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Forsmark site investigation

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September 2006

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Abstract

This report presents geological single-hole interpretations of the cored borehole KFM01D and the percussion boreholes HFM24, HFM25, HFM27 and HFM29 at Forsmark. The interpretation combines the geological core mapping, interpreted 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 deformation zone is provided.

The geological single-hole interpretation shows that four rock units (RU1–RU4) occur in KFM01D. Metagranite-granodiorite (101057) dominates the borehole. The four rock units have been distinguished on the basis of differences in fracture frequency, grain size, and the presence of static recrystallization. Subordinate rock types in the different units are pegmatitic granite (101061), fine- to medium-grained metagranitoid (101051), amphibolite (102017), felsic to intermediate metavolcanic rock (103076) and aplitic metagranite (101058). Five possible deformation zones of brittle character have been identified in KFM01D (DZ1–DZ5).

The percussion borehole HFM24 is dominated by medium-grained metagranite-granodiorite (101057), which constitutes one rock unit (RU1). Pegmatitic granite (101061), fine- to medium-grained granite (111058), fine- to medium-grained metagranitoid (101051) and amphibolite (102017) occur as subordinate rock types. Three possible deformation zones of brittle character have been identified in HFM24 (DZ1–DZ3).

One rock unit (RU1) occurs in percussion borehole HFM25, which is dominated by medium-grained metagranite-granodiorite (101057). Pegmatitic granite (101061), amphibolite (102017), aplitic metagranite (101058) and fine- to medium-grained granite (111058) occur as subordinate rock types. Five possible deformation zones of brittle character have been identified in HFM25 (DZ1–DZ5).

The percussion borehole HFM27 is dominated by medium-grained metagranite-granodiorite (101057), which constitutes one rock unit (RU1). Subordinate rock types are amphibolite (102017) and pegmatitic granite (101061). Three possible deformation zones of brittle character have been identified in HFM27 (DZ1–DZ3).

The percussion borehole HFM29 contains one rock unit (RU1), which is dominated by medium-grained metagranite-granodiorite (101057). Subordinate rock types are pegmatitic granite (101061), amphibolite (102017), aplitic metagranite (101058) and felsic to intermediate metavolcanic rock (103076). Three possible deformation zones of brittle character have been identified in HFM29 (DZ1–DZ3).

Sammanfattning

Denna rapport behandlar geologisk enhålstolkning av kärnborrhålet KFM01D och hammarborrhålen HFM24, HFM25, HFM27 och HFM29 i Forsmark. Den geologiska enhålstolkningen syftar till att utifrån den geologiska karteringen, tolkade geofysiska loggar och borrhålsradarmätningar indikera olika litologiska enheters fördelning i borrhålet samt möjliga deformationszoners läge och utbredning. En kort beskrivning av varje bergenhet och deformationszon presenteras.

Denna undersökning visar att det i KFM01D finns fyra litologiska enheter (RU1–RU4). Metagranit-granodiorit (101057) dominerar borrhålet. De fyra litologiska enheterna har tolkats genom skillnader i sprickfrekvens, kornstorlek och förekomst av icke-rörelsebetingad omkristallisering. I mindre omfattning i de olika litologiska enheterna förekommer pegmatitisk granit (101061), fin- till medelkornig metagranitoid (101051), amfibolit (102017), felsisk till intermediär metavulkanisk bergart (103076) och aplitisk metagranit (101058). Fem möjliga deformationszoner som är spröda har identifierats i KFM01D (DZ1–DZ5).

Hammarborrhål HFM24 domineras av medelkornig metagranit-granodiorit (101057), vilken utgör en litologisk enhet (RU1). I mindre omfattning förekommer pegmatitisk granit (101061), fin- till medelkornig granit (111058), fin- till medelkornig metagranitoid (101051) och amfibolit (102017). Tre möjliga deformationszoner av spröd karaktär har identifierats i HFM24 (DZ1–DZ3).

En litologisk enhet (RU1) har identifierats i hammarborrhål HFM25. Borrhålet domineras av medelkornig metagranit-granodiorit (101057). Pegmatitisk granit (101061), amfibolit (102017), aplitisk metagranit (101058) och fin- till medelkornig granit (111058) förekommer som underordnade bergarter. Fem möjliga deformationszoner av spröd karaktär har identifierats i HFM25 (DZ1–DZ5).

Hammarborrhål HFM27 domineras av medelkornig metagranit-granodiorit (101057) vilken utgör en litologisk enhet (RU1). Underordnade bergarter utgörs av amfibolit (102017) och pegmatitisk granit (101061). Tre möjliga deformationszoner av spröd karaktär har identifierats i HFM27 (DZ1–DZ3).

Hammarborrhål HFM29 består av en litologisk enhet (RU1), vilken domineras av medelkornig metagranit-granodiorit (101057). Underordnade bergarter utgörs av pegmatitisk granit (101061), amfibolit (102017), aplitisk metagranit (101058) och felsisk till intermediär metavulkanisk bergart (103076). Tre möjliga deformationszoner av spröd karaktär har identifierats i HFM29 (DZ1–DZ3).

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 KFM01D, HFM24, HFM25, HFM27 and HFM29 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 400-06-056. 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.

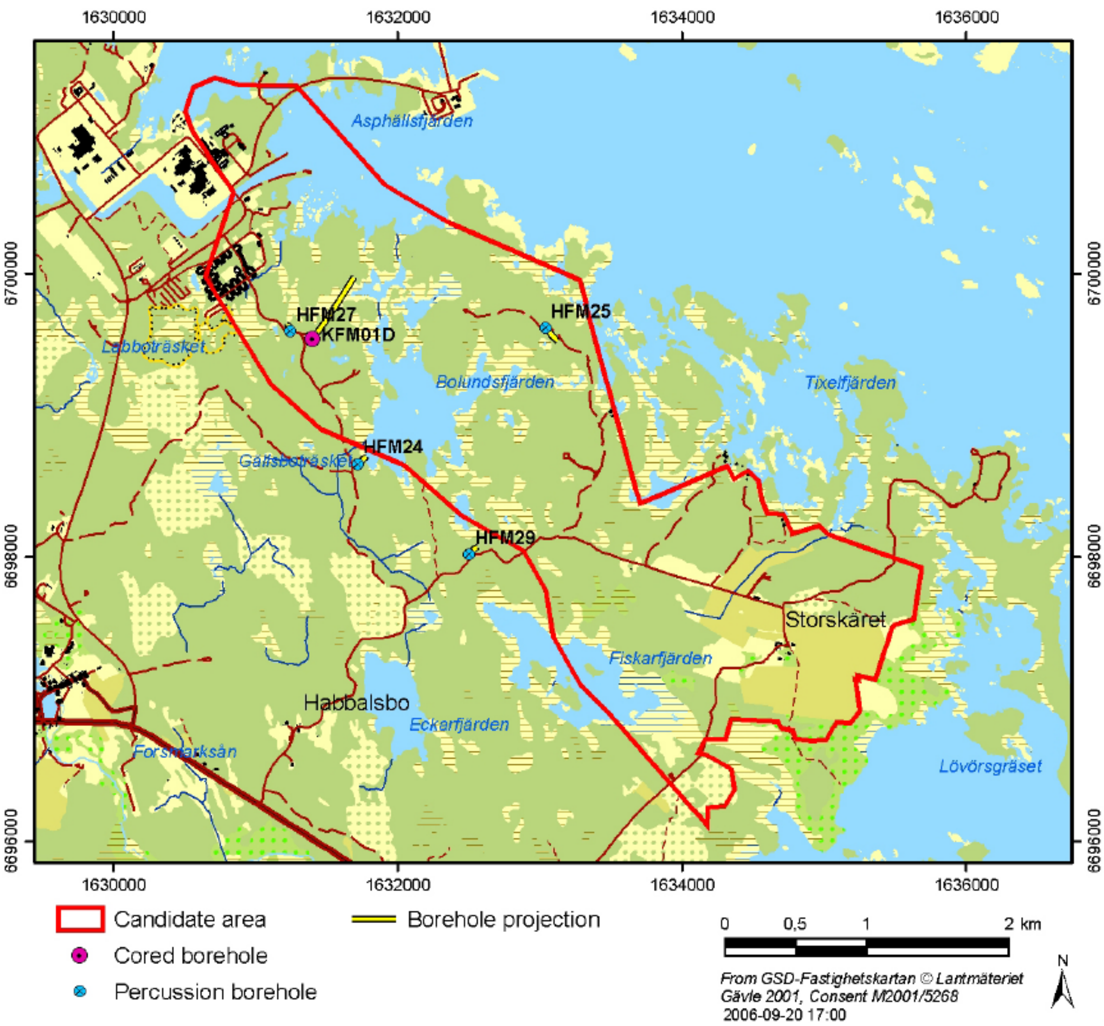

Figure 1-1. *Map showing position and horizontal projection of the cored borehole KFM01D and the percussion boreholes HFM24, HFM25, HFM27 and HFM29.*

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

Activity plan	Number	Version
Geologisk enhålstolkning av KFM01D, HFM24, HFM25, HFM27 och HFM29	AP PF 400-06-056	1.0
Method description	**Number**	**Version**
Metodbeskrivning för geologisk enhålstolkning	SKB MD 810.003	3.0

2 Objective and scope

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

The geological mapping of the cored boreholes involves a documentation of the character of the bedrock in the drill core. This work component is carried out in combination with an inspection of the oriented image of the borehole walls that is obtained with the help of the Borehole Image Processing System (BIPS). The geological mapping of the percussion boreholes 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 KFM01D, HFM24, HFM25, HFM27 and HFM29:

- Boremap data (including BIPS and geological mapping data) /3, 4/.
- Generalized geophysical logs and their interpretation /5, 6, 7/.
- Radar data and their interpretation /8, 9, 10/.

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 the magnetic 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.

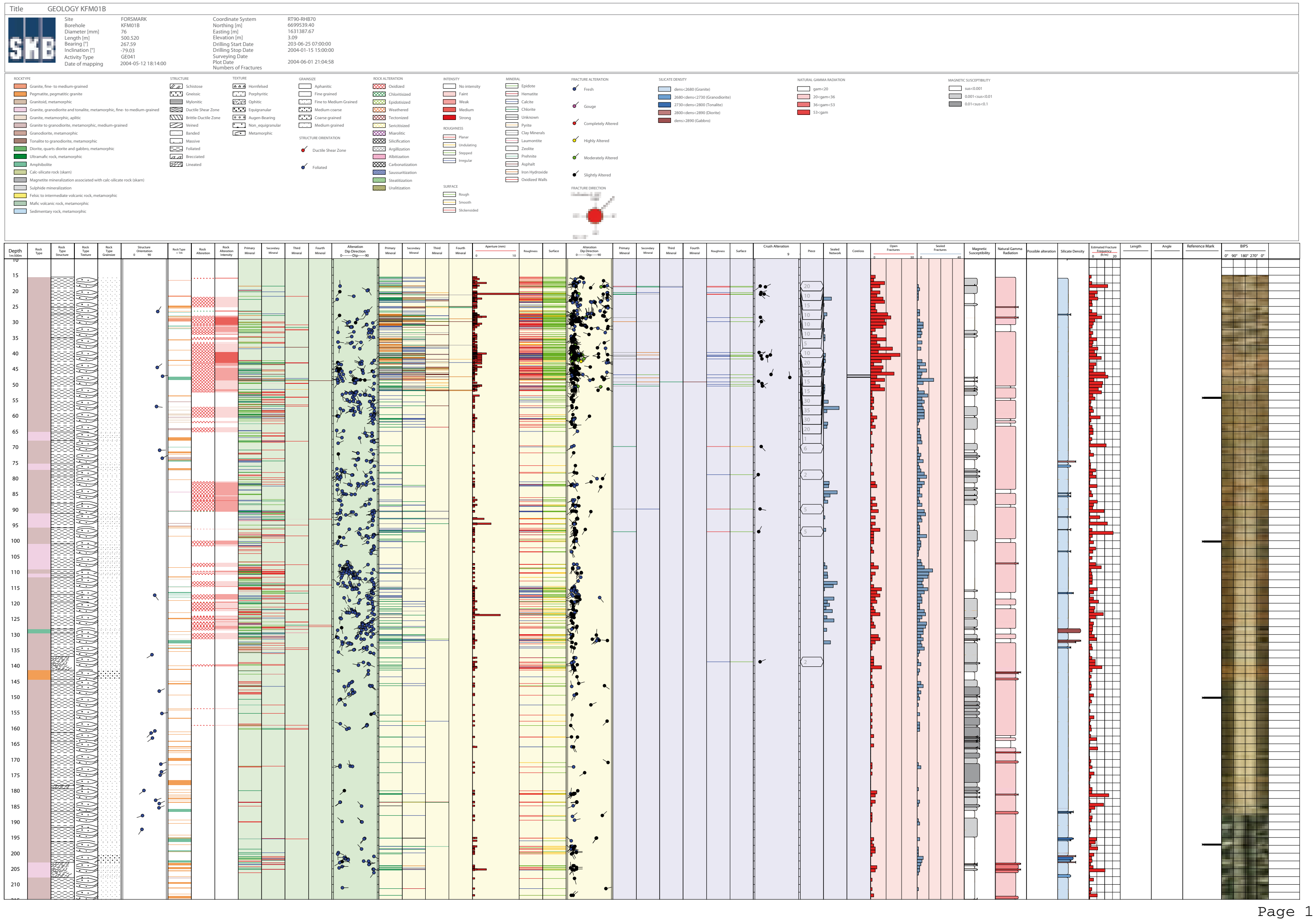

***Figure 3-1.** Example of WellCad plot (from borehole KFM01B) used as a basis for the single-hole interpretation.*

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.

