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Boremap mapping of core drilled borehole KFM09A

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June 2006

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Abstract

This report presents the results from the Boremap logging of core drilled borehole KFM09A. The borehole is located in the camp area, south of the Forsmark nuclear power plant, and plunges 60° towards SSW. The main purpose for the location of this borehole was to define the northwestern margin of the tectonic domain that largely coincides with the candidate area. The full length of KFM09A is 799.67 m. The BIPS-image usable for mapping covers the interval 7.80–795.21 m after length adjustment. All intersected structures and lithologies have been documented in detail by integrating information from the drill core and the BIPS-image. The lowermost metres of the drill core were mapped in Boremap without any complementary BIPS-image.

KFM09A is drilled just inside the northwestern limit of the candidate area into a ductile, high-strain belt, which defines the southwestern margin of the structurally more homogeneous rock domain 29. The predominant rock type in the borehole is a medium-grained metagranite, similar to that in the previously drilled deep boreholes located in the candidate area. However, the structural character is highly variable throughout the borehole, and the rock is locally intensely foliated, with streaks of increased biotite content. The lowermost 41 m of KFM09A consist of an intensely deformed sequence of intermediate rock of inferred volcanic origin, intercalated with fine- to medium-grained metagranodiorite, metagranite and metatonalite to granodiorite. Additional rock units that form continuous occurrences of volumetric importance in the borehole include a section of fine- to medium-grained metagranitoid of granodioritic composition at 124–242 m adjusted length, as well as pegmatitic granite at 21–52 m adjusted length. The fine- to medium-grained metagranitoid has obviously intruded after the development of the tectonic foliation and only show a weak mineral lineation. Virtually all rocks in the borehole have experienced Svecofennian metamorphism under amphibolite facies conditions. An interval of vuggy, syenitic rock, formed as a result of selective quartz dissolution, occurs at 511.75–520.03 m adjusted length.

Totally 175 narrow zones of more intense ductile and brittle-ductile deformation have been registered in KFM09A. The majority of the shear zones in KFM09A are steeply dipping and strikes roughly NW–SE (i.e. more or less parallel with the local tectonic foliation).

The total number of fractures registered *outside crush zones and sealed networks* during the Boremap-logging of KFM09A amounts to 5,062. Of these are 1,105 open, 93 partly open and 3,864 sealed. In addition, there are 135 sealed networks, 18 breccias, seven crush zones and one cataclasite registered in the mapped interval. The total length of all sealed networks in KFM09A amount to 43 m (i.e. about 5% of the mapped interval). Chlorite and calcite are the most frequent fracture filling minerals within KFM09A. A typical mineral assemblage, commonly found in fractures inferred to be sealed, consists of laumontite together with calcite, chlorite, and locally also adularia, hematite, pyrite and quartz. Other minerals preferably found in the sealed fractures are prehnite, epidote and white feldspar. Minerals largely restricted to open fractures include clay minerals, Fe-hydroxide and asphalt. Pyrite is common in both sealed and open fractures.

Sammanfattning

Föreliggande rapport redovisar resultaten från Boremapkarteringen av kärnborrhål KFM09A. Borrhålet är beläget vid bostadsområdet söder om Forsmark kärnkraftverk och stupar 60° mot SSV. Det huvudsakliga syftet med borrhålets placering var att definiera den nordvästra begränsningen av den tektoniska domän som i hög grad sammanfaller med kandidatområdet. Den totala längden av KFM09A är 799,67 m och den BIPS-bild som är användbar för kartering täcker intervallet 7,80–795,21 m, efter längdjustering. Alla strukturer och litologier i det Boremapkarterade intervallet har dokumenterats i detalj genom att integrera information från borrkärnorna och BIPS-bilderna. De understa metrarna av borrhålet är dock karterade med Boremap utan kompletterande BIPS-bild.

KFM09A har borrats strax innanför den nordvästra begränsningen av kandidatområdet, in i ett stråk av kraftig plastisk deformation som definierar den sydvästra begränsningen av den strukturellt homogena bergartsdomän 29. Den dominerande bergarten i borrhålet är en medelkornig metagranit av samma typ som den i övriga djupa kärnborrhål i kandidatområdet. Den strukturella karaktären varierar dock betydligt i borrhålet och bergarten är lokalt kraftigt folierad med stråk av förhöjt biotitinnehåll. De understa 41 metrarna av KFM09A utgörs av en kraftigt deformerad sekvens som inkluderar en intermediär bergart av vulkaniskt ursprung tillsammans med fin- till medelkornig metagranorit, metagranit och metatonalit till granodiorit. Ytterligare bergartsenheter som bildar kontinuerliga förekomster av volymmässig vikt i borrhålet inkluderar en sektion med fin- till medelkornig metagranitoid av granodioritisk sammansättning på 124–242 m justerad längd och en pegmatitisk granit på 21–52 m justerad längd. Den fin- till medelkorniga metagranitoiden har uppenbarligen intruderat efter bildandet av den tektoniska foliationen och uppvisar därmed endast en svag mineralstänglighet. Största delen av berggrunden i området har genomgått Svekofennisk amfibolitfacies-metamorfos. Ett intervall med en porös, syenitisk bergart, som bildats genom selektiv kvartsupplösning, förekommer på 511,75–520,03 m justerad längd.

Totalt 175 mindre zoner med plastisk och spröd-plastisk deformation har registrerats i KFM09A. Flertalet skjuvzoner i KFM09A stupar brant och stryker ungefär NV-SO (dvs mer eller mindre parallellt med den lokala tektoniska foliationen).

Det totala antalet sprickor som registrerats och inte ingår i krosszoner eller läkta spricknätverk vid Boremapkarteringen av KFM09A uppgår till 5 062. Av dessa är 1 105 öppna, 93 partiellt öppna och 3 864 läkta. Dessutom har 135 läkta spricknätverk, 18 breccior, sju krosszoner och en kataklasit registrerats i det karterade intervallet. Den totala längden av de läkta spricknätverken uppgår till 43 m (dvs ungefär 5 % av det karterade intervallet). Klorit och kalcit är de överlägset vanligaste sprickmineralen i KFM09A. En typisk mineralassociation, som vanligtvis uppträder i sprickor som bedömts vara läkta, utgörs av laumontit tillsammans med kalcit och klorit, samt lokalt adularia, hematit, pyrit och kvarts. Andra mineral som främst påträffats i läkta sprickor är prehnit, epidot och vit fältspat. Mineral som till största delen är begränsade till öppna sprickor är lermineral, järnhydroxid och bergbeck. Pyrit är vanligt förekommande både i läkta och öppna sprickor.

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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 Forsmark site investigation area, three deep, sub-vertical boreholes were drilled. After completion of these initial drillings, SKB launched a more extensive, complementary drilling programme, aiming to solve more specific geological issues. An important aspect is to define the northwestern margin of the tectonic domain, which largely coincides with the boundary of the site investigation area. To obtain such information, borehole KFM09A was drilled in the camp area, south of the Forsmark nuclear power plant, with 60° inclination towards SSW (200°) (Figure 1-1). The borehole has a total length of about 800 m.

The drilling activities in KFM09A were finished 27 October 2005, and the geological logging of the borehole started 30 November 2005 and ended 4 February 2006.

A detailed geological logging of the drill cores 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 geological drill core logging, or alternatively, the drill cuttings, when a core is not available, with information from BIPS-logging (Borehole Image Processing System) and calculates the absolute position and orientation of fractures and various planar lithological features (SKB MD 143.006 and 146.005).

This document reports the results gained by the geological logging of KFM09A, which is one of the activities performed within the site investigation at Forsmark. The work was carried out in accordance with activity plan AP PF 400-05-095. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents.

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

Activity plan	Number	Version
Boremapkartering av kärnborrhål KFM09A	AP PF 400-05-095	1.0
Method documents	**Number**	**Version**
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
Instruktion: Regler för bergarters benämningar vid plats-undersökningen i Forsmark	SKB MD 132.005	1.0

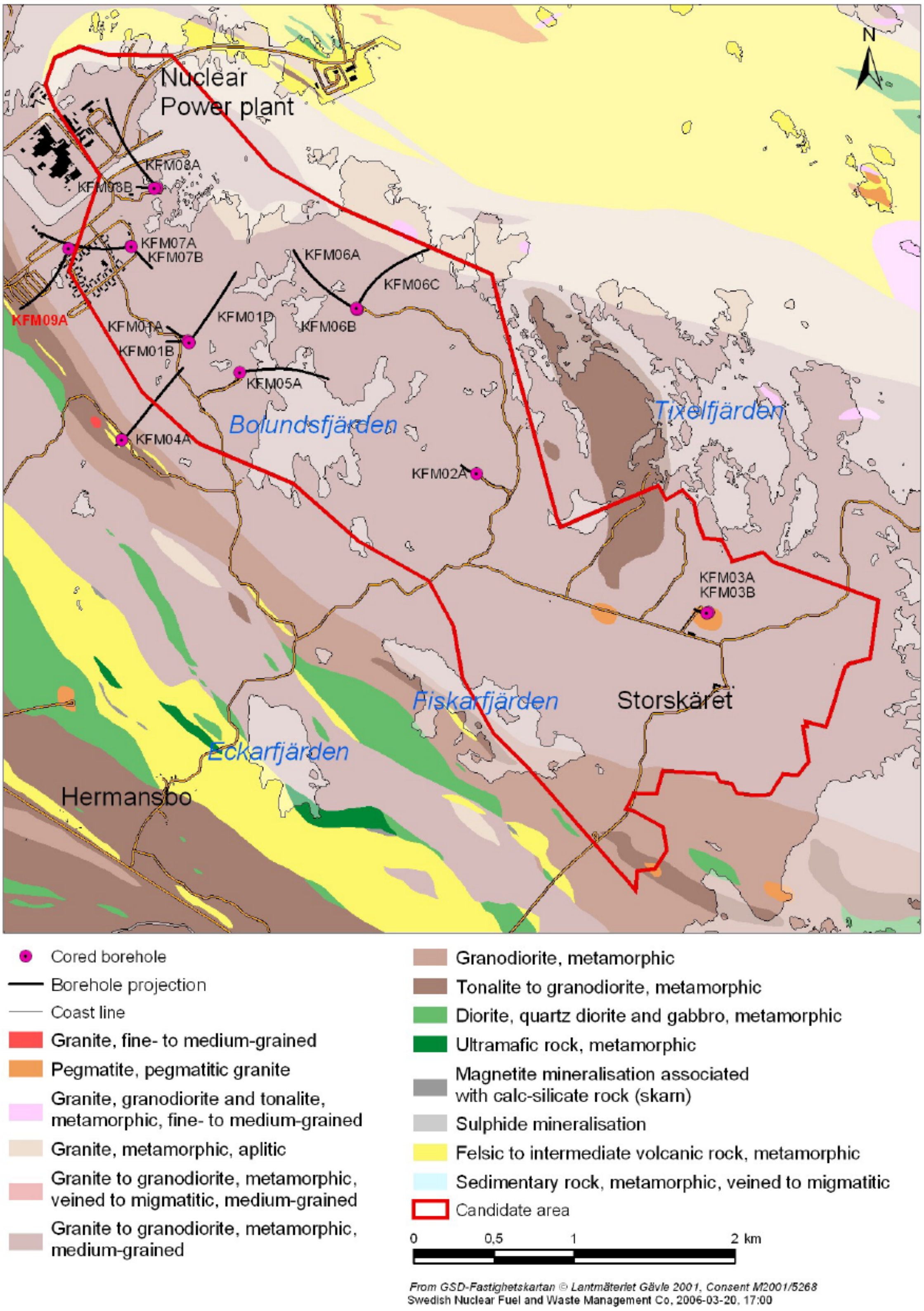

Figure 1-1. *Generalized geological map over Forsmark site investigation area and the projection of KFM09A in relation to other cored boreholes from the drilling programme.*

2 Objective and scope

The bedrock starts at 7.23 m length in borehole KFM09A. The initial 0.56 m, down to 7.79 m length is drilled by HQ at Ø = 96 mm, whereas the remaining part of the borehole is drilled by WL at Ø = 77.0 mm down to full its length at 799.67 m. The diameters of the two drill cores are 63.3 and 51 mm, respectively, under ideal conditions. The BIPS-image usable for geological logging covers the length interval 7.80–791.80 m (after adjustment 7.80–795.21 m). Thus, remaining part of the drill core, from 795.21 to 799.80 m (799.46 m after adjustment), was mapped by Boremap without any complementary BIPS-image.

The aim of the geological borehole logging is to obtain a detailed documentation of all structures and lithologies in the interval that was core drilled at Ø = 77 mm. 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 three-dimensional modelling.

