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Revised October 2006

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June 2004

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Keywords: Forsmark, Geophysics, Geology, Borehole, Bedrock, Fractures, Field note: Forsmark 314, AP PF 400-04-39.

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 as well as in Appendix 1.

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, 2 and 3 are updated.

Abstract

This report constitutes geological single-hole interpretations of the cored boreholes KFM04A and the percussion boreholes HFM09-10 in Forsmark. The geological single-hole interpretation combines the geological core mapping, interpreted geophysical logs and borehole radar measurements to interpret where lithological rock units and possible deformation zones occurs in the boreholes.

The geological single-hole interpretation shows that eight lithological rock units occur in KFM04A. The rock units are further subdivided into 13 sections based on degree of plastic deformation and fracture frequency. Metagranitoid and a felsic to intermediate metavolcanic rock type occur in the upper part of the borehole. Below 177 m, medium-grained metagranite-granodiorite dominates. Pegmatitic granite, amphibolite, fine-medium grained metagranitoid and metavolcanic rock occurs as subordinate rock types. Some sections with a fine-medium grained rock type rich in hornblende-quartz-feldspar also occur. Five possible deformation zones have been identified in KFM04A.

The percussion borehole HFM09 is dominated by fine-grained metatonalite-granodiorite. Amphibolite, aplitic metagranite and a fine-grained felsic to intermediate metavolcanic rock occurs as subordinate rock types. One possible deformation zones have been identified in HFM09.

The percussion borehole HFM10 is dominated by fine-medium grained metatonalite-granodiorite. Amphibolite, metagranite-granodiorite, pegmatitic granite, aplitic metagranite and a few sections with felsic to intermediate metavolcanic rock occurs as subordinate rock types. Two possible deformation zones have been identified in HFM10.

Sammanfattning

Denna rapport behandlar geologisk enhålstolkning av kärnborrhål KFM04A samt hammarborrhålen HFM09-10 i Forsmark. Den geologiska enhålstolkningen syftar till att utifrån data från den geologiska karteringen, tolkade geofysiska loggar och borrhålsradarmätningar indikera olika litologiska enheters fördelning i borrhålen samt möjliga deformationszoners läge och utbredning.

Denna undersökning visar att det i KFM04A finns 8 litologiska enheter. På grund av graden av plastisk deformation och sprickfrekvens samt repetition av vissa enheter kan borrhålet delas in i 13 sektioner. Metagranitoid och felsisk till intermediär metavulkanisk bergart förekommer i den övre delen av borrhålet. Under 177 m dominerar metagranit-granodiorit. Pegmatitisk granit, amfibolit, fint medelkornig metagranitoid och metavulkanisk bergart förekommer i mindre omfattning. Partier med fin- till medelkornig hornbländerik kvartsfältspat bergart förekommer också. Fem möjliga deformationszoner har identifierats i KFM04A.

Hammarborrhål HFM09 domineras av finkornig metatonalit-granodiorit med mindre inslag av amfibolit, aplitisk metagranit och en finkornig felsisk till intermediär metavulkanisk bergart. En möjlig deformationszon har identifierats i HFM09.

Hammarborrhål HFM10 domineras av fint medelkornig metatonalit-granodiorit med mindre inslag av amfibolit, metagranit-granodiorit, pegmatitisk granit, aplitisk metagranit och ett fåtal sektioner med felsisk till intermediär metavulkanisk bergart. Två möjliga deformationszoner har identifierats i HFM10.

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

This document reports the geological single-hole interpretation of three boreholes at drilling site 4 (DS4) in the Forsmark area. These includes the cored borehole KFM04A and the percussion-drilled boreholes HFM09 and HFM10 (Figure 1-1). Also the percussion drilled part (100 m) of KFM04A has been completed. The core drilling, from 100 m and downwards, is planned for a later time and the single hole interpretation will therefore be postponed until the borehole is completed.

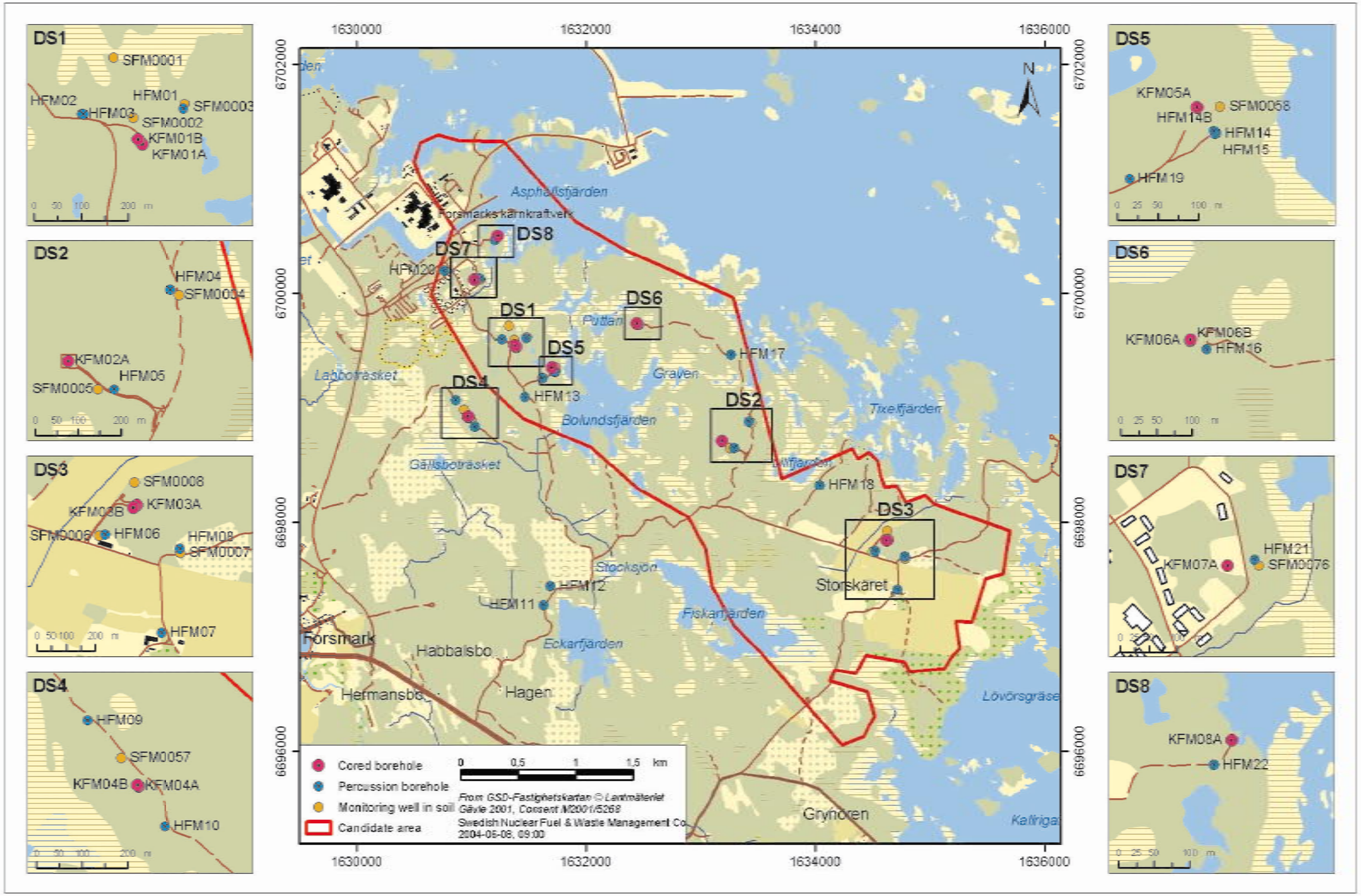


Figure 1-1. *Map showing the location of drilling site 4 (DS4) and the position of the boreholes KFM04A and HFM09-10.*

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, 4 and 5/.
- Radar data and their interpretation /6/.

