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Oskarshamn site investigation

Correlation of Posiva Flow Log anomalies to core mapped features in KLX09, KLX09B–G, KLX10, KLX10B–C and KLX11A–F

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Abstract

In the boreholes KLX09, KLX09B–G. KLX10, KLX10B–C and KLX11A–F the difference flow logging and core mapping with the Boremap system were conducted during 2005 and 2006. These data have been used to identify individual geological mapped features as fractures or crush zones that correspond to flow anomalies identified with the Posiva Flow Log/ Difference Flow (PFL) method.

A few general results of the Boremap are shown in Tables I, III and V and corresponding anomalies in Tables II, IV and VI. In several cases a flow anomaly can be connected to several fractures if they are close to the anomaly. In most of these cases, it may be one of the interpreted fractures, some of them, or even all of them that correspond to the anomaly.

Table I. Boremap data for the PFL-s (5 m sequential measurements) measured interval in KLX09, KLX09B–E.

Object	KLX09	KLX09B	KLX09C	KLX09D	KLX09E
Measured interval in the borehole with PFL-s (m)	102.0–871.45	12.6–97.6	15.50–117.00	12.91–117.91	13.87–114.40
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	1,953 (80 / 982 / 891)	171 (4 / 46 / 121)	226 (19 / 71 / 136)	304 (32 / 82 / 190)	278 (27 / 66 / 185)
Mean fracture frequency of **open fractures** (fractures/m)	2.54	2.01	2.23	2.90	2.77
No of **partly** open fractures mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	6 (4 / 2 / 0)	1 (1 / 0 / 0)	0 (0 / 0 / 0)	6 (6 / 0 / 0)	2 (0 / 2 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.008	0.012	0.000	0.057	0.020
No of **crush zones** in the PFL-s measured interval	27	3	1	0	2
Appr. No of fractures in **crush zones** assuming 40 fractures/m	271.90	8.80	2.50	–	36.08
Mean No of fractures in a **crush zone**	10.07	2.93	2.50	–	18.04
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (fractures/m)	2.90	2.13	2.25	2.95	3.14
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	1,244 (932 / 303 / 1)	381 (381 / 0 / 0)	457 (457 / 0 / 0)	493 (493 / 0 / 0)	654 (654 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	3.51	4.48	4.50	4.70	6.51

Table II. Flow anomalies in KLX09, KLX09B–E.

Object	KLX09	KLX09B	KLX09C	KLX09D	KLX09E
Measured interval in the borehole with PFL-s (m)	102.0–871.45	12.6–97.6	15.50–117.00	12.91–117.91	13.87–114.40
Total No of PFL-f anomalies ("Certain"+"Uncertain")	68	44	36	41	34
No of **PFL-f anomalies** mapped as **"Certain"**	47	32	22	37	25
No of **PFL-f anomalies** mapped in **crush zones**	16	3	1	0	3
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.088	0.518	0.355	0.390	0.338
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	27 / 16	3 / 3	1 / 1	0 / 0	2 / 2
Mean frequency of crush zones with PFL-f anomalies	0.59	1.00	1.00	0.00	1.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy					
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	62	41	35	30	33
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	3	2	1	10	1
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0	0	0	1	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	2	0	0	0	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0	0 / 1	0 / 0	0 / 0	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	1 / 0	0 / 0	0 / 0	0 / 0	0 / 0

Table III. Boremap data for the PFL-s (5 m sequential measurements) measured interval in KLX09F–G. KLX10, KLX10B–C.

Object	KLX09F	KLX09G	KLX10	KLX10B	KLX10C
Measured interval in the borehole with PFL-s (m)	9.90–146.53	22.3–92.58	102.13–993.21	10.73–43.50	9.75–139.75
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	312 (43 / 89 / 180)	265 (12 / 128 / 125)	583 (142 / 117 / 324)	496 (261 / 103 / 132)	374 (24 / 101 / 249)
Mean fracture frequency of **open fractures** (fractures/m)	2.28	3.77	0.65	15.14	2.88
No of **partly** open fractures mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	4 (4 / 0 / 0)	1 (1 / 0 / 0)	11 (7 / 3 / 1)	10 (9 / 0 / 1)	1 (1 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.029	0.014	0.012	0.305	0.008
No of **crush zones** in the PFL-s measured interval	0	0	26	7	0
Appr. No of fractures in **crush zones** assuming 40 fractures/m	0.00	0.00	437.76	40.88	0.00
Mean No of fractures in a **crush zone**	0.00	0.00	16.84	5.84	0.00
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (fractures/m)	2.31	3.78	1.16	16.69	2.88
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	683 (683 / 0 / 0)	449 (449 / 0 / 0)	3,239 (3,238 / 0 / 1)	229 (229 / 0 / 0)	1,101 (1,101 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	5.00	6.39	3.63	6.99	8.47

Table IV. Flow anomalies in KLX09F–G, KLX10, KLX10B–C.

Object	KLX09F	KLX09G	KLX10	KLX10B	KLX10C
Measured interval in the borehole with PFL-s (m)	9.90–146.53	22.3 –-92.58	102.13–993.21	10.73–43.50	9.75–139.75
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	43	42	191	24	25
No of **PFL-f anomalies** mapped as **“Certain”**	35	28	105	19	21
No of **PFL-f anomalies** mapped in **crush zones**	0	0		5	4
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.315	0.598	0.214	0.732	0.192
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	0 / 0	0 / 0	26 / 15	7 / 2	0 / 0
Mean frequency of crush zones with PFL-f anomalies	0.00	0.00	0.58	0.29	0.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy					
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	21	36	182	24	20
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	20	5	5	0	4
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	2	0	0	0	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0	1	0	0	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0

Table V. Boremap data for the PFL-s (5 m sequential measurements) measured interval in KLX11A.

Object	KLX11A
Measured interval in the borehole with PFL-s (m)	101.53–985.12
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	1,072 (54 / 418 / 600)
Mean fracture frequency of **open fractures** (fractures/m)	1.21
No of **partly** open fractures mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	2 (0 / 2 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.002
No of **crush zones** in the PFL-s measured interval	14
Appr. No of fractures in **crush zones** assuming 40 fractures/m	74.80
Mean No of fractures in a **crush zone**	5.34
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (fractures/m)	1.30
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	4,278 (4,274 / 3 / 1)
Mean fracture frequency of **sealed fractures** (fractures/m)	4.84

Table VI. Flow anomalies in KLX11A.

Object	KLX11A
Measured interval in the borehole with PFL-s (m)	101.53–985.12
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	66
No of **PFL-f anomalies** mapped as **“Certain”**	41
No of **PFL-f anomalies** mapped in **crush zones**	9
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.075
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	14 / 8
Mean frequency of crush zones with PFL-f anomalies	0.57
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	61
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	2
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	1
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

Table VII. Boremap data for the PFL-s (5 m sequential measurements) measured interval in KLX11B–F.

Object	KLX11B	KLX11C	KLX11D	KLX11E	KLX11F
Measured interval in the borehole with PFL-s (m)	4.18–94.26	5.66–115.73	12.55–112.54	2.00–115.28	3.37–113.38
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	156 (4 / 41 / 111)	125 (8 / 30 / 87)	187 (22 / 69 / 96)	202 (12 / 36 / 154)	120 (20 / 17 / 93)
Mean fracture frequency of **open fractures** (fractures/m)	1.73	1.14	1.87	1.78	1.09
No of **partly** open fractures mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	0 (0 / 0 / 0)	0 (0 / 0 / 0)	0 (0 / 0 / 0)	0 (0 / 0 / 0)	0 (0 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.000	0.000	0.000	0.000	0.000
No of **crush zones** in the PFL-s measured interval	2	0	0	0	2
Appr. No of fractures in **crush zones** assuming 40 fractures/m	2.40	0.00	0.00	0.00	7.48
Mean No of fractures in a **crush zone**	1.20	0.00	0.00	0.00	3.74
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (fractures/m)	1.76	1.14	1.87	1.78	1.16
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	249 (249 / 0 / 0)	308 (308 / 0 / 0)	445 (445 / 0 / 0)	453 (452 / 1 / 0)	293 (293 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	2.76	2.80	4.45	4.00	2.66

Table VIII. Flow anomalies in KLX11B–F.

Object	KLX11B	KLX11C	KLX11D	KLX11E	KLX11F
Measured interval in the borehole with PFL-s (m)	4.18–94.26	5.66–115.73	12.55–112.54	2.00–115.28	3.37–113.38
Total No of PFL-f anomalies ("Certain"+"Uncertain")	37	41	49	37	24
No of **PFL-f anomalies** mapped as **"Certain"**	33	31	40	32	16
No of **PFL-f anomalies** mapped in **crush zones**	2	0	0	0	
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.411	0.372	0.490	0.327	0.218
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	2 / 2	0 / 0	0 / 0	0 / 0	2 / 2
Mean frequency of crush zones with PFL-f anomalies	1.00	0.00	0.00	0.00	1.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy					
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	36	39	47	33	21
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	0	1	1	4	1
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0	0	0	0	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	1	0	0	0	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0	1 / 0	0 / 0	0 / 0	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0	0 / 0	0 / 1	0 / 0	0 / 0

Contents

Appendices attached on CD

1 Introduction

The difference flow logging and core mapping with the Boremap system in the core drilled borehole, KLX09, KLX09B–G. KLX10, KLX10B–C and KLX11A–F within Laxemar local model area near Oskarshamn, Sweden, were conducted during 2005 and 2006. The locations of the boreholes within the Oskarshamn area are shown in Figure 1-1.

The results from the Posiva Flow Log/Difference Flow (PFL) method were reported in /Sokolnicki and Väisäsvaara 2006, Sokolnicki 2006, Sokolnicki and Kristiansson 2007, Väisäsvaara et al. 2006a,b/ and /Väisäsvaara et al. 2007/.

Data from the PFL, Boremapping and BIPS images were received from the SICADA database.

Boremap-PFL anomaly correlation for other boreholes are presented in /Forssman et al. 2005a,b, Teurneau et al. 2007, Wikström et al. 2007a,b/ and /Forsmark et al. 2007/.

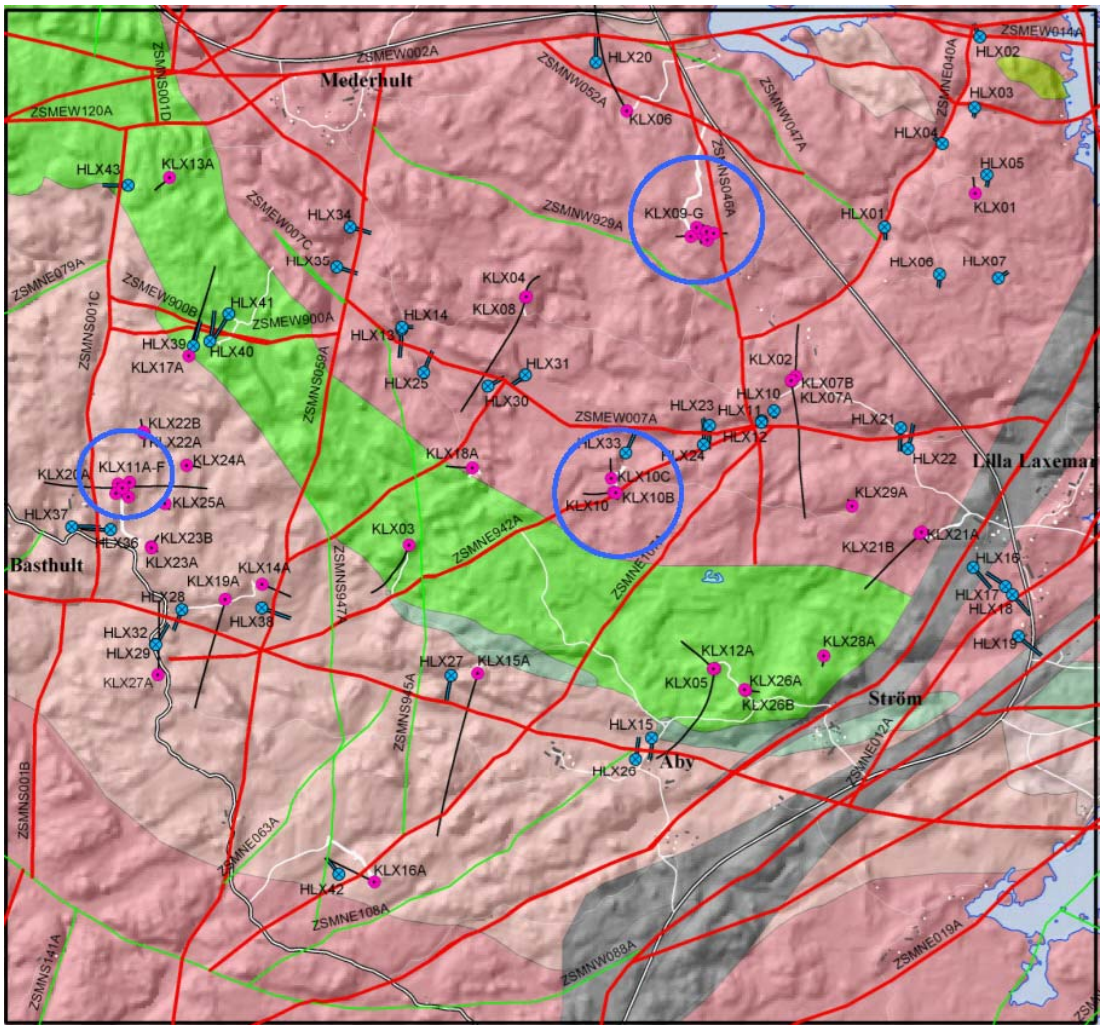


Figure 1-1. *Location of core-drilled boreholes KLX09, KLX09B–G. KLX10, KLX10B–C, KLX11A–F within Laxemar local model area.*

2 Objective and scope

The main objective for the work leading to this report was to identify which geological features mapped as fractures or crush zones that correspond to flow anomalies identified with the Posiva Flow Log/Difference Flow (PFL) method.

The identification of these geological features was made in 16 cored boreholes KLX09, KLX09B–G, KLX10, KLX10B–C and KLX11A–F within Laxemar local model area.

The results are presented in this report and have also been delivered as a database to SKB (indicated as “database” in text below).

3 Methodology

Hydraulically conductive features (flow anomalies) have been correlated to mapped geological features (fractures and/or crush zones). Below, the interpretation methodology is described.

Data used:

1) Boremap data.
2) BIPS images with BDT-files showing mapped features as fractures, crush, foliation etc.
3) Interpretation of Posiva Flow Logg (PFL) anomalies from the overlapping measurements.

3.1 Boremap data

The cored boreholes are documented by geological mapping of the core, using the Boremap system and a borehole image of the borehole wall from BIPS (Borehole Image Processing System). All borehole loggings, including BIPS, are length corrected to facilitate correlation between core data and logging data.

3.1.1 Length correction

During drilling, marks are made in the borehole wall approximately every 50 m. These marks are used to make length corrections of all borehole logging and borehole mapping. A Calliper tool fitted to the logging unit is used to get a reference for the length correction.

3.1.2 BIPS and BDT files

The Boremap data of geological features in SICADA can be superimposed in the BIPS image using a file with extension BDT. The image of the borehole wall from the BIPS-file may deviate cm-dm from the trace shown with the BDT file, due to that linear correction is made between the drilling marks. In the figures and tables in the appendices it is always the corrected length ("Adjusted secup", not "Secup") in Boremap data that is compared to the PFL flow anomaly position.

It should be noted that the features seen in the BIPS image with traces according to the BDT-file does not only correspond to fractures; rock contacts etc. are displayed in the same way and there is, unfortunately, no indication on the lines of which type of object that is shown.

BIPS resolution, with SKB standard logging procedure, is in the vertical direction approximately 1 mm and in the horizontal direction 0.66 mm in a borehole with diameter 76 mm, the lower detection limit is thus more or less 1 mm. However, sometimes apertures are set to a value within 0.5–1.0 mm for "open" and "partly open" fractures when the geologist estimates the aperture from the BIPS image and the core. In these cases the fracture may be mapped as "1=visible in BIPS" or "0= not visible in BIPS" in column VISIBLE_IN_BIPS(code). The aperture in percussion holes are also estimated from BIPS and should normally be 0 (sealed) or 1 mm or larger. In some cases the geologist has even for percussion holes estimated apertures as small as 0.5 mm.

3.1.3 Boremap and core mapping

Each mapped fracture is first documented as “Broken” or “Unbroken” – depending on how it is found in the core. Each fracture is then classified as “Sealed”, “Open” or “Partly open” and with a judgement of how certain the geologist is of this classification: “Certain”, “Probable” or Possible”. Some old boreholes are mapped according to the Petrocore system and in such cases only unbroken/broken can be used to separate sealed and (possibly) open fractures.

In more detail, the following is made during mapping:

1. If the fracture splits the core it is mapped as broken, otherwise unbroken
2. If an aperture is seen in BIPS and the core is unbroken, the fracture is mapped as partly open. If an aperture is seen in BIPS and the core is broken the fracture is mapped as open. The aperture is mapped in BIPS and is intended to represent an approximate mean aperture (mean aperture as seen on the borehole wall, may not have much to do with hydraulic aperture).
3. Sometimes when the core is broken no aperture is seen in BIPS. If the core pieces fit badly the aperture is set to 0.5 mm and the fracture is mapped as open and probable. If it is a good fit between the pieces and the surfaces are not fresh, the aperture is set to 0.5 mm and the fracture is mapped as open and possible. If there is a good fit between the pieces and the surfaces are fresh, the aperture is set to 0 mm and the fracture is mapped as sealed.

