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April 2005

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This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the authors and do not necessarily coincide with those of the client.

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Abstract

This report presents the results from the Boremap mapping of telescopic drilled borehole KFM07A. The borehole is located close to the Forsmark camp area and plunges 60° towards west with the intention to investigate the rock volume along the north-western boundary of the candidate area. The full length of KFM07A is 1,001.55 m, and the BIPS-images of the core-drilled part cover the interval 101.91–994.00 m. All structures and lithologies intersected by the BIPS-logged interval have been documented in detail by integrating information from the drill core and the BIPS-image. The lowermost 7.55 m of the borehole, for which no BIPS-image was available, was mapped conventionally.

The borehole deviates northwards (~ 4°/100 m) and enters a belt of more intense brittle-ductile deformed bedrock, at a length of about 800 m (i.e. a true depth of c 650 m). The lithology within this more intensely deformed part is rather heterogeneous relative to the remaining part of the borehole, with an increased concentration of ductile high-strain zones, local enrichment of biotite ± muscovite and a general grain-size reduction. The predominant rock type in KFM07A is a medium-grained metagranite, which becomes more fine-grained and texturally blurred within the last 200 m of the borehole. Other rock types of volumetric importance are pegmatitic granite (especially in the lowermost 200 m of the borehole) and various amphibolites. Virtually all rocks have experienced Svecofennian metamorphism under amphibolite facies conditions.

Structurally, KFM07A is characterised by composite L-S fabrics, with a general predominance of planar mineral fabrics, striking N–S and dipping vertically or sub-vertically. A majority of all ductile and brittle-ductile deformation zones registered in KFM07A are concentrated in the lowermost 200 m of the borehole. All zones are more or less parallel with the local tectonic foliation, and their individual lengths range typically up to about one metre. A faint to weak oxidation or red discolouration of feldspars is locally encountered in the upper and lower 200 m of the borehole.

The total number of fractures registered in KFM07A is 3,243. However, only about one fifth of these fractures are inferred to be open or partly open. At least two, probably three distinct fracture sets can be distinguished in the borehole. The most well-defined group, preferentially found in the upper 100–220 m of the borehole, consists of near horizontal to gently dipping fractures. A considerable proportion of these fractures are inferred to be open and several have apertures that are clearly visible in the BIPS-image (i.e. > 1 mm). Nine of the ten crush zones found in KFM07A belong to this group. The most frequent infillings in this group are chlorite, calcite and clay minerals. Another conspicuous group, especially in the lowermost 200 m of the borehole, appears to include two steep fracture sets: one of mainly sealed fractures that strike roughly NE–SW, and a second of NNW–SSE striking fractures that are more or less parallel with the tectonic foliation. This latter set includes a considerable amount of open fractures. Most breccias and sealed networks belong to these two sets. The typical mineral assemblages in these fractures include laumontite, calcite, chlorite, adularia and sub-microscopic hematite.

Sammanfattning

Föreliggande rapport redovisar resultaten från Boremapkarteringen av teleskopborrhål KFM07A. Hålet är borrat från en plats i närheten av Forsmarks barrackområde och stupar 60° åt väst i syfte att undersöka bergvolymen längs den nordvästra begränsningen av kandidatområdet. Den totala längden av KFM07A är 1 001,55 m och BIPS-bilden över den kärnborrade delen täcker längdintervallet 101,91–994,00 m. Alla strukturer och bergartstyper som förekommer i det BIPS-loggade intervallet har dokumenterats i detalj genom att integrera information från borrkärnan och BIPS-bilden. De understa 7,55 m av borrhålet, för vilka det saknas BIPS-bild, är konventionellt karterade.

Borrhålet kröker norrut (~ 4°/100 m) och tvärar igenom ett område med mer kraftig spröd-plastisk deformation på en längd av ungefär 800 m (dvs ett djup på c 650 m). Berggrunden i denna mer kraftigt deformerade del är förhållandevis heterogen jämfört med den resterande delen av borrhålet, med en förhöjd koncentration av plastiska zoner, lokala anrikningar av biotit ± muskovit och en generell kornstorleksförminskning. Den dominerande bergarten i KFM07A är en medelkornig metagranit, som blir mer finkornig och får en otydligare textur i de nedersta 200 m av borrhålet. Andra bergarter av volymmässig betydelse är pegmatitisk granit (framför allt i de nedersta 200 m av borrhålet) och olika amfiboliter. I det närmaste alla bergarter har genomgått Svekofennisk amfibolitfacies-metamorfos.

KFM07A karakteriseras av en sammansatt L-S-struktur, med en förhärskande foliationskomponent, som stryker i N–S och stupar vertikalt till subvertikalt. En huvuddel av alla plastiska och spröd-plastiska deformationszoner som registrerats i KFM07A är koncentrerade till de nedre 200 m av borrhålet. Alla zoner är mer eller mindre parallella med den lokala foliationen och deras individuella utbredning längs borrhålet varierar normalt upp till ungefär en meter. En svag till mycket svag oxidation eller rödfärgning av fältspater förekommer lokalt i de övre och undre 200 m av borrhålet.

Det totala antalet registrerade sprickor i KFM07A är 3 243. Endast en femtedel av dessa har karterats som öppna eller partiellt öppna. Minst två, möjligen tre tydliga sprickgrupper kan urskiljas i borrhålet. Den mest väldefinierade gruppen, som företrädelsevis förekommer i de övre 100–220 m av borrhålet, utgörs av subhorisontella och flackt stupande sprickor. En betydande andel av dessa sprickor är registrerade som öppna och flera har öppningar som är klart synliga i BIPS-bilden (dvs > 1 mm). Nio av de tio krosszoner som påträffats i KFM07A ingår i denna grupp. De vanligaste sprickfyllnaderna i denna grupp är klorit, kalcit och lermineral. En annan tydlig grupp, speciellt i de understa 200 m av borrhålet, tycks omfatta två branta sprickuppsättningar: en med huvudsakligen läkta sprickor som stryker i NO–SV, och en med NNV–SSO strykande sprickor som är mer eller mindre parallella med den tektoniska foliationen. De senare omfattar ett stort antal öppna sprickor. Flertalet breccior och läkta spricknätverk ingår i dessa två sprickuppsättningar. Laumontit, kalcit, klorit, adularia och submikroskopisk hematit är typiska mineral i dessa sprickor.

Contents

1 Introduction

Since 2002, SKB investigates two potential sites at Forsmark and Oskarshamn, for a deep repository in the Swedish Precambrian basement. In order to characterise the bedrock down to a depth of about 1 km in the central part of the test site area at Forsmark, three deep telescopic boreholes were drilled. Each borehole starts with 100 m of percussion drilling, followed by core drilling down to about 1,000 m depth. To obtain drill cores for the upper 100 m, additional boreholes were drilled adjacent to telescopic boreholes at drill site (DS) 1 and 3. After completion of these initial drillings, SKB launched a more extensive, complementary drilling programme, aiming to solve more specific geological questions. An important aspect when localizing KFM07A, was to investigate the rock volume along the north-western boundary of the candidate area (Figure 1-1). Consequently, the borehole was set close to the Forsmark camp area and plunges 60° towards west. The borehole is a telescopic borehole (cf MD 620.004, SKB internal controlling document), identical with the six previous deep boreholes in the area, with a total length of about 1,000 m. The drilling activities in KFM07A were finished during December 2004. The geological logging of KFM07A started in January and was finished in March 2005.

A detailed mapping of the material obtained through the drilling programs is essential for subsequent sampling and borehole investigations, and consequently, for the three-dimensional modelling of the site geology. For this purpose, the so-called Boremap system has been developed. The system integrates results from drill core mapping, or alternatively, the drill cuttings from percussion drilled boreholes, with information from BIPS-logging (Borehole Image Processing System) and calculates the absolute position and orientation of fractures and various lithological features (MD 143.006 and MD 146.005, SKB internal controlling documents).

This report presents the results from the mapping of KFM07A in the Boremap system. The work was carried out in accordance with activity plan AP PF 400-04-115. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are part of SKB's internal controlling documents.

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

Activity plan	Number	Version
Boremapkartering av teleskopborrhål KFM07A.	AP PF 400-04-115	1.0
Method documents	**Number**	**Version**
Metodbeskrivning för Boremap-kartering.	SKB MD 143.006	1.0
Nomenklatur vid Boremap-kartering.	SKB MD 143.008	1.0
Mätsystembeskrivning för Boremapkartering, Boremap v 3.0.	SKB MD 146.005	1.0

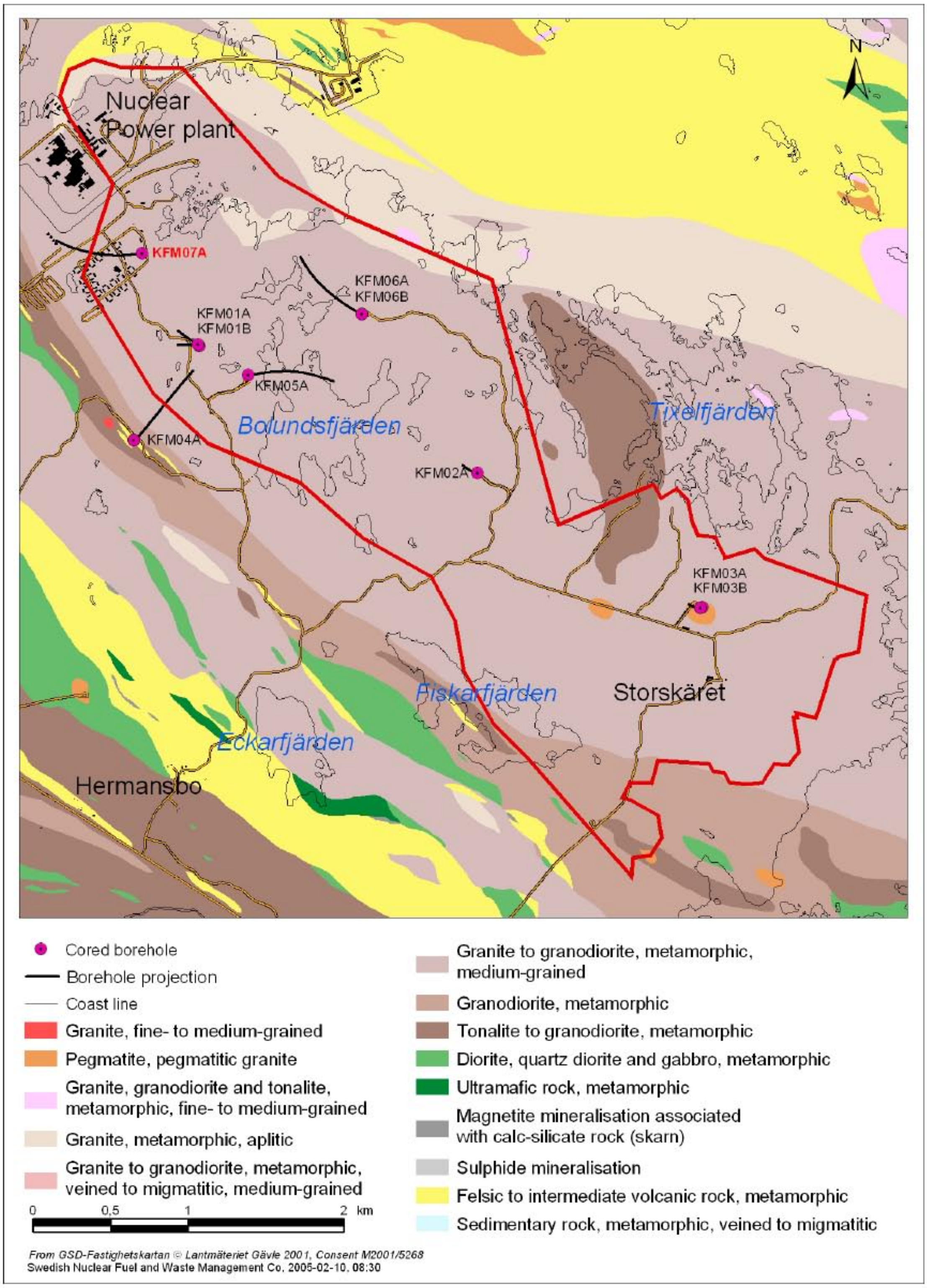


Figure 1-1. *Generalized geological map over Forsmark site investigation area showing the projection of KFM07A in relation to other cored boreholes from the drilling programme.*

2 Objective and scope

Borehole KFM07A starts with percussion drilling (Ø = 165 mm) to a length of 100.40 m, followed by core drilling at Ø = 77 mm down to full borehole length at 1,001.55 m. The diameter of the drill core is 51 mm. The soil cover is about 3.8 m and the BIPS-image from the upper, percussion-drilled part of the borehole covers the length interval 9.00–99.86 m. The percussion drilled part was not included in the mapping engagement, due to the forthcoming drilling of KFM07B that will yield a complimentary drill core for this interval. The usable BIPS-image of the cored part of the borehole covers the length interval 101.91–994.00, after adjustment. Thus, there is no BIPS-image available for the last 7.55 m of the borehole, from 994.00 to 1,001.55 m.

The aim of the Boremap mapping is to obtain a detailed documentation of all structures and lithologies intersected by the BIPS-logged intervals of borehole KFM07A. In addition, the engagement includes conventional mapping of the drill core from the lowermost 7.55 m of the borehole. These data will serve as a platform for forthcoming analyses of the drill cores, aimed at investigating geological, petrophysical and mechanical aspects of the rock volume, as well as site descriptive modelling.

3 Equipment

3.1 Description of equipment and interpretation tools

All BIPS-based mapping was performed in Boremap v 3.5.0.0. This software contains the bedrock and mineral standard used by the Geological Survey of Sweden (SGU) for geological mapping of the surface at the Forsmark investigation site, to enable correlation with the surface geology. Additional software used during the course of the mapping was BIPS Viewer v 1.10 and Microsoft Access. The final data presentation was made by Geoplot and WellCAD v 3.2.

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

4 Execution

4.1 General

During the mapping, the c 900 m drill core obtained from the interval 100.40–1,001.55 m of KFM07A was available in its full length on roller tables in the core-mapping accommodation at Forsmark (the Llentab hall, near the SKB/SFR-office). The BIPS-based mapping of KFM07A was preceded by an overview mapping made by Kenneth Åkerström. No thin-sections were available from the drill cores, and all lithological descriptions are based on ocular inspection. Three geologists from SwedPower AB, Jesper Petersson, Göran Skogsmo and Anders Wängnerud, were involved in the actual mapping, though only two geologists were active at a time, forming a mapping team.

This document reports the results gained by the Boremap mapping of KFM07A, which is one of the activities performed within the site investigation at Forsmark. The work was carried out with Boremap v 3.5.0.0 in accordance with activity plan SKB AP PF 400-04-115.

The generalised geophysical logs arrived in the beginning of March, when the mapping reached a borehole length of about 700 m. A WellCAD summary of the mapping is presented in Appendix 1.

4.2 Preparations

The length registered in the BIPS-image deviates from the true borehole length with increasing depth, and the difference at the bottom of the borehole is about 5 m. The length is adjusted with reference to groove millings cut into the borehole wall at every 50 m, with the deepest slot at a length of 980 m. The exact level of each reference mark can be found in SKB's database SICADA (Appendix 4). However, the adjusted length is still not completely identical with the one given in the drill core boxes, as the core recovery may yield erroneous lengths. The difference at every 50 m is given in Table 4-2, and may locally exceed 3 dm.

Data necessary for calculations of absolute orientation of structures in the borehole includes borehole diameter, azimuth and inclination, and these data were imported directly from SKB's database SICADA (Appendices 2 and 3). Corrections for the borehole deviation were done at every twelfth metre.

