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Äspö HRL

A descriptive rock mechanics model for the 380–500 m level

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SUMMARY

By request of SKB NGI has compiled a rock mechanical model of the –380to –500m depth zone at Äspö. The model is divided into 30x30x30m^3 blocks, and for each block values for different rock mechanical properties such as deformation modulus and rock mass compression strength are estimated. The stress situation within the model is also evaluated. The basis for the model is existing data found in different reports and in SKBs data base SICADA. For estimation of the different parameters the Q-system and partly RMR have been used. The model is presented in two versions: Model A where tunnel design is taken into consideration, and Model B where tunnels are disregarded.

1 INTRODUCTION

By request of SKB NGI has compiled a rock mechanical model of the –380m to –500m depth zone at Äspö. This model embraces the central part of the underground Äspö rock mechanical laboratory and is located inside a larger model which is currently under construction by SKB consultants. In the model the rock mass mechanical properties such as deformation modulus, Poisson's ratio and compressive strength have been predicted from Q and RMR values. In addition the stress situation inside the model is also evaluated. The results are visualised by means of tables and figures. The model has been constructed by means of existing data mainly from tunnel mapping and core logging. The data has been extracted from SKB reports and from SKBs data base SICADA.

Based on comments on the draft report from SKB and Nick Barton, NGI has been requested to produce an alternative model. In the alternative model rock mass characterisation is attempted disregarding tunnel design in the rock masses. In the following the first model will be called Model A, and the alternative model is Model B.

The main objective of the present work is to establish procedures required for generating intermediate scale conceptual rock mechanical models at possible Swedish underground nuclear waste storage localities. For the current project the area around the Äspö underground laboratory is used as a test case.

2 THE MODEL

The Äspö area and the rock mechanical model are shown in Fig.1. NGI's model is located between elevation -380 and -500m. The area encompassing the model is 600m long and 180m wide and has been divided into 30×30×30m cubes (blocks). The model contains 480 blocks, which have been numbered from 1 to 480 starting at the top layer with no.1. These blocks are the smallest units for presentation of the data. This means that there are four block layers, see Figures 2 and 3.

Layer 1: -380 to -410m
Layer 2: -410 to -440m
Layer 3: -440 to -470m
Layer 4: -470 to -500m

The model is cut by the Äspö tunnel system, and the central part of the underground laboratory is inside the model, see Fig. 4.

The following parameters have been estimated or assumed:

E_m - deformation modulus for the rock mass
σ_m - rock mass compression strength
ν - Poisson's ratio of the rock mass
σ_1 - σ_3 - principal stresses

The results are presented in tables and visualised by using excel spreadsheets showing the different layers in the model, i.e. four horizontal layers and six longitudinal, vertical sections. The different parameter values are given for each block in the model. The ranges in parameter values throughout the models are also visualised in the figures by use of a specific colour code. In general Q-values are used as the basis for the estimation of the parameter values, and therefore the Q-value is estimated for each block. For some blocks only RMR-data are available. In these cases the parameter values have been calculated directly from RMR, or the RMR-values have been transformed to Q-values. For Model B only Q-data has been used.

3 INPUT DATA

3.1 General

The model is based on existing data found in SKB reports and in the SKB data base SICADA, supported by information from the rock mechanical literature.

Available data are unevenly distributed in the model. Only in 93 out of 480 blocks data (Q or RMR-values) from tunnels or boreholes is available. Out of the remaining 387 blocks 161 border at least with one side with a block with data. For the rest of the blocks (226) no direct data is available. In Model B only the 70 blocks with Q-data have been used.

To correlate data from mapping in the tunnels and core logging with the 30x30x30 m^3 blocks in NGI's model, the coordinates for each block are calculated. Data from tunnel mapping (Q/RMR) is then transferred by help of Figure 4. For core logging data, SICADA calculates the xyz coordinates for each logging interval, and the data can then easily be correlated with the block locations.

3.2 Geology of the Äspö area

The Äspö area is covered by metamorphic rocks of Precambrian age (Wikström 1989, Talbot 1989 and 1991). Most of the rocks are of igneous origin, and the major rock types are: Äspö diorite, Småland granite, fine grained granite and greenstone. In addition several fault zones with some mylonite are found, see Figure 5. The model area consists mainly of Äspö diorite with some dikes and lenses of granite and greenstone.

The most distinct fault zones are striking NE-SW and ENE-WSW. The following major zones intersect the model area: EW-1, NE-1 and NE-2. Specifically the zones EW-1 and NE-1 are complex and are therefore considered as significant for the stability of underground openings. In the fault zones crushed rocks and even clay zones are observed.

In addition to these NE to ENE striking structures, NW-SE oriented fractures intersect the rock mass. These fractures have an orientation close to the major principle stress (σ_1) and many of the water bearing structures have this orientation.

Based on the available data 8 minor weakness zones have been identified. In the models these zones have been named MWZ1-8 (Minor Weakness Zone).

Outside the fault zones the intensity of fracturing is usually low, and RQD values of 90-100 are usual. Generally at least two sets of fractures are present.

3.3 Borehole data

A large number of core drillings have been carried out in the Äspö area. Data from core logging has been the most important source of information. In 2001 NGI (NGI 2001) has logged the following cores:

KA2511A	3.28-293m
KAS02	160.92-612.95m
KA2598A	2.34-300.77m

In connection with the Zedex project in 1994/1995 (NGI 1994, 1995), the following boreholes have been logged by NGI previously:

KXZA1-KXZA7 length	266.91 m
KXZB1-KXZB8 length	155.11 m
KXZC1-KXZC7 length	352.65 m
KXZRD and KXZRT length	71.85 m

Totally NGI has Q and RMR logged 1886m of core at Äspö. In Boreholes KA2511A 3.28-293m, KAS02 160.92-612.95m and KA2598A 2.34-300.77m tilt testing and profiling of joint roughness were also carried out.

In addition data from the following boreholes, logged by SKB, have been used:
KA3065A02, KA3067A, KA2563A, KA3110A, KA3105A, KA3590G02, KA3554G02
KA3566G02, KA3542, KA3600F, KA3573A, KA3590G0, KA3548A01, KA3542G01
KA3510A, KA3385A, KA2563A, KG0048A01, KG0021A01, KI0023B, KI0025F03
KI0025F, KI0025F02, KJ0050F01, KJ0052F02, KJ0052F03, KJ0044F01

For these boreholes RQD values only (no Q or RMR) are given for each meter of core, plus some other geological information.

3.4 Tunnel mapping data

The tunnel system within the model area is shown in Figure 4. NGI has mapped the Zedex tunnel (38m) and the first 50m of the TBM tunnel by use of the Q- and RMR system. The rest of the tunnels has been mapped by SKB by use of the RMR system. The tunnel system inside the model consists of the 400m long TBM tunnel, about 170m of the access tunnel, 60m of lift shaft and several test tunnels.

3.5 Laboratory data

A lot of laboratory testing on rock from the Äspö area has been carried out. Some results from this testing are given by Rhen (1997), see Table 1:

Table 1. Rock mechanical data from laboratory tests on rock cores collected by boreholes (BH) drilled from the surface or from the tunnel.

Parameter	Greenstone	Fine-grained granite	Äspö diorite	Småland granite
σ_c mean from surface BH	119 MPa	236 MPa	184 MPa	189 MPa
σ_c range from surface BH	103-168 MPa	152-336 MPa	164-217 MPa	147-260 MPa
No. of tests	4	4	4	4
σ_c mean from tunnel BH	207 MPa	258 MPa	171 MPa	255 MPa
σ_c range from tunnel BH	121-274 MPa	103-329 MPa	103-221 MPa	197-275 MPa
No. of tests	10	9	10	10
Young's modulus mean from surface BH	53 GPa	65 GPa	60 GPa	62 GPa
Young's modulus range from surface BH	32-74 GPa	59-70 GPa	54-65 GPa	62-63 GPa
No. of tests	4	4	4	4
Young's modulus mean from tunnel BH	78 GPa	77 GPa	73 GPa	74 GPa
Young's modulus range from tunnel BH	71-96 GPa	72-80 GPa	65-80 GPa	63-79 GPa
No. of tests	10	9	10	10
Poisson's ratio mean from surface BH	0.25	0.22	0.23	0.24
Poisson's ratio range from surface BH	0.24-0.26	0.20-0.22	0.20-0.25	0.24
No. of test	4	4	4	4
Poisson's ratio mean from tunnel BH	0.24	0.23	0.24	0.23
Poisson's ratio range from surface BH	0.18-0.31	0.21-0.25	0.22-0.29	0.20-0.26
No. of tests	10	9	10	10

Table 1 indicates no significant difference between the different rock types concerning most of the parameters, and it can therefore be concluded that the rock type may have only a slight influence on the variation in the rock mass properties in the model area. Based on the available data, it is not possible to make any difference between the different blocks in the model with respect to rock type.

4 METHOD

4.1 General principles for calculation of Q-values

As mentioned above, data for each block have been collected. These data are Q and RMR-values, or mainly RQD for the boreholes logged by SKB. Since Q-values are used as basis for estimation of the rock mechanical parameters, Q-values had to be estimated from only RQD-values in some cases. Q-values are calculated based on 6 parameters according to the equation (Barton, Lien and Lunde, 1974):

$$Q = \frac{RQD}{J_n} x \frac{J_r}{J_a} x \frac{J_w}{SRF}$$

The Q-system is primarily developed for tunnel mapping, but can also be used for core logging. During core logging some of the Q-parameter values may not be available or may be uncertain. This is especially the case for J_w and SRF. The principle used by SKB for core logging is that the values of these two parameters shall be set to 1, and the Q-value calculated in this way is usually called Q'. This principle has been used by NGI during the logging of the Boreholes KA2511A, KA2598A and KAS02. During the mapping of the Zedex tunnel and logging of the Zedex boreholes, Q-values were calculated by using observations from the tunnel for stipulation of J_w and SRF. This should be kept in mind when comparing Q-values from different reports.

For estimating the rock mechanical parameters, real Q-values have to be used, and the Q'-values must then be transformed into Q, by stipulating values for J_w and SRF.

The RMR-system has been used by SKB (Bieniawski 1989). SKBs principle for core logging is to set the ground water factor to 15 and the fracture orientation factor to 0. It is however, not quite clear if this principle has been used during the mapping of the access tunnel at Äspö. This must be kept in mind by comparing Q- and RMR-values and when transforming data from one system to the other.

The values of rock mechanical parameters can be estimated either directly from RMR-values, or the RMR-values can first be transformed to Q-values. Generally, NGI has followed the principle to use Q-values where Q-values have been directly mapped, and RMR-values where only RMR-values have been mapped.

NGI has logged 1886m of drill cores at Äspö by using both the Q- and the RMR-system (NGI 2001). The same cores were previously logged by SKB, and here the RQD-values have been calculated for each metre. In the SKB- log there is also some information about natural fractures per metre, fracture infill, alteration, crushed zones and rock type. NGI has developed a system for calculating the Q-values for the cores based on the information found in the SKB-logs, i.e. mainly RQD-values. The method is based on NGI's experience from the core logging at Äspö, see Fig. 6. In Fig. 6 the relation between RQD and J_n, J_r and J_a found in Boreholes KAS02, KA2511A and KA2598A is shown.

The principles for calculation of Q used in Model A are as follows:

<u>For core sections RQD = 100</u>
$J_n = 4$, $J_r = 3$, $J_a = 2$, $J_w = 1$, SRF = 2

<u>For core sections RQD = 50-99</u>
$J_n = 6$, $J_r = 3$, $J_a = 2$ $J_w = 1$, SRF = 2

<u>For core sections RQD = >0-49 (10-49) in Q-calculation)</u>
$J_n = 9$, $J_r = 3$, $J_a = 3$, $J_w = 1$, SRF = 2

<u>For crushed zones with small content of clay (RQD = 0)</u>
$J_n = 15$, $J_r = 1$, $J_a = 4$, $J_w = 0.66$, SRF = 2

<u>For clay zones (RQD = 0)</u>
$J_n = 15\text{-}20$, $J_r = 1$, $J_a = 8$, $J_w = 0.66$, SRF = 5

For Model B some changes have been made concerning J_w and SRF, see Section 4.11. The background for the choice of parameter values shown above is as follows:

<u>J_n (Joint set number)</u>
Observations in the Äspö tunnels show that there are usually at least two fracture sets in the rock mass, and therefore the minimum value for J_n should be 4. Experience from the core logging shows also that the J_n-value usually increases with decreasing RQD, and a J_n –value of 6 - 9 has therefore been given for RQD-values lower than 100. In crushed zones the J_n-value will be 15, and in clay zones or crushed zones with considerable content of clay, the J_n-value will be 20. For RQD between 50-99, a J_n- value of 6 is the most frequent (Fig. 6) and has therefore been used, and for RQD-values between 0-49 a J_n- value of 9 is the most frequent.

<u>J_r (Joint roughness number)</u>
Most of the fractures are rough and more or less undulating, therefore J_r generally is set to 3, see Fig. 6. Smooth fractures and fractures with slickensides occur in connection with faults, and therefore $J_r = 1$ is used in crushed zones. In clay zones and crushed zones with a considerable content of clay J_r will generally be 1.

<u>J_a (Joint alteration number)</u>
Most fractures have only a staining or a thin more or less continuous coating of epidote, chlorite or calcite which usually gives $J_a = 2$. In more fractured zones there are often a more continuous coating, and therefore $J_a = 3$ has been used for RQD 0-49, see Fig. 6. In crushed zones with clay filling J_a is set to 4-8. In clay zones J_a will be 8 or higher, depending on the content of swelling clay.

<u>J_w (Joint water reduction factor)</u>
Water leakage into the tunnels is usually small, and therefore J_w is generally set to 1. Some leakage may occur along faults and crushed zones and $J_w = 0.66$ is used for these zones. However, it should be kept in mind that grouting has been carried out in some tunnel sections, and therefore the observed leakage may be less than in the "virgin" rock masses.

SRF (Stress reduction factor)
In the tunnels only minor stress problems have been experienced, but at some locations faint slabbing has taken place, indicating a SRF-value of 2. The SRF-value can also be determined from the σ_c/σ_1 ratio. Stress measurements in the model area shows values of σ_1 in the range 8-45.6 MPa. With an unconfined rock compression strength (σ_c) of 150-200 MPa the σ_c/σ_1 ratio indicates a SRF-value in the range 0.5-5.0. The stress measurements show generally that the stress increases with increasing depths. Because the stress measurements are rather few, there seems not to be any instance for a variation of the SRF-value inside the model. SRF has therefore generally been set to 2 in Model A, but in the central part of one of the weakness zone NE-1, which is a clay zone, the SRF- value has been increased to 5. A SRF-value of 2 may be too unfavourable for some parts of the model. On the other hand, a J_w-value of 1 has generally been used, and this value may be too favourable, since considerable water leakage has been observed in some of the boreholes. However, seen in connection, a combination of SRF = 2 and $J_w = 1$ is expected to give correct Q-values for most of the model area. For Model B SRF = 0.5 has been used as recommended by Nick Barton.

4.2 Principles for calculation of Q-values in the different blocks in the model

The rock mechanical model is subdivided into 30m x 30m x 30m blocks, and parameter values have been estimated for each of these blocks. This estimation is mainly based on Q or RMR-values. The source for the Q and RMR-values are either tunnel mapping or core logging. In some of the blocks there are both tunnel and borehole data, in some only one of these, and in many blocks no data at all are available, see also Section 3.1.

The Q-data for each block have been collected in Excel spreadsheets, see example in Fig. 7. Since the RQD-values usually are given for each metre in the core logs, one metre is used as standard length unit in these spreadsheets. In the spreadsheets the distribution of the different Q-parameter values are shown by means of histograms, and the minimum, maximum and mean Q-values for each block are calculated. The question arrives which of these values should be used as the representative Q-value for the block. The minimum- and maximum Q-value may not be realistic since the most unfavourable or most favourable values for each parameter may not occur at the same position and definitely not throughout the whole block. Since one metre has been used as the logging unit, only one metre of poor rock may give a low minimum Q-value, but it is generally unrealistic to calculate the Q-values for only one metre. It is also uncertain whether the mean Q-values should be used as the Q-value for the blocks, since the Q-system follows the principle that J_r- and J_a-values from the fracture set considered as most unfavourable for the stability of a tunnel shall be used for the calculation of the Q-value. Furthermore this will also depend on the orientation of the tunnel, and in the model no particular tunnel orientation has been considered when calculating Q.

Therefore the following principles have been used for calculation of the Q-values for each block in the model, i.e. Q_{block}:

The mean RQD-value values have been used. For J_n, J_r and J_a the most unfavourable values have been used if these values make up more than 10% of the total number of observations. If the most unfavourable values of J_n, J_r and J_a make up less than 10% of the observations, the mean values of these parameters have been used. In a few blocks the values of J_n, J_r or J_a are very scattered, and in these cases the general principles listed above are disregarded, and the parameter values are estimated by a general judgement.

J_w is generally set to 1, but in major weakness zones Jw = 0.66 is used. In Model B J_w is also stipulated 0.66 for the minor weakness zones striking NW-SE.

In Model A SRF is generally set to 2, but for thick clay zones, SRF has been set to 5.
In Model B SRF is generally set to 0.5.

In the histograms, see Fig. 7, the value Q_{block} is calculated according to the principles given above.

For blocks with Q-values logged by NGI, this data has been used in preference to Q-values estimated from RQD. For blocks with no available data, the Q-value is calculated from the Q_{block} values in the neighbouring block or blocks. Neighbouring blocks are defined as blocks having one side in common. Blocks having only corners or edges in common are not defined as neighbouring blocks. If the Q-values in the neighbouring blocks are very different, for example if a block is adjacent to a fault, a special evaluation is done. For blocks with no data and no neighbouring block containing data, the Q-value is set to 12 in Model A and 48 or 32 in Model B depending on the J_w-value.

The model is cut by three major weakness zones, however, the exact position of these zones is rather uncertain. The areas in the model where the zones are likely to occur, are marked and given a Q-value based on data observed in the zones. These data come from boreholes more or less outside the model area. Q-values for the blocks affected by a major weakness zones are also calculated according to the general principles stated above, i.e. from data inside the block. The Q-value calculated in this way should be considered as the Q-value for the part of the block not affected by the weakness zone, whereas the zone itself usually has a lower Q-value.

4.3 Q-RMR relation

Sometimes it is necessary to convert RMR-values to Q or vice-versa. The two classification systems partly use the same parameters. A principal difference is that RMR uses the uniaxial compression strength of the rock as a basis for one of the parameters whereas Q uses a stress-strength relation, the SRF-factor. RMR uses a parameter for the orientation of fractures related to the tunnel direction, while in the Q-system the J_r- and J_a-values from the fracture set considered as most unfavourable for the stability of the tunnel are used. This means that it is difficult to find a general conversion equation between the two systems. Several attempts have been made in the literature to develop such a equation. A certain conversion equation may be valid for a special rock type or for a limited range of Q- or RMR-values. Therefore a single conversion equation cannot be used indiscriminately.

Barton (1995) has given the following equation:

$$RMR = 15 \log Q + 50 \qquad (1)$$

During earlier core logging at Äspö (Zedex) NGI has found the equation (NGI 1994):

$$RMR = 6.28 \ln Q + 52.48 \qquad (2)$$

From the latest core logging by NGI of Boreholes KA2511A, KAS02 and KA2598A (NGI 2001) the following relation was obtained:

$$RMR = 15 \log Q + 56 \qquad (3)$$

Bieniawski (1989) gives the following relationship:
RMR = 9lnQ + 44 (4)

In Boreholes KA2511A, KAS02 and KA2598A the Q-values are rather uniform, often in the range 10-20, and for this range the relation RMR = 15logQ + 56 fits well. For comparison of the different equations, see Table 2 and Figure 8.

Table 2 Transformation of Q to RMR by different correlation

Q	RMR = 15logQ + 50 (1)	RMR = 6.28lnQ +52.48 (2)	RMR = 15logQ + 56 (3)	RMR = 9lnQ + 44 (4)
100	80	81	86	85
40	74	76	80	77
20	70	71	76	71
10	65	67	71	65
4	59	61	65	57
1	50	52	56	44
0.1	35	38	41	23
0.01	20	24	26	3

Table 3 Classification used by SKB

Class	RMR	Q
(I) Very good rock	80-100	>40
(II) Good rock	60-80	10-40
(III) Fair rock	40-60	4-10
(IV) Poor rock	20-40	1-4
(V) Very poor rock	<20	<1

It can be seen that there is a rather good agreement between Table 3 and the equations in Table 2 concerning rock mass classes II and III. For classes IV-V the agreement is poor. Most Äspö rocks belong to class II and III for which equation 3 gives a good agreement.

The following distribution of Q-values are found (with SFR = 2) in the three Boreholes KA2511A, KA2598A and KAS02 logged by NGI:

Table 4 Distribution of Q-values in Boreholes KA2511A, KA2598A and KAS02, total length of logged cores 1040m.

Class	Q	%
(I) Very good rock	>40	0.7
(II) Good rock	10-40	61.8
(III) Fair rock	4-10	27.8
(IV) Poor rock	1-4	7.6
(V) Very poor rock	<1	2.1

For use in the rock mechanical model, equation 1 is used for transformation between Q and RMR:

RMR = 15logQ + 50 (1)

The reason for using equation 1 and not 3, is that equation 3 was developed from core logs where fixed values were used for some of the parameters. Equation 1 is therefore considered as more general.

4.4 Estimation of Youngs modulus of deformation of rock mass (E_m)

E_m can be estimation from Q or RMR-values:

$E_m = 10 \times Q^{1/3}$ (Barton 1995) (5)

$E_m = 2 \times RMR - 100$ (Bieniawski 1989) (6)

$E_m = 10^{(RMR-10)/40}$ (Serafim and Pereira 1983) (7)

A comparison between these three methods is given in Table 5 and Fig. 9 and 10.

Table 5 E_m estiamted from Q and RMR

Q	RMR	(5) $E_m = 10Q^{1/3}$	(6) E_m= 2xRMR-100	(7) $E_m = 10^{(RMR-10)/40}$
40	74	34	48	40
20	70	27	40	32
10	65	21	30	24
4	59	16	18	17
1	50	10		10
0.1	35	5		4
0.01	20	2		2

Equation 1 (RMR = 15logQ + 50) has here been used for the relation between Q and RMR. It can be seen from Table 5 that for the usual rock mass qualities found at Äspö, i. e. Q = 10-20, equation 6 and 7 generally gives higher E_m-values than equation 5.

Since the NGI model primarily is based on the Q-system, Equation 5 has been used for the estimation of E_m where Q-values are available, and where only RMR-values are available equation 7 is used, since equation 7 shows smaller variance from equation 5 than equation 6 does.

4.5 Estimation of rock mass compression strength (σ_m)

The number of fracture sets and the properties of the fractures have a strong influence on the rock mass compression strength (σ_m). In case of only one or two fracture sets, the shear strength of the fractures present will control σ_m. A Mohr-Coulomb and/or Barton-Bandis shear strength criteria may then be used to estimate σ_m. For more densely fractured rock masses a Hoek and Brown criteria may be used. To perform such estimation, different rock mechanical data are necessary. Q or RMR-values have already been assigned to the different blocks in the model. It is therefore convenient to base the estimation of σ_m on the Q-values. According to Singh et al. (1992), σ_m can be estimated from the equation:

$$\sigma_m = 0.7 \text{ x } \gamma \text{ x } Q^{1/3} \text{ (MPa)} \quad (8)$$

where γ is the rock unit weight in kN/m^3.

The above equation underestimates the σ_m-values for hard rocks with high Q-values. Grimstad and Bhasin (1996) have therefore modified the equation for hard rock masses by incorporating the uniaxial compressive strength (σ_c) of the rock in the following way:

$$\sigma_m = (\sigma_c / 100) \text{ x } 0.7 \text{x } \gamma \text{ x } Q^{1/3} \text{ (MPa)} \quad (9)$$

According to Stille et al. (1982) a correlation between RMS, which is a RMR-value modified with respect to the number of fracture sets, and σ_m can be given in the following way:

Table 6 Relation between RMS and σ_m

RMS	100-81	80-61	60-41	40-21	<20
σ_m (MPa	30	12	5	2.5	0.5

This relation seems to give considerably lower values (maximum 30 MPa) for σ_m than equations 8 and 9. Since our main data is based on Q-values, equation 9 has been generally used for estimation of $\sigma_{m.}$ For the major weakness zones equation 8 has been used.

4.6 Poissson's ratio (ν)

The Poisson's ratio for rock samples can be determined in the laboratory. Laboratory tests performed by SKB show values of 0.18-0,31 with a mean value of 0.25 for the Äspö rocks (Rhen 1997). To estimate Poisson's ratios for rock masses is more complicated. The small strain dynamic Poisson's ratio can, however, be estimated from seismic measurements when both V_p- and V_s- velocities have been measured. Goodman (1980) reproduces the following formula for calculation of ν:

$$\nu = \frac{(V_p^2 / V_s^2) - 2}{2((V_p^2 / V_s^2) - 1)} \quad (10)$$

where V_p is compressional wave velocity
and V_s is shear wave velocity

In the Zedex tests at Äspö V_p was measured to about 6000m/sek and V_s to about 3400m/sec (NGI 1995). If these values are used in the above equation, we get a value for ν of 0.26, which is almost identical to the mean value from the laboratory tests performed by SKB. Since the rock mass quality is rather uniform at Äspö, we consider 0.25 as a general representative dynamic Poisson's ratio value. In the weakness zones the dynamic Poisson's ratio is likely to be higher than 0.25.

Experiences from seismic measurements show that the relation V_p/V_s will increase with increasing degree of fracturing which will result in increasing dynamic Poisson's ratio values.

Domenico (1984) gives the relation V_p/V_s for some sedimentary rocks. In shale for example, V_p/V_s may vary from 1.70 to 3.00. The measurements at Äspö shows V_p/V_s = 6000/3400 = 1.76. The weakness zones may be compared with a fractured shale, and for a value of $V_p/V_s = 3$ the dynamic Poisson's ratio will be 0.44 when equation 10 is used. Based on this, it is proposed to give the weakness zone a general dynamic Poisson's ratio value of 0.3, and 0.4 for the central clay zone in NE-1. These values must however be considered as uncertain.

