P-07-78

Forsmark site investigation

Interpretation of geophysical borehole measurements from KFM07C, HFM36 and HFM37

Håkan Mattsson, Mikael Keisu
GeoVista AB

April 2007

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

ISSN 1651-4416
SKB P-07-78

Forsmark site investigation

Interpretation of geophysical borehole measurements from KFM07C, HFM36 and HFM37

Håkan Mattsson, Mikael Keisu
GeoVista AB

April 2007

Keywords: Borehole, Logging, Geophysics, Geology, Bedrock, Fractures, Forsmark, AP PF 400-06-104.

Abstract

This report presents the compilation and interpretations of geophysical logging data from the cored borehole KFM07C and the percussion drilled boreholes HFM36 and HFM37.

The main objective of the investigation is to use the results as supportive information during the geological core mapping and as supportive information during the geological single-hole interpretation.

The rocks in the vicinity of KFM07C are completely dominated by silicate density < 2,680 kg/m^3. Sections with silicate density < 2,680 kg/m^3 generally have natural gamma radiation in the interval 20–30 µR/h and magnetic susceptibility in the range 0.005–0.015 SI, and this combination of physical properties most likely indicate a dominant occurrence of metagranite.

The estimated fracture frequency is generally low along the entire borehole length. Only one significant possible deformation zone is identified in KFM07C. The zone occurs in the section c 347–387 m, and it is characterized by decreased bulk resistivity, magnetic susceptibility, several caliper anomalies and partly decrease P-wave velocity. The vertical temperature gradient shows a major anomaly centered at c 157 m. The anomaly coincides with significantly decreased resistivity and P-wave velocity, and this combination of properties strongly indicates the presence of a water bearing fracture at this location in the borehole.

The rocks in the vicinity of HFM36 show large variations in physical properties. The major part of HFM36 is characterized by increased density (with large variations) and decreased natural gamma radiation. However, in the sections c 17–42 m and 124–134 m the silicate density is < 2,680 kg/m^3. The estimated fracture frequency presented indicates very low fracturing along the entire borehole. However, since no data were collected with the normal resistivity logs or the SPR log the fracture estimation is most likely underestimated.

Based on the silicate density log HFM37 can be divided into four parts. The sections c 10–71 m and 103–136 m are mainly characterized by silicate density in the range 2,680–2,800 kg/m^3, magnetic susceptibility of c 0.003–0.010 SI and natural gamma radiation < 20 µR/h. The combination of physical properties indicates rock with mineral composition corresponding to that of granodiorite or tonalite. The remaining two parts of the borehole, sections c 71–103 m and 136–191 m mainly have silicate density < 2,680 kg/m^3, magnetic susceptibility < 0.001 SI and natural gamma radiation of 20–36 µR/h, which suggests the occurrences of granite rock.

The fracture frequency estimated for HFM37 is mainly low, and only partly moderate in the lower half of the borehole. A possible minor deformation zone is indicated in the section c 15–18 m. The section is characterized by significantly decreased resistivity and distinct caliper anomalies, which suggests brittle fracturing.

Sammanfattning

Föreliggande rapport presenterar en sammanställning och tolkning av geofysiska borrhålsmätningar från kärnborrhålet KFM07C samt hammarborrhålen HFM36 och HFM37.

Syftet med denna undersökning är framförallt att ta fram ett material som på ett förenklat sätt åskådliggör resultaten av de geofysiska loggningarna, s k generaliserade geofysiska loggar. Materialet används dels som stödjande data vid borrkärnekarteringen samt som underlag vid den geologiska enhålstolkningen.

Berggrunden i närheten av KFM07C domineras helt av bergarter med silikatdensitet < 2 680 kg/m^3. Dessa partier har generellt naturlig gammastrålning i intervallet 20–30 μR/h och magnetisk susceptibilitet på 0,005–0,015 SI. Kombination av fysikaliska egenskaper indikerar förekomst av s k metagranit.

Den beräknade sprickfrekvensen i KFM07C är generellt låg och endast en större möjlig deformationszon kan identifieras. Den förekommer i intervallet ca 347–387 m och karaktäriseras av sänkt bulkresistivitet, magnetisk susceptibilitet, ett flertal caliper-anomalier samt delvis nedsatt P-vågshastighet. Den vertikala temperaturgradientloggen uppvisar en kraftig anomali vid ca 157 m som sammanfaller med sänkt resistivitet och en caliperanomali. Sammantaget indikerar data förekomst av en vattenförande spricka i denna del av borrhålet.

Berget i närheten av HFM36 uppvisar kraftiga variationer i fysikaliska egenskaper. En stor del av HFM36 karaktäriseras av förhöjd densitet (med stora variationer) och sänkt naturlig gammastrålning. Längs sektionerna ca 17–42 m och 124–134 m är dock silikatdensiteten < 2 680 kg/m^3. Sprickfrekvensen som uppskattats för HFM36 är generellt mycket låg, men avsaknaden av data från de två normala resistivitetsloggarna, samt även från SPR-loggen, medför troligen att den beräknade sprickfrekvensen är något underskattad.

Baserat på silikatdensitetloggen kan HFM37 delas in i fyra delar. Sektionerna ca 10–71 m och 103–136 m karaktäriseras av silikatdensitet i intervallet 2 680–2 800 kg/m^3, magnetisk susceptibilitet av 0,003–0,010 SI och naturlig gammastrålning < 20 μR/h. Kombinationen av fysikaliska egenskaper indikerar förekomst av bergarter med mineralsammansättning motsvarande den för granodiorit eller tonalit. Övriga delar av borrhålet domineras av silikatdensitet < 2 680 kg/m^3, magnetisk susceptibilitet < 0,001 SI och naturlig gammastrålning i intervallet 20–36 μR/h, vilket indikerar förekomst av granitiska bergarter. Sprickfrekvensen uppskattad för HFM37 är generellt låg men bitvis förhöjd i borrhålets nedre halva. En möjlig mindre deformationszon kan identifieras längs sektionen ca 15–18 m. Sektionen karaktäriseras av kraftigt sänkt resistivitet och distinkta caliper-anomalier, vilket indikerar spröd deformation.

Contents

1 Introduction

SKB performs site investigations for localization of a deep repository for high level radioactive waste. The site investigations are performed at two sites, Forsmark and Simpevarp/Laxemar. This document reports the results gained from the interpretation of geophysical borehole logging data from the cored borehole KFM07C and the percussion drilled boreholes HFM36 and HFM37 in Forsmark (Figure 1-1).

