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Site investigation SFR

Overview Boremap mapping of drill cores from KFR04, KFR08, KFR09, KFR13, KFR35, KFR36, KFR54, KFR55, KFR7A, KFR7B and KFR7C

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Abstract

This report presents the results from a renewed geological overview mapping of 11 drill cores obtained during the construction of the final repository for low and middle level radioactive operational waste (SFR) during the 80's. Drill cores from KFR04, KFR08, KFR09, KFR13, KFR35, KFR36, KFR54, KFR55, KFR7A, KFR7B and KFR7C, with a total length of 837 m, was selected primarily because of their distinctly crosscutting relationship with inferred deformation zones in the area. The main purpose for this geological mapping is calibration with the original mappings, which in turn aims to facilitate geological single-hole interpretation.

The mapping was generally focused on the location and infilling mineralogy of broken and unbroken fractures, as well as crush zones, breccias and sealed networks. Also the overview lithology, alterations and ductile shear zones were documented.

All boreholes selected for renewed mapping are located in a ductile, high-strain belt, which defines the northeastern margin of a structurally more homogeneous tectonic lens. The main component of the high-strain belt is felsic to intermediate rocks of inferred volcanic origin. The predominant rock in the selected drill cores is, however, a fine- to finely medium-grained metagranite, which clearly appears to be a high-strain variety of the typically medium-grained metagranite-granodiorite that prevails the tectonic lens. It is obvious that varieties of this high-strain rock previously was inferred to be metavolcanic rocks. Other volumetrically important rock types in the drill cores are pegmatitic granite, finely medium-grained granite and metagranodiorite-tonalite, aplitic metagranite, amphibolites and slightly coarser metagabbros. Virtually all rocks in the borehole have experienced Svecofennian metamorphism under amphibolite facies conditions.

Excluding fractures within crush zones and sealed networks, there is a predominance of broken fractures in most of the drill cores. The total fracture frequency varies between 8 and 19 fractures/metre, which is rather high, but nevertheless within the expected range, considering their association with inferred deformation zones. Throughout all selected drill cores, the frequencies of broken and unbroken fractures vary rather coherently, with an increased number of broken fractures in intervals with concentrations of unbroken fractures. There are, however, exceptions, but these sections are all of rather limited extent. The two most frequent fracture minerals are calcite and chlorite, which are found in 59 and 38% of the total registered fractures, respectively. Other abundant minerals are various clay minerals, laumontite, microscopic hematite/Fe-hydroxides, and more rarely adularia and quartz.

Sammanfattning

Föreliggande rapport redovisar resultaten från en förnyad geologisk översiktskartering av 11 borrkärnor från byggnationen av slutförvar för kortlivat låg- och medelaktivt avfall (SFR) under 80-talet. Borrkärnor från KFR04, KFR08, KFR09, KFR13, KFR35, KFR36, KFR54, KFR55, KFR7A, KFR7B och KFR7C, med en total längd av 837 m, valdes i första hand ut på grund av att de skär igenom förmodade deformationszoner i området. Det huvudsakliga syftet är kalibrering med den ursprungliga karteringen, för att möjliggöra geologisk enhålstolkning av resterande borrkärnor från SFR.

Karteringen fokuserades främst på läge och mineralogi i brutna och obrutna sprickor, samt krosszoner, breccior och läkta nätverk. Också översiktlig litologi, omvandlingar och plastiska skjuvzoner har dokumenterats.

Alla borrhål som valts ut för förnyad kartering är lokaliserade i ett stråk med intensiv plastisk deformation, som definierar den nordöstra begränsningen av en strukturellt mer homogen tektonisk lins. Huvudkomponenten i stråket är felsiska till intermediära bergarter av förmodat vulkaniskt ursprung. Huvudbergarten i de utvalda borrkärnorna är däremot en fin- till fint medelkornig metagranit-granodiorit som förefaller vara en kraftigt deformerad variant av den medelkorniga bergart som dominerar i den tektoniska linsen. Det är uppenbart att varianter av denna kraftigt deformerade bergart tidigare förmodades vara metavulkaniska bergarter. Andra volymmässigt viktiga bergarter i borrkärnorna är pegmatitisk granit, fint medelkornig granit och metagranodiorit-tonalit, aplitisk metagranit, amfibolit och något grövre metagabbro. Största delen av berggrunden i området har genomgått Svekofennisk amfibolitfacies-metamorfos.

Frånsett sprickor i krosszoner och läkta nätverk, är övervägande delen av sprickorna i borrkärnorna brutna. Den totala sprickfrekvensen varierar mellan 8 och 19 sprickor/meter, vilket är relativt högt, men ändå vad som kan förväntas eftersom de borrats igenom förmodade deformationszoner. I alla borrkärnorna är det en generell följsamhet i mängden brutna och obrutna sprickor, det vill säga antalet brutna sprickor ökar i intervall med ansamlingar av obrutna sprickor. Det finns dock undantag, men alla dessa längdsektioner är relativt begränsade i sin utbredning. De två vanligast förekommande sprickfyllnadsmineralen är kalcit och klorit, som påträffats i 59, respektive 38 % av de registrerade sprickorna. Andra vanliga mineral är olika lermineral, laumontit, mikroskopisk hematit/Fe-hydroxider, och mer sällan adularia och kvarts.

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1 Introduction

SKB initiated 2008 an investigation programme for the future expansion of the final repository for radioactive operational waste (SFR). An essential part of the preparations for this work is to update the geological model for the SFR. This necessitates a reassessment of existing geological data from the construction of the SFR, at the basis of the experiences from the preceding site investigation Forsmark. The main emphasis lies on the mappings from about forty drill cores achieved during the SFR construction and the activity should generally follow the SKB methodology with geological single-hole interpretation (SKB MD 810.003).

However, a brief examination of the mappings revealed several obscurities in the methodology, especially in the fracture mapping. The methodology appears, moreover, to differ among the companies involved in the mapping. Therefore, it was decided that 11 of the drill cores should be subjected to renewed overview mapping according to the so-called Boremap system (SKB MD 143.006). The prime criteria for the selection of these drill cores were their distinctly crosscutting relationship with inferred deformation zones in the original geological model of the SFR. These new mapping data will be used for calibration with the original mappings, with the aim to facilitate geological single-hole interpretation of the remaining, pre-existing drill cores, only at the basis of their original mappings.

The renewed overview mapping of the SFR drill cores was generally focused on the location and infilling mineralogy of broken and unbroken fractures, as well as crush zones, breccias and sealed networks. Also the lithology, alterations and ductile shear zones were documented.

This document reports the results gained by the geological overview mapping of the following 11 drill cores obtained during the construction of SFR: KFR04, KFR08, KFR09, KFR13, KFR35, KFR36, KFR54, KFR55, KFR7A, KFR7B and KFR7C (Figure 1-1). It is one of the activities performed within the investigation programme, preceding the design of the expanded SFR. The work was carried out in accordance with activity plan AP SFR-07-004. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents.

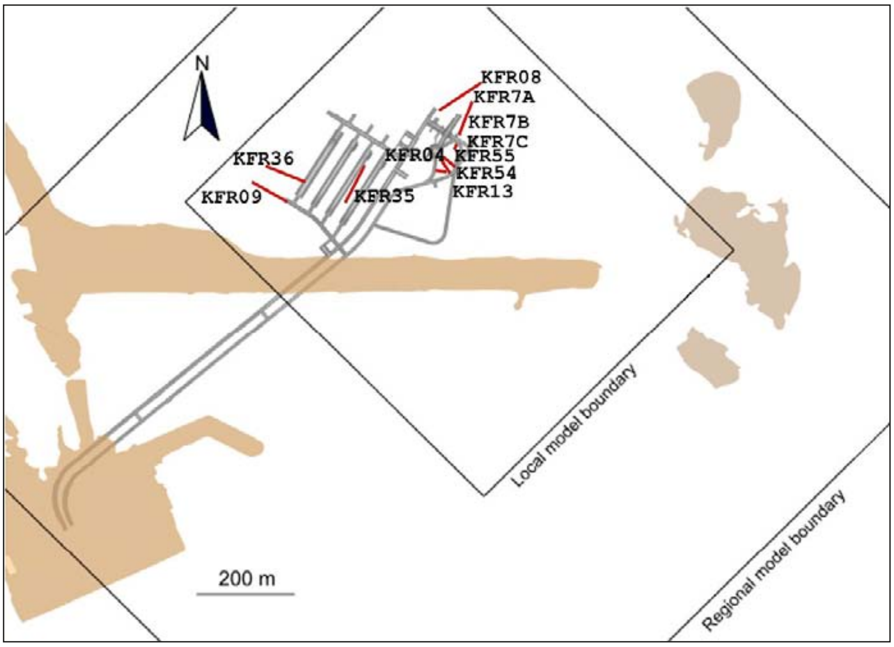

Figure 1-1. *Map showing the horizontal projections of the cored boreholes KFR04, KFR08, KFR09, KFR13, KFR35, KFR36, KFR54, KFR55, KFR7A, KFR7B and KFR7C. Modified from /Curtis et al. 2011/.*

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

Activity plan	Number	Version
Översiktlig boremapkartering av borrkärnor från KFR04, KFR08, KFR09, KFR13, KFR35, KFR36, KFR54, KFR55, KFR7A, KFR7B och KFR7C	AP SFR-07-004	1.0
Method description	**Number**	**Version**
Instruktion: Regler för bergarters benämningar vid platsundersökningen i Forsmark	SKB MD 132.005	1.0
Metodbeskrivning för Boremap-kartering	SKB MD 143.006	2.0
Nomenklatur vid Boremap-kartering	SKB MD 143.008	1.0
Mätsystembeskrivning för Boremapkartering, Boremap v. 3.0	SKB MD 146.005	1.0

2 Objective and scope

Except for KFR35 and KFR36, all boreholes selected for renewed overview mapping are core drilled at Ø = 56 mm. KFR35 and KFR36, on the other hand, start with core drilling at Ø = 86 mm to a length of 18.00 and between 16.00 and 18.15 m, respectively, followed by core drilling at Ø = 56 mm to their full lengths at 140.17 and 123.90 m, respectively. All cores drilled at Ø = 56 mm, as well as the first 2.15 m of KFR36, drilled at Ø = 86 mm, were included in the mapping engagement. All together the total length of the mapped cores amounts to about 837 m. Table 2-1 gives the lengths of individual drill cores, as well as the various deformation zones they are inferred to penetrate according to the original SFR model /cf. Axelsson and Hansen 1997/ and the site descriptive model of the PLU /cf. SKB 2005/.

The aim of the geological borehole mapping is to obtain a registration of the following features in the cores drilled at Ø = 56 mm: (1) lithological units that exceeds 1 m in drill core length, (2) rock alterations, (3) the exact position along the drill core of broken and unbroken fractures, (4) fracture mineralogy, (5) α-angles (i.e. the angle between a fracture plane and the drill core length axis) for the predominant fracture sets, (6) crush zones, (7) breccias, (8) sealed fracture networks, and (9) ductile shear zones. These data will serve as a platform for forthcoming calibration with the original mappings, which in turn aim to facilitate geological single-hole interpretation of the remaining, pre-existing drill cores, only at the basis of their original mappings.

Table 2-1. Boreholes from the SFR selected for geological overview mapping.

New borehole ID-code	Original bore-hole ID-code	Total mapped drill core length (m)	Penetrated deformation zones (SFR model)	Penetrated deformation zones (PLU model)
KFR04	HK4	100.50	Zone H2	ZFMNE0871
KFR08	HK8	104.40	Zone 8	ZFMNW0805
KFR09	HK9	80.24	Zone 3	ZFMNE0869
KFR13	HK13	76.60	Zone H2	ZFMNE0871
KFR35	KB15	18.00–140.17	Zone 6	ZFMNW1209
KFR36	KB16	16.00–123.90	Zone 3	ZFMNE0869
KFR54	KB24	53.30	Zone 9	ZFMNE0870
KFR55	KB25	61.90	Zone 9	ZFMNE0870
KFR7A	HK7A	74.45	Zone H2 and 8	ZFMNE0871 and ZFMNW0805
KFR7B	HK7B	21.10	Zone H2	ZFMNE0871
KFR7C	HK7C	34.00	Zone H2	ZFMNE0871

3 Equipment

3.1 Description of equipment/interpretation tools

All mapping was performed in Boremap v. 3.9. This software contains the lithology and mineral standard used both for the borehole and surface mapping during the course of site investigation Forsmark. Additional software used during and after the geological mapping was WellCAD v. 3.2 and Microsoft Access.