4.7 Evaluation of the data quality

4.7.1 General

The equations used for estimation of various rock mass parameters are associated with uncertainties. However, in view of the lack of direct measurements/tests (which would have been expensive and complicated), several of the available equations are used. The basis for the estimation of various rock mass parameters is either Q or RMR, and the reliability of these input data is discussed in this section.

Since the data used in the model are from different sources, they will be of varying quality. The Q and RMR-values have been derived differently. Both the Q- and RMR-system are designed for tunnel mapping, and therefore data from tunnel mapping should be most reliable. Q and RMR can also be used for core logging, but some of the parameter values will then be more uncertain. Therefore the Q- and RMR-values from core logging must be considered as more uncertain than those from tunnel mapping. A considerable part of the Q-values have been back-calculated from core logs only containing RQD values. In such cases the data reliability will be even more reduced.

4.7.2 Tunnel mapping

The tunnels have been mapped by SKB by use of the RMR-system. In addition NGI has mapped the Zedex test tunnel (38m) and the first 50m of the TBM tunnel using both the Q and RMR-system.

Q and RMR data from tunnels can be considered generally as reliable. But there are still some sources of errors. To some degree the data are dependent of the experience of the observer, and some of the parameter values may be difficult to determine, especially in TBM tunnels. In tunnels with low overburden the water leakage into the tunnel may be dependent of the precipitation. For deep tunnels this will not be the case, and the water leakage observed in the Äspö tunnel should therefore give a correct J_w in the Q-system. However, grouting has been carried out in the tunnel, and the observed leakage may therefore be different from the virgin situation. The stress conditions (SRF in the Q-system) may sometimes be difficult to evaluate. Generally stress will increase with increasing depth, but the situation may be more complicated because of an anisotropic stress field. Sometimes stress problems occur immediately after excavation (rock burst), but in other cases spalling caused by stress may occur months after excavation. At Äspö, however, both observations in the tunnel and the

σ_c / σ_1 ratio indicate an SRF-value of 2 for tunnel design. In Model B the stress situation is considered independent of any excavation and high stresses and tight structure are considered, giving SRF = 0.5.

Similar to the Q-mapping, it is difficult to evaluate the quality of the RMR mapping done by others if the details are not available. This is specially the case for TBM-tunnels.

Mapping of TBM tunnels is usually more difficult than drill and blast tunnels. The walls in a TBM tunnel are usually smooth, and it may therefore be difficult to make observations of fractures. This means for the Q-system that the evaluation of RQD, J_r, and J_a will be more uncertain than in drill and blast tunnels. Generally the Q and RMR values tend be higher in TBM- tunnels compared to tunnels driven by drill and blast (D&B). This is because the blasting may create new fractures, and originally closed fractures may be opened. By definition only natural fractures shall be taken into account for calculation of RQD. When using the Q-system in tunnels, all fractures have to be considered natural. This means that RQD-values generally may be reduced by blasting.

This effect has been studied by Løset (1992) in the Svartisen road tunnel in Northern Norway. In this tunnel 4.6km were at first excavated by TBM with a diameter of 6.3m. The circular cross-section of the TBM tunnel was subsequently enlarged by drill and blast to a horseshoe cross-section. The rocks in this tunnel are mica gneiss, meta-sandstone and marble. The tunnel was mapped by use of the Q-system both before and after the blasting. It was observed that the blasting reduced the Q-value. The mean Q-value before blasting was 20.5, after blasting 18.5. A more detailed study showed that the reduction of the Q-values only occurred in relatively short sections where the Q-values before enlargement ranged from 4 to 30. In some sections the Q-values were reduced to about the half. The reduction in the Q-value was mainly caused by reduction of RQD. But in some places the J_a values were underestimated in the TBM tunnel, since it was difficult to observe clay on the fractures. Some problems for the Q-mapping were caused by the fact that spalling caused by high stresses occurred several weeks after excavation. Mapping shortly after excavation, underestimated the SRF values.

At Äspö it is possible to make some comparison between TBM and drill and blast. The Zedex test tunnels were excavated by D&B and by TBM. The D&B tunnel is parallel to the TBM tunnel, and the distance between the two tunnels is about 25m. Since the geology in the area is homogeneous, the rock masses in the two tunnels should be almost of identical quality. Table 7 shows the distribution in Q-values in the Zedex D&B tunnel and in the upper 50m of the TBM tunnel where they run parallel.

Table 7 Distribution of Q-values in % in D&B and TBM tunnels

Q	D&B (38m)	TBM (50m)
4-10	21	0
10-15	11	0
15-20	0	70
20-25	39	30
25-30	29	0

Table 7 shows a considerable difference between the two tunnels. This difference might be caused mainly by the excavation method, but the fact that mapping is more difficult in a TBM tunnel should also be taken into consideration.

Based on the RMR mapping by SKB we can compare the whole TBM tunnel of about 400m length with the main D&B tunnel from the starting point of the TBM and 400m upwards:

Table 8 Distribution of RMR values in % in TBM tunnel and in preceding D&B access tunnel

RMR	TBM tunnel, 400m	D&B tunnel, 400m
81-100	19	10
61-80	74	64
41-60	7	17
21-40	0	9

The two tunnels are not driven in the same rock masses, and the D&B tunnel is partly outside the NGI model. However, since the rock mass quality in the area is rather uniform, some of the differences in RMR values are probably caused by the excavation method.

It can be concluded that the Q and RMR-values found in TBM tunnels are nearer to the "virgin" Q and RMR-values for the rock mass, if correct observations of fractures are made, than the values found in D&B tunnels. However, the values in a D&B tunnel will be relevant for the stability situation in that type of tunnel.

4.7.3 Q and RMR logging of drill cores

Several of the input parameters for Q and RMR calculation may be more difficult to determine from drill cores than from tunnel mapping, and the Q and RMR values from drill cores will therefore be more uncertain.

RQD can be directly measured from drill cores. The direction of the borehole will influence the result. Fractures parallel to the borehole will be underrepresented in the core, and the RQD value measured in the cores may in such cases generally be too high. If the borehole is going along a fracture zone, the RQD-value from the core may be low compared to the general value in the rock mass. The same will be the case for J_n. It is therefore important during core logging to evaluate the J_n-value over core sections of several metres in length, because one or two fracture sets might be missing in shorter sections.

Since only small sections of a fracture can be studied in a core, it may be difficult to determine the J_r-value. Soft minerals such as clay may be washed away from the fractures during drilling. Consequently J_a-values determined by core logging may be too low.

J_w and SRF can not usually be determined directly from core logging. Permeability tests and observations during drilling the boreholes may, however, give an indication of the J_w-value. For the Model A, J_w- and SRF-values are mainly based on tunnel observations, whereas the values for Model B is based on a more general evaluation.

It is possible to compare Q-values from core logging and tunnel mapping. Around the Zedex D&B and the TBM tunnels there are many boreholes, and the cores were logged by NGI. The so-called A, B and C holes have a total length of about 775m. The results from these holes are compared to the results from the Zedex tunnel mapping in Table 9.

Table 9 Distribution of Q-values in % in boreholes and in the Zedex tunnels

Q	Boreholes A,B,C, 775m	D&B tunnel (38m)	TBM tunnel (50m)
<4	1	0	0
4-10	12	21	0
10-15	15	11	0
15-20	26	0	70
20-25	20	39	30
25-30	14	29	0
>30	12	0	0

What can be seen from Table 9 is that the boreholes show more evenly distributed Q-values compared to the tunnels. The boreholes and the tunnels are placed in an almost homogeneous regional geology, but the boreholes include a larger volume of rock. The small variation in rock mass quality in the TBM tunnel may partly be caused by the already mentioned difficulties to determine the different parameter values.

4.7 4 Q-values derived from RQD

The cores logged by SKB contain RQD as the only Q-parameter, and values are calculated for each metre. To get data for the model it has therefore been necessary to estimate Q-values from RQD. The principles for this estimation are described in Chapter 4.1. Generally an estimation of Q from RQD only, will be rather uncertain. NGI has logged several boreholes at Äspö by the Q-method, and the principles for transformation of RQD into Q are based on experiences from this logging. Since the values of the Q-parameters seem to be rather uniform in the model area, the determination of Q from RQD is considered as relatively reliable, but will of course be more uncertain than direct logging of the Q-values.

This method for estimation of Q-values from RQD is tested by comparing Q-values estimated from RQD with logged Q-values of the same cores logged by NGI. From Borehole KA2598A four sections have been selected for such comparison. The result is shown in the Table 10:

Table 10 Q-values logged from RQD compared with Q-values directly logged from cores in Borehole KA2598A

Section in KA2598A	Q from RQD max	Logged Q max	Q from RQD min.	Logged Q min	Q from RQD mean	Logged Q mean
9-56m	18.8	17.8	9.4	4.0	16.2	10.9
56-76m	18.8	8.9	0.3	0.2	7.9	3.1
109-151	18.8	17.8	9.4	7.9	14.3	12.2
245-272	18.8	75	18.8	18.8	18.8	30

As can be seen from Table 10 the two methods give some differences. However, the Q-values calculated in different ways fall into the same rock mass class, with the exception of Q_{max} in the sections 56-76m and 245-272m.

In short sections of cores the two methods of determining Q-values can give quite different results. For example a narrow fault zone with unfavourable values for J_r and J_a can be difficult to identify from RQD.

4.8 Volumes of rock-rock mass quality

Rock masses are by nature inhomogeneous, and therefore the properties may vary inside any volume. Since the blocks are as large as $30x30x30m^3$, the Q-values given for such a block will not always be a good description of the rock mass quality throughout the block. Usually Q-values have been used as the basis for the estimation of the rock mechanical properties, and the scale effects and uncertainties can therefore partly be evaluated by study of the Q-values. The data show that there may be some variation in Q-values within a block. This means that there also will be a variation in other properties.

The variation in physical properties within a rock mass will to some degree depend on the volume under consideration. Usually there will be less variation in small volumes than in larger ones. A Q-value can in principle be given for any volume of rock. Since the method is designed for tunnel mapping and tunnel support, the most realistic volumes will be of the same size as the span width of a tunnel (i.e. some metres), or expressed in another way: the rock mass volume that needs a certain type of support. During tunnel mapping, sections that need a certain type of support will be mapped as one unit with a specific Q-value. In such a unit the rock mass quality should be rather uniform and within a certain rock mass class. The realistic area to be given a certain type of support, will usually be of the size of some tens of square metres, less when weakness zones are involved.

For weakness zones, the width of a zone will be vital for the support. A 0.5cm wide zone will usually need another type of support than a 5m wide zone, even if the zones have about the same quality. For a thin zone the supported area will consist of the zone itself plus a couple of metres on each side. In such case the mean Q-value for the total area is vital for the support. For a zone several metres wide the support will be according to the rock mass quality in this zone.

For very small volumes of rocks, for example one cubic meter, the Q-value will not be a realistic measure of rock mass quality. Such a small volume may for example be situated in between the fractures, and the Q-value may therefore be very high. On the other hand such small rock volumes may be more or less inside a weakness zone, and the Q-value may then be very low and only representative for the small volume in question. During core logging one metre is often used as unit for RQD, but if the other Q-parameters are determined for each metre, it will usually not give a realistic Q-value.

For large volumes of rock there will usually be some variation in the rock mass quality, and a mean Q-value for the volume will not necessarily give a good description of the mass. We can for example think of a block with the size $30x30x30m^3$ which is cut by a 2-3m wide weakness zone. In this zone the Q-value may be very low. The mean Q-value for the block may still be high, but the zone may cause serious stability problems for a tunnel. This means that for blocks of the size used in the model, the mean Q-value will not always give a correct picture of the rock mass quality. We have therefore not always used the mean value as the Q-value for a block, but instead calculated the Q_{block}-value in a special way, see Section 4.2. Generally we can say that the block size used in this model is too large to be described by only one Q-value.

4.9 Variation in Q-values inside a block

The rock mass quality is generally rather uniform in the total model area, but inside the blocks some variation occurs quite frequently. In Table 11 the variation of $Q_{min,}$, Q_{max} and the Q_{block} used in Model A is shown. In addition the quantity of data for each block is shown by means of metre of logged drill cores or metre of mapped tunnels. As can be seen, the amount of data varies from 1m to 358m of drill cores for one block. This will of course have influence on the reliability with which the Q-values can be calculated. Based on only one metre of core, it is almost impossible to say what the representative Q-value for the block should be.

Table11 Variation in Q-values and quantity of data in blocks with Q-data or Q estimated from RQD (Model A)

Block	Metre of cores or tunnels (T)	Q_{min}	Q_{max}	Q_{block}
4	16	7.9	12	8
5	39	3.5	17.8	4
6	5	0.15	4	0.3
19	10	8.1	19	12
20	11	12	19	12
35	2	24	24	24
39	7	9.4	19	12
40	10	8.1	19	12
50	30	7.1	17.8	8
55	4	18	18	18
65	36	0.6	19	12
66	8	9.4	19	12
75	14	12	25	16
105	8	5.9	17.8	6
124	7	12	12	12
140	25	12	19	19
143	9	19	19	19
154	16	7.1	18	8
155	99	7.9	75	9
156	13	12	75	12
160	20	2.5	19	11
162	19	10.6	19	12
163	25	12	19	12
164	14	12	19	12
170	30	17.8	23.8	18
174	68+30T	3.1	75	12
175	358+35T	1.8	75	8
176	17+4T	5.9	75	12
177	14	10.6	19	12
178	27	10.6	19	12

Block	Metre of cores or tunnels (T)	Q_{min}	Q_{max}	Q_{block}
179	31	10.6	19	12
180	24	0.06	12.4	0.7
185	2	10.6	19	12
194	19T	2.6	75	12
195	Ca 180+21T	4.1	100	9
196	24	8.9	18	9
204	38	2.5	19	11
205	6	10.6	19	12
245	21	10.6	19	12
246	33	12	19	19
262	17	12	19	12
263	35	12	19	12
264	16	12	19	19
265	35	12	19	12
266	8	12	19	12
281	32	12	19	12
282	57	8.1	19	12
283	111	9.4	19	12
284	43	9.4	19	12
285	2	12	19	12
290	30	5.3	19	6
295	10	24	24	24
302	26	12	19	12
303	39	8.1	19	12
304	74	9.4	19	12
305	4	12	19	12
309	14	1.9	19	11
323	41	1.9	19	11
324	141	0.6	19	12
329	21	8.1	19	11
343	9	19	19	19
344	27	10.6	19	19
390	29	3.5	47.5	4
410	1	5	5	5
422	32	10.6	19	12
423	28	10.6	19	12
444	7	10.6	19	12
462	39	2.5	19	12
463	76	9.4	19	12
464	48	10.6	19	12

From Table 11 it can be seen that there are usually only small variations in the Q-values (min, max, block) within most of the blocks. This will depend not only on the real variation of rock mass quality, but also on the amount of data for a specific block. In 50% of the cases Q_{min} and Q_{max} fall within the same rock mass class, and the Q_{block}-value should then give a good description of the rock mass quality in the block. Some of the lower values of Q_{min} are caused by short core sections with many fractures, and since the sections are short, and thereby make up few observations of the total number of observations, they do not influence much on the Q_{block}-value.

Only four of the blocks have a Q_{min} less than 1:
Block 6 has a Q_{min} of 0.15 caused by a 2m wide fault zone. Since there is totally only 5m of cores from this block, the Q_{block}-value is low (0.3). The Q_{block} -value for the block would possibly have been higher with more available data.

Block 65 has a Q_{min} of 0.6 caused by a fractured zone about 1m wide. This has minor influence on the Q_{block} -value since 36m of cores of better quality have been logged from the same block.

Block 180 has a Q_{min} of 0.06. Most of the 24m of cores from this block is rather fractured and about 2m has RQD = 0. This gives a Q_{block}-value of 0.7.

Block 324 has a Q_{min} of 0.6 caused by a 1-2m wide fracture zone which is only seen in one of the boreholes from this block. Since there is totally 142m of cores from this block of better quality, the fracture zone has only minor influence on the Q_{block}-value.

4.10 Evaluation of the method

For estimation of the rock mechanical parameters Q-values and partly RMR values have been used as a basis. Direct measurements of parameters such as E_m and σ_m are difficult and extremely costly in situ. However, the major benefit of the method used here, is its simple logic, which avoids the impression that complicated mathematical processes allow to penetrate rock mechanical data without sufficient background data.

Table 5 in Section 4.4 shows a comparison of E_m – values calculated in different ways. Even if the differences are considerable, the values are in the same order of magnitude. It is difficult to say if one method is more correct than the other, without calibration with for example plate loading tests.

For estimation of σ_m, equation 9 ($\sigma_m = (\sigma_c / 100) \text{ x } 0.7\text{x } \gamma \text{ x } Q^{1/3}$) has been used, see Section 4.5. If we use mean values in Model A for the different parameters in this equation, we get for example:

$$\sigma_m = (150 / 100) \text{ x } 0.7\text{x } 27 \text{ x } 12^{1/3} \sim 65\text{MPa}$$

As can be seen, this value is considerably higher than those given in Table 6. The major principal stress in the area (σ_1) is in the range 20-40 MPa, and if σ_m is in the same range or even smaller as would be the situation if Table 6 was used, considerable deformations should have taken place. σ_m-values calculated from equation 9 are therefore considered as realistic.

Concerning Poisson's ratio (ν), both laboratory tests and dynamic calculation from V_p / V_s measurements give about the same results, and a value of about 0.25 is therefore considered to be valid for most of the rock masses at Äspö, see also Section 4.6. In the model area there exist only V_p and V_s values from rock masses of good quality, i.e. in the Zedex test area. For the weakness zones the values of Poisson's ratio are uncertain. The ratio V_p/V_s will usually be higher in more heavily fractured rock masses than in rocks with fewer fractures. By use of equation 10 Poisson's ratio will increase when the V_p/V_s ratio increases. The equation is not necessarily valid for all types of rock masses, but higher values of dynamic Poisson's ratio have been stipulated in the weakness zones than for the good quality rocks.

If we consider these methods for estimation of rock mass properties as reliable, the main uncertainty will be related with the input data, i. e. Q-values or RMR-values. As described before the quantity and quality of Q- and RMR data varies throughout the model. Generally a type of mean Q-value for each block has been used as a basis for the calculations. For blocks with only small variation in the Q-parameter it seems rational to use the real mean Q-value, i. e. $Q_{block} = Q_{mean}$. In blocks with considerable variation in the Q-parameters it is not so clear which Q_{block} -value should be used. By calculation of the Q_{block}-value the mean RQD has been used. For J_n, J_r and J_a the most unfavourable values have been used if the number of observations of these minimum values make up more than 10% of the total number of observations. The reason for this is that the unfavourable parameter values will be vital for the rock mass quality if they appear with some frequency and have an unfavourable orientation in relative to loading. Whether a frequency of 10% is the correct threshold value, can of course be discussed. If for example a block is intersected by a 3m wide weakness zone, this zone may constitute about 10% of the rock mass in the block. If a tunnel crosses this block, it is very probable that the zone will have consequences for the tunnel, i.e. the tunnel support will more or less be controlled by the rock mass quality in this zone. In what way this should be considered if we disregard any tunnel, is a matter of discussion. It should also be stated that in drill cores, the values of J_n and J_a may be underestimated. Even if only a minor part of a drill core has $J_n = 9$, i. e. three fracture sets, it is likely that three fracture sets are present in a larger rock volume than the logging is suggesting.

For blocks with no data it seems reasonable to use the mean of the Q_{block}-values of the neighbouring blocks. For blocks with no neighbouring blocks with data it seems reasonable to use the mean Q_{block}-value for the model area since the rock mass quality seems rather uniform. For these blocks the Q-value therefore has been estimated to 12 in Model A, and in Model B the Q_{cha}-value has been estimated to 32 or 48 depending on the J_w-value. These assumptions may not be valid for all blocks, and a more sophisticated method based on some type of probability calculation could be developed.

4.11 An alternative model (Model B)

After a review of NGIs draft report, SKB requests an alternative model, which we have called Model B. This model shall be based on pure characterisation, i.e. a model where tunnels and tunnel design are ignored. This means that the intention with Model B is to describe the virgin state in the rock masses. Model B will generally be based on the same data set and involve the same volume of rock as the first model.

The purpose of this project is to describe a certain volume of rock by means of different parameters such as E_m , σ_m and Poisson' ratio. As we understand it, the project does not include a characterisation of the rock masses by means of the Q-system or any other classification system. By working with the first model, we came to the conclusion that Q-values were the best basis for estimation of several of the parameters. This means that Q-values had to be estimated, and therefore the models also contain a rock mass characterisation by means of the Q-system.

The Q-system is an empirical method developed for tunnel design, and it could therefore be questioned if the Q-system is adequate for pure characterisation. We think that with some modification the Q-system can be used, and since our data is mainly based on the Q-system, it is convenient to use this system also for Model B.

As mentioned some modifications of the Q-system are necessary for use in pure characterisation. The first four parameters in the Q-equation RQD, J_n, J_r and J_a are independent of any tunnel, and therefore these parameters are used in the same way in Model B as in Model A. The parameters J_w and SRF can be said to depend on both the virgin state of the rock masses and the situation around a tunnel and can therefore not be used in a pure characterisation without reservations. A simple solution could therefore be to disregard these parameters, and base the characterisation on a Q' – values, i.e. Q-values based on RQD, J_n, J_r and J_a. The values for J_w and SRF are in such cases set to 1.

Both the water condition and the stress situation have in some way influence on the rock mass properties, and therefore it may not be correct to disregard the parameters J_w and SRF. In laboratory tests on rock samples it is usually seen that the triaxial strength is higher than the uniaxial compression strength, and the triaxial strength will usually increase with increasing confined pressure. This should also to some degree also be valid for σ_m. This means that the values of σ_m will generally increase with increasing depth when the other properties of the rock mass are similar. If we based on this theory shall estimate σ_m by means of equation 9, increasing Q-values with increasing depth should be needed. Usually the Q-values below a certain depth will be reduced, because the SRF-value will increase with increasing stress if we consider a tunnel. This means that ordinary Q-values can not be used in this case. Some other reservations must also be taken. In case of an anisotropic stress situation the relation between stress and σ_m is not so clear. To make it even more complicated: rock masses usually contain fractures. The shear strength of fractures and fracture orientation will therefore also have some influence.

A quite different way to consider this problem, is to say that rock masses at great depths will already to some degree be loaded, and the extra load this masses can bear, will then be reduced compared to a rock mass less loaded. If we look at it in this way, the ordinary Q-values with increasing SRF with increasing depth may fit for an estimation of $\sigma_{m,}$ and this is the case in Model A.

Since there are few results from direct measurements of E_m and σ_m, it is difficult to know what the correct values should be, and it is therefore also difficult to say which method for estimation is the best. In Model B we have used a method recommended by Nick Barton. This method is based on the assumption that the values of σ_m and E_m generally increase with increasing stress. This means that the ordinary way of using the Q-system can not be used. Barton proposes a modified version with SRF-values different from those used for tunnel design. In this version SRF-values decrease with decreasing depth in the following way:

Depth 0-25m	SRF = 2.5
Depth 25-250m	SRF = 1.0
Depth below 250m	SRF = 0.5

Since the model is situated below 380m, the SRF-value according to this will be 0.5. The SRF-value in the model area when tunnel design is considered, is considered to be 1-2, and the value of 2 has been chosen in Model A. This means that we get two sets of Q-values: the ordinary Q-values for tunnel design, and Q-values for pure characterisation. We think that this situation may lead to some confusion, and we therefore have used the name Q_{cha} for the Q-values used for pure characterisation in Model B.

It is probable that J_w also will have some influence on the values of E_m and σ_m. We think that the J_w-values concerning characterisation will not be very different for from those concerning tunnel design. In Model B we have therefore used the same general principle for estimation of J_w as for Model A. We have, however, made some modifications that we think will give a more realistic picture of the water conditions.

The data from Äspö shows that large volumes of rock are dry, indicating $J_w = 1$. The value 1 has therefore been used as a basis for the model. Locally, considerable quantity of water occurs, indicating $J_w = 0.66\text{-}0.5$. Water occurs along the major weakness zones and certain fractures or fracture zones, especially fractures parallel to σ_1, i.e. NW-SE. Therefore, for the blocks affected by the major weakness zones and those of the minor weakness zones striking NW-SE, the J_w- value is stipulated to 0.66. It could of course be discussed if some of the zones should have a J_w-value of 0.5, but this will in any case have little influence on the model. It should also be naturally to think that J_w to some degree will depend on RQD and J_n. Studies on data from boreholes in Norway show no clear connection between RQD and Lugeon values (NGI 1999), and we have therefore not gone further with this problem.

For estimation of E_m and σ_m we have in principle used the same equations in Model B as in Model A. But as recommended by Nick Barton we have used:

$E_m = 10 \text{ x } Q_c^{1/3}$ (5b)

instead of $E_m = 10 \text{ x } Q^{1/3}$ (5)

This means that the Q-value is modified according to the rock compression strength, i. e $Q_c = 150/100 \text{ x } Q$.

Barton also discusses the equation for estimation of σ_m.

$\sigma_m = (\sigma_c / 100) \text{ x } 0.7\text{x } \gamma \text{ x } Q^{1/3}$ (MPa) (9)

(where γ is given in KN/m^3)
In this connection he mentions an equation he has developed for description of TBM cutter penetration:

$\sigma_m = 5 \gamma Q_c^{1/3}$ (Barton 2000) (11)

(where γ is given in tnf/m^3)

Bartons equation is based on an orientated RQD for calculation of Q_c. Since we do not have such data, we have used equation 9 also in Model B.

As can be seen from Table 12 Equation 11 gives consequently lower values for σ_m than equation 9.

Table 12 Estimation of σ_m by different equations (γ = 27 KN/m^3 or 2.7 tnf/m^3) and c_c = 150 MPa)

Q	σ_m MPa from Eq. 9	σ_m in MPa from Eq. 11
100	130	93
80	120	86
40	96	68
20	76	54
10	61	43
1	28	20
0.1	13	10
0.01	6	3

For 23 blocks in the model only RMR-data exists. In Model A this data has been transformed to Q-values for estimation of σ_m. This transformation is connected with some uncertainty, and we have not data on the relation between RMR and Q_{cha}. In Model B we have therefore omitted the RMR-data and based the model on the 70 blocks where Q-data are available.