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 KFM01D and the percussion boreholes HFM24, HFM25, HFM27 and HFM29 (Figures 4-3 to 4-7). A 5 m window and 1 m steps have been used in the calculation procedure. The moving averages for open fractures alone, the total number of open fractures (open, partly open and crush), the sealed fractures alone, and the total number of sealed fractures (sealed and sealed fracture network) are shown in each diagram.

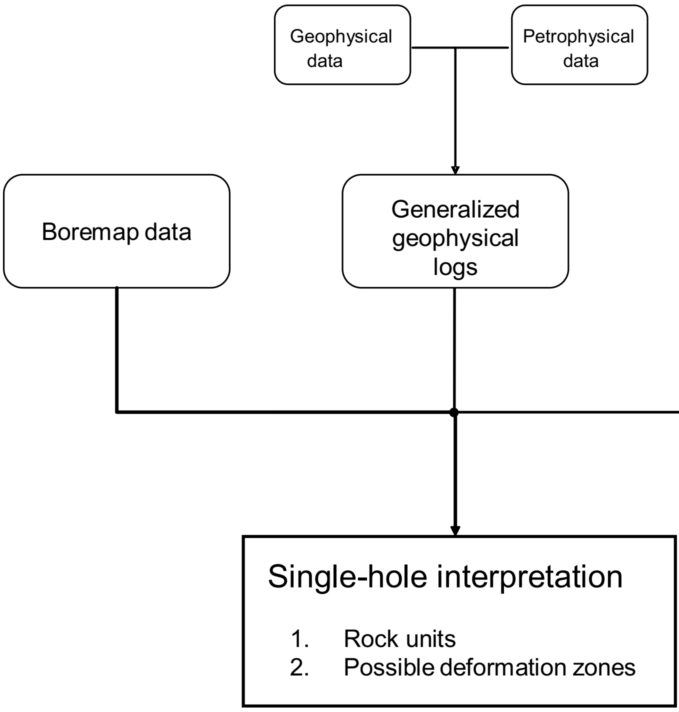

Figure 4-1. *Schematic chart that shows the procedure for the development of a geological single-hole interpretation.*

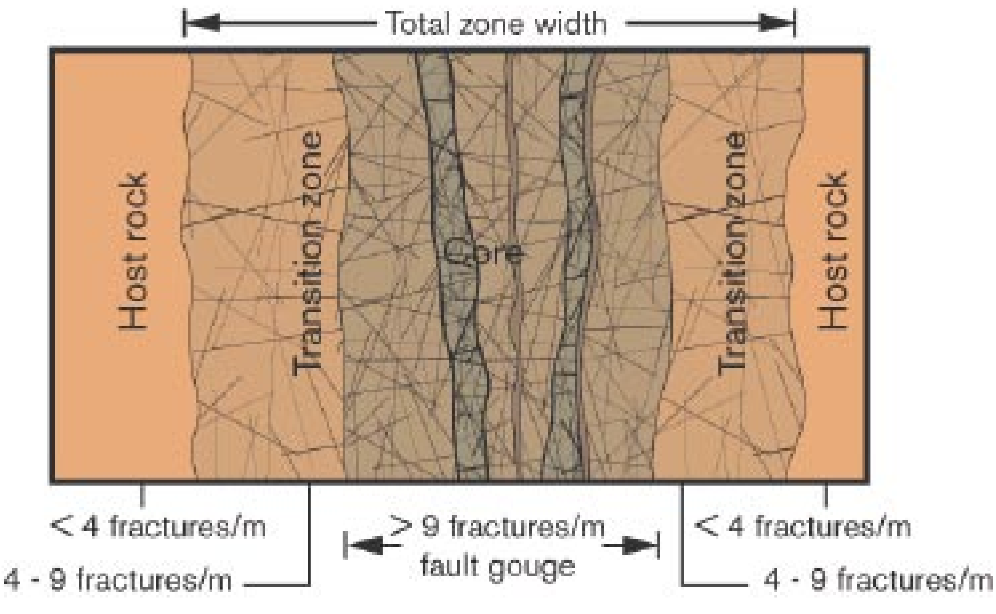

Figure 4-2. *Terminology for brittle deformation zones (after /2/).*

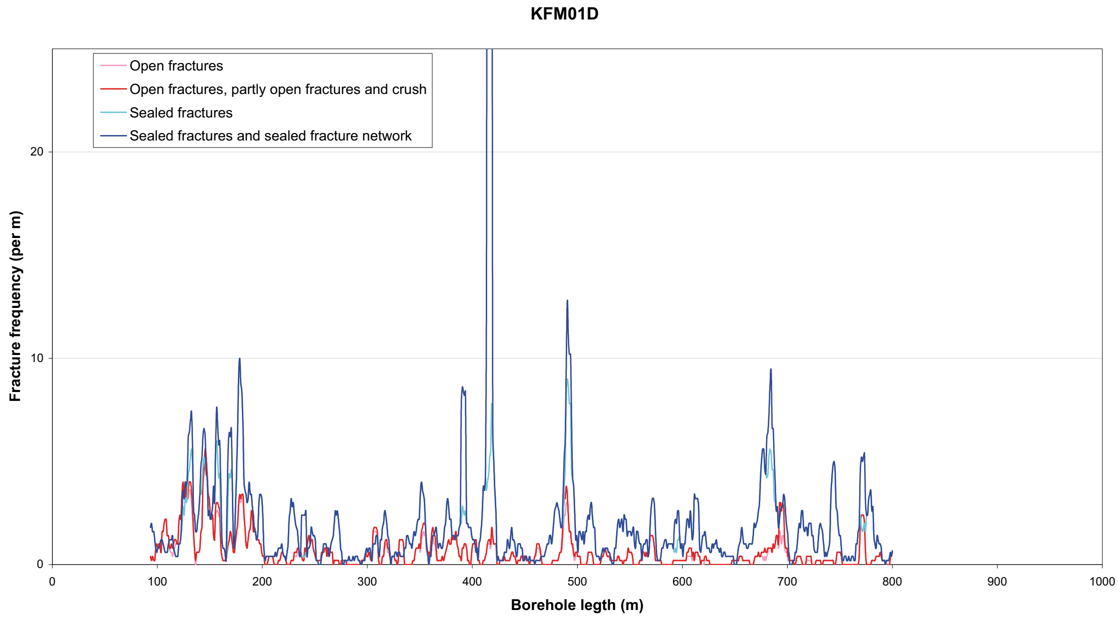

Figure 4-3. Fracture frequency plot for KFM01D. Moving average with a 5 m window and 1 m steps.

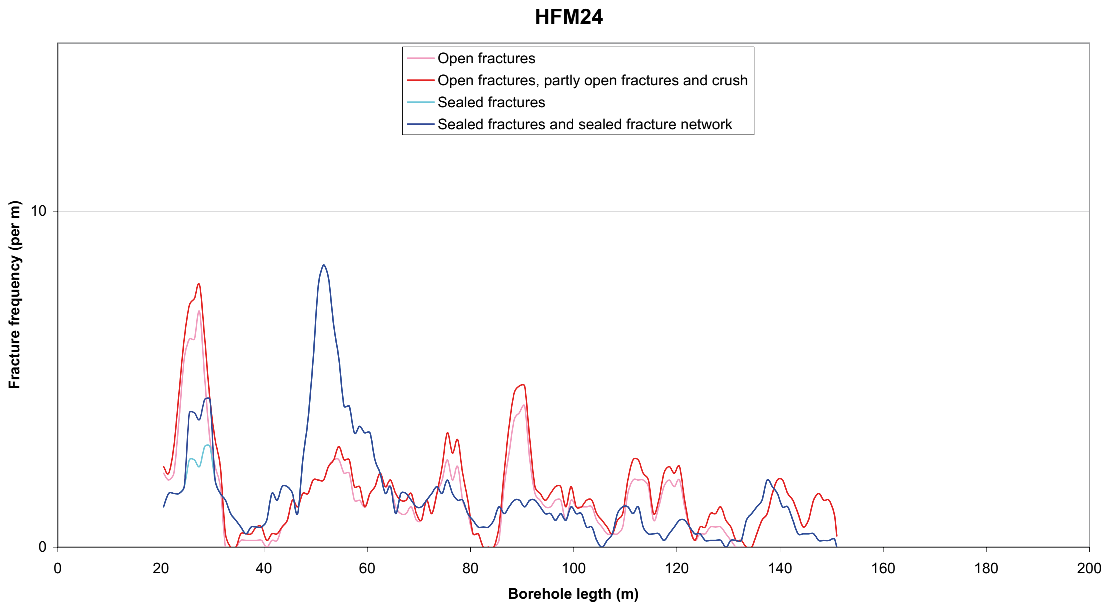

Figure 4-4. Fracture frequency plot for HFM24. Moving average with a 5 m window and 1 m steps.

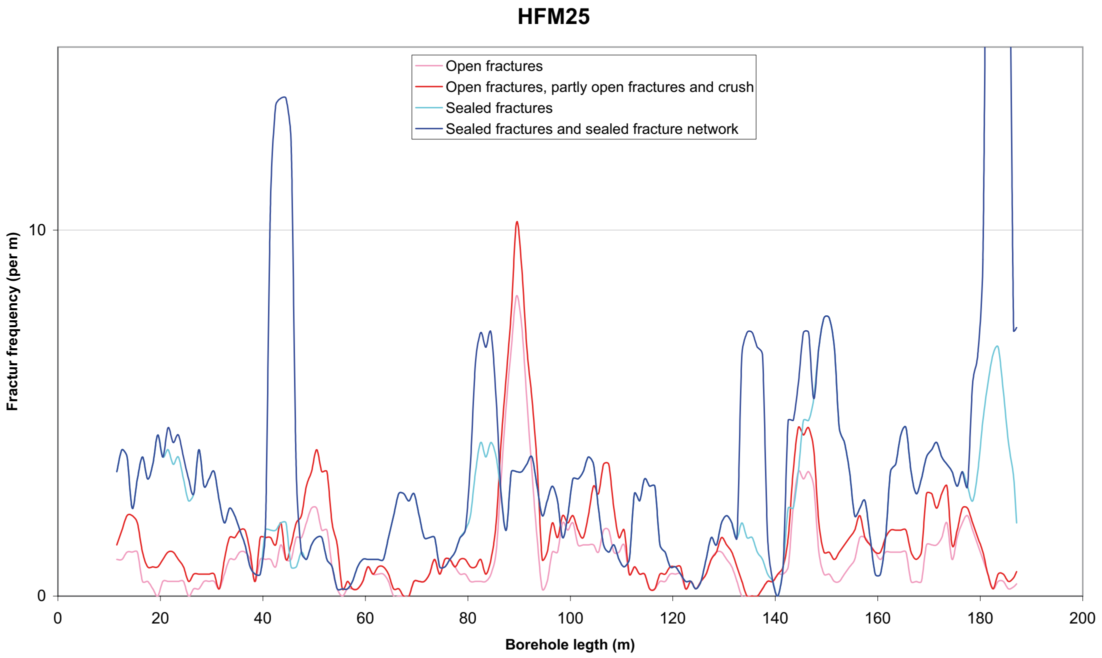

Figure 4-5. *Fracture frequency plot for HFM25. Moving average with a 5 m window and 1 m steps.*

