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Forsmark site investigation

Geological single-hole interpretation of KFM07C and HFM26

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October 2006

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Keywords: Forsmark, Geophysics, Geology, Borehole, Bedrock, Fractures, AP-PF 400-06-088.

Abstract

This report presents geological single-hole interpretations of the cored borehole KFM07C and the percussion borehole HFM26 at Forsmark. The interpretation combines the geological core mapping, generalized geophysical logs and borehole radar measurements to identify where rock units and possible deformation zones occur in the boreholes. A brief description of the character of each rock unit and possible deformation zone is provided.

The geological single-hole interpretation shows that two rock units (RU1–RU2) occur in KFM07C. Medium-grained metagranite-granodiorite (101057) dominates the borehole. Subordinate rock types are pegmatitic granite (101061), amphibolite (102017), fine- to medium-grained metagranitoid (101051), aplitic metagranite (101058), felsic to intermediate metavolcanic rock (103076) and one occurrence of medium- to coarse-grained metagabbro (101033). Increased fracture frequency characterizes RU1 compared to RU2. Three possible deformation zones of brittle character have been identified in KFM07C (DZ1–DZ3).

The percussion borehole HFM26 is dominated by medium-grained metagranite-granodiorite (101057). The borehole is divided into two rock units (RU1–RU2). Subordinate rock types in the upper part include amphibolite (102017), pegmatitic granite (101061) and one occurrence of fine- to medium-grained metagranitoid (101051). The BIPS image is not interpretable below 161.0 m. Inspection of drill cuttings below 161.0 m indicates medium-grained metagranite-granodiorite (101057) affected by a strong oxidation, which constitutes RU2. Two possible deformation zones of brittle character have been identified in HMF26 (DZ1–DZ2).

Sammanfattning

Denna rapport behandlar geologisk enhålstolkning av kärnborrhål KFM07C och hammarborrhål HFM26 i Forsmark. Den geologiska enhålstolkningen syftar till att utifrån den geologiska karteringen, tolkade geofysiska loggar och borrhålsradarmätningar indikera olika litologiska enheters fördelning i borrhålen samt möjliga deformationszoners läge och utbredning. En kort beskrivning av varje bergenhet och möjlig deformationszon presenteras.

Denna undersökning visar att det i KFM07C finns två litologiska enheter (RU1–RU2). Medelkorning metagranit-granodiorit (101057) dominerar borrhålet. I mindre omfattning förekommer pegmatitisk granit (101061), amfibolit (102017), fin- till medelkornig metagranitoid (101051), aplitisk metagranit (101058), felsisk till intermediär metavulkanisk bergart (103076) och en förekomst av medel- till grovkornig metagabbro (101033). Förhöjd sprickfrekvens karaktäriserar RU1 i förhållande till RU2. Tre möjliga deformationszoner som är spröda har identifierats i KFM07C (DZ1–DZ3).

Hammarborrhål HFM26 domineras av medelkornig metagranit-granodiorit (101057). Borrhålet delas in i två litologiska enheter (RU1 och RU2). I mindre omfattning förekommer amfibolit (102017), pegmatitisk granit (101061) och en förekomst av fin- till medelkornig metagranitoid (101051). BIPS-bilden är inte tolkningsbar nedanför 161,0 m. Granskning av borrkax nedanför 161,0 m visar på en möjlig förekomst av medelkornig metagranit-granodiorit (101057) vilken är påverkad av en stark oxidering. Denna bergart utgör RU2. Två möjliga deformationszoner av spröd karaktär har identifierats i HFM26 (DZ1–DZ2).

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 modelling in the 3D-CAD Rock Visualization 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 interpretations of boreholes KFM07C and HFM26 in the Forsmark area. The horizontal projections of the boreholes are shown in Figure 1-1. The work was carried out in accordance with activity plan SKB PF 400-06-088. The controlling documents for performing this activity are listed in Table 1-1. Both the activity plan and method description are SKB's internal controlling documents.

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

Activity plan	Number	Version
Geologisk enhålstolkning av KFM07C och HFM26	AP PF 400-06-088	1.0
Method description	**Number**	**Version**
Metodbeskrivning för geologisk enhålstolkning	SKB MD 810.003	3.0

Figure 1-1. Map showing position and horizontal projection of the cored borehole KFM07C and the percussion borehole HFM26.

2 Objective and scope

A geological single-hole interpretation is carried out in order to identify and to describe briefly the characteristics of major rock units and possible deformation zones within a borehole. The work involves an integrated interpretation of data from the geological mapping of the borehole (Boremap), different borehole geophysical logs and borehole radar data.

The geological mapping of the cored borehole involves a documentation of the character of the bedrock in the drill core. This work component is carried out in combination with an inspection of the oriented image of the borehole walls that is obtained with the help of the *Borehole Image Processing System* (BIPS). The geological mapping of the percussion borehole focuses more attention on an integrated interpretation of the information from the geophysical logs and the BIPS images. For this reason, the results from the percussion borehole mapping are more uncertain. The interpretations of the borehole geophysical and radar logs are available when the single-hole interpretation is completed. The result from the geological single-hole interpretation is presented in a WellCad plot. A more detailed description of the technique is provided in the method description for geological single-hole interpretation (SKB MD 810.003, internal document). The work reported here concerns stage 1 in the single-hole interpretation, as defined in the method description.

3 Data used for the geological single-hole interpretation

The following data and interpretations have been used for the single-hole interpretation of the boreholes KFM07C and HFM26:

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

The material used as a basis for the geological single-hole interpretation was a WellCad plot consisting of parameters from the geological mapping in the Boremap system, geophysical logs and borehole radar. An example of a WellCad plot used during geological single-hole interpretation is shown in Figure 3-1. The plot consists of ten main columns and several subordinate columns. These include:

1: Length along the borehole

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 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. The rocks with high natural gamma radiation have been included in the younger, Group D intrusive suite /1/.

Possible alteration: This parameter has not been used in the geological single-hole interpretation in the Forsmark area.

Silicate density: This parameter indicates the density of the rock after subtraction of themagnetic 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, P-wave velocity as well as focused resistivity 140 and 300. The estimated fracture frequency is based on a statistical connection after a comparison has been made between the geophysical logs and the mapped fracture frequency. The log provides an indication of sections with low and high fracture frequencies.

Close inspection of the borehole radar data was carried out during the interpretation process, especially during the identification of possible deformation zones. The occurrence and orientation of radar anomalies within the possible deformation zones are commented upon in the text that describes these zones.