5 DATA PRESENTATION

The Q/RMR data and the estimated parameter values for each block in the models are shown by means of spreadsheets in Appendix A. In addition the Q-data for each block are presented by means of histograms showing the variation in the different Q-parameters and Q_{min}, Q_{max}, Q_{mean} and the Q-value used for the blocks, Q_{block}.

The model is illustrated by figures showing the blocks in the different layers. The four horizontal layers of the models are shown as figures where each block is reproduced as squares with 120 blocks in each layers. In the same way there are longitudinal, vertical sections with 80 blocks in each section. The data for the different blocks are written inside the squares. For the Q-values three colours have been used: black for Q-values from drill cores or tunnel mapping, blue for Q-values extrapolated from neighbouring blocks and red for blocks without data where a mean value has been used. In addition the different ranges of Q-values, E_m and σ_m are shown in the figures by means of colour coding.

For Q the ordinary rock mass classes are used for the colour coding:
Q 0.01-0.1
Q 0.1-1
Q 1-4
Q 4-10
Q 10-40
Q > 40

For E_m the following ranges are used for the colour coding:
E_m < 10 GP
E_m 10-20 GPa
E_m 20-30 GPa
E_m 30-40 Gpa
E_m >40 Gpa

And for σ_m the following range is used for the colour coding:
σ_m < 40 MPa
σ_m 40-55 MPa
σ_m 55-70 MPa
σ_m 70-95 MPa
σ_m > 95 MPa

The areas where the major weakness zones may occur, are defined by read lines, and the areas are given pale colours. In these "pale" areas the weakness zones are expected to be found, but they are not necessarily occupying the whole "pale" areas. The parameter values for blocks affected by the major zones are generally estimated from data coming from the block itself and are therefore not necessarily describing the weakness zone. The parameter values expected to be valid for the weakness zones are showed in squares outside the drawing of the model. The minor weakness zones are indicated by dotted, blue lines.

6 GEOLOGICAL INTERPRETATION

6.1 Rock types

The main rock type in the model area is the Äspö diorite. In addition there are some dikes and lenses of granite. Both the granite and the diorite have nearly the same mechanical properties. There are also some irregular lenses of greenstone which may be somewhat different from the other rocks concerning mechanical properties. In some of the blocks the properties to some degree may be dependent on the greenstone, but since detailed data on the position and size of the greenstone lenses are insufficient, this has not been evaluated.

6.2 Major weakness zones

Three major weakness zones called NE-1, NE-2 and EW-1 cross the model. The location of these zones has been given by SKB by showing areas where the zones are likely to be encountered. The data from the zones are mainly from boreholes which are mainly located outside the model area.

<u>Zone EW-1</u>
This zone can be regarded as a part of the approx. 300m wide low-magnetic zone trending NE, which divides Äspö into two blocks (Stanfors et al. 1997). It seems to be a complex fracture zone with two branches with very intense fracturing, mylonitization and hydrothermal alteration. The rock mass between the branches is more or less altered, especially at the surface. The interpretation of the zone is based on lineament interpretation,

outcrop observations and various boreholes. The existence of the zone at the depth of the model is therefore unsure.

The zone is found in Borehole KAS04 at 54-70m and 175-190m depth (elevation –40 and –140m) and in Borehole KA1755A at 90-100m and 198-210m depth (elevation –270 and –305m).

From the core logs the following Q-values have been estimated for this zone
(see Histogram A 71):
Q_{min} = 0.008
Q_{max} = 12.4
Q_{mean} = 2.4
A Q-value of 1.8 has been proposed for this zone by using the same principles as for the individual block in the model, however the rock mass quality will vary inside the zone.

<u>Zone NE-2</u>
The zone crosses the spiral tunnel at 1601, 1844 and 2480m (elevation –220, -280 and –340m). RMR-values of 40-60 have been mapped (Markström and Erlström 1996).
The strike is NNE/NE and dip 75-80^{o}SE. It is a 1-5m wide mylonite zone containing crushed and highly altered rocks.
The zone probably occurs in the vertical shaft as a 10m wide mylonite zone.
Borehole KAS04 cuts the zone at 431-438m depth (elevation – 352 to -358m). The following Q-values have been estimated from the drill cores in the zone (see Histogram A 72):
Q_{min} = 1.9
Q_{max} = 7.8
Q_{mean} = 5.0
A Q-value of 5 has been calculated for this zone by using the same principles as for the individual blocks in the model.

<u>Zone NE-1</u>
The zone is about 60m wide and consists of three branches. The strike is N50-60^{o}E and dip 70-75^{o}NW (Stanfors et al. 1997). The two southernmost branches are highly fractured and more or less water-bearing. The northern branch is about 20m wide in the tunnel and highly water-bearing. An 8m wide part of this branch has open fractures with a few centimetres in width. This branch contains partly clay-altered rock and is surrounded by 10-15m wide sections of more or less fractured rock. A central section of 1 metre is completely altered to clay. The zone has been mapped by SKB in the tunnel between 1240-1320m (elevation about –200) (Markström and Erlström 1996), see Table 12 :

Table 13 KB Mapping of zone NE-1 in the tunnel

Tunnel length	RMR	Q (Eq. 1)
1240-1250	40-60	0.2-4
1250-1260	20-40	0.01-0.2
1260-1268	40-60	0.2-4
1268-1272	60-80	4-100
1272-1276	40-60	0.2-4
1276-1280	20-40	0.01-0.2
1280-1297	40-60	0.2-4
1297-1302	20-40	0.01-0.2
1302-1303	<20	<0.01
1303-1310	20-40	0.01-0.2
1310-1320	40-60	0.2-4

Borehole KAS02 cuts the zone between at 805-923m depth (elevation -795- -912m). The following Q-values are estimated from the drill cores (see Histogram A73):
Q_{min} = 0.01
Q_{max} = 12.4
Q_{mean} = 3.2

According to the general principles for the calculation of Q-values for the individual blocks, a Q-value of 3 is generally used for the zone, but since there is a central clay zone of 1m width, the minimum Q-value of 0.01 is used for this central part of the zone.

6.3 Minor weakness zones

From the data 8 minor weakness zones have been identified. In the model this zones have been named MWZ 1-8.

MWZ 1,2 3
At chainage 3060, 3080 and 3090 (block 38 and 39) three minor fracture zones cross the tunnel (Markström and Erlström 1996). The zones have little influence on the rock mass quality since RMR is 60-80, i.e. good. The zones seem to be striking about NW-SE. MWZ1 is dipping steeply to the SW, MWZ2 dips steely to the NE and MWZ3 dips steeply to the SW. These zones can probably be correlated with a fractured section between 47 and 69m in Borehole KA3105A (block 180). In this borehole the RQD-values varies, and two metres of cores have RQD = 0. One of the zones may also be correlated with a fracture zone at the chainage 2920 in the tunnel.

MWZ 4
In the Zedex tunnel (block 175/195) there is a 3-4m wide fracture zone with Q about 5. The zone dips nearly vertical and has a strike direction about NW-SE.

MWZ 5
In the TBM tunnel at chainage 3230 there is a thin fracture zone striking SW-NE and dipping steeply to the SE.

MWZ6
In the tunnel extension to the left at chainage 3380-3390 (block 389/309) the RMR-value is 61 (Markström and Erlström 1996). This seems to be caused by some water bearing fractures striking NW-SE. In the tunnel parallel to the TBM tunnel at chainage 3430 (block 268/288) the RMR-value is 63. It seems probable that these rather low RMR-values are caused by a fracture zone striking NW-SE and dipping nearly vertically.

MWZ7
In the TBM tunnel at chainage 3465-3475 , block 306, the RMR-value is in the range 40-60 i.e. fair. No fracture zone is here indicated, but there are some water bearing fractures striking NW-SE which indicate a minor zone with this orientation.

MWZ8
In the TBM tunnel at chainage 3520, block 284, a fracture zone with thickness of some metres is indicated. The zone is striking NE-SW and dipping nearly vertical. In the tunnel parallel to the TBM tunnel at chainage 3500, block 265, a fracture zone also striking NE-SW and with RMR-value 57 occurs. It is probable that this is the same zone as the zone in the TBM tunnel, i.e. MWZ 8.

7 ÄSPÖ IN SITU STRESS MODEL

7.1 Input data

7.1.1 General

The conceptual stress model is based on existing stress measurement data found in SKB reports and in the SKB data base SICADA. Full details of the data from the SICADA data base are presented in Appendix B.

Available data are unevenly distributed in the model Block, Figures 11 to 20. Data from 8 series of overcoring tests are available in or on the border of only 14 of the 480 cubes. Data from 4 hydrofracture tests are only available in or on the border of 4 cubes. Four additional hydrofracture tests close to the model Block have also been used to determine the local trend with depth.

7.1.2 Stress Data

The sources of stress data that has been used in developing the model are summarised in Table 14.

Table 14 Summary of stress measurement data sources in or adjacent to the Model Block

Borehole	Depth of tests in BH (m)	No. of tests	Method	Reliability	Comments
KAS02	339 – 515	8	Hydrofracture	2D – minimum	Surface
KA3068A	16,18+	3	CSIRO	3D	Ramp
KA3579G	20,06+	4	Borre	3D	Prototype
KXZSD8HR	12,9 – 20,2	7	Borre	3D	Zedex-TBM
KXZSD8HL	23,4 – 25,4	4	Borre	3D	Zedex
KK0045G01	31,7-35,5	3	Borre	3D	K-Tunnel
KK0045G01	62,8 – 64,5	3	Borre	3D	K-Tunnel
KZ0059B	7,8 – 14,7	6	CSIRO	3D	Zedex –TBM
KF0093A01	32,14 – 35,38	3	Borre	3D	

7.2 Methods of stress measurement

7.2.1 General

The stress in a rock mass is a tensor quantity which is defined at a point in a continuum. There is no method available for measuring the rock stress tensor directly at a point. Existing techniques use indirect methods to measure the average stresses over a volume of rock.

For practical engineering purposes the stress tensor, averaged over a reasonably large volume of rock equivalent to the scale of the excavation, is required.

The stress tensor is normally described in terms of the three orthogonal principal vectors (σ_1, σ_2 & σ_3), their magnitude, direction with respect to North (Äspö) and plunge (downward positive). Alternatively the stress tensor may be described in terms of the stresses and shear stresses (σ_{xx}, σ_{yy}, σ_{zz}, τ_{xy}, τ_{xz}, & τ_{yz}) with respect to the local axes X(=Äspö N), Y, Z – right hand system. In order to compare results between hydrofracture and overcoring tests the stress tensor may be described in terms of the vertical stress and maximum and minimum horizontal stresses (σ_v, σ_H, & σ_h).

7.2.2 Types of measurement

Full details of the stress measurement procedures are provided in the SKB reports and summarised in Lundholm (2000a). The following comments summarise some of the specific attributes of the different methods relevant for interpretation of the stress model.

<u>Hydrofracture</u>
The hydrofracture method is the most direct method for measuring the minimum principal stress provided that the borehole is parallel to a principal stress (not the minimum). The method measures stresses averaged over a reasonably large volume of rock – of the order of 1 m^3 or more. However while the minimum stress may be reasonably accurately determined by the shut-in pressure (depending on interpretation method) provided the borehole is parallel to a principal stress (as indicated by orientation of the fracture from impression tests), the determination of the maximum stress is subject to large errors due to multiplication of errors

in minimum stress and determination of hydrofracture tensile strength or reopening pressure. Measurement error may especially occur when the ratio of principal stresses perpendicular to the borehole is greater than 2:1 (which appears to be the case at Äspö). In this case the stress concentration on the borehole wall is such that the fracture begins to reopen with an hydraulic pressure of less than the shut-in pressure and the correct re-opening pressure is therefore very hard to detect.

Relatively close to a flat ground surface, as on Äspö, it is expected that the principal stresses are oriented vertically (perpendicular to the free surface) and horizontally. Normally, therefore, the stresses are measured in a vertical borehole and, provided vertical (axial) fractures are induced, the stresses measured or interpreted will be the minimum and maximum principal stresses.

The orientation of the maximum horizontal principal stress is taken to be parallel with the induced fracture.

No information is obtained on the stress parallel with the borehole. In the case of a vertical borehole the vertical principal stress is calculated from the weight of the overburden.

CSIRO Cell
The CSIRO cell determines the three dimensional state of stress in one overcoring operation. It consists of several strain gauge rosettes mounted in a plastic cylinder which is glued into a pilot hole before overcoring. The strain gauges indirectly record the strain due to relaxation of stress under overcoring at several different points around the circumference of the pilot hole. These strain gauges are not in intimate contact with the rock which may have the advantage that it tends to lessen the sensitivity to local stress disturbances due to large crystal grains or small cracks in the rock.

The cell has been used by many practitioners for many years and is generally considered a reliable instrument. Problems can occur if the bond between cell and pilot hole is not perfect. This is generally indicated when one of the principal stresses is oriented parallel to the borehole. There are more than the required minimum number of strain gauges to determine the stress tensor and so redundant information is obtained which can be used to give an indication of the reliability of the measurements.

The results at Äspö have been presented in the SKB reports as individual results for each test with a measure of the standard error for each component, and also an average derived from all the tests in a borehole, again with standard error for each component. The standard error may be considered as a measure of the local variability of the stress field or rock properties but also includes errors due to inaccurate readings.

Borre Probe
The Borre Probe also determines the three dimensional state of stress in one overcoring operation. It consists of strain gauge rosettes that are glued directly to the wall of the pilot hole before overcoring. The strain gauges are therefore in intimate contact with the rock which tends to make it sensitive to local stress disturbances due to large crystal grains or small cracks in the rock. The probe can be used in longer boreholes than the CSIRO cell and tests may therefore be made in rock far from the tunnel with stresses undisturbed by excavation.

The results at Äspö have been presented in the SKB reports as individual results for each test and also an average derived from all the tests in a borehole in terms of the principal stresses. No statistical information is available.

7.2.3 Scale effects

The in situ stress in the rock mass will vary widely as a rock mass is not an homogeneous and isotropic medium. Measured over the scale of the component crystals the stresses will vary due to irregular crystal contacts, differing moduli of the component mineral crystals, orientation of the anisotropic crystals, microfractures etc. Measured over a larger scale, over 10× crystal size, the stresses will vary due to fractures in the rock mass and other inhomogenuities giving rise to variable rock mass modulus.

With overcoring methods the stresses are measured indirectly (strain caused by release of stresses) over a small volume of rock (of the order of 0,001 m^3). The results are affected therefore by changes in modulus, inhomogeneities, and anisotropy (down to crystal size), giving rise to a large spread of individual test results.

The Hydrofracture method measures stresses averaged over a much larger volume of rock, (of at least the order of 1 m^3). Similar results (for minimum horizontal stress) are often found in adjacent tests, but tests 10m apart may show large variations from the mean (up to 30% even in apparently homogeneous rock).

7.3 Stress measurements at Äspö

7.3.1 Data availability

Before excavation
Prior to excavation, stress determinations were made in 3 deep boreholes. Hydrofracture tests were conducted in boreholes KAS02 and KAS03 and overcoring using the Borre probe in KAS05. Only four of the hydrofracture tests in KAS02 were made inside the Block.

During excavation of the incline and spiral
Several measurements were made by overcoring using the CSIRO cell in short boreholes (BH's KA1045A, KA1054A, KA1192A, KA1623A, KA1625A, KA1626A, KA1899A, KA2198A, KA2510A, KA2870A, KA3068A) drilled in test niches. Only the tests in KA3068A lie within the model Block and the others are therefore of little direct relevance to this work, but they have been used to evaluate the reliability of the data. Some of these tests may have been conducted too close to the zone of stress disturbance caused by the tunnel/niche excavation. The tests in KA3068A, however, were conducted more than 16m from the tunnel wall and are therefore unlikely to have been made in the zone of significant stress disturbance.

Within the laboratory
Most of the tests in this area were conducted by overcoring using the Borre probe (BH's KA3579G, KXZSD8HR, KXZSD8HL, KZ0059B(CSIRO), KK0045G01 & KF0093A01). Supplemented recently by overcoring the 2D borehole doorstopper in one location (KA2599G01). All of these tests are inside the model Block. Some of the individual tests

were made close to the excavations to investigate the distribution of stress around the openings and are therefore not relevant to the present study.

7.3.2 Data selection and interpretation

All the available data were first collected from reports and from the SICADA data base.

<u>Assessment of all the data – magnitude</u>
Plots of maximum principal stress and minimum principal stress averaged for each series of tests are presented in Figures 21 to 23.
These indicate that:

- There is a trend for principal stresses increasing with depth, but the trend does not appear to be a simple linear relationship (Figure 21 and 23).

- Down to 500 m depth the stresses measured by hydraulic fracture tests in two holes are consistent (Figure 21 and 23). Below 500 m depth there appears to be a break in continuity with high stresses below this depth as measured by hydraulic fracturing in two boreholes (there are no overcoring tests at depths greater than 500 m depth) and the results are no longer consistent between the two hydraulic fracture holes.

- The minimum principal stresses measured by overcoring are consistent with the minimum stresses measured in the hydrofracture tests (Figure 21). However the orientation of the minimum stresses measured in the overcoring tests is often very divergent from the horizontal values interpreted from the hydrofracture tests, this is discussed in the next section.

- The intermediate(σ_2) and minimum(σ_3) principal stresses measured in overcoring are similar and close in value to the vertical stress calculated from the weight of overburden down to 300 m depth. Between 300 and 500 m depth these stresses vary widely compared to the calculated vertical stress (Figure 22).

- The maximum principal stresses measured by overcoring are generally much greater than the maximum stresses calculated from the hydrofracture tests (Figure 23).

The results of individual tests from within one borehole show a considerable degree of scatter. In view of the large variability of individual tests the mean values of a each series of tests has been used for further interpretation of the data. This effectively increases the volume of rock for the measurement and reduces the large variability of the individual test results due to local and small scale effects.

Using the statistical data presented in the reports from tests conducted with the CSIRO cell, Lundholm (2000a) used a Monte Carlo approach to determine the 95% confidence limits for the mean value. A similar approach was adopted to confirm Lundholm's results and was applied on a additional series of tests with the CSIRO cell (KZ0059B). Figures 21 and 23 show the mean and 95% level of confidence for the minimum and maximum horizontal stresses for these tests (note that on these figures the minimum and maximum <u>principal</u> stresses are plotted, but the 95% confidence limits are for the minimum and maximum <u>horizontal</u> stresses).

Results of overcoring tests from 8 boreholes and 8 hydrofracture tests in one borehole lie within or close to the Block. The large spread in magnitudes and poor distribution over the model Block make identification of trends (except in the vertical direction for the hydrofracture tests) uncertain.

The relationship with modulus inhomogeneities in the rock is also complex and so, even if the variations in modulus was known, it is not possible to estimate the effect on the stresses without substantial numerical modelling and extensive additional testing. It is therefore considered that the best that can be achieved from the present data in practice is an estimate of the range of stresses likely to be encountered at the level of each layer of cubes.

In view of the apparent non-linear trend of the stresses over the whole depth range of the data, the relationship between stress magnitudes and depth has been determined from the overcoring tests from 8 boreholes and 8 hydrofracture tests in one borehole that lie within or very close to the model Block

<u>Assessment of all the data – orientation</u>
The plot, Figure 24, of the maximum principal stress orientation for all the overcoring tests indicates that there is a great scatter of data, though some trend towards NW-SE is apparent. The mean orientations, therefore, of a series of tests have been used in further analysis.

A plot of maximum principal stress direction for means of all the overcoring series and hydrofracture data against depth is presented on Figure 25. A plot of maximum principal stress orientations from the same data is presented on Figure 26. A stereographic plot of intermediate and minimum principal stress orientations is presented on Figure 27. These figures indicate that:

- The direction of the maximum principal stress is relatively consistent and there does not appear to be any trend with depth or location (Figure 25).

- There does not appear to be any consistent principal stress orientation near the vertical (Figure 27). A near vertical principal stress is expected due to the flat landscape in Äspö area and the closeness of the tests to the free surface of the 'infinite halfspace'. The induced fractures, however, in hydrofracture tests were apparently axial, which suggests that, in fact, the principal stresses are vertical and horizontal. This apparent contradiction may be partly explained by the intermediate and minimum principal stresses being close in magnitude, so the equations to determine their orientations from the overcoring data are poorly constrained and very sensitive to small errors.

- The plunge of the maximum principal stress as determined in overcoring tests is up to 35° from the horizontal with an average of 5° which is close to the expected value of 0° (Figure 26). The maximum stress is of much greater magnitude than the intermediate and minimum stresses and therefore the equations should be well constrained and the orientation not particularly sensitive to small errors.

Plots of the orientation of the maximum principal stress from means of all the overcoring series and the hydrofracture tests in KAS02 indicate an average direction of 318° (Äspö North) with a standard deviation of 19°. The mean plunge of the maximum principal stress indicated by the mean of the overcoring tests is 5°, very close to the expected value of 0° and the standard deviation is 16°.

Comparison with other results from Scandinavia

Lundholm (2000a) reported that the results at Äspö agree quite well with the stress state in Fennoscandinavia, especially in orientation, though the horizontal stresses are slightly lower at Äspö.

Hansen (1997) concluded that high horizontal stresses prevail in the western part of Fennoscandinavia with thrust faulting regimes in the upper 1000 m of crust. The results reported showed a wide variation in stress orientation. The results at Äspö agree well with this description.

7.4 The stress model result summary

7.4.1 Magnitudes

The minimum principal stress is most convincingly measured by the hydrofracture method, though there might be a tendency to slightly underestimate the magnitude if the shut-in pressure is interpreted by the tangent-intersection method. In the depth range of interest (-380 m to -500 m) the results from the average of overcoring results from each borehole are in close agreement with the hydrofracture results (Figure 21). This gives considerable confidence in the overcoring results in general in this area.

The interpretation of the maximum principal stress from hydrofracture tests is subject to large errors. Especially for the case where the ratio between the maximum and minimum principal stresses is greater than around 2:1 (which appears to be the case at Äspö). In this case the stress concentration on the borehole wall is such that the fracture begins to reopen with an hydraulic pressure of less than the shut-in pressure and the correct re-opening pressure is therefore very hard to detect. The ratio of stresses determined by the hydrofracture method is usually close to, but never more than 2, whereas the average ratio determined by overcoring is close to 3. It is therefore considered that the maximum principal stress can be considerably underestimated under the stress conditions prevalent at Äspö.

Given the good agreement between the minimum stress from the overcoring and hydrofracture it is proposed that the maximum stress from the overcoring is adopted as the best estimate. There is, however, a considerable spread in values of the maximum principal stress, probably the result of local variations of modulus/stress within the rock mass. The scale of these variations and the sparse nature of the data mean that prediction of the variations in stress magnitude at the level of detail of the 30m sized cube is not justified, except in the vertical direction.

Estimates of the magnitudes of the stresses in the model Block have been determined for components of the stress tensor, Figures 28 to 33. The estimates were obtained from a regression against depth of the means of each set of overcoring tests. The 95% confidence interval, i.e. from the 2,5% level to the 97,5% level, for the magnitude of each stress component was determined for the depth range -380 to -500 m from the regression statistics, Table 15.

Table 15   Estimates of the 95% confidence limits for the mean stress magnitudes in a series of overcoring tests for the four cube layers in the model Block.

Depth m	σ_1 MPa	σ_2 MPa	σ_3 MPa	σ_H MPa	σ_h MPa	σ_v MPa
-380 – -410	8.0 – 30.5	5.2 – 15.1	2.9 – 9.9	7.5 – 29.7	4.6 – 12.7	2.4 – 15.0
-410 – -440	16.1 – 31.2	9.4 – 16.6	5.8 – 10.8	15.0 – 29.6	7.5 – 13.1	7.7 – 16.8
-440 – -470	21.9 – 37.4	12.8 – 20.1	8.0 – 13.1	20.4 – 35.3	9.7 – 15.4	11.9 – 21.1
-470 – -500	22.1 – 45.6	14.1 – 24.4	8.7 – 16.0	19.8 – 43.0	9.9 – 18.4	14.0 – 26.5

The large range in the data, particularly at the top and bottom of the model Block is partly explained by the little data available. The statistics are based on the averages of only 8 tests and are therefore not very reliable. The 95% interval is not strictly correct as the values quoted are the lowest of the minimums and highest of the maximums for the upper and lower depth of the interval.

The ranges represent the likely mean values determined in a set of overcoring tests with 4 to 5 tests and therefore incorporate measurement error in addition to the likely variation of stresses. It should be noted that many of the 30 m cubes are located outside the area where data is available. The estimate for these cubes should be considered as less reliable than for cubes near or between data points.

The few indications of high local stresses (rock spalling from tunnels) that have been observed at several places in the facility have not been taken into account. One of these coincides with apparently high stresses indicated in boreholes KA3068A and KA2870A at a depth of 379 – 408 m, but these results have large spreads in the 95% confidence limits and their reliability are considered to be low. The geological models for modulus and Q-value do not indicate particularly strong deviation from the average block values in this area and there is therefore no clear correlation between possible high stresses in this area and rock properties averaged over the 30 m block size. There could, however, be a correlation on a much smaller scale than the 30 m block size which is not revealed by the present study.

7.4.2 Orientations

Estimates of the 95% confidence interval for the orientations of the stresses in the Block have been determined for the three components of the stress tensor, Table 16. As there is no clear trend in the data, the means and standard deviations have been calculated from the means of all the overcoring data and from all the hydrofracture tests in KAS02. The estimates of the 95% confidence interval were obtained assuming a normal distribution of the measured directions (from overcoring and hydrofracture data) and plunges (from overcoring data only). The distribution may not be strictly normal, but it appears to be a reasonable approximation for the maximum principal stress direction, Figure 34.

Table 16 Estimates of the 95% confidence limits for the mean principal stress orientations in a series of overcoring tests for the whole model Block. These estimates are applicable to the whole depth range of the model Block.

w.r.t Äspö North	σ_1	σ_2	σ_3
Direction	279° to 356°	#	#
Plunge (+'ve downwards)	-26° to +37°*	#	#

*) when measured over a sufficiently large volume of rock the maximum principal stress should be horizontal.