Table 4-2. Differences between adjusted length in the BIPS-image and the length given in the drill core boxes.

Adjusted length in BIPS (m)	Approximate length in the drill core boxes (m)	Difference (m)
102.10	101.95	+0.15
150.00	149.975	+0.025
200.00	200.00	± 0.00
250.00	250.08	–0.08
300.00	300.03	–0.03
350.00	349.99	+0.01
400.00	400.015	–0.015
450.00	450.055	–0.055
500.00	500.07	–0.07
550.00	550.08	–0.08
600.00	599.95	+0.05
650.00	650.14	–0.14
700.00	700.22	–0.22
750.00	750.31	–0.31
800.00	800.16	–0.16
850.00	850.19	–0.19
900.00	900.20	–0.20
950.00	950.34	–0.34

4.3 Data handling

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

To avoid that some broken fractures become unregistered, the number of broken fractures in the drill core was regularly checked against the number of registered fractures. The quality routines include also daily controls of the mapping by detailed examination of Boremap generated variable/summary reports and WellCad log to match. The final quality check of the mapping was done by a routine in the Boremap software. The data were subsequently exported to the SKB database SICADA and stored under field note no Forsmark 460.

4.4 Analyses and interpretations

The Boremap system has obviously some limitations, since all geological features must be represented by intersecting planar surfaces. Non-planar structures, such as small scale folding, linear features (e.g. mineral lineation) and curved fractures can therefore not be correctly documented. The major problem is curved structures (e.g. fractures), which run almost parallel with the borehole axis. During the mapping sessions of KFM07A, such features were normally approximated by fitting the plane after one of their ends in the borehole. The fact that some of these structures do not actually intersect the borehole is only noted in the attached comments.

Another shortage with the mapping system is related to geological features (mainly fractures) that can be observed only in the drill core. This shortage usually arises from poor resolution in the BIPS-image, which in this case, often is caused by the presence of suspended drill cuttings and/or brownish black coating on the borehole walls. However, even in the most perfect BIPS-image, it is sometimes difficult to distinguish a thin fracture sealed by some low contrast mineral. All fractures observed in the drill core, but not in the BIPS-image, have been registered as 'not visible in BIPS' in Boremap to prevent them from being used in forthcoming fracture orientation analysis. Fractures suspected to be induced by drilling fall within this category. Obviously drill-induced fractures are not included in the mapping.

Even though reliable measurements of fracture widths/apertures ≤ 1 mm would be possible to obtain in the drill core, it is often beyond the resolution of the BIPS-image. The minimum width/aperture given is, therefore, 0.5 mm. However, if the fracture width measured in the drill core is much less, it is normally noted in the attached comment.

The 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. To decide if a fracture actually was open or sealed in the rock volume (i.e. in situ), SKB has developed a confidence classification expressed at three levels, 'possible', 'probable' and 'certain', based on the weathering and fit of the fracture planes. The criteria for this classification are given in SKB method description for Boremap mapping, SKB MD 143.006 (v 1.0).

Up to four infilling minerals can be registered in each fracture. As far as possible, they are given in order of decreasing abundance in the fracture. Additional minerals, which occur in a few fractures, are noted in the attached comment. However, it must be emphasized that this provides no information on the volumetrical amount of individual minerals. In a fracture with two minerals, the mineral registered as 'second' may range from sub-microscopic staining up to amounts equal to that of the mineral registered as 'first'. Hematite, for example, which is found in more than 18% of the registered fractures in the cored interval of KFM07A, occurs consistently as extremely thin coatings or impurities in other fracture minerals.

The last 7.55 m of the drill core, for which no BIPS-image is available, was mapped conventionally. The results are reported in Appendix 5, and include rock type, occurrences, alterations and a separation of fractures into unbroken, broken, sealed and open.

4.5 Nonconformities

A large amount of the fractures intersected by KFM07A are sealed by laumontite (Ca-zeolite). These fractures occur as both broken and unbroken, but dehydration of laumontite tends produce volumetrical changes, and the sealing will eventually crackle and break the drill core. Thus, all laumontite-bearing fractures suspected to have been sealed originally are registered as unbroken.

Some fracture filling minerals are more conspicuous than other. For example, the distinct red tinting shown by sub-microscopic hematite impregnation 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.

As in previous cored boreholes, the mapping was locally hampered by suspended drill cuttings, brownish black coatings on the borehole walls as well as turning of the borehole walls. The moderate plunge of the last 200 m of KFM07A (< 53°; Appendix 3) in combination with the turning have locally led to mottling of the BIPS-image. Geological structures (e.g. fractures) depicted in these mottled intervals are typically highly distorted, and the registered orientations may, consequently, differ greatly from the actual orientations. However, the amount of dark coating is generally less than in the first four boreholes in the area. This coating phenomenon is obviously drill induced, and the explanation proposed by /Askling and Odén, 2004/ is that the coatings originate from metal fragments abraded from the drill pipes.

Core loss has been noted at the following three length intervals of KFM07A: 116.46–117.29, 128.61–128.64 and 129.28–129.95 m. Fractures and a crush zone visible in the BIPS-image from these intervals were, nevertheless, recorded, but all registered characteristics, except for orientation, width and aperture, are highly uncertain.

Both during the mapping and the subsequent work with the mapping data, we noted a number of inexplicable errors in the database. These were all corrected, though there might still be unnoticed errors. We disclaim the responsibility for all such errors caused by the shortcomings in the software.

5 Results

5.1 General

Borehole KFM07A is located in the north-western part of the test site area and plunges 60° westward, towards the ductile, high-strain belt, which defines the south-western margin of rock domain RFM029 /cf SKB, 2004/. However, the borehole deviates northwards (ca 4°/100 m) and enters a belt of more intense brittle-ductile deformated bedrock at a length of about 800 m (i.e. a true depth of c 650 m). The lithology within this high-strain interval is rather heterogeneous relative to the remaining part of the borehole, and deformational grain-size reduction and superimposed alterations have locally rendered the recognition of individual rock units difficult. Another striking feature in this interval is the increased frequency of pegmatitic granite.

5.2 Core lithology

The predominant rock type in KFM07A is a medium-grained metagranite (rock code 101057) with a tendency to be slightly granodioritic. This is also the most abundant rock type in the last 200 m of the borehole that penetrates the high-strain belt. However, the character of the rock changes somewhat here and it becomes more fine-grained. Other rock types of volumetric importance are pegmatitic granite (rock code 101061) and various amphibolites (rock code 102017). Fine- to finely medium-grained leucogranites (111058) and metagranitoids (101051), which are frequent in some of the other deep boreholes in the Forsmark area /Petersson and Wängnerud, 2003; Petersson et al. 2003a, 2004a,b/, are rather scarce and limited to a few minor occurrences. Except for some late veins or dykes, all rocks in KFM07A have experienced Svecofennian metamorphism under amphibolite facies conditions.

The medium-grained metagranite (rock code 101057) is identical with the predominant variety of metagranite-granodiorite in the other deep boreholes located in RFM029 of the Forsmark area /SKB, 2004/. In KFM07A, it occupies about 77% of the mapped interval. Texturally, the rock is rather equigranular with elongated domains of quartz, alternating with feldspar-dominated domains and thin streaks of biotite. The fine-to finely medium-grained variety in the lowermost 200 m of the borehole displays typically a more blurred texture, locally with an increased content of biotite. The colour of the rock varieties ranges from greyish red to grey. A completely grey variety, lacking the reddish tint, forms a more or less continuous length interval between approximately 500 and 800 m. This coincides with a distinct increase in the magnetic susceptibility /cf Mattsson, 2005/. Minor sections variably speckled by fine-grained, whitish plagioclase occur sporadically throughout the borehole. Microscopic examination of similar rocks from KFM01A and KFM03A suggests that the feature is a result of retrograde sericitization /Petersson et al. 2004c/.

Dykes, veins and segregations of pegmatite and pegmatitic granite (rock code 101061) are frequent throughout the borehole, and the rock type occupies slightly more than 14% of the mapped interval. Most occurrences are some decimetre or less, but there are several exceptions, especially in the lowermost 200 m of the borehole, which reach up to a few metres in width. The most extensive occurrence forms a more or less continuous intrusive at the length interval 942–966 m. The pegmatitic granites are generally texturally heterogeneous, often with a highly variable grain-size, and some occurrences include intervals of finely medium-grained, equigranular granite. Rather coarse magnetite, and subordinately hematite, has been identified in several pegmatites. Other frequent minerals, typically found in accessory amounts, are garnet, pyrite and pyrrhotite. Considering the orientation of the pegmatites and pegmatitic granites, the vast majority are oriented parallel with the tectonic foliation and tends to form two groups: one with vertical or sub-vertical contacts that strike N–S and the other with E–W trending contacts that dip moderately towards south (Figure 5-1). Rocks related to the pegmatitic material, such as fine to finely medium-grained leucogranite (111058) and some minor aplites, constitute less than 2% of the mapped interval. Some of the leucogranites are highly reminiscent of the more granitic varieties of the fine- to finely medium-grained metagranitoids discussed below. A distinctive criterion apart from their late-tectonic character is, however, their anomalously high natural gamma radiation /cf Mattsson, 2005/. The aplites, on the other hand, have been separated into two types on the basis of their tectonic character. Those that show a distinct foliation were mapped as “aplitic metagranite” (rock code 101058), whereas more massive occurrences were registered as “aplite” (rock code 1062). Quartz-dominated segregations or veins were coded as 8021. Some of them are sulphide bearing with scattered grains of pyrite and pyrrhotite.

Amphibolites (rock code 102017) and related rocks occupy 5.8% of the total mapped interval of KFM07A. All extensions and contacts are more or less parallel with the tectonic foliation (Figure 5-1). Generally, the amphibolites are fine-grained, equigranular with a large proportion of biotite. Disseminations of pyrite and/or pyrrhotite are macroscopically visible in some of the occurrences. None of the amphibolites form occurrences that exceed a few metres in core-length, and some are surrounded by up to 1 dm wide rims of whitish, leucogranitic material. These whitish intervals are obviously of metasomatic origin and believed to be the result of intense albitization. A continuous, over 200 m long interval affected by this alteration has been recorded in KFM06A /Petersson et al. 2005/. Similar occurrences, which are clearly disconnected from the amphibolites, are locally associated with grey varieties of the medium-grained metagranite (101057) between 608 and 841 m in KFM07A. However, individual occurrences are typically vaguely defined and few exceed a few decimetres in length. Based on the fact that some cutting veins of fine- to finely medium-grained metagranitoids (rock code 101051) seem unaffected by the whitening, it is suggested that the alteration is syn-metamorphic. There is, moreover, no apparent relationship to existing brittle structures. For more details on the whitened rock see /Petersson et al. 2005/.

Some minor occurrences of inferred skarn-like material (rock code 108019) occur locally in association with the whitened intervals in KFM07A. They are all vaguely defined and distinguished by their visible content of epidote and/or prehnite. Other conspicuous components are quartz, magnetite and garnet. Individual occurrences range up to about 2 dm in length. A minor magnetite mineralization associated with skarn-like material at 799.56–799.60 m has the rock code 109014.

Other rocks registered in KFM07A includes some minor (< 4 dm in length) occurrences of fine- to finely medium-grained metagranitoids (rock code 101051) of mostly granodioritic composition and a fine-grained rock of dacitic composition at 501.76–503.59 m that were coded as ‘intermediate metavolcanic rock’ (rock code 103076). In addition, there are a few minor occurrences of quartz diorite, tonalite and granodiorite in the length interval 714–756 m and one at 537.66–537.70 m. None of them appears to fit into the bedrock nomenclature defined by SKB (‘Regler för bergarters benämningar vid platsundersökningarna i Simpevarp och Forsmark’, v 1.0). Instead they were coded as 1038 (unspecified quartz diorite), 1053 (unspecified tonalite) and 1056 (unspecified granodiorite).

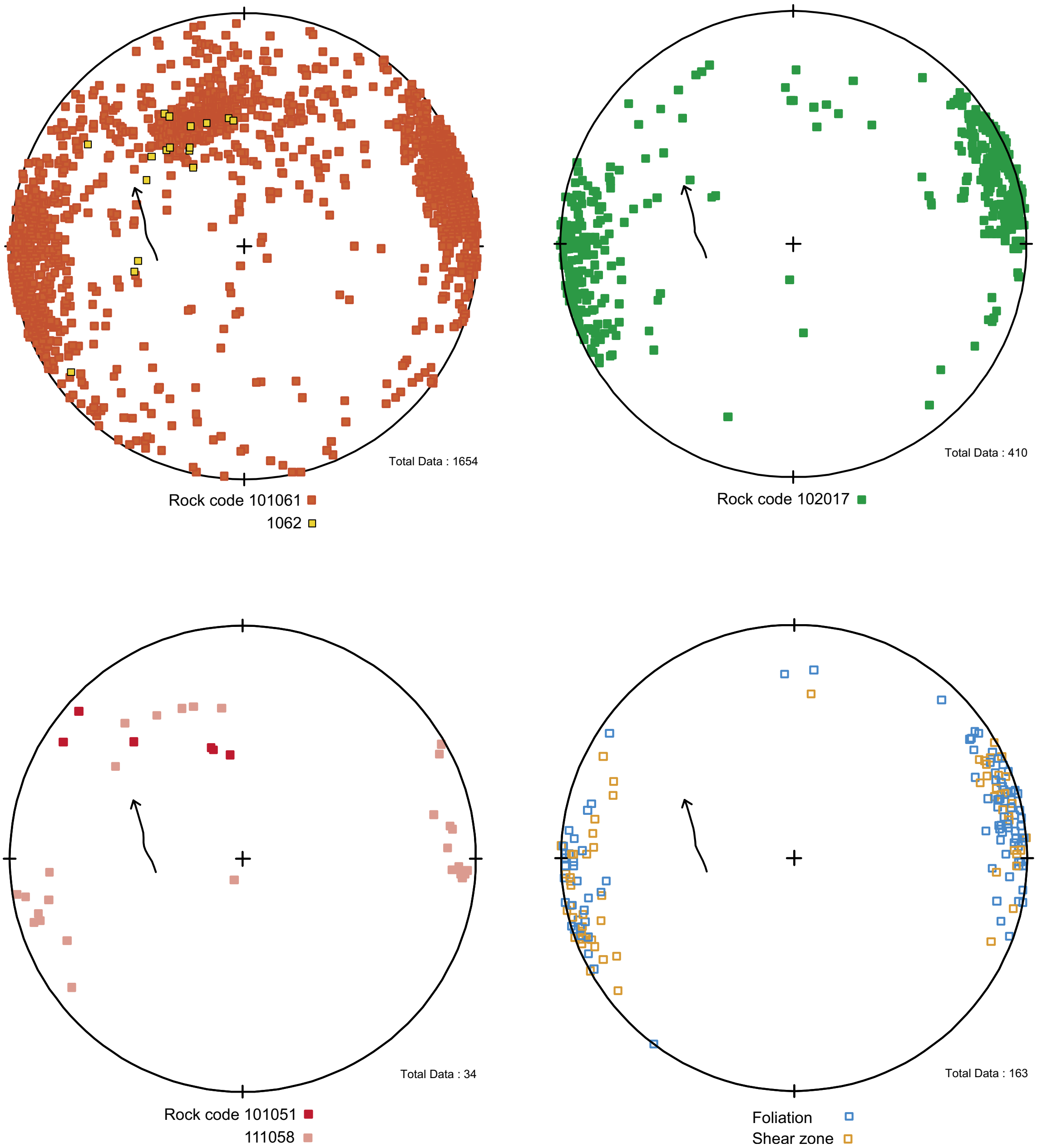


Figure 5-1. *Lower hemisphere, equal-area stereographic projection showing poles to upper and lower rock contacts for dyke- or vein-like rock occurrences pegmatitic granites (101061), aplite (1062), amphibolites (102017), fine- to medium-grained metagranitoids (101051) and fine- to medium-grained granites (111058)) and ductile/brittle-ductile planar structures in KFM07A. Arrows mark the orientation of the borehole axis towards depth.*

5.3 Ductile structures

Based on the intensity of the ductile strain, KFM07A can be divided into a lower, 'high-strain part', comprising the lowermost 200 m of the borehole, and an upper part where the ductile deformation is less intense. The rocks in the upper part are characterised by composite L-S fabrics, with a general predominance of distinct planar mineral fabrics. However, it often is difficult to distinguish tectonic fabric visually in the pegmatites and some of the fine-grained mafic rocks, but the fact that these appear massive does not necessarily mean that they actually are post-kinematic. The more intensely deformed part, on the other hand, is characterised by an increased concentration of ductile high-strain zones, local enrichment of biotite ± muscovite and a general grain-size reduction. The orientation of the foliation is more or less consistent throughout the borehole with N–S strike and vertical or sub-vertical dips (Figure 5-1). There is, however, one exception at about 905–915 m, where the foliation abruptly changes in orientation and strikes E–W. None of the linear fabrics have been possible to register, though the general impression is that they are gently to moderately dipping.

