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Revised November 2006

Forsmark site investigation

Geological single-hole interpretation of HFM11-13 and HFM16-18

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Jaana Gustafsson, Malå GeoScience AB

June 2004

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

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Reading instruction

The revised report 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. Adjustments of borehole length for rock units and possible deformation zones have been made in order to fit corresponding values in SICADA.

Appendices 1–6 are updated.

Abstract

This report constitutes geological single-hole interpretations of the percussion boreholes HFM11-13 and HFM16-18 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 occur in the boreholes.

The geological single-hole interpretation shows that two lithological rock units occur in HFM11. The extensions of the units are based on degree of homogeneity. Fine-medium grained metagranite-granodiorite dominates in the borehole. Subordinate rock types are amphibolite, pegmatitic granite, fine-medium grained metagranitoid and aplitic metagranite. One possible deformation zones have been identified in HFM11.

The percussion borehole HFM12 is dominated by fine-medium grained metagranite-granodiorite. Subordinate rock types are amphibolite, pegmatitic granite and aplitic metagranite. One small section with an ultramafic rock type also occurs. One possible deformation zones have been identified in HFM12.

Two rock units is interpreted in the percussion borehole HFM13. The upper part of the borehole display a higher fracture frequency compared with the lower part. The borehole is dominated by fine-medium grained metagranite-granodiorite. Subordinate rock types are pegmatitic granite, medium grained metagranite-granodiorite, amphibolite and aplitic metagranite. One possible deformation zones have been identified in HFM13.

Two rock units are interpreted in the percussion borehole HFM16. Due to repetition of RU1 (RU1a and RU1b), the borehole is divided into three rock sections. The borehole is dominated by fine-medium grained metagranite-granodiorite. Subordinate rock types are amphibolite, pegmatitic granite, fine-medium grained metagranitoid and aplitic metagranite. One possible deformation zones have been identified in HFM16.

The percussion borehole HFM17 is dominated by fine-medium grained metagranite-granodiorite. Subordinate rock types are pegmatitic granite, fine-medium grained metagranitoid, amphibolite and aplitic metagranite. No possible deformation zones have been identified in HFM17.

Two rock units are interpreted in the percussion borehole HFM18. The upper unit is a mix of mainly pegmatitic granite and medium grained metatonalite-granodiorite. In most parts of the borehole medium grained metagranite-granodiorite dominates with pegmatitic granite, amphibolite, aplitic metagranite and fine-medium grained metagranitoid as subordinate rock types. Three possible deformation zones have been identified in HFM18.

Sammanfattning

Denna rapport behandlar geologisk enhålstolkning av hammarborrhålen HFM11-13 och HFM16-18 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 HFM11 finns två litologiska enheter. Generellt sett dominerar fint medelkorning metagranit-granodiorit. Amfibolit, pegmatitisk granit, fin- medelkornig metagranitoid, och aplitisk metagranit förekommer i mindre omfattning. Enheterna har delats in på grund av deras homogenitet. En möjlig deformationszon har identifierats i HFM11.

Hammarborrhål HFM12 domineras av fin- medelkorning metagranit-granodiorit. Amfibolit, pegmatitisk granit och aplitisk metagranit förekommer i mindre omfattning. Ultramafit förekommer i ett parti i borrhålet. En möjlig deformationszon har identifierats i HFM12.

Hammarborrhålet HFM13 består av två litologiska enheter. Den övre delen visar en högre sprickfrekvens relativt till den undre delen. Hålet domineras av fin- medelkorning metagranit-granodiorit med mindre inslag av pegmatitisk granit, medelkornig metagranit-granodiorit, amfibolit och aplitisk metagranit. En möjlig deformationszon har identifierats i HFM13.

Hammarborrhål HFM16 indelas i två litologiska enheter. Genom att RU1 upprepas (RU1a och RU1b), kan borrhålet delas in i tre sektioner. Hålet domineras av fin- medelkorning metagranit-granodiorit med mindre inslag av amfibolit, pegmatitisk granit, fin- medelkornig metagranitoid, och aplitisk metagranit. En möjlig deformationszon har identifierats i HFM16.

I hammarborrhål HFM17 förekommer huvudsakligen fin- medelkorning metagranit-granodiorit. Pegmatitisk granit, fin- medelkornig metagranitoid, amfibolit och aplitisk metagranit förekommer i mindre omfattning. Ingen deformationszon har identifierats i HFM17.

Hammarborrhål HFM18 indelas i två litologiska enheter. Enheten i den övre delen innehåller en blandning av huvudsakligen pegmatitgranit och medelkorning metatonalit-granodiorit. Den större delen av borrhålet domineras av medelkorning metagranit-granodiorit med inslag av pegmatitisk granit, amfibolit, aplitisk metagranit och fin-medelkornig metagranitoid. Tre möjliga deformationszoner har identifierats i HFM18.

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 loggings and accompanying descriptive documents.

This document reports the geological single-hole interpretation of six percussion-drilled boreholes in the Forsmark area. These include boreholes HFM11, HFM12, HFM13, HFM16, HFM17, and HFM18 (Figure 1-1).

