P-07-106

Forsmark site investigation

Boremap mapping of percussion boreholes HFM33–37

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December 2007

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ISSN 1651-4416
SKB P-07-106

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Keywords: Geology, Fractures, BIPS, Boremap, Percussion drilling, Drilling rate, Geophysical logs, AP PF 400-06-115.

Abstract

This report presents the result from the Boremap mapping of the percussion drilled boreholes HFM33–37. The boreholes were drilled in spring 2006 – summer 2006. The boreholes are drilled outside the tectonic lens in association to borehole KFM11A and KFM12A, which penetrates the Singö and Forsmark deformation zone respectively. The boreholes are drilled in order to penetrate identified lineaments.

The mapping of the boreholes started in June 2006 and was finished in April 2007. The mappings are based on the borehole image (BIPS), generalized geophysical logs and drilling penetration rate. In some cases the drill cuttings were investigated to support the mapping.

Since the boreholes HFM33–37 are situated outside the candidate area the rock types differ from those within the tectonic lens, with regard to both the lithology and degree of deformation. HFM33, HFM34 and HFM35 are drilled in association to the Singö deformation zone north-east of the candidate area. The rock type is dominated by felsic to intermediate metavolcanic rock, with the typical rock types of the candidate area as subordinate rock types. HFM36 and HFM37 are drilled approximately 500 m west of Hermansbo, in association to the Forsmark zone. The dominating rock types are amphibolite, granodiorite, pegmatite and tonalite to granodiorite.

Oxidation of the bedrock is occurring more frequently in the boreholes HFM36 and HFM37. Albitization is generally sporadic and associated with amphibolite, but in borehole HFM34 albitization is observed in both granite to granodiorite and in felsic to intermediate volcanic rock. Chloritization occurs in several sections in HFM36, often in association with amphibolite.

The boreholes commonly show mean fracture frequencies of 1.7–3.4 interpreted open fractures/m (crush excluded), 0–0.6 interpreted partly open fractures/m and 1.3–4.2 interpreted sealed fractures/m (sealed network excluded). HFM35 has 2.3 interpreted open fractures/m (crush excluded) and 3.8 interpreted sealed fractures/m (sealed network excluded), HFM36 has 3.4 interpreted open fractures/m (crush excluded) and 3.9 interpreted sealed fractures/m (sealed network excluded), and finally HFM37 has 1.7 interpreted open fractures/m (crush excluded) and 4.2 sealed fractures/m (sealed network excluded).

Crushed rock occurs in HFM34, HFM35 and HFM36. Most frequent orientation of crushed sections is sub-horizontal to gently dipping. HFM35 is characterized by eight crushed sections, of which four are gently dipping and striking NNE to ESE. Gently dipping crushed sections also occur in HFM36 (oriented 296°/17°, 321°/13° and 044°/29°) and sub-vertically dipping crushed sections occur in HFM34 (298°/82° and 267°/88°) and in HFM35 (140°/82°).

Sammanfattning

Denna rapport redovisar resultatet från Boremapkartering av de hammarborrade borrhålen HFM33–37. Borrhålen borrades under våren 2006 – sommaren 2006. Borrhålen är borrade utanför den tektoniska linsen, i anslutning till borrhålen KFM11A och KFM12A, vilka penetrerar Singö- respektive Forsmarkzonen. Borrhålen är borrade i syfte att penetrera identifierade lineament.

Karteringen av borrhålen påbörjades i juni 2006 och avslutades i april 2007. Karteringarna är baserade på borrhålsbilden (BIPS), generaliserade geofysiska loggar och borrsjunkningshastighet. I några fall har borrkaxet undersökts för att ge stöd åt karteringen.

Eftersom borrhålen HFM33–37 är borrade utanför kandidatområdet skiljer sig bergarterna från de innanför med avseende på litologi och grad av deformation. Borrhålen HFM33–35 är borrade i Singözonen, karteringen domineras av felsisk- till intermediär metavulkanit tillsammans med de typiska bergarterna för kandidatområdet som underordnade bergarter. Borrhålen HFM36–37 är borrade i Forsmarkzonen, uppskattningsvis 500 m väster om Hermansbo och domineras av amfibolit, granodiorit, pegmatit och tonalit till granodiorit.

Oxidation av berget förekommer mer frekvent i borrhålen HFM36 och HFM37. Albitisering förekommer vanligen sporadiskt och i anslutning till amfiboliter, men i HFM34 har albitisering observerats i både metagranit till granodiorit och i felsisk till intermediär metavulkanit. Kloritisering förekommer i flera sektioner i HFM36, ofta i samband med amfibolit.

Borrhålen uppvisar vanligen sprickfrekvenser på 1,7–3,4 tolkade öppna sprickor/m (kross exkluderat), 0–0,6 tolkade delvis öppna sprickor/m och 1,3–4,2 tolkade läkta sprickor/m (läkta spricknätverk exkluderade). HFM35 innehåller 2,3 tolkade öppna sprickor/m (kross exkluderat) och 3,8 tolkade läkta sprickor/m (läkta spricknätverk exkluderade), HFM36 har 3,4 tolkade öppna sprickor/m (kross exkluderat) och 3,9 tolkade läkta sprickor/m (läkta spricknätverk exkluderade), och slutligen HFM37 har 1,7 tolkade öppna sprickor/m (kross exkluderat) och 4,2 tolkade läkta sprickor/m (läkta spricknätverk exkluderade).

Sektioner med kross förekommer i HFM34, HFM35 och HFM36. Den vanligaste orienteringen hos de krossade borrhålsavsnitten är subhorisontell. Borrhål HFM35 innehåller åtta krossade sektioner, av vilka fyra är moderat till brant stupande och stryker NNO till OSO. Borrhålssektioner med subhorisontella krossavsnitt förekommer även i HFM36 (med orienteringen 296°/17°, 321°/13° och 044°/29°) och subvertikalt stupande krossar i HFM34 (298°/82° och 267°/88°) och i HFM35 (140°/82°).

Contents

1 Introduction

This document reports the data gained by the Boremap mapping of five percussion boreholes, drilled within the site investigation area at Forsmark. The work was carried out during 2006 and 2007 in accordance with activity plan AP PF 400-06-115. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents.

Original data from the reported activity are stored in the primary database Sicada, where they are traceable by the Activity Plan number (AP PF 400-06-115). Only data in SKB's databases are accepted for further interpretation and modelling. The data presented in this report are regarded as copies of the original data. Data in the databases may be revised, if needed. Such revisions will not necessarily result in a revision of the P-report, although the normal procedure is that major data revisions entail a revision of the P-report. Minor data revisions are normally presented as supplements, available at www.skb.se.

Locations of the percussion drilled boreholes are presented in Figure 1-1. The boreholes were drilled in connection with core drilled boreholes, or with the aim to identify lineaments.

The percussion drilled boreholes were, after completion of drilling, investigated with several logging methods, such as conventional geophysical logging, borehole radar and TV-logging. The latter method implies logging with a colour TV-camera to produce images of the borehole wall, so called BIPS-images (Borehole Image Processing System). The method is described in SKB MD 222.006 Metodbeskrivning för TV-loggning med BIPS (SKB, internal controlling document).

The boreholes were mapped during the period June 2006 – April 2007. Mapping of percussion boreholes, according to the Boremap method, is based on the use of BIPS-images of the borehole wall supported by study of drill cuttings, drilling penetration rate (Appendix 5) and generalised geophysical logs (Appendix 6).

The BIPS-images enable the study of the distribution of fractures along the borehole. Fracture characteristics like aperture, colour of fracture minerals etc are possible to study as well. Furthermore, since the BIPS software has the potential of calculating strike and dip of planar structures such as foliations, rock contacts and fractures intersecting the borehole, also the orientation of each planar structure is documented with the Boremap method.

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

Activity Plan	Number	Version
Boremapkartering av borrhålen HFM33–37	SKB AP PF 400-06-115	1.0
Method Descriptions	**Number**	**Version**
Metodbeskrivning för Boremapkartering	SKB MD 143.006	2.0
Mätsystembeskrivning för Boremap	SKB MD 146.001	1.0
Nomenklatur vid Boremapkartering	SKB MD 143.008	1.0
Instruktion: Regler för bergarters benämningar vid platsundersökningen i Forsmark	SKB MD 132.005	1.0

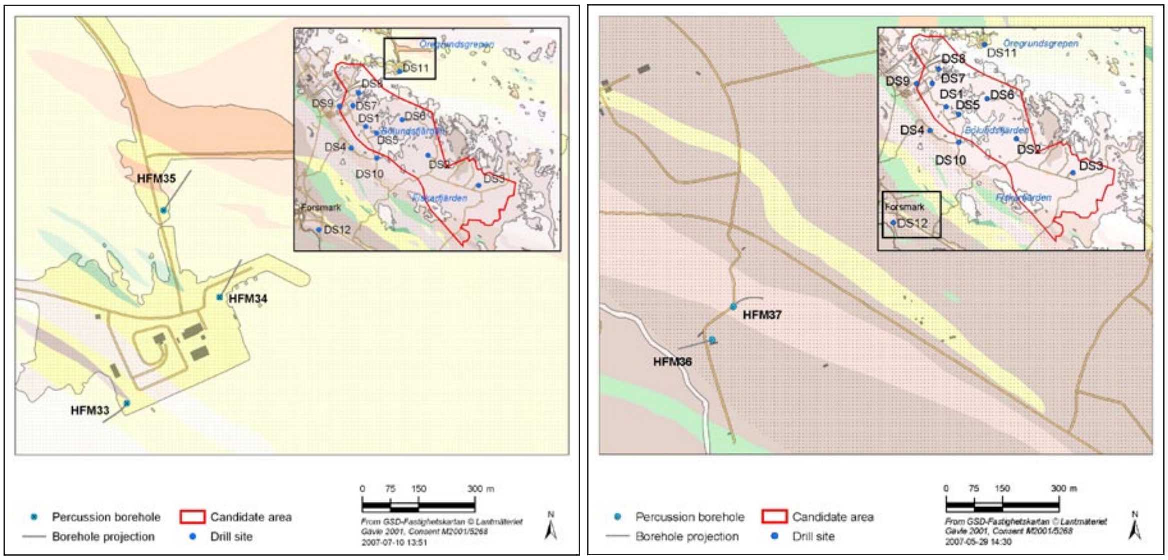

Figure 1-1. Locations of HFM33–37, Forsmark. To the left HFM33–35, and to the right HFM36–37.

Background data collected from SICADA prior to the Boremap mapping included:

- borehole diameter (Appendix 3),
- total borehole length (Appendix 3),
- deviation data (Appendix 4).

Background data from Geovista AB was generalized geophysical logs from the boreholes HFM33–37 (Appendix 6).

Geometrical data for boreholes HFM33–37 are given in Table 4-1.

2 Objective and scope

The aim of this activity was to document lithologies, ductile structures and the occurrence and character of fractures and fractured borehole section in the bedrock penetrated by the percussion drilled boreholes HFM33–37. Other data obtained from the percussion drilled boreholes, such as thickness of soil cover, soil stratigraphy, groundwater level and groundwater flow, will not be treated in this report.

3 Equipment

3.1 Description of interpretation tools

Mapping of the boreholes based on BIPS-images was performed with the software Boremap 3.7.5. The Boremap software calculates actual directions (strike and dip) of planar structures penetrated by the borehole (foliations, fractures, fracture zones, rock contacts etc). Inclination, bearing and diameter of the borehole are used as in-data for the calculations (Table 4-1). The BIPS-image lengths were calibrated (Table 4-2). The Boremap software is loaded with the rock types and mineral standard used for surface mapping at the Forsmark investigation site, to enable correlation with the surface geology.

Schematic presentations of the boreholes are presented in WellCAD-diagrams (Appendix 1).

When investigating the drill cuttings, see Figures 3-1 and 3-2, tap water, an ordinary kitchen strainer, a hand lens or stereo microscope and 10% hydrochloric acid was used.

3.1.1 BIPS-image quality

The BIPS-image qualities of the boreholes are listed in Appendix 2. The results from the BIPS-loggings are presented in P-reports /1, 2, 3, 4, 5/.

Figure 3-1. *Unwashed drill cutting sample.*

Figure 3-2. *Washed drill cutting sample.*

4 Execution

4.1 General

Boremap mapping of the percussion drilled boreholes HFM33–37 was performed and documented according to activity plan AP PF 400-06-115 (SKB, internal document). Geophysical logs of the boreholes and drilling penetration rate supported the mapping and the drill cuttings were investigated when considered necessary. The mapping was performed in accordance with the SKB method description for Boremap mapping SKB MD 143.006, v.2, as well as SKB MD 146.001, v.1.0 (SKB internal controlling documents) and R-01-19 /6/. Information from earlier performed investigations in the area were also helpful in the interpretations /7, 8, 9/.

4.2 Preparations

Geometric data for boreholes HFM33–37 are listed in Table 4-1. Length corrections of the BIPS-images were made for all the boreholes.

Length corrections were made, since it is known that the registered length in the BIPS-images in general deviates with approximately 0.5 m per 100 m from the real length (SKB MD 143.006, v. 2.0, SKB internal controlling document), and that the last 30 cm of the boreholes cannot be logged with BIPS. The end of casing has also been used for length correction. All length corrections made are listed in Table 4-2.

Background data collected from SICADA prior to the Boremap mapping included:

- borehole diameter (Appendix 3),
- total borehole length (Appendix 3),
- borehole deviation data (Appendix 4),
- drilling penetration rate (Appendix 5).

Generalized geophysical logs from Geovista AB were used as supporting data for the mapping of all boreholes (Appendix 6).

Table 4-1. Borehole data for HFM33–HFM37.

ID-code	Northing	Easting	Bearing (degrees)	Inclination (degrees)	Diameter (mm)	Borehole length (m)	Mapping interval (m)	End of casing
HFM33	6701041.38	1632221.99	220.0	–59.0	140	140.20	12.35–139.84	12.35
HFM34	6701326.40	1632471.00	58.5	–28.2	138	200.75	12.08–179.00	12.08
HFM35	6701555.86	1632320.51	031.6	–57.3	138	200.75	12.00–200.52	12.00
HFM36	6696503.67	1630080.17	252.1	–57.6	138	152.55	12.06–152.25	12.06
HFM37	6696593.59	1630138.38	041.4	–59.2	140	191.75	9.07–191.46	9.07

Table 4-2. Length adjustments for BIPS images.

BIPS-image	Rec. length (m)	Adj. length (m)	Difference (m)
HFM33	12.261	12.35	+0.089
	139.751	139.84	+0.089
HFM34	12.082	12.08	–0.002
	194.988	195.962	+0.974
HFM35	12.045	12.04	–0.005
	199.38	200.377	+0.997
HFM36	12.064	12.060	–0.004
	151.702	152.25	+0.548
HFM37	9.07	9.07	0
	190.909	191.450	+0.541

4.3 Execution of measurements

Available geological information is more limited for Boremap mapping of percussion drilled boreholes than core drilled boreholes, where the drill core can be directly compared with BIPS-images of the borehole wall. During mapping of percussion boreholes, fractures and rock types can only be seen in the BIPS-images. As solid rock samples are not accessible, certain assumptions and simplifications have to be made during mapping. These are described below.

4.3.1 Fractures

As fractures could be studied only in the BIPS-image they could not be confidently classified as rough, smooth or slickensided, nor could their mineralogy or alteration be determined. The following assumptions were made:

- Width of very thin fractures (< 1.5 mm) were impossible to measure accurately and was therefore, as a rule, interpreted as 1 mm thick or, if only partly or vaguely observed, as 0.7 mm thick.
- Fractures were assumed to be open, if not clearly observed to be sealed.
- Fractures that were only indicated by shadows were mapped as open with a possible aperture of 0.7 mm.
- Fractures with reddish rims were mapped as “oxidized walls”. No other fracture mineral was generally documented.

4.3.2 Rock colour and alteration

Colours in the BIPS-images appear somewhat altered and bleached, and the classifications of the rock colours are therefore likely to be less accurate.

The varying exposure of the BIPS-camera, as well as drill cutting in suspension in the borehole water, complicates the interpretation of oxidized sections, since sections with higher exposure are less reddish than sections with lower exposure, and sections rich in suspensions look more brownish/reddish in BIPS than other sections.

Albitization /10/ is relatively easy to recognize when it occurs adjacent to amphibolitic rock, but if not, this type of alteration is hard to distinguish from metamorphic pegmatites.

Other rock alterations are not distinguishable on the BIPS image, due to somewhat bleached colour, and the resolution of the image.

4.3.3 Rock contacts

Orientation of irregular or diffuse rock contacts may be difficult to observe and measure with the Boremap method, since only planar and discrete features can be accurately measured.

4.3.4 Lithologies

Classifications of lithologies were sometimes difficult, since the boreholes contain different types of granitic rocks. It is difficult to distinguish fine- to medium-grained metagranite from metagranite-granodiorite-tonalite (C-generation, code 101051) or aplitic metagranite, (B-generation, code 101058) in the BIPS-image and in the geophysical logs. If the granitic occurrence is narrow, it is not confident that fine- to medium-grained granite (D-generation, code 111058) is indicated by higher gamma-radiation, and then it can be difficult to separate from other granitoids. Even very narrow occurrences of pegmatite (code 101061) can sometimes be difficult to separate from the rock occurrences mentioned above, especially if the pegmatitic veins are metamorphic. Therefore some misinterpretations must be accounted. When it is impossible to determine what generation the fine-grained granite belongs to with some probability, the granitic vein is mapped simply as granite (code 1058).

Drill cutting samples were investigated to classify the rock types and/or alterations only when it was considered necessary.

4.3.5 Grain-size

Classification of grain-size can be difficult, especially for minor rock occurrences of fine or medium grain-size. This is due to the pixel resolution of the BIPS-image and the difficulty to measure the width of grains less than 2 mm. When the rock is composed of minerals of similar colours, the grain-size can be overestimated when relying too much on the BIPS-images, since single grains are hard to distinguish.

4.3.6 Foliation and lineation

Foliation and lineation are difficult to separate from each other in the BIPS-image, unless the structure is clearly developed. Intersection angle of the structures also affects the possibility to distinguish foliation from lineation. Although some attempts have been made to separate them in the Boremap mapping. A structure that looks like foliation or lineation in BIPS, is interpreted as foliation when it is steeply dipping or vertical and as lineation when it is sub-horizontal to gently dipping. This relation has been observed during the regional mapping, but the relationship is not definite and therefore some misinterpretations may occur.

4.3.7 Supporting data

Schematic presentations of generalized geophysical logs (Appendix 6) were used to support the classifications of rock types. Silica density is useful for separating tonalites from granites, while natural gamma radiation is useful for recognizing occurrences younger granites. Reports of the bedrock mapping in Forsmark /7, 8, 9/ were also helpful when interpreting the lithologies.

Drilling penetration rate was used as supporting data for the geological interpretation (Appendix 5). For example, faster drilling penetration usually correlates well with crush zones, densely fractured sections and pegmatites, while slower drilling penetration rate generally correlates with amphibolites.

4.4 Data handling

The Boremap mappings of HFM33–37 were performed on a local computer disk, while a back-up of the Boremap mapping was saved on Geosigma's network before each break exceeding 15 minutes.

When the mappings were finished and quality checked by the authors and by a computer routine in Boremap, the data was submitted to SKB for exportation to SICADA.

All data are stored in the SKB SICADA database, and it is only these data that should be used for further interpretation.

4.5 Nonconformities

4.5.1 Lacking geophysical data

The mapping of borehole HFM33 started without access to geophysical data. This might have prolonged the mapping-time since the geophysical logs are of vital importance for the recognition of rock type in percussion drilled boreholes.

4.5.2 Deviations from activity plan

Soil depth and soil stratigraphy are not documented in the Boremap mapping. Fracture minerals were not documented on the request of SKB.

5 Results

The Boremap mappings of HFM33–37 are stored in SICADA, and it is only these data that shall be used for further interpretation and modelling. The user of this data should be aware of the assumptions mentioned in Section 4.

Results from the Boremap mappings are briefly described in Sections 5.1–5.6 below and the graphical presentations of the data are given as WellCAD-diagrams in Appendix 1.

Summaries of rock types and fracture frequency in HFM33–HFM37 are presented in Tables 5-1 and 5-2, respectively.

5.1 General lithology

The boreholes HFM33–35 show a similar lithology since they are drilled close to the same area, drill site 11 (DS 11). Boreholes HFM33–HFM35 are dominated by foliated felsic to metavolcanic rock (103076) followed by massive or foliated pegmatites (101061) and foliated aplitic metagranite (101058), the latter is more abundant in HFM35. Boreholes HFM36–37 are dominated by foliated granodiorite (101056) followed by foliated, cataclastic or brecciated amphibolite (102017) and massive or foliated pegmatite to pegmatitic granite (101061). Less frequently occurring rock types are not found in all boreholes. They include minor occurrences of fine- to medium-grained granites (codes 111058 and 1058), tonalite to metagranodiorite (101054), fine- to medium-grained metagranite-granodiorite-tonalite (101051), diorite, quartz diorite and gabbro (101033), granite to granodiorite (101057), as well as quartz dominated hydrothermal vein (8021), breccia (6005), hybrid rock (5105), supracrustal rock (6000) and cataclastic rock (8003). The different rock types are described in earlier SKB-reports /7, 8, 9/.

Table 5-1. Rock type distribution in HFM33–37.

Borehole	101057	101056	101061	102017	101033	101054	101058	111058	101051	103076	other
HFM33			16	11				4		68	< 1
HFM34			26	9			< 1	< 1		65	< 1
HFM35			37	3			25	3	< 1	31	< 1
HFM36	6		31	38	3	17			2		3
HFM37		57	8	18		4	3	< 1	11		< 1

Table 5-2. Fracture frequency in HFM33–37.

Borehole	Open fractures/m	Sealed fractures/m	Partly open fractures/m
HFM33	2.7	1.3	0.000
HFM34	1.9	3.6	0.006
HFM35	2.3	3.8	0.324
HFM36	3.4	3.9	0.613
HFM37	1.7	4.2	0.104

5.2 HFM33

HFM33 is located outside the candidate area, close to drill site 11 (DS11), on the artificial island next to SFR (Figure 1-1). The borehole has a length of 140.20 m, a bearing of 220.0° and an inclination of –59° (Appendix 3 and Appendix 4). The mapped rock types in HFM33 are the fine- to medium-grained felsic to intermediate metavolcanic rock (103076) dominates over pegmatite (101061) and amphibolite (102017) (Table 5-1 and Appendix 1a). The felsic to intermediate metavolcanic rock is generally weakly foliated in the interval 12.35–122.47 m, apart from a medium veined section between 28.23–57.21 m and some minor banded borehole sections. The foliation is roughly 329/68.