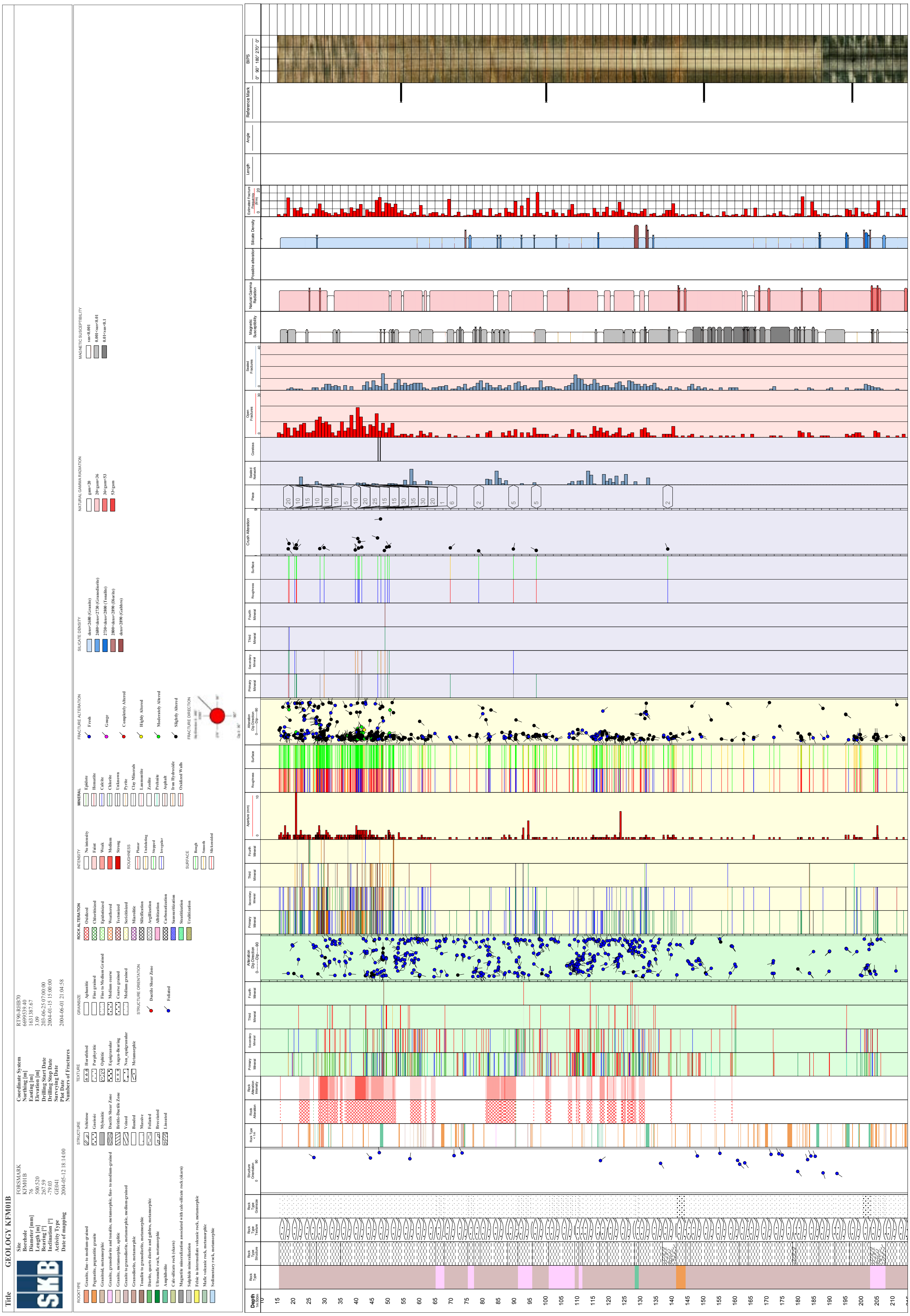

***Figure 3-1.** Example of WellCad plot (from borehole KFM01B) used as a basis for the single-hole interpretation.*

4 Execution of the geological single-hole interpretation

4.1 General

The geological single-hole interpretation has been carried out by a group of geoscientists consisting of both geologists and geophysicists. Several of these geoscientists previously participated in the development of the source material for the single-hole interpretation. All data to be used (see Chapter 3) are visualized side by side in a borehole document extracted from the software WellCad. The working procedure is summarized in Figure 4-1 and in the text below.

The first step in the working procedure is to study all types of data (rock type, rock alteration, silicate density, natural gamma radiation, etc) related to the character of the rock type and to merge sections of similar rock types, or sections where one rock type is very dominant, into rock units (minimum length of c 5 m). Each rock unit is defined in terms of the borehole length interval and provided with a brief description for inclusion in the WellCad plot. The confidence in the interpretation of a rock unit is made on the following basis: 3 = high, 2 = medium and 1 = low.

The second step in the working procedure is to identify possible deformation zones by visual inspection of the results of the geological mapping (fracture frequency, fracture mineral, aperture, alteration, etc) in combination with the geophysical logging and radar data. The section of each identified possible deformation zone is defined in terms of the borehole length interval and provided with a brief description for inclusion in the WellCad plot. This includes a brief description of the rock types affected by the possible deformation zone. The confidence in the interpretation of a possible deformation zone is made on the following basis: 3 = high, 2 = medium and 1 = low.

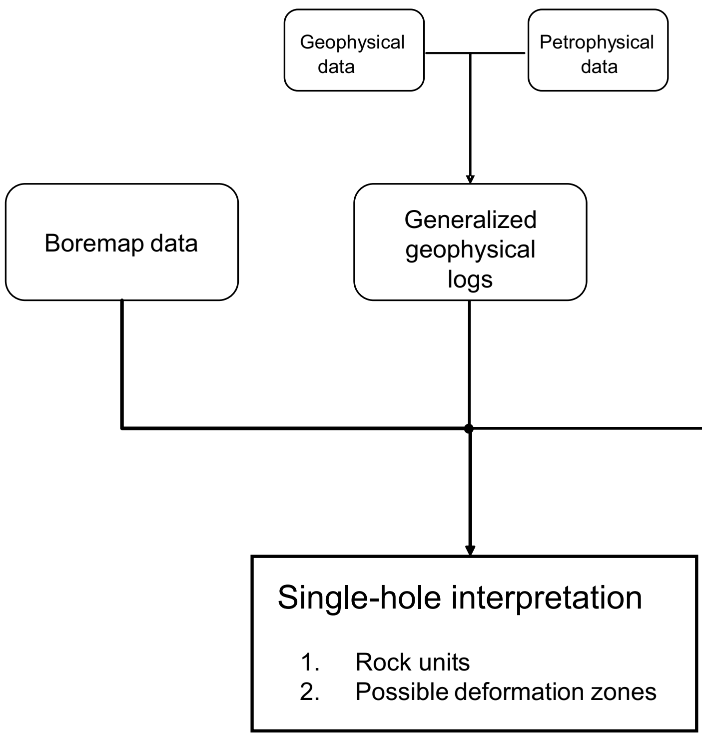

Figure 4-1. *Schematic chart that shows the procedure for the development of a geological single-hole interpretation.*

Inspection of BIPS images is carried out wherever it is judged necessary during the working procedure. Furthermore, following definition of rock units and possible deformation zones, with their respective confidence estimates, the drill cores are inspected in order to check the selection of the boundaries between these geological entities. If judged necessary, the location of these boundaries is adjusted.