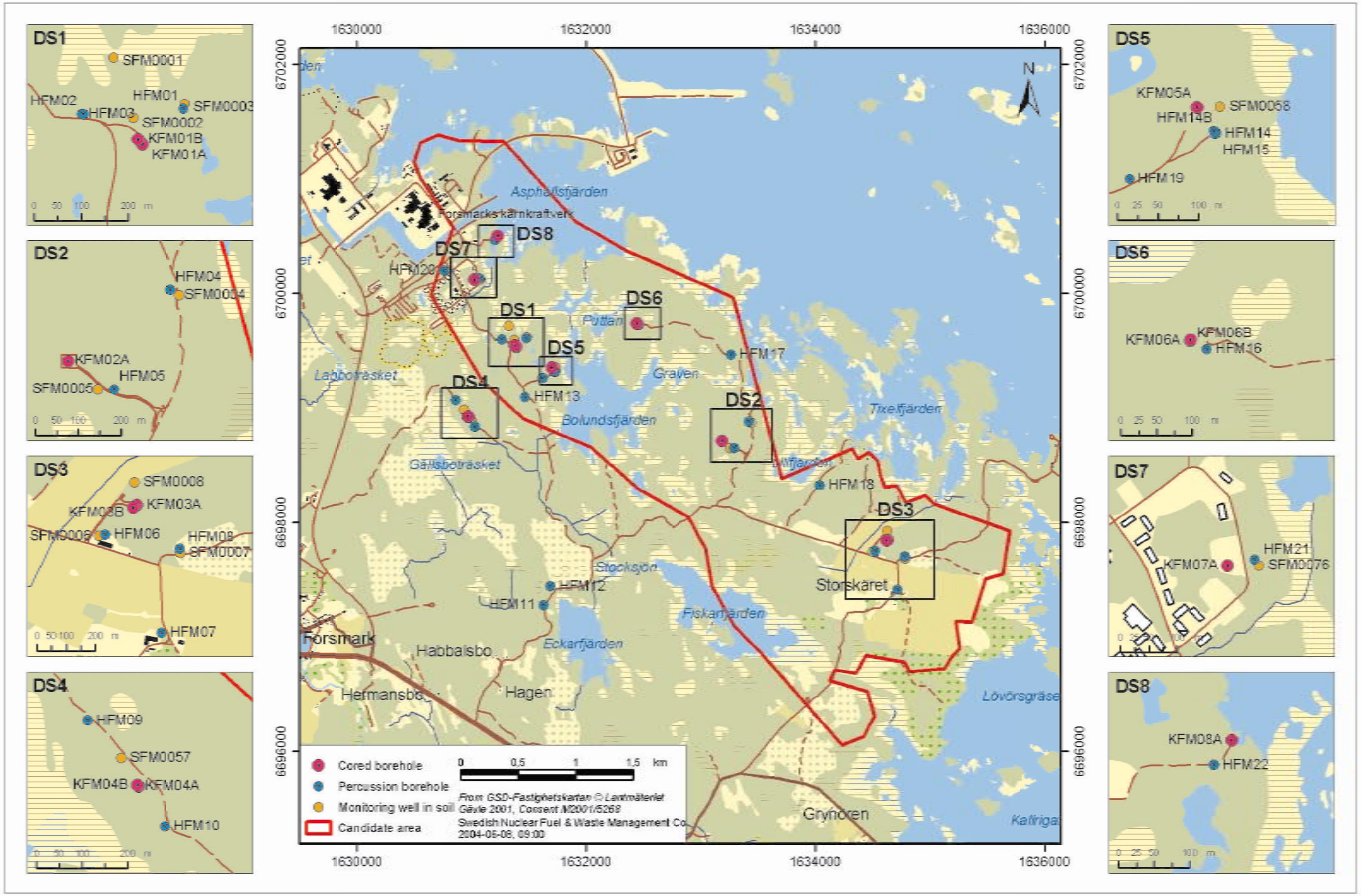


Figure 1-1. *Map showing the position of the percussion-drilled boreholes HFM11-13 and HFM16-18.*

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. 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 geological single-hole interpretation:

- Boremap data (including BIPS and geological mapping data) /1, 2 and 3/.
- Generalized geophysical logs and their interpretation /4, 5 and 6/.
- Radar data and their interpretation /7, 8 and 9/.

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: Rock type

  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 /10/.

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.

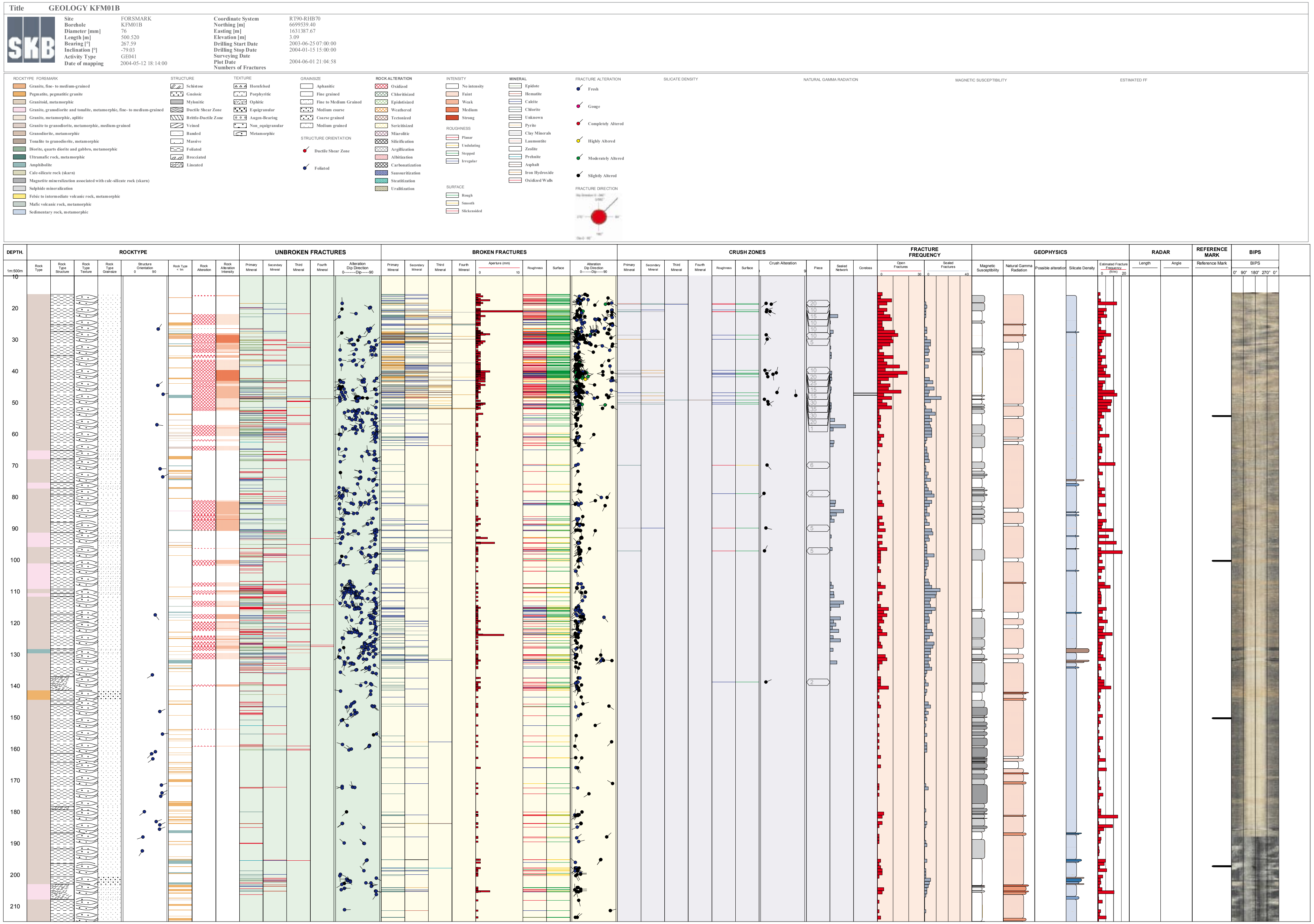


Figure 3-1. Example of WellCad plot used as basis for the geological single-hole interpretation.

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.

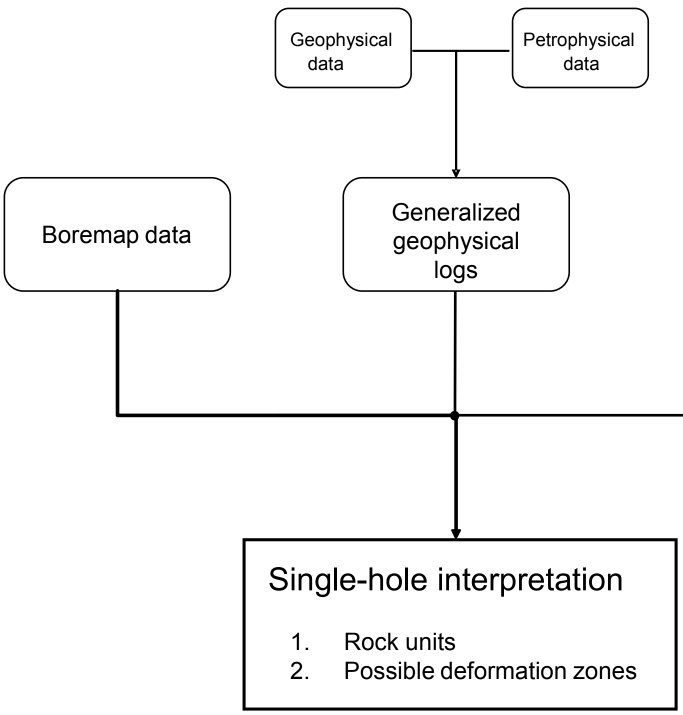


Figure 4-1. *Schematic block diagram of geological single-hole interpretation.*

5 Results

The detailed results of the geological single-hole interpretations are presented as print-outs from the software WellCad (Appendix 1 for HFM11, Appendix 2 for HFM12, Appendix 3 for HFM13, Appendix 4 for HFM16, Appendix 5 for HFM17 and Appendix 6 for HFM18). The confidence level for interpretation of rock units and possible deformation zones have been made on the following basis: 3 = high, 2 = medium, 1 = low.