Totally 62 zones of more intense ductile and brittle-ductile deformation have been registered in KFM07A. About 75% of these are concentrated in the lowermost 200 m of the borehole. The length of individual zones ranges typically up to about 1 m. However, one continuous zone at 986.96–991.86 m reach almost 6 m. The formation of at least some of these zones precedes evidently the intrusion of the post-kinematic aplites (1062)(Figure 5-2). The protolith in the zones seems mainly to consist of a highly deformed and grain-sized reduced variety of the metagranite (101057). Some of the zones are intimately associated with occurrences of inferred skarn-like material and amphibolites. All ductile and brittle-ductile shear zones in the boreholes are more or less parallel with the local tectonic foliation (Figure 5-1). Thus, except for one steep, E–W striking zone at 905.36–905.46, all recorded zones are vertical to sub-vertical and strike roughly N–S.

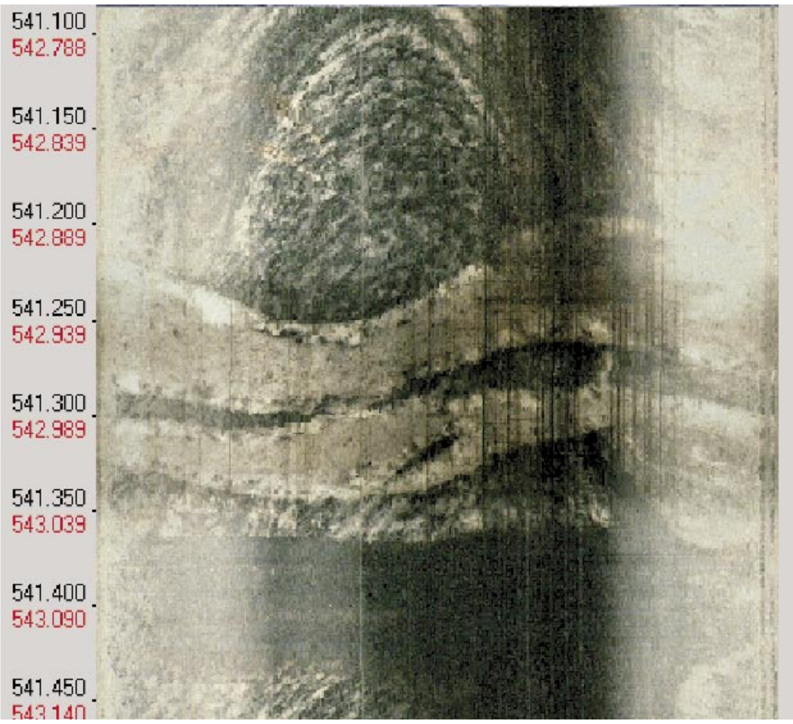


***Figure 5-2.** BIPS-image from the length interval 542.77–543.15 m of KFM07A, illustrating a high-strain zone cut by two veins of aplite (rock code 1062). Note the two fractures with oxidized walls visible in the upper left part of the image.*

5.4 Alteration

Besides the metasomatic whitening as discussed in section 5.1, the most common alteration encountered in KFM07A is varying degrees of oxidation or red discolouration of feldspars by sub-microscopic hematite impregnation. It is almost always associated with more intensely fractured intervals. Most oxidation is, therefore, encountered in the upper and lower 200 m of the borehole, and about 11% of the cored interval has been affected. The majority of this oxidation is faint to weak, and more rarely medium to strong, in intensity.

Other types of alterations are mainly concentrated to the lowermost, more intensely deformed part of KFM07A, and include above all chloritization and probable muscovitization, but also minor occurrences of epidotization, argillization, sassuritization, carbonatization and prehnitization. The chloritization is mainly restricted to amphibolites, whereas the probable muscovitization (registered as 'sericitization' in Boremap) typically occurs in ductile high-strain zones enriched in biotite. Individual occurrences are generally less than a few decimetres in length, though an interval of probable muscovitization reaches 3.3 m.

5.5 Fractures

5.5.1 Fracture frequencies and orientations

Excluding crush zones and sealed networks, the total number of broken (parting the core) and unbroken (not parting the core) fractures registered within the cored interval of KFM07A amounts to 3,243, i.e. about 3.6 fractures/m. However, the difference in fracture frequency between the ductile high-strain part below 790 m in the borehole and the upper part, characterised by less intense ductile deformation, is striking, with 6.9 and 2.6 fractures/m, respectively. The value for the upper part is comparable with the fracture frequencies yielded in the previous deep boreholes within the tectonic lens, which range from 1.7 to 4.3 fractures/m /Petersson and Wängnerud, 2003; Petersson et al. 2003a,b, 2004a,b, 2005/. Throughout all these intervals, the frequency of open and sealed fractures varies rather coherently, with an increased number of open fractures in intervals with concentrations of sealed fractures (Appendix 1). However, only about one fifth of all fractures registered in KFM07A are inferred to be open (broken fractures with aperture > 0) or partly open (unbroken fractures with aperture > 0). The proportion of open fractures tends to increase towards the surface.

It is reasonable to expect that mechanical discontinuities, such as lithological contacts, should be the locus of fracture formation. For this reason we have noted the proportion of fractured amphibolite contacts. About 23% of the contacts in the mapped interval of KFM07A are fractured, though more than 90% of these fractures occur adjacent to amphibolites in the lowermost 200 m of the borehole. This can be compared with KFM02A, KFM03A, KFM04A, KFM05A and KFM06A+B, in which 22–35% of the contacts are fractured /Petersson et al. 2003a,b, 2004a,b, 2005/.

The fracture orientations vary considerably throughout KFM07A, though the stereographic projections in Figure 5-3 reveal at least two, probably three distinct fracture sets. The most well-defined group, mainly found in the upper 220 m of the borehole, consists of near horizontal to gently dipping fractures (Figure 5-3). A considerable proportion of these fractures are inferred to be open and several have apertures that are clearly visible in the BIPS-image (i.e. > 1 mm). A few apertures reach up to 3–3.5 mm. Nine of the ten crush zones found in the cored interval of KFM07A belong to this group.

Of these zones are eight limited to the upper 270 m of the borehole. Another conspicuous group, especially in the lowermost 200 m of the borehole, consists of vertical to sub-vertical fractures with strikes that range from NNW–SSE to NE–SW (Figure 5-3). However, this group appears to be composed of two fracture sets: one of mainly sealed fractures that strike roughly NE–SW, and a second of NNW–SSE striking fractures that are more or less parallel with the tectonic foliation. This latter set includes a considerable amount of open fractures (Figure 5-3).

Totally ten breccia zones and 109 sealed fracture networks have been registered in KFM07A. However, the distinction between breccia and sealed fracture network is not straight forward, but normally zones with only minor rotation of individual rock fragments has been mapped as sealed fracture network. All breccias and three forth of all sealed fracture networks occur in the lowermost 200 m of the borehole. Most breccias and sealed fracture networks belong to the NNW–SSE to NE–SW striking fracture group (Figure 5-3). Except for the registered breccia zones, fractures with measurable reverse displacements, indicating that they have been initiated or reactivated as shear fractures, are found at eight levels in KFM07A: 155.10, 170.67, 171.01, 440.05, 440.09, 889.95, 963.30 and 975.65 m. From 830 m to the bottom of the borehole, there is also a marked increase in the frequency of slickensided fractures.

Inferred core discing occurs sporadically in the lowermost 150 m of the drill core. In addition, there is an interval at 531.61–531.83 m. Some intervals include also initial core discing that not actually breaks the core. None of the intervals exceed 3 dm in width, and the typical dimension of individual discs range between 1 and 3 cm. The fractures are all planar to slightly saddle-shaped.

5.5.2 Fracture mineralogy

Chlorite and/or calcite are found in three fourth of the total number of the registered fractures in KFM07A. These minerals are frequent in all abovementioned fracture groups. Other infilling minerals, in order of decreasing abundance, include laumontite, sub-microscopic hematite, adularia, quartz, undifferentiated clay minerals, prehnite, pyrite, epidote, illite or possibly talc, sericite, pyrrhotite, biotite, Fe-hydroxide, fluorite, apofyllite, zeolite and chalcopyrite. In addition, there are a few fractures with unknown mineral filling. XRD analyses of similar material from the previously mapped cored boreholes in the area have revealed that most such filling are mineral mixtures, or in some cases, feldspars, apophyllite or analcime /Sandström et al. 2004/. There are also 72 fractures that are virtually free from visible mineral coatings. The majority of them belong to the sub-horizontal set (Figure 5-4).

The various clay minerals are more or less restricted to open fractures of two groups: (1) the flat lying sets in the upper 200 m and (2) the NNW–SSE striking set in the lowermost 150 m of the borehole. Some of the clay minerals registered at depths below 200 m are corrensite, often intimately associated with chlorite. Pyrite shows a similar pattern, with a preference for flat lying, often open, fractures (Figure 5-4). Fe-hydroxide, typically expected in flat lying fractures down to about 100 m in the Forsmark area /cf Petersson et al. 2005/, was only encountered in two fractures at the borehole lengths 797.93 and 960.80 m! Other minerals limited to the open fractures are the few findings of sericite, apofyllite and an unspecified zeolite. All other minerals, as well as the presence of oxidized walls, are preferentially associated with sealed fractures (Figure 5-4).

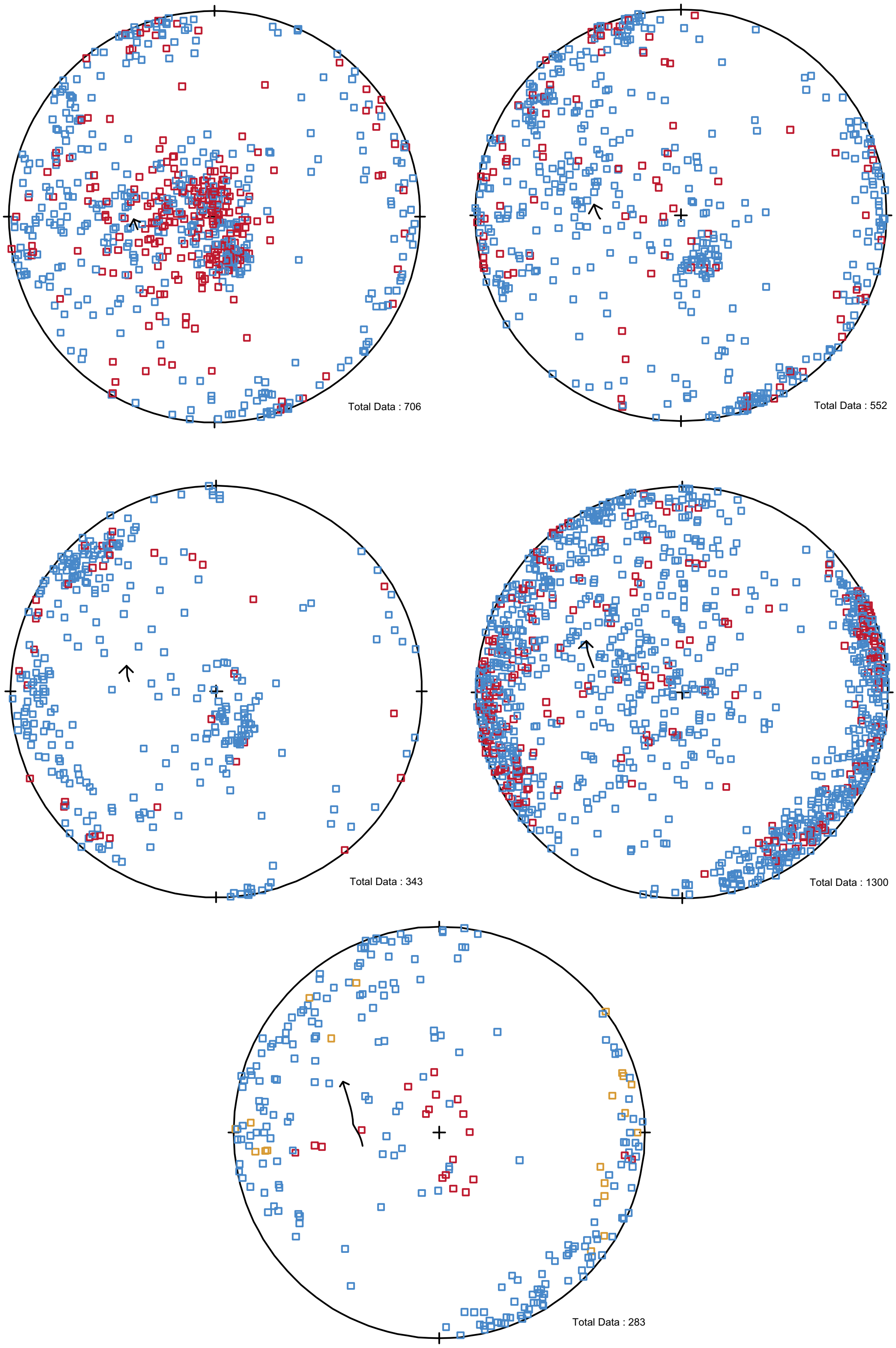
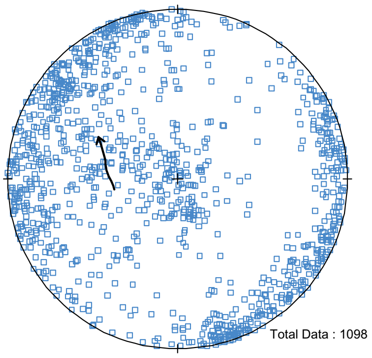
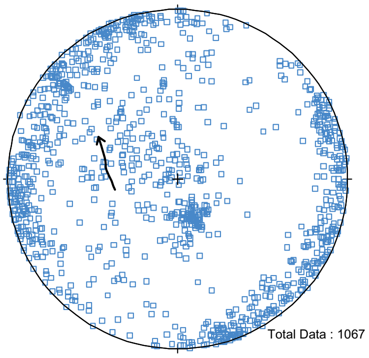