Generally, it is not possible to see in the BIPS picture if a certain fracture is open or not. Some fractures look quite open in the picture, but the database says they are sealed and sometimes even unbroken. Therefore only the information available in the data file is used to determine if a fracture is open or sealed. When evaluating the pictures the focus has been on the ones mapped as “open” in the database, therefore it has not been controlled that all fractures who are said to be “Visible in BIPS” really are visible and the other way around. It is possible to find open, possibly flowing, fractures said to be “Visible in BIPS” which cannot be found in the BIPS picture. These cases have been noted in the appendices. Concerning “Visible in BIPS”, the mapping geologist has had better possibilities to identify fracture traces in the BIPS image than people involved in this report.

In the appendix pictures, the resolution is not quite as good as in the BIPS pictures seen using the computer. The pictures in the appendices are also slightly smaller than on the computer screen and include white correlation lines and the arrows we have added. The white correlation line makes it even harder to see if a fracture looks open or not in the appendices (but, as mentioned above, the fracture trace may sometimes not be seen on the computer screen using only the BIPS pictures without the white correlation lines).

It should be quite easy to find the fractures in the database if the appendix pictures are used. In the picture itself, the information about strike, dip and adjusted secup can be found. The adjusted secup could, though, be hard to get if the fracture has high amplitude. Using the text associated with the pictures in the appendix, it should not be a problem, because all fractures correlated to the anomaly are listed in adjusted secup order. **The adjusted secup for a fracture is the mean value of the sinusoidal fracture trace, with all points along the trace expressed as adjusted secup coordinates**. Sometimes there are small deviations between strike and dip in figures in appendix B and in Boremap data mainly due to round off in the BDT-data. It is the values in Boremap data that should be considered as the correct ones.

Due to updates of the borehole orientations and BIPS-tool orientation during 2007 there may also be some difference (generally very small) in the figures in Appendices for the fracture orientation compared to the ones in the database, as updated BIPS images were not available for this evaluation.

3.2 PFL data

After a sequential flow logging (PFL-s) in 5 m sections, flow logging with 1 m section by moving the 1 m section in steps of 0.1 m (PFL-f) is made in PFL-s sections above the measurement limit. See e.g. /Sokolnicki and Väisäsvaara 2006/, for details.

3.2.1 Position in the borehole of the flow anomaly

The PFL data and corrections made are in detail described in e.g. /Sokolnicki and Väisäsvaara 2006/.

Accurate length scale of measurements is difficult to achieve in long boreholes. The main cause of inaccuracy is stretching of the logging cable. The stretching depends on the tension of the cable that in turn depends, among other things, on the inclination of the borehole and on the friction of the borehole wall. The cable tension is higher when the borehole is measured when the cable is moving upward. The cables, especially new ones, may also stretch out permanently.

The length marks in the borehole wall (occurring approximately every 50 m) are detected with the SKB calliper tool. The length scale is firstly corrected according to these length marks. Single point resistance (SPR) is also recorded simultaneously with the calliper logging.

Since SPR is recorded during all measurements, all flow measurement sequences can then be length corrected by synchronising the SPR results with the original calliper/SPR measurement.

In spite of the length correction described above, there are still length errors due to following reasons:

1) Point interval in flow measurements is 0.1 m in overlapping mode. This could cause an error +/– 0.05 m.
2) The length of the test section is not exact. The specified section length denotes the distance between the nearest upper and lower rubber disks. Effectively, the section length can be longer. At the upper end of the test section there are four rubber disks. The distance between these is 5 cm. This will cause rounded flow anomalies, there may be detected flow already when a fracture is between the upper rubber disks. These phenomena can only be seen with short step length (0.1 m). This could cause an error of +/– 0.05 m.
3) Corrections between the length marks can be other than linear. This could cause error +/– 0.1 m in the calliper/SPR measurement.
4) SPR curves may be imperfectly synchronized. This could cause error +/– 0.1 m

In the “worst case”, the errors of points 1, 2, 3 and 4 above are summed up. The total estimated error for geological features located far from a length mark would then be +/– 0.3 m.

Near the length marks the situation is slightly better. In the “worst case”, when the errors of points 1, 2, and 4 above are summed up, the total estimated error would be +/– 0.2 m for geological features located near a length mark.

Accurate location is important when different measurements are compared, for instance if the flow logging and BIPS are compared. In that case the situation may not be as severe as the worst case above since parts of the length errors are systematic and the length error is nearly constant for fractures near each other. However, the error of point 1 is of random type.

Fractures nearly parallel with the borehole may also be problematic. Fracture location may be difficult to accurately define in such cases.

3.2.2 Flow anomaly uncertainty

The existence of a flow anomaly is sometime uncertain and in such a case the anomaly is marked ”uncertain” in the database and in the appendices.

3.3 Correlation of Boremap data and PFL anomalies

Assumptions:

- As a first assumption, the open and partly open fractures as well as crush zones are assumed to be possible flowing features.
- It is assumed that the precision of the position (LA) in the borehole of the PFL-anomaly is not on the dm level. If an open, partly open fracture or crush zone is within ±0.5 m of a PFL-anomaly, it is assumed that it can correspond to the PFL-anomaly (in a few cases larger differences have been accepted). The parameters added to the database are;
  - **PFL anom (1):** An index set to 1 if geological features possibly can be associated to a PFL-f anomaly (one or several fractures (or crush) are documented as possible flowing features.)
  - **PFL anom. No.:** Sequential numbering of PFL-f flow anomalies, starting with 1 for the uppermost flow anomaly in a specific borehole.
  - **PFL-anom.Confidence:** Judgement of how close (on a dm-scale) the nearest part of the sinusoidal fracture trace is to LA.
  - **PFL-Deviation fr. L:** The actual deviation (on a dm-scale) of the fractures Adjusted_ Secup from LA (defined positive if the fracture is located below LA).
  - **PFL Confidence:** Certain or uncertain, based on PFL measurements.
  - **Best Choice fracture and Alternative Best Choice fracture:** The most likely fracture/ crush among the features noted in **PFL anom (1) (**“one or several fractures (or crush) are documented as possible flowing features”) that can be associated to a PFL-f anomaly; see below for definition.
- A few **sealed fractures** have been indicated in some boreholes as possible flowing features if the core has been broken AND adjusted secup (Boremap) ≈ LA (Borehole length) for the PFL anomaly AND that no open fracture was <0.6 m from LA, OR that the nearest open fracture is positioned closer than 0.6 m but very well matches another anomaly. When interpreting these broken/sealed fractures, usually only the ones located +/– 0.1 m from the anomaly has been mapped. However, in rare occasions, when there are no other opportunities, fractures located at a longer distance have been chosen. These fractures are considered to be very uncertain and may be excluded from the analysis. “PFL anomaly Confidence” is set to zero (0) in the database for these cases (Example 1 and 2).
- Frequently, several **open fractures** are within ±0.2 m of LA for the PFL-anomaly and it is judged that one or all of them may be flowing features. If “FRACT_INTERPRET” is used in the database, the “Certain, Probable, Possible” can be used to judge if one fracture may be more likely to be a flowing feature. (See also the “Best Choice”-discussion below.) In a few cases, the mapped open fractures are so close (< 1 cm) that possibly one could consider them as one fracture. In some cases where open fractures have been identified within ±0.2 m of LA, there may be more open fractures at a distance ±0.2–0.5 m that are not included in the database as possible flowing features.

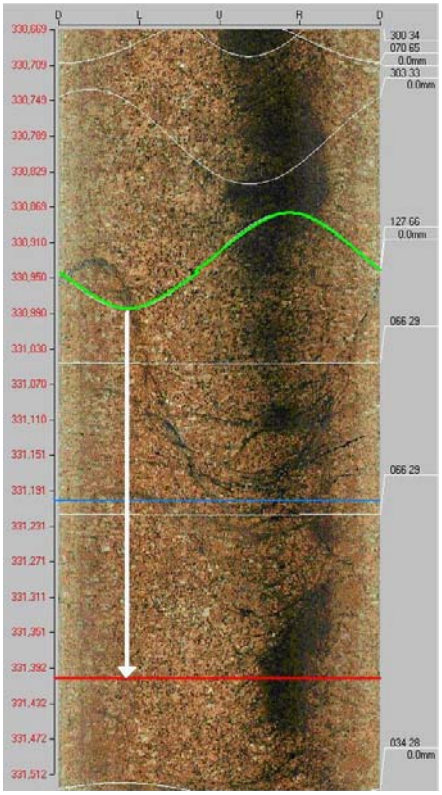
PFL-anom. Confidence

Example 1: KLX06. PFL anomaly no 108

Bh-length, LA (for PFL-anomaly) = 331.40 m (red line)
Adjusted secup (for fracture) = 330.93 m
PFL-anom. confidence = 5

The green line marks the open fracture closest to the anomaly. Since the distance between LA and the adjusted secup is >0,4 m (white arrow), PFL-anomaly confidence is set to 5 and Deviation to –5. Confidence is measured from the nearest trace of the fracture, while Deviation is measured from the adjusted secup to LA.

In a few cases the when the fracture trace have not been shown in the BIPS image, the PFL-anom. Confidence is set to PFL-Deviation fr. L, but without sign.



Example 2: KLX09B. PFL anomaly no 5

Bh-length, LA (for PFL-anomaly) = 23.80 m
Adjusted secup (for fracture) = 23.84 m
Fract_interpret / Varcode = **sealed /broken**
PFL-anom. confidence = 0
Nearest open fracture secup = 24.13 m

If no open fractures exist in the vicinity (< 0.6 m) of the anomaly, a sealed fracture can be chosen most probable. The attribute should generally be Sealed/broken, indicating a (weak) possibility that it actully can be an open fracture. In a few cases Sealed/unbroken have been used in a few bore-holes but is extremly rare. PFL-anom. Confidence is then 0.

- In some cases several PFL anomalies may be connected to a single geological feature, generally a crush zone but sometimes also an open fracture with a fracture trace with high sinusoidal amplitude. Some PFL-anomalies are located very close to each other Secup-wise; in these cases a fracture with “normal” sinusoidal amplitudes can be correlated to both anomalies. In those cases where a single fracture has been assigned Best choice of several anomalies, a single “1” is put in the core file column for Best Choice fracture and the sequential number of the anomalies are put into the columns bc_seq_no_anom_1, bc_seq_ no_anom_2, and bc_seq_no_anom_3 respectively.

- Some open, possibly flowing, fractures have very high amplitudes, stretching over up to several metres of the borehole wall. These fractures can, because of their shape, have an influence on the flow conditions quite a long distance from the level indicated by the fractures "adjusted secup"-value. When evaluating the data, these fractures have been given a lower "PFL-anomaly confidence" than suggested only by the distance between the fractures adjusted secup and the level of the PFL anomaly. **PFL-anomaly confidence is measured from the nearest trace of the fracture, while Deviation is measured from the adjusted secup to the position LA of the PFL anomaly** (see Example 1). If the fracture cuts the level of the PFL-anomaly, the PFL-anomaly confidence is set to one (1, which is the highest confidence), independent of how long the distance between the adjusted secup value and the level of the anomaly is. To be consequent, some fractures with high amplitudes that **almost** (+/– 0.2 m) cut the PFL-anomaly level have also been included in the analysis. The PFL-anomaly confidence has been set to 2 in these cases, even if the trace is closer than 1 dm from the adjusted secup of the anomaly (Example 3). However, in some cases the PFL-anomaly confidence has been set to 1 if the trace is closer than 1 dm from the adjusted secup of the anomaly.

- For each PFL-anomaly ONE fracture is chosen as the most probable to represent the PFL-anomaly, which is marked as "**Best Choice fracture**" in the data base. The reason for this is that several fractures may represent a single PFL-anomaly according to the criteria stated above. Similar choices are made for crush zones (Best Choice Crush: See Example 4). The choice is made in the following order:

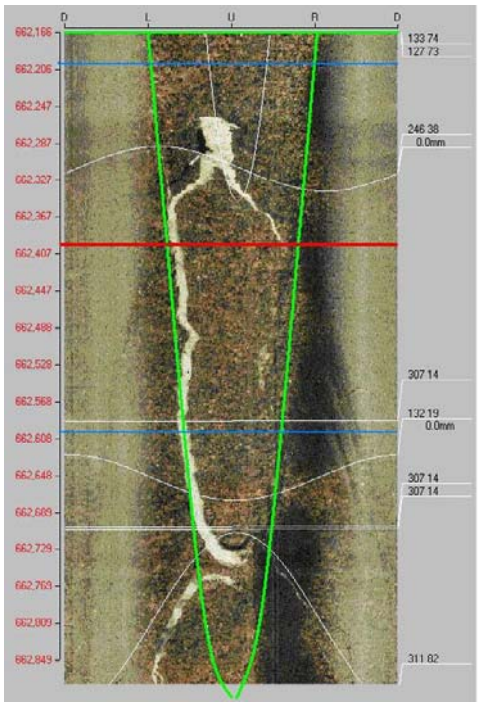
  1. If the aperture of the fracture is **visible** in the BIPS image, mapped as **"open" and "certain"** and the fracture trace for the fracture is within ±0.2 m from the PFL-anomaly, the fracture is chosen. If two or more fractures are at the same distance from the PFL-anomaly, the uppermost listed in the data file is chosen. However, if one LOOKS more plausible viewing the BIPS image, than the other, that one is chosen. This decision is based on the judgement that the chosen fracture´s aperture seems more open than others.
  2. Criterion 1 is not satisfied. If the fractures aperture is **NOT visible** in the BIPS image, mapped as **"open" and "certain"** and that the fracture trace for the fracture is within ±0.2 m from the PFL-anomaly, the fracture is chosen. If two or more fractures are at the same distance from the PFL-anomaly, the uppermost listed in the data file is chosen.
  3. Criteria 1and 2 are not satisfied. If the fractures aperture is **NOT visible** in the BIPS image, mapped as **"open" and "probable"** and that the fracture trace for the fracture is within ±0.2 m from the PFL-anomaly, the fracture is chosen. If two or more fractures are at the same distance from the PFL-anomaly, the uppermost listed in the data file is chosen.
  4. Criteria 1–3 are not satisfied. If the fractures aperture is **NOT visible** in the BIPS image, mapped as **"open" and "possible"** and that the fracture trace for the fracture is within ±0.2 m from the PFL-anomaly, the fracture is chosen. If two or more fractures are at the same distance from the PFL-anomaly, the uppermost listed in the data file is chosen.
  5. Criteria 1–4 are not satisfied. If the fractures aperture is **NOT visible** in the BIPS image, mapped as **"sealed" and "broken"** and that the fracture trace for the fracture is within ±0.2 m from the PFL-anomaly, the fracture is chosen. If two or more fractures are at the same distance from the PFL-anomaly, the uppermost listed in the data file is chosen.
  6. Criteria 1–5 are not satisfied, the nearest of the other identified fractures that possibly corresponds to the PFL-anomaly, is chosen as "Best Choice fracture".

High amplitude

Example 3: KLX03. PFL anomaly no 38

Bh-length, LA (for PFL-anomaly) = 662.40 m
Adjusted secup (for fracture) = 662.17 m
PFL-anom. confidence = 1

The distance between adjusted secup of the fracture (green line on top) and the anomaly (red line) is further away than ±0,2 m (blue lines). However, because of its high amplitude, the fracture cuts the anomaly: PFL-anom. Confidence = 1.



Best choice

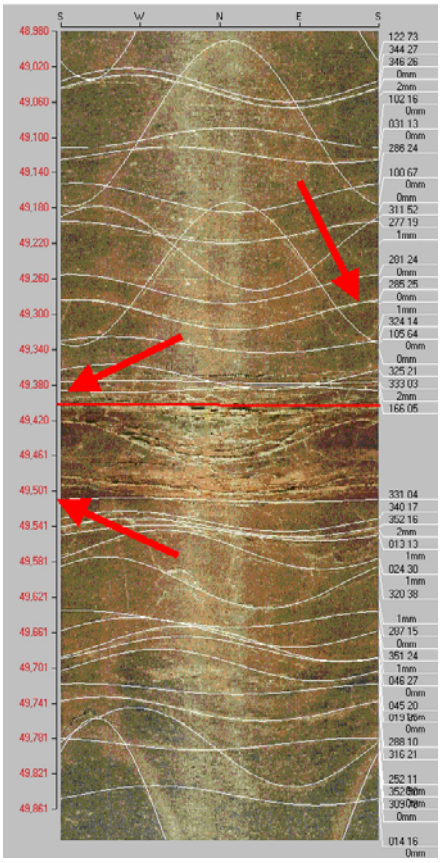
Example 4: KLX09B PFL anomaly no 19

Bh-length LA (for PFL-anomaly) = 49.40 m
Adjusted secup (for fracture) = 49.30 m
Fract_interpret / Varcode = open fracture

Adjusted secup – seclow = 49.38–49.51 m
Fract_interpret / Varcode = crush zone
Best choice crush

In some cases both a fracture and a crush zone is as plausible as an explanation to an anomaly. Then only the crush zone is documented as Best choice (even if they are both within ±0.2 m from the PFL-anomaly). The fracture is noted as “alternative Best Choice”.

The red arrows pointing at the length scale show the secup and seclow of the crush. (Always red arrows for crushs.) The red arrow pointing at the white trace is the Best choice fracture. The red horizontal line is the LA for the flow anomaly.



When the criteria above are considered: **If several fractures with the above attributes are within ±0.2 m from the PFL-anomaly, the fracture closest to the PFL-anomaly is chosen as "Best Choice fracture"** among the features noted in **PFL anom (1) (**"one or several fractures (or crush) are documented as possible flowing features")**. The other fractures are notified in the data base as "alt BC fr".** The number in "alt BC fr" column gives the number of fractures that satisfies the above criteria. (It is thus possible to search for the cases where it is more or less impossible to make a single fracture as "Best Choice fracture".) However, if one LOOKS more plausible viewing the BIPS image, than the other, that one is chosen as **"Best Choice fracture".**.

