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Oskarshamn site investigation

Geological single-hole interpretation of KSH01A, KSH01B, HSH01, HSH02 and HSH03

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March 2004

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1 Introduction

Much of the primary geological and geophysical borehole data stored in the SKB database SICADA need to be integrated and synthesized before they can be used for modeling in RVS. The end result of this procedure is a geological single-hole interpretation, which consist of integrated series of different loggings and accompanying descriptive documents /1/.

The work was carried out in agreement with the instructions and guidelines from SKB (activity plan AP PS 400-03-038 and applicable parts of method description SKB MD 810.003, SKB internal controlling documents).

This document reports the geological single-hole interpretation, by the use of two methods, for the boreholes KSH01A, KSH01B, HSH01, HSH02 and HSH03 (Figure 1-1).

The methods are

- 1. Interpretation based on Boremap, geophysical loggings (raw data), interpretation of radar data and FZI.
- 2. Interpretation based on Boremap, pseudogeological loggings (statistically classified geophysical loggings), interpretation of radar data and FZI.



Figure 1-1. Map showing the position of the boreholes.

2 Objective and scope

The single-hole interpretation is performed in order to make a generalized classification of major lithological units and possible deformation zones within the borehole. The classification is performed manually by a combined interpretation of the different logging data. The results are presented as two comment-logs, one indicating the lithological unit (+ comments) at the corresponding depth co-ordinates and the other indicating the position and width of possible deformation zones (+ comments), see Figure 7-1 in Chapter 7 for an example of the presentation.

The main purpose of the work presented in this report is to perform and compare the single-hole interpretations for the boreholes KSH01A, KSH01B, HSH01, HSH02 and HSH03 based on two different methods. Based on this, we present our recommendation on how future single-hole interpretations should be performed. However, due to poor data quality of some of the geophysical loggings from the percussion drilled boreholes HSH01-HSH03 /2/, no single-hole interpretation is performed based on method 2 for these boreholes. Thus, a comparison between the two methods has only been performed for the cored boreholes KSH01A and KSH01B.

3 Data used for the single-hole interpretation

3.1 Data used for method 1

The data used for method 1 are:

- Boremap /3, 4/ (including BIPS and core mapping data).
- Geophysical loggings (raw data). For rock type identification: density, natural gamma and magn. susceptibility. For fracture identification: resistivity loggings, SPR, sonic and caliper.
- Interpreted radar data
- FZI (Fracture Zone Index, only used for KSH01A, KSH01B and HSH01) /5/.

3.2 Data used for method 2

The data used for method 2 are:

- Boremap (including BIPS and core mapping data).
- Pseudogeology, pseudofracture frequency and pseudoalteration (only used for KSH01A and KSH01A).
- Interpreted radar data.
- FZI (Fracture Zone Index, only used for KSH01A, KSH01B and HSH01).

3.3 Geophysical interpretation

The pseudogeology is the result of a maximum likelihood classification of rock types based on the methods gamma-gamma (density), natural gamma radiation and magnetic susceptibility /2/. The signatures of the different rock types have mainly been established by petrophysical measurements on core samples from KSH01A, KSH01B and partly also from a surface sampling /6/. The petrophysical database of core samples so far (2003-10-27) covers the rock types:

- quartz monzodiorite
- fine-grained dioritoid
- fine-grained granite
- granite (medium- to coarse-grained)
- fine-grained diorite to gabbro (only 2 samples)
- Ävrö granite (only 1 sample).

This means that the only possible rock types which may come out of the pseudogeological classification are the ones listed above. If the logging data do not fit any of the listed rock types the section is left unclassified. It is important to note that the petrophysical signatures of quartz monzodiorite and fine-grained dioritoid are very similar, which leads to the fact that these two rock types can not be significantly separated in the statistical classification.

