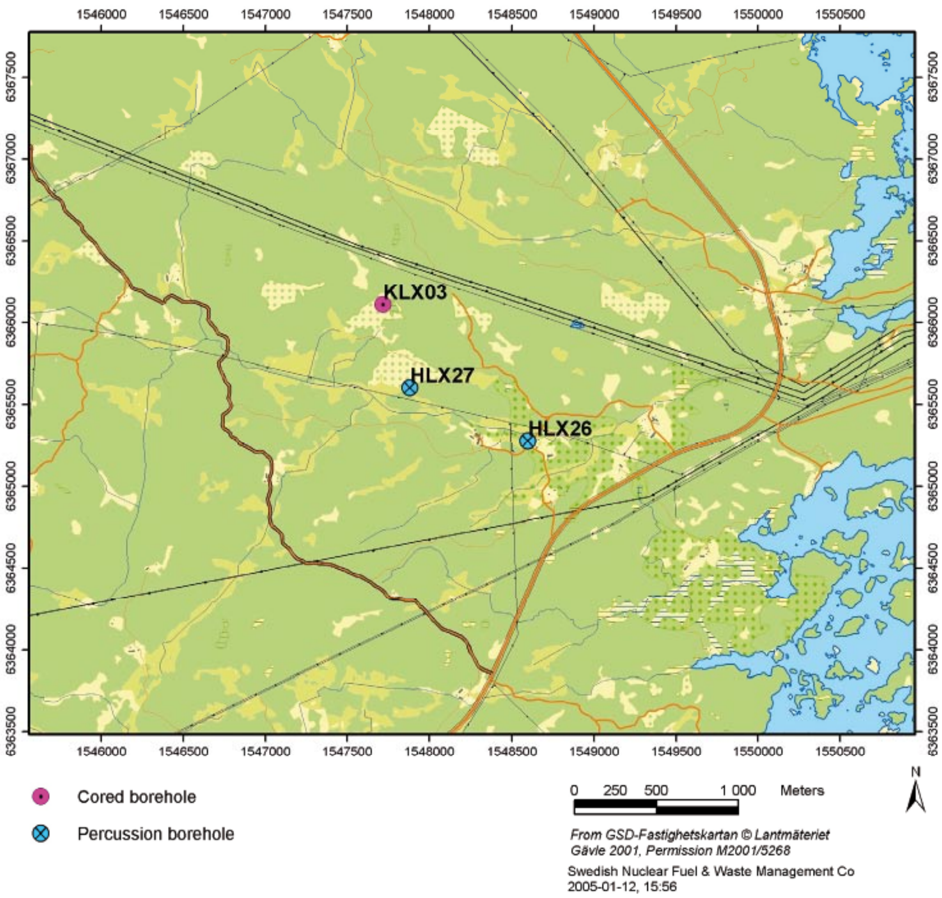


Figure 1-1. *Map showing the position of the cored borehole KLX03 and the percussion drilled boreholes HLX26 and HLX27.*

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

Activity plan	Number	Version
Geologisk enhålstolkning av KLX03, HLX26 och HLX27	AP PS 400-04-108	1.0
Method description	**Number**	**Version**
Metodbeskrivning för geologisk enhålstolkning	SKB MD 810.003	1.0

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

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 *B*orehole *I*mage *P*rocessing *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.

3 Equipment

The following data have been used in the single-hole interpretations of the boreholes KLX03, HLX26 and HLX27:

- Boremap data (including BIPS and geological mapping data) /1,2/.
- Generalized geophysical logs and their interpretation /3/.
- Radar data and their interpretation /4,5/.

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 ten main columns and several subordinate columns. These include:

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)
    5.9: Sealed network
    5.10: Core loss

7: Fracture frequency
    6.1: Sealed fractures
    6.2: Open fractures

9: BIPS

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.