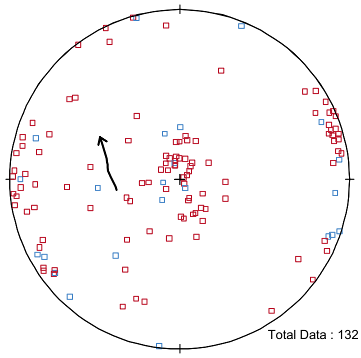
Figure 5-3. *Lower hemisphere, equal-area stereographic projections showing the poles to all sealed (blue squares) and open (red squares) fractures, as well as the orientation of breccias (orange squares) and the prevailing fracture orientations in sealed networks (blue squares) and crush zones (red squares) in borehole KFM07A. The fracture data are divided into four length intervals (102–250, 250–500, 500–750 and 750–994 m). Arrows mark the orientation of the borehole axis towards depth.*



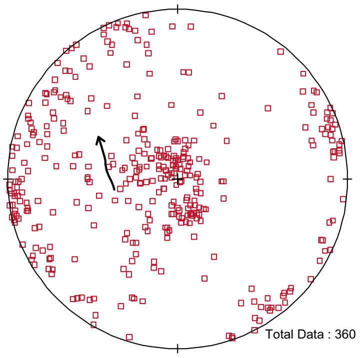
Calcite, aperture =0



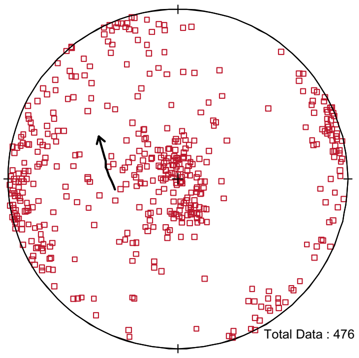
Chlorite, aperture =0



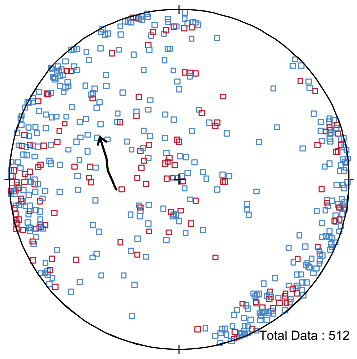
Clay minerals



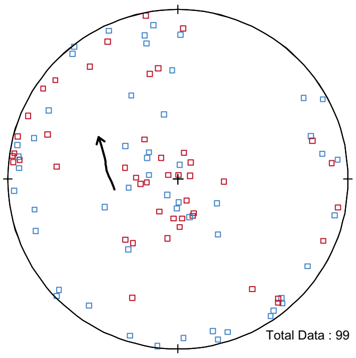
Calcite, aperture >0



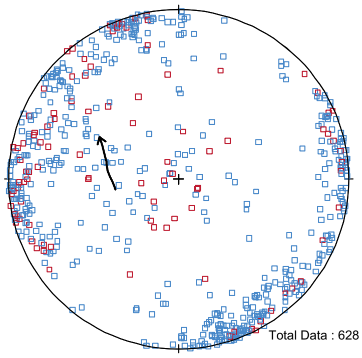
Chlorite, aperture >0



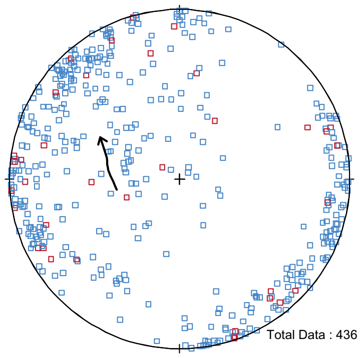
Hematite



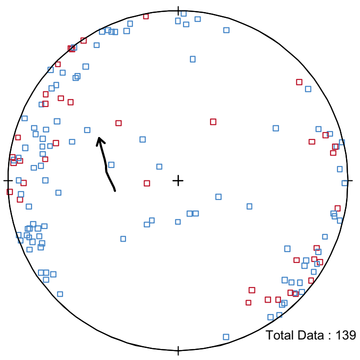
Pyrite



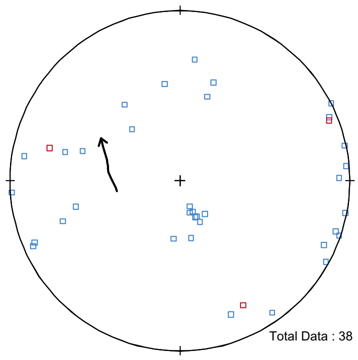
Laumontite



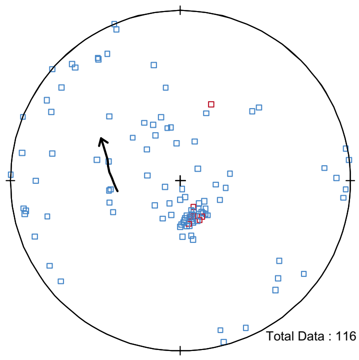
Adularia



Quartz



Epidote



Prehnite

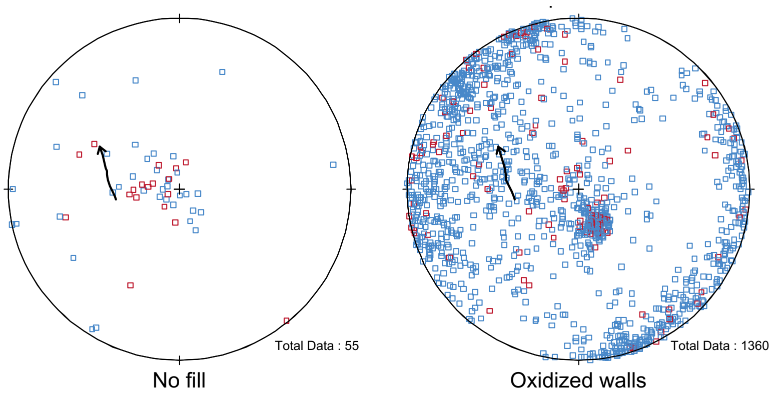


Figure 5-4. *Lower hemisphere, equal-area stereographic projections showing the poles to sealed (blue squares) and open (red squares) fractures filled with: calcite, chlorite, clay minerals, pyrite, laumontite, adularia, hematite, quartz, epidote and prehnite. Also shown are those that are free from visible filling and those surrounded by oxidized walls. Arrows mark the orientation of the borehole axis towards depth.*

A typical mineral assemblage is laumontite + calcite + chlorite ± pyrite. However, the exact assemblage varies locally. Thus, individual fractures seldom contain the full range of minerals. Laumontite tends to contract, and eventually crackle in the drill core. Thus, some laumontite-bearing fractures that are broken in the drill core may in fact represent originally unbroken fractures. As in the other deep, cored boreholes in the area, the laumontite-dominated assemblage is mainly found in sealed fractures of the NNW–SSE to NE–SW trending sets (Figure 5-4). This is also the assemblage most commonly found in the breccias and sealed networks (Figure 5-3). Other typical infilling mineral in the NNW–SSE to NE–SW trending sets, often associated with the laumontite-dominated assemblage, are adularia, hematite and, to some extent, quartz (Figure 5-4). Hematite occurs exclusively as sub-microscopic staining of various silicates, mainly laumontite and adularia. Fractures sealed by the laumontite-dominated assemblage, adularia and/or hematite, typically exhibit oxidized walls. A number of very thin (<< 1 mm), sealed fractures are typically revealed only by their oxidized walls.

The orientation of fractures filled prehnite and epidote are more variable, though there is a predominance of NE–SW trending fractures that dip gently towards NW (Figure 5-4). A majority of the fractures inferred to be filled by prehnite are less than 0.5 mm in width and restricted to amphibolites. In some cases, it is difficult to distinguish prehnite from epidote, and some of the light greenish mineral mapped as prehnite is likely to be adularia. It is, moreover, noteworthy that epidote locally is associated with the laumontite-dominated assemblage (e.g. at 881.73, 882.15, 902.46, 902.52 and 902.77 m).

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Appendix 1

WellCAD images

Title	LEGEND FOR FORSMARK	KFM07A

Site	FORSMARK
Borehole	KFM07A
Plot Date	2005-05-11 23:12:19

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

- Epidote
- Hematite
- Calcite
- Chlorite
- Quartz
- Unknown
- Pyrite
- Clay Minerals
- Laumontite
- Prehnite
- 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

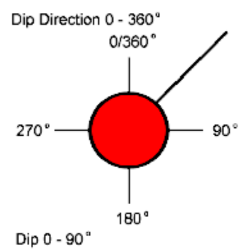
- Slightly Altered
- Moderately Altered
- Highly Altered
- Completley Altered
- Gouge
- Fresh

FRACTURE ALTERATION

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

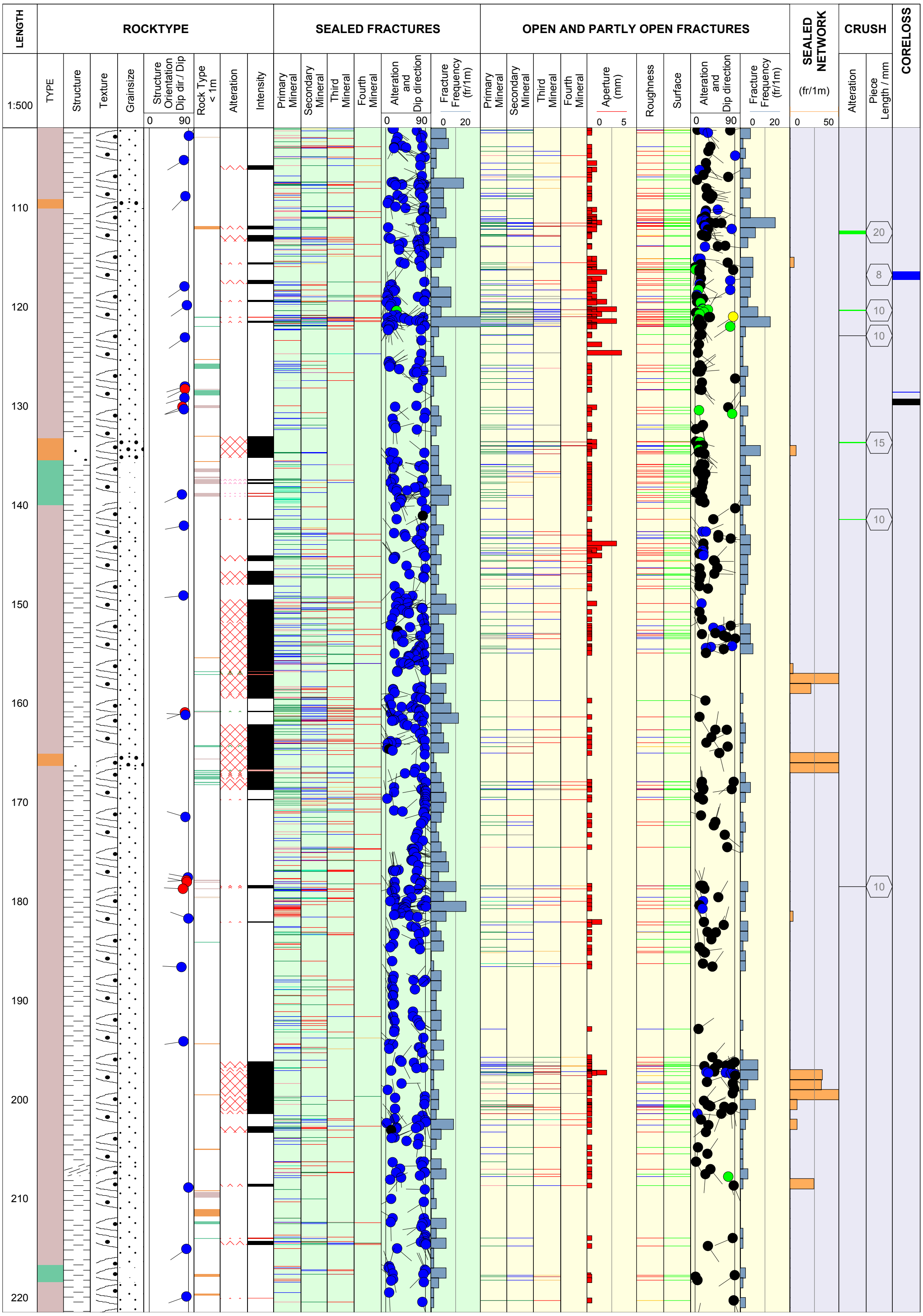
FRACTURE DIRECTION

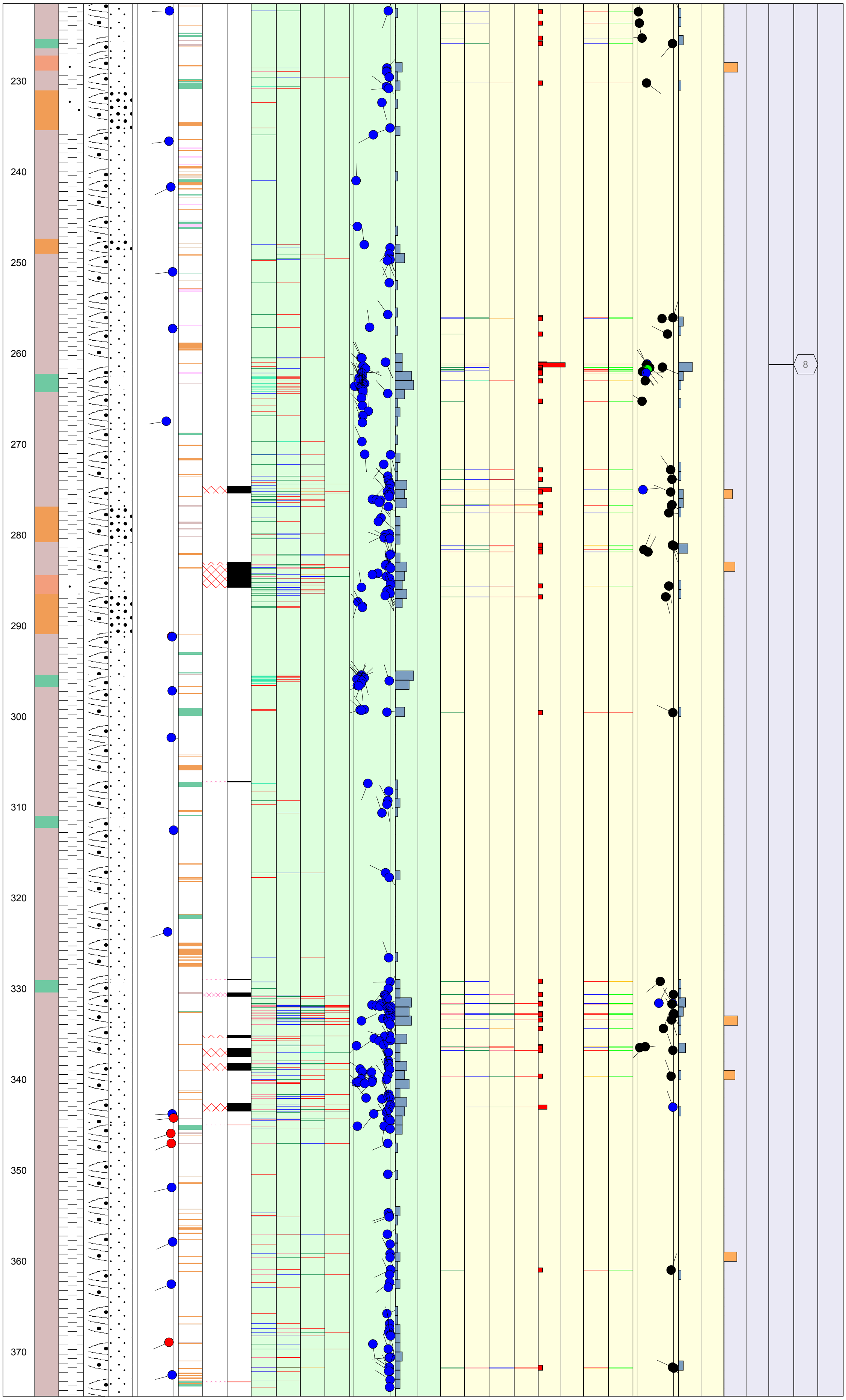
STRUKTURE ORIENTATION



Title GEOLOGY IN KFM07A **Appendix: 1**

Site	FORSMARK	**Coordinate System**	RT90-RHB70
Borehole	KFM07A	**Northing [m]**	6700127.08
Diameter [mm]	77	**Easting [m]**	1631031.57
Length [m]	1001.550	**Elevation [m.a.s.l.]**	3.33
Bearing [°]	261.47	**Drilling Start Date**	2004-06-07 08:00:00
Inclination [°]	-59.21	**Drilling Stop Date**	2004-12-09 11:40:00
Date of coremapping	2005-01-17 15:59:00	**Plot Date**	2005-06-20 23:18:06
Rocktype data from	p_rock_XXXXX	**Fracture data from**	p_fract_core