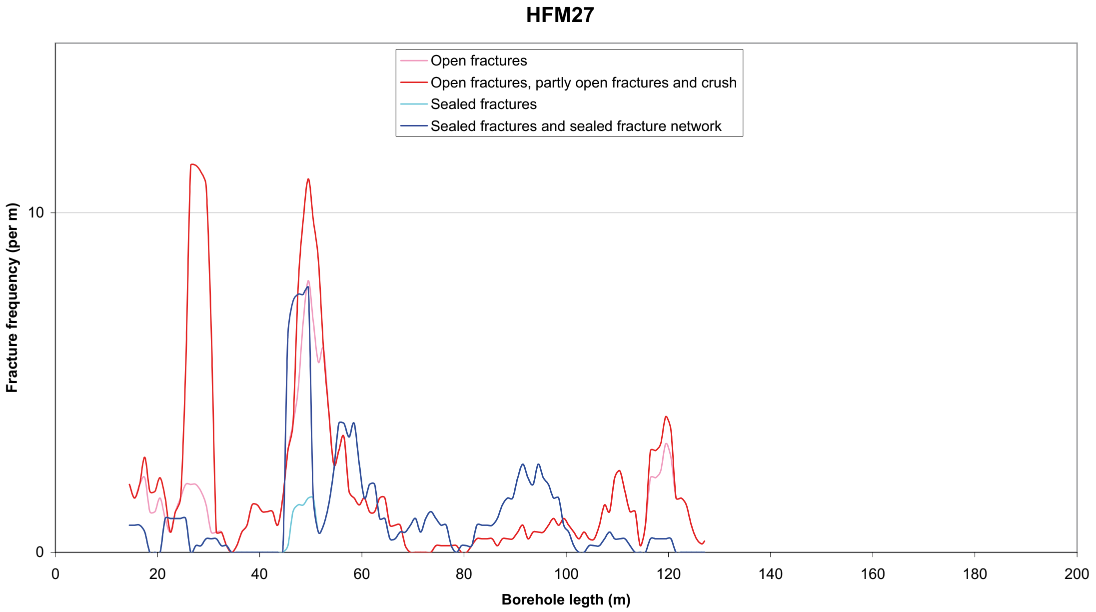

Figure 4-6. *Fracture frequency plot for HFM27. Moving average with a 5 m window and 1 m steps.*

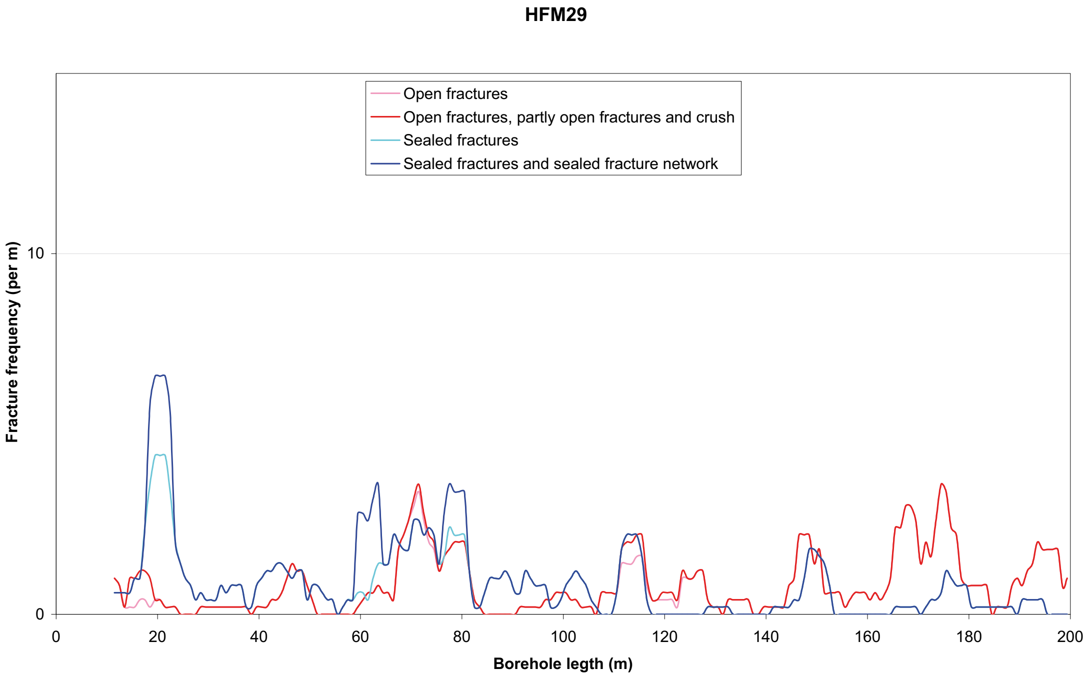

Figure 4-7. *Fracture frequency plot for HFM29. Moving average with a 5 m window and 1 m steps.*

The occurrence and orientation of radar anomalies within the possible deformation zones are used during the identification of these zones. An overview of the borehole radar measurements in KFM01D, HFM24, HFM25, HFM27 and HFM29 is shown in Figures 4-8 to 4-12. 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 density log was not correctly calibrated during time for the single-hole interpretation.

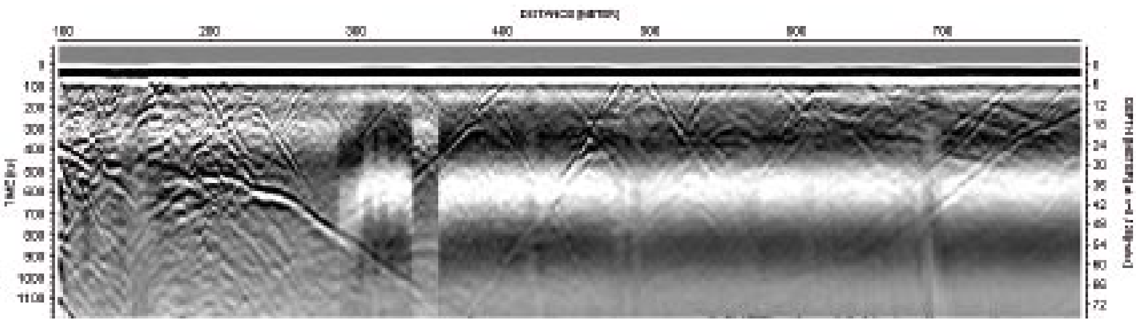

Figure 4-8. *Overview (20 MHz data) of the borehole radar measurements in KFM01D.*

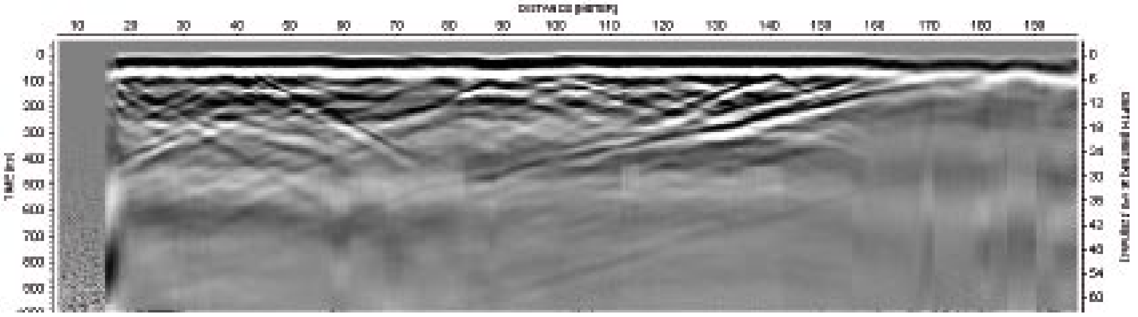

Figure 4-9. *Overview (20 MHz data) of the borehole radar measurements in HFM24.*

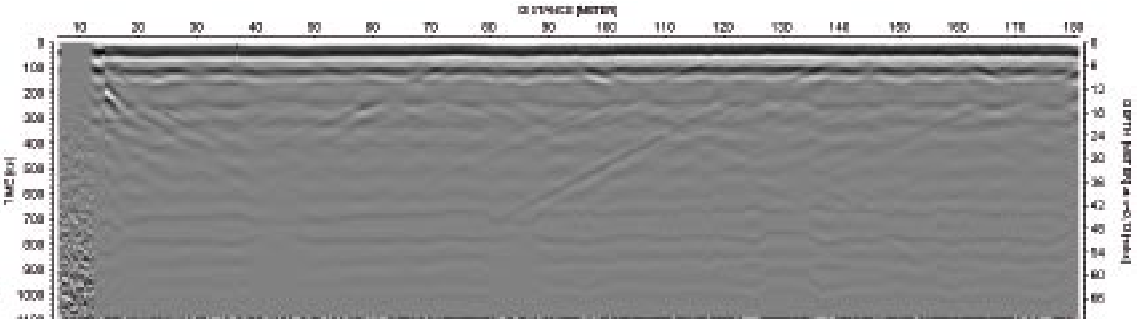

Figure 4-10. *Overview (20 MHz data) of the borehole radar measurements in HFM25.*

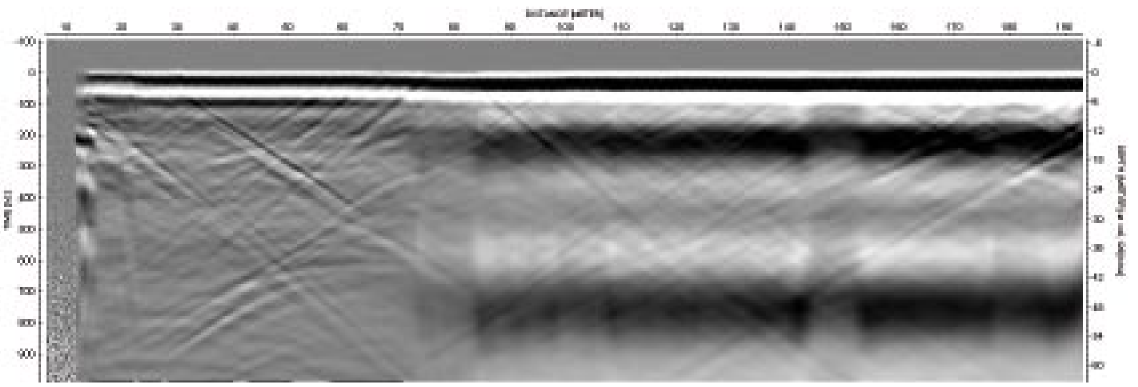

Figure 4-11. *Overview (20 MHz data) of the borehole radar measurements in HFM27.*

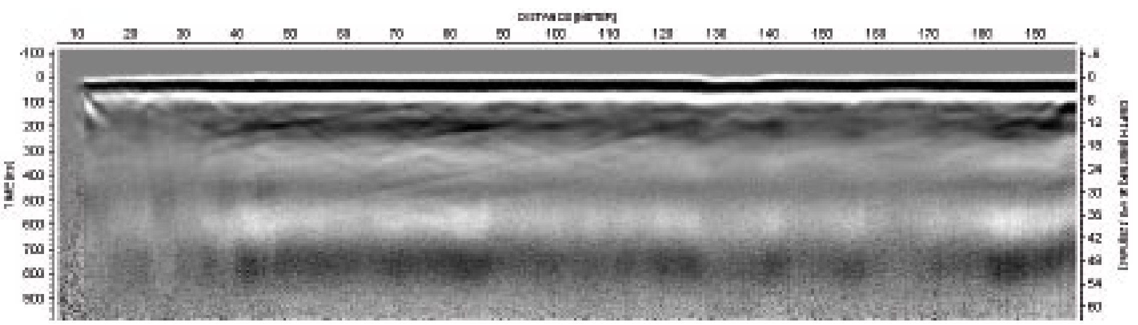

Figure 4-12. *Overview (20 MHz data) of the borehole radar measurements in HFM29.*

5 Results

The result of the geological single-hole interpretation is presented as print-outs from the software WellCad (Appendix 1 for KFM01D, Appendix 2 for HFM24, Appendix 3 for HFM25, Appendix 4 for HFM27 and Appendix 5 for HFM29).