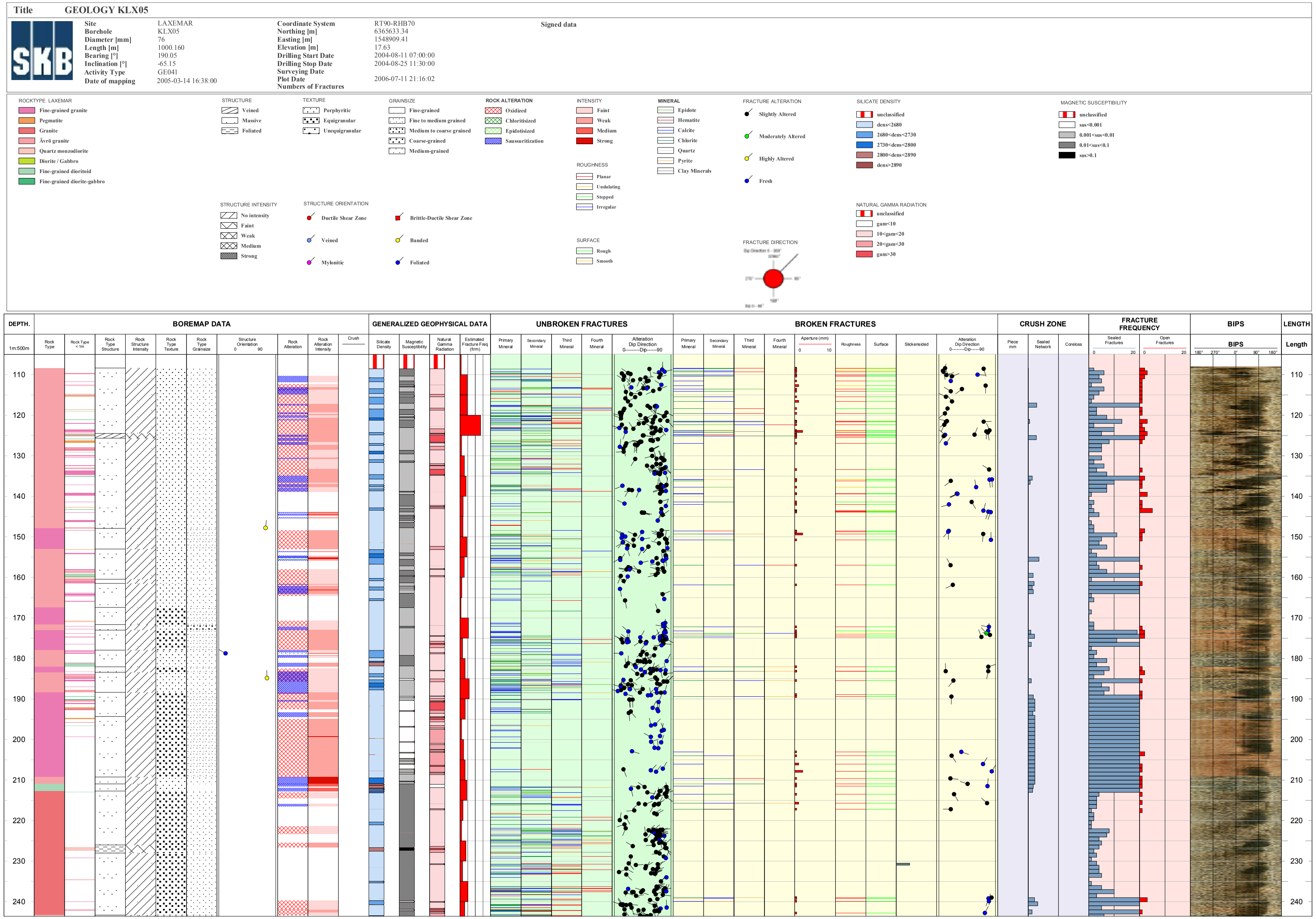


Figure 3-1. *Example of WellCad plot (from borehole KLX05 in Laxemar) used as a basis for the single-hole interpretation.*

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. Several of these geoscientists previously participated in the development of the source material for the single-hole interpretation. All data to be used (see above) 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.

Step 1 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. The frequencies of open and sealed fractures have been assessed in the identification procedure, and the character of the rock unit has been presented in stereo plot in appendices. Partly open fractures are included together with open fractures. The confidence in the interpretation of a rock unit is made on the following basis: 3 = high, 2 = medium, 1 = low and 0 = not estimated.

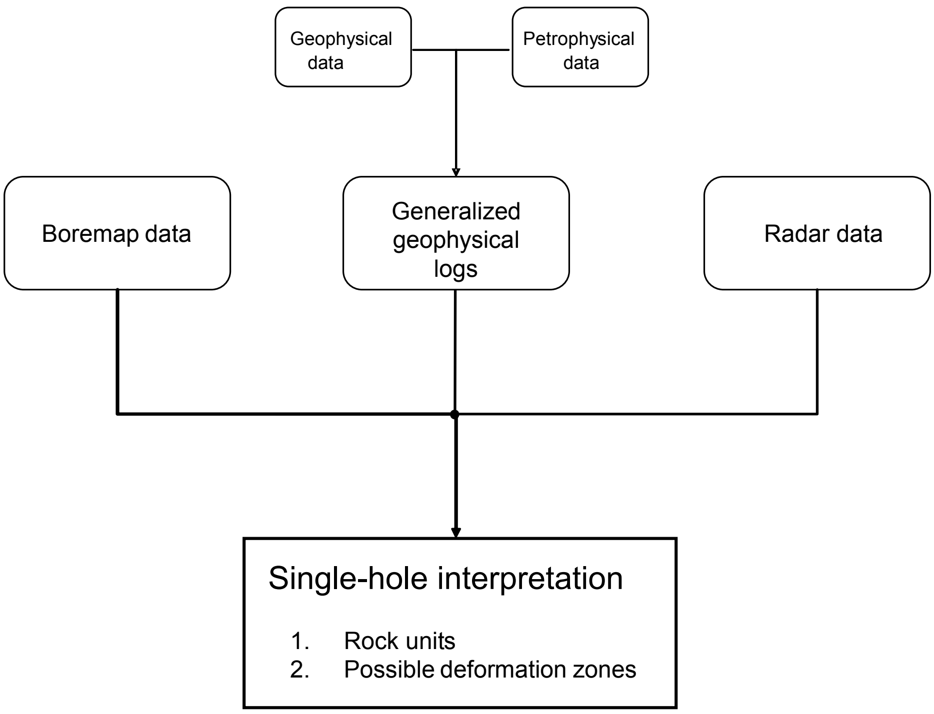


Figure 4-1. *Schematic block-scheme of single-hole interpretation.*

Step 2 in the working procedure is to identify 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 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 deformation zone is made on the following basis: 3 = high, 2 = medium, 1 = low and 0 = not estimated.

Inspection of BIPS images is carried out wherever 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.

Deformation zones that are brittle in character have been identified primarily on the basis of the frequency of fractures, according to the recommendations in /6/. Both the transitional part, with a fracture frequency in the range 4–9 fractures/m, and the cored part, with a fracture frequency > 9 fractures/m, have been included in each zone (Figure 4-2). 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 the zones.

4.2 Nonconformities

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 dip/strike using the right-hand rule.

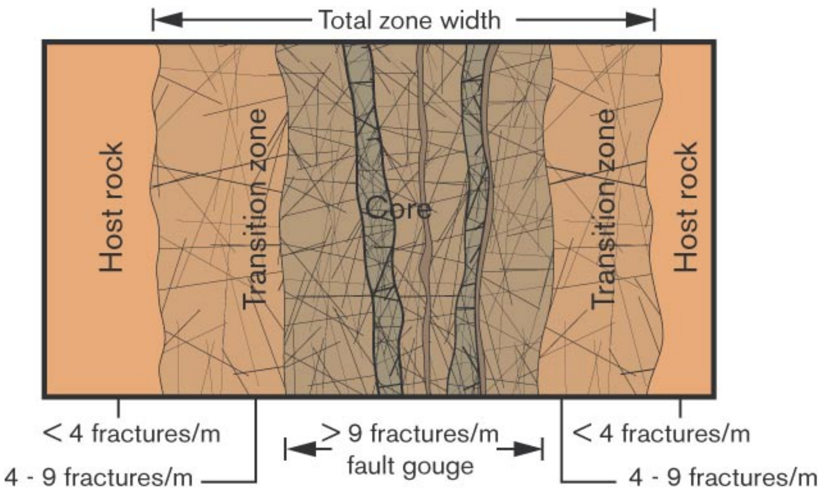


Figure 4-2. *Terminology for brittle deformation zones (after /6/).*

5 Results

The results of the geological single-hole interpretations are presented as print-outs from the software WellCad (Appendix 1 for KLX03, Appendix 2 for HLX26 and Appendix 3 for HLX27). The legend of the WellCad is presented in Chapter 6. In 5.1 to 5.3 all identified rock units and possible deformation zones in KLX03, HLX26 and HLX27 are presented.