Generalized geophysical loggings related to lithological variations are presented together with indicated fracture loggings, including estimated fracture frequency. Calculations of the estimated salinity and apparent porosity are also presented for the boreholes. The logging measurements were conducted in 2006 by Rambøll /1/.

The interpretation presented in this report is performed by GeoVista AB in accordance with the instructions and guidelines from SKB (Table 1-1).

Original data from the reported activity are stored in the primary database Sicada. Data are traceable in Sicada by the activity plan number. Only data in 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 revisions entail a revision of the P-report. Minor revisions are normally presented as supplements, available at *www.skb.se*.

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

Activity plan	Number	Version
Tolkning av geofysiska borrhålsdata från KFM07C, HFM36 och HFM37.	AP PF 400-06-104	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för tolkning av geofysiska borrhålsdata	SKB MD 221.003	3.0

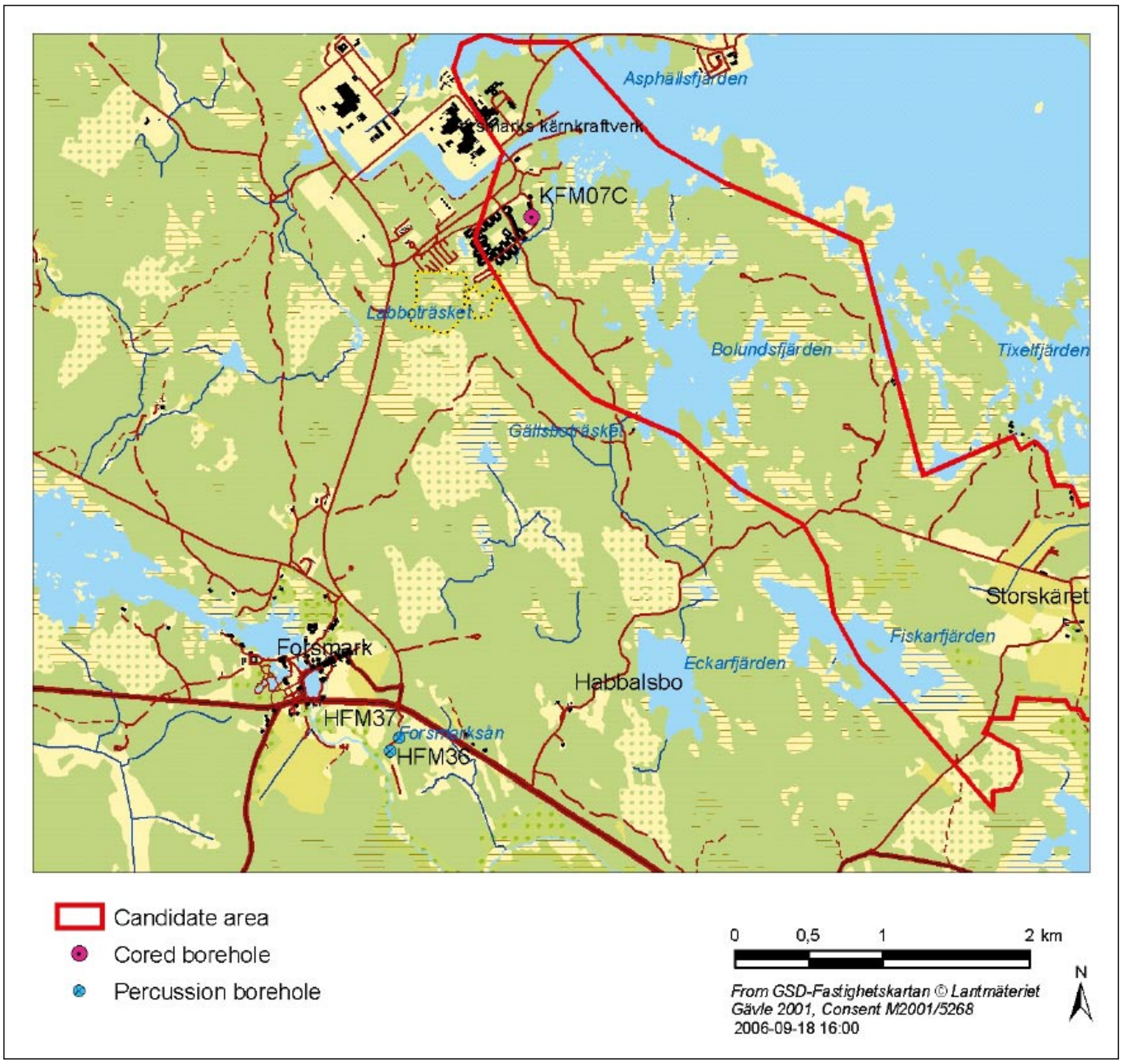


Figure 1-1. *Map showing the location of the investigated boreholes.*

2 Objective and scope

The purpose of geophysical measurements in boreholes is to gain knowledge of the physical properties of the bedrock in the vicinity of the borehole. A combined interpretation of the "lithological" logging data silicate density, magnetic susceptibility and natural gamma radiation, together with petrophysical data makes it possible to estimate the physical signature of different rock types. The three loggings are generalized and are then presented in a simplified way. The location of major fractures and an estimation of the fracture frequency along the borehole are calculated by interpreting data from the resistivity loggings, the single point resistance (SPR), caliper and sonic loggings.

An estimation of the salinity and the apparent porosity are presented for the cored boreholes. These parameters indicate saline water and the transportation properties of the rock volume in the vicinity of the borehole.

The main objective of these investigations is to use the results as supportive information during the geological core mappings and as supportive information during the so called "single-hole interpretation", which is a combined borehole interpretation of core logging (Boremap) data, geophysical data and radar data.

3 Equipment

3.1 Description of equipment for analyses of logging data

The software used for the interpretation are WellCad v3.2 (ALT) and Strater 1.00.24 (Golden Software), that are mainly used for plotting, Grapher v5 (Golden Software), mainly used for plotting and some statistical analyses, and a number of in-house software developed by GeoVista AB on behalf of SKB.

4 Execution

4.1 Interpretation of the logging data

The execution of the interpretation can be summarized in the following five steps:

1. Preparations of the logging data (calculations of noise levels, median filtering, error estimations, re-sampling, drift correction, length adjustment).

The loggings are median or mean filtered (generally 5 point filters for the resistivity loggings and 3 point filters for other loggings) and re-sampled to common depth co-ordinates (0.1 m point distance).

The density logging data are calibrated with respect to petrophysical data from KLX20A /2/. The magnetic susceptibility logging data are calibrated with respect to a combination of petrophysical data from the boreholes KFM01A and KFM02A /3 and 4/.