3 Equipment

3.1 Description of equipment/interpretation tools

All BIPS-based mapping was performed in Boremap v. 3.74. 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 site investigation area, to enable correlation with the surface geology. Additional software used during the course of the geological logging 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 logging: 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 core logging, the c. 800 m drill core obtained from the interval 7.23–799.67 m of KFM09A 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 KFM09A 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. Most of the mapping was done by two geologists at a time, forming a core logging team. One of the geologists did the core logging while the other registered the information in Boremap.

The core logging of KFM09A was performed in Boremap v. 3.74 according to activity plan AP PF 400-05-095 (SKB internal document) following the SKB method description/instruction for Boremap mapping, SKB MD 143.006 (v. 2.0) and 143.008 (v. 1.0). However, the generalised geophysical logs arrived after the geological mapping of the borehole was finished. The use of these logs was, therefore, limited to a few lithological ambiguities that remained after the mapping.

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 KFM09A is about 3.4 m. It was, therefore, necessary to adjust the length in KFM09A with reference to groove millings cut into the borehole wall at every 50 m, with the deepest slot at a length of 725 m. The precise 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 does never exceed 2 dm. All borehole lengths given in this report are adjusted with reference to the groove millings.

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).

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 drives.

In order to avoid that some broken fractures had not been registered, 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 primary data were subsequently exported to the SKB database SICADA, where they are traceable by the activity plan number.

4.4 Analyses and interpretations

A problem with the Boremap system is that certain geological features (mainly fractures) only can be observed in the drill core. This problem usually arises from poor resolution in the BIPS-image, which in the present case often is caused by the occurrence of suspension from drilling and/or brownish black coating from the drilling rods on the borehole walls (see Section 4.5). However, even in the most perfect BIPS-image, it is sometimes difficult to distinguish a thin fracture, sealed by a low contrast mineral. All fractures observed in the drill core, but not recognized 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. If possible, they are still oriented relative to other structures with known orientations. Fractures supposed to be induced by the drilling activities fall within this category. Obviously drilling-induced fractures are not included in the mapping.

The resolution of the BIPS-image does generally make it possible to estimate the width of fractures with an error of ± 0.5 mm. Thus, reliable measurements of fracture widths/apertures less than 1 mm are possible to obtain in the drill core. The minimum width/aperture given is therefore 0.5 mm, in accordance with the nomenclature for Boremap mapping (SKB MD 143.008; v. 1.0).

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 or the following treatment of the core. To decide if a fracture was open, partly 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', on the basis of the weathering of the fracture surface 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. 2.0).

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 attached comment. 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 consistently as extremely thin coatings or impurities in other fracture minerals, such as adularia and laumontite.

Drill induced crushes have been registered at 256.77–256.89 and 262.58–262.72 m of KFM09A.

4.5 Nonconformities

Several fractures within KFM09A are sealed by laumontite (Ca-zeolite). These fractures occur as both broken and unbroken, but dehydration of laumontite tends to produce volumetric changes, and the sealing will eventually crackle and break the drill core. Thus, 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 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 under-represented in unbroken fractures.

As in previous cored boreholes, the mapping of KFM09A was locally hampered by deposited drill cuttings as well as brownish black coatings on the borehole. The most crucial quality-reducing factor is the drill cuttings. From about 500 m to the bottom of the bore-hole, the deposited drill cuttings obscure the lower 180° of the borehole wall. Only a few high-contrast features are distinguishable through the cover below about 600 m. Another, more local problem, is the brownish black coating. Typically, it occurs as a spiral pattern or a single band along the borehole axis. This coating phenomenon is obviously drill induced, and the explanation proposed is that the coatings originate from metal fragments abraded from the drill rods.

Both during the mapping and the subsequent work with mapping data from other boreholes in the drilling programme, we have noted a few inexplicable errors in the databases. No such errors have been observed for KFM09A, though there might still be unnoticed errors. We disclaim the responsibility for all errors caused by the shortcomings in the software.

5 Results

5.1 Lithology

5.1.1 General

Borehole KFM09A is located just outside the northwestern limit of the candidate area and plunges 60° southwestward towards a ductile, high-strain belt, which defines the southwestern margin of the structurally more homogeneous rock domain 29 /cf SKB 2005/. Thus, KFM09A should be expected to have a lithological sequence that more or less is a mirror image of that revealed in borehole KFM04A /cf Petersson et al. 2004a/. However, an important issue is whether rock domain 32, which mainly consists of aplitic metagranite, wedges in from the north, between the high-strain belt and RFM0029 in KFM09A.

The predominant rock type in KFM09A is a medium-grained metagranite (rock code 101057), which also prevails in the previously drilled deep boreholes located in the site investigation area (i.e. rock domain 29). However, the structural and mineralogical character of the rock varies throughout the borehole. Down to about 440 m adjusted length, the foliation is variable and locally intense, especially in sections with increased biotite content. In the interval between about 440 and 640 m adjusted length, the rock is more homogeneous and the foliation becomes less intense. Further down, the intensity of the foliation gradually increases. The borehole enters rock domain 18 at 758 m adjusted length. The lowermost 41 m of KFM09A consist of an intensely deformed sequence of intermediate rock of inferred volcanic origin (rock code 103076), intercalated with fine- to medium-grained metagranodiorite (rock code 101056), metagranite (rock code 101057) and metatonalite to granodiorite (rock code 101054).

Additional rock units that form continuous occurrences of volumetric importance in the borehole include an intrusion of fine- to medium-grained metagranitoid (rock code 101051), between 124 and 242 m adjusted length, as well as a pegmatitic granite (rock code 101061) at 21–52 m adjusted length. The fine- to medium-grained metagranitoid is generally granodioritic in composition and has obviously intruded after the development of the tectonic foliation. Less extensive occurrences, none more than about ten metres in length, include various pegmatites, pegmatitic granites (rock code 101061), amphibolites (rock code 102017), the intermediate rock of inferred metavolcanic origin (rock code 103076), fine- to finely medium-grained metagranitoids (rock code 101051), aplitic metagranites (rock code 101058) and an interval of metamorphic quartz diorite (rock code 101033). Except for a few late veins or dykes, all rocks have experienced Svecofennian metamorphism under amphibolite facies conditions.

5.1.2 Rock types

The predominant medium-grained metagranite (rock code 101057) is similar with the predominant variety of metagranite-granodiorite in the other deep boreholes located in rock domain 29. It is typically granitic with a tendency to be slightly granodioritic. Texturally, the rock is rather equigranular with elongated quartz domains, alternating with feldspar-dominated domains and thin streaks of biotite. More intensely deformed varieties of the rock that occur in the upper 440 m of the borehole are typically heterogeneously enriched in biotite. The colour of the rock varieties ranges from greyish red to grey. Completely grey varieties, lacking the reddish tint, are typically biotite-rich or associated with amphibolites. Minor sections that appear to have been affected by static recrystallization occur sporadically throughout the borehole. Microscopic examination of similar rocks from KFM01A and KFM03A, suggests that at least the characteristic fine-grained, whitish plagioclase in these sections is a result of retrograde sericitization /Petersson et al. 2004c/. Three centimetre-wide, pyrite-rich streaks found at 91.07–91.08, 684.91–684.93, 779.82–779.83 m adjusted depth within the metagranite are coded as 'sulphide mineralization' (rock code 109010).

Fine- to medium-grained metagranitoids (rock code 101051) of mostly granodioritic composition form a more or less continuous interval at 124–242 m adjusted length. Occurrences outside this interval are scarce and are typically less than a few metres wide. The majority is equigranular and ranges from grey to reddish grey in colour. The mineral fabric is commonly linear and external contacts are typically discordant to the tectonic foliation in the wall rock.

Dykes, veins and segregations of pegmatite, pegmatitic granite, aplite and leucogranitic material are frequent throughout the borehole. Most occurrences are some decimetre or less, but several pegmatites/pegmatitic granites reach up to about ten metres in width. The most extensive pegmatitic granite forms a continuous occurrence at the adjusted length interval 21–52 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, up to about one centimetre in diameter, has been identified in some pegmatites. A few pegmatites also contain accessory amounts of pyrite. Despite the textural variability and temporal span within this unit, most of these rocks were grouped as 'pegmatite, pegmatitic granite' (rock code 101061). Rocks related to the pegmatitic material, such as aplitic metagranites (rock code 101058) and fine to finely medium-grained leucogranite (rock code 111058), constitutes about 2% of the mapped interval. All aplitic metagranites in KFM09A show a distinct tectonic foliation. The majority are some decimetre or less, though there are a few metre-wide occurrences, especially in the length interval 400–460 m. 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 occur sporadically throughout KFM09A. The longest, continuous intervals of amphibolite occur at 420.8–431.0 and 496.7–504.0 m adjusted length. None of the other occurrences exceed a few metres in length. Generally, the amphibolites are fine-grained, equigranular with a large proportion of biotite. In addition, there is an amphibolite-like occurrence of highly variable mineralogical composition at 733.2–738.2 m adjusted length. This rock has a slightly coarse grain-size relative to the amphibolites, and most of the occurrence is mapped as metamorphic quartz diorite (rock code 101033), although the compositional span ranges from tonalite to diorite/gabbro. Extensions and contacts of both the amphibolites and the quartz metadiorite are more or less parallel with the tectonic fabric. Some occurrences are surrounded by up to one decimetre wide rims of whitish, leucogranitic material, inferred to be the result of albitization. Disseminations of pyrite and/or other unidentifiable sulphides are macroscopically visible in some of the occurrences.

Occurrences of intermediate rock of inferred volcanic origin (rock code 103076) are mainly found in the lowermost 35 m of KFM09A, within rock domain 18. A second concentration occurs in the length interval 338–503 m. Individual occurrences in this latter interval range up to a few metres in length, though the majority are 1–3 dm or less. All occurrences outside these intervals are less than 1.1 m in borehole length. The rock is generally equigranular, dark grey in colour and all contacts are parallel with the tectonic fabric. Most occurrences are structureless, and except for the grain-size and in some cases a faint banding, there is no textural or structural macroscopic feature that unambiguously points towards a volcanic origin of the rocks. Some of the rocks are highly reminiscent of amphibolites discussed above, especially in the interval 338–503 m. A distinctive criterion apart from their more felsic character is, however, their anomalously high magnetic susceptibility relative to the amphibolites /cf Mattsson 2006/.

Similar to the inferred metavolcanic rock, the occurrence of fine- to medium-grained metagranodiorite (rock code 101056) and metatonalite-granodiorite (101054) are mainly limited to the lowermost 35 m of KFM09A. There are, however, minor occurrences of metagranodiorite registered at more shallow levels in the borehole as well. The rocks are all equigranular and range from grey to dark grey in colour. The metagranodiorite is locally difficult to distinguish from the more intensely foliated varieties of the metagranite (101057). The macroscopic separation is based on the rock colour and content of ferro-magnesian phases.

In addition, there are a few minor occurrences of granite, granite-granodiorite, granodiorite and tonalite in KFM09A. None of them appears to fit into the bedrock nomenclature defined by SKB MD 132.005. Instead they were coded as 1058 (unspecified granite), 1057 (unspecified granite-granodiorite), 1056 (unspecified granodiorite) and 1053 (unspecified tonalite). Two minor occurrences of skarn-like material (rock code 108019), distinguished by their visible content of epidote and/or prehnite, occur at 567.83–567.85 and 595.74–595.88 m adjusted length.

5.2 Ductile structures

Virtually all rocks in KFM09A are characterized by composite L-S fabrics, with a general predominance of tectonic foliations. An exception is, however, some of the pegmatitic granites and the fine- to medium-grained metagranodiorite (rock code 101051), which is post-tectonic with respect to the main deformation, and therefore only show a weak mineral lineation. The intensity of the deformational fabric in KFM09A is mostly medium to strong, and more rarely faint or weak (Figure 5-1). A continuous interval of less intense ductile deformation occurs at about 440–640 m adjusted length. It must, however, be emphasized that the distinctness of a fabric does not necessarily reflect the intensity of the strain. The fact that a rock may appear massive does not always implicate that they actually are unaffected by strain. It is, for example, often difficult to distinguish tectonic fabric visually in the pegmatites and some of the fine-grained mafic rocks. Most rocks have also undergone varying degrees of static recrystallization.

The structural orientation in KFM09A is rather constant throughout the borehole and registered foliations are consistently steeply dipping and strike NW–SE (Figure 5-2). None of the linear fabrics have been possible to register with the present methodology, but the general impression is that they are gently to moderately dipping.

