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Revised March 2008

Oskarshamn site investigation

Simplified Boremap mapping of percussion boreholes HLX34 and HLX35 on lineament NS059 and of percussion boreholes HLX36 and HLX37 on lineament NS001

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May 2006

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Keywords: Simplified Boremap mapping.

Reading instruction

The revision no. 1 of this report: The origin of rock type diorite/gabbro has been revised in boreholes HLX36 and HLX37 after the drilling and subsequent investigation of identical rock type in KLX20A, to Dolerite /7/. See Figure 1-1, Table 5-3 and Table 5-4, as well as Chapters 5 and 6. See also WellCAD representations in Appendix 3 and Appendix 4. See also new Table 1-2.

Abstract

Simplified Boremap mapping has been performed for percussion boreholes HLX34 and HLX35 situated at the linked lineament NS059, as well as boreholes HLX36 and HLX37 situated at the linked lineament NS001, all in the western part of the Laxemar subarea at the site investigation Oskarshamn, Sweden.

The purpose of the activity reported here is to map the lithology and structural parameters in the percussion boreholes based on results from drilling in conjunction with digital BIPS-images (Borehole Image Processing System) of the borehole walls.

The dominating rock type of the mapped boreholes HLX34 and HLX35 is Ävrö granite, carrying minor amounts of mafic rocks (fine-grained diorite-gabbro and to a lesser extent diorite/gabbro), all cut by the occasional thin dykes/veins of felsic rocks (fine-grained granite, granite or pegmatite). Increase of open fractures is observed at certain intervals generally coinciding with water yielding open fractures. Boreholes HLX36 and HLX37 are dominated by Quartz monzodiorite cut by occasional fine-grained granite and/or pegmatite as well as one Dolerite dike. The Dolerite dike shows marked increase in fracture density but no water inflow. At first the mafic rock was characterized as a fine-grained Diorite/gabbro, but core borehole KLX20A cuts through the same rock and was sampled and analysed, making it clear that the mafic rock was in fact a Dolerite dike. Alteration occurs in the form of red staining (oxidation). In boreholes HLX34 and HLX35 the rocks are more or less altered, while the alteration is relatively minor in boreholes HLX36 and HLX37.

The present report comprises a description of the applied equipment and the performed activities, the observations, data delivery together with a presentation and discussion of the results.

Sammanfattning

Förenklad Boremap kartering är utförd på hammarborrhål HLX34 och HLX35 på lineament NS059, samt hammarborrhål HLX36 och HLX37 på lineament NS001, båda i västra delen av delområde Laxemar, vid platsundersökningen Oskarshamn.

Syftet med aktiviteten som rapporteras här är att kartera litologiska och strukturella parametrar i hammarborrhålen baserad på resultaten från borrningen i förbindelse med digitala BIPS-bilder (Borehole Image Processing System) av borrhålsväggarna.

Den dominerande bergarten i de karterade borrhålen HLX34 och HLX35 är Ävrögranit, med mindre mängder av mafiska bergarter (finkornig diorit-gabbro och enstaka diorit/gabbro), allt klipps av enstaka tunna gångar/ådror av felsiska bergarter (finkornig granit, granit eller pegmatit). Förhöjning i antalet öppna spricker observeras vid vissa intervaller generellt sammanfallande med vattenförande öppna sprickor i båda borrhålen. På andra sidan är borrhål HLX36 och HLX37 dominerade av kvartsmonzodiorit som klipps av enstaka gångar/ådror bestående av finkornig granit och/eller pegmatit samt en diabasgång. Diabasgången visar en kraftig ökning i antalet öppna sprickor, dock utan vatteninflöde. I början blev den mafiska bergarten karakteriserad som en finkornig diorit-gabbro, men borrhål KLX20A går igenom samma bergart som blev provtagen och analyserad, klargjorde att den mafiska bergarten var en diabasgång. Omvandling förekommer som rödfärgning (oxidering). I borrhålen HLX34 och HLX35 är bergarterna mer eller mindre omvandlade medan omvandlingen förekommer i mindre mängder i borrhål HLX36 och HLX37.

Denna rapport beskriver använd utrustning och genomförd aktivitet, observationer, leverans av data samt en presentation och diskussion av resultaten.

Contents

1 Introduction

To investigate the linked, north-south trending lineaments with the designation NS059 and NS001 /6/, in the western part of the Laxemar subarea of the Oskarshamn site investigation, see Figure 1-1, four percussion boreholes were drilled in 2005 /1/ and /2/.

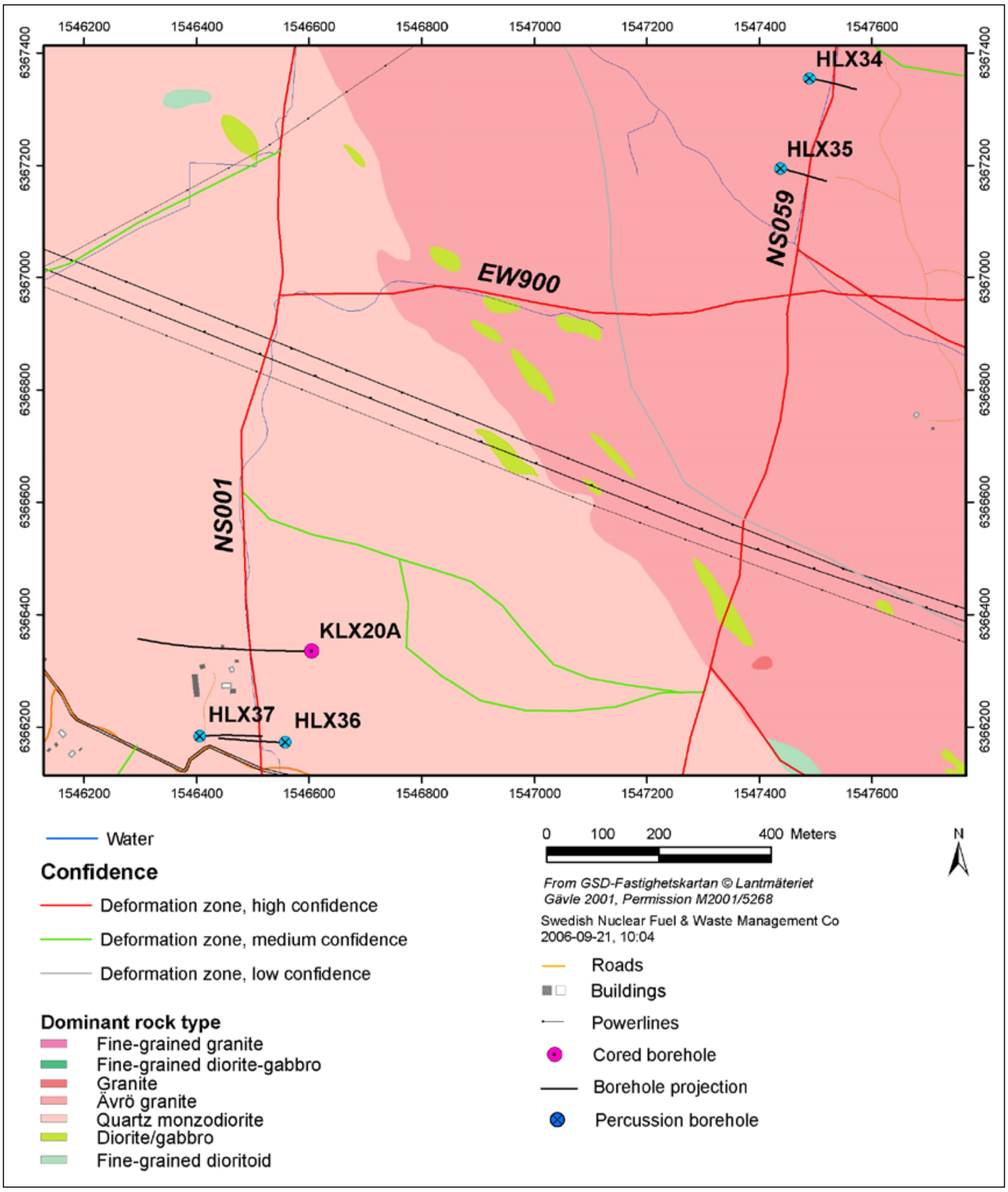


Figure 1-1. *Location of boreholes HLX34, HLX35, HLX36 and HLX37 in the Laxemar subarea. The map shows the bedrock geology, linked lineaments, power lines, roads and houses. The boreholes HLX34 and HLX35 are located on the western side of the north-south trending lineament NS059 and boreholes HLX36 and HLX37 are located on both sides of the north-south trending lineament NS001. Core borehole KLX20A is located on the eastern side of lineament NS001 and drilled towards the west.*

This document reports data gained by Simplified Boremap mapping of these percussion boreholes; HLX34, HLX35, HLX36 and HLX37 during the later part of 2005. The work was carried out in accordance with activity plan AP PS 400-06-013. Table 1-1 lists the controlling documents for performing this activity. Both activity plan and method description are SKB internal controlling documents.