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 mark, 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 /6/.

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 short and long normal resistivity, SPR, sonic 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.

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.

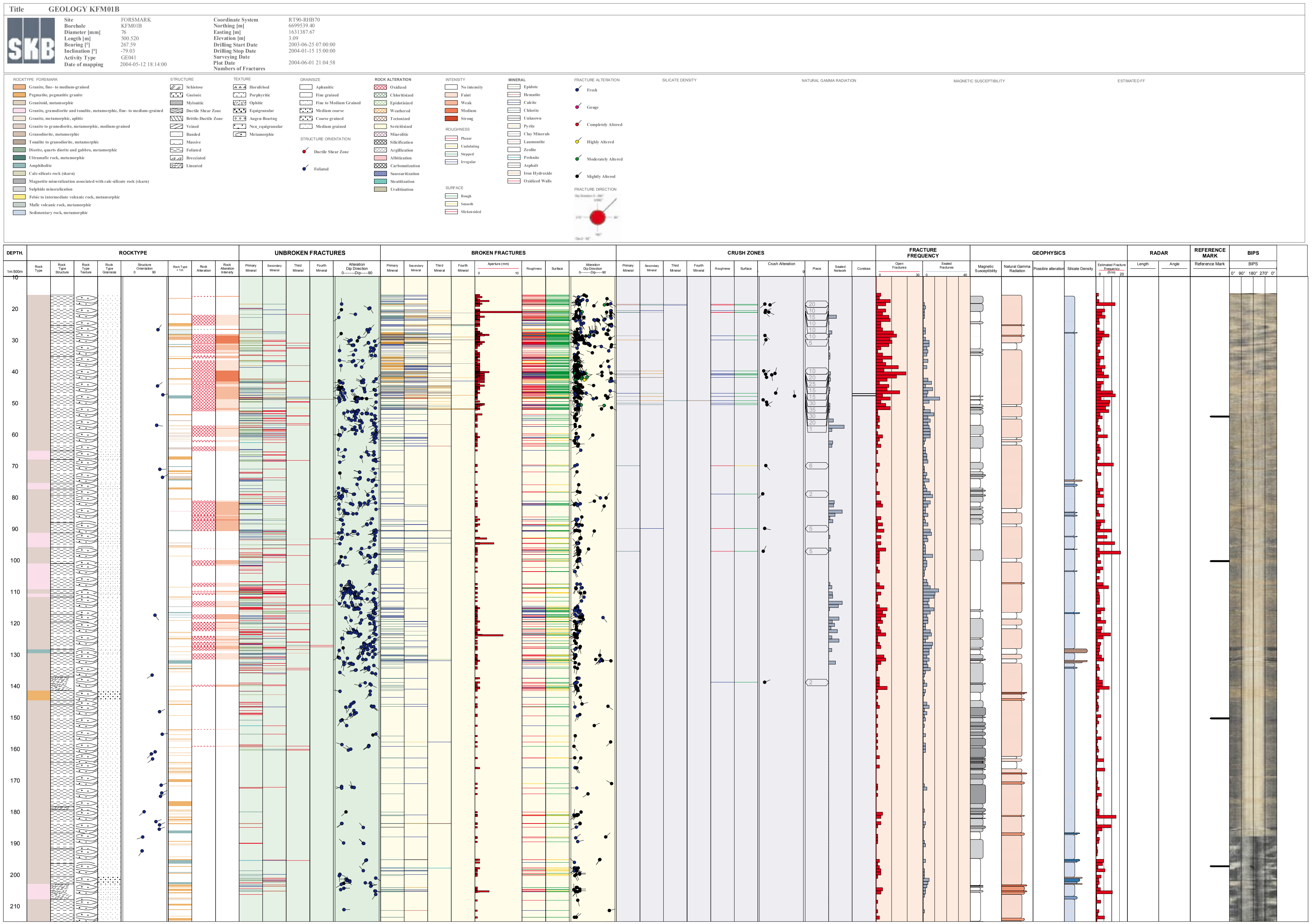


Figure 3-1. Example of WellCad plot used as basis for the single-hole interpretation.

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.

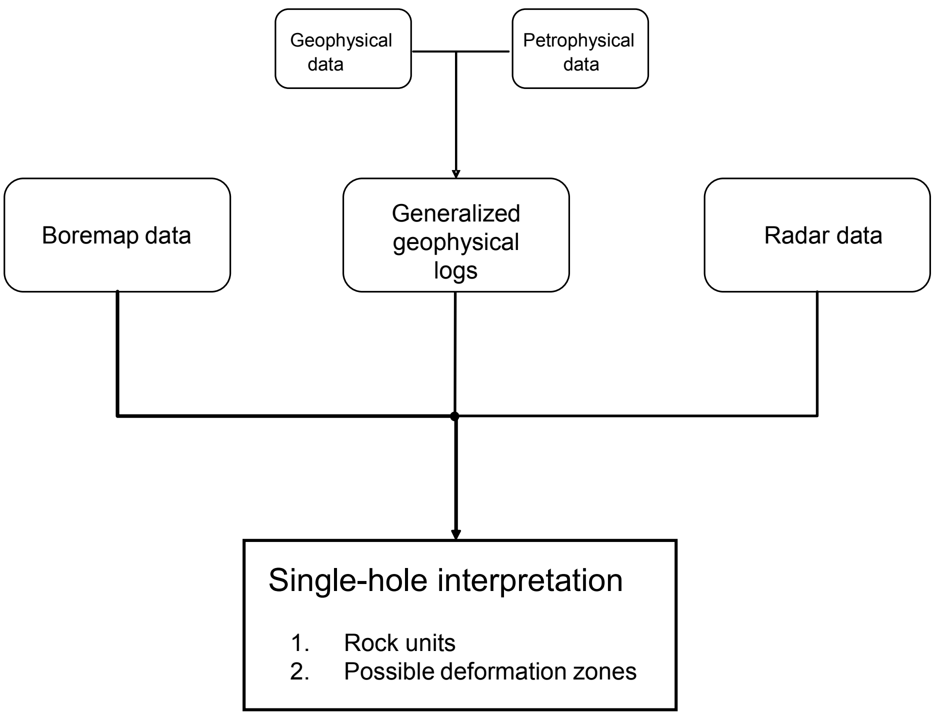


Figure 4-1. Schematic block diagram of geological single-hole interpretation.

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 KFM04A, Appendix 2 for HFM09, and Appendix 3 for HFM10). 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 KFM04A

The borehole can be divided into eight different rock units, some of which are recurrent in the borehole. Furthermore, the upper 500 m of the borehole shows more intense ductile deformation and a higher fracture frequency relative to the lower part of the borehole. For this reasons the borehole is divided into 13 rock sections:

12-88 m	RU1: Fine-grained, felsic to intermediate metavolcanic rock and fine- to medium-grained metagranodiorite and metagranite-granodiorite in approximately equal proportions. Subordinate occurrences of pegmatitic granite and at the base of the section one c. 1 m wide amphibolite. Confidence level = 2.
88-177 m	RU2: Strongly foliated, fine- to medium-grained metagranodiorite with subordinate occurrences of pegmatitic granite, fine-grained, felsic to intermediate metavolcanic rock in the upper half of the interval and amphibolite in the lower half of the interval. Generally increased fracture frequency relative to the lower half of the borehole. Generally higher density and lower natural gamma radiation relative to the rock unit below. Confidence level = 3.
177-275 m	RU3a: Strongly foliated, fine- to medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite and amphibolite, and a few occurrences of finegrained, felsic to intermediate metavolcanic rock and fine- to medium-grained metagranitoid. Generally increased fracture frequency relative to the lower half of the borehole. Confidence level = 3.
275-342 m	RU4: More inhomogeneous mixture of strongly foliated, fine- to medium-grained metagranite-granodiorite and fine-grained, felsic to intermediate metavolcanic rock. Subordinate occurrences of pegmatitic granite, amphibolite and fine- to medium-grained metagranitoid. Two ductile, high strain zones in the lower part of the rock unit. Generally increased fracture frequency relative to the lower half of the borehole. Confidence level = 3.
342-443 m	RU5: Mixture of fine- to medium-grained metagranitoid and strongly foliated, fine-to medium-grained metagranite-granodiorite. Subordinate occurrences of pegmatitic granite and amphibolite. Several ductile, high strain zones, some of which are associated with muscovite alteration. Generally increased fracture frequency relative to the lower half of the borehole. Also minor oxidation and a c. 15 cm wide crush zone at a length

of c. 360 m. In the interval 342-393 m there are several thin intervals with high natural gamma radiation. The interval 393-443 m shows a dominantly low magnetic susceptibility. Confidence level = 3.

