P-07-208

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December 2007

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

Data in SKB's database can be changed for different reasons. Minor changes in SKB's database will not necessarily result in a revised report. Data revisions may also be presented as supplements, available at www.skb.se.

A pdf version of this document can be downloaded from www.skb.se.

# Abstract

This report contains geological single-hole interpretation of the cored borehole KLX16A 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 the borehole KLX16A is dominated by quartz monzodiorite (501036) which constitutes one rock unit (RU1). Subordinate rock types comprise occurrences of fine-grained diorite-gabbro (505102), fine-grained granite (511058), pegmatite (501061), granite (501058) and fine-grained dioritoid (501030) in the interval 421.33–433.55 m. Twelve possible deformation zones are identified in KLX16A (DZ1–DZ12).

# Sammanfattning

Denna rapport behandlar geologisk enhålstolkning av kärnborrhålet KLX16A 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 kärnborrhålet KLX16A domineras av kvartsmonzo-diorit (501036) vilken utgör en litologisk enhet (RU1). Underordnade bergarter utgörs av fin-kornig diorit-gabbro (505102), finkornig granit (511058), pegmatit (501061), granit (501058) samt finkornig dioritoid (501030) i intervallet 421.33–433.55 m. Tolv möjliga deformations-zoner har identifierats i KLX16A (DZ1–DZ12).

# 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 borehole KLX16A 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 400-07-043. 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.

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

| Activity plan | Number | Version |
|---|---|---|
| Geologisk enhålstolkning av KLX16A | AP PS 400-07-043 | 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 |