#) σ_2 &σ_3 directions measured in overcoring tests could lie anywhere on the plane perpendicular to the σ_1 direction but must be orthogonal to each other. When measured over a sufficiently large volume of rock one of these stresses should have a magnitude equivalent to the overburden weight and be vertical, the other should be horizontal and at right angles to the maximum principal stress.

7.4.3 Effect of geological structures

The effect of major geological discontinuities on the state of stress has been studied by Lundholm (2000b). The main conclusions from this study were that orientations and magnitudes of the principal stresses are affected around and within a weakness zone with mechanical properties differing from the rock mass. The degree to which the stress tensor is affected depends mostly on the orientation of the zone with respect to the principal stresses and whether shear movements have occurred along the zone. According to Lundholm, the normal and shear stiffness of the zone is not very important for the degree to which the stress tensor is affected.

Three major fracture zones, identified as EW-1b, NE-1 and NE-2, intersect the block. They all dip steeply and are oriented within 15° of a right angle to the maximum principal stress, so they are close to perpendicular to the maximum principal stress. According to the study this orientation would give minimal disturbance to the stress tensor.

The Lundholm study also concluded that many parameters, both local and regional, influence the stresses in the rock mass. It is therefore impossible to predict the effect of the major discontinuities that have been identified in the model Block, especially on the scale of the 30 m cube.

The stress measurement tests do not appear to have been conducted in the immediate vicinity of the fracture zones. In the absence of further evidence it is considered that the ranges of values given for the stresses also cover the cubes that are affected by the fracture zones.

7.5 Conclusions and recommendations

There is a large quantity of high quality stress measurement data, which has been obtained through three different methods. Three independent reviews of the data, Myrvang (1997), Lundholm (2000) and Hardenby (2001) have confirmed this conclusion. Despite the apparent quality of the data and despite the impression that the rock mass at Äspö is relatively homogeneous, the data from individual tests show a significant variation in both magnitude and orientation of the in situ stress tensor. However the averages of each series of overcoring tests in the same borehole show much improved consistency.

The in situ stress tensor can vary widely depending on the scale of measurement and natural variations in the rock mass caused by variations in the modulus and depth. The overcoring methods involve a much smaller volume of rock than the hydrofracture method and much of the variation in the measurements may reflect real variations in the stress tensor at the scale of measurement. Some of the variation in results from overcoring, though, is due to measurement errors arising from measuring the strains at different points around the borehole wall as the borehole may not be deformed uniformly as predicted due to errors in the assumptions regarding homogenuity and isotropy of the rock material. There may also be errors in measuring small deformations accurately.

The standard error data presented in the reports on CSIRO overcoring tests is very useful as it can be used to obtain the 95% confidence limits for the data and thereby an estimate of the reliability of the data. It is therefore recommended that the standard errors for the overcoring tests using the Borre probe data are determined and the reliability of the tests assessed by using the Monte Carlo approach described previously to determine the 95% confidence limits.

The hydraulic fracture measurements of the minimum stress and direction give a consistent pattern down to -500 m depth. The minimum stress is measured in a fairly direct manner over an area of several square metres and the direction an average over a borehole length of up to 1 m. It is therefore considered that the minimum stress and its orientation are most reliably measured in a properly executed programme of stress measurement using the hydraulic fracture method.

The magnitude and orientation of the minimum stress measured by overcoring correlates well with the hydrofracture results.

The vertical stress should be a principal stress with a magnitude equal to the weight of overburden. The results from overcoring down to -300 m depth indicate that the intermediate and minimum principal stresses are similar and coincide with the expected weight of the overburden. The overcoring results below -300 m indicate that the mean value of the intermediate principal stress is generally significantly greater than the expected weight of the overburden, while the minimum stress is generally significantly less. The results generally indicate that both stresses are inclined at a significant angle to the vertical. For individual tests this might be explained by an arching effect on a non-slipping discontinuity or over an area of different modulus, however the average of several tests should indicate a vertical principal stress with a magnitude equal to the weight of the overburden.

There is a discrepancy between the maximum stress measurements made using the hydrofracture method and those using the overcoring method. The hydrofracture results generally show a ratio of maximum to minimum stress of a little less than 2:1, whereas the overcoring results have a ratio nearer to 3:1. This discrepancy may be explained by the difficulty in measuring the re-opening pressure in the hydrofracture test when the stress ratio is close to 2:1 or greater. The results from both overcoring and hydrofracture show the same direction. It is therefore considered that the overcoring results are more reliable than the hydrofracture.

It is therefore considered that the overcoring results, when averaged for each series of tests, give a better indication of the stress tensor than the hydrofracture method. This is especially true for the maximum principal stress. However, there are some discrepancies in the determination of the vertical stress magnitude which have not yet been satisfactorily explained.

It is therefore recommended that hydrofracture tests are conducted in some of the horizontal holes used for overcoring stress measurement in order to determine the minimum and if possible the intermediate stress magnitudes and orientation and compare these with the overcoring results at the same location. The overcoring holes however may not be aligned with one of the principal stresses and therefore hydrofracture tests may be ambiguous. An alternative method for determining the vertical stress would be to conduct hydrofracture tests in new holes drilled parallel with both the minimum and maximum principal stress orientations.

8 ROCK MECHANICAL MODEL RESULT SUMMARY

8.1 Model A

The model consists of totally 480 blocks from 380 to 500m depth divided into four horizontal layers, such that each layer contains 120 blocks. 93 blocks in the model contain either Q, RQD (transformed to Q, see Section 4.1) or RMR data. This means that 387 of the blocks, or about 80% have no data, and for these blocks the rock mass properties have to be extrapolated from blocks with data. Because of this the uncertainty in the model is by principle rather high. However, the rock mass quality is rather uniform in the total model volume such that the rock mass properties are often near the mean value.

In Tables 17 – 19 a summary of results from the 93 blocks with data is given. The values given in these tables are based on the Q or RMR value addressed as the block value. A larger range of values would have been shown in the tables if the variations within the various blocks had been included.

Table 17 Summary of Q_{block} -values

Data source	$Q_{block, minimum}$	$Q_{block, maximum}$	$Q_{block, mean}$
Q data (70 blocks)	0.3	24	11
RMR data (23 blocks)	5	63	20
Q and RMR data (93 blocks)	0.3	63	12

Table 18 Summary of rock mass compression strength, σ_m (MPa)

Data source	$\sigma_{m, block, minimum}$	$\sigma_{m, block, maximum}$	$\sigma_{m, block, mean}$
Q data (70 blocks)	19	82	63
RMR data (23 blocks)	47	113	79
Q and RMR data (93 blocks)	19	113	67

Table 19 Summary of Youngs modulus of deformation of rock mass, E_m (GPa)

Data source	$E_{m, block, minimum}$	$E_{m, block, maximum}$	$E_{m, block, mean}$
Q data (70 blocks)	7	29	22
RMR data (23 blocks)	18	47	32
Q and RMR data (93 blocks)	7	47	25

Table 20 summarises the data from the weakness zones. Here is the variation (min. max.) in the zones also shown.

Table 20 Summary of data from weakness zones

Weakness zone	Minimum			Maximum			Mean		
	Q	σ_m (MPa)	E_m (GPa)	Q	σ_m (MPa)	E_m (GPa)	Q	σ_m (MPa)	E_m (GPa)
EW-1	0.008	4	2	12	44	23	1.8	23	12
NE-1	0.011	4	2	12	44	23	3	27	14
NE-1 (central zone)	-	-	-	-	-	-	0.011	4	2
NE-2	1.9	24	12	8	37	20	4	30	16

In Table 21 the data of the different layers of model are shown. Data addressed as block values are given in the table. No major differences between the different layers can be seen. It must here be stated the same SRF value of 2 has been used for the whole model. In the lower layers the stresses may be somewhat higher than in the upper ones, and possibly this could have justified a variation in the SRF-value. This would have resulted in somewhat lower Q-values in the lower layers compared to the higher ones.

Table 21 Summary of data (block values) from various layers (depth ranges)

Depth	Minimum			Maximum			Mean		
	Q	σ_m (MPa)	E_m (GPa)	Q	σ_m (MPa)	E_m (GPa)	Q	σ_m (MPa)	E_m (GPa)
-380 to –410m (19 blocks)	0.3	19	7	40	97	40	11.4	67	25
-410 to –440m (33 blocks)	0.7	25	9	63	113	47	13.7	70	26
-440 to –470m (33 blocks)	4.6	47	18	34	92	38	12.6	66	24
-470 to –500m (8 blocks)	4.0	45	16	12	65	23	9.4	60	21

The weakness zone NE-2 divides the model in a western and an eastern part. In Table 22 the Q-values in the blocks belonging to the western part of the model are compared to the blocks in the eastern part of the model.

Table 22 Distribution of Q_{block}-values in blocks in the western and eastern part of the model

Q-range	West, blocks with data %	East, blocks with data %	West, all blocks %	East, all blocks %
>10	72	53	77	81
4-10	19	45	17	17
1-4	7	0	5	0.5
< 1	2	2	1	1.5

Table 22 shows that there is no essential difference between the two parts of the model. However, there seems to be a bit more low Q-values in the western part of the model than in the eastern part.

8.2 Model B

The basis for both models is the Q-system. In Model A the Q-system is used in its ordinary way i.e. as for tunnel design. In model B a general characterisation of the rock masses shall be given without referring to any tunnel. This means that some adjustments have to be made concerning the use of the Q-system. It may of course be discussed how this shall be done, but in our performance we have mainly followed a proposal given by Nick Barton. The revised Q-values we have called Q_{cha}, i.e. Q for characterisation.

Both models embrace the same volume of rock, however, the data basis is a little different. In model B the RMR data has been ignored since we think the relation between RMR and Q_{cha} is not quite clear. In Model A there seems also to be some differences of the parameter values depending on whether they are estimated from Q or RMR. This means that Model B is based on the 70 blocks where Q-data is available. In addition the blocks affected by the major weakness zones and the minor weakness zones striking NW-SE have been given a reduced J_w-value ($J_w = 0.66$) in Model B.

Table 23 shows mean values for block minimum, block maximum and block mean for different parameters in the 70 blocks with data in Model B.

Table 23 Summary of Q_{cha}, E_m and σ_m in Model B

Parameter	Block minimum	Block maximum	Block mean
Q_{cha}	30	82	40
E_m (GPa)	34	48	38
σ_m (MPa)	84	118	94

8.3 General discussion

If we compare the two models evident differences can be seen in Table 24.

Table 24 Comparison of mean values for Q (Q_{cha}), E_m and σ_m in the 70 blocks with Q-data

Parameter	Block mean Model A	Block mean Model B
Q (Q_{cha})	11	40
E_m (GPa)	22	38
σ_m (MPa)	63	94

In model B the Q-values are 3-4 times higher than in Model A, but this is mainly caused by the fact that Q_{cha} is used in Model B. This means also that the values of E_m and σ_m are considerably higher in Model B than in Model A. Concerning the values of E_m in Model B they are also modified by means of the rock compression strength which results in increased values. For estimation of σ_m we have used the same equation in both models (Equation 9). Use of Bartons equation (11) will generally give lower values for σ_m, see Table 12.

As we can see from this there are a lot of uncertainties in the models. These uncertainties may be said to be on two levels: First there are the uncertainties concerning the data input i.e. Q (Q_{cha}) and RMR data and the handling of this data in each of the blocks in the models. The other level of uncertainties is concerning the methods used for estimation of the different parameter values from the available Q and RMR data. It is several equation for this use, and it may be several opinions about which of these equations that give the most reliable values.

The uncertainties are also varying from block to block since the quantity and quality of data are variable, and the extrapolation of data to blocks without data is carried out in a simple way. A more sophisticated method based on calculation of probability could here be developed. A study of the uncertainties in relation to the quantity and quality of data would also have been interesting. At different steps during the planning of a project there will be different quantities of data of different types available. Prognoses made from this data will therefore be more or less reliable. A comparison between these prognoses with results of the project would therefore have been valuable. This could be done concerning Q-values where the results could be picked up from an existing tunnel.

To test the different equation for estimation of for example E_m plate loading tests could be carried out. σ_m could be tested by numerical analyses. Rather simple UDEC-models could here be used (see for example Bhasin and Høeg 1998). Input data for such models such as JRC, JCS and σ_c are available, and several models could therefore be analysed at moderate costs.

9 REFERENCES

Andersson, J., Ström, A., Svemar, C., Almen, K-E., Ericsson, L.O. 2000
Vilka krav ställer djupförsavaret på berget? Geovitenskapliga lämplighetsindikatorer och kriterier för lokalisering och platsutvärdering.
SKB R-00-15

Barton, N., Lien, R., Lunde, J., 1974
Engineering classification of rock masses for the design of tunnel support.
Rock Mechanics, v. 6, No. 4, pp 189-236

Barton 1995
The influence of joint properties in modelling rock masses
In Fuji (ed.), Keynote Lecture-Proc. 8th ISRM congress, Tokyo. 3: 1023-1032
Rotterdam:Balkema.

Barton, N. 2000
TBM tunnelling in jointed and faulted rock
A.A.Balkema/Rotterdam/Brookfield/2000

Bhasin, R., Høeg, K. 1998
Numerical Modelling of Block Size Effects in Influence of Joint Properties in Multiply Jointed Rock
Tunnelling and Underground Space Technology, Vol. 13, No.2 pp. 181-188, 1998

Bieniawski, Z.T. 1989
Engineering Rock Mass Classifications
John Wiley & Sons
New York

Domenico, S.N., 1984
Rock lithology and porosity determination from shear and compression wave velocity
Geophysics, Vol. 49, pp 1188-1195.

Goodman, R.E. 1980
Introduction to Rock Mechanics
John Wiley & Sons
New York

Grimstad, E. and Bhasin, R. 1996
Stress strength relationships and stability in hard rock
International Conference on Recent Advances in Tunnel Technology, New Delhi 1996
Indian Society for Rock Mechanics and Tunnel Technology

Hansen, S.H. 1997
Investigations of some rock stress measuring techniques and the stress field in Norway.
NTNU Institutt for geologi and bergteknikk, doktor ingeniørhandling 1997:144, 187pp.

Hardenby, C. 2001
Quality control of rock stress measurements using the overcoring method. To be published by SKB.

Hermanson, J. 1995
Structural Geology of Water-Bearing Fractures
SKB Progress Report 25-95-23

Hermanson, J., Stigsson, M., Wei, L. 1998
A Discrete Fracture Network Model of the Äspö Zedex Tunnel Section
SKB Proggress Report HRL-98-29

Løset, F. 1992
Support needs compared at the Svartisen road tunnel
Tunnels & Tunnelling, June 1992

Lundholm, B. 2000a
Rock stress and rock stress measurements at Äspö HRL. SKB International Progress Report IPR-00-24. 77pp.

Lundholm, B 2000b
Numerical modelling of discontinuities to study the effect on the state of stress. SKB International Progress Report IPR-00-25. 62pp.

Markström, I., Erlström, M. 1996
Äspö hard rock laboratory
Overview of documentation of tunnel, niches and core boreholes
SKB Progress Report HRL-96-19

Munier, R. 1989
Brittle Tectonics on Äspö, SE Sweden
SKB Progress Report 25-89-15

Myrvang, A. M. 1997
Evaluation of in situ rock stress measurements at the Zedex test area. SKB Progress Report HRL-97-22. 14pp, September 1997.

NGI 1994
Zedex Q and RMR Logging of Boreholes C 1-8 from the Äspö tunnel
NGI Report 941025-1

NGI 1994
ZEDEX- Results of Geotechnical Mapping of the TBM Tunnel 0-50m at Äspö
NGI Report 941025-4

NGI 1994
ZEDEX- Results of Geotechnical Core Logging of B and DBH Boreholes at Äspö, Sweden
NGI Report 941025-5

NGI 1995
ZEDEX-Results of Geotechnical Mapping of the Test Tunnel at Äspö, Sweden
NGI Report 941025-8

NGI 1995
ZEDEX- Results of Geotechnical Core Logging of A Boreholes at Äspö, Sweden
NGI Report 941025-6

NGI 1995
ZEDEX- Seismic Tomography in the TBM Drift at Äspö, Sweden
NGI Report 941025-3

NGI 1995
ZEDEX- Seimsic Tomography in the D&B Drift at Äspö, Sweden
NGI Report 941025-10

NGI 1995
ZEDEX-Results of Geotechnical Core Logging of Remaining B abd DBH Boreholes at Äspö, Sweden
NGI Report 941025-9

NGI 1999
Forurensningstransport og permeabilitet i oppsprukket fjell
NGI rapport 543073-1

NGI 2001
Results of Q- and RMR logging and tilt testing of drill cores from KA2511A, KAS02 and KA2598A.
Presented as a SKB report

Olsson, O. (Ed) 1994
ZEDEX – A Joint Study by ANDRA- UK-NIREX-SKB
A Preliminary Assessment of Results from the TBM-tunnel
SKB 25-94-27z

Olsson, O. (Ed) 1995
ZEDEX – A Joint Study by ANDRA- UK-NIREX-SKB
A Preliminary Assessment of Results from the D&B drift
SKB 25-95-27z

Rhen, I., Stanfors, R. 1993
Passage Through Water-Bearing Fracture Zones. Evaluation of Investigations in Fracture zones NE-1, EW-7 and NE-3
SKB Progress Report 25-92-18

Rhen, I., Stanfors, R. 1995
Supplementary Investigations of Fracture Zones in Äspö Tunnel
SKB Progress Report 25-95-04

Rhen,I. (Ed) 1995
Documentation of Tunnel and Shaft Data. Tunnel Section 2874-3600m Hoist and Ventilation Shafts 0-450m
SKB Progress Report 25-95-28

Rhen, I. ed. 1997
ÄSPÖ HRL – Geoscientific evaluation 1997/5
Model based on characterization 1986-1995
SKB Technical Report 97-06

Sehlstedt, S., Stråle,A. 1991
Identification of Water Conductive Orientated Fractures in the Boreholes KAS02 and KAS06
SKB Progress Report 25-91-11

Serafim, J.L., Pereira 1983
Considerations of the Geomechanical Classification of Bieniawski
Proc. Int. Symp. Eng. Geol. Underground Constr. pp 33-43
A.A. Balkema, Boston

Singh, B., Jetwa,J.L., Duybe,A.K., and Singh, B. 1992
Correlation between Observed Support Pressure and Rock Mass Quality.
Tunnelling and Underground Space Technology, Vol. 7, No. 1 59-74

SKB 1992
Passage through Water-Bearing Fracture Zones. Compalition of Technical Notes.
Investigation during Passage of Fracture Zone EW-7, NE-3 and NE-1
SKB Progress Reports 25-92-18A and 25-92-18B

Stanfors, R. 1988
Geological Borehole Description KAS02, KAS03, KAS04, KLX01
SKB Progress Report 25-88-18

Stanfors, R., Rhen, I., Forsmark, T., Wikberg, P. 1994
Evaluation of Fracture Zone EW-1, Based on the Cored Boreholes KA1755A, KA1751, KA1754A and KAS04
SKB Progress Report 25-94-39

Stanfors, R. Olsson, P., Stille, H. 1997
ÄSPÖ HRL- Geoscientific evaluation 1997/3
Results from pre-investigations and detailed site characterization.
SKB Technical Report 97-04

Stille, H., Groth, T., Fredriksson, A. 1982
FEM Analysis of Rock Mechanics Problems by JOBFEM
Swedish Rock Engineering Research Foundation Publication, No. 307, 1982, pp 1-8.

Stille, H., Olsson, P. 1989
SKB, Hard Rock Laboratory First Evaluation of Rock Mechanics
SKB Progress Report 25-89-07

Stille, H., Olsson, P. 1996
Summary of Rock Mechanical Results from the Construction of Äspö Hard Rock Laboratory
SKB Progress Report HRL-96-07

Talbot, C., Munier, R. 1989
Faults and Fractures Zones in Äspö
SKB Progress Report 25-89-11

Talbot, C. 1991
Preliminary Structural Geology Underground in the Äspö Hard Rock Laboratory
SKB Progress Report 25-92-03

Wikstrøm, A. 1989
General Geological-Tectonic Study of the Simpevarp Area with Special Attention to the Äspö Island
SKB Progress Report 25-89-06

10 LIST OF FIGURES

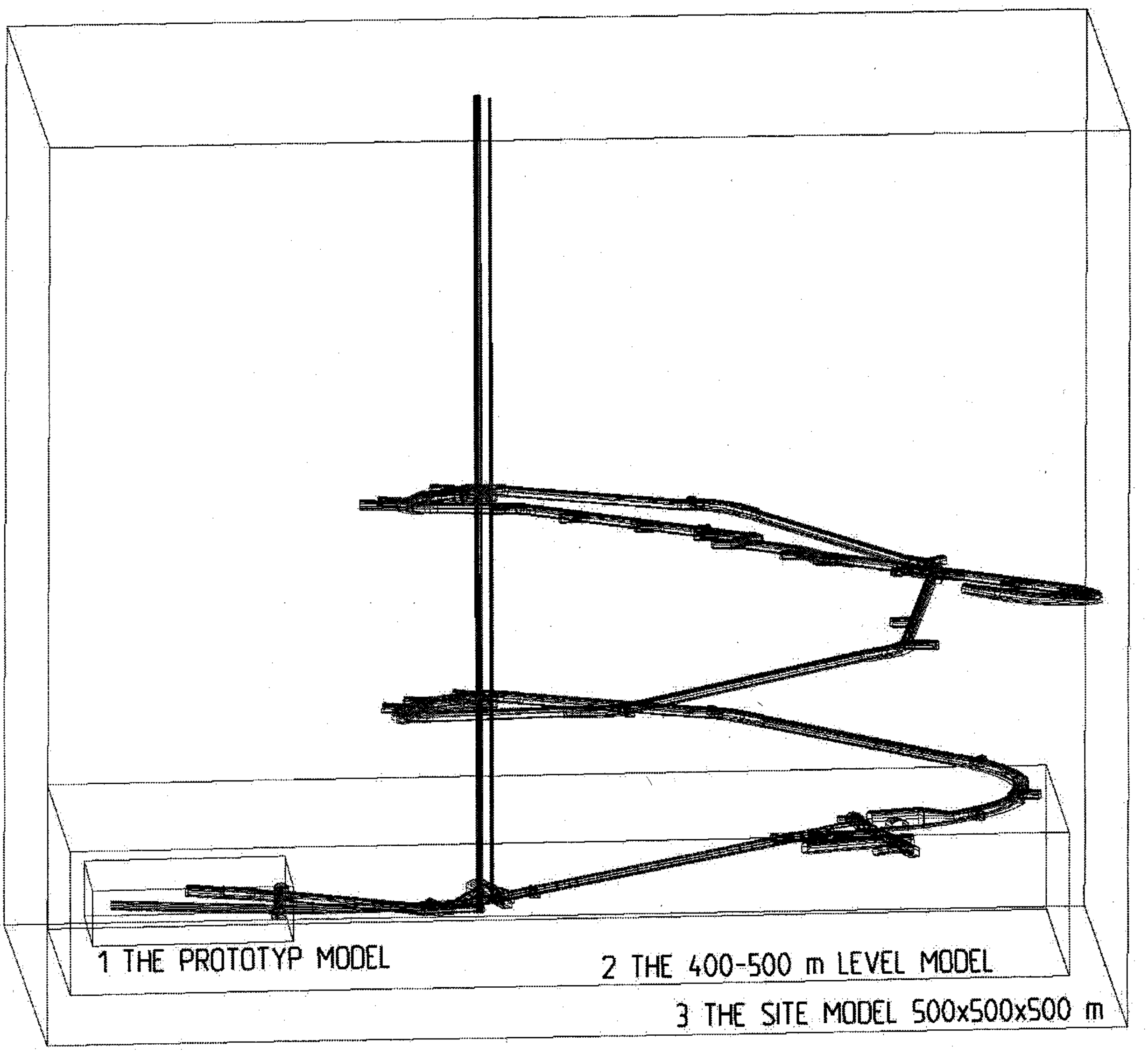


Figure 1 Location of the conceptual rock mechanical model for the –380m to –500m depth zone