Fractures are identified from the short normal resistivity, SPR, focused resistivity (300 cm), caliper and sonic loggings. The position of fractures is calculated by applying a second derivative filter to the logging data and then locating maxima (or minima depending on the logging method) in the filtered logging. The estimated fracture frequency is calculated by applying a power function to the weighted sum of the maxima (minima) loggings. The power function is estimated by correlating the weighted sum to the true fracture frequency in one cored borehole (in our case KSH01A) /2/.

The investigation of geophysical logging data along sections of high intensity rock alteration zones in KSH01A indicates low density, low magnetic susceptibility and low natural gamma radiation along these sections. On basis of these data a "signature" of possible rock alteration was established which is used to create a logging of possible alteration zones within each of the investigated boreholes. The basic principle of the method is simply to identify sections where, simultaneously, the silicate density < 2800 kg/m^3 , the magnetic susceptibility < 0.003 SI and the natural gamma radiation is < 20 µR/h.

4 Execution of the single-hole interpretation

The single-hole interpretation method is an integrated interpretation of the information from four sources, and these are the Boremap investigation, geophysical loggings, borehole radar data and FZI data. The interpretation is performed by a group of experts consisting of at least one geologist and one geophysicist. (Field notes: Simpevarp 12, Simpevarp 40, Simpevarp 43, Simpevarp 100 and Simpevarp 101, respectively.)

All data to be used (see above) are visualized side by side in a borehole document in the software WellCAD (see Appendices 1 and 2 for examples).

Step 1 is to manually (visually) go through the rock-type related logging data and merge sections of similar rock types, or sections where one rock type is very dominant, to a major lithological unit (minimum length of c 10 m). Four rock type descriptions (A-D) are representative for the bedrock in the investigated boreholes in the Simpevarp area.

Step 2 is to identify possible deformation zones by visual inspection of the fracture frequency loggings, alteration loggings, radar logging, FZI logging (only KSH01A and B) and the penetration rate logging (only HSH01-03). The section of each identified possible deformation zone is indicated and shortly described in text.

Two different methods on how to perform the single-hole interpretation are presented in this report. The two methods only differ in the way the geophysical loggings are presented. In method 1 (Figure 4-1) the raw data of 8 geophysical loggings are plotted and interpreted side by side. In method 2 (Figure 4-2) the 8 geophysical loggings are replaced by 3 pseudo-loggings, one displaying estimated lithology, one displaying possible alteration zones and the third shows an estimation of the fracture frequency.



Figure 4-1. Schematic block-scheme of single-hole interpretation, method 1.



Figure 4-2. Schematic block-scheme of single-hole interpretation, method 2.

5 Results

The detailed results of the single-hole interpretations are presented as print-outs from the software WellCad (Appendices 1 and 2).

5.1 KSH01A

Method 1

The number of indicated lithological units is 7 and the number of indicated deformation zones is 13 (including low grade ductile zones). See Appendix 1 for a detailed presentation of the results.

Method 2

The number of indicated lithological units is 7 and the number of indicated deformation zones is 13 (including low grade ductile zones). See Appendix 2 for a detailed presentation of the results.

5.2 KSH01B

Method 1

The number of indicated lithological units is 1 and the number of indicated deformation zones is 0. See Appendix 1 for a detailed presentation of the results.

Method 2

The number of indicated lithological units is 1 and the number of indicated deformation zones is 0. See Appendix 2 for a detailed presentation of the results.

5.3 HSH01

Only method 1

The number of indicated lithological units is 2 and the number of indicated deformation zones is 2. See Appendix 1 for a detailed presentation of the results.

5.4 HSH02

Only method 1

The number of indicated lithological units is 2 and the number of indicated deformation zones is 4. See Appendix 1 for a detailed presentation of the results.

5.5 HSH03

Only method 1

The number of indicated lithological units is 3 and the number of indicated deformation zones is 1. See Appendix 1 for a detailed presentation of the results.

6 Discussion

A comparison between single-hole interpretation based on method 1 and method 2 shows good agreemen between the methods. There are two reasons for this. The first is that the Boremap data is given the most importance in both interpretations and thus give a strong influence on the results. Secondly, there is generally a good agreement between the Boremap data and the geophysical/pseudogeological data, both for lithological units and possible deformation zones.