The following equipment was used to facilitate the core mapping: folding rule, concentrated hydrochloric acid diluted with three parts of water, compass with inclinometer, unglazed porcelain plate, knife, hand lens, paintbrush and tap water.

4 Execution

4.1 General

During the core mapping, the drill cores from all 11 boreholes were available in their full length on roller tables in the core-mapping accommodation at Forsmark (the Llentab hall, near the SKB/SFR-office). No thin-sections were available from the drill cores, and all lithological descriptions and mineral identification are based on ocular inspection.

The core mapping of the 11 boreholes was performed in Boremap v. 3.9 according to activity plan AP SFR-07-004 (SKB internal document), generally following the SKB method description/instruction for Boremap mapping, SKB MD 143.006 (v. 2.0) and 143.008 (v. 1.0). However, the methodology differs somewhat from the one used during the site investigation programme. Since no BIPS-images were available, it was a general judgement that the quality of the registered parameters should be high and uniform, even if the principle of two geologists in each core mapping team was abandoned. Thus, all mapping was done by geologists with experiences from the site investigation Forsmark working alone. In addition, there were no generalised geophysical logs available.

WellCAD summaries of the mapping are presented in Appendix 1.

4.2 Preparations

As neither downhole deviation measurements nor length reference marks were available for any of the selected boreholes, no preparations were necessary. Thus, the borehole lengths given in this report are based exclusively on the uptake lengths given in the drill core boxes.

4.3 Data handling and quality routines

To obtain the best possible data security, the mapping was performed on the SKB intranet, with regular back-ups on the local drives.

The quality routines include detailed examination of variable/summary reports generated by Boremap and WellCAD logs, printed out after the mapping of each drill core. An additional check was done when the mapping databases were re-examined for the writing of this report. The final quality check of the mappings was made by a routine in the Boremap software. The primary data were subsequently exported to the SKB database Sicada, where they are traceable by the activity plan number.

4.4 Analyses and interpretations

The overview fracture mapping focuses on the division into broken and unbroken fractures, depending on whether they are parting the core or not. Broken fractures include both open fractures and originally sealed fractures, which were broken during the drilling or the following treatment of the core. Fractures judged to be induced during the drilling are not included in the mapping. Each fracture was examined for mineral filling. Up to four infilling minerals can be registered in the database for each fracture. As far as possible, they are given in order of decreasing abundance in the fracture. Additional minerals (i.e. five or more), which occur in a few fractures, are noted in the commentary field. However, it must be emphasized that this provides no information of the volumetric amount of individual minerals. In a fracture with two minerals, the mineral registered as 'second mineral' may range from sub-microscopic staining up to amounts equal to that of the mineral registered as 'first mineral'. Hematite, for example, occurs typically as extremely thin coatings or impurities in other fracture minerals, such as chlorite and laumontite.

In addition to drill core length and mineral filling, α-angles were registered for about 2–5 representative fractures per drill core box. Other fracture sub-variables, such as width, aperture and interpretations of whether a fracture has been open, partly open or sealed in the rock volume (i.e. in situ), were not part of the mapping engagement. For crush zones and sealed fracture networks the mapping also includes a piece length estimate (i.e. a rough estimation of the spacing between individual fractures).

Lithological units, exceeding 1 m in drill core length, were characterised in terms of rock type, colour, grain-size, texture, structure and structure intensity. Only one texture and one structure type is allowed by the mapping system. The only less extensive litological features registered are breccias, cataclastic rocks and ductile shear zones. These are rather briefly described in the attached comments than in terms of sub-variables. Rock alterations are registered with their intensity irrespective of their extent.

The distinction between breccia/cataclastic rock and sealed network is not always straight forward, but normally zones with none or minor rotation of individual rock fragments has been mapped as sealed network. Breccias and cataclastic rocks, on the other hand, are distinguished by their volumetric content of matrix; occurrences with more than 90% matrix have been mapped as cataclastic rocks. Significant fractures that differ markedly in mineralogy from the majority of the fractures within the sealed networks are mapped separately.

Core losses have been registered at the following intervals in four of the drill cores:

KFR04: 32.89–32.99 m.

KFR09: 70.55–70.62 and 71.50–71.54 m.

KFR35: 63.84–64.15, 124.78–125.64 and 130.48–131.39 m.

KFR36: 107.25–107.444 m.

KFR55: 1.77–1.91, 6.24–8.06, 17.86–18.51, 19.13–19.37, 33.48–33.60, 34.89–35.33, 41.51–42.15 and 59.50–59.70 m.

KFR7B: 14.48–14.88 and 15.98–16.25 m.

It must be emphasized that this is an overview mapping without BIPS-images. All features, except for a few fractures with registered α-angles non-oriented.

4.5 Nonconformities

During the mapping, it was noted that whole uptakes of drill core have been put upside down in the boxes. This problem has been noted in about half of the drill cores, though there might still be unnoticed errors, especially in highly fractured sections with uniform lithology.

Some fracture filling minerals are more conspicuous than other. For example, the distinct red staining shown by sub-microscopic hematite reveals extremely low concentrations of the mineral. Also the use of diluted hydrochloric acid for identification of calcite makes it possible to detect amounts that are macroscopically invisible. The amount of fractures filled with other less conspicuous minerals may, on the other hand, be underestimated. Pyrite, which typically forms up to millimetre-sized, isolated crystals, might for example be underrepresented in unbroken fractures.

Another problem in most of these drill cores is the mapping of clay as fracture filling. The clay-sized drill cuttings are often indistinguishable from the ‘natural clay’ that originally occurs in the fractures. Several broken fractures have, moreover, been affected by slight weathering into clay minerals. During the preceding site investigation Forsmark, such fractures were recorded as ‘altered’, without any further trace of clay in the database. However, this option was not possible during the overview mapping. Clay minerals in such fractures, therefore, generally recorded as a separate mineral in the database.

5 Results

5.1 General lithology

All boreholes selected for renewed mapping are located in a ductile, high-strain belt (Figure 5-2), which defines the northeastern margin of a structurally more homogeneous tectonic lens. Spatially, the latter coincides more or less with the area of the preceding site investigation Forsmark. Based on the geological data from the construction of the SFR and the surface mapping carried out by the

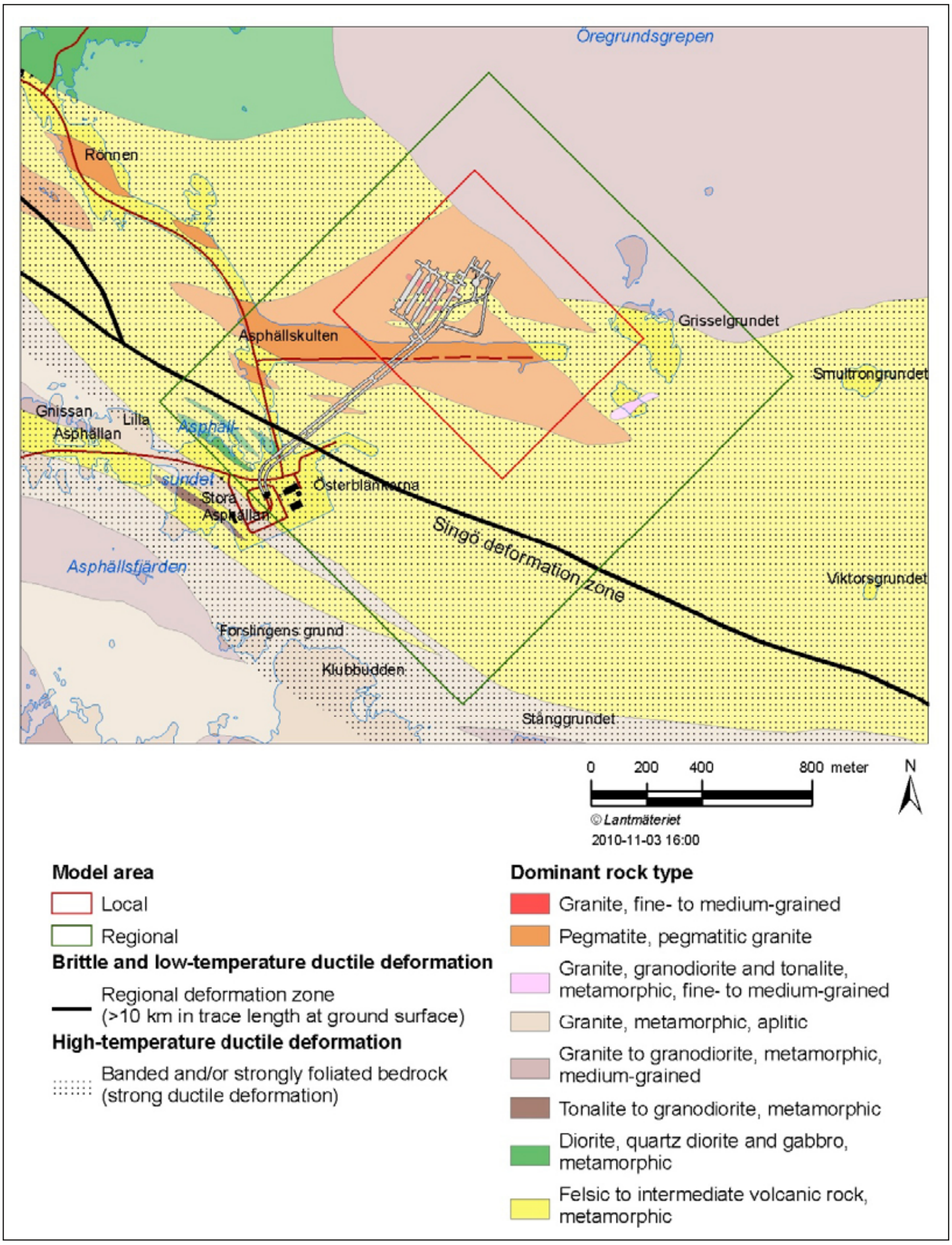

Figure 5-2. *Bedrock geological map of the area around SFR based on the bedrock geological map, Forsmark stage 2.3 /Stephens et al. 2008/ produced during the Forsmark site investigation. Local and regional SFR model areas are also shown. The paler shades for each colour on the map indicate that the corresponding rock unit is covered by water.*

Swedish Geological Survey during 2003, it was inferred that the high-strain belt in the SFR area mainly consists of intermediate metavolcanic rocks, together with pegmatitic granite and, locally fine- to medium-grained granite /e.g. SKB 2005/. However, felsic to intermediate metavolcanic rocks (103076) are a subordinate component in the 11 drill cores selected for renewed mapping. The predominant rock is a fine- to finely medium-grained metagranite, which clearly appears to be a high-strain variety of the typically medium-grained metagranite-granodiorite (101057) that prevails the tectonic lens. It must be emphasized, however, that the distinction between this rock and the rocks of inferred volcanic origin in some cases are difficult. The main criteria for their distinction are: (1) compositional banding, (2) mica content and (3) the typical 'domain texture' exhibited by the metagranite.

Other volumetrically important rock types in the drill cores are pegmatitic granite (101061) and finely medium-grained granite (111058). The most extensive occurrences of the latter are found in the drill cores from KFR04, KFR08 and KFR36, where it occupies 39, 30 and 28%, respectively, of the total drill core length. Relative to the fine- to finely medium-grained metagranite (101057), it is typically less affected by ductile strain and shows a more homogeneous distribution of the major mineral components (i.e. no aggregation).