443-500 m RU3b: Strongly foliated, fine- to medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite and amphibolite, and a few occurrences of fine- to medium-grained metagranitoid. Generally increased fracture frequency relative to the lower half of the borehole. Several thin intervals of high natural gamma radiation. One distinct radar reflector intersects the borehole at c. 425 m and can be followed down to c. 600 m; strike 300 degrees and dip 60 degrees, which corresponds in orientation with a pegmatite contact at 443 m. Confidence level = 3.

500-724 m RU6a: Medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite, amphibolite and fine- to medium-grained metagranitoid. The upper 25 m interval of the rock unit has low magnetic susceptibility, whereas the interval 636-724 m has high magnetic susceptibility. Confidence level = 3.

724-743 m RU7a: Fine- to medium-grained, hornblende-rich quartz-feldspar rock (mapped as amphibolite), with sulphide dissemination. Subordinate occurrences of medium-grained metagranite-granodiorite and pegmatitic granite. High density, low magnetic susceptibility and low natural gamma radiation. Confidence level = 3.

743-938 m RU6b: Medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite and amphibolite, as well as two minor occurrences of fine- to medium-grained metagranitoid and one, almost 2 m wide occurrence of fine-grained, felsic to intermediate metavolcanic rock. Confidence level = 3.

938-967 m RU8: Fine- to medium-grained metagranitoid with subordinate occurrences of pegmatitic granite and medium-grained metagranite-granodiorite. The whole rock unit has low magnetic susceptibility and partly increased density. Confidence level = 3.

967-990 m RU6c: Medium-grained metagranite-granodiorite with subordinate occurrences of fine- to medium-grained metagranitoid and pegmatitic granite. Confidence level = 3.

990-999 m RU7b: Fine- to medium-grained, hornblende-rich quartz-feldspar rock (mapped as amphibolite), with sulphide dissemination. Subordinate occurrences of medium-grained metagranite-granodiorite and pegmatitic granite. High density, low magnetic susceptibility and low natural gamma radiation. Confidence level = 3.

999-1001.5 m RU6d: Medium-grained metagranite-granodiorite with one, minor occurrence of pegmatitic granite. Confidence level = 3.

Five possible deformation zones are indicated in KFM04A:

169-176 m	DZ1: Slightly increased frequency of both sealed and open, steeply dipping fractures. Generally weak oxidation. Predominant fracture fillings are calcite, chlorite, hematite and prehnite. Clearly decreased electric resistivity and slightly decreased P-wave velocity. One oriented radar reflector occurs at 170.9 m with the orientation 326/32 and one non-oriented at 168.6 m with the angle 55 degrees to borehole axis. Confidence level = 2.
202-213 m	DZ2: Marked increased frequency of flat lying, open fractures and steeply dipping, sealed fractures. Fracture apertures range up to 7 mm in width. Generally faint to weak oxidation. Predominant fracture minerals are calcite, hematite and chlorite. Also a few fractures with epidote and laumontite. Clearly decreased electric resistivity and slightly decreased P-wave velocity. Two radar reflectors occur at 205.9 m (128/73) and at 210.9 m (316/11) and one non-oriented radar reflector at 208.6 m with an intersection angle to the borehole of 48 degrees. Confidence level = 3.
232-242 m	DZ3: Marked increased frequency of flat lying, open fractures filled by calcite, hematite and chlorite. Fracture apertures range up to more than 10 mm in width. One c. 15 cm wide crush zone and sealed network in the lower part of the possible zone. Faint to strong oxidation. Clearly decreased electric resistivity and P-wave velocity. Distinct caliper anomaly. One radar reflector at 234.7 m with the orientation 136/57 or 044/9. Confidence level = 3.
412-462 m	DZ4: Marked by a network of fractures mainly sealed by laumontite, calcite and chlorite. Also some open fractures with apertures greater or equal to 5 mm. Alterations in the interval include varying degrees of oxidation, epidotization and clay alteration. The possible zone includes parts affected by high ductile strain. Section 412-435 m indicated by a low electric resistivity. No other geophysical anomalies. Five oriented radar reflectors occur at 425.0 m (243/61), 434.5 m (338/7), 447.6 m (253/6 or 120/70), 455.2 m (350/8) and 459.3 m (206/87). Three non-oriented radar reflectors occur at 412.5 m, 444.0 m and 459.3 m with the angle 46, 11 and 49 degrees to borehole axis, respectively. Confidence level = 3.
654-661 m	DZ5: Marked by increased frequency of sealed fractures and weak oxidation. Corresponds also to a brittle-ductile high strain zone and a c. 1 m wide amphibolite. Predominant fracture sealing minerals are prehnite, calcite, epidote and chlorite. Clearly decreased electric resistivity and slightly decreased P-wave velocity. One distinct radar reflector at 658.0 m with the orientation 143/78 and one non-oriented at a length of 654.8 m with the angle 55 degrees to borehole axis. Confidence level = 2.

5.2 HFM09

The borehole consists of one rock unit:

17-50 m RU1: Fine-grained metatonalite-granodiorite with subordinate occurrences of amphibolite, aplitic metagranite and fine-grained, felsic to intermediate metavolcanic rock, and one occurrence of pegmatitic granite. Confidence level = 2.

One possible deformation zone is indicated:

18-28 m DZ1: The possible zone is defined by an increased frequency of flat lying, open fractures and two major crush zones; one of them c. 1.5 m wide. Locally medium oxidation. The crush zones correspond to two radar reflectors with an intersection angle of 90 and 78 degrees to the borehole axis. Confidence level = 2.

5.3 HFM10

The borehole consists of one rock unit:

12-149 m RU1: Fine- to medium-grained metatonalite-granodiorite with subordinate occurrence of amphibolite, fine- to medium-grained metagranite-granodiorite, pegmatitic granite, aplitic metagranite and a few minor occurrences of fine-grained, felsic to intermediate metavolcanic rock. Silicate density indicates mainly tonalitic composition. Confidence level = 2.

There are two possible deformation zones in the borehole:

65-69 m DZ1: Slight increase in the frequency of open fractures. Also a minor crush zone and strong oxidation. Decrease in electric resistivity and P-wave velocity. Minor caliper anomaly. Three radar reflectors with an intersection angle of 21, 40 and 57 degrees to the borehole axis. Confidence level = 2.

108-117 m DZ2: Decrease in electric resistivity and P-wave velocity. Distinct caliper anomaly. Three radar reflectors with an intersection angle of 23, 59 and 90 degrees to the borehole axis. Confidence level = 2.