The weakness of using geophysical raw data loggings (method 1) is fairly obvious. Even for a trained geophysicist it may be difficult, and time consuming, to simultaneously interpret eight different loggings. There is also an obvious risk of subjective influence on the results. To reduce the number of loggings and to create user friendly presentations we therefore suggest that different methods are combined. These are two reasons for the production of the pseudogeology loggings. For example, the pseudo fracture frequency combines five loggings into one, and the results so far look very promising (especially when considering the possible use of the technique in percussion drilled boreholes). A third reason for doing the pseudogeology loggings is that the results are based on independent measurements of physical properties and are therefore not biased by any subjective interpretation.

However, the pseudogeological "lithology" has been criticized for not managing to differ between rock types with similar petrophysical properties. The quartz monzodiorite and the fine-grained dioritoid have very similar physical properties and when comparing the boremap data and the pseudogeology, it is evident that large sections that are mapped as fine-grained dioritoid in boremap, are statistically classified by the pseudogeology as quartz monzodiorite, see Appendix 2.

To overcome this problem we therefore suggest that the pseudogeological lithology logging is replaced by simplified (generalized) versions of the three "rock-type-dependent" loggings silicate density, magnetic susceptibility and natural gamma radiation (see example in Figure 6-1 below). The pseudo fracture frequency is kept as it is, but we suggest that it is termed "estimated fracture frequency" instead. The pseudo alteration logging is also suggested to be kept as it is, but will be termed "possible alteration".

The generalized loggings take short time to produce. If the logging company can deliver data shortly after the completion of the measurements it is possible to produce the generalized logging well in time for the boremap investigation. In that case the geophysical loggings would be used in the single-hole interpretation and also serve as supportive information to the geologists during the boremap investigation. This has already been tried out for the mapping of KAV01, which immediately became much appreciated by the mapping crew.

In Chapter 7 below a recommendation on how to perform future single-hole interpretations is presented.





7 Recommendation

On basis of the results from this investigation we suggest the following procedure for future single-hole interpretations and treatment of geophysical logging data.

- 1. The logging company processes and delivers the geophysical logging data at the site, as soon as possible after (or during) the completion of the measurements. A quality control is performed on-line by a geophysicist, who controls the data quality and decides when the measurements are finished.
- 2. As soon as the logging data are approved, the production of the generalized loggings starts. The processed data is delivered to SKB to be used by the geologist performing the boremap investigation.
- 3. The boremap investigation is performed with support from the processed geophysical logging data. A short introduction (writing and/or oral) on how to use the geophysical data during mapping is given to the mapping crew by a geophysicist. Continuous communication between the mapping crew and the geophysicist is maintained through out the entire mapping procedure. A concise compilation of the petrophysical data of all known rock types in the area is placed at the mapping crew's disposal. If (when) new rock types are discovered these are sampled for petrophysical analyses, added to the data base, and their signatures can be identified in the geophysical logging data.
- 4. The single-hole interpretation is performed on basis of
 - Boremap
 - Generalized geophysical loggings
 - Interpreted radar data

and it is performed according to the following scheme:



The FZI **can** be used during the single-hole interpretation, but may also be calculated at a later stage and used only in the RVS modeling work.

A new WellCAD script for the data is suggested to be used during the single-hole interpretation, see Figure 7-1 below for an example.



Figure 7-1. Example from KSH01B of suggested presentation of single-hole interpretation layout.