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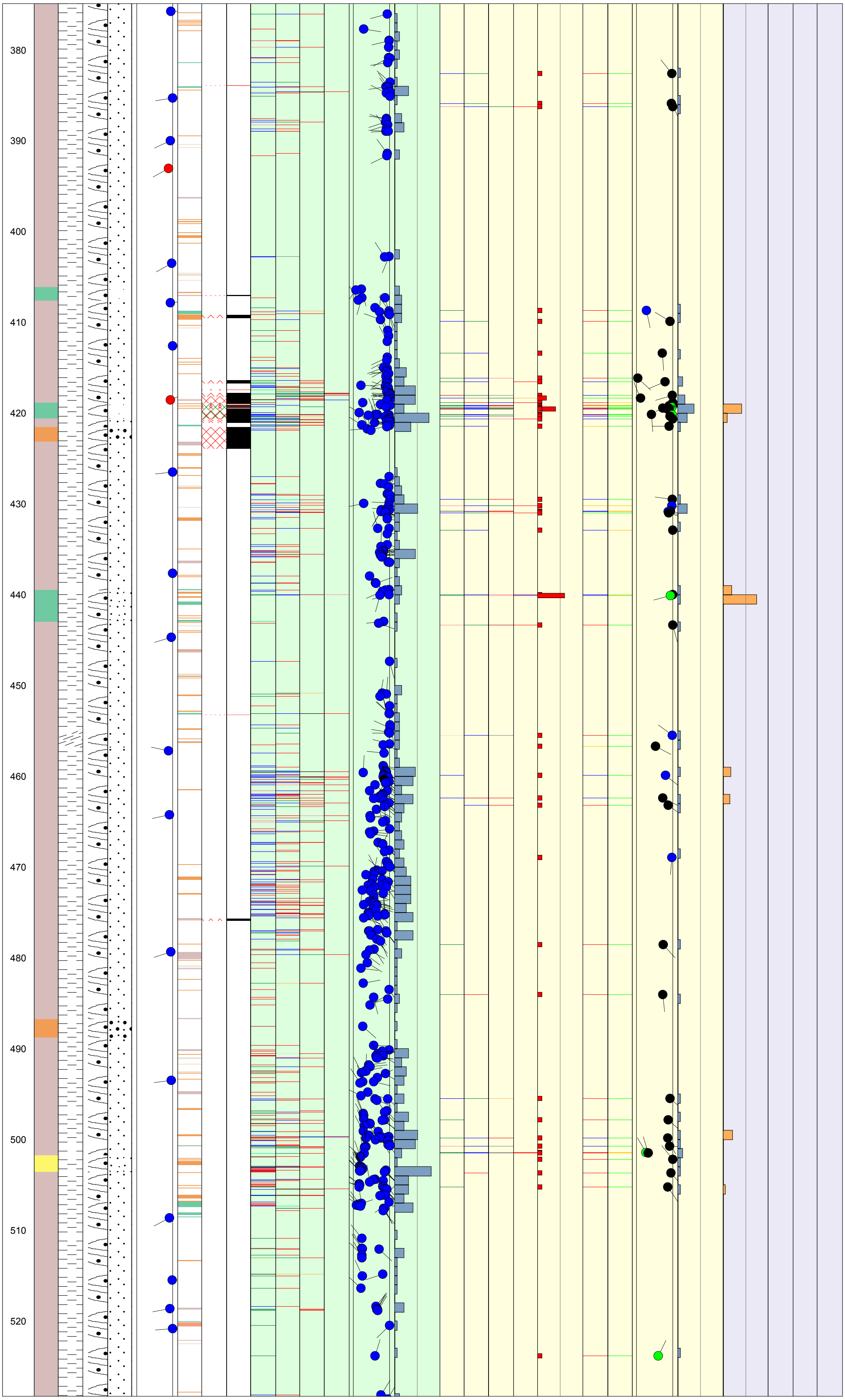

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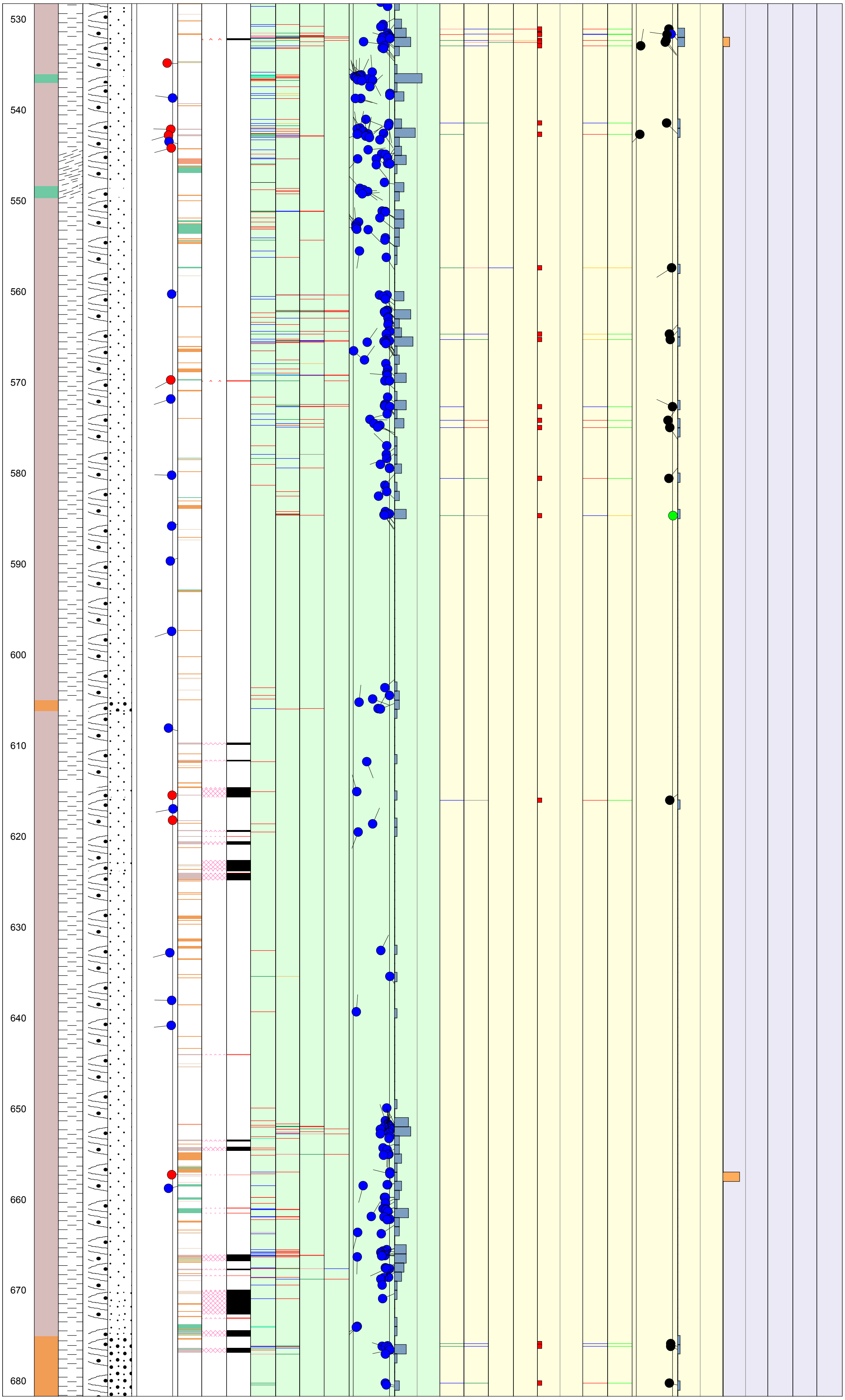
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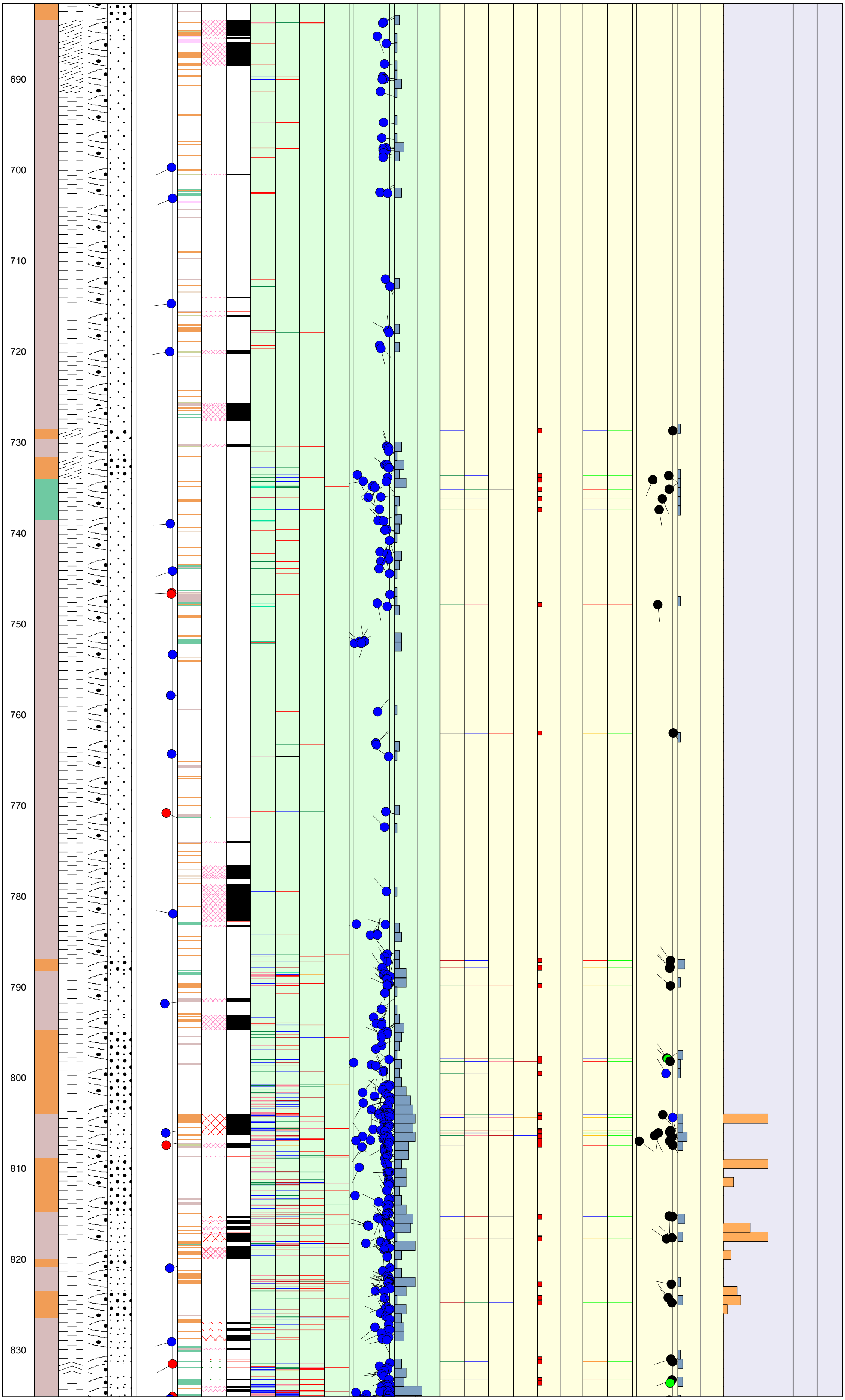

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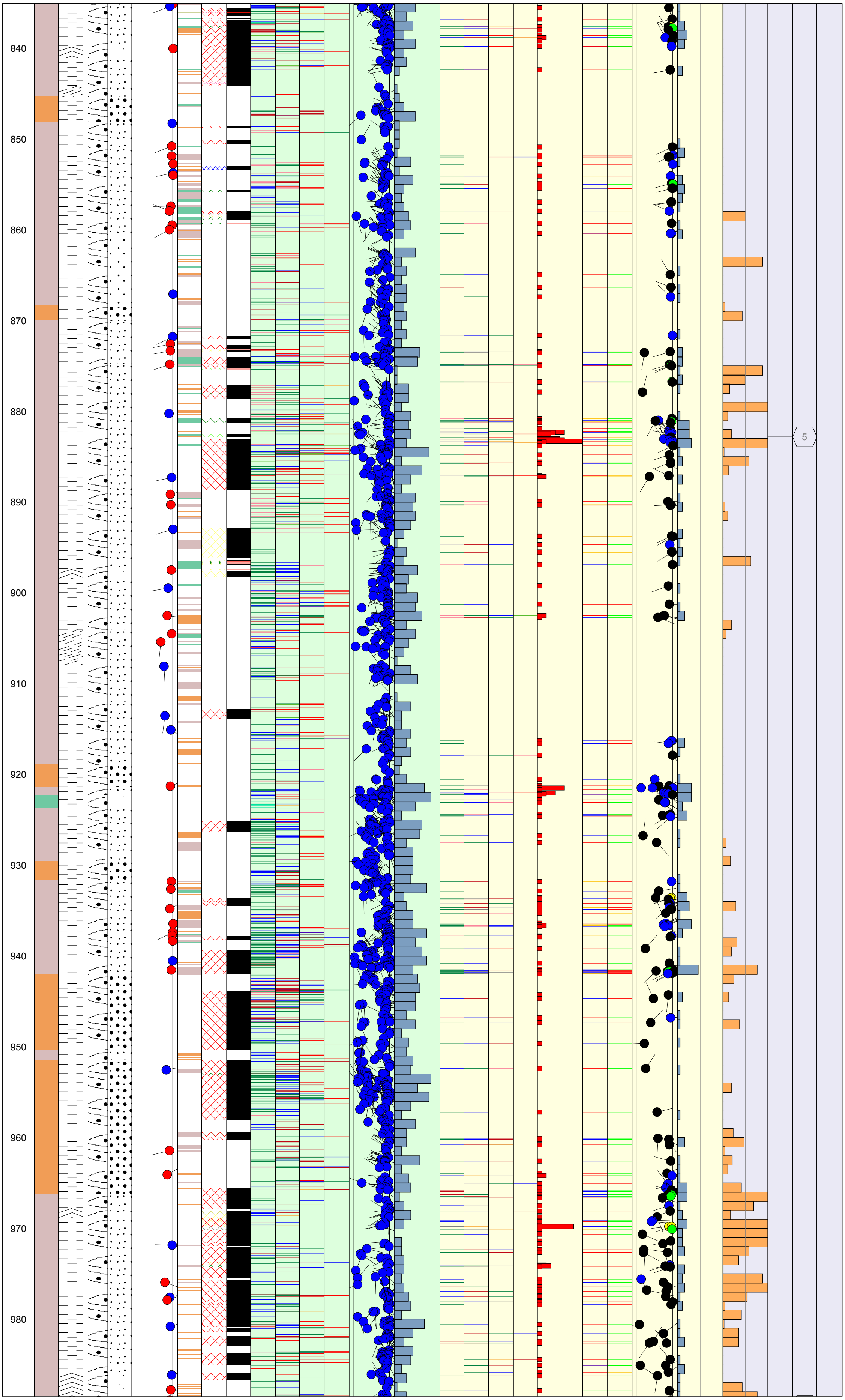
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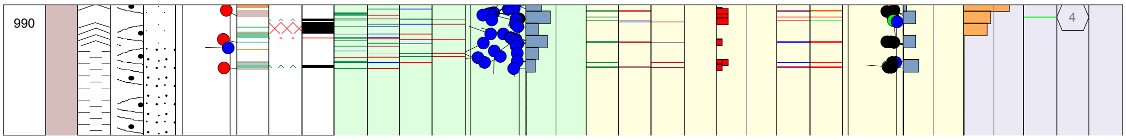
990
4

Appendix 2

Borehole diameter

Hole Diam T – Drilling: Borehole diameter

KFM07A, 2004-06-07 08:00:00 – 2004-12-09 11:40:00 (100.400–1,001.550 m).