After completing a percussion borehole it is logged with a colour TV-camera to produce images of the borehole wall called a BIPS-image (Borehole Image Processing System) /3/. Mapping of the percussion borehole is then done according to the Simplified Boremap method, in accordance with method description SKB MD 143.006 (SKB internal document). Using the preliminary mapping of drill cuttings /1/ and /2/ for comparison, the Simplified Boremap mapping is based on the BIPS-image where both petrography (rock types, rock occurrences and alteration) and structures (open fractures, crush zones and ductile deformation) of the bedrock that the borehole cuts through can be determined. In addition the mapping software (Boremap) calculates the orientation (strike and dip) of each marked planar feature.

Rock type nomenclature that has been used is shown in Table 1-2.

All data were stored in the primary data base SICADA for Oskarshamn and are traceable by the activity plan number.

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

Activity plans	Number	Version
Förenklad Boremapkartering av HLX34, HLX35, HLX36 och HLX37	AP PS 400-06-013	1.0
Method description	**Number**	**Version**
Metodbeskrivning för Boremap – kartering	SKB MD 143.006	2.0

Table 1-2. Rock type nomenclature for the site investigation at Oskarshamn.

Rock type	Rock code	Rock description
Dolerite	501027	Dolerite
Fine-grained Götemar granite	531058	Granite, fine- to medium-grained, (“Götemar granite”)
Coarse-grained Götemar granite	521058	Granite, coarse-grained, (“Götemar granite”)
Fine-grained granite	511058	Granite, fine- to medium-grained
Pegmatite	501061	Pegmatite
Granite	501058	Granite, medium- to coarse-grained
Ävrö granite	501044	Granite to quartz monzodiorite, generally porphyritic
Quartz monzodiorite	501036	Quartz monzonite to monzodiorite, equigranular to weakly porphyritic
Diorite/gabbro	501033	Diorite to gabbro
Fine-grained dioritoid	501030	Intermediate magmatic rock
Fine-grained diorite-gabbro	505102	Mafic rock, fine-grained
Sulphide mineralization	509010	Sulphide mineralization
Sandstone	506007	Sandstone

2 Objective and scope

The purpose of this survey is to map the lithology and structural parameters of percussion boreholes HLX34, HLX35, HLX36 and HLX37 in greater detail than the preliminary mapping of drill cuttings and results of measurements made while drilling the percussion holes, by using the Simplified Boremap mapping method.

The mapped parameters of the Simplified Boremap mapping are:

- Rock types (> 1 m wide).
- Rock occurrences (> 0.2 to < 1 m wide).
- Rock contacts.
- Alteration (mainly the intensity of red staining).
- Open fractures (including crush zones).
- Ductile structures (e.g. foliation, shear zones etc).

3 Equipment

3.1 Description of equipment/interpretation tools

Mapping of BIPS-images according to the Simplified Boremap method is done on desktop computer using the software Boremap (version 3.7.3), which shows the BIPS-image as can be seen in Figure 3-1. Boremap is loaded with SKB rock and mineral standard.

The accuracy of the Simplified Boremap mapping depends on several parameters.

- The clarity of the borehole water (i.e. the amount of material in suspension).
- The condition of the borehole walls (e.g. the amount of sedimentation on the borehole wall).
- The quality of the BIPS-image (i.e. the technical limitations of the image).

The BIPS-image quality of boreholes HLX34 and HLX35 is good /3/ and very good in boreholes HLX36 and HLX37. Some thin sedimentation occurs on the bottom of HLX35 and HLX37, with little effect on visibility. Mud in suspension occurs at a few intervals in boreholes HLX34, HLX35 and HLX36, impairing visibility slightly.

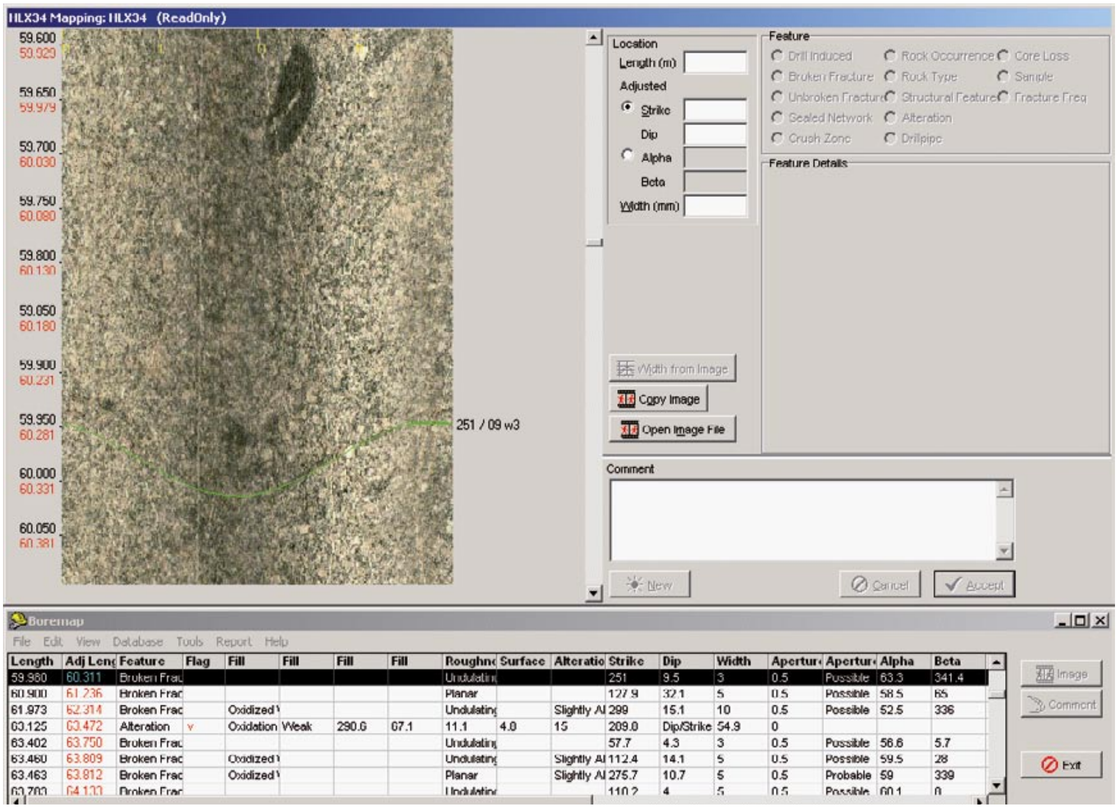


Figure 3-1. Good quality BIPS-image as it is seen in Boremap. Borehole HLX34, showing unaltered (fresh), medium to coarse grained, massive, porphyritic Ävrö granite, carrying occasional small fragments of fine-grained diorite-gabbro. One open fracture marked (green line).

For closer examination of drill cuttings normal field geologist equipment was used; a hand held lens, streak plate (a piece of white, unglazed porcelain), small magnet, hydrochloric acid (HCl 10% solution) and a knife. A stereomicroscope Zeiss Stemi DV 4 (magnification 8–32x) was used when necessary. Susceptibility meter JH-8, from Geoinstruments Finland, was used for measurements of the magnetic susceptibility in the drill cuttings.

4 Execution

4.1 General

Simplified Boremap mapping is comprised of data from:

- BIPS-image /3/,
- preliminary mapping of drill cuttings /1/ and /2/,
- results from percussion drilling /1/ and /2/,
- available geophysical measurements and interpretations /4/ and /5/.

The BIPS-image is opened in Boremap where the observed appropriate parameters are marked and described. To increase the accuracy of the mapping comparisons are made with preliminary mapping of drill cuttings, drilling penetration rate and when available results from geophysical measurements.

4.2 Preparations

Data from the SKB database SICADA used for Simplified Boremap mapping is listed in Table 4-1. The length of the BIPS-image is adjusted from bottom of casing, see Figure 4-1, to bottom of image according to a constant (the measured length registered in the BIPS-image deviates from the true length by a factor of approximately 0.5 m per 100 m), in addition the BIPS-image stops at least 30 cm before the full length of the borehole because of the camera construction.

The orientation of the borehole i.e. the azimuth and dip are the basis for calculating the strike and dip of the mapped planar structures. Data from Magnetic accelerometer deviation measurement is used to correct for changes in direction of the boreholes with length.