2. Interpretation rock types (generalization of the silicate density, magnetic susceptibility and natural gamma radiation loggings).

The silicate density is calculated with reference to /5/ and the data are then divided into 5 sections *indicating* a mineral composition corresponding to granite, granodiorite, tonalite, diorite and gabbro rocks, according to /6/. The sections are bounded by the threshold values.

		granite	<	2,680 kg/m³
2,680 kg/m³	<	granodiorite	<	2,730 kg/m³
2,730 kg/m³	<	tonalite	<	2,800 kg/m³
2,800 kg/m³	<	diorite	<	2,890 kg/m³
2,890 kg/m³	<	gabbro		

The magnetic susceptibility logging is subdivided into steps of decades and the natural gamma radiation is divided into steps of “low” (< 20 µR/h), “medium” (20 µR/h < gamma < 36 µR/h), “high” (36 µR/h < gamma < 53 µR/h) and “very high” (> 53 µR/h).

3. For the cored boreholes the normal resistivity loggings are corrected for the influence of the borehole diameter and the borehole fluid resistivity. The apparent porosity is calculated during the correction of the resistivity loggings. The calculation is based on Archie’s law /7/; $\sigma = a\,\sigma_w^k\,\phi^m + \sigma_s$ where σ = bulk conductivity (S/m), σ_w = pore water conductivity (S/m), ϕ = volume fraction of pore space, σ_s = surface conductivity (S/m) and “a”, “k” and “m” are constants. Since “a”, “k” and “m” may vary with variations in the borehole fluid resistivity, estimations of the constants are performed with reference to the actual fluid resistivity in each borehole respectively.

The estimated water salinity is calculated as ppm NaCl in water following the simple relation from Crain’s Petrophysical Handbook where:

$$WS = \frac{400000}{(1.8t+32)^{0.88}\sqrt{\rho}}$$

WS = Water salinity (ppm NaCl), t = temperature (°C) and ρ = resistivity (Ωm).

The salinity is only calculated for cored boreholes.

4. Interpretation of the position of large fractures and estimated fracture frequency (classification to fracture logging and calculation of the estimated fracture frequency logging are based on analyses of the short and long normal resistivity, caliper mean, single point resistance (SPR), focused resistivity (140 and 300 cm) and sonic. The position of large fractures is estimated by applying a second derivative filter to the logging data and then locating maxima (or minima depending on the logging method) in the filtered logging. Maxima (or minima) above (below) a certain threshold value (Table 4-1) are selected as probable fractures. The result is presented as a column diagram where column height 0 = no fracture, column height 1 = fracture indicated by all logging methods.

The estimated fracture frequency is calculated by applying a power function to the weighted sum of the maxima (minima) derivative loggings. Parameters for the power functions were estimated by correlating the weighted sum to the mapped fracture frequency in the cored boreholes KFM01A and KFM02A. The linear coefficients (weights) used are presented in Table 4-1.

5. Report evaluating the results.

4.2 Preparations and data handling

The logging data were delivered as Microsoft Excel files via email from SKB. The data of each logging method were saved separately in ASCII-files. The data processing was performed on the ASCII-files. The data used for interpretation were:

- Density (gamma-gamma).
- Magnetic susceptibility.
- Natural gamma radiation.
- Focused resistivity (300 cm).
- Focused resistivity (140 cm).
- Sonic (P-wave).
- Caliper mean.
- SPR (Single Point Resistance).
- Short normal resistivity (16 inch).
- Long normal resistivity (64 inch).
- Fluid resistivity.
- Fluid temperature.

Table 4-1. Threshold values and weights used for estimating position of fractures and calculate estimated fracture frequency, respectively.

	Borehole	Sonic	Focused res. 140	Focused res. 300	Caliper	SPR	Normal res. 64	Normal res. 16	Lateral res.
Threshold	KFM07C	1.0	1.5	1.5	0.5	1.0	5.0	5.0	–
Weight	KFM07C	4.0	2.56	4.0	2.0	2.56	0.24	1.75	–
Threshold	HFM36	1.5	1.5	1.5	1.0	–	–	–	–
Weight	HFM36	4.0	2.56	4.0	2.0	–	–	–	–
Threshold	HFM37	1.0	1.5	1.5	1.0	1.5	4.0	4.0	–
Weight	HFM37	4.0	2.56	4.0	2.0	2.56	0.24	1.75	–

4.3 Analyses and interpretations

The analyses of the logging data are made with respect to identifying major variations in physical properties with depth as indicated by the silicate density, the natural gamma radiation and the magnetic susceptibility. Since these properties are related to the mineral composition of the rocks in the vicinity of the borehole they correspond to variations in lithology and in thermal properties.

The resistivity, sonic and caliper loggings are mainly used for identifying sections with increased fracturing and alteration. The interpretation products salinity and apparent porosity help identifying saline ground water and porous rocks.

4.4 Nonconformities

Apparent porosity calculations and corrections for the borehole diameter and fluid resistivity are not presented for the long normal resistivity loggings since the calculation show unrealistic values. No SPR, short or long normal resistivity data were delivered for HFM36.

5 Results

5.1 Quality controll of the logging data

Noise levels of the raw data for each logging method are presented in Table 5-1. For all boreholes the natural gamma radiation data have noise levels clearly above the recommended value of 0.3 μR/h. The density data are also above the recommended level for all three boreholes, especially note the very high noise level in HFM36 which most likely affects the interpretation of high frequency anomalies in this borehole. To reduce the influence of the noise, all logs were average filtered prior to the interpretation.

A qualitative inspection was performed on the loggings. The data were checked for spikes and/or other obvious incorrect data points. Erroneous data were replaced by null values (–999) by the contractor Rambøll prior to the delivery of the data, and all null values were disregarded in the interpretation.

5.2 Interpretation of the logging data

The presentation of interpretation products presented below includes:

- Classification of silicate density.
- Classification of natural gamma radiation.
- Classification of magnetic susceptibility.
- Position of inferred fractures (0 = no method, 1 = all methods).
- Estimated fracture frequency in 5 meter sections.
- Classification of estimated fracture frequency (0 to 3, 3 to 6 and > 6 fractures/m).

Table 5-1. Noise levels in the investigated geophysical logging data.