5.1 HFM11

The borehole can be divided into two rock units:

12.0-83 m — RU1: Fine- to medium-grained metagranite-granodiorite with subordinate occurrences of amphibolite (down to 54 m), pegmatitic granite and fine- to medium-grained metagranitoid. Locally, up to a few metre wide intervals of oxidation. Slightly higher fracture frequency relative to the lower part of the borehole (below 116 m). One fracture with an aperture wider than 10 mm at 25 m. Medium to high magnetic susceptibility. Confidence level = 3.

83-182.23 m — RU2: More heterogeneous mixture dominated by fine-grained metagranite-granodiorite with subordinate occurrences of amphibolite, aplitic metagranite and pegmatitic granite. Also a 1 m wide occurrence of ultramafic rock at 97.5-98.5 m. Low magnetic susceptibility. Confidence level = 3.

One possible deformation zone is indicated in HFM11:

83-160 m — DZ1: Occurrence of brittle-ductile shear zones and strongly foliated bedrock between 105-160 m, and high frequency of sealed fractures between 83-116 m. Fractures sealed by calcite. Also high frequency of weak to medium oxidation zones. Several radar reflectors 22-74° (mainly c. 60°) towards the borehole axis. Low resistivity in the upper part (above 116 m). Confidence level = 3.

5.2 HFM12

The borehole consists of one rock unit:

14.91-208.55 m — RU1: Fine- to medium-grained metagranite-granodiorite with subordinate occurrences of amphibolite, pegmatitic granite, aplitic metagranite and fine- to medium-grained metagranitoid. Also an ultramafite occurrence at 92-97 m. Magnetic susceptibility between 56 and 89 m higher than in the remaining part of the borehole. Confidence level = 3.

One possible deformation zone is indicated:

91-170 m DZ1: Occurrence of brittle-ductile shear zones throughout the zone and a mylonite at the top of the zone at 91-92 m. Increased frequency of fractures, especially steep fractures in the interval 147-170 m. Mostly sealed by calcite, and quartz in the 147-170 m interval. Two fractures with apertures wider than 10 mm. Several radar reflectors 35-75° (mainly c. 50°) towards the borehole axis. Low resistivity below 147 m. Low magnetic susceptibility in the entire zone, and a number of sonic anomalies. Confidence level = 3.

5.3 HFM13

The borehole consists of two rock units. The upper part of the borehole displays a slightly increased fracture frequency relative to the lower part:

14.90-93 m RU1: Fine- to medium-grained metagranite-granodiorite with minor occurrences of amphibolite, pegmatitic granite, fine- to medium-grained metagranitoid and aplitic metagranite. Slightly increased fracture frequency relative to the section between 93 and 162 m. Whole interval shows weak oxidation. Distinct, sub-parallel radar reflector 6-12 m from the borehole. Lower magnetic susceptibility relative to the lower part of the borehole. Confidence level = 3.

93-175.30 m RU2: Fine- to medium-grained metagranite-granodiorite with minor occurrences of amphibolite, pegmatitic granite, fine- to medium-grained metagranitoid and aplitic metagranite. Distinct, sub-parallel radar reflector 0-6 m from the borehole. Confidence level = 3.

There is one possible deformation zone in the borehole:

162-175.30 m DZ1: Increased frequency of steep fractures filled or coated by calcite and chlorite. Weak oxidation. One fracture with aperture wider than 10 mm at 162 m. Three radar reflectors 47-58° towards the borehole axis. Slightly decreased background resistivity and sonic velocity. Confidence level = 2.

5.4 HFM16

The borehole consists of two rock units, divided into three rock sections:

12.04-18.07 m RU1a: Medium-grained metagranite-granodiorite with minor occurrences of pegmatitic granite and aplitic metagranite. Confidence level = 3.

18.07-35.04 m RU2: Pegmatitic granite with subordinate occurrences of medium-grained metagranite-granodiorite. High gamma radiation and low magnetic susceptibility. Sub-parallel radar reflectors 18-30 m from the borehole. Confidence level = 3.

35.04-129.47 m RU1b: Medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite, amphibolite, aplitic metagranite and at the bottom of the hole fine- to medium-grained metagranitoid. Low magnetic susceptibility and zones of oxidation above 100 m. Sub-parallel radar reflectors 18-25 m from the borehole. Confidence level = 3.

There is one possible deformation zone in the borehole:

12.04-71 m DZ1: High frequency of both flat-lying and steep fractures with apertures filled or coated by calcite and chlorite. Six crush zones. In the interval 57-71 m there is an increased frequency of fractures with wider apertures, occasionally wider than 10 mm. Several, up to a few metre wide zones of oxidation. Several flat-lying radar reflectors 51-76° towards the borehole axis. Distinct resistivity and sonic anomalies between 57 and 71 m. Confidence level = 3.

5.5 HFM17

The borehole consists of one rock unit:

8.01-209.21 m RU1: Medium-grained metagranite-granodiorite with minor occurrences of pegmatitic granite, fine- to medium-grained metagranitoid, amphibolite and aplitic metagranite. Locally, up to a few metre wide intervals of weak oxidation. One crush zone at 31.5 m. Corresponds to a flat-lying radar reflector 88° towards the borehole axis at 32 m. Sub-parallel radar reflector 15-24 m from the borehole, distinct in the upper part of the borehole. Increased frequency of minor resistivity anomalies between 90 and 150 m. Confidence level = 3.

There is no possible deformation zone in borehole HFM17.

5.6 HFM18

The borehole consists of two rock units:

8.99-29.71 m RU1: Mixture of pegmatitic granite, medium-grained metatonalite-granodiorite, amphibolite and fine- to medium-grained metagranitoid (silicate density suggest a tonalitic to granodioritic composition). Minor occurrences of aplitic metagranite. Except for the pegmatitic granite, low magnetic susceptibility and gamma radiation. Confidence level = 3.

29.71-180.34 m RU2: Medium-grained metagranite-granodiorite with subordinate occurrence of pegmatitic granite, amphibolite, aplitic metagranite and fine- to medium-grained metagranitoid. Locally, up to a few metre wide intervals of weak to medium oxidation. Sub-parallel radar reflector c. 25 m from the borehole. Confidence level = 3.

There are three possible deformation zones in the borehole:

8.99-11 m — DZ1: Increased frequency of fractures with apertures up to 7 mm. Quartz and chlorite filling/coating. Low resistivity and sonic velocity. Confidence level = 2.

36-49 m — DZ2: Two crush zones and two fractures with apertures of 4 and >10 mm. Fractures mainly coated by chlorite. Three radar reflectors 68-82° towards the borehole axis. Distinct resistivity and sonic anomalies. Low magnetic susceptibility and weak oxidation below 42 m. Confidence level = 2.

119-148 m — DZ3: Slightly increased fracture frequency, especially in the lower part. Fractures mainly coated by chlorite. Several radar reflectors, one 27º and five 55-90° towards the borehole axis. Low resistivity, especially below 136 m. Low magnetic susceptibility throughout the zone and weak to medium oxidation below 130 m. Confidence level = 3.