Amphibolites (102017) and slightly coarser metagabbros (101033) occur sporadically throughout the drill cores. Except for two ca 5 m long occurrences in the drill cores from KFR08 and KFR35, none of them exceed a few metres in drill core length. Extensions and contacts of all these rock occurrences are more or less parallel with the tectonic fabric.

In addition, there are a few length intervals of aplitic metagranite (101058) (similar to that observed at Klubbudden about 1.5 km south of the SFR) and fine- to finely medium-grained metagranodiorite-tonalite (101051). The aplitic metagranite is restricted to KFR7A and KFR36, where it constitutes 18 and 8%, respectively, of the total drill core lengths. Similar to the fine- to finely medium-grained metagranite (101057), it has generally been affected by ductile, high-strain. The finely medium-grained metagranodiorite-tonalite, on the other hand, has a texture and fabric highly reminiscent of those exhibited by the finely medium-grained granite (111058). The rock is limited to 4.0 and 3.4 m long sections in KFR13 and KFR35, respectively.

Except for the finely medium-grained granite (111058) and a few pegmatitic granites (101061), all rocks in the drill cores have experienced Svecofennian metamorphism under amphibolite facies metamorphism.

5.2 Rock alterations

The most common alteration type encountered in the selected drill cores is oxidation, or rather red pigmentation of feldspars by sub-microscopic hematite. It is typically associated with more intensely fractured intervals, especially with fractures filled by laumontite and/or adularia. The most extensive occurrences of oxidized rock are found in KFR04, KFR08, KFR09 and KFR36. Normally the oxidation is faint to weak in intensity, and more rarely medium.

Other type of alterations in the drill cores are rather sparse, but includes argillization, chloritization, laumontitization, epidotization, carbonatization, steatitization, quartz dissolution and albitization. Argillization is mainly restricted to highly fractured intervals with predominantly clay minerals in the fractures in KFR04, KFR54, KFR7A and KFR7C. The most extensive intervals of chloritization coincide with amphibolites and a metagabbro in KFR08, KFR09 and KFR36. The six registered intervals of laumontitization are intimately associated with a high frequency of fractures filled with laumontite in KFR08, KFR13 and KFR36, whereas the inferred steatitization occurs in an interval with several talc-bearing fractures in KFR36. A few short intervals of bleached feldspar in KFR08, KFR7A and KFR7C are inferred to be the result of albitization. The feature is evidently pre- to syn-metamorphic with no relationship to existing brittle structures. The registered carbonatization at 26.98–27.18 m length in KFR35 is associated with a single calcite filled fracture. Intervals with quartz dissolution are restricted to 72.55–73.30 and 77.95–79.55 m length of KFR08.

5.3 Fracture characteristics

5.3.1 General

Apart from fractures included in crush zones and sealed networks, there is a predominance of broken fractures in most of the 11 drill cores (Table 5-1). This is in clear contrast to the drill cores achieved during the site investigation Forsmark, in which unbroken fractures always outnumbered the broken fractures. The difference is most certainly the result of one or more of the following three factors: (1) the shallow level of the SFR boreholes, (2) the drilling technique (double compared to triple tube technique) and (3) the transportation and handling of the drill cores. The total fracture frequencies vary between 8 and 19 fractures/metre, which is rather high, but nevertheless within the expected range, considering their association with inferred deformation zones. Throughout all selected drill cores, the frequencies of broken and unbroken fractures vary rather coherently, with an increased number of broken fractures in intervals with concentrations of unbroken fractures. There are, however, exceptions, but these sections are all of rather limited extent.

The two most frequent fracture minerals are calcite and chlorite, which are found in 59 and 38% of the total registered fractures, respectively. Other frequent minerals, in order of decreasing abundance, are staining by hematite/Fe-hydroxides, laumontite, adularia, various clay minerals, and more rarely quartz. Additional minerals, of which none occurs in more than about 1% of the total fractures, include pyrite, asphalt, epidote, white feldspar (adularia or albite), sericite, prehnite, analcime, apophyllite, fluorite and unspecified sulphides. In addition, there are a few fractures with unknown mineral filling. Most of them are colourless, rather soft minerals. Analyses by XRD of similar material from drill cores achieved during the site investigation Forsmark have revealed that most such fillings are mineral mixtures, or in some cases, feldspars, apophyllite or analcime /Sandström et al. 2004/. There are also 469 fractures that are virtually free from *visible* mineral fillings. Most of these fractures are broken.

Clay minerals are mainly found in broken fractures and include clay formed both by direct precipitation and by alteration of feldspars and phyllosilicates. The latter is often difficult to distinguish from clay-sized drill cuttings, which are frequent on fracture surfaces in all selected drill cores. In some sections, the clay is red stained by the presence of Fe-hydroxide and/or hematite. The distinction between Fe-hydroxide and hematite is far from obvious, but discolouration by rust or a dark brownish red tint of the filling is generally inferred to indicate the presence of Fe-hydroxides. Except for clay, hematite and Fe-hydroxides occur typically together with chlorite, adularia and laumontite.

Laumontite is frequent in both broken and unbroken fractures. Considering the drilling technique and crackle of laumontite due to dehydration, it is most certain that a majority of the broken, laumontite-bearing fractures originally were unbroken. The presence of laumontite is typically associated with calcite and oxidized or reddened fracture walls.

Table 5-1. Quantitative fracture characteristic of drill cores from the SFR.

ID-code	Broken fractures	Unbroken fractures	Total fractures	Fractures/ metre	Crush zones (total length)	Sealed networks (total length)	Breccias
KFR04	591	464	1,055	10.5	2 (0.25 m)	21 (2.93 m)	1
KFR08	1,048	537	1,585	15.2	19 (4.02 m)	50 (49.46 m)	–
KFR09	851	576	1,427	17.8	7 (0.56 m)	65 (37.50 m)	–
KFR13	375	273	648	8.5	1 (0.07 m)	20 (4.20 m)	2
KFR35	860	672	1,532	12.5	6 (0.56 m)	30 (5.03 m)	6
KFR36	954	1,053	2,007	18.6	10 (2.34 m)	55 (19.85 m)	5
KFR54	325	309	634	11.9	1 (0.02 m)	10 (1.63 m)	2
KFR55	422	361	783	12.6	1 (0.13 m)	20 (4.21 m)	–
KFR7A	579	239	818	11.0	19 (16.68 m)	39 (14.71 m)	–
KFR7B	202	67	269	12.7	4 (1.34 m)	–	–
KFR7C	260	107	367	10.8	5 (0.42 m)	2 (0.10 m)	–

Quartz, adularia and epidote, often in intimate associations, are preferentially found in unbroken fractures. Epidote-bearing fractures are generally surrounded by strongly oxidized or reddened walls.

Both pyrite and sericite occur typically in broken fractures. This might, however, be an artefact of the occurrences of the two minerals; pyrite as up to millimetre-sized, isolated crystals and sericite as a possible part of the wall rock.

5.3.2 KFR04

The fracture frequency in the drill core is consistently high, but variable, with a peak in the first three metres and a more extensive anomaly between approximately 14 and 63 m length. In addition, there is a less distinct peak of mainly unbroken fractures at 87–93 m length.

The primary fracture filling minerals in the highly fractured interval at 0–3 m length is chlorite, along with subordinate calcite, epidote and laumontite. An α–angle of 88° has been registered for a chlorite filled fracture, whereas a laumontite–calcite filled has an α–angle of 21°.

The highly fractured interval at about 14–63 m length includes all, except for two, sealed networks in the drill core, one breccia at 33.00–33.22 m and one crush zone at 32.605–32.77 m length. Most of the networks, as well as the breccia, are sealed by laumontite and calcite, which also are the major constituents within other fractures in this interval. Two laumontite–calcite and calcite sealed fractures of considerable widths, at 20.17–20.23 and 32.82–32.89 m length, respectively, were mapped as 'rock occurrences'. The laumontite-bearing fractures in the interval are generally gently to moderately steeping towards the drill core length axis (registered α–angles < 53°). The occurrence of clay minerals is mainly concentrated to two short sections at 20–23 and 32–36 m length.

Fractures in the section at 87–93 m length are typically occupied by chlorite, quartz and calcite. Other noteworthy infilling minerals are laumontite and epidote. None of the fractures have α–angles exceeding 34°.

5.3.3 KFR08

The fracture frequency is rather high throughout the drill core, with a maximum of broken fractures in the interval from about 41 to 87 m length. This interval includes all 19 crush zones registered in the drill core, as well as most sealed fracture networks. Unbroken fractures outside sealed networks are, however, scarce. The frequency of unbroken fractures shows a broad peak in the approximate interval at 3–19 m length.

The principal fracture filling minerals in the interval at 41–87 m length are calcite, chlorite, laumontite and adularia, typically discoloured by hematite. In addition, there are a number of fractures with unidentifiable soft minerals, which might be a zeolite, saussurite and/or clay minerals. Registered α–angles for fractures in this interval are variable, but generally moderately steeping towards the drill core length axis.

Most fractures within the more highly fractured interval at about 3–19 m length are filled with chlorite, calcite and laumontite, in varying proportions. Registered α–angles for fractures in this interval are highly variable between 10 and 81°.

Quartz-dominated fractures are concentrated to a short length interval at 27.6–33.0 m.

Noteworthy, there are three fluorite-bearing and one asphaltite-bearing fractures recorded in the drill core. Relative to the other SFR drill cores selected for renewed mapping, clay mineral fillings are rather scarce in the drill core from KFR08.

5.3.4 KFR09

The fracture frequency in the drill core from KFR09 is among the highest registered during this activity. The fracture distribution is, moreover, rather even throughout the drill core, and distinct anomalies are absent. However, the frequency of broken fractures and sealed fracture networks tend to be slightly higher in the lower half of the drill core.

Calcite, chlorite, adularia and laumontite are the most frequently registered fracture filling minerals in the drill core. Typically, the latter three minerals are variably discoloured by microscopic hematite. The occurrence of laumontite is, generally restricted to three distinct sections at 0–24, 40–45 and 69–75 m length, and the laumontite-bearing fractures are typically steeping moderately towards the drill core length axis (registered α–angles of 57–78°). None of the other major mineral phases exhibit such distinct distribution pattern.

Numerous asphalt-bearing fractures have been registered in the length interval 26–61 m. Similar to the drill core from KFR08, the occurrence of clay mineral fillings is rather scarce.

5.3.5 KFR13

Relative to the other SFR drill cores in this activity, the drill core from KFR13 has a low fracture frequency. Four intervals of increased fracture frequency at 21–30, 36–41, 46–50 and 57–68 m length can be distinguished. A conspicuous fracture filling minerals in all four intervals is laumontite, especially in the uppermost interval at 21-30 m length, where also is the primary infilling mineral in two breccias, one crush zone and all sealed networks. The laumontite-bearing fractures are generally gently steeping at towards the drill core length axis (registered α–angles at 3 and 43°).

The principal components in the second and third interval, at 36–41 and 46–50 m length are laumontite, chlorite and calcite. These minerals are also frequent in fractures in the lowermost interval at 57–68 m length. However, there are also a number of broken fractures with clay minerals, concentrated to the section at 60.1–64.5 m length. Their α–angles range between 42 and 78° towards the drill core length axis.

A concentration of epidote filled fractures with oxidized or red stained wall rock occurs at 67.9–71.3 m length and has a registered α–angle at 85°.

5.3.6 KFR35

The total fracture frequency in the drill core is generally high with a conspicuous fracture concentration in the interval between about 31 and 82 m length, where the fracture frequency locally exceeds 20 fractures/metre outside sealed networks and crush zones. Based primarily on the infilling assemblages, this interval can be separated into sub-sections.

The most extensive section, dominated by fractures containing an assemblage of adularia, calcite and quartz, occurs at 34–68 m length. All breccias, a cataclastic rock and two thirds of all sealed networks in the drill core occur in this section. Virtually all these features are infilled by the adularia–calcite–quartz assemblage. These fractures are typically steeping gently to moderately towards the drill core length axis (registered α–angles at 21–61°). Fractures with asphaltite, typically associated with calcite, are more or less limited to this section (two α–angles at 22 and 76° registered). In addition, there are a number of fractures with a black unknown mineral that resembles asphaltite, but might, at least in some cases, be corrensite. This mineral is restricted to 20.1–71.6 m length.