If a crush zone is present within ±0.2 m from the PFL-anomaly, "**Best Choice crush**" is chosen. If two crush zones are at the same distance from the PFL-anomaly, the uppermost is chosen. In these cases if fractures are documented within crush zone in the fracture data base, they are noted as "alternative Best Choice" in the data file and the crush zone as Best Choice. This choice is made in addition to the "Best Choice Fracture" procedure described above. **The connection between the fractures and the crush zones and which ones are chosen as Best Choice has to be examined by the user of the data base (Example 4).** If several crush zones are within ±0.2 m from the PFL-anomaly, the crush closest to the PFL-anomaly is chosen as "Best Choice crush". The other crush zones are notified in the data base as "alt BC crush". The number in alt BC crush" column gives the number of crush zones that satisfies the above criteria. (It is thus possible to search for the cases where it is more or less impossible to make a single crush zone as "best choice crush".)

Alternative Best choice

Example 5: KLX09F. PFL anomaly no 5c and 5d

Bh-length LA (for PFL-anomaly) = 17.20 m

5c Adjusted secup (for fracture) = 17.37 m
Best choice

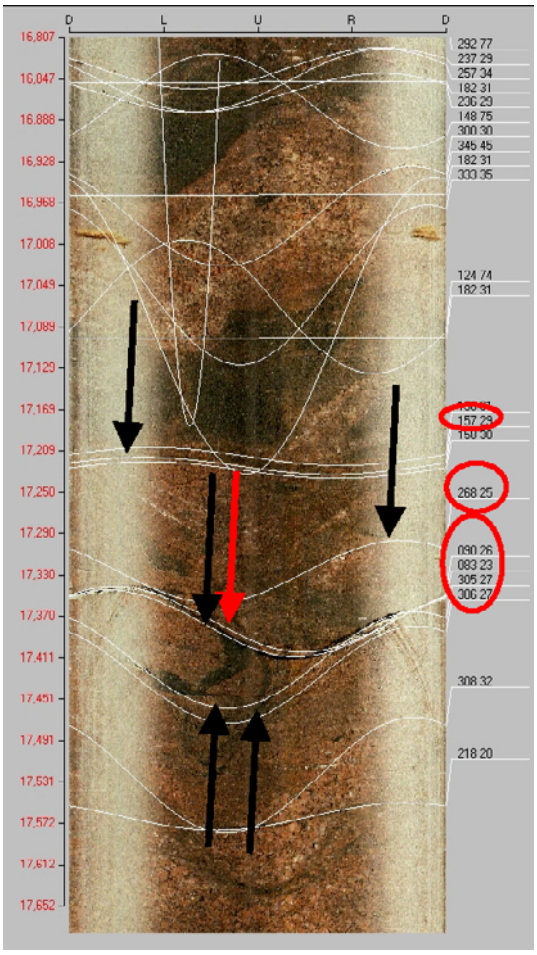
5d Adjusted secup = 17.38 m
Fract_interpret / Varcode = open fracture

Frac.interp. confidence = Certain
PFL-anom. confidence = 2

Two identical fractures, both certain, close to each other and both candidates to be the best choice. This is an obvious case where alternative best choice is assigned.

If 3 fractures carry the same attributes (Fract interpretation, Fract. Confidence, PFL Confidence and Deviation) the upper fracture is chosen Best choice and all of the fractures are given the number 3 as alt. best choice in the database. Thus, the number in column "alt BC fr" can be used to search for these cases and get a view on how frequent "alt BC fr" is and then how many fractures are involved.

Red arrow shows Best Choice. Black arrows are used for Alt-Best choice fractures and possible other fractures. (Alt-Best choice fractures and other possible fractures are for some boreholes not shown in appendices (but in data base) as the figures became less readable due to all the black arrows. Red rings around the orientation indicate the fractures considered possible, including Best choice.)



3.4 Example of data presentation

In Figure 3-1 an example is shown on how parts of the results are presented. Below some comments are made on how to interpret the figure.

3.4.1 Flow indication confidence levels for open fractures (PFL confidence)

The classification of "flow indication level of confidence", equal to the "PFL-anomaly confidence", is defined as the distance between the anomaly and the interpreted fracture trace. That is, if the anomaly has a flow indication in class 1, the interpreted fracture is within 1 dm from the anomaly. In the same way, the anomaly has the flow indication class 2, if the interpreted fracture is within 2 dm from the anomaly. Four classes have been defined;

Class 1 0–1 dm

Class 2 1–2 dm

Class 3 2–3 dm

Class 4 3–4 dm

Class 5 4–5 dm (*not plotted*)

This classification is used in the figures in this report. In the database, only the numbers (1–5) are used to describe the PFL confidence. Features with PFL confidence > 4 are rare and considered to be non-significant and are not plotted in the diagrams as the one with confidence 1–4.

3.4.2 Confidence level open fractures

The confidence level for open fractures describes the certainty with which the fracture is interpreted. In this report, three levels of confidence in the SICADA database are used;

Level 1 Certain

Level 2 Probable

Level 3 Possible

3.4.3 Database nomenclature

The interpretation of how the PFL anomalies are linked to mapped fractures or crush has been added to the original Boremap and PFL anomaly files provided by SKB. In Tables 3-1 to 3-4 the structure and explanations are shown.

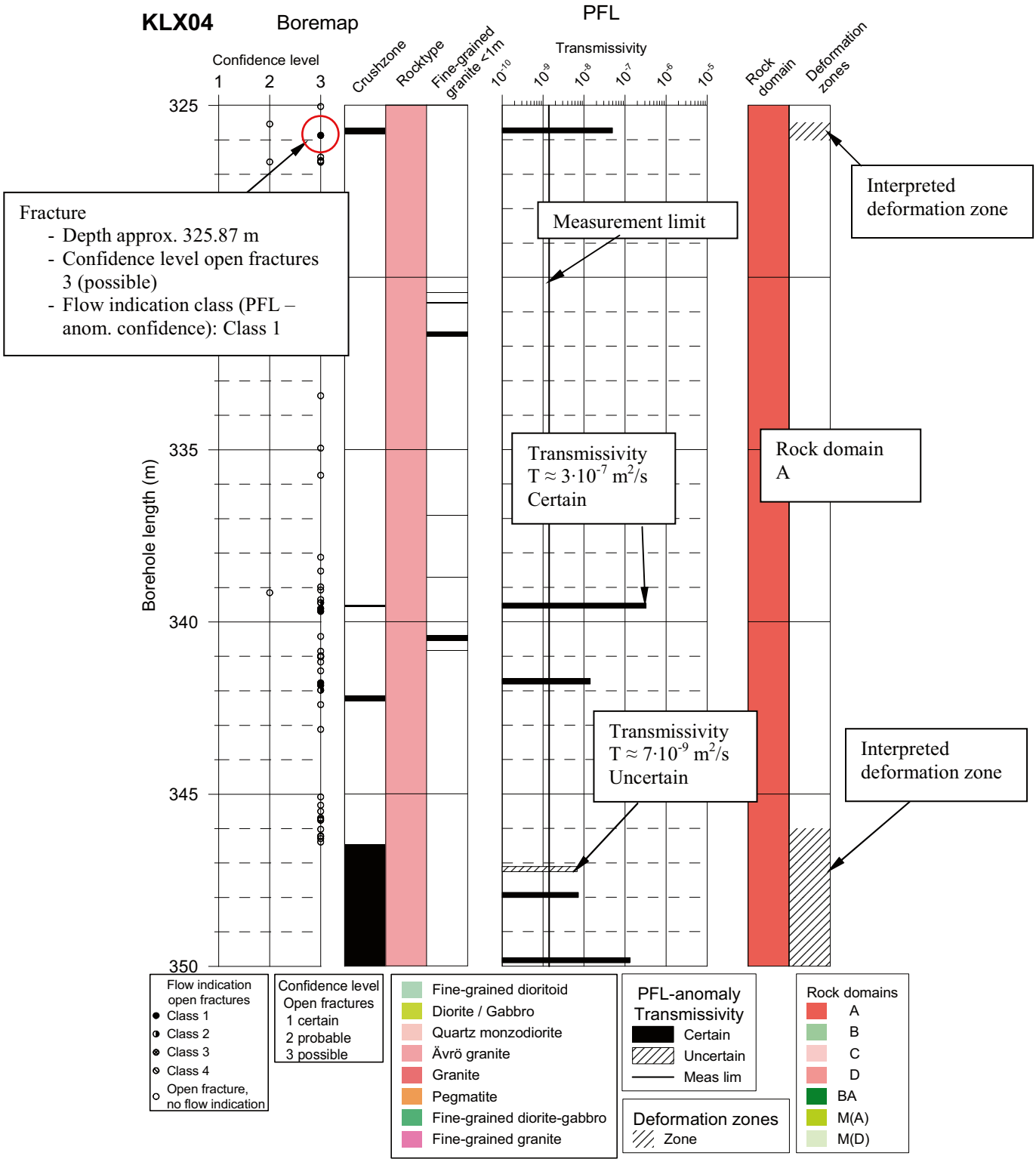


Figure 3-1. *Example of a borehole diagram including an interpretation of the flow anomalies and mapped open fractures.*

Table 3-1. Structure of essential columns in the database of fractures.

No	Column name in database	Content	Originally in Boremap file	Interpre-tation of PFL anomalies
1	FRACT_MAPPED	Broken/ Unbroken, as found in core.	X	
2	FRACT_INTERPRET	Sealed/ Open/ Partly open, judgement by the geologist.	X	
3	FRACT_INTERPRET No	1=Sealed/ 2=open/ 3= partly open . For Petrocore data: 1= Unbroken (assumed be sealed), 4= Broken, can probably be assumed to be open.		(added sorting No)
4	APERTURE (mm)	Estimation of aperture from BIPS image.	X	
5	VISIBLE_IN_BIPS (code)	1= Visible in BIPS / 0=Not visible in BIPS.	X	
6	CONFIDENCE	Certain/ Probable/ Possible, judgement by the geolgist of the interpretation of FRACT_INTERPRET.	X	
7	CONFIDENCE No	1=Certain/ 2=Probable/ 3=Possible, based on CONFIDENCE for the fracture.		(added sorting No)
8	PFL anom (1)	An index set to 1 if geological features possibly can be associated to a PFL-f anomaly (one or several fractures (or crush) are documented as possible flowing features.)		X
9	PFL-anom. No	PFL No in the PFL-f-anomaly file that is used together with the IDCODE for the borehole to identify PFL-f-anomaly properties. (Sequential numbering of PFL-f flow anomalies, starting with 1 for the uppermost flow anomaly in a specific borehole.)		X
10	PFL-anom. Confidence	A number showing the **shortest distance in dm between the geological features trace and the PFL-f anomaly position LA**. If =0 then it is a sealed fracture that is broken or unbroken that is linked to the PFL-f anomaly and the interpretation is considered uncertain.		X
11	PFL-Deviation fr. L (+ downwards, dm)	A number showing the distance in dm between the **geological features adjusted secup and the position LA** of the PFL-f anomaly. **If positive** it indicates that the **geological feature is below the PFL-f anomaly.**		X
12	PFL-CONFIDENCE	Certain/ Uncertain, judgement by the performer and reporter of the PFL-f measurements how certain the interpreted PFL-f anomaly was.		X
14	PFL-CONFIDENCE No	1=Certain/ 2= Uncertain, based on PFL-CONFIDENCE.		X
15	Best Choice frac	The fracture that most probable corresponds to a PFL-f-anomaly is given No=1 (BC: Best Choice).		X
16	Alt BC fr	If several fractures of the same character are within ± 0.2 m from the PFL-f-anomaly that could be chosen as “Best Choice fracture”, the observation is notified with a number in the column, and the number indicates how many fractures that could be chosen as “Best Choice fracture”.		X
17	ADJUSTEDSECUP (m)	The mid point of a feature trace that generally has a sinusoidal shape on the BIPS image.	X	
18	STRIKE (degrees)	Strike of the fracture.	X	
19	DIP (degrees)	Dip of the fracture.	X	

Table 3-2. Structure of essential columns in the database of crush zones.

No	Column name in database	Content	Originally in Boremap file	Interpre-tation of PFL anomalies
1	VARCODE	Crush Zone	X	
8	PFL anom (1)	An index set to 1 if geological features possibly can be associated to a PFL-f anomaly (one or several fractures (or crush) are documented as possible flowing features.)		X
9	PFL-anom. No	PFL No in the PFL-f-anomaly file that is used together with the IDCODE for the borehole to identify PFL-f-anomaly properties. (Sequential numbering of PFL-f flow anomalies, starting with 1 for the uppermost flow anomaly in a specific borehole.)		X
10	PFL-anom. Confidence	A number showing the **shortest distance in dm between the geological features trace and the PFL-f anomaly position LA**.		X
11	PFL-Deviation fr. L (+ downwards, dm)	A number showing the distance in dm between the **geological features adjusted secup and the position LA** of the PFL-f anomaly. **If positive** it indicates that the **geological feature is below the PFL-f anomaly.**		X
12	PFL-CONFIDENCE	Certain/ Uncertain, judgement by the performer and reporter of the PFL-f measurements how certain the interpreted PFL-f anomaly was.		X
14	PFL-CONFIDENCE No	1=Certain/ 2= Uncertain, based on PFL-CONFIDENCE.		(added sorting No)
15	Best Choice crush	The crush that most probable corresponds to a PFL-anomaly is given No=1		X
16	Alt BC crush	If several crush are within ± 0.2 m from the PFL-anomaly that could be chosen as “Best Choice crush”, the observation is notified with a number in the column, and the number indicates how may crush zones that could be chosen as “Best Choice crush.		X
17	ADJUSTEDSECUP (m)	The mid point of the upper part of the crush zone trace that generally have a sinusoidal shape on the BIPS image.	X	
18	ADJUSTEDSECLOW (m)	The mid point of the lower part of the crush zone trace that generally has a sinusoidal shape on the BIPS image.	X	
19	STRIKE (degrees)	Strike of first fracture set.	X	
20	DIP (degrees)	Dip of first fracture set.	X	

Table 3-3. Structure of essential columns in the database of PFL anomalies.

No	Column name in database	Content	Originally in PFL-anomaly file	Interpre-tation of PFL anomalies
1	PFL-anom. No	PFL No in the PFL-f-anomaly file that is used together with the IDCODE for the borehole to identify PFL-f-anomaly properties. (Sequential numbering of PFL-f flow anomalies, starting with 1 for the uppermost flow anomaly in a specific borehole.)		x
2	LA	Position if flow anomaly along the borehole (same starting coordinate as for “secup, seclow in fracture and crush files).	X	
3	TRANSMISSIVITY_TDA	Estimated transmissivity of flow anomaly.	X	
4	VALUE_TYPE_TDA	0: value within range for test equipment. –1: value at or below measurement limit, +1 value at or above measurement limit.	X	
5	PFL-CONFIDENCE	Estimation of how certain the existence of the flow anomaly is		(based on column comments)
6	PFL-CONFIDENCE No	Index based on PFL-CONFIDENCE		(added sorting No)

4 KLX09

The borehole KLX09 was measured in May and June 2006. It was flow logged with PFL using 5 m test sections in borehole section interval 95.77 to 871.45 m (PFL-s). Upper most section in the borehole for statistics is the lower position of the cone in the borehole (SUB SECLOW): 102.0 m. Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 68 PFL-anomalies, of which 47 are mapped as "certain". 18 of the anomalies have been correlated to a single fracture. 16 anomalies have been correlated to the borehole sections mapped as crush zones.

Strike and dip are not defined for fractures close to anomalies 1 (106.5 m), 57 (535.2 m) and 62 (540.8 m).

At anomalies 30 (256.1 m) and 31 (258.5 m) open fractures are only present at distances larger than 6 dm from the anomaly.

At anomaly 35 (270.6 m) one open structure is visible in BIPS but fractures defined as Broken, Open, in the BOREMAP data is present at distances larger than 4 dm. A Broken, Sealed, fracture was chosen.

At anomaly 56 (533.7 m) one fracture does not have a BDT trace defined in the BIPS image and the fracture is not visible in the BIPS image.

At anomaly 62 (540.8 m) strike or dip is not defined.

At anomaly 68 (755.9 m) the BIPS image is blurry and does not present information for fractures within the area.

Table 4-1. Boremap data for the PFL-s measured interval in KLX09.

Object	KLX09
Measured interval in the borehole with PFL-s (m)	102.0–871.45
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	1,953 (80 / 982 / 891)
Mean fracture frequency of **open fractures** (fractures/m)	2.54
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	6 (4 / 2 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.008
No of **crush zones** in the PFL-s measured interval	27
Appr. no of fractures in **crush zones** assuming 40 fr./m	271.90
Mean no of fractures in a **crush zone**	10.07
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	2.90
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	1,244 (932 / 303 / 1)
Mean fracture frequency of **sealed fractures** (fractures/m)	3.51

Table 4-2. Flow anomalies in KLX09.