Table 4-1. Borehole data for HLX34, HLX35, HLX36 and HLX37 (values from top of casing). Data taken from SKB database SICADA and Boremap (adjusted length).

ID-code	Northing	Easting	Bearing (degrees)	Inclination (degrees)	Diameter (mm)	Borehole length (m)	End of casing (m)	BIPS-image interval, adj. length (m)
HLX34	6367355.125	1547489.558	101.068	–59.727	137	151.8	9.10	9.1–151.3
HLX35	6367194.788	1547437.792	102.216	–59.877	140	151.8	6.10	6.04–151.19
HLX36	6366172.935	1546558.452	270.608	–59.301	140	199.8	6.10	6.03–193.74
HLX37	6366183.660	1546406.214	86.182	–59.246	140	199.8	12.10	12.1–199.59

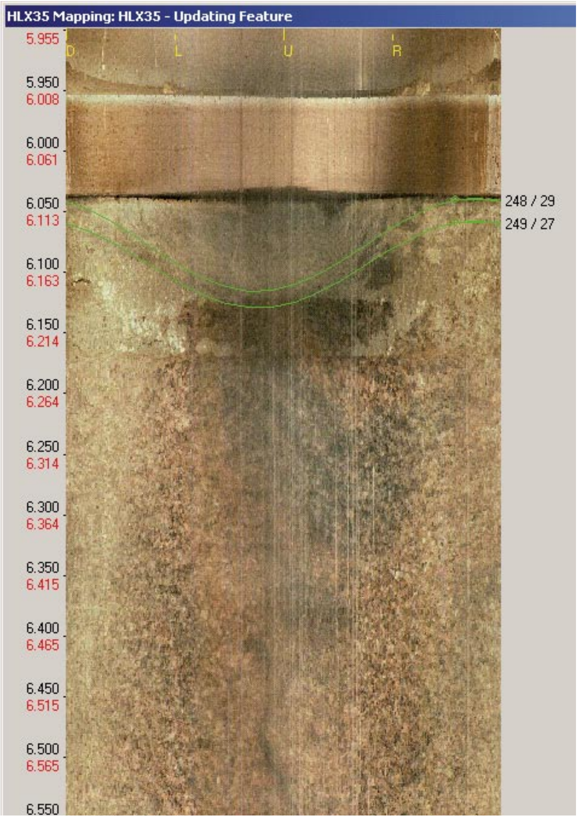


Figure 4-1. *BIPS-image as seen in Boremap, borehole HLX35 showing the lowest part of the casing pipe, some rests of concrete from the bottom plug and the borehole wall. Rock type is Ävrö granite showing red staining (alteration) of medium intensity. Green lines mark the top of rock type and red staining. Vertical streaks are impurities on protective glass of BIPS-camera and light grey material is lowest part of the concrete seal /1/. Bottom of casing pipe is at 6.1 m.*

4.3 Execution of measurements

BIPS-images make it possible to map features in percussion boreholes that are not discernible using rock cuttings and/or geophysical measurements. Planar structures such as open fractures, rock contacts, and deformational structures can be mapped accurately.

Below is a list of the parameters that are mapped with a short description and explanations for the WellCAD representation in Appendix 1–4:

- Lithology. Rock contacts, rock types (> 1 m wide) and rock occurrences (> 0.2 to < 1 m wide).
  - The lithological classification is sometimes difficult in the drill cuttings because of small fragment size of drill cuttings and the sometimes strong red staining/oxidation of the rock, but usually not a problem when drill cuttings and good quality BIPS-image can be compared.
  - Rock structure, texture and grain size is easily discerned in good quality BIPS-images, especially in medium to coarse grained rocks, while finer grained rocks often need to be seen in the drill cuttings. The WellCAD presentation shows these parameters for the rock types only, although they are also mapped for the rock occurrences.
  - Sharp rock contacts are easily mapped, but diffuse and undulating contacts of e.g. veins are often approximations. Rock contacts are shown as horizontal lines in the Well CAD presentations, regardless of their true orientation.

- Alteration and alteration intensity.
  - The only rock alteration that is mapped with some certainty in good quality BIPS-images are the red staining of the rock (oxidation) and its intensity. Other alterations are normally difficult to identify in the BIPS-image, but can sometimes be recognized in the drill cuttings.
- Open fractures and crush zones.
  - Only fractures that seemingly show apertures in the BIPS-image are mapped. Their apparent aperture is measured in the image, if a fracture is less than 1 mm wide it is assigned an aperture of 0.5 mm (Open Fracture Aperture).
  - Roughness of open fractures is determined as planar, undulating or stepped and represented as coloured lines (Open Fracture Roughness).
  - The alteration intensity of open fractures are determined and represented as coloured dots (Open Fracture Alteration) in the WellCAD presentation. The strike and dip of each fracture is represented with the coloured dot marking the dip (0–90°) and a short line pointing to the direction (0–360°).
  - The number of open fractures is calculated by the software for each metre and represented in the column Open Fracture Frequency (fr/m).
  - Crush zones are also mapped from the BIPS-image, the average size of fragments is measured in mm (Natural Piece Size) and the alteration intensity is decided. The colouring is the same as the Open Fracture Alteration in the WellCAD representation. Two interpreted main fracture directions are also marked within each crush zone.

4.3 Data handling

The Simplified Boremap mapping of the percussion boreholes is performed on a local computer disk at the core storage facility and saved on back-up in SKB internal network. When a borehole has been mapped the file is quality checked by the author and by a computer routine in Boremap. The data is then submitted to SKB for exportation to SICADA.

4.4 Nonconformities

No formal nonconformities have been registered during the activity.

For revision no. 1 of this report the origin of rock type Diorite/gabbro in boreholes HLX36 and HLX37 has been revised after the drilling and subsequent investigation of identical rock type in KLX20A, to Dolerite /7/. See Figure 1-1, Table 5-3 and Table 5-4, as well as Chapters 5 and 6. See also WellCAD representations in Appendix 3 and Appendix 4.

5 Results

Below the results from mapping of lithology, alteration and open fractures are given for boreholes HLX34, HLX35, HLX36 and HLX37. The percentages of different lithologies are given in Tables 5-1 through 5-4. The amount of alteration (red staining/oxidation) as well as their intensity is listed in Table 5-5, while the number of open fractures and the average fracture frequency per metre can be seen in Table 5-6, and finally the crush zones mapped from the BIPS-image are listed in Table 5-7.

HLX34

See Appendix 1 for WellCAD presentation of mapping results.

Lithology: The dominant rock type is Ävrö granite carrying small amounts of fine-grained diorite-gabbro and to a lesser extent diorite/gabbro, all cut by minor dykes and veins of fine-grained granite and granite, see Figure 5-1 and Table 5-1.

Alteration: Alteration in the form of red staining (oxidation) occurs often, in total 85% see Table 5-5. The highest intensity (medium) is roughly concentrated between ca 50 and 119 m and 141–145 m, see Appendix 1.

Open fractures: Mapped open fractures are 563, resulting in an average of 3.96 per metre, see Table 5-6. An increase in fracture frequency can be noted at several intervals; the first one at approximately 69–73 m (water inflow), 83–96 m, 111–113 m (water inflow) and 140–146 m (possibly some water inflow), all coinciding with a general increase in red staining (oxidation) intensity. Only the first increase in fracture frequency roughly agrees with the interpretation of geophysical measurements /5/. One crush zone is marked at ca 34.4 m (water inflow), see Table 5-7.

Table 5-1. Lithology of HLX34. Percents calculated from adjusted length of BIPS-image.