Broken fractures filled by clay minerals, as well as all crush zones in the drill core, are concentrated to a rather short interval at 56.2–68.7 m length. The α–angles are highly variable between 13 and 79° towards the drill core length axis.

Fractures outside the abovementioned sections are typically dominated by calcite and/or chlorite. Laumontite-bearing fractures are, more or less, restricted to the interval at 76–105 m length, with a peak at 92–93 m length.

Three fluorite-bearing fractures occur in the borehole at 19.82–19.87 m length.

5.3.7 KFR36

The fracture frequency is extremely high throughout the drill core from KFR36 with an average of 18.6 fractures/metre. Generally, there is a slight increase in the frequency of unbroken fractures at approximately 50–114 m, relative to the remaining part of the drill core. This coincides largely with a slight decrease in the frequency of broken fracture at about 62–97 m length. Intensely fractured intervals with mainly broken fractures occur at 44–53, 60–62 and 97–114 m length. The latter interval includes all crush zones registered in the drill core except one.

The primary infilling minerals in the interval between 50 and 114 m length are adularia, calcite and laumontite, together with trace amounts of hematite. All five breccias and most sealed networks in the drill core occur in this interval. The majority of these fractures are rather gently steeping towards the drill core length axis (registered α–angles < 45°, with a maximum at 65°).

In the intensely fractured interval at 44–53 m length, there is a majority of fractures filled by calcite and chlorite, with subordinate amounts of hematite. The interval includes one minor crush zone filled by adularia, calcite and chlorite, at 49.11–49.15 m length. The registered α–angles of these fractures range between 13 and 88°.

The distinct peak in the fracture frequency at 60–62 m length consists generally of fractures filled by adularia and chlorite together with a white unidentifiable mineral that might be kaolinite or a zeolite. Two α–angles at 12 and 30° are registered in the interval.

Calcite and chlorite are the primary infilling minerals in the interval at 97–114 m length. Also adularia is rather frequent in the interval. Laumontite, on the other hand, is frequent down to about 101 m length. Registered α–angles range between 19 and 83°, with an average at 40°. In addition, there are several asphalt-bearing fractures, concentrated to the interval between 105–114 m length.

5.3.8 KFR54

The total fracture frequency is typically more than 10 fractures/metre throughout the drill core, with a distinct drop at 19–25 m length and a more vaguely defined drop in the last 13 m of the drill core.

Almost all clay minerals together with hematite and laumontite in the drill core occur in the highly fractured interval between 27 and 39 m length. Within this interval, the clay minerals and hematite are restricted to two intervals of anomalously high fracture frequencies at 26.9–28.2 and 31.1–37.4 m length, whereas laumontite mainly is restricted to 28.0–31.2 and 37.3–39.1 m length. Both assemblages include often calcite. The chlorite content, on the other hand, is very low relative to that in other parts of the drill core. The clay–hematite-bearing fractures are typically steeping gently to moderately towards the drill core length axis (registered α–angles at 30, 37, 60 and 71°).

Both broken and unbroken fractures in the highly fractured interval between 0 and 19 m are primarily filled by calcite and/or chlorite with minor amounts of clay minerals and several exhibit oxidized walls. The α–angles are typically gently to moderately steeping (30, 32, 48 and 51°) towards the drill core length axis.

Two minor breccias and one chlorite–calcite-bearing crush zone occur at 11.56–11.57, 35.61–35.89 and 16.05–16.07 m length, respectively. A fluorite-bearing fracture was found at 52.94 m length.

5.3.9 KFR55

The fracture frequency in the drill core from KFR55 is high, but rather variable. An interval with anomalously low fracture frequency, closely associated with a pegmatitic granite, occurs at 4.5–8.0 m length. Highly fractured interval, with fracture frequencies above 10 fractures/metre occur at the following lengths: 0–4.5, 8.0–38.8 and 53.9–57.2 m.

The fractures in the first of the three highly fractured intervals are typically filled by laumontite ± calcite ± hematite or chlorite ± calcite. The only crush zone in the drill core occurs in this interval at 0.39–0.52 m length.

The second, most extensive, interval exhibits a more complex fracture distribution. The most frequently fracture filling minerals, which occur throughout the interval, are calcite, and to some extent chlorite. Fractures with clay minerals as the primary infilling are generally restricted to the interval at 16.8–19.5 m length, with registered α–angles at 69°. Laumontite ± calcite filled fractures, on the other hand, are distribute among three intervals at 8.0–12.6, 16.0–16.5 and 20.4–28.1 m length. Two α–angles are registered in the uppermost (68 and 77°) and three in the lowermost (50, 57 and 65°) intervals.

The third highly fractured interval at 53.9–57.2 m length consists mainly of unbroken fractures with calcite and chlorite as the primary infilling minerals. Most fractures exhibit oxidized walls.

5.3.10 KFR7A

This drill core is highly fractured throughout its length, generally with more than 10 fractures/metre, and the most intensely fractured intervals at 3.5–13.4, 49.1–56.7 and 65.1–74.45 m length are largely mapped as crush zones.

Fractures filled with laumontite form swarms throughout the drill core, with the most extensive occurrence at 56.9–64.8 m length. Most of these fractures have gently steeping α–angles less than 25°, with a few ranging up to 55° towards the drill core length axis.

The fractures in the most intensely fractured intervals at 3.5–13.4 and 49.1–56.7 m length are typically infilled by clay minerals, calcite and Fe-hydroxide, whereas the fracture filling at 65.1–74.45 m length are dominated by calcite, laumontite and hematite down to 67.9 m length and beneath that clay minerals and Fe-hydroxide down to 74.45 m length. The deficiency of clay minerals together with the fact that several of the fractures run more or less parallel with the drill core length axis in the interval 65.1–67.5 m, suggest that most fractures originally were sealed. Fractures filled by clay minerals together with subordinate amounts of Fe-hydroxide/hematite are also frequent in the intervals at 21–31 and 42–46 m length. The registered α–angles of clay filled fractures are highly variable, ranging from 0 to 85°.

Chlorite filled fractures are scarce relative to other drill cores selected for renewed mapping.

5.3.11 KFR7B

The major part of the drill core has a fracture frequency exceeding 10 fractures/metre. There are, however, two intervals at about 7–9 and 17–21 m length with conspicuously less fractures than in the remaining part of the borehole.

The unbroken fractures in the drill core are generally concentrated to the highly fractured interval at about 9–17 m length, though the majority of the fractures in the interval are nevertheless broken. Calcite, chlorite and clay minerals, locally with hematite/Fe-hydroxide staining, are frequent in this interval. The registered α–angles are 60, 69 and 72°. Two crush zones rich in clay minerals, hematite and white feldspar occur in this interval at 14.34–14.88 and 15.98–16.25 m length, though their exact extent are uncertain due to core loss.

In the other highly fractured interval at 0–7 m length, unbroken fractures constitute less than 12% of the total fracture amount. Predominant fracture minerals are chlorite and clay minerals, locally with hematite/Fe-hydroxide discolouration. Noteworthy, calcite is virtually absent. The two α–angles registered are 43 and 72°. Two crush zones rich in clay minerals and hematite occur in this interval at 0.67–1.01 and 4.14–4.33 m length.

Laumontite was only recorded in 5 fractures.

5.3.12 KFR7C

The fracture frequency exceeds 10 fractures/metre in most parts of the drill core. Decrease in the fracture frequency down to 6 fractures/metre or less occur, however at 0–6 and 23–26 m length.

The occurrence of clay minerals, locally accompanied by Fe-hydroxide/hematite discolouration is generally restricted to a highly fractured interval at 8–23 m. Other frequent minerals in this interval are mainly chlorite and calcite. Most fractures are steeping moderately towards the drill core length axis (registered α–angles at 29–74°). In this interval occur also three crush zones with clay coatings at 8.47–8.50, 9.25–9.40 and 14.67–14.77 m length.

Virtually all laumontite-bearing fractures are concentrated in a zone with low α–angle (9 and 10° for individual fractures) at 6.24–7.15 m length. Directly below that zone there is a short interval at 7.19–8.19 m length with calcite filled fractures that includes two crush zones at 7.89–7.95 and 8.11–8.19 m length.

The second highly fractured interval of several metres length, from 26 m to the end of the drill core at 34.00 m, is dominated by chlorite-bearing fractures with minor calcite and clay minerals.

Three fractures with probable epidote filling were recorded at 28.34–28.54 m length.

6 References

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WellCAD images

Title GEOLOGY KFR04

Site	FORSMARK - SFR	**Coordinate System**	RT90-RHB70
Borehole	KFR04	**Northing [m]**	6701946.04
Diameter [mm]		**Easting [m]**	1633055.96
Length [m]	100.500	**Elevation [m]**	-77.18
Bearing [°]	98.20	**Plot Date**	2010-02-25
Inclination [°]	-74.99	**Date of mapping**	2007-10-04
Activity Type	GE038		

ROCKTYPE
- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granite to granodiorite, metamorphic, medium-grained
- Diorite, quarts diorite and gabbro, metamorphic
- Amphibolite
- Felsic to intermediate volcanic rock, metamorphic