6 Comments

The results from the geological single-hole interpretations of the KFM04A, HFM09 and HFM10 are presented in WellCad plots (Appendices 1-3). 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)

Nonconformities:

Fractures not visible in BIPS are not excluded from stereo diagrams.

No geophysical logging data was available from HFM09.

7 References

/1/ SKB P-report P-04-116. Boremap mapping of telescopic drilled borehole KFM04A. Petersson J, Wängnerud A, Danielsson P, Stråhle A.

/2/ SKB P-report P-04-101. Boremap mapping of percussion boreholes HFM09-12. Nordman C.

/3/ SKB P-report P-04-143. Interpretation of borehole geophysical measurements in KFM04A, KFM06A (0-100 m) and HFM10-HFM19. Mattsson H, Keisu M, Thunehed H. (in preparation)

/4/ SKB P-report P-04-144. Borehole logging in borehole KFM04A, KFM06A, HFM10, HFM11, HFM12 and HFM13. Nielsen U T, Ringgaard J.

/5/ SKB P-report P-04-67. RAMAC and BIPS logging in borehole KFM04A, KFM04B, HFM09 and HFM10. Gustafsson J, Gustafsson C.

/6/ 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, 2003.

Appendix 1

Geological single-hole interpretation for KFM04A

Title SINGLE HOLE INTERPRETATION KFM04A

Site	FORSMARK	Inclination [°]	-60.07	Elevation [m.a.s.l.]	8.77	Signed data
Borehole	KFM04A	Date of mapping	2003-12-08 00:00:00	Drilling Start Date	2003-05-20 07:00:00	
Diameter [mm]	77	Coordinate System	RT90-RHB70	Drilling Stop Date	2003-06-30 17:40:00	
Length [m]	1001.420	Northing [m]	6698921.74	Surveying Date		
Bearing [°]	45.24	Easting [m]	1630978.96	Plot Date	2006-09-20 21:10:12	

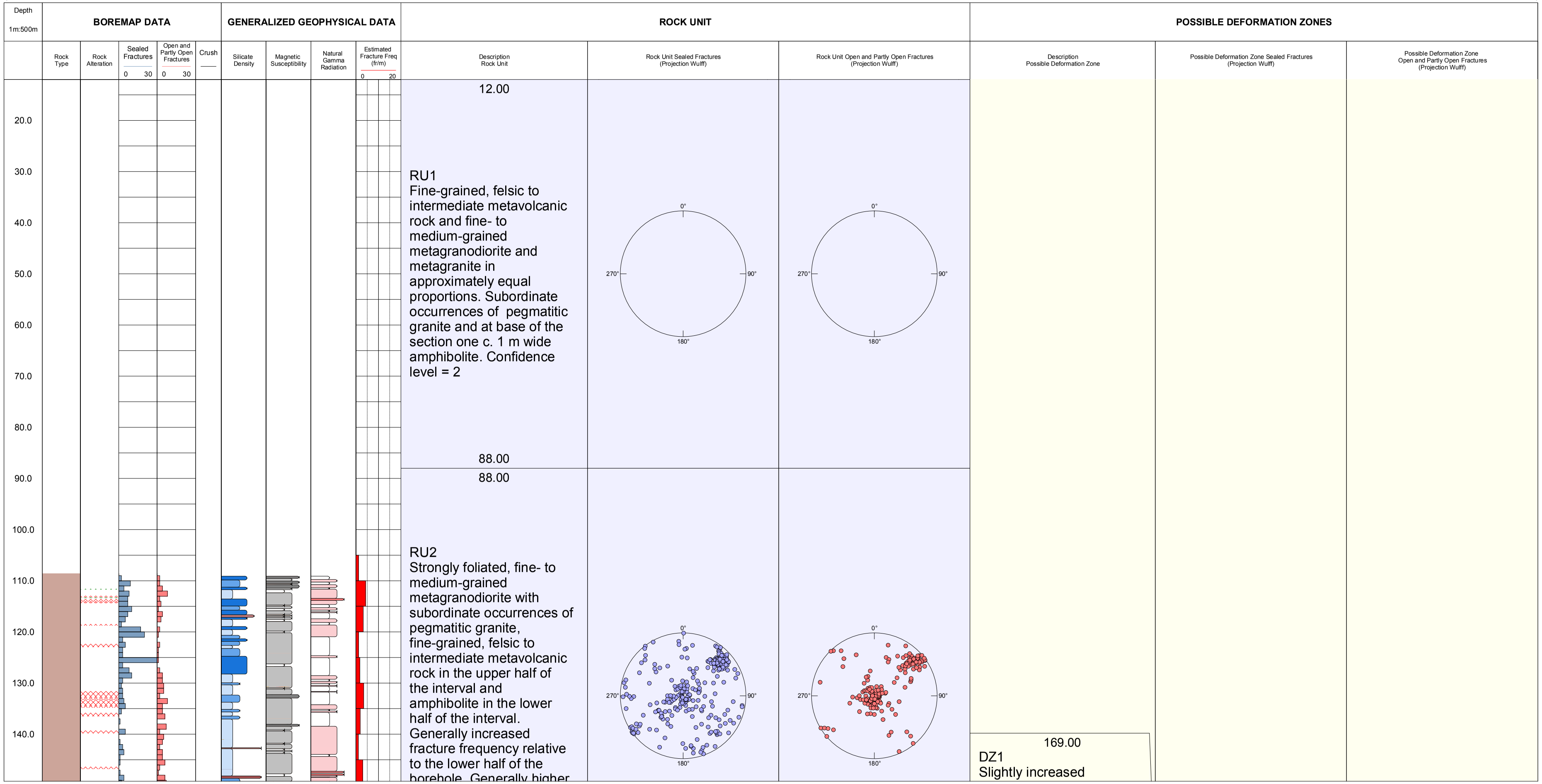
ROCKTYPE FORSMARK
- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite to granodiorite, metamorphic, medium-grained
- Granodiorite, metamorphic
- Amphibolite
- Felsic to intermediate volcanic rock, metamorphic

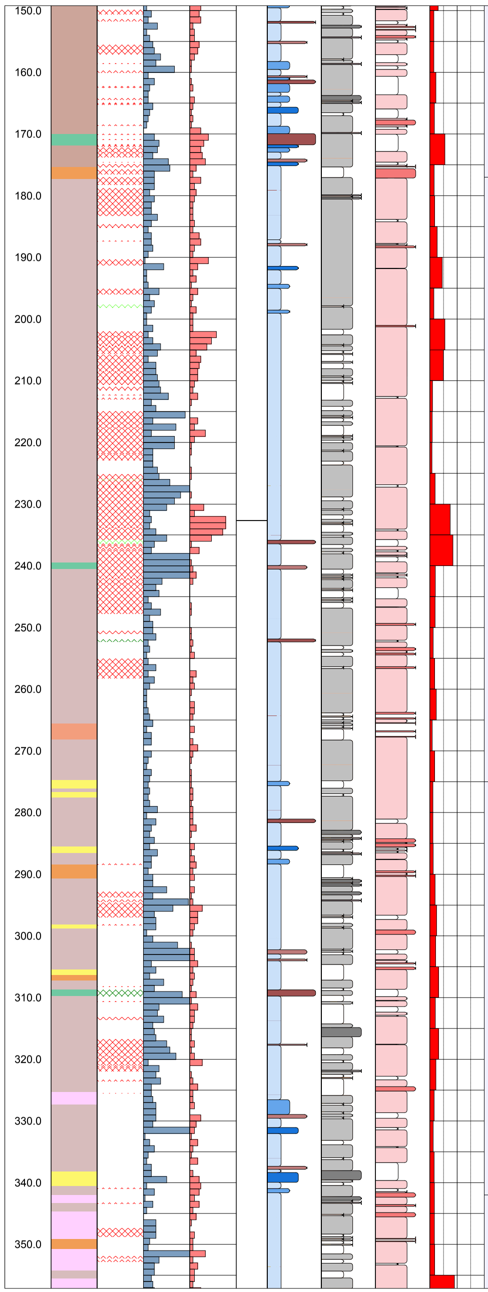
ROCK ALTERATION
- Oxidized
- Chloritisized
- Epidotisized
- Sericitisized
- Argillization

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
- sus>0.1

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





borehole. Generally higher density and lower natural gamma radiation relative to the rock unit below. Confidence level = 3

177.00

177.00

RU3a
Strongly foliated, fine- to medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite and amphibolite, and a few occurrences of fine- grained, felsic to intermediate metavolcanic rock and fine- to medium-grained metagranitoid. Generally increased fracture frequency relative to the lower half of the borehole. Confidence level = 3.