6 Comments

The results from the geological single-hole interpretations of the HFM11, HFM12, HFM13, HFM16, HFM17 and HFM18 are presented in WellCad plots (Appendices 1-6). 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 included in the stereo diagrams.

No geophysical logging has been performed in HFM09.

7 References

/1/ SKB P-report P-04-101. Boremap mapping of percussion boreholes HFM09-12. Nordman C.

/2/ SKB P-report P-04-112. Boremap mapping of percussion boreholes HFM13-15 and HFM19. Nordman C.

/3/ SKB P-report P-04-114. Boremap mapping of percussion boreholes HFM16-18. Nordman C, Samuelsson E.

/4/ 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

/5/ SKB P-report P-04-144. Borehole logging in borehole KFM04A, KFM06A, HFM10, HFM11, HFM12 and HFM13. Nielsen U T, Ringgaard J.

/6/ SKB P-report P-04-145. Borehole logging in borehole KFM01B, HFM14, HFM15, HFM16, HFM17 and HFM18. Nielsen U T, Ringgaard J.

/7/ SKB P-report P-04-39. RAMAC and BIPS logging in borehole HFM11 and HFM12. Gustafsson J, Gustafsson C.

/8/ SKB P-report P-04-68. RAMAC and BIPS logging in borehole HFM13, HFM14 and HFM15. Gustafsson J, Gustafsson C.

/9/ SKB P-report P-04-69. RAMAC and BIPS logging in borehole KFM06A, HFM16, HFM17, HFM18 and HFM19. Gustafsson J, Gustafsson C.

/10/ 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 HFM11

Title	SINGLE HOLE INTERPRETATION HFM11					
Site	FORSMARK	Inclination [°]	-49.31	Elevation [m.a.s.l.]	7.56	Signed data
Borehole	HFM11	Date of mapping	2003-10-28 00:00:00	Drilling Start Date	2003-08-21 12:16:00	
Diameter [mm]	139	Coordinate System	RT90-RHB70	Drilling Stop Date	2003-09-01 16:04:00	
Length [m]	182.350	Northing [m]	6697283.40	Surveying Date		
Bearing [°]	63.51	Easting [m]	1631636.33	Plot Date	2006-11-14 22:12:36	

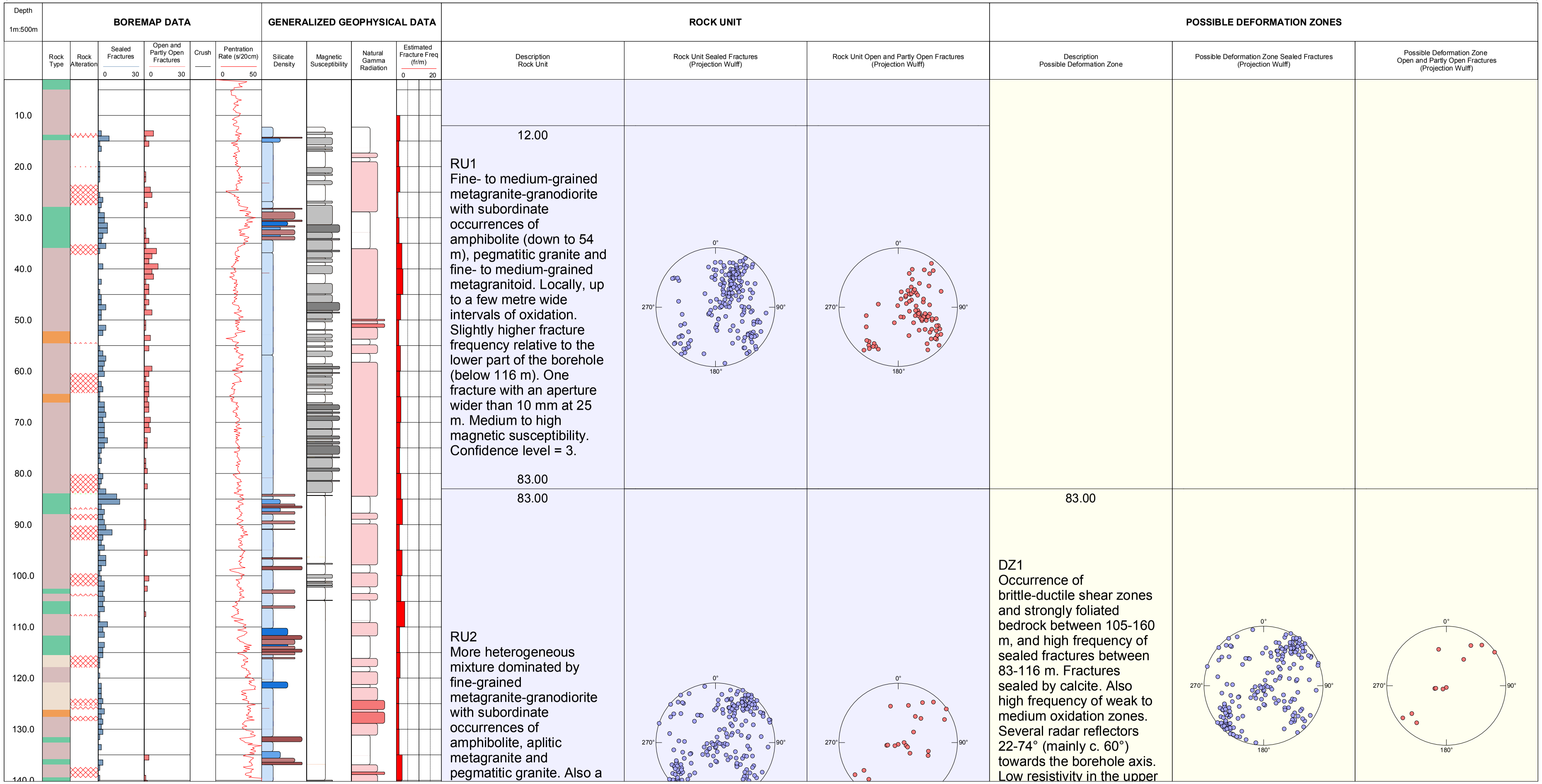
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite, metamorphic, aplitic
- Granite to granodiorite, metamorphic, medium-grained
- Amphibolite

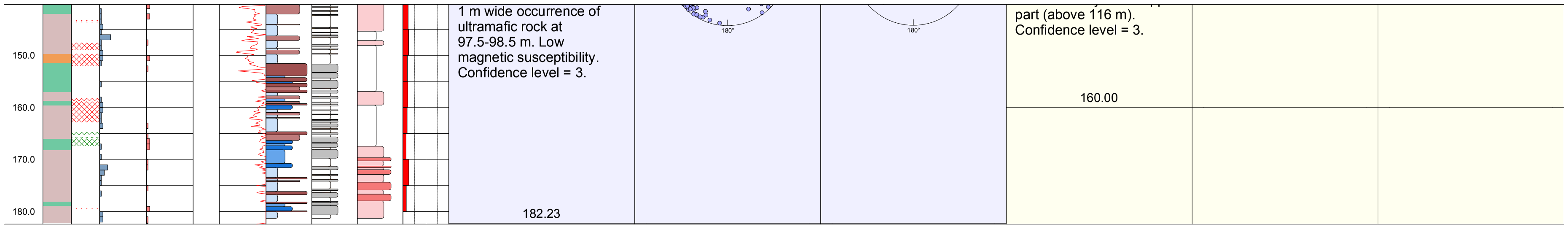
ROCK ALTERATION
- Oxidized
- Chloritisized
- Epidotisized