Rock name	SKB rock code	%
Ävrö granite	501044	89.9
Fine-grained diorite-gabbro	505102	5.5
Diorite/gabbro	501033	3.3
Fine-grained granite	511058	0.7
Granite	501058	0.6

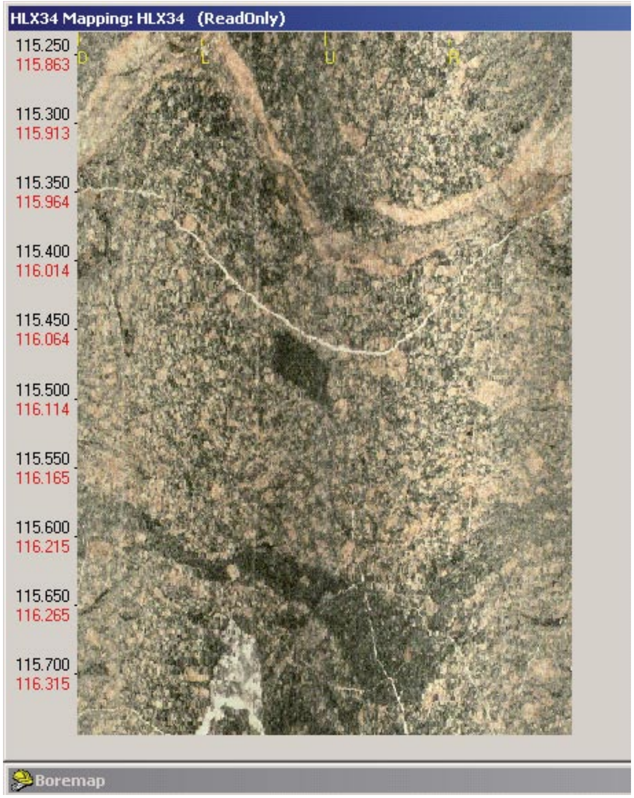


Figure 5-1. *BIPS-image as seen in Boremap, showing porphyritic Ävrö granite in borehole HLX34 containing fragments of fine-grained diorite-gabbro and cut by fine-grained granite vein. White irregular lines are filled fractures.*

HLX35

See Appendix 2 for WellCAD presentation of mapping results.

Lithology: The dominant rock type is Ävrö granite carrying minor amounts of fine-grained diorite-gabbro and one diorite/gabbro, all cut by subordinate dykes and veins of pegmatite and fine-grained granite, see Table 5-2.

Alteration: Alteration in the form of red staining (oxidation) occurs, in total 55% see Table 5-5. The dominant intensity is weak with very minor medium intensity, mainly in the first ca 15 m of the borehole, see Figure 5-2.

Open fractures: Mapped open fractures are 442, resulting in an average of 3.05 per metre, see Table 5-6. One major increase in fracture frequency can be noted at ca 116–127 m (water inflow), weaker increases in fracture frequency can be noted at several intervals; approximately 10–11 m, 49–53 m and 94–95 m, roughly agreeing with the interpretation of geophysical measurements /5/. The increases in fracture frequency usually coincide with red staining, mainly of weak intensity. One crush zone is marked at ca 141.7 m (water inflow), see Table 5-7.

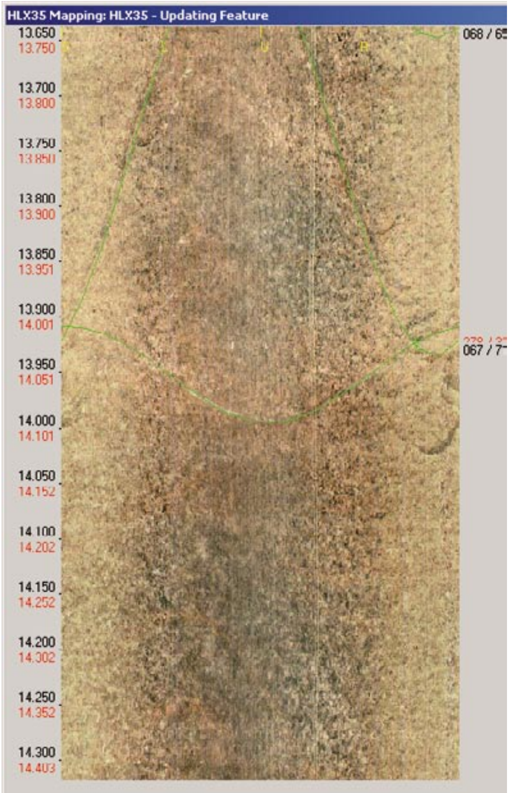


Figure 5-2. *BIPS-image as seen in Boremap, showing part of borehole HLX35 between 13.8 to 14.4 m (adjusted length). The rock type is Ävrö granite, altered to medium intensity. Two green lines mark probable open fractures with red stained walls (oxidized).*

Table 5-2. Lithology of HLX35. Percents calculated from adjusted length of BIPS-image.

Rock name	SKB rock code	%
Ävrö granite	501044	87.5
Fine-grained diorite-gabbro	505102	11.7
Pegmatite	501061	0.4
Fine-grained granite	511058	0.3
Diorite/gabbro	501033	0.1

HLX36

See Appendix 3 for WellCAD presentation of mapping results.

Lithology: Quartz monzodiorite containing minor amounts of fine-grained diorite-gabbro and cut by subordinate dykes and veins of fine-grained granite, see Figure 5-3, and pegmatite dominates slightly over a relatively homogenous and often strongly fractured mafic rock designated as dolerite, see Table 5-3.

Alteration: Some minor red staining (oxidation) is noted in the quartz monzodiorite, in total ca 14% and of weak intensity, see Table 5-5.

Open fractures: Mapped open fractures are 873, resulting in an average of 4.65 per metre, see Table 5-6. The main increase in fracture density is noted at 109–191 m, coinciding with the dolerite dike, which also contains one crush zone at 168.2 m, see Table 5-7.

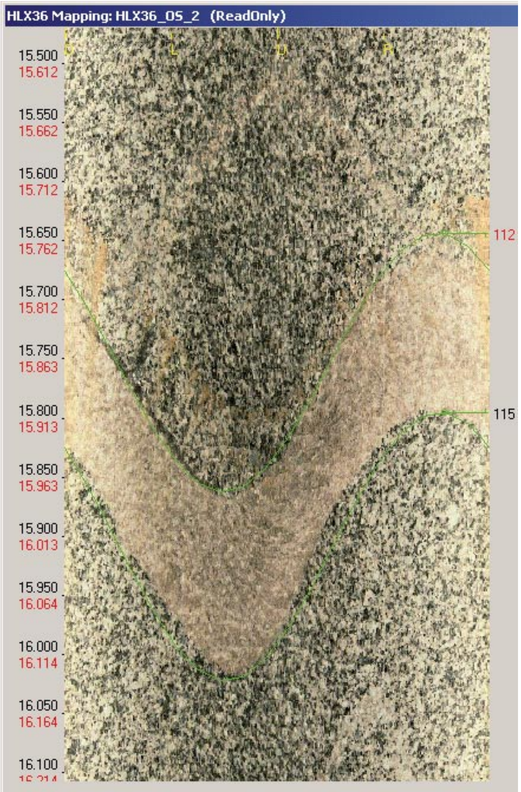


Figure 5-3. *BIPS-image as seen in Boremap, borehole HLX36 showing the unaltered quartz monzodiorite cut by a thin dike of fine-grained granite.*

Table 5-3. Lithology of HLX36. Percents calculated from adjusted length of BIPS-image.

Rock name	SKB rock code	%
Quartz monzodiorite	501036	55.2
Dolerite	501027	42.3
Fine-grained granite	511058	2.1
Fine-grained diorite-gabbro	505102	0.2
Pegmatite	501061	0.2

HLX37

See Appendix 4 for WellCAD presentation of mapping results.

Lithology: The dominant rock type is quartz monzodiorite, cut by minor dykes and veins of fine-grained granite, a substantial rock type is also the relatively homogenous and often strongly fractured mafic rock designated as dolerite, see Table 5-4 and Figure 5-4.

Alteration: Alteration in the form of red staining (oxidation) occurs in the quartz monzodiorite, mostly showing weak intensity but occasionally medium, in total 49% see Table 5-5.

Open fractures: Mapped open fractures are 633, resulting in an average of 3.39 per metre, see Table 5-6. Highest intensity of fracture frequency occurs in the dolerite dike at ca 122–147 m length. Fractures with some water inflow occur at ca 100 m and 148.5 m, see Figure 5-5. Two crush zones are marked at 143.1 m and 145.3 m, see Table 5-7.

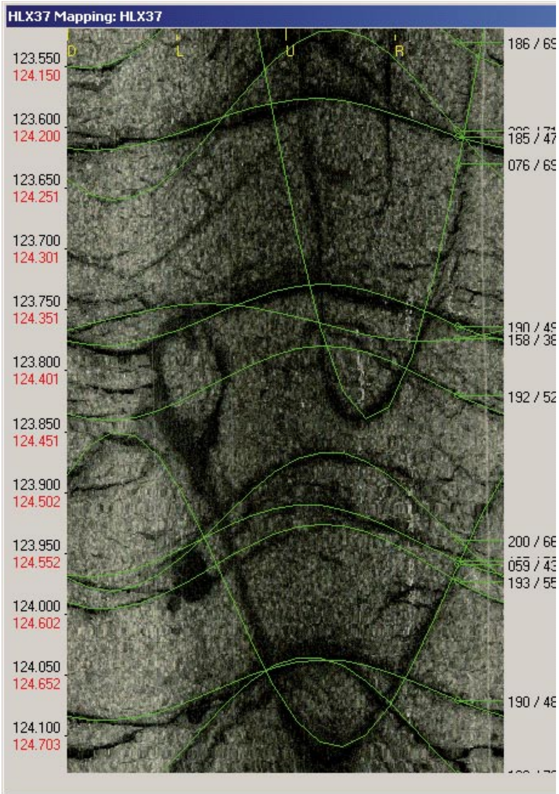


Figure 5-4. *BIPS-image as seen in Boremap, borehole HLX37 showing the unaltered, fine to medium grained, homogenous and often strongly fractured dolerite dike. Green lines mark the probable open fractures.*

Table 5-4. Lithology of HLX37. Percents calculated from adjusted length of BIPS-image.