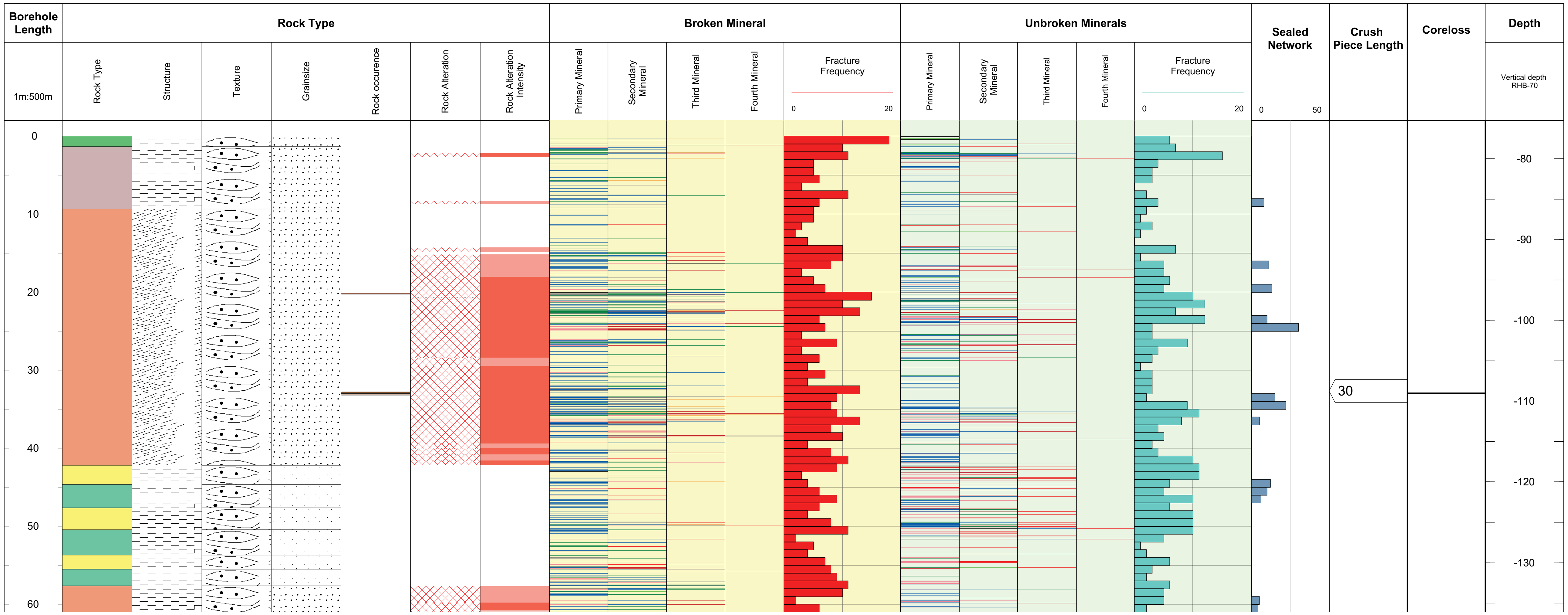
STRUCTURE
- Foliated
- Lineated

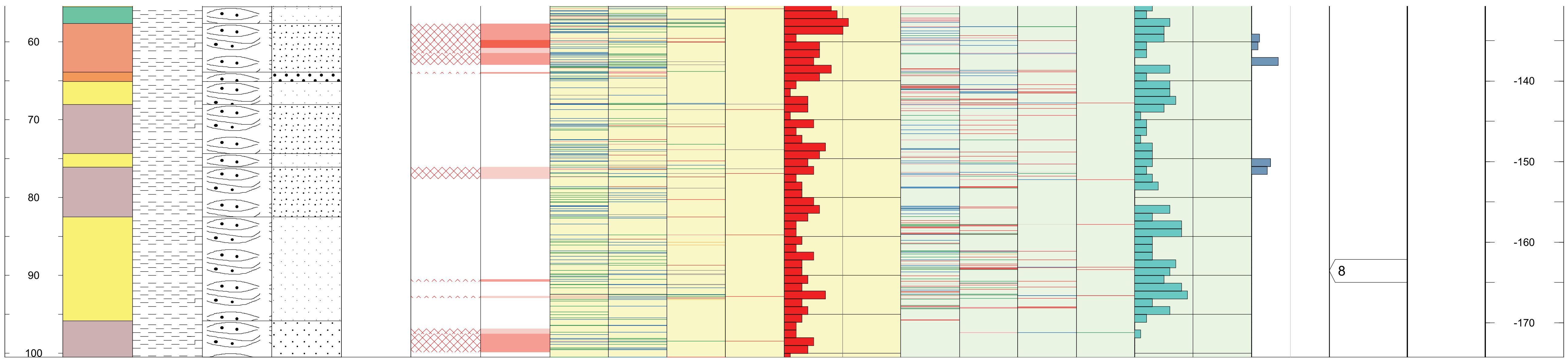
TEXTURE
- Metamorphic

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

ROCK ALTERATION
- Oxidized
- Argillization

MINERAL
- Epidote
- White Feldspar
- Hematite
- Calcite
- Chlorite
- Quartz
- Unknown
- Clay Minerals
- Laumontite

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Title GEOLOGY KFR08

Site	FORSMARK - SFR	**Coordinate System**	RT90-RHB70
Borehole	KFR08	**Northing [m]**	6702071.23
Diameter [mm]		**Easting [m]**	1633066.45
Length [m]	104.400	**Elevation [m]**	-86.01
Bearing [°]	56.40	**Plot Date**	2010-02-25
Inclination [°]	-4.99	**Date of mapping**	2007-10-04
Activity Type	GE038		

ROCKTYPE
- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granite to granodiorite, metamorphic, medium-grained
- Diorite, quarts diorite and gabbro, metamorphic
- Felsic to intermediate volcanic rock, metamorphic

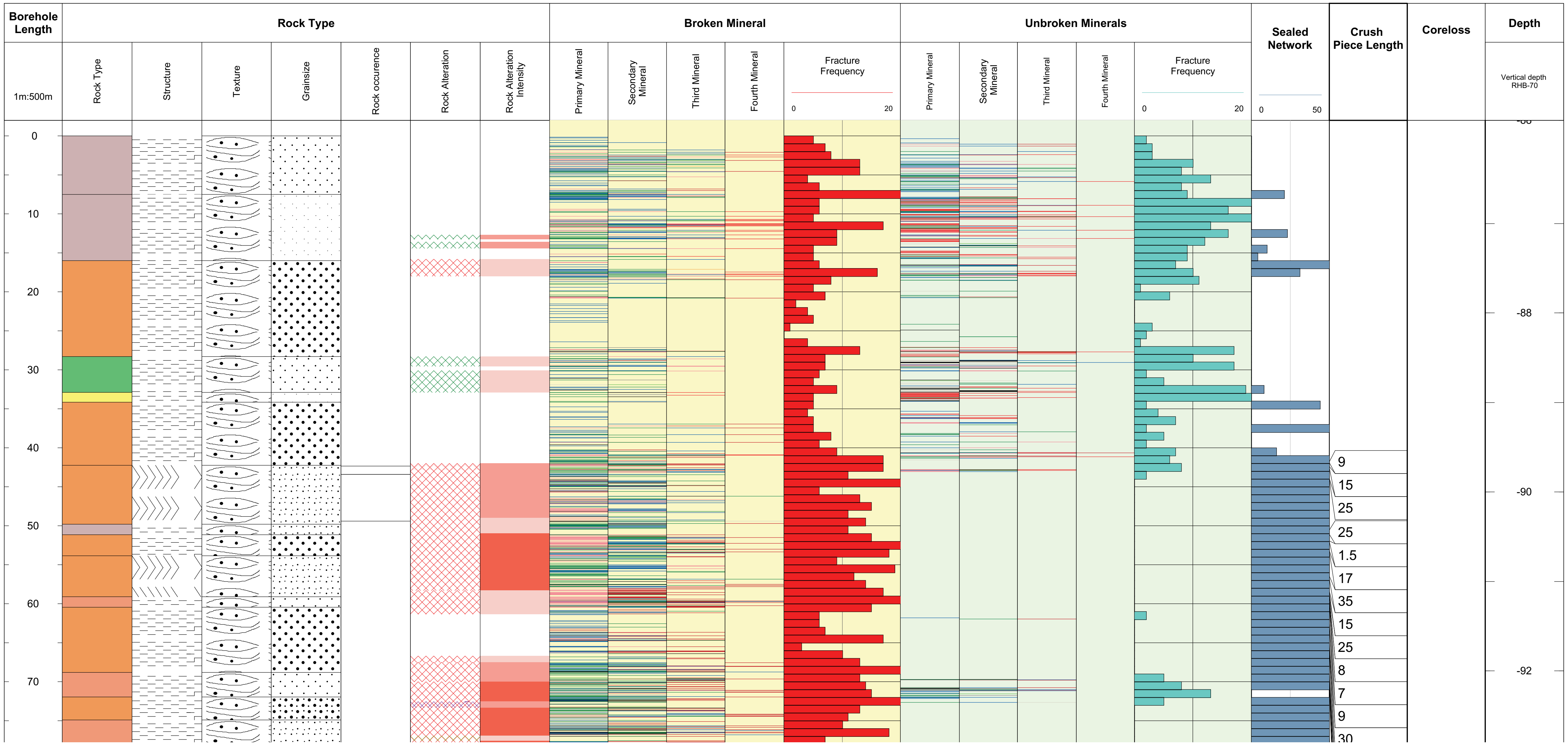
STRUCTURE
- Brittle-Ductile Zone
- Foliated

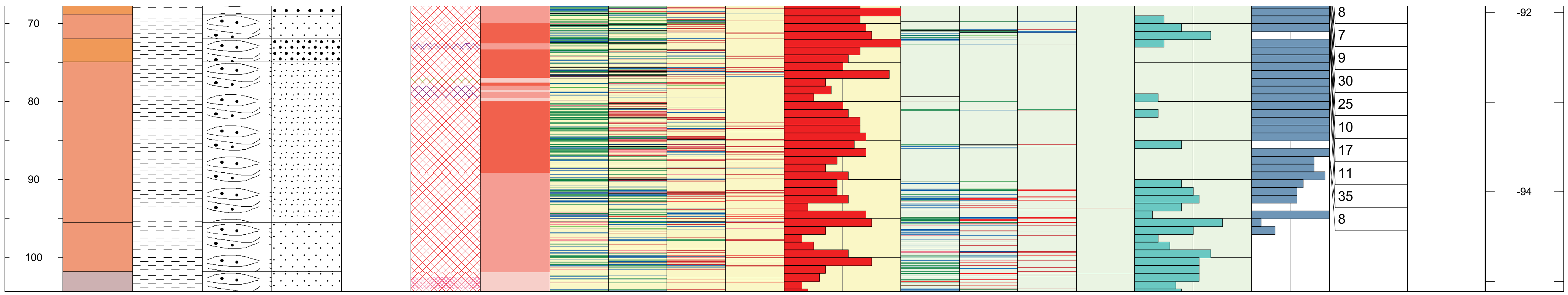
TEXTURE
- Metamorphic

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

ROCK ALTERATION
- Oxidized
- Chloritisized
- Epidotisized
- Quartz dissolution
- Albitization
- Laumontitization

MINERAL
- Epidote
- Flourite
- White Feldspar
- Hematite
- Calcite
- Chlorite
- Quartz
- Unknown
- Clay Minerals
- Laumontite
- Oxidized Walls

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Title **GEOLOGY KFR09**

Site	FORSMARK - SFR	**Coordinate System**	RT90-RHB70
Borehole	KFR09	**Northing [m]**	6701881.84
Diameter [mm]		**Easting [m]**	1632755.38
Length [m]	80.240	**Elevation [m]**	-77.43
Bearing [°]	299.90	**Plot Date**	2010-02-25
Inclination [°]	-4.99	**Date of mapping**	2007-10-04
Activity Type	GE038		

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

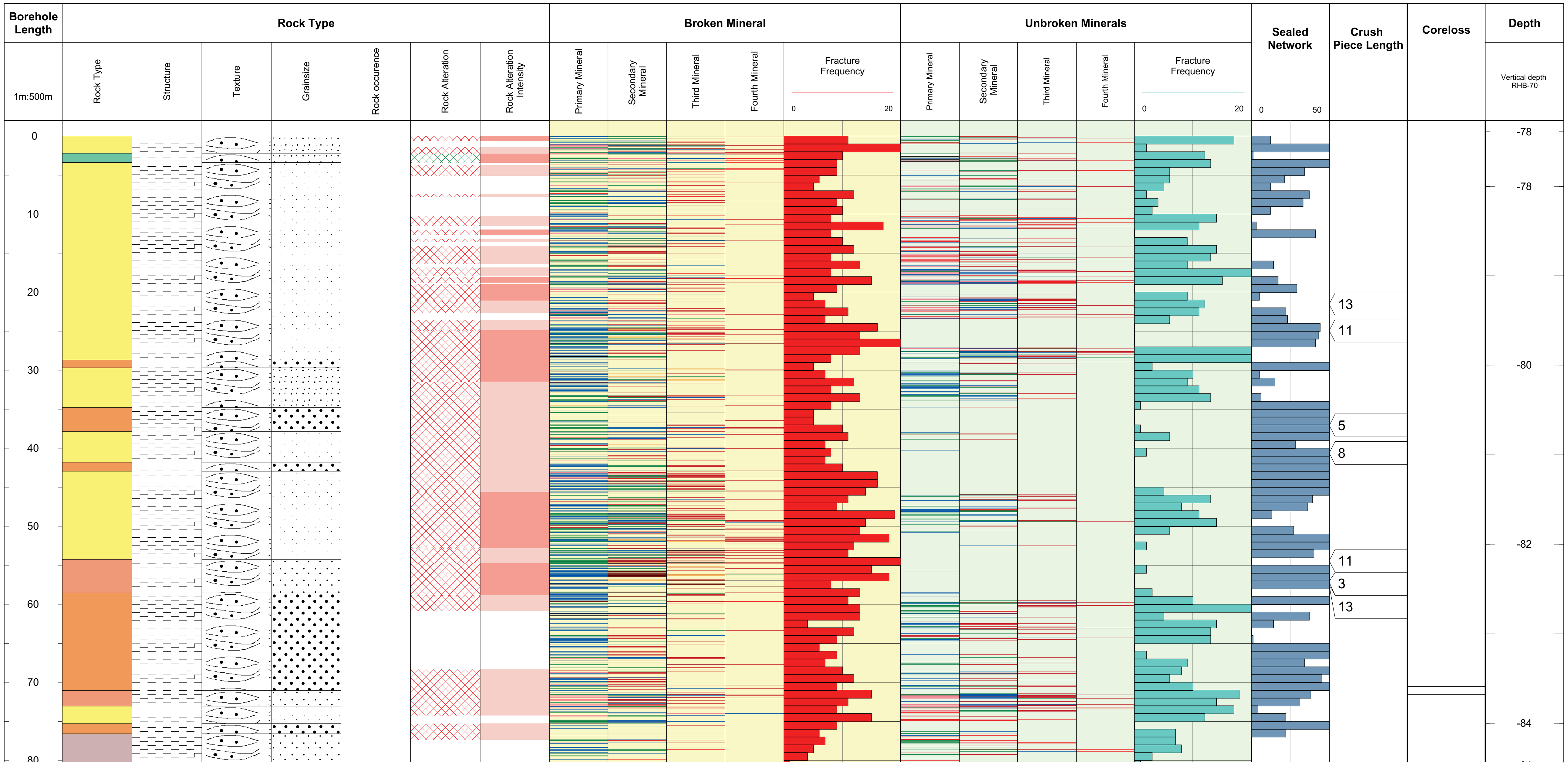
STRUCTURE
- Foliated

TEXTURE
- Metamorphic

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

ROCK ALTERATION
- Oxidized
- Chloritisized

MINERAL
- White Feldspar
- Asphalt
- Hematite
- Oxidized Walls
- Calcite
- Chlorite
- Quartz
- Unknown
- Sulfides
- Clay Minerals
- Laumontite



