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

Abstract

This report contains geological single-hole interpretation of the cored boreholes KLX18A and KLX20A 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 KLX18A. However, the borehole can be divided into three separate sections due to the repetition of RU1 (RU1a and RU1b). In general, borehole KLX18A is dominated by Ävrö granite (501044). One section in the lower part of the borehole is dominated by fine-grained dioritoid (501030). Subordinate rock types comprise occurrences of fine-grained diorite-gabbro (505102), fine-grained granite (511058), pegmatite (501061), fine-grained dioritoid (501030) and granite (501058). Nine possible deformation zones are identified in KLX18A (DZ1–DZ9).

Two rock units (RU1–RU2) occur in KLX20A. However, the borehole can be divided into three separate sections due to the repetition of RU1 (RU1a and RU1b). In general, borehole KLX20A is dominated by quartz monzodiorite (501036), except for a large section in the central part of the borehole which is dominated by dolerite (501027). Subordinate rock types comprise occurrences of fine-grained granite (511058), pegmatite (501061), granite (501058) and fine-grained diorite-gabbro (505102). Four possible deformation zones are identified in KLX20A (DZ1–DZ4).

Sammanfattning

Denna rapport behandlar geologisk enhålstolkning av kärnborrhålen KLX18A och KLX20A 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 KLX18A kan delas in i två litologiska enheter (RU1–RU2). Baserat på repetition av enhet RU1 (RU1a och RU1b) kan borrhålet delas in i tre sektioner. Generellt sett domineras borrhålet av Ävrögranit (501044). En sektion i den nedre delen av borrhålet domineras av finkornig dioritoid (501030). Finkornig diorit-gabbro (505102), finkornig granit (511058), pegmatit (501061), finkornig dioritoid (501030) och granit (501058) förekommer som underordnade bergarter. Nio möjliga deformationszoner har identifierats i KLX18A (DZ1–DZ9).

Två litologiska enheter (RU1–RU2) förekommer i KLX20A. Baserat på repetition av enhet RU1 (RU1a och RU1b) kan borrhålet delas in i tre sektioner. Borrhålet domineras av kvartsmonzodiorit (501036), frånsett en omfattande del i den centrala delen av borrhålet vilken domineras av diabas (501027). Finkornig granit (511058), pegmatit (501061), granit (501058) och finkornig diorit-gabbro (505102) förekommer som underordnade bergarter. Fyra möjliga deformationszoner har identifierats i KLX20A (DZ1–DZ4).

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 KLX18A and KLX20A 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 400-06-081. 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.

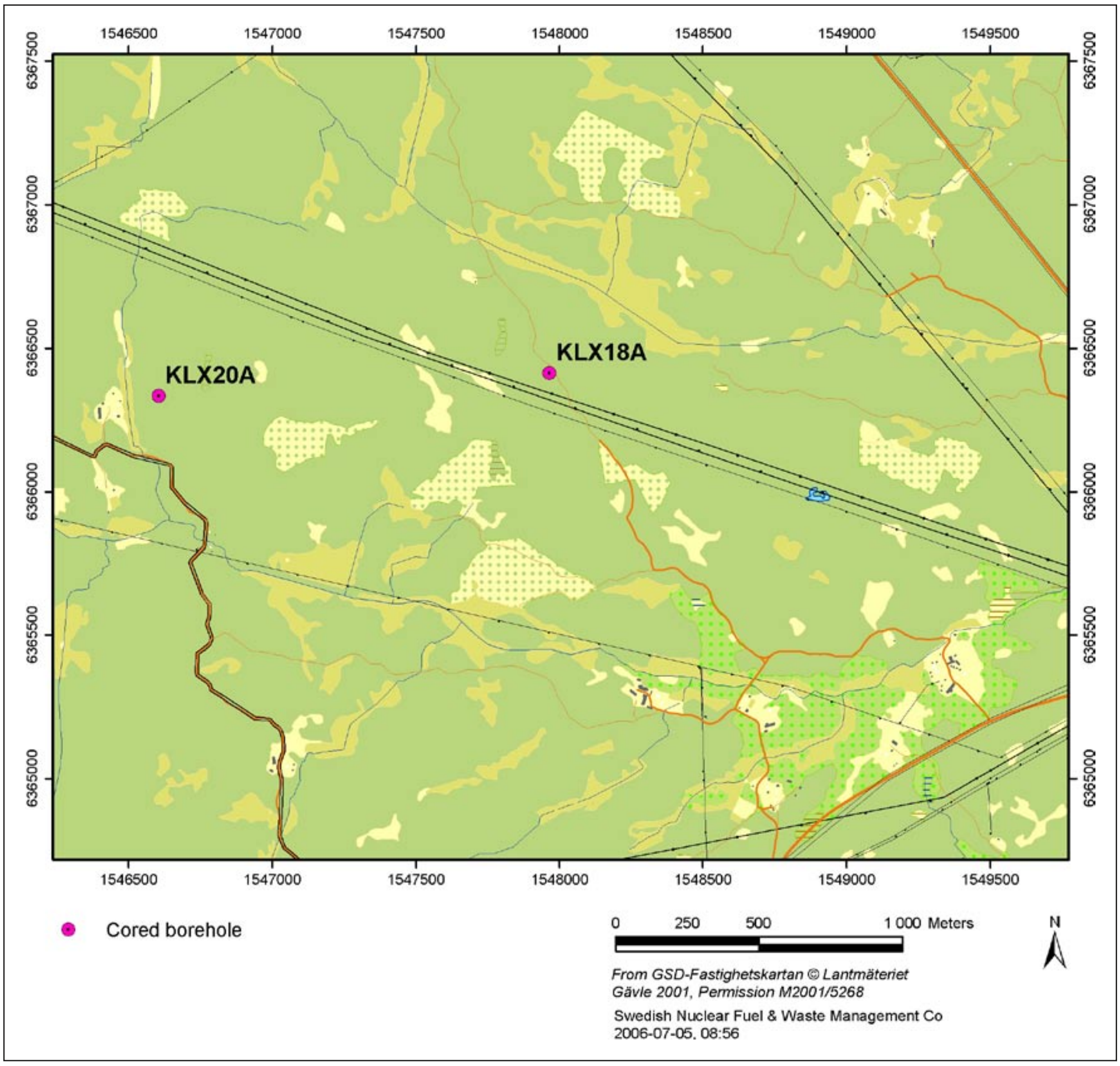


Figure 1-1. *Map showing the position of the cored boreholes KLX18A and KLX20A.*

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

Activity Plan	Number	Version
Geologisk enhålstolkning av KLX18A och KLX20A	AP PS 400-06-081	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

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 System (BIPS). 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 KLX18A and KLX20A:

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

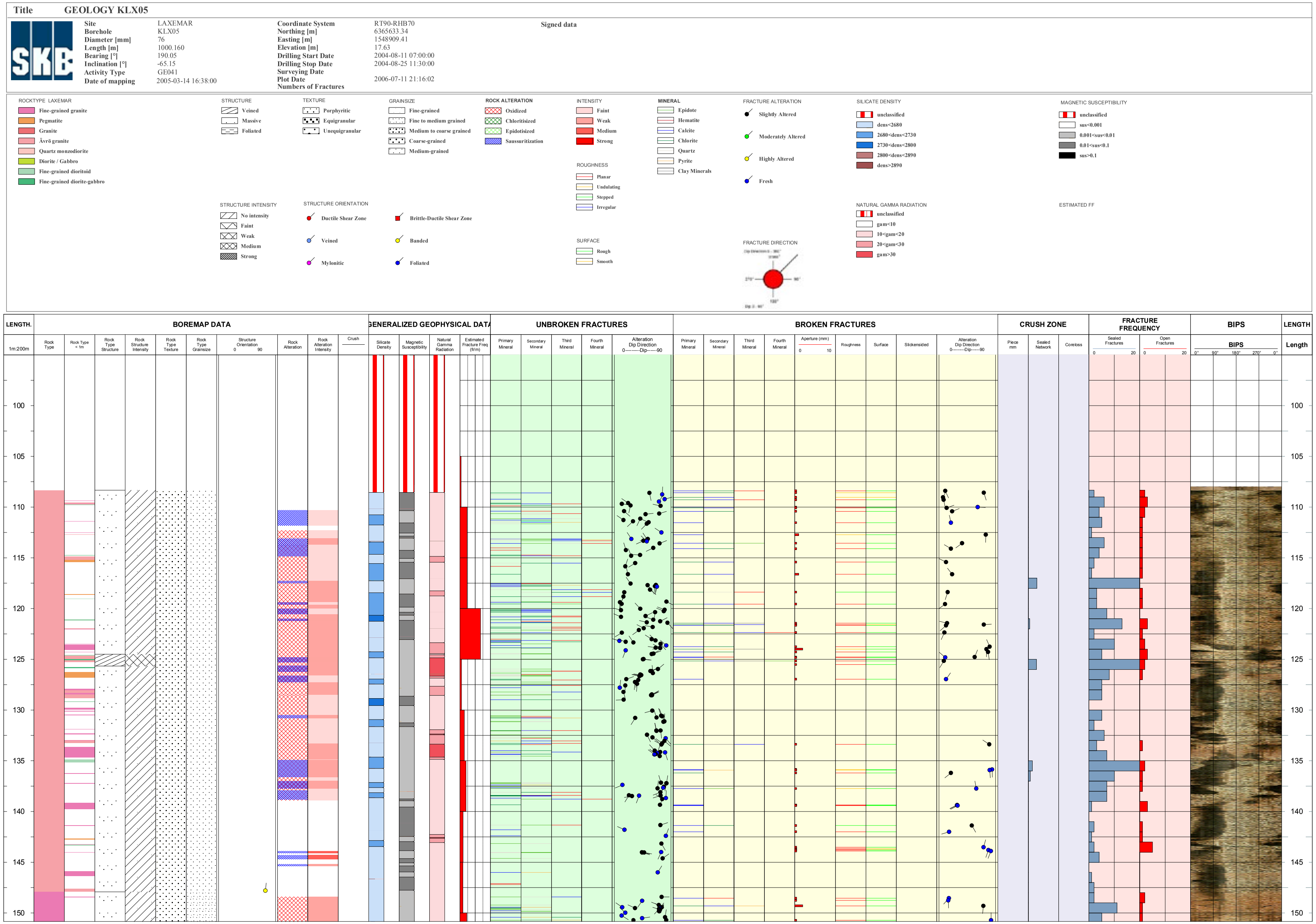


Figure 3-1. Example of WellCad plot (from borehole KLX05 in Laxemar) used as a basis for the single-hole interpretation.

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.

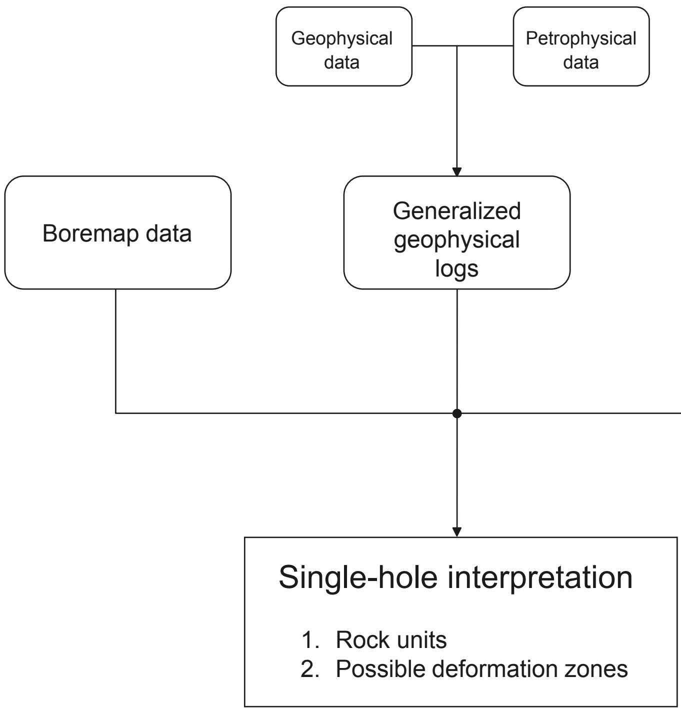
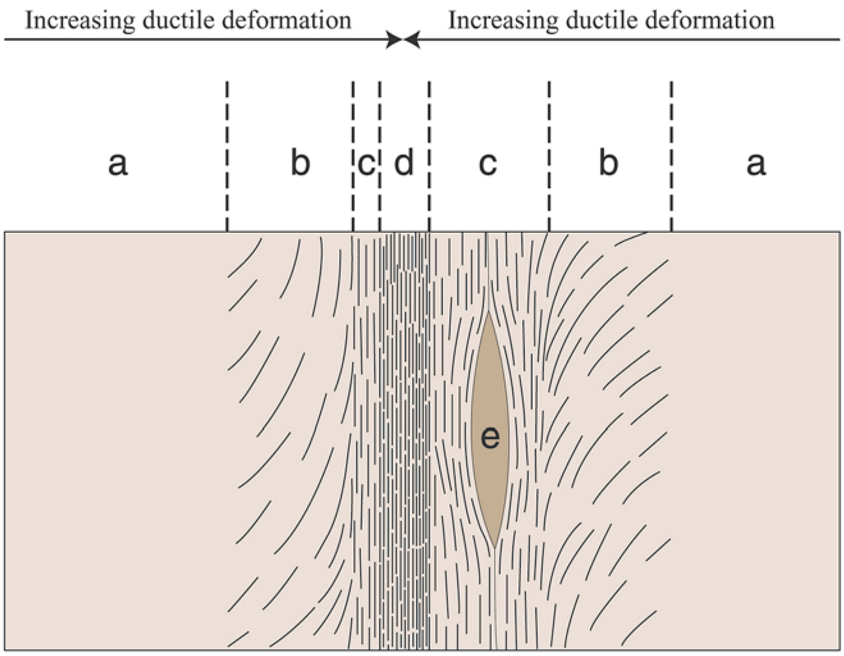


Figure 4-1. Schematic block-scheme of single-hole interpretation.