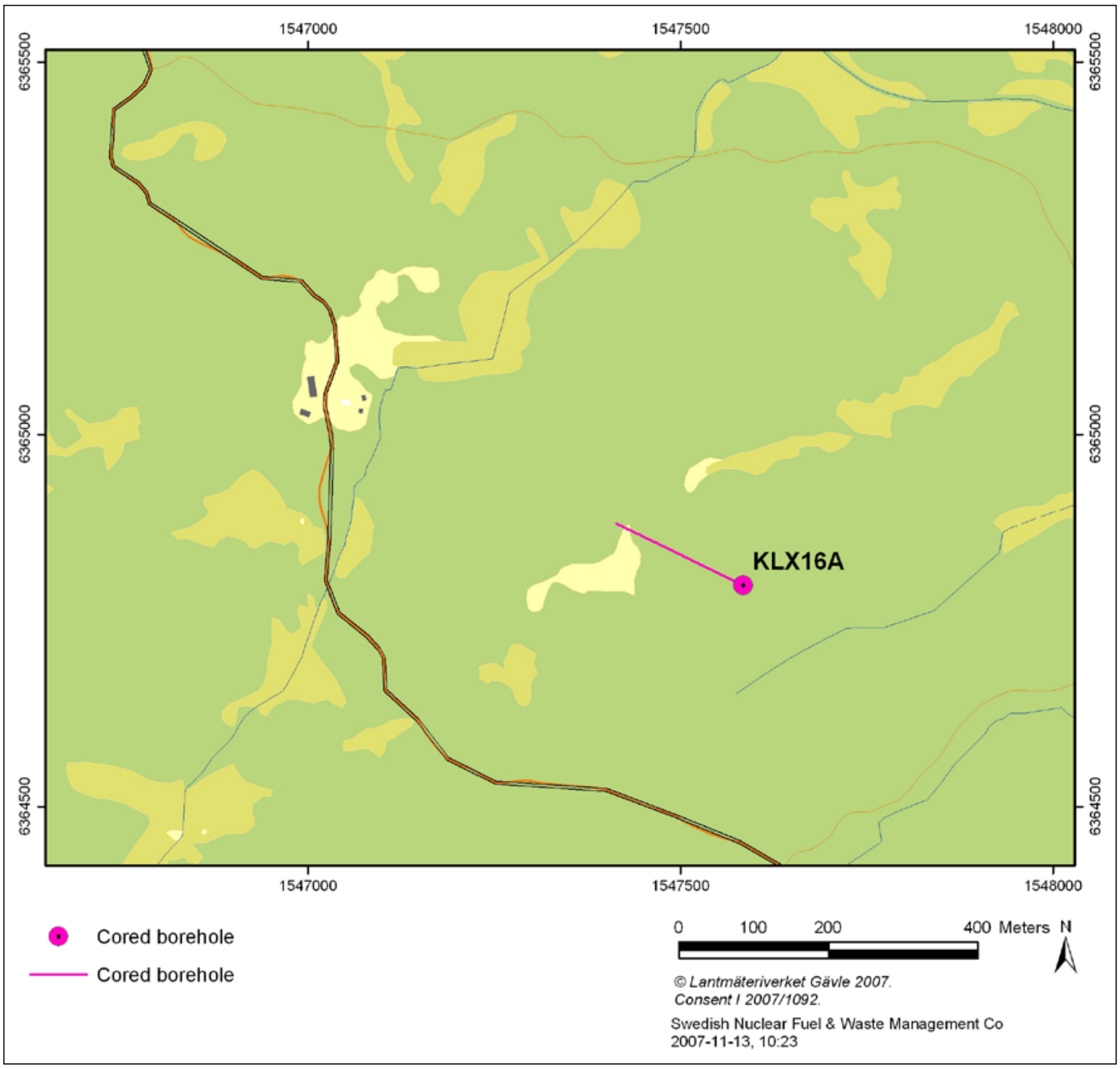


***Figure 1-1.*** *Map showing the position of the cored borehole KLX16A.*

# 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 borehole KLX16A:

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

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

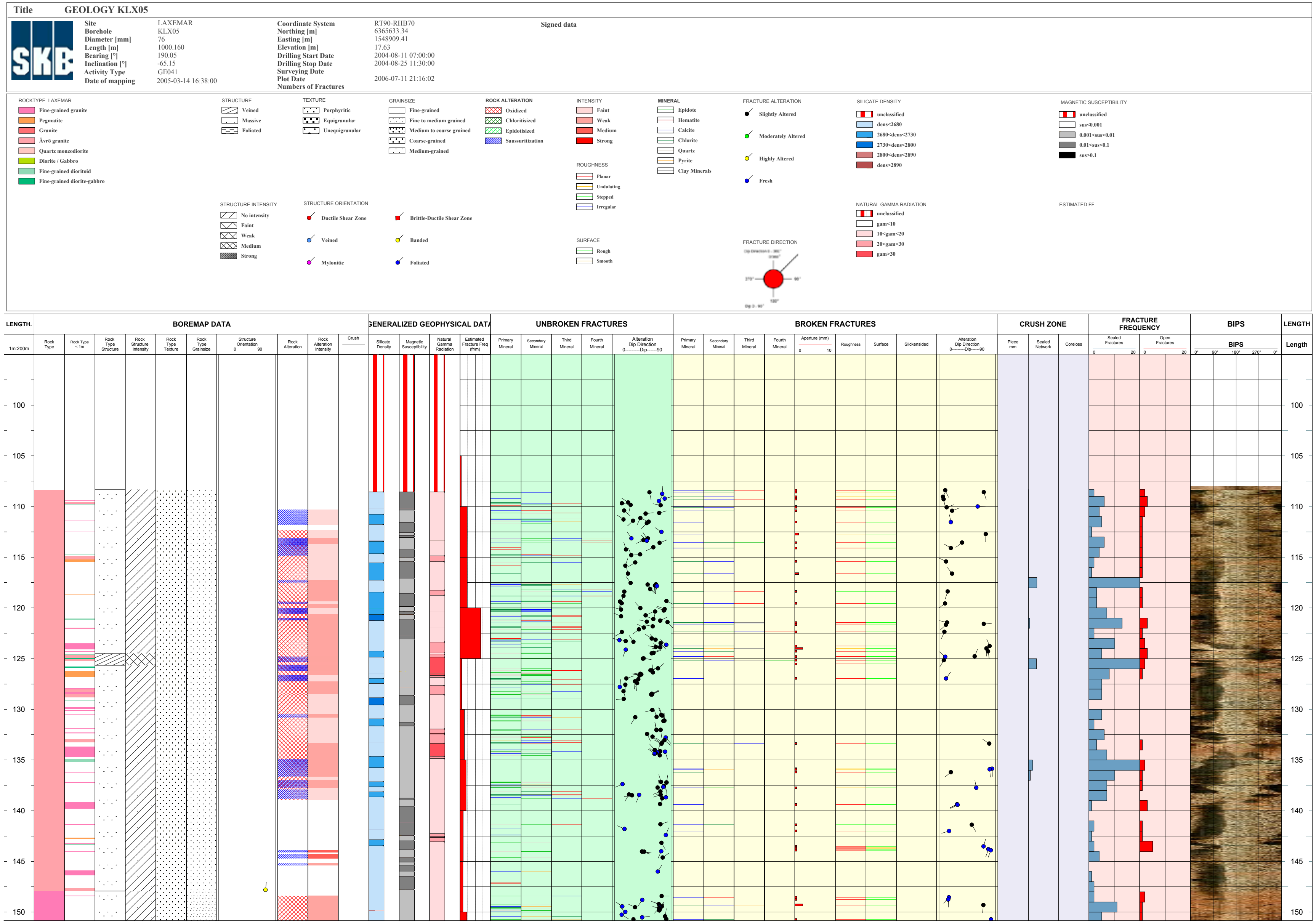


*Figure 3-1. Example of WellCad plot (from borehole KLX05 in Laxemar) used as a basis for the single-hole interpretation.*

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 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.

# 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.

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

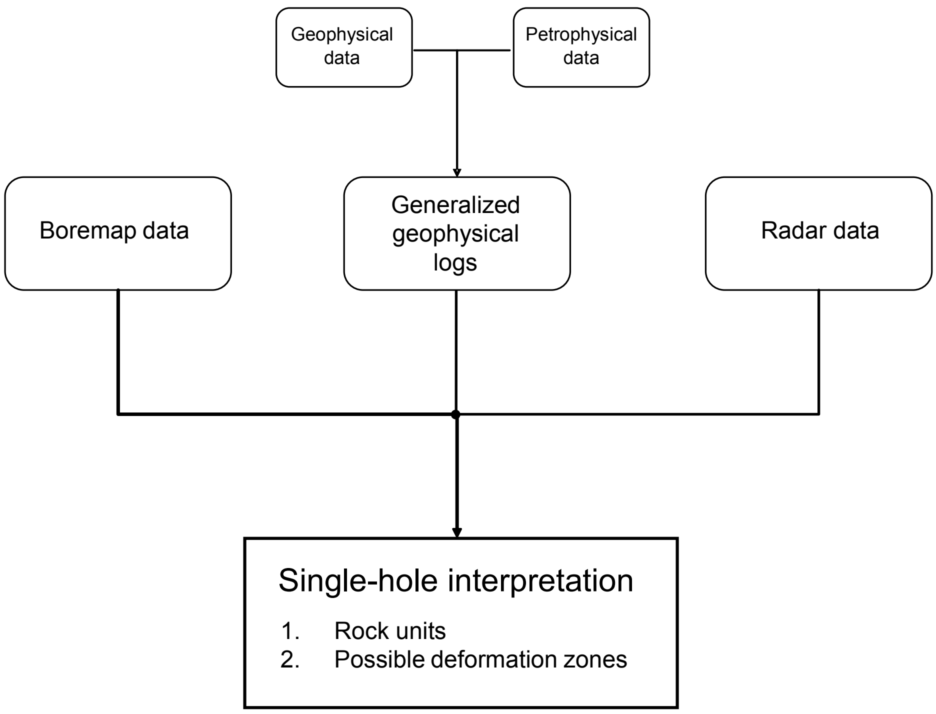


***Figure 4-1.*** *Schematic block-scheme of single-hole interpretation.*

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.