A total number of 507 fractures were documented (mapped interval 12.35–139.84 m borehole length), of which 339 are considered open, 168 sealed and no partly open, giving a total fracture frequency of 4.0 fractures/m with a distribution of 2.7 open fractures/m (crush excluded), 1.3 sealed fractures/m (sealed network excluded) (Table 5-2). One sub-horizontal crushed section is observed at 52.04–52.10 m. No sealed fracture networks were observed in the borehole.

Two intervals at 23–86 m and 150–170 m have relatively high fracture frequencies. The first section correlates with a higher frequency of sealed oxidized fractures and the second one coincides with a larger frequency of broken fractures (Appendix 1a). Five crush sections were observed of which four are steeply to sub-vertically dipping. There are twelve sealed fracture networks in HFM33.

Two borehole intervals show a slightly higher frequency of fractures 24–36 m and 82–86 m. The first section correlates with a larger frequency of open fractures with a general aperture of 0.7 mm, except for three fractures with a slightly larger aperture of 2.0 respectively 2.5 mm. The second interval coincides with a higher frequency of sealed fractures. The largest measured aperture in HFM33 is 8 mm and is observed at 136.54 m borehole length (Appendix 1a). Five crush sections were observed of which four are steeply to sub-vertically dipping.

No rock alteration was observed in HFM33.

5.3 HFM34

HFM34 is located close to drill site 11 (DS11), on the artificial island next to SFR (Figure 1-1). The borehole has a length of 200.75 m, a bearing of 30.5° and an inclination of –58.6° (Appendix 3 and Appendix 4). The rock types observed in HFM34 correspond well to the general geology in the area; fine- to medium-grained felsic to intermediate metavolcanic rock (103076) dominates over pegmatite (101061) and amphibolite (102017) (Table 5-1 and Appendix 1b). Other, less frequently observed rock types are aplitic metagranite (101058) which is observed at 96.42 m borehole length, and fine- to medium-grained granite (111058). The foliation in the felsic to intermediate metavolcanic rock (103076) is roughly estimated to have the orientation ~ 118/72.

A total number of 930 fractures were documented in HFM34 (mapped interval 12.080–179.004 m total borehole length), of which 323 are considered open, 607 sealed and 1 partly open. This results in an interpreted total fracture frequency of 5.6 fractures/m with a distribution of 1.9 open fractures/m (crush excluded) and 3.6 sealed fractures/m (sealed network excluded) (Table 5-2).

Two intervals at 23–86 m and 150–170 m are relatively rich in fractures. The first section correlates with a higher frequency of sealed fractures with oxidized walls, and the second one coincides with a larger frequency of broken fractures with a general aperture of 0.7 mm, except for a few with an aperture of 1 mm. The largest measured aperture in HFM34 is 5 mm, observed at 86.01 m borehole length (Appendix 1b). Five crush sections were observed of which four are steeply to sub-vertically dipping. There are twelve sealed networks in HFM34.

Three interpreted sections with shear banding have been observed and interpreted as possible cataclasites. The width of the possible cataclasites varies between 15 and 88 cm. They occur at

87.57–91.18 m borehole length. A possible breccia is observed in close connection to the lower part of this section. All structures show a steep to moderate dip.

Weak oxidation is frequently observed in the intervals 89.27–94.88 m and 134.14–137.46 m borehole length. A minor occurrence of what is interpreted as albitization has been observed in association with amphibolite. However the altered section is only 35 cm in width.

5.4 HFM35

HFM35 is located north of drill site 11 (DS11), along the road to the Biotest lake (Figure 1-1). The borehole has a length of 200.75 m, a bearing of 33° and an inclination of –59.3° (Appendix 3 and Appendix 4). The dominating rock type is pegmatitic granite (101061), followed by felsic to intermediate metavolcanic rock (103076) and aplitic metagranite (101058). The pegmatitic granite is generally massive, while the felsic to intermediate metavolcanic rock is overall foliated. The aplitic granite, which constitutes the lower part of the borehole (126.89–191.67 m), varies between foliated weak to medium. The measured foliation is generally 139/81 throughout the borehole. Subordinate rock types are amphibolite (102017), fine to medium-grained granite (111058) and amphibolite (102017) (Table 5-1 and Appendix 1c).

In total 1,147 fractures were documented in HFM35 (mapped interval 12,000–200,518 m total borehole length) of which 433 are considered open, 714 sealed and 61 partly open. This result in an interpreted total fracture frequency of 6.1 fractures/m with a distribution of 2.3 open fractures/m (crush excluded), 3.8 sealed fractures/m (sealed network excluded) and 0.3 partly open fractures/m (Table 5-2).

Three borehole intervals at 15–60 m, 102–159 m and 167–200.5 m have a relatively high fracture frequency. The first interval is relatively rich in open fractures while the second and third interval shows a high frequency in both open fractures and sealed fractures related to oxidized walls. The intervals with high frequency of open fractures show a general aperture of 0.7 mm, except for a few fractures with an aperture up to 3.5 mm. The largest measured aperture in HFM35 is 6 mm and is observed at 136.54 m. Eight crushed sections occur in the borehole. Five sections are sub-horizontal to gently dipping, the remaining three are sub-vertical to steeply and moderately dipping. Five borehole sections containing sealed networks occur in HFM35 (Appendix 1c).

Four narrow section with possible shear banding have been observed close to the contact between a pegmatitic granite and a felsic to metavolcanic rock (121.24 m borehole length). The structures are interpreted as cataclasites. The width of the possible cataclasites varies between 3 and 6 cm and show a steep to moderate dip. A brecciated section is overlapping one of the cataclasites. The section with the breccia has steeply dipping contacts.

Medium intensity of oxidation is frequently observed in the intervals 138.93–155.36 m and 188.62–190.08 m borehole length. Weak oxidation is frequently observed in the interval 160.35–163.05 m. A minor occurrence of what is interpreted as epidote alteration has been observed. However, the altered section is only 3 cm in width.

5.5 HFM36

HFM36 is located outside of the candidate area to the south-west, in connection to drill site 12 (DS12) (Figure 1-1). The borehole has a length of 152.55 m, a bearing of 256.6° and an inclination of –59° (Appendix 3 and Appendix 4). The borehole is predominantly composed of amphibolite (102017), pegmatitic granite (101061) and metatonalite to granodiorite (101054), and subordinate occurrences of metagranite-granodiorite (101057), medium-grained metadiorite-gabbro (101033) and fine to medium-grained metagranitoid (101051) (Table 5-1 and Appendix 1d). Minor occurrences of a hybrid rock (5105) occur at 16.83 m borehole length.

The hybrid rock is interpreted as a magma-mingling between metatonalite to granodiorite (101054) and amphibolite (102017). Another minor occurrence is a light grey, banded rock with relatively high silica density (~ 2,700 kg/m^3), interpreted as a supracrustal rock (6000), possibly a limestone or a marble. The remaining subordinate rock types are cataclastic rock (8003), granite (1058) and quartz-dominated hydrothermal vein (8021), which constitute less than 1% of the total rock volume.

The interpreted structure in the amphibolite varies from medium to weakly foliated, with some cataclastic sections in the upper half of the borehole. The rocks in the lower part of the borehole are weakly foliated, containing some brecciated sections. The general orientation of the foliation is 333/72.

1022 fractures were documented in HFM36 (mapped interval 12.060–152,250 m total borehole length). In total, 482 fractures are considered open and 540 sealed. The frequency of interpreted open fractures is 3.4 fractures/m (crush excluded) and of interpreted sealed fractures 3.9 fractures/m (sealed fracture networks excluded), (Table 5-2). The overall fracture frequency is 7.3 fractures/m. HFM36 have generally two intervals with a increased fracture frequency. The first peak is between 48 and 100 m, and is mostly a result of a large number of open fractures with a general aperture of 0.7 mm, except for two fractures with an aperture of 4 respectively 5 mm. The second interval is between 107 and 148 m and correlates with a larger number of sealed fractures. The largest measured aperture in HFM36 is 5 mm and is observed at 56.50 m.

Four crushed sections have been observed in the following intervals 27.50–27.59 m, 51.37–51.46 m, 111.99–112.11 m and 127.34–127.44 m. They are sub-horizontal to gently dipping 9–29°, striking N-NE and NW. Eleven sealed fracture networks occur in HFM36 (Appendix 1d).

Seven narrow section have been interpreted as cataclasites. The width of the possible cataclasites varies between 11 and 65 cm. However, the structures show no general orientation trend. Four possible brecciated sections, mostly associated with amphibolite and the medium-grained metadiorite-gabbro occur in HFM36. The structures are moderate to steeply dipping.

Medium intensity of oxidation is common in the intervals 44.15–51.96 m and 124.97–133.67 m borehole length. Weak oxidation is frequently observed in the intervals 75.70–89.20 m, and 109.87–116.66 m. Chloritization is often associated with amphibolite and is generally weak to medium in intensity. The following intervals show a larger abundance of chlorite altered rock 43.87–51.96 m and 84.63–108.87 m. A possible carbonatization occurs sporadically throughout the interval 100.03–107.04 m. Both pegmatite and amphibolite is affected by the possible carbonatization. A minor occurrence of what is interpreted as epidote has been observed, however the altered section is only 26 cm in width.

5.6 HFM37

HFM37 is located to the south-west of the candidate area, close to drill site 12 (DS 12) (Figure 1-1). The borehole has a length of 191.75 m, a bearing of 41.4° and an inclination of –59.2° (Appendix 3 and Appendix 4). The borehole is predominately composed of a weakly foliated medium-grained metagranodiorite (101056), followed by amphibolite (102017), fine- to medium-grained metagranitoid (101051), pegmatitic granite (101061) and metatonalite to granodiorite (101054). (Table 5-1 and Appendix 1e). Minor occurrences of fine- to medium-grained granites of different ages occur (codes 101058, 111058 and 1058) as well as cataclastic rock (8003), breccia (6005) and quartz dominated hydrothermal veins (8021). The latter constitute less than 1% of the borehole. The general foliation in the medium-grained metagranodiorite (101056) is 121/76.

A quite large amount of fractures were documented in HFM37, 1,075 fractures in the mapped interval 9.070–191.455 m borehole length. In total, 301 fractures are considered open and 774 sealed. The frequency of interpreted open fractures is 1.7 fractures/m and of interpreted sealed fractures 4.2 fractures/m (Table 5-2). The overall fracture frequency is 5.9 fractures/m. Two sections in HFM37 have an increased frequency of fractures. The first section occurs between 15 and 23 m, and is a result of a high frequency of sealed fractures with oxidized walls. The second section is between 71 m and 191.455 m. The latter section is also dominated by sealed fractures with oxidized walls. The interpreted open fractures are mainly sub-horizontal, striking W-NW having a general aperture of 0.7 mm. The largest measured aperture in HFM37 is 2 mm.

No crushed sections are observed in HFM37. There are 10 sections containing sealed networks in HFM37 (Appendix 1e).

At 12.59 m borehole length, a section with possible shear banding has been observed. The section has an apparent reduction of grain-size and is interpreted as a cataclasite. The width of the possible cataclasite is 27 cm. Six possible brecciated sections were observed, two of these are interpreted as the kind of breccia were the protolith cant be determined, (6005). All structures are generally sub-vertical.

Medium intensity of oxidation is frequently observed in the interval 71.16–91.21 m affecting the meta-granodiorite and some minor occurrences of amphibolite and pegmatitic granite. Weak to faint oxidation is frequently observed in the intervals 92.20–100.65 m, 138.86–147.44 m and 159.60–182.61 m. A few minor occurrences, of what is interpreted as albitization and chloritization, have been observed. Both alteration types are generally associated with amphibolites.

References

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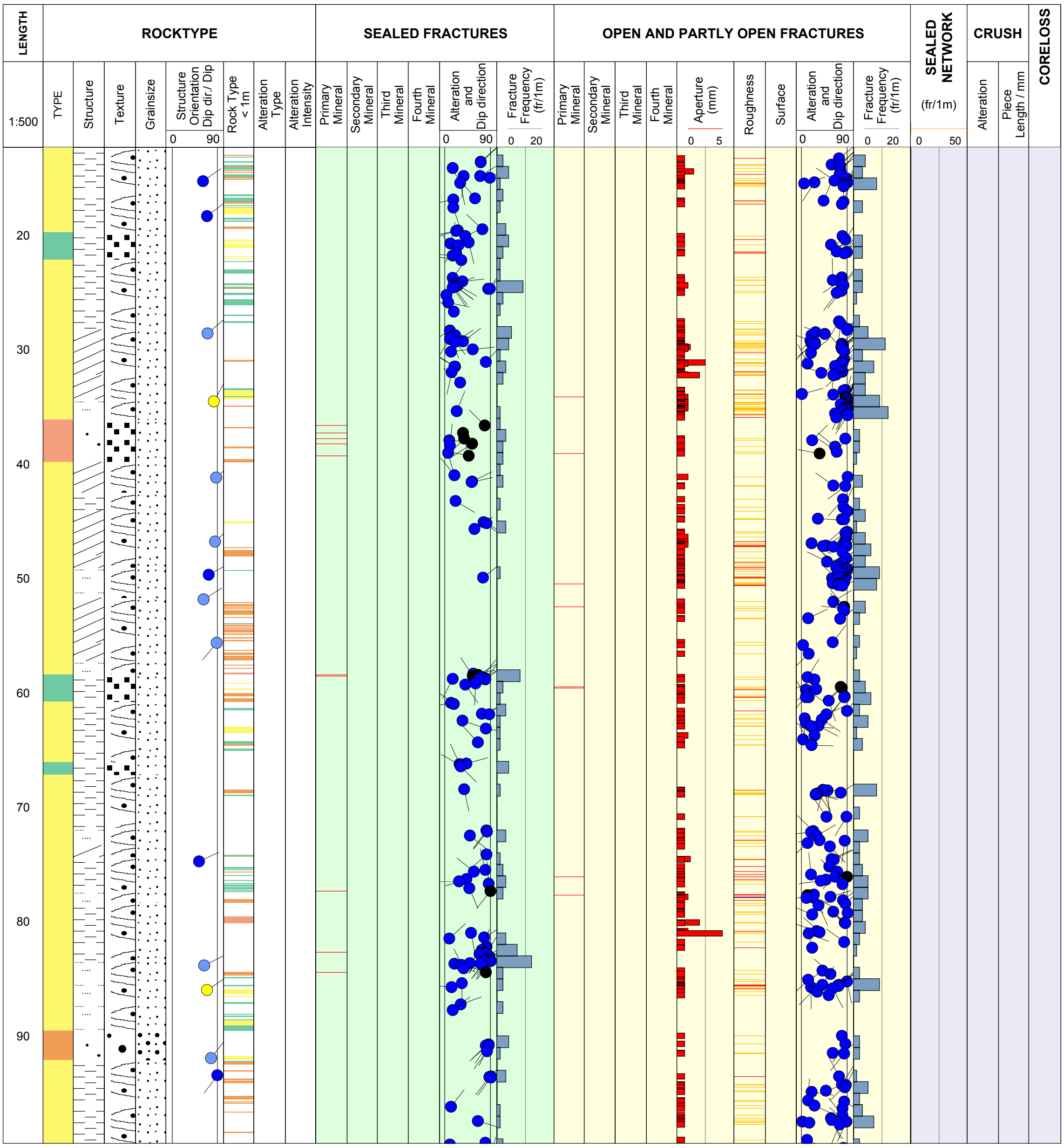
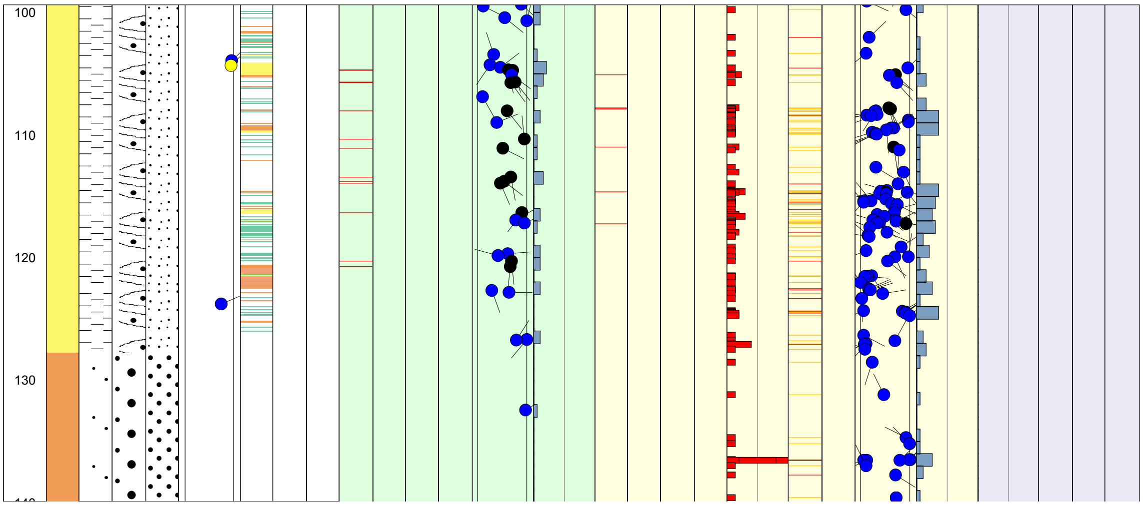
Appendix 1

WellCad-diagrams

Title GEOLOGY IN HFM33 **Appendix: 1a**

Site	FORSMARK	**Coordinate System**	RT90-RHB70
Borehole	HFM33	**Northing [m]**	6701042.57
Diameter [mm]	139	**Easting [m]**	1632222.99
Length [m]	140.200	**Elevation [m.a.s.l.]**	2.62
Bearing [°]	220.03	**Drilling Start Date**	2006-04-26 10:00:00
Inclination [°]	-59.18	**Drilling Stop Date**	2006-05-03 12:25:00
Date of coremapping	2006-06-12 11:37:00	**Plot Date**	2007-10-11 22:03:04
Rocktype data from	p_rock	**Signed data**	

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130

Title	LEGEND FOR FORSMARK	HFM33	Appendix: 1a

Site FORSMARK
Borehole HFM33
Plot Date 2007-10-14 22:03:05
Signed data

ROCKTYPE FORSMARK

- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granitoid, metamorphic
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite, metamorphic, aplitic
- Granite to granodiorite, metamorphic, medium-grained
- Granodiorite, metamorphic
- Tonalite to granodiorite, metamorphic
- Diorite, quarts diorite and gabbro, metamorphic
- Ultramafic rock, metamorphic
- Amphibolite
- Calc-silicate rock (skarn)
- Magnetite mineralization associated with calc-silicate rock (skarn)
- Sulphide mineralization
- Felsic to intermediate volcanic rock, metamorphic
- Mafic volcanic rock, metamorphic
- Sedimentary rock, metamorphic

ROCK ALTERATION

- Oxidized
- Chloritisized
- Epidotisized
- Weathered
- Tectonized
- Sericitisized
- Quartz dissolution
- Silicification
- Argillization
- Albitization
- Carbonatization
- Saussuritization
- Steatitization
- Uralitization
- Laumontitization
- Fract zone alteration

MINERAL

- Oxidized Walls

STRUCTURE

- Cataclastic
- Schistose
- Gneissic
- Mylonitic
- Ductile Shear Zone
- Brittle-Ductile Zone
- Veined
- Banded
- Massive
- Foliated
- Brecciated
- Lineated

TEXTURE

- Hornfelsed
- Porphyritic
- Ophitic
- Equigranular
- Augen-Bearing
- Unequigranular
- Metamorphic

GRAINSIZE

- Aphanitic
- Fine-grained
- Fine to medium grained
- Medium to coarse grained
- Coarse-grained
- Medium-grained

STRUCTURE ORIENTATION

- Cataclastic
- Bedded
- Gneissic
- Schistose
- Brittle-Ductile Shear Zone
- Ductile Shear Zone
- Lineated
- Banded
- Veined
- Brecciated
- Foliated
- Mylonitic

ROCK ALTERATION INTENSITY

- No intensity
- Faint
- Weak
- Medium
- Strong

ROUGHNESS

- Planar
- Undulating
- Stepped
- Irregular

SURFACE

- Rough
- Smooth
- Slickensided

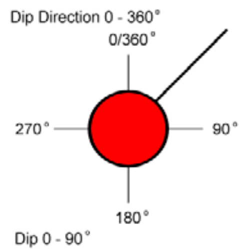
CRUSH ALTERATION

- Slightly Altered
- Moderately Altered
- Highly Altered
- Completley Altered
- Gouge
- Fresh

FRACTURE ALTERATION

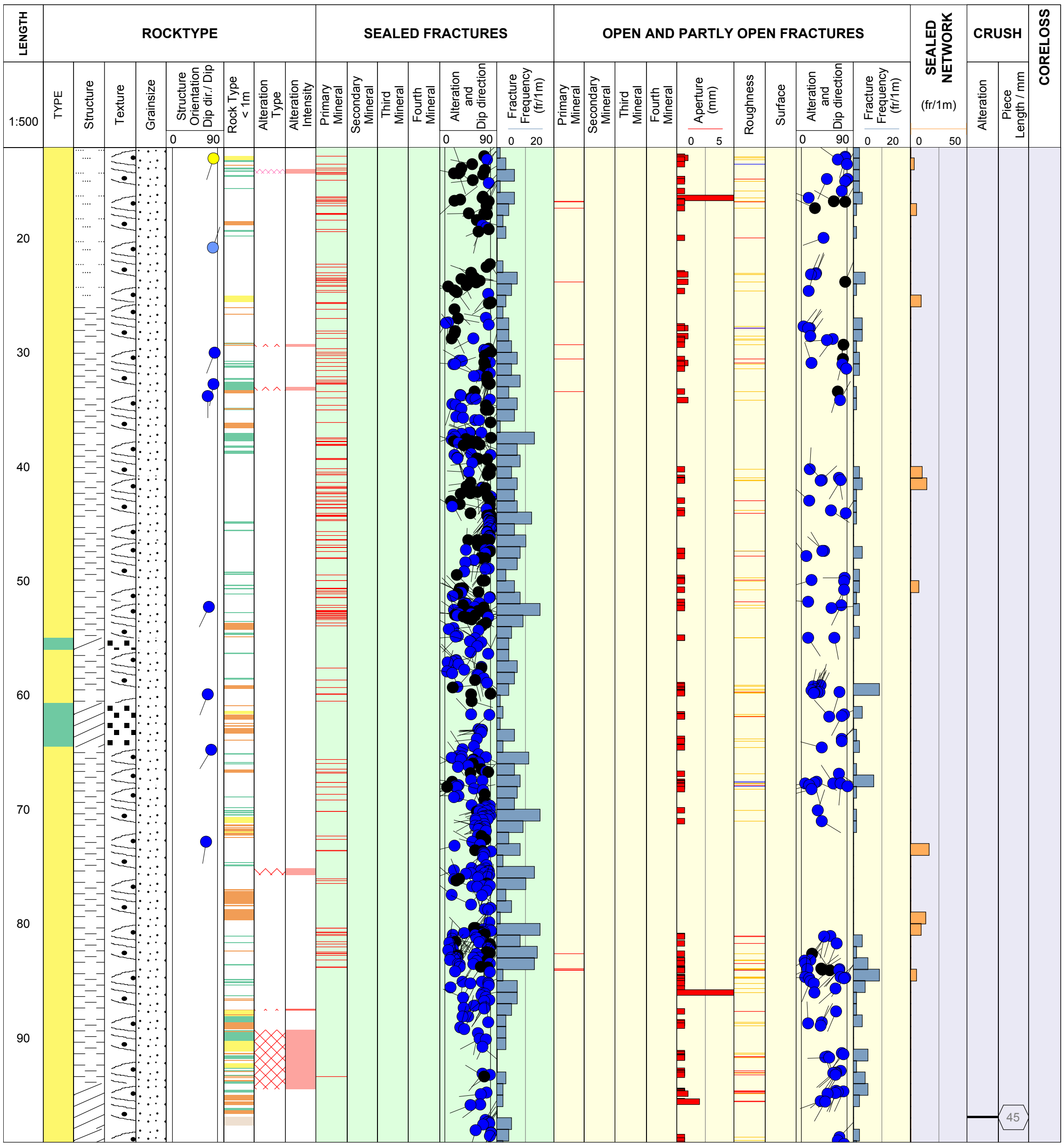
- Slightly Altered
- Moderately Altered
- Highly Altered
- Completely Altered
- Gouge
- Fresh