Object	KLX09
Measured interval in the borehole with PFL-s (m)	102.0–871.45
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	68
No of **PFL-f anomalies** mapped as **“Certain”**	47
No of **PFL-f anomalies** mapped in **crush zones**	16
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.088
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	27 / 16
Mean frequency of crush zones with PFL-f anomalies	0.59
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	62
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	3
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	2
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	1 / 0

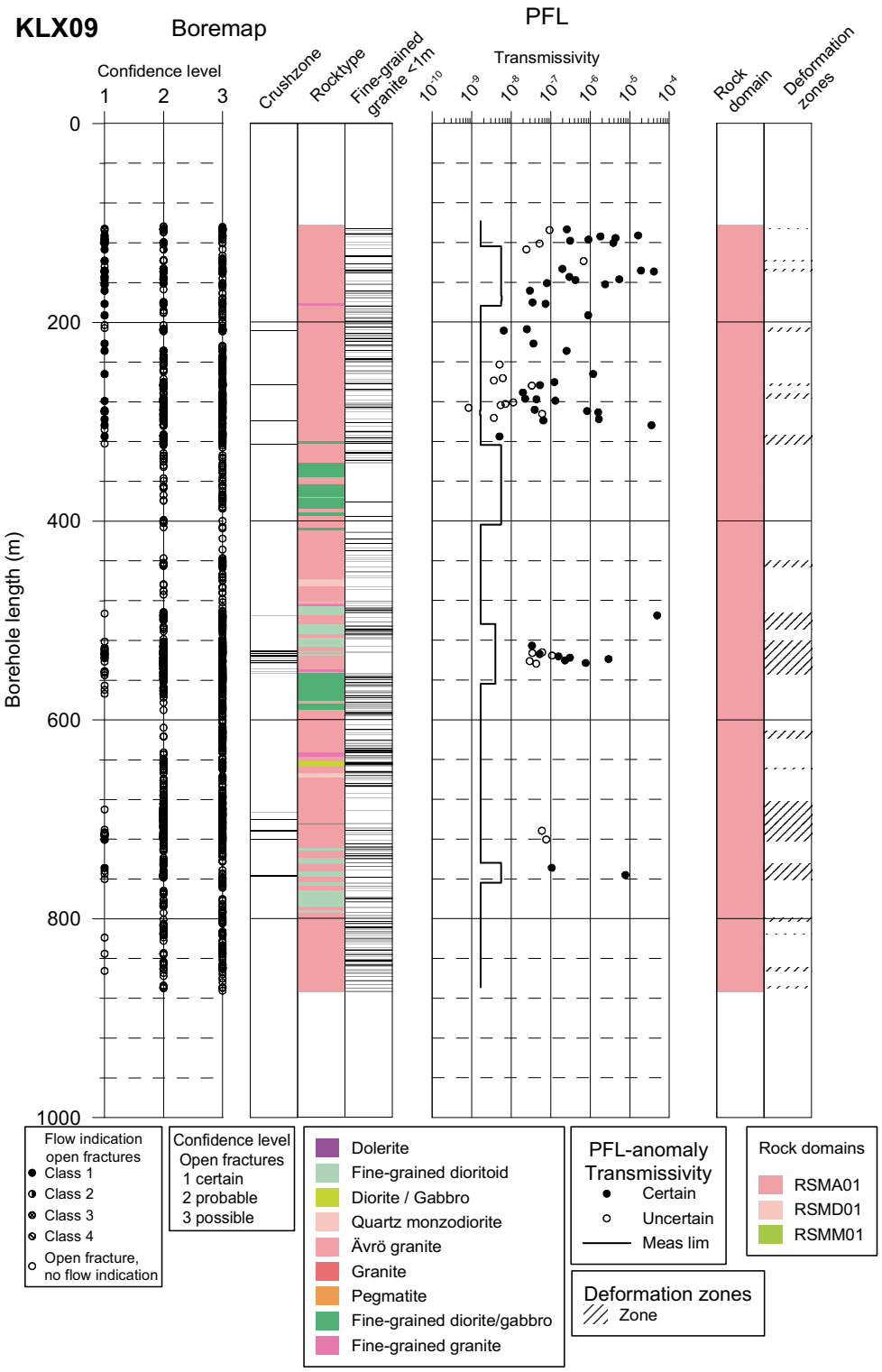


Figure 4-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX09. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

5 KLX09B

The borehole KLX09B was measured in February, March and April 2006 in a joint campaign with the boreholes KLX09C–F. It was flow logged with PFL using 5 m test sections in borehole section interval 12.6 to 97.6 m (PFL-s). Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 44 PFL-anomalies, of which 32 are mapped as "certain". 15 of the anomalies have been correlated to a single fracture. Three anomalies have been correlated to the borehole sections mapped as crush zones.

At anomaly no. 5 (23.8 m) an Unbroken, Sealed fracture was chosen Best choice since the nearest open fracture was correlated to another anomaly.

At anomaly no. 36 (uncertain anomaly) a fracture defined as Possible has been chosen before one defined as Probable, since the latter was better fitting anomaly no. 35 (certain anomaly).

In two cases fractures with PFL-anom. Confidence > 2 have been chosen best choice: Anomalies no. 21 and 26, both with Confidence 3.

Table 5-1. Boremap data for the PFL-s measured interval in KLX09B.

Object	KLX09B
Measured interval in the borehole with PFL-s (m)	12.6–97.6
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	171 (4 / 46 / 121)
Mean fracture frequency of **open fractures** (fractures/m)	2.01
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	1 (1 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.012
No of **crush zones** in the PFL-s measured interval	3
Appr. no of fractures in **crush zones** assuming 40 fr./m	8.80
Mean no of fractures in a **crush zone**	2.93
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	2.13
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	381 (381 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	4.48

Table 5-2. Flow anomalies in KLX09B.

Object	KLX09B
Measured interval in the borehole with PFL-s (m)	12.6–97.6
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	44
No of **PFL-f anomalies** mapped as **“Certain”**	32
No of **PFL-f anomalies** mapped in **crush zones**	3
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.518
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	3 / 3
Mean frequency of crush zones with PFL-f anomalies	1.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	41
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	2
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 1
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

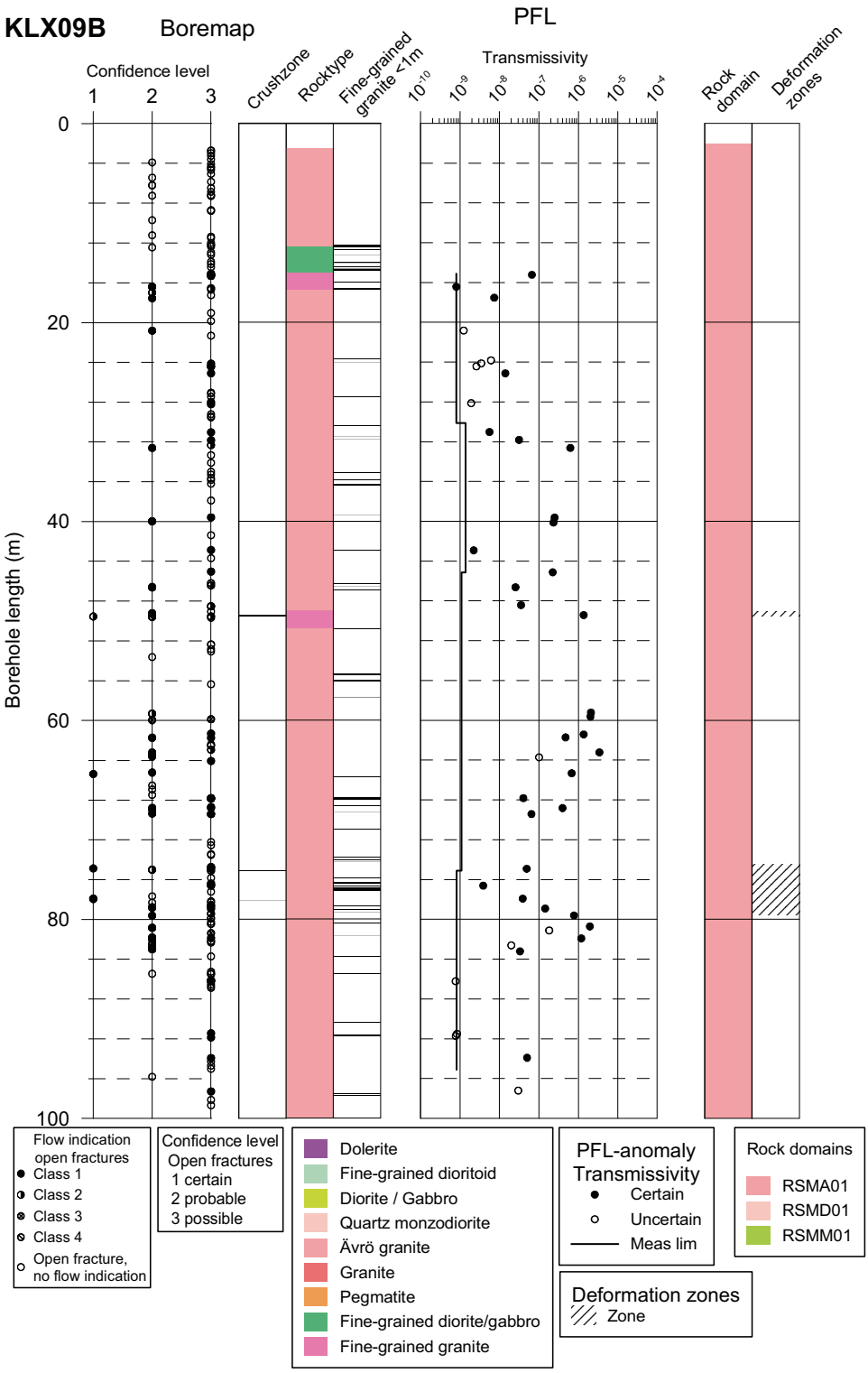


Figure 5-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX09B. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

6 KLX09C

The borehole KLX09CB was measured in February, March and April 2006 in a joint campaign with the boreholes KLX09B, and KLX09D–F. It was flow logged with PFL using 5 m test sections in borehole section interval 16.36–116.36 m (PFL-s). Upper most section in the borehole for statistics is the uppermost position of a flow anomaly in the borehole: 15.5 m Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 36 PFL-anomalies, of which 22 are mapped as “certain”. 10 of the anomalies have been correlated to a single fracture. One anomaly has been correlated to the borehole sections mapped as crush zone.

In one case a fracture with PFL-anom. Confidence > 2 has been chosen best choice: Anomaly no. 36 with Confidence 3. The transmissivity of the anomaly was considerable (6.32E–5 m^2/s) and the chosen fracture had greater aperture and was judged more obvious.

At anomaly no. 33 (certain anomaly) a fracture defined as Possible has been chosen before one defined as Probable, since it was bigger, closer and more visible. Also at anomaly no. 34 (uncertain anomaly) a fracture defined as Possible has been chosen before one defined as Probable.

There is one sealed fracture at adjusted secup 74.96 m where Confidence has not been defined. No anomaly was correlated to it. In the statistics this is counted as a Certain.

Table 6-1. Boremap data for the PFL-s measured interval in KLX09C.

Object	KLX09C
Measured interval in the borehole with PFL-s (m)	15.50–117.00
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	226 (19 / 71 / 136)
Mean fracture frequency of **open fractures** (fractures/m)	2.23
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	0 (0 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.000
No of **crush zones** in the PFL-s measured interval	1
Appr. no of fractures in **crush zones** assuming 40 fr./m	2.50
Mean no of fractures in a **crush zone**	2.50
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	2.25
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	457 (457 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	4.50

Table 6-2. Flow anomalies in KLX09C.

Object	KLX09C
Measured interval in the borehole with PFL-s (m)	15.50–117.00
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	36
No of **PFL-f anomalies** mapped as **“Certain”**	22
No of **PFL-f anomalies** mapped in **crush zones**	1
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.355
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	1 / 1
Mean frequency of crush zones with PFL-f anomalies	1.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	35
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	1
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

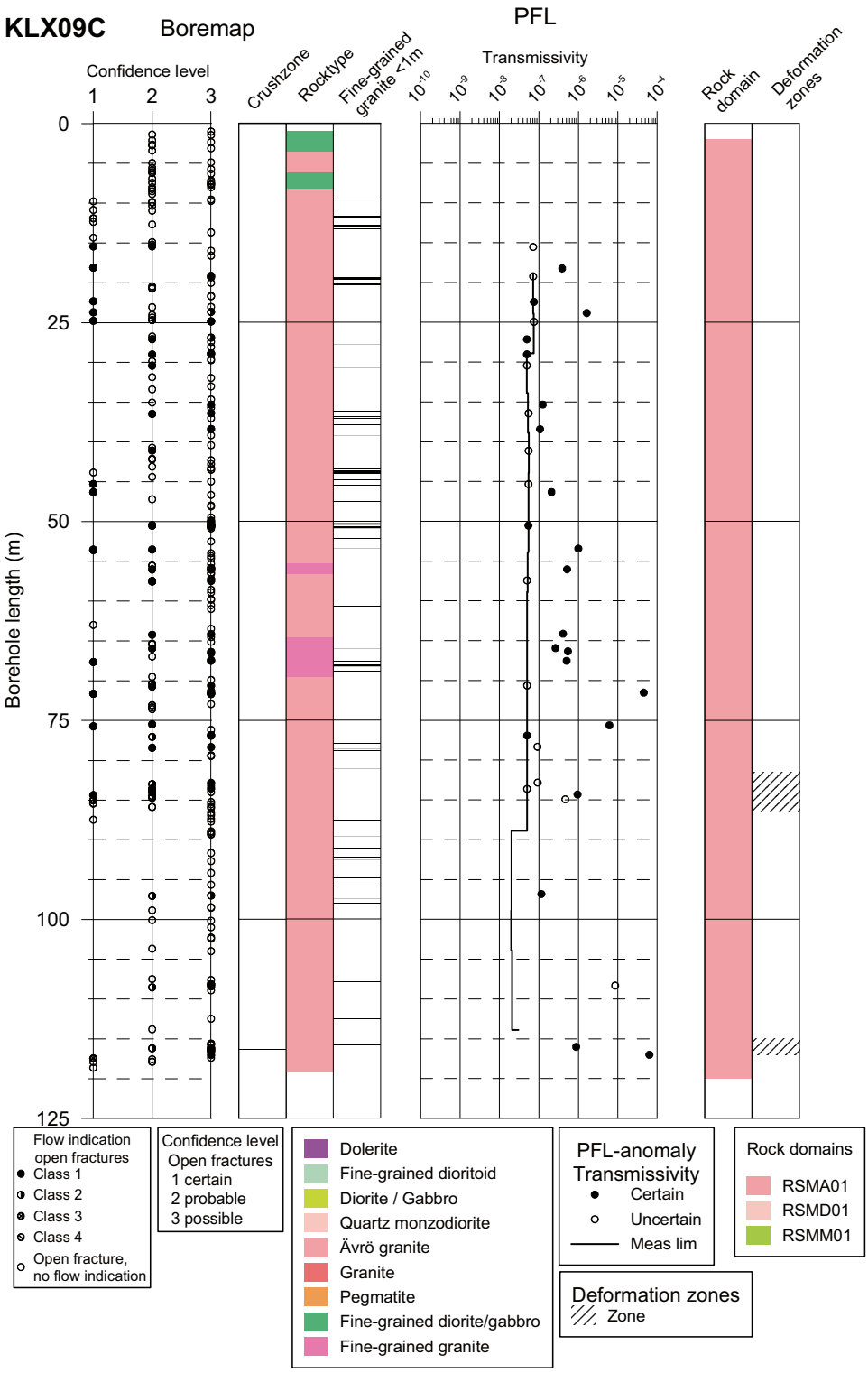


Figure 6-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX09C. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

7 KLX09D

The borehole KLX09C was measured in February, March and April 2006 in a joint campaign with the boreholes KLX09B–C, and KLX09E–F. It was flow logged with PFL using 5 m test sections in borehole section interval 12.91–117.91 m (PFL-s). Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 41 PFL-anomalies, of which 37 are mapped as "certain". 16 of the anomalies have been correlated to a single fracture. No anomalies have been correlated to the borehole sections mapped as crush zones.

In several cases fractures with PFL-anom. Confidence > 2 has been chosen Best Choice: Seven Best Choices with Confidence 3, three Best Choices with Confidence 4 and one Best Choice with Confidence 5. In most cases this depends on the lack of closer alternatives. However, at anomalies no. 17 and 21 fractures with PFL-anom. Confidence 3 have been chosen because they had Confidence Certain unlike other fractures that were closer to the anomaly secup. In both cases the transmissivity was exceptionally high and the fractures chosen Best Choice had exceptionally big Apertures.

There is one sealed fracture at adjusted secup 86.97 m where Confidence has not been defined. No anomaly was correlated to it. In the statistics this is counted as a Certain.

At anomaly no. 18 (certain anomaly) a fracture defined as Possible has been chosen before one defined as Probable, since it was closer.

At anomaly no. 19 the strike data differs between the core file data and the BIPS image.

At anomaly no. 29 (certain anomaly) a fracture defined as partly open was chosen alternative Best Choice since it was judged very plausible along side the open fracture chosen Best Choice.

Table 7-1. Boremap data for the PFL-s measured interval in KLX09D.

Object	KLX09D
Measured interval in the borehole with PFL-s (m)	12.91–117.91
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	304 (32 / 82 / 190)
Mean fracture frequency of **open fractures** (fractures/m)	2.90
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	6 (6 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.057
No of **crush zones** in the PFL-s measured interval	0
Appr. no of fractures in **crush zones** assuming 40 fr./m	0
Mean no of fractures in a **crush zone**	0
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	2.95
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	493 (493 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	4.70

Table 7-2. Flow anomalies in KLX09D.