Totally 175 narrow zones of more intense ductile and brittle-ductile deformation have been registered in KFM09A. Nine of them are registered as mylonite, 95 as ductile shear zones and 71 as brittle ductile shear zones. Mylonites are distinguished from the shear zones by the fact that the protolith is unidentifiable. Generally, the deformation zones tend to concentrate in intervals of more intense tectonic foliation (see Figure 5-1). Individual zones range up to 3.7 m in width. However, the typical width is less than a few decimetres. The protolith in the zones mainly seems to be a highly deformed and grain-size reduced variety of the metagranite (rock code 101057), but also amphibolites (rock code 102017), pegmatitic granites (rock code 101061) and the intermediate rock of inferred volcanic origin (rock code 103076) have been affected. Interestingly, the fine- to medium-grained metagranitoid (rock code 101051) is virtually free from ductile deformation zones. The brittle component

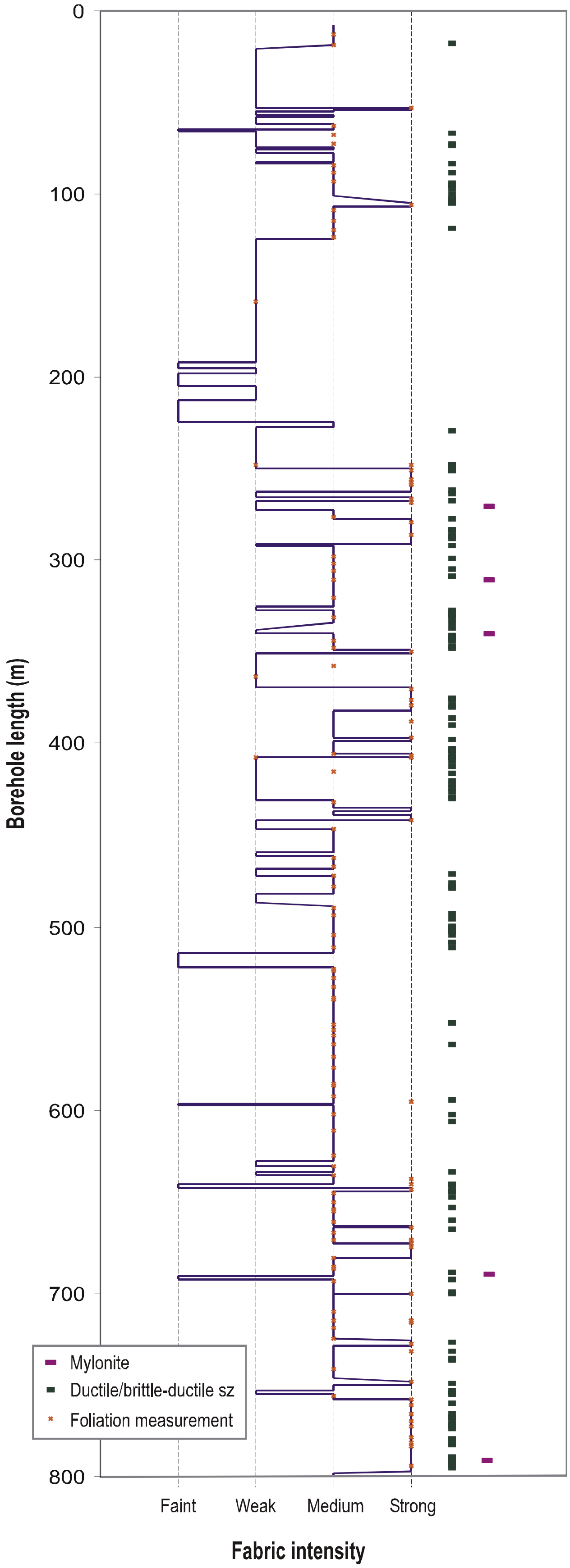

Figure 5-1. Intensity of foliation/mineral lineation versus borehole length in KFM09A. Also indicated are the location of individual ductile/brittle-ductile shear zones, mylonites and foliation measurements.

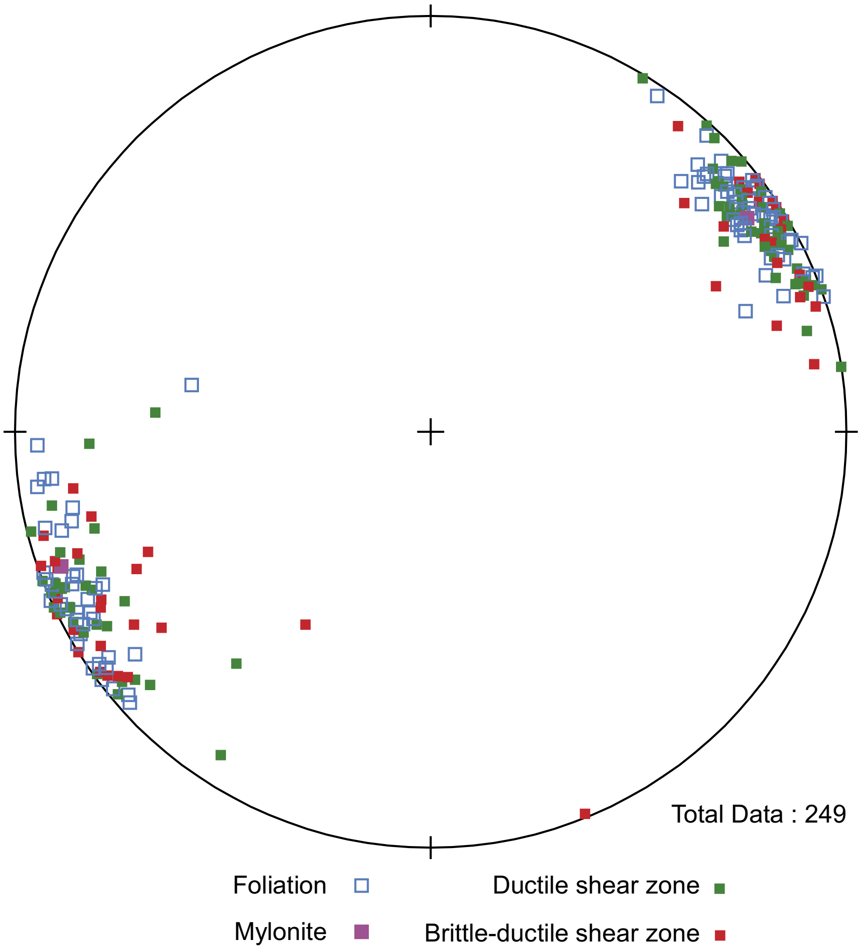

Figure 5-2. *Lower hemisphere, equal area stereographic projection showing poles to ductile/ brittle-ductile structures in KFM09A.*

of some deformation zones are typically characterized by epidote and/or chlorite filled fractures. Calcite, prehnite and hematite occur more rarely. More or less all shear zones in KFM09A are steeply dipping and strikes roughly NW–SE (i.e. more or less parallel with the local tectonic foliation; Figure 5-2).

5.3 Alteration

The most common alteration encountered in KFM09A is varying degrees of oxidation or red pigmentation of feldspars by sub-microscopic hematite. It is generally associated with more intensely fractured intervals, and about 10% of the mapped interval of KFM09A has been affected by oxidation. Normally this oxidation is faint to weak in intensity, and more rarely medium.

Other types of alterations within KFM09A include laumontization, chloritization sericitization, epidotization, argillization, an occurrence of quartz dissolution and an alteration that gives the rock a slightly darker, blurred appearance (mapped as 'sassuritization' in Boremap). The presence laumontization is restricted to intervals with anomalously high frequency of laumontite sealed fractures, and occurs in to two length intervals: 228–250 and 738–745 m. Totally nine intervals of chloritization have been registered KFM09A. They are typically restricted to amphibolites and none of them are wider than a few decimetres.

Sericitization and epidotization are registered in seven and six intervals, respectively. Individual occurrences are generally a few decimetres in borehole length. Clay dominated or argillic alteration is limited to two shorter intervals at 240.61–240.66 and 241.56–241.74 m adjusted length. An interval of vuggy, syenitic rock at 511.75–520.03 m adjusted length is more or less identical to the rock found in borehole KFM02A /Möller et al. 2003, Petersson et al. 2003a/, and according to the IUGS recommendations /Le Maitre 2002/ it should be denoted 'episyenite' as it apparently was formed by hydrothermal processes involving the selective removal of quartz. The occurrence was, therefore, mapped as 'quartz dissolution', though other types of alteration have also affected it.

Another alteration product, mainly found below 600 m length of the borehole, is up to a few decimetre wide occurrences of whitish leucogranite. Individual occurrences are typically vaguely defined and there is no apparent relationship to existing brittle structures. Based on microprobe analysis of similar rocks from KFM06A it is suggested that these rocks resulted from pre- to syn-metamorphic albitization /Petersson et al. 2005a/.

5.4 Fractures

5.4.1 Fracture frequencies and orientations

The total number of open (broken fractures with aperture > 0), partly open (unbroken fractures with aperture > 0) and sealed fractures (broken and unbroken fractures with aperture = 0) registered *outside crush zones and sealed networks* during the Boremap logging of KFM09A amounts to 5,062, i.e. about 6.4 fractures/metres. Of these are 1,105 open, 93 partly open and 3,864 sealed. This separation in open, partly open or sealed fractures is made on the basis of the weathering of the fracture surface and the fit of the fracture planes. It should be emphasized that there is a certain degree of uncertainty in these judgements.

In addition, there are 135 sealed networks, 18 breccias and one cataclasite registered in the mapped interval. The distinction between breccia/cataclasite and sealed network is not straight forward, but normally zones with none or minor rotation of individual rock fragments has been mapped as sealed network. Breccias and cataclasites, on the other hand, are distinguished by their volumetric content of matrix; occurrences with more than 90% matrix have been mapped as cataclasites. Significant fractures that differ markedly (e.g. in aperture or infilling mineralogy) from the majority of fractures within the sealed networks are mapped separately. The total length of all sealed networks in KFM09A amount to 43 m (i.e. about 5% of the mapped interval). The piece length (i.e. the distance between individual fractures) within these networks is typically about 2 cm, but ranges up to 4.5 cm. This makes more than 2,000 additional sealed fractures in the mapped interval of the borehole. Breccias are mainly concentrated in three length intervals throughout the borehole (33–48, 230–248 and 732–793 m), and individual occurrences range up to one metre in width. However, most of them are less than one decimetre wide. Except for the registered zones with breccia and cataclasite, where faulting obviously have occurred, there are eleven fractures with measurable displacements registered in KFM09A.

Totally seven crush zones occur sporadically throughout KFM09A. Except for a nine decimetres wide length interval at 263.79–264.68 m, they are all about one decimetre or less in width. The three uppermost zones are sub-horizontal to gently dipping, whereas the four deeper zones are steeper and strikes roughly NW–SE to NNW–SSE.

Throughout the borehole, 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). Generally, there are two length intervals with a slightly decrease in the fracture frequency relative to the remaining part of the borehole. One occurs between approximately 125 and 240 m, and coincides hence with the intrusive of fine- to medium-grained metagranitoid (rock code 101051), whereas the other occurs at about 510–640 m within the medium-grained metagranite (rock code 101057). In addition, there are intervals with anomalously high fracture frequencies. The most well-defined intervals occur at 15–40, 86–116 and 217–280 m. All three are dominated by sealed fractures, some of which are included in sealed fracture networks.

It is reasonable to expect that mechanical discontinuities, such as lithological contacts, should be the locus of fracture formation more frequently than within a homogeneous rock. For this reason we have noted the proportion of fractured amphibolite contacts. About 28% of the contacts in the mapped interval of KFM09A are fractured. This can be compared with other cored boreholes from the Forsmark drilling programme, in which 22–42% of the contacts are fractured /Petersson et al. 2003ab, 2004ab, 2005bcde/.

Inferred core discing occurs at the following lengths along KFM09A: 252.28–252.35, 267.75, 704.40–704.45 and 704.95–705.00 m. One interval also includes what appears to be initial core discing that not actually breaks the core. None of the intervals exceed 7 cm in width, and the typical dimension of individual discs range between 8 and 20 mm. The fractures are all planar to slightly saddle-shaped.

5.4.2 Fracture mineralogy

Chlorite and/or calcite are found in about 77% of the total number of the registered fractures in KFM09A. Other infilling minerals, in order of decreasing abundance, include laumontite, adularia, sub-microscopic hematite, pyrite, clay minerals, quartz, prehnite, epidote, apophyllite and more rarely, white feldspar, unspecified sulphides, biotite, iron hydroxide, asphalt, sericite, fluorite and hornblende. In addition, there are ten fractures with unknown mineral filling. Analyses by XRD 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 211 fractures that are virtually free from visible mineral coatings. These are mostly open, though there are also sealed fractures with no *visible* mineral sealing.

The various clay minerals are more or less restricted to open fractures. Fractures with clay minerals are found throughout the borehole, though the majority occur in the upper half of the borehole. Clay minerals registered in fractures at greater depths are typically corrensite and illite, often intimately associated with chlorite. Other minerals preferably found in open fractures are iron hydroxide and asphalt. Both minerals are restricted to rather short intervals above 103 m length.