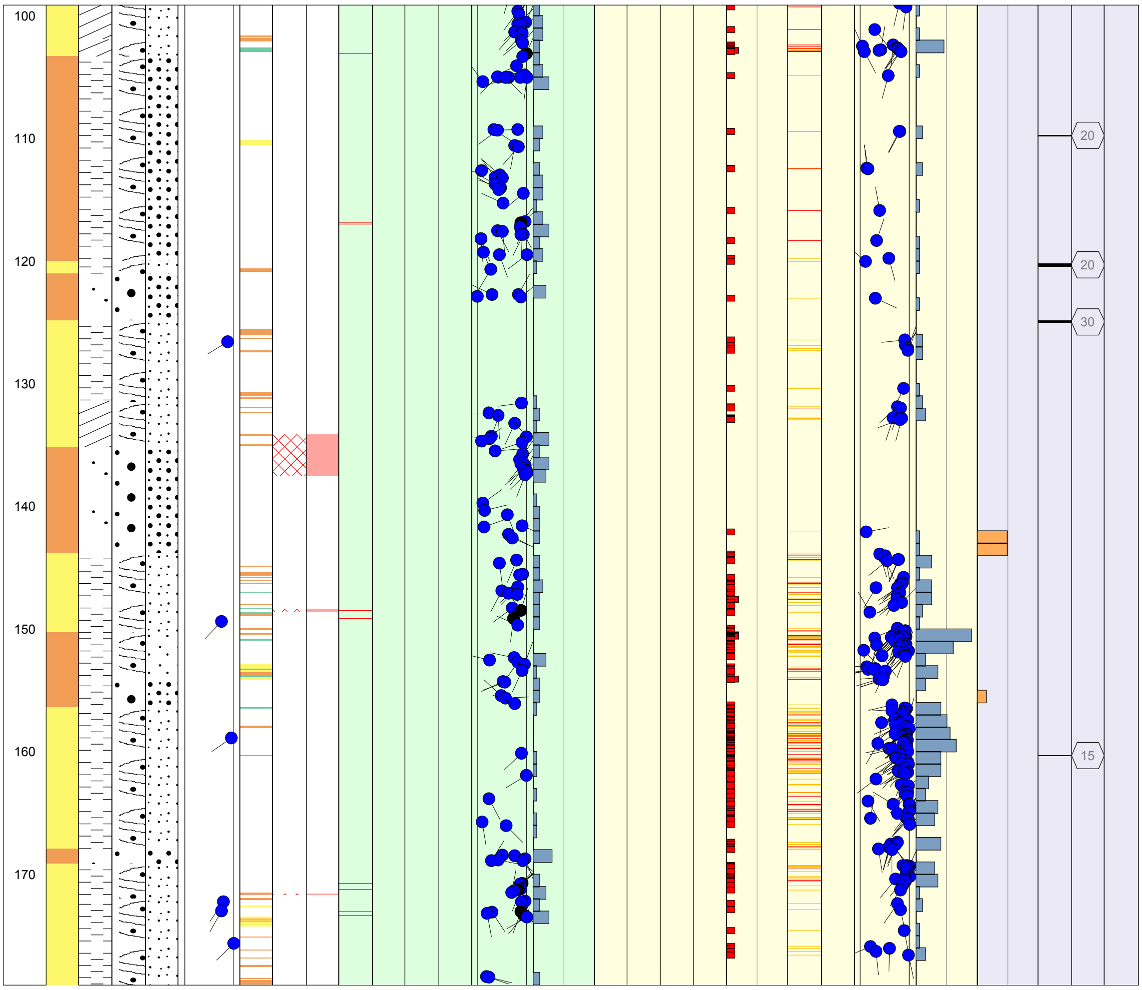
FRACTURE DIRECTION
STRUKTURE ORIENTATION



Title **GEOLOGY IN HFM34** **Appendix: 1b**

Site	FORSMARK	**Coordinate System**	RT90-RHB70
Borehole	HFM34	**Northing [m]**	6701325.06
Diameter [mm]	137	**Easting [m]**	1632470.21
Length [m]	200.750	**Elevation [m.a.s.l.]**	2.45
Bearing [°]	30.50	**Drilling Start Date**	2006-05-24 12:30:00
Inclination [°]	-58.58	**Drilling Stop Date**	2006-06-02 12:00:00
Date of coremapping	2007-02-05 10:41:00	**Plot Date**	2007-10-11 22:03:04
Rocktype data from	p_rock	**Signed data**	

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Title	LEGEND FOR FORSMARK	HFM34	Appendix: 1b

Site FORSMARK
Borehole HFM34
Plot Date 2007-10-14 22:03:05
Signed data

ROCKTYPE FORSMARK

- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granitoid, metamorphic
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite, metamorphic, aplitic
- Granite to granodiorite, metamorphic, medium-grained
- Granodiorite, metamorphic
- Tonalite to granodiorite, metamorphic
- Diorite, quarts diorite and gabbro, metamorphic
- Ultramafic rock, metamorphic
- Amphibolite
- Calc-silicate rock (skarn)
- Magnetite mineralization associated with calc-silicate rock (skarn)
- Sulphide mineralization
- Felsic to intermediate volcanic rock, metamorphic
- Mafic volcanic rock, metamorphic
- Sedimentary rock, metamorphic

ROCK ALTERATION

- Oxidized
- Chloritisized
- Epidotisized
- Weathered
- Tectonized
- Sericitisized
- Quartz dissolution
- Silicification
- Argillization
- Albitization
- Carbonatization
- Saussuritization
- Steatitization
- Uralitization
- Laumontitization
- Fract zone alteration

MINERAL

- Oxidized Walls

STRUCTURE

- Cataclastic
- Schistose
- Gneissic
- Mylonitic
- Ductile Shear Zone
- Brittle-Ductile Zone
- Veined
- Banded
- Massive
- Foliated
- Brecciated
- Lineated

TEXTURE

- Hornfelsed
- Porphyritic
- Ophitic
- Equigranular
- Augen-Bearing
- Unequigranular
- Metamorphic

GRAINSIZE

- Aphanitic
- Fine-grained
- Fine to medium grained
- Medium to coarse grained
- Coarse-grained
- Medium-grained

STRUCTURE ORIENTATION

- Schistose
- Gneissic
- Bedded
- Cataclastic
- Ductile Shear Zone
- Brittle-Ductile Shear Zone
- Veined
- Banded
- Lineated
- Brecciated
- Mylonitic
- Foliated

ROCK ALTERATION INTENSITY

- No intensity
- Faint
- Weak
- Medium
- Strong

ROUGHNESS

- Planar
- Undulating
- Stepped
- Irregular

SURFACE

- Rough
- Smooth
- Slickensided

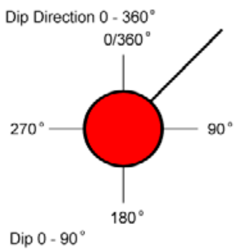
CRUSH ALTERATION

- Slightly Altered
- Moderately Altered
- Highly Altered
- Completley Altered
- Gouge
- Fresh

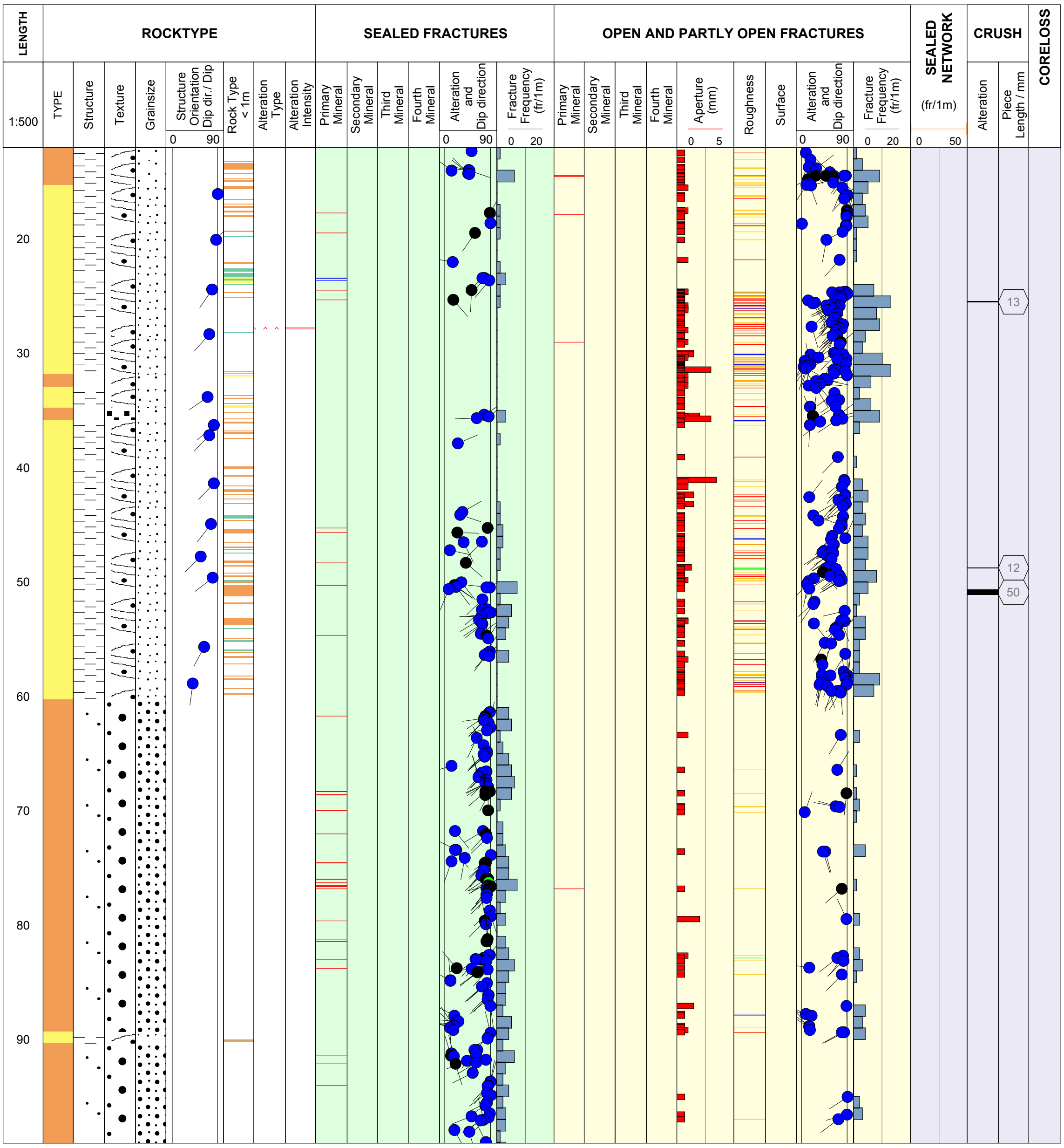
FRACTURE ALTERATION

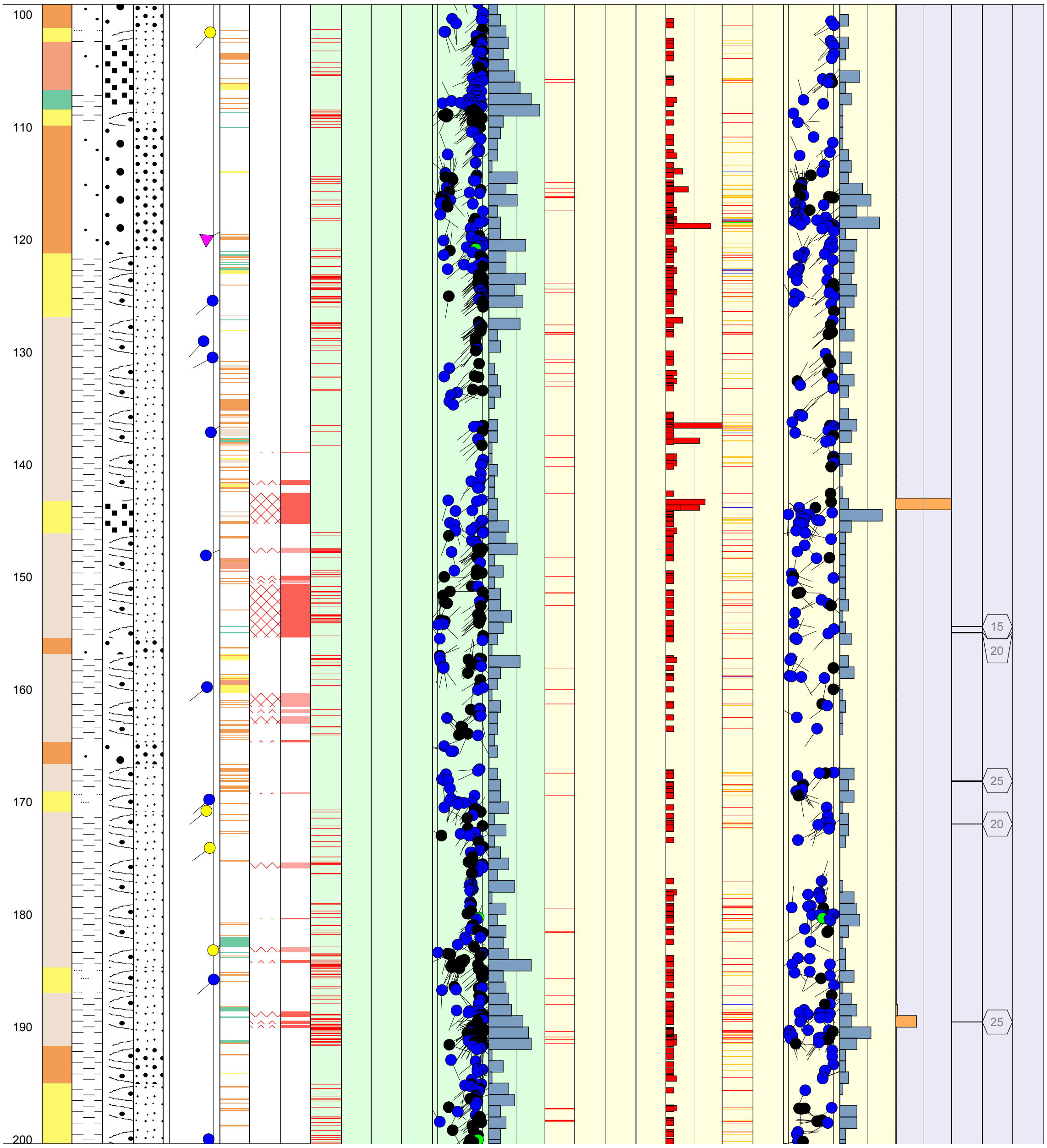
- Fresh
- Gouge
- Completely Altered
- Highly Altered
- Moderately Altered
- Slightly Altered

FRACTURE DIRECTION
STRUKTURE ORIENTATION



Title	GEOLOGY IN HFM35		Appendix: 1c
Site	FORSMARK	Coordinate System	RT90-RHB70
Borehole	HFM35	Northing [m]	6701555.86
Diameter [mm]	136	Easting [m]	1632320.51
Length [m]	200.750	Elevation [m.a.s.l.]	1.90
Bearing [°]	32.96	Drilling Start Date	2006-06-06 08:00:00
Inclination [°]	-59.26	Drilling Stop Date	2006-06-14 11:00:00
Date of coremapping	2007-02-13 14:10:00	Plot Date	2007-10-11 22:03:04
Rocktype data from	p_rock	Signed data	

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25

Title	LEGEND FOR FORSMARK	HFM35	Appendix: 1c

Site FORSMARK
Borehole HFM35
Plot Date 2007-10-14 22:03:05
Signed data

ROCKTYPE FORSMARK

- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granitoid, metamorphic
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite, metamorphic, aplitic
- Granite to granodiorite, metamorphic, medium-grained
- Granodiorite, metamorphic
- Tonalite to granodiorite, metamorphic
- Diorite, quarts diorite and gabbro, metamorphic
- Ultramafic rock, metamorphic
- Amphibolite
- Calc-silicate rock (skarn)
- Magnetite mineralization associated with calc-silicate rock (skarn)
- Sulphide mineralization
- Felsic to intermediate volcanic rock, metamorphic
- Mafic volcanic rock, metamorphic
- Sedimentary rock, metamorphic

ROCK ALTERATION

- Oxidized
- Chloritisized
- Epidotisized
- Weathered
- Tectonized
- Sericitisized
- Quartz dissolution
- Silicification
- Argillization
- Albitization
- Carbonatization
- Saussuritization
- Steatitization
- Uralitization
- Laumontitization
- Fract zone alteration

MINERAL

- Oxidized Walls

STRUCTURE

- Cataclastic
- Schistose
- Gneissic
- Mylonitic
- Ductile Shear Zone
- Brittle-Ductile Zone
- Veined
- Banded
- Massive
- Foliated
- Brecciated
- Lineated

TEXTURE

- Hornfelsed
- Porphyritic
- Ophitic
- Equigranular
- Augen-Bearing
- Unequigranular
- Metamorphic

GRAINSIZE

- Aphanitic
- Fine-grained
- Fine to medium grained
- Medium to coarse grained
- Coarse-grained
- Medium-grained

STRUCTURE ORIENTATION

- Cataclastic
- Bedded
- Gneissic
- Schistose
- Brittle-Ductile Shear Zone
- Ductile Shear Zone
- Lineated
- Banded
- Veined
- Brecciated
- Foliated
- Mylonitic

ROCK ALTERATION INTENSITY

- No intensity
- Faint
- Weak
- Medium
- Strong

ROUGHNESS

- Planar
- Undulating
- Stepped
- Irregular

SURFACE

- Rough
- Smooth
- Slickensided

CRUSH ALTERATION

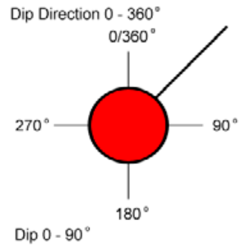
- Slightly Altered
- Moderately Altered
- Highly Altered
- Completley Altered
- Gouge
- Fresh

FRACTURE ALTERATION

- Slightly Altered
- Moderately Altered
- Highly Altered
- Completely Altered
- Gouge
- Fresh