5.1 KFM01D

The borehole direction at the start is 035/–54.9°.

Rock units

The borehole can be divided into four different rock units, RU1–RU4, all of which have been recognized with a high degree of confidence.

91.61–191.15 m

RU1: Medium-grained metagranite-granodiorite (101057) with subordinate occurrences of pegmatitic granite (101061), fine- to medium-grained metagranitoid (101051), amphibolite (102017), fine- to medium-grained granite (111058), felsic to intermediate metavolcanic rock (103076), aplitic metagranite (101058) and calc-silicate rock (108019). Increased frequency of sealed and open fractures, and low resistivity and caliper anomalies, relative to the remaining part of the borehole outside possible deformation zones. Confidence level = 3.

191.15–424.15 m

RU2: Fine- to finely medium-grained metagranite-granodiorite (101057) with subordinate occurrences of pegmatitic granite (101061), fine- to medium-grained metagranitoid (101051) and amphibolite (102017). Sub-parallel radar reflector from 190–350 m, located 35–65 m from the borehole. Confidence level = 3.

424.15–499.88 m

RU3: Fine- to finely medium-grained metagranite-granodiorite (101057) affected by static recrystallization. Subordinate occurrences of pegmatitic granite (101061), amphibolite (102017), fine- to medium-grained granite (111058), aplitic metagranite (101058) and one occurrence of felsic to intermediate metavolcanic rock (103076) at 491.53–496.33 m. The metavolcanic rock corresponds to increased density values. The section c. 407–514 m is characterized by decreased density and increased natural gamma radiation relative to the medium-grained metagranite-granodiorite (101057). Confidence level = 3.

499.88–800.07 m

RU4: Medium-grained metagranite-granodiorite (101057) with subordinate occurrences of fine- to medium-grained metagranitoid (101051), pegmatitic granite (101061), amphibolite (102017), fine- to medium-grained granite (111058) and one occurrence of aplitic metagranite (101058) at 660.72–663.78. The medium-grained metagranite-granodiorite in the uppermost c. 10 m of the rock unit shows the same type of static recrystallization as RU3. Three sub-parallel radar reflectors from 700–760 m, located 10–25 m from the borehole. Confidence level = 3.

Possible deformation zones

Five possible deformation zones of brittle character that have been recognised with a high degree of confidence are present in KFM01D.

176–184 m

DZ1: Increased frequency of sealed and open fractures. Gently dipping fractures and fractures that strike SSE and dip steeply westwards dominate. Apertures 1 mm or less. Faint to strong oxidation throughout the zone. One 17 cm wide calcite sealed fracture in the central part of the possible deformation zone. Low resistivity and caliper anomalies and also a slightly decreased P-wave velocity. Four radar reflectors of which one is confidently oriented (137/71). The most frequent fracture filling minerals in the order of decreasing abundance include calcite, chlorite, adularia and clay minerals. Zone situated in medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite, aplitic metagranite and amphibolite. Confidence level = 3.

411–421 m

DZ2: Increased frequency of sealed fractures including sealed fracture networks. Fractures that strike NNW and dip steeply eastwards dominate. Gently dipping fractures are also present. Apertures 1 mm or less. Decreased bulk resistivity in the interval 415.7–421 m. Five radar reflectors of which one is confidently oriented (351/89). The most frequent fracture filling minerals in the order of decreasing abundance include calcite, laumontite and chlorite. The zone occurs close to the base of RU2 in fine- to finely medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite and fine- to medium-grained metagranitoid. Confidence level = 3.

488–496 m

DZ3: Increased frequency of sealed and open fractures. One gently dipping crush zone at 488.99–489.00 m. Fractures that strike SSE and dip steeply westwards as well as gently dipping fractures with variable orientation are present. Apertures 0.5 mm or less. Minor low resistivity anomalies and decreased magnetic susceptibility. Four radar reflectors of which one is confidently oriented (067/13). The most frequent fracture filling minerals in the order of decreasing abundance include calcite, chlorite, laumontite and adularia. The zone occurs close to the base of RU3 in fine- to finely medium-grained metagranite-granodiorite affected by static recrystallization and a felsic to intermediate metavolcanic rock. The metavolcanic rock displays ductile high-strain zones along its margins. Subordinate occurrences of pegmatitic granite, amphibolite, aplitic metagranite, metamorphic granitoid and fine- to medium-grained granite. Confidence level = 3.

670–700 m

DZ4: Increased frequency of sealed fractures, and in the lower part open fractures. Steeply dipping fractures that strike NE (SE dip) and NW (NE dip) dominate. Gently dipping fractures with variable orientation are also present. Apertures typically less than 1 mm, with a few up to 7 mm. Locally faint oxidation. The section 665–701 m is characterized by low resistivity, distinct caliper anomalies and decreased magnetic susceptibility. Eight radar reflectors of which one is confidently oriented (162/40). Prominent radar wave attenuation in the interval 686–694 m. The most frequent fracture filling minerals in the order of decreasing abundance include calcite, chlorite, laumontite and clay minerals. Zone situated in medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite, aplitic metagranite, pegmatite and amphibolite, directly above the contact to a fine- to medium-grained metagranitoid. Confidence level = 3.

771–774 m

DZ5: Increased frequency of sealed and open fractures. The open fractures are steeply dipping and strike ESE (SSW dip), SE (SW dip) and WSW (NNW dip). Apertures 0.5 mm or less. Weak to medium oxidation throughout the interval. Slightly decreased resistivity. One non-oriented radar reflectors and one oriented with the orientation 219/51 or 247/82. The most frequent fracture filling minerals in the order of decreasing abundance include chlorite, calcite and clay minerals. Zone situated in medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite. Confidence level = 3.

5.2 HFM24

The borehole direction at the start is 046/–57.8°.

Rock units

The borehole consists of one rock unit, RU1, which has been recognized with a medium degree of confidence.

18.03–151.05 m

RU1: Medium-grained metagranite-granodiorite (101057), with subordinate occurrences of pegmatitic granite (101061), fine- to medium grained granite (111058), fine- to medium-grained metagranitoid (101051) and amphibolite (102017). Weak, sub-parallel radar reflector between 70 and 140 m occurs approximately 30–40 m from the borehole. Confidence level = 2.

Possible deformation zones

Three possible deformation zones of brittle character that have been recognised with a medium or low degree of confidence are present in HFM24.

18–32 m

DZ1: Increased frequency of open and sealed fractures, including one sealed fracture network. The open fractures are predominantly gently dipping. Open fractures that strike SE and dip steeply to SW are also present. The sealed fractures predominantly strike SE and show a variable dip to the SW. Fracture apertures 2 mm or less. Generally weak to medium oxidation. Significantly decreased resistivity and distinct caliper anomalies in the interval 24.5–30 m. Low magnetic susceptibility throughout the zone. Three radar reflectors (angle to borehole axis 40–61°) and most prominent radar wave attenuation between 24 and 30 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of pegmatitic granite and amphibolite. Confidence level = 2.

42–63 m

DZ2: Increased frequency of sealed and open fractures. The open fractures dip gently to the NE, N and E. Steeply dipping fractures with SE strike (SW dip) are also present. Sealed fractures predominantly strike SE and show a variable dip to the SW. Fracture apertures 2 mm or less. Generally weak to medium oxidation in the lower half of the interval. Several distinct caliper anomalies in the interval 43–55 m. Decreased magnetic susceptibility and bulk resistivity in the interval 49–63 m. Nine radar reflectors (angle to borehole axis 43–61°). Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of fine- to medium-grained granite, aplitic metagranite, pegmatitic granite and amphibolite. Confidence level = 2.

67–103 m

DZ3: The section is characterized by decreased bulk resistivity and magnetic susceptibility. Nine radar reflectors (angle to borehole axis 27–63°) and prominent radar wave attenuation throughout the interval. Slight increase in fracture frequency. Fractures with SE strike and steep dips to the SW dominate. Gently dipping fractures with variable dip northwards are also present. Fracture apertures 1 mm or less. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of pegmatitic granite, amphibolite, aplitic metagranite and fine- to medium-grained metagranitoid. Confidence level = 1.

5.3 HFM25

The borehole direction at the start is 139/–57.6°.

Rock units

The borehole consists of one rock unit, RU1, which has been recognized with a medium degree of confidence.

9.04–187.21 m

RU1: Medium-grained metagranite-granodiorite (101057) with subordinate occurrences of pegmatitic granite (101061), amphibolite (102017), aplitic metagranite (101058) and fine- to medium-grained granite (111058). Confidence level = 2.

Possible deformation zones

Five possible deformation zones of brittle character that have been recognised with a medium or low degree of confidence are present in HFM25.

9.04–36 m

DZ1: General decrease in the bulk resistivity. Partly decreased magnetic susceptibility. Four radar reflectors (angle to borehole axis 40–67°). Four breccias less than 1 dm wide each. Slight increase in fracture frequency, including one sealed fracture network. Steeply dipping fractures with ENE strike dominate. Fracture apertures 1 mm or less. Locally weak to medium oxidation. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of amphibolite, pegmatitic granite and aplitic metagranite. Confidence level = 1.

42–54 m

DZ2: Increased frequency of sealed and open fractures, including one sealed fracture network in the upper part of the interval. Steeply dipping fractures with NE and SSE (WSW dip) strike dominate. Fracture apertures 1 mm or less. Partly decreased magnetic susceptibility and resistivity. Eight radar reflectors (angle to borehole axis 25–85°) and most prominent radar wave attenuation at 43–46 m and 51–54 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.

80–92 m

DZ3: Increased frequency of sealed fractures, including one sealed fracture network in the upper part of the interval, and open fractures in the lower part. Steeply dipping fractures that strike NE and dip to the SE dominate. Some gently dipping fractures are also present. Fracture apertures 1.5 mm or less. Weak to medium oxidation in the lower part. A few low resistivity anomalies. Three radar reflectors (angle to borehole axis 51–59°) and most prominent radar wave attenuation at 82–86 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.

143–155 m

DZ4: Increased frequency of sealed fractures, including one sealed fracture network and open fractures, especially in the upper part. Steeply dipping fractures with variable strike dominate. Only steeply dipping fractures with NW strike are absent. Some gently dipping fractures are also present. Fracture apertures 1 mm or less. Weak to medium oxidation. Partly decreased resistivity and magnetic susceptibility. Six radar reflectors (angle to borehole axis 47–66°) and most prominent radar wave attenuation at 144–147 m and 151–154 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.

169–187 m

DZ5: Increased frequency of sealed fractures, including several sealed fracture networks, especially in the lower part. Steeply dipping fractures with variable strike dominate. Only steeply dipping fractures with NW strike are absent. Some gently dipping fractures are also present. Fracture apertures 1 mm or less. Weak to medium oxidation, especially in the lower part. Partly decreased resistivity and magnetic susceptibility. Five radar reflectors (angle to borehole axis 45–72°) and most prominent radar wave attenuation at 180–186 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.

5.4 HFM27

The borehole direction at the start is 336/–67.7°.

Rock units

The borehole consists of one rock unit, RU1, which has been recognized with a medium degree of confidence.

12.04–127.20 m

RU1: Medium-grained metagranite-granodiorite (101057) with subordinate occurrences of amphibolite (102017) and pegmatitic granite (101061). One crush zone at 19.90–19.95 m and one breccia at 85.07–85.15 m. Confidence level = 2.

Possible deformation zones

Three possible deformation zones of brittle character that have been recognised with a medium degree of confidence are present in HFM27.

26–30 m

DZ1: One 70 cm crush zone at 27.75–28.45 m. Fracture apertures generally 1 mm or less, only two fractures up to 2.5 mm. Distinct low resistivity and caliper anomalies. One radar reflector (angle to borehole axis 43°) and prominent radar wave attenuation in the whole interval. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of pegmatitic granite. Confidence level = 2.

45–63 m

DZ2: Increased frequency of open fractures especially in the upper part. Gently dipping fractures that dip northwards dominate. Fracture apertures generally less than 1.5 mm, one up to 2.5 mm. One sealed fracture network, one crush zone and possible brittle-ductile deformation between 49.56 and 49.66 m. Decreased bulk resistivity along the entire section. Several caliper anomalies and decreased magnetic susceptibility in the interval 45–57 m. Seven radar reflectors (angle to borehole axis 50–63°) and prominent radar wave attenuation at 48–53 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.