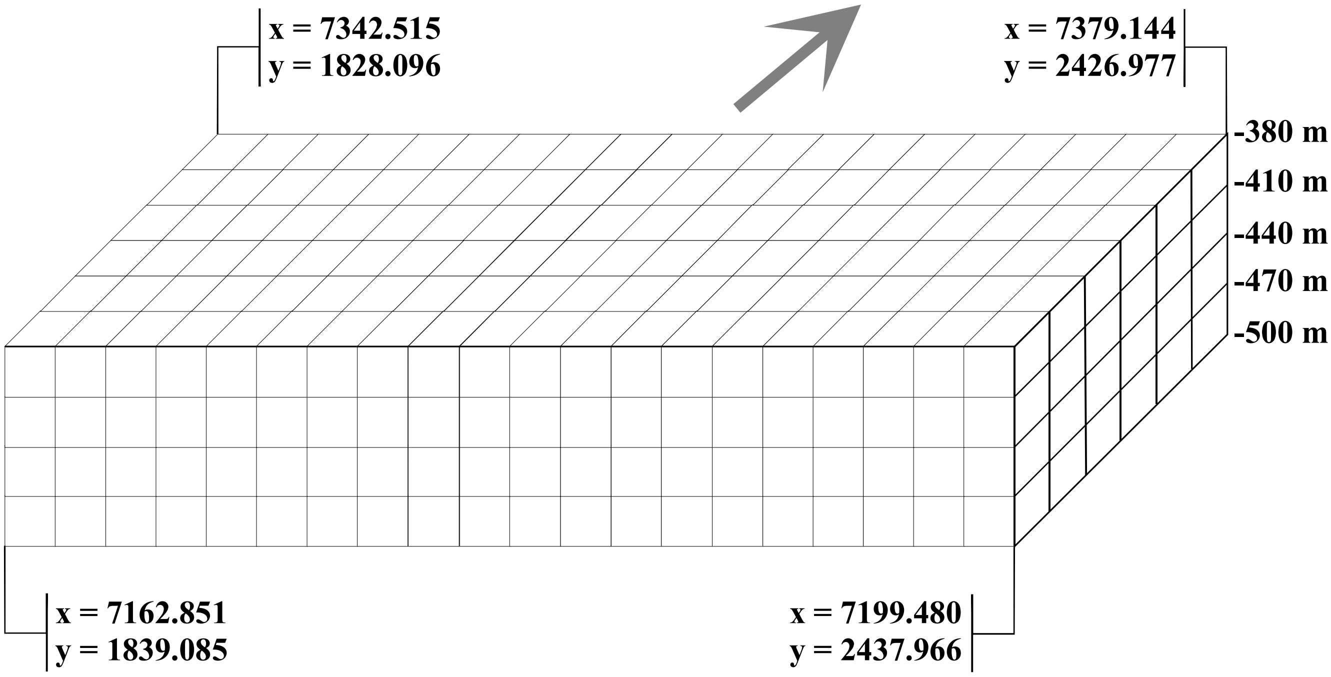


Figure 2 The coordinates and four layers of the conceptual rock mechanical model

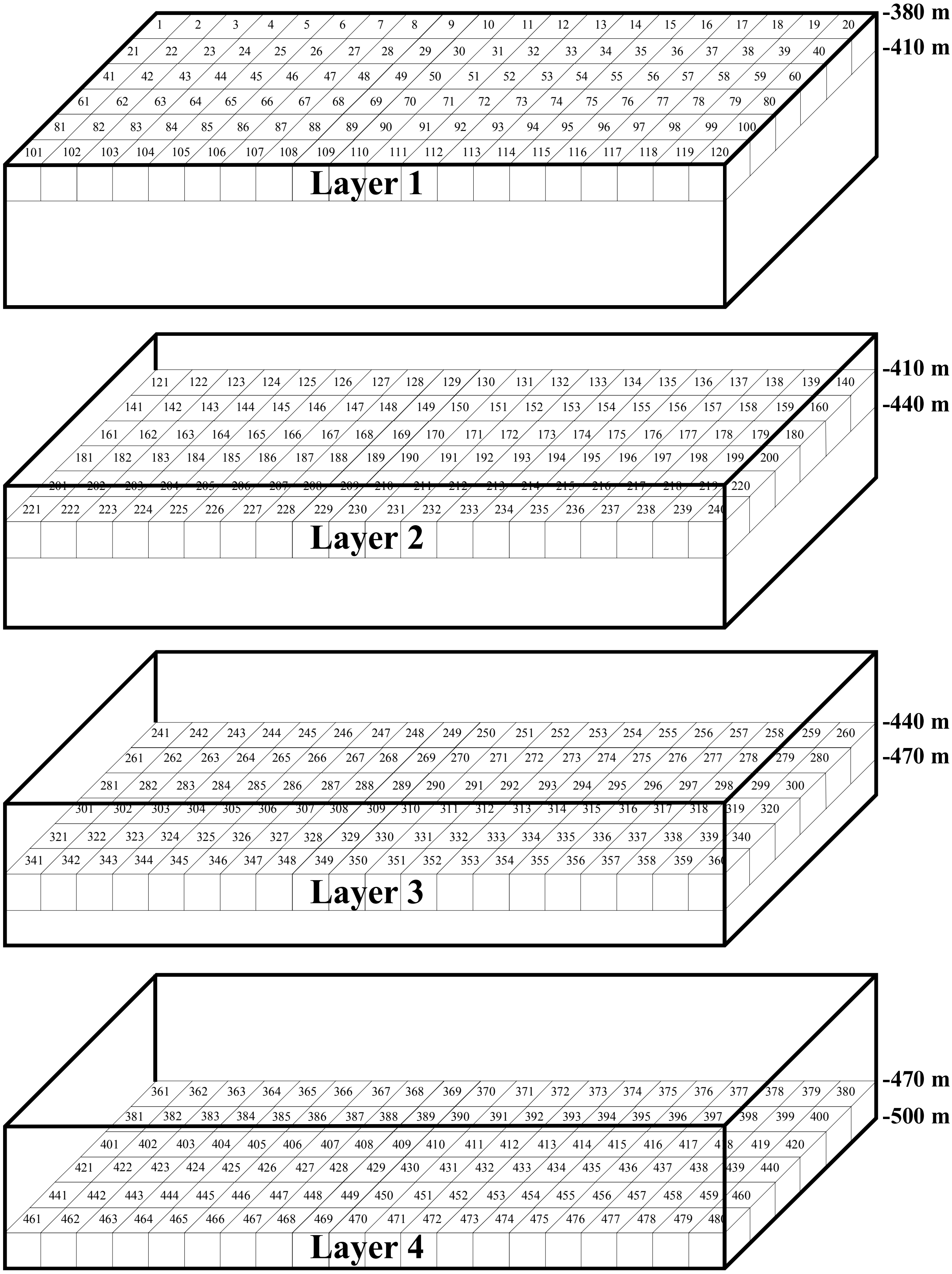


Figure 3 Numbering of the blocks in the conceptual rock mechanical model

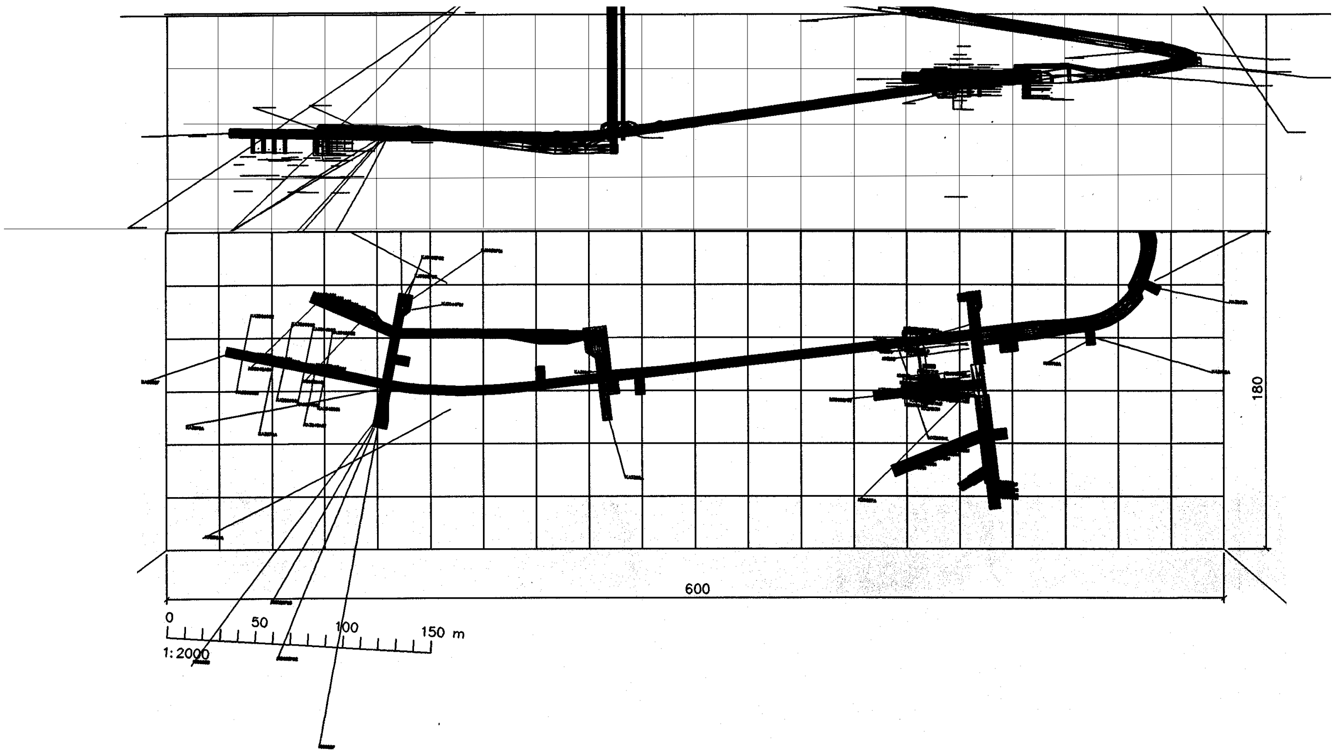


Figure 4 Vertical (top) and horizontal (bottom) cross-section through the conceptual rock mechanical model. The grid lines correspond to the 30x30x30m blocks.

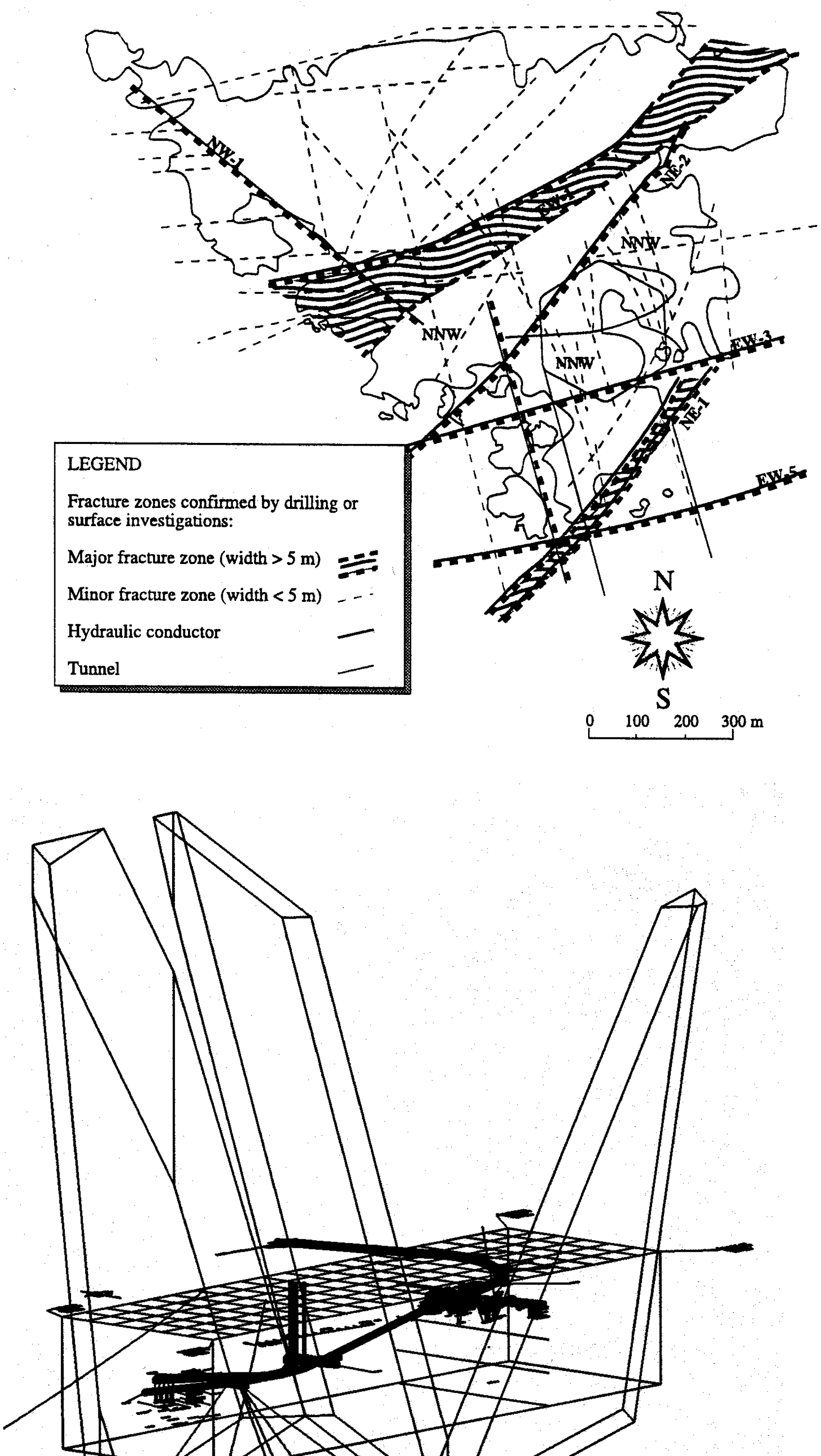


Figure 5 Top: Conceptual model of the major fault zones in the Äspö area (after Stanfors et al. 1994)
Bottom: Major fault zones cutting through the conceptual rock mechanical

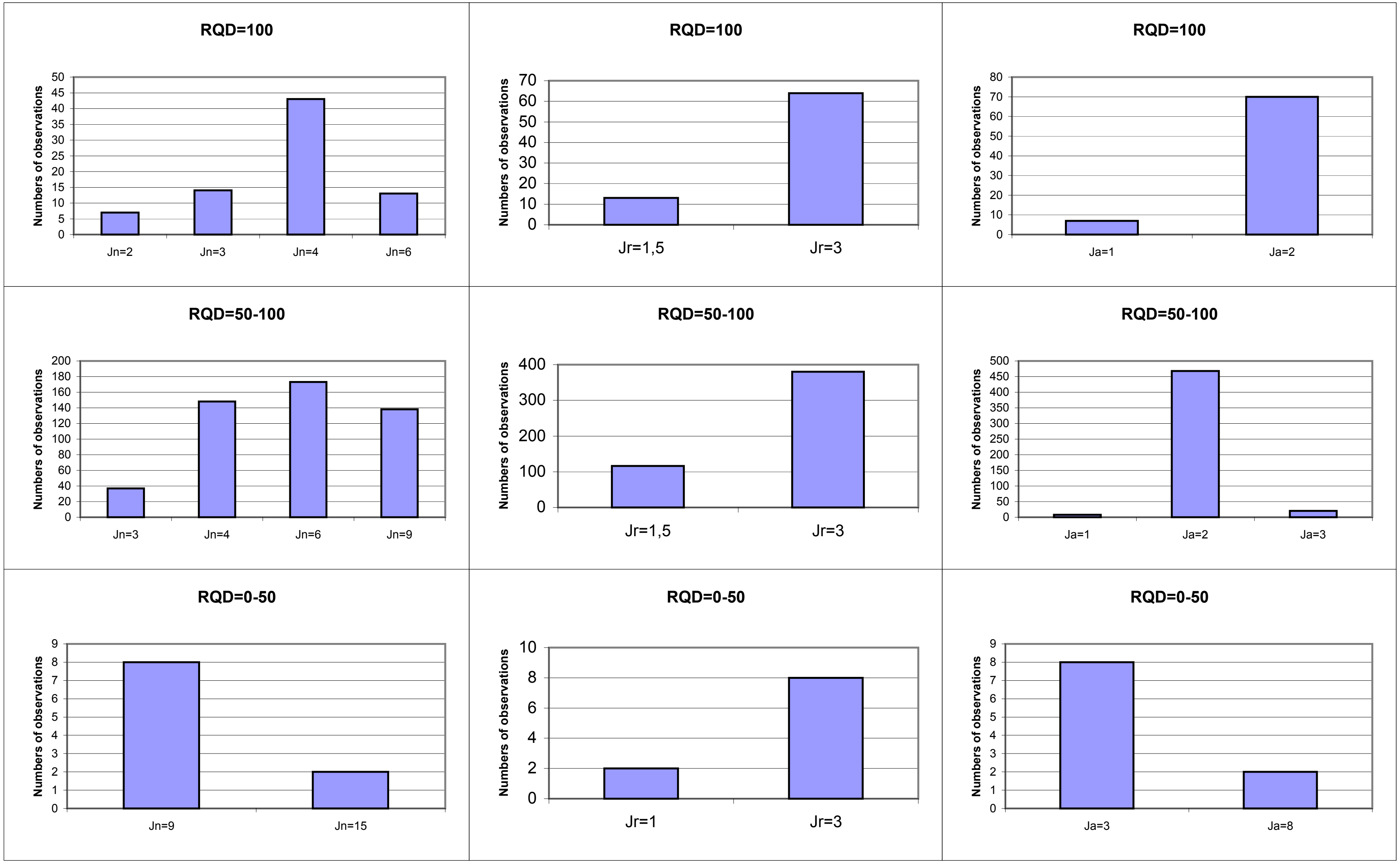
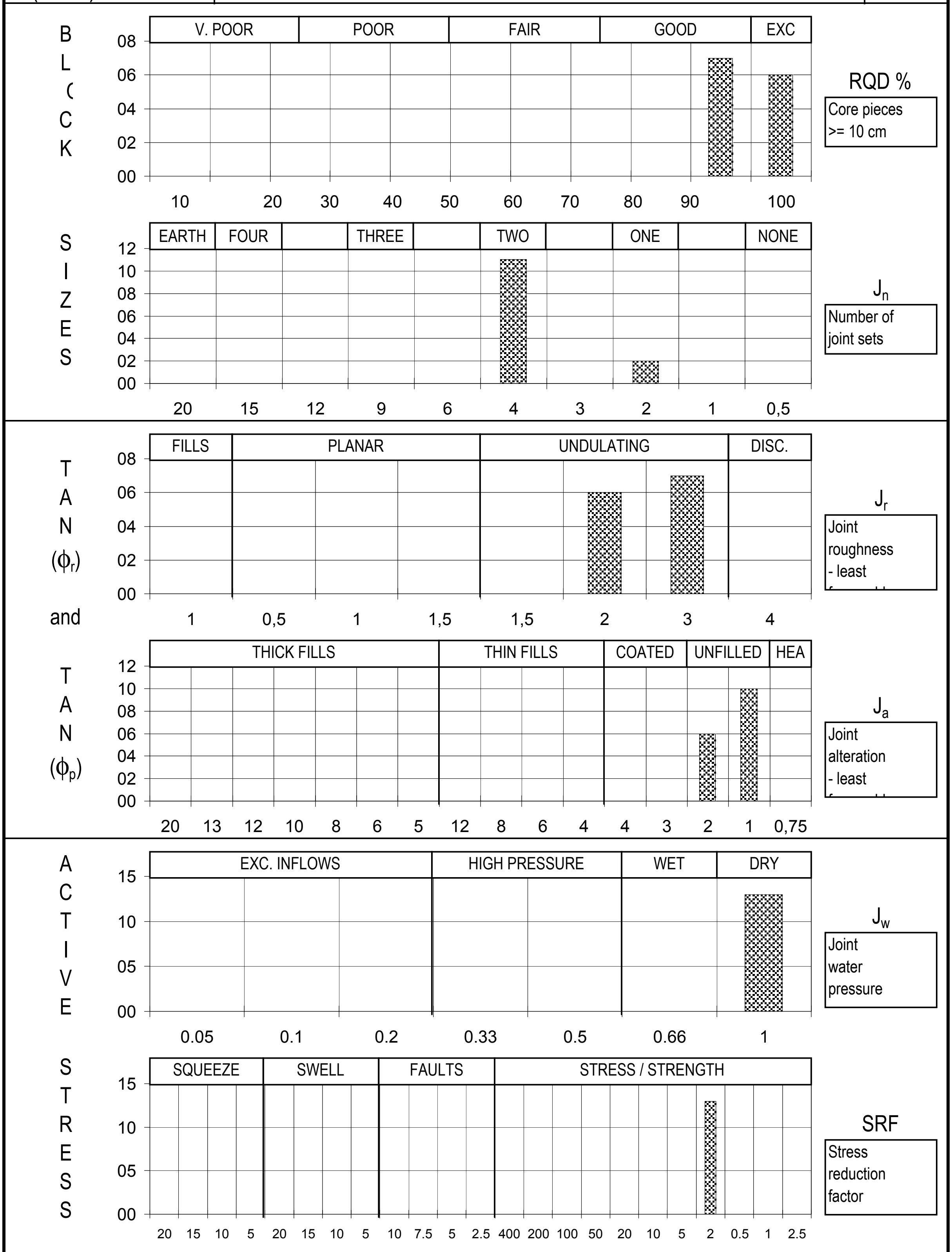


Fig. 6 Relation between RQD and other Q-parameters in Borehole KAS02, KA2511A and KA2598A

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	4.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	2.0	*	3.0	/	1.0	*	1.00	/	2.0	=	**75.0**
Q (mean value)=	97	/	3.7	*	2.5	/	1.4	*	1.00	/	2.0	=	**24.33**
Q (block)=	97	/	4.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**12.00**



	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		0	7
Q - REGISTRATIONS CHART	Block No. : 156	Drawn by FL	Date 2001-06-12
KXZC1 0-7m, KXZC2 0-6m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[fig7.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