Rock name	SKB rock code	%
Quartz monzodiorite	501036	84.2
Dolerite	501027	13.0
Fine-grained granite	511058	2.8

Table 5-5. Total alteration of percussion boreholes HLX34, HLX35, HLX36 and HLX37.

Alteration	Intensity	HLX34 (%)	HLX35 (%)	HLX36 (%)	HLX37 (%)
Oxidation	Weak	46	49	14	42
	Medium	39	6	–	7

Table 5-6. Total number of open fractures in percussion boreholes HLX34, HLX35, HLX36 and HLX37.

	Total number of open fractures	Fractures/metre
HLX34	563	3.9
HLX35	442	3.0
HLX36	873	4.7
HLX37	633	3.4

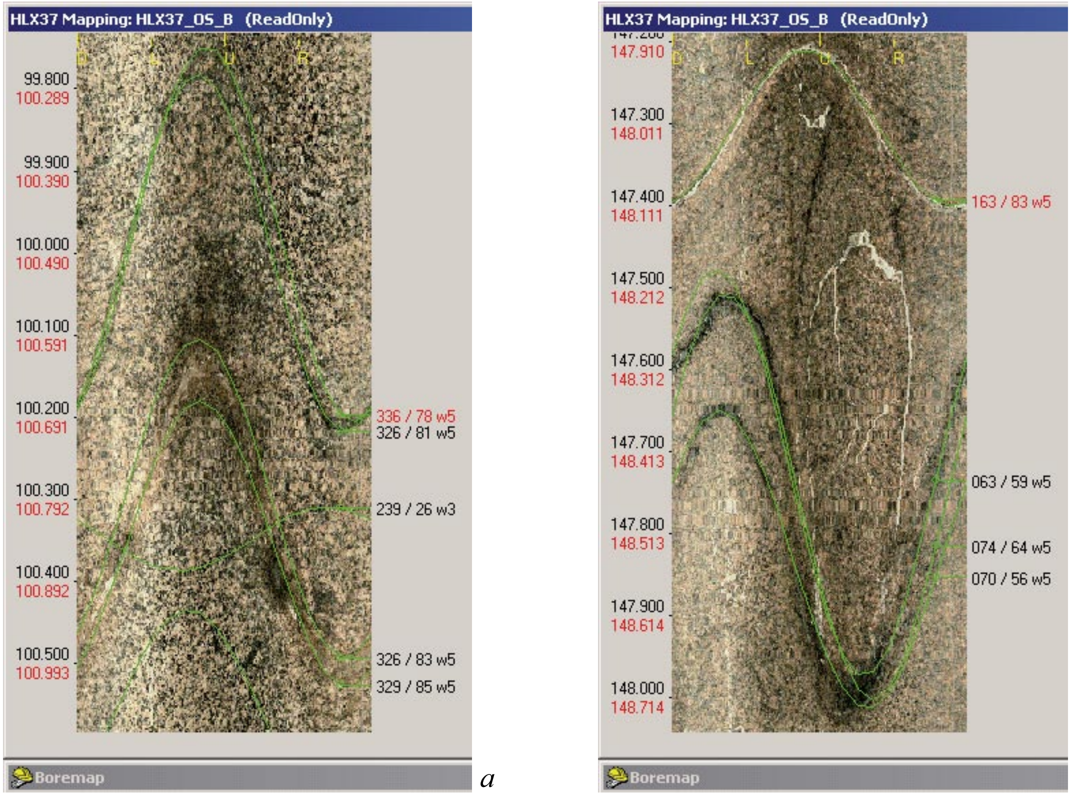


Figure 5-5. *BIPS-images as seen in Boremap, borehole HLX37 showing quartz monzodiorite with alteration of weak intensity. Water yielding fractures occur at ca 100 m in the left image (a) and at 148.5 m in the right image (b). Green lines mark the probable open fractures, white irregular lines and grey areas in the fractures are fracture fillings (b). The black area in the fractures is probably aperture, but could possibly be in some cases fracture filling. On the left hand of each image measured length is in black while adjusted length is in red. On the right hand of each image (both in red and black) is the strike/dip as well as the assumed width of each fracture in mm.*

Table 5-7. Mapped crush zones in percussion boreholes HLX34, HLX35, HLX36 and HLX37. Strike/Dip from top of crush zone.

Borehole ID	Adjusted length (m)	Total width of zone (m)	Piece length (m)	Strike/Dip (degrees)
HLX34	34.36	0.94	0.25	284/16
HLX35	141.68	0.14	0.28	105/32
HLX36	168.15	0.58	0.60	180/84
HLX37	143.10	0.22	0.50	189/69
HLX37	145.33	0.11	0.25	181/81

6 Summary and discussions

The four holes described in this report divide into two sets, the HLX34 and HLX35 drilled to test the lineament NS059 and the HLX36 and HLX37 drilled to test the lineament NS001.

The lithology dominating HLX34 and HLX35 is Ävrö granite, with only minor variations, see Tables 5-1 and 5-2. Alterations in the form of red staining (oxidation) are both more extensive and intense in HLX34 than in HLX35, see Table 5-5. Both holes show distinct increases in fracture frequencies that are usually accompanied with moderate to strong inflow of water /1/. The existence of these water yielding open fracture zones does not proof the existence of a deformational zone, but it suggests one possible explanation of the linked lineament at the point of intersection with the boreholes.

The lithology dominating HLX36 and HLX37 is quartz monzodiorite, with the main variation being the amount of the fine to medium grained, homogenous with even and unaffected contacts and often strongly fractured dolerite dike. Alterations in the form of red staining (oxidation) of mainly weak intensity occur in the quartz monzodiorite. Both boreholes show distinct increases in fracture frequencies in the dolerite dike, see Appendices 4 and 5, but no water inflow. Minor to moderate inflow of water was noted in HLX37 in the quartz monzodiorite both above and just below the dolerite /2/.

The mafic rocks in boreholes HLX34 and HLX35 are often heterogenous and show uneven and affected rock contacts, contradicting any new interpretation on their origins.

The parameters not represented in the WellCAD representations are either uncommon or difficult to map from the BIPS-image. As an example fracture minerals which sometimes occur in open fractures are all labelled as unknown mineral, because of the difficulties in identifying them accurately from the BIPS-image. In the rock cuttings secondary minerals are identified when possible, e.g. the talc and serpentine in the dolerite dike of boreholes HLX36 and HLX37, but can normally not be assigned to a specific fracture. Only one alteration type of open fractures is identified in the BIPS-image i.e. red colouring of rims, but they can rarely be verified in the rock cuttings.

7 References

/1/ **Sigurdsson O, Ask H, Zetterlund M, 2005.** Oskarshamn site investigation. Percussion drilling of boreholes HLX34 and HLX35. SKB P-05-237, Svensk Kärnbränslehantering AB.

/2/ **Ask H, 2006.** Oskarshamn site investigation. Percussion drilling of boreholes HLX36 and HLX37 for investigatioin of lineament NS001. SKB P-05-275, Svensk Kärnbränslehantering AB.

/3/ **Gustafsson J, Gustafsson C, 2005.** Oskarshamn site investigation. RAMAC and BIPS logging in boreholes KLX07A, KLX07B, HLX34 and HLX35 and deviation logging in boreholes KLX07B, HLX34 and HLX35. SKB P-05-231, Svensk Kärnbränslehantering AB.

/4/ **Nielsen U T, Ringgard J, Fris Dahl J, 2005.** Oskarshamn site investigation. Geophysical borehole logging in boreholes KLX07A, HLX07B, HLX20, HLX34 and HLX35. SKB P-05-228, Svensk Kärnbränslehantering AB.

/5/ **Mattsson H, Keisu M, 2005.** Oskarshamn site investigation. Interpretation of geophysical borehole measurements from KLX07A, KLX07B, HLX20, HLX32, HLX34 and HLX35. SKB P-05-259, Svensk Kärnbränslehantering AB.

/6/ **Triumf C-A, 2004.** Oskarshamn site investigation. Joint interpretation of lineaments. SKB P-04-049, Svensk Kärnbränslehantering AB.