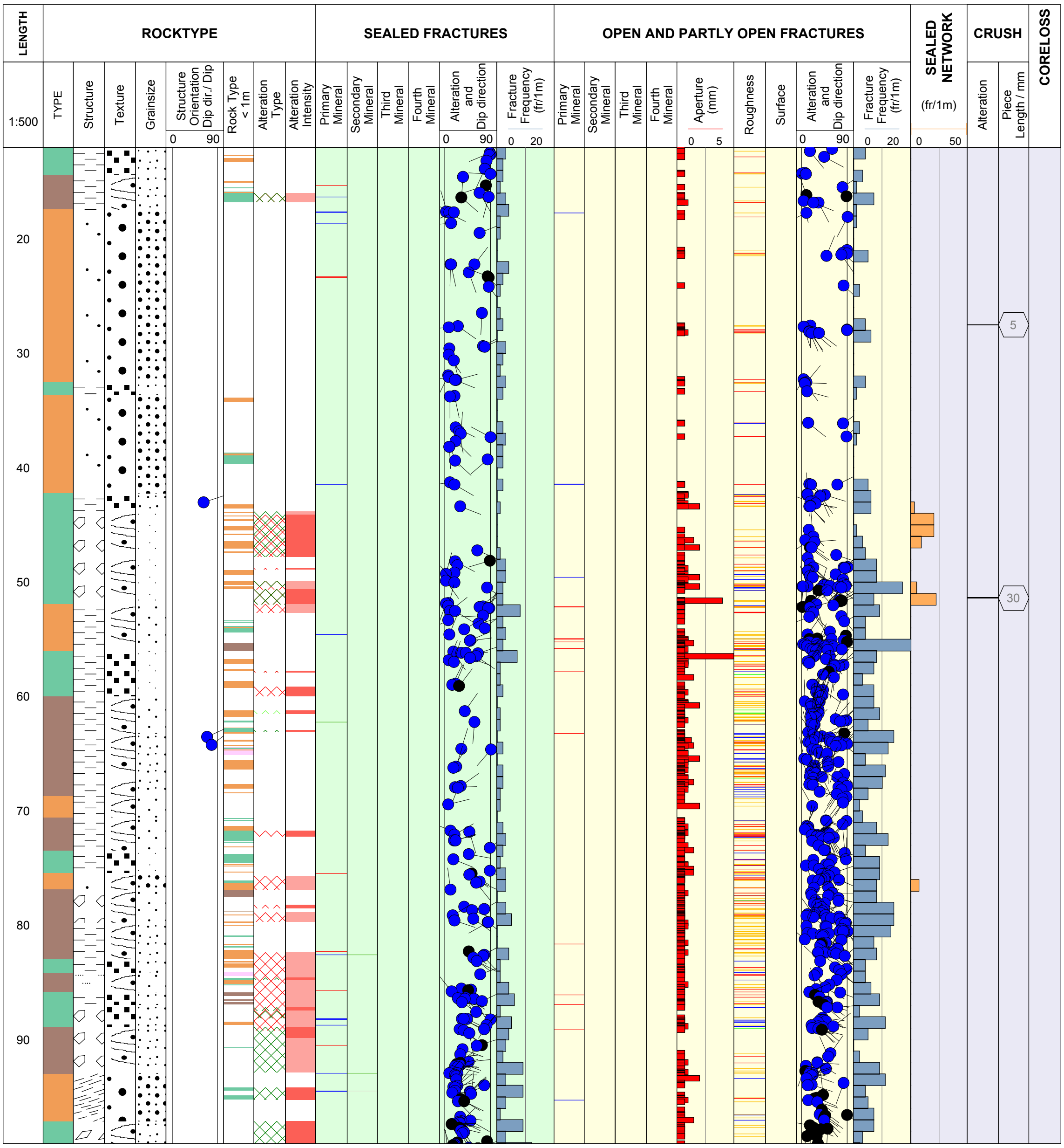
FRACTURE DIRECTION

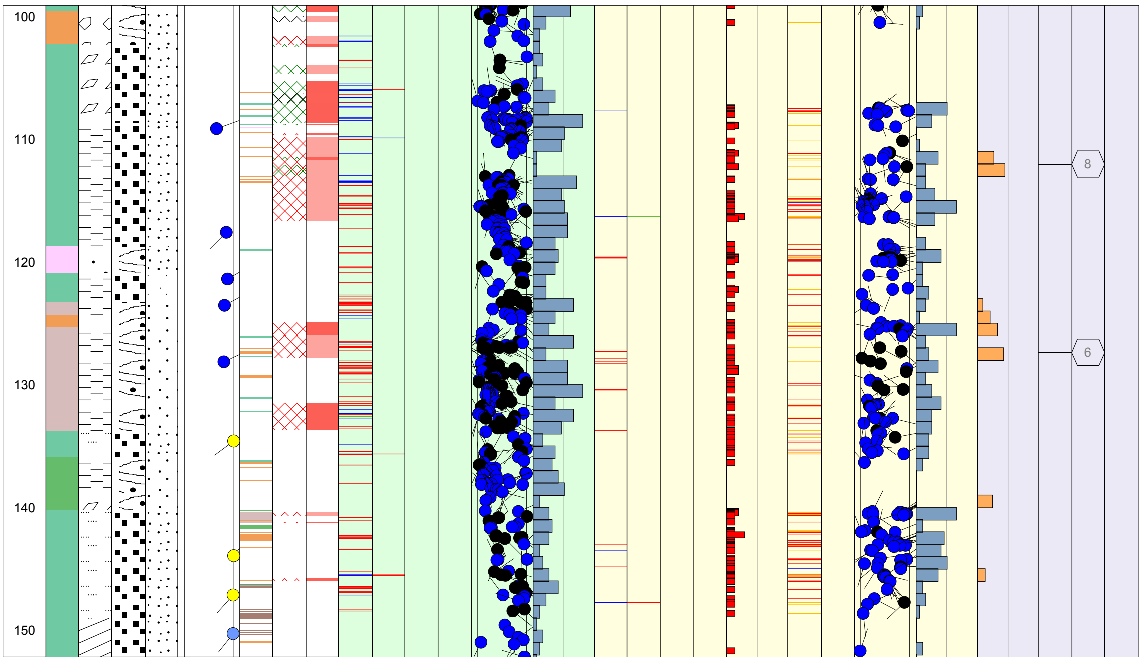
STRUKTURE ORIENTATION



Title **GEOLOGY IN HFM36** **Appendix: 1d**

Site	FORSMARK	**Coordinate System**	RT90-RHB70
Borehole	HFM36	**Northing [m]**	6696504.03
Diameter [mm]	137	**Easting [m]**	1630081.68
Length [m]	152.550	**Elevation [m.a.s.l.]**	8.42
Bearing [°]	256.61	**Drilling Start Date**	2006-08-28 14:00:00
Inclination [°]	-59.00	**Drilling Stop Date**	2006-09-04 11:00:00
Date of coremapping	2007-03-09 10:58:00	**Plot Date**	2007-10-11 22:03:04
Rocktype data from	p_rock	**Signed data**	

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140
150
8
6

Title	LEGEND FOR FORSMARK	HFM36	Appendix: 1d

Site FORSMARK
Borehole HFM36
Plot Date 2007-10-14 22:03:05
Signed data

ROCKTYPE FORSMARK
- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granitoid, metamorphic
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite, metamorphic, aplitic
- Granite to granodiorite, metamorphic, medium-grained
- Granodiorite, metamorphic
- Tonalite to granodiorite, metamorphic
- Diorite, quarts diorite and gabbro, metamorphic
- Ultramafic rock, metamorphic
- Amphibolite
- Calc-silicate rock (skarn)
- Magnetite mineralization associated with calc-silicate rock (skarn)
- Sulphide mineralization
- Felsic to intermediate volcanic rock, metamorphic
- Mafic volcanic rock, metamorphic
- Sedimentary rock, metamorphic

ROCK ALTERATION
- Oxidized
- Chloritisized
- Epidotisized
- Weathered
- Tectonized
- Sericitisized
- Quartz dissolution
- Silicification
- Argillization
- Albitization
- Carbonatization
- Saussuritization
- Steatitization
- Uralitization
- Laumontitization
- Fract zone alteration

MINERAL
- Calcite
- Oxidized Walls

STRUCTURE
- Cataclastic
- Schistose
- Gneissic
- Mylonitic
- Ductile Shear Zone
- Brittle-Ductile Zone
- Veined
- Banded
- Massive
- Foliated
- Brecciated
- Lineated

TEXTURE
- Hornfelsed
- Porphyritic
- Ophitic
- Equigranular
- Augen-Bearing
- Unequigranular
- Metamorphic

GRAINSIZE
- Aphanitic
- Fine-grained
- Fine to medium grained
- Medium to coarse grained
- Coarse-grained
- Medium-grained

STRUCTURE ORIENTATION
- Schistose
- Gneissic
- Bedded
- Cataclastic
- Ductile Shear Zone
- Brittle-Ductile Shear Zone
- Veined
- Banded
- Lineated
- Brecciated
- Mylonitic
- Foliated

ROCK ALTERATION INTENSITY
- No intensity
- Faint
- Weak
- Medium
- Strong

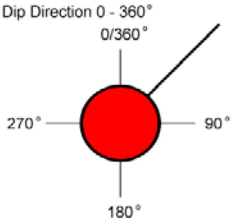
ROUGHNESS
- Planar
- Undulating
- Stepped
- Irregular

SURFACE
- Rough
- Smooth
- Slickensided

CRUSH ALTERATION
- Slightly Altered
- Moderately Altered
- Highly Altered
- Completley Altered
- Gouge
- Fresh

FRACTURE ALTERATION
- Fresh
- Gouge
- Completely Altered
- Highly Altered
- Moderately Altered
- Slightly Altered

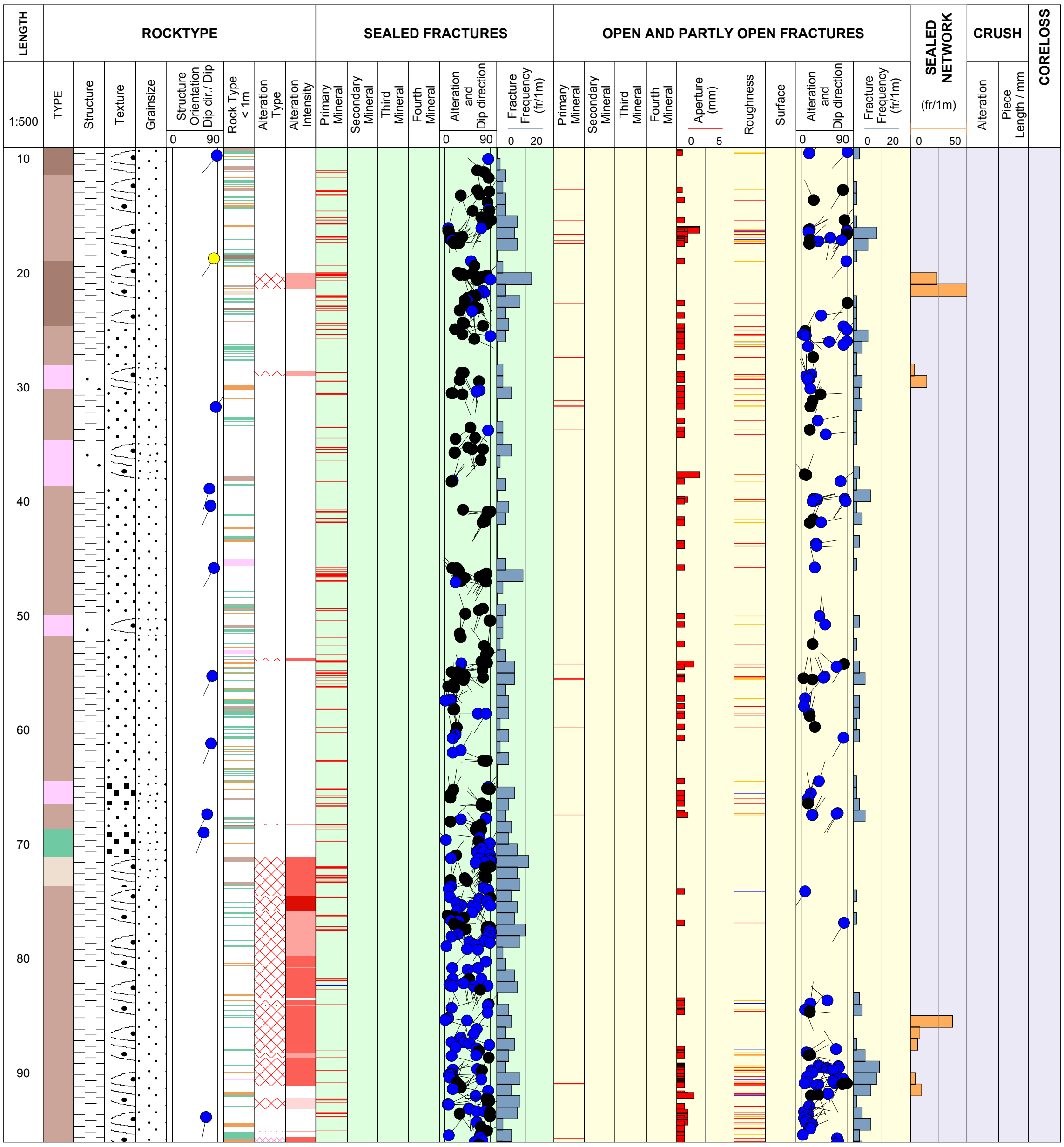
FRACTURE DIRECTION
STRUKTURE ORIENTATION
Dip Direction 0 - 360°

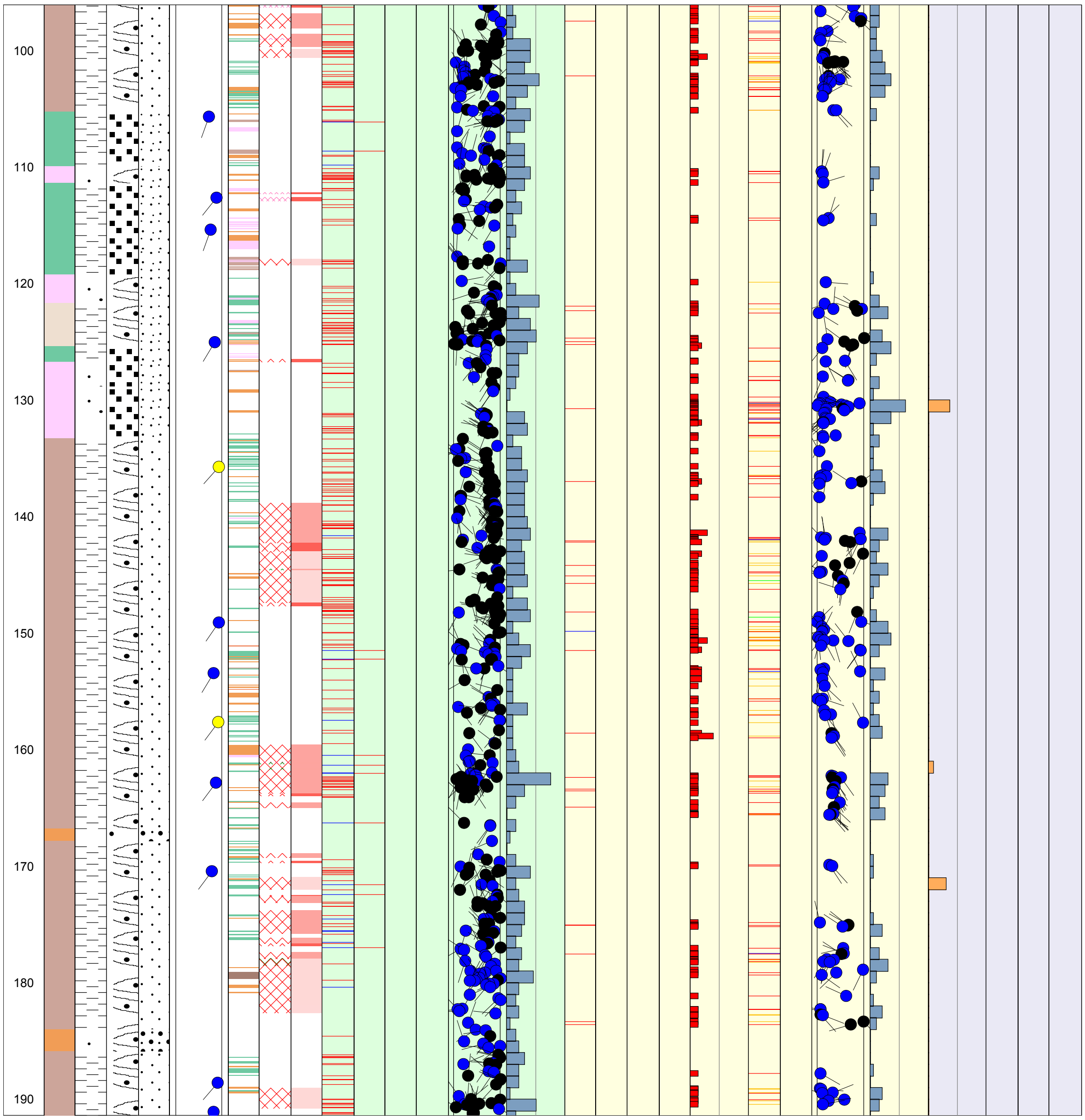


Dip 0 - 90°

Title GEOLOGY IN HFM37 **Appendix: 1e**

Site	FORSMARK	**Coordinate System**	RT90-RHB70
Borehole	HFM37	**Northing [m]**	6696592.43
Diameter [mm]	139	**Easting [m]**	1630137.37
Length [m]	191.750	**Elevation [m.a.s.l.]**	11.39
Bearing [°]	41.35	**Drilling Start Date**	2006-08-07 16:00:00
Inclination [°]	-59.16	**Drilling Stop Date**	2006-08-16 15:00:00
Date of coremapping	2007-03-14 14:35:00	**Plot Date**	2007-10-11 22:03:04
Rocktype data from	p_rock	**Signed data**	




100
110
120
130
140
150
160
170
180
190

Title	LEGEND FOR FORSMARK	HFM37	Appendix: 1e

Site FORSMARK
Borehole HFM37
Plot Date 2007-10-14 22:03:05
Signed data

ROCKTYPE FORSMARK

- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granitoid, metamorphic
- Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained
- Granite, metamorphic, aplitic
- Granite to granodiorite, metamorphic, medium-grained
- Granodiorite, metamorphic
- Tonalite to granodiorite, metamorphic
- Diorite, quarts diorite and gabbro, metamorphic
- Ultramafic rock, metamorphic
- Amphibolite
- Calc-silicate rock (skarn)
- Magnetite mineralization associated with calc-silicate rock (skarn)
- Sulphide mineralization
- Felsic to intermediate volcanic rock, metamorphic
- Mafic volcanic rock, metamorphic
- Sedimentary rock, metamorphic

ROCK ALTERATION

- Oxidized
- Chloritisized
- Epidotisized
- Weathered
- Tectonized
- Sericitisized
- Quartz dissolution
- Silicification
- Argillization
- Albitization
- Carbonatization
- Saussuritization
- Steatitization
- Uralitization
- Laumontitization
- Fract zone alteration

MINERAL

- Calcite
- Oxidized Walls

STRUCTURE

- Cataclastic
- Schistose
- Gneissic
- Mylonitic
- Ductile Shear Zone
- Brittle-Ductile Zone
- Veined
- Banded
- Massive
- Foliated
- Brecciated
- Lineated

TEXTURE

- Hornfelsed
- Porphyritic
- Ophitic
- Equigranular
- Augen-Bearing
- Unequigranular
- Metamorphic

GRAINSIZE

- Aphanitic
- Fine-grained
- Fine to medium grained
- Medium to coarse grained
- Coarse-grained
- Medium-grained

STRUCTURE ORIENTATION

- Cataclastic
- Bedded
- Gneissic
- Schistose
- Brittle-Ductile Shear Zone
- Ductile Shear Zone
- Lineated
- Banded
- Veined
- Brecciated
- Foliated
- Mylonitic

ROCK ALTERATION INTENSITY

- No intensity
- Faint
- Weak
- Medium
- Strong

ROUGHNESS

- Planar
- Undulating
- Stepped
- Irregular

SURFACE

- Rough
- Smooth
- Slickensided

CRUSH ALTERATION

- Slightly Altered
- Moderately Altered
- Highly Altered
- Completley Altered
- Gouge
- Fresh

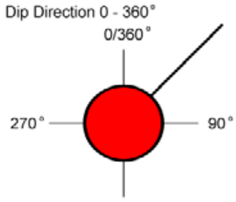
FRACTURE ALTERATION

- Slightly Altered
- Moderately Altered
- Highly Altered
- Completely Altered
- Gouge
- Fresh

FRACTURE DIRECTION

STRUKTURE ORIENTATION

Dip Direction 0 - 360°



Dip 0 - 90°

Appendix 2

BIPS-image quality

BIPS Image Quality of HFM33

From	To	% visible	Comment
12.35	137.15	100	Good. White strips parallel to the borehole, probably due to water or scratches on the window of the camera probe.
137.15	139.90	60	Good. The borders of the image is diffuse due to sediments. White strips parallel to the borehole, probably due to water or scratches on the window of the camera probe.

BIPS Image Quality of HFM34

From	To	% visible	Comment
12.08	97.09	100	Good. Minor occurrence of white strips parallel to the borehole, probably due to water or scratches on the window of the camera probe.
97.09	97.20	40	Bad. Elongated pixels.
97.20	100.12	40	Bad. Diffuse image, like a thin veil of suspended material. White strips parallel to the borehole, probably due to water or scratches on the window of the camera probe.
100.12	179.004	60	Acceptable. White strips parallel to the borehole, probably due to water or scratches on the window of the camera probe. Mapping was stopped due to the bad BIPS-image quality.

BIPS Image Quality of HFM35

From	To	% visible	Comment
12.00	143.30	100	Good. Minor occurrence of white strips parallel to the borehole, probably due to water or scratches on the window of the camera probe.
143.30	198.20	100	Good. A rusty, transparent coating on the boarders of the image.
198.20	200.518	85	Good. A rusty, semitransparent coating on the boarders of the image.

BIPS Image Quality of HFM36

From	To	% visible	Comment
12.060	55.70	80	Good. White strips parallel to the borehole, probably due to water or scratches on the window of the camera probe.
55.70	74.80	100	Good. Minor occurrence of white strips parallel to the borehole, probably due to water or scratches on the window of the camera probe.
74.80	108.80	90	Good. A rusty, transparent coating on the boarders of the image.
108.80	123.30	50	Bad. A rusty or grey coating on the borders of the image together with a possible overexposure.
123.30	128.00	80	Good. A semitransparent coating on the boarders of the image.
128.00	139.70	95	Good. A transparent coating on the boarders of the image.
139.70	152.25	50	Bad. A grey coating on the borders of the image.

BIPS Image Quality of HFM37

From	To	% visible	Comment
9.07	176.40	100	Good. No comment.
176.40	191.455	90	Good. A transparent grey coating on the borders of the image.

In-data: Borehole length and diameter

Hole Diam T – Drilling: Borehole diameter

HFM33, 2006-04-26 10:00:00–2006-05-03 12:25:00 (0.000–140.200 m)

Sub Secup (m)	Sub Seclow (m)	Hole Diam (m)	Comment
0.300	12.350	0.1800	Tubex 140.
12.350	122.200	0.1397	Omslipning vid 122.20 till 139.5 mm.
122.200	140.200	0.1390	Krona vid borrslut.

Printout from SICADA 2006-10-25 09:54:07.

Hole Diam T – Drilling: Borehole diameter

HFM34, 2006-05-24 12:30:00–2006-06-02 12:00:00 (0.000–200.750 m)

Sub Secup (m)	Sub Seclow (m)	Hole Diam (m)	Comment
0.350	12.080	0.1800	
12.080	92.250	0.1380	
92.250	200.750	0.1368	

Printout from SICADA 2006-10-25 10:03:11.

Hole Diam T – Drilling: Borehole diameter

HFM35, 2006-06-06 08:00:00–2006-06-14 11:00:00 (0.000–200.750 m)

Sub Secup (m)	Sub Seclow (m)	Hole Diam (m)	Comment
0.300	12.040	0.1800	
12.040	122.250	0.1377	
122.250	200.750	0.1356	

Printout from SICADA 2006-10-25 10:07:56.

Hole Diam T – Drilling: Borehole diameter

HFM36, 2006-08-28 14:00:00–2006-09-04 11:00:00 (0.350–152.550 m)

Sub Secup (m)	Sub Seclow (m)	Hole Diam (m)	Comment	QC
0.350	12.060	0.1800		*
12.060	101.300	0.1375	Krona vid start. Omslipning vid 101.3 m till 137.2 mm.	*
101.300	152.550	0.1368	Krona vid borrslut 136.8 mm.	*

Printout from SICADA 2007-05-30 11:02:45.

Hole Diam T – Drilling: Borehole diameter

HFM37, 2006-08-07 16:00:00–2006-08-16 15:00:00 (0.350–191.750 m)

Sub Secup (m)	Sub Seclow (m)	Hole Diam (m)	Comment
0.350	9.070	0.1800	
9.070	110.250	0.1398	Krona vid start 141.0. Omslipning vid 110.25m till 139.5mm.
110.250	191.750	0.1385	

Printout from SICADA 2007-02-05 10:33:05.