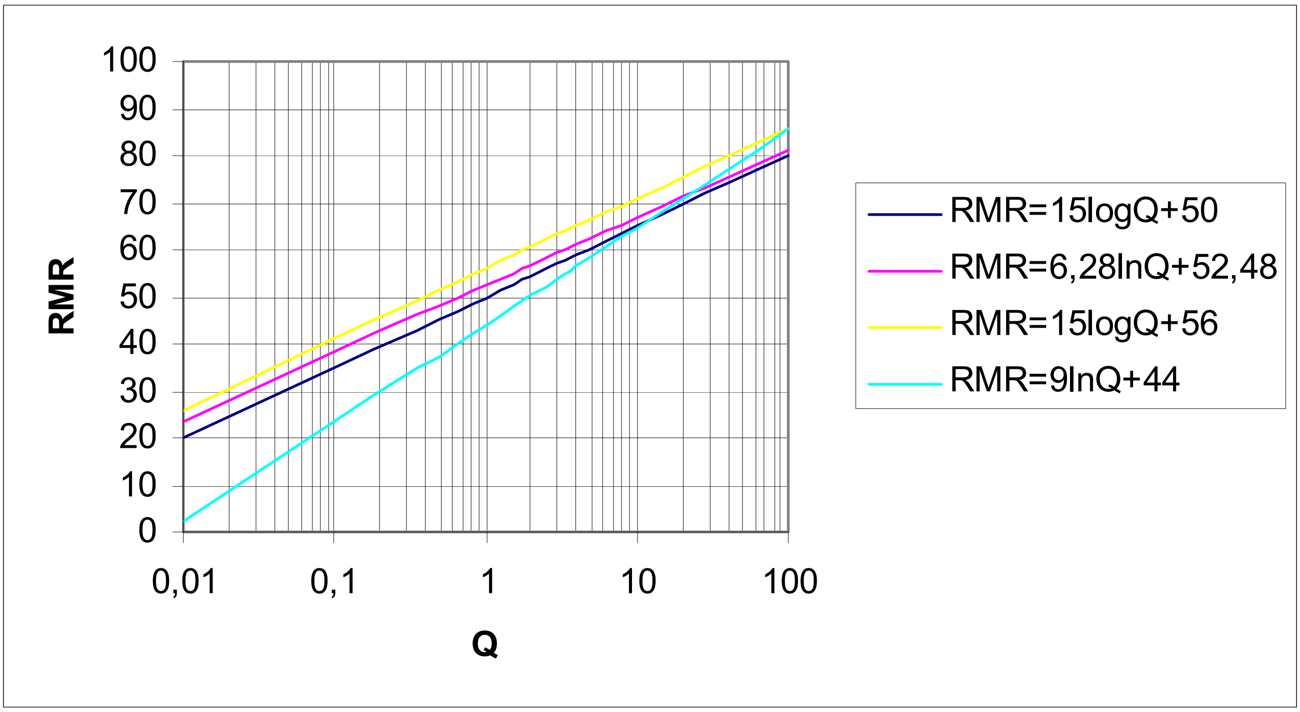


Figure 8 Correlation between Q and RMR

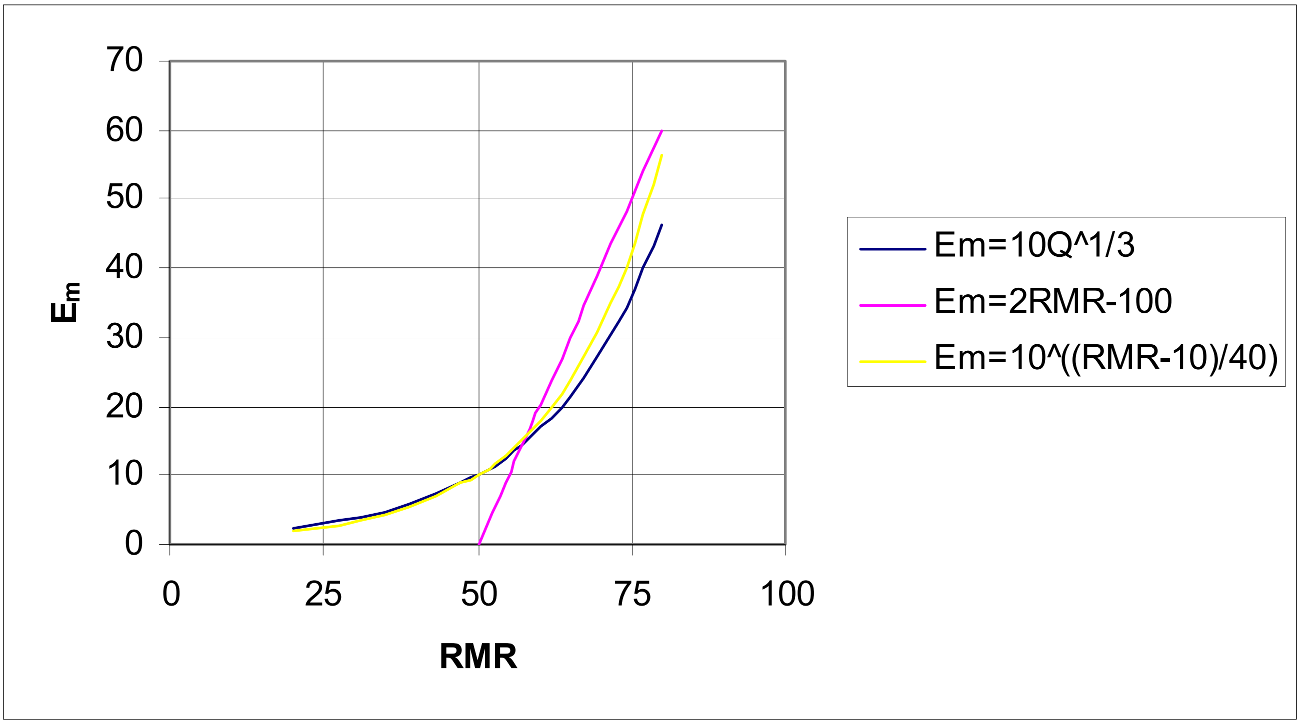


Figure 9 Correlation between E_m and RMR

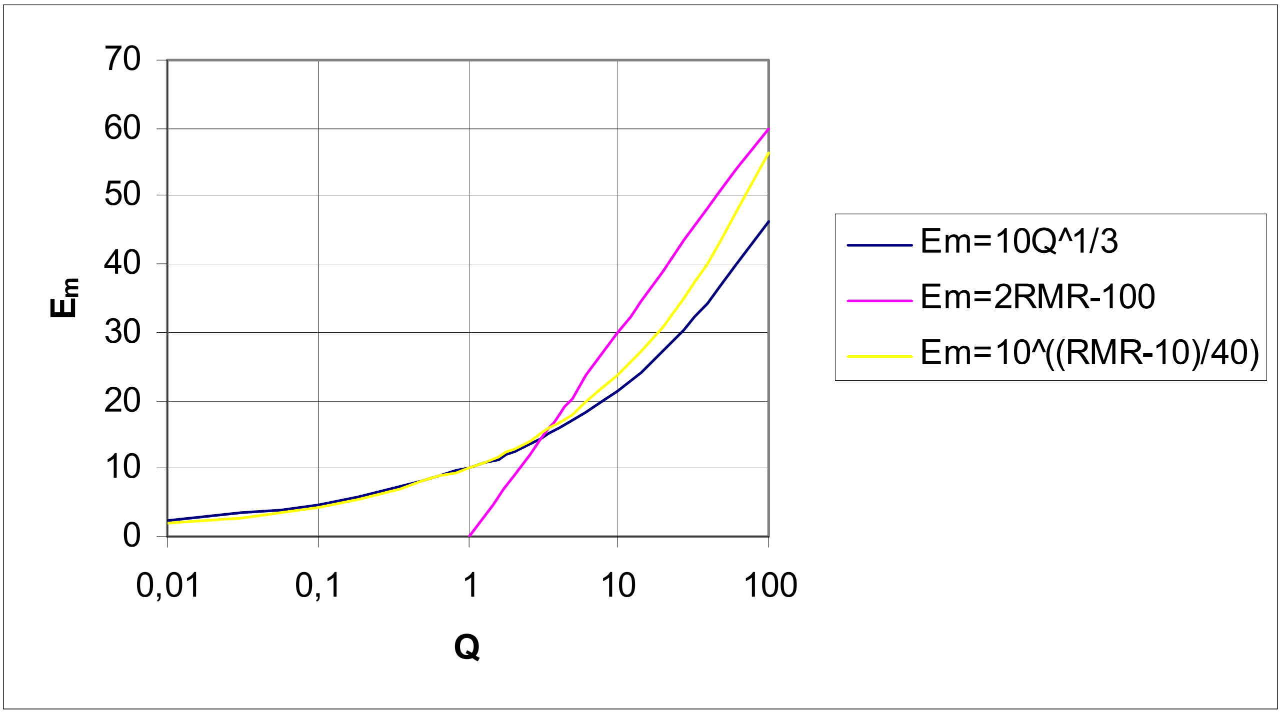


Figure 10 Correlation between E_m and Q

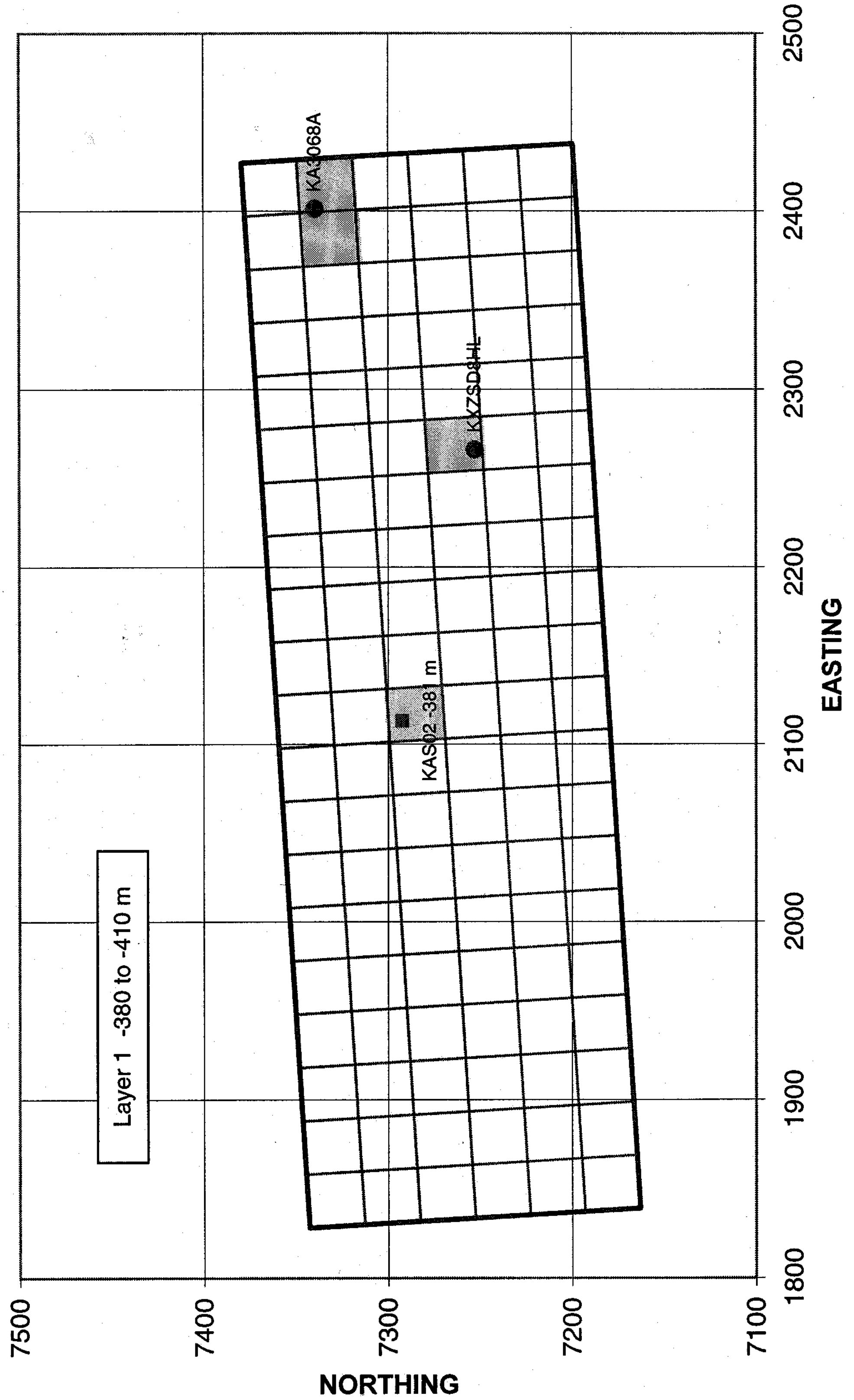


Figure 11 Location of data from stress measurement boreholes in the conceptual model, layer 1 -380 to -410 m

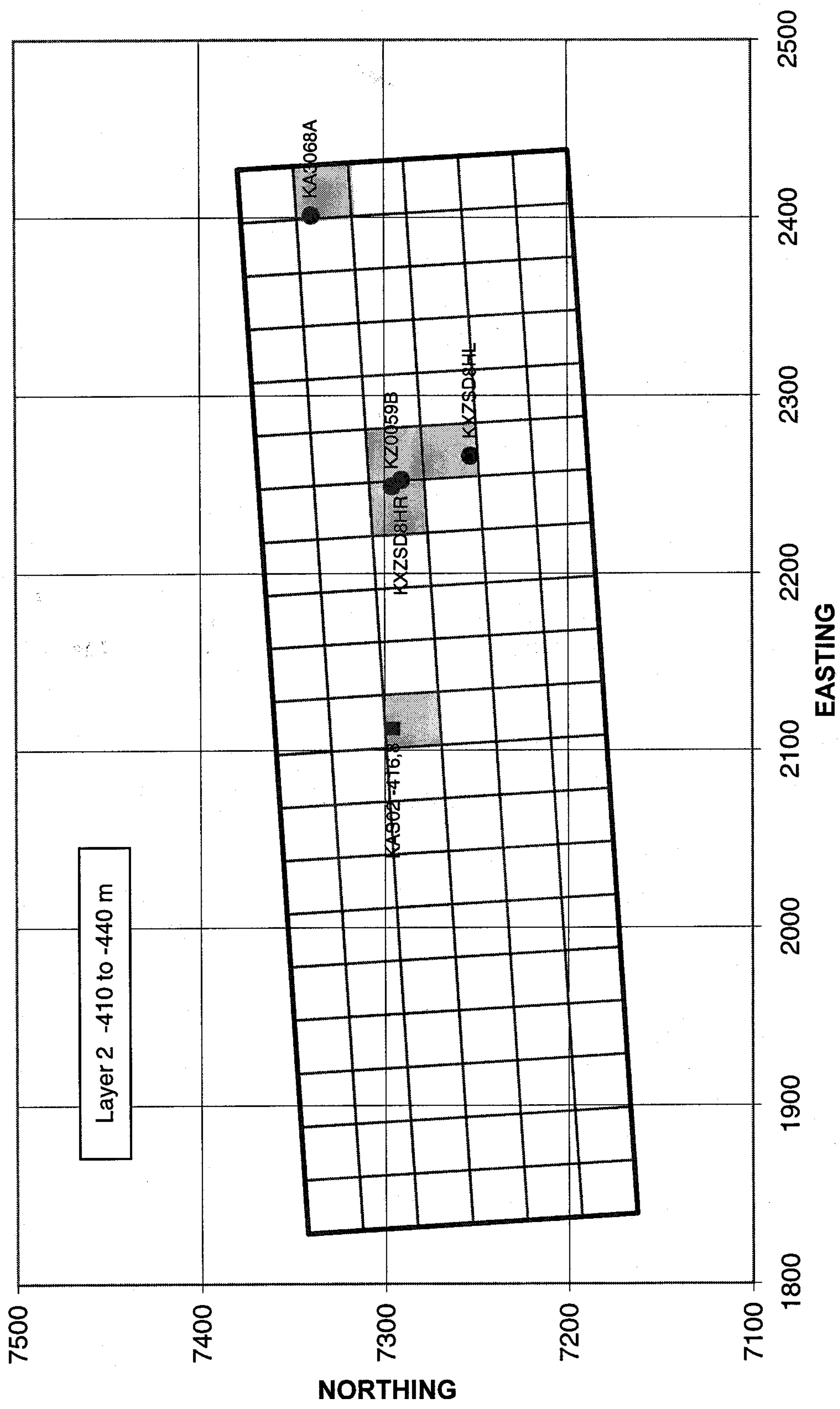


Figure 12 Location of data from stress measurement boreholes in the conceptual model, layer 2 -410 to -440 m

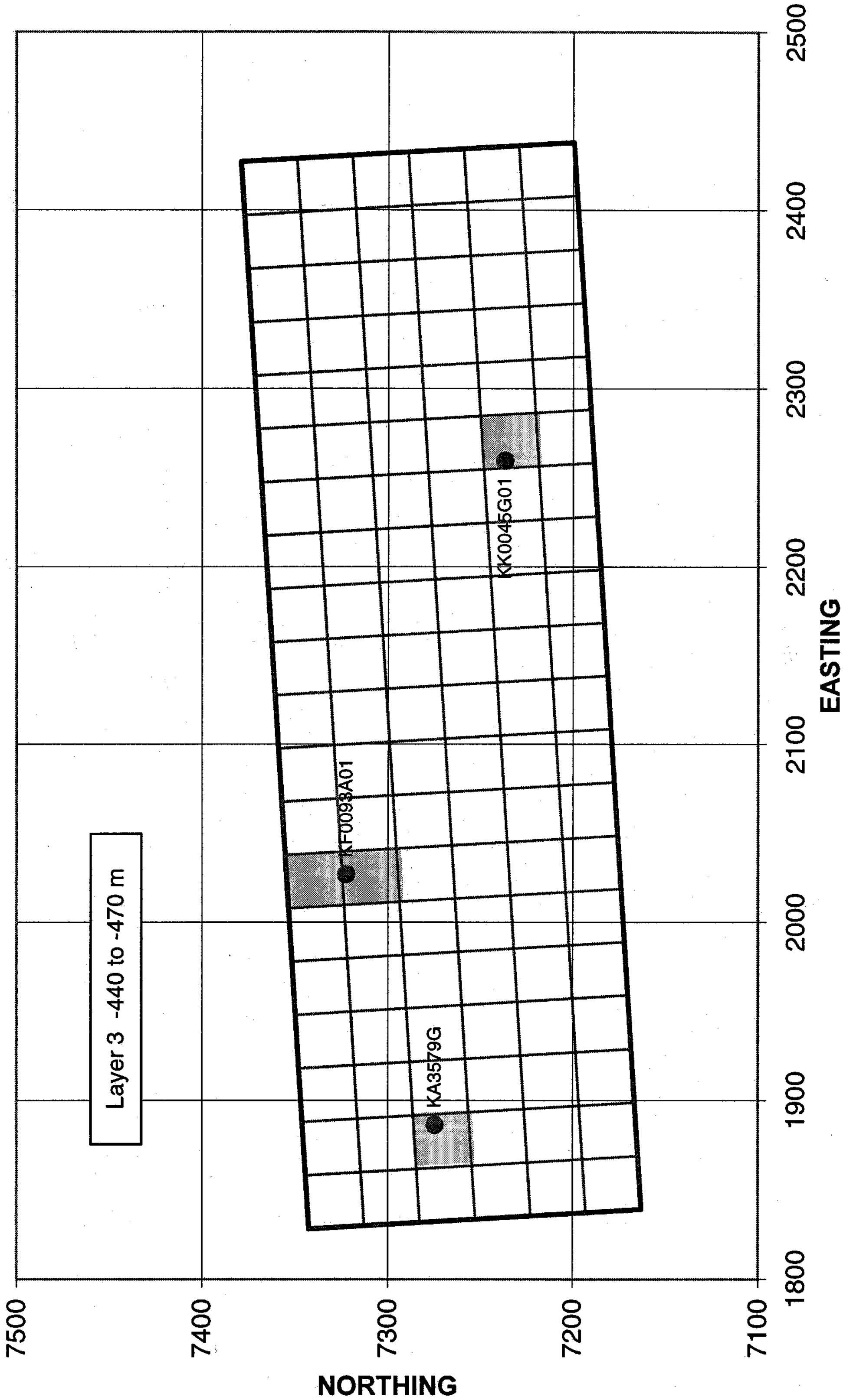


Figure 13 Location of data from stress measurement boreholes in the conceptual model, layer 3 -440 to -470 m

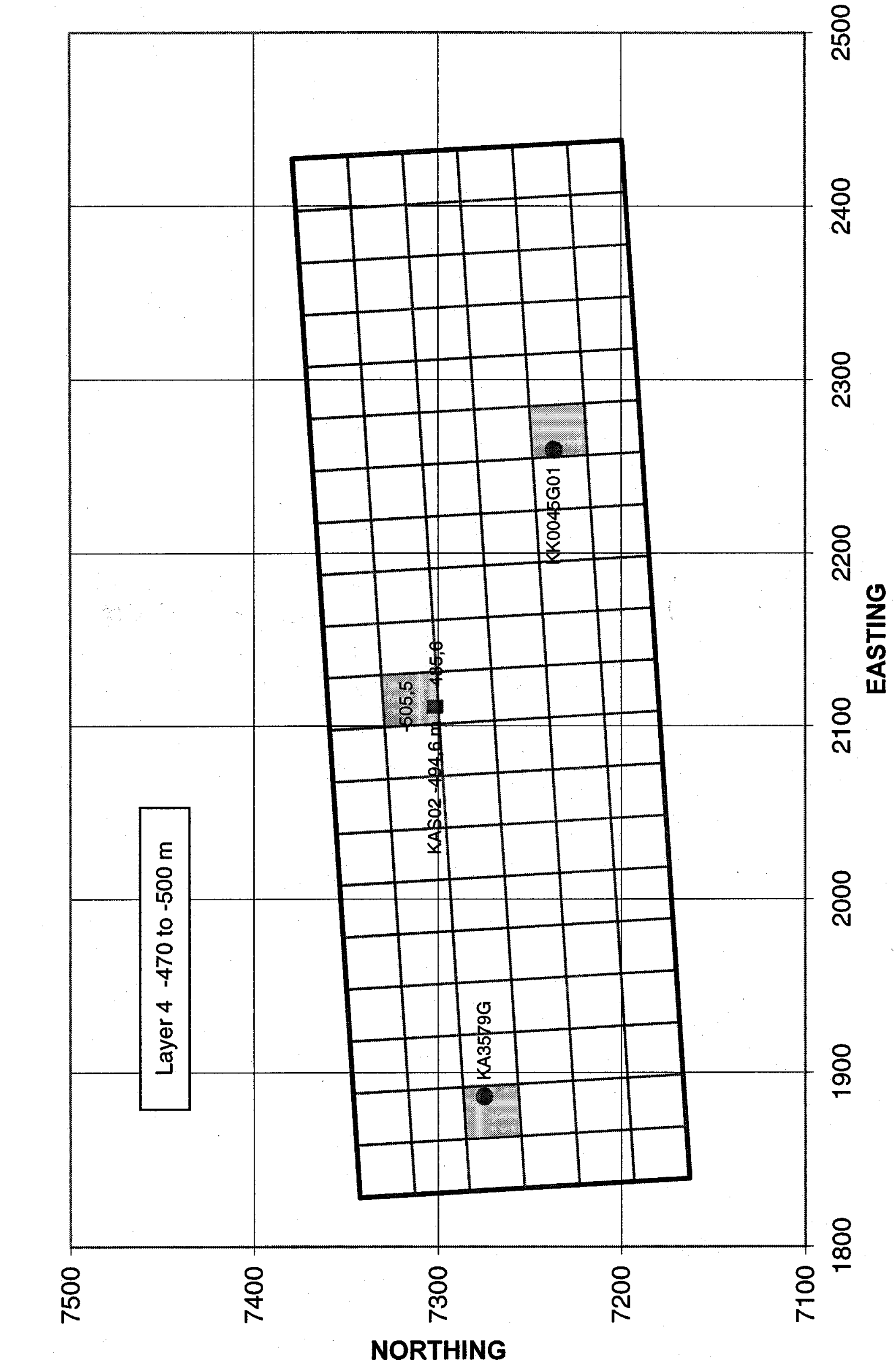


Figure 14 Location of data from stress measurement boreholes in the conceptual model, layer 4 -470 to -500 m

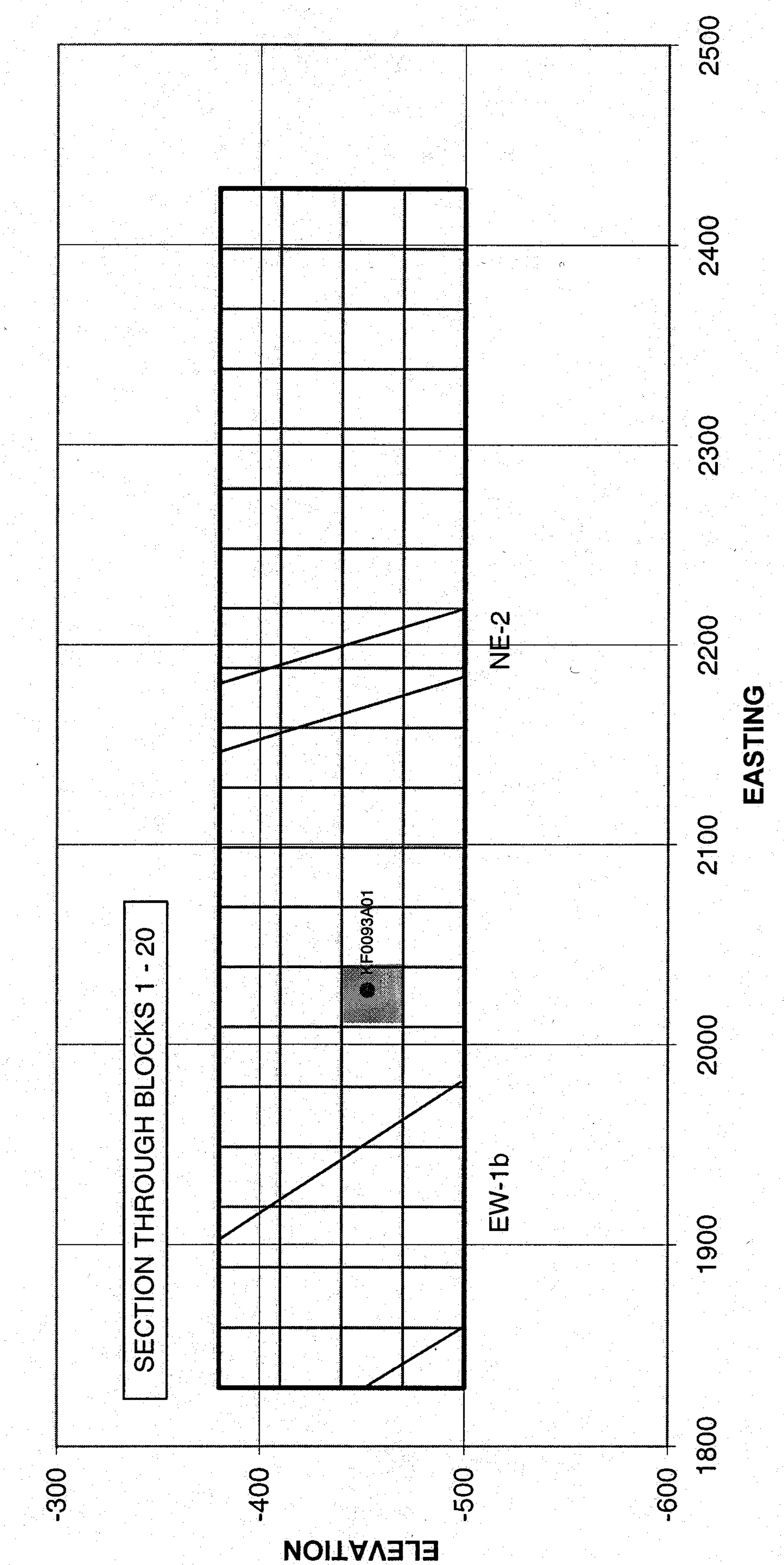


Figure 15 Location of data from stress measurement boreholes in the conceptual model, section through blocks 1-20

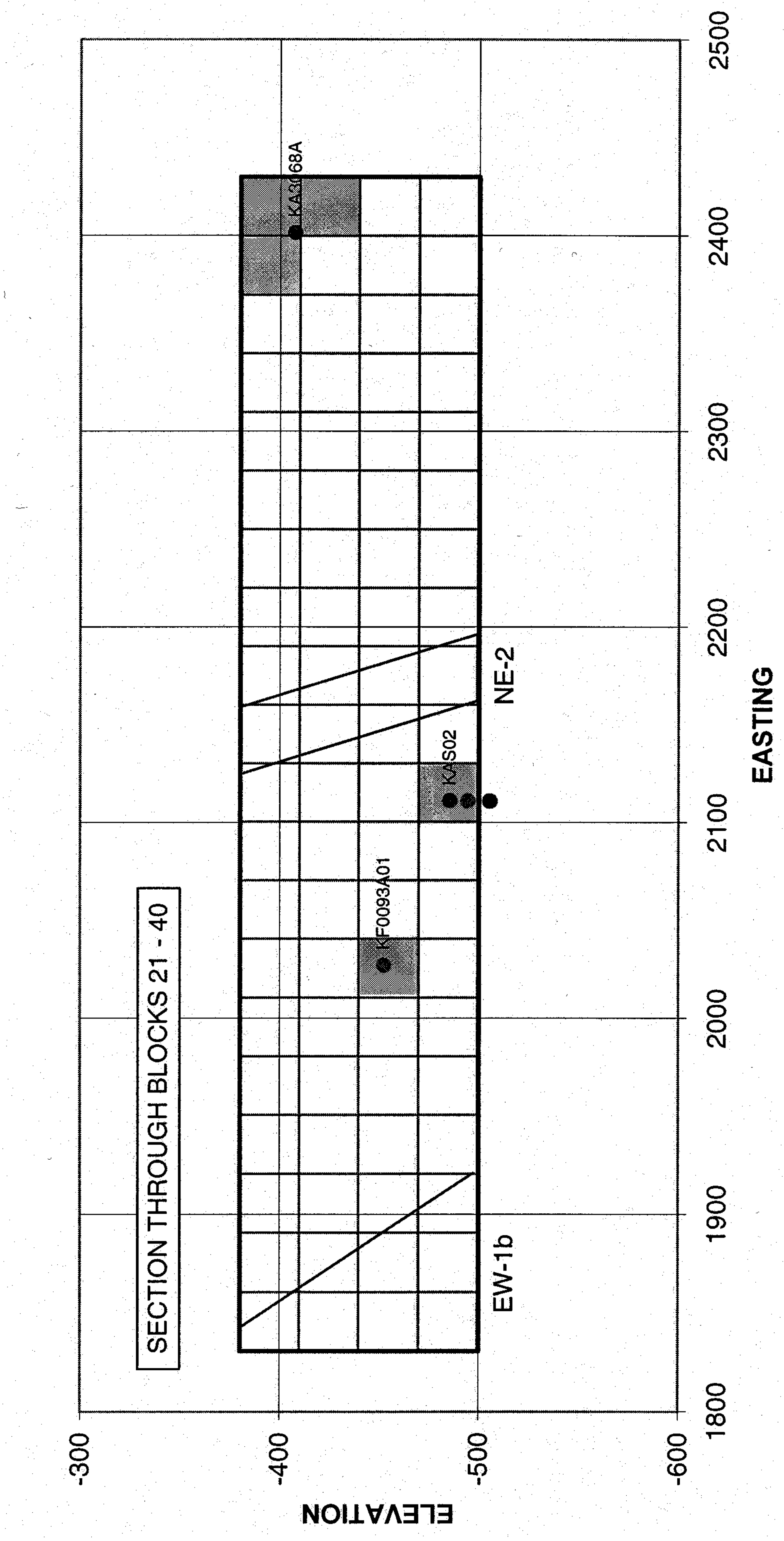


Figure 16 Location of data from stress measurement boreholes in the conceptual model, section through blocks 21-40