Object	KLX09D
Measured interval in the borehole with PFL-s (m)	12.91–117.91
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	41
No of **PFL-f anomalies** mapped as **“Certain”**	37
No of **PFL-f anomalies** mapped in **crush zones**	0
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.390
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	0 / 0
Mean frequency of crush zones with PFL-f anomalies	0.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	30
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	10
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	1
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

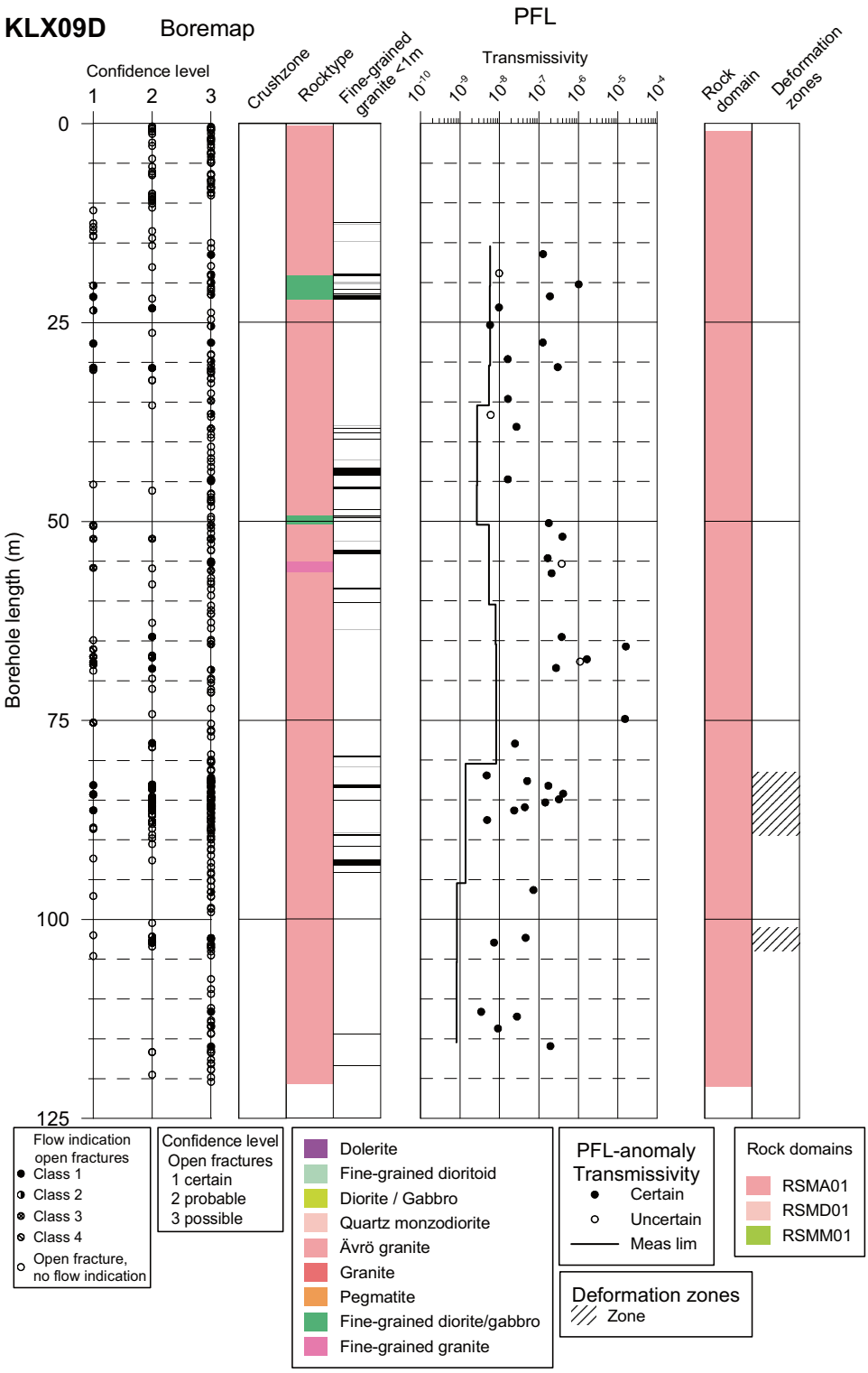


Figure 7-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX09D. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

8 KLX09E

The borehole KLX09E was measured in February, March and April 2006 in a joint campaign with the boreholes KLX09B–D, and KLX09F. It was flow logged with PFL using 5 m test sections in borehole section interval 13.87–113.87 m (PFL-s). Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 34 PFL-anomalies, of which 25 are mapped as "certain". 13 of the anomalies have been correlated to a single fracture. Three anomalies have been correlated to the borehole sections mapped as crush zones.

At anomaly no. 19 (uncertain anomaly) the fracture chosen is missing in the BIPS image.

At anomaly no. 29 (uncertain anomaly) a fracture with PFL-anom. Confidence > 2 (Confidence 3) has been chosen Best Choice because of lack of closer fractures.

Anomaly no. 34 (uncertain anomaly) has been found outside of the PFL-s interval and transmissivity data are missing.

Table 8-1. Boremap data for the PFL-s measured interval in KLX09E.

Object	KLX09E
Measured interval in the borehole with PFL-s (m)	13.87–114.40
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	278 (27 / 66 / 185)
Mean fracture frequency of **open fractures** (fractures/m)	2.77
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	2 (0 / 2 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.020
No of **crush zones** in the PFL-s measured interval	2
Appr. no of fractures in **crush zones** assuming 40 fr./m	36.08
Mean no of fractures in a **crush zone**	18.04
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	3.14
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	654 (654 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	6.51

Table 8-2. Flow anomalies in KLX09E.

Object	KLX09E
Measured interval in the borehole with PFL-s (m)	13.87–114.40
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	34
No of **PFL-f anomalies** mapped as **“Certain”**	25
No of **PFL-f anomalies** mapped in **crush zones**	3
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.338
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	2 / 2
Mean frequency of crush zones with PFL-f anomalies	1.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	33
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	1
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

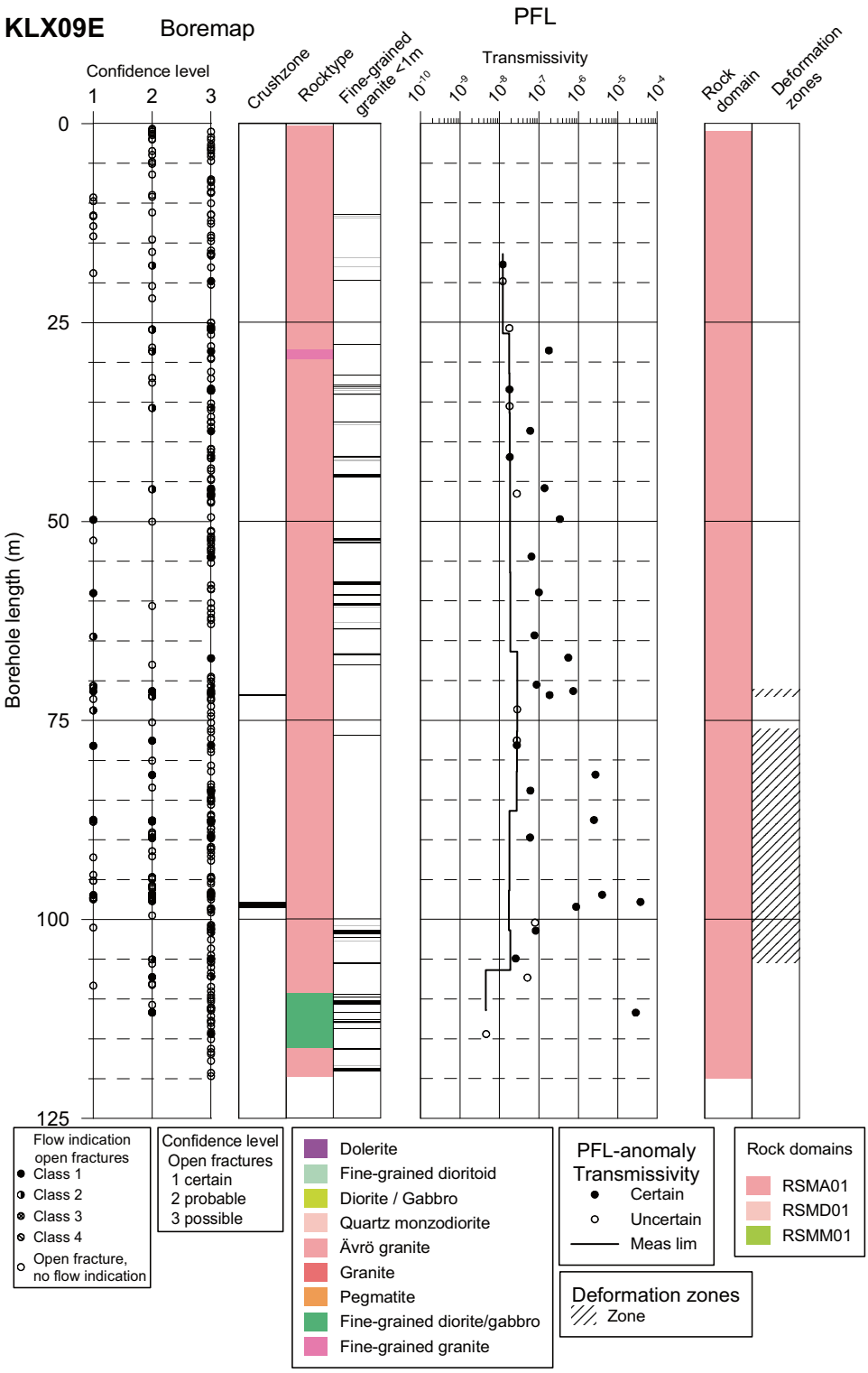


Figure 8-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX09E. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

9 KLX09F

The borehole KLX09F was measured in February, March and April 2006 in a joint campaign with the boreholes KLX09B–E. It was flow logged with PFL using 5 m test sections in borehole section interval 11.53–146.53 m (PFL-s). Upper most section in the borehole for statistics is the uppermost position of a flow anomaly in the borehole: 9.90 m. Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 43 PFL-anomalies, of which 35 are mapped as "certain". 13 of the anomalies have been correlated to a single fracture. No anomalies have been correlated to the borehole sections mapped as crush zones.

The correlation between flowing features and flow anomalies is very good in boreholes KLX09 A to E, while in F we notice a possible displacement. For several consecutive PFL-anomalies (more than ten), plausible /well suitable fractures were found 0.3–0.4 m below the anomaly depth. Considering that no depth adjustment in the bottom was available in these holes, it is possible to explain this mismatching with the lack of depth adjustment. In these cases, assessment of the fractures has been made with the assumption that length observations were displaced 0.1–0.3 m downwards. Examples of this can be seen at anomalies no. 16–20 or 40–42, where fractures with PFL-anom. Confidence 35 have been chosen before closer fractures.

In many cases fractures with PFL-anom. Confidence > 2 has been chosen Best Choice: Eleven Best Choices with Confidence 3, eight Best Choices with Confidence 4 and two Best Choices with Confidence 5.

Table 9-1. Boremap data for the PFL-s measured interval in KLX09F.

Object	KLX09F
Measured interval in the borehole with PFL-s (m)	9.90–146.53
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	312 (43 / 89 / 180)
Mean fracture frequency of **open fractures** (fractures/m)	2.28
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	4 (4 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.029
No of **crush zones** in the PFL-s measured interval	0
Appr. no of fractures in **crush zones** assuming 40 fr./m	0.00
Mean no of fractures in a **crush zone**	0.00
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	2.31
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	683 (683 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	5.00

Table 9-2. Flow anomalies in KLX09F.

Object	KLX09F
Measured interval in the borehole with PFL-s (m)	9.90–146.53
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	43
No of **PFL-f anomalies** mapped as **“Certain”**	35
No of **PFL-f anomalies** mapped in **crush zones**	0
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.315
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	0 / 0
Mean frequency of crush zones with PFL-f anomalies	0.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	21
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	20
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	2
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

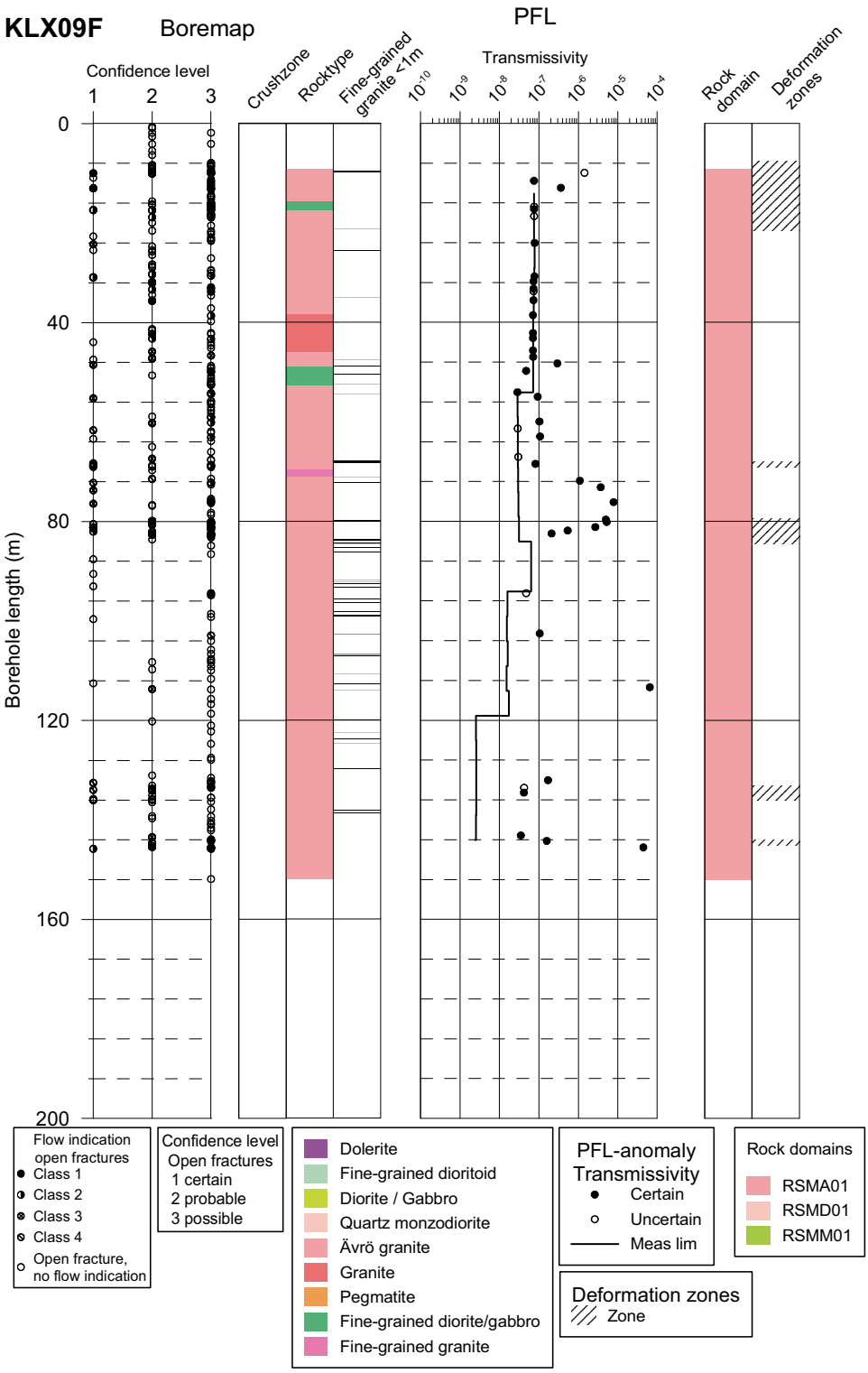


Figure 9-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX09F. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

10 KLX09G

The borehole KLX09G was measured in July 2006. It was flow logged with PFL using 5 m test sections in borehole section interval 22.58 to 92.58 m (PFL-s). Upper most section in the borehole for statistics is the uppermost position of a flow anomaly in the borehole: 22.3 m. Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 42 PFL-anomalies, of which 28 are mapped as "certain". 7 of the anomalies have been correlated to a single fracture. No anomalies have been correlated to the borehole sections mapped as crush zones.

In the vicinity of anomalies 12 (41.5 m) and 13 (41.7 m) a fracture obvious in the BIPS image does not have a trace marked by the BDT file.

At anomalies 38 (71.7 m), 39 (81.6 m), 40 (82.1 m) and 41 (84.5 m) open fractures are only present at distances larger than 3 dm. At anomaly 40 one open fracture is present at a distance larger than 8 dm.

Table 10-1. Boremap data for the PFL-s measured interval in KLX09G.

Object	KLX09G
Measured interval in the borehole with PFL-s (m)	22.3–92.58
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	265 (12 / 128 / 125)
Mean fracture frequency of **open fractures** (fractures/m)	3.77
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	1 (1 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.014
No of **crush zones** in the PFL-s measured interval	0
Appr. no of fractures in **crush zones** assuming 40 fr./m	0.00
Mean no of fractures in a **crush zone**	0.00
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	3.78
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	449 (449 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	6.39

Table 10-2. Flow anomalies in KLX09G.