Logging method	KFM07C	HFM36	HFM37	Recommended max noise level
Density (kg/m^3)	11	24	14	3–5
Magnetic susceptibility (SI)	$1\cdot10^{-4}$	$0.7\cdot10^{-4}$	$2\cdot10^{-4}$	$1\cdot10^{-4}$
Natural gamma radiation (μR/h)	1.0	0.9	0.9	0.3
Long normal resistivity (%)	0.3	No data	2.7	2.0
Short normal resistivity (%)	0.1	No data	1.9	2.0
Fluid resistivity (%)	0.04	0.07	0.03	2
Fluid temperature (ºC)	$5\cdot10^{-4}$	$4\cdot10^{-4}$	$4\cdot10^{-4}$	0.01
Lateral resistivity (%)	Not used	Not used	Not used	2
Single point resistance (%)	0.3	No data	1.0	No data
Caliper (meter)	$2\cdot10^{-5}$	$3\cdot10^{-4}$	$2\cdot10^{-4}$	0.0005
Focused resistivity 300 (%)	9	17	18	No data
Focused resistivity 140 (%)	0.7	11	3	No data
Sonic (m/s)	12	28	28	20

5.2.1 Interpretation of KFM07C

The results of the generalized logging data and fracture estimations of KFM07C are presented in Figure 5-1, and in a more detailed scale in Appendix 1. The distribution of silicate density classes with borehole length is presented in Table 5-2.

The rocks in the vicinity of KFM07C are completely dominated by silicate density < 2,680 kg/m^3 (Figure 5-1 and Table 5-2). Sections with silicate density < 2,680 kg/m^3 generally have natural gamma radiation in the interval 20–30 μR/h and magnetic susceptibility in the range 0.005–0.015 SI, and this combination of physical properties most likely indicate a dominant occurrence of metagranite in the vicinity of KFM07C.

Short intervals, generally < 5 m long, with increased density of amplitude c 2,800–3,000 kg/m^3, occur in scattered places along the entire borehole. The most prominent high density anomalies are identified in the sections c 180–217 m and c 428–434 m. The majority of the positive density anomalies coincide with decreased natural gamma radiation and magnetic susceptibility, which suggests the occurrence of amphibolite. Many of the indicated amphibolite dykes occur close to positive natural gamma radiation anomalies related to pegmatite or fine-grained granite, which indicates that mafic and felsic dykes are often spatially related. In the interval c 213–217 m with increased density (2,730–2,830 kg/m^3) the natural gamma radiation is not decreased, which suggests the occurrence of granodiorite to tonalite rock.

The magnetic susceptibility is greatly decreased along short (< 1 m) intervals along large parts of KFM07C. These low magnetic anomalies are most likely related to occurrences of dykes (amphibolite, pegmatite or fine-grained granite) or occurrences of single large fractures. However, in the section c 330–357 m the decrease in magnetic susceptibility is most likely related to rock deformation combined with mineral alteration.

The estimated fracture frequency is generally low along the entire borehole length. Only one significant possible deformation zone is identified in KFM07C. The zone occurs in the section c 347–387 m, and it is characterized by decreased bulk resistivity, magnetic susceptibility, several caliper anomalies and partly decreased P-wave velocity.

In the section c 100–165 m there are several indicated occurrences of minor deformation zones (< 1 m wide), or single large fractures, mainly characterized by decreased resistivity.

The apparent porosity (black line in Figure 5-2) averages at c 0.6% which is considered normal for crystalline rock in this area. In the section c 100–165 m there is an increased occurrence of porosity anomalies related to the resistivity anomalies discussed in the previous paragraph. Along the possible deformation zone at c 347–387 m there is a clear increase in the apparent porosity.

The vertical temperature gradient, which helps identifying water bearing fractures, shows a major anomaly centered at c 157 m (blue line in Figure 5-2). The anomaly coincides with significant low resistivity anomalies and decreased P-wave velocity, and this combination of properties strongly indicates the presence of a water bearing fracture at this location in the borehole.

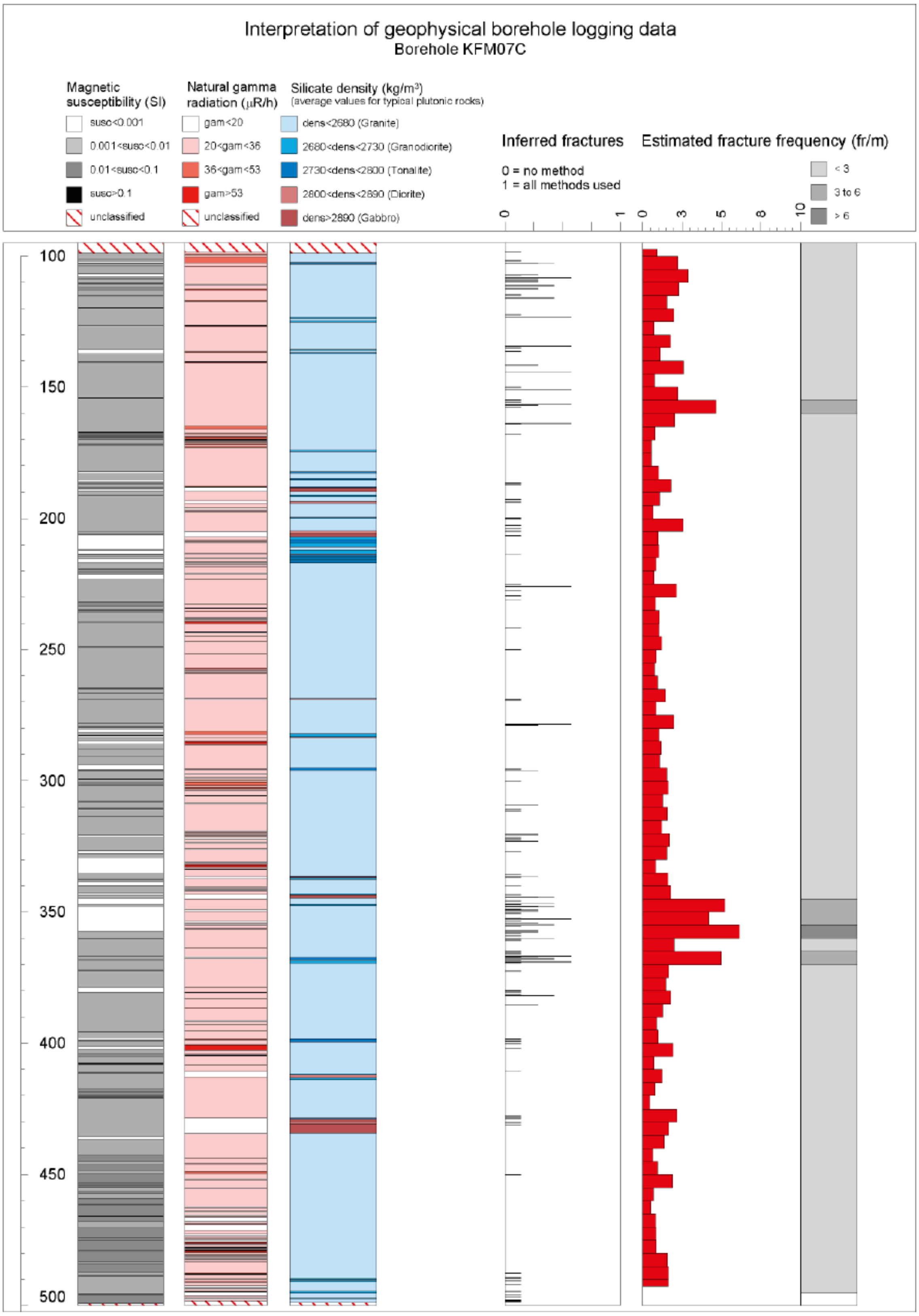


Figure 5-1. Generalized geophysical logs of KFM07C.