/7/ **Rauséus G, Ehrenborg J, 2006.** Oskarshamn site investigation. Boremap mapping of core drilled borehole KLX20A. SKB P-06-241, Svensk Kärnbränslehantering AB.

Simplified geology HLX34

Title SIMPLIFIED GEOLOGY HLX34 **Appendix**

SKB

Site	LAXEMAR	**Coordinate System**	RT90-RHB70
Borehole	HLX34	**Northing [m]**	6367355.13
Diameter [mm]	137	**Easting [m]**	1547489.56
Length [m]	151.800	**Elevation [m.a.s.l.]**	14.29
Bearing [°]	101.07	**Drilling Start Date**	2005-05-09 13:00:00
Inclination [°]	-59.72	**Drilling Stop Date**	2005-06-14 19:30:00
Date of mapping	2005-09-01 15:42:00	**Plot Date**	2008-05-07 22:05:06
		Signed data	

ROCKTYPE LAXEMAR
- Ävrö granite
- Diorite / Gabbro
- Fine-grained diorite-gabbro

ROCK STRUCTURE
- Veined
- Massive

ROCK ALTERATION
- Oxidized

INTENSITY
- Weak
- Medium

FRACTURE ALTERATION

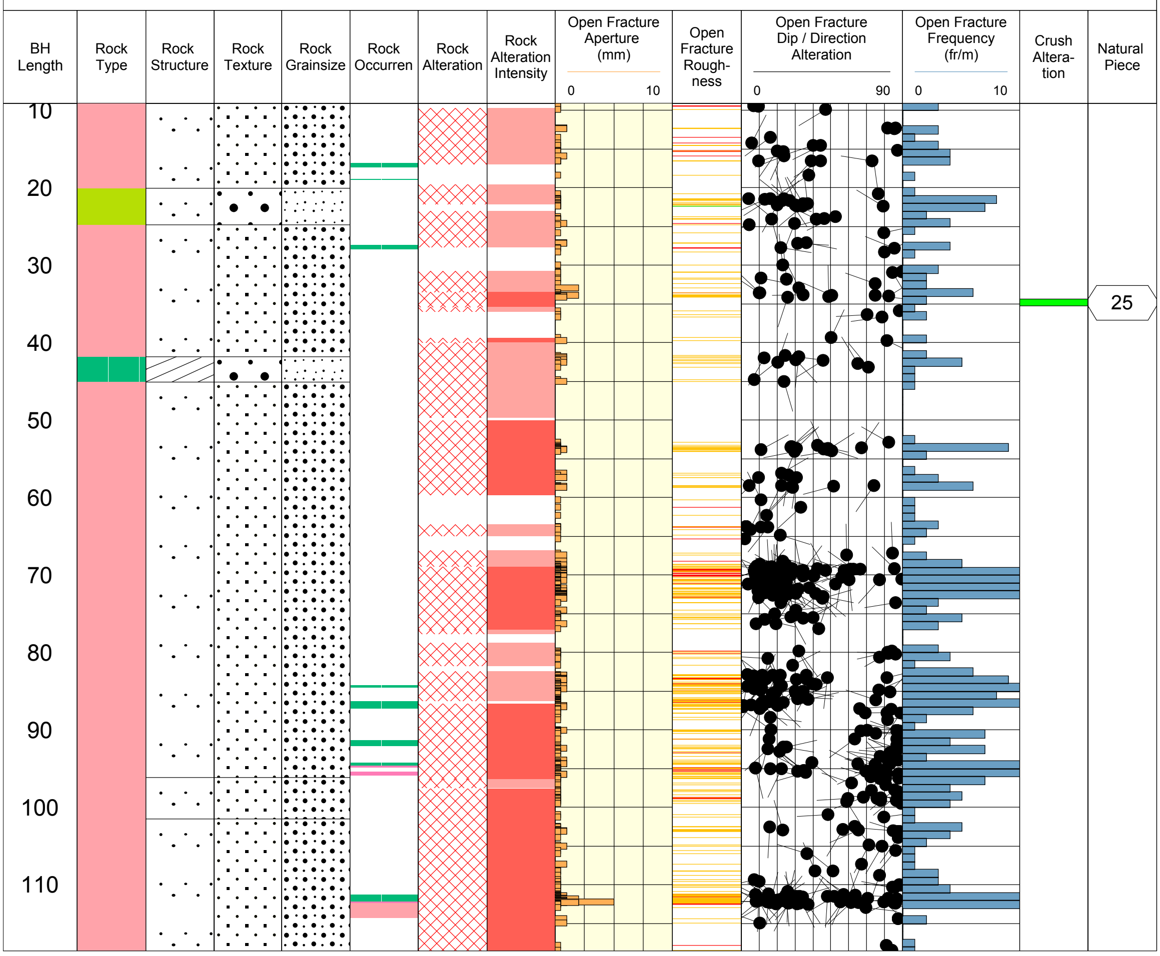
ROCK TEXTURE
- Porphyritic
- Unequigranular

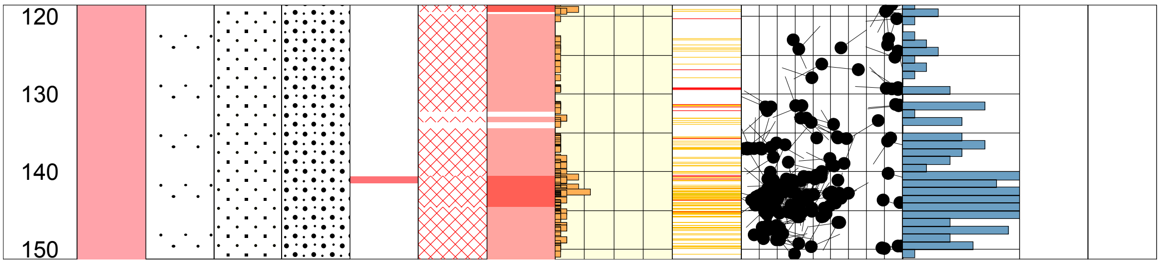
ROUGHNESS
- Planar
- Undulating
- Stepped

ROCK OCCURRENCE
- Fine-grained granite
- Granite
- Ävrö granite
- Fine-grained diorite-gabbro

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

SIMPLIFIED BOREMAP MAPPING




120
130
140
150

Simplified geology HLX35

Title	SIMPLIFIED GEOLOGY HLX35		Appendix
Site	LAXEMAR	Coordinate System	RT90-RHB70
Borehole	HLX35	Northing [m]	6367194.79
Diameter [mm]	140	Easting [m]	1547437.79
Length [m]	151.800	Elevation [m.a.s.l.]	14.44
Bearing [°]	102.22	Drilling Start Date	2005-05-28 07:00:00
Inclination [°]	-60.12	Drilling Stop Date	2005-06-02 20:00:00
Date of mapping	2005-09-08 08:51:00	Plot Date	2008-05-07 22:05:06
		Signed data	