Appendix 4

In-data: Deviation data

Magnetic Acc Dev T – Magnetic accelerometer deviation measurement

HFM33, 2006-05-04 12:50:00–2006-05-04 13:40:00 (3.000–138.000 m)

Bhlen (m)	Dip (degrees)	Magnetic Bearing (degrees)	Easting (m)	Northing (m)	Elevation (m)
3.00	–59.41	218.62			
6.00	–58.95	219.21			
9.00	–58.33	219.81			
12.00	–57.78	220.40			
15.00	–57.77	220.40			
18.00	–57.49	220.59			
21.00	–57.35	221.16			
24.00	–57.24	221.72			
27.00	–57.02	221.99			
30.00	–56.88	222.62			
33.00	–56.64	223.58			
36.00	–56.54	224.19			
39.00	–56.84	224.15			
42.00	–56.46	224.62			
45.00	–56.33	225.91			
48.00	–56.03	227.20			
51.00	–55.55	228.05			
54.00	–55.38	228.97			
57.00	–54.79	229.83			
60.00	–54.47	230.27			
63.00	–54.28	230.44			
66.00	–54.10	230.62			
69.00	–53.65	231.80			
72.00	–53.43	231.62			
75.00	–53.32	232.40			
78.00	–53.03	232.91			
81.00	–52.72	233.41			
84.00	–52.49	233.60			
87.00	–52.24	233.60			
90.00	–51.99	233.79			
93.00	–51.61	233.49			
96.00	–51.19	233.70			
99.00	–51.06	234.09			
102.00	–50.60	234.12			
105.00	–50.46	234.79			
108.00	–50.45	235.10			
111.00	–50.43	235.38			
114.00	–50.25	235.38			
117.00	–50.23	235.38			
120.00	–50.11	235.38			
123.00	–50.04	235.38			
126.00	–49.98	235.38			
129.00	–49.88	235.38			
132.00	–49.73	235.65			
135.00	–49.69	236.09			
138.00	–49.49	235.72			

Printout from SICADA 2006-10-25 10:00:17.

Magnetic Acc Dev T – Magnetic accelerometer deviation measurement

HFM34, 2006-06-05 15:20:00–2006-06-05 16:30:00 (3.000–198.000 m)

Bhlen (m)	Dip (degrees)	Magnetic Bearing (degrees)	Easting (m)	Northing (m)	Elevation (m)
3.00	–58.54	28.79			
6.00	–58.30	29.09			
9.00	–59.05	29.38			
12.00	–58.93	29.68			
15.00	–58.68	29.68			
18.00	–58.68	29.08			
21.00	–58.78	29.27			
24.00	–58.88	29.26			
27.00	–58.98	29.54			
30.00	–58.99	29.35			
33.00	–59.01	29.03			
36.00	–59.10	29.03			
39.00	–59.11	28.71			
42.00	–59.13	28.79			
45.00	–59.18	28.06			
48.00	–59.24	27.57			
51.00	–59.21	27.07			
54.00	–59.12	27.25			
57.00	–58.79	27.24			
60.00	–58.62	27.24			
63.00	–58.26	27.23			
66.00	–58.01	26.99			
69.00	–58.03	27.33			
72.00	–57.98	26.78			
75.00	–57.67	26.93			
78.00	–57.61	26.74			
81.00	–57.42	26.76			
84.00	–57.16	26.79			
87.00	–56.80	26.84			
90.00	–56.73	26.95			
93.00	–56.53	27.15			
96.00	–56.19	27.29			
99.00	–56.03	27.09			
102.00	–55.85	26.99			
105.00	–55.60	26.70			
108.00	–55.43	26.80			
111.00	–55.35	26.71			
114.00	–55.09	26.57			
117.00	–54.99	26.38			
120.00	–54.73	26.76			
123.00	–54.59	26.22			
126.00	–54.27	26.68			
129.00	–53.81	26.81			
132.00	–53.25	27.10			
135.00	–53.10	26.93			

Bhlen (m)	Dip (degrees)	Magnetic Bearing (degrees)	Easting (m)	Northing (m)	Elevation (m)
138.00	–52.90	27.17			
141.00	–52.63	26.94			
144.00	–52.35	27.13			
147.00	–51.90	27.46			
150.00	–51.64	27.76			
153.00	–51.43	27.62			
156.00	–51.25	28.01			
159.00	–50.90	28.31			
162.00	–50.73	28.30			
165.00	–50.26	28.21			
168.00	–49.85	27.88			
171.00	–49.29	27.86			
174.00	–48.91	28.10			
177.00	–48.32	27.63			
180.00	–48.02	27.44			
183.00	–47.61	27.36			
186.00	–47.36	27.42			
189.00	–47.12	27.20			
192.00	–47.04	27.19			
195.00	–46.69	27.09			
198.00	–46.49	27.19			

Printout from SICADA 2006-10-25 10:01:11.

Magnetic Acc Dev T – Magnetic accelerometer deviation measurement

HFM35, 2006-06-14 17:40:00–2006-06-14 18:30:00 (3.000–198.000 m)

Bhlen (m)	Dip (degrees)	Magnetic Bearing (degrees)	Easting (m)	Northing (m)	Elevation (m)
3.00	–59.35	31.12			
6.00	–58.31	31.28			
9.00	–57.84	31.44			
12.00	–57.30	31.60			
15.00	–57.24	31.60			
18.00	–57.04	31.38			
21.00	–56.41	31.36			
24.00	–56.11	31.35			
27.00	–55.48	31.20			
30.00	–54.78	31.33			
33.00	–54.47	31.67			
36.00	–54.26	31.64			
39.00	–53.70	31.71			
42.00	–53.07	31.80			
45.00	–52.56	31.96			
48.00	–51.96	31.96			
51.00	–51.70	32.13			
54.00	–51.56	32.27			
57.00	–51.33	31.99			

Bhlen (m)	Dip (degrees)	Magnetic Bearing (degrees)	Easting (m)	Northing (m)	Elevation (m)
60.00	–51.05	31.56			
63.00	–51.03	31.44			
66.00	–50.83	31.70			
69.00	–50.84	31.98			
72.00	–50.67	32.14			
75.00	–50.47	32.21			
78.00	–50.37	32.44			
81.00	–50.32	32.60			
84.00	–50.27	32.66			
87.00	–50.07	32.44			
90.00	–49.85	32.35			
93.00	–49.65	32.27			
96.00	–49.51	32.37			
99.00	–49.29	32.34			
102.00	–49.20	32.37			
105.00	–49.19	32.52			
108.00	–49.03	32.60			
111.00	–48.81	32.60			
114.00	–48.32	32.49			
117.00	–47.77	32.71			
120.00	–47.32	32.35			
123.00	–47.06	32.15			
126.00	–46.91	32.13			
129.00	–46.81	32.16			
132.00	–46.61	32.18			
135.00	–46.46	32.01			
138.00	–46.34	31.98			
141.00	–46.11	31.77			
144.00	–46.00	31.57			
147.00	–45.95	31.57			
150.00	–45.78	31.38			
153.00	–45.62	31.74			
156.00	–45.39	31.40			
159.00	–45.15	31.55			
162.00	–45.11	31.60			
165.00	–44.95	31.30			
168.00	–44.77	31.42			
171.00	–44.74	31.50			
174.00	–44.67	31.77			
177.00	–44.58	31.88			
180.00	–44.51	31.25			
183.00	–44.45	31.22			
186.00	–44.30	31.24			
189.00	–44.33	31.54			
192.00	–44.26	30.74			
195.00	–44.17	30.39			
198.00	–44.12	29.91			

Printout from SICADA 2006-10-25 10:09:04.

Magnetic Acc Dev T – Magnetic accelerometer deviation measurement

HFM36, 2006-09-04 13:00:00–2006-09-04 14:05:00 (3.000–150.000 m)

Bhlen (m)	Dip (degrees)	Magnetic Bearing (degrees)	Easting (m)	Northing (m)	Elevation (m)
3.00	–59.11	253.79			
6.00	–58.88	253.23			
9.00	–58.72	252.68			
12.00	–57.62	252.12			
15.00	–57.16	252.12			
18.00	–56.84	254.09			
21.00	–56.49	253.83			
24.00	–55.90	252.75			
27.00	–55.28	251.86			
30.00	–54.94	251.59			
33.00	–54.36	252.57			
36.00	–54.04	251.23			
39.00	–53.66	251.67			
42.00	–53.47	251.37			
45.00	–53.20	251.73			
48.00	–52.81	251.80			
51.00	–52.49	251.58			
54.00	–52.15	251.74			
57.00	–51.86	251.76			
60.00	–51.68	251.78			
63.00	–51.52	249.85			
66.00	–51.39	250.45			
69.00	–51.29	252.81			
72.00	–51.17	252.86			
75.00	–50.95	252.29			
78.00	–50.76	250.67			
81.00	–50.56	251.07			
84.00	–50.38	253.13			
87.00	–50.28	251.87			
90.00	–49.95	251.51			
93.00	–49.91	251.95			
96.00	–49.77	252.94			
99.00	–49.61	252.99			
102.00	–49.66	252.69			
105.00	–49.18	253.12			
108.00	–49.17	252.74			
111.00	–48.92	253.02			
114.00	–48.51	253.39			
117.00	–48.23	253.50			
120.00	–47.86	253.72			
123.00	–47.40	254.11			
126.00	–47.14	254.04			
129.00	–47.06	254.12			
132.00	–46.86	254.05			
135.00	–46.43	254.05			
138.00	–46.04	254.54			
141.00	–45.60	255.05			
144.00	–45.33	253.62			
147.00	–44.82	252.86			
150.00	–44.78	255.07			

Printout from SICADA 2006-10-25 10:10:04.

Magnetic Acc Dev T – Magnetic accelerometer deviation measurement

HFM37, 2006-08-16 15:30:00–2006-08-16 16:20:00 (3.000–189.000 m)

Bhlen (m)	Dip (degrees)	Magnetic Bearing (degrees)	Elevation (m)	Magfield (nT)	Magdip (degrees)	Gravfield	Toolroll (degrees)	Magtoolface (degrees)	Dls (degrees/m)	Status	Magh (nT)	Magv (nT)	Updown (m)	Leftright (m)	Shortfall (m)
3.00	–59.19	40.05	0.000	55145	73.63	0.9998	73.07	229.53	0.000	1	15546.0	52908.0	0.00	0.00	0.00
6.00	–59.39	41.01	–2.580	53018	73.72	0.9998	78.71	230.27	1.546	1	14860.0	50893.0	–0.01	0.12	0.00
9.00	–59.73	41.98	–5.160	52075	73.71	1.0004	14.24	164.12	1.119	1	14605.0	49985.0	–0.04	0.45	–0.02
12.00	–60.06	42.95	–7.740	51530	73.06	0.9999	173.65	320.35	0.409	0	15012.0	49295.0	–0.10	0.85	–0.05
15.00	–60.81	43.92	–10.350	51340	73.10	1.0000	155.18	300.45	0.329	0	14927.0	49123.0	–0.22	1.24	–0.08
18.00	–60.94	44.89	–12.970	51109	72.99	1.0008	253.25	37.80	0.139	0	14951.0	48873.0	–0.36	1.66	–0.11
21.00	–61.41	44.89	–15.600	51315	72.98	1.0004	189.91	333.05	0.521	0	15019.0	49068.0	–0.52	2.12	–0.15
24.00	–61.68	45.35	–18.240	50989	73.49	1.0006	179.84	323.92	0.115	0	14487.0	48888.0	–0.72	2.62	–0.20
27.00	–61.86	45.97	–20.880	51003	73.13	1.0007	210.24	352.90	0.115	0	14799.0	48809.0	–0.94	3.12	–0.25
30.00	–62.21	47.36	–23.530	51102	72.97	1.0009	228.10	9.55	0.246	0	14964.0	48862.0	–1.17	3.65	–0.30
33.00	–62.73	48.99	–26.190	50972	73.02	1.0004	213.59	354.15	0.305	0	14886.0	48750.0	–1.44	4.20	–0.37
36.00	–63.10	51.14	–28.860	50967	73.07	1.0003	210.56	350.54	0.350	0	14838.0	48759.0	–1.75	4.78	–0.44
39.00	–63.23	52.45	–31.540	50971	72.99	0.9997	29.68	169.18	0.202	0	14910.0	48741.0	–2.08	5.39	–0.52
42.00	–63.45	54.03	–34.220	50736	73.20	0.9995	94.32	234.04	0.248	0	14664.0	48570.0	–2.44	6.03	–0.61
45.00	–63.72	55.90	–36.910	50786	73.20	0.9993	103.29	242.62	0.292	0	14677.0	48619.0	–2.83	6.70	–0.72
48.00	–64.03	57.10	–39.600	50919	73.18	0.9994	98.98	237.82	0.204	0	14732.0	48741.0	–3.24	7.40	–0.83
51.00	–64.22	59.01	–42.300	50800	73.05	0.9992	109.22	247.55	0.285	0	14813.0	48593.0	–3.68	8.11	–0.95
54.00	–64.48	59.59	–45.000	50910	73.03	0.9993	99.46	237.37	0.121	0	14860.0	48693.0	–4.15	8.85	–1.08
57.00	–64.57	61.96	–47.710	50943	73.13	0.9994	87.55	225.88	0.341	0	14782.0	48752.0	–4.64	9.61	–1.22
60.00	–64.62	62.64	–50.420	50939	72.99	0.9992	111.36	249.34	0.099	0	14902.0	48711.0	–5.15	10.39	–1.37
63.00	–64.90	64.09	–53.140	50891	73.13	0.9994	111.58	249.70	0.226	0	14766.0	48702.0	–5.68	11.19	–1.52
66.00	–64.96	65.14	–55.850	50556	73.15	0.9992	74.44	212.69	0.149	0	14659.0	48385.0	–6.23	12.00	–1.69
69.00	–64.91	67.05	–58.570	50881	73.03	0.9990	78.26	216.62	0.270	0	14854.0	48664.0	–6.80	12.84	–1.86
72.00	–64.82	68.33	–61.290	50888	73.06	0.9989	88.60	227.43	0.184	0	14829.0	48680.0	–7.39	13.71	–2.05
75.00	–64.86	69.90	–64.000	50902	73.02	0.9993	111.99	250.98	0.223	0	14867.0	48682.0	–8.00	14.60	–2.25
78.00	–65.01	70.74	–66.720	50852	73.02	0.9986	125.79	264.75	0.128	0	14851.0	48636.0	–8.63	15.50	–2.46
81.00	–65.03	71.39	–69.440	50852	73.07	1.0005	287.19	66.39	0.092	0	14805.0	48649.0	–9.27	16.42	–2.68
84.00	–65.10	72.84	–72.160	50871	73.11	0.9991	78.26	217.76	0.205	0	14782.0	48676.0	–9.92	17.35	–2.90
87.00	–64.87	74.25	–74.880	50901	73.13	0.9991	75.15	215.34	0.212	0	14768.0	48712.0	–10.60	18.30	–3.14
90.00	–64.72	74.84	–77.590	50945	73.13	0.9993	71.09	211.61	0.098	0	14783.0	48753.0	–11.28	19.28	–3.39
93.00	–64.39	75.40	–80.300	50916	73.08	0.9996	41.14	182.10	0.137	0	14819.0	48712.0	–11.96	20.27	–3.64

Bhlen (m)	Dip (degrees)	Magnetic Bearing (degrees)	Elevation (m)	Magfield (nT)	Magdip (degrees)	Gravfield	Toolroll (degrees)	Magtoolface (degrees)	Dls (degrees/m)	Status	Magh (nT)	Magv (nT)	Updown (m)	Leftright (m)	Shortfall (m)
96.00	–64.45	76.73	–83.010	50906	73.09	0.9988	96.06	237.28	0.192	0	14810.0	48704.0	–12.65	21.28	–3.90
99.00	–64.39	77.23	–85.710	50872	73.01	0.9990	97.57	238.82	0.075	0	14868.0	48650.0	–13.35	22.30	–4.17
102.00	–64.08	77.51	–88.410	50855	73.14	0.9997	33.26	175.22	0.110	0	14748.0	48670.0	–14.06	23.34	–4.44
105.00	–63.73	78.70	–91.110	50828	73.07	0.9993	55.41	197.92	0.210	0	14800.0	48626.0	–14.76	24.40	–4.72
108.00	–63.61	79.43	–93.800	50773	73.03	0.9987	94.73	237.46	0.115	0	14818.0	48563.0	–15.47	25.48	–5.02
111.00	–63.44	80.98	–96.480	50843	73.12	0.9993	111.32	254.79	0.238	0	14765.0	48652.0	–16.19	26.58	–5.32
114.00	–63.30	81.29	–99.160	50775	73.06	0.9993	65.61	209.19	0.065	0	14796.0	48571.0	–16.92	27.70	–5.64
117.00	–63.18	82.11	–101.840	50645	73.20	0.9989	93.73	237.91	0.130	0	14635.0	48484.0	–17.66	28.83	–5.96
120.00	–62.97	82.87	–104.520	51019	73.15	0.9990	99.09	243.92	0.336	0	14787.0	48829.0	–18.42	29.98	–6.29
123.00	–62.94	82.87	–107.190	50725	73.19	0.9993	113.53	258.42	0.024	0	14667.0	48558.0	–19.19	31.16	–6.64
126.00	–62.90	83.63	–109.860	51007	72.74	0.9989	90.52	234.51	0.079	0	15137.0	48710.0	–19.96	32.33	–6.99
129.00	–62.72	84.85	–112.530	51194	72.68	0.9990	109.65	254.03	0.195	0	15240.0	48874.0	–20.73	33.51	–7.34
132.00	–62.71	86.23	–115.200	50777	72.96	0.9992	104.07	249.30	0.211	0	14880.0	48548.0	–21.51	34.71	–7.71
135.00	–62.87	87.05	–117.860	50859	72.96	0.9989	115.91	261.20	0.135	0	14905.0	48626.0	–22.32	35.92	–8.08
138.00	–62.94	87.79	–120.530	50825	73.06	0.9992	95.24	240.84	0.115	0	14809.0	48620.0	–23.15	37.13	–8.47
141.00	–63.03	88.15	–123.210	50858	72.98	0.9993	103.81	249.28	0.062	0	14889.0	48629.0	–23.99	38.35	–8.86
144.00	–62.97	88.93	–125.880	50859	72.98	0.9992	103.77	249.50	0.119	0	14889.0	48630.0	–24.84	39.57	–9.25
147.00	–62.99	89.67	–128.550	50819	73.08	0.9996	84.10	230.19	0.112	0	14790.0	48619.0	–25.71	40.80	–9.66
150.00	–62.86	90.54	–131.220	50891	73.09	0.9991	86.71	233.17	0.140	0	14807.0	48690.0	–26.59	42.04	–10.07
153.00	–62.73	91.33	–133.890	50920	73.05	0.9991	74.86	221.60	0.128	0	14844.0	48708.0	–27.47	43.29	–10.49
156.00	–62.60	91.44	–136.560	50857	73.03	0.9994	84.26	231.11	0.046	0	14842.0	48643.0	–28.37	44.56	–10.92
159.00	–62.61	92.00	–139.220	50761	73.00	0.9988	110.33	257.28	0.086	0	14842.0	48543.0	–29.27	45.83	–11.36
162.00	–62.30	92.74	–141.880	50816	73.11	0.9988	79.01	226.59	0.154	0	14767.0	48623.0	–30.18	47.11	–11.80
165.00	–62.10	93.81	–144.530	50722	73.13	0.9990	87.13	235.20	0.178	0	14724.0	48538.0	–31.09	48.41	–12.26
168.00	–61.97	94.16	–147.180	50718	73.04	0.9990	110.31	258.44	0.070	0	14799.0	48511.0	–32.02	49.73	–12.73
171.00	–61.65	94.97	–149.830	50860	72.97	0.9994	46.50	195.00	0.167	0	14898.0	48629.0	–32.95	51.06	–13.21
174.00	–61.51	95.74	–152.470	50771	73.00	0.9990	103.40	252.28	0.131	0	14846.0	48552.0	–33.90	52.40	–13.70
177.00	–61.22	96.47	–155.100	50764	73.07	0.9989	89.18	238.59	0.151	0	14779.0	48564.0	–34.85	53.76	–14.20
180.00	–61.21	96.94	–157.730	50735	73.01	0.9990	103.28	252.72	0.076	0	14828.0	48519.0	–35.81	55.14	–14.71
183.00	–60.83	97.91	–160.350	50710	73.21	0.9997	42.27	192.55	0.201	0	14653.0	48547.0	–36.78	56.52	–15.24
186.00	–60.71	98.56	–162.970	50682	73.11	0.9990	73.99	224.40	0.113	0	14724.0	48496.0	–37.76	57.93	–15.77
189.00	–60.20	100.16	–165.580	50713	72.99	0.9993	71.86	222.88	0.314	0	14838.0	48494.0	–38.76	59.35	–16.33