Title **GEOLOGY KFR13**

Site	FORSMARK - SFR	**Coordinate System**	RT90-RHB70
Borehole	KFR13	**Northing [m]**	6701910.29
Diameter [mm]		**Easting [m]**	1633092.89
Length [m]	76.600	**Elevation [m]**	-123.33
Bearing [°]	0.00	**Plot Date**	2010-02-25
Inclination [°]	-89.99	**Date of mapping**	2007-10-04
Activity Type	GE038		

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

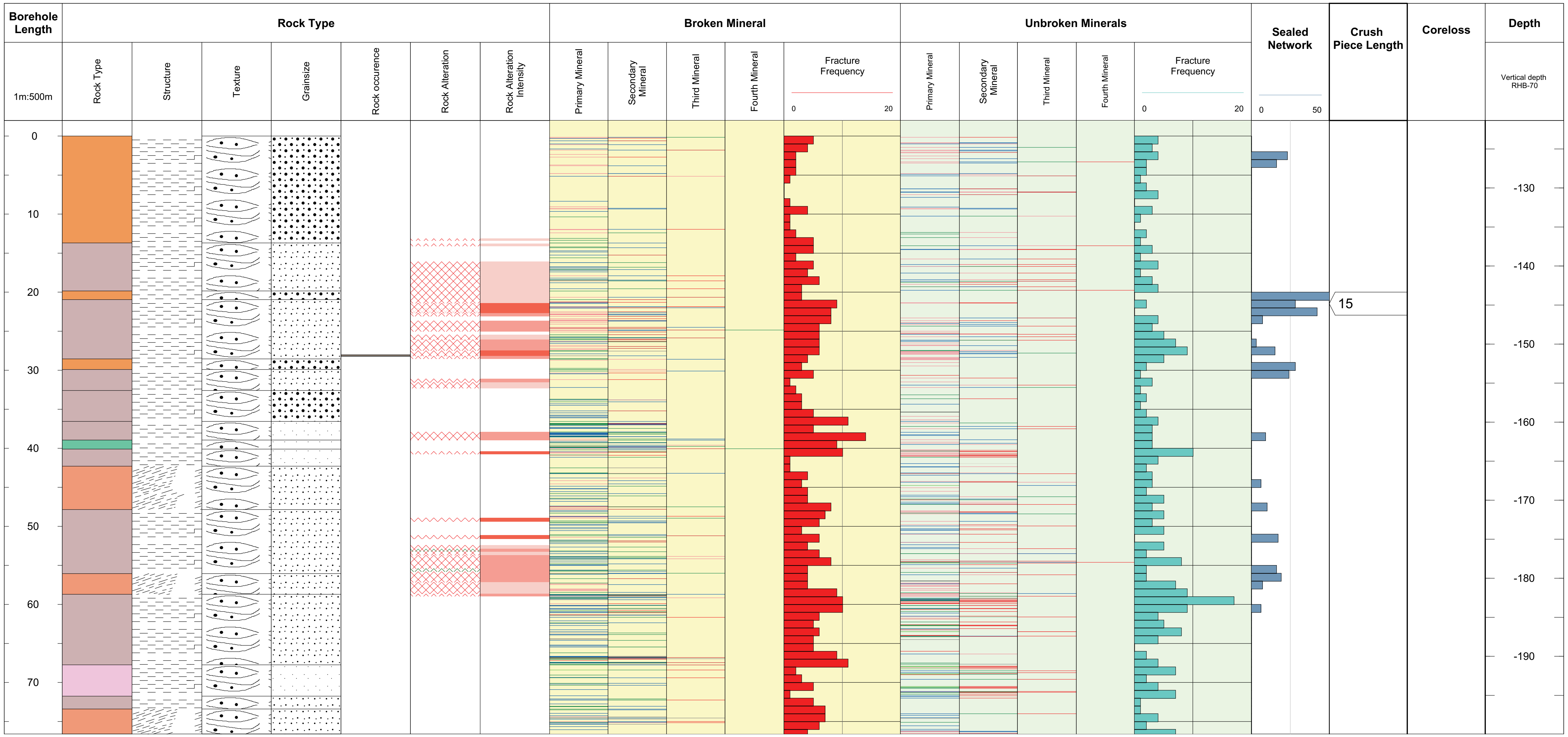
STRUCTURE
- Foliated
- Lineated

TEXTURE
- Metamorphic

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

ROCK ALTERATION
- Oxidized
- Chloritisized
- Laumontitization

MINERAL
- Epidote
- Hematite
- Calcite
- Chlorite
- Clay Minerals
- Laumontite



Title **GEOLOGY KFR35**

Site	FORSMARK - SFR	**Coordinate System**	RT90-RHB70
Borehole	KFR35	**Northing [m]**	6701956.28
Diameter [mm]		**Easting [m]**	1632915.93
Length [m]	140.200	**Elevation [m]**	5.10
Bearing [°]	208.11	**Plot Date**	2010-02-25
Inclination [°]	-51.49	**Date of mapping**	2007-10-04
Activity Type	GE038		

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

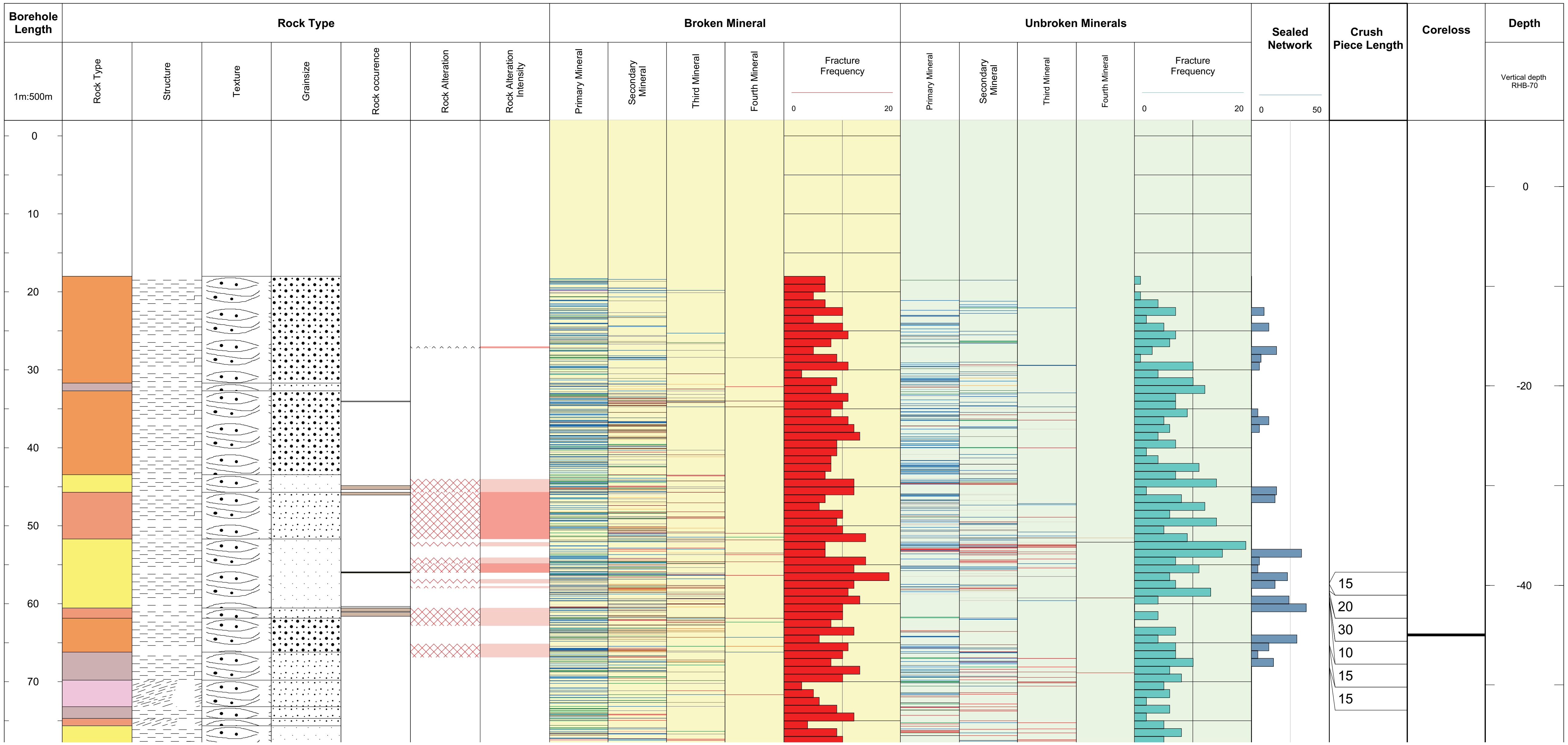
STRUCTURE
- Massive
- Foliated
- Lineated

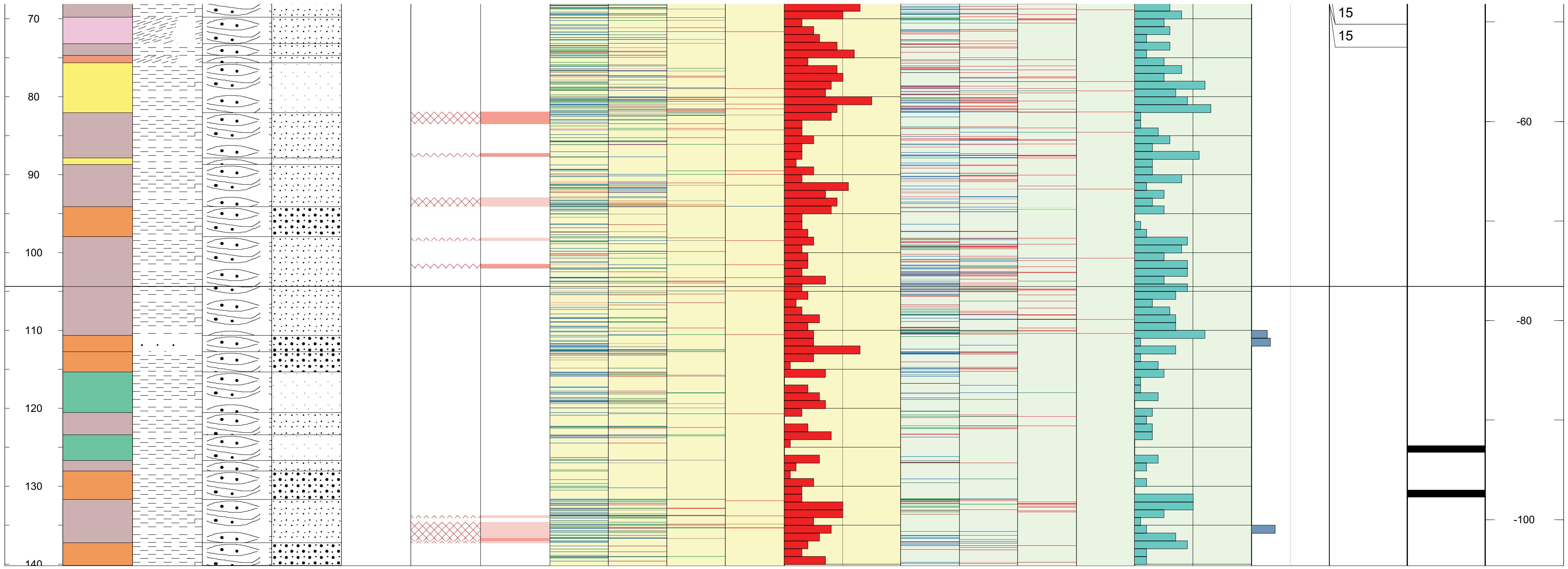
TEXTURE
- Metamorphic

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

ROCK ALTERATION
- Oxidized
- Carbonatization

MINERAL
- Flourite
- Hematite
- Calcite
- Chlorite
- Quartz
- Unknown
- Pyrite
- Clay Minerals
- Laumontite
- Asphalt
- Iron Hydroxide
- Oxidized Walls

