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Revised October 2006

Forsmark site investigation

Geological single-hole interpretation of KFM03B, KFM03A and HFM06-08 (DS3)

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June 2004

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Keywords: Forsmark, Geophysics, Geology, Borehole, Bedrock, Fractures, Field note: Forsmark 314, AP PF 400-04-22.

Reading instruction

For revision no. 1 of this report a recalculation of the oriented radar data has been carried out.

The strike and dip of the oriented radar data are now recalculated 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. The new values for strike and dip are updated in Chapter 5.1 and 5.2 as well as in Appendix 1 and Appendix 2.

The revised report also presents updated identification codes from rock units, in accordance with the revised method description for single-hole interpretation. The term “confidence level” also replaces the term “uncertainty” in accordance with the revised method description.

Appendices 1–5 are updated.

Abstract

This report constitutes geological single-hole interpretations of the cored boreholes KFM03B and KFM03A, as well as the percussion boreholes HFM06-08 in Forsmark. The geological single-hole interpretation combines the geological core mapping, interpreted geophysical logs, borehole radar measurements and seismic reflectors to interpret where lithological rock units and possible deformation zones occurs in the boreholes.

The geological single-hole interpretation shows that one lithological rock units occurs in borehole KFM03B, while four rock units occur in KFM01A. Medium-grained metagranite-granodiorite and pegmatitic granite occur in equally proportions in KFM03B.

Generally, medium-grained metagranite-granodiorite dominates in KFM03A. However a rather homogeneous section of medium-grained metatonalite-granodiorite occurs in the upper part of the borehole. Pegmatitic granite, amphibolite and a fine-medium grained metagranitoid occurs as subordinate rock types in both boreholes. Two possible deformation zones have been identified in KFM03B and five possible deformation zones in KFM03A.

The percussion borehole HFM06 is dominated by medium-grained metagranite-granodiorite. Pegmatitic granite and amphibolite occurs as subordinate rock types. One possible deformation zone has been identified in HFM06.

The percussion borehole HFM07 is dominated by medium-grained metagranite-granodiorite. Pegmatitic granite, amphibolite and a small section with fine-medium grained metagranitoid, occurs as subordinate rock types. One possible deformation zone has been identified in HFM07.

The percussion borehole HFM08 is dominated by medium-grained metagranite-granodiorite.

Pegmatitic granite and amphibolite are subordinate rock types. One possible deformation zone has been identified in HFM08.

Sammanfattning

Denna rapport behandlar geologisk enhålstolkning av kärnborrhål KFM03B och KFM03A samt hammarborrhål HFM06-08 i Forsmark. Den geologiska enhålstolkningen syftar till att utifrån data från den geologiska karteringen, tolkade geofysiska loggar, borrhålsradarmätningar och seismiska reflektorer indikera olika litologiska enheters fördelning i borrhålen samt möjliga deformationszoners läge och utbredning.

Denna undersökning visar att det i KFM03B finns en litologisk enhet medan det i KFM03A finns fyra litologiska enheter. KFM03B innehåller både medelkornig metagranit-granodiorit och pegmatitgranit i ungefär lika proportioner. Generellt sett dominerar medelkornig metagranit-granodiorit i KFM03A, men ett homogent parti av medelkornig metatonalit-granodiorit förekommer i den övre delen av borrhålet. Pegmatitgranit, amfibolit och fint medelkornig metagranitoid förekommer i mindre omfattning i båda borrhålen. Två möjliga deformationszoner har identifierats i KFM03B. I KFM03A har fem möjliga deformationszoner identifierats.

Hammarborrhål HFM06 domineras av medelkornig metagranit-granodiorit med mindre inslag av pegmatitisk granit och amfibolit. En möjlig deformationszon har identifierats i HFM06.

Hammarborrhål HFM07 domineras av medelkornig metagranit-granodiorit med mindre inslag av pegmatitisk granit och amfibolit, samt ett mindre parti med medelkornig metagranitoid. En möjlig deformationszon har identifierats i HFM07.

Hammarborrhål HFM08 domineras av medelkornig metagranit-granodiorit med mindre inslag av pegmatitisk granit och amfibolit. En möjlig deformationszon har identifierats i HFM08.

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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 Visualisation System (RVS). The end result of this procedure is a geological single-hole interpretation, which consists of an integrated series of different loggings and accompanying descriptive documents.

This document reports the geological single-hole interpretation of five boreholes at drilling site 3 (DS3) in the Forsmark area. These includes the cored borehole KFM03B and KFM03A and the percussion-drilled boreholes HFM06, HFM07 and HFM08 (Figure 1-1).

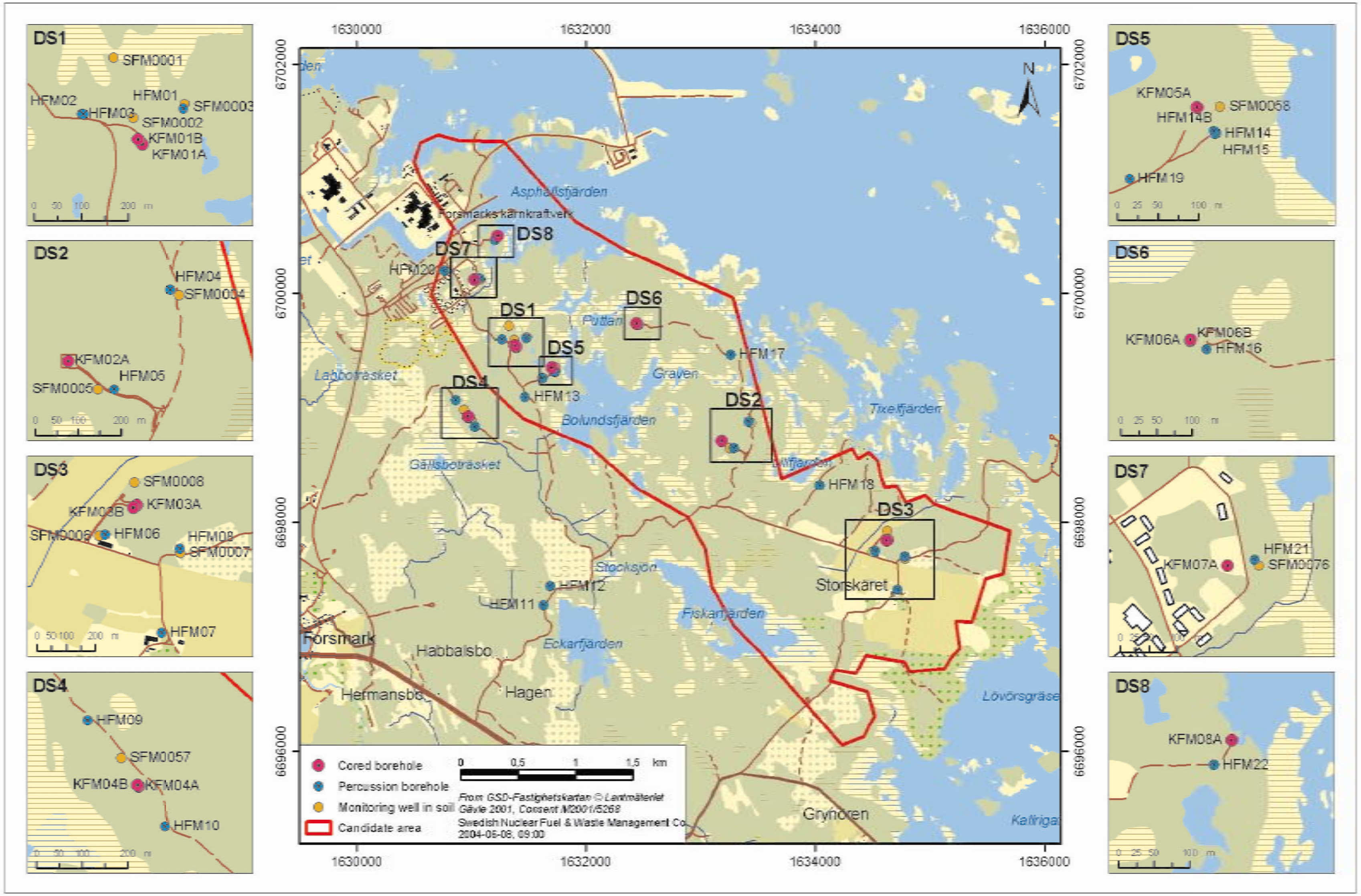


Figure 1-1. *Map showing the location of drilling site 3 (DS3) and the position of the boreholes KFM03A, KFM03B and HFM06-08.*

2 Objective and scope

A geological single-hole interpretation is carried out in order to identify and briefly describe the 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 and, when available, reflection seismic anomalies. The results from the geological single-hole interpretation are presented in a WellCad plot. A detailed description of the technique is provided in the method description for geological single-hole interpretation (SKB MD 810.003, internal document).

3 Data used for the geological single-hole interpretation

The following data are used for the single-hole interpretation:

- Boremap data (including BIPS and geological mapping data) /1 and 2/.
- Generalized geophysical logs and their interpretation /3 and 4/.
- Radar data and their interpretation /5 and 6/.
- Reflection seismic reflector data and their interpretation /7/.

The reflection seismic measurements were not carried out in the borehole but on the ground surface. The measurements and the data evaluation were completed before the borehole was drilled and the reflectors used in this report correspond to those that were predicted to intersect the borehole /7/.