117–123 m

DZ3: Slight increase in open fractures and one crush zone. The open fractures are predominantly subhorizontal. Apertures are generally less than 1 mm, but two apertures are 3 mm and 16 mm respectively. Two coincident low resistivity and caliper anomalies. Three radar reflectors (angle to borehole axis 84–86°) and prominent radar wave attenuation at 117–120 m and 121–123 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of pegmatitic granite and amphibolite. Confidence level = 2.

5.5 HFM29

The borehole direction at the start is 030/–58.7°.

Rock units

The borehole consists of one rock unit, RU1, which has been recognized with a medium degree of confidence.

9.03–199.69 m

RU1: Medium-grained metagranite-granodiorite (101057) with several narrow occurrences of pegmatitic granite (101061), amphibolite (102017), aplitic metagranite (101058) and felsic to intermediate metavolcanic rock (103076). One 2 cm crush zone is situated at 16.38–16.40 m. Confidence level = 2.

Possible deformation zones

Three possible deformation zones of brittle character that have been recognised with a medium or low degree of confidence are present in HFM29.

19–25 m

DZ1: Slightly increased frequency of sealed fractures and one sealed fracture network. One documented open fracture. The sealed fractures strike SE and dip steeply to SW. Generally weak oxidation in the upper part. Several low resistivity and caliper anomalies, and decreased magnetic susceptibility. Three radar reflectors (angle to borehole axis 44–61°). Zone situated in metagranite-granodiorite with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 1.

62–81 m

DZ2: Increased fracture frequency and two sealed fracture networks. The open fractures show variable orientation but are predominantly gently dipping. The sealed fractures are predominantly steeply dipping and show variable strike between SE (SW dip) and E (S dip). Fracture apertures are not larger than 1 mm. Weak oxidation in the upper part. Several low resistivity and caliper anomalies, and partly decreased magnetic susceptibility. Six radar reflectors (angle to borehole axis 62–79°) and radar wave attenuation at 78–82 m. Zone situated in metagranite-granodiorite with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.

146–150 m

DZ3: Slightly increased fracture frequency. The open fractures are predominantly subhorizontal. The sealed fractures strike SE and dip steeply to the SW. Fracture apertures generally less than 1 mm. Several low resistivity and caliper anomalies, and decreased magnetic susceptibility. Three radar reflectors (angle to borehole axis 43–71°). Zone situated in metagranite-granodiorite with subordinate occurrences of felsic to intermediate metavolcanic rock, amphibolite and pegmatitic granite. Confidence level = 1.

6 Comments

The results of the geological single-hole interpretations of KFM01D, HFM24, HFM25, HFM27 and HFM29 are presented in WellCad plots (Appendix 1–5). The 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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Geological single-hole interpretation of KFM01D

Appendix 1

Title SINGLE HOLE INTERPRETATION KFM01D

Site	FORSMARK	**Inclination [°]**	-54.89	**Elevation [m.a.s.l.]**	2.95	**Signed data**
Borehole	KFM01D	**Date of mapping**	2006-03-28 13:20:00	**Drilling Start Date**	2005-11-21 07:00:00	
Diameter [mm]	76	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2005-12-05 14:30:00	
Length [m]	800.240	**Northing [m]**	6699542.07	**Surveying Date**		
Bearing [°]	35.03	**Easting [m]**	1631404.52	**Plot Date**	2006-09-12 21:11:42	

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
- Amphibolite
- Felsic to intermediate volcanic rock, metamorphic

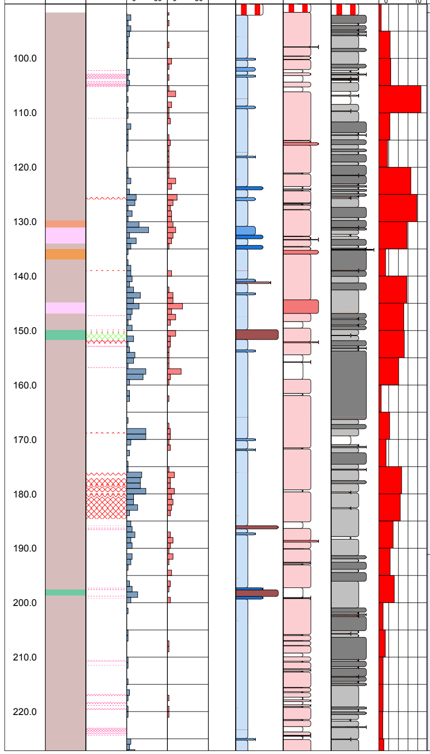
ROCK ALTERATION
- Oxidized
- Chloritisized
- Epidotisized
- Albitization
- Saussuritization

SILICATE DENSITY

SUSCEPTIBILITET

NATURAL GAMMA

Depth 1m:500m	BOREMAP DATA	GENERALIZED GEOPHYSICAL DATA	ROCK UNIT			POSSIBLE DEFORMATION ZONES		
	Rock Type, Rock Alteration, Sealed Fractures (0–30), Open and Partly Open Fractures (0–30), Crush	Silicate Density, Magnetic Susceptibility, Natural Gamma Radiation, Estimated Fracture Freq (fr/m) (0–10)	Description Rock Unit	Rock Unit Sealed Fractures	Rock Unit Open and Partly Open Fractures	Description Possible Deformation Zone	Possible Deformation Zone Sealed Fractures	Possible Deformation Zone Open and Partly Open Fractures



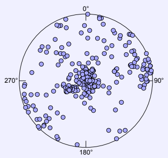
Rock unit

91.61

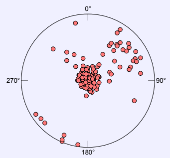
RU1
Medium-grained metagranite-granodiorite (101057) with subordinate occurrences of pegmatitic granite (101061), fine- to medium-grained metagranitoid (101051), amphibolite (102017), fine- to medium-grained granite (111058), felsic to intermediate metavolcanic rock (103076), aplitic metagranite (101058) and calc-silicate rock (108019). Increased frequency of sealed and open fractures, and low resistivity and caliper anomalies, relative to the remaining part of the borehole outside possible deformation zones. Confidence level = 3.

191.15

Rock unit sealed fractures:



Rock unit open and partly open fractures:



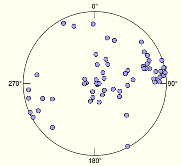
191.15

Possible deformation zone

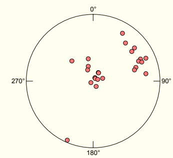
176.00

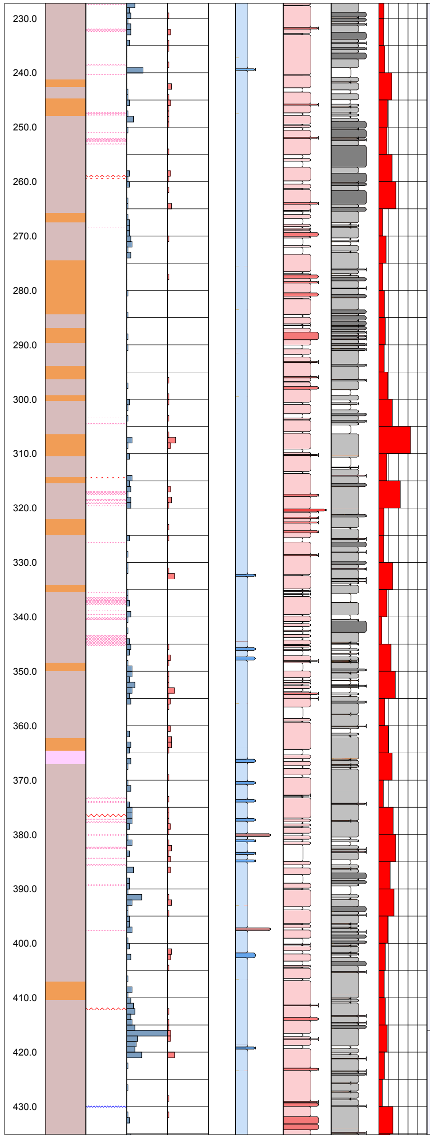
DZ1
Increased frequency of sealed and open fractures. Gently dipping fractures and fractures that strike SSE and dip steeply westwards dominate. Apertures 1 mm or less. Faint to strong oxidation throughout the zone. One 17 cm wide calcite sealed fracture in the central part of the possible deformation zone. Low resistivity and caliper anomalies and also a slightly decreased P-wave velocity. Four radar reflectors of which one is confidently oriented (137/71). The most frequent fracture filling minerals in the order of decreasing abundance include calcite, chlorite, adularia and clay minerals. Zone situated in medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite, aplitic metagranite and amphibolite.

Possible deformation zone sealed fractures:



Possible deformation zone open and partly open fractures:



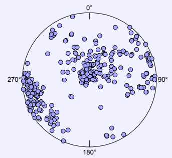


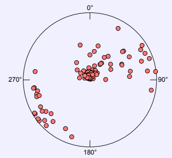
RU2
Fine- to finely medium-grained metagranite-granodiorite (101057) with subordinate occurrences of pegmatitic granite (101061), fine- to medium-grained metagranitoid (101051) and amphibolite (102017). Sub-parallel radar reflector from 190-350 m, located 35-65 m from the borehole. Confidence level = 3.

424.15

424.15

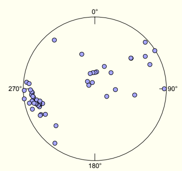
RU3
Fine- to finely medium-grained metagranite-granodiorite (101057) affected by static

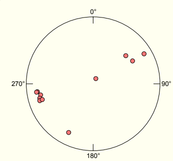


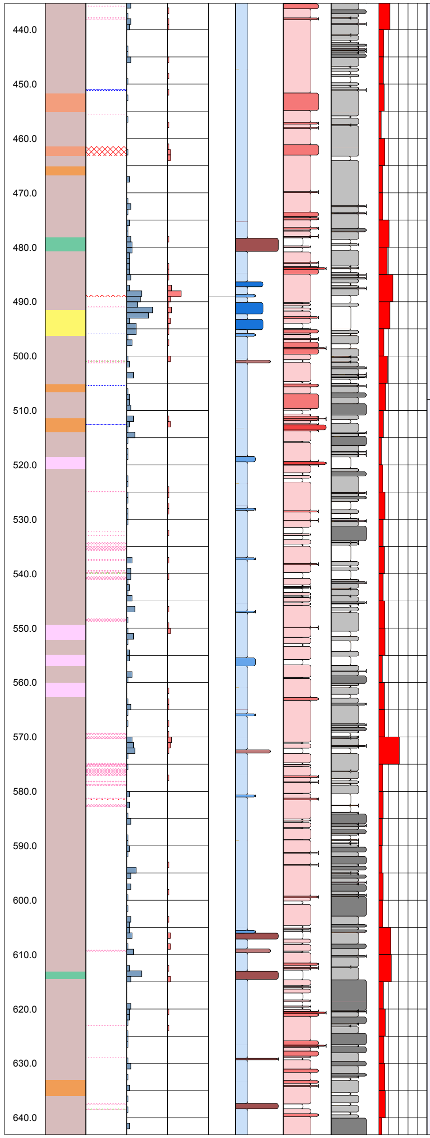


Confidence level = 3.
184.00

411.00
DZ2
Increased frequency of sealed fractures including sealed fracture networks. Fractures that strike NNW and dip steeply eastwards dominate. Gently dipping fractures are also present. Apertures 1 mm or less. Decreased bulk resistivity in the interval 415.7-421 m. Five radar reflectors of which one is confidently oriented (351/89). The most frequent fracture filling minerals in the order of decreasing abundance include calcite, laumontite and chlorite. The zone occurs close to the base of RU2 in fine- to finely







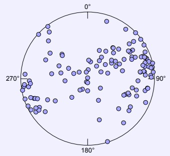
recrystallization. Subordinate occurrences of pegmatitic granite (101061), amphibolite (102017), fine- to medium-grained granite (111058), aplitic metagranite (101058) and one occurrence of felsic to intermediate metavolcanic rock (103076) at 491.53-496.33 m. The metavolcanic rock corresponds to increased density values. The section c. 407-514 m is characterized by decreased density and increased natural gamma radiation relative to the medium-grained metagranite-granodiorite (101057). Confidence level = 3.