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 KLX16A (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.

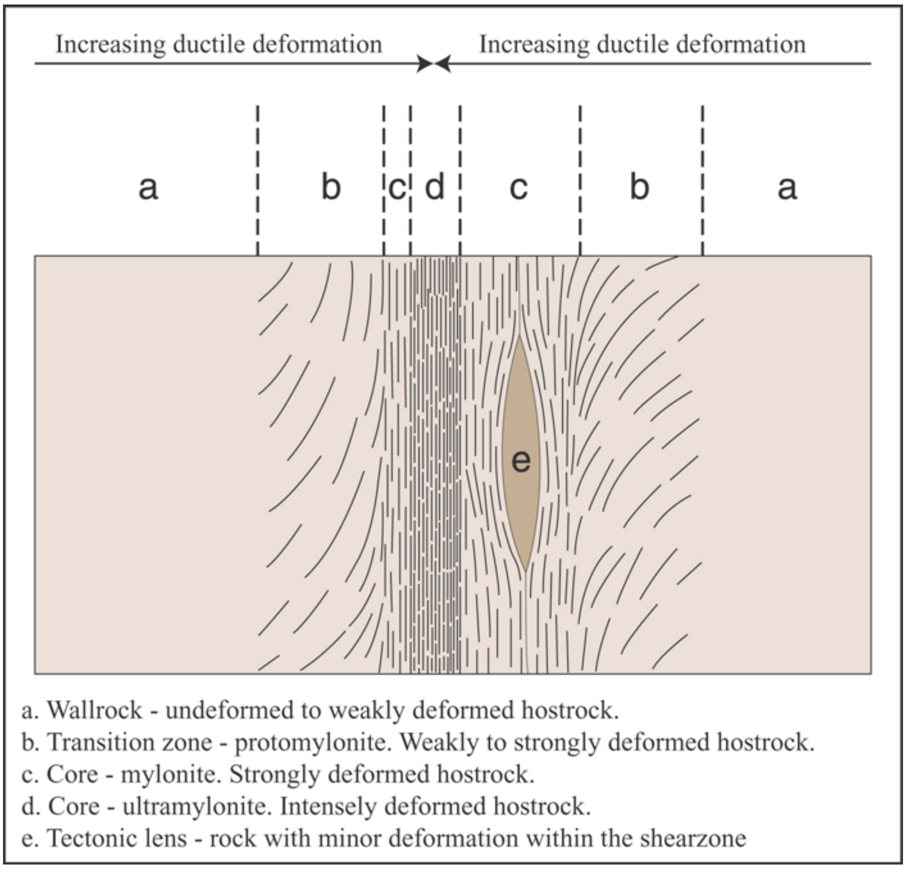


***Figure 4-2.*** *Schematic example of a ductile shear zone. Homogeneous rock which is deformed under low- to medium-grade metamorphic conditions (after /1/).*

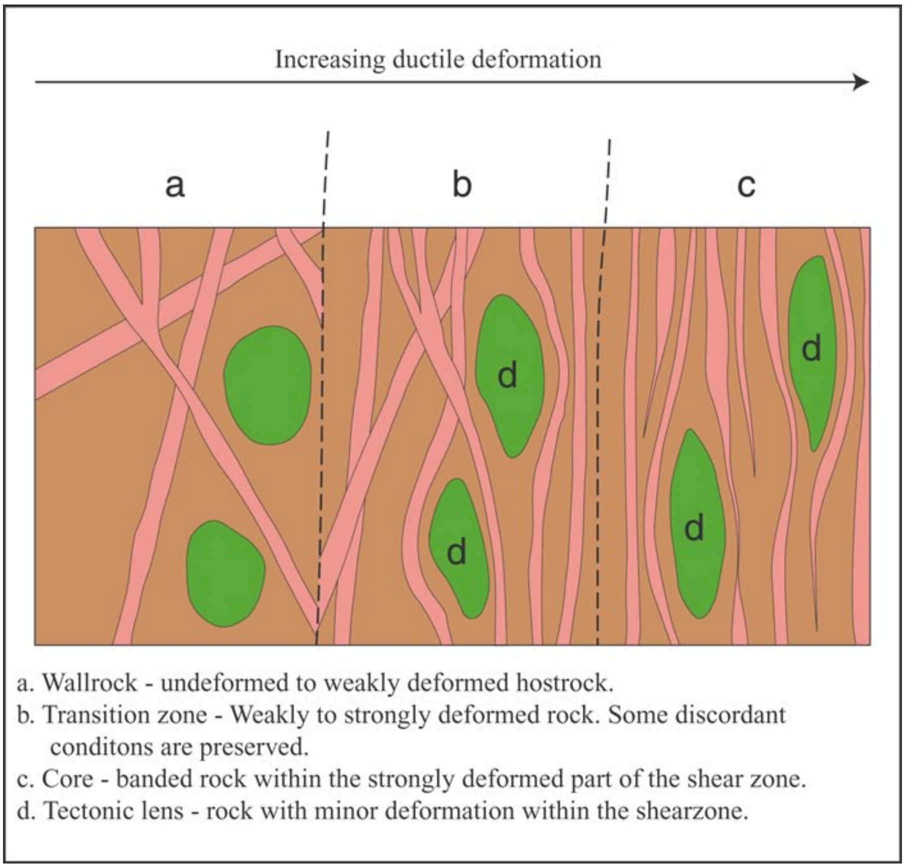


***Figure 4-3.*** *Schematic example of a ductile shear zone. Heterogeneous rock which is deformed under low- to high-grade metamorphic conditions (after /1/).*