Sub Secup (m)	Sub Seclow (m)	Hole Diam (m)	Comment
0.000	9.140	0.346	
9.140	100.350	0.251	
100.350	100.400	0.164	
100.400	101.950	0.086	
101.950	1,001.550	0.077	

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Appendix 3

Downhole deviation measurements

Maxibor T – Borehole deviation: Maxibor

KFM07A, 2004-12-09 06:00:00 – 2004-12-09 12:30:00 (0.000–996.000 m).

Length (m)	Northing (m)	Easting (m)	Elevation (m)	Coord System	Inclination (degrees)	Bearing (degrees)	Local A (m)	Local B (m)	Local C (m)	Extrapol Flag
0.00	6700127.08	1631031.57	–3.33	RT90-RHB70	–59.22	261.47	0.0000	0.0000	0.0000	
3.00	6700126.85	1631030.05	–0.75	RT90-RHB70	–59.24	261.32	1.5400	0.0000	0.0000	
6.00	6700126.62	1631028.54	1.83	RT90-RHB70	–59.20	261.22	3.0700	0.0000	0.0000	
9.00	6700126.39	1631027.02	4.40	RT90-RHB70	–59.26	261.12	4.6100	–0.0100	0.0000	
12.00	6700126.15	1631025.50	6.98	RT90-RHB70	–59.34	261.11	6.1400	–0.0200	0.0000	
15.00	6700125.91	1631023.99	9.56	RT90-RHB70	–59.46	261.28	7.6700	–0.0300	–0.0100	
18.00	6700125.68	1631022.48	12.15	RT90-RHB70	–59.50	261.33	9.1900	–0.0300	–0.0200	
21.00	6700125.45	1631020.98	14.73	RT90-RHB70	–59.49	261.36	10.7200	–0.0400	–0.0400	
24.00	6700125.22	1631019.47	17.31	RT90-RHB70	–59.55	261.35	12.2400	–0.0400	–0.0500	
27.00	6700124.99	1631017.97	19.90	RT90-RHB70	–59.60	261.27	13.7600	–0.0400	–0.0700	
30.00	6700124.76	1631016.47	22.49	RT90-RHB70	–59.60	261.10	15.2800	–0.0500	–0.0900	
33.00	6700124.53	1631014.97	25.08	RT90-RHB70	–59.59	260.99	16.8000	–0.0600	–0.1100	
36.00	6700124.29	1631013.47	27.66	RT90-RHB70	–59.56	260.95	18.3100	–0.0700	–0.1300	
39.00	6700124.05	1631011.97	30.25	RT90-RHB70	–59.59	260.92	19.8300	–0.0900	–0.1400	
42.00	6700123.81	1631010.47	32.84	RT90-RHB70	–59.59	260.95	21.3500	–0.1000	–0.1600	
45.00	6700123.57	1631008.97	35.42	RT90-RHB70	–59.57	260.96	22.8700	–0.1100	–0.1800	
48.00	6700123.34	1631007.47	38.01	RT90-RHB70	–59.52	260.83	24.3900	–0.1300	–0.2000	
51.00	6700123.09	1631005.97	40.60	RT90-RHB70	–59.56	260.71	25.9100	–0.1500	–0.2200	
54.00	6700122.85	1631004.47	43.18	RT90-RHB70	–59.62	260.59	27.4300	–0.1700	–0.2400	
57.00	6700122.60	1631002.97	45.77	RT90-RHB70	–59.63	260.53	28.9500	–0.1900	–0.2600	
60.00	6700122.35	1631001.47	48.36	RT90-RHB70	–59.67	260.50	30.4700	–0.2100	–0.2800	
63.00	6700122.10	1630999.98	50.95	RT90-RHB70	–59.61	260.58	31.9800	–0.2400	–0.3000	
66.00	6700121.85	1630998.48	53.54	RT90-RHB70	–59.64	260.74	33.5000	–0.2600	–0.3200	
69.00	6700121.61	1630996.99	56.13	RT90-RHB70	–59.62	260.76	35.0100	–0.2800	–0.3400	
72.00	6700121.36	1630995.49	58.71	RT90-RHB70	–59.55	260.88	36.5300	–0.3000	–0.3700	
75.00	6700121.12	1630993.99	61.30	RT90-RHB70	–59.53	260.89	38.0500	–0.3200	–0.3800	
78.00	6700120.88	1630992.49	63.89	RT90-RHB70	–59.49	261.01	39.5700	–0.3300	–0.4000	
81.00	6700120.64	1630990.98	66.47	RT90-RHB70	–59.52	261.08	41.0900	–0.3400	–0.4100	
84.00	6700120.41	1630989.48	69.06	RT90-RHB70	–59.50	261.15	42.6200	–0.3500	–0.4300	
87.00	6700120.17	1630987.97	71.64	RT90-RHB70	–59.51	261.28	44.1400	–0.3600	–0.4400	
90.00	6700119.94	1630986.47	74.23	RT90-RHB70	–59.53	261.33	45.6600	–0.3700	–0.4600	
93.00	6700119.71	1630984.96	76.81	RT90-RHB70	–59.50	261.45	47.1800	–0.3700	–0.4700	
96.00	6700119.49	1630983.46	79.40	RT90-RHB70	–59.52	261.70	48.7100	–0.3700	–0.4900	
99.00	6700119.27	1630981.95	81.98	RT90-RHB70	–59.49	261.89	50.2300	–0.3700	–0.5100	
102.00	6700119.05	1630980.44	84.57	RT90-RHB70	–59.43	261.85	51.7500	–0.3600	–0.5200	
105.00	6700118.84	1630978.93	87.15	RT90-RHB70	–59.42	261.91	53.2800	–0.3500	–0.5300	
108.00	6700118.62	1630977.42	89.73	RT90-RHB70	–59.44	261.92	54.8000	–0.3300	–0.5400	
111.00	6700118.41	1630975.91	92.31	RT90-RHB70	–59.39	262.12	56.3300	–0.3200	–0.5500	
114.00	6700118.20	1630974.40	94.90	RT90-RHB70	–59.39	262.16	57.8500	–0.3000	–0.5600	

117.00	6700117.99	1630972.89	97.48	RT90-RHB70	–59.38	262.32	59.3800	–0.2900	–0.5700
120.00	6700117.78	1630971.37	100.06	RT90-RHB70	–59.37	262.40	60.9100	–0.2600	–0.5800
123.00	6700117.58	1630969.86	102.64	RT90-RHB70	–59.34	262.53	62.4400	–0.2400	–0.5900
126.00	6700117.38	1630968.34	105.22	RT90-RHB70	–59.31	262.71	63.9700	–0.2100	–0.5900
129.00	6700117.19	1630966.82	107.80	RT90-RHB70	–59.20	262.86	65.5000	–0.1800	–0.6000
132.00	6700117.00	1630965.30	110.38	RT90-RHB70	–59.16	263.03	67.0300	–0.1400	–0.6000
135.00	6700116.81	1630963.77	112.95	RT90-RHB70	–59.10	263.20	68.5700	–0.1000	–0.5900
138.00	6700116.63	1630962.24	115.53	RT90-RHB70	–59.08	263.40	70.1100	–0.0500	–0.5900
141.00	6700116.45	1630960.71	118.10	RT90-RHB70	–59.04	263.50	71.6500	0.0000	–0.5800
144.00	6700116.28	1630959.18	120.68	RT90-RHB70	–59.02	263.65	73.2000	0.0500	–0.5700
147.00	6700116.11	1630957.64	123.25	RT90-RHB70	–59.00	263.77	74.7400	0.1100	–0.5600
150.00	6700115.94	1630956.11	125.82	RT90-RHB70	–58.99	263.89	76.2800	0.1800	–0.5500
153.00	6700115.77	1630954.57	128.39	RT90-RHB70	–58.95	264.00	77.8300	0.2400	–0.5400
156.00	6700115.61	1630953.03	130.96	RT90-RHB70	–58.92	264.14	79.3700	0.3100	–0.5300
159.00	6700115.45	1630951.49	133.53	RT90-RHB70	–58.88	264.23	80.9200	0.3800	–0.5200
162.00	6700115.30	1630949.95	136.10	RT90-RHB70	–58.87	264.34	82.4700	0.4600	–0.5000
165.00	6700115.15	1630948.40	138.67	RT90-RHB70	–58.85	264.43	84.0200	0.5300	–0.4800
168.00	6700115.00	1630946.86	141.23	RT90-RHB70	–58.83	264.53	85.5700	0.6100	–0.4700
171.00	6700114.85	1630945.31	143.80	RT90-RHB70	–58.82	264.59	87.1200	0.7000	–0.4500
174.00	6700114.70	1630943.77	146.37	RT90-RHB70	–58.78	264.70	88.6700	0.7800	–0.4300
177.00	6700114.56	1630942.22	148.93	RT90-RHB70	–58.78	264.80	90.2200	0.8700	–0.4100
180.00	6700114.42	1630940.67	151.50	RT90-RHB70	–58.77	264.92	91.7700	0.9600	–0.3900
183.00	6700114.28	1630939.12	154.06	RT90-RHB70	–58.72	265.06	93.3300	1.0500	–0.3700
186.00	6700114.14	1630937.57	156.63	RT90-RHB70	–58.66	265.20	94.8800	1.1500	–0.3400
189.00	6700114.01	1630936.01	159.19	RT90-RHB70	–58.63	265.35	96.4400	1.2500	–0.3200
192.00	6700113.89	1630934.46	161.75	RT90-RHB70	–58.57	265.51	97.9900	1.3600	–0.2900
195.00	6700113.76	1630932.90	164.31	RT90-RHB70	–58.51	265.62	99.5600	1.4700	–0.2600
198.00	6700113.65	1630931.34	166.87	RT90-RHB70	–58.42	265.71	101.1200	1.5800	–0.2200
201.00	6700113.53	1630929.77	169.42	RT90-RHB70	–58.36	265.78	102.6800	1.7000	–0.1900
204.00	6700113.41	1630928.20	171.98	RT90-RHB70	–58.32	265.87	104.2500	1.8200	–0.1400
207.00	6700113.30	1630926.63	174.53	RT90-RHB70	–58.27	265.96	105.8300	1.9400	–0.1000
210.00	6700113.19	1630925.05	177.08	RT90-RHB70	–58.25	266.04	107.4000	2.0600	–0.0600
213.00	6700113.08	1630923.48	179.63	RT90-RHB70	–58.23	266.12	108.9700	2.1900	–0.0100
216.00	6700112.97	1630921.90	182.19	RT90-RHB70	–58.21	266.21	110.5500	2.3100	0.0400
219.00	6700112.87	1630920.33	184.74	RT90-RHB70	–58.19	266.30	112.1200	2.4400	0.0900
222.00	6700112.76	1630918.75	187.28	RT90-RHB70	–58.16	266.43	113.7000	2.5800	0.1400
225.00	6700112.67	1630917.17	189.83	RT90-RHB70	–58.13	266.52	115.2700	2.7100	0.1900
228.00	6700112.57	1630915.59	192.38	RT90-RHB70	–58.08	266.65	116.8500	2.8500	0.2400
231.00	6700112.48	1630914.00	194.93	RT90-RHB70	–58.00	266.79	118.4300	3.0000	0.2900
234.00	6700112.39	1630912.42	197.47	RT90-RHB70	–57.93	266.91	120.0100	3.1400	0.3500
237.00	6700112.30	1630910.83	200.01	RT90-RHB70	–57.84	267.04	121.6000	3.3000	0.4100
240.00	6700112.22	1630909.23	202.55	RT90-RHB70	–57.77	267.14	123.1900	3.4500	0.4800
243.00	6700112.14	1630907.63	205.09	RT90-RHB70	–57.75	267.25	124.7800	3.6100	0.5500
246.00	6700112.06	1630906.04	207.63	RT90-RHB70	–57.73	267.37	126.3700	3.7700	0.6200
249.00	6700111.99	1630904.44	210.16	RT90-RHB70	–57.73	267.52	127.9700	3.9300	0.6900
252.00	6700111.92	1630902.83	212.70	RT90-RHB70	–57.74	267.60	129.5600	4.1000	0.7600
255.00	6700111.85	1630901.24	215.24	RT90-RHB70	–57.75	267.76	131.1500	4.2700	0.8300
258.00	6700111.79	1630899.64	217.78	RT90-RHB70	–57.74	267.92	132.7400	4.4500	0.9000