8 References

- /1/ **SKB R-03-07.** Geological site descriptive model a strategy for the model development during site investigations. Raymond Munier et al, 2003.
- /2/ SKB P-XX-XX. Interpretation of geophysical borehole data from KSH01A, KSH01B, KSH02 (0-100 m), HSH01, HSH02 and HSH03, and compilation of petrophysical data from KSH01A and KSH01B. Håkan Mattsson and Hans Thunehed, GeoVista AB. In press.
- /3/ SKB P-04-01. Boremap mapping of telescopic drilled boreholes KSH01A and KSH01B. Jan Ehrenborg and Vladislav Steiskal.
- /4/ SKB P-04-01. Boremap mapping of percussion boreholes HSH01-03. Christin Nordman.
- /5/ **SKB P-03-93.** Calculation of fracture zone index (FZI) for KSH01A. Lennart Lindqvist, Bergsten & Co i Värnamo AB, Hans Thunehed, GeoVista AB.
- /6/ SKB P-XX-XX. Compilation of petrophysical data from rock samples and in situ gamma-ray spectrometry measurements Håkan Mattsson, Hans Thunehed and Carl-Axel Triumf, GeoVista AB. In press.

Appendix 1

Method 1. Results of the single-hole interpretations of KSH01A, KSH01B, HSH01, HSH02 and HSH03

Title	G	EOL	OGI	CAL SING	LE HOLE I	NTI	ERPRETATION			-	KSH(1A	
			Site		SIMPEVARP		Coordinate System RT90-RHB70						
			Bore	hole leter [mm]	KSH01A 75		Northing [m] 6366013.45 Easting [m] 15524/2.09						
			Leng	th [m]	1003.000		Elevation [m.a.s.l.] 5.31						
K			Bear	ing [°]	173.60		Drilling Start Date 2002-08-22 13 Drilling Start Date 2002-12 10 21	:00:00)				
			Date	of mapping	2004-03-09 17:57	:00	Plot Date 2002-12-18 21 Plot Date 2004-03-09 21	:03:28	8 Script Name \$Sc	ript			
										*			
ROCKT	YPE SIM	PEVARP		R	OCK ALTERATION		ROCK UNIT A Rock unit dominated by quartz monzy of fine-grained granite, permatite and	odiorite 1 sparse	(quartz monzonite to monzodiorite), with s ely porhyritic Ävrö granite (granite to quartz	ubordinate : monzodiori	sections ite)	* Apple to be	rehole avis
	Fine-grai	ined gran	nte		Epidotisized		ROCK UNIT B Rock unit dominated by fine-grained of	dioritoid	I (fine-grained, intermediate, magmatic rocl	()		Augre to be	
	Granite			12			with subordinate sections of quartz m fine- to medium-grained granite, pegr	ionzodio natite a	prite (quartz monzonite to monzodiorite), ind fine-grained diorite to gabbro (fine-grain	ed mafic ro	ck).		
	Ävrö gra	nite					ROCK UNIT C Rock unit characterized by a mixture	of span	sely porphyritic Ävrö granite (granite to qua	rtz monzod	iorite)		
	Quartz n	nonzodior	rite				and quartz monzodiorite (quartz mon medium-grained granite, medium- to and beomatite.	coarse-	-grained granite, fine- grained diorite to gab	bro (fine-gr	ained mafic i	ock)	
	Diorite /	Gabbro	it ald	AL	TERATION INTENSITY	Mod	INTERNET IN THE ROCK UNIT D Rock unit dominated by sporebly por	hyritic	Ävrö granite (granite to quartz monzodiosite	2)			
	r me-grai	mea diori ined diori	ite-gabbro		Weak	Strot	with subordinate sections of fine- to fi gabbro (fine-grained mafic rock), peg	nely me matite a	adium-grained granite, fine-grained diorite- and diorite to gabbro	to			
						-		1					
DEPTH			BOR		ТА				POSSIBLE	.		F	zi
									DEFORMATION Z	ONES	5		
Depth		D . 1	Rock	Fra	ctures					Ra	ıdar	F	ZI
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						1		1					
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								1		49.08	25.05		
60.0								1					
80.0								1					
								1		89.17	23.66		
100.0				2				-					
								1					
120.0								1					
								1	/Increased,	1			
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							Deek unit A		Indication : Low	145.00	25		
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		~~~~						1	resistivity.	171 20	73		
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200.0						↓				191.30	70		
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220.0		00000					Rock unit B	1		212.50 215.20	16 55		
220.0							Sealed fracture frequency verv	1	Increased				
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									resistivity.				
280.0							Rock unit A	1	shear-zone				
									Increased	1			
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								1	alteration.				
320.0						Ļ		4	Indication: Low				
									density, sonic och				
340.0								1	resistivity.				
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360.0								1					
										364.80	36		
380.0										381 50	47		
				E				1		383.30	30		
400.0		~~~~						1		395.60	71		
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	Quartz n	nonzodior	ite		Oxidized		ROCK UNIT B Rock unit dominated by fine-grainer	I dioritoir	d (fine-grained intermediate magmatic ro	ick)	10)	" Angle to b	orenoie axis
							with subordinate sections of quartz fine- to medium-grained granite, pe	monzodi matite a	orite (quartz monzonite to monzodiorite), and fine-grained diorite to gabbro (fine-gra	ained mafic ro	ck).		
							ROCK UNIT C Rock unit characterized by a mixtur	- e of spar	rsely porphyritic Ävrö granite (granite to q	uartz monzod	iorite)		
							and quartz monzodiorite (quartz mo medium-grained granite, medium- t	nzonite o coarse	to monzodiorite), with subordinate sectior -grained granite, fine- grained diorite to g	is of fine- to fi abbro (fine-gr	nely ained mafic	rock)	
					ALTERATION INTENSIT	Y	ROCK LINIT D D designation		X				
					Faint Weak		with subordinate sections of fine- to aphro (fine-grained matic mock) pa	finely m	Avro granite (granite to quartz monzodio) edium-grained granite, fine-grained diorite and diorite to gabbro	e- to			
							gubblo (mile grunou mano rook), po	ginatite					
DEDTU					ATA				POSSIBLE			E	71
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										73.6	50		