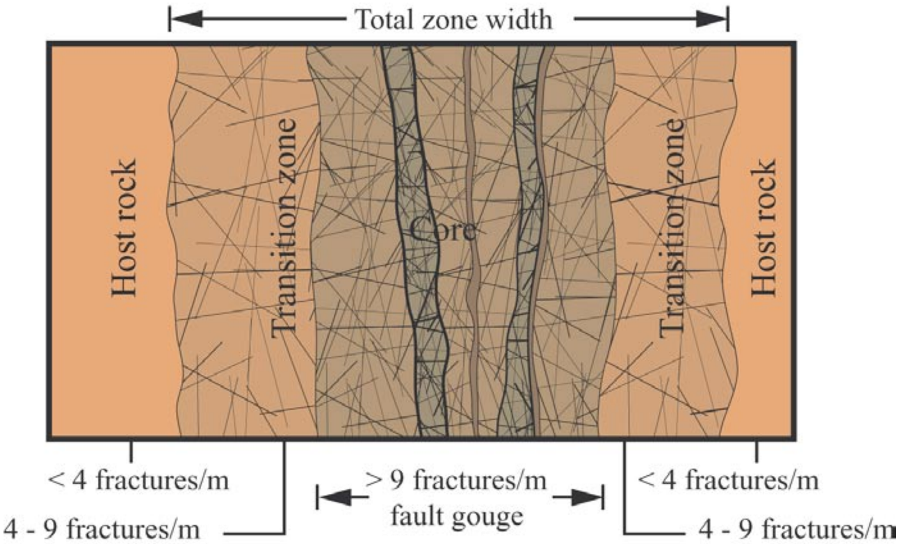


***Figure 4-4.*** *Schematic example of a brittle deformation zone (after /1/).*

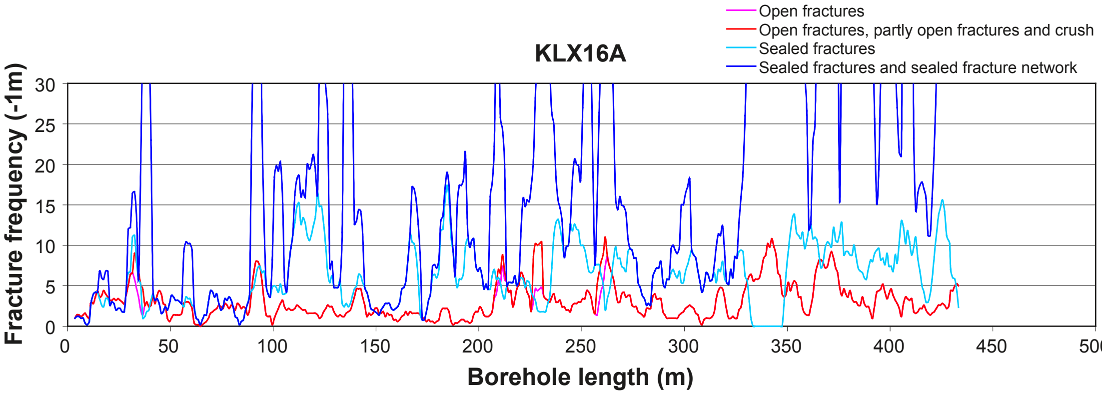


***Figure 4-5.*** *Fracture frequency plot for KLX16A. Moving average with a 5 m window and 1 m steps.*

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 KLX16A is shown in Figure 4-6. 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.

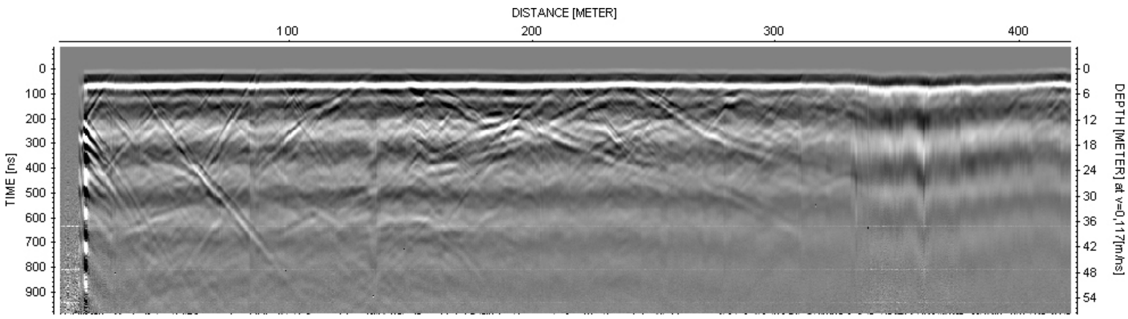


***Figure 4-6.*** *Overview (20 MHz data) of the borehole radar measurement in KLX16A.*

# 5 Results

The detailed result of the single-hole interpretation is presented as print-out from the software WellCad (Appendix 1 for KLX16A).

## 5.1 KLX16A

### *Rock units*

The borehole consists of one rock unit (RU1).