Table 5-2. Distribution of silicate density classes with borehole length in KFM07C.

Silicate density interval (kg/m^3)	Borehole length (m)	Relative borehole length (%)
dens < 2,680 (granite)	352	88
2,680 < dens < 2,730 (granodiorite)	25	6
2,730 < dens < 2,800 (tonalite)	10	3
2,800 < dens < 2,890 (diorite)	5	1
dens > 2,890 (gabbro)	8	2

There is also a significant temperature gradient anomaly centered at c 369 m within the suggested deformation, which indicates that there are water bearing fractures along parts of the deformation zone.

The estimated fluid water salinity (green line in Figure 5-2) shows only minor variations within the range 6,750–4,580 ppm NaCl. There are no significant salinity anomalies indicated in KFM07C.

5.2.2 Interpretation of HFM36

The results of the generalized logging data and fracture estimations of HFM36 are presented in Figure 5-3 below.

The rocks in the vicinity of HFM36 show large variations in physical properties. In the sections c 17–42 m and 124–134 m the silicate density is < 2,680 kg/m^3, which indicates rock with granitic mineral composition. In the upper section the natural gamma radiation is increased, 40–80 μR/h, and this most likely corresponds to fine-grained granite or possibly pegmatite. In the lower section the natural gamma radiation is mainly 20–30 μR/h, and this suggests the occurrence of "normal" granitic rock, e.g. metagranite.

The major part of HFM36 is characterized by increased density (with large variations) and decreased natural gamma radiation. Along the sections c 12–17m, 42–124 m and 134–152 m the density varies in the range c 2,750–3,200 kg/m^3 and the natural gamma radiation is mainly < 20 μR/h.

The magnetic susceptibility is generally decreased (< 0.001 SI) along the entire borehole. However, in the intervals c 57–85 m, 110–123 m and 134–149 m there is partly increased magnetic susceptibility. In the sections with increased density combined with increased susceptibility there are most likely occurrences of tonalite, diorite and gabbro rocks (or other rock types with a corresponding mineral composition). The high density sections with decreased magnetic susceptibility most likely correspond to amphibolites.

The estimated fracture frequency presented in Figure 5-3 indicates very low fracturing along the entire borehole. However, since no data were collected with the normal resistivity logs or the SPR log the fracture estimation is most likely underestimated.

Along the low density section c 17–42 m the resistivity is of the order 10^4 ohm-meter. Below 42 m there is a distinct decrease in resistivity, in average with one order in magnitude (10^3 ohm-meters). Since the resistivity decrease is correlated to the density increase there might be a connection to the variation in lithology. However, the resistivity decrease may also indicate mineral alteration or possibly increased fracturing.

At c 86–87 m there is a distinct decreased in fluid waters resistivity, which coincides with a negative resistivity anomaly and also a clear caliper anomaly. This combination of anomalies strongly suggests the occurrence of a water bearing fracture zone.

Significant caliper anomalies combined with decreased resistivity also occur at c 27–28 m, 50–52 m and 111–112 m.

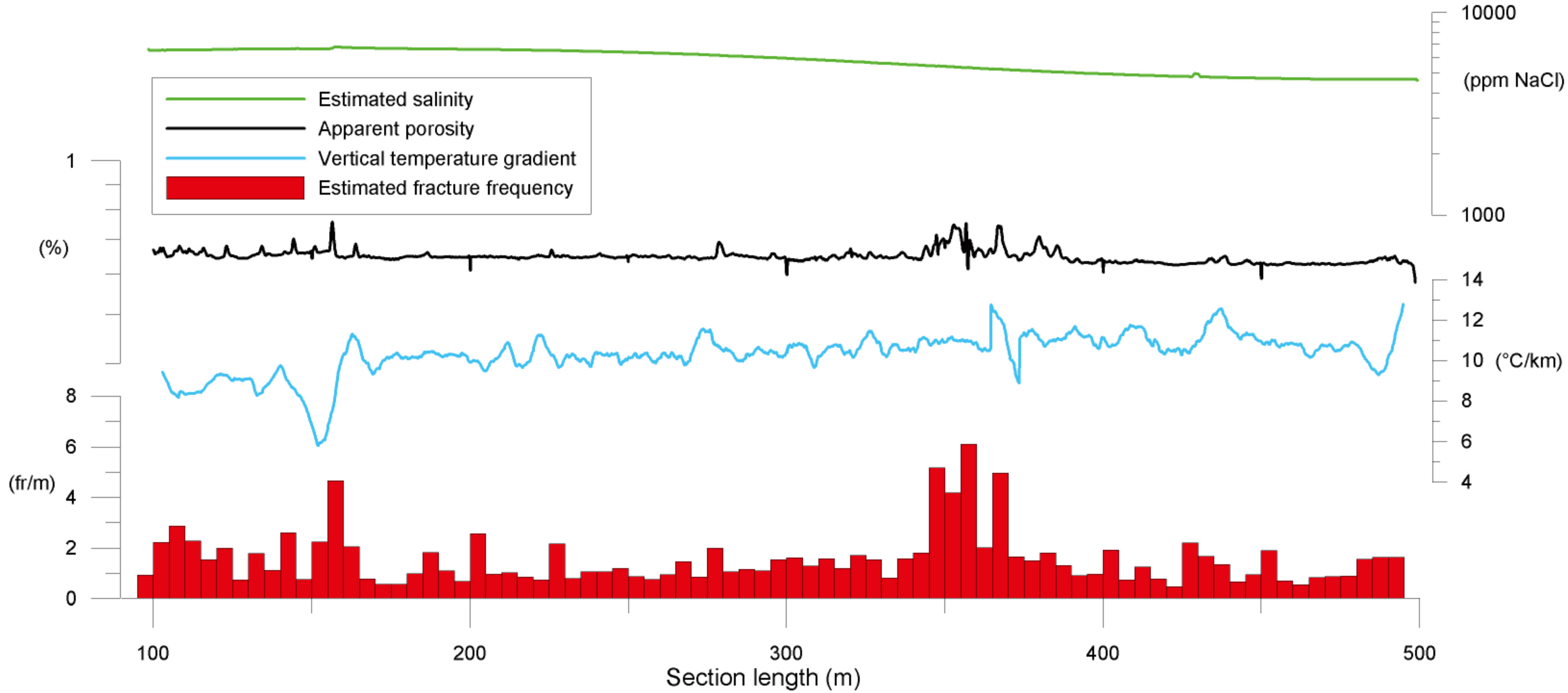


Figure 5-2. *Estimated salinity, apparent porosity, vertical temperature gradient and estimated fracture frequency of KFM07C.*