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140.0 160.0 180.0				And the state of the				The unit is by fine gr dioritoid. Indicated and drill c	s dominated ained by BIPS uttings.	V	Increased fracturing.	(143.22	23.51			

Ti	tle	G	EOL	OGICA	L SINC	GLE H	OL	E INTER	RPRETAT	IO	N HSH03				
		K	B	Site Borehole Diameter Length [1 Bearing Inclinatio Date of n	[mm] n] °] on [°] napping	SIMPEV HSH03 139 201.000 218.94 -79.49 2003-03-	AR-10	P 00:00:00	Coordinate S Northing [m] Easting [m] Elevation [m Drilling Star Drilling Stop Plot Date	Syste .a.s. t Da Dat	m RT90-R1 6366213 1552544 L] 2.52 te 2002-07- te 2002-07- 2004-03-	HB70 .94 .52 -02 17:3 -09 19:0 -24 21:0	0:00 0:00 03:42		
R0 [[СКТҮР	E Granit Ävrö g Quartz	e ranite z monzod	liorite				CCK ALTERATI	ced TENSITY Strong		RADAR # Angle to borehole axi	is			
DEPTH		1	BOF	REMAP	DATA			ROCK	UNIT	D	POSSIB EFORMATIO	LE N ZO	NES	F	ZI
1:1500	Rock Type	Rock Alteratio	Rock Alteration Intensity	Rate (s/20cm)	Fra Frequen Open	icture icy (fr/1m) Sealed	-	Co	mment		Comment	RAI Length	DAR # Angle	6 F.	ZI2
20.0 40.0				o au				Rock unit by Ävrö-g Indicated and drill c	dominated ranite by BIPS uttings.		Increased fracturing and	54.42	22.02		
60.0 80.0				W Why was a way was a way a way of the second s				Rock unit by quartz monzodio and Ävrö	dominated rite, granite granite		alteration indicated by BIPS, drill cuttings, high penetration rate and	(68.78	52.02		
120.0				And how want of the second		Ատհամեր	-	with subo sections of grained gr Indicated drill cutting natural ga	rdinate of fine ranite by BIPS, gs and umma		geophysical logging data.	106.97 109.77 128.44	41.69 14.04 52.48		
140.0 160.0				Mar Marine Lan	andha nmhaind			Rock unit	dominated	-		(138.14 (144.96 (150.55	30.65 36.47 21.72	 	
180.0				A WWWWWWW				monzodio probably sections c fine-grain granite.	rite with more of ed			(187.53	20.2		
200.0				~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			-	Indicated drill cuttin natural gamma.	by BIPS, gs and						