**0.93–433.55 m**

RU1: Totally dominated by quartz monzodiorite (501036). Subordinate rock types comprise fine-grained diorite-gabbro (505102), fine-grained granite (511058), pegmatite (501061), granite (501058) and fine-grained dioritoid (501030) in the interval 421.33–433.55 m. Scattered ≤ c. 10 m long sections are faintly to weakly foliated in the interval c. 225 m to the bottom. The quartz monzodiorite (501036) has a density in the range 2,750–2,830 kg/m$^3$ along the entire rock unit. The magnetic susceptibility is mainly in the range 0.015–0.040 SI in the section 12–207 m, and 0.001–0.0015 in the section 207–347 m. Confidence level = 3.

### *Possible deformation zones*

Twelve possible deformation zones have been recognised in KLX16A (DZ1–DZ12).

**33.80–34.25 m**

DZ1: Low-grade ductile shear zone in composite intrusion, including crush. Geophysical logs display decreased resistivity, P-wave velocity and magnetic susceptibility. One oriented reflector occurs at 34.2 m with the orientation 324/28. The reflector is of medium strength and can be observed to a distance of 12 m outside the borehole. A non-oriented reflector at 33.3 m exhibits strong character and occurs with the angle 58° to borehole axis. Low radar amplitude occurs at 35 m. The host rock is totally dominated by fine-grained diorite-gabbro (505102). Subordinate rock types include quartz monzodiorite (501036) and fine-grained granite (511058). Confidence level = 3.

**78.66–78.98 m**

DZ2: Low-grade ductile shear zone in composite intrusion. The geophysical logs show only a minor decrease in the resistivity. The host rock is dominated by fine-grained diorite-gabbro (505102) and fine-grained granite (511058). Confidence level = 3.

**90.89–93.72 m**

DZ3: Brittle deformation zone characterized by increased frequency of open and sealed fractures, faint red staining, slickensides and apertures ≤ 5 mm. The geophysical measurements show significantly decreased resistivity and magnetic susceptibility. There is also partly decreased P-wave velocity and one caliper anomaly. One oriented and two non-oriented radar reflectors occur within DZ3. The oriented reflector occurs at 93.0 m with the orientation 338/27 or 062/36. The radar reflector is strong and can be observed to a distance of 25 m outside the borehole. The non-oriented reflectors occur at 90.7 m and 92.7 m with the angle 63° and 62° to borehole axis, respectively. Low radar amplitude occurs in the interval 90–95 m. The host rock is dominated by fine-grained diorite-gabbro (505102), quartz monzodiorite (501036) and fine-grained granite (511058). Subordinate rock type comprises pegmatite. Confidence level = 3.

**139.90–143.00 m**

DZ4: Brittle deformation zone characterized by slight increased frequency of open and sealed fractures, apertures ≤ 7 mm, faint red staining and chloritization. There is significantly decreased resistivity. There is also partly decreased magnetic susceptibility, P-wave velocity and a few minor caliper anomalies. Three non-oriented radar reflectors occur at 140.7 m, 141.5 m and 143.3 m (just outside DZ4) with the angle 68°, 28° and 34° to borehole axis, respectively. Low radar amplitude occurs in the interval 135–140 m, i.e. partly above DZ4. The host rock is dominated by quartz monzodiorite (501036). Subordinate rock type is fine-grained granite (511058). Confidence level = 3.

**207.08–207.22 m**

DZ5: Low-grade ductile shear zone. Increased frequency of sealed fractures and faint red staining. The DZ is located on a significant negative magnetic susceptibility gradient. There are no other indications in the geophysical logging data. The host rock is totally dominated by quartz monzodiorite (501036). Confidence level = 3.

**209.95–210.92 m**

DZ6: Low-grade ductile shear zone. Increased frequency of sealed and open fractures, slickensides, crush and faint to medium red staining and saussuritization. There is one significant caliper anomaly. The DZ is also characterized by decreased magnetic susceptibility and partly decreased P-wave velocity and resistivity. One oriented radar reflector occurs at 209.9 m with the orientation 008/59 or 143/18. The reflector is strong and can be observed to a distance of 20 m outside the borehole. The host rock is dominated by quartz monzodiorite (501036). Subordinate rock types are granite (501058) and fine-grained granite (511058). Confidence level = 3.

**213.33–213.88 m**

DZ7: Brittle-ductile shear zone. Increased frequency of open fractures. The resistivity is slightly decreased and the magnetic susceptibility is significantly decreased. The host rock is dominated by quartz monzodiorite (501036). Subordinate rock types is pegmatite (501061). Confidence level = 3.

**224.63–225.35 m**

DZ8: Low-grade ductile shear zone in composite intrusion. The magnetic susceptibility is significantly decreased, but there are no other indications in the geophysical logging data. One non-oriented radar reflector occurs at 225.3 m with the angle to borehole axis of 52°. The host rock is dominated by fine-grained granite (511058) and fine-grained diorite-gabbro (505102). Confidence level = 3.

**228.20–230.90 m**

DZ9: Low-grade ductile shear zone. Increased frequency of open and sealed fractures, apertures ≤ 3 mm, minor crush and faint to weak red staining. There is significantly decreased resistivity and magnetic susceptibility. There is also partly decreased P-wave velocity and one minor caliper anomaly. One oriented radar reflector occurs at 230.1 m with the orientation 072/85 or 268/55. The reflector is of medium strength and can be observed to a distance of 10 m outside the borehole. The host rock is dominated by granite (501058) and quartz monzodiorite (501036). Subordinate rock type is fine-grained granite (511058). Confidence level = 3.

**251.85–253.71 m**

DZ10: Low-grade ductile shear zone. Increased frequency of sealed fractures and slight increase in open fractures. The DZ is characterized by decreased resistivity and magnetic susceptibility. One non-oriented radar reflector occurs at 253.2 m with the angle 9° to borehole axis. The host rock is dominated by quartz monzodiorite (501036). Subordinate rock type is fine-grained granite (511058). Confidence level = 3.