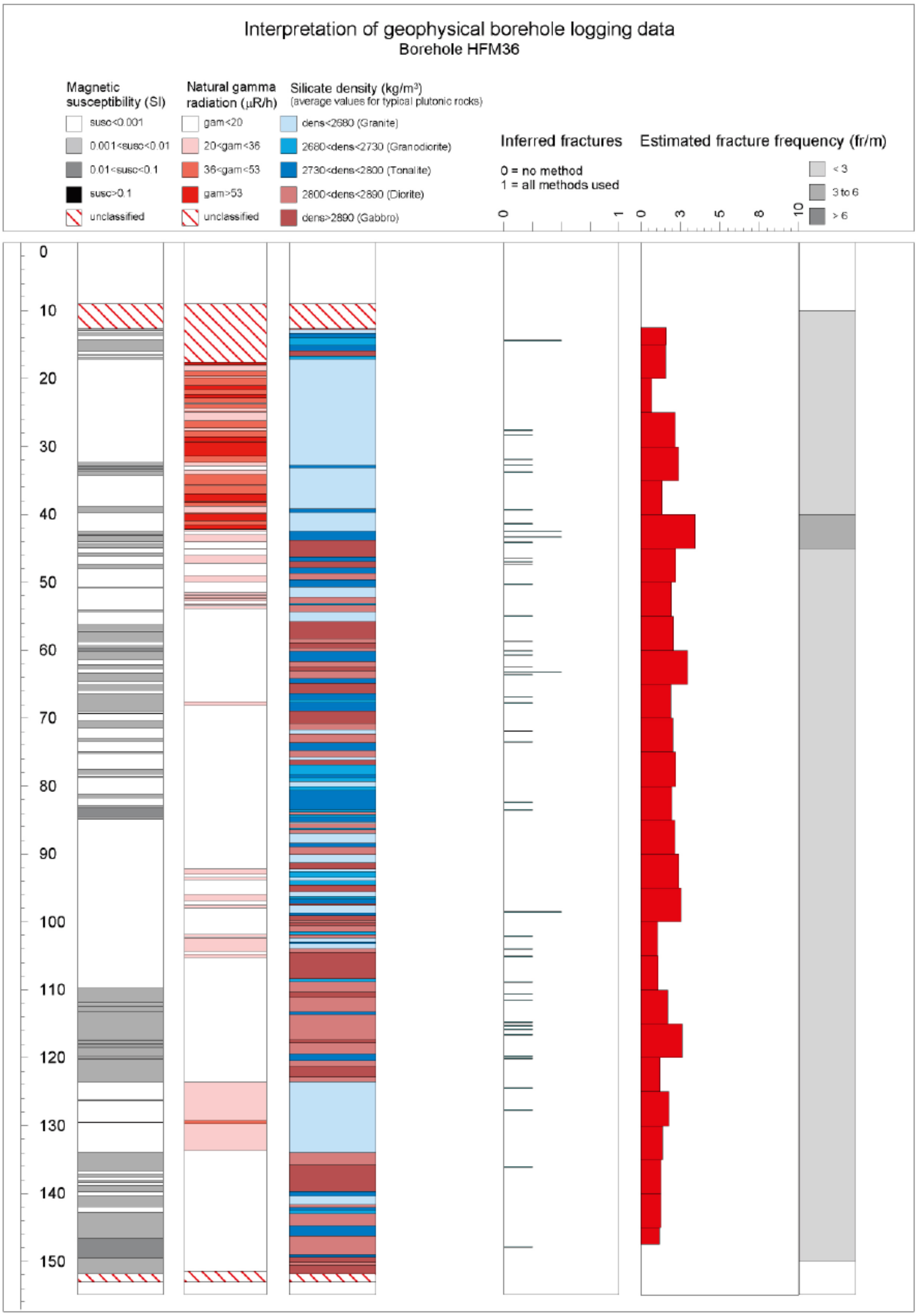


Figure 5-3. Generalized geophysical logs of HFM36.

5.2.3 Interpretation of HFM37

The results of the generalized logging data and fracture estimations of HFM37 are presented in Figure 5-4 below.