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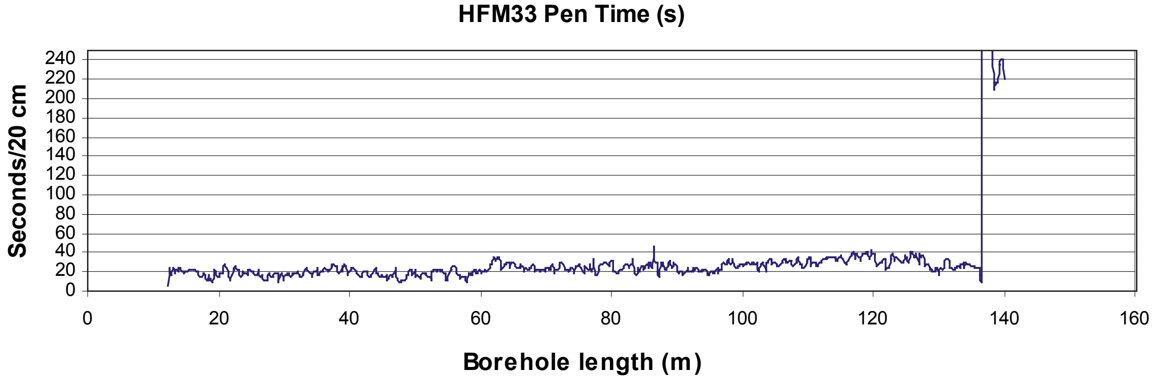
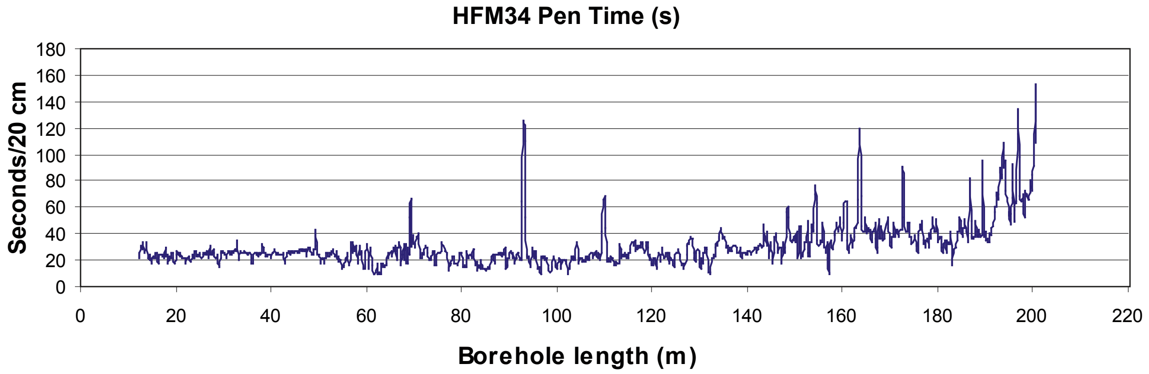
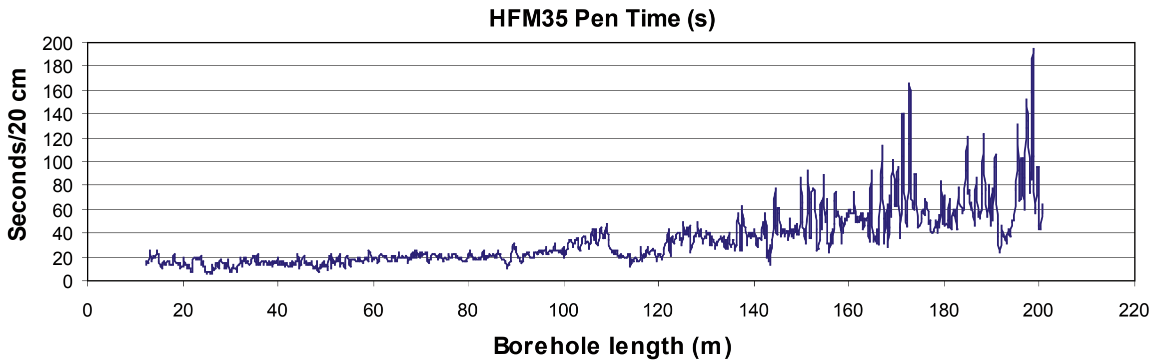
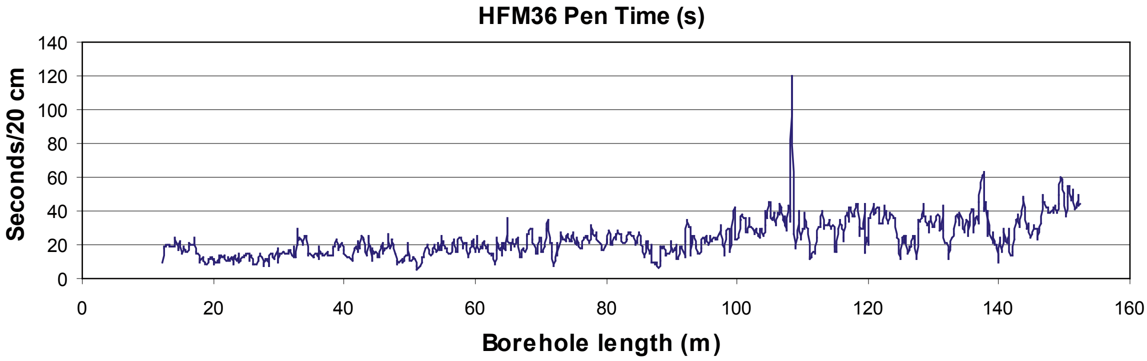
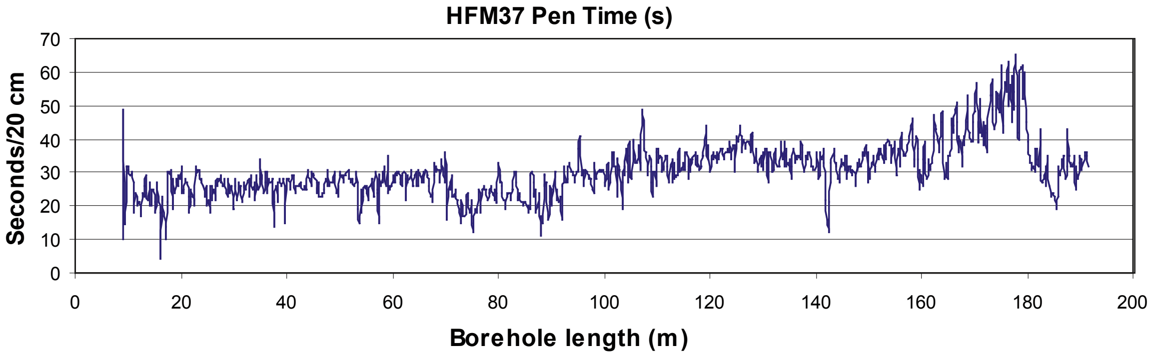
In-data: Drilling penetration rate





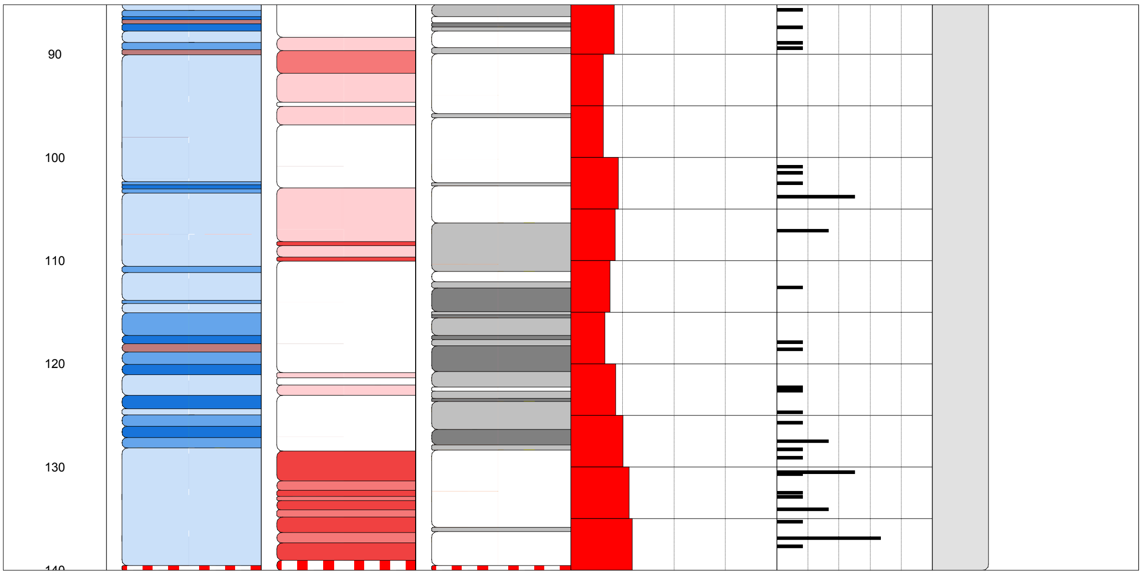



HFM36 Pen Time (s)
Seconds/20 cm
0
20
40
60
80
100
120
140
0
20
40
60
80
100
120
140
160
Borehole length (m)

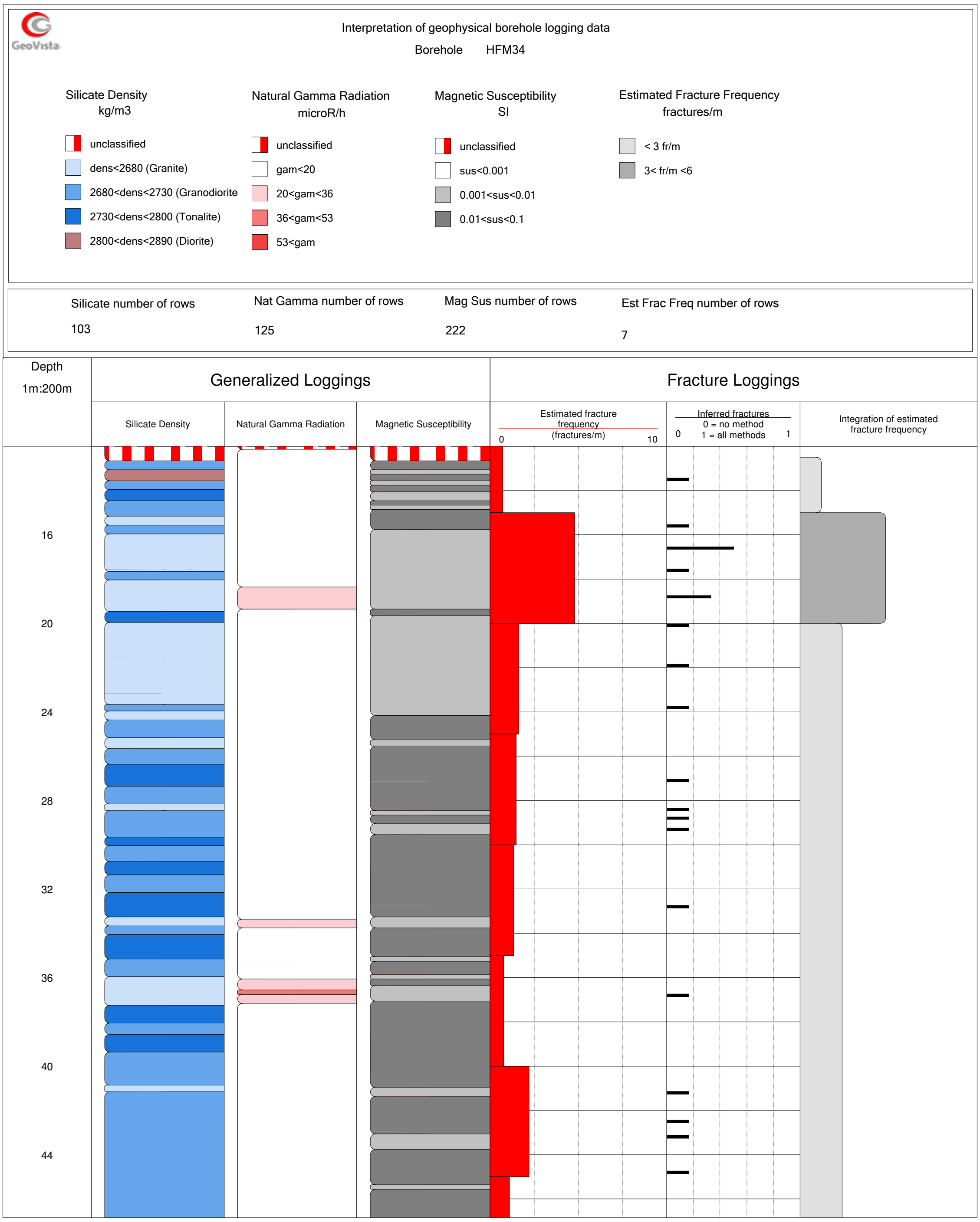

HFM37 Pen Time (s)
Seconds/20 cm
0
10
20
30
40
50
60
70
0
20
40
60
80
100
120
140
160
180
200
Borehole length (m)

Appendix 6

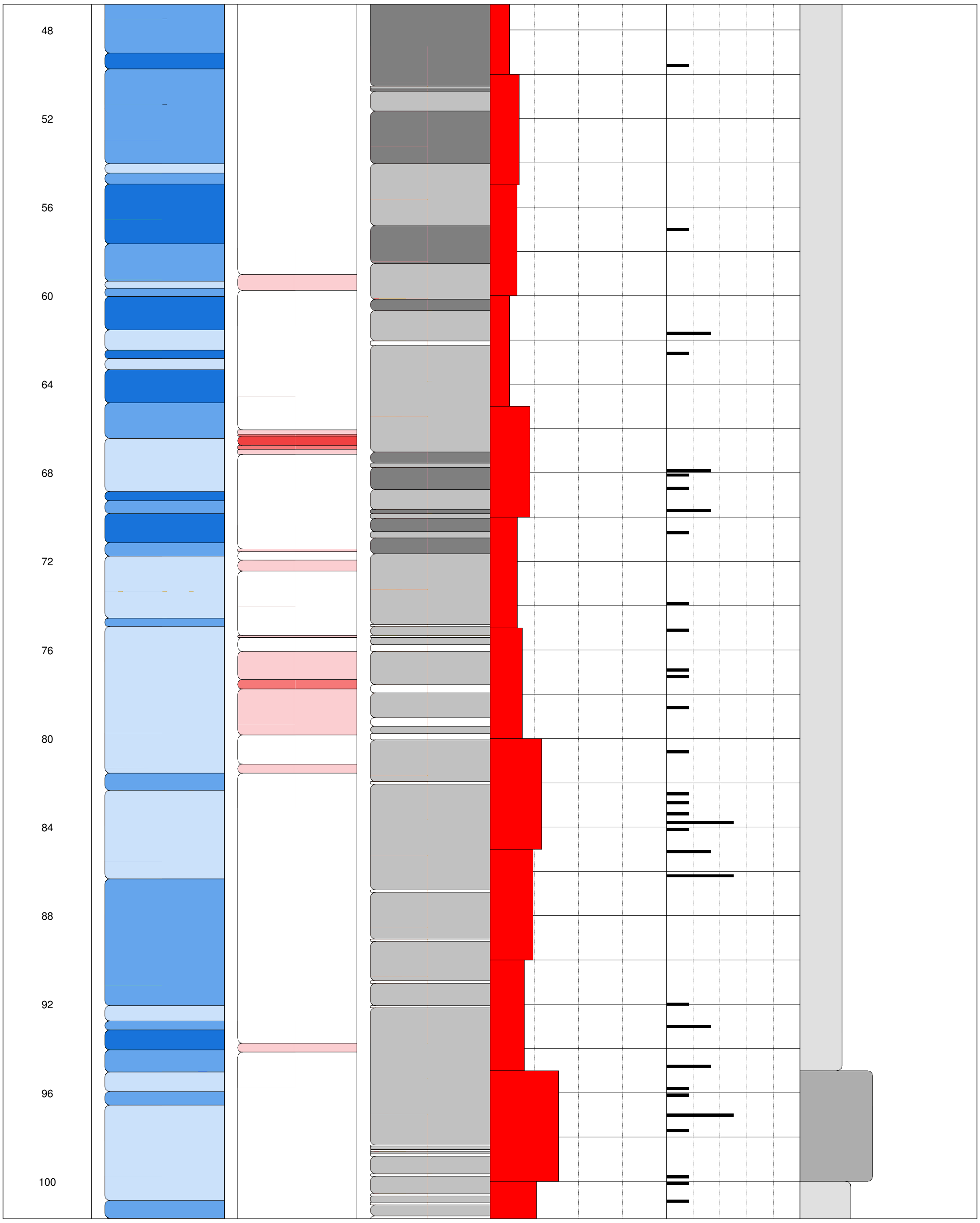
Generalized geophysical logs

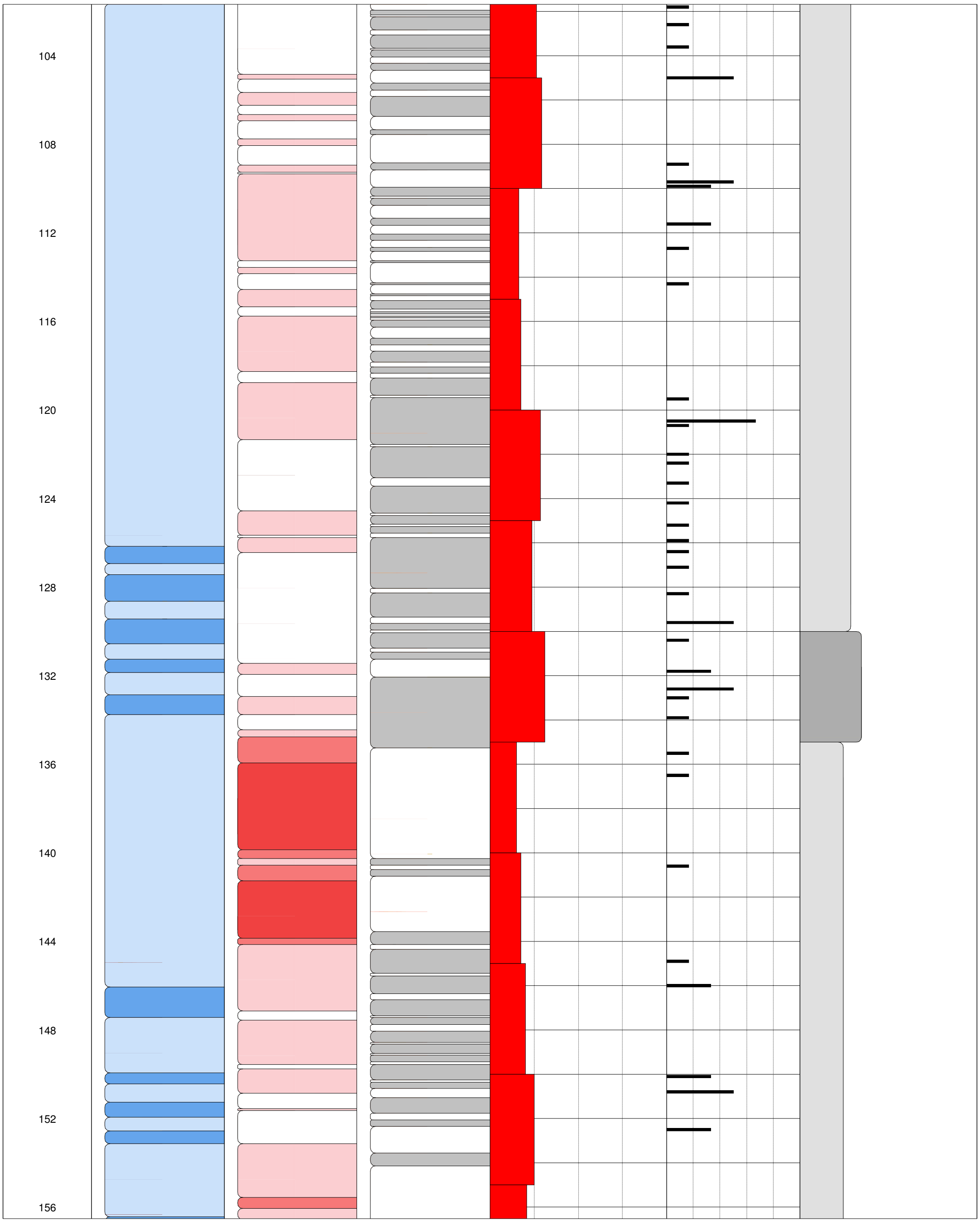


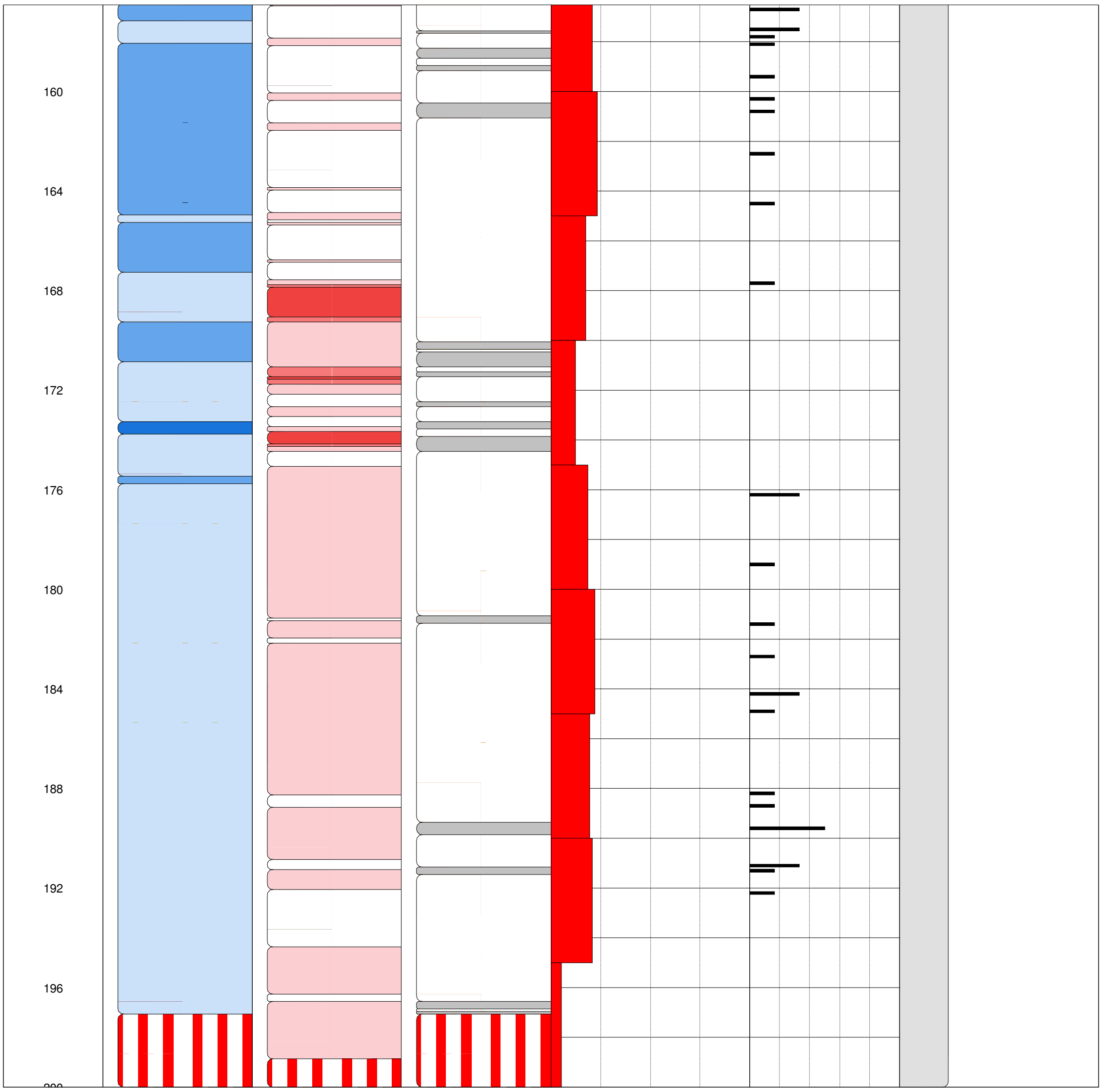
90
100
110
120
130



GeoVista
Interpretation of geophysical borehole logging data
Borehole HFM34
Silicate Density
kg/m3
unclassified
dens<2680 (Granite)
2680<dens<2730 (Granodiorite
2730<dens<2800 (Tonalite)
2800<dens<2890 (Diorite)
Natural Gamma Radiation
microR/h
unclassified
gam<20
20<gam<36
36<gam<53
53<gam
Magnetic Susceptibility
SI
unclassified
sus<0.001
0.001<sus<0.01
0.01<sus<0.1
Estimated Fracture Frequency
fractures/m
< 3 fr/m
3< fr/m <6
Silicate number of rows
103
Nat Gamma number of rows
125
Mag Sus number of rows
222
Est Frac Freq number of rows
7
Depth
1m:200m
Generalized Loggings
Fracture Loggings
Silicate Density
Natural Gamma Radiation
Magnetic Susceptibility
Estimated fracture frequency (fractures/m)
0
10
Inferred fractures
0 = no method
1 = all methods
0
1
Integration of estimated fracture frequency
16
20
24
28
32
36
40
44