Possible deformation zones that are brittle in character have been identified primarily on the basis of the frequency of fractures, according to the concept presented in /2/. Brittle deformation zones defined by an increased fracture frequency of extensional fractures (joints) or shear fractures (faults) are not distinguished. Both the transitional part, with a fracture frequency in the range 4–9 fractures/m, and the core part, with a fracture frequency > 9 fractures/m, have been included in each zone (Figure 4-2). The frequencies of open and sealed fractures have been assessed in the identification procedure, and the character of the zone has been described accordingly. Partly open fractures are included together with open fractures in the brief description of each zone. The presence of bedrock alteration, the occurrence and, locally, inferred orientation of radar reflectors, the resistivity, SPR, P-wave velocity, caliper and magnetic susceptibility logs have all assisted in the identification of the zones. The anomalies in these parameters that assist with the identification are presented in the short description.

Since the frequency of fractures is of key importance for the definition of the possible deformation zones, moving average plots for this parameter are shown for the cored borehole KFM07C and the percussion borehole HFM26 (Figures 4-3 to 4-4). A 5 m window and 1 m steps have been used in the calculation procedure. The moving average for open fractures alone, the total number of open fractures (open, partly open and crush), the sealed fractures alone, and the total number of sealed fractures (sealed and sealed fracture network) are shown in each diagram.

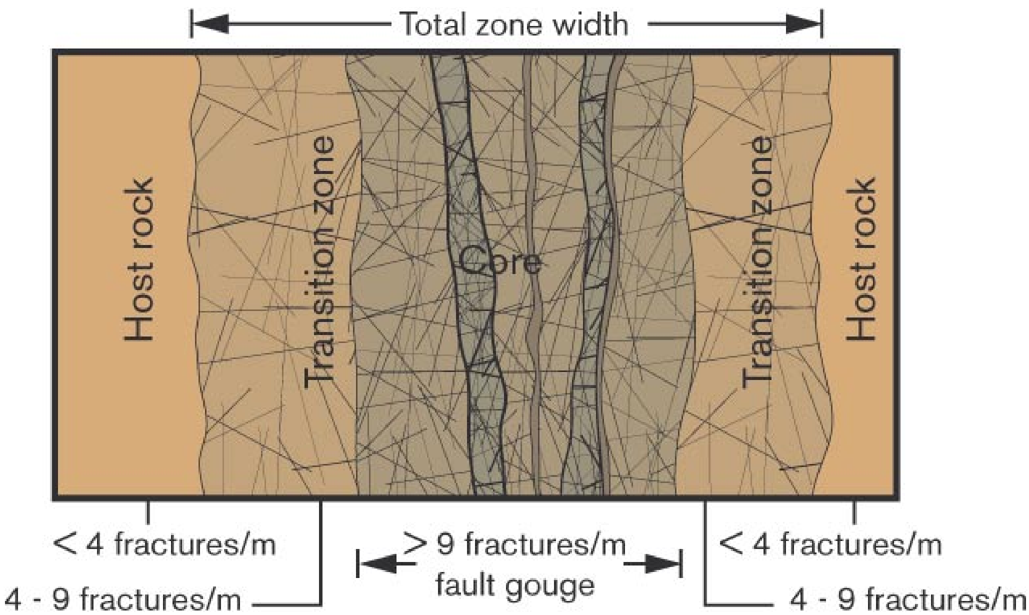

Figure 4-2. *Terminology for brittle deformation zones (after /2/).*

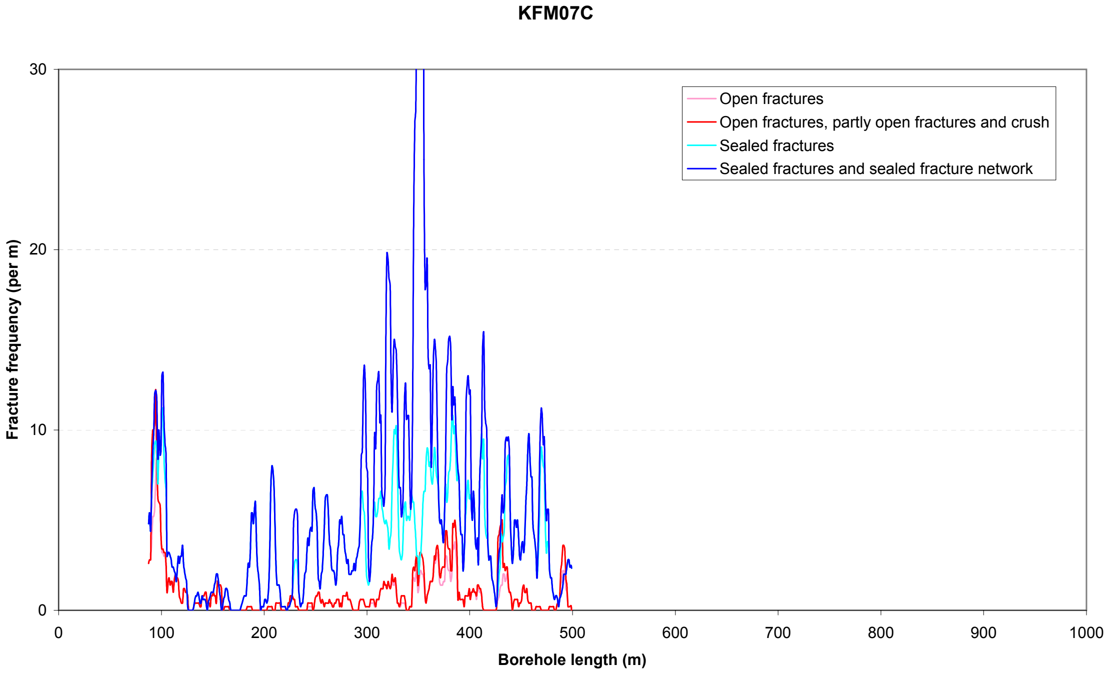

Figure 4-3. *Fracture frequency plot for KFM07C. Moving average with a 5 m window and 1 m steps.*