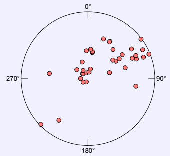
499.88

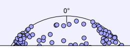
499.88

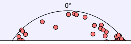
RU4

Medium-grained metagranite-granodiorite (101057) with subordinate occurrences of fine- to medium-grained metagranitoid (101051), pegmatitic granite (101061), amphibolite (102017), fine- t...









medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite and fine- to medium-grained metagranitoid. Confidence level = 3.

421.00

488.00

DZ3

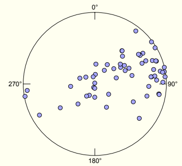
Increased frequency of sealed and open fractures. One gently dipping crush zone at 488.99-489.00 m. Fractures that strike SSE and dip steeply westwards as well as gently dipping fractures with variable orientation are present. Apertures 0.5 mm or less. Minor low resistivity anomalies and decreased magnetic susceptibility. Four radar reflectors of which one is confidently oriented (067/13). The most frequent fracture filling minerals in the order of decreasing abundance include calcite, chlorite, laumontite and adularia. The zone occurs close to the base of RU3 in fine- to finely medium-grained metagranite-granodiorite affected by static recrystallization and a felsic to intermediate metavolcanic rock. The metavolcanic rock displays ductile high-strain zones along its margins. Subordinate occurrences of pegmatitic granite, amphibolite, aplitic metagranite, metamorphic granitoid and fine- to medium-grained granite. Confidence level = 3.

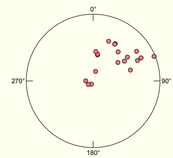
496.00

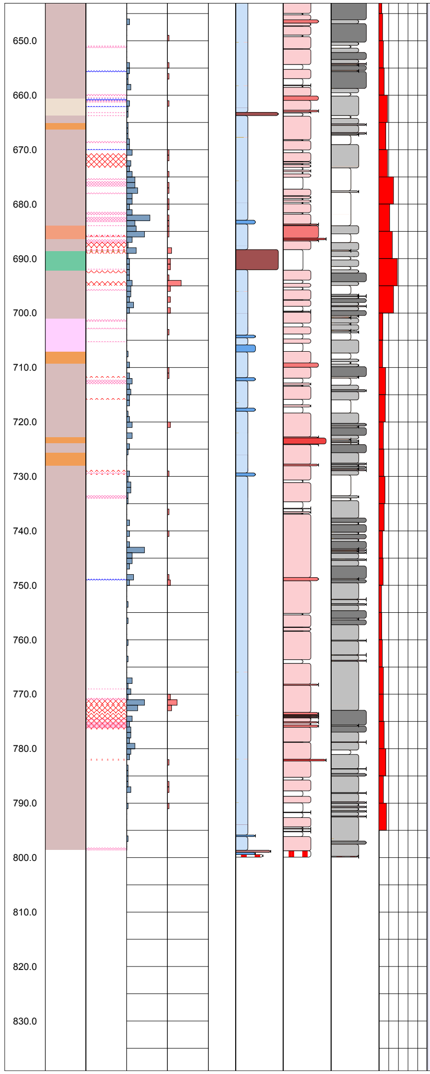
670.00

DZ4

Increased frequency of sealed fractures, and in the lower part open fractures. Steeply dipping fractures that strike NE (SE dip) and NW (NE dip)...

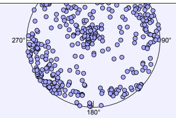


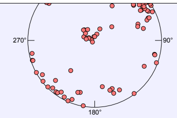




(102017), fine- to medium-grained granite (111058) and one occurrence of aplitic metagranite (101058) at 660.72-663.78. The medium-grained metagranite-granodiorite in the uppermost c. 10 m of the rock unit shows the same type of static recrystallization as RU3. Three sub-parallel radar reflectors from 700-760 m, located 10-25 m from the borehole. Confidence level = 3.

800.07





dominate. Gently dipping fractures with variable orientation are also present. Apertures typically less than 1 mm, with a few up to 7 mm. Locally faint oxidation. The section 665-701 m is characterized by low resistivity, distinct caliper anomalies and decreased magnetic susceptibility. Eight radar reflectors of which one is confidently oriented (162/40). Prominent radar wave attenuation in the interval 686-694 m. The most frequent fracture filling minerals in the order of decreasing abundance include calcite, chlorite, laumontite and clay minerals. Zone situated in medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite, aplitic metagranite, pegmatite and amphibolite, directly above the contact to a fine- to medium-grained metagranitoid. Confidence level = 3.

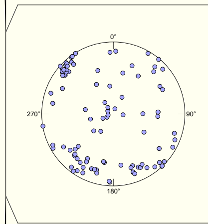
700.00

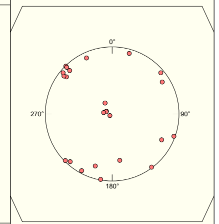
771.00

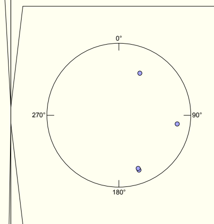
DZ5

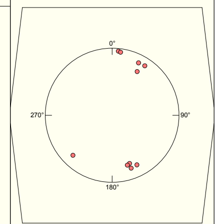
Increased frequency of sealed and open fractures. The open fractures are steeply dipping and strike ESE (SSW dip), SE (SW dip) and WSW (NNW dip). Apertures 0.5 mm or less. Weak to medium oxidation throughout the interval. Slightly decreased resistivity. One non-oriented radar reflectors and one oriented with the orientation 219/51 or 247/82. The most frequent fracture filling minerals in the order of decreasing abundance include chlorite, calcite and clay minerals. Zone situated in medium-grained metagranite-granodiorite with subordinate occurrences of pegmatitic granite. Confidence level = 3.

774.00









Geological single-hole interpretation of HFM24

Appendix 2

Title	SINGLE HOLE INTERPRETATION HFM24					
Site	FORSMARK	Inclination [°]	-59.55	Elevation [m.a.s.l.]	3.68	Signed data
Borehole	HFM24	Date of mapping	2006-03-09 11:23:00	Drilling Start Date	2005-11-22 10:00:00	
Diameter [mm]	138	Coordinate System	RT90-RHB70	Drilling Stop Date	2005-11-22 11:00:00	
Length [m]	151.350	Northing [m]	6698662.37	Surveying Date		
Bearing [°]	47.29	Easting [m]	1631719.64	Plot Date	2006-09-12 21:11:42	

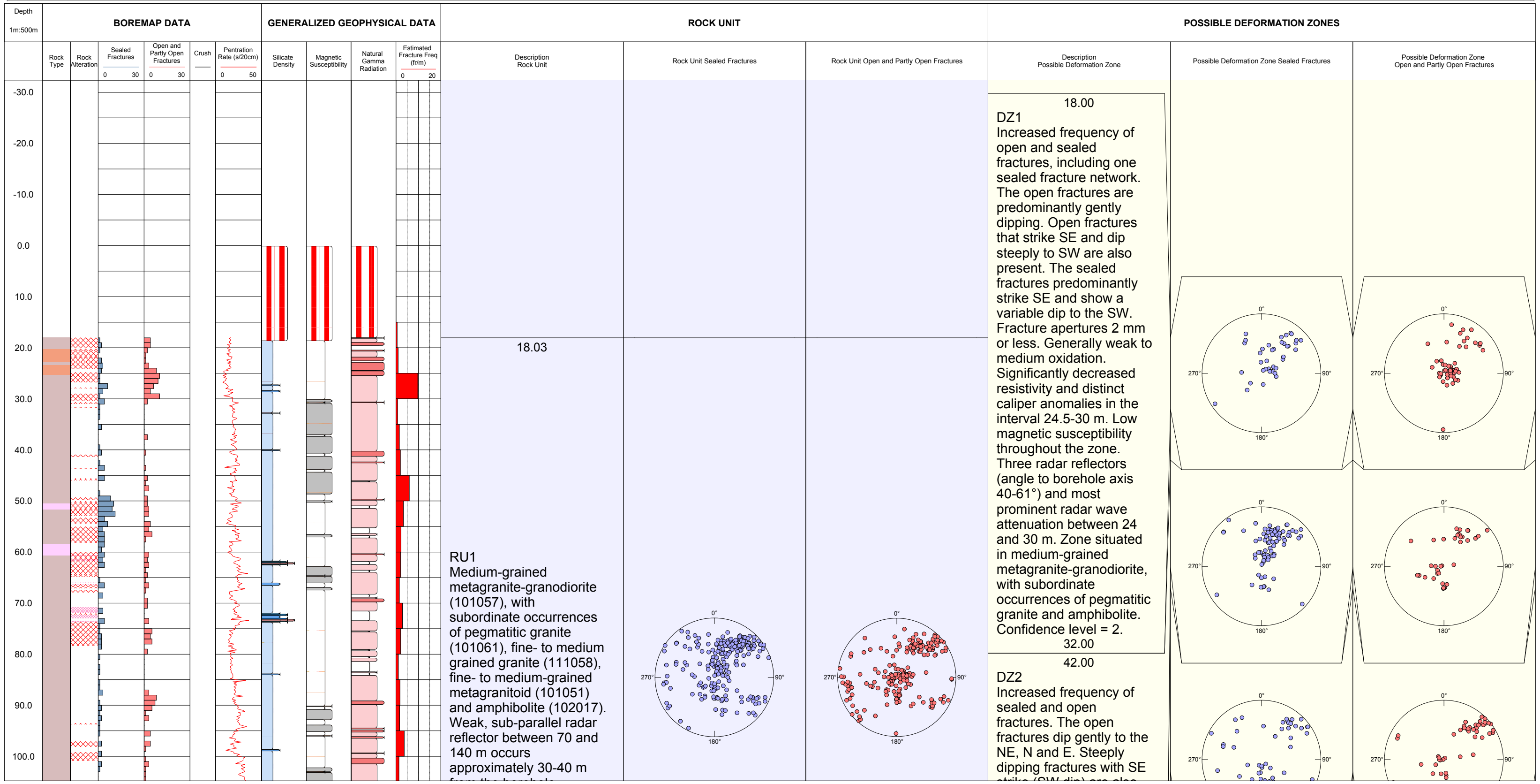
ROCKTYPE FORSMARK
- Granite, fine- to medium-grained
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite to granodiorite, metamorphic, medium-grained

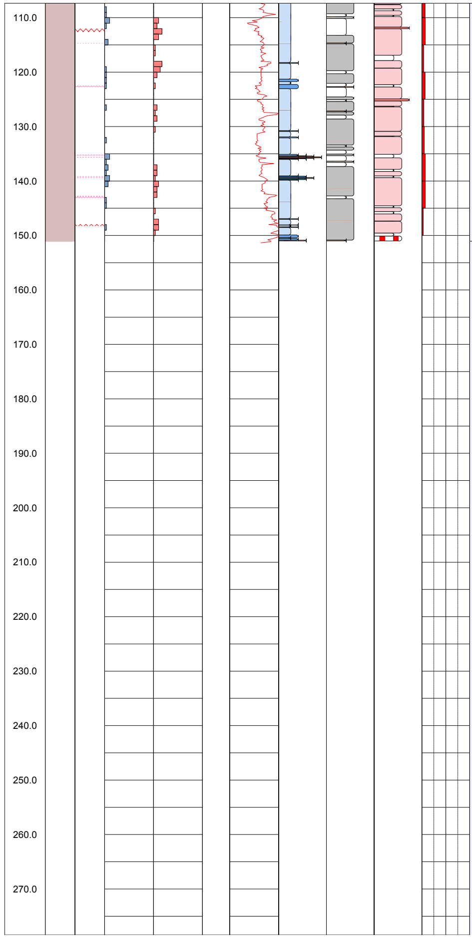
ROCK ALTERATION
- Oxidized
- Albitization

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

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





Confidence level = 2.

151.05

present. Sealed fractures predominantly strike SE and show a variable dip to the SW. Fracture apertures 2 mm or less. Generally weak to medium oxidation in the lower half of the interval. Several distinct caliper anomalies in the interval 43-55 m. Decreased magnetic susceptibility and bulk resistivity in the interval 49-63 m. Nine radar reflectors (angle to borehole axis 43-61°). Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of fine- to medium-grained granite, aplitic metagranite, pegmatitic granite and amphibolite. Confidence level = 2.