The material used as basis for the geological single-hole interpretation was a WellCad plot consisting of parameters from Boremap-mapping, geophysical logs and borehole radar. 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: Depth

2: Rocktype

  2.1: Rock type

  2.2: Rock type structure

  2.3: Rock type texture

  2.4: Rock type grain size

  2.5: Structure orientation

  2.6: Rock occurrence (< 1 m)

  2.7: Rock alteration

  2.8: Rock alteration intensity

3: Unbroken fractures

  3.1: Primary mineral

  3.2: Secondary mineral

  3.3: Third mineral

  3.4: Fourth mineral

  3.5: Alteration, dip direction

4: Broken fractures

4.1: Primary mineral

- 4.2: Secondary mineral
- 4.3: Third mineral
- 4.4: Fourth mineral
- 4.5: Aperture (mm)
- 4.6: Roughness
- 4.7: Surface
- 4.8: Alteration, dip direction

5: Crush zones

5.1: Primary mineral

- 5.2: Secondary mineral
- 5.3: Third mineral
- 5.4: Fourth mineral
- 5.5: Roughness
- 5.6: Surface
- 5.7: Crush alteration, dip direction
- 5.8: Piece (mm)
- 5.9: Sealed network
- 5.10: Core loss

6: Fracture frequency

- 6.1: Open fractures
- 6.2: Sealed fractures

7: Geophysics

- 7.1: Magnetic susceptibility
- 7.2: Natural gamma radiation
- 7.3: Possible alteration
- 7.4: Silicate density
- 7.5: Estimated fracture frequency

8: Radar

- 8.1: Length
- 8.2: Angle

9: Reference marks. (Not used for percussion-drilled boreholes)

10: 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 measurement 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. All these rocks have been included in the younger, Group D intrusive suite /8/.

Silicate density: This parameter indicates the density of the rock after subtraction of the magnetite component in the rock. 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 sonic and focused resistivity 300 in the cored hole and calculated from lateral, short and long normal resistivity and SPR in the percussion drilled holes. 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.

Possible alteration: This parameter has only been used slightly in the geological single-hole interpretation in the Forsmark area.

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.

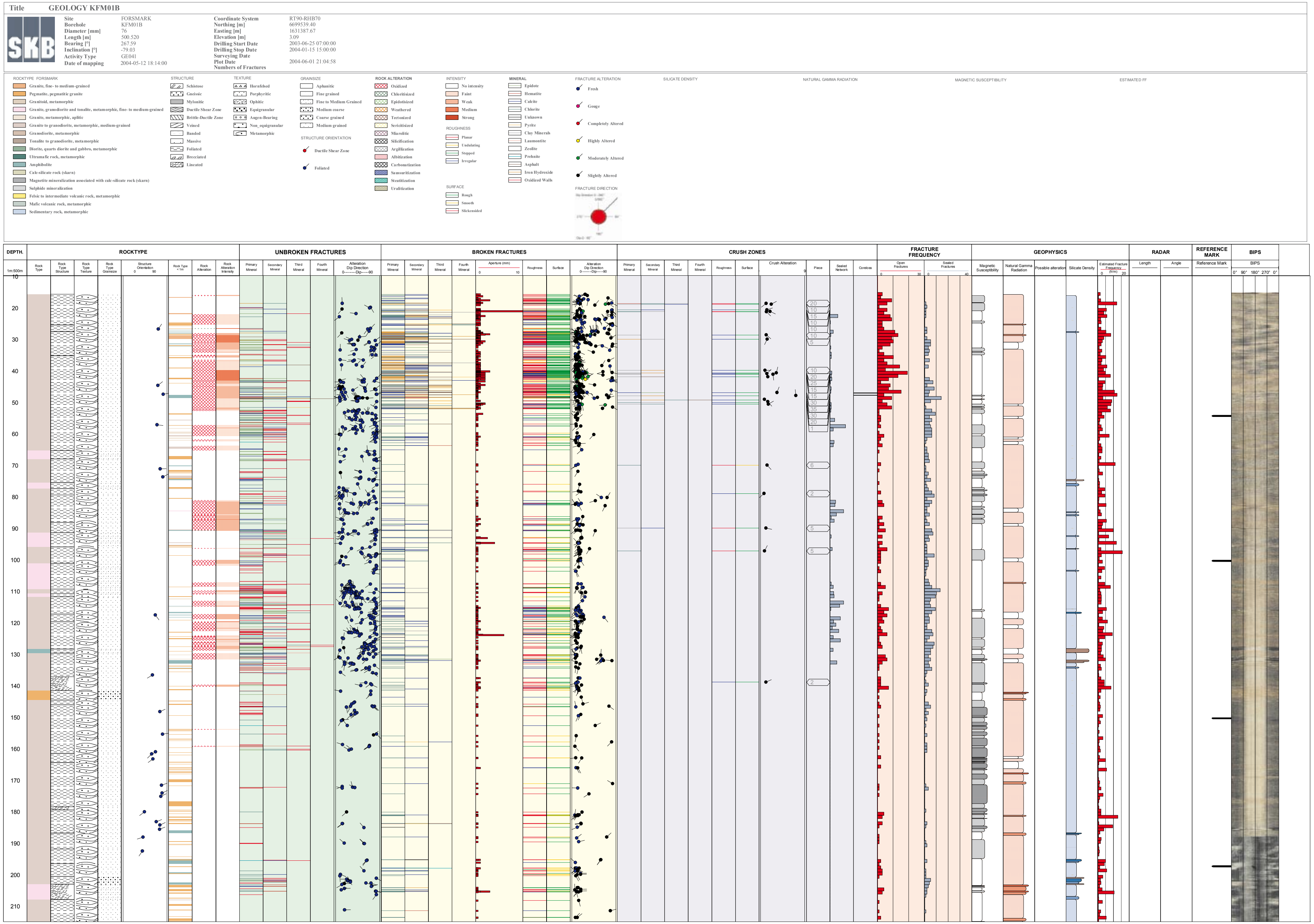


Figure 3-1. Example of WellCad plot used as basis for the single-hole interpretation.

4 Execution of the geological single-hole interpretation

The geological single-hole interpretation has been carried out by a group of experts consisting of both geologists and geophysicists. Several of these participants previously participated in the development of the source material for the single-hole interpretation. All data to be used are visualized side by side in a borehole document extracted from the software WellCad.

Stage 1 in the working procedure is to study the rock type related logging data 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 indicated and provided with a description from the WellCad plot.

Stage 2 is to identify possible deformation zones by visual inspection of geological mapping (fracture frequency, alteration, etc.), geophysical data, and radar data. The section of each identified possible deformation zone is indicated and described in the WellCad plot.

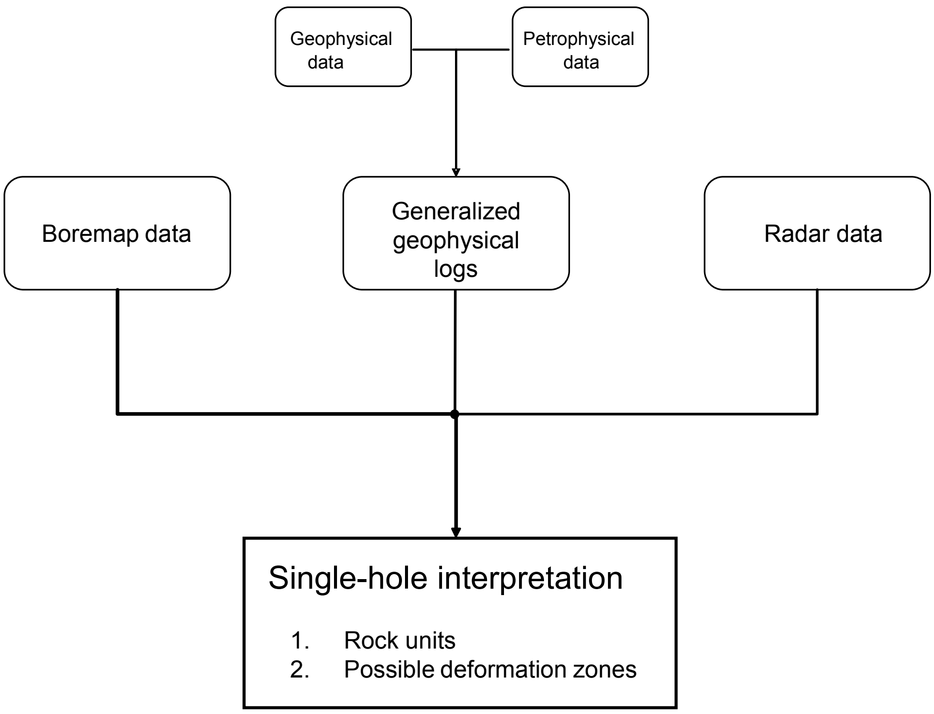


Figure 4-1. *Schematic block diagram of geological single-hole interpretation.*

4.1 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.

5 Results

The detailed results of the geological single-hole interpretations are presented as print-outs from the software WellCad (Appendix 1 for KFM03B and KFM03A, Appendix 2 for HFM06, Appendix 3 for HFM07, and Appendix 4 for HFM08). The confidence in the interpretation of rock units and possible deformation zones is made on the following basis: 3 = high, 2 = medium and 1 = low.

5.1 KFM03B

The borehole consists of one rock unit.

6-97 m RU1: Medium-grained metagranite-granodiorite and pegmatitic granite in approximately equal proportions with subordinate occurrences of amphibolite in the central part (c. 25-70 m). Also minor occurrences of fine- to medium-grained metagranitoid. Confidence level = 3.