Object	KLX09G
Measured interval in the borehole with PFL-s (m)	22.3–92.58
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	42
No of **PFL-f anomalies** mapped as **“Certain”**	28
No of **PFL-f anomalies** mapped in **crush zones**	0
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.598
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	0 / 0
Mean frequency of crush zones with PFL-f anomalies	0.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	36
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	5
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	1
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

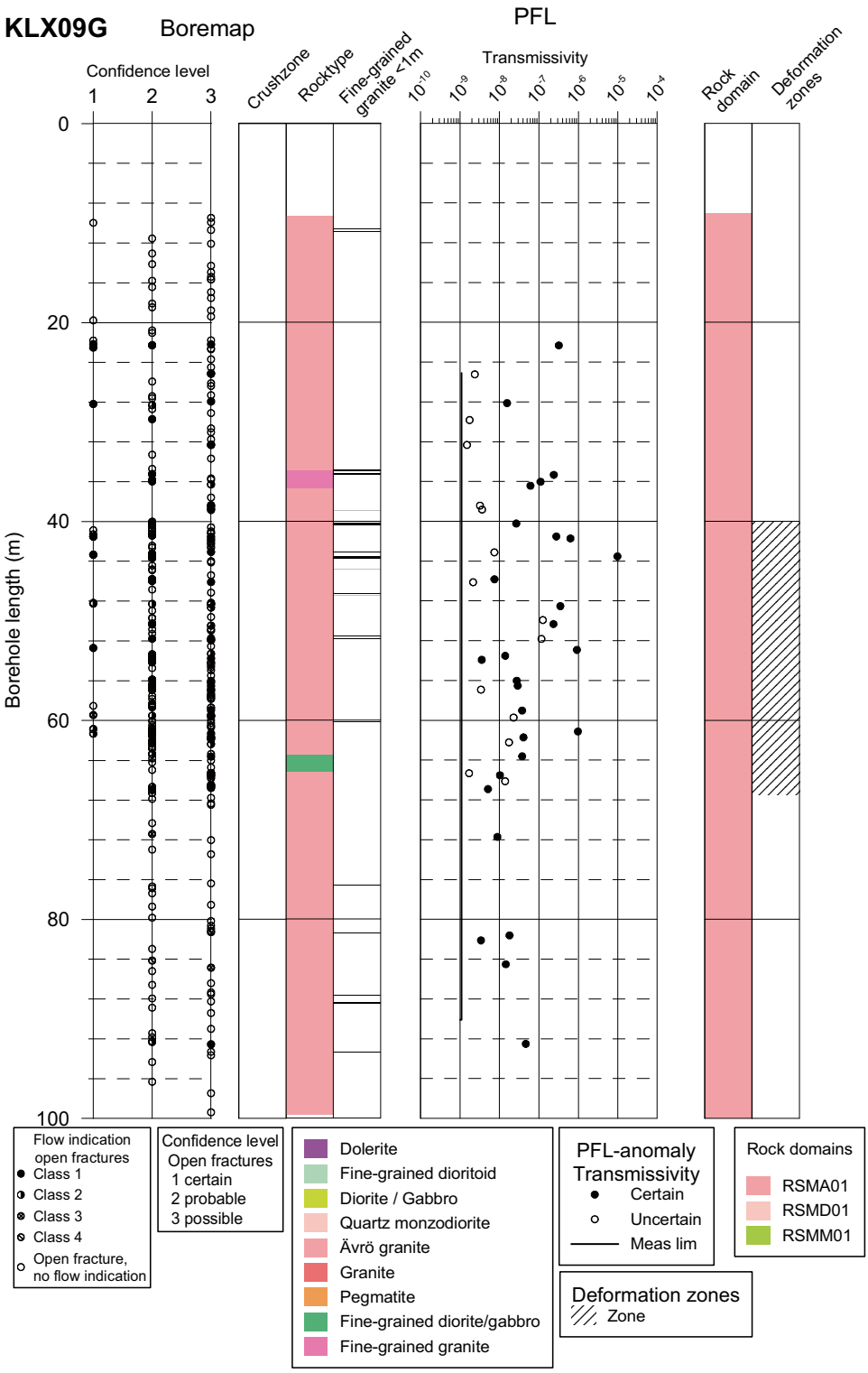


Figure 10-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX09G. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

11 KLX10

The borehole KLX10 was measured in December 2005. It was flow logged with PFL using 5 m test sections in borehole section interval 92.20 to 993.21 m (PFL-s). Upper most section in the borehole for statistics is the lower position of the cone in the borehole (SUB SECLOW): 102.13 m. Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 191 PFL-anomalies, of which 105 are mapped as "certain". 31 of the anomalies have been correlated to a single fracture.

Sixteen (16) anomalies have been correlated to the borehole sections mapped as crush zones. Of these seven (7) anomalies are correlated to both a crush zone and separate fractures.

Anomaly 87 (at 219.9 m) can not be correlated to any fracture.

Anomaly 116 (at 300 m) can not be correlated to any fracture.

Anomalies 133 and 134 (at 336.2 and 336.7 m) can not be correlated to any fracture due to the fact that the borehole wall is stabilized by a steel pipe at that level.

Anomalies 83,182 is correlated to a fracture at a distance > 2 dm due to the absence of other possible fractures.

Table 11-1. Boremap data for the PFL-s measured interval in KLX10.

Object	KLX10
Measured interval in the borehole with PFL-s (m)	102.13–993.21
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	583 (142 / 117 / 324)
Mean fracture frequency of **open fractures** (fractures/m)	0.65
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	11 (7 / 3 / 1)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.012
No of **crush zones** in the PFL-s measured interval	26
Appr. no of fractures in **crush zones** assuming 40 fr./m	437.76
Mean no of fractures in a **crush zone**	16.84
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	1.16
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	3,239 (3,238 / 0 / 1)
Mean fracture frequency of **sealed fractures** (fractures/m)	3.63

Table 11-2. Flow anomalies in KLX10.

Object	KLX10
Measured interval in the borehole with PFL-s (m)	102.13–993.21
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	191
No of **PFL-f anomalies** mapped as **“Certain”**	105
No of **PFL-f anomalies** mapped in **crush zones**	
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.214
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	26 / 15
Mean frequency of crush zones with PFL-f anomalies	0.58
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	182
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	5
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

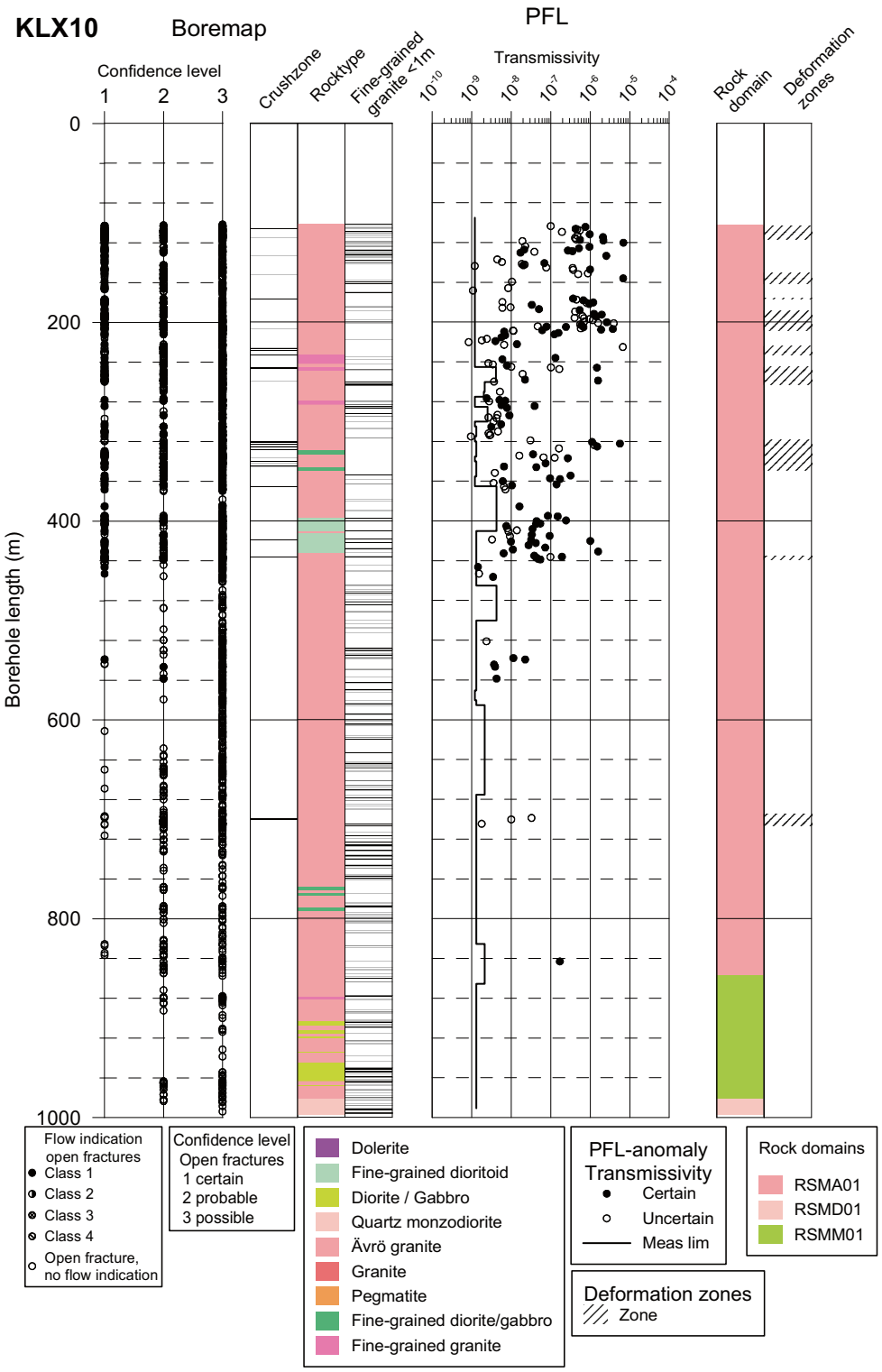


Figure 11-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX10. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

12 KLX10B

The borehole KLX10B was measured in July 2006. It was flow logged with PFL using 5 m test sections in borehole section interval 10.73 to 40.72 m (PFL-s). Lower most section in the borehole for statistics is the lowermost position of a flow anomaly in the borehole : 43.5 m. Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 24 PFL-anomalies, of which 19 are mapped as “certain”. 7 of the anomalies have been correlated to a single fracture.

Two (2) anomalies have been correlated to the borehole sections mapped as crush zones. Both of these anomalies are correlated to both a crush zone and separate fractures.

No transmissivity values have been set for anomalies 19–24.

Table 12-1. Boremap data for the PFL-s measured interval in KLX10B.

Object	KLX10B
Measured interval in the borehole with PFL-s (m)	10.73–43.50
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	496 (261 / 103 / 132)
Mean fracture frequency of **open fractures** (fractures/m)	15.14
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	10 (9 / 0 / 1)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.305
No of **crush zones** in the PFL-s measured interval	7
Appr. no of fractures in **crush zones** assuming 40 fr./m	40.88
Mean no of fractures in a **crush zone**	5.84
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	16.69
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	229 (229 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	6.99

Table 12-2. Flow anomalies in KLX10B.

Object	KLX10B
Measured interval in the borehole with PFL-s (m)	10.73–43.50
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	24
No of **PFL-f anomalies** mapped as **“Certain”**	19
No of **PFL-f anomalies** mapped in **crush zones**	5
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.732
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	7 / 2
Mean frequency of crush zones with PFL-f anomalies	0.29
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	24
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

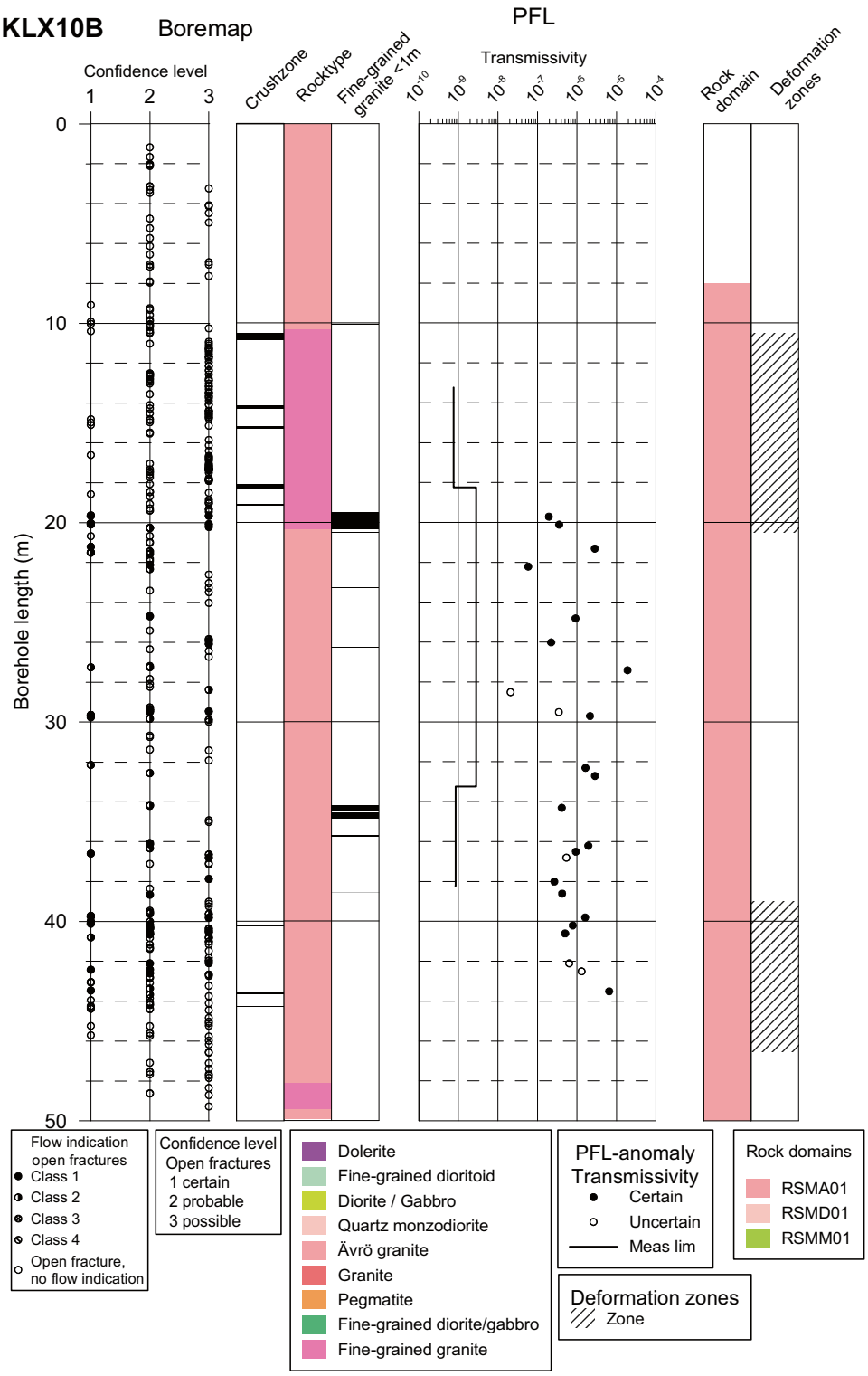


Figure 12-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX10B. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

13 KLX10C

The borehole KLX10C was measured in July 2006. It was flow logged with PFL using 5 m test sections in borehole section interval 9.75 to 139.75 m (PFL-s). Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 25 PFL-anomalies, of which 21 are mapped as “certain”. 12 of the anomalies have been correlated to a single fracture.

No crush zones exist in this borehole.

Anomaly 14 (90.8 m) could not be correlated to any fracture.

Table 13-1. Boremap data for the PFL-s measured interval in KLX10C.

Object	KLX10C
Measured interval in the borehole with PFL-s (m)	9.75–139.75
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	374 (24 / 101 / 249)
Mean fracture frequency of **open fractures** (fractures/m)	2.88
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	1 (1 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.008
No of **crush zones** in the PFL-s measured interval	0
Appr. no of fractures in **crush zones** assuming 40 fr./m	0.00
Mean no of fractures in a **crush zone**	0.00
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	2.88
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	1,101 (1,101 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	8.47

Table 13-2. Flow anomalies in KLX10C.

Object	KLX10C
Measured interval in the borehole with PFL-s (m)	9.75–139.75
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	25
No of **PFL-f anomalies** mapped as **“Certain”**	21
No of **PFL-f anomalies** mapped in **crush zones**	4
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.192
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	0 / 0
Mean frequency of crush zones with PFL-f anomalies	0.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	20
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	4
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

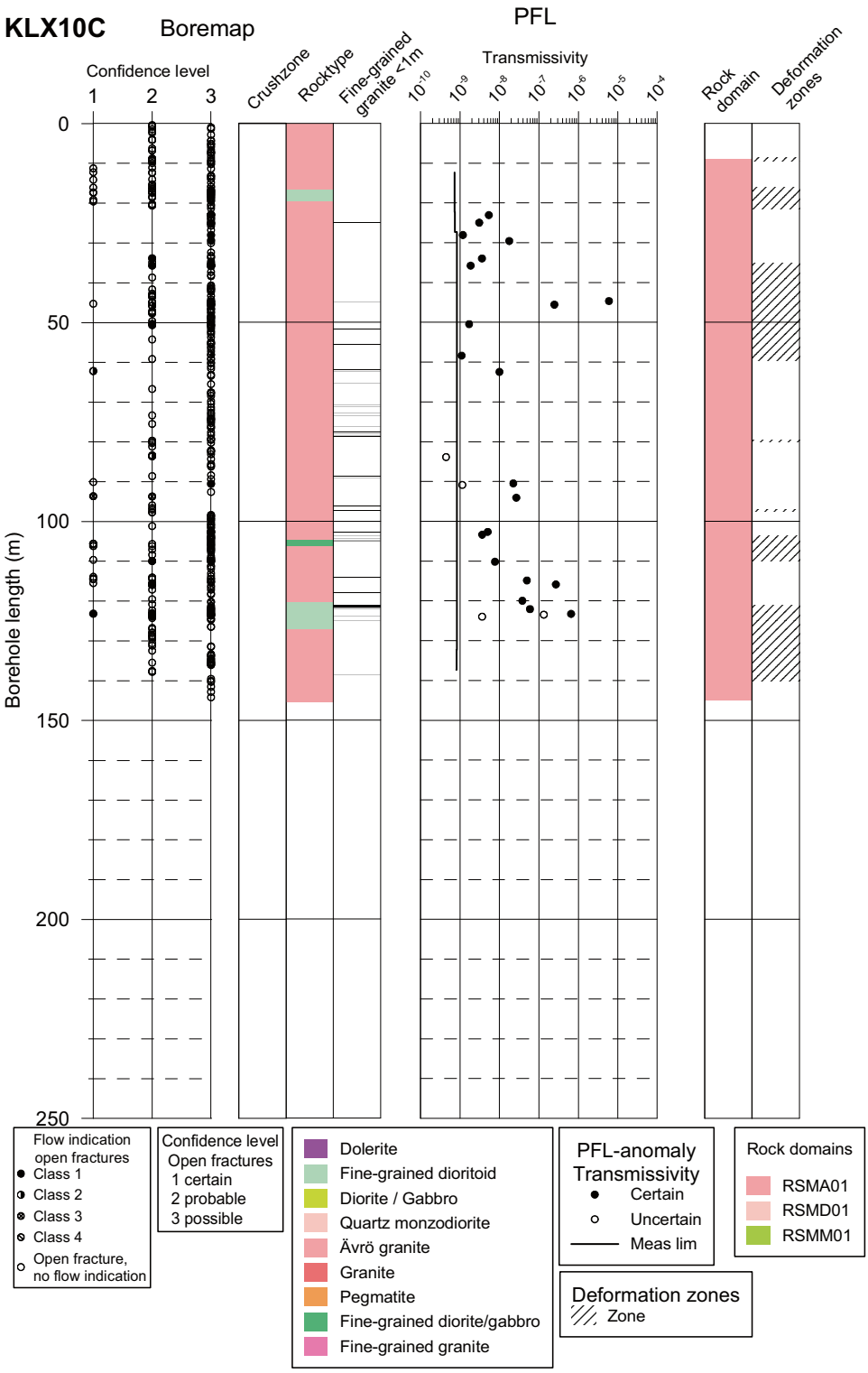


Figure 13-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX10C. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

14 KLX11A

The borehole KLX11A was measured in October and November 2006. It was flow logged with PFL using 5 m test sections in borehole section interval 99.36 to 985.12 m (PFL-s). Upper most section in the borehole for statistics is the lower position of the cone in the borehole (SUB SECLOW): 101.53 m. Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 66 PFL-anomalies, of which 41 are mapped as "certain". Fifteen (15) of the anomalies have been correlated to a single fracture. Nine (9) anomalies have been correlated to the borehole sections mapped as crush zones.