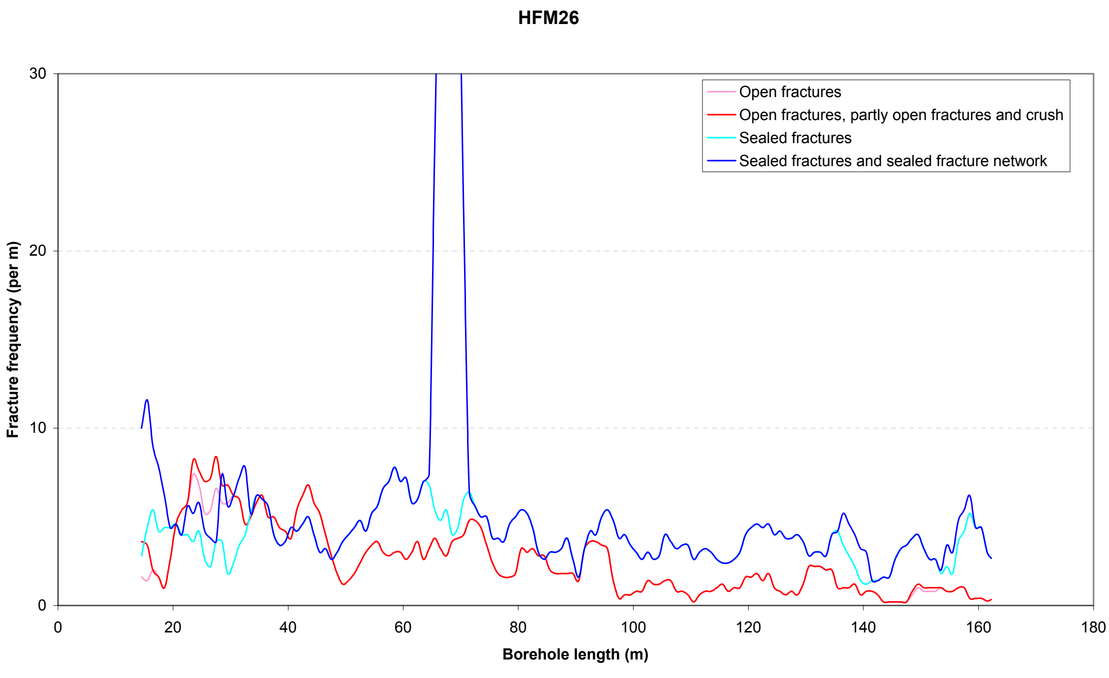

Figure 4-4. *Fracture frequency plot for HFM26. Moving average with a 5 m window and 1 m steps.*

The occurrence and orientation of radar anomalies within the possible deformation zones are used during the identification of these zones. Overviews of the borehole radar measurements in KFM07C and the percussion borehole HFM26 are shown in Figures 4-5 and 4-6. A conductive environment causes attenuation of the radar wave, which in turn decreases the penetration. The effect of attenuation can be observed in the boreholes and is particularly conspicuous in the lower part of HFM26 (Figure 4-6). The effect of attenuation varies between the different antenna frequencies (20 MHz, 100 MHz, 250 MHz and 60 MHz directional antenna). In some cases, alternative orientations for oriented radar reflectors are presented. One of the alternatives is considered to be correct, but due to uncertainty in the interpretation of radar data, a decision concerning which of the alternatives that represent the true orientation cannot be made. Orientations from directional radar are presented as strike/dip using the right-hand-rule.

4.2 Nonconformities

The sections 85.19–98.38 m and 499.03–500.77 m adjusted length in KFM07C were mapped without access to BIPS images.

Borehole KFM07C was shielded by a perforated metal plate along the section 428.08–430.07 m. The metal plate was present during geophysical, BIPS and borehole radar logging.

There are no geophysical data above 99.5 m in KFM07C.

The section 161.0–202.7 m in HFM26 was not mapped due to the very poor quality of the BIPS image which prevented interpretation.

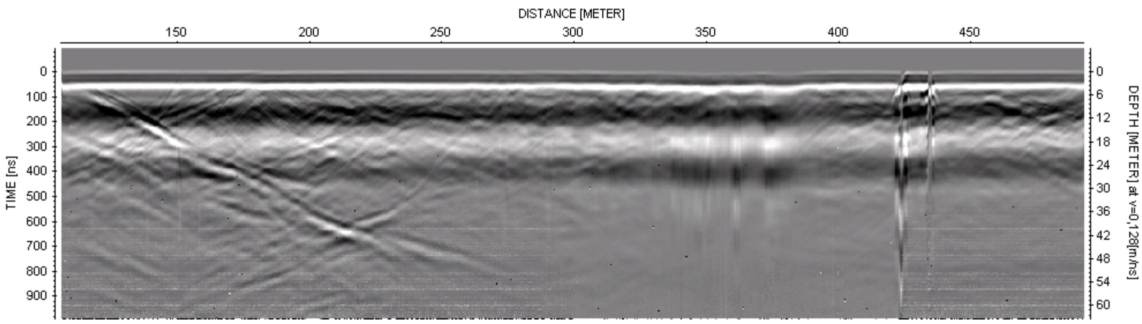

Figure 4-5. Overview (20 MHz data) of the borehole radar measurements in KFM07C.

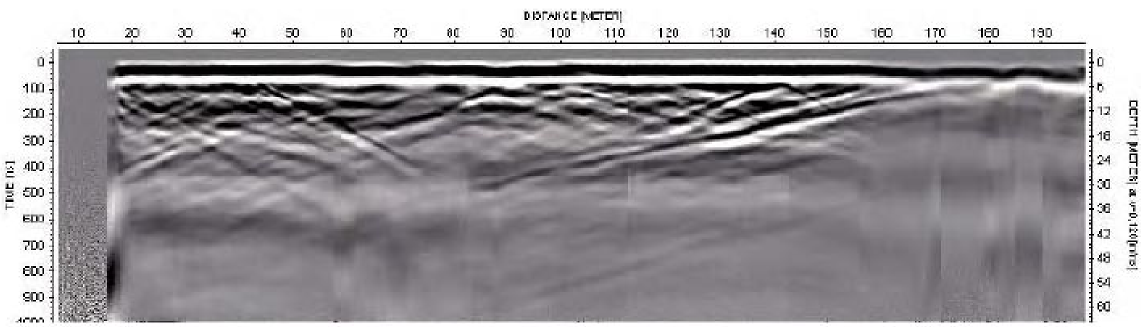

Figure 4-6. Overview (20 MHz data) of the borehole radar measurements in HFM26.