Two possible deformation zones are indicated:

24-42 m DZ1: Slightly increased frequency of broken fractures; some with apertures. Fractures coated by chlorite, calcite and clay minerals. Some fractures occur along contact to amphibolite. Low resistivity. One non-oriented radar reflector occurs at 34.0 m with the angle 59 degrees to borehole axis. Three oriented radar reflectors at 27.0 m (276/25 or 096/25), 29.0 m (096/44) and 37.0 m (180/33 or 000/33). Confidence level = 2.

62-67 m DZ2: A central, meter-wide crush zone. Slightly increased frequency of broken fractures; some with apertures. Fractures coated by chlorite, calcite and hematite. Also with a weak oxidation. Very low resistivity and caliper indicated a large cavity, >100 mm. Seismic reflector (A5) with an inferred intersection depth at 60 m, and an orientation of 075/30. Distinct radar reflector at 66.0 m with the orientation 359/36. Confidence level = 3.

5.2 KFM03A

The borehole can be divided into four rock units and some of them are repeated in the borehole. On this basis the borehole can be divided into the following six rock sections:

102-220 m RU1a: Medium-grained metagranite-granodiorite with subordinate amounts of pegmatitic granite and minor occurrences of amphibolite and fine- to medium-grained metagranitoid. Minor intervals of oxidation, often associated with slightly increased fracture frequency. Confidence level = 3.

220-293 m RU2: Medium-grained metatonalite-metagranodiorite with subordinate pegmatitic granite and a fine- to medium-grained metatonalite. Generally slightly higher density and consistently low magnetic susceptibility. Confidence level = 3.

293-349 m RU3a: Homogeneous interval of fine- to medium-grained metatonalite with a c. 2 m interval of medium-grained metagranite-granodiorite and several minor occurrences of pegmatitic granite. Higher density, lower gamma radiation and low magnetic susceptibility. Confidence level = 3.

349-377 m RU4: Pegmatitic granite with minor occurrences of fine- to medium-grained metatonalite. Confidence level = 3.

377-399 m RU3b: Fine- to medium-grained metatonalite and medium-grained metagranite-granodiorite with minor occurrences of pegmatitic granite and amphibolite. Generally higher density, lower gamma radiation and low magnetic susceptibility. Confidence level = 3.

399-1000 m RU1b: Medium-grained metagranite-granodiorite with subordinate amounts of pegmatitic granite, amphibolite and fine- to medium-grained metagranitoid. Minor intervals of oxidation, often associated with slightly increased fracture frequency. Confidence level = 3.

Five possible deformation zones are indicated:

356-399 m DZ1: Three decimetre-wide crush zones and an increased frequency of open fractures with apertures up to about 7 mm. Two intervals with more than ten fractures per metre. Some of the fractures are filled with calcite and/or chlorite, whereas the majority are unfilled. Low resistivity and P-wave velocity. Seismic reflector (A4) with an inferred intersection depth at 370 m, and an orientation of 065/25. Two non-oriented radar reflectors at 373.0 m and 382.0 m with the angle to borehole axis 79 and 62 degrees, respectively. Six oriented radar reflectors occur at 359.0 m (353/36 or 171/26), 365.0 m (116/14 or 321/21), 367.0 m (040/78 or 222/70), 375.0 m (194/23 or 010/33), 389.0 m (277/22 or 073/23) and 399.0 m (082/24). Confidence level = 3.

448-455 m DZ2: Slightly increased frequency of both unbroken and broken fractures in association with an amphibolite. One fracture with an aperture of 8 mm. Also an interval with medium oxidation directly beneath the amphibolite. Typically chlorite and/or calcite coated fractures, with a few coated by prehnite, hematite and clay minerals. Low resistivity and slightly decreased P-wave velocity. One distinct radar reflector at 452.0 m with the orientation 043/36 or 235/27. Confidence level = 3.

638-646 m DZ3: Slightly increased frequency of both unbroken and broken fractures in association with an amphibolite. Several with apertures, ranging up to 5 mm. Also an interval with medium oxidation directly beneath the amphibolite. Typically chlorite, prehnite and calcite coated fractures. Low resistivity and slightly decreased P-wave velocity. Gamma ray anomaly at the same depth as the oxidation. Seismic reflector (B1) with an inferred intersection depth at 650 m, and an orientation of 030/25. One radar reflector at 640.0 m with the orientation 183/20 or 008/34 and one distinct radar reflector at 644.0 m with the orientation 030/30. Confidence level = 3.

803-816 m DZ4: Increased frequency of broken fractures especially in the uppermost and lowermost part of this possible zone. Some with measurable apertures, ranging up to 5 mm. Typically chlorite and/or calcite coated fractures, with a few coated by clay minerals and prehnite. Characterised by low resistivity and slightly decreased P-wave velocity. Gamma ray anomaly in the uppermost part of the possible zone. Seismic reflector (A3) with an inferred intersection depth at 800 m, and an orientation of 065/25. Oriented radar reflectors occur at 804.0 m (268/27), 811.0 m (092/23) and 815.0 m (328/21 or 109/17). Confidence level = 3.

942-949 m DZ5: Increased frequency of broken fractures; some with apertures ranging up to 6 mm. Fracture with 6 mm aperture is situated along the lower contact of a minor amphibolite occurrence. Also variable degree of oxidation beneath the amphibolite. Typically chlorite, calcite, hematite and clay mineral coatings. Characterised by low resistivity and slightly decreased P-wave velocity. Gamma ray anomaly in the central part of the possible zone. Seismic reflector (A2) has an inferred intersection depth at 900 m and an orientation of 080/22. No clear indication for a deformation zone in the borehole at this depth. One distinct radar reflector at 944.0 m with the orientation 031/26. Confidence level = 3.

5.3 HFM06

The borehole consists of one rock unit:

11-108 m RU1: Medium-grained metagranite-granodiorite with subordinate amounts of pegmatitic granite and amphibolite. Also indications from the drill cuttings of a fine- to medium-grained metagranitoid in the upper eight metres. Confidence level = 3.

One possible deformation zone is indicated:

61-71 m DZ1: Two crush zones, one in the uppermost part (3 cm wide) and one in the lowermost part (25 cm wide) within an amphibolite. Slightly increased fracture frequency. Several fractures with measured apertures, ranging up to 5 mm. Very low resistivity and a caliper anomaly that correspond to the crush zones. A radar reflector 62 degrees to the borehole axis at c. 70 m. Confidence level = 3.

3.4 HFM07

The borehole consists of one rock unit:

11-109 m RU1: Medium-grained metagranite-granodiorite with subordinate amounts of pegmatitic granite and minor occurrences of amphibolite. Also a c. 7 m wide occurrence of fine- to medium-grained metagranitoid in the lowermost part. Confidence level = 3.

There is one possible deformation zone in the borehole:

54-66 m DZ1: A distinct increase in the fracture frequency associated with oxidation. Several fractures have measurable apertures, averaging 2 mm, and two in the upper part of the possible zone are about 10 mm. Very low resistivity and caliper anomalies. Several radar reflector 23-52 degrees to the borehole axis. Confidence level = 3.

5.5 HFM08

The borehole can be divided into three rock units and some of them are repeated in the borehole. On this basis the borehole can be divided into the following five rock sections:

17-27 m RU1a: Medium-grained metagranite-granodiorite with subordinate amounts of amphibolite and pegmatitic granite. Confidence level = 3.

27-41 m RU2: Amphibolite and pegmatitic granite in approximately equal proportions. Also minor occurrences of medium-grained metagranite-granodiorite. Confidence level = 3.

41-78 m RU1b: Medium-grained metagranite-granodiorite with subordinate amounts of pegmatitic granite and amphibolite. Confidence level = 3.

78-115 m RU3: Pegmatitic granite with subordinate amounts of medium-grained metagranite-granodiorite and amphibolite. Confidence level = 3.

115-142 m RU1c: Medium-grained metagranite-granodiorite with subordinate amounts of pegmatitic granite and amphibolite. One 4 m wide occurrence of pegmatitic granite in the lower part. Confidence level = 3.

There is one possible deformation zone in the borehole:

136-141 m DZ1: Slightly increased fracture frequency, some with measurable apertures up to 3 mm. This possible zone occurs together with a 1 m wide amphibolite. Low resistivity and caliper anomalies. Radar reflector at 138 m, 81 degrees to the borehole axis. Confidence level = 3.

6 Comments

The results from the geological single-hole interpretations of the KFM03B, KFM03A, HFM06, HFM07 and HFM08 are presented in WellCad plots (Appendices 1-5). Each WellCad plot consists of the following columns:

1: Depth

2: Rock type

3: Rock alteration

4: Sealed fractures (blue symbols)

5: Open fractures (red symbols)

6: Silicate density

7: Susceptibility

8: Natural gamma radiation

9: Estimated fracture frequency

10: Comment: Rock unit

11: Stereogram for sealed fractures in rock unit (blue symbols)

12: Stereogram for open fractures in rock unit (red symbols)

13: Comment: Possible deformation zone

14: Stereogram for sealed fractures in possible deformation zone (blue symbols)

15: Stereogram for open fractures in possible deformation zone (red symbols)

Fractures not visible in BIPS are included in the data.

7 References

/1/ SKB P-report P-04-102. Boremap mapping of telescopic drilled borehole KFM03A and KFM03B. Petersson J, Wängnerud A, Danielsson P, Stråhle A.

/2/ SKB P-report P-03-22. Boremap mapping of percussion boreholes HFM06-08. Nordman C.