Anomaly 1 (105.1 m) is situated > 0.5 m from the chosen fracture and is considered rather uncertain.

Anomaly 18 (at 199.9 m) can not be correlated to any fracture.

Anomaly 24 (at 299.9 m) can not be correlated to any fracture.

Anomalies 33 and 34 are correlated to the same fracture, which is rather vertical.

Table 14-1. Boremap data for the PFL-s measured interval in KLX11A.

Object	KLX11A
Measured interval in the borehole with PFL-s (m)	101.53–985.12
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	1,072 (54 / 418 / 600)
Mean fracture frequency of **open fractures** (fractures/m)	1.21
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	2 (0 / 2 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.002
No of **crush zones** in the PFL-s measured interval	14
Appr. no of fractures in **crush zones** assuming 40 fr./m	74.80
Mean no of fractures in a **crush zone**	5.34
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	1.30
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	4,278 (4,274 / 3 / 1)
Mean fracture frequency of **sealed fractures** (fractures/m)	4.84

Table 14-2. Flow anomalies in KLX11A.

Object	KLX11A
Measured interval in the borehole with PFL-s (m)	101.53–985.12
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	66
No of **PFL-f anomalies** mapped as **“Certain”**	41
No of **PFL-f anomalies** mapped in **crush zones**	9
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.075
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	14 / 8
Mean frequency of crush zones with PFL-f anomalies	0.57
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	61
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	2
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	1
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

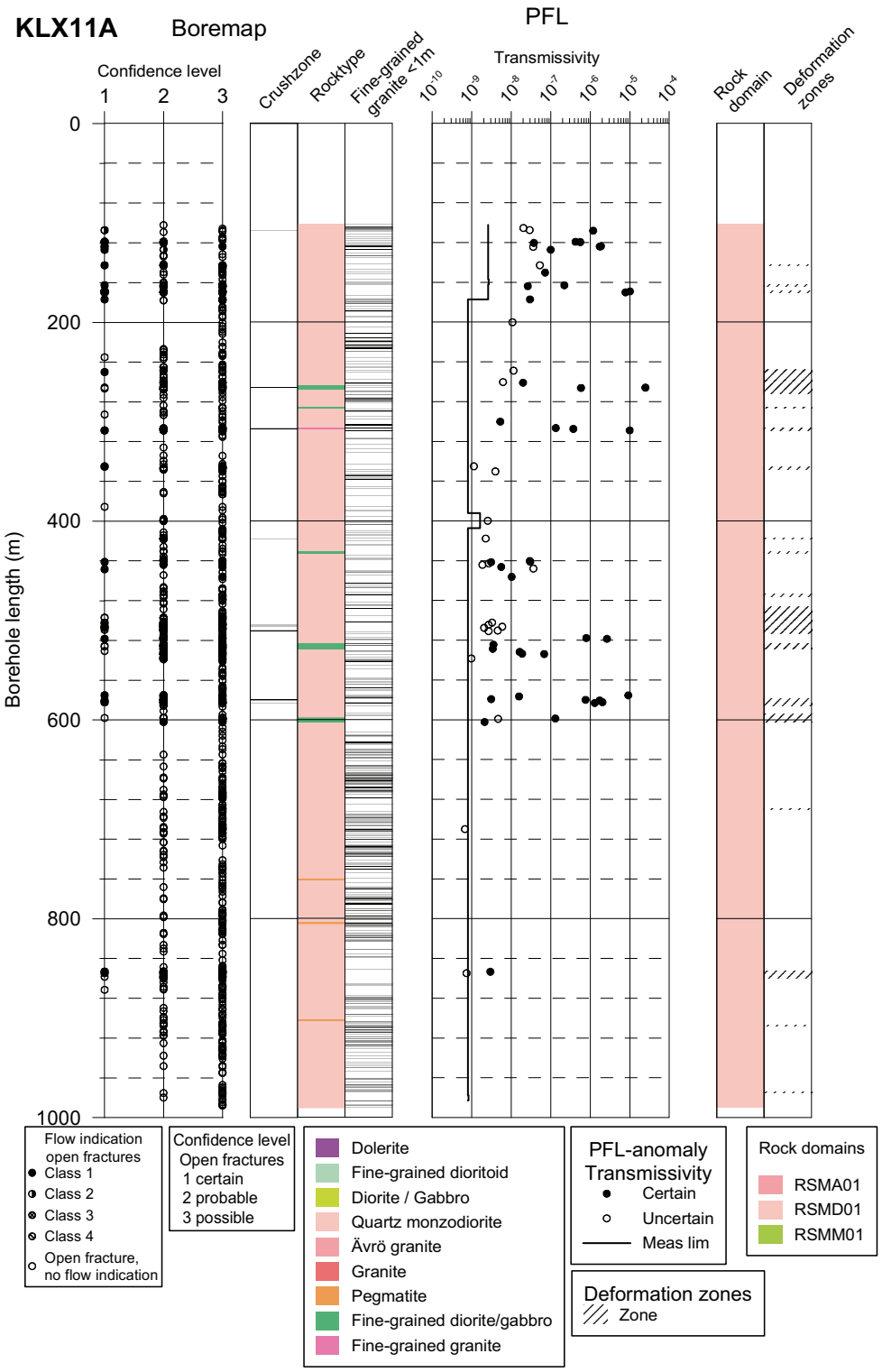


Figure 14-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX11A. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

15 KLX11B

The borehole KLX11B was measured in September and October 2006. It was flow logged with PFL using 5 m test sections in borehole section interval 4.18 to 94.26 m (PFL-s). Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 37 PFL-anomalies, of which 33 are mapped as “certain”. 18 of the anomalies have been correlated to a single fracture. No anomalies have been correlated to the borehole sections mapped as crush zones.

Anomaly 29 (71 m) has the nearest open fracture at 10 dm distance.

Strike or dip is not defined for one fracture at anomaly 31 (73.2 m).

At anomaly 36 (85.9 m) the adjusted secup differs between the BIPS image and the BOREMAP data. The adjusted secup from the BOREMAP data is chosen as the correct value for the fracture.

At anomaly 37 (88.5 m) the adjusted secup differs between the BIPS image and the BOREMAP data. The adjusted secup from the BOREMAP data is chosen as the correct value for the fracture.

Table 15-1. Boremap data for the PFL-s measured interval in KLX11B.

Object	KLX11B
Measured interval in the borehole with PFL-s (m)	4.18–94.26
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	156 (4 / 41 / 111)
Mean fracture frequency of **open fractures** (fractures/m)	1.73
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	0 (0 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.000
No of **crush zones** in the PFL-s measured interval	2
Appr. no of fractures in **crush zones** assuming 40 fr./m	2.40
Mean no of fractures in a **crush zone**	1.20
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	1.76
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	249 (249 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	2.76

Table 15-2. Flow anomalies in KLX11B.

Object	KLX11B
Measured interval in the borehole with PFL-s (m)	4.18–94.26
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	37
No of **PFL-f anomalies** mapped as **“Certain”**	33
No of **PFL-f anomalies** mapped in **crush zones**	2
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.411
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	2 / 2
Mean frequency of crush zones with PFL-f anomalies	1.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	36
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	1
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

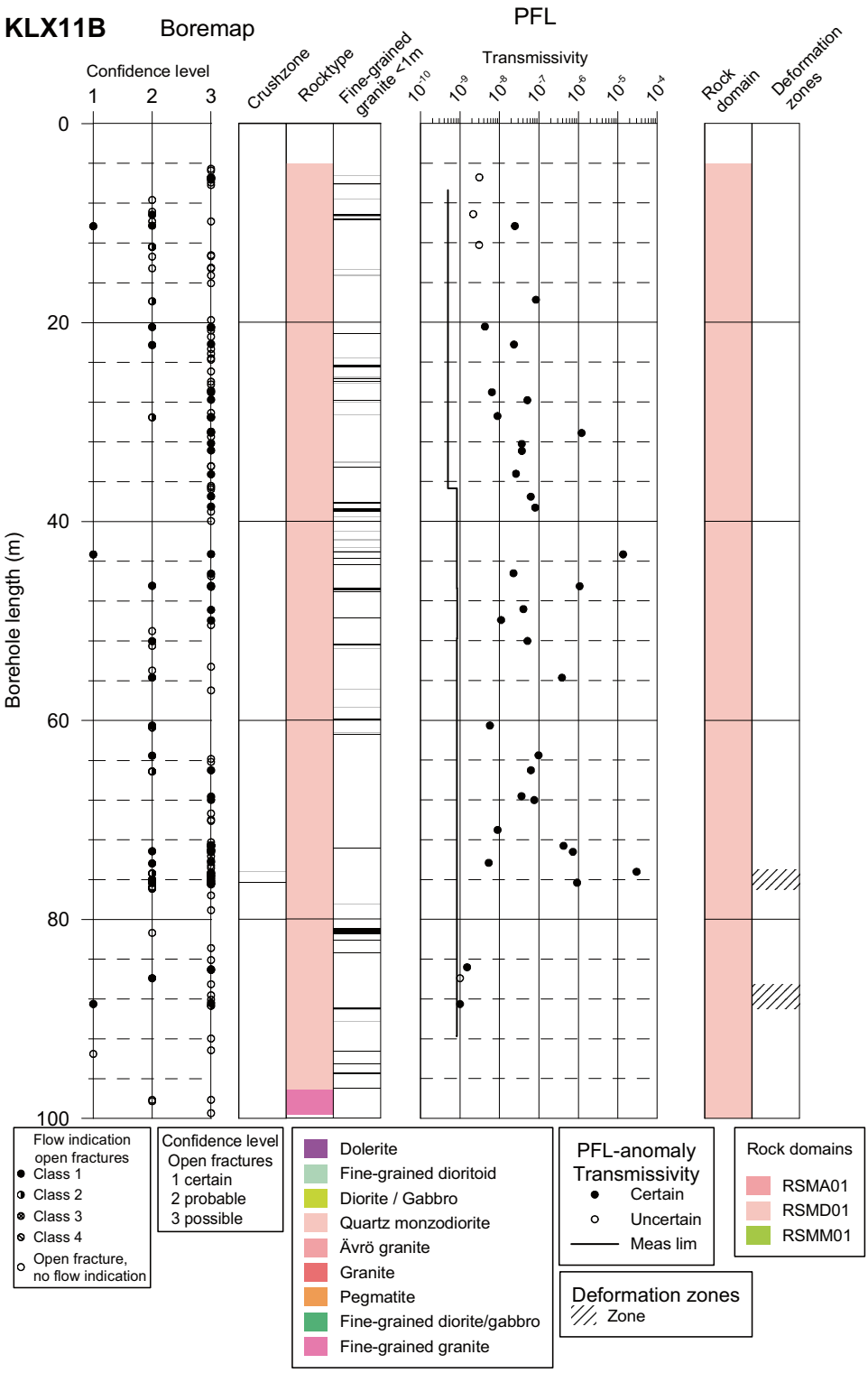


Figure 15-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX11B. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

16 KLX11C

The borehole KLX11C Sweden, was measured in September and October 2006. It was flow logged with PFL using 5 m test sections in borehole section interval 5.66 to 115.73 m (PFL-s). Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 41 PFL-anomalies, of which 31 are mapped as “certain”. 22 of the anomalies have been correlated to a single fracture. No anomalies have been correlated to the borehole sections mapped as crush zones.

No Broken, Open, fracture is present at anomaly 37 (31.9 m) a Broken, Sealed fracture is chosen as Best Choice.

At anomaly 41 (102.3 m) a fracture defined in the BOREMAP data is not visible with a trace from the BDT file in the BIPS image.

Table 16-1. Boremap data for the PFL-s measured interval in KLX11C.

Object	KLX11C
Measured interval in the borehole with PFL-s (m)	5.66–115.73
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	125 (8 / 30 / 87)
Mean fracture frequency of **open fractures** (fractures/m)	1.14
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	0 (0 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.000
No of **crush zones** in the PFL-s measured interval	0
Appr. no of fractures in **crush zones** assuming 40 fr./m	0.00
Mean no of fractures in a **crush zone**	0.00
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	1.14
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	308 (308 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	2.80

Table 16-2. Flow anomalies in KLX11C.

Object	KLX11C
Measured interval in the borehole with PFL-s (m)	5.66–115.73
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	41
No of **PFL-f anomalies** mapped as **“Certain”**	31
No of **PFL-f anomalies** mapped in **crush zones**	0
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.372
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	0 / 0
Mean frequency of crush zones with PFL-f anomalies	0.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	39
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	1
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	1 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

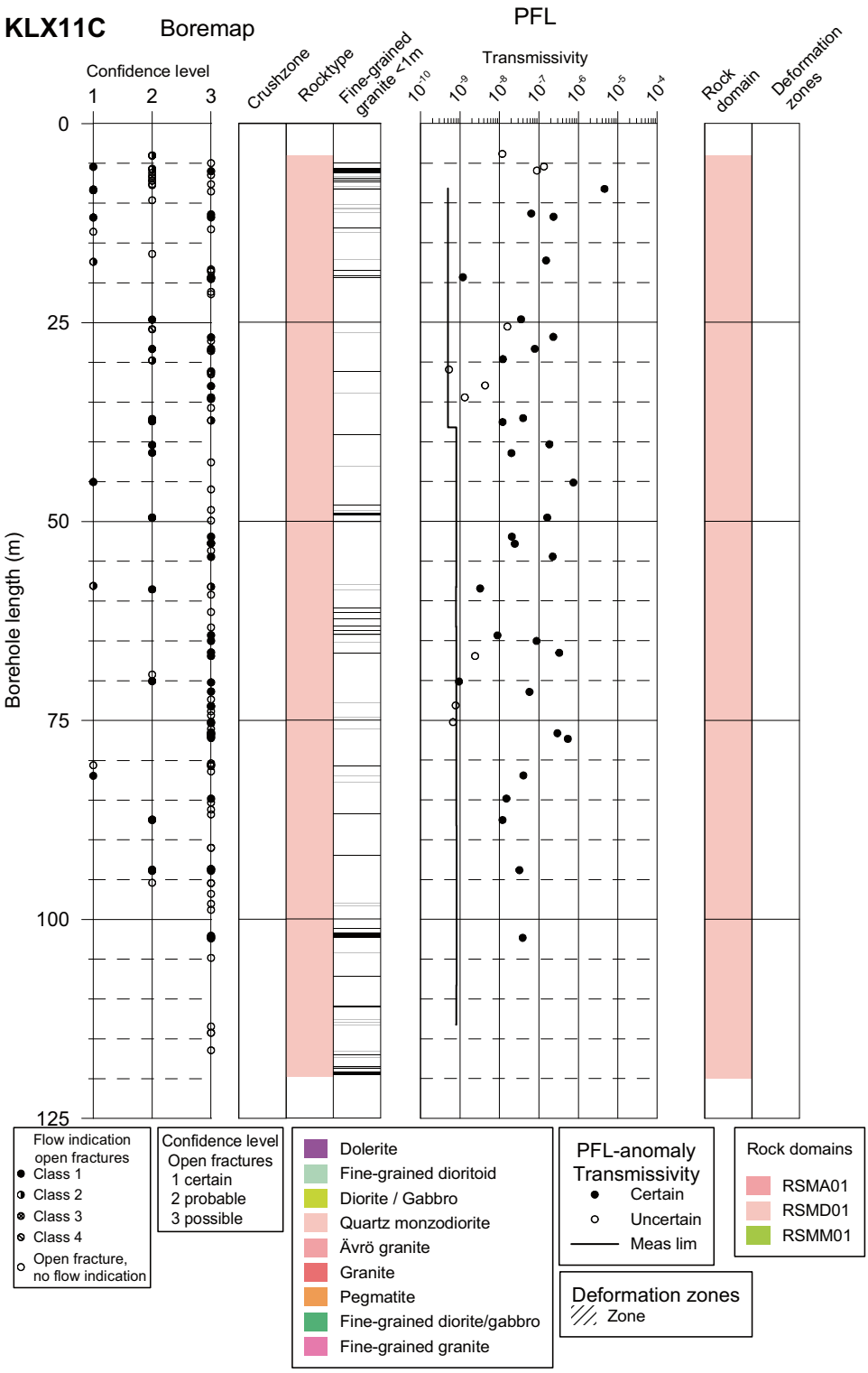


Figure 16-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX11C. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

17 KLX11D

The borehole KLX11D was measured in September and October 2006. It was flow logged with PFL using 5 m test sections in borehole section interval 12.55 to 112.54 m (PFL-s). Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 49 PFL-anomalies, of which 40 are mapped as “certain”. 20 of the anomalies have been correlated to a single fracture. No anomalies have been correlated to the borehole sections mapped as crush zones.

At anomaly 9 (34.5 m) no Broken, Open, or Broken, Sealed, fracture is present in the BOREMAP data nor in the BIPS image an Unbroken, Sealed fracture was chosen.