5 Results

The results of the geological single-hole interpretation are presented as print-outs from the software WellCad (Appendix 1 for KFM07C and Appendix 2 for HFM26).

5.1 KFM07C

The borehole direction at the start is 143°/–85°.

Rock units

The borehole can be divided into two different rock units, RU1–RU2. The rock units have been recognized with a high degree of confidence.

85.19–123.0 m

RU1: Medium-grained metagranite-granodiorite (101057) with subordinate pegmatitic granite (101061). Increased fracture frequency relative to the remaining part of the borehole, possible deformation zones excluded. Frequent resistivity anomalies. Confidence level = 3.

123.0–500.77 m

RU2: Medium-grained metagranite-granodiorite (101057) with subordinate occurrences of pegmatitic granite (101061), amphibolite (102017), fine- to medium-grained metagranitoid (101051) and aplitic metagranite (101058). Several occurrences of felsic to intermediate metavolcanic rock (103076) in the interval 207–216 m and one occurrence of medium- to coarse-grained metagabbro (101033) at 428–430 m. Confidence level = 3.

Possible deformation zones

Three possible deformation zones of brittle character, of which all have been recognised with a high degree of confidence, are present in KFM07C.

92–103 m

DZ1: Increased frequency of open and sealed fractures. Most fractures strike NE and show a variable dip. A minor group of fractures strikes SE and dips moderately to steeply to the SW. Apertures generally less than 1 mm. Locally faint to medium oxidation. Two crush zones at the top of the possible deformation zone. Seven radar reflectors occur, of which three are oriented (160/68, 151/49 or 320/50, 151/68). One reflector is prominent and can be observed 50 m from the borehole. The most frequent fracture filling minerals are chlorite and calcite. Zone situated in medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite. Confidence level = 3.

308–388 m

DZ2: Increased frequency of sealed and open fractures, including a common occurrence of sealed fracture network. Fractures that strike WSW and dip steeply to the NNW and fractures that are gently dipping to subhorizontal dominate. Fractures with other orientations are also present. Seven brecciated intervals. The central part of the zone (346–357 m) shows the highest fracture frequency. Apertures generally less than 1 mm, with a few ranging up to 7 mm. Faint to medium oxidation throughout the interval, medium oxidation in the central part. Frequent negative resistivity anomalies and very low resistivity below 345 m. Low P–wave velocity in the interval 345–355 m. Low magnetic susceptibility between 329 and 358 m. Twenty five radar reflectors of which three are oriented (264/73 or 086/62, 130/76, 276/70 or 102/58). Slightly reduced radar penetration in the possible zone The most frequent fracture filling minerals in the order of decreasing abundance include calcite, chlorite, laumontite, adularia and pyrite. The zone is situated in medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite and amphibolite. Confidence level = 3.

429–439 m

DZ3: Increased frequency of sealed fractures in the lower part and a crush zone in the upper part (429.2–429.6 m). Fractures that strike WSW and dip variably to the NNW are present. Fractures that dip gently to the SE or are subhorizontal are also present. Apertures are less than 1 mm. Faint to medium chloritization of amphibolite and metagabbro in the upper part, and weak to medium oxidation of the metagranite-granodiorite in the lower part. Two negative resistivity anomalies at 434 and 438 m. The latter anomaly also coincides with low P-wave velocity. Low magnetic susceptibility. Two weak radar reflectors occur. The most frequent fracture filling minerals in the order of decreasing abundance include calcite, chlorite and laumontite. Confidence level = 3.

5.2 HFM26

The borehole direction at the start is 112°/–54°.

Rock units

The borehole consists of two rock units, RU1–RU2, one of which has been recognized with a high degree of confidence and one with a low degree of confidence.

12.03–161.0 m

RU1: Medium-grained metagranite-granodiorite (101057), with subordinate occurrences of amphibolite (102017), especially in the upper part of the borehole, and pegmatitic granite (101061). One occurrence of fine- to medium-grained metagranitoid (101051) at 138–140 m. Confidence level = 3.

161.0–202.7 m

RU2: BIPS image is not interpretable. Low density, low magnetic susceptibility, slightly increased gamma radiation, very low bulk resistivity and a large number of small caliper anomalies. Geophysical signature similar to that observed in vuggy granite along other boreholes. Strongly reduced radar penetration. Inspection of drill cuttings shows a rock type of granitic composition, probably medium-grained metagranite-granodiorite (101057), with a similar mineral assembly throughout the interval, except for a section between 184 and 190 m which contains a slightly larger amount of dark minerals. The entire interval is affected by a strong oxidation. Confidence level (rock type) = 1.

Possible deformation zones

Two possible deformation zones of brittle character, recognised with a medium or low degree of confidence, are present in HFM26.

12.03–46 m

DZ1: Increased frequency of open and sealed fractures. Fractures show variable orientation. Subvertical fractures with NS strike, fractures that dip moderately to the S and fractures that dip variably between N and W are present. Three crush zones and sealed fracture networks in the upper half. Fracture apertures generally 1 mm or less with the exception of two which are 5 mm. Locally faint to medium oxidation. Low resistivity, magnetic susceptibility and caliper anomalies between 23 and 29 m. Low magnetic susceptibility between 39 and 46 m. Six radar reflectors of which one is prominent at 30 m. The zone is situated in medium-grained metagranite-granodiorite, with subordinate occurrences of pegmatitic granite and amphibolite. Confidence level = 2.

60–95 m

DZ2: Increased frequency of sealed fractures and open fractures with a sealed fracture network at 66.97–68.80 m. Fractures show a highly variable orientation. Fractures that dip gently to moderately to the SSW are conspicuous. Fracture apertures generally 1 mm or less with a few up to 30 mm. Locally weak to medium oxidation. Low resistivity and low magnetic susceptibility throughout the possible zone. Six radar reflectors, one prominent at 69.5 m. The zone is situated in medium-grained metagranite-granodiorite and amphibolite with subordinate occurrences of pegmatitic granite. Confidence level = 1.

6 Comments

The results of the geological single-hole interpretations of KFM07C and HFM26 are presented in WellCad plots (Appendix 1–2). Each WellCad plot consists of the following columns:

1: Depth (length along the borehole).

2: Rock type.