Pyrite is frequent in both sealed and open fractures. The presence of other sulphides, including pyrrhotite, chalcopyrite, sphalerite and 'unspecified sulphides', are rare and restricted to twelve fractures. Minerals mapped as unspecified sulphides include pyrite, chalcopyrite and/or pyrrhotite. Also the findings of apophyllite (mapped as X1) are spread rather equally between open or sealed fractures.

All other minerals, as well as oxidized walls, are preferentially associated with fractures inferred to be sealed. A typical mineral assemblage, commonly found both in individual fractures and sealed fracture networks consists of laumontite together with calcite, chlorite, and locally adularia, hematite, pyrite and quartz. However, the exact assemblage varies locally. The majority of these fractures are concentrated into two length intervals of

KFM09A: 106–270 and 690–790 m. A number of very thin (<< 1 mm), sealed fractures are typically only revealed by their oxidized walls. Several of these thin fractures are sealed by a mineral inferred to be hematite, but it might well be hematite-stained laumontite or adularia. This interpretation is based on the fact the hematite within KFM09A typically occurs in two main varieties: (1) thin, reddish coatings, preferentially found in flat lying fractures, and (2) staining of various silicates, such as adularia and laumontite.

Another, less common, but yet characteristic assemblage mainly found in the sealed fractures is epidote + calcite + chlorite ± quartz ± adularia. These fractures are mostly found below 540 m length, and at more shallow levels, in two narrow intervals at 96–98 and 401–429 m. A single fluorite-bearing fracture, dominated by quartz-epidote, occurs at 83.56 m adjusted depth in KFM09A. Prehnite are with few exceptions limited to thin, sealed fractures found within amphibolites and related rocks. Subsequent EDS-analysis of some of these fractures has revealed that most of the light greenish minerals inferred to be prehnite in fact are epidote (B. Sandström, written communication).

White feldspar is mainly registered in fractures in the length interval 657–679 m. The term is used for white or colourless adularia as well as suspected albite. Biotite and hornblende are found in fractures inferred to be late-, rather than post-metamorphic. These fractures are typically mono-mineralic or include minor amounts of pyrite or quartz.

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WellCAD image

Site	FORSMARK
Borehole	KFM09A
Plot Date	2006-05-07 21:15:00
Signed data	

ROCKTYPE FORSMARK

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

ROCK ALTERATION

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

MINERAL

- Epidote
- Hematite
- Calcite
- Chlorite
- Quartz
- Unknown
- Pyrite
- Sphalerite
- Clay Minerals
- Laumontite
- Prehnite
- Iron Hydroxide
- Oxidized Walls

STRUCTURE

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

TEXTURE

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

GRAINSIZE

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

STRUCTURE ORIENTATION

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

ROCK ALTERATION INTENSITY

- No intensity
- Faint
- Weak
- Medium
- Strong

ROUGHNESS

- Planar
- Undulating
- Stepped
- Irregular

SURFACE

- Rough
- Smooth
- Slickensided

CRUSH ALTERATION

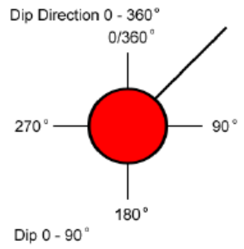
- Slightly Altered
- Moderately Altered
- Highly Altered
- Completley Altered
- Gouge
- Fresh

FRACTURE ALTERATION

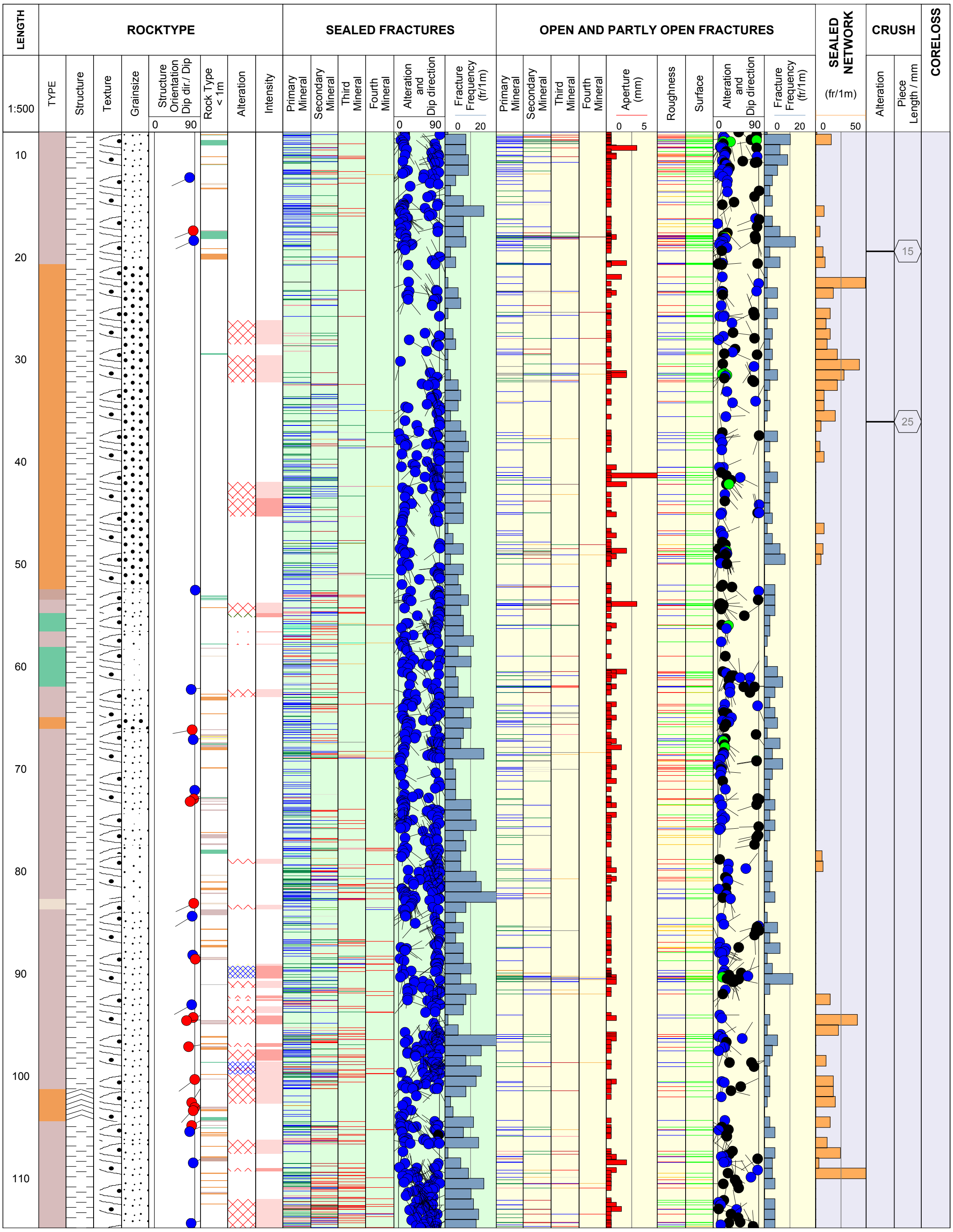
- Slightly Altered
- Moderately Altered
- Highly Altered
- Completely Altered
- Gouge
- Fresh

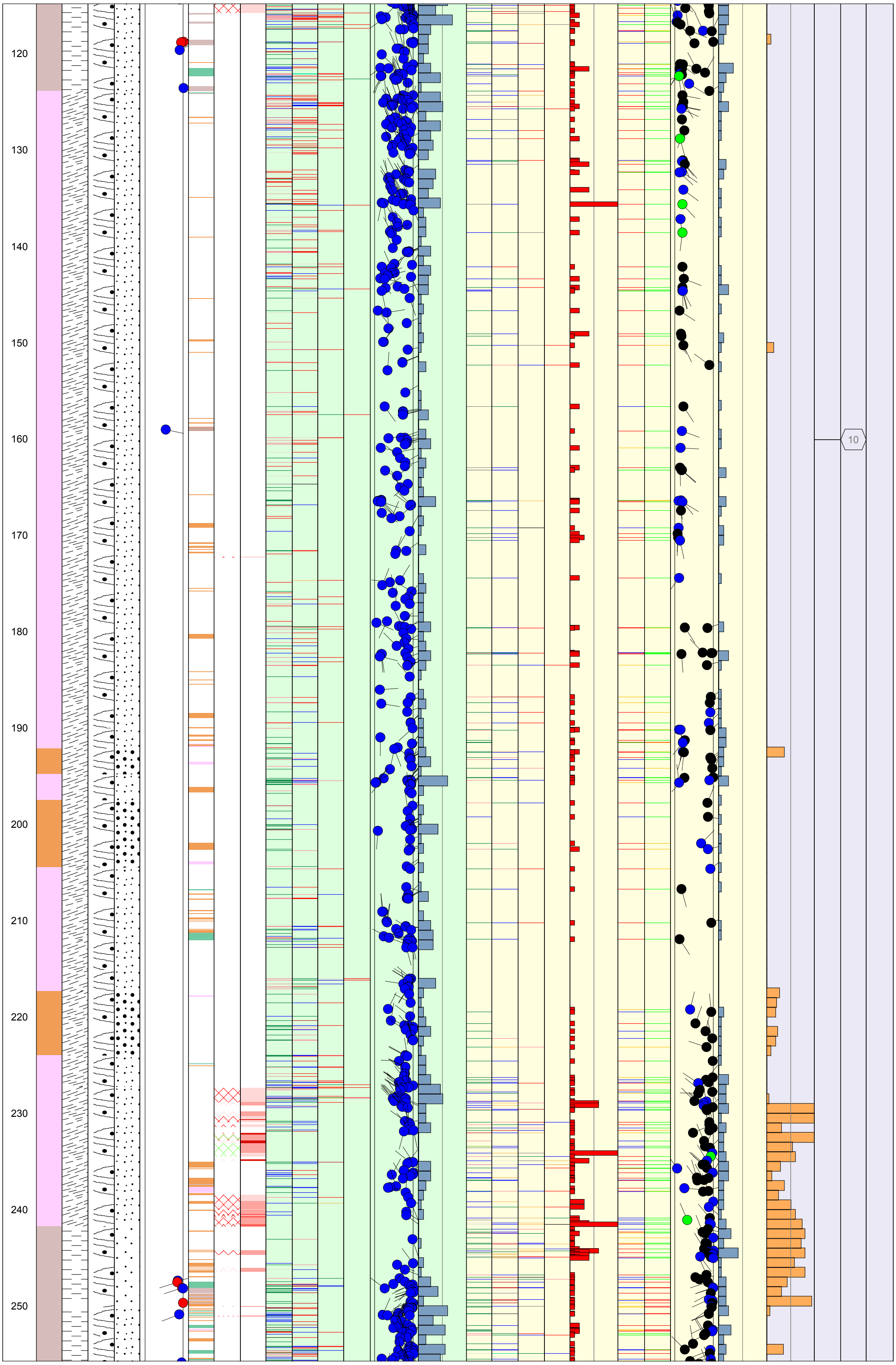
FRACTURE DIRECTION

STRUKTURE ORIENTATION



Site	FORSMARK	**Coordinate System**	RT90-RHB70
Borehole	KFM09A	**Northing [m]**	6700115.04
Diameter [mm]	77	**Easting [m]**	1630647.50
Length [m]	799.670	**Elevation [m.a.s.l.]**	4.29
Bearing [°]	200.08	**Drilling Start Date**	2005-08-31 00:00:00
Inclination [°]	-59.45	**Drilling Stop Date**	2005-10-27 13:00:00
Date of coremapping	2005-11-29 20:07:00	**Plot Date**	2006-05-07 21:15:00
Rocktype data from	p_rock	**Signed data**	