275.00

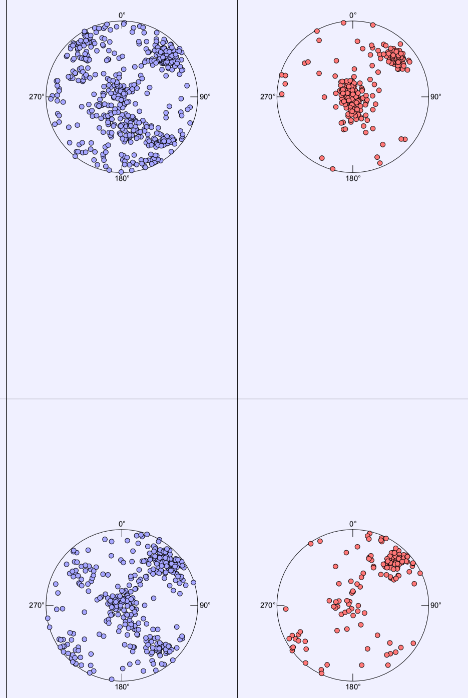
275.00

RU4
More inhomogeneous mixture of strongly foliated, fine- to medium-grained metagranite-granodiorite and fine-grained, felsic to intermediate metavolcanic rock. Subordinate occurrences of pegmatitic granite, amphibolite and fine- to medium-grained metagranitoid. Two ductile, high strain zones in the lower part of the rock unit. Generally increased fracture frequency relative to the lower half of the borehole. Confidence level = 3.

342.00

342.00

RU5
Mixture of fine- to medium-grained metagranitoid and strongly



frequency of both sealed and open, steeply dipping fractures. Generally weak oxidation. Predominant fracture fillings are calcite, chlorite, hematite and prehnite. Clearly decreased electric resistivity and slightly decreased P-wave velocity. One oriented radar reflector occurs at 170.9 m with the orientation 326/32 and one non-oriented at 168.6 m with the angle 55 degrees to borehole axis. Confidence level = 2.

176.00

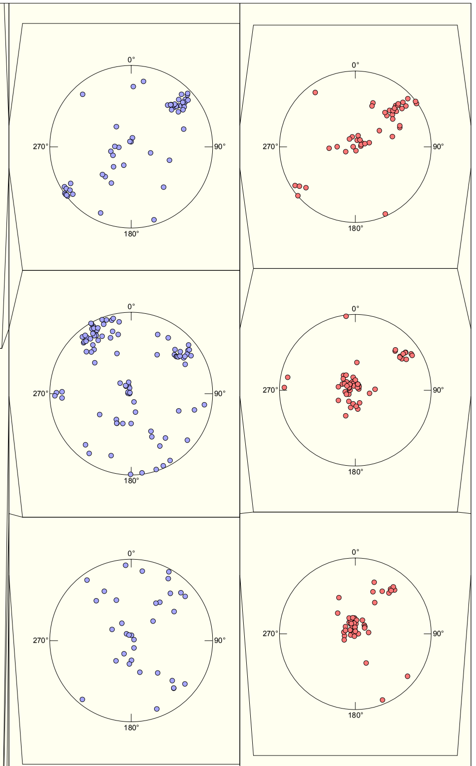
202.00

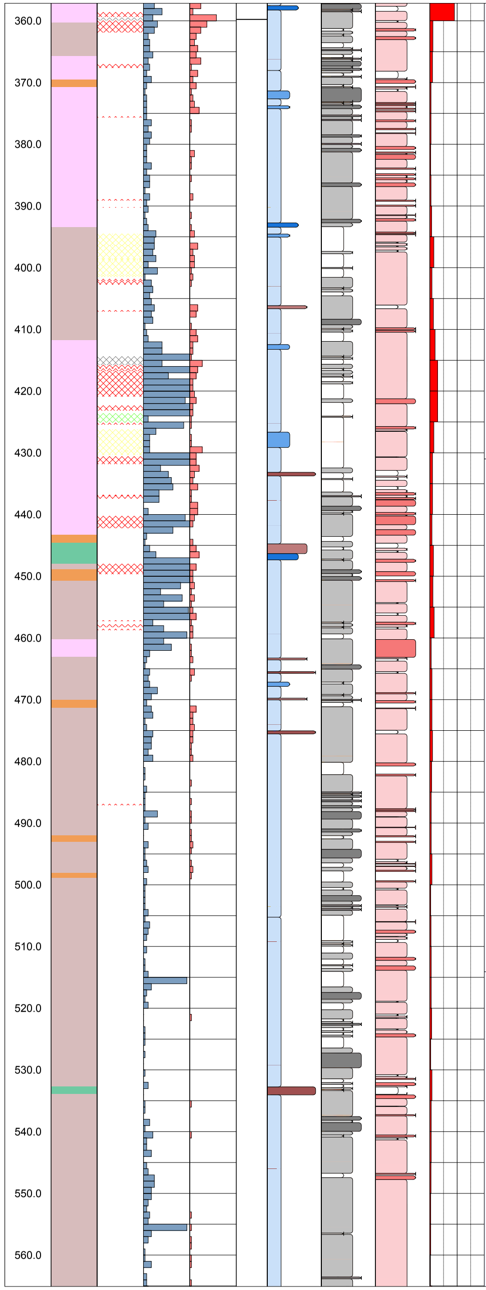
DZ2
Marked increased frequency of flat lying, open fractures and steeply dipping, sealed fractures. Fracture apertures range up to 7 mm in width. Generally faint to weak oxidation. Predominant fracture minerals are calcite, hematite and chlorite. Also a few fractures with epidote and laumontite. Clearly decreased electric resistivity and slightly decreased P-wave velocity. Two radar reflectors occur at 205.9 m (128/73) and at 210.9 m (316/11) and one non-oriented radar reflector at 208.6 m with an intersection angle to the borehole of 48 degrees. Confidence level = 3.

213.00

232.00

DZ3
Marked increased frequency of flat lying, open fractures filled by calcite, hematite and chlorite. Fracture apertures range up to more than 10 mm in width. One c. 15 cm wide crush zone and sealed network in the lower part of the possible zone. Faint to strong oxidation. Clearly decreased electric resistivity and P-wave velocity. Distinct caliper anomaly. One radar reflector at 234.7 m with the orientation 136/57 or 044/9. Confidence level = 3.





foliated, fine-to medium-grained metagranite-granodiorite. Subordinate occurrences of pegmatitic granite and amphibolite. Several ductile, high strain zones, some of which are associated with muscovite alteration. Generally increased fracture frequency relative to the lower half of the borehole. Also minor oxidation and a c. 15 cm wide crush zone at a length of c. 360 m. In the interval 342-393 m there are several thin sections with high natural gamma radiation. The interval 393-443 m shows a dominantly low magnetic susceptibility. Confidence level = 3.