5.1 KLX03

The borehole can be divided into four different rock units, RU1–RU4.

RU1: 101.48–426.18 m
Totally dominated by Ävrö granite. Subordinate rock types comprise fine-grained granite, fine-grained diorite to gabbro, fine-grained dioritoid, quartz monzodiorite, diorite to gabbro and pegmatite. Along the section 288–323 m the natural gamma radiation is lower and the density and magnetic susceptibility are higher compared to the rest of the rock unit. Confidence: 3.

RU2: 426.18–619.87 m
Totally dominated by Ävrö granite. Subordinate rock types are dominated by diorite to gabbro (≤ 8 m long sections). Furthermore, sections of fine-grained granite, quartz monzodiorite, fine-grained dioritoid and fine-grained diorite to gabbro occur. Confidence: 3.

RU3: 619.87–798.02 m
Totally dominated by quartz monzodiorite. Subordinate rock types comprise ≤ c 17 m long sections of fine-grained diorite to gabbro. Furthermore, subordinate rock types comprise Ävrö granite, fine-grained granite, pegmatite and fine-grained dioritoid. Very large variations in the magnetic susceptibility occur along the entire section. Confidence: 3.

RU4: 798.02–998.206 m
Totally dominated by quartz monzodiorite. Subordinate rock types comprise fine-grained granite, pegmatite, fine-grained dioritoid and granite. Confidence: 3.

One deformation zones has been recognised in KLX03:

DZ1: 722.5–814 m
Sealed, hydrothermally altered fracture zone with relatively low frequency of open fractures. Scattered narrow sections are strongly foliated (low grade ductile shear zones) and overprinted by the hydrothermal alteration and the sealed fracture network. Sixteen borehole radar reflectors occur within the section. Reflectors at 729.5 m with the orientation 19/108, at 733.7 m with orientation 29/057, at 759.5 m with orientation 87/191 and at 768.0 m with the orientation 29/053. Twelve non-oriented reflectors have the angle 49–77° to borehole axis. The geophysical logging data show decreased resistivity, P-wave velocity and density together with fluctuating magnetic susceptibility. Uncertainty: 3.

5.2 HLX26

The borehole contains one rock unit:

RU1: 9.10–151.20 m
Totally dominated by quartz monzodiorite. Subordinate rock types comprise fine-grained diorite to gabbro, fine-grained granite and pegmatite. Confidence: 2.

One deformation zone has been recognised in HLX26:

DZ1: 63–72 m
Medium to strong alteration, increased fracturing and a narrow crush zone. Geophysical loggings show major caliper anomalies and low resistivity, low p-wave velocity and partly low density along the section. Confidence: 2.

5.3 HLX27

The borehole contains one rock unit:

RU1: 6.10–164.7 m
Totally dominated by quartz monzodiorite. Subordinate rock types comprise fine-grained diorite to gabbro, fine-grained granite and pegmatite. Confidence: 2.

One deformation zone has been recognised in HLX27:

DZ1: 156–164.7 m
Strong alteration and large apertures. Decreased density, low susceptibility, major caliper anomaly and low resistivity. Confidence: 2.

6 Comments

The result from the geological single-hole interpretation of KLX03, HLX26 and HLX27 are presented in WellCad plots (Appendix 1–3). The WellCad plots consist 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

/1/ **Ehrenborg J, Dahlin P, 2005.** Oskarshamn site investigation. Boremap mapping of core drilled borehole KLX03. SKB P-05-24, Svensk Kärnbränslehantering AB.

/2/ **Sigurdsson O, 2005.** Oskarshamn site investigation. Simplified Boremap mapping of percussion boreholes HLX15, HLX26, HLX27, HLX28 and HLX32 on lineament NW042. SKB P-05-083, Svensk Kärnbränslehantering AB.

/3/ **Mattsson H, Thunehed H, Keisu M, 2005.** Oskarshamn site investigation. Interpretation of geophysical borehole measurements and compilation of petrophysical data from KLX01, KLX03, KLX04, HLX21, KLX22, HLX23, HLX24, HLX25, HLX26, HLX27 and HLX28. SKB P-05-34, Svensk Kärnbränslehantering AB.

/4/ **Gustafsson J, Gustafsson C, 2004.** Oskarshamn site investigation. RAMAC and BIPS logging in boreholes KLX03, HAV11 to HAV13, and HLX21 to HLX25. SKB P-04-275, Svensk Kärnbränslehantering AB.

/5/ **Gustafsson J, Gustafsson C, 2004.** Oskarshamn site investigation. RAMAC and BIPS logging in boreholes HLX10, HLX26, HLX27 and HLX28. SKB P-04-297, Svensk Kärnbränslehantering AB.

/6/ **Munier R, Stenberg L, Stanfors R, Milnes A G, Hermanson J, Triumf CA, 2003.** Geological site descriptive model. A strategy for the model development during site investigations. SKB R-03-07, Svensk Kärnbränslehantering AB.