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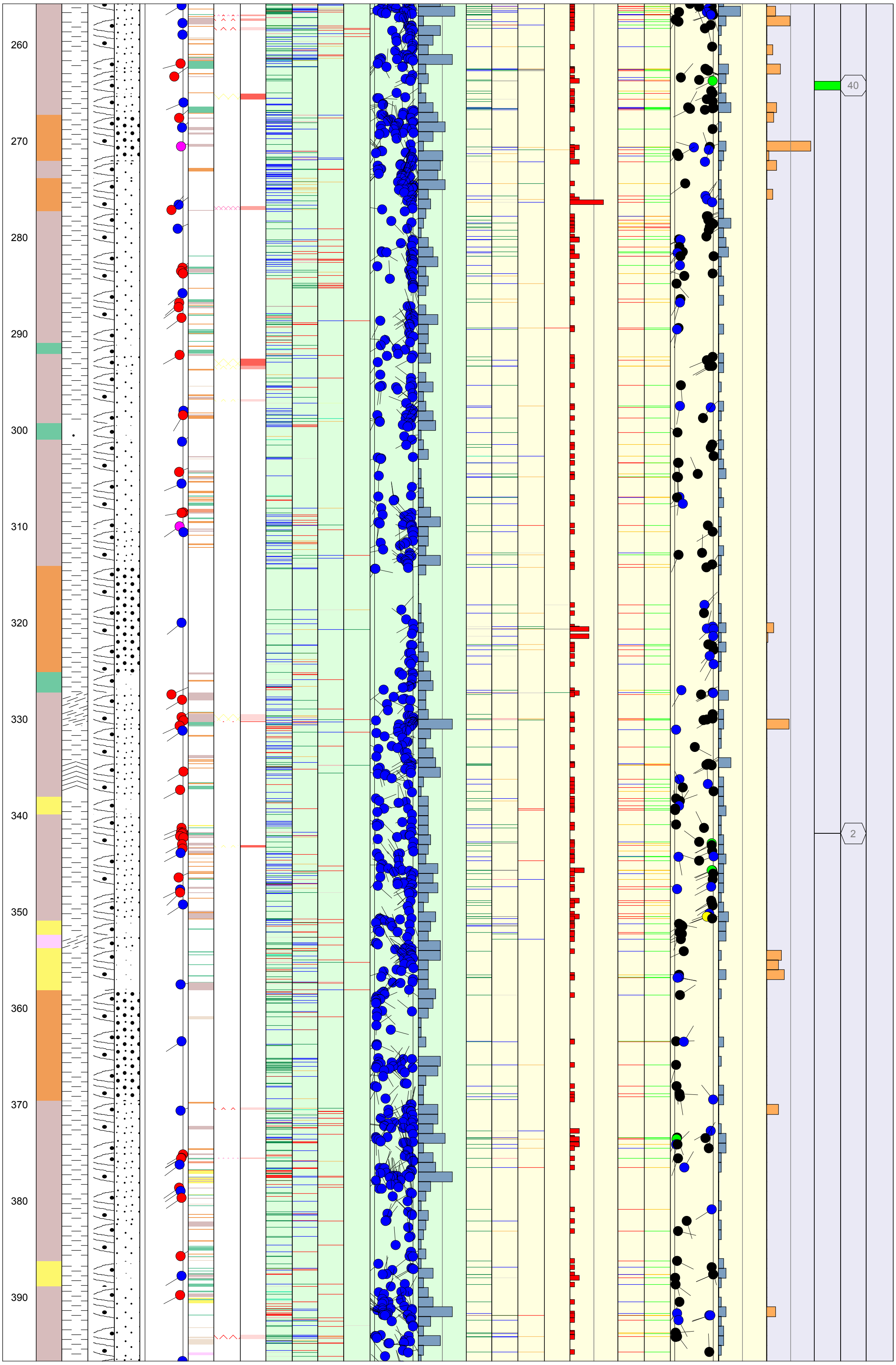
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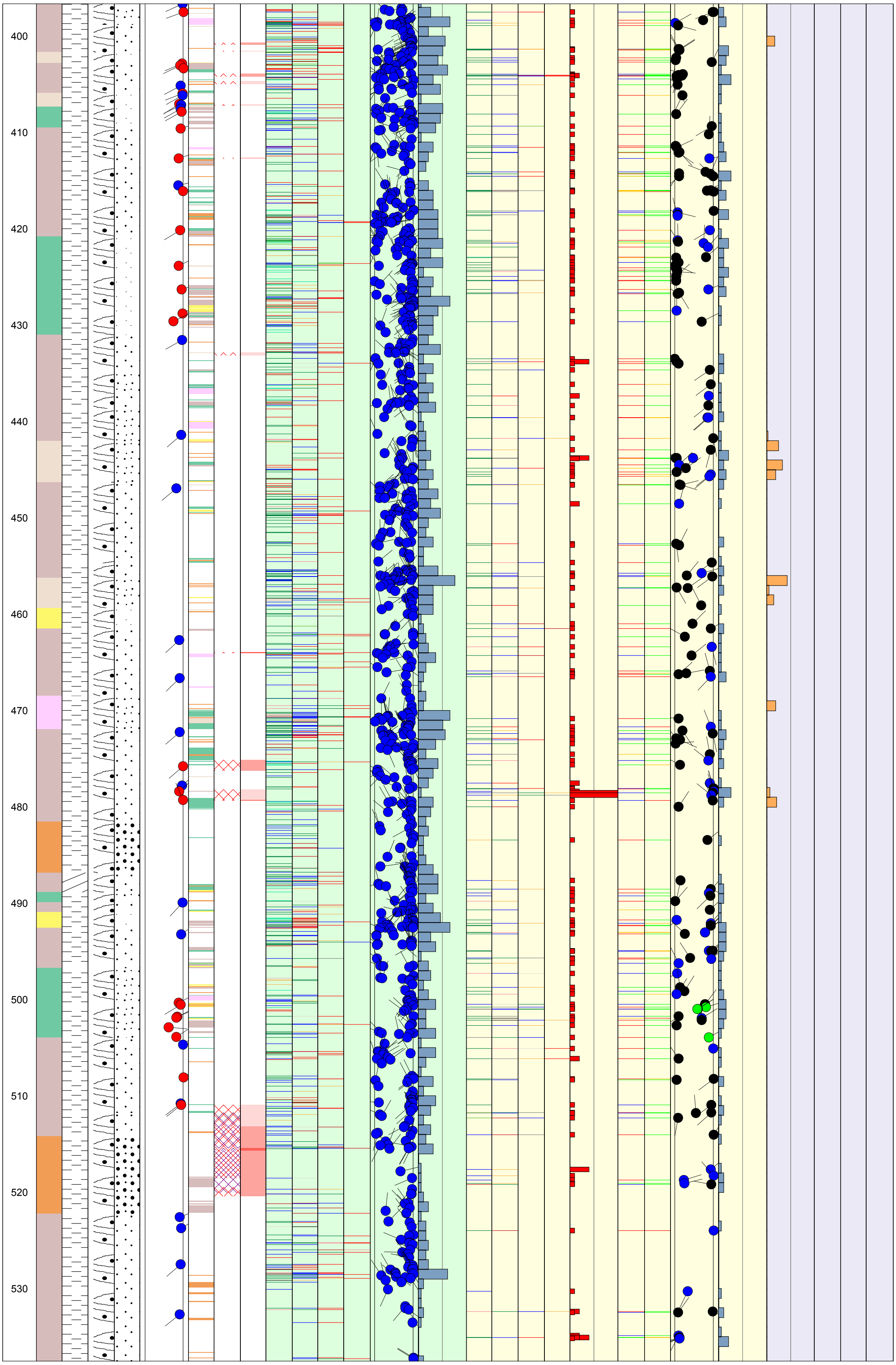
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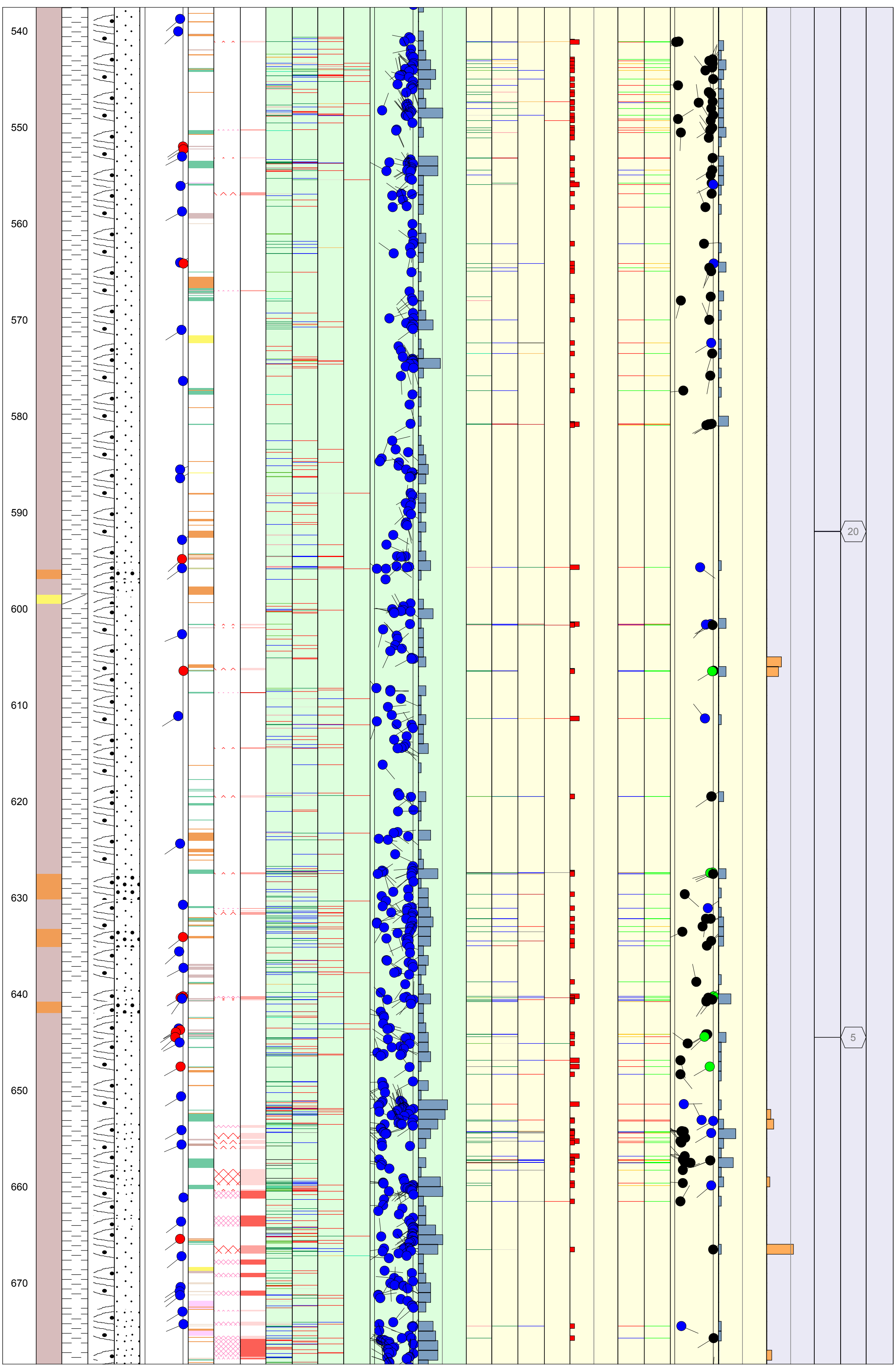
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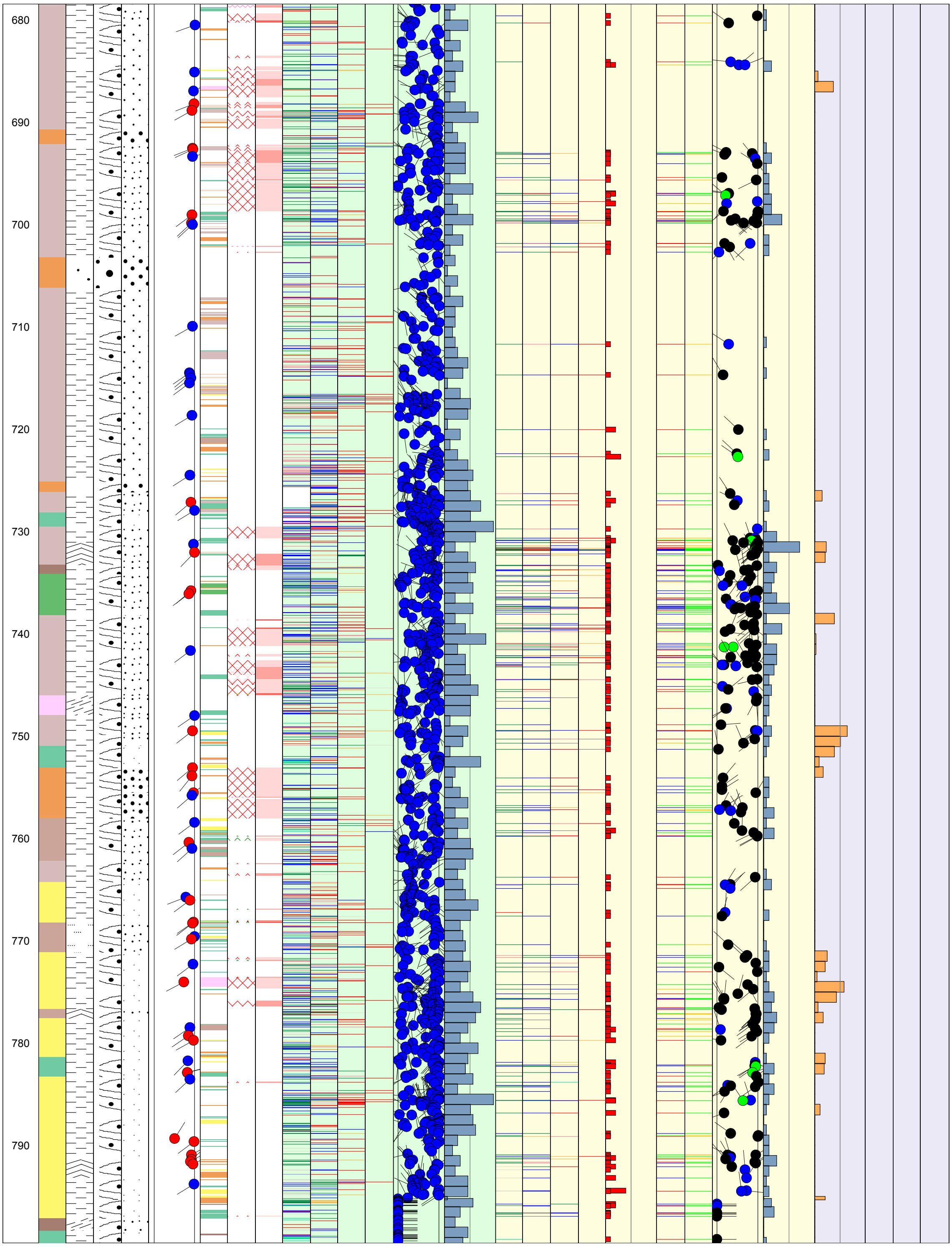
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770
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790