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




150.0
160.0
170.0
180.0
1 m wide occurrence of ultramafic rock at 97.5-98.5 m. Low magnetic susceptibility. Confidence level = 3.
182.23
180°
180°
part (above 116 m). Confidence level = 3.
160.00

Appendix 2

Geological single-hole interpretation for HFM12

Title SINGLE HOLE INTERPRETATION HFM12

Site	FORSMARK	Inclination [°]	-49.04	Elevation [m.a.s.l.]	7.03	Signed data
Borehole	HFM12	Date of mapping	2003-11-05 00:00:00	Drilling Start Date	2003-09-03 13:30:00	
Diameter [mm]	135	Coordinate System	RT90-RHB70	Drilling Stop Date	2003-09-16 15:00:00	
Length [m]	209.550	Northing [m]	6697446.46	Surveying Date		
Bearing [°]	245.16	Easting [m]	1631695.67	Plot Date	2006-11-14 22:12:36	

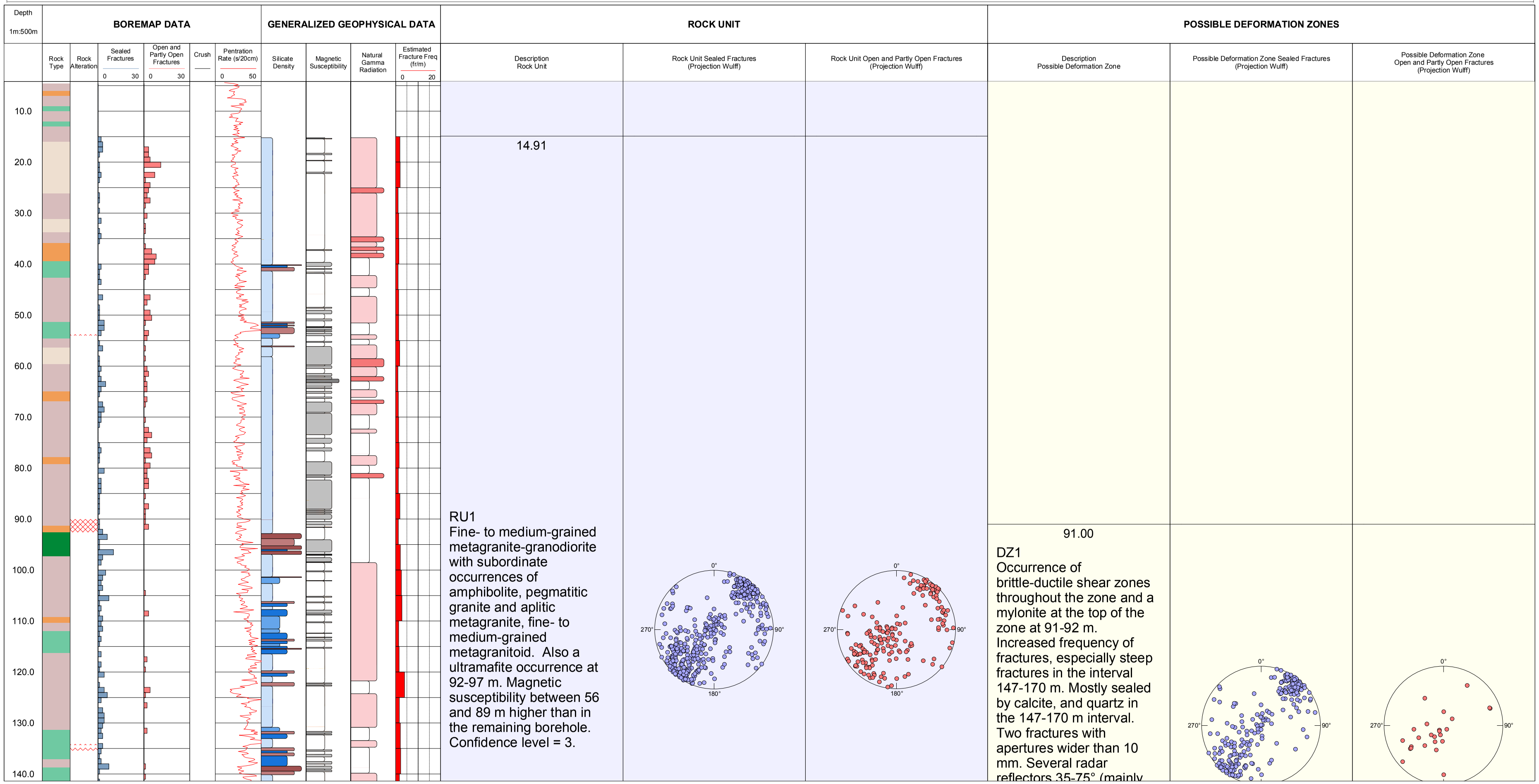
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite, metamorphic, aplitic
- Granite to granodiorite, metamorphic, medium-grained
- Ultramafic rock, metamorphic
- Amphibolite

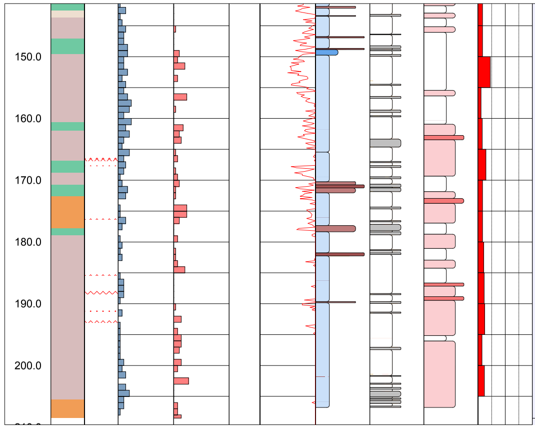
ROCK ALTERATION
- Oxidized

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





208.55			c. 50°) towards the borehole axis. Low resistivity below 147 m. Low magnetic susceptibility in the entire zone, and a number of sonic anomalies. Confidence level = 3. 170.00	180°	180°

Appendix 3

Geological single-hole interpretation for HFM13

Title	SINGLE HOLE INTERPRETATION HFM13						
Site	FORSMARK	Inclination [°]	-58.84	Elevation [m.a.s.l.]	5.69	Signed data	
Borehole	HFM13	Date of mapping	2004-02-26 00:00:00	Drilling Start Date	2003-09-18 12:30:00		
Diameter [mm]	135	Coordinate System	RT90-RHB70	Drilling Stop Date	2003-10-02 17:00:00		
Length [m]	175.600	Northing [m]	6699093.68	Surveying Date			
Bearing [°]	51.19	Easting [m]	1631474.40	Plot Date	2006-11-14 22:12:36		