Geological single-hole interpretation of KLX03

Title SINGLE HOLE INTERPRETATION KLX03

Site	LAXEMAR	**Inclination [°]**	-74.92	**Elevation [m.a.s.l.]**	18.42	**Signed data**
Borehole	KLX03	**Date of mapping**	2004-10-27 08:45:00	**Drilling Start Date**	2004-05-03 14:30:00	
Diameter [mm]	76	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2004-05-13 11:00:00	
Length [m]	1000.420	**Northing [m]**	6366111.77	**Surveying Date**		
Bearing [°]	199.04	**Easting [m]**	1547718.97	**Plot Date**	2006-07-13 21:14:56	

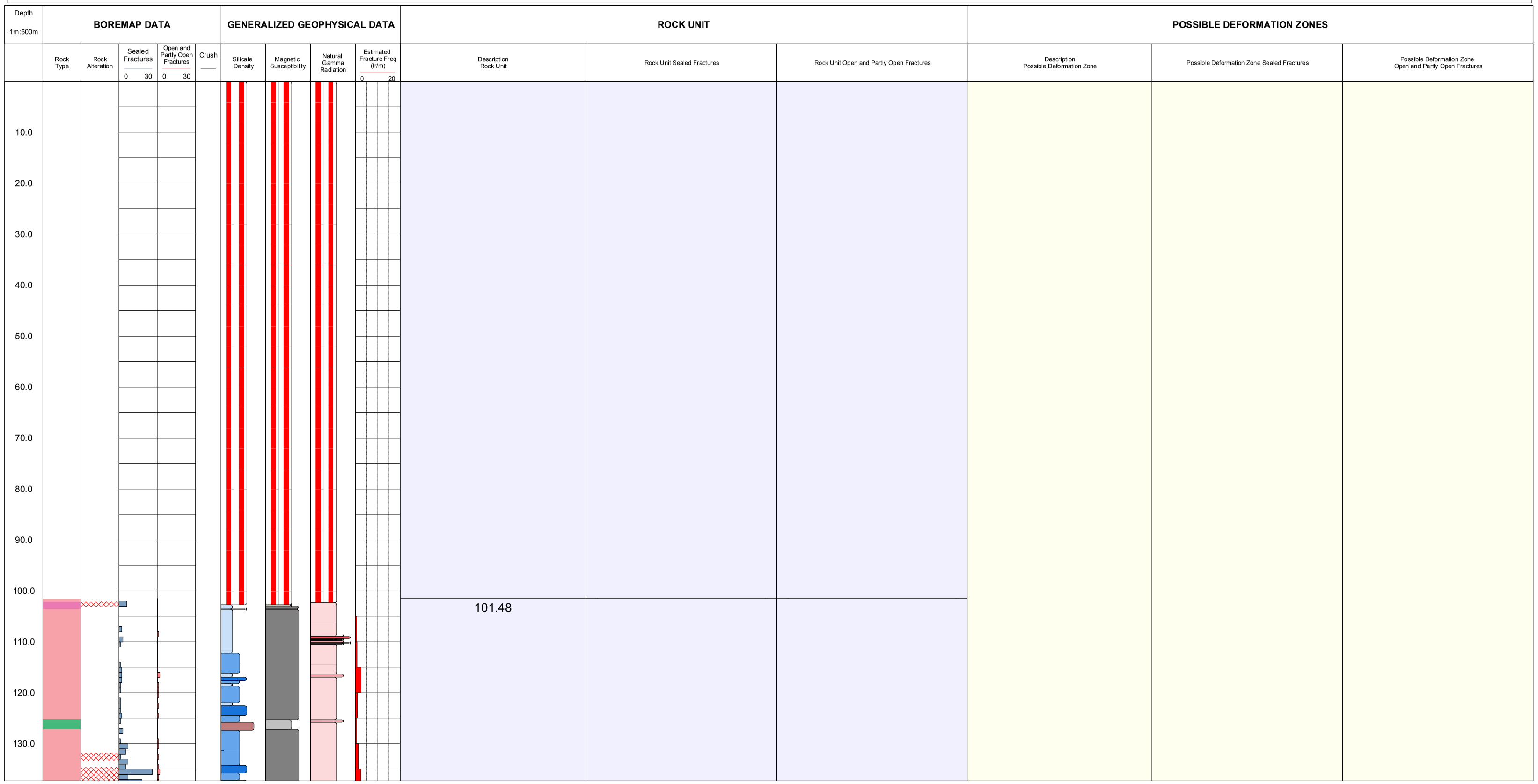
ROCKTYPE LAXEMAR
- Fine-grained granite
- Ävrö granite
- Quartz monzodiorite
- Diorite / Gabbro
- Fine-grained dioritoid
- Fine-grained diorite-gabbro

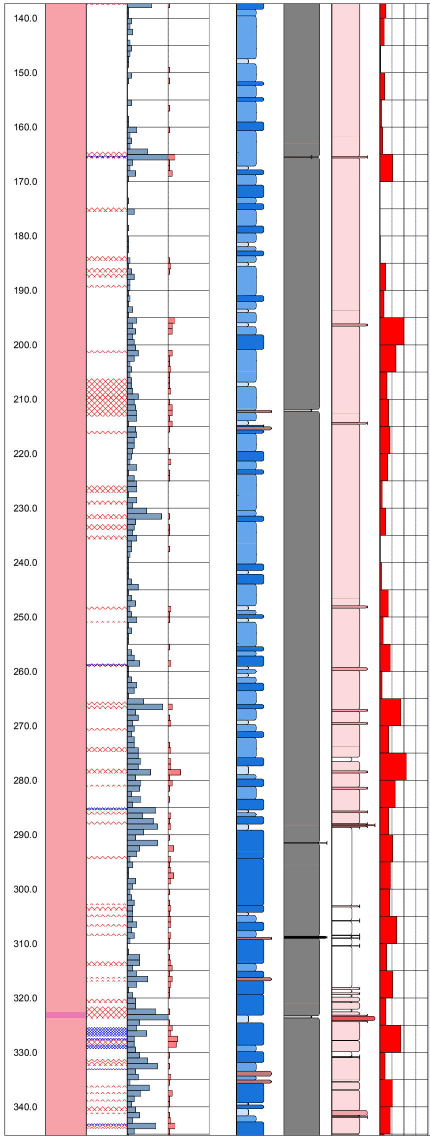
ROCK ALTERATION
- Oxidized
- Chloritisized
- Epidotisized
- Quartz dissolution
- Silicification
- Saussuritization

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

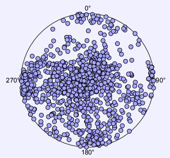
SUSCEPTIBILITET
- unclassified
- sus<0.001
- 0.001<sus<0.01
- 0.01<sus<0.1
- sus>0.1

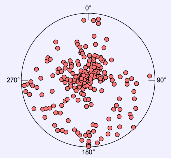
NATURAL GAMMA
- unclassified
- gam<10
- 10<gam<20
- 20<gam<30
- gam>30