Appendix 2

Borehole diameters

Hole Diam T – Drilling: Borehole diameter

KFM09A, 2005-08-31 00:00:00–2005-10-27 13:00:00 (0.000–799.670 m)

Sub secup (m)	Sub seclow (m)	Hole diam (m)	Comment
0.000	7.230	0.1160	
7.230	7.790	0.0960	HQ
7.790	799.670	0.0770	

Printout from SICADA 2006-04-18 12:46:18.

Appendix 3

Downhole deviation measurements

Maxibor T – Borehole deviation: Maxibor

KFM09A, 2005-10-31 15:00:00–2005-10-31 23:00:00 (0.000–798.000 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	6700115.04	1630647.50	–4.29	RT90-RHB70	–59.46	200.08				
3.00	6700113.61	1630646.98	–1.71	RT90-RHB70	–59.46	200.08	0.0000	0.0000	0.0000	
6.00	6700112.18	1630646.46	0.87	RT90-RHB70	–59.32	200.20	1.5200	0.0000	0.0000	
9.00	6700110.74	1630645.93	3.45	RT90-RHB70	–59.27	200.38	3.0600	0.0000	0.0100	
12.00	6700109.30	1630645.40	6.03	RT90-RHB70	–59.21	200.53	4.5900	0.0100	0.0200	
15.00	6700107.86	1630644.86	8.61	RT90-RHB70	–59.15	200.70	6.1200	0.0200	0.0300	
18.00	6700106.42	1630644.31	11.19	RT90-RHB70	–59.09	200.81	7.6600	0.0400	0.0500	
21.00	6700104.98	1630643.77	13.76	RT90-RHB70	–59.03	200.91	9.2000	0.0600	0.0700	
24.00	6700103.54	1630643.22	16.33	RT90-RHB70	–58.98	201.05	10.7500	0.0800	0.0900	
27.00	6700102.10	1630642.66	18.90	RT90-RHB70	–58.95	201.19	12.2900	0.1100	0.1100	
30.00	6700100.66	1630642.10	21.47	RT90-RHB70	–58.94	201.33	13.8400	0.1400	0.1400	
33.00	6700099.21	1630641.54	24.04	RT90-RHB70	–58.92	201.48	15.3900	0.1700	0.1700	
36.00	6700097.77	1630640.97	26.61	RT90-RHB70	–58.90	201.63	16.9400	0.2100	0.1900	
39.00	6700096.33	1630640.40	29.18	RT90-RHB70	–58.89	201.77	18.4800	0.2500	0.2200	
42.00	6700094.89	1630639.83	31.75	RT90-RHB70	–58.86	201.85	20.0300	0.3000	0.2500	
45.00	6700093.45	1630639.25	34.32	RT90-RHB70	–58.81	201.87	21.5800	0.3400	0.2800	
48.00	6700092.01	1630638.67	36.88	RT90-RHB70	–58.78	201.92	23.1400	0.3900	0.3200	
51.00	6700090.57	1630638.09	39.45	RT90-RHB70	–58.73	201.98	24.6900	0.4400	0.3500	
54.00	6700089.12	1630637.51	42.01	RT90-RHB70	–58.68	202.06	26.2500	0.4900	0.3900	
57.00	6700087.68	1630636.92	44.58	RT90-RHB70	–58.66	202.15	27.8100	0.5500	0.4300	
60.00	6700086.23	1630636.33	47.14	RT90-RHB70	–58.60	202.32	29.3700	0.6100	0.4700	

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
63.00	6700084.79	1630635.74	49.70	RT90-RHB70	–58.53	202.41	30.9300	0.6700	0.5100	
66.00	6700083.34	1630635.14	52.26	RT90-RHB70	–58.48	202.49	32.4900	0.7300	0.5600	
69.00	6700081.89	1630634.54	54.81	RT90-RHB70	–58.45	202.55	34.0600	0.8000	0.6100	
72.00	6700080.44	1630633.94	57.37	RT90-RHB70	–58.41	202.65	35.6300	0.8600	0.6600	
75.00	6700078.99	1630633.33	59.93	RT90-RHB70	–58.36	202.77	37.2000	0.9300	0.7200	
78.00	6700077.54	1630632.72	62.48	RT90-RHB70	–58.31	202.89	38.7700	1.0100	0.7700	
81.00	6700076.09	1630632.11	65.03	RT90-RHB70	–58.26	202.99	40.3400	1.0800	0.8300	
84.00	6700074.63	1630631.50	67.58	RT90-RHB70	–58.22	203.10	41.9200	1.1600	0.8900	
87.00	6700073.18	1630630.88	70.13	RT90-RHB70	–58.17	203.20	43.5000	1.2500	0.9600	
90.00	6700071.73	1630630.25	72.68	RT90-RHB70	–58.12	203.26	45.0800	1.3300	1.0200	
93.00	6700070.27	1630629.63	75.23	RT90-RHB70	–58.08	203.33	46.6600	1.4200	1.0900	
96.00	6700068.81	1630629.00	77.78	RT90-RHB70	–58.04	203.41	48.2400	1.5100	1.1600	
99.00	6700067.36	1630628.37	80.32	RT90-RHB70	–57.99	203.48	49.8300	1.6000	1.2300	
102.00	6700065.90	1630627.73	82.87	RT90-RHB70	–57.94	203.53	51.4200	1.7000	1.3100	
105.00	6700064.44	1630627.10	85.41	RT90-RHB70	–57.89	203.62	53.0100	1.7900	1.3800	
108.00	6700062.98	1630626.46	87.95	RT90-RHB70	–57.85	203.76	54.6000	1.8900	1.4600	
111.00	6700061.52	1630625.82	90.49	RT90-RHB70	–57.84	203.91	56.1900	2.0000	1.5400	
114.00	6700060.06	1630625.17	93.03	RT90-RHB70	–57.82	204.04	57.7800	2.1000	1.6300	
117.00	6700058.60	1630624.52	95.57	RT90-RHB70	–57.76	204.13	59.3800	2.2100	1.7100	
120.00	6700057.14	1630623.86	98.11	RT90-RHB70	–57.70	204.20	60.9700	2.3300	1.7900	
123.00	6700055.68	1630623.21	100.64	RT90-RHB70	–57.64	204.32	62.5700	2.4400	1.8800	
126.00	6700054.21	1630622.55	103.18	RT90-RHB70	–57.59	204.44	64.1700	2.5600	1.9700	
129.00	6700052.75	1630621.88	105.71	RT90-RHB70	–57.53	204.56	65.7800	2.6800	2.0700	
132.00	6700051.28	1630621.21	108.24	RT90-RHB70	–57.49	204.66	67.3800	2.8100	2.1700	
135.00	6700049.82	1630620.54	110.77	RT90-RHB70	–57.43	204.74	68.9900	2.9400	2.2600	
138.00	6700048.35	1630619.86	113.30	RT90-RHB70	–57.38	204.82	70.6000	3.0700	2.3700	
141.00	6700046.88	1630619.18	115.82	RT90-RHB70	–57.34	204.89	72.2100	3.2000	2.4700	
144.00	6700045.41	1630618.50	118.35	RT90-RHB70	–57.32	204.99	73.8300	3.3400	2.5800	

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
147.00	6700043.95	1630617.82	120.88	RT90-RHB70	–57.27	205.01	75.4400	3.4800	2.6800	
150.00	6700042.48	1630617.13	123.40	RT90-RHB70	–57.20	205.03	77.0600	3.6100	2.7900	
153.00	6700041.00	1630616.44	125.92	RT90-RHB70	–57.15	205.06	78.6700	3.7600	2.9100	
156.00	6700039.53	1630615.75	128.44	RT90-RHB70	–57.12	205.08	80.3000	3.9000	3.0200	
159.00	6700038.05	1630615.06	130.96	RT90-RHB70	–57.10	205.10	81.9200	4.0400	3.1400	
162.00	6700036.58	1630614.37	133.48	RT90-RHB70	–57.07	205.12	83.5400	4.1800	3.2600	
165.00	6700035.10	1630613.68	136.00	RT90-RHB70	–57.05	205.14	85.1700	4.3200	3.3800	
168.00	6700033.63	1630612.99	138.51	RT90-RHB70	–57.02	205.16	86.7900	4.4700	3.5000	
171.00	6700032.15	1630612.29	141.03	RT90-RHB70	–56.97	205.18	88.4200	4.6100	3.6200	
174.00	6700030.67	1630611.60	143.55	RT90-RHB70	–56.93	205.22	90.0500	4.7600	3.7400	
177.00	6700029.19	1630610.90	146.06	RT90-RHB70	–56.92	205.35	91.6800	4.9000	3.8700	
180.00	6700027.71	1630610.20	148.57	RT90-RHB70	–56.91	205.48	93.3100	5.0600	4.0000	
183.00	6700026.23	1630609.49	151.09	RT90-RHB70	–56.89	205.59	94.9400	5.2100	4.1200	
186.00	6700024.75	1630608.79	153.60	RT90-RHB70	–56.84	205.74	96.5700	5.3700	4.2500	
189.00	6700023.27	1630608.07	156.11	RT90-RHB70	–56.78	205.87	98.2000	5.5300	4.3800	
192.00	6700021.79	1630607.36	158.62	RT90-RHB70	–56.72	205.95	99.8400	5.6900	4.5200	
195.00	6700020.31	1630606.64	161.13	RT90-RHB70	–56.64	206.04	101.4700	5.8600	4.6500	
198.00	6700018.83	1630605.91	163.64	RT90-RHB70	–56.58	206.16	103.1200	6.0300	4.7900	
201.00	6700017.35	1630605.18	166.14	RT90-RHB70	–56.50	206.25	104.7600	6.2100	4.9300	
204.00	6700015.86	1630604.45	168.64	RT90-RHB70	–56.44	206.37	106.4000	6.3900	5.0800	
207.00	6700014.38	1630603.72	171.14	RT90-RHB70	–56.39	206.47	108.0500	6.5700	5.2300	
210.00	6700012.89	1630602.98	173.64	RT90-RHB70	–56.35	206.56	109.7000	6.7500	5.3800	
213.00	6700011.40	1630602.23	176.14	RT90-RHB70	–56.30	206.66	111.3500	6.9400	5.5400	
216.00	6700009.92	1630601.49	178.63	RT90-RHB70	–56.25	206.73	113.0100	7.1300	5.6900	
219.00	6700008.43	1630600.74	181.13	RT90-RHB70	–56.25	206.82	114.6600	7.3200	5.8500	
222.00	6700006.94	1630599.98	183.62	RT90-RHB70	–56.24	206.90	116.3200	7.5200	6.0100	
225.00	6700005.45	1630599.23	186.12	RT90-RHB70	–56.20	207.01	117.9700	7.7200	6.1700	
228.00	6700003.97	1630598.47	188.61	RT90-RHB70	–56.12	207.10	119.6300	7.9200	6.3300	