Method 2. Results of the single-hole interpretations of KSH01A and KSH01B

Tit	le (GEOI	LOG	ICAL SING	LE HOLE I	NTE	RPR	RETA	TION	N				-	KSH(01A	
S	ľ	B	Site Bor Dia Len Bea Incl Dat	ehole meter [mm] gth [m] ring [°] ination [°] e of mapping	SIMPEVARP KSH01A 75 1003.000 173.60 -80.44 2004-03-09 17:57	7:00	Coo Noi Eas Ele Dri Dri Plo	ordinat rthing [sting [m vation illing St illing St t Date	e Syster m] i] [m.a.s.l art Dat op Date	m .] te e	RT90-RHB70 6366013.45 1552442.98 5.31 2002-08-22 13:00:00 2002-12-18 21:10:00 2004-03-15 21:03:26		Script Name \$Scri	pt			
ROCI	KTYPE Fine-9	rained ora	nite		PSEUDO ALTER Unclassi	ATION				R	CK UNIT A Rock unit dominated by q of fine-grained granite, pe	quartz egma	monzodiorite (quartz monzonite to mo tite and sparsely porhyritic Ävrö granite	nzodiorite). (granite to	with subor quartz mor	dinate sections nzodiorite)	
	Pegma	ranieu gra itite	inte		Possible	oxidatior				R	OCK UNIT B Rock unit dominated by fi	ine-gr	rained dioritoid (fine-grained, intermedi	ate, magma	tic rock)		
	Granit Ävrö s	te zranite								R	fine- to medium-grained g	granit	e, pegmatite and fine-grained diorite to	gabbro (fin	e-grained r	nafic rock).	
	Quart	z monzodio	orite								Rock unit characterized b and quartz monzodiorite (medium-grained granite, I	oy a n (quar medi	nixture of sparsely porphyritic Avrö gran tz monzonite to monzodiorite), with sut um- to coarse-grained granite, fine- gra	nite (granite oordinate se iined diorite	to quartz r ctions of fir to gabbro	nonzodiorite) ne- to finely (fine-grained mafi	ic rock)
	Diorite Fine-g	e / Gabbro rained dio	ritoid			TENCITY	,			R	and pegmatite. DCK UNIT D Rock unit dominated by s	parse	ely porphyritic Ävrö granite (granite to q	uartz monz	odiorite),		
	Fine-g	rained dio	rite-gabbi	ro	Faint	TENSIT	Medium	h			with subordinate sections gabbro (fine-grained mafie	of fin c rock	 he- to finely medium-grained granite, fir k), pegmatite and diorite to gabbro 	e-grained o	liorite- to		
× ×	Oxidiz	ed			Weak		Strong										
	Epidot	tisized								*.	ADAR Angle to borehole axis						
DEPTH			BOR	EMAP DAT	A	C	PSE SEOI	UDO LOG1	r		ROCK UNIT		POSSIBLE DEFORMATION 2	ZONE	s	FZ	ZI
Depth	Rock	Rock	Rock	Frac	tures	Pseudo	Pseudo	Pseudo I Frequ (fractu	Fracture ency res/m)		Comment			RAI	DAR	FZ	ZI
	Туре	Alteration	Intensity	Open (Fr / 1m) 0 20	Sealed (Fr / 1m) 0 20	Geology	Alteration	0	20		comment			Length	* Angle	0	2
0.0														(<u>-10.56</u>	13.02		
20.0														(14.42	14.61		
40.0														48.08	19.97		
60.0														<u>\49.28</u>	25.05		
80.0														(89.17	23.66		
100.0										4							
120.0		*****									Book upit A		/Increased,				
140.0						\square			-		altered section		fracturing.	141.50 145.00	23 25		
160.0		*****					-				classified as fine grained dioritoid	V	fracture freq. and				
100.0		~~~~~						E			in pseudogeology		pseudo alteration	(171.30	(73		
180.0														171.40	31		
									+					191.30	21		
200.0		****								X	Rock unit B.	11		205.40	30		
220.0									•	T	Mainly classified as		Increased	212.50	55		
			<u>.</u>						+		quartzmonzodiorite		fracturing. Partly				
240.0										ţ	pseudogeology	ŧ	alteration.				
260.0						\equiv	***		-			X	fracture freq. and				
						$ \rightarrow$			-		Rock unit A.		Low-Grade,	-			
280.0									+		altered section classified as fine	V	ductile				
300.0											grained dioritoid		Increased				
							Ļ	E	+		pooddogoology		alteration.				
320.0							┝──		+			$\left \right $	Increased pseudo				
340.0										T			pseudo alteration.				
							L		+								
360.0							Ē							364.80	(36		
380.0						\neg								381.50	(47		
							00000	F-						383.30	30		