ROCKTYPE LAXEMAR
- Ävrö granite
- Fine-grained diorite-gabbro

ROCK STRUCTURE
- Veined
- Massive

ROCK ALTERATION
- Oxidized

INTENSITY
- Weak
- Medium

FRACTURE ALTERATION

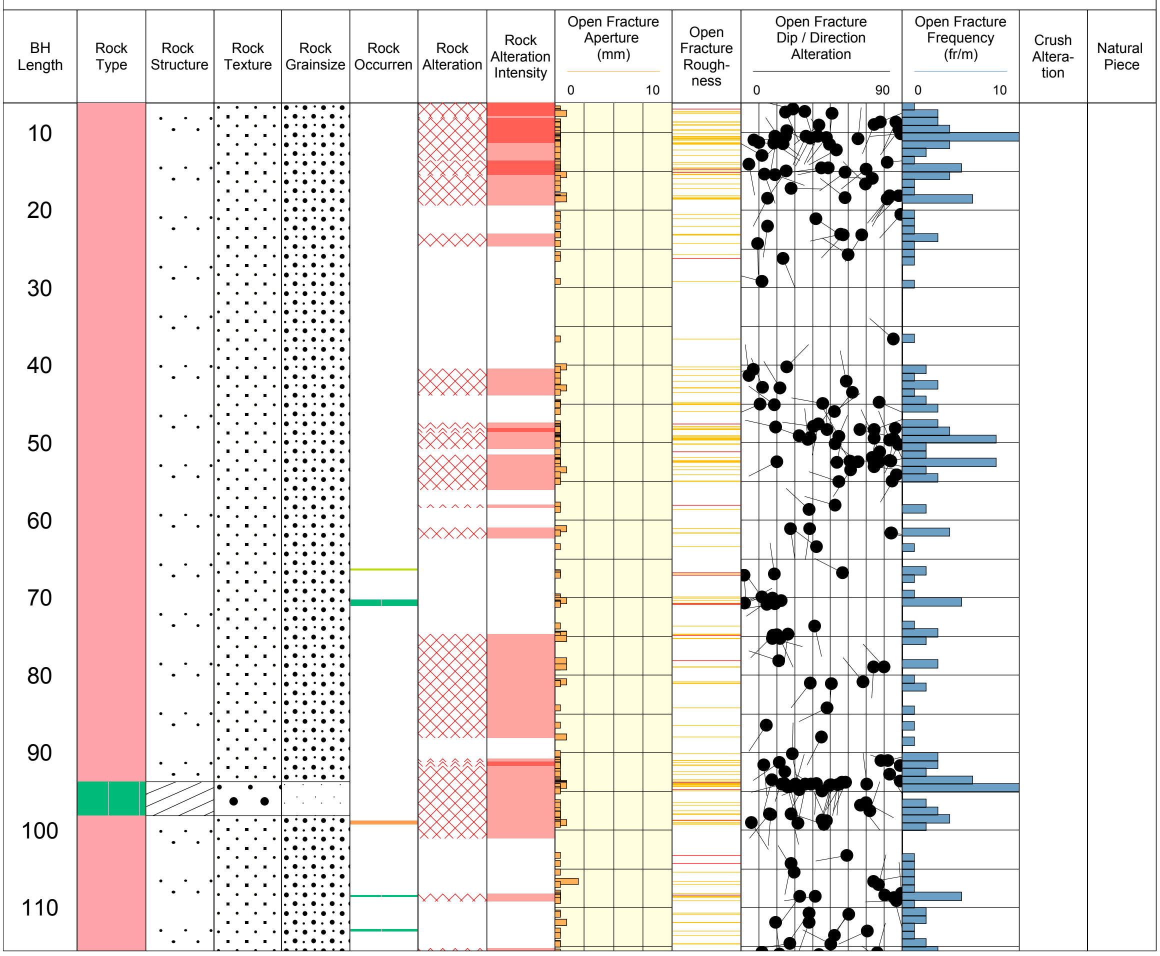
ROCK TEXTURE
- Porphyritic
- Unequigranular

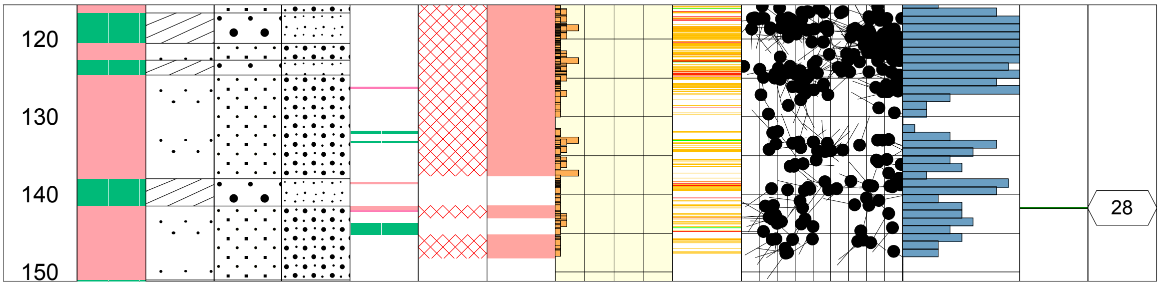
ROUGHNESS
- Planar
- Undulating
- Stepped

ROCK OCCURRENCE
- Fine-grained granite
- Pegmatite
- Ävrö granite
- Diorite / Gabbro
- Fine-grained diorite-gabbro

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

SIMPLIFIED BOREMAP MAPPING

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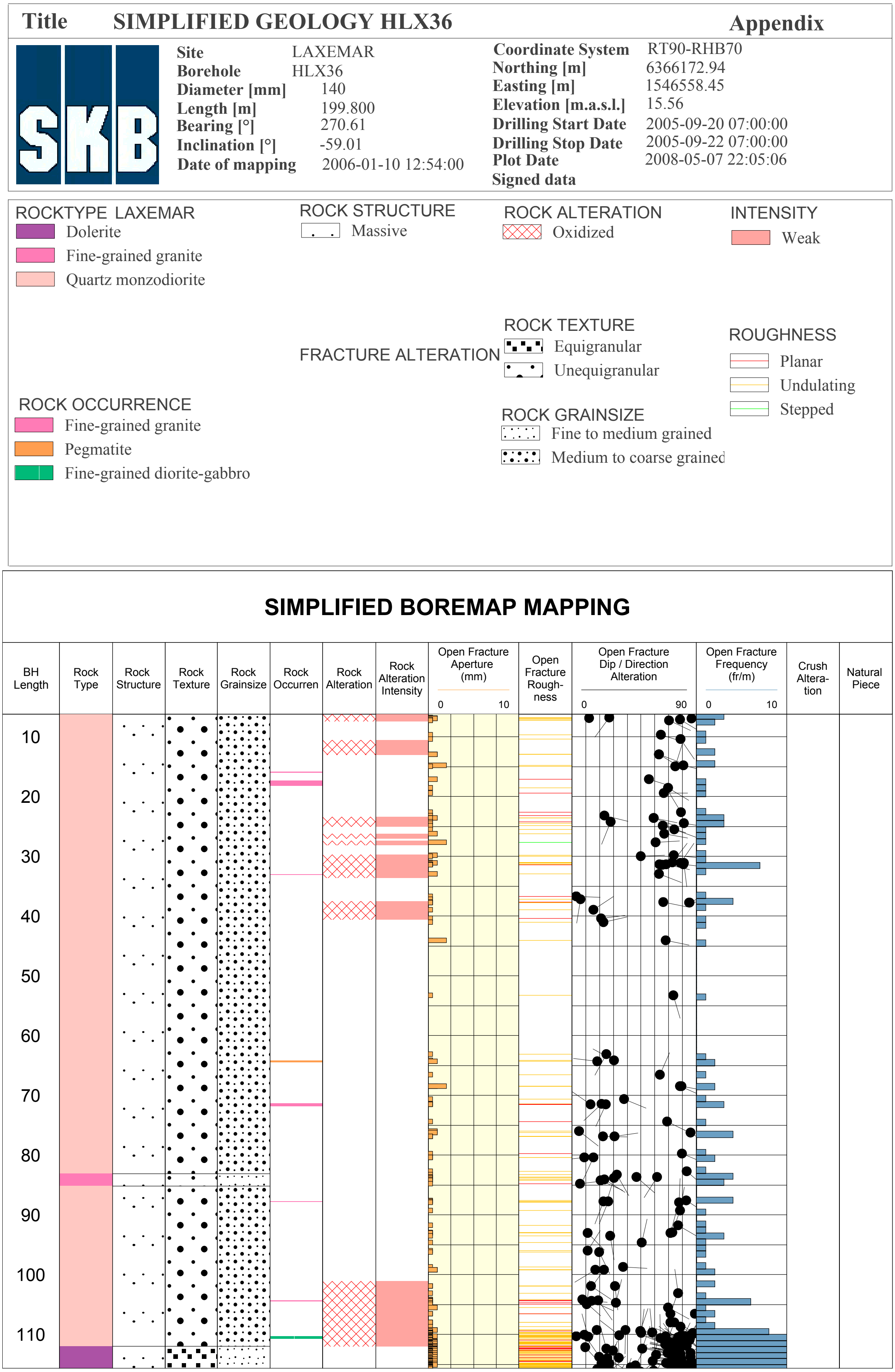
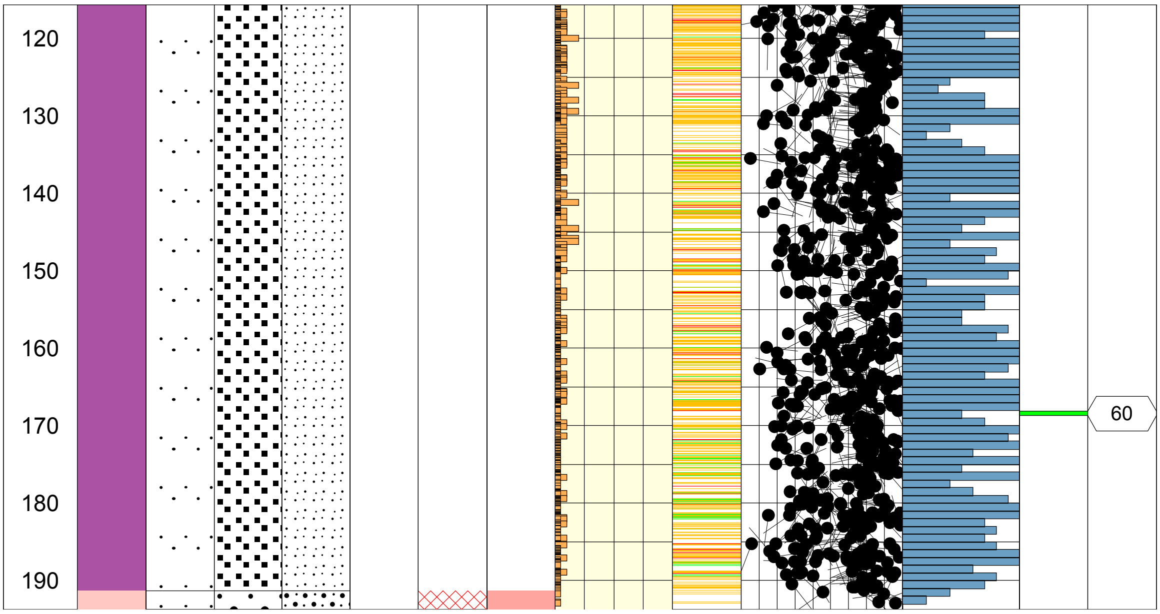
Simplified geology HLX36