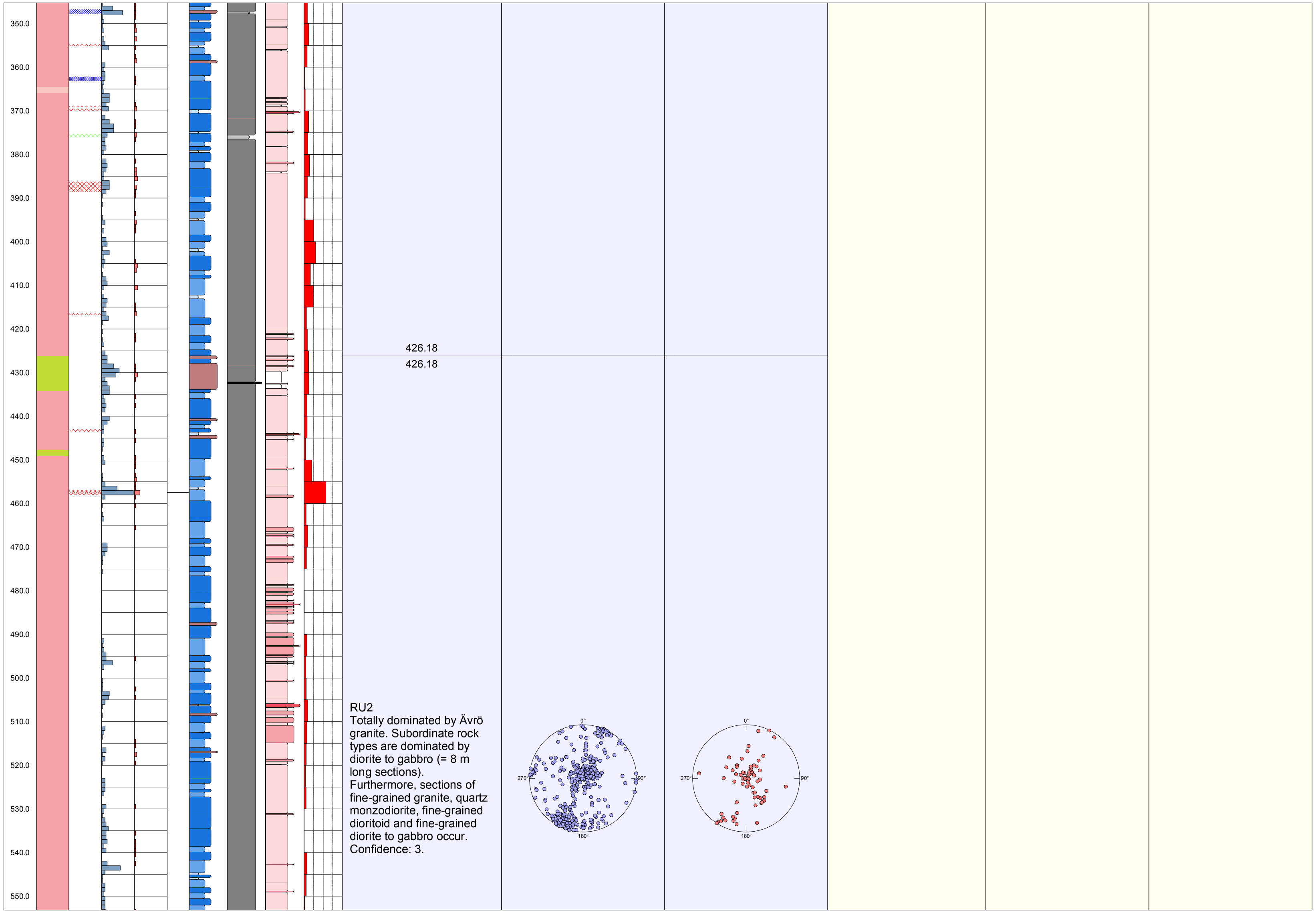


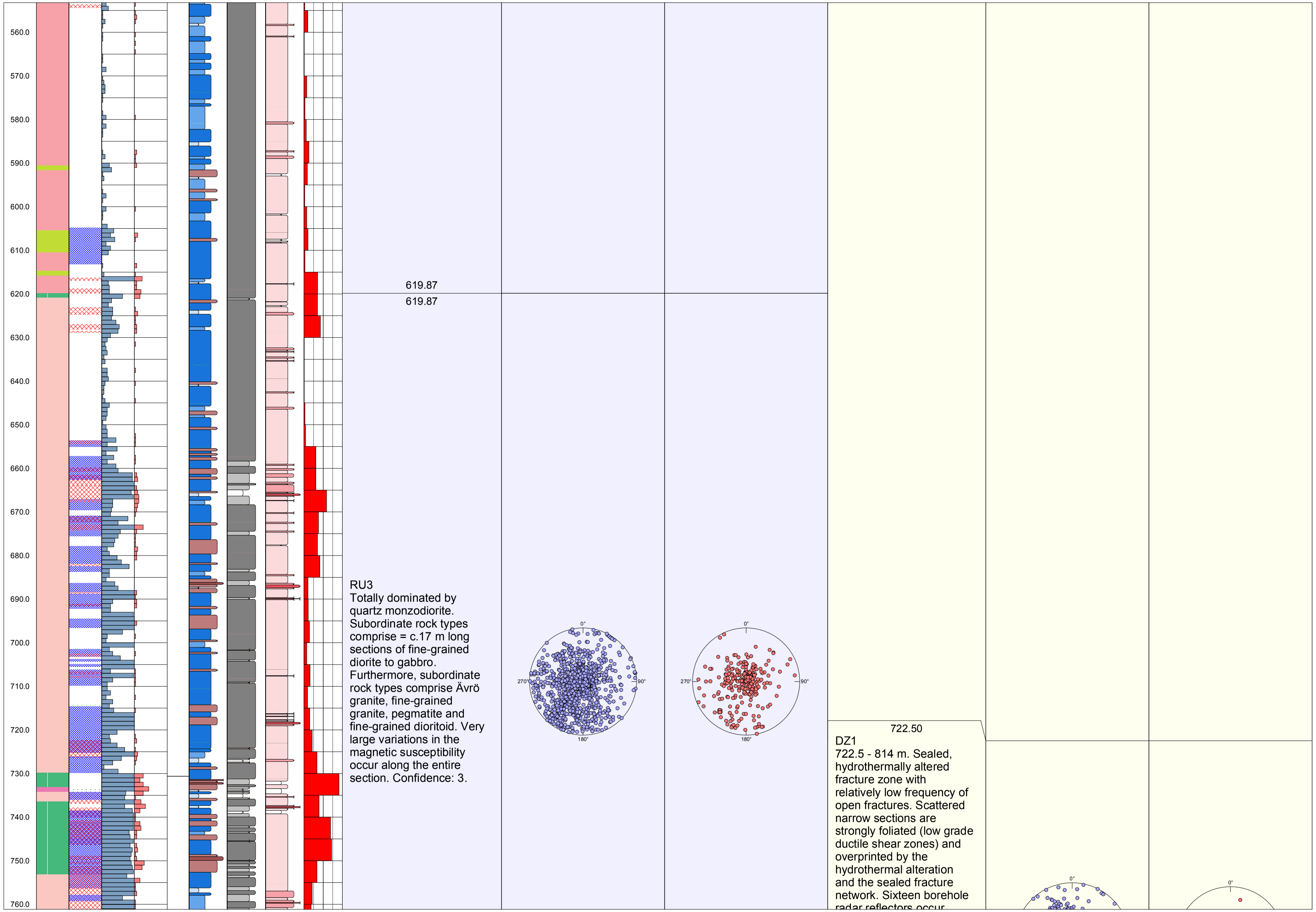


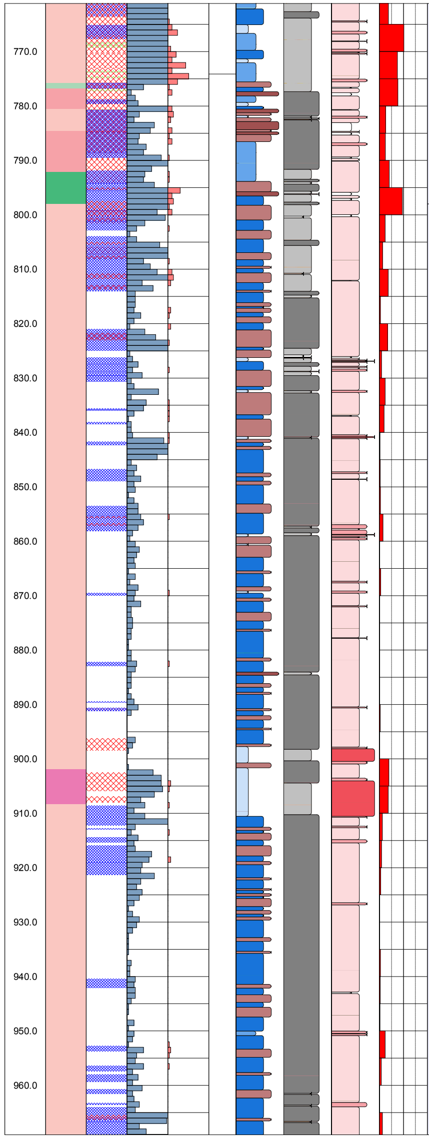
RU1
Totally dominated by Ävrö granite. Subordinate rock types comprise fine-grained granite, fine-grained diorite to gabbro, fine-grained dioritoid, quartz monzodiorite, diorite to gabbro and pegmatite. Along the section 288-323 m the natural gamma radiation is lower and the density and magnetic susceptibility are higher compared to the rest of the rock unit. Confidence: 2.






350.0
360.0
370.0
380.0
390.0
400.0
410.0
420.0
430.0
440.0
450.0
460.0
470.0
480.0
490.0
500.0
510.0
520.0
530.0
540.0
550.0
426.18
426.18
RU2
Totally dominated by Ävrö granite. Subordinate rock types are dominated by diorite to gabbro (= 8 m long sections). Furthermore, sections of fine-grained granite, quartz monzodiorite, fine-grained dioritoid and fine-grained diorite to gabbro occur. Confidence: 3.
0°
90°
180°
270°
0°
90°
180°
270°

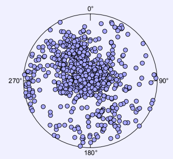

560.0
570.0
580.0
590.0
600.0
610.0
620.0
630.0
640.0
650.0
660.0
670.0
680.0
690.0
700.0
710.0
720.0
730.0
740.0
750.0
760.0
619.87
619.87
RU3
Totally dominated by quartz monzodiorite. Subordinate rock types comprise = c.17 m long sections of fine-grained diorite to gabbro. Furthermore, subordinate rock types comprise Ävrö granite, fine-grained granite, pegmatite and fine-grained dioritoid. Very large variations in the magnetic susceptibility occur along the entire section. Confidence: 3.
722.50
DZ1
722.5 - 814 m. Sealed, hydrothermally altered fracture zone with relatively low frequency of open fractures. Scattered narrow sections are strongly foliated (low grade ductile shear zones) and overprinted by the hydrothermal alteration and the sealed fracture network. Sixteen borehole

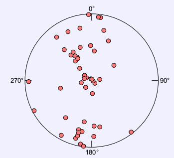


798.02

798.02

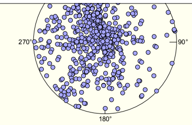
RU4
Totally dominated by quartz monzodiorite. Subordinate rock types comprise fine-grained granite, pegmatite, fine-grained dioritoid and granite. Confidenc: 3.