3: Rock alteration.

4: Sealed fractures.

5: Open and partly open fractures.

6: Crush zones.

7: Silicate density.

8: Magnetic susceptibility.

9: Natural gamma radiation.

10: Estimated fracture frequency.

11: Description: Rock unit.

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

13: Stereogram for open and partly open fractures in rock unit (red symbols).

14: Description: Possible deformation zone.

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

16: Stereogram for open and partly open fractures in possible deformation zone (red symbols).

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Appendix 1

Geological single-hole interpretation of KFM07C

Title SINGLE HOLE INTERPRETATION KFM07C

Site	FORSMARK	Inclination [°]	-85.39	Elevation [m.a.s.l.]	3.35	Signed data
Borehole	KFM07C	Date of mapping	2006-09-04 09:21:00	Drilling Start Date	2005-12-20 14:30:00	
Diameter [mm]	76	Coordinate System	RT90-RHB70	Drilling Stop Date	2006-01-17 13:00:00	
Length [m]	500.340	Northing [m]	6700125.61	Surveying Date		
Bearing [°]	142.71	Easting [m]	1631034.45	Plot Date	2006-11-22 23:18:12	

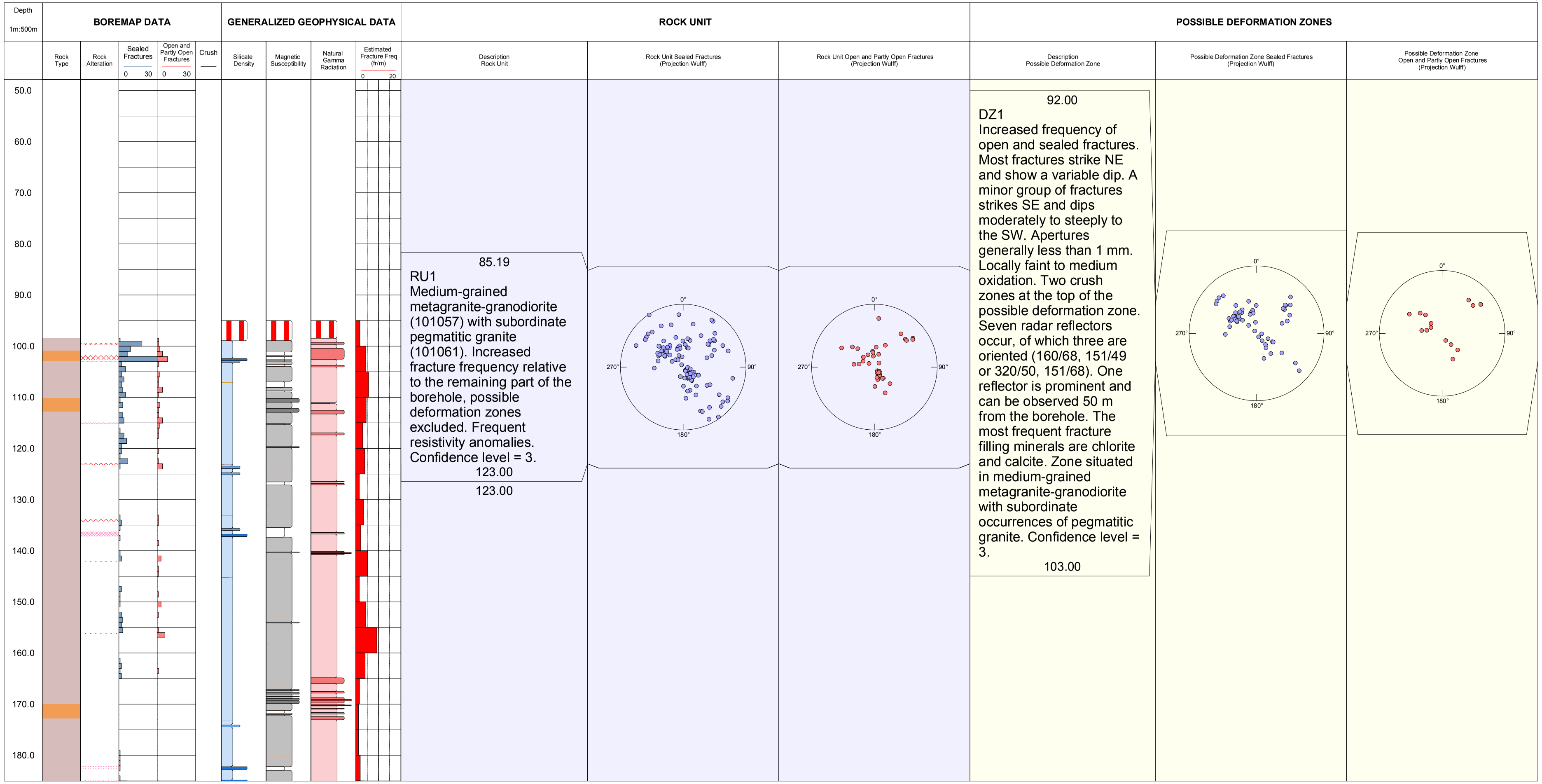
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite to granodiorite, metamorphic, medium-grained
- Ultramafic rock, metamorphic
- Amphibolite
- Felsic to intermediate volcanic rock, metamorphic

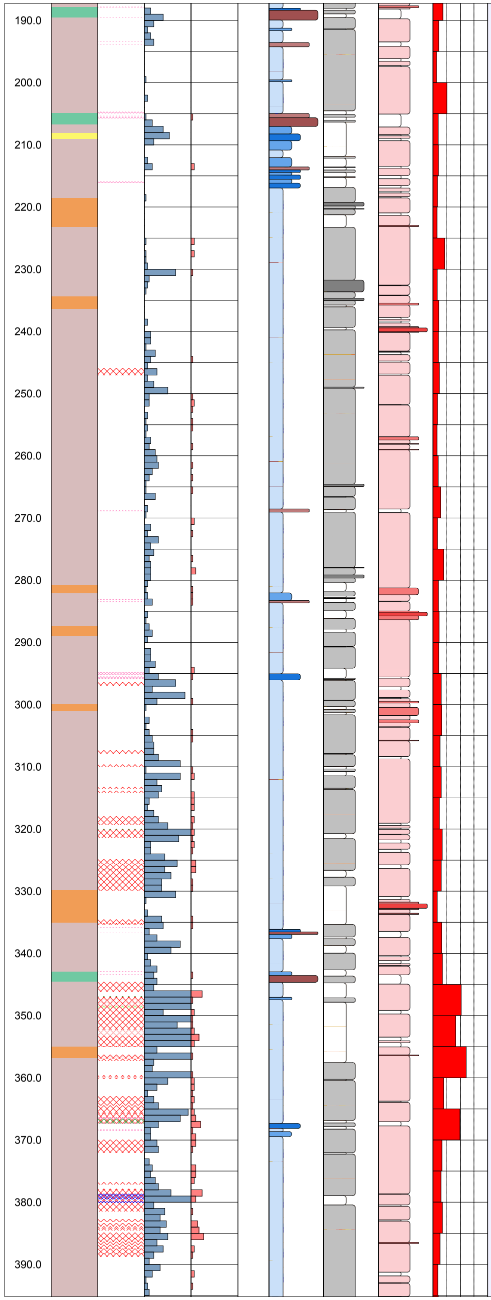
ROCK ALTERATION
- Oxidized
- Chloritisized
- Epidotisized
- Albitization
- Saussuritization
- Laumontitization