443.00

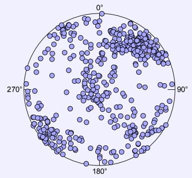
443.00

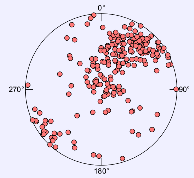
RU3b

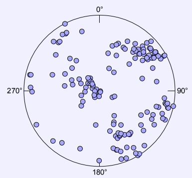
Strongly foliated, fine- to medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite and amphibolite, and a few occurrences of fine- to medium-grained metagranitoid. Generally increased fracture frequency relative to the lower half of the borehole. Several thin intervals of high natural gamma radiation. One distinct radar reflector intersects the borehole at c. 425 m and can be followed down to c. 600 m; strike 300 degrees and dip 60 degrees, which corresponds in orientation with a pegmatite contact at 443 m. Confidence level = 3.

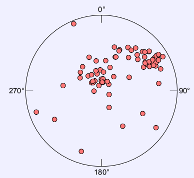
500.00

500.00









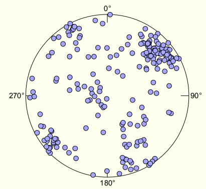
242.00

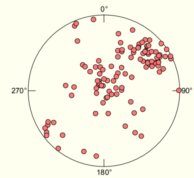
412.00

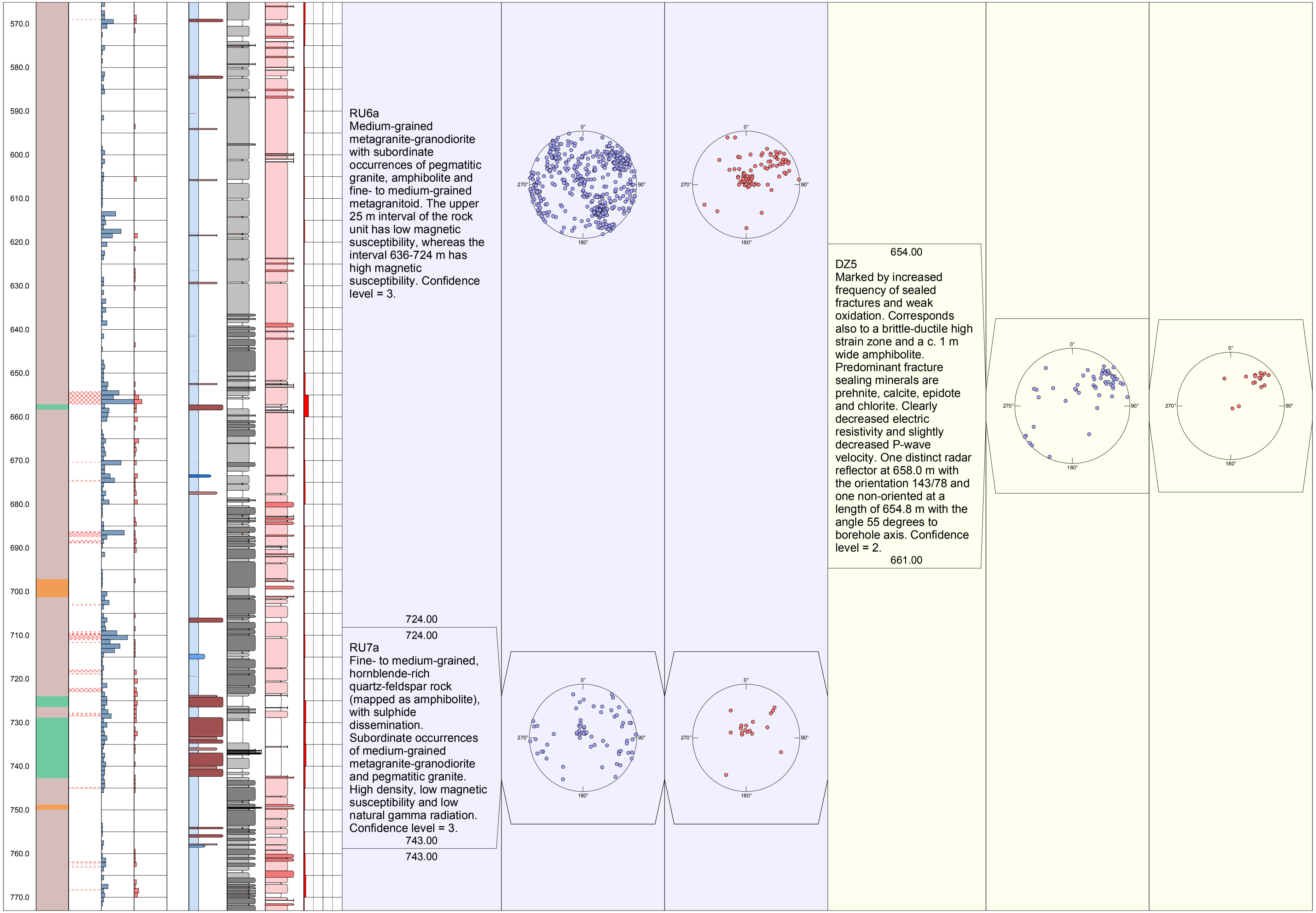
DZ4

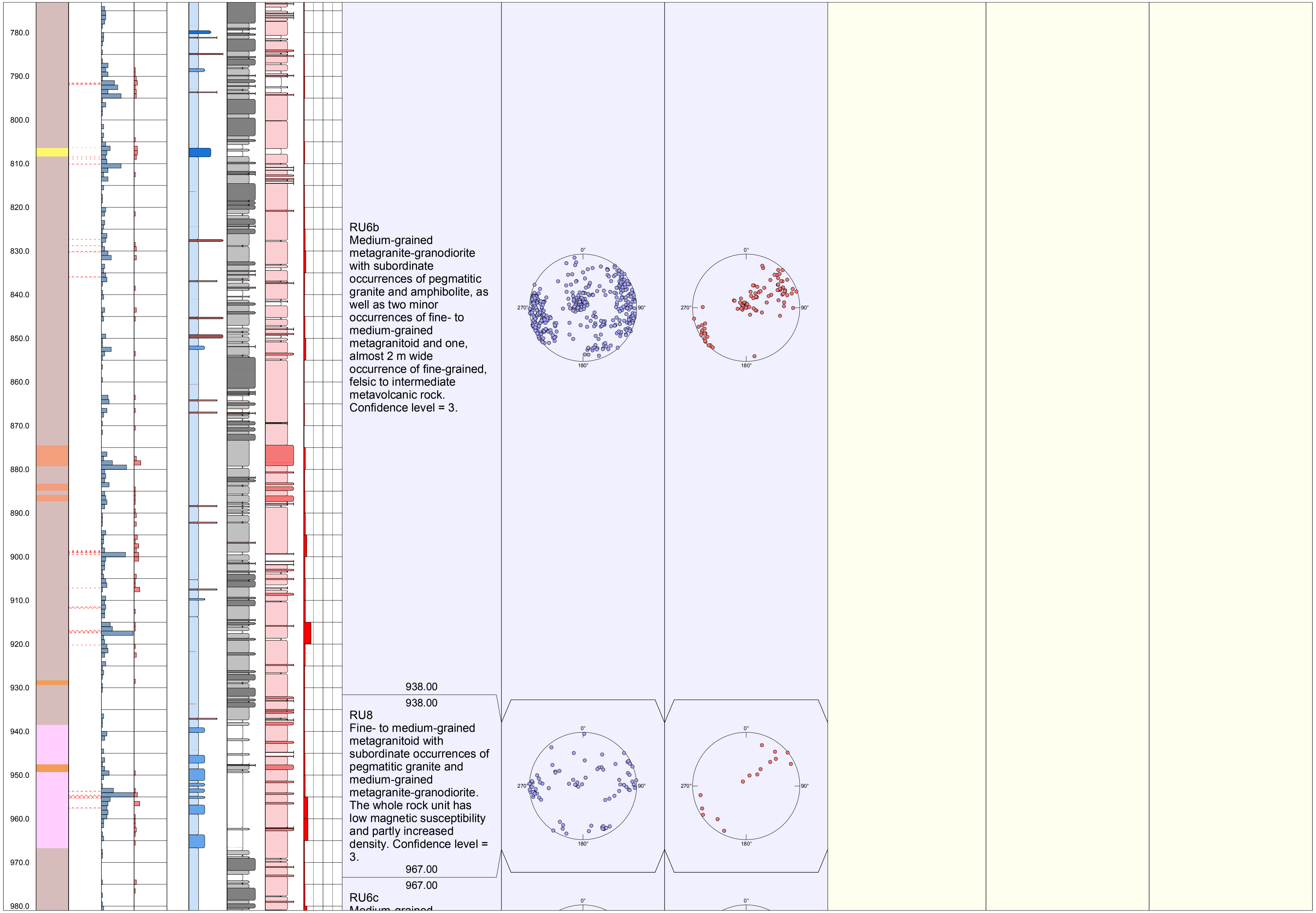
Marked by a network of fractures mainly sealed by laumontite, calcite and chlorite. Also some open fractures with apertures greater or equal to 5 mm. Alterations in the interval include varying degrees of oxidation, epidotization and clay alteration. The possible zone includes parts affected by high ductile strain. Section 412-435 m indicated by a low electric resistivity. No other geophysical anomalies. Five oriented radar reflectors occur at 425.0 m (243/61), 434.5 m (338/7), 447.6 m (253/6 or 120/70), 455.2 m (350/8) and 459.3 m (206/87). Three non-oriented radar reflectors occur at 412.5 m, 444.0 m and 459.3 m with the angle 46, 11 and 49 degrees to borehole axis, respectively. Confidence level = 3.