/3/ SKB P-report P-04-98. Interpretation of borehole geophysical measurements in KFM02A, KFM03A, KFM03B and HFM04 to HFM08. Hans Thunehed.

/4/ SKB P-report P-04-97. Geophysical borehole logging. Borehole KFM02A, KFM03A and KFM03B. Nielsen U T, Ringgaard J.

/5/ SKB P-report P-03-54. Geophysical, radar and BIPS logging in boreholes HFM06, HFM07 and HFM08. Nilsson P, Aaltonen J.

/6/ SKB P-report P-04-41. RAMAC and BIPS logging in borehole KFM03A and KFM03B. Gustafsson J, Gustafsson C.

/7/ SKB R-report R-02-43. Reflection seismic studies in the Forsmark area – stage 1. Juhlin C, Bergman B, Palm H.

/8/ SKB P-report P-03-75. Forsmark site investigation. Bedrock mapping. Rock types, their petrographic and geochemical characteristics, and a structural analysis of the bedrock based on Stage 1 (2002) surface data. Stephens M B, Lundqvist S, Bergman T, Andersson J.

Appendix 1

Geological single-hole interpretation for KFM03B

Title SINGLE HOLE INTERPRETATION KFM03B

Site	FORSMARK	**Inclination [°]**	-85.29	**Elevation [m.a.s.l.]**	8.47	**Signed data**
Borehole	KFM03B	**Date of mapping**	2003-08-12 09:26:00	**Drilling Start Date**	2003-06-29 09:30:00	
Diameter [mm]	77	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2003-07-02 14:05:00	
Length [m]	101.540	**Northing [m]**	6697844.20	**Surveying Date**		
Bearing [°]	264.49	**Easting [m]**	1634618.68	**Plot Date**	2006-09-20 21:10:12	

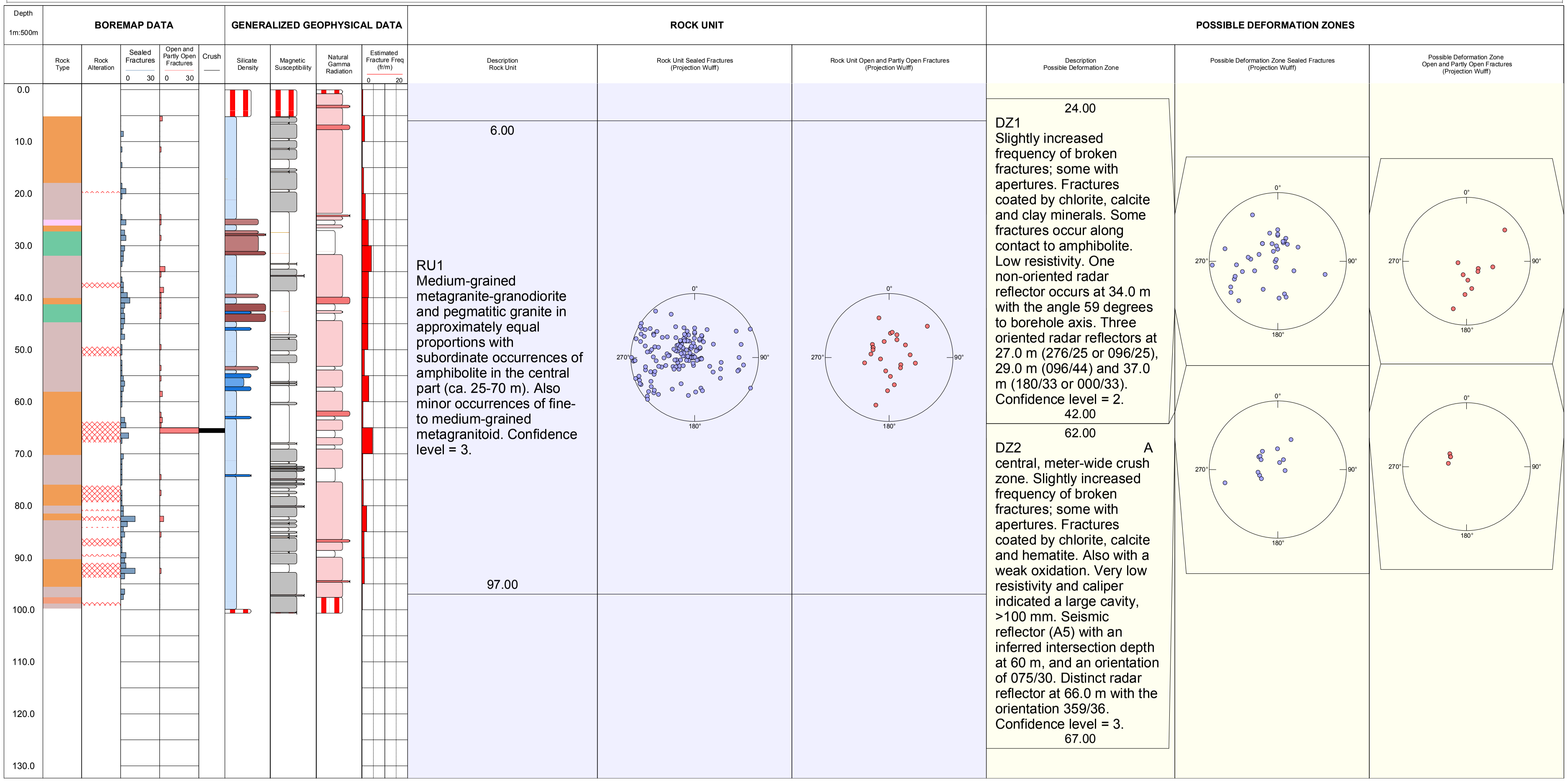
ROCKTYPE FORSMARK
- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite to granodiorite, metamorphic, medium-grained
- Amphibolite

ROCK ALTERATION
- Oxidized

SILICATE DENSITY
- unclassified
- dens<2680 (Granite)
- 2680<dens<2730 (Granodiorite)
- 2730<dens<2800 (Tonalite)
- 2800<dens<2890 (Diorite)
- dens>2890 (Gabbro)

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

NATURAL GAMMA
- unclassified
- gam<20
- 20<gam<36
- 36<gam<53



Appendix 2

Geological single-hole interpretation for KFM03A

Title SINGLE HOLE INTERPRETATION KFM03A

Site	FORSMARK	**Inclination [°]**	-85.74	**Elevation [m.a.s.l.]**	8.29	**Signed data**
Borehole	KFM03A	**Date of mapping**	2003-08-28 08:56:00	**Drilling Start Date**	2003-03-18 09:10:00	
Diameter [mm]	77	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2003-03-28 14:30:00	
Length [m]	1001.190	**Northing [m]**	6697852.10	**Surveying Date**		
Bearing [°]	271.52	**Easting [m]**	1634630.74	**Plot Date**	2006-09-20 21:10:12	

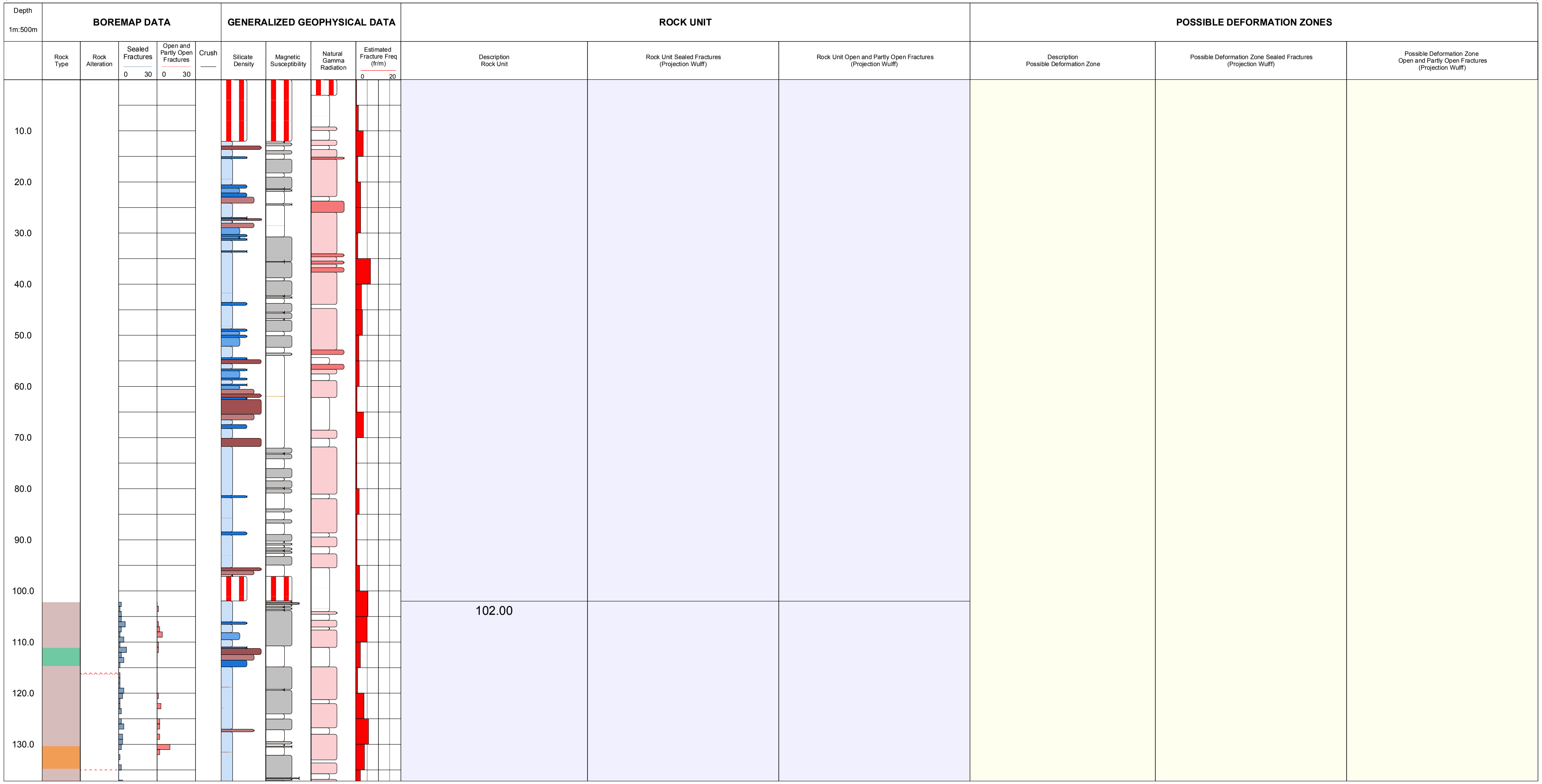
ROCKTYPE FORSMARK
- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite to granodiorite, metamorphic, medium-grained
- Tonalite to granodiorite, metamorphic
- Amphibolite