400.0	r				IT I						395.60	(71		
400.0		.		\square	ll I									
	*****			\square						Partly increased	409.20	31		
	^^^^^				\square					fracturing Lloour				
420.0		L								fracturing. Heavy				
										alteration.				
										Slightly increased				
440.0	*****			\square						olightly increased				
440.0				\vdash	· · · · ·					pseudo fracture				
	*****			\parallel		┋┿╸┼			V	freg. and clear	447.90	11		
								Rock unit B	1	indication of	450.90	<u>21</u>		
460.0		3						Rock unit D.		indication of				
			e e e e e e e e e e e e e e e e e e e		-			mainly classified		pseudo alteration.				
		ì				F		as						
480.0				Ħ	\vdash			quartzmonzodiorite						
					_			in the						
500.0								pseudogeology						
500.0						2								
		-		\vdash		5					510 40	13		
520.0		-		\dashv	1	r								
	~~~~	L	· · · ·	$\vdash$										
	~~~~				-									
540.0		<u> </u>			l I									
			, , , , , , , , , , , , , , , , , , ,							Partly increased	542.40	20		
	×××××		,							fracturing Partly				
560.0	~~~~			⊨						how alteration		(70		
000.0				\vdash	lf			1		Death in a	561.10	52		
1	*****						+	1		Partly increased				
	[]	E				<u>, </u>		1		pseudo fracture	L			
580.0	XXXXX							1		freq and pseudo	219.30	01	1	
1		-						1		altoration	590.60	46		
							-	1		alteration.	330.00	10		
600.0							+	1		Low Crode				
1								1	1	Low-Grade,				
1								1	1	ductile				
620.0					1			1	I	\shear-zone				
020.0								r	Ŧ	Partly increased				
	*****						+		1	any increased	628.20	34		
040.0										tracturing. Partly				
640.0										heavy alteration.				
										Increased pseudo				
										increased pseudo				
660.0		L		\dashv						fracture freq. and				
				$ \rightarrow $						pseudo alteration.	667.40	47		
				⊢	-					Increased		-		
680.0										increased				
000.0									L	tracturing.				
					<u> </u>				X	Partly increased				
700.0									T	nseudo fracture				
700.0								Rock unit C			703.50	16		
					m			onom high		freq. and pseudo				
								anom. nigh		alteration.				
720.0					\vdash			density, low susc.		Low-Grade	720.00	58		
								at 703-720 m.		duatile				
		2			\succ	F		classified as fine		ductile				
740.0								classified as fille		shear-zone.				
		-				5 I I		grained		Increased				
					-			diorite-gabbro in		fracturing				
760.0								the		Deaths in one of a				
700.0						2		neeudeneelemu	V	Partly increased				
		-			1			pseudogeology		pseudo fracture				
		2		$ \rightarrow $						freg and pseudo				
780.0		-								alteration				
1								1						
1	lanal	1						1		Low-Grade,				
800.0		-					+	1		ductile			1	
		2	÷			<u>, </u>		1		shear-zone			1	
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820.0		-		\square			+	1		Low-Grade,				
1	×××××					-		1		ductile				
1								r	1	shear-zono	834 70	66		
840.0	h	P					\rightarrow			Decude	838.40	21		
	*****					<u> </u>				rseudo				
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940.0 960.0 980.0		- 			-			Rock unit C.			(985.70	(40		