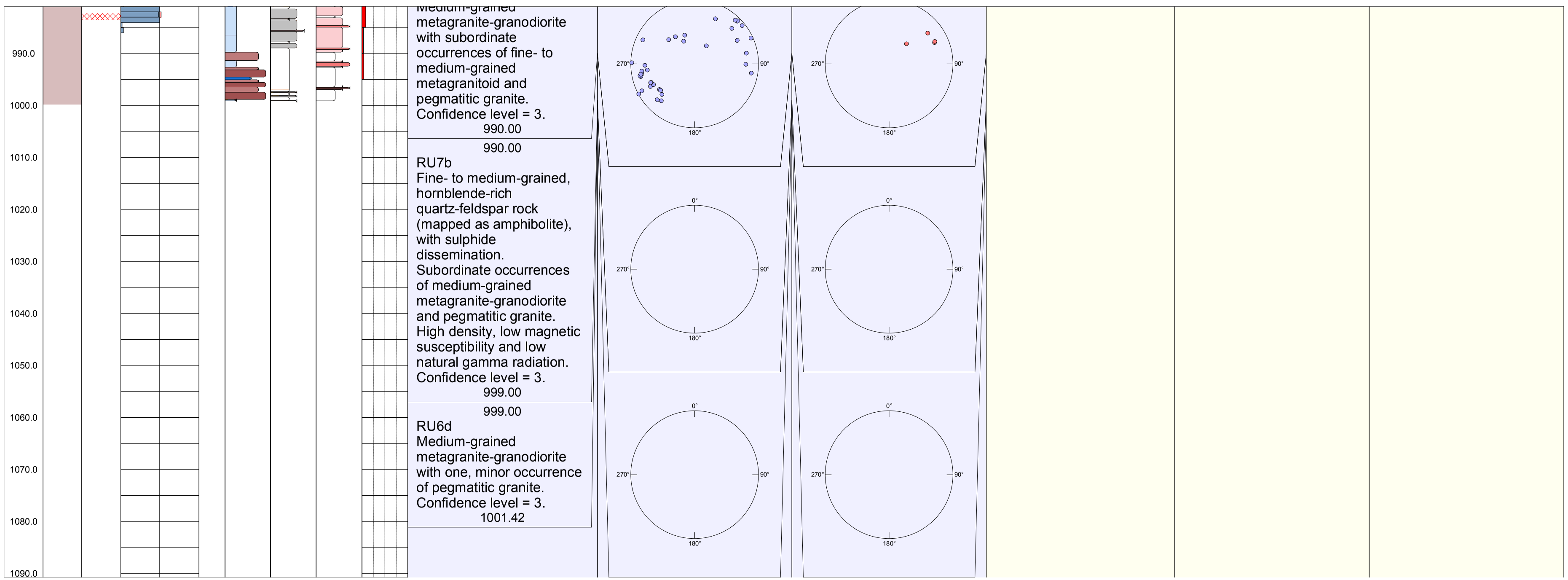
462.00






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
770.0
RU6a
Medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite, amphibolite and fine- to medium-grained metagranitoid. The upper 25 m interval of the rock unit has low magnetic susceptibility, whereas the interval 636-724 m has high magnetic susceptibility. Confidence level = 3.
724.00
724.00
RU7a
Fine- to medium-grained, hornblende-rich quartz-feldspar rock (mapped as amphibolite), with sulphide dissemination. Subordinate occurrences of medium-grained metagranite-granodiorite and pegmatitic granite. High density, low magnetic susceptibility and low natural gamma radiation. Confidence level = 3.
743.00
743.00
654.00
DZ5
Marked by increased frequency of sealed fractures and weak oxidation. Corresponds also to a brittle-ductile high strain zone and a c. 1 m wide amphibolite. Predominant fracture sealing minerals are prehnite, calcite, epidote and chlorite. Clearly decreased electric resistivity and slightly decreased P-wave velocity. One distinct radar reflector at 658.0 m with the orientation 143/78 and one non-oriented at a length of 654.8 m with the angle 55 degrees to borehole axis. Confidence level = 2.
661.00
0°
90°
180°
270°


780.0
790.0
800.0
810.0
820.0
830.0
840.0
850.0
860.0
870.0
880.0
890.0
900.0
910.0
920.0
930.0
940.0
950.0
960.0
970.0
980.0
RU6b
Medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite and amphibolite, as well as two minor occurrences of fine- to medium-grained metagranitoid and one, almost 2 m wide occurrence of fine-grained, felsic to intermediate metavolcanic rock. Confidence level = 3.
938.00
938.00
RU8
Fine- to medium-grained metagranitoid with subordinate occurrences of pegmatitic granite and medium-grained metagranite-granodiorite. The whole rock unit has low magnetic susceptibility and partly increased density. Confidence level = 3.
967.00
967.00
RU6c
0°
90°
180°
270°


990.0
1000.0
1010.0
1020.0
1030.0
1040.0
1050.0
1060.0
1070.0
1080.0
1090.0
Medium-grained metagranite-granodiorite with subordinate occurrences of fine- to medium-grained metagranitoid and pegmatitic granite. Confidence level = 3.
990.00
990.00
RU7b
Fine- to medium-grained, hornblende-rich quartz-feldspar rock (mapped as amphibolite), with sulphide dissemination. Subordinate occurrences of medium-grained metagranite-granodiorite and pegmatitic granite. High density, low magnetic susceptibility and low natural gamma radiation. Confidence level = 3.
999.00
999.00
RU6d
Medium-grained metagranite-granodiorite with one, minor occurrence of pegmatitic granite. Confidence level = 3.
1001.42
0°
90°
180°
270°