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/).*

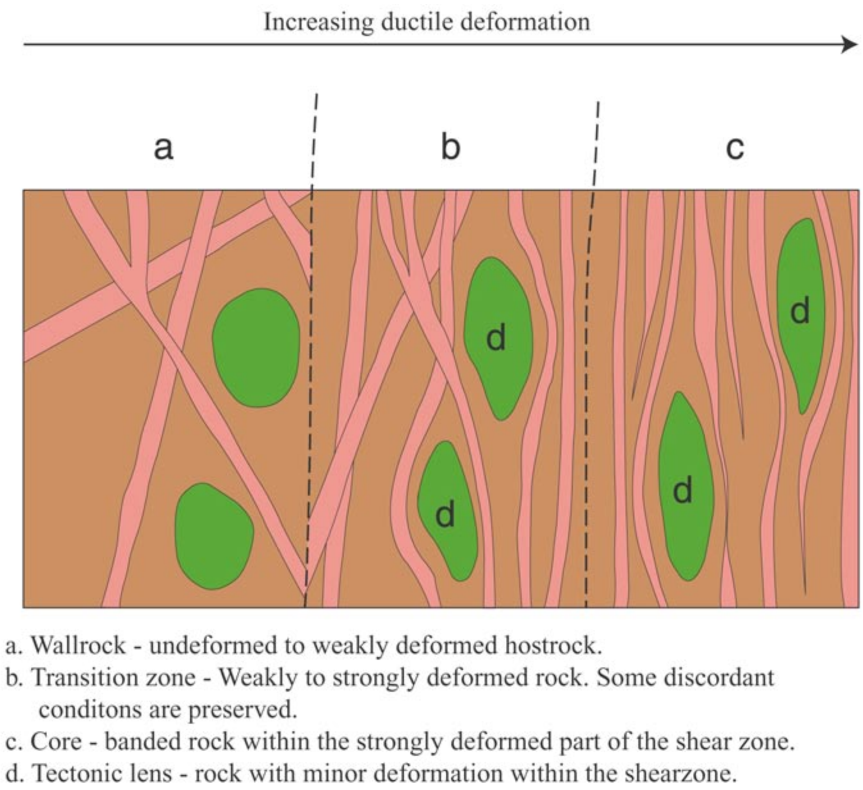


Figure 4-3. *Schematic example of a ductile shear zone. Heterogeneous rock which is deformed under low- to high-grade metamorphic conditions (after /1/).*

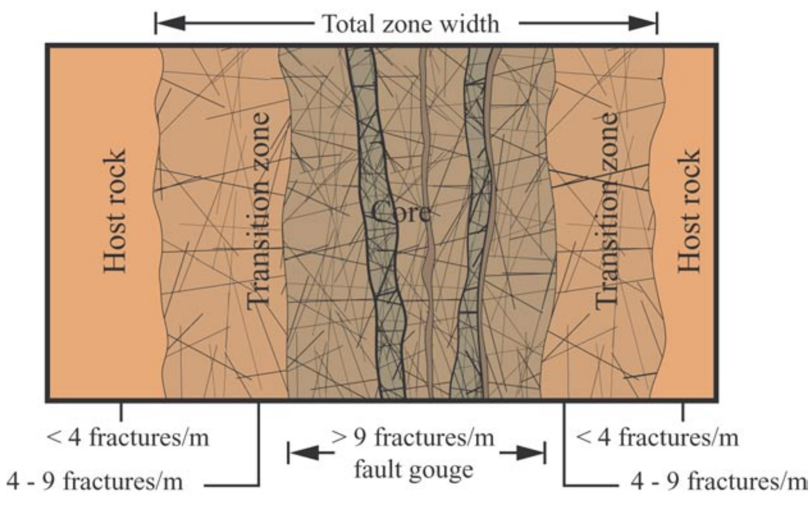


Figure 4-4. *Schematic example of a brittle deformation zone (after /1/).*

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 boreholes KLX18A and KLX20A (Figure 4-5 and Figure 4-6). 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 KLX18A is shown in Figure 4-7 and for KLX20A 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.

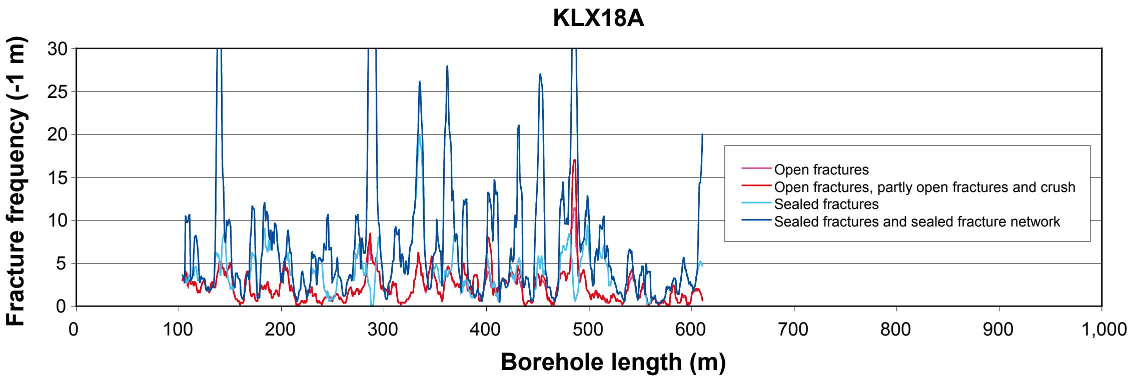


Figure 4-5. *Fracture frequency plot for KLX18A. Moving average with a 5 m window and 1 m steps.*

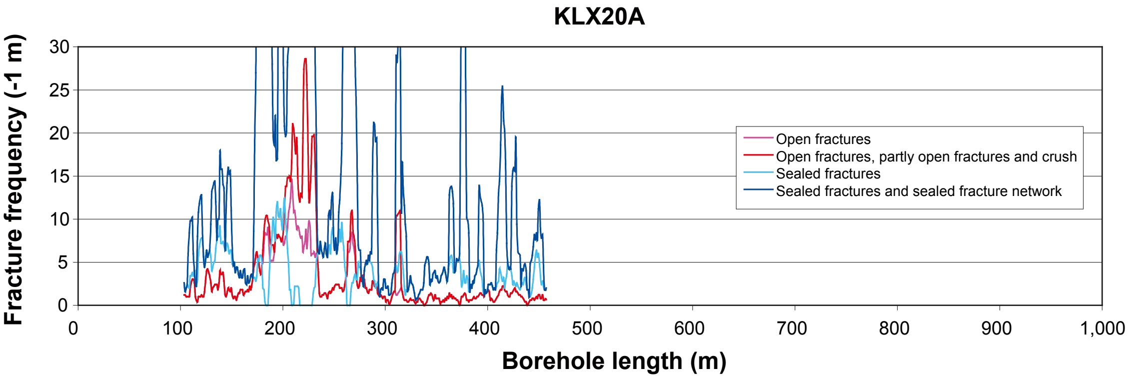


Figure 4-6. *Fracture frequency plot for KLX20A. Moving average with a 5 m window and 1 m steps.*

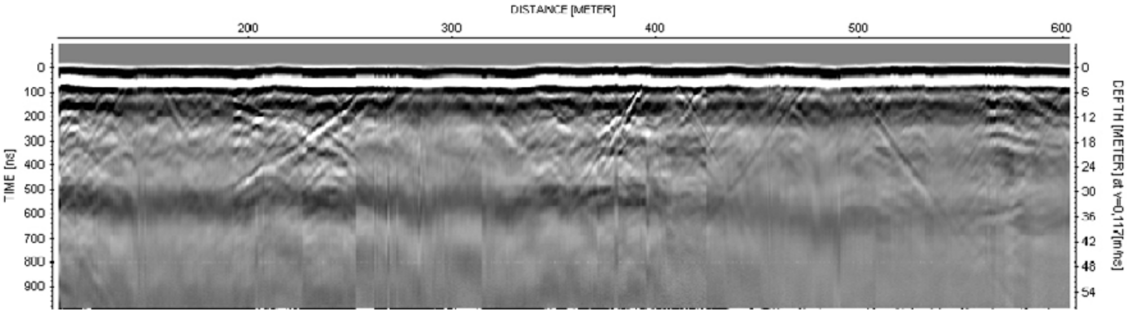


Figure 4-7. *Overview (20 MHz data) of the borehole radar measurement in KLX18A.*