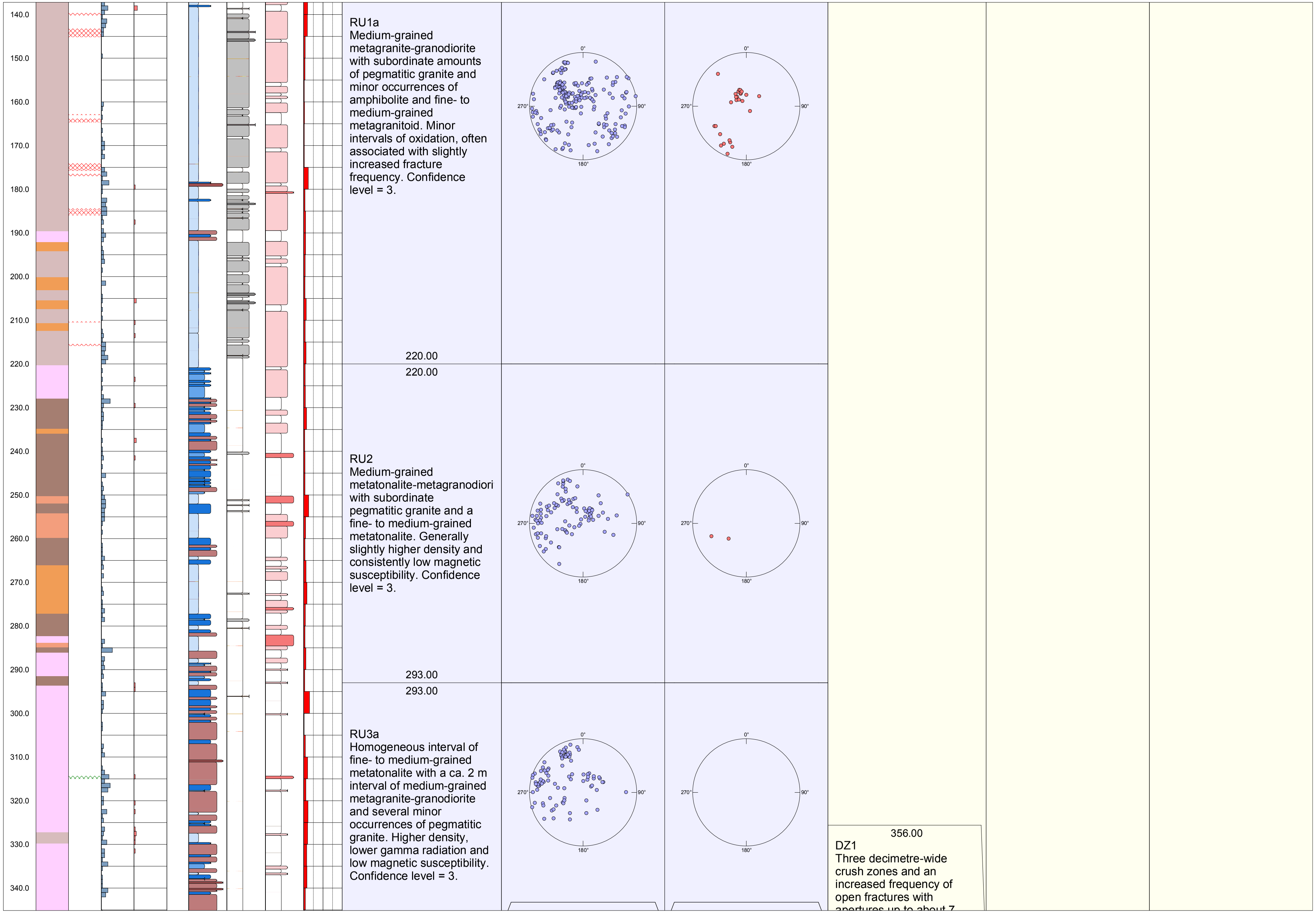
ROCK ALTERATION
- Oxidized
- Chloritisized
- Sericitisized

SILICATE DENSITY
- unclassified
- dens<2680 (Granite)
- 2680<dens<2730 (Granodiorite)
- 2730<dens<2800 (Tonalite)
- 2800<dens<2890 (Diorite)
- dens>2890 (Gabbro)

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

NATURAL GAMMA
- unclassified
- gam<20
- 20<gam<36
- 36<gam<53

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150.0
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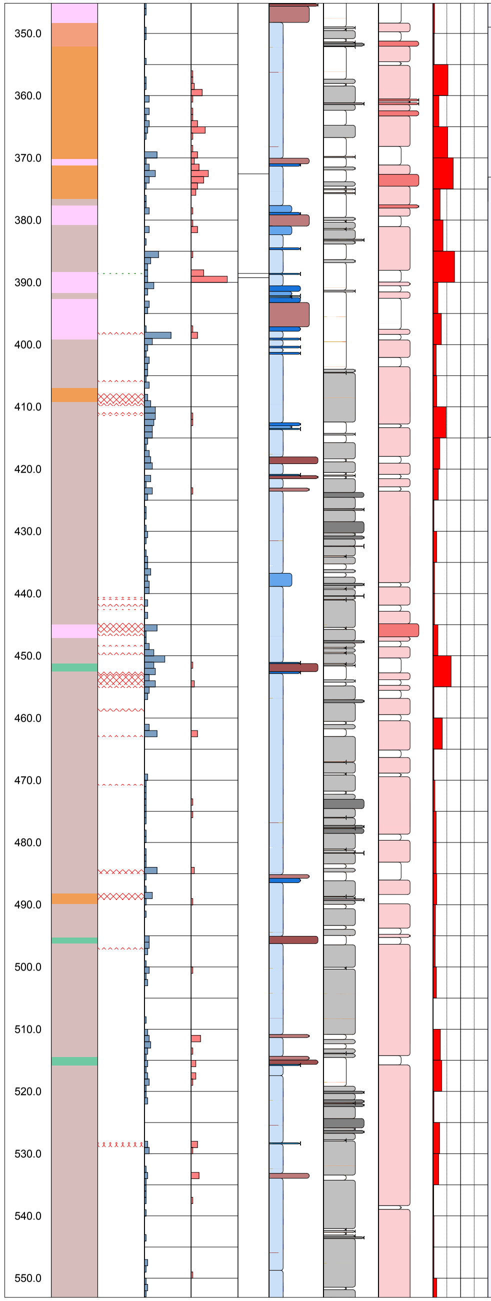
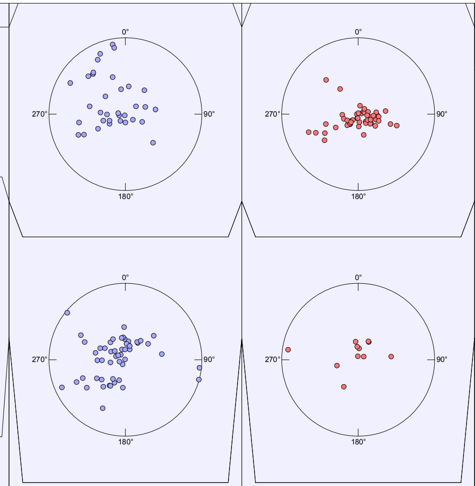
270.0
280.0
290.0
300.0
310.0
320.0
330.0
340.0
RU1a
Medium-grained metagranite-granodiorite with subordinate amounts of pegmatitic granite and minor occurrences of amphibolite and fine- to medium-grained metagranitoid. Minor intervals of oxidation, often associated with slightly increased fracture frequency. Confidence level = 3.
220.00
220.00
RU2
Medium-grained metatonalite-metagranodiori with subordinate pegmatitic granite and a fine- to medium-grained metatonalite. Generally slightly higher density and consistently low magnetic susceptibility. Confidence level = 3.
293.00
293.00
RU3a
Homogeneous interval of fine- to medium-grained metatonalite with a ca. 2 m interval of medium-grained metagranite-granodiorite and several minor occurrences of pegmatitic granite. Higher density, lower gamma radiation and low magnetic susceptibility. Confidence level = 3.
0°
90°
180°
270°
356.00
DZ1
Three decimetre-wide crush zones and an increased frequency of open fractures with