**259.30–265.00 m**

DZ11: Brittle deformation zone characterized by increased frequency of open and sealed fractures, apertures ≤ 5 mm, slickensides, minor crush, weak red staining and faint saussuritization. The DZ is characterized by decreased resistivity and magnetic susceptibility. There is also partly decreased P-wave velocity and one minor caliper anomaly. Two oriented and one non-oriented radar reflector occur within DZ11. The oriented reflectors occur at 260.8 m with the orientation 248/89 and at 264.6 m with the orientation 335/41. The reflectors are medium to strong and can be observed to a distance of 15 m and 18 m outside the borehole, respectively. The non-oriented reflector occurs at 263.6 m with the angle 72° to borehole axis. Low radar amplitude occurs in the interval 250–285 m, i.e. partly above and below DZ11. Host rock is dominated by quartz monzodiorite (501036). Subordinate rock types are pegmatite (501061), fine-grained granite (511058) and granite (501058). Confidence level = 3.

**327.00–433.55 m**

DZ12: Inhomogeneous brittle deformation zone including overprinting of scattered low-grade ductile shear zones. The most intensely deformed section is 327–381 m, which is characterized by marked increase in frequency of sealed fractures, increased frequency of open fractures, numerous slickensides, frequent cataclasites, inhomogeneous faint to medium red staining and saussuritization. The section 381–433.5 m (transition zone) is characterized by increased frequency of sealed fractures, slight increase in open fractures, slickensides, occasional cataclasites and faint to medium red staining and saussuritization. The entire DZ is characterized by an increased number of sections with decreased resistivity, magnetic susceptibility and P-wave velocity. The highest concentration of geophysical anomalies occurs in the core zone. In the section 338–345 m the resistivity is anomalously low, there is significantly decreased P-wave velocity and there are several caliper anomalies. Three oriented radar reflectors occur at 339.1 m with the orientation 243/62, at 344.7 m with the orientation 035/49 or 309/08 and at 370.8 m with the orientation 319/27 or 061/44. The upper radar reflector is strong and can be observed to a distance of 18 m outside the borehole. Nineteen non-oriented reflectors occur inside DZ12 having an angle from 11° to 78° to borehole axis. Low radar amplitude occurs in the intervals 335–370 m, 400–415 m and at 425 m. Host rock is dominated by quartz monzodiorite (501036). Subordinate rock types are fine-grained diorite-gabbro (505102), pegmatite (501061), fine-grained granite (511058), fine-grained dioritoid (501030) and granite (501058). Confidence level = 3.

# 6 Comments

The results from the geological single-hole interpretation of KLX16A is presented in a WellCad plot (Appendix 1). 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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# Geological single-hole interpretation of KLX16A

| Title | SINGLE HOLE INTERPRETATION KLX16A | | | | | |
|---|---|---|---|---|---|---|
| Site | LAXEMAR | Inclination [°] | -64.97 | Elevation [m.a.s.l.] | 18.78 | Signed data |
| Borehole | KLX16A | Date of mapping | 2007-03-01 09:13:00 | Drilling Start Date | 2006-11-28 13:00:00 | |
| Diameter [mm] | 76 | Coordinate System | RT90-RHB70 | Drilling Stop Date | 2007-01-09 13:00:00 | |
| Length [m] | 433.550 | Northing [m] | 6364796.87 | Surveying Date | | |
| Bearing [°] | 294.37 | Easting [m] | 1547584.10 | Plot Date | 2007-10-14 22:03:05 | |

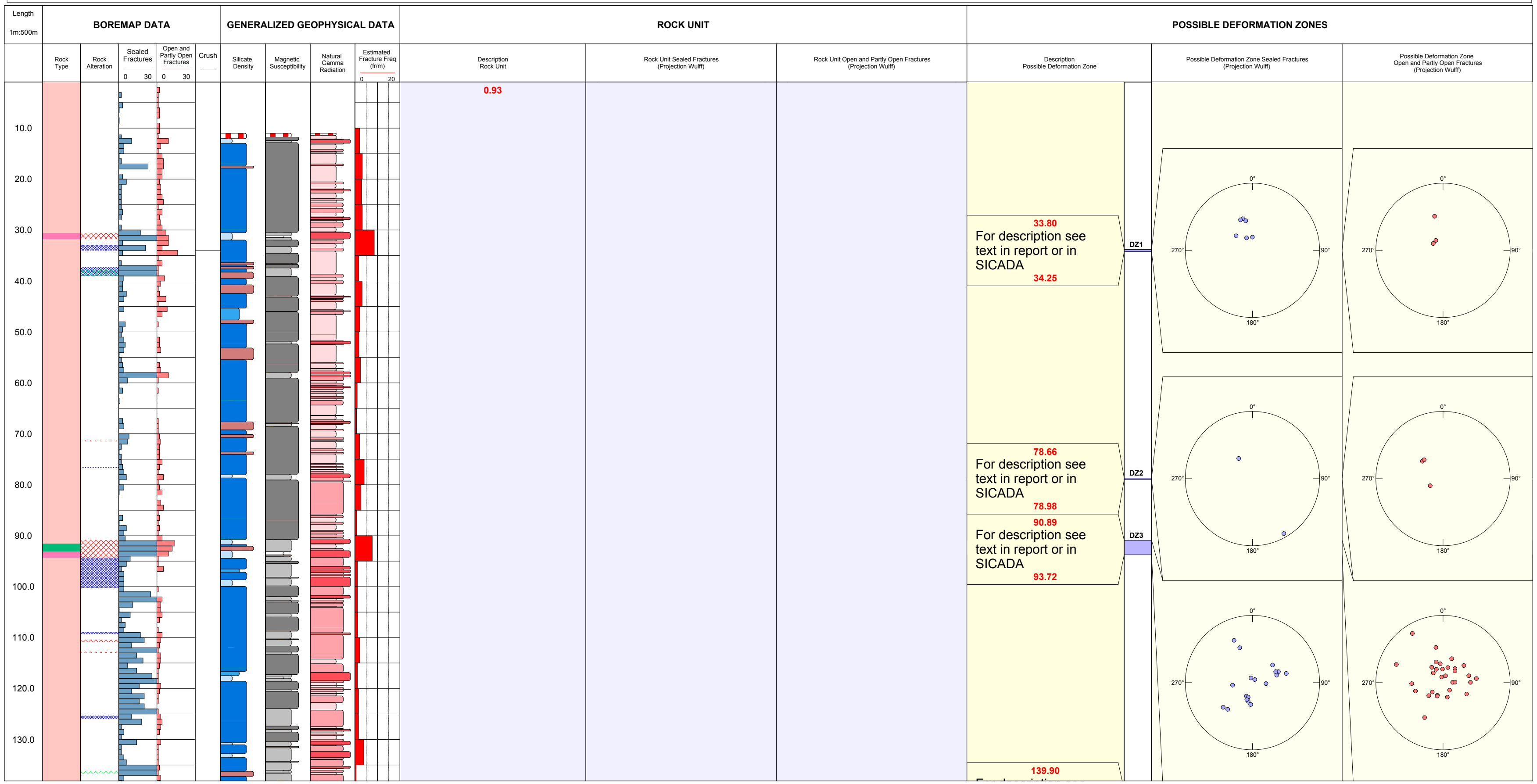
**ROCKTYPE LAXEMAR**
- Fine-grained granite
- Pegmatite
- Granite
- Quartz monzodiorite
- Fine-grained dioritoid
- Fine-grained diorite-gabbro