Т	itle	GEOI	LOGI	CAL SINC	GLE HOLE I	INTI	RPF	RETAT	ION	N				-	KSH	01B	
	51	í B	Site Bore Diam Leng Bear Inclin Date	hole neter [mm] th [m] ing [°] nation [°] of mapping	SIMPEVARP KSH01B 75 100.250 177.76 -87.88 2003-03-13 14:4	6:00	Co No Ea: Dr Dr Plo	ordinate orthing [m] sting [m] evation [n illing Sta illing Sta of Date	Syste 1] n.a.s.l rt Dat p Dat	m .] te e	RT90-RHB70 6366014.03 1552442.89 5.20 2003-01-17 12:00:00 2003-01-27 19:00:00 2004-03-15 21:03:26		Script Name \$\$6	cript			
R	Qua	artz monzodio	orite		PSEUDO ALTER	RATION oxid thres	h			RC	OCK UNIT A Rock unit dominated by q of fine-grained granite, pe	uart gma	z monzodiorite (quartz monzonite to atite and sparsely porhyritic Ävrö gra	monzodiorite) nite (granite to	, with subo o quartz mo	rdinate sections onzodiorite)	
										R	OCK UNIT B Rock unit dominated by fi with subordinate sections fine- to medium-grained of	ne-g of q	rained dioritoid (fine-grained, interm uartz monzodiorite (quartz monzonii te, pegmatite and fine-grained diorite	ediate, magm e to monzodio to gabbro (fi	atic rock) prite), ne-grained	matic rock)	
										R	DCK UNIT C Rock unit characterized b and quartz monzodiorite (medium-grained granite, and pegmatite.	y a r quai med	mixture of sparsely porphyritic Ävrö (rtz monzonite to monzodiorite), with ium- to coarse-grained granite, fine-	granite (granite subordinate s grained diorite	e to quartz ections of f e to gabbro	monzodiorite) ine- to finely (fine-grained ma	fic rock)
R	OCK ALTE	RATION			ALTERATION IN Faint Weak	TENSIT	Y			R	OCK UNIT D Rock unit dominated by s with subordinate sections gabbro (fine-grained mafi	pars of fil c roc	ely porphyritic Ävrö granite (granite t ne- to finely medium-grained granite k), pegmatite and diorite to gabbro	o quartz mon: , fine-grained	zodiorite), diorite- to		
	Oxic	dized								RA	ADAR						
										*,	Angle to borehole axis						
	<u> </u>					<u> </u>						Γ	DOCCIDI	-			
DEP	гн	I	BORE	MAP DA	ТА	(JEO	LOGY			ROCK UNIT		DEFORMATION	LE I ZONE	s	F	ZI
Dept	th Rock	k Rock	Rock Alteration	Frac	ctures	Pseudo	Pseudo	Pseudo Fra Frequer (fractures	acture ncy s/m)		Comment		Comment	RA	DAR	F	ZI
1m:50	Dm	Alteration	Intensity	0 20	0 20	Geology	Alteration	0	20					Length	* Angle	0	2
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			-											(10.0			
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								E+			quartz monzodiorite			55.2	(21		
60.0	D																
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