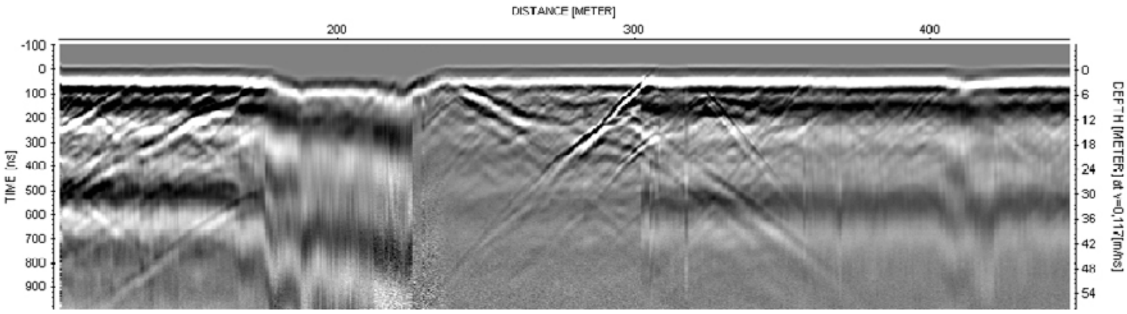


Figure 4-8. *Overview (20 MHz data) of the borehole radar measurement in KLX20A.*

5 Results

The detailed result of the single-hole interpretation is presented as print-out from the software WellCad (Appendix 1 for KLX18A and Appendix 2 for KLX20A).

5.1 KLX18A

Rock units

The borehole consists of two rock units (RU1 and RU2). Rock unit RU1 occur at two separate borehole intervals. These are distinguished using the identification codes RU1a and RU1b.

100.81–587.92 m

RU1a: Totally dominated by Ävrö granite (501044). Subordinate rock types comprise ≤ 10 m long sections of fine-grained diorite-gabbro (505102), diorite/gabbro (501033), minor occurrences of fine-grained granite (511058) and very minor occurrences of pegmatite (501061), fine-grained dioritoid (501030) and granite (501058). The density (c. 2,760 kg/m^3) in the sections with diorite/gabbro indicates a quartz dioritic composition. Scattered ≤ 10 m long sections are foliated. The foliation is faint to weak in character. In the section c. 120–337 m, the Ävrö granite has a density in the range 2,720–2,780 kg/m^3, a natural gamma radiation in the range 10–15 μR/h and the magnetic susceptibility is in the range 0.035–0.045 SI. In the section c. 337–588 m, the Ävrö granite has a density in the range 2,670–2,710 kg/m^3, a natural gamma radiation in the range 15–25 μR/h and the magnetic susceptibility is in the range 0.020–0.030 SI. Confidence level = 3.

587.92–607.43 m

RU2: Totally dominated by fine-grained dioritoid (501030). Subordinate rock types comprise Ävrö granite (501044) and very minor occurrences of pegmatite (501061) and fine-grained granite (511058). The major part of the rock unit is characterized by faint foliation. In the section c. 588–602 m the density is c. 2,720–2,770 kg/m^3. Confidence level = 3.

607.43–610.91 m

RU1b: Totally dominated by Ävrö granite (501044) with a density of c. 2,700 kg/m^3. Confidence level = 3.

Possible deformation zones

Nine possible deformation zones have been recognised in KLX18A.

137.80–143.90 m

DZ1: Inhomogeneous brittle to brittle-ductile deformation zone. Two 4–7 mm thick cataclasites. Faint to strong red staining. High frequency of sealed fractures and sealed network. Slickensides are observed. Decreased bulk resistivity and magnetic susceptibility. One non-oriented radar reflector occurs at 140.2 m with the angle 62° to borehole axis, and one oriented reflector occurs at 137.2 m with the orientation 129/25 or 333/39. Furthermore, there is one oriented reflector (no. 7x) outside the borehole and probably not intersecting the borehole. The orientation is 114/71 or 299/78. The host rock is dominated by Ävrö granite (501044). Subordinate rock type is fine-grained granite (511058). Confidence level = 3.

148.60–149.40 m

DZ2: Inhomogeneous brittle to brittle-ductile deformation zone. Faint to medium red staining. High frequency of sealed fractures and sealed network. Slickensides are observed. Distinct low resistivity anomaly and slightly decreased magnetic susceptibility. One rather strong oriented radar reflector at 148.7 m with the orientation 133/26 or 335/40. The host rock is dominated by Ävrö granite (501044). Confidence level = 3.

283.75–291.60 m

DZ3: Inhomogeneous brittle to brittle-ductile deformation zone. Two small sections of breccia, 1 cm and 30 cm. Faint to medium red staining. High frequency of sealed fractures and sealed network. Slightly increased frequency of open fractures and a 17 cm thick crush zone. Core loss at 285.62–285.81 and 289.07–289.98 m. Slickenside is observed. Major decrease in the bulk resistivity and magnetic susceptibility. Minor caliper anomalies and partly decreased P-wave velocity. One non-oriented radar reflector occurs at 288.2 m with the angle 25° to borehole axis, and one strong and persistent oriented reflector occurs at 287.0 m with the orientation 251/65. The host rock is dominated by Ävrö granite (501044). Subordinate rock type is fine-grained granite (511058) and fine-grained diorite-gabbro (505102). Confidence level = 3.

359.60–366.20 m

DZ4: Inhomogeneous brittle to brittle-ductile deformation zone. Eight 4–20 mm thick cataclasites. Faint to medium red staining. High frequency of sealed fractures and sealed network. Slickensides are observed. Several distinct low resistivity anomalies and decreased magnetic susceptibility. Two non-oriented radar reflectors occur at 360.1 m and 362.5 m with the angle 55° and 57° to borehole axis, respectively. The host rock is dominated by Ävrö granite (501044). Confidence level = 2.

378.60–378.85 m

DZ5: Inhomogeneous brittle deformation zone. One cataclasite (55 mm). Faint red staining is present. High frequency of sealed fractures. One sharp low resistivity anomaly and decreased P-wave velocity and magnetic susceptibility. The host rock is dominated by Ävrö granite (501044). Confidence level = 3.

401.00–404.20 m

DZ6: Inhomogeneous brittle-ductile deformation zone, highly fractured between 402.48 and 403.20 m. High frequency of sealed fractures and moderate increase in open fractures. Minor core loss (5 cm). Weak red staining. Crush zone (0.8 m). Significantly decreased resistivity and magnetic susceptibility. Caliper anomalies and partly decreased P-wave velocity. One non-oriented radar reflector occurs at 401.1 m with the angle 56° to borehole axis, and one strong and persistent oriented reflector occurs at 402.3 m with the orientation 092/30 or 299/35. The host rock is dominated by Ävrö granite (501044). Subordinate rock type is fine-grained diorite-gabbro (505102). Confidence level = 3.

428.00–434.00 m

DZ7: Inhomogeneous brittle-ductile deformation zone. One cataclasite (13 cm). One crush zone (7 cm). Faint red staining is present. Moderate increase in sealed fractures. Two distinct low resistivity anomalies and decreased magnetic susceptibility. Two non-oriented radar reflectors occur at 431.4 m and 432.6 m with the angle 56° and 57° to borehole axis, respectively. One oriented reflector outside the borehole and probably not reaching the borehole, is interpreted to occur at 432.2 m with the orientation 186/87. The host rock is dominated by Ävrö granite (501044). Subordinate rock type is fine-grained granite (511058). Confidence level = 2.

448.35–456.55 m

DZ8: Inhomogeneous brittle-ductile deformation zone. High frequency of sealed fractures. One cataclasite (2 cm). Weak red staining. Decreased resistivity and magnetic susceptibility, and partly decreased P-wave velocity. Two non-oriented radar reflectors occur at 448.8 m and 450.2 m with the angle 66° and 47° to borehole axis, respectively. Low radar amplitude in the interval 446–450 m. The host rock is dominated by Ävrö granite (501044). Subordinate rock type is fine-grained granite (511058). Confidence level = 2.