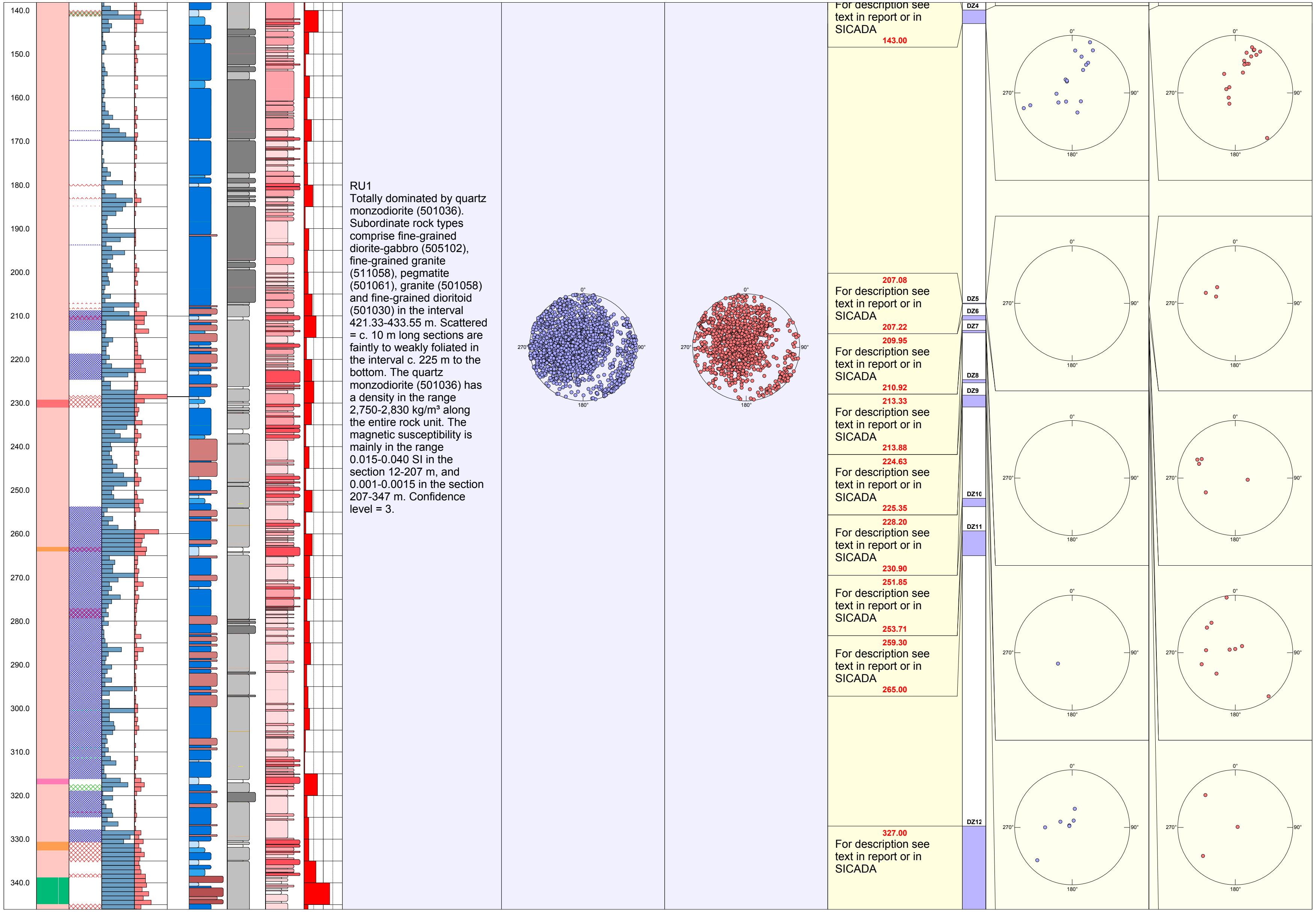
**ROCK ALTERATION**
- Oxidized
- Chloritisized
- Epidotisized
- Silicification
- Argillization
- Albitization
- Saussuritization