48
52
56
60
64
68
72
76
80
84
88
92
96
100


104
108
112
116
120
124
128
132
136
140
144
148
152
156

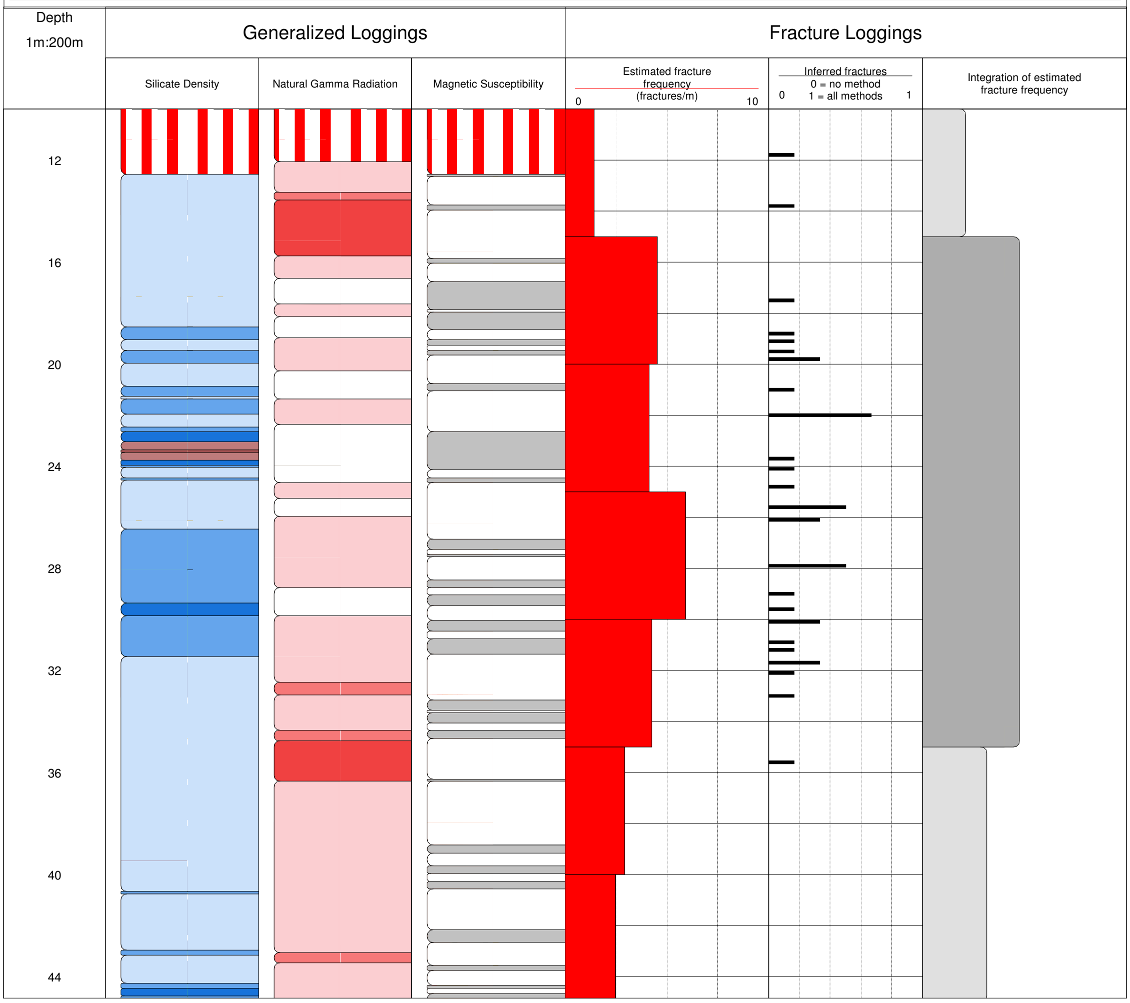

160
164
168
172
176
180
184
188
192
196

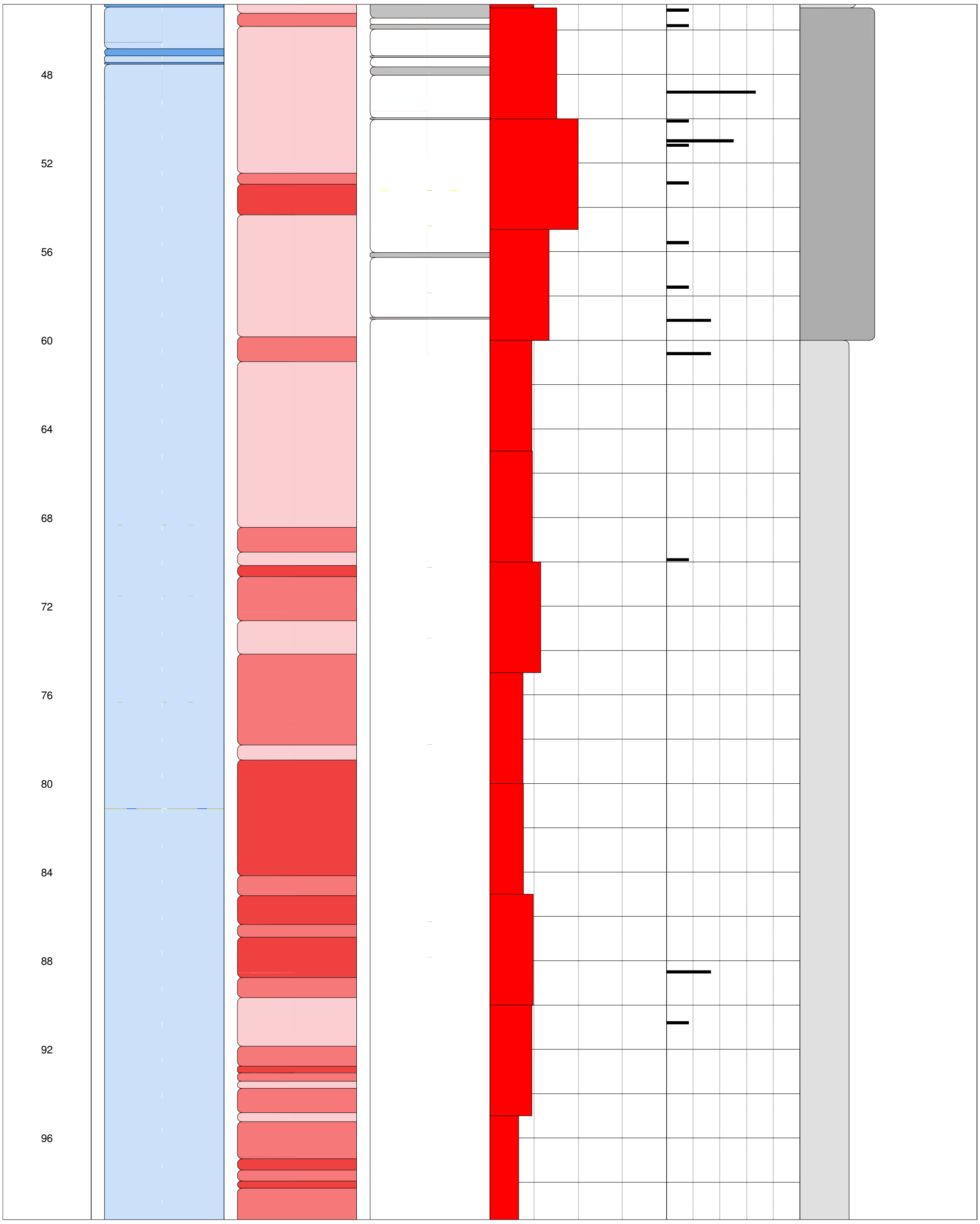
Interpretation of geophysical borehole logging data

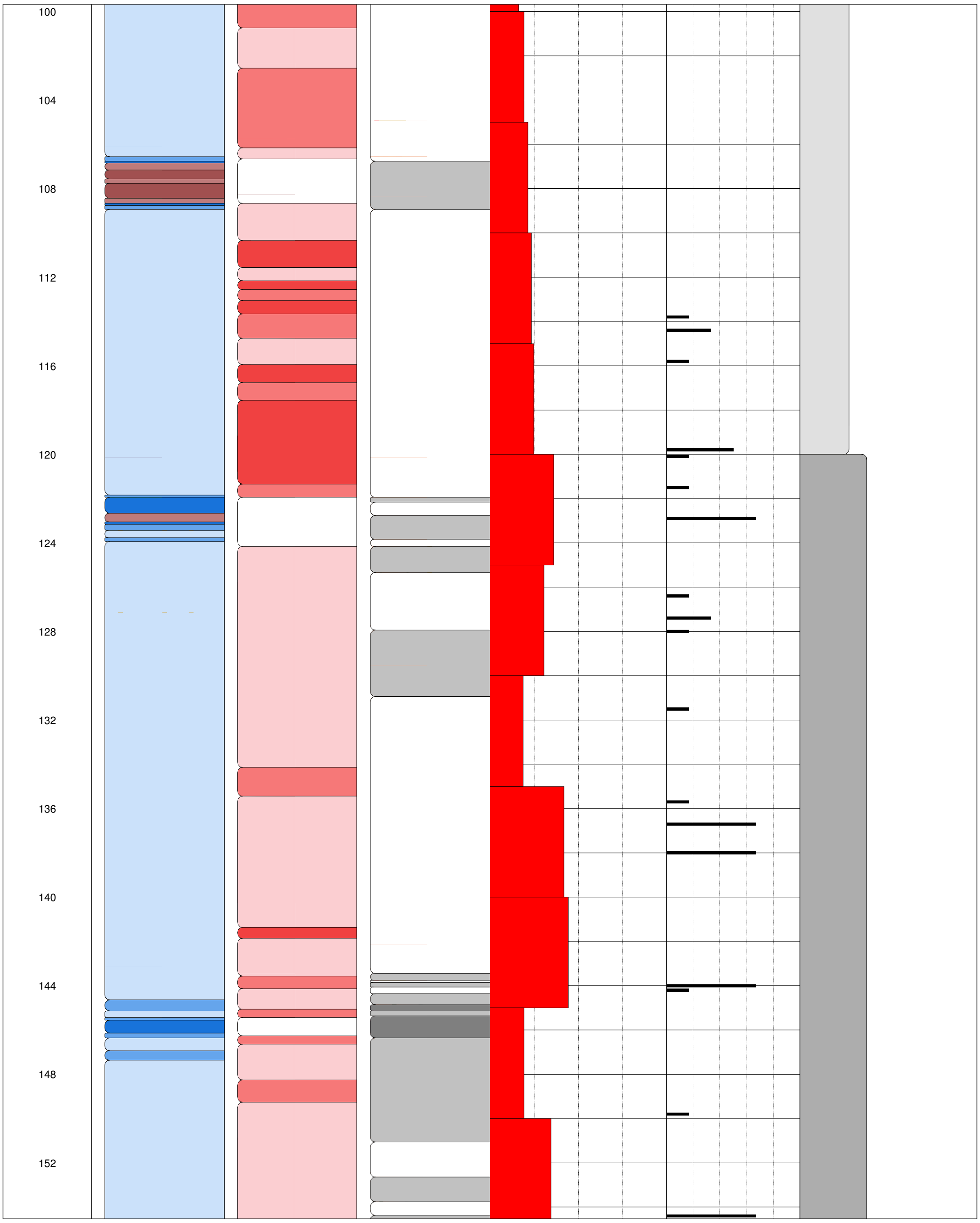
Borehole HFM35

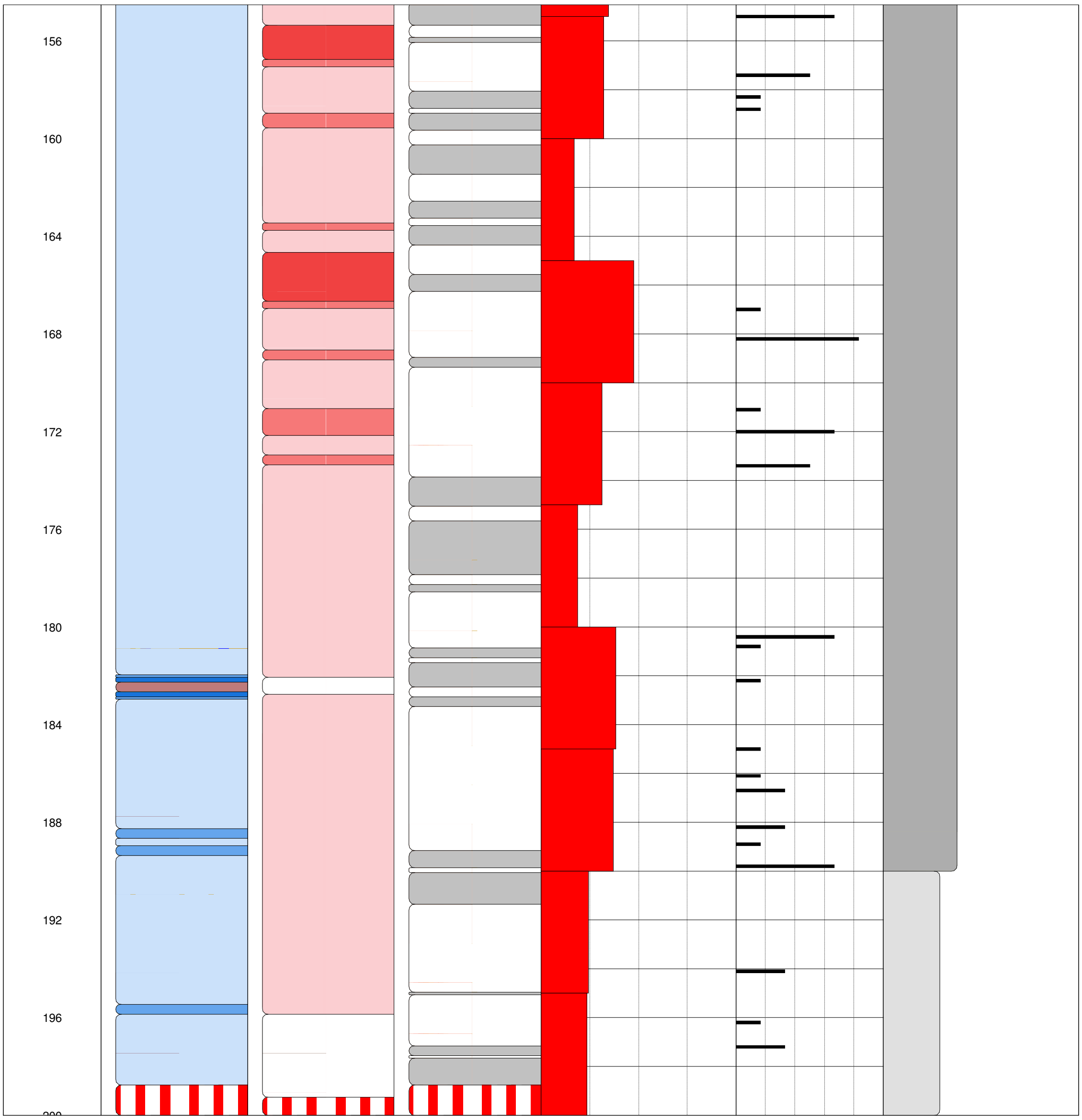
Silicate Density kg/m3	Natural Gamma Radiation microR/h	Magnetic Susceptibility SI	Estimated Fracture Frequency fractures/m
unclassified	unclassified	unclassified	< 3 fr/m
dens<2680 (Granite)	gam<20	sus<0.001	3< fr/m <6
2680<dens<2730 (Granodiorite	20<gam<36	0.001<sus<0.01	
2730<dens<2800 (Tonalite)	36<gam<53	0.01<sus<0.1	
2800<dens<2890 (Diorite)	53<gam		
dens>2890 (Gabbro)			

Silicate number of rows	Nat Gamma number of rows	Mag Sus number of rows	Est Frac Freq number of rows
75	106	129	7