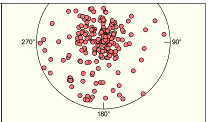


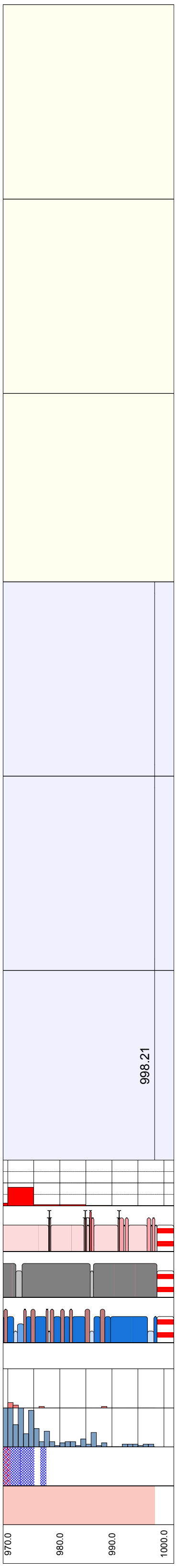


radar reflectors occur within the section. Reflectors at 729.5 m with the orientation 19/108, at 733.7 m with orientation 29/057, at 759.5 m with orientation 87/191 and at 768.0 m with the orientation 29/053. Twelve non-oriented reflectors have the angle 49-77º to borehole axis. The geophysical logging data show decreased resistivity, P-wave velocity and density together with fluctuating magnetic susceptibility. Confidence: 3.

814.00






998.21
970.0
980.0
990.0
1000.0

Geological single-hole interpretation of HLX26

Appendix 2

Title SINGLE HOLE INTERPRETATION HLX26

Site	LAXEMAR	**Inclination [°]**	-60.41	**Elevation [m.a.s.l.]**	6.48	**Signed data**
Borehole	HLX26	**Date of mapping**	2004-12-07 18:10:00	**Drilling Start Date**	2004-09-23 16:40:00	
Diameter [mm]	137	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2004-09-28 18:00:00	
Length [m]	151.200	**Northing [m]**	6365278.71	**Surveying Date**		
Bearing [°]	12.37	**Easting [m]**	1548600.53	**Plot Date**	2006-08-15 21:14:45	

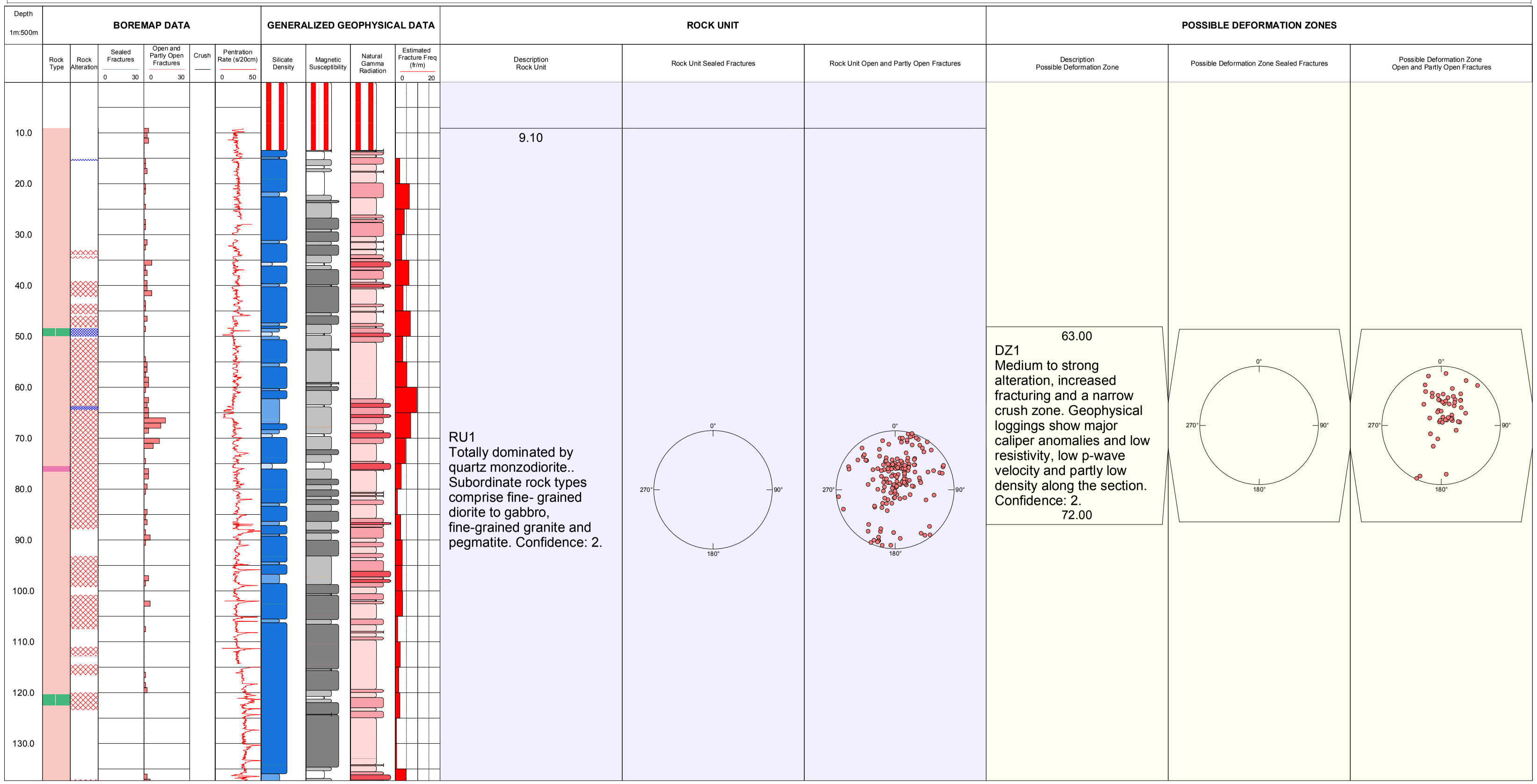
ROCKTYPE LAXEMAR
- Fine-grained granite
- Quartz monzodiorite
- Fine-grained diorite-gabbro

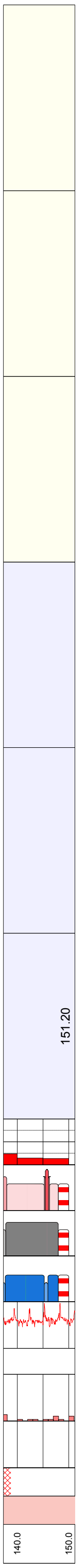
ROCK ALTERATION
- Oxidized
- Saussuritization