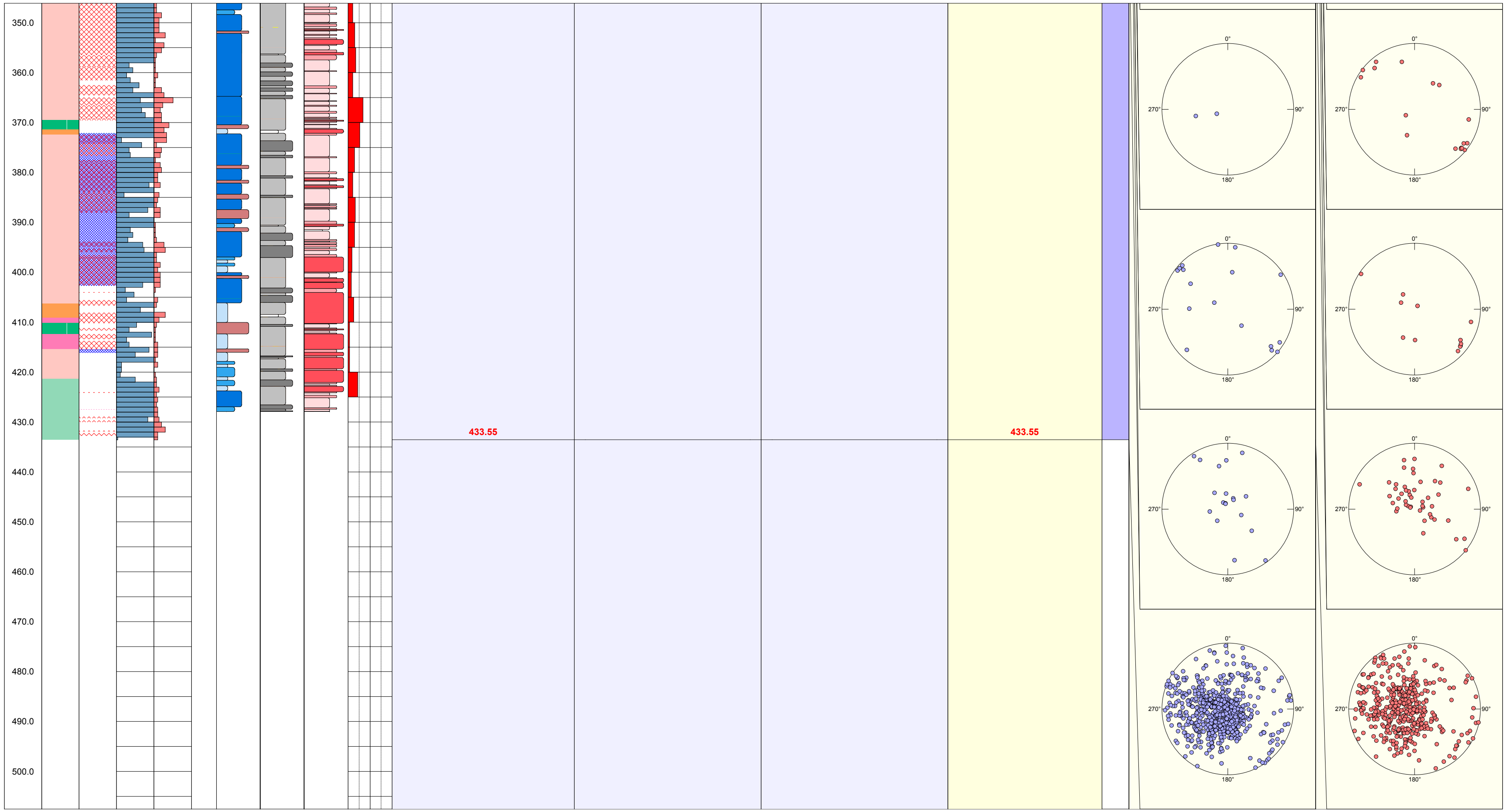
**SILICATE DENSITY**
- unclassified
- dens<2680
- 2680<dens<2730
- 2730<dens<2800
- 2800<dens<2890
- dens>2890

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

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




140.0
150.0
160.0
170.0
180.0
190.0
200.0
210.0
220.0
230.0
240.0
250.0
260.0
270.0
280.0
290.0
300.0
310.0
320.0
330.0
340.0
RU1
Totally dominated by quartz monzodiorite (501036). Subordinate rock types comprise fine-grained diorite-gabbro (505102), fine-grained granite (511058), pegmatite (501061), granite (501058) and fine-grained dioritoid (501030) in the interval 421.33-433.55 m. Scattered = c. 10 m long sections are faintly to weakly foliated in the interval c. 225 m to the bottom. The quartz monzodiorite (501036) has a density in the range 2,750-2,830 kg/m³ along the entire rock unit. The magnetic susceptibility is mainly in the range 0.015-0.040 SI in the section 12-207 m, and 0.001-0.0015 in the section 207-347 m. Confidence level = 3.
For description see text in report or in SICADA
143.00
207.08
For description see text in report or in SICADA
207.22
209.95
For description see text in report or in SICADA
210.92
213.33
For description see text in report or in SICADA
213.88
224.63
For description see text in report or in SICADA
225.35
228.20
For description see text in report or in SICADA
230.90
251.85
For description see text in report or in SICADA
253.71
259.30
For description see text in report or in SICADA
265.00
327.00
For description see text in report or in SICADA
DZ4
DZ5
DZ6
DZ7
DZ8
DZ9
DZ10
DZ11
DZ12
0°
90°
180°
270°


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
433.55
433.55
0°
90°
180°
270°