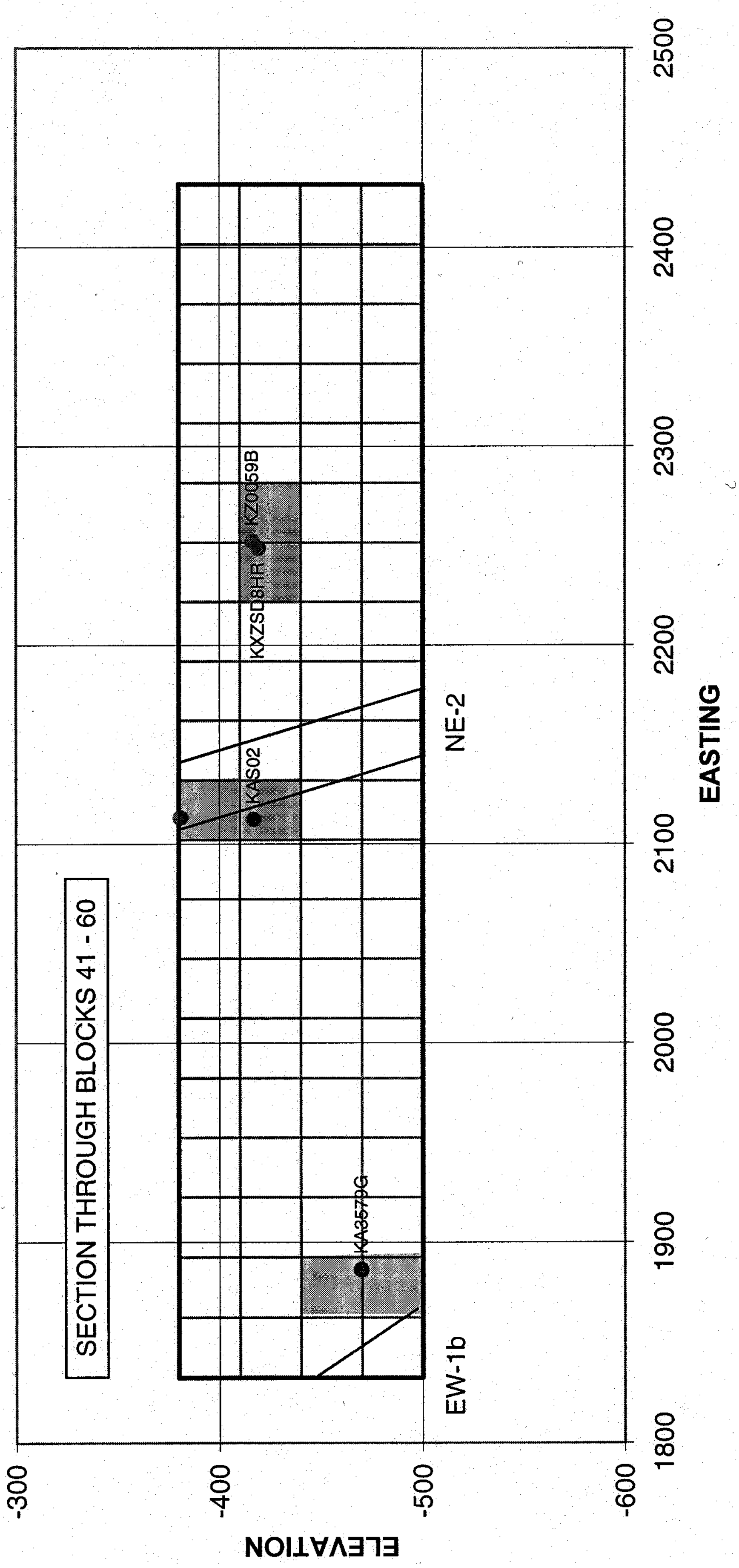


Figure 17 Location of data from stress measurement boreholes in the conceptual model, section through blocks 41-60

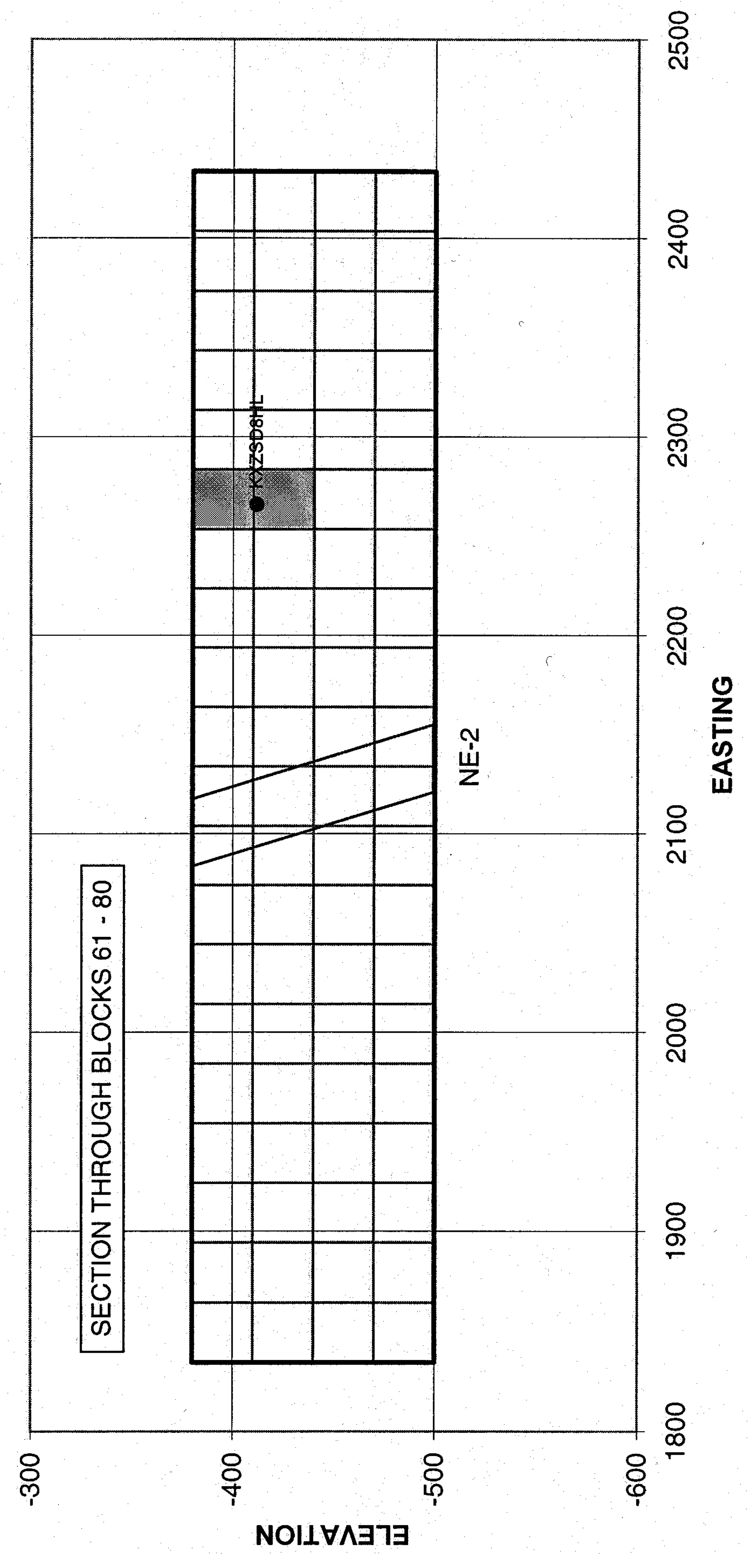


Figure 18 Location of data from stress measurement boreholes in the conceptual model, section through blocks 61-80

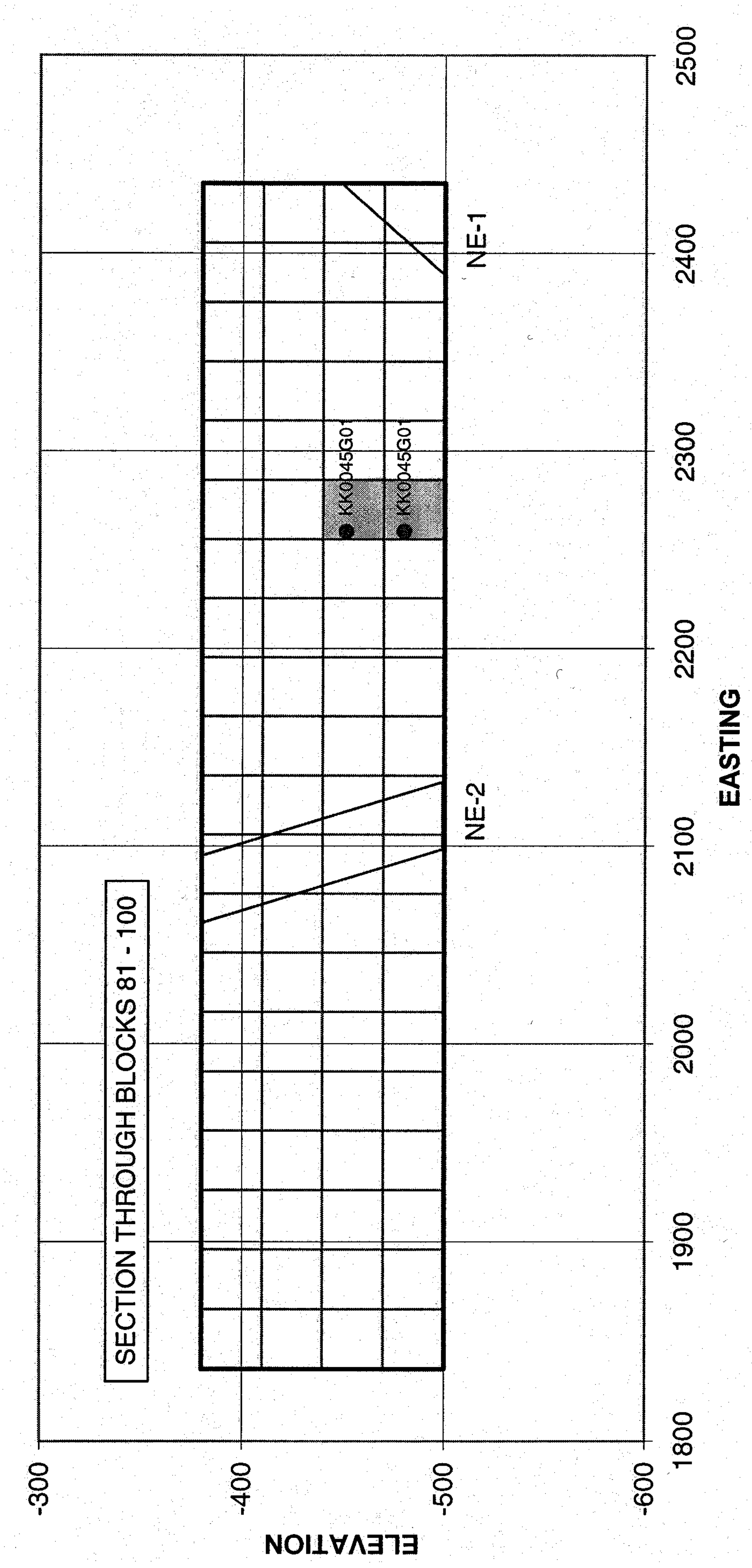


Figure 19 Location of data from stress measurement boreholes in the conceptual model, section through blocks 81-100

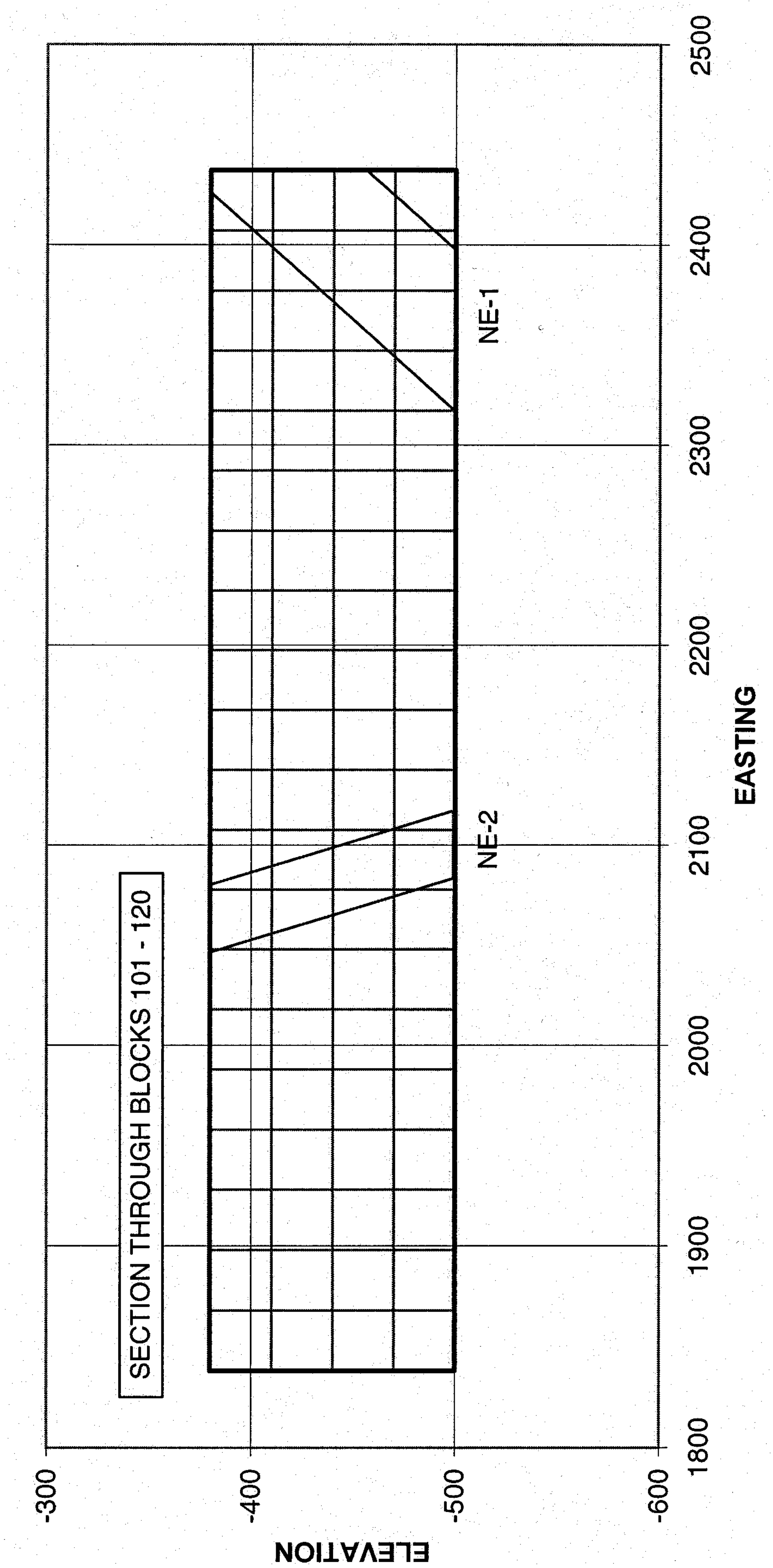


Figure 20 Location of data from stress measurement boreholes in the conceptual model, section through blocks 100-120

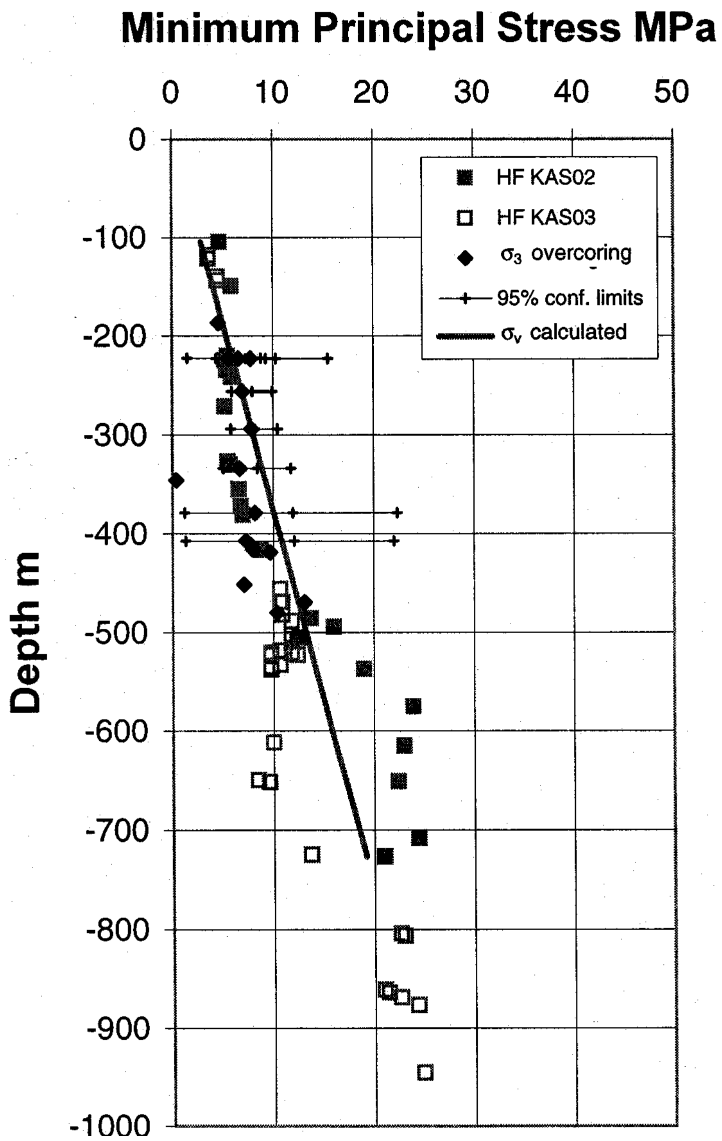


Figure 21 Minimum principal stress (σ_3) determined by hydrofracture (HF) tests in boreholes KAS02 and KAS03 and the mean value for each overcoring series plotted against depth. The 95% confidence limits are plotted for overcoring tests using the CSIRO cell.

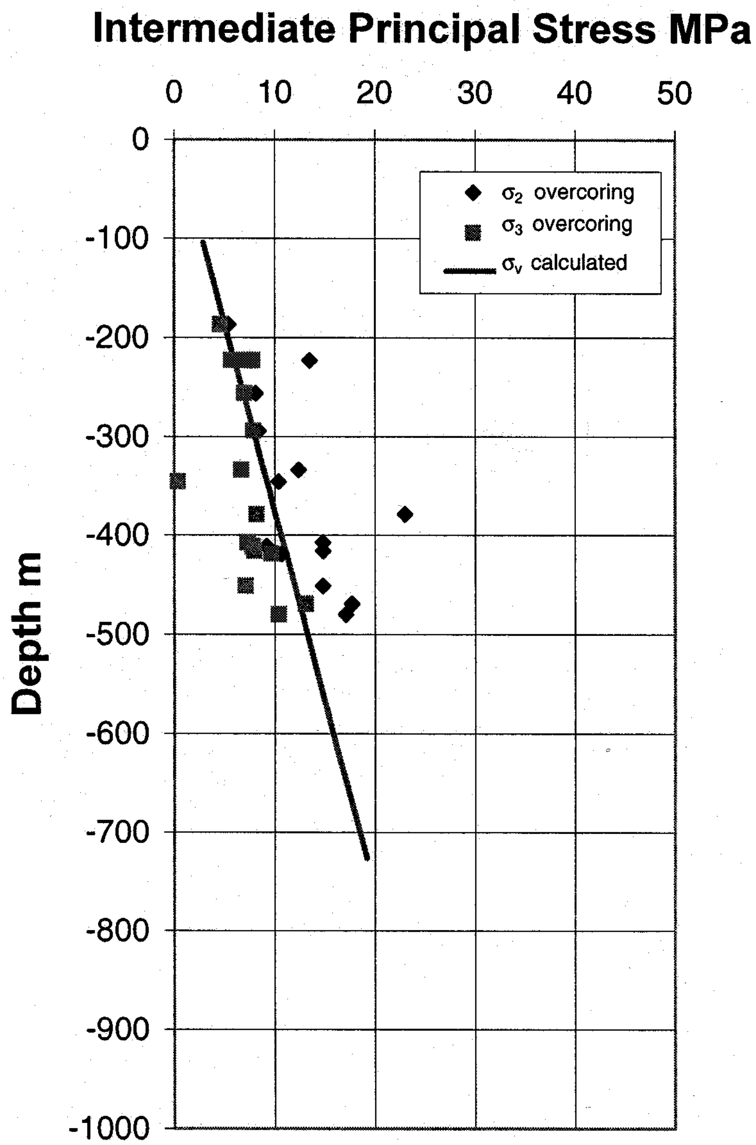


Figure 22 Intermediate (σ_2) and minimum (σ_3) principal stresses determined as the mean value for each overcoring series compared with expected vertical stress calculated from weight of overburden plotted against depth.

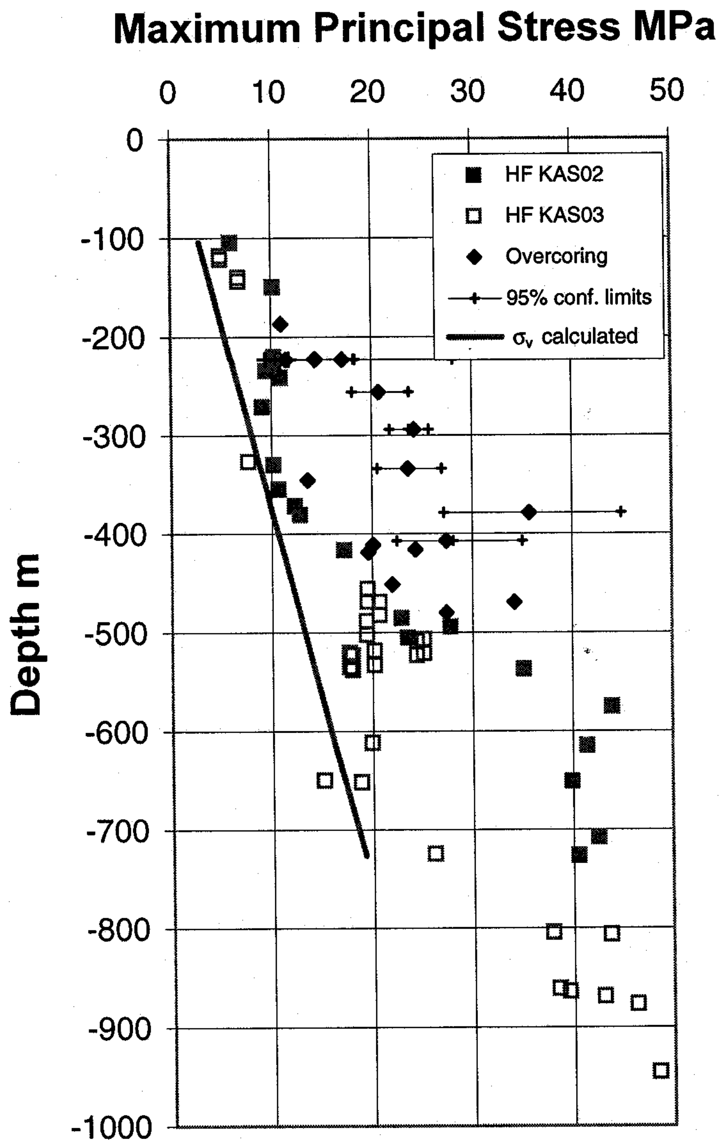


Figure 23 Maximum principal stress (σ_1) determined by hydrofracture (HF) tests in boreholes KAS02 and KAS03 and the mean value for each overcoring series plotted against depth. The 95% confidence limits are plotted for overcoring tests using the CSIRO cell.

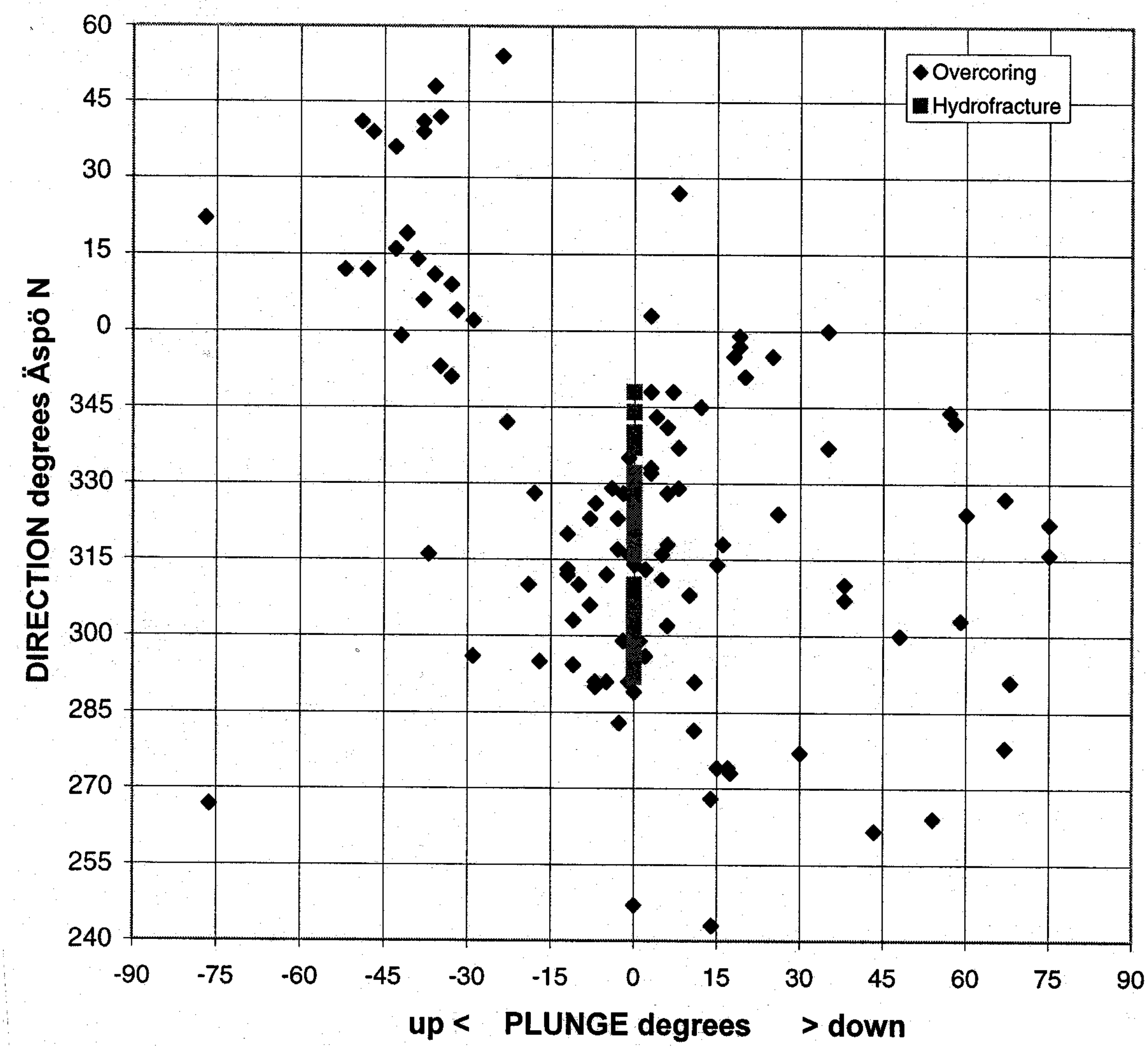


Figure 24 Orientation of the maximum principal stress (σ_1) plotted as direction and plunge. Data from all hydrofracture tests in boreholes KAS02 and KAS03 and individual tests from each overcoring series.