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Title GEOLOGY KFR36

Site	FORSMARK - SFR	Coordinate System	RT90-RHB70
Borehole	KFR36	Northing [m]	6701922.23
Diameter [mm]		Easting [m]	1632792.99
Length [m]	123.900	Elevation [m]	5.00
Bearing [°]	291.71	Plot Date	2010-02-25
Inclination [°]	-45.99	Date of mapping	2007-10-04
Activity Type	GE038		

ROCKTYPE
- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granite, metamorphic, aplitic
- Granite to granodiorite, metamorphic, medium-grained
- Diorite, quarts diorite and gabbro, metamorphic
- Amphibolite
- Felsic to intermediate volcanic rock, metamorphic

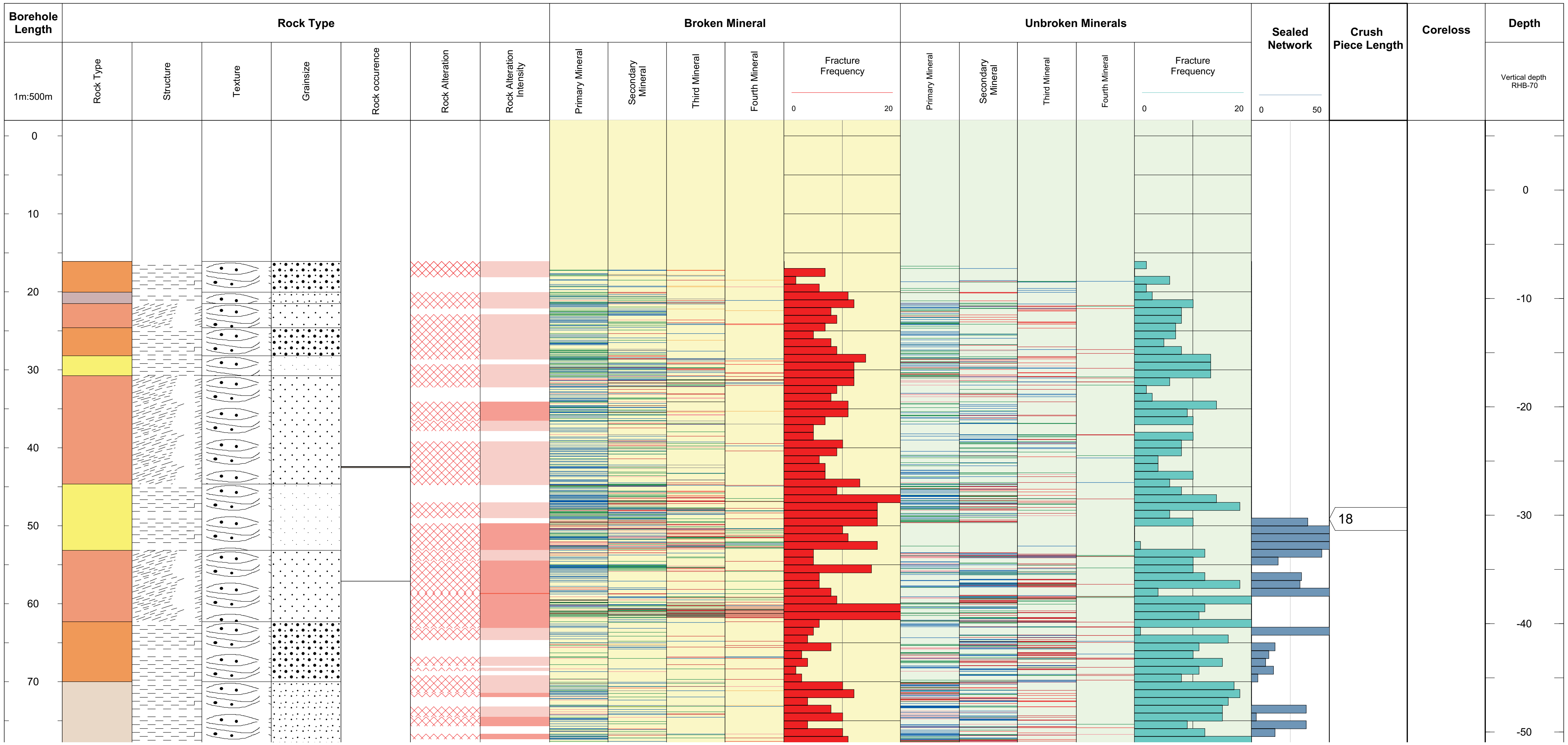
STRUCTURE
- Foliated
- Lineated

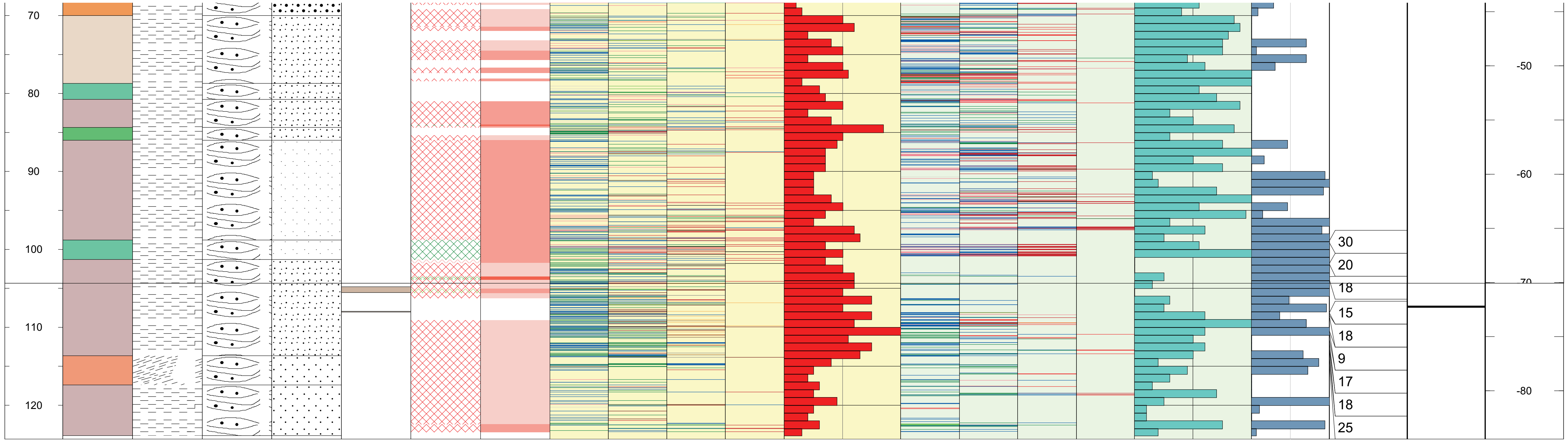
TEXTURE
- Metamorphic

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

ROCK ALTERATION
- Oxidized
- Chloritisized
- Epidotisized
- Steatitization
- Laumontitization

MINERAL
- Epidote
- Hematite
- Calcite
- Chlorite
- Quartz
- Unknown
- Clay Minerals
- Laumontite
- Zeolite
- Asphalt

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Title	GEOLOGY KFR54		
Site	FORSMARK - SFR	Coordinate System	RT90-RHB70
Borehole	KFR54	Northing [m]	6701949.71
Diameter [mm]		Easting [m]	1633102.00
Length [m]	53.300	Elevation [m]	-81.64
Bearing [°]	309.97	Plot Date	2010-02-25
Inclination [°]	-47.69	Date of mapping	2007-10-04
Activity Type	GE038		

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

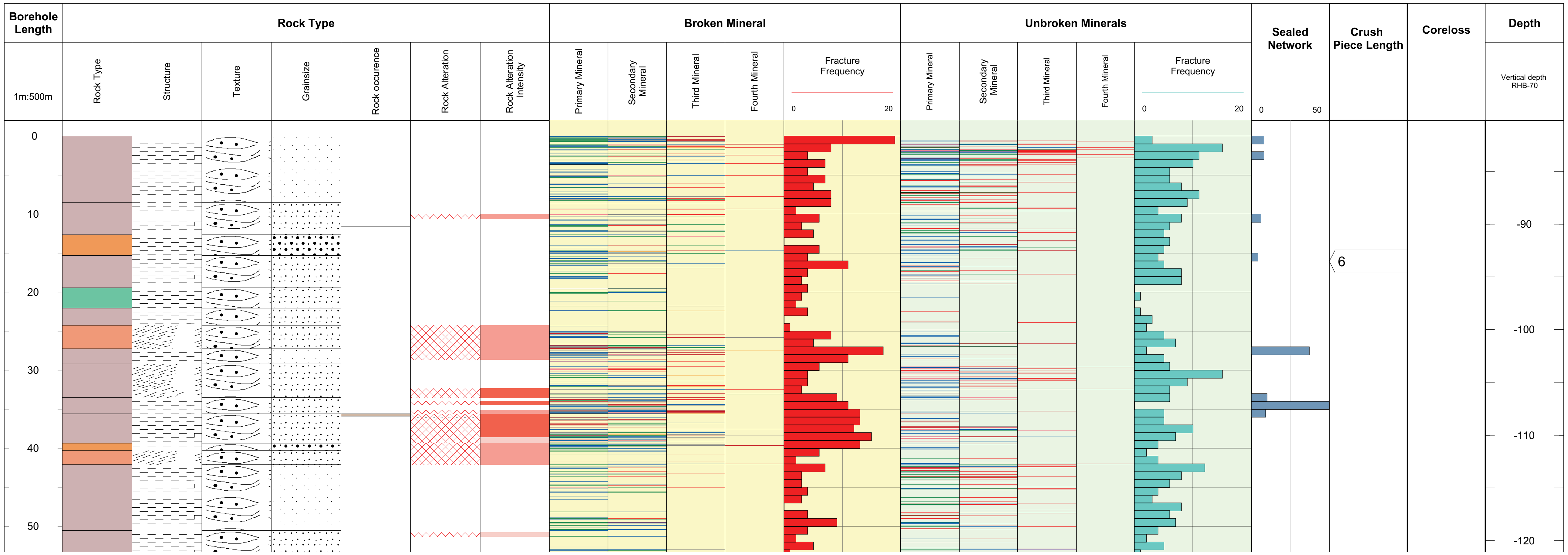
STRUCTURE
- Foliated
- Lineated

TEXTURE
- Metamorphic

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

ROCK ALTERATION
- Oxidized
- Argillization

MINERAL
- White Feldspar
- Hematite
- Calcite
- Chlorite
- Unknown
- Clay Minerals
- Laumontite
- Zeolite
- Prehnite