349.00
349.00

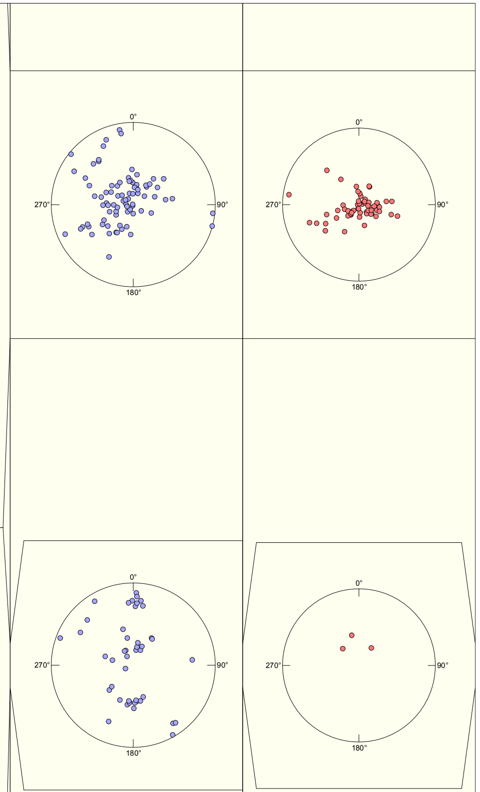
RU4
Pegmatitic granite with minor occurrences of fine- to medium-grained metatonalite. Confidence level = 3
377.00
377.00

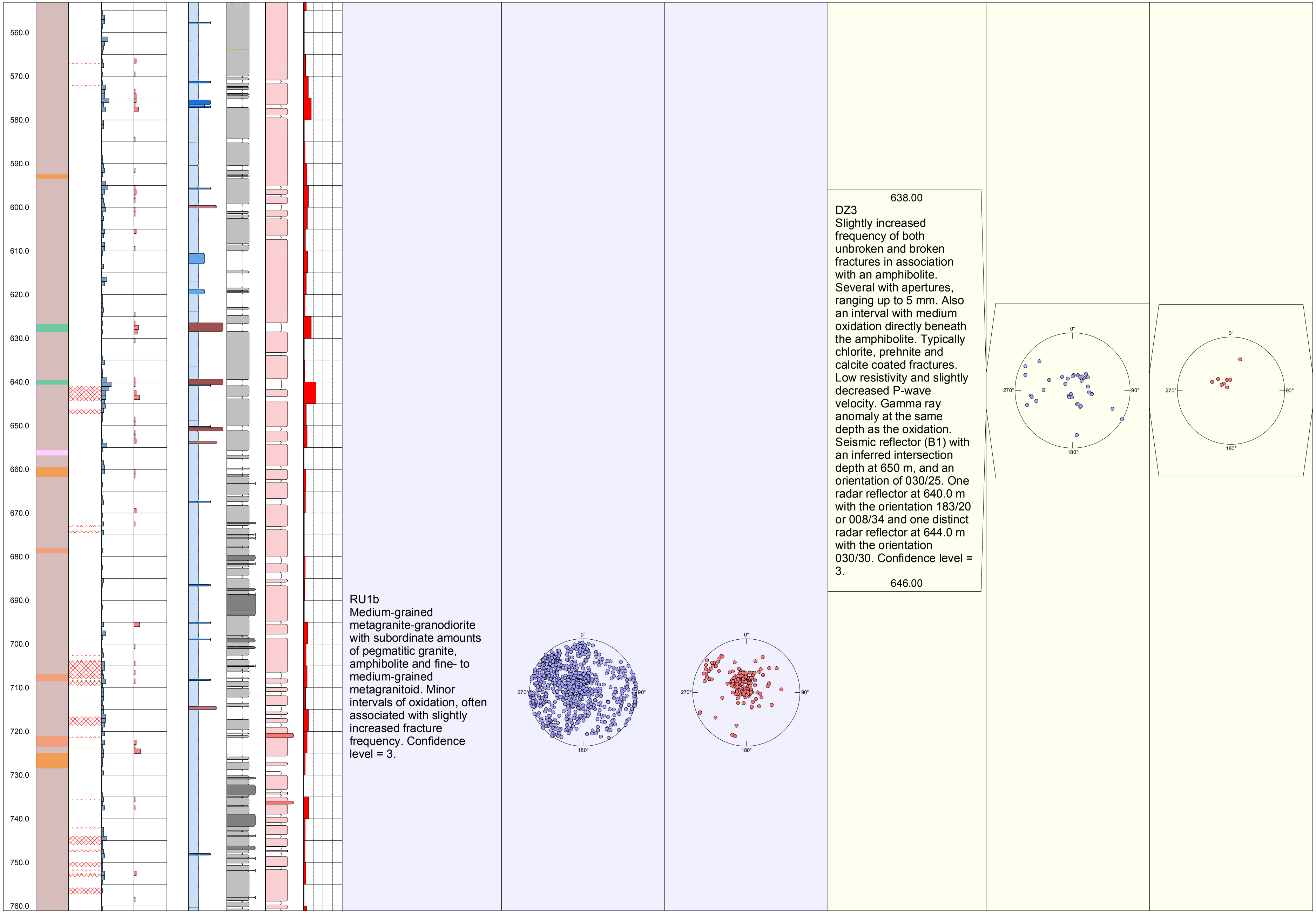
RU3b
Fine- to medium-grained metatonalite and medium-grained metagranite-granodiorite with minor occurrences of pegmatitic granite and amphibolite. Generally higher density, lower gamma radiation and low magnetic susceptibility. Confidence level = 3.
399.00
399.00

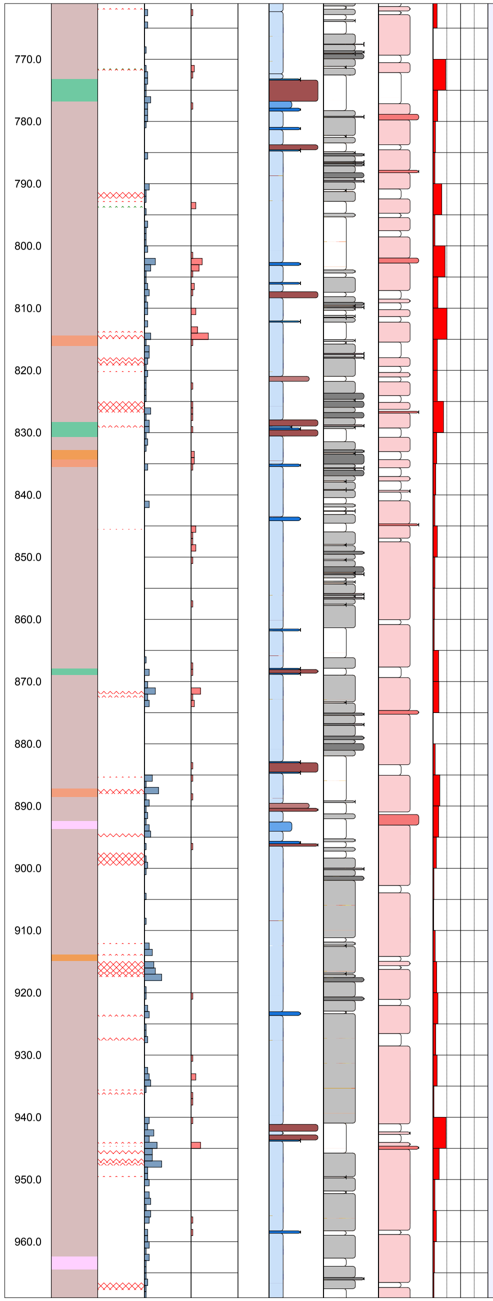


apertures up to about 7 mm. Two intervals with more than ten fractures per metre. Some of the fractures are filled with calcite and/or chlorite, whereas the majority are unfilled. Low resistivity and P-wave velocity. Seismic reflector (A4) with an inferred intersection depth at 370 m, and an orientation of 065/25. Two non-oriented radar reflectors at 373.0 m and 382.0 m with the angle to borehole axis 79 and 62 degrees, respectively. Six oriented radar reflectors occur at 359.0 m (353/36 or 171/26), 365.0 m (116/14 or 321/21), 367.0 m (040/78 or 222/70), 375.0 m (194/23 or 010/33), 389.0 m (277/22 or 073/23) and 399.0 m (082/24). Confidence level = 3.
399.00
448.00

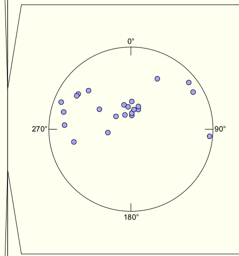
DZ2
Slightly increased frequency of both unbroken and broken fractures in association with an amphibolite. One fracture with an aperture of 8 mm. Also an interval with medium oxidation directly beneath the amphibolite. Typically chlorite and/or calcite coated fractures, with a few coated by prehnite, hematite and clay minerals. Low resistivity and slightly decreased P-wave velocity. One distinct radar reflector at 452.0 m with the orientation 043/36 or 235/27. Confidence level = 3.
455.00