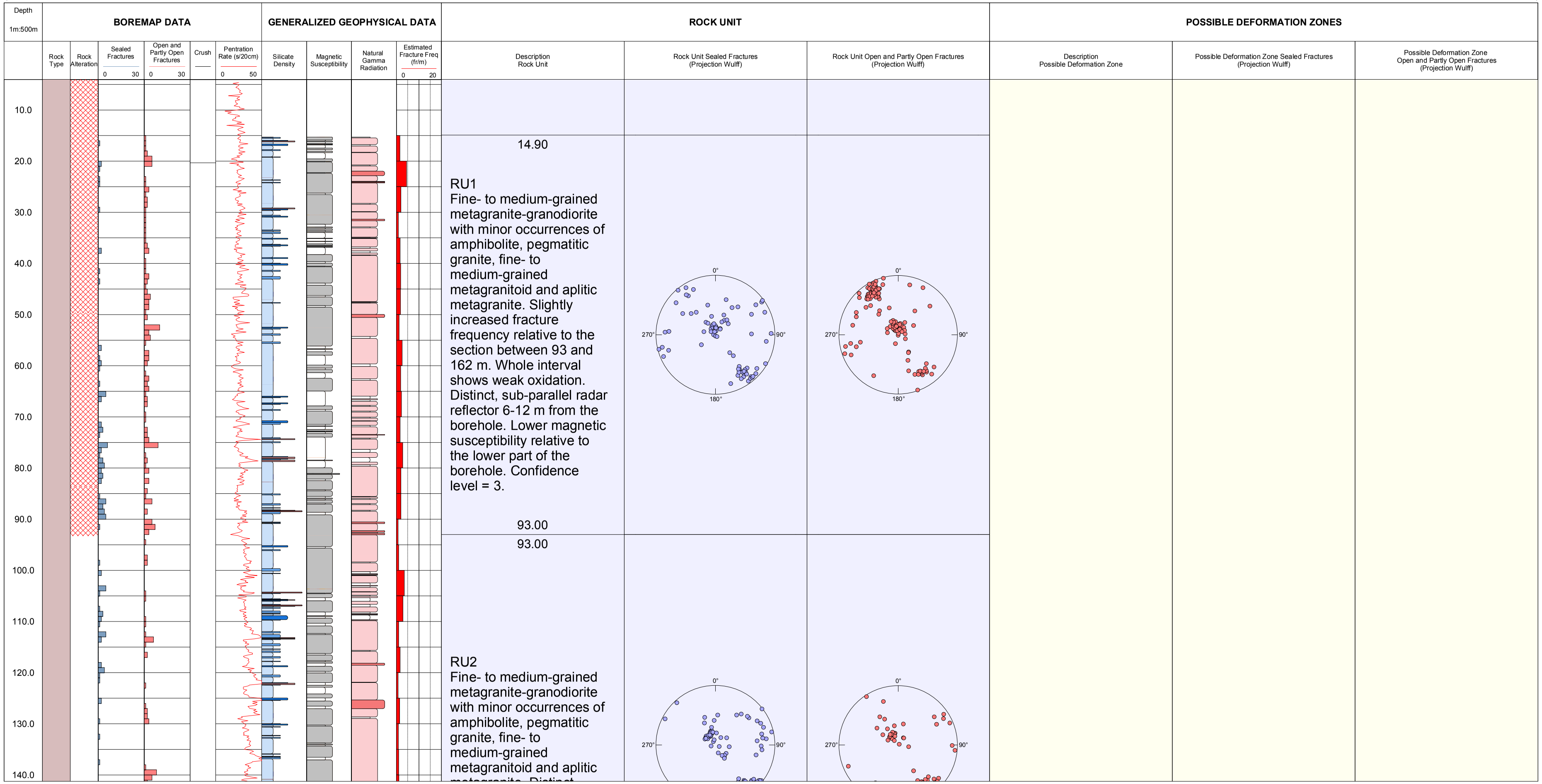
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite to granodiorite, metamorphic, medium-grained

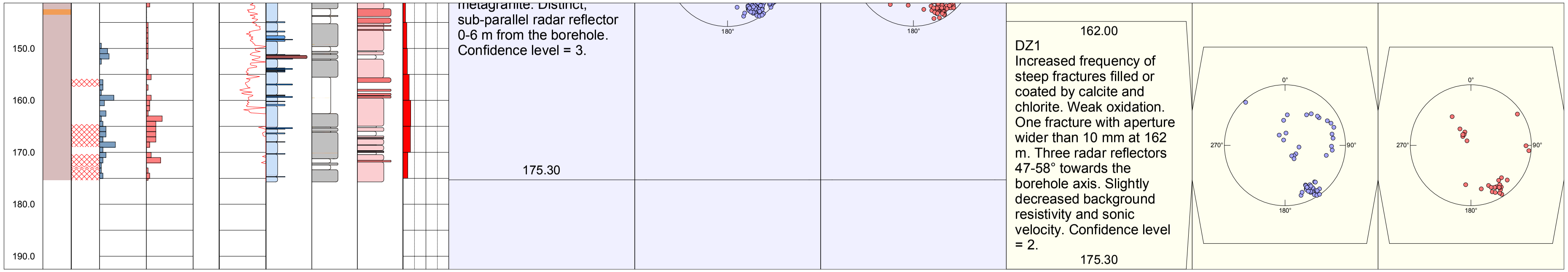
ROCK ALTERATION
- Oxidized

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




150.0
160.0
170.0
180.0
190.0
metagranite. Distinct, sub-parallel radar reflector 0-6 m from the borehole. Confidence level = 3.
175.30
180°
180°
162.00
DZ1
Increased frequency of steep fractures filled or coated by calcite and chlorite. Weak oxidation. One fracture with aperture wider than 10 mm at 162 m. Three radar reflectors 47-58° towards the borehole axis. Slightly decreased background resistivity and sonic velocity. Confidence level = 2.
175.30
0°
90°
180°
270°
0°
90°
180°
270°

Appendix 4

Geological single-hole interpretation for HFM16

Title SINGLE HOLE INTERPRETATION HFM16

Site	FORSMARK	Inclination [°]	-84.21	Elevation [m.a.s.l.]	3.21	Signed data
Borehole	HFM16	Date of mapping	2004-04-26 00:00:00	Drilling Start Date	2003-11-04 07:00:00	
Diameter [mm]	139	Coordinate System	RT90-RHB70	Drilling Stop Date	2003-11-11 16:00:00	
Length [m]	132.500	Northing [m]	6699721.10	Surveying Date		
Bearing [°]	327.96	Easting [m]	1632466.18	Plot Date	2006-11-14 22:12:36	