471.90–488.90 m

DZ9: Inhomogeneous brittle-ductile deformation zone. High frequency of sealed fractures and open fractures with large (2–5 mm) apertures. Gouge (15 mm) and one cataclasite (16 mm). Three crush zones (17–22 cm). Core zone at 484.00–487.90 m. Faint to medium red staining. Significantly decreased resistivity and magnetic susceptibility, and partly decreased P-wave velocity in the interval 483.5–488.9 m. Two non-oriented radar reflectors occur at 473.4 m and 476.5 m with the angle 42° and 59° to borehole axis, respectively. Two strong and persistent oriented reflectors occur at 482.3 m and 485.0 m with the orientation 018/89 and 193/37, respectively. The host rock is dominated by Ävrö granite (501044). Subordinate rock type is fine-grained granite (511058). Confidence level = 3.

5.2 KLX20A

Rock units

The borehole consists of two rock units (RU1 and RU2). Rock unit RU1 occur at two separate borehole intervals. These are distinguished using the identification codes RU1a and RU1b.

100.93–182.37 m

RU1a: Totally dominated by quartz monzodiorite (501036). Subordinate rock types comprise fine-grained granite (511058), dolerite (501027), pegmatite (501061) and granite (501058). Scattered ≤ 15 m long sections are foliated. The foliation is faint to weak in character. Confidence level = 3.

182.37–230.90 m

RU2: Totally dominated by dolerite (501027). Subordinate rock type comprises quartz monzodiorite (501036). Confidence level = 3.

230.90–457.01 m

RU1b: Totally dominated by quartz monzodiorite (501036). Subordinate rock types comprise fine-grained diorite-gabbro (501052), fine-grained granite (511058) and very minor occurrences of dolerite (501027), pegmatite (501061) and granite (501058). Scattered ≤ 10 m long sections are foliated. The foliation is faint to weak in character. Confidence level = 3.

Possible deformation zones

Four possible deformation zones have been recognised in KLX20A.

171.38–234.45 m

DZ1: Inhomogeneous brittle-ductile deformation zone. Large number of caliper anomalies, decreased P-wave velocity and magnetic susceptibility. Major decrease in the bulk resistivity. Very low borehole radar amplitude in the interval 182–233 m. *Upper transition zone: 171.38–182.20 m.* Host rock is dominated by quartz monzodiorite (501036). Subordinate rock types are fine-grained granite (511058) and dolerite (501027). Three breccias (8–10 mm). Weak saussuritization and red staining. High frequency of sealed fractures. Slickensides are observed. One non-oriented radar reflector occurs at 171.5 m with the angle 35° to borehole axis. Two oriented reflectors occur at 175.9 m and 178.7 m with the orientation 261/42 and 289/13, respectively. *Core zone: 182.20–231.00 m.* The host rock is dominated by dolerite (501027). Subordinate rock type is quartz monzodiorite (501036). 16 crush zones (highly fractured rock, total length 6.14 m). One breccia (23 mm). Weak red staining. High frequency of sealed and open fractures. One core loss (15 cm). Several slickensides are observed. Six non-oriented radar reflectors occur with angles to borehole axis in the interval 18–58°. Three oriented reflectors occur at 199.9 m, 220.7 m and 221.6 m with the orientation 160/46, 178/74 and 092/18, respectively. *Lower transition zone: 231.00–234.45 m.* The host rock is dominated by quartz monzodiorite (501036). Weak saussuritization. Moderate frequency of sealed and open fractures. Slickensides are observed. One non-oriented radar reflector occurs at 231.7 m with the angle 46° to borehole axis. Confidence level = 3.

261.00–265.90 m

DZ2: Inhomogeneous ductile deformation zone. Faint to weak red staining, silicification, saussuritization and epidotization. Crush zone (7 cm). High frequency of sealed fractures. Moderate frequency of open fractures. Decreased magnetic susceptibility and partly decreased resistivity. Three non-oriented radar reflectors occur at 262.0 m, 262.7 m and 264.3 m with the angle 63°, 21° and 32° to borehole axis, respectively. One oriented reflector occurs at 265.8 m with the orientation 053/87 or 271/48. The host rock is dominated by quartz monzodiorite (501036). Confidence level = 3.

312.55–313.00 m

DZ3: Inhomogeneous brittle deformation zone. Crush zone (0.36 m). High frequency of sealed and open fractures. Major caliper anomaly, low resistivity anomaly and partly decreased magnetic susceptibility. One very strong and persistent oriented reflector occurs at 312.7 m with the orientation 029/78 or 286/23. The host rock is dominated by dolerite (501027). Subordinate rock type is quartz monzodiorite (501036). Confidence level = 3.

410.10–416.40 m

DZ4: Inhomogeneous brittle deformation zone. Breccia (8 mm). Faint to medium red staining, epidotization and saussuritization. High frequency of sealed fractures. Slickenside is observed. Decreased bulk resistivity and magnetic susceptibility, and partly decreased P-wave velocity. One non-oriented radar reflector occurs at 410.5 m with the angle 50° to borehole axis. The host rock is dominated by quartz monzodiorite (501036). Confidence level = 2.

6 Comments

The results from the geological single-hole interpretation of KLX18A and KLX20A are presented in a WellCad plot (Appendix 1 and Appendix 2). 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 uni.t
	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/ **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.

/2/ **Mattsson K-J, Eklund S, 2006.** Oskarshamn site investigation. Boremap mapping of core drilled borehole KLX18A. SKB P-06-238, Svensk Kärnbränslehantering AB.

/3/ **Rauséus G, Ehrenborg J, 2006.** Oskarshamn site investigation. Boremap mapping of core drilled borehole KLX20A. SKB P-06-241, 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/ **Gustafsson J, Gustafsson C, 2006.** Oskarshamn site investigation. RAMAC, BIPS and deviation logging in boreholes KLX11B, KLX11C, KLX11D, KLX11E, KLX11F, KLX18A, KLX20A, HLX38 and HLX40 and BIPS and deviation logging in KLX19A. SKB P-06-159, Svensk Kärnbränslehantering AB.

Appendix 1

Geological single-hole interpretation of KLX18A

Title	SINGLE HOLE INTERPRETATION KLX18A				
Site	LAXEMAR	**Inclination [°]**	-82.10	**Elevation [m.a.s.l.]**	20.94
Borehole	KLX18A	**Date of mapping**	2006-05-22 08:46:00	**Drilling Start Date**	2006-02-15 07:00:00
Diameter [mm]	76	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2006-02-21 15:30:00
Length [m]	611.280	**Northing [m]**	6366412.57	**Surveying Date**	
Bearing [°]	271.40	**Easting [m]**	1547966.39	**Plot Date**	2007-10-14 22:03:05