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

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

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




151.20
140.0
150.0

Geological single-hole interpretation of HLX27

Appendix 3

Title SINGLE HOLE INTERPRETATION HLX27

SKB

Site	LAXEMAR	**Inclination [°]**	-59.40	**Elevation [m.a.s.l.]**	8.25	**Signed data**
Borehole	HLX27	**Date of mapping**	2004-12-08 16:01:00	**Drilling Start Date**	2004-09-20 14:00:00	
Diameter [mm]	137	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2004-09-22 18:30:00	
Length [m]	164.700	**Northing [m]**	6365605.07	**Surveying Date**		
Bearing [°]	191.00	**Easting [m]**	1547882.69	**Plot Date**	2006-08-15 21:14:45	

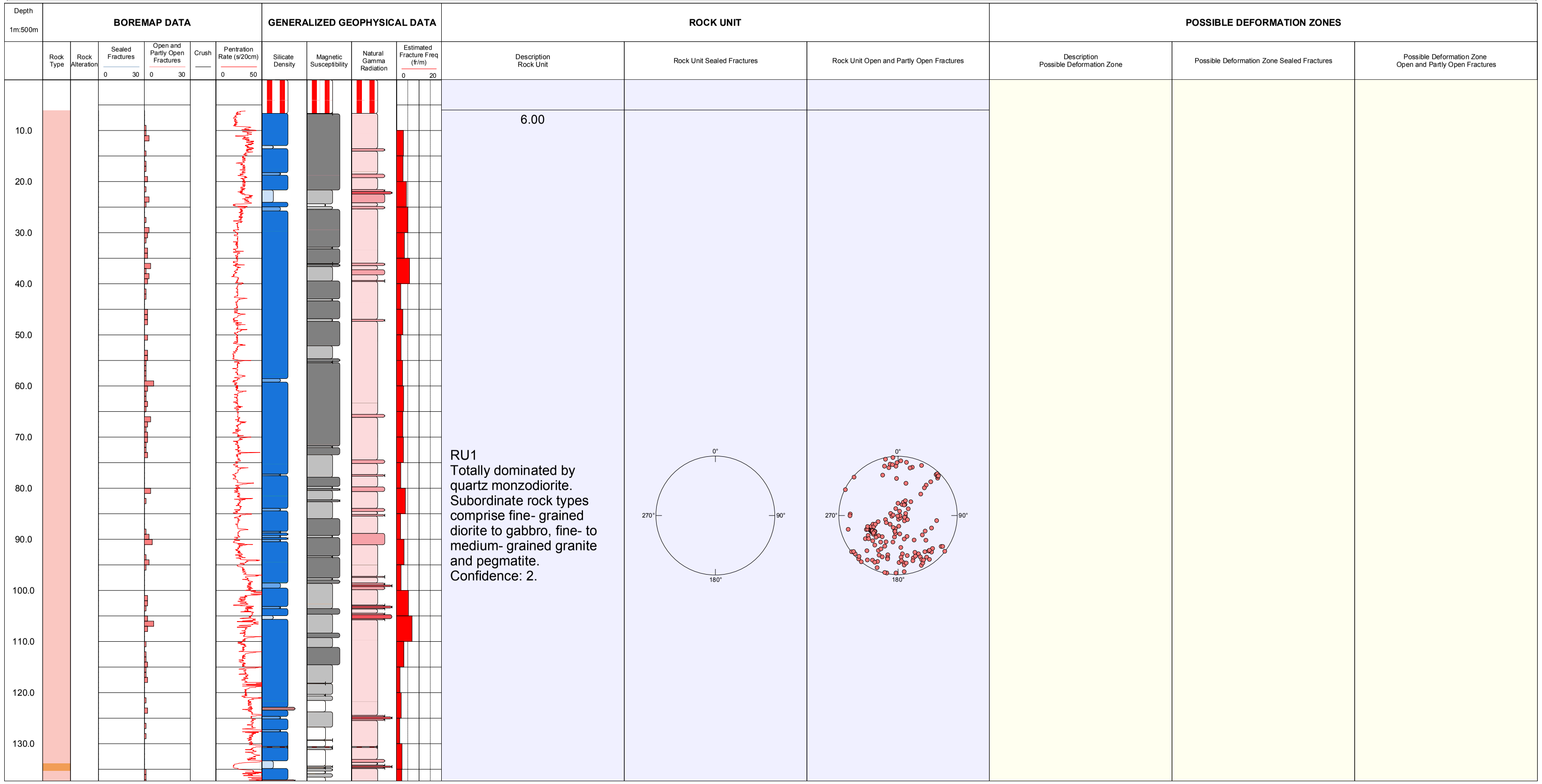
ROCKTYPE LAXEMAR
- Pegmatite
- Quartz monzodiorite

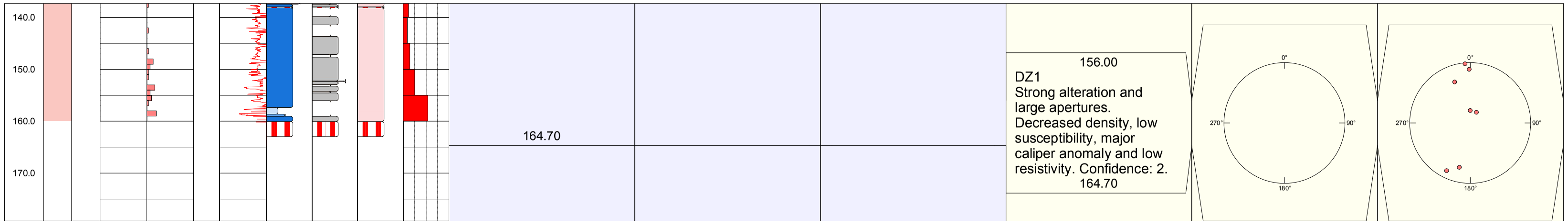
ROCK ALTERATION

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
- 10<gam<20
- 20<gam<30
- gam>30




140.0
150.0
160.0
170.0
164.70
156.00
DZ1
Strong alteration and
large apertures.
Decreased density, low
susceptibility, major
caliper anomaly and low
resistivity. Confidence: 2.
164.70
0°
90°
180°
270°