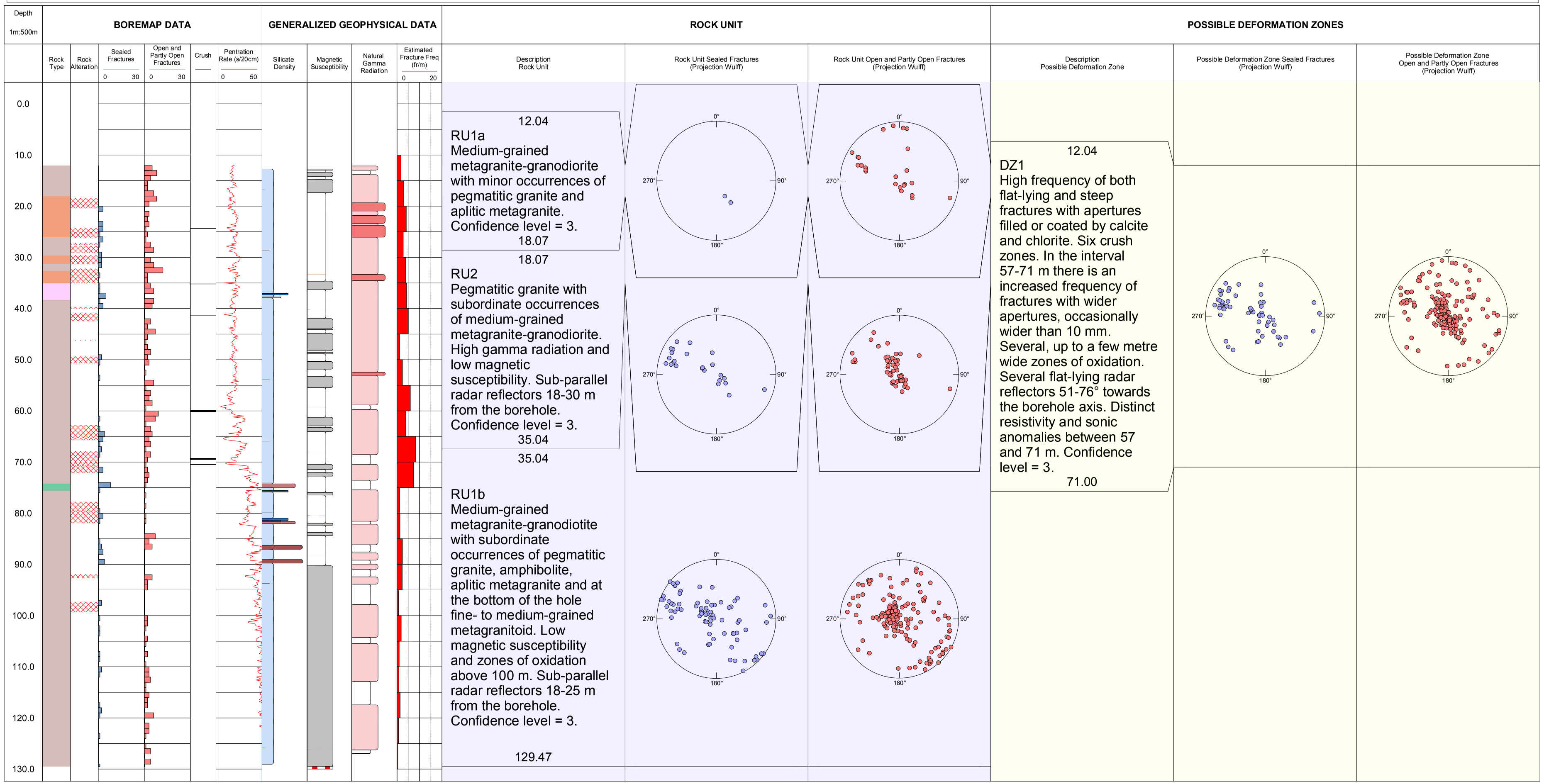
ROCKTYPE FORSMARK
- Granite, fine- to medium-grained
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite to granodiorite, metamorphic, medium-grained
- Amphibolite

ROCK ALTERATION
- Oxidized

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

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

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



Appendix 5

Geological single-hole interpretation for HFM17

Title SINGLE HOLE INTERPRETATION HFM17

Site	FORSMARK	**Inclination [°]**	-84.18	**Elevation [m.a.s.l.]**	3.75	**Signed data**
Borehole	HFM17	**Date of mapping**	2004-04-27 00:00:00	**Drilling Start Date**	2003-12-01 14:30:00	
Diameter [mm]	136	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2003-12-08 19:00:00	
Length [m]	210.650	**Northing [m]**	6699461.95	**Surveying Date**		
Bearing [°]	318.58	**Easting [m]**	1633261.31	**Plot Date**	2006-11-14 22:12:36	

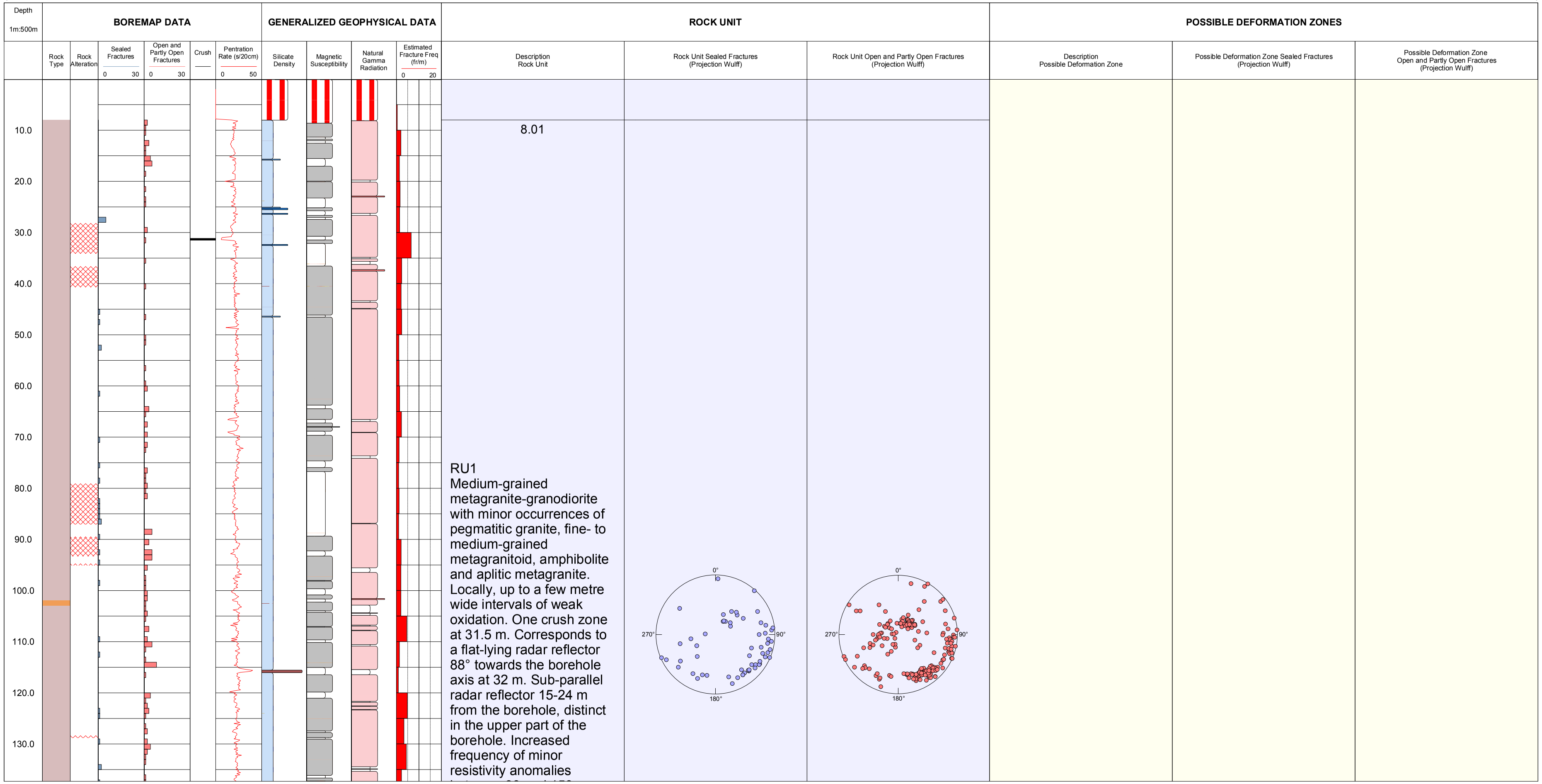
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite to granodiorite, metamorphic, medium-grained