Signed data

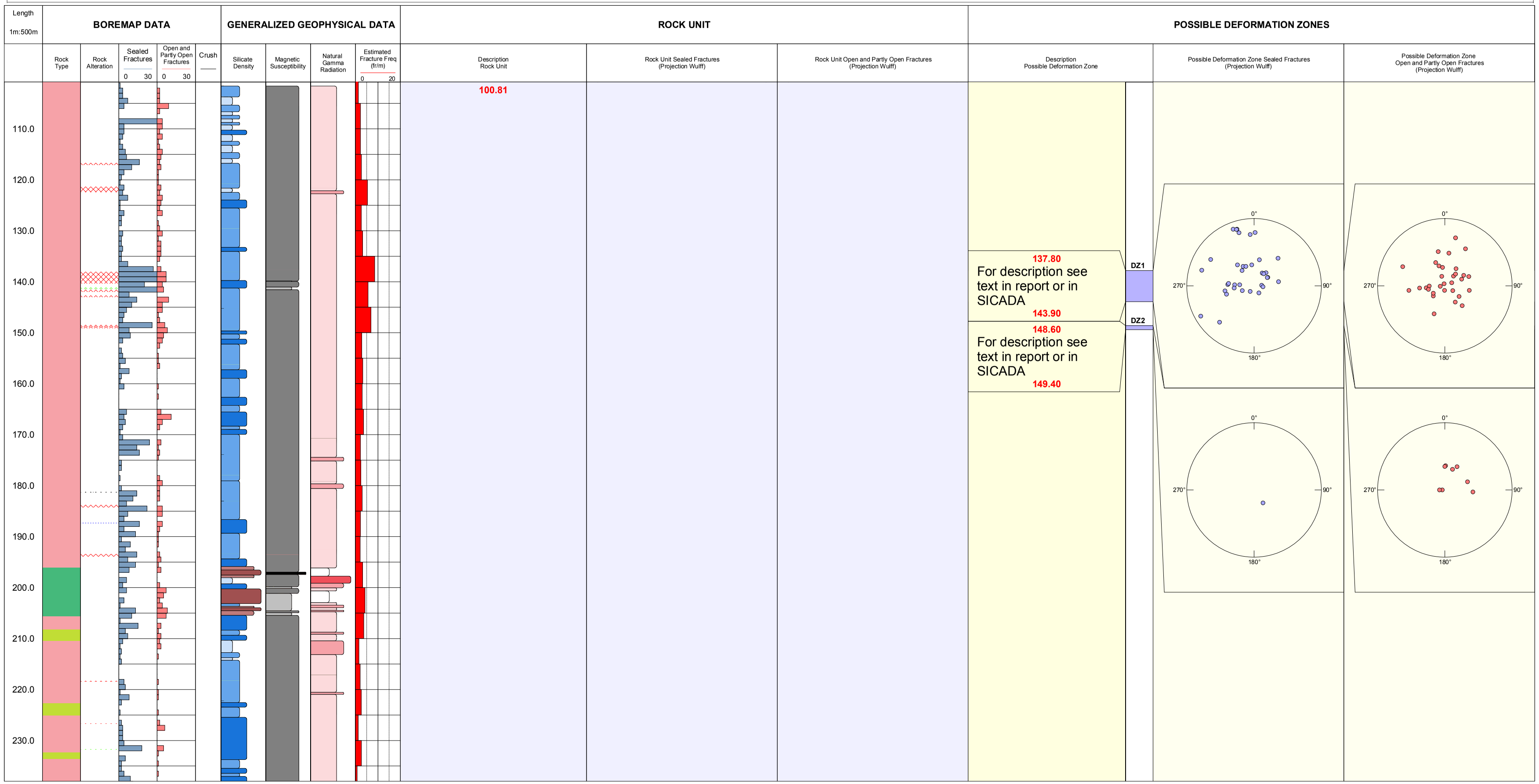
ROCKTYPE LAXEMAR
- Fine-grained granite
- Ävrö granite
- Diorite / Gabbro
- Fine-grained diorite-gabbro

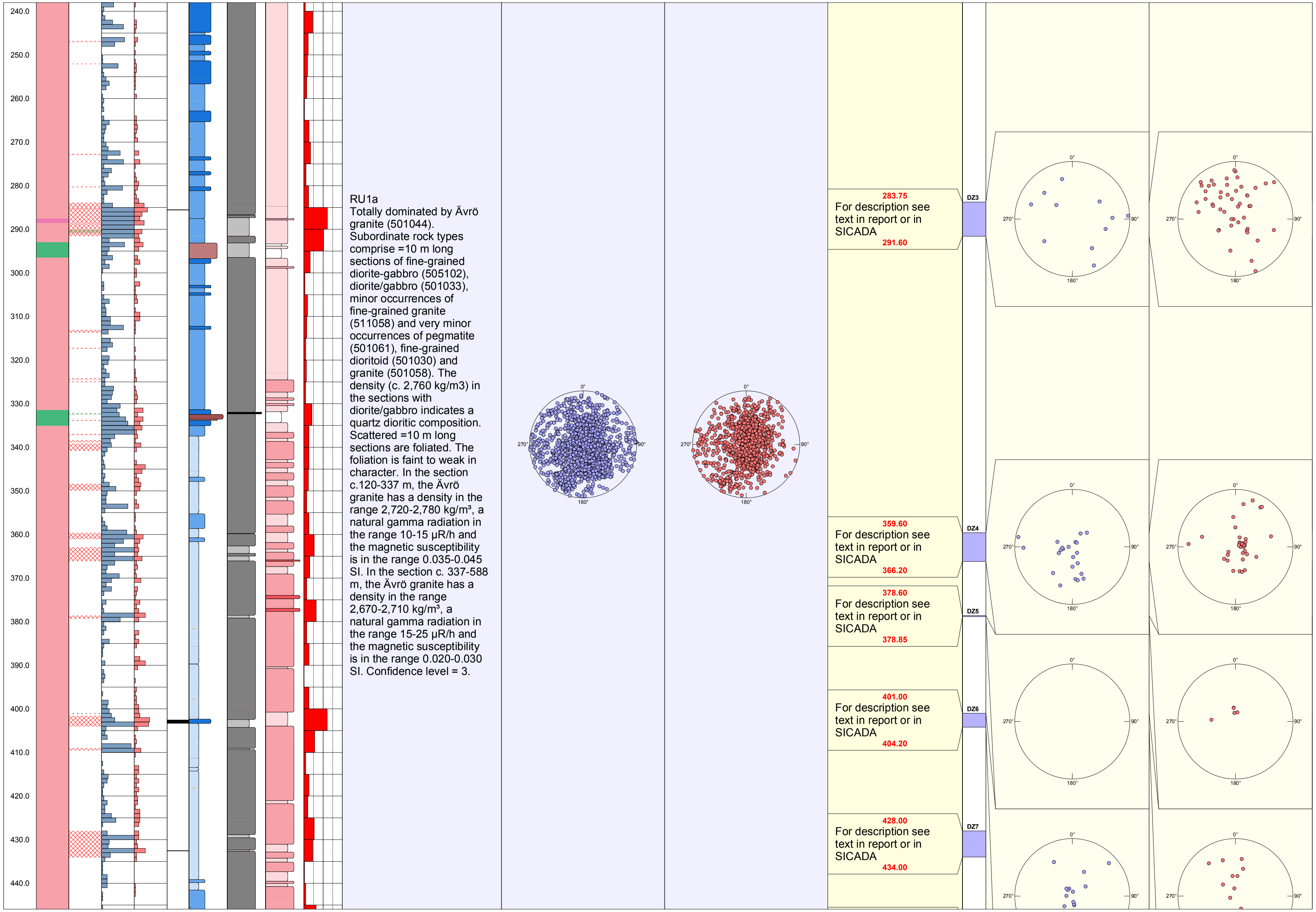
ROCK ALTERATION
- Oxidized
- Chloritisized
- Epidotisized
- Silicification
- Saussuritization