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

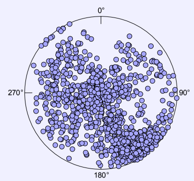
SUSCEPTIBILITET
- unclassified
- sus<0.001
- 0.001<sus<0.01
- 0.01<sus<0.1

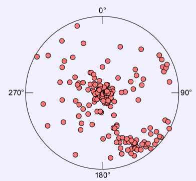
NATURAL GAMMA
- unclassified
- gam<20
- 20<gam<36
- 36<gam<53
- 53<gam





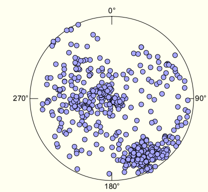
RU2
Medium-grained metagranite-granodiorite (101057) with subordinate occurrences of pegmatitic granite (101061), amphibolite (102017), fine- to medium-grained metagranitoid (101051) and aplitic metagranite (101058). Several occurrences of felsic to intermediate metavolcanic rock (103076) in the interval 207-216 m and one occurrence of medium- to coarse-grained metagabbro (101033) at 428-430 m. Confidence level = 3.

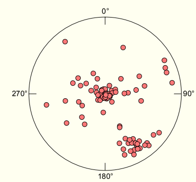


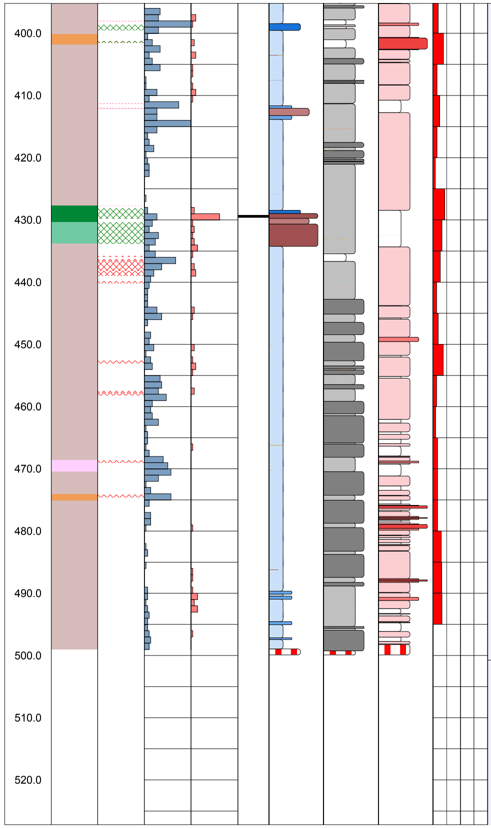


308.00

DZ2
Increased frequency of sealed and open fractures, including a common occurrence of sealed fracture network. Fractures that strike WSW and dip steeply to the NNW and fractures that are gently dipping to subhorizontal dominate. Fractures with other orientations are also present. Seven brecciated intervals. The central part of the zone (346-357 m) shows the highest fracture frequency. Apertures generally less than 1 mm, with a few ranging up to 7 mm. Faint to medium oxidation throughout the interval, medium oxidation in the central part. Frequent negative resistivity anomalies and very low resistivity below 345 m. Low P-wave velocity in the interval 345-355 m. Low magnetic susceptibility between 329 and 358 m. Twenty five radar reflectors of which three are oriented (264/73 or 086/62, 130/76, 276/70 or 102/58). Slightly reduced radar penetration in the possible zone The most frequent fracture filling minerals in the order of decreasing abundance include calcite, chlorite



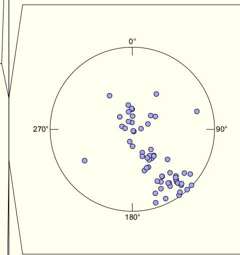


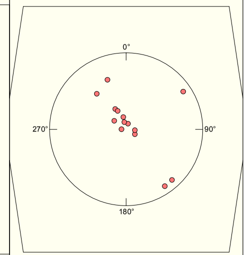


500.77

include calcite, chlorite, laumontite, adularia and pyrite. The zone is situated in medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite and amphibolite. Confidence level = 3.
388.00

429.00
DZ3
Increased frequency of sealed fractures in the lower part and a crush zone in the upper part (429.2-429.6 m). Fractures that strike WSW and dip variably to the NNW are present. Fractures that dip gently to the SE or are subhorizontal are also present. Apertures are less than 1 mm. Faint to medium chloritization of amphibolite and metagabbro in the upper part, and weak to medium oxidation of the metagranite-granodiorite in the lower part. Two negative resistivity anomalies at 434 and 438 m. The latter anomaly also coincides with low P-wave velocity. Low magnetic susceptibility. Two weak radar reflectors occur. The most frequent fracture filling minerals in the order of decreasing abundance include calcite, chlorite and laumontite.
Confidence level = 3.
439.00





Geological single-hole interpretation of HFM26

Title	SINGLE HOLE INTERPRETATION HFM26					
Site	FORSMARK	Inclination [°]	-53.74	Elevation [m.a.s.l.]	2.73	Signed data
Borehole	HFM26	Date of mapping	2006-09-25 12:02:00	Drilling Start Date	2005-11-10 07:00:00	
Diameter [mm]	138	Coordinate System	RT90-RHB70	Drilling Stop Date	2005-11-18 07:00:00	
Length [m]	202.700	Northing [m]	6698008.93	Surveying Date		
Bearing [°]	112.42	Easting [m]	1633516.39	Plot Date	2006-11-22 23:18:12	