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
231.00	6700002.48	1630597.71	191.10	RT90-RHB70	–56.07	207.23	121.2900	8.1200	6.4900	
234.00	6700000.99	1630596.94	193.59	RT90-RHB70	–56.04	207.31	122.9500	8.3300	6.6600	
237.00	6699999.50	1630596.17	196.08	RT90-RHB70	–56.02	207.39	124.6100	8.5400	6.8200	
240.00	6699998.01	1630595.40	198.57	RT90-RHB70	–56.00	207.47	126.2800	8.7600	6.9900	
243.00	6699996.52	1630594.63	201.05	RT90-RHB70	–55.97	207.57	127.9400	8.9700	7.1600	
246.00	6699995.03	1630593.85	203.54	RT90-RHB70	–55.91	207.66	129.6100	9.1900	7.3300	
249.00	6699993.55	1630593.07	206.02	RT90-RHB70	–55.84	207.75	131.2700	9.4100	7.5000	
252.00	6699992.06	1630592.29	208.51	RT90-RHB70	–55.79	207.81	132.9400	9.6400	7.6800	
255.00	6699990.56	1630591.50	210.99	RT90-RHB70	–55.74	207.91	134.6100	9.8600	7.8600	
258.00	6699989.07	1630590.71	213.47	RT90-RHB70	–55.68	208.00	136.2900	10.0900	8.0400	
261.00	6699987.58	1630589.92	215.94	RT90-RHB70	–55.63	208.07	137.9600	10.3300	8.2200	
264.00	6699986.08	1630589.12	218.42	RT90-RHB70	–55.59	208.14	139.6400	10.5600	8.4100	
267.00	6699984.59	1630588.32	220.89	RT90-RHB70	–55.55	208.23	141.3200	10.8000	8.6000	
270.00	6699983.09	1630587.52	223.37	RT90-RHB70	–55.50	208.34	143.0000	11.0400	8.7900	
273.00	6699981.60	1630586.71	225.84	RT90-RHB70	–55.47	208.44	144.6800	11.2900	8.9800	
276.00	6699980.10	1630585.90	228.31	RT90-RHB70	–55.44	208.57	146.3600	11.5300	9.1700	
279.00	6699978.61	1630585.09	230.78	RT90-RHB70	–55.36	208.69	148.0400	11.7800	9.3700	
282.00	6699977.11	1630584.27	233.25	RT90-RHB70	–55.28	208.87	149.7300	12.0400	9.5700	
285.00	6699975.61	1630583.44	235.72	RT90-RHB70	–55.18	209.09	151.4200	12.3000	9.7700	
288.00	6699974.12	1630582.61	238.18	RT90-RHB70	–55.06	209.29	153.1100	12.5700	9.9700	
291.00	6699972.62	1630581.77	240.64	RT90-RHB70	–54.92	209.46	154.8100	12.8400	10.1800	
294.00	6699971.12	1630580.92	243.09	RT90-RHB70	–54.81	209.65	156.5100	13.1200	10.4000	
297.00	6699969.62	1630580.07	245.55	RT90-RHB70	–54.71	209.84	158.2100	13.4100	10.6200	
300.00	6699968.11	1630579.20	247.99	RT90-RHB70	–54.61	210.03	159.9200	13.7100	10.8500	
303.00	6699966.61	1630578.33	250.44	RT90-RHB70	–54.53	210.24	161.6300	14.0100	11.0800	
306.00	6699965.10	1630577.46	252.88	RT90-RHB70	–54.46	210.44	163.3500	14.3100	11.3200	
309.00	6699963.60	1630576.57	255.32	RT90-RHB70	–54.41	210.66	165.0600	14.6300	11.5500	
312.00	6699962.10	1630575.68	257.76	RT90-RHB70	–54.35	210.86	166.7800	14.9500	11.7900	

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315.00	6699960.60	1630574.79	260.20	RT90-RHB70	–54.30	211.05	168.5000	15.2700	12.0300	
318.00	6699959.10	1630573.88	262.64	RT90-RHB70	–54.25	211.21	170.2100	15.6100	12.2800	
321.00	6699957.60	1630572.98	265.07	RT90-RHB70	–54.22	211.38	171.9300	15.9500	12.5200	
324.00	6699956.10	1630572.06	267.51	RT90-RHB70	–54.17	211.57	173.6500	16.2900	12.7600	
327.00	6699954.61	1630571.14	269.94	RT90-RHB70	–54.11	211.75	175.3700	16.6400	13.0100	
330.00	6699953.11	1630570.22	272.37	RT90-RHB70	–54.04	211.94	177.1000	16.9900	13.2600	
333.00	6699951.61	1630569.29	274.80	RT90-RHB70	–53.98	212.14	178.8200	17.3600	13.5100	
336.00	6699950.12	1630568.35	277.22	RT90-RHB70	–53.94	212.36	180.5500	17.7200	13.7600	
339.00	6699948.63	1630567.40	279.65	RT90-RHB70	–53.88	212.57	182.2700	18.1000	14.0200	
342.00	6699947.14	1630566.45	282.07	RT90-RHB70	–53.81	212.81	184.0000	18.4800	14.2700	
345.00	6699945.65	1630565.49	284.49	RT90-RHB70	–53.72	213.03	185.7300	18.8700	14.5300	
348.00	6699944.16	1630564.52	286.91	RT90-RHB70	–53.63	213.25	187.4600	19.2700	14.7900	
351.00	6699942.67	1630563.55	289.33	RT90-RHB70	–53.57	213.42	189.1900	19.6800	15.0600	
354.00	6699941.19	1630562.57	291.74	RT90-RHB70	–53.53	213.61	190.9200	20.0900	15.3200	
357.00	6699939.70	1630561.58	294.15	RT90-RHB70	–53.49	213.77	192.6600	20.5000	15.5900	
360.00	6699938.22	1630560.59	296.57	RT90-RHB70	–53.46	213.93	194.3900	20.9300	15.8600	
363.00	6699936.74	1630559.59	298.98	RT90-RHB70	–53.43	214.08	196.1300	21.3500	16.1300	
366.00	6699935.25	1630558.59	301.38	RT90-RHB70	–53.40	214.23	197.8600	21.7900	16.4000	
369.00	6699933.78	1630557.58	303.79	RT90-RHB70	–53.36	214.38	199.5900	22.2200	16.6700	
372.00	6699932.30	1630556.57	306.20	RT90-RHB70	–53.32	214.56	201.3300	22.6700	16.9400	
375.00	6699930.82	1630555.55	308.61	RT90-RHB70	–53.27	214.74	203.0600	23.1100	17.2100	
378.00	6699929.35	1630554.53	311.01	RT90-RHB70	–53.19	214.90	204.8000	23.5700	17.4800	
381.00	6699927.87	1630553.50	313.41	RT90-RHB70	–53.13	215.07	206.5400	24.0300	17.7600	
384.00	6699926.40	1630552.47	315.81	RT90-RHB70	–53.06	215.23	208.2800	24.4900	18.0400	
387.00	6699924.93	1630551.43	318.21	RT90-RHB70	–52.99	215.39	210.0200	24.9700	18.3200	
390.00	6699923.46	1630550.38	320.61	RT90-RHB70	–52.94	215.53	211.7600	25.4400	18.6000	
393.00	6699921.98	1630549.33	323.00	RT90-RHB70	–52.91	215.68	213.5000	25.9200	18.8800	
396.00	6699920.51	1630548.28	325.39	RT90-RHB70	–52.87	215.86	215.2400	26.4100	19.1700	

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399.00	6699919.05	1630547.22	327.78	RT90-RHB70	–52.80	216.03	216.9900	26.9000	19.4600	
402.00	6699917.58	1630546.15	330.17	RT90-RHB70	–52.73	216.20	218.7300	27.4000	19.7400	
405.00	6699916.11	1630545.08	332.56	RT90-RHB70	–52.68	216.36	220.4800	27.9100	20.0300	
408.00	6699914.65	1630544.00	334.95	RT90-RHB70	–52.65	216.52	222.2200	28.4200	20.3200	
411.00	6699913.19	1630542.92	337.33	RT90-RHB70	–52.63	216.68	223.9700	28.9300	20.6200	
414.00	6699911.73	1630541.83	339.72	RT90-RHB70	–52.59	216.84	225.7100	29.4500	20.9100	
417.00	6699910.27	1630540.73	342.10	RT90-RHB70	–52.55	217.01	227.4600	29.9800	21.2000	
420.00	6699908.81	1630539.64	344.48	RT90-RHB70	–52.50	217.17	229.2000	30.5100	21.4900	
423.00	6699907.36	1630538.53	346.86	RT90-RHB70	–52.43	217.34	230.9500	31.0400	21.7900	
426.00	6699905.90	1630537.42	349.24	RT90-RHB70	–52.36	217.52	232.6900	31.5900	22.0800	
429.00	6699904.45	1630536.31	351.61	RT90-RHB70	–52.29	217.66	234.4400	32.1400	22.3800	
432.00	6699903.00	1630535.19	353.99	RT90-RHB70	–52.25	217.84	236.1900	32.6900	22.6800	
435.00	6699901.55	1630534.06	356.36	RT90-RHB70	–52.22	218.01	237.9400	33.2500	22.9800	
438.00	6699900.10	1630532.93	358.73	RT90-RHB70	–52.18	218.13	239.6900	33.8200	23.2800	
441.00	6699898.65	1630531.79	361.10	RT90-RHB70	–52.11	218.27	241.4400	34.3900	23.5900	
444.00	6699897.20	1630530.65	363.47	RT90-RHB70	–52.06	218.41	243.1900	34.9600	23.8900	
447.00	6699895.76	1630529.51	365.83	RT90-RHB70	–52.03	218.56	244.9400	35.5400	24.2000	
450.00	6699894.32	1630528.36	368.20	RT90-RHB70	–51.99	218.71	246.6900	36.1300	24.5000	
453.00	6699892.87	1630527.20	370.56	RT90-RHB70	–51.95	218.83	248.4400	36.7200	24.8100	
456.00	6699891.43	1630526.04	372.93	RT90-RHB70	–51.87	218.96	250.1900	37.3100	25.1200	
459.00	6699889.99	1630524.88	375.29	RT90-RHB70	–51.78	219.11	251.9400	37.9100	25.4300	
462.00	6699888.55	1630523.70	377.64	RT90-RHB70	–51.68	219.24	253.7000	38.5200	25.7400	
465.00	6699887.11	1630522.53	380.00	RT90-RHB70	–51.62	219.37	255.4600	39.1300	26.0600	
468.00	6699885.67	1630521.35	382.35	RT90-RHB70	–51.53	219.52	257.2100	39.7400	26.3800	
471.00	6699884.23	1630520.16	384.70	RT90-RHB70	–51.45	219.69	258.9700	40.3600	26.7000	
474.00	6699882.79	1630518.97	387.04	RT90-RHB70	–51.39	219.87	260.7400	40.9900	27.0200	
477.00	6699881.36	1630517.77	389.39	RT90-RHB70	–51.32	220.07	262.5000	41.6200	27.3500	
480.00	6699879.92	1630516.56	391.73	RT90-RHB70	–51.24	220.28	264.2600	42.2600	27.6800	

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483.00	6699878.49	1630515.34	394.07	RT90-RHB70	–51.21	220.42	266.0200	42.9100	28.0100	
486.00	6699877.06	1630514.13	396.41	RT90-RHB70	–51.13	220.55	267.7800	43.5700	28.3400	
489.00	6699875.63	1630512.90	398.74	RT90-RHB70	–50.99	220.65	269.5500	44.2200	28.6700	
492.00	6699874.19	1630511.67	401.07	RT90-RHB70	–50.87	220.76	271.3200	44.8900	29.0100	
495.00	6699872.76	1630510.43	403.40	RT90-RHB70	–50.74	220.91	273.0900	45.5600	29.3500	
498.00	6699871.33	1630509.19	405.72	RT90-RHB70	–50.63	221.06	274.8600	46.2300	29.7000	
501.00	6699869.89	1630507.94	408.04	RT90-RHB70	–50.53	221.23	276.6400	46.9100	30.0500	
504.00	6699868.46	1630506.68	410.36	RT90-RHB70	–50.44	221.39	278.4200	47.6000	30.4100	
507.00	6699867.02	1630505.42	412.67	RT90-RHB70	–50.33	221.51	280.2000	48.3000	30.7600	
510.00	6699865.59	1630504.15	414.98	RT90-RHB70	–50.23	221.65	281.9800	49.0000	31.1200	
513.00	6699864.16	1630502.88	417.29	RT90-RHB70	–50.13	221.77	283.7600	49.7000	31.4900	
516.00	6699862.72	1630501.60	419.59	RT90-RHB70	–50.02	221.87	285.5500	50.4100	31.8600	
519.00	6699861.29	1630500.31	421.89	RT90-RHB70	–49.92	221.99	287.3400	51.1300	32.2300	
522.00	6699859.85	1630499.02	424.18	RT90-RHB70	–49.84	222.14	289.1300	51.8500	32.6100	
525.00	6699858.42	1630497.72	426.48	RT90-RHB70	–49.76	222.28	290.9300	52.5700	32.9900	
528.00	6699856.98	1630496.42	428.77	RT90-RHB70	–49.67	222.44	292.7200	53.3100	33.3700	
531.00	6699855.55	1630495.11	431.05	RT90-RHB70	–49.60	222.59	294.5200	54.0500	33.7500	
534.00	6699854.12	1630493.79	433.34	RT90-RHB70	–49.52	222.74	296.3100	54.7900	34.1400	
537.00	6699852.69	1630492.47	435.62	RT90-RHB70	–49.43	222.89	298.1100	55.5400	34.5300	
540.00	6699851.26	1630491.14	437.90	RT90-RHB70	–49.32	222.97	299.9100	56.3000	34.9200	
543.00	6699849.83	1630489.81	440.17	RT90-RHB70	–49.18	223.06	301.7100	57.0600	35.3200	
546.00	6699848.39	1630488.47	442.44	RT90-RHB70	–49.05	223.13	303.5100	57.8200	35.7200	
549.00	6699846.96	1630487.12	444.71	RT90-RHB70	–48.93	223.22	305.3200	58.5900	36.1200	
552.00	6699845.52	1630485.77	446.97	RT90-RHB70	–48.83	223.33	307.1400	59.3700	36.5400	
555.00	6699844.09	1630484.42	449.23	RT90-RHB70	–48.72	223.49	308.9500	60.1500	36.9500	
558.00	6699842.65	1630483.06	451.48	RT90-RHB70	–48.63	223.69	310.7700	60.9300	37.3700	
561.00	6699841.22	1630481.69	453.74	RT90-RHB70	–48.56	223.88	312.5800	61.7300	37.7900	
564.00	6699839.79	1630480.31	455.98	RT90-RHB70	–48.46	224.08	314.4000	62.5300	38.2100	