261.00	6700111.73	1630898.04	220.31	RT90-RHB70	–57.72	268.08	134.3300	4.6300	0.9600
264.00	6700111.68	1630896.43	222.85	RT90-RHB70	–57.66	268.27	135.9300	4.8100	1.0300
267.00	6700111.63	1630894.83	225.38	RT90-RHB70	–57.62	268.42	137.5200	5.0000	1.1100
270.00	6700111.59	1630893.22	227.92	RT90-RHB70	–57.58	268.51	139.1100	5.2000	1.1800
273.00	6700111.54	1630891.62	230.45	RT90-RHB70	–57.56	268.60	140.7100	5.3900	1.2500
276.00	6700111.50	1630890.01	232.98	RT90-RHB70	–57.54	268.69	142.3100	5.5900	1.3300
279.00	6700111.47	1630888.40	235.51	RT90-RHB70	–57.53	268.83	143.9000	5.8000	1.4100
282.00	6700111.44	1630886.79	238.04	RT90-RHB70	–57.50	268.94	145.5000	6.0000	1.4800
285.00	6700111.41	1630885.18	240.57	RT90-RHB70	–57.46	269.10	147.1000	6.2100	1.5600
288.00	6700111.38	1630883.56	243.10	RT90-RHB70	–57.42	269.30	148.7000	6.4300	1.6400
291.00	6700111.36	1630881.95	245.63	RT90-RHB70	–57.42	269.50	150.3000	6.6500	1.7200
294.00	6700111.35	1630880.33	248.16	RT90-RHB70	–57.40	269.70	151.9000	6.8700	1.8000
297.00	6700111.34	1630878.72	250.69	RT90-RHB70	–57.38	269.82	153.5000	7.1000	1.8900
300.00	6700111.33	1630877.10	253.21	RT90-RHB70	–57.38	269.92	155.1000	7.3400	1.9700
303.00	6700111.33	1630875.48	255.74	RT90-RHB70	–57.39	269.99	156.7000	7.5800	2.0500
306.00	6700111.33	1630873.86	258.27	RT90-RHB70	–57.48	270.04	158.3000	7.8200	2.1300
309.00	6700111.33	1630872.25	260.80	RT90-RHB70	–57.50	270.16	159.8900	8.0600	2.2100
312.00	6700111.34	1630870.64	263.33	RT90-RHB70	–57.49	270.29	161.4900	8.3000	2.2800
315.00	6700111.34	1630869.03	265.86	RT90-RHB70	–57.48	270.43	163.0800	8.5500	2.3500
318.00	6700111.36	1630867.41	268.39	RT90-RHB70	–57.47	270.57	164.6700	8.8000	2.4300
321.00	6700111.37	1630865.80	270.91	RT90-RHB70	–57.45	270.73	166.2700	9.0500	2.5000
324.00	6700111.39	1630864.19	273.44	RT90-RHB70	–57.44	270.87	167.8600	9.3100	2.5800
327.00	6700111.42	1630862.57	275.97	RT90-RHB70	–57.41	271.02	169.4500	9.5800	2.6500
330.00	6700111.45	1630860.96	278.50	RT90-RHB70	–57.38	271.17	171.0400	9.8500	2.7300
333.00	6700111.48	1630859.34	281.03	RT90-RHB70	–57.35	271.35	172.6400	10.1200	2.8000
336.00	6700111.52	1630857.72	283.55	RT90-RHB70	–57.29	271.45	174.2300	10.4000	2.8800
339.00	6700111.56	1630856.10	286.08	RT90-RHB70	–57.26	271.58	175.8300	10.6800	2.9600
342.00	6700111.60	1630854.48	288.60	RT90-RHB70	–57.21	271.67	177.4300	10.9600	3.0400
345.00	6700111.65	1630852.86	291.12	RT90-RHB70	–57.16	271.76	179.0300	11.2500	3.1200
348.00	6700111.70	1630851.23	293.64	RT90-RHB70	–57.12	271.88	180.6300	11.5400	3.2100
351.00	6700111.75	1630849.60	296.16	RT90-RHB70	–57.09	272.01	182.2300	11.8300	3.3000
354.00	6700111.81	1630847.97	298.68	RT90-RHB70	–57.08	272.16	183.8300	12.1300	3.3800
357.00	6700111.87	1630846.34	301.20	RT90-RHB70	–57.05	272.35	185.4300	12.4400	3.4700
360.00	6700111.94	1630844.71	303.72	RT90-RHB70	–56.99	272.53	187.0400	12.7400	3.5600
363.00	6700112.01	1630843.08	306.23	RT90-RHB70	–56.92	272.67	188.6400	13.0600	3.6500
366.00	6700112.09	1630841.45	308.75	RT90-RHB70	–56.88	272.84	190.2500	13.3700	3.7400
369.00	6700112.17	1630839.81	311.26	RT90-RHB70	–56.84	272.94	191.8500	13.7000	3.8400
372.00	6700112.25	1630838.17	313.77	RT90-RHB70	–56.79	273.04	193.4600	14.0200	3.9400
375.00	6700112.34	1630836.53	316.28	RT90-RHB70	–56.72	273.15	195.0700	14.3500	4.0300
378.00	6700112.43	1630834.88	318.79	RT90-RHB70	–56.64	273.24	196.6800	14.6900	4.1400
381.00	6700112.52	1630833.24	321.29	RT90-RHB70	–56.57	273.33	198.3000	15.0200	4.2400
384.00	6700112.62	1630831.59	323.80	RT90-RHB70	–56.50	273.45	199.9200	15.3600	4.3500
387.00	6700112.72	1630829.93	326.30	RT90-RHB70	–56.43	273.54	201.5300	15.7100	4.4600
390.00	6700112.82	1630828.28	328.80	RT90-RHB70	–56.39	273.66	203.1600	16.0500	4.5800
393.00	6700112.93	1630826.62	331.30	RT90-RHB70	–56.34	273.75	204.7800	16.4000	4.6900
396.00	6700113.04	1630824.96	333.79	RT90-RHB70	–56.32	273.86	206.4000	16.7600	4.8100
399.00	6700113.15	1630823.30	336.29	RT90-RHB70	–56.32	273.95	208.0300	17.1100	4.9300
402.00	6700113.26	1630821.64	338.79	RT90-RHB70	–56.32	274.06	209.6500	17.4700	5.0500

405.00	6700113.38	1630819.98	341.28	RT90-RHB70	–56.29	274.16	211.2800	17.8400	5.1600
408.00	6700113.50	1630818.32	343.78	RT90-RHB70	–56.26	274.25	212.9000	18.2000	5.2800
411.00	6700113.63	1630816.66	346.27	RT90-RHB70	–56.22	274.37	214.5300	18.5700	5.4000
414.00	6700113.75	1630815.00	348.77	RT90-RHB70	–56.19	274.50	216.1500	18.9400	5.5200
417.00	6700113.88	1630813.33	351.26	RT90-RHB70	–56.17	274.62	217.7800	19.3200	5.6400
420.00	6700114.02	1630811.67	353.75	RT90-RHB70	–56.15	274.73	219.4100	19.7000	5.7700
423.00	6700114.16	1630810.00	356.24	RT90-RHB70	–56.10	274.84	221.0300	20.0800	5.8900
426.00	6700114.30	1630808.34	358.73	RT90-RHB70	–56.07	274.90	222.6600	20.4700	6.0100
429.00	6700114.44	1630806.67	361.22	RT90-RHB70	–56.03	275.00	224.2900	20.8600	6.1400
432.00	6700114.59	1630805.00	363.71	RT90-RHB70	–56.00	275.08	225.9200	21.2500	6.2700
435.00	6700114.73	1630803.33	366.20	RT90-RHB70	–55.98	275.20	227.5500	21.6500	6.3900
438.00	6700114.89	1630801.65	368.68	RT90-RHB70	–55.94	275.30	229.1800	22.0400	6.5200
441.00	6700115.04	1630799.98	371.17	RT90-RHB70	–55.89	275.38	230.8100	22.4500	6.6500
444.00	6700115.20	1630798.31	373.65	RT90-RHB70	–55.82	275.45	232.4500	22.8500	6.7800
447.00	6700115.36	1630796.63	376.13	RT90-RHB70	–55.80	275.55	234.0800	23.2600	6.9200
450.00	6700115.52	1630794.95	378.62	RT90-RHB70	–55.78	275.69	235.7200	23.6700	7.0500
453.00	6700115.69	1630793.27	381.10	RT90-RHB70	–55.79	275.79	237.3500	24.0800	7.1900
456.00	6700115.86	1630791.59	383.58	RT90-RHB70	–55.75	275.92	238.9900	24.5000	7.3200
459.00	6700116.03	1630789.91	386.06	RT90-RHB70	–55.74	276.02	240.6200	24.9200	7.4600
462.00	6700116.21	1630788.23	388.54	RT90-RHB70	–55.71	276.12	242.2600	25.3400	7.6000
465.00	6700116.39	1630786.55	391.02	RT90-RHB70	–55.69	276.19	243.8900	25.7700	7.7300
468.00	6700116.57	1630784.87	393.49	RT90-RHB70	–55.69	276.28	245.5300	26.2000	7.8700
471.00	6700116.76	1630783.19	395.97	RT90-RHB70	–55.66	276.40	247.1600	26.6300	8.0100
474.00	6700116.95	1630781.51	398.45	RT90-RHB70	–55.64	276.51	248.8000	27.0700	8.1400
477.00	6700117.14	1630779.83	400.92	RT90-RHB70	–55.63	276.59	250.4300	27.5100	8.2800
480.00	6700117.33	1630778.15	403.40	RT90-RHB70	–55.63	276.73	252.0700	27.9500	8.4200
483.00	6700117.53	1630776.46	405.88	RT90-RHB70	–55.62	276.83	253.7000	28.4000	8.5600
486.00	6700117.73	1630774.78	408.35	RT90-RHB70	–55.61	276.95	255.3300	28.8500	8.6900
489.00	6700117.94	1630773.10	410.83	RT90-RHB70	–55.60	277.07	256.9700	29.3000	8.8300
492.00	6700118.15	1630771.42	413.30	RT90-RHB70	–55.58	277.17	258.6000	29.7500	8.9600
495.00	6700118.36	1630769.73	415.78	RT90-RHB70	–55.55	277.32	260.2300	30.2100	9.1000
498.00	6700118.58	1630768.05	418.25	RT90-RHB70	–55.49	277.37	261.8700	30.6800	9.2400
501.00	6700118.79	1630766.37	420.73	RT90-RHB70	–55.43	277.45	263.5000	31.1400	9.3800
504.00	6700119.01	1630764.68	423.20	RT90-RHB70	–55.38	277.50	265.1400	31.6100	9.5200
507.00	6700119.24	1630762.99	425.66	RT90-RHB70	–55.36	277.61	266.7700	32.0800	9.6600
510.00	6700119.46	1630761.30	428.13	RT90-RHB70	–55.33	277.70	268.4100	32.5600	9.8100
513.00	6700119.69	1630759.61	430.60	RT90-RHB70	–55.33	277.77	270.0500	33.0300	9.9500
516.00	6700119.92	1630757.92	433.07	RT90-RHB70	–55.29	277.92	271.6900	33.5100	10.0900
519.00	6700120.16	1630756.22	435.53	RT90-RHB70	–55.26	278.10	273.3300	34.0000	10.2400
522.00	6700120.40	1630754.53	438.00	RT90-RHB70	–55.20	278.30	274.9600	34.4800	10.3900
525.00	6700120.65	1630752.84	440.46	RT90-RHB70	–55.13	278.48	276.6000	34.9800	10.5300
528.00	6700120.90	1630751.14	442.92	RT90-RHB70	–55.10	278.58	278.2400	35.4800	10.6800
531.00	6700121.15	1630749.44	445.38	RT90-RHB70	–55.07	278.66	279.8800	35.9900	10.8300
534.00	6700121.41	1630747.75	447.84	RT90-RHB70	–55.07	278.72	281.5200	36.4900	10.9800
537.00	6700121.67	1630746.05	450.30	RT90-RHB70	–55.07	278.76	283.1700	37.0000	11.1300
540.00	6700121.93	1630744.35	452.76	RT90-RHB70	–55.07	278.80	284.8100	37.5100	11.2900
543.00	6700122.20	1630742.65	455.22	RT90-RHB70	–55.07	278.87	286.4500	38.0300	11.4400
546.00	6700122.46	1630740.96	457.68	RT90-RHB70	–55.07	278.97	288.0800	38.5400	11.5800

549.00	6700122.73	1630739.26	460.14	RT90-RHB70	–55.06	279.08	289.7200	39.0600	11.7300
552.00	6700123.00	1630737.56	462.60	RT90-RHB70	–55.06	279.22	291.3600	39.5800	11.8800
555.00	6700123.28	1630735.87	465.06	RT90-RHB70	–55.02	279.35	293.0000	40.1000	12.0300
558.00	6700123.56	1630734.17	467.52	RT90-RHB70	–54.99	279.44	294.6300	40.6300	12.1800
561.00	6700123.84	1630732.47	469.98	RT90-RHB70	–54.97	279.56	296.2700	41.1600	12.3300
564.00	6700124.12	1630730.77	472.43	RT90-RHB70	–54.94	279.68	297.9100	41.6900	12.4800
567.00	6700124.41	1630729.07	474.89	RT90-RHB70	–54.91	279.80	299.5500	42.2300	12.6300
570.00	6700124.71	1630727.37	477.34	RT90-RHB70	–54.88	279.90	301.1800	42.7700	12.7800
573.00	6700125.00	1630725.67	479.80	RT90-RHB70	–54.86	280.01	302.8200	43.3200	12.9300
576.00	6700125.30	1630723.97	482.25	RT90-RHB70	–54.84	280.10	304.4600	43.8700	13.0800
579.00	6700125.61	1630722.27	484.70	RT90-RHB70	–54.84	280.20	306.0900	44.4200	13.2300
582.00	6700125.91	1630720.57	487.15	RT90-RHB70	–54.82	280.32	307.7300	44.9800	13.3800
585.00	6700126.22	1630718.87	489.61	RT90-RHB70	–54.80	280.45	309.3700	45.5300	13.5300
588.00	6700126.54	1630717.17	492.06	RT90-RHB70	–54.75	280.59	311.0000	46.1000	13.6800
591.00	6700126.86	1630715.47	494.51	RT90-RHB70	–54.69	280.72	312.6400	46.6600	13.8300
594.00	6700127.18	1630713.77	496.96	RT90-RHB70	–54.62	280.83	314.2700	47.2400	13.9900
597.00	6700127.50	1630712.06	499.40	RT90-RHB70	–54.58	280.91	315.9100	47.8100	14.1400
600.00	6700127.83	1630710.35	501.85	RT90-RHB70	–54.55	281.01	317.5500	48.3900	14.3000
603.00	6700128.17	1630708.65	504.29	RT90-RHB70	–54.55	281.11	319.1900	48.9700	14.4600
606.00	6700128.50	1630706.94	506.73	RT90-RHB70	–54.57	281.22	320.8300	49.5600	14.6200
609.00	6700128.84	1630705.23	509.18	RT90-RHB70	–54.56	281.33	322.4700	50.1400	14.7700
612.00	6700129.18	1630703.53	511.62	RT90-RHB70	–54.56	281.44	324.1000	50.7400	14.9300
615.00	6700129.53	1630701.82	514.07	RT90-RHB70	–54.54	281.57	325.7400	51.3300	15.0800
618.00	6700129.87	1630700.12	516.51	RT90-RHB70	–54.52	281.69	327.3700	51.9300	15.2300
621.00	6700130.23	1630698.41	518.95	RT90-RHB70	–54.50	281.84	329.0100	52.5300	15.3900
624.00	6700130.58	1630696.71	521.40	RT90-RHB70	–54.46	281.98	330.6400	53.1400	15.5400
627.00	6700130.95	1630695.00	523.84	RT90-RHB70	–54.41	282.13	332.2700	53.7500	15.7000
630.00	6700131.31	1630693.29	526.28	RT90-RHB70	–54.38	282.21	333.9100	54.3600	15.8500
633.00	6700131.68	1630691.59	528.72	RT90-RHB70	–54.36	282.28	335.5400	54.9800	16.0100
636.00	6700132.05	1630689.88	531.15	RT90-RHB70	–54.34	282.37	337.1800	55.6000	16.1600
639.00	6700132.43	1630688.17	533.59	RT90-RHB70	–54.32	282.47	338.8100	56.2300	16.3200
642.00	6700132.81	1630686.46	536.03	RT90-RHB70	–54.29	282.56	340.4400	56.8500	16.4700
645.00	6700133.19	1630684.75	538.46	RT90-RHB70	–54.26	282.66	342.0800	57.4800	16.6300
648.00	6700133.57	1630683.04	540.90	RT90-RHB70	–54.23	282.78	343.7100	58.1200	16.7900
651.00	6700133.96	1630681.33	543.33	RT90-RHB70	–54.19	282.86	345.3400	58.7500	16.9500
654.00	6700134.35	1630679.62	545.77	RT90-RHB70	–54.16	282.96	346.9800	59.3900	17.1100
657.00	6700134.75	1630677.91	548.20	RT90-RHB70	–54.11	283.03	348.6100	60.0400	17.2700
660.00	6700135.14	1630676.19	550.63	RT90-RHB70	–54.09	283.12	350.2500	60.6800	17.4300
663.00	6700135.54	1630674.48	553.06	RT90-RHB70	–54.08	283.22	351.8800	61.3300	17.5900
666.00	6700135.94	1630672.77	555.49	RT90-RHB70	–54.06	283.32	353.5200	61.9900	17.7500
669.00	6700136.35	1630671.05	557.92	RT90-RHB70	–54.03	283.42	355.1500	62.6400	17.9100
672.00	6700136.76	1630669.34	560.34	RT90-RHB70	–53.98	283.49	356.7900	63.3000	18.0700
675.00	6700137.17	1630667.62	562.77	RT90-RHB70	–53.92	283.59	358.4200	63.9600	18.2400
678.00	6700137.58	1630665.91	565.20	RT90-RHB70	–53.87	283.70	360.0600	64.6300	18.4000
681.00	6700138.00	1630664.19	567.62	RT90-RHB70	–53.84	283.83	361.7000	65.3000	18.5700
684.00	6700138.43	1630662.47	570.04	RT90-RHB70	–53.82	283.97	363.3300	65.9700	18.7400
687.00	6700138.85	1630660.75	572.46	RT90-RHB70	–53.80	284.12	364.9700	66.6500	18.9000
690.00	6700139.29	1630659.03	574.88	RT90-RHB70	–53.78	284.23	366.6100	67.3300	19.0700