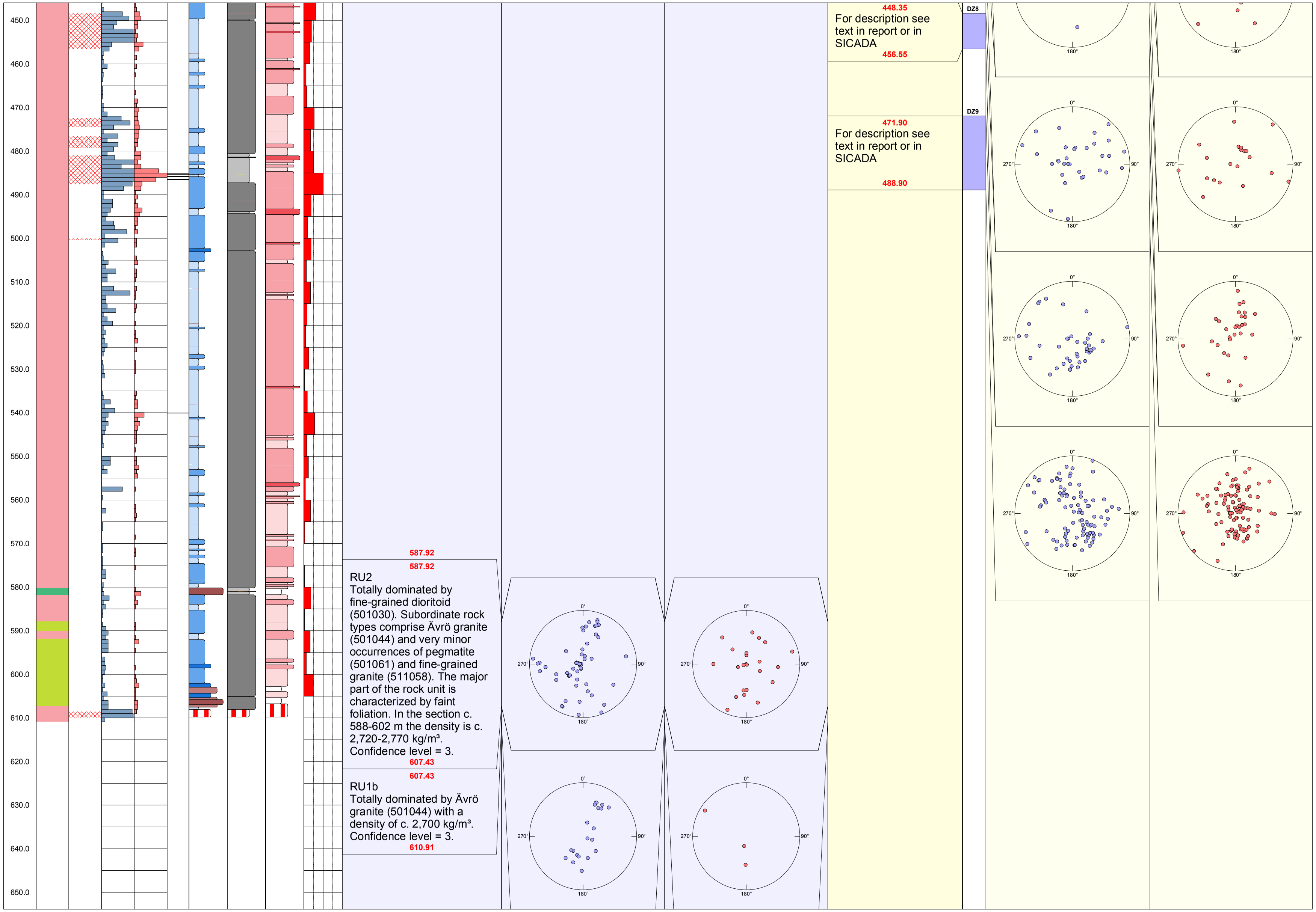
SILICATE DENSITY
- unclassified
- dens<2680
- 2680<dens<2730
- 2730<dens<2800
- 2800<dens<2890
- dens>2890

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

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




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
RU1a
Totally dominated by Ävrö granite (501044). Subordinate rock types comprise =10 m long sections of fine-grained diorite-gabbro (505102), diorite/gabbro (501033), minor occurrences of fine-grained granite (511058) and very minor occurrences of pegmatite (501061), fine-grained dioritoid (501030) and granite (501058). The density (c. 2,760 kg/m3) in the sections with diorite/gabbro indicates a quartz dioritic composition. Scattered =10 m long sections are foliated. The foliation is faint to weak in character. In the section c.120-337 m, the Ävrö granite has a density in the range 2,720-2,780 kg/m³, a natural gamma radiation in the range 10-15 µR/h and the magnetic susceptibility is in the range 0.035-0.045 SI. In the section c. 337-588 m, the Ävrö granite has a density in the range 2,670-2,710 kg/m³, a natural gamma radiation in the range 15-25 µR/h and the magnetic susceptibility is in the range 0.020-0.030 SI. Confidence level = 3.
283.75
For description see text in report or in SICADA
291.60
DZ3
359.60
For description see text in report or in SICADA
366.20
DZ4
378.60
For description see text in report or in SICADA
378.85
DZ5
401.00
For description see text in report or in SICADA
404.20
DZ6
428.00
For description see text in report or in SICADA
434.00
DZ7



450.0
460.0
470.0
480.0
490.0
500.0
510.0
520.0
530.0
540.0
550.0
560.0
570.0
580.0
590.0
600.0
610.0
620.0
630.0
640.0
650.0
587.92
587.92
RU2
Totally dominated by fine-grained dioritoid (501030). Subordinate rock types comprise Ävrö granite (501044) and very minor occurrences of pegmatite (501061) and fine-grained granite (511058). The major part of the rock unit is characterized by faint foliation. In the section c. 588-602 m the density is c. 2,720-2,770 kg/m³. Confidence level = 3.
607.43
607.43
RU1b
Totally dominated by Ävrö granite (501044) with a density of c. 2,700 kg/m³. Confidence level = 3.
610.91
448.35
For description see text in report or in SICADA
456.55
471.90
For description see text in report or in SICADA
488.90
DZ8
DZ9
0°
90°
180°
270°

Appendix 2

Geological single-hole interpretation of KLX20A

Title SINGLE HOLE INTERPRETATION KLX20A

Site	LAXEMAR	**Inclination [°]**	-50.02	**Elevation [m.a.s.l.]**	27.17	**Signed data**
Borehole	KLX20A	**Date of mapping**	2006-05-29 08:59:00	**Drilling Start Date**	2006-02-22 13:30:00	
Diameter [mm]	76	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2006-03-08 17:30:00	
Length [m]	457.920	**Northing [m]**	6366333.75	**Surveying Date**		
Bearing [°]	270.60	**Easting [m]**	1546604.94	**Plot Date**	2007-10-14 22:03:05	