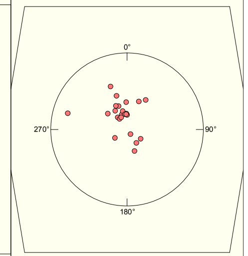



560.0
570.0
580.0
590.0
600.0
610.0
620.0
630.0
640.0
650.0
660.0
670.0
680.0
690.0
700.0
710.0
720.0
730.0
740.0
750.0
760.0
RU1b
Medium-grained metagranite-granodiorite with subordinate amounts of pegmatitic granite, amphibolite and fine- to medium-grained metagranitoid. Minor intervals of oxidation, often associated with slightly increased fracture frequency. Confidence level = 3.
0°
90°
180°
270°
638.00
DZ3
Slightly increased frequency of both unbroken and broken fractures in association with an amphibolite. Several with apertures, ranging up to 5 mm. Also an interval with medium oxidation directly beneath the amphibolite. Typically chlorite, prehnite and calcite coated fractures. Low resistivity and slightly decreased P-wave velocity. Gamma ray anomaly at the same depth as the oxidation. Seismic reflector (B1) with an inferred intersection depth at 650 m, and an orientation of 030/25. One radar reflector at 640.0 m with the orientation 183/20 or 008/34 and one distinct radar reflector at 644.0 m with the orientation 030/30. Confidence level = 3.
646.00

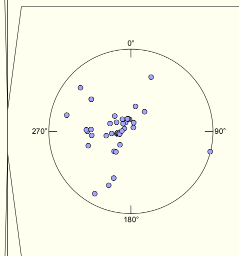


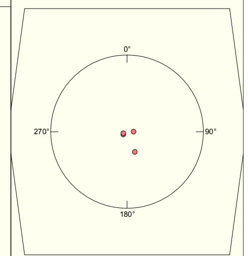
803.00
DZ4
Increased frequency of broken fractures especially in the uppermost and lowermost part of this possible zone. Some with measurable apertures, ranging up to 5 mm. Typically chlorite and/or calcite coated fractures, with a few coated by clay minerals and prehnite. Characterised by low resistivity and slightly decreased P-wave velocity. Gamma ray anomaly in the uppermost part of the possible zone. Seismic reflector (A3) with an inferred intersection depth at 800 m, and an orientation of 065/25. Oriented radar reflectors occur at 804.0 m (268/27), 811.0 m (092/23) and 815.0 m (328/21 or 109/17). Confidence level = 3.
816.00

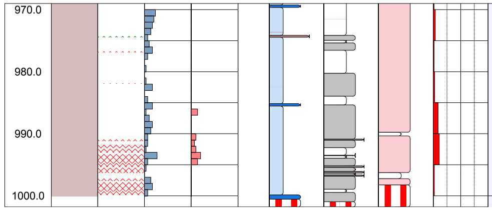




942.00
DZ5
Increased frequency of broken fractures; some with apertures ranging up to 6 mm. Fracture with 6 mm aperture is situated along the lower contact of a minor amphibolite occurrence. Also variable degree of oxidation beneath the amphibolite. Typically chlorite, calcite, hematite and clay mineral coatings. Characterised by low resistivity and slightly decreased P-wave velocity. Gamma ray anomaly in the central part of the possible zone. Seismic reflector (A2) has an inferred intersection depth at 900 m and an orientation of 080/22. No







1000.00

clear indication for a deformation zone in the borehole at this depth. One distinct radar reflector at 944.0 m with the orientation 031/26. Confidence level = 3.
949.00

Appendix 3

Geological single-hole interpretation for HFM06

Title	SINGLE HOLE INTERPRETATION HFM06					
Site	FORSMARK	Inclination [°]	-84.59	Elevation [m.a.s.l.]	6.64	Signed data
Borehole	HFM06	Date of mapping	2003-02-27 00:00:00	Drilling Start Date	2002-12-18 07:00:00	
Diameter [mm]	134	Coordinate System	RT90-RHB70	Drilling Stop Date	2003-01-14 12:00:00	
Length [m]	110.700	Northing [m]	6697752.01	Surveying Date		
Bearing [°]	2.44	Easting [m]	1634522.19	Plot Date	2006-09-20 21:10:12	

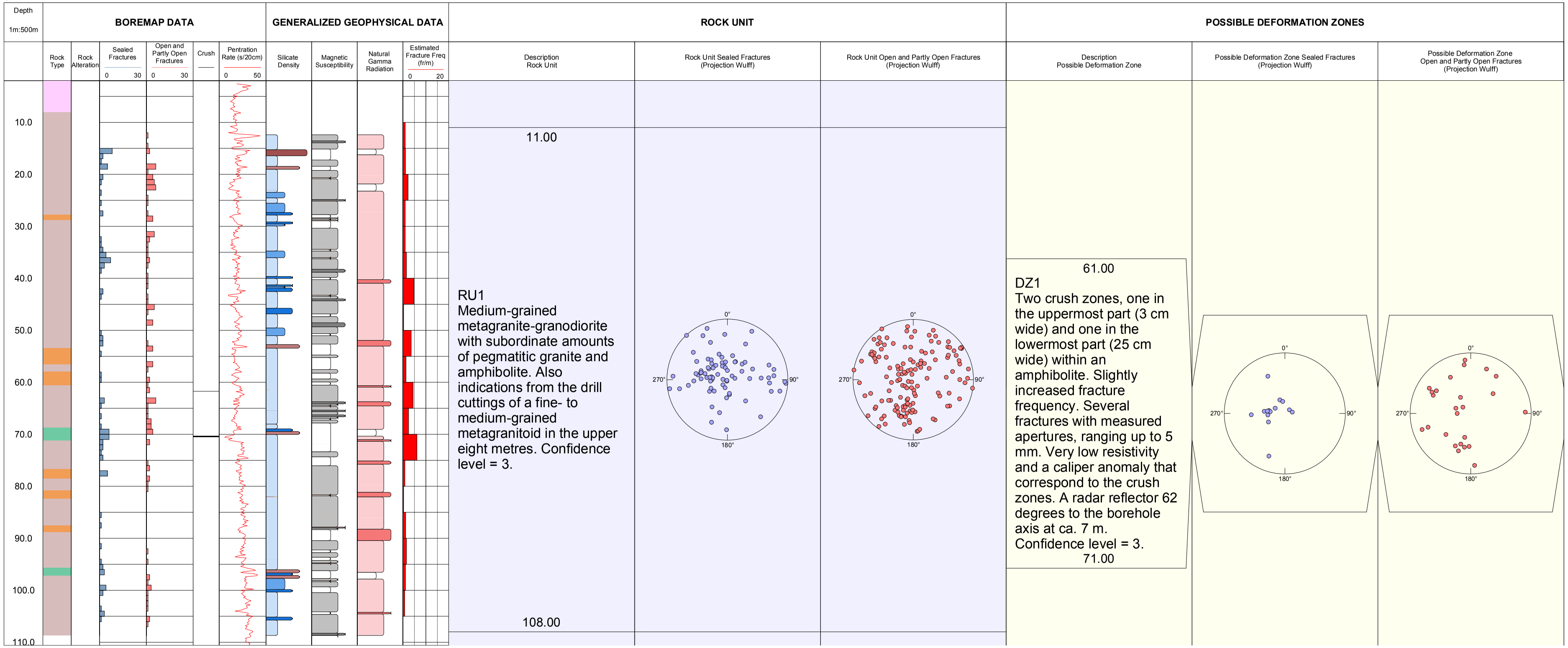
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite to granodiorite, metamorphic, medium-grained
- Amphibolite

ROCK ALTERATION

SILICATE DENSITY
- dens<2680 (Granite)
- 2680<dens<2730 (Granodiorite)
- 2730<dens<2800 (Tonalite)
- 2800<dens<2890 (Diorite)
- dens>2890 (Gabbro)

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

NATURAL GAMMA
- gam<20
- 36<gam<53
- 20<gam<36



Appendix 4

Geological single-hole interpretation for HFM07

Title SINGLE HOLE INTERPRETATION HFM07

Site	FORSMARK	**Inclination [°]**	-84.51	**Elevation [m.a.s.l.]**	5.78
Borehole	HFM07	**Date of mapping**	2003-03-06 00:00:00	**Drilling Start Date**	2003-01-16 13:00:00
Diameter [mm]	140	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2003-01-28 13:00:00
Length [m]	122.500	**Northing [m]**	6697416.25	**Surveying Date**	
Bearing [°]	342.32	**Easting [m]**	1634715.69	**Plot Date**	2006-09-20 21:10:12