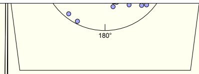
63.00

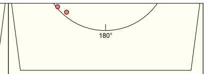
67.00

DZ3

The section is characterized by decreased bulk resistivity and magnetic susceptibility. Nine radar reflectors (angle to borehole axis 27-63°) and prominent radar wave attenuation throughout the interval. Slight increase in fracture frequency. Fractures with SE strike and steep dips to the SW dominate. Gently dipping fractures with variable dip northwards are also present. Fracture apertures 1 mm or less. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of pegmatitic granite, amphibolite, aplitic metagranite and fine- to medium-grained metagranitoid. Confidence level = 1.

103.00





Geological single-hole interpretation of HFM25

Appendix 3

Title	**SINGLE HOLE INTERPRETATION HFM25**					
Site	FORSMARK	**Inclination [°]**	-57.80	**Elevation [m.a.s.l.]**	3.86	**Signed data**
Borehole	HFM25	**Date of mapping**	2006-01-13 15:33:00	**Drilling Start Date**	2005-09-05 14:00:00	
Diameter [mm]	139	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2005-09-08 12:15:00	
Length [m]	187.500	**Northing [m]**	6699616.18	**Surveying Date**		
Bearing [°]	140.84	**Easting [m]**	1633039.37	**Plot Date**	2006-09-12 21:11:42	

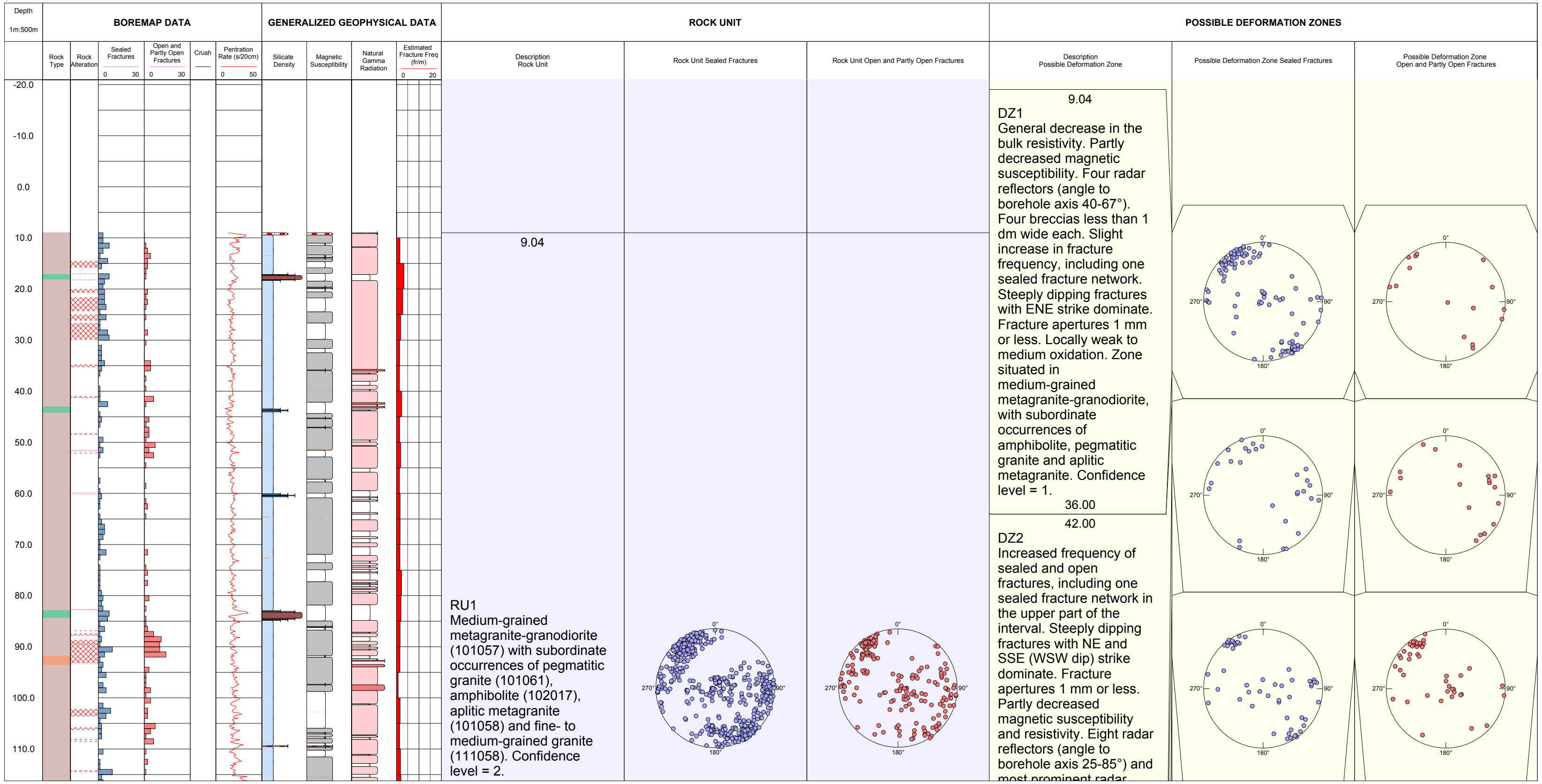
ROCKTYPE FORSMARK
- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granite to granodiorite, metamorphic, medium-grained
- Amphibolite

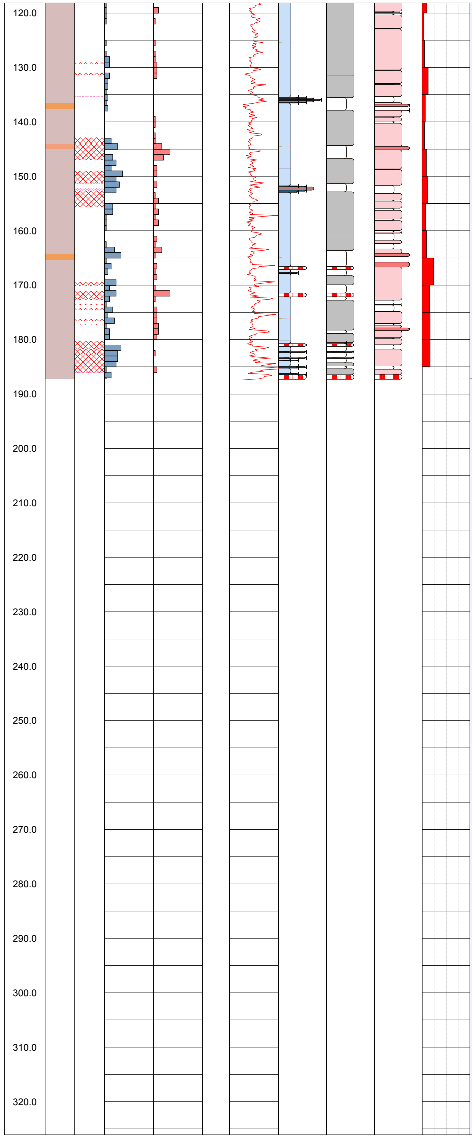
ROCK ALTERATION
- Oxidized
- Albitization

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

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



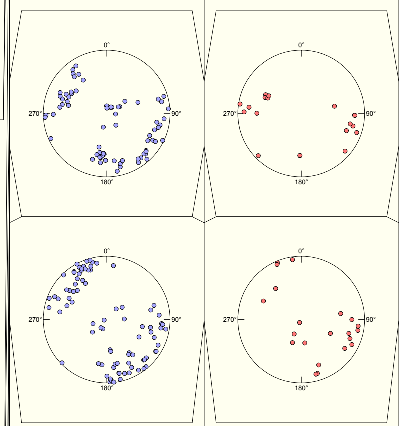


187.21

wave attenuation at 43-46 m and 51-54 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.
54.00

80.00
DZ3
Increased frequency of sealed fractures, including one sealed fracture network in the upper part of the interval, and open fractures in the lower part. Steeply dipping fractures that strike NE and dip to the SE dominate. Some gently dipping fractures are also present. Fracture apertures 1.5 mm or less. Weak to medium oxidation in the lower part. A few low resistivity anomalies. Three radar reflectors (angle to borehole axis 51-59°) and most prominent radar wave attenuation at 82-86 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.
92.00

143.00
DZ4
Increased frequency of sealed fractures, including one sealed fracture network and open fractures, especially in the upper part. Steeply dipping fractures with variable strike dominate. Only steeply dipping fractures with NW strike are absent. Some gently dipping fractures are also present. Fracture apertures 1 mm or less. Weak to medium oxidation. Partly decreased resistivity and magnetic susceptibility. Six radar reflectors (angle to borehole axis 47-66°) and most prominent radar wave attenuation at 144-147 m and 151-154 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate



330.0	with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.
340.0	155.00
	169.00
350.0	DZ5 Increased frequency of sealed fractures, including several sealed fracture networks, especially in the lower part. Steeply dipping fractures with variable strike dominate. Only steeply dipping fractures with NW strike are absent. Some gently dipping fractures are also present. Fracture apertures 1 mm or less. Weak to medium oxidation, especially in the lower part. Partly decreased resistivity and magnetic susceptibility. Five radar reflectors (angle to borehole axis 45-72°) and most prominent radar wave attenuation at 180-186 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.
360.0	
370.0	
380.0	
390.0	
400.0	
410.0	
420.0	
430.0	
440.0	187.00

43

Geological single-hole interpretation of HFM27 Appendix 4

Title	SINGLE HOLE INTERPRETATION HFM27					
Site	FORSMARK	Inclination [°]	-67.82	Elevation [m.a.s.l.]	2.45	Signed data
Borehole	HFM27	Date of mapping	2006-02-22 12:47:00	Drilling Start Date	2005-11-03 16:00:00	
Diameter [mm]	139	Coordinate System	RT90-RHB70	Drilling Stop Date	2005-11-10 19:00:00	
Length [m]	127.500	Northing [m]	6699595.26	Surveying Date		
Bearing [°]	337.26	Easting [m]	1631245.94	Plot Date	2006-09-12 21:11:42	

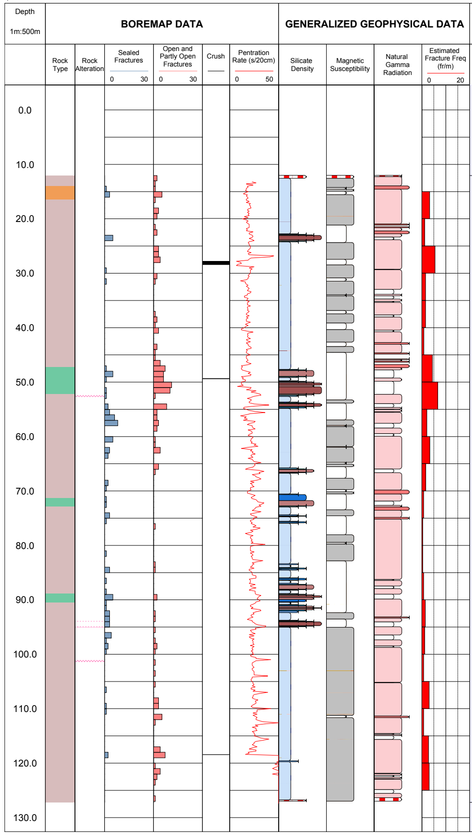
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite to granodiorite, metamorphic, medium-grained
- Amphibolite

ROCK ALTERATION
- 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

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



ROCK UNIT

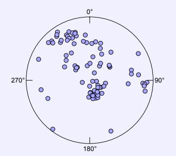
Description Rock Unit

12.04

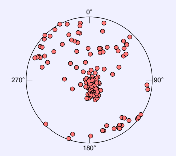
RU1
Medium-grained metagranite-granodiorite (101057) with subordinate occurrences of amphibolite (102017) and pegmatitic granite (101061). One crush zone at 19.90-19.95 m and one breccia at 85.07-85.15 m. Confidence level = 2.