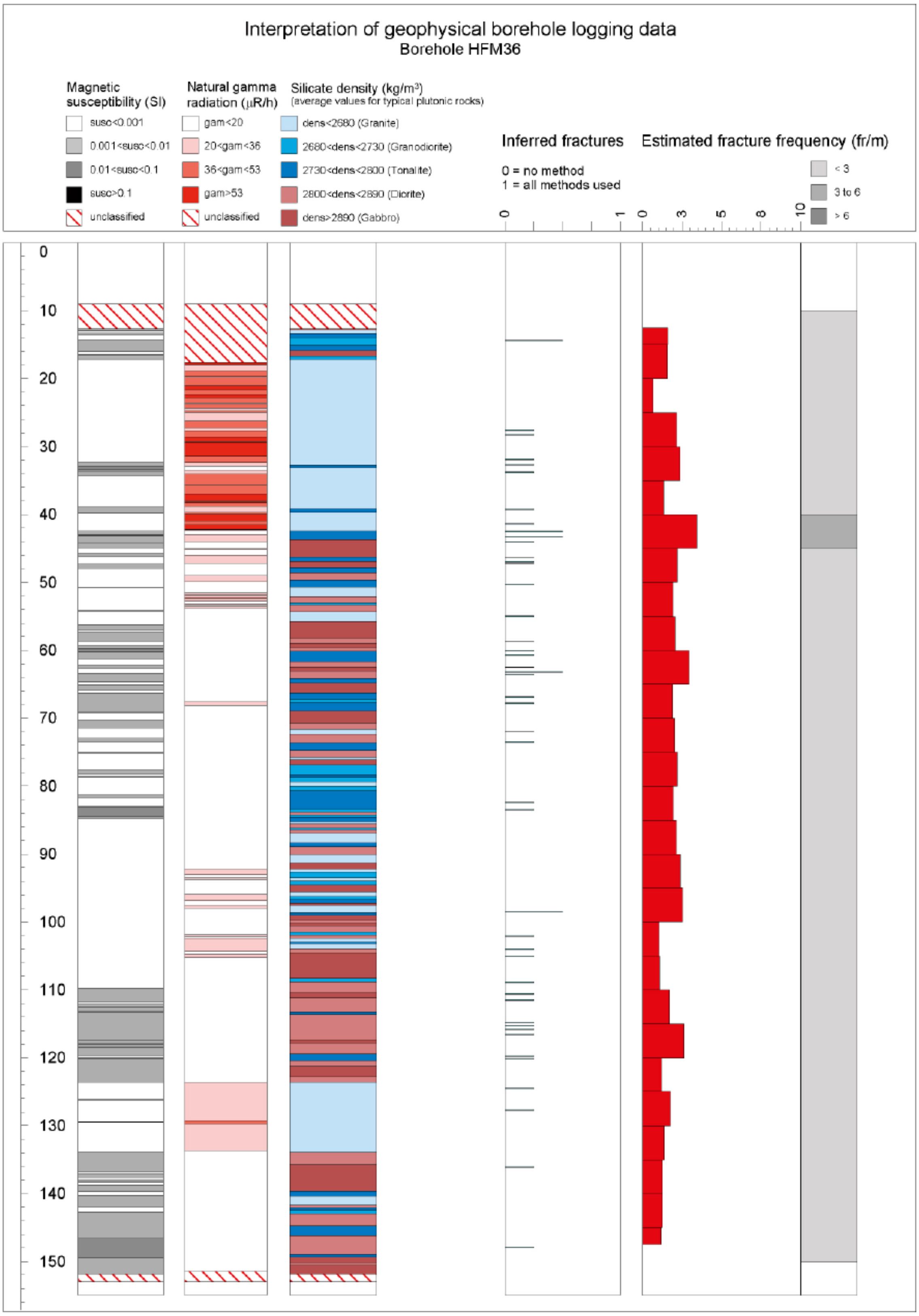


Figure 5-4. Generalized geophysical logs of HFM37.

Based on the silicate density log HFM37 can be divided into four parts. The sections c 10–71 m and 103–136 m are mainly characterized by silicate density in the range 2,680–2,800 kg/m^3, magnetic susceptibility of c 0.003–0.010 SI and natural gamma radiation < 20 μR/h. The combination of physical properties indicates rock with mineral composition corresponding to that of granodiorite or tonalite.

The remaining two parts of the borehole, sections c 71–103 m and 136–191 m mainly have silicate density < 2,680 kg/m^3, magnetic susceptibility < 0.001 SI and natural gamma radiation of 20–36 μR/h, which suggests the occurrences of granite rock.

Minor occurrences (< 1 m long sections) of amphibolite dykes and pegmatite and/or fine-grained granite dykes are indicated in scattered places along the entire borehole length.

The fracture frequency estimated for HFM37 is mainly low, and only partly moderate in the lower half of the borehole. A possible minor deformation zone is indicated in the section c 15–18 m. The section is characterized de significantly decreased resistivity and distinct caliper anomalies, which suggests brittle fracturing.

In the section c 67–104 m the bulk resistivity is decreased in combination with the occurrences of several negative sonic anomalies (slightly decreased P-wave velocity). The interval coincides with a section of decreased density (see the text above), and may indicate a section with mineral alteration in combination with partly decrease rock mechanical properties. The physical properties along the section c 140–165 m remind a great deal of those indicated in the section c 67–104 m.

References

/1/ **Nielsen U T, Ringgaard J, 2006.** Geophysical borehole logging in boreholes KFM07C, HFM36 and HFM37. SKB P-07-04, Svensk Kärnbränslehantering AB.

/2/ **Mattsson H, Keisu M, 2006.** Interpretation of geophysical borehole measurements from KLX18A, KLX20A, KLX09B, KLX09D, KLX09F, KLX11B, HLX38, HLX39, HLX40, HLX41 and interpretation of petrophysical data from KLX20A. SKB P-06-292, Svensk Kärnbränslehantering AB. In press.

/3/ **Mattsson H, Thunehed H, Keisu M, 2005.** Interpretation of borehole geophysical measurements in KFM01A, KFM01B, HFM01, HFM02 and HFM03. SKB P-04-80, Svensk Kärnbränslehantering AB.