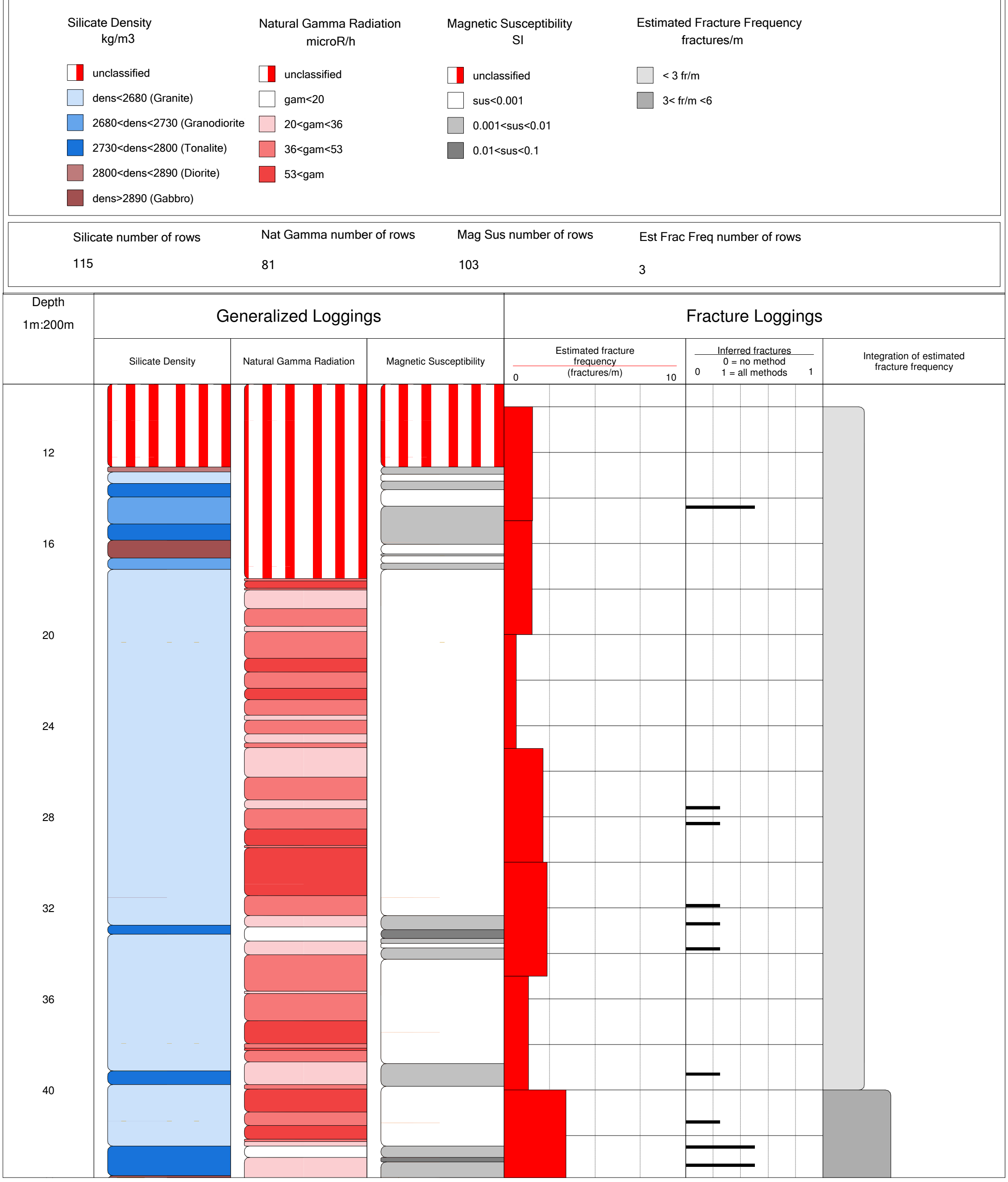

48
52
56
60
64
68
72
76
80
84
88
92
96

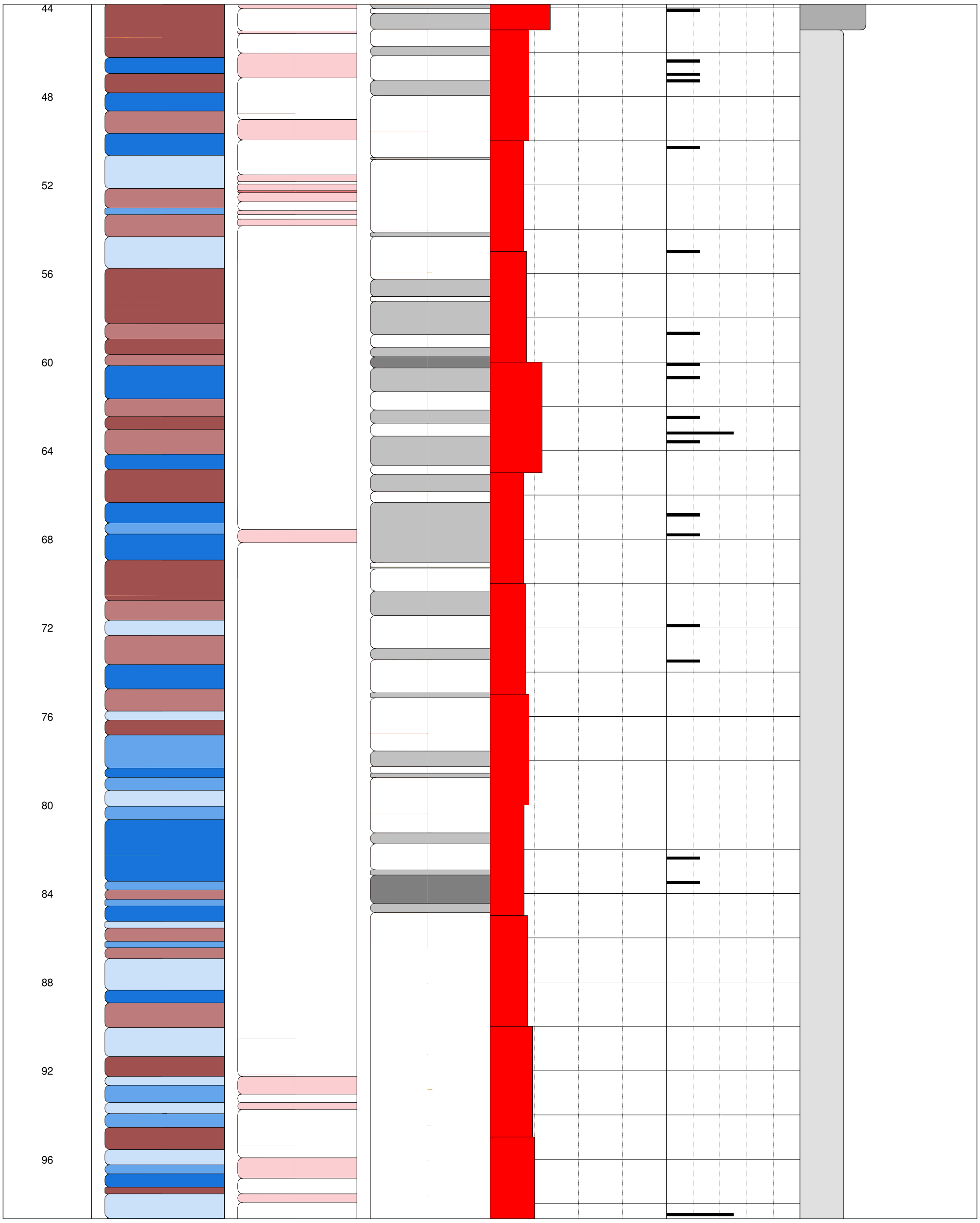

100
104
108
112
116
120
124
128
132
136
140
144
148
152

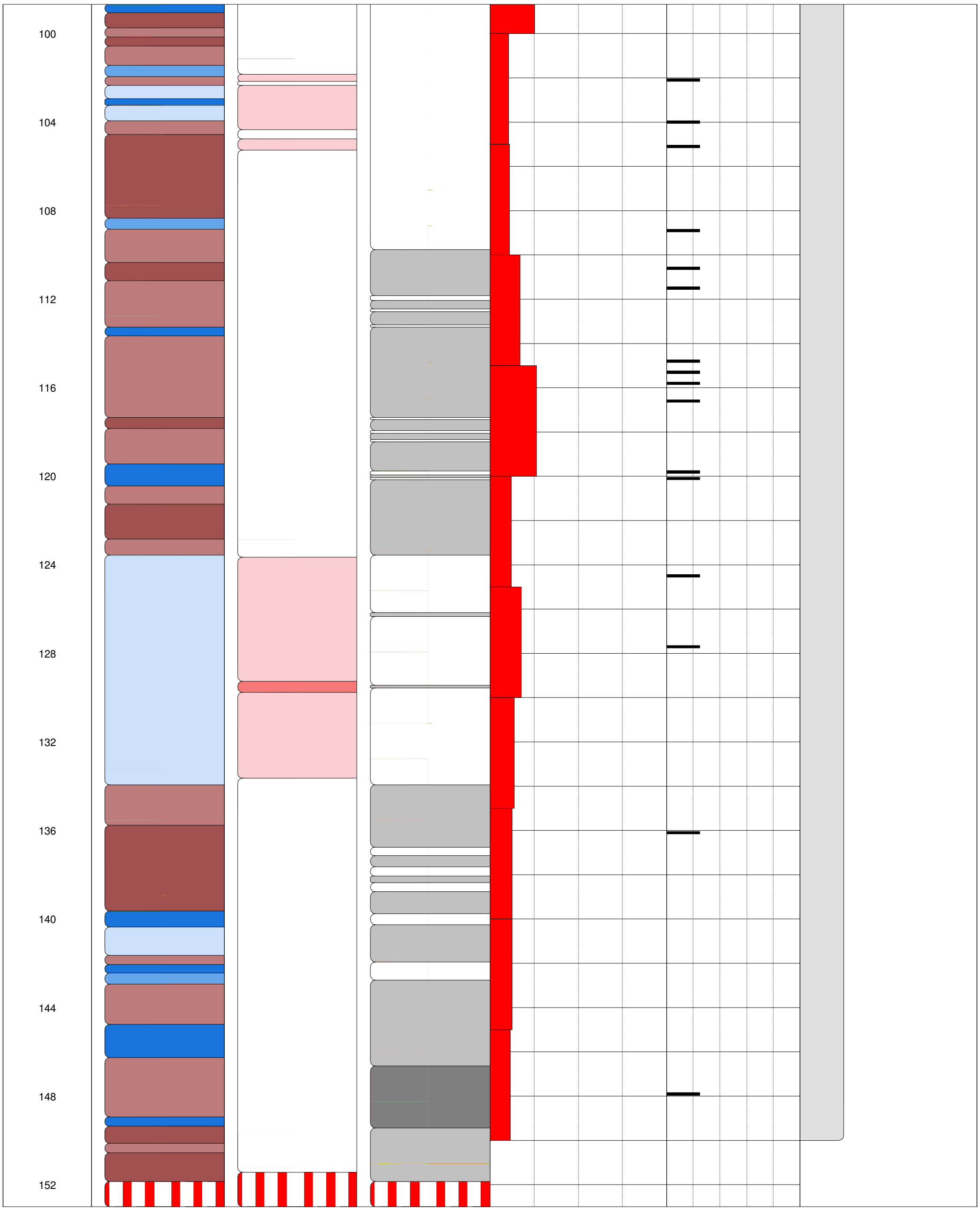

156
160
164
168
172
176
180
184
188
192
196

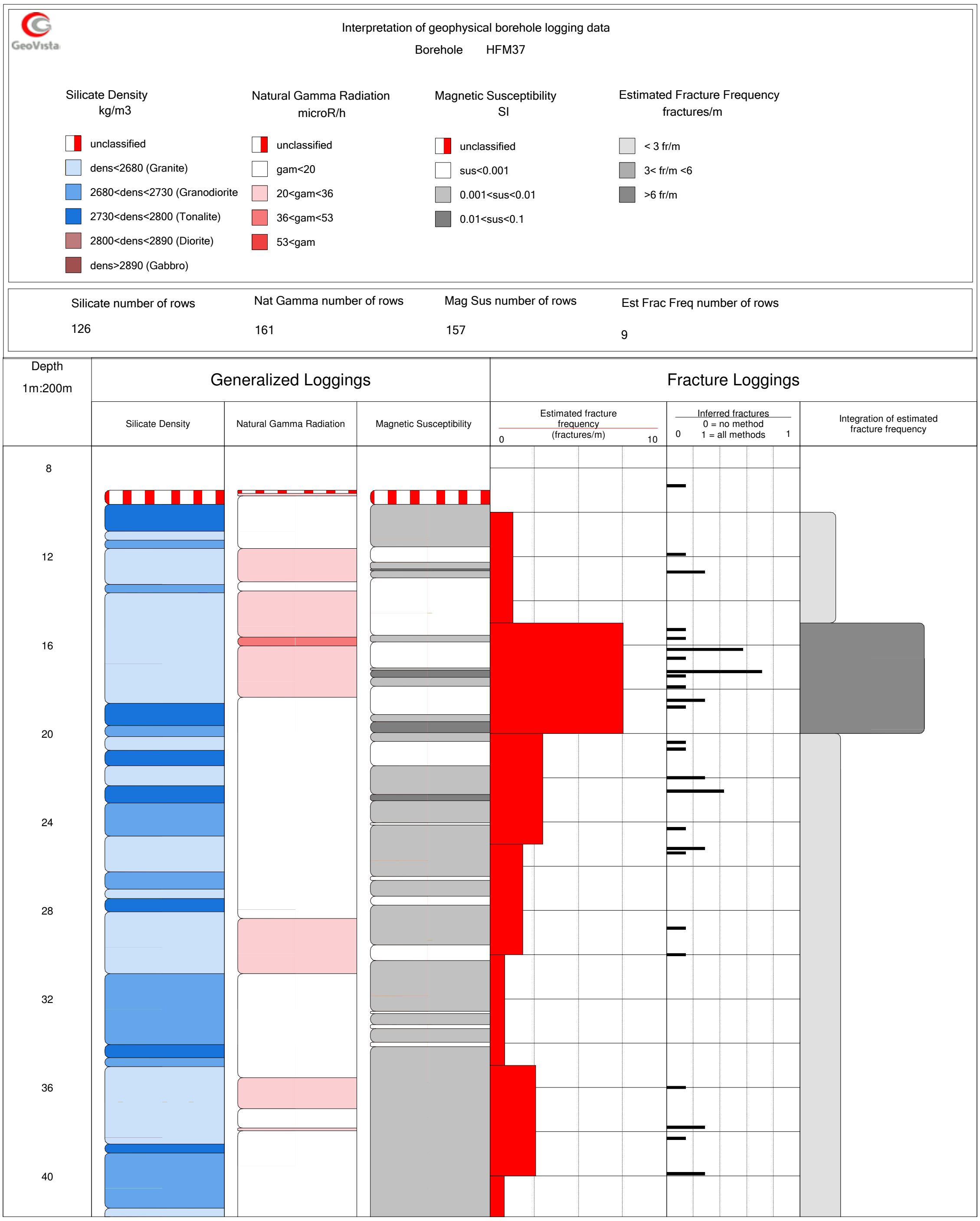
Interpretation of geophysical borehole logging data

Borehole HFM36

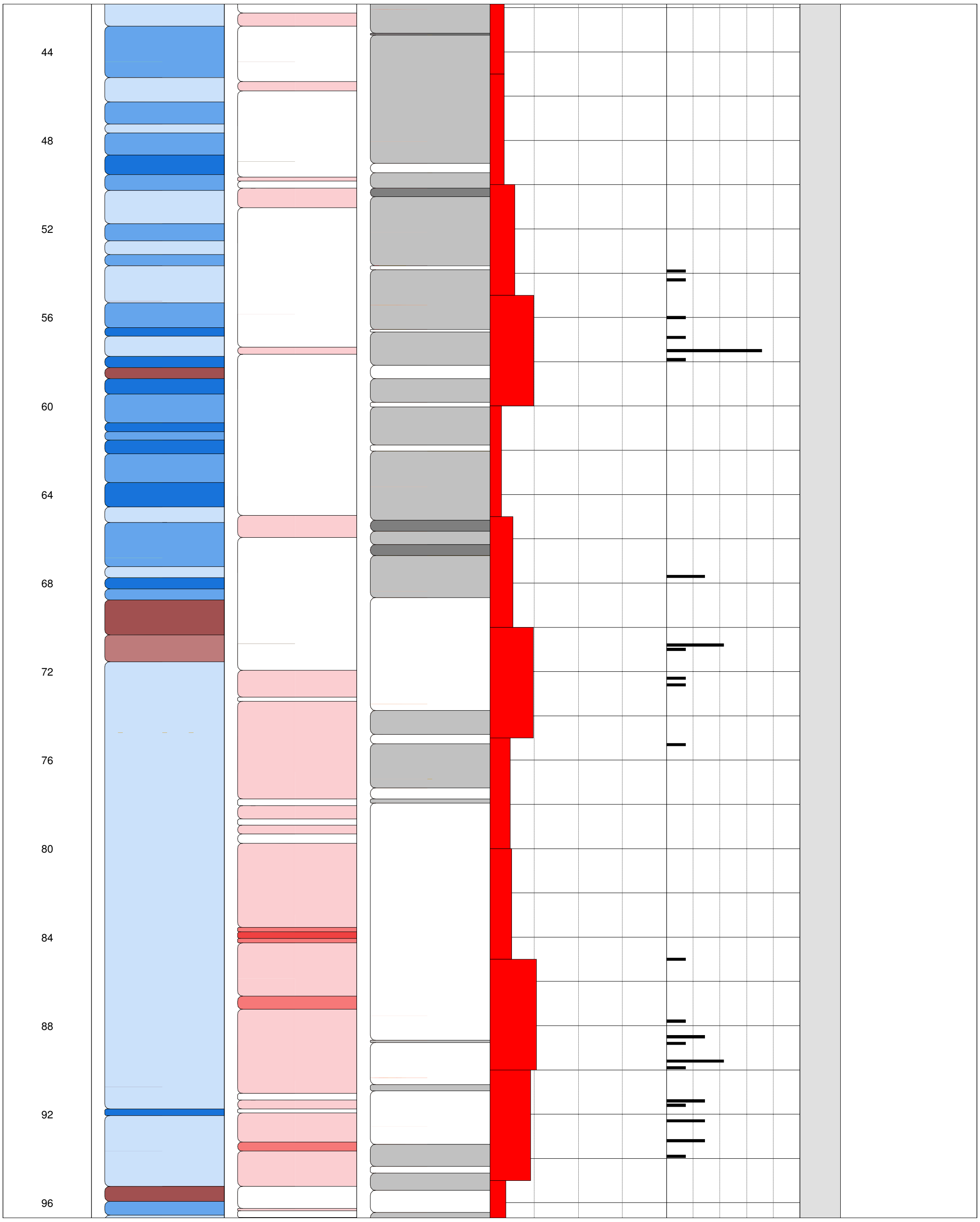


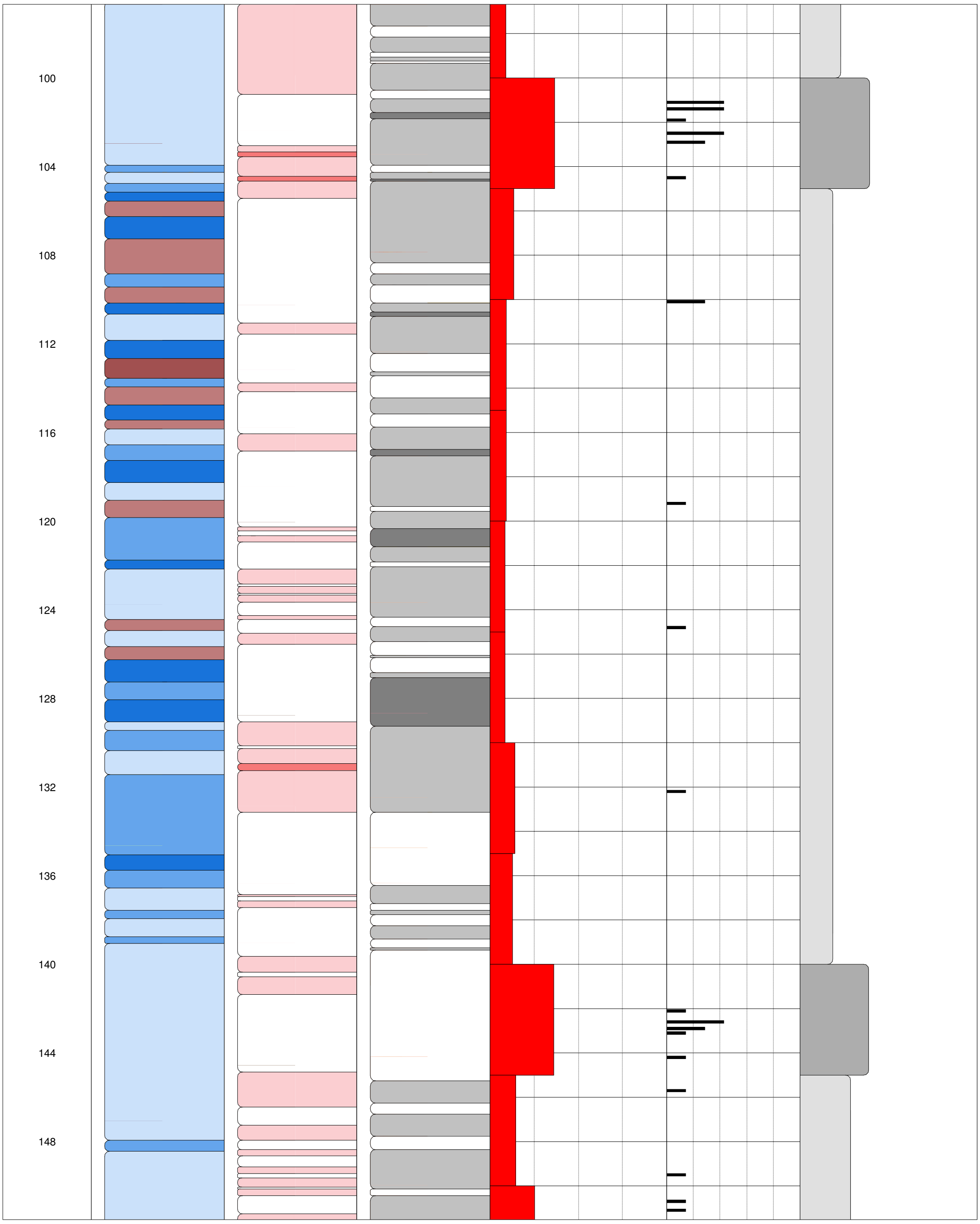

44
48
52
56
60
64
68
72
76
80
84
88
92
96

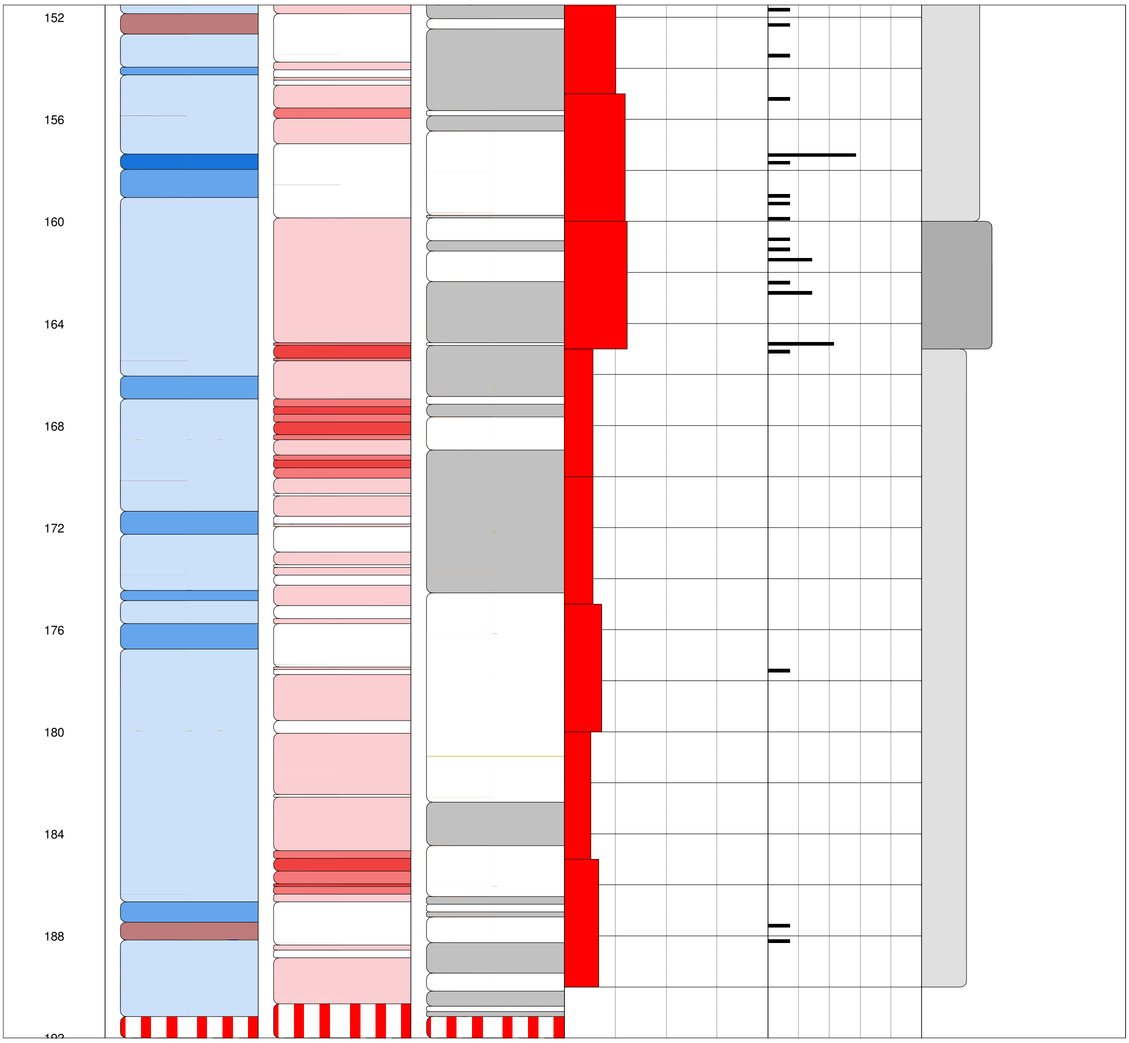

100
104
108
112
116
120
124
128
132
136
140
144
148
152



Interpretation of geophysical borehole logging data
Borehole HFM37
Silicate Density kg/m3
unclassified
dens<2680 (Granite)
2680<dens<2730 (Granodiorite
2730<dens<2800 (Tonalite)
2800<dens<2890 (Diorite)
dens>2890 (Gabbro)
Natural Gamma Radiation microR/h
unclassified
gam<20
20<gam<36
36<gam<53
53<gam
Magnetic Susceptibility SI
unclassified
sus<0.001
0.001<sus<0.01
0.01<sus<0.1
Estimated Fracture Frequency fractures/m
< 3 fr/m
3< fr/m <6
>6 fr/m
Silicate number of rows 126
Nat Gamma number of rows 161
Mag Sus number of rows 157
Est Frac Freq number of rows 9
Depth 1m:200m
Generalized Loggings
Fracture Loggings
Silicate Density
Natural Gamma Radiation
Magnetic Susceptibility
Estimated fracture frequency (fractures/m)
0
10
Inferred fractures
0 = no method
1 = all methods
0
1
Integration of estimated fracture frequency
8
12
16
20
24
28
32
36
40


44
48
52
56
60
64
68
72
76
80
84
88
92
96


100
104
108
112
116
120
124
128
132
136
140
144
148



152
156
160
164
168
172
176
180
184
188