127.20

Rock Unit Sealed Fractures



Rock Unit Open and Partly Open Fractures



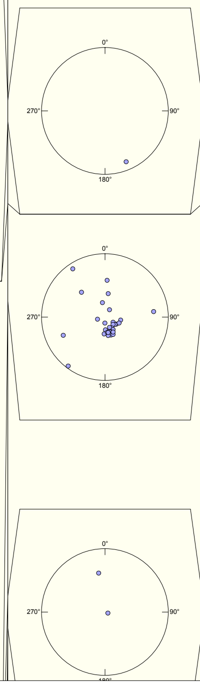
POSSIBLE DEFORMATION ZONES

Description Possible Deformation Zone

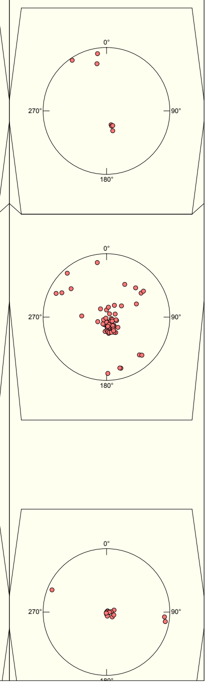
26.00
DZ1
One 70 cm crush zone at 27.75-28.45 m. Fracture apertures generally 1 mm or less, only two fractures up to 2.5 mm. Distinct low resistivity and caliper anomalies. One radar reflector (angle to borehole axis 43°) and prominent radar wave attenuation in the whole interval. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of pegmatitic granite. Confidence level = 2.
30.00

45.00
DZ2
Increased frequency of open fractures especially in the upper part. Gently dipping fractures that dip northwards dominate. Fracture apertures generally less than 1.5 mm, one up to 2.5 mm. One sealed fracture network, one crush zone and possible brittle-ductile deformation between 49.56 and 49.66 m. Decreased bulk resistivity along the entire section. Several caliper anomalies and decreased magnetic susceptibility in the interval 45-57 m. Seven radar reflectors (angle to borehole axis 50-63°) and prominent radar wave attenuation at 48-53 m.

Possible Deformation Zone Sealed Fractures



Possible Deformation Zone Open and Partly Open Fractures



140.0
150.0
160.0
170.0
180.0
190.0
200.0
210.0
220.0
230.0

Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.
63.00

117.00
DZ3
Slight increase in open fractures and one crush zone. The open fractures are predominantly subhorizontal. Apertures are generally less than 1 mm, but two apertures are 3 mm and 16 mm respectively. Two coincident low resistivity and caliper anomalies. Three radar reflectors (angle to borehole axis 84-86°) and prominent radar wave attenuation at 117-120 m and 121-123 m. Zone situated in medium-grained metagranite-granodiorite, with subordinate occurrences of pegmatitic granite and amphibolite. Confidence level = 2.
123.00

Geological single-hole interpretation of HFM29

Appendix 5

Title SINGLE HOLE INTERPRETATION HFM29

Site	FORSMARK	**Inclination [°]**	-58.56	**Elevation [m.a.s.l.]**	4.47	**Signed data**
Borehole	HFM29	**Date of mapping**	2006-04-13 10:26:00	**Drilling Start Date**	2005-12-12 07:00:00	
Diameter [mm]	138	**Coordinate System**	RT90-RHB70	**Drilling Stop Date**	2005-12-19 12:30:00	
Length [m]	199.700	**Northing [m]**	6698018.65	**Surveying Date**		
Bearing [°]	29.95	**Easting [m]**	1632502.81	**Plot Date**	2006-09-12 21:11:42	

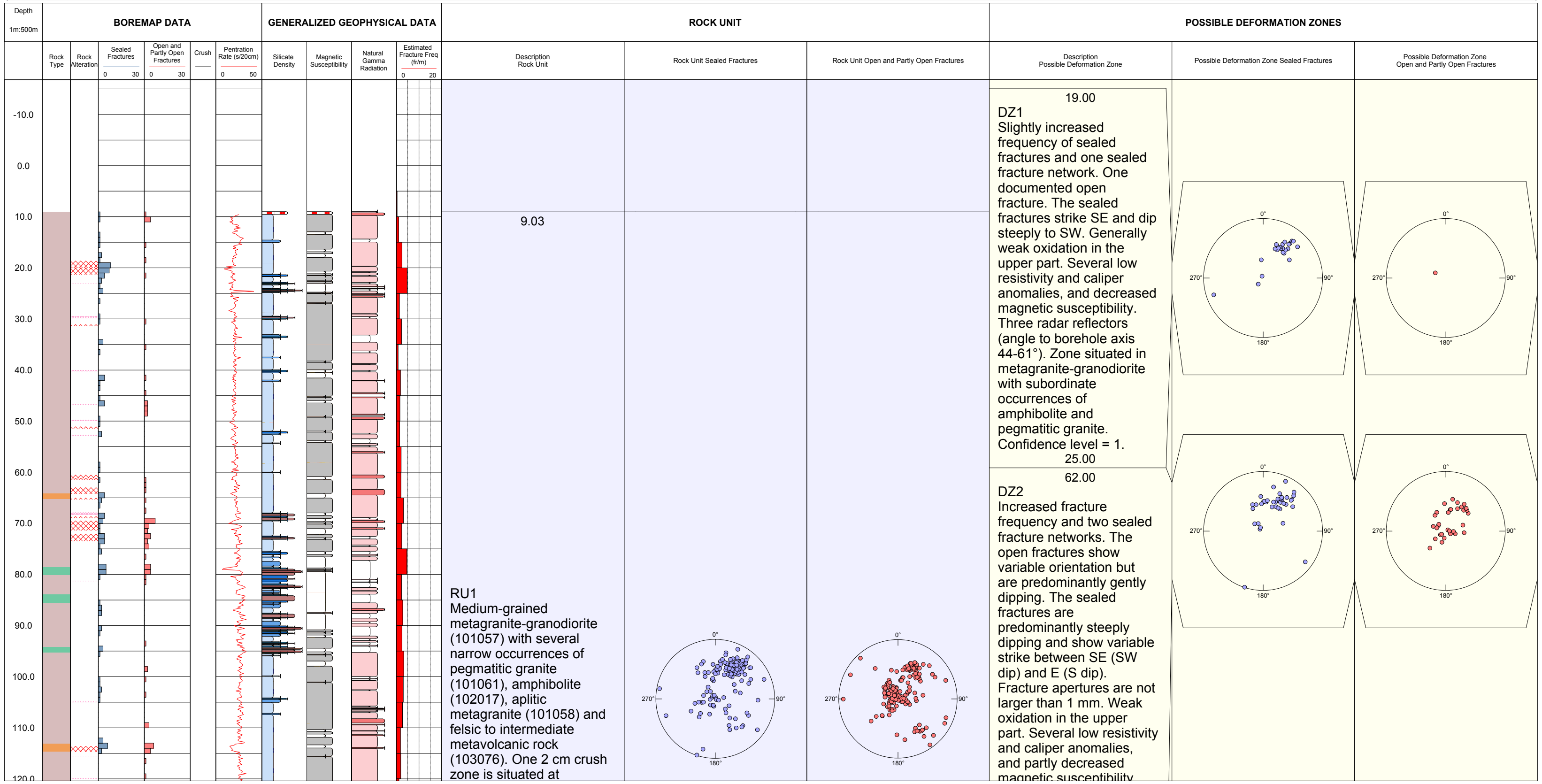
ROCKTYPE FORSMARK
- Pegmatite, pegmatitic granite
- Granite to granodiorite, metamorphic, medium-grained
- Amphibolite

ROCK ALTERATION
- Oxidized
- 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



9.03

RU1
Medium-grained metagranite-granodiorite (101057) with several narrow occurrences of pegmatitic granite (101061), amphibolite (102017), aplitic metagranite (101058) and felsic to intermediate metavolcanic rock (103076). One 2 cm crush zone is situated at

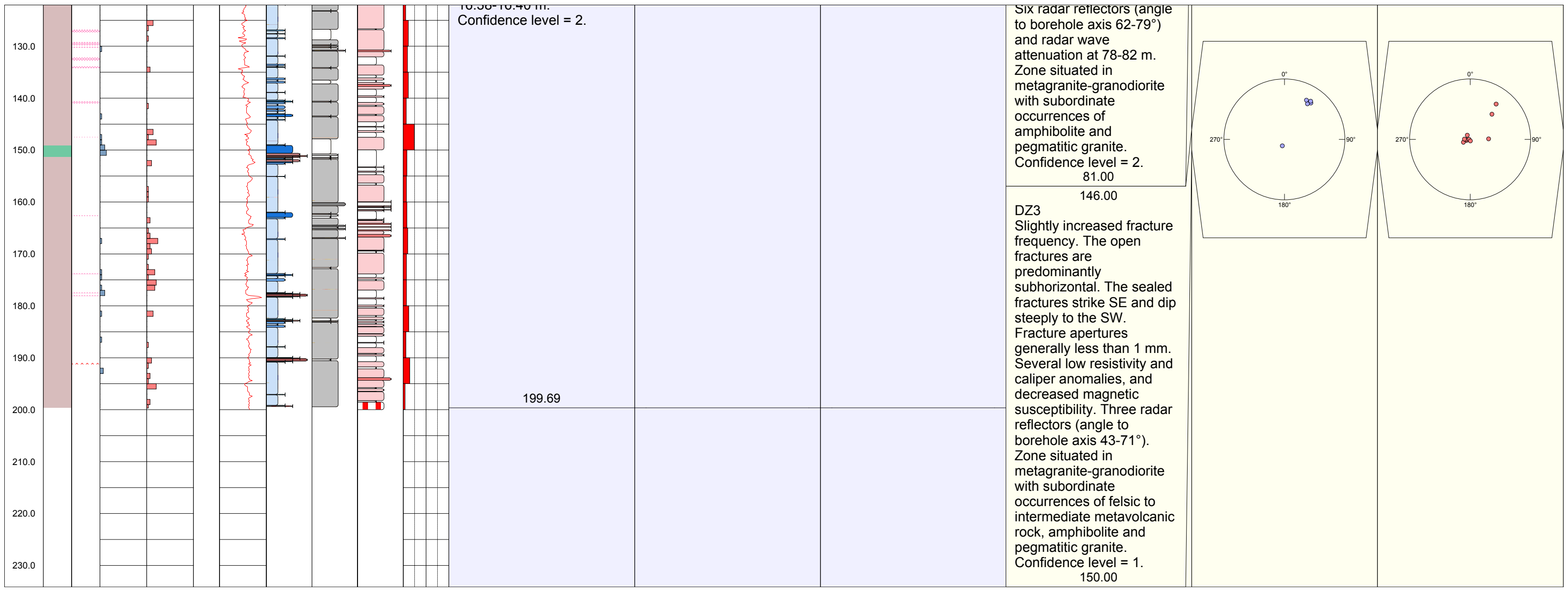
19.00

DZ1
Slightly increased frequency of sealed fractures and one sealed fracture network. One documented open fracture. The sealed fractures strike SE and dip steeply to SW. Generally weak oxidation in the upper part. Several low resistivity and caliper anomalies, and decreased magnetic susceptibility. Three radar reflectors (angle to borehole axis 44-61°). Zone situated in metagranite-granodiorite with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 1.
25.00

62.00

DZ2
Increased fracture frequency and two sealed fracture networks. The open fractures show variable orientation but are predominantly gently dipping. The sealed fractures are predominantly steeply dipping and show variable strike between SE (SW dip) and E (S dip). Fracture apertures are not larger than 1 mm. Weak oxidation in the upper part. Several low resistivity and caliper anomalies, and partly decreased magnetic susceptibility

46


130.0
140.0
150.0
160.0
170.0
180.0
190.0
200.0
210.0
220.0
230.0
Confidence level = 2.
199.69
Six radar reflectors (angle to borehole axis 62-79°) and radar wave attenuation at 78-82 m. Zone situated in metagranite-granodiorite with subordinate occurrences of amphibolite and pegmatitic granite. Confidence level = 2.
81.00
146.00
DZ3
Slightly increased fracture frequency. The open fractures are predominantly subhorizontal. The sealed fractures strike SE and dip steeply to the SW. Fracture apertures generally less than 1 mm. Several low resistivity and caliper anomalies, and decreased magnetic susceptibility. Three radar reflectors (angle to borehole axis 43-71°). Zone situated in metagranite-granodiorite with subordinate occurrences of felsic to intermediate metavolcanic rock, amphibolite and pegmatitic granite. Confidence level = 1.
150.00
0°
90°
180°
270°
0°
90°
180°
270°