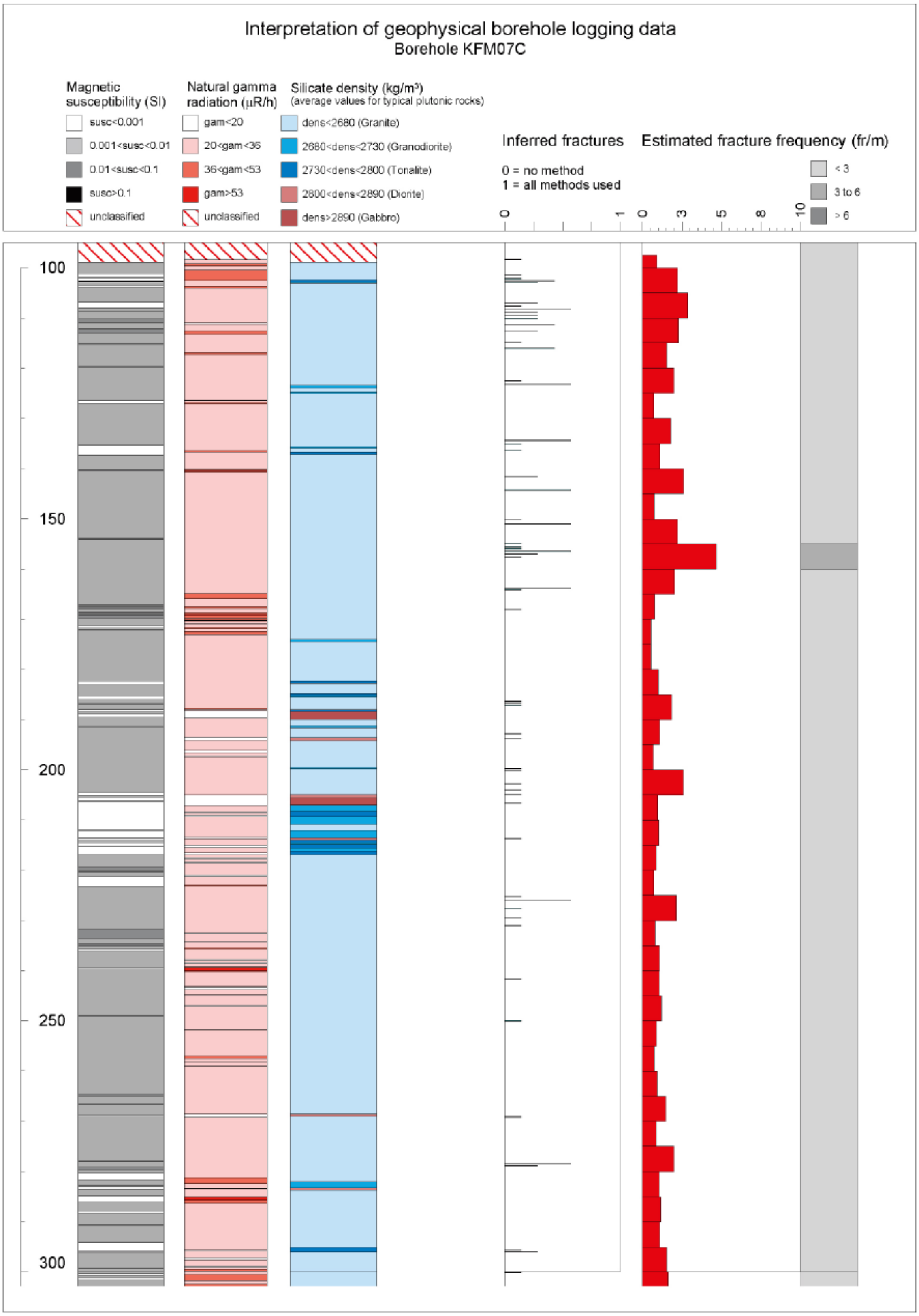
/4/ **Thunehed H, 2004.** Interpretation of borehole geophysical measurements in KFM02A, KFM03A, KFM03B and HFM04 to HFM08. SKB P-04-98, Svensk Kärnbränslehantering AB.

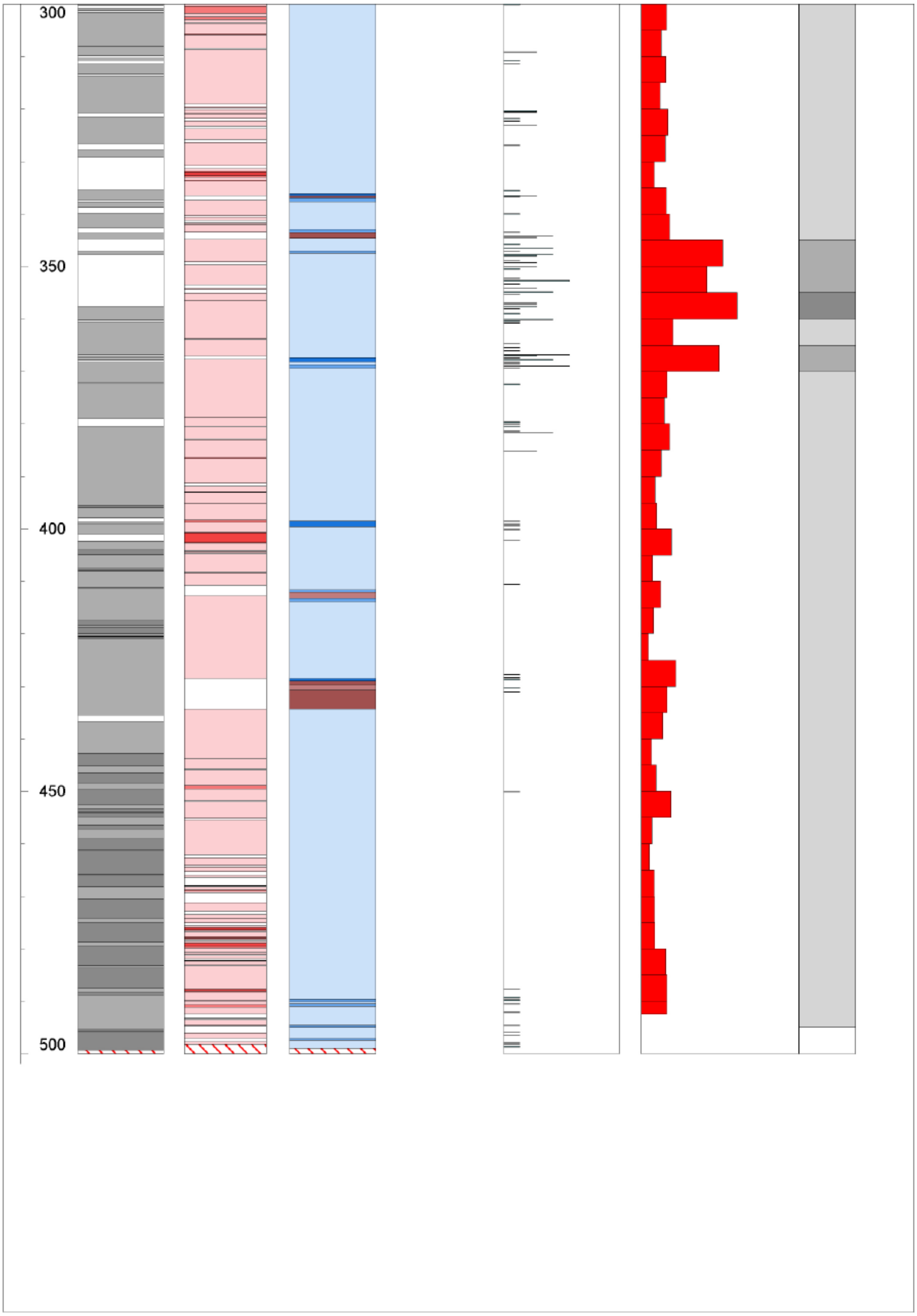
/5/ **Henkel H, 1991.** Petrophysical properties (density and magnetization) of rock from the northern part of the Baltic Shield. Tectonophysics 192, 1–19.

/6/ **Puranen R, 1989.** Susceptibilities, iron and magnetite content of precambrian rocks in Finland. Geological survey of Finland, Report of investigations 90, 45 pp.

/7/ **Archie G E, 1942.** The electrical resistivity log as an aid in determining some reservoir characteristics: Trans. Am. Inst. Min., Metallurg., Petr. Eng., 146, 54–62.

Generalized geophysical loggings of KFM07C




300
350
400
450
500