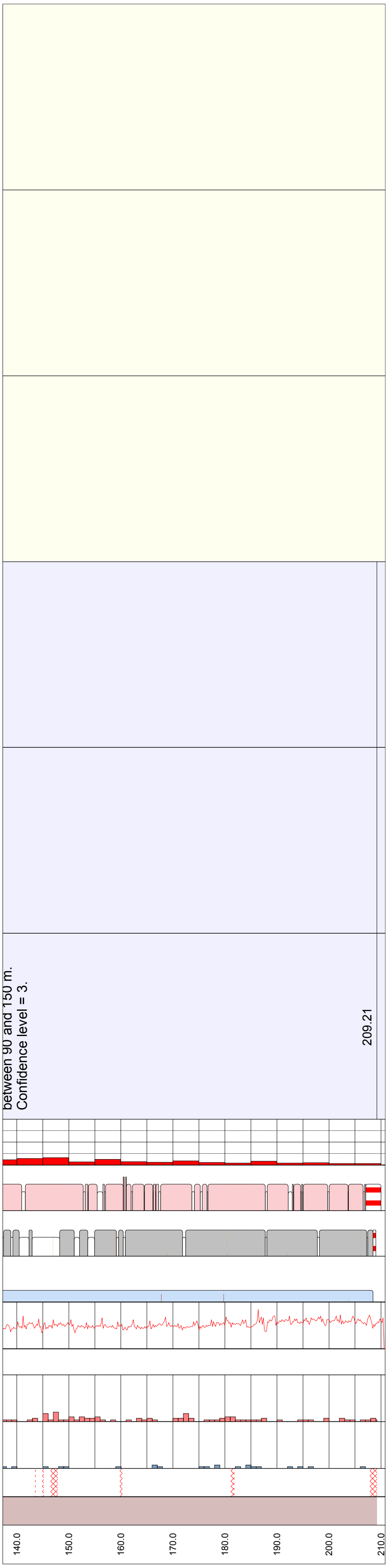
ROCK ALTERATION
- Oxidized

SILICATE DENSITY
- unclassified
- dens<2680 (Granite)
- 2680<dens<2730 (Granodiorite)
- 2730<dens<2800 (Tonalite)
- 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




between 90 and 150 m.
Confidence level = 3.
209.21
140.0
150.0
160.0
170.0
180.0
190.0
200.0
210.0

Appendix 6

Geological single-hole interpretation for HFM18

Title SINGLE HOLE INTERPRETATION HFM18

Site	FORSMARK	Inclination [°]	-59.35	Elevation [m.a.s.l.]	5.04	Signed data
Borehole	HFM18	Date of mapping	2004-05-06 00:00:00	Drilling Start Date	2003-12-10 12:30:00	
Diameter [mm]	138	Coordinate System	RT90-RHB70	Drilling Stop Date	2003-12-16 20:00:00	
Length [m]	180.650	Northing [m]	6698326.86	Surveying Date		
Bearing [°]	313.30	Easting [m]	1634037.37	Plot Date	2006-11-14 22:12:36	

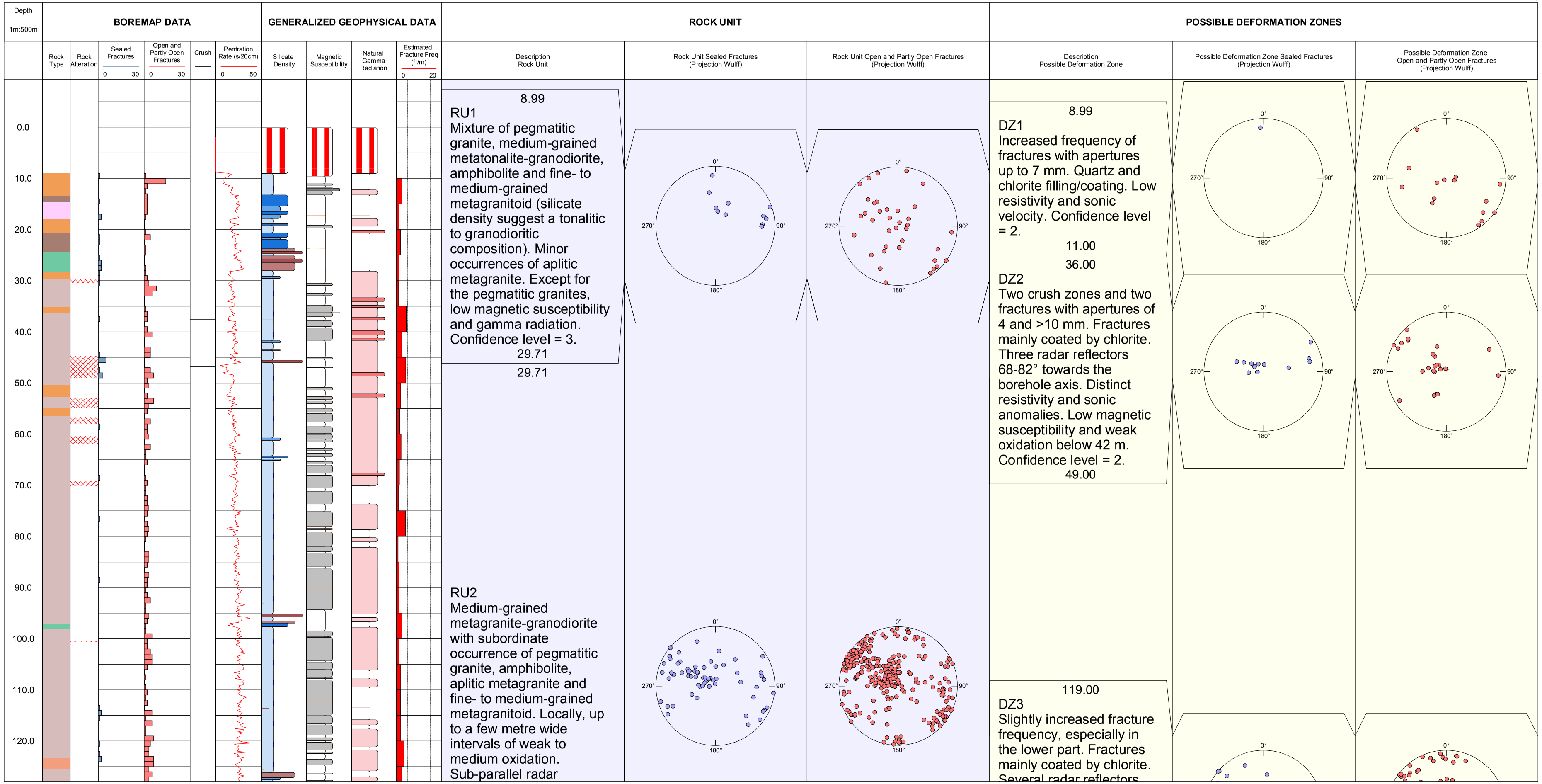
ROCKTYPE FORSMARK
- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite, metamorphic, aplitic
- Granite to granodiorite, metamorphic, medium-grained
- Tonalite to granodiorite, metamorphic
- Amphibolite

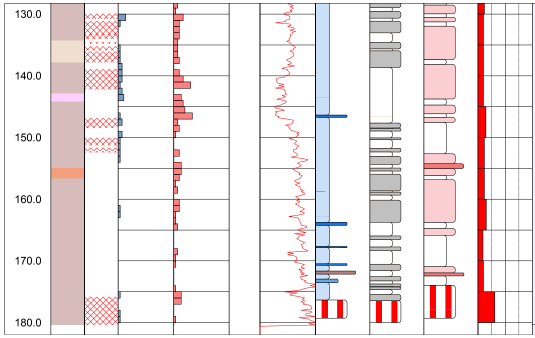
ROCK ALTERATION
- Oxidized

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





reflector c. 25 m from the borehole. Confidence level = 3.

180.34

one 27 and five 55-90° towards the borehole axis. Low resistivity, especially below 136 m. Low magnetic susceptibility throughout the zone and weak to medium oxidation below 130 m. Confidence level = 3.

148.00