At anomaly 27 (60.8 m) one fracture, defined in the BOREMAP data and visible in BIPS, is not marked with a BDT trace in the BIPS image.

Table 17-1. Boremap data for the PFL-s measured interval in KLX11D.

Object	KLX11D
Measured interval in the borehole with PFL-s (m)	12.55–112.54
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	187 (22 / 69 / 96)
Mean fracture frequency of **open fractures** (fractures/m)	1.87
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	0 (0 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.000
No of **crush zones** in the PFL-s measured interval	0
Appr. no of fractures in **crush zones** assuming 40 fr./m	0.00
Mean no of fractures in a **crush zone**	0.00
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	1.87
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	445 (445 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	4.45

Table 17-2. Flow anomalies in KLX11D.

Object	KLX11D
Measured interval in the borehole with PFL-s (m)	12.55–112.54
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	49
No of **PFL-f anomalies** mapped as **“Certain”**	40
No of **PFL-f anomalies** mapped in **crush zones**	0
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.490
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	0 / 0
Mean frequency of crush zones with PFL-f anomalies	0.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	47
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	1
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 1

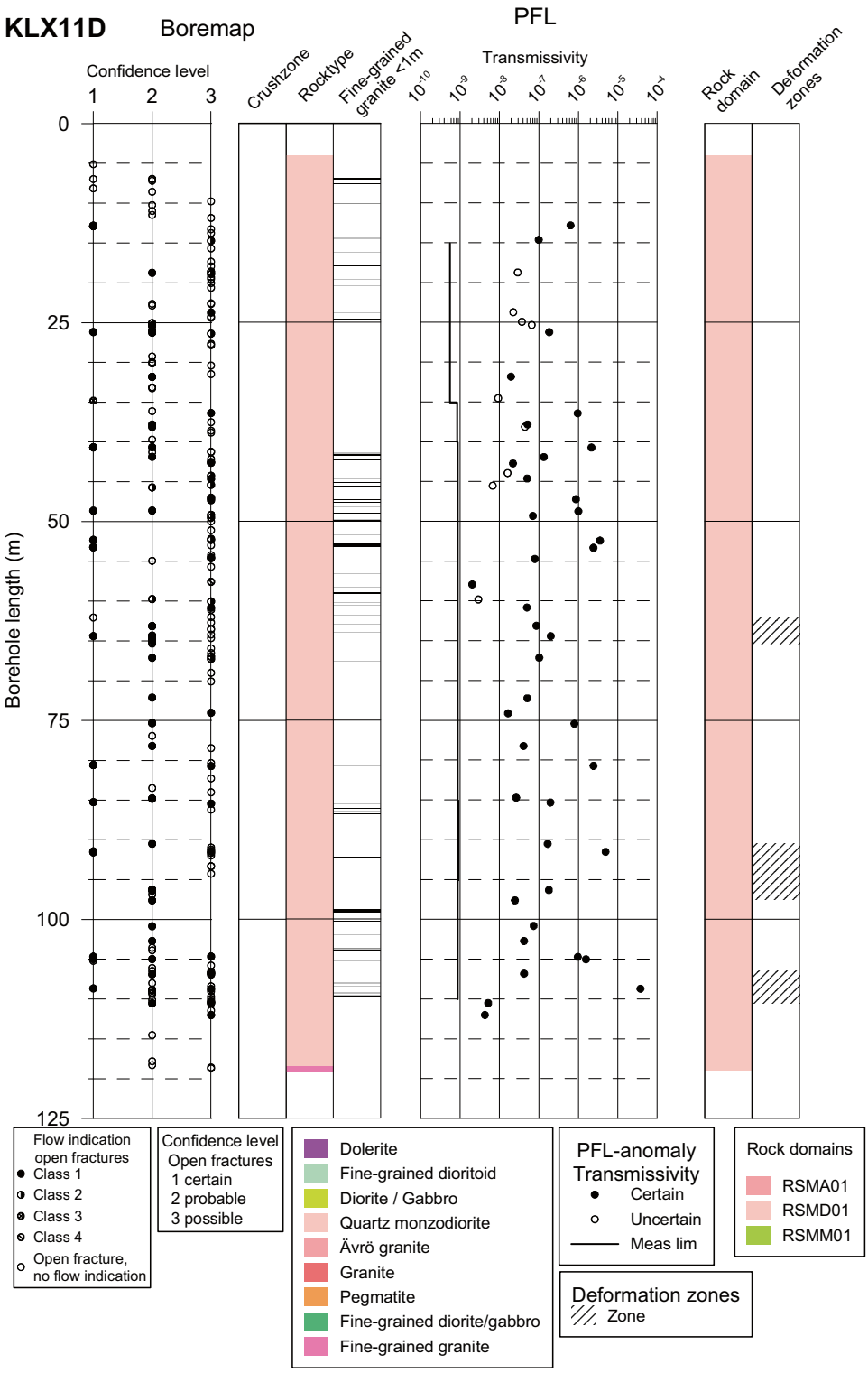


Figure 17-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX11D. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

18 KLX11E

The borehole KLX11E was measured in September and October 2006. It was flow logged with PFL using 5 m test sections in borehole section interval 0.36 to 115.28 m (PFL-s). Upper most section in the borehole for statistics is the lower position of the casing in the borehole (SUB SECLOW): 2.0m. Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 37 PFL-anomalies, of which 32 are mapped as “certain”. 12 of the anomalies have been correlated to a single fracture. No anomalies have been correlated to the borehole sections mapped as crush zones.

A fracture defined in the BOREMAP data within 2 dm of anomaly 25 (68 m) does not have a trace from the BDT data present in the BIPS image.

Table 18-1. Boremap data for the PFL-s measured interval in KLX11E.

Object	KLX11E
Measured interval in the borehole with PFL-s (m)	2.00–115.28
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	202 (12 / 36 / 154)
Mean fracture frequency of **open fractures** (fractures/m)	1.78
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	0 (0 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.000
No of **crush zones** in the PFL-s measured interval	0
Appr. no of fractures in **crush zones** assuming 40 fr./m	0.00
Mean no of fractures in a **crush zone**	0.00
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	1.78
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	453 (452 / 1 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	4.00

Table 18-2. Flow anomalies in KLX11E.

Object	KLX11E
Measured interval in the borehole with PFL-s (m)	2.00–115.28
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	37
No of **PFL-f anomalies** mapped as **“Certain”**	32
No of **PFL-f anomalies** mapped in **crush zones**	0
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.327
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	0 / 0
Mean frequency of crush zones with PFL-f anomalies	0.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	33
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	4
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

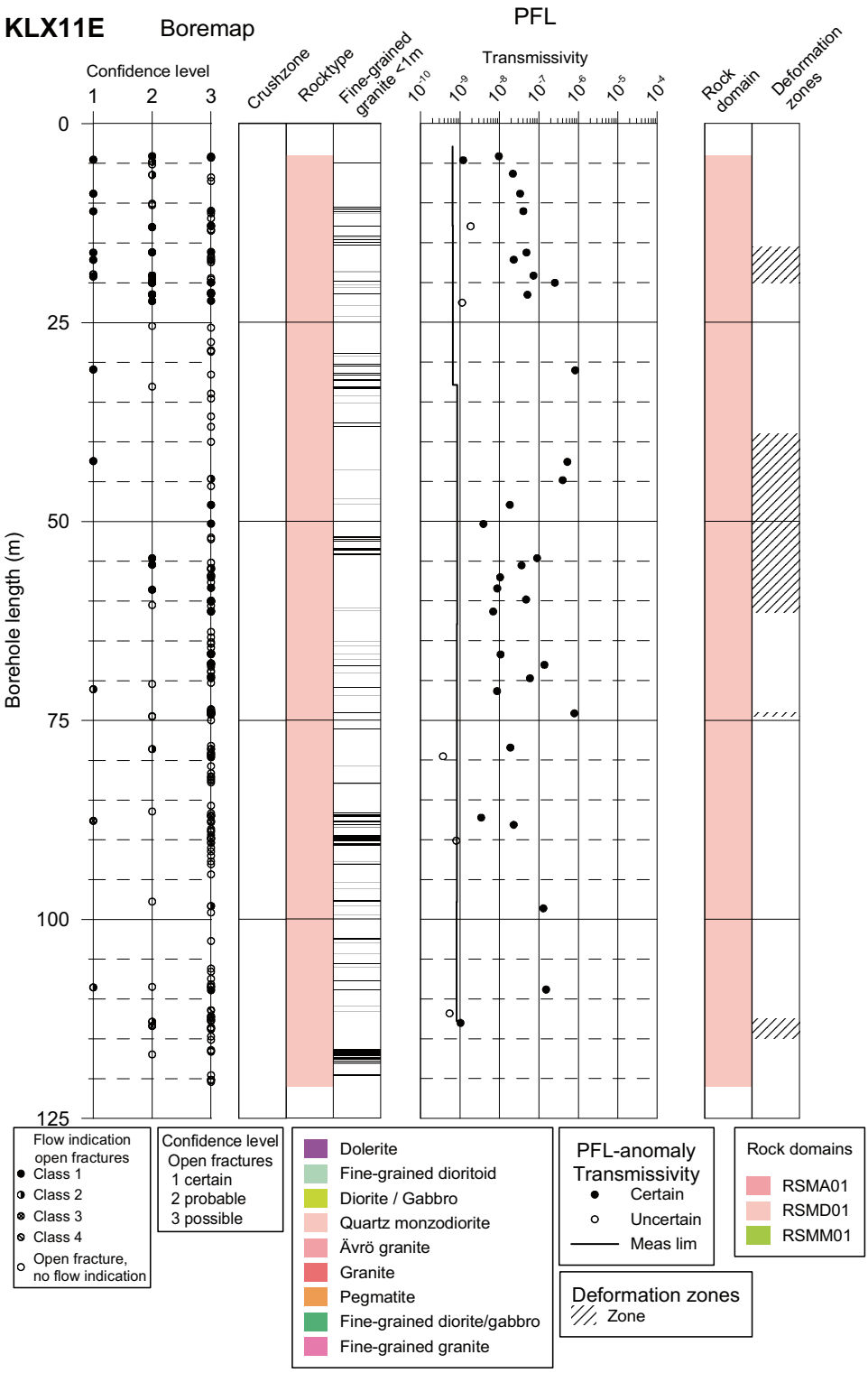


Figure 18-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX11E. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

19 KLX11F

The borehole KLX11F, was measured in September and October 2006. It was flow logged with PFL using 5 m test sections in borehole section interval 3.37 to 113.38 m (PFL-s). Flow logging for flow anomalies was made in the 1 m test sections (PFL-f) in PFL-s sections with measurable flow rates.

The borehole includes 24 PFL-anomalies, of which 16 are mapped as “certain”. 10 of the anomalies have been correlated to a single fracture. Two anomalies have been correlated to the borehole sections mapped as crush zones.

At anomaly 2 (9.50 m) one fracture is without defined strike or dip.

At anomaly 9 (44.0 m) a fracture defined in the BOREMAP data does not have a trace from the BDT data visible in the BIPS image.

At anomaly 12 (51.7 m) a structure is present in the BIPS photo at 51.6 m. The structure is not marked with a trace from the BDT data in the BIPS image. No Broken, Open, or Broken, Sealed, fracture is present in the BOREMAP data. **Anomaly 12 (51.7 m) could not be correlated to any fracture.**

At anomaly 20 (85.1 m) no Broken, Open or Sealed, Broken fracture is present in the BOREMAP data nor in the BIPS image. **Anomaly 20 (85.1 m) could not be correlated to any fracture.**

PFL-f anomalies 15 and 16 are both considered BC for identified fractures and crush.

Table 19-1. Boremap data for the PFL-s measured interval in KLX11F.

Object	KLX11F
Measured interval in the borehole with PFL-s (m)	3.37–113.38
No of **open fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	120 (20 / 17 / 93)
Mean fracture frequency of **open fractures** (fractures/m)	1.09
No of **partly** open fractures mapped as Total /(Certain/ Probable/ Possible) in the PFL-s measured interval	0 (0 / 0 / 0)
Mean fracture frequency of **partly open fractures** (fractures/m)	0.000
No of **crush zones** in the PFL-s measured interval	2
Appr. no of fractures in **crush zones** assuming 40 fr./m	7.48
Mean no of fractures in a **crush zone**	3.74
Mean fracture frequency of **Total open fractures** (All open, partly open and crush zone fractures) (features/m)	1.16
No of **sealed fractures** mapped as Total /(Certain/ Probable/Possible) in the PFL-s measured interval	293 (293 / 0 / 0)
Mean fracture frequency of **sealed fractures** (fractures/m)	2.66

Table 19-2. Flow anomalies in KLX11F.

Object	KLX11F
Measured interval in the borehole with PFL-s (m)	3.37–113.38
Total No of PFL-f anomalies (“Certain”+”Uncertain”)	24
No of **PFL-f anomalies** mapped as **“Certain”**	16
No of **PFL-f anomalies** mapped in **crush zones**	
Mean feature frequency of **PFL-f anomalies** (Total) (anomalies/m)	0.218
No of crush zones in the PFL-s interval, **Total/No. with one or more PFL-f anomalies**	2 / 2
Mean frequency of crush zones with PFL-f anomalies	1.00
PFL-f anomaly connected to a Geological feature (Best Choice), accuracy	
Number of PFL anomalies identified within distance <0.2 m from Geological features (open and partly open fractures and crush zones)	21
Number of PFL anomalies identified within distance 0.2–0.4 m from Geological features (open and partly open fractures and crush zones)	1
Number of PFL anomalies identified within distance 0.2–0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies identified within distance >0.5 m from Geological features (open and partly open fractures and crush zones)	0
Number of PFL anomalies within a distance of 0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0
Number of PFL anomalies within a distance of >0.1 m from sealed fractures (broken / unbroken), thus, **not** correlated to open fractures or crush zones	0 / 0

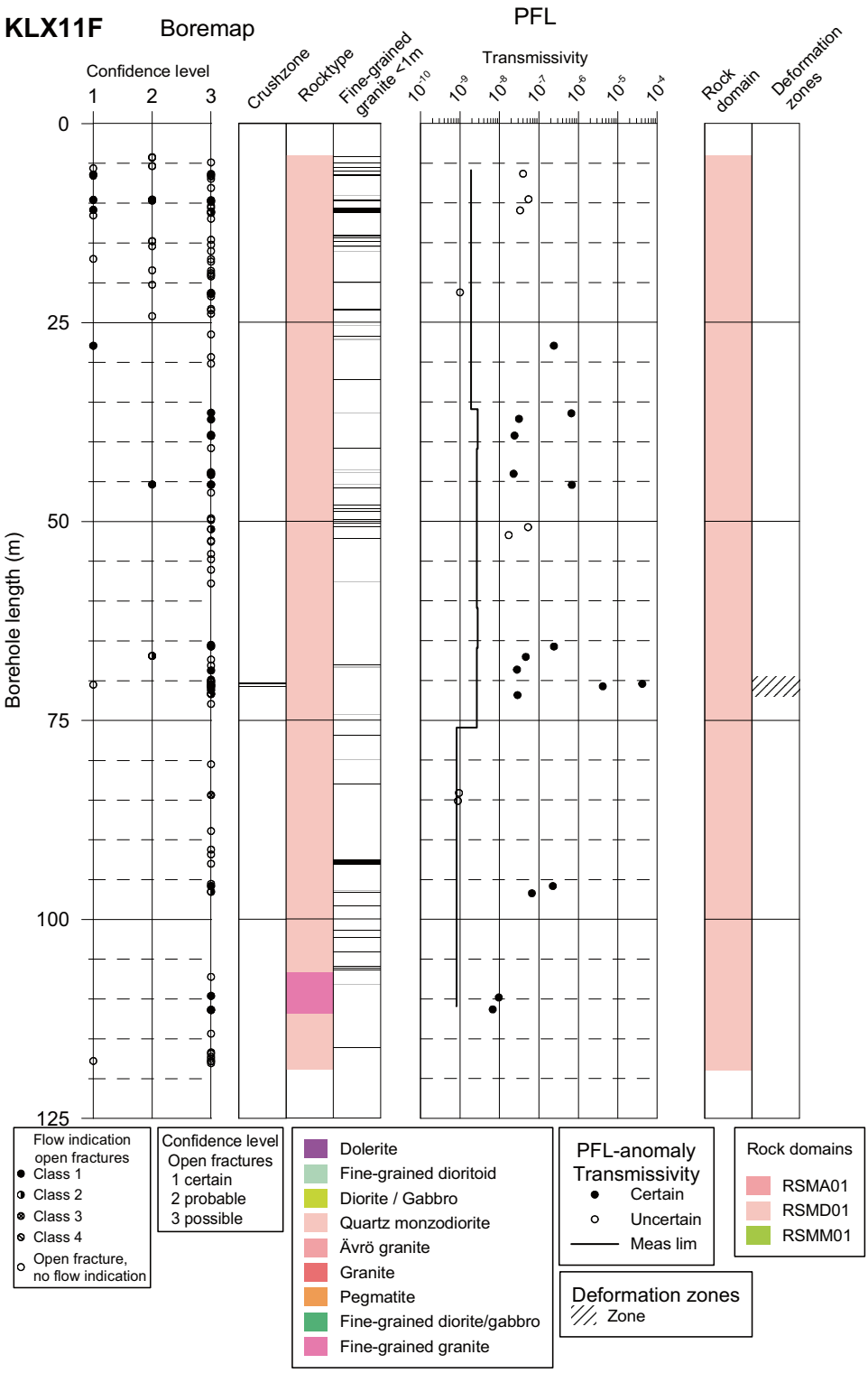


Figure 19-1. *Correlations of hydraulic features based on PFL-f measurements, to mapped open / partly open fractures (all plotted as open fractures above) or crush zones in KLX11F. Interpreted deformation zones and Rock Domains shown to the right. Fractures with PFL-anom confidence (flow indication class above) > 4 are not plotted.*

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