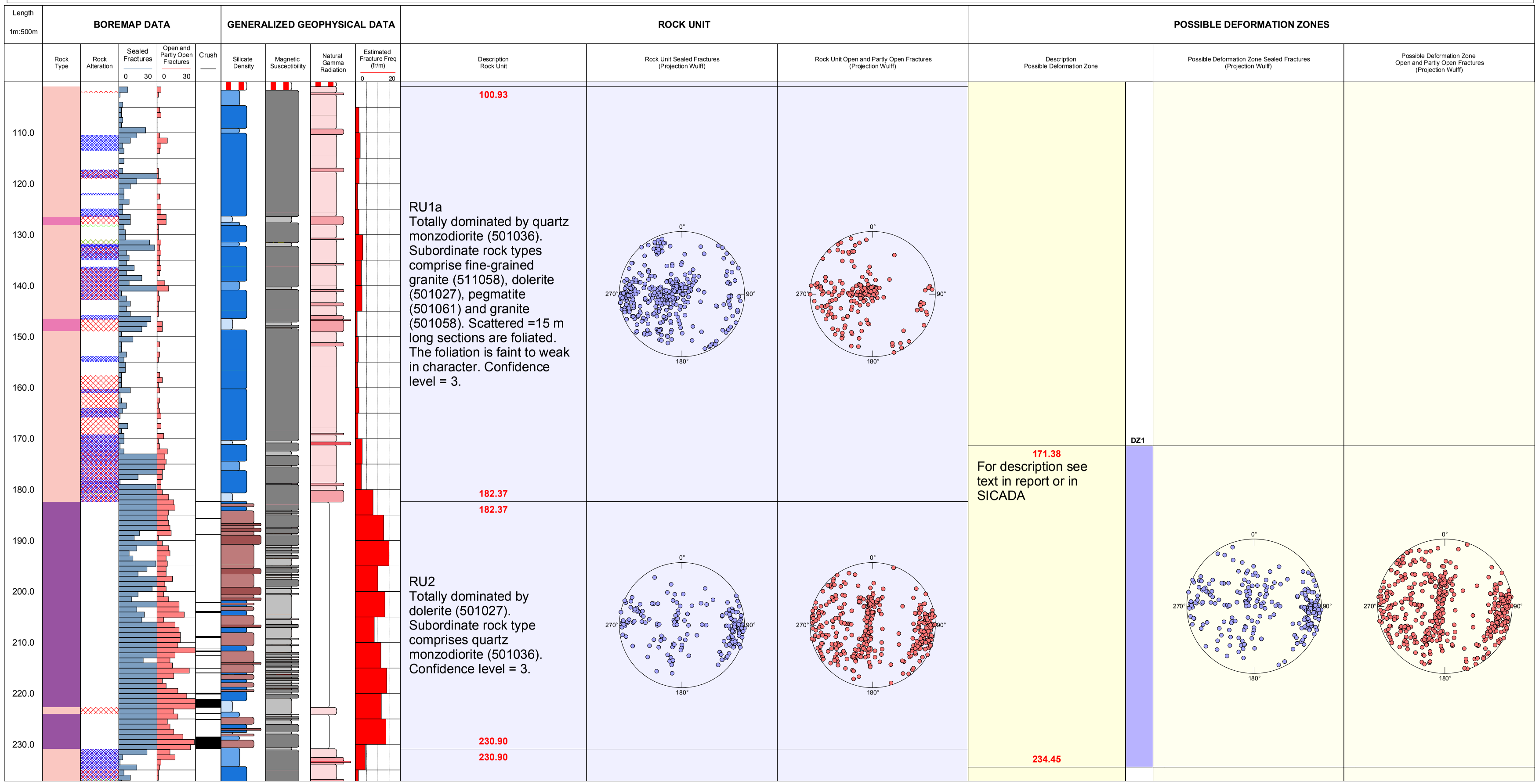
ROCKTYPE LAXEMAR
- Dolerite
- Fine-grained granite
- Quartz monzodiorite
- Fine-grained diorite-gabbro

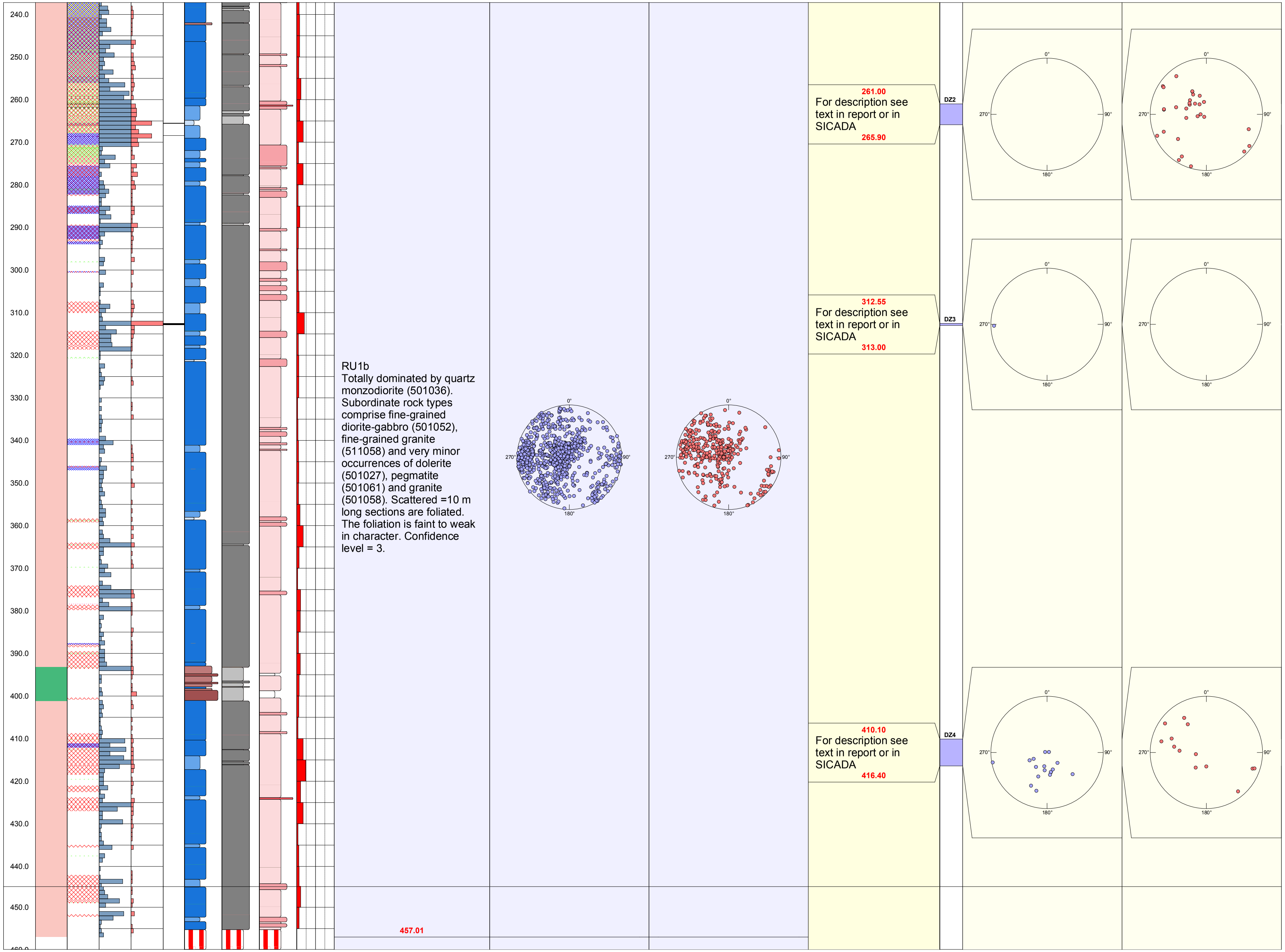
ROCK ALTERATION
- Oxidized
- Epidotisized
- Quartz dissolution
- Silicification
- Albitization
- Saussuritization

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





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
450.0
RU1b
Totally dominated by quartz monzodiorite (501036). Subordinate rock types comprise fine-grained diorite-gabbro (501052), fine-grained granite (511058) and very minor occurrences of dolerite (501027), pegmatite (501061) and granite (501058). Scattered ≈10 m long sections are foliated. The foliation is faint to weak in character. Confidence level = 3.
457.01
261.00
For description see text in report or in SICADA
265.90
312.55
For description see text in report or in SICADA
313.00
410.10
For description see text in report or in SICADA
416.40
DZ2
DZ3
DZ4