Appendix 2

Geological single-hole interpretation for HFM09

Title SINGLE HOLE INTERPRETATION HFM09

Site	FORSMARK	**Inclination [°]**	-68.89	**Elevation [m.a.s.l.]**	5.15
Borehole	HFM09	**Date of mapping**	2003-10-27 00:00:00	**Drilling Start Date**	2003-06-18 12:30:00
Diameter [mm]	141	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2003-06-30 09:00:00
Length [m]	50.250	**Northing [m]**	6699064.65	**Surveying Date**	
Bearing [°]	139.36	**Easting [m]**	1630869.12	**Plot Date**	2006-09-20 21:10:12

Signed data

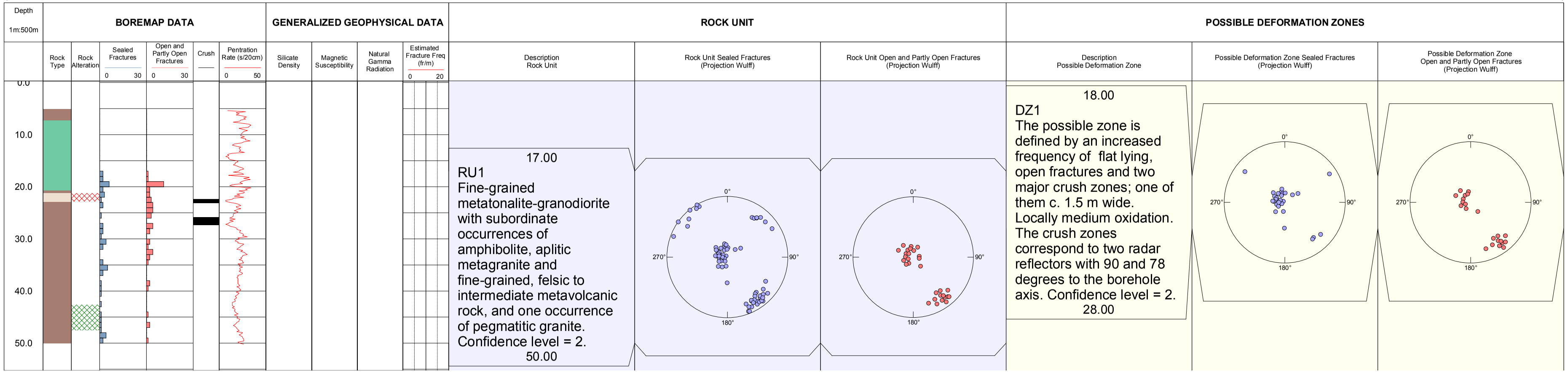
ROCKTYPE FORSMARK
- Granite, metamorphic, aplitic
- Tonalite to granodiorite, metamorphic
- Amphibolite

ROCK ALTERATION
- Oxidized
- Chloritisized

SILICATE DENSITY

SUSCEPTIBILITET

NATURAL GAMMA



Appendix 3

Geological single-hole interpretation for HFM10

Title **SINGLE HOLE INTERPRETATION HFM10**

Site	FORSMARK	**Inclination [°]**	-68.69	**Elevation [m.a.s.l.]**	4.99	**Signed data**
Borehole	HFM10	**Date of mapping**	2003-10-17 00:00:00	**Drilling Start Date**	2003-08-11 09:10:00	
Diameter [mm]	139	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2003-08-19 16:57:00	
Length [m]	150.000	**Northing [m]**	6698834.79	**Surveying Date**		
Bearing [°]	92.93	**Easting [m]**	1631037.19	**Plot Date**	2006-09-20 21:10:12	

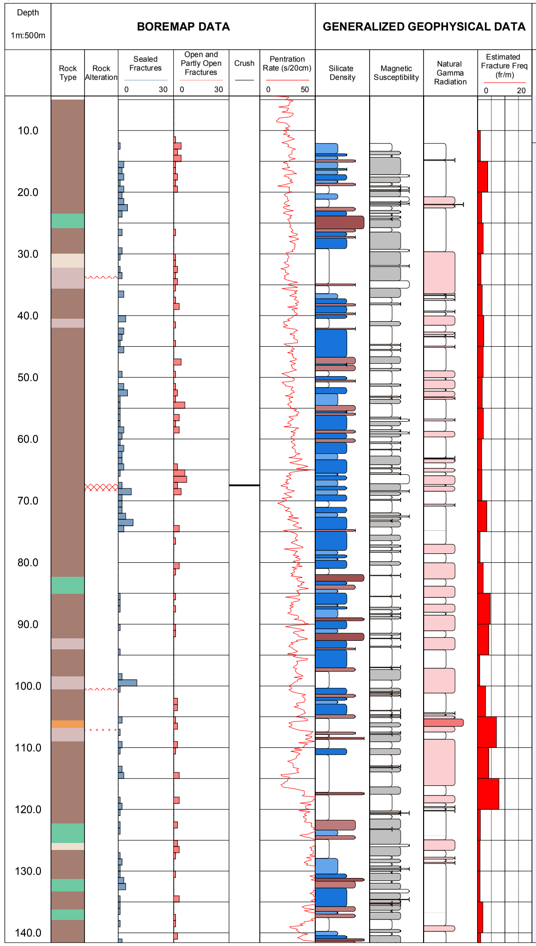
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite, metamorphic, aplitic
- Granite to granodiorite, metamorphic, medium-grained
- Tonalite to granodiorite, metamorphic
- Amphibolite

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
- gam<20
- 20<gam<36
- 36<gam<53

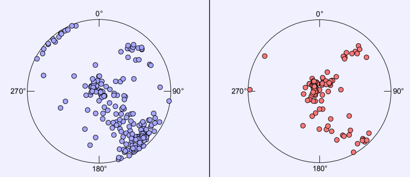


ROCK UNIT

Description Rock Unit

12.00

RU1
Fine- to medium-grained metatonalite-granodiorite with subordinate occurrence of amphibolite, fine- to medium-grained metagranite-granodiorite, pegmatitic granite, aplitic metagranite and a few minor occurrences of fine-grained, felsic to intermediate metavolcanic rock. Silicate density indicates mainly tonalitic composition. Confidence level = 2.

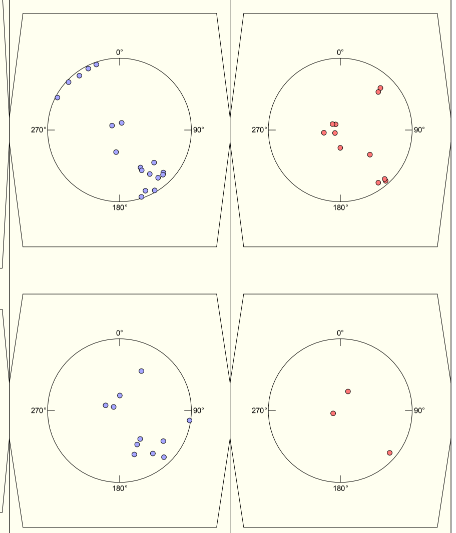


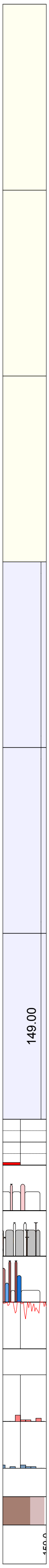
POSSIBLE DEFORMATION ZONES

Description Possible Deformation Zone

65.00
DZ1
Slight increase in the frequency of open fractures. Also a minor crush zone and strong oxidation. Three radar reflectors with 21, 40 and 57 degrees to the borehole axis. Decrease in electric resistivity and P-wave velocity. Minor caliper anomaly.
Confidence level = 2
69.00

108.00
DZ2
Decrease in electric resistivity and P-wave velocity. Distinct caliper anomaly. Three radar reflectors with 23, 59 and 90 degrees to the borehole axis. Confidence level = 2.
117.00




149.00