693.00	6700139.72	1630657.32	577.30	RT90-RHB70	–53.75	284.34	368.2400	68.0100	19.2300
696.00	6700140.16	1630655.60	579.72	RT90-RHB70	–53.68	284.52	369.8700	68.7000	19.4000
699.00	6700140.61	1630653.88	582.14	RT90-RHB70	–53.64	284.61	371.5100	69.4000	19.5700
702.00	6700141.06	1630652.16	584.56	RT90-RHB70	–53.63	284.73	373.1400	70.1000	19.7400
705.00	6700141.51	1630650.44	586.97	RT90-RHB70	–53.64	284.87	374.7800	70.8000	19.9000
708.00	6700141.96	1630648.72	589.39	RT90-RHB70	–53.64	285.00	376.4100	71.5100	20.0700
711.00	6700142.42	1630647.00	591.80	RT90-RHB70	–53.61	285.11	378.0400	72.2200	20.2400
714.00	6700142.89	1630645.28	594.22	RT90-RHB70	–53.58	285.24	379.6700	72.9300	20.4000
717.00	6700143.36	1630643.56	596.63	RT90-RHB70	–53.53	285.35	381.3000	73.6500	20.5700
720.00	6700143.83	1630641.84	599.04	RT90-RHB70	–53.46	285.48	382.9300	74.3700	20.7300
723.00	6700144.31	1630640.12	601.45	RT90-RHB70	–53.38	285.60	384.5600	75.1000	20.9000
726.00	6700144.79	1630638.40	603.86	RT90-RHB70	–53.32	285.73	386.2000	75.8300	21.0700
729.00	6700145.27	1630636.67	606.27	RT90-RHB70	–53.27	285.85	387.8300	76.5700	21.2400
732.00	6700145.76	1630634.95	608.67	RT90-RHB70	–53.22	285.95	389.4700	77.3100	21.4200
735.00	6700146.26	1630633.22	611.08	RT90-RHB70	–53.17	286.04	391.1000	78.0500	21.5900
738.00	6700146.75	1630631.49	613.48	RT90-RHB70	–53.16	286.12	392.7400	78.8000	21.7700
741.00	6700147.25	1630629.76	615.88	RT90-RHB70	–53.14	286.20	394.3700	79.5500	21.9400
744.00	6700147.75	1630628.03	618.28	RT90-RHB70	–53.13	286.30	396.0100	80.3000	22.1200
747.00	6700148.26	1630626.31	620.68	RT90-RHB70	–53.09	286.40	397.6400	81.0600	22.3000
750.00	6700148.77	1630624.58	623.08	RT90-RHB70	–53.05	286.49	399.2700	81.8200	22.4700
753.00	6700149.28	1630622.85	625.47	RT90-RHB70	–53.02	286.55	400.9100	82.5800	22.6500
756.00	6700149.79	1630621.12	627.87	RT90-RHB70	–52.97	286.65	402.5400	83.3400	22.8300
759.00	6700150.31	1630619.39	630.27	RT90-RHB70	–52.93	286.72	404.1800	84.1100	23.0100
762.00	6700150.83	1630617.66	632.66	RT90-RHB70	–52.89	286.80	405.8100	84.8800	23.1900
765.00	6700151.36	1630615.92	635.05	RT90-RHB70	–52.84	286.87	407.4500	85.6600	23.3700
768.00	6700151.88	1630614.19	637.44	RT90-RHB70	–52.77	286.95	409.0900	86.4400	23.5500
771.00	6700152.41	1630612.45	639.83	RT90-RHB70	–52.73	287.03	410.7200	87.2200	23.7400
774.00	6700152.94	1630610.72	642.22	RT90-RHB70	–52.71	287.12	412.3600	88.0000	23.9200
777.00	6700153.48	1630608.98	644.61	RT90-RHB70	–52.70	287.20	414.0000	88.7900	24.1100
780.00	6700154.02	1630607.24	646.99	RT90-RHB70	–52.68	287.27	415.6400	89.5800	24.2900
783.00	6700154.56	1630605.51	649.38	RT90-RHB70	–52.62	287.33	417.2800	90.3700	24.4800
786.00	6700155.10	1630603.77	651.76	RT90-RHB70	–52.57	287.44	418.9100	91.1600	24.6700
789.00	6700155.64	1630602.03	654.14	RT90-RHB70	–52.51	287.61	420.5500	91.9600	24.8600
792.00	6700156.20	1630600.29	656.52	RT90-RHB70	–52.47	287.79	422.1900	92.7700	25.0500
795.00	6700156.76	1630598.55	658.90	RT90-RHB70	–52.45	287.92	423.8300	93.5800	25.2400
798.00	6700157.32	1630596.81	661.28	RT90-RHB70	–52.43	288.06	425.4700	94.3900	25.4300
801.00	6700157.89	1630595.07	663.66	RT90-RHB70	–52.38	288.22	427.1000	95.2100	25.6100
804.00	6700158.46	1630593.33	666.04	RT90-RHB70	–52.32	288.39	428.7400	96.0300	25.8000
807.00	6700159.04	1630591.59	668.41	RT90-RHB70	–52.27	288.57	430.3700	96.8600	25.9900
810.00	6700159.62	1630589.85	670.78	RT90-RHB70	–52.25	288.71	432.0100	97.7000	26.1800
813.00	6700160.21	1630588.11	673.16	RT90-RHB70	–52.22	288.81	433.6400	98.5400	26.3700
816.00	6700160.80	1630586.37	675.53	RT90-RHB70	–52.13	288.92	435.2700	99.3900	26.5600
819.00	6700161.40	1630584.63	677.89	RT90-RHB70	–52.03	289.06	436.9100	100.2300	26.7500
822.00	6700162.00	1630582.88	680.26	RT90-RHB70	–51.96	289.20	438.5400	101.0900	26.9500
825.00	6700162.61	1630581.14	682.62	RT90-RHB70	–51.91	289.31	440.1800	101.9500	27.1500
828.00	6700163.22	1630579.39	684.98	RT90-RHB70	–51.88	289.46	441.8200	102.8100	27.3400
831.00	6700163.84	1630577.64	687.34	RT90-RHB70	–51.86	289.63	443.4500	103.6800	27.5400
834.00	6700164.46	1630575.90	689.70	RT90-RHB70	–51.80	289.84	445.0900	104.5600	27.7400

837.00	6700165.09	1630574.15	692.06	RT90-RHB70	–51.77	290.07	446.7200	105.4400	27.9300
840.00	6700165.73	1630572.41	694.42	RT90-RHB70	–51.72	290.27	448.3500	106.3300	28.1300
843.00	6700166.37	1630570.67	696.77	RT90-RHB70	–51.66	290.50	449.9800	107.2200	28.3200
846.00	6700167.02	1630568.92	699.13	RT90-RHB70	–51.57	290.67	451.6000	108.1200	28.5100
849.00	6700167.68	1630567.18	701.48	RT90-RHB70	–51.47	290.83	453.2300	109.0300	28.7100
852.00	6700168.35	1630565.43	703.82	RT90-RHB70	–51.37	290.97	454.8600	109.9500	28.9100
855.00	6700169.02	1630563.68	706.17	RT90-RHB70	–51.29	291.17	456.4900	110.8700	29.1100
858.00	6700169.69	1630561.93	708.51	RT90-RHB70	–51.20	291.37	458.1200	111.8000	29.3100
861.00	6700170.38	1630560.18	710.84	RT90-RHB70	–51.12	291.58	459.7500	112.7400	29.5200
864.00	6700171.07	1630558.43	713.18	RT90-RHB70	–51.03	291.83	461.3800	113.6800	29.7200
867.00	6700171.77	1630556.68	715.51	RT90-RHB70	–50.96	292.03	463.0100	114.6400	29.9200
870.00	6700172.48	1630554.93	717.84	RT90-RHB70	–50.85	292.20	464.6300	115.6000	30.1300
873.00	6700173.20	1630553.18	720.17	RT90-RHB70	–50.73	292.33	466.2600	116.5700	30.3400
876.00	6700173.92	1630551.42	722.49	RT90-RHB70	–50.63	292.45	467.8900	117.5400	30.5500
879.00	6700174.65	1630549.66	724.81	RT90-RHB70	–50.52	292.62	469.5200	118.5200	30.7700
882.00	6700175.38	1630547.90	727.13	RT90-RHB70	–50.41	292.81	471.1600	119.5100	30.9800
885.00	6700176.12	1630546.14	729.44	RT90-RHB70	–50.29	292.98	472.7900	120.5000	31.2000
888.00	6700176.87	1630544.37	731.75	RT90-RHB70	–50.17	293.16	474.4200	121.5000	31.4300
891.00	6700177.62	1630542.61	734.05	RT90-RHB70	–50.08	293.32	476.0600	122.5100	31.6500
894.00	6700178.39	1630540.84	736.35	RT90-RHB70	–49.97	293.51	477.6900	123.5300	31.8800
897.00	6700179.16	1630539.07	738.65	RT90-RHB70	–49.86	293.69	479.3300	124.5500	32.1100
900.00	6700179.93	1630537.30	740.94	RT90-RHB70	–49.75	293.91	480.9700	125.5800	32.3400
903.00	6700180.72	1630535.53	743.23	RT90-RHB70	–49.63	294.09	482.6000	126.6200	32.5700
906.00	6700181.51	1630533.75	745.52	RT90-RHB70	–49.52	294.21	484.2400	127.6700	32.8100
909.00	6700182.31	1630531.97	747.80	RT90-RHB70	–49.39	294.34	485.8800	128.7200	33.0500
912.00	6700183.12	1630530.20	750.08	RT90-RHB70	–49.28	294.45	487.5200	129.7800	33.2900
915.00	6700183.93	1630528.41	752.35	RT90-RHB70	–49.16	294.58	489.1600	130.8500	33.5400
918.00	6700184.74	1630526.63	754.62	RT90-RHB70	–49.03	294.79	490.8000	131.9200	33.7900
921.00	6700185.57	1630524.84	756.88	RT90-RHB70	–48.90	295.05	492.4500	133.0000	34.0400
924.00	6700186.40	1630523.06	759.14	RT90-RHB70	–48.77	295.25	494.0900	134.0900	34.3000
927.00	6700187.24	1630521.27	761.40	RT90-RHB70	–48.70	295.38	495.7300	135.1900	34.5600
930.00	6700188.09	1630519.48	763.65	RT90-RHB70	–48.67	295.47	497.3800	136.3000	34.8100
933.00	6700188.95	1630517.69	765.91	RT90-RHB70	–48.58	295.51	499.0200	137.4000	35.0700
936.00	6700189.80	1630515.90	768.16	RT90-RHB70	–48.44	295.62	500.6600	138.5100	35.3400
939.00	6700190.66	1630514.11	770.40	RT90-RHB70	–48.32	295.76	502.3100	139.6300	35.6000
942.00	6700191.53	1630512.31	772.64	RT90-RHB70	–48.24	295.91	503.9600	140.7600	35.8700
945.00	6700192.40	1630510.51	774.88	RT90-RHB70	–48.16	296.07	505.6100	141.8900	36.1400
948.00	6700193.28	1630508.71	777.12	RT90-RHB70	–48.07	296.22	507.2500	143.0200	36.4100
951.00	6700194.17	1630506.92	779.35	RT90-RHB70	–47.98	296.38	508.9000	144.1600	36.6900
954.00	6700195.06	1630505.12	781.58	RT90-RHB70	–47.89	296.55	510.5500	145.3100	36.9600
957.00	6700195.96	1630503.32	783.80	RT90-RHB70	–47.76	296.70	512.1900	146.4700	37.2400
960.00	6700196.86	1630501.52	786.02	RT90-RHB70	–47.64	296.85	513.8400	147.6300	37.5100
963.00	6700197.78	1630499.71	788.24	RT90-RHB70	–47.54	297.00	515.4900	148.8000	37.8000
966.00	6700198.70	1630497.91	790.45	RT90-RHB70	–47.44	297.19	517.1400	149.9800	38.0800
969.00	6700199.62	1630496.10	792.66	RT90-RHB70	–47.30	297.37	518.7800	151.1700	38.3600
972.00	6700200.56	1630494.30	794.87	RT90-RHB70	–47.19	297.54	520.4300	152.3600	38.6500
975.00	6700201.50	1630492.49	797.07	RT90-RHB70	–47.06	297.72	522.0800	153.5600	38.9400
978.00	6700202.45	1630490.68	799.26	RT90-RHB70	–46.93	297.82	523.7300	154.7700	39.2300

981.00	6700203.41	1630488.87	801.46	RT90-RHB70	–46.78	297.88	525.3800	155.9800	39.5300
984.00	6700204.37	1630487.05	803.64	RT90-RHB70	–46.64	297.98	527.0300	157.2000	39.8300
987.00	6700205.34	1630485.23	805.82	RT90-RHB70	–46.48	298.08	528.6900	158.4300	40.1400
990.00	6700206.31	1630483.41	808.00	RT90-RHB70	–46.32	298.17	530.3400	159.6600	40.4500
996.00	6700208.28	1630479.75	812.33	RT90-RHB70	–46.07	298.31	533.6700	162.1500	41.0900

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Appendix 4

Length reference marks

Reference Mark T – Reference mark in drillhole

KFM07A, 2004-12-13 14:00:00 – 2004-12-14 15:00:00 (150.000–980.000 m).

Bhlen (m)	Rotation Speed (rpm)	Start Flow (l/min)	Stop Flow (l/min)	Stop Pressure (bar)	Cutter Time (s)	Trace Detectable	Cutter Diameter (mm)	Comment
150.00	400.00	300	400	33.0	1	JA		Signal JA
203.00	400.00	300	400	33.0	1	JA		Signal JA
250.00	400.00	300	400	35.0	0	JA		Signal JA
300.00	400.00	260	400	35.0	1	JA		Signal JA
350.00	400.00	350	600	35.0	1	JA		Signal JA
400.00	400.00	380	600	35.0	1	JA		Signal JA
450.00	400.00	380	550	35.0	1	JA		Signal JA
500.00	400.00	450	650	35.0	1	JA		Signal JA
550.00	400.00	550	700	38.0	1	JA		Signal JA
600.00	400.00	550	750	42.0	1	JA		Signal JA
650.00	400.00	550	800	40.0	1	JA		Signal JA
700.00	400.00	600	900	42.0	2	JA		Signal JA
750.00	400.00	550	700	42.0	3	JA		Signal JA
800.00	400.00	550	700	45.0	4	JA		Signal JA
849.00	400.00	550	800	45.0	3	JA		Signal JA
900.00	400.00	500	700	48.0	2			Signal JA (Kom inte ner med detektor)
950.00	400.00	400	700	55.0	9			Signal NEJ (Kom inte ner med detektor)
980.00	400.00	500	800	55.0	8			Signal NEJ (Kom inte ner med detektor)

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Appendix 5

Conventional geological logging of the section 993.80–1,001.55 m