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
567.00	6699838.36	1630478.93	458.23	RT90-RHB70	–48.34	224.29	316.2200	63.3400	38.6400	
570.00	6699836.93	1630477.53	460.47	RT90-RHB70	–48.22	224.53	318.0400	64.1600	39.0600	
573.00	6699835.50	1630476.13	462.71	RT90-RHB70	–48.13	224.77	319.8600	64.9800	39.4900	
576.00	6699834.08	1630474.72	464.94	RT90-RHB70	–48.06	224.96	321.6800	65.8200	39.9300	
579.00	6699832.66	1630473.30	467.17	RT90-RHB70	–48.00	225.16	323.4900	66.6600	40.3600	
582.00	6699831.25	1630471.88	469.40	RT90-RHB70	–47.94	225.36	325.3100	67.5100	40.7900	
585.00	6699829.84	1630470.45	471.63	RT90-RHB70	–47.88	225.54	327.1300	68.3700	41.2200	
588.00	6699828.43	1630469.02	473.86	RT90-RHB70	–47.80	225.70	328.9500	69.2400	41.6600	
591.00	6699827.02	1630467.57	476.08	RT90-RHB70	–47.74	225.88	330.7600	70.1100	42.0900	
594.00	6699825.62	1630466.12	478.30	RT90-RHB70	–47.66	226.08	332.5800	70.9900	42.5300	
597.00	6699824.21	1630464.67	480.52	RT90-RHB70	–47.61	226.28	334.4000	71.8700	42.9700	
600.00	6699822.82	1630463.21	482.73	RT90-RHB70	–47.56	226.47	336.2100	72.7700	43.4100	
603.00	6699821.42	1630461.74	484.95	RT90-RHB70	–47.49	226.64	338.0200	73.6700	43.8400	
606.00	6699820.03	1630460.27	487.16	RT90-RHB70	–47.42	226.80	339.8400	74.5700	44.2800	
609.00	6699818.64	1630458.79	489.37	RT90-RHB70	–47.36	226.97	341.6500	75.4800	44.7200	
612.00	6699817.25	1630457.30	491.57	RT90-RHB70	–47.30	227.11	343.4600	76.4000	45.1600	
615.00	6699815.87	1630455.81	493.78	RT90-RHB70	–47.20	227.25	345.2800	77.3300	45.6000	
618.00	6699814.48	1630454.31	495.98	RT90-RHB70	–47.03	227.41	347.0900	78.2600	46.0400	
621.00	6699813.10	1630452.81	498.17	RT90-RHB70	–46.84	227.61	348.9100	79.2000	46.4900	
624.00	6699811.72	1630451.29	500.36	RT90-RHB70	–46.72	227.76	350.7300	80.1500	46.9500	
627.00	6699810.33	1630449.77	502.55	RT90-RHB70	–46.65	227.89	352.5500	81.1000	47.4100	
630.00	6699808.95	1630448.24	504.73	RT90-RHB70	–46.54	228.03	354.3700	82.0600	47.8700	
633.00	6699807.57	1630446.71	506.90	RT90-RHB70	–46.41	228.15	356.1900	83.0300	48.3300	
636.00	6699806.19	1630445.17	509.08	RT90-RHB70	–46.30	228.23	358.0200	84.0000	48.8000	
639.00	6699804.81	1630443.62	511.25	RT90-RHB70	–46.20	228.27	359.8400	84.9800	49.2700	
642.00	6699803.43	1630442.07	513.41	RT90-RHB70	–46.09	228.30	361.6700	85.9600	49.7500	
645.00	6699802.05	1630440.52	515.57	RT90-RHB70	–45.99	228.39	363.5100	86.9500	50.2300	
648.00	6699800.66	1630438.96	517.73	RT90-RHB70	–45.85	228.53	365.3400	87.9300	50.7100	

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
651.00	6699799.28	1630437.39	519.88	RT90-RHB70	–45.75	228.67	367.1800	88.9300	51.2000	
654.00	6699797.90	1630435.82	522.03	RT90-RHB70	–45.65	228.80	369.0200	89.9300	51.6900	
657.00	6699796.52	1630434.24	524.18	RT90-RHB70	–45.51	228.93	370.8600	90.9400	52.1800	
660.00	6699795.13	1630432.66	526.32	RT90-RHB70	–45.37	229.11	372.7000	91.9500	52.6800	
663.00	6699793.75	1630431.07	528.45	RT90-RHB70	–45.24	229.24	374.5400	92.9800	53.1900	
666.00	6699792.38	1630429.47	530.58	RT90-RHB70	–45.09	229.33	376.3900	94.0100	53.6900	
669.00	6699790.99	1630427.86	532.71	RT90-RHB70	–44.94	229.43	378.2300	95.0400	54.2000	
672.00	6699789.61	1630426.25	534.83	RT90-RHB70	–44.81	229.59	380.0800	96.0800	54.7200	
675.00	6699788.23	1630424.63	536.94	RT90-RHB70	–44.72	229.78	381.9400	97.1300	55.2400	
678.00	6699786.86	1630423.00	539.05	RT90-RHB70	–44.60	229.93	383.7900	98.1900	55.7700	
681.00	6699785.48	1630421.36	541.16	RT90-RHB70	–44.46	230.04	385.6400	99.2500	56.2900	
684.00	6699784.11	1630419.72	543.26	RT90-RHB70	–44.31	230.23	387.5000	100.3200	56.8200	
687.00	6699782.73	1630418.07	545.36	RT90-RHB70	–44.22	230.44	389.3500	101.4000	57.3500	
690.00	6699781.36	1630416.41	547.45	RT90-RHB70	–44.13	230.65	391.2100	102.4800	57.8900	
693.00	6699780.00	1630414.75	549.54	RT90-RHB70	–44.06	230.87	393.0600	103.5800	58.4200	
696.00	6699778.64	1630413.08	551.62	RT90-RHB70	–43.97	231.09	394.9100	104.6800	58.9600	
699.00	6699777.28	1630411.40	553.71	RT90-RHB70	–43.91	231.30	396.7600	105.7900	59.4900	
702.00	6699775.93	1630409.71	555.79	RT90-RHB70	–43.81	231.49	398.6100	106.9100	60.0300	
705.00	6699774.58	1630408.02	557.86	RT90-RHB70	–43.72	231.67	400.4600	108.0400	60.5700	
708.00	6699773.24	1630406.32	559.94	RT90-RHB70	–43.64	231.86	402.3100	109.1800	61.1000	
711.00	6699771.90	1630404.61	562.01	RT90-RHB70	–43.54	232.04	404.1500	110.3200	61.6400	
714.00	6699770.56	1630402.89	564.07	RT90-RHB70	–43.41	232.19	406.0000	111.4700	62.1800	
717.00	6699769.22	1630401.17	566.13	RT90-RHB70	–43.30	232.38	407.8400	112.6300	62.7200	
720.00	6699767.89	1630399.44	568.19	RT90-RHB70	–43.20	232.52	409.6900	113.8000	63.2600	
723.00	6699766.56	1630397.71	570.25	RT90-RHB70	–43.08	232.71	411.5400	114.9700	63.8100	
726.00	6699765.23	1630395.96	572.29	RT90-RHB70	–42.98	232.88	413.3800	116.1500	64.3600	
729.00	6699763.91	1630394.21	574.34	RT90-RHB70	–42.86	233.02	415.2300	117.3400	64.9100	
732.00	6699762.59	1630392.46	576.38	RT90-RHB70	–42.78	233.17	417.0700	118.5400	65.4600	

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
735.00	6699761.27	1630390.69	578.42	RT90-RHB70	–42.69	233.34	418.9200	119.7400	66.0200	
738.00	6699759.95	1630388.92	580.45	RT90-RHB70	–42.59	233.49	420.7600	120.9500	66.5700	
741.00	6699758.64	1630387.15	582.48	RT90-RHB70	–42.47	233.71	422.6000	122.1700	67.1300	
744.00	6699757.33	1630385.37	584.51	RT90-RHB70	–42.35	233.98	424.4500	123.3900	67.6800	
747.00	6699756.02	1630383.57	586.53	RT90-RHB70	–42.27	234.19	426.2900	124.6300	68.2400	
750.00	6699754.72	1630381.77	588.55	RT90-RHB70	–42.18	234.38	428.1200	125.8700	68.8000	
753.00	6699753.43	1630379.96	590.56	RT90-RHB70	–42.12	234.54	429.9600	127.1300	69.3600	
756.00	6699752.14	1630378.15	592.57	RT90-RHB70	–42.04	234.73	431.8000	128.3800	69.9200	
759.00	6699750.85	1630376.33	594.58	RT90-RHB70	–41.97	234.95	433.6300	129.6500	70.4700	
762.00	6699749.57	1630374.51	596.59	RT90-RHB70	–41.87	235.13	435.4600	130.9300	71.0300	
765.00	6699748.29	1630372.67	598.59	RT90-RHB70	–41.75	235.27	437.2900	132.2100	71.5900	
768.00	6699747.02	1630370.83	600.59	RT90-RHB70	–41.63	235.40	439.1200	133.5000	72.1500	
771.00	6699745.74	1630368.99	602.58	RT90-RHB70	–41.50	235.56	440.9500	134.8000	72.7100	
774.00	6699744.47	1630367.14	604.57	RT90-RHB70	–41.35	235.70	442.7800	136.1000	73.2800	
777.00	6699743.20	1630365.28	606.55	RT90-RHB70	–41.22	235.83	444.6100	137.4100	73.8500	
780.00	6699741.94	1630363.41	608.53	RT90-RHB70	–41.08	235.99	446.4400	138.7300	74.4200	
783.00	6699740.67	1630361.53	610.50	RT90-RHB70	–40.99	236.12	448.2700	140.0600	75.0000	
786.00	6699739.41	1630359.65	612.47	RT90-RHB70	–40.90	236.26	450.1000	141.3900	75.5700	
789.00	6699738.15	1630357.77	614.43	RT90-RHB70	–40.80	236.40	451.9300	142.7300	76.1500	
792.00	6699736.89	1630355.88	616.39	RT90-RHB70	–40.73	236.54	453.7600	144.0700	76.7300	
798.00	6699734.39	1630352.07	620.30	RT90-RHB70	–40.60	236.74	457.4200	146.7900	77.8900	

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Appendix 4

Length reference marks

Reference Mark T – Reference mark in drillhole

KFM09A, 2005-10-24 10:00:00–2005-10-24 15:30:00 (50.000–725.000 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
50.00	400.00	300	400	30.0	1,200			
100.00	400.00	300	400	30.0	1,320			
150.00	400.00	300	400	30.0	1,500			
200.00	400.00	300	400	30.0	1,500			
250.00	400.00	300	400	30.0	1,800			
300.00	400.00	300	450	30.0	1,800			
350.00	400.00	300	450	30.0	1,620			
400.00	400.00	300	450	30.0	1,500			
450.00	400.00	400	500	30.0	1,500			
500.00	400.00	400	500	30.0	1,800			
550.00	400.00	400	500	30.0	2,100			
600.00	400.00	400	500	30.0	1,920			
650.00	400.00	400	500	30.0	3,120			
725.00	400.00	500	700	30.0	4,080			

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