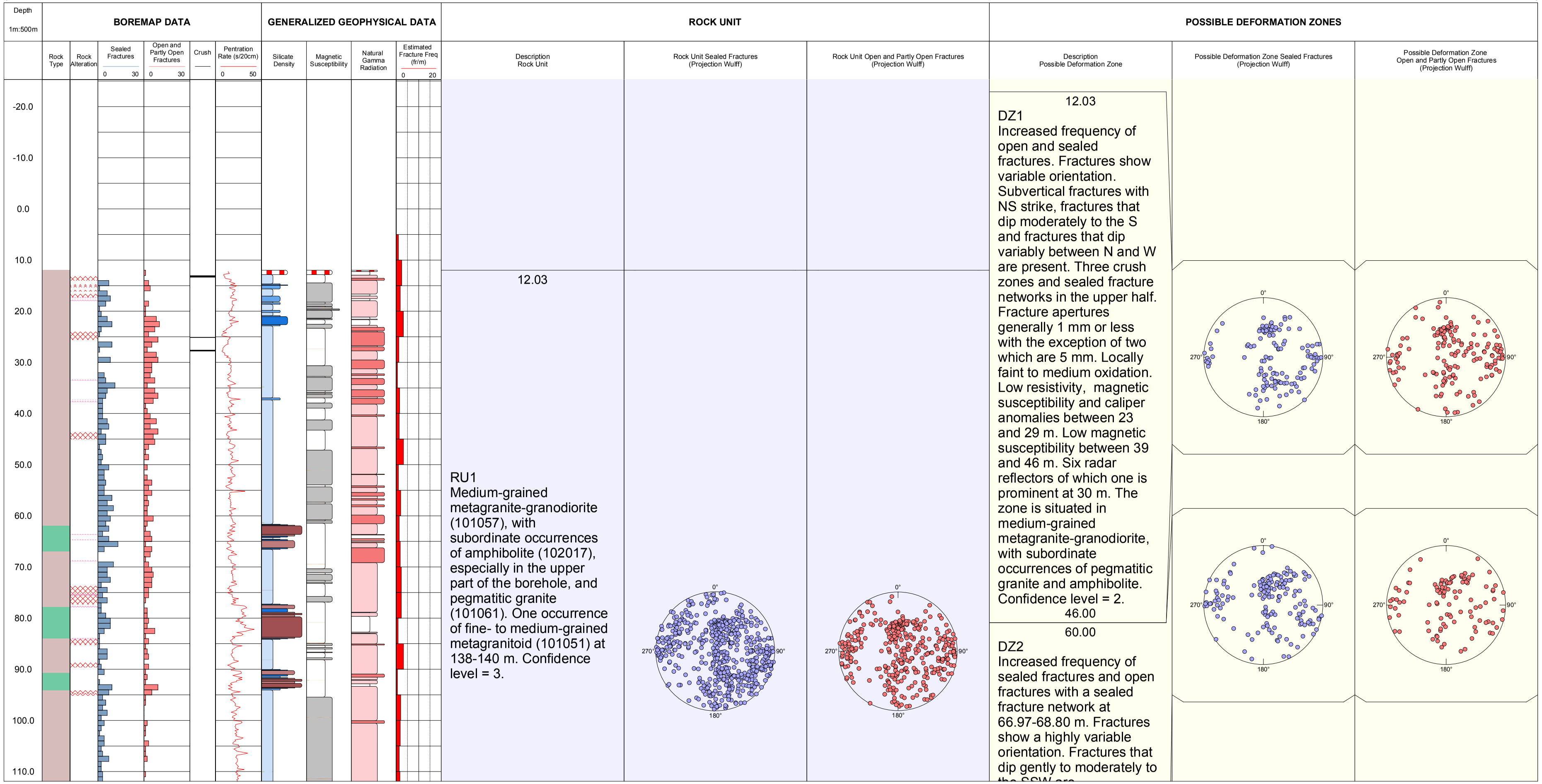
ROCKTYPE FORSMARK
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite to granodiorite, metamorphic, medium-grained
- Amphibolite

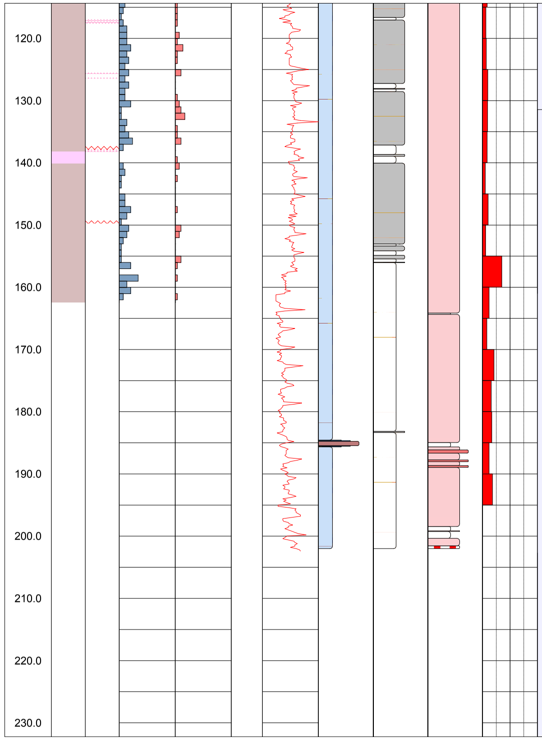
ROCK ALTERATION
- Oxidized
- Epidotisized
- Albitization

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

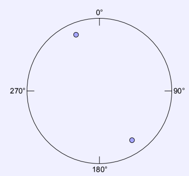


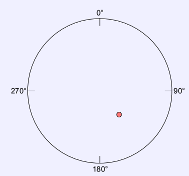


161.00

161.00

RU2
BIPS image is not interpretable. Low density, low magnetic susceptibility, slightly increased gamma radiation, very low bulk resistivity and a large number of small caliper anomalies. Geophysical signature similar to that observed in vuggy granite along other boreholes. Strongly reduced radar penetration. Inspection of drill cuttings shows a rock type of granitic composition, probably medium-grained metagranite-granodiorite (101057), with a similar mineral assembly throughout the interval, except for a section between 184 and 190 m which contains a slightly larger amount of dark minerals. The entire interval is affected by a strong oxidation. Confidence level (rock type) = 1.
202.70





conspicuous. Fracture apertures generally 1 mm or less with a few up to 30 mm. Locally weak to medium oxidation. Low resistivity and low magnetic susceptibility throughout the possible zone. Six radar reflectors, one prominent at 69.5 m. The zone is situated in medium-grained metagranite-granodiorite and amphibolite with subordinate occurrences of pegmatitic granite. Confidence level = 1.
95.00