Signed data

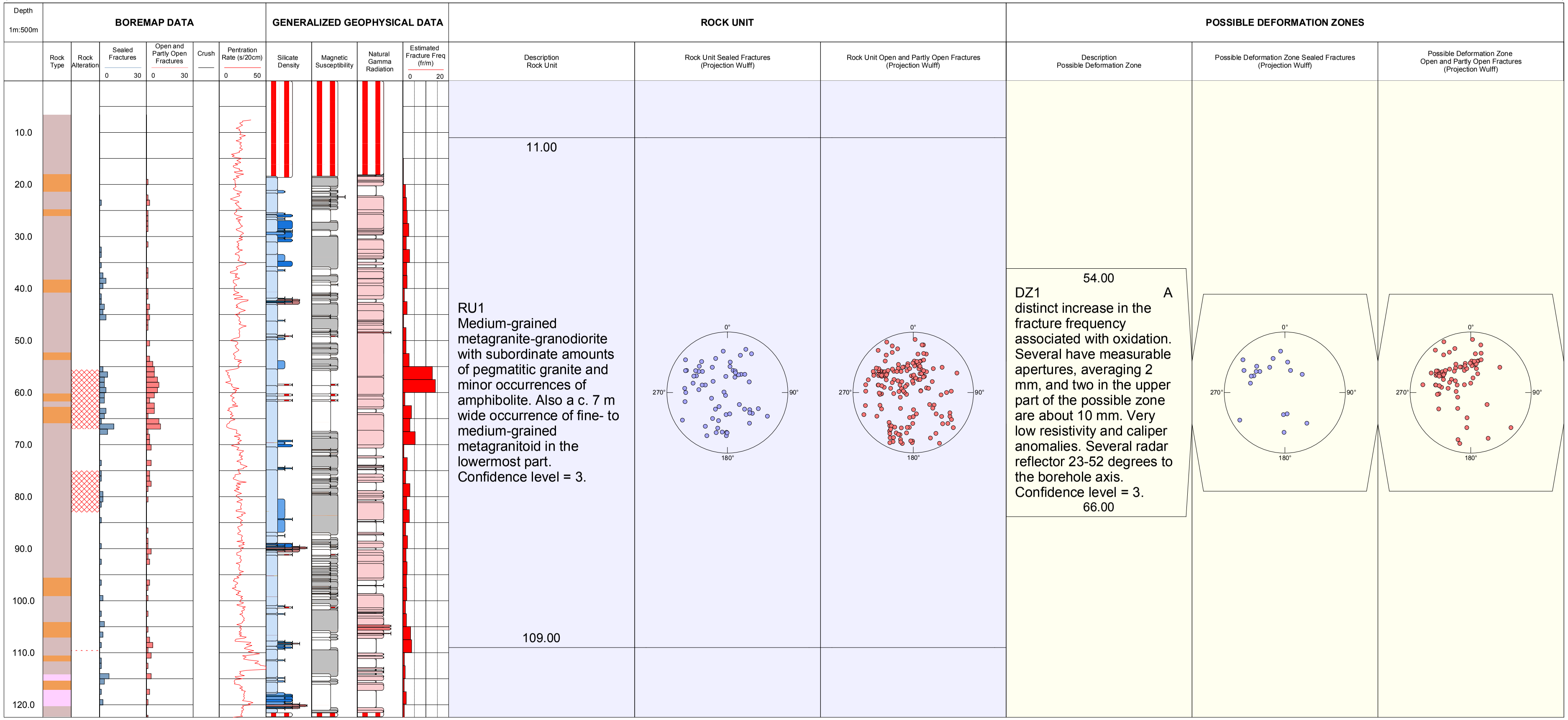
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite to granodiorite, metamorphic, medium-grained

ROCK ALTERATION
- Oxidized

SILICATE DENSITY
- unclassified
- dens<2680 (Granite)
- 2680<dens<2730 (Granodiorite)
- 2730<dens<2800 (Tonalite)
- 2800<dens<2890 (Diorite)
- dens>2890 (Gabbro)

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

NATURAL GAMMA
- 36<gam<53
- gam<20
- 20<gam<36
- unclassified
- gam<20
- 20<gam<36
- 36<gam<53



Appendix 5

Geological single-hole interpretation for HFM08.

Title SINGLE HOLE INTERPRETATION HFM08

Site	FORSMARK	**Inclination [°]**	-84.43	**Elevation [m.a.s.l.]**	7.13	**Signed data**
Borehole	HFM08	**Date of mapping**	2003-03-06 00:00:00	**Drilling Start Date**	2003-01-29 09:00:00	
Diameter [mm]	137	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2003-02-12 12:00:00	
Length [m]	143.500	**Northing [m]**	6697703.28	**Surveying Date**		
Bearing [°]	348.69	**Easting [m]**	1634777.50	**Plot Date**	2006-09-20 21:10:12	

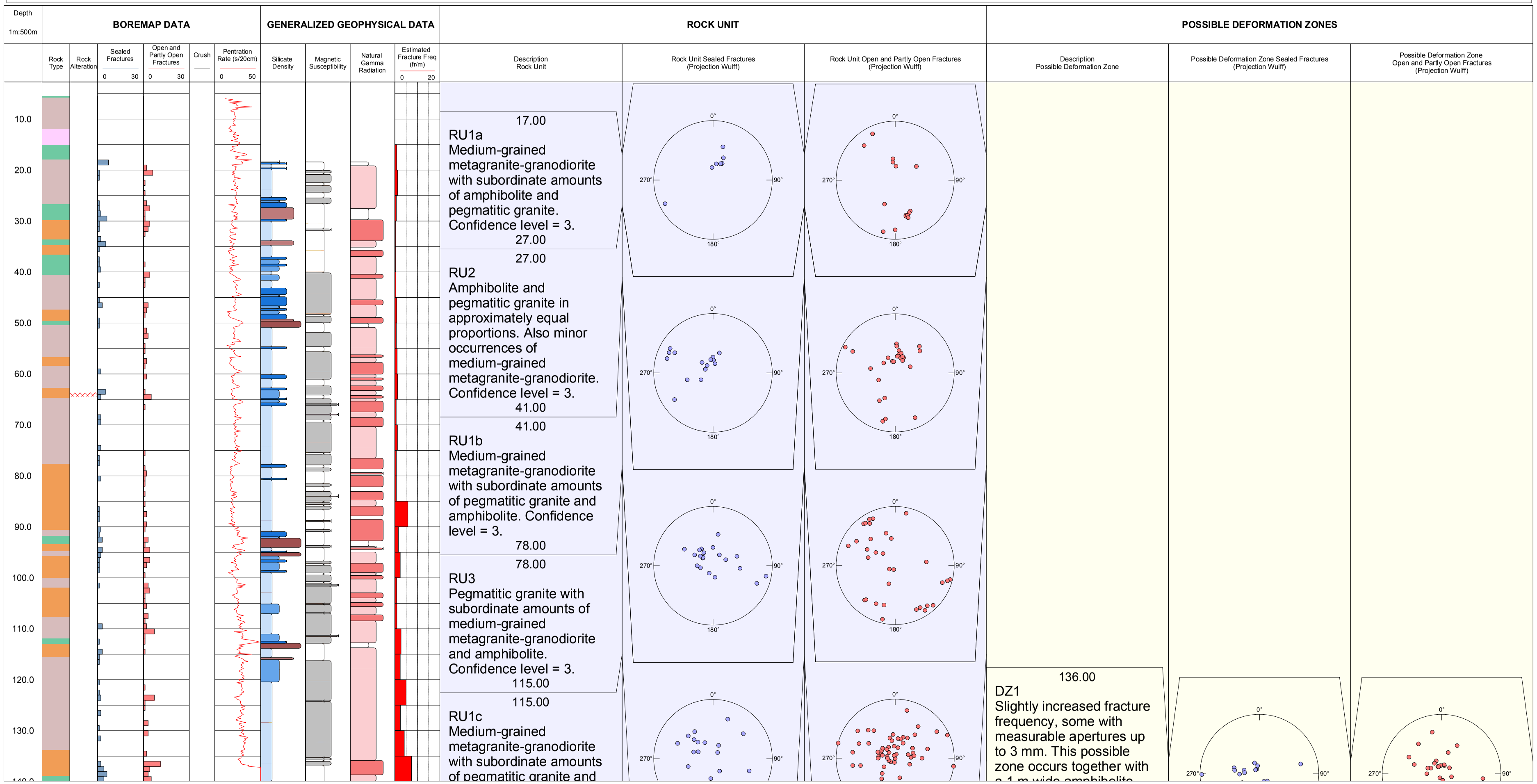
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite to granodiorite, metamorphic, medium-grained
- Amphibolite

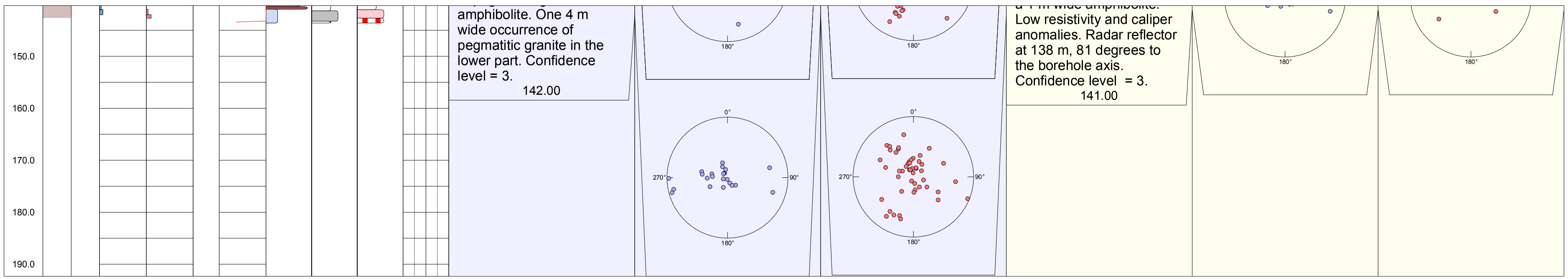
ROCK ALTERATION
- Oxidized

SILICATE DENSITY
- dens<2680 (Granite)
- 2680<dens<2730 (Granodiorite)
- 2730<dens<2800 (Tonalite)
- 2800<dens<2890 (Diorite)
- dens>2890 (Gabbro)

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

NATURAL GAMMA
- 20<gam<36
- 36<gam<53
- unclassified
- gam<20




150.0
160.0
170.0
180.0
190.0
amphibolite. One 4 m
wide occurrence of
pegmatitic granite in the
lower part. Confidence
level = 3.
142.00
0°
90°
180°
270°
Low resistivity and caliper
anomalies. Radar reflector
at 138 m, 81 degrees to
the borehole axis.
Confidence level = 3.
141.00