Title **GEOLOGY KFR55**

Site	FORSMARK - SFR	**Coordinate System**	RT90-RHB70
Borehole	KFR55	**Northing [m]**	6701930.05
Diameter [mm]		**Easting [m]**	1633094.49
Length [m]	61.890	**Elevation [m]**	-125.57
Bearing [°]	328.98	**Plot Date**	2010-02-25
Inclination [°]	-10.99	**Date of mapping**	2007-10-04
Activity Type	GE038		

ROCKTYPE
- Granite, fine- to medium-grained
- Pegmatite, pegmatitic granite
- Granite to granodiorite, metamorphic, medium-grained
- Felsic to intermediate volcanic rock, metamorphic

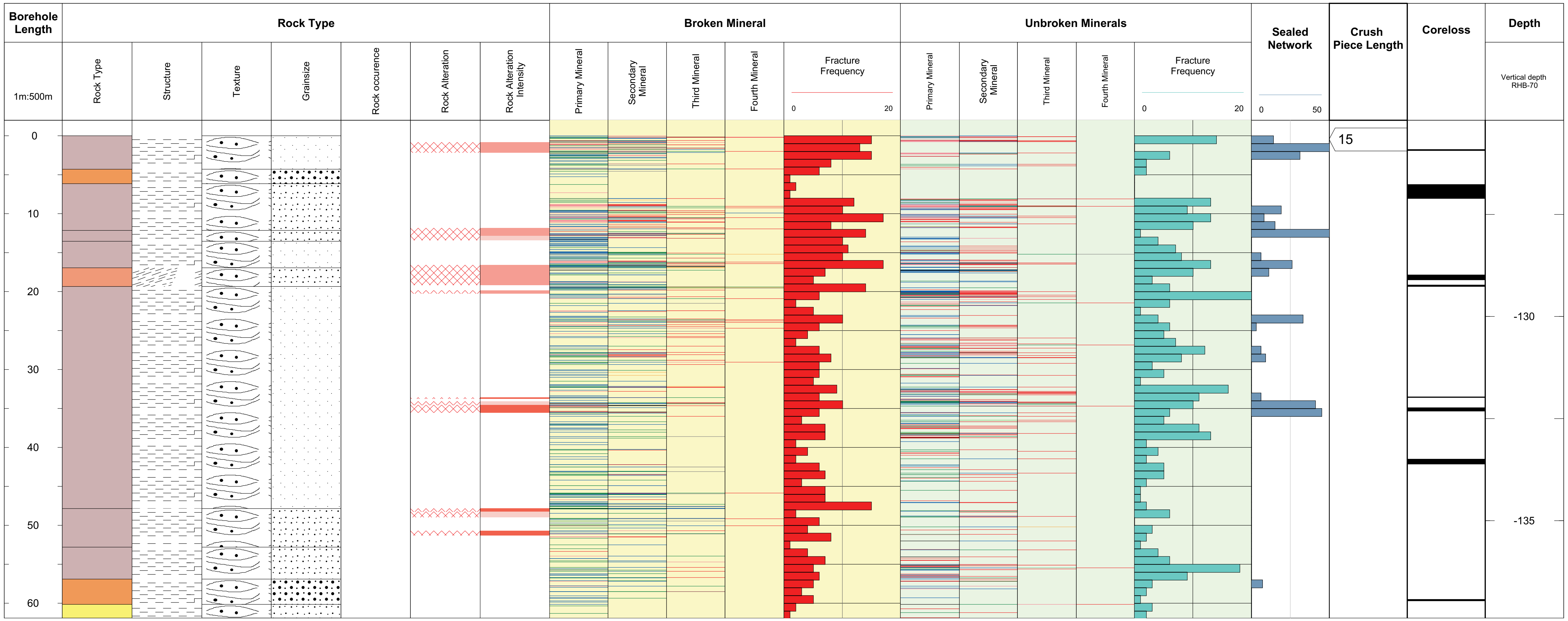
STRUCTURE
- Foliated
- Lineated

TEXTURE
- Metamorphic

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

ROCK ALTERATION
- Oxidized

MINERAL
- White Feldspar
- Oxidized Walls
- Hematite
- Calcite
- Chlorite
- Unknown
- Pyrite
- Clay Minerals
- Laumontite
- Zeolite



Title **GEOLOGY KFR7A**

Site	FORSMARK - SFR	**Coordinate System**	RT90-RHB70
Borehole	KFR7A	**Northing [m]**	6702020.20
Diameter [mm]		**Easting [m]**	1633107.36
Length [m]	74.700	**Elevation [m]**	-132.28
Bearing [°]	20.80	**Plot Date**	2010-02-25
Inclination [°]	-1.99	**Date of mapping**	2007-10-04
Activity Type	GE038		

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

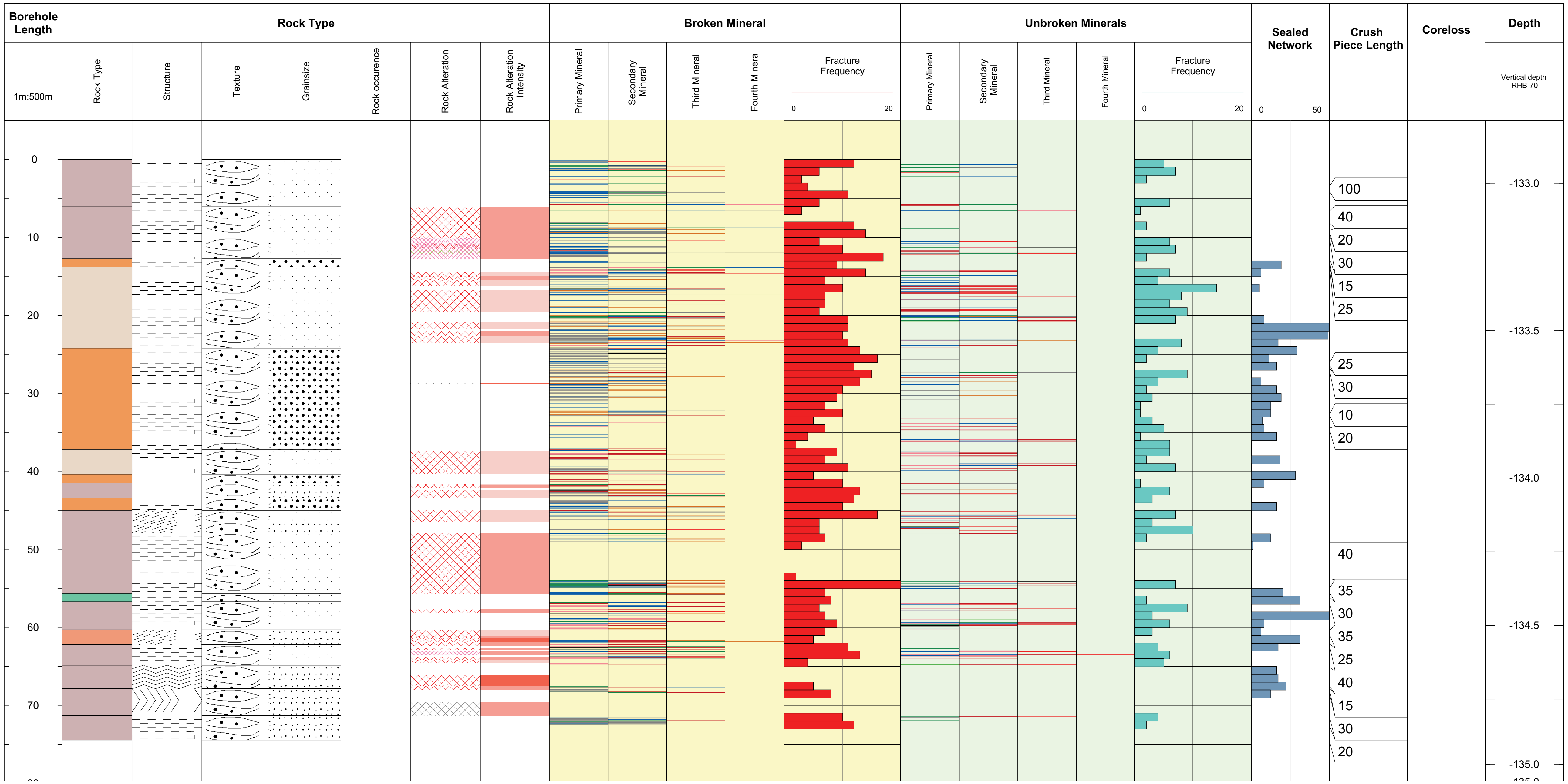
STRUCTURE
- Ductile Shear Zone
- Brittle-Ductile Zone
- Foliated
- Lineated

TEXTURE
- Metamorphic

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

ROCK ALTERATION
- Oxidized
- Epidotisized
- Argillization
- Albitization

MINERAL
- White Feldspar
- Oxidized Walls
- Hematite
- Calcite
- Chlorite
- Quartz
- Unknown
- Clay Minerals
- Laumontite
- Iron Hydroxide



Title GEOLOGY KFR7B

Site	FORSMARK - SFR	**Coordinate System**	RT90-RHB70
Borehole	KFR7B	**Northing [m]**	6702017.62
Diameter [mm]		**Easting [m]**	1633109.54
Length [m]	21.100	**Elevation [m]**	-133.24
Bearing [°]	11.50	**Plot Date**	2010-02-25
Inclination [°]	-74.99	**Date of mapping**	2007-10-04
Activity Type	GE038		

ROCKTYPE

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

STRUCTURE

- Foliated

TEXTURE

- Metamorphic

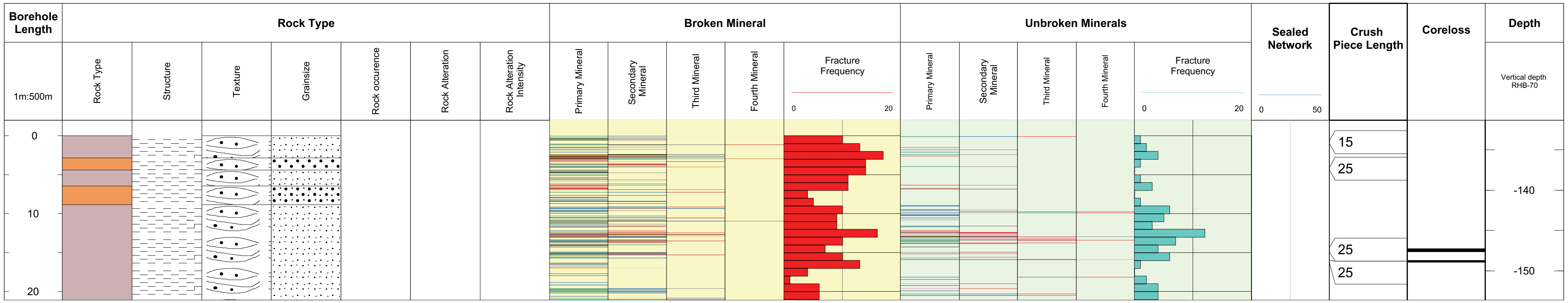
GRAINSIZE

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

ROCK ALTERATION

MINERAL

- White Feldspar
- Hematite
- Calcite
- Chlorite
- Unknown
- Pyrite
- Clay Minerals
- Iron Hydroxide



Title **GEOLOGY KFR7C**

Site	FORSMARK - SFR	**Coordinate System**	RT90-RHB70
Borehole	KFR7C	**Northing [m]**	6701999.29
Diameter [mm]		**Easting [m]**	1633100.63
Length [m]	34.000	**Elevation [m]**	-133.39
Bearing [°]	196.00	**Plot Date**	2010-02-25
Inclination [°]	-69.99	**Date of mapping**	2007-10-04
Activity Type	GE038		

ROCKTYPE

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

STRUCTURE

- Foliated

TEXTURE

- Metamorphic

GRAINSIZE

- Fine-grained
- Fine to medium grained
- Coarse-grained

ROCK ALTERATION

- Oxidized
- Argillization
- Albitization

MINERAL

- Epidote
- White Feldspar
- Hematite
- Calcite
- Chlorite
- Unknown
- Pyrite
- Clay Minerals
- Laumontite
- Iron Hydroxide