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Appendix 4

Simplified geology HLX37

Title SIMPLIFIED GEOLOGY HLX37 **Appendix**

Site	LAXEMAR	**Coordinate System**	RT90-RHB70
Borehole	HLX37	**Northing [m]**	6366183.66
Diameter [mm]	139	**Easting [m]**	1546406.21
Length [m]	199.800	**Elevation [m.a.s.l.]**	15.19
Bearing [°]	86.18	**Drilling Start Date**	2005-09-26 09:00:00
Inclination [°]	-59.24	**Drilling Stop Date**	2005-09-28 12:00:00
Date of mapping	2006-01-31 10:30:00	**Plot Date**	2008-05-07 22:05:06
		Signed data	

ROCKTYPE LAXEMAR
- Dolerite
- Fine-grained granite
- Quartz monzodiorite

ROCK STRUCTURE
- Massive

ROCK ALTERATION
- Oxidized

INTENSITY
- Weak
- Medium

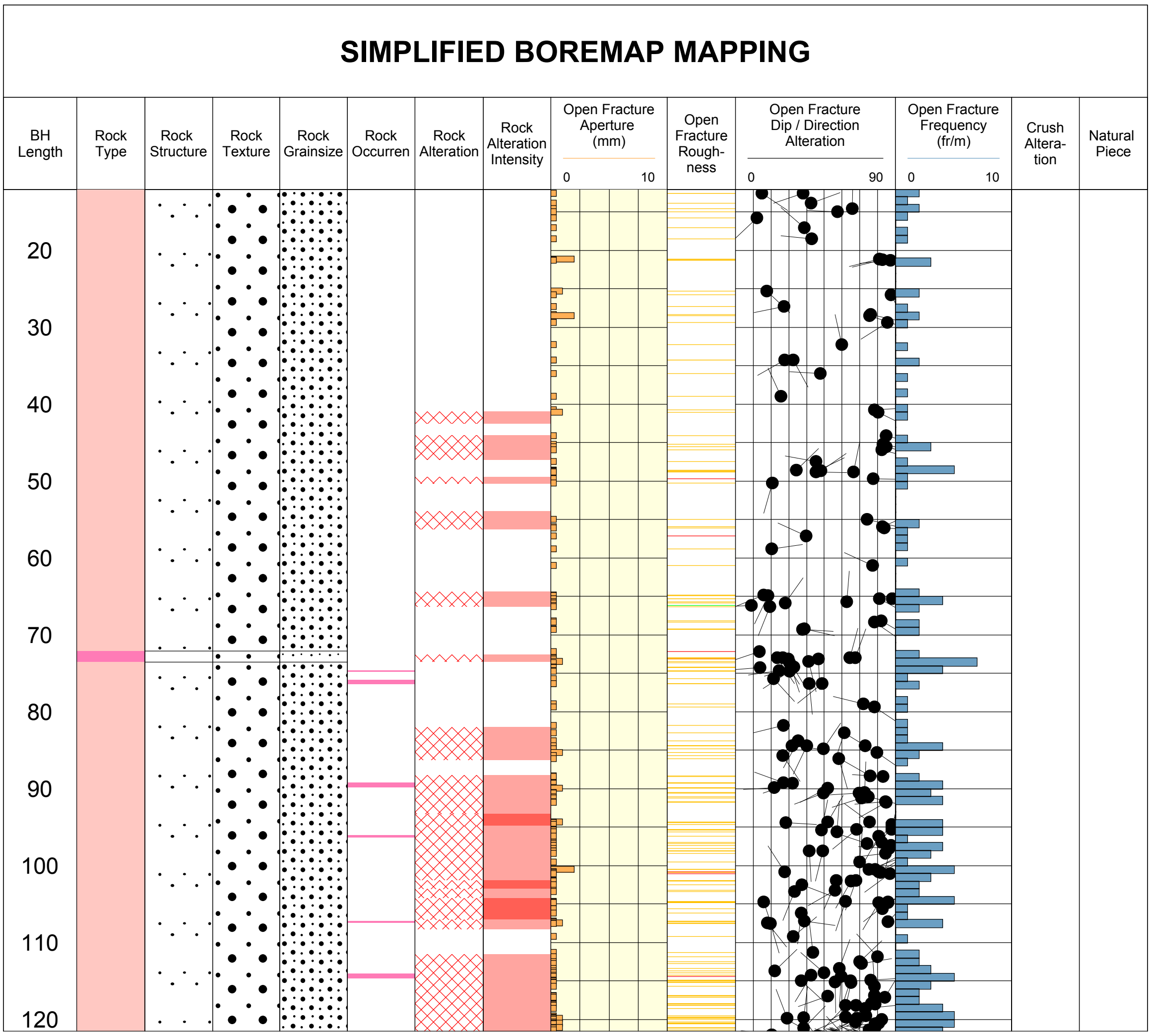
FRACTURE ALTERATION

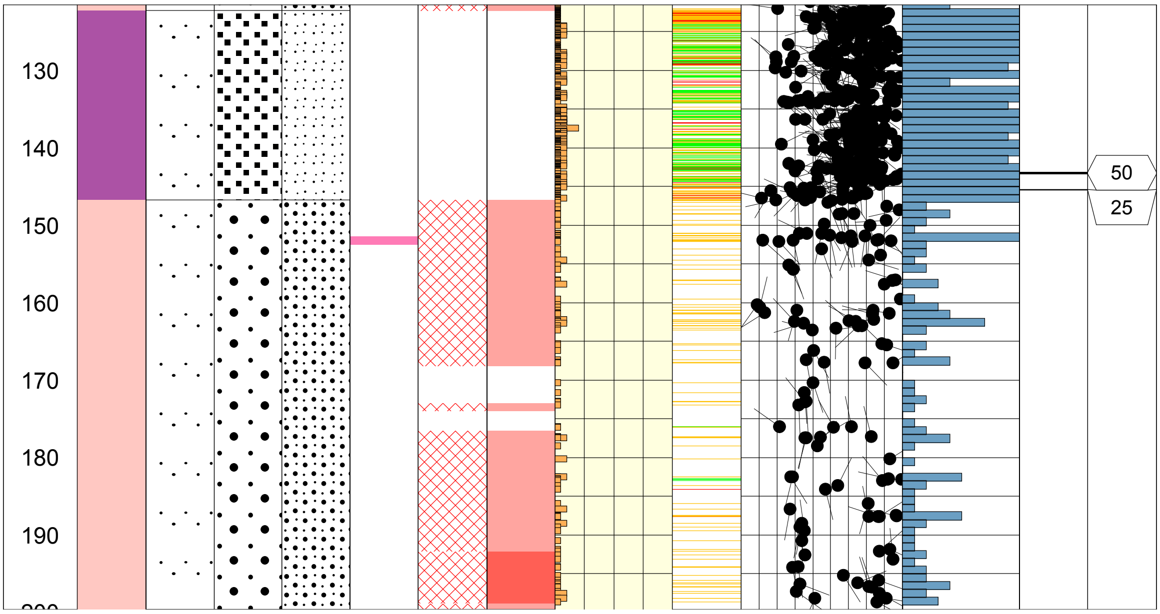
ROCK TEXTURE
- Equigranular
- Unequigranular

ROUGHNESS
- Planar
- Undulating
- Stepped

ROCK OCCURRENCE
- Fine-grained granite

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





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