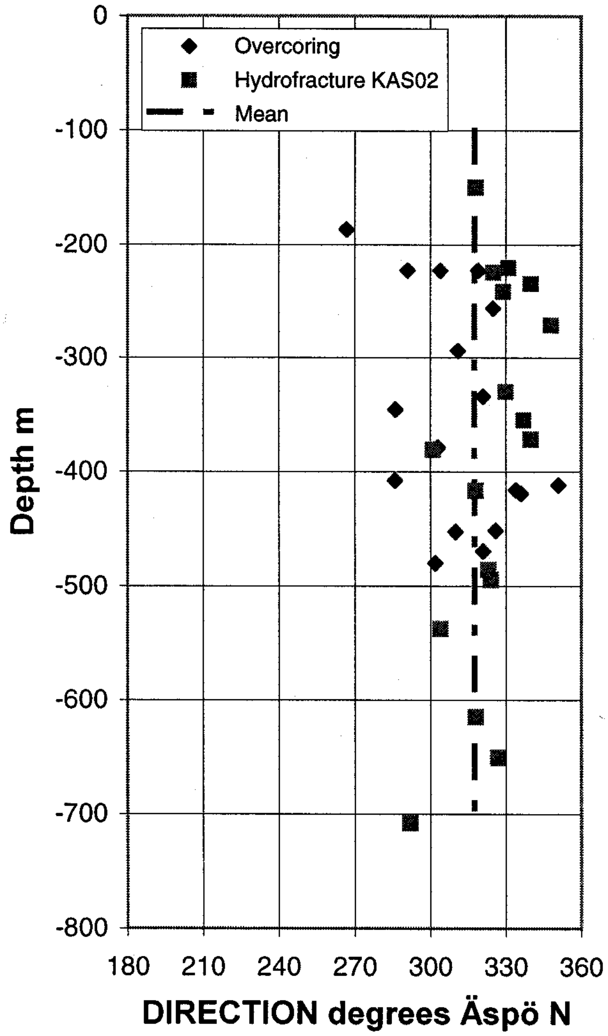


Figure 25 Orientation of the maximum principal stress (σ_1) plotted against depth. Data from all hydrofracture tests in borehole KAS02 and mean values from each overcoring series. The mean value of all these results is shown for comparison.

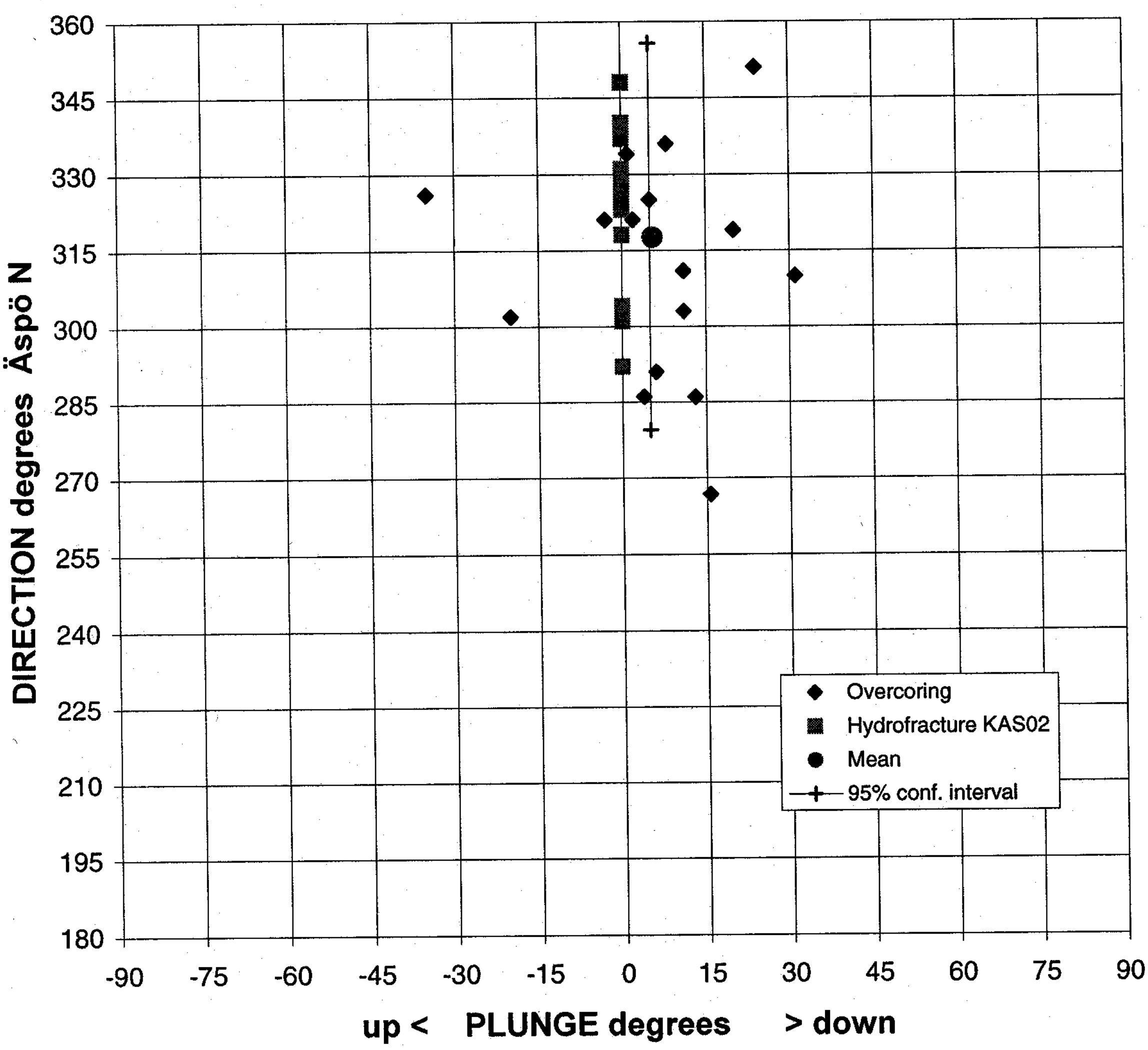


Figure 26 Orientation of the maximum principal stress (σ_1) plotted as direction and plunge. Data from all hydrofracture tests in borehole KAS02 and mean values from each overcoring series. The mean value and 95% confidence limits, derived assuming normal distribution, for the direction is shown.

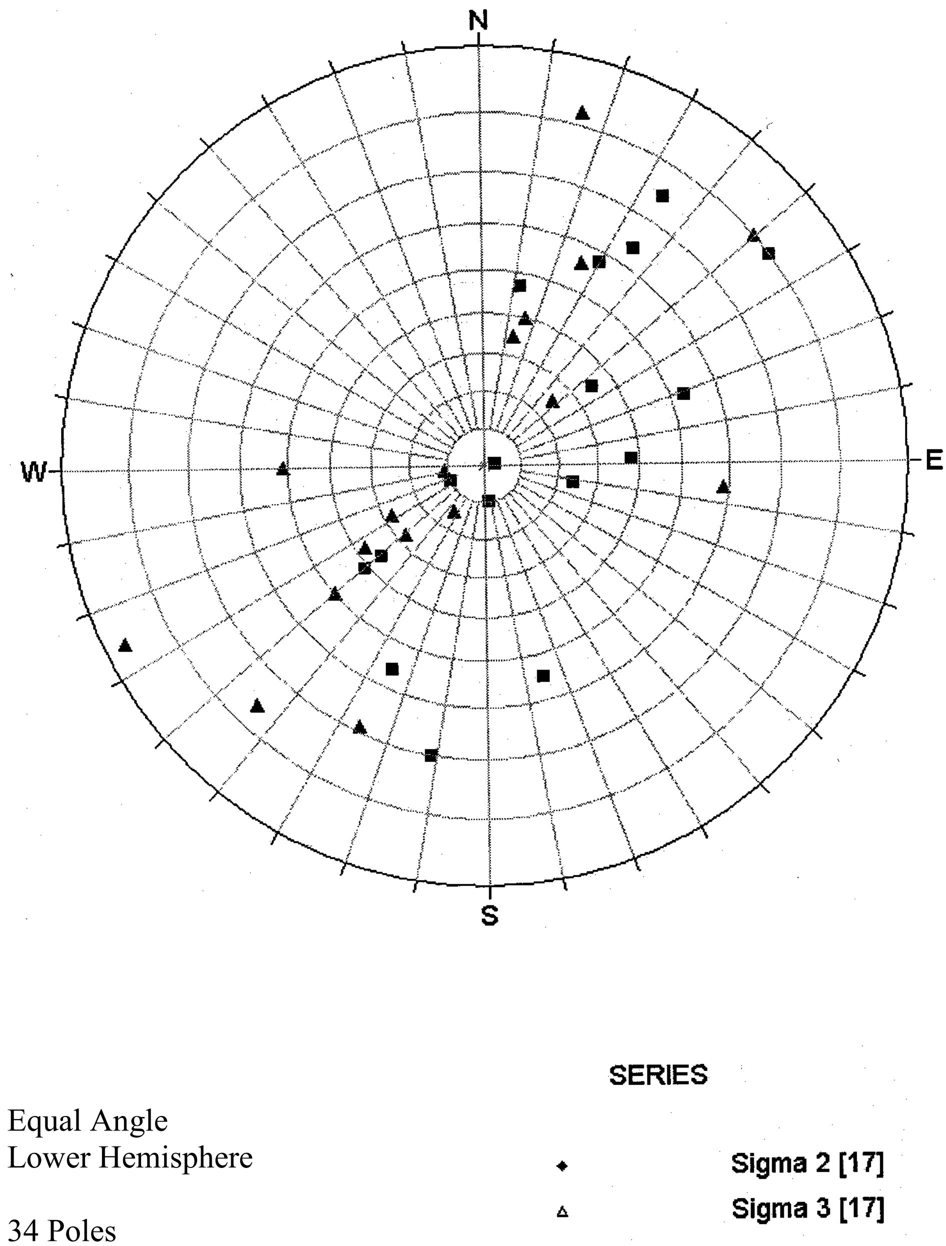


Figure 27 Stereographic plot of orientation of intermediate (σ_2) and minimum (σ_3) principal stresses. Data from mean values for each overcoring series

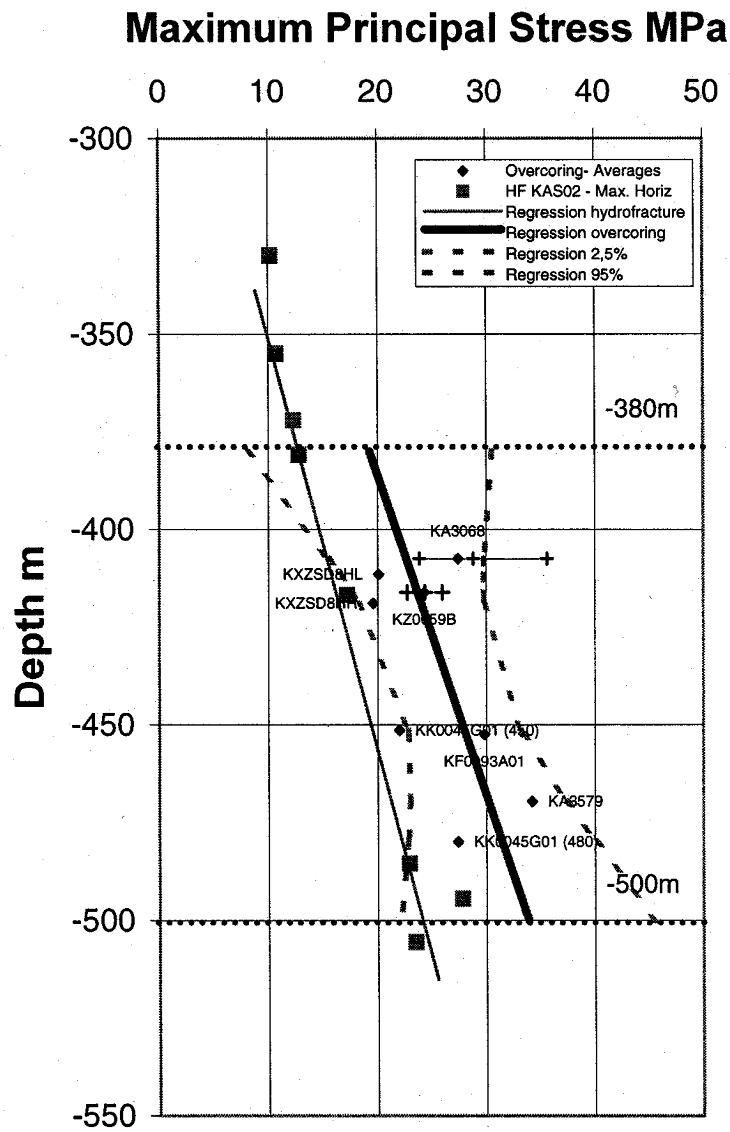


Figure 28 Maximum principal stress (σ_1) plotted against depth over the block model. Data from hydrofracture tests in KAS02 between -372 and -515 m depth and mean values from overcoring tests within the block. Regression line with 95% confidence limits from overcoring data only.

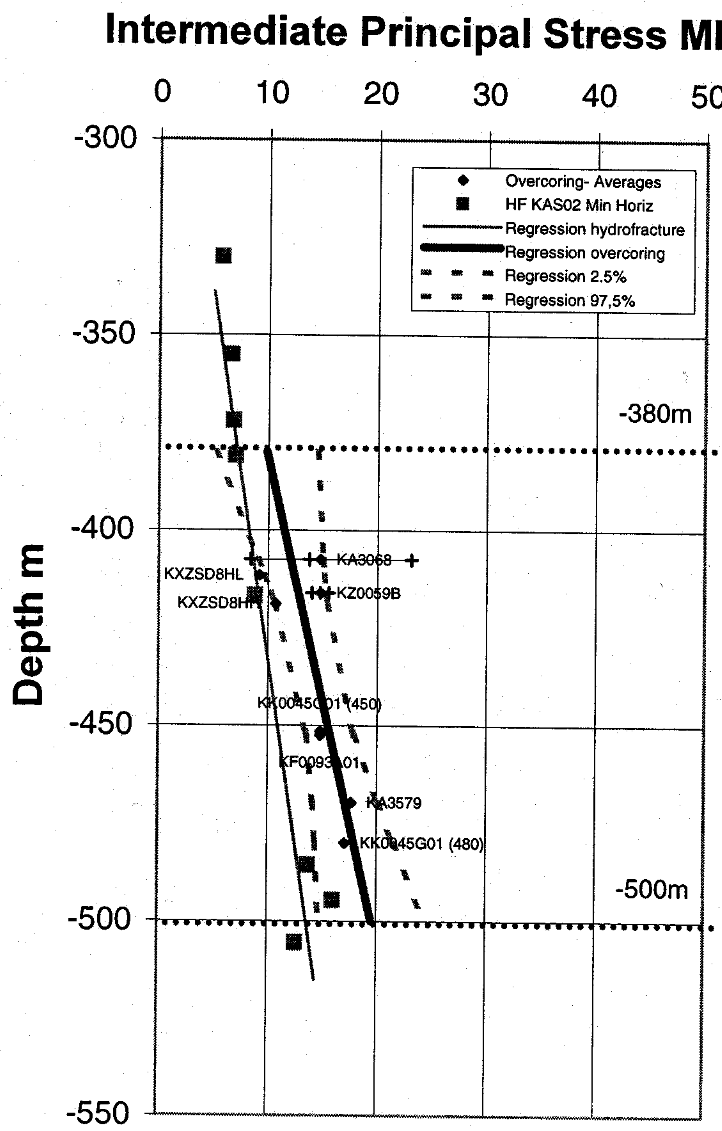


Figure 29 Intermediate principal stress (σ_2) plotted against depth over the block model. Data from mean values from overcoring tests within the block. Regression line with 95% confidence limits from overcoring data. Minimum stresses from hydrofracture tests in KAS02 between -372 and -515 m depth are shown for comparison.

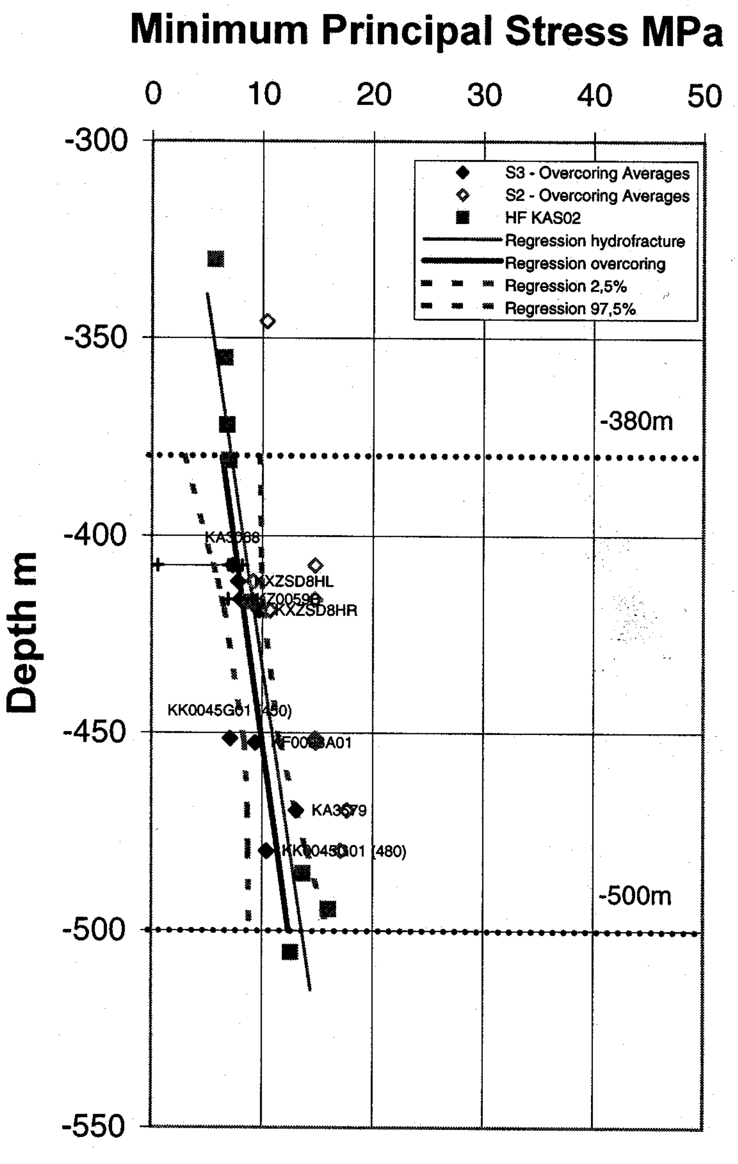


Figure 30 Minimum principal stress (s_3) plotted against depth over the block model. Data from hydrofracture tests in KAS02 between -372 and -515 m depth and mean values from overcoring tests within the block. Regression line with 95% confidence limits from overcoring data only. Intermediate principal stress (s_2) data from mean values from overcoring tests show for comparison.

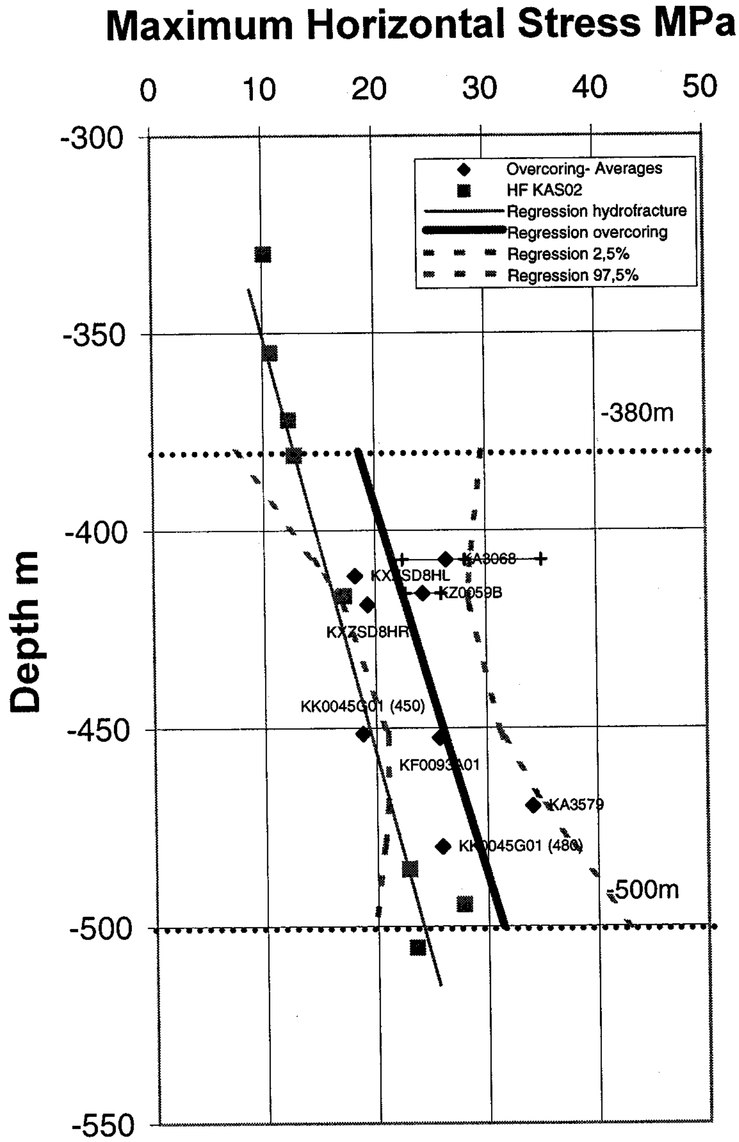


Figure 31 Maximum horizontal stress (σ_H) plotted against depth over the block model. Data from hydrofracture tests in KAS02 between -372 and -515 m depth and mean values from overcoring tests within the block. Regression line with 95% confidence limits from overcoring data only.

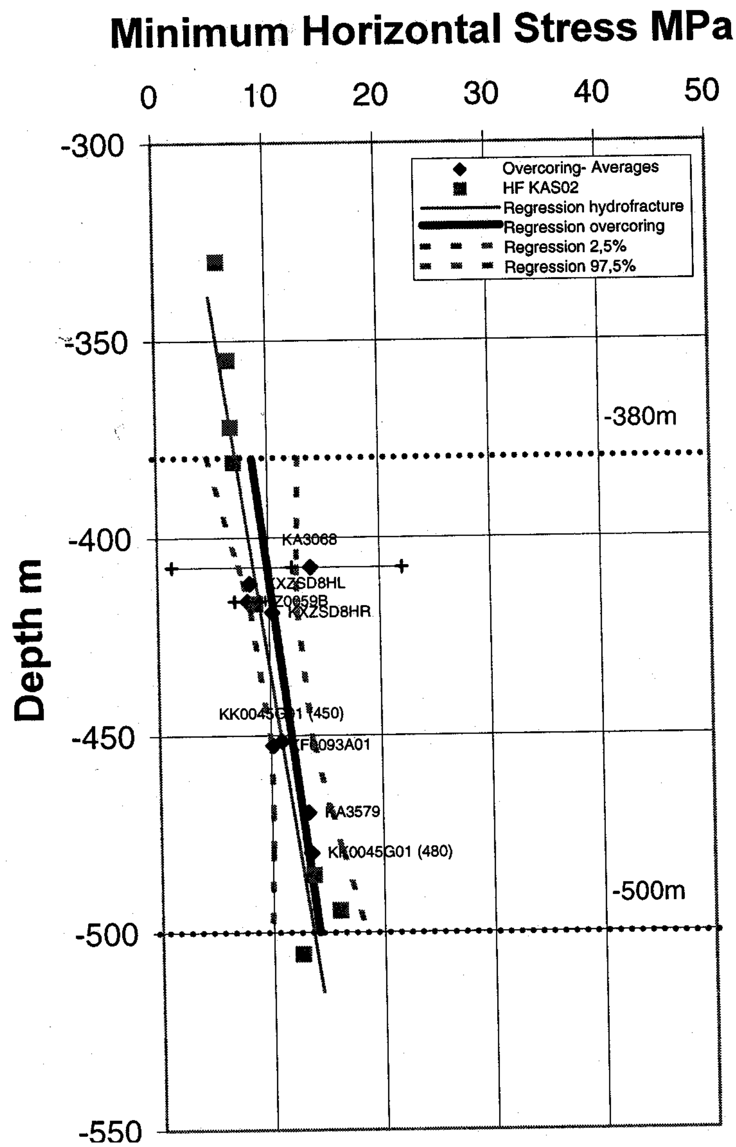


Figure 32 Minimum horizontal stress (σ_h) plotted against depth over the block model. Data from hydrofracture tests in KAS02 between -372 and -515 m depth and mean values from overcoring tests within the block. Regression line with 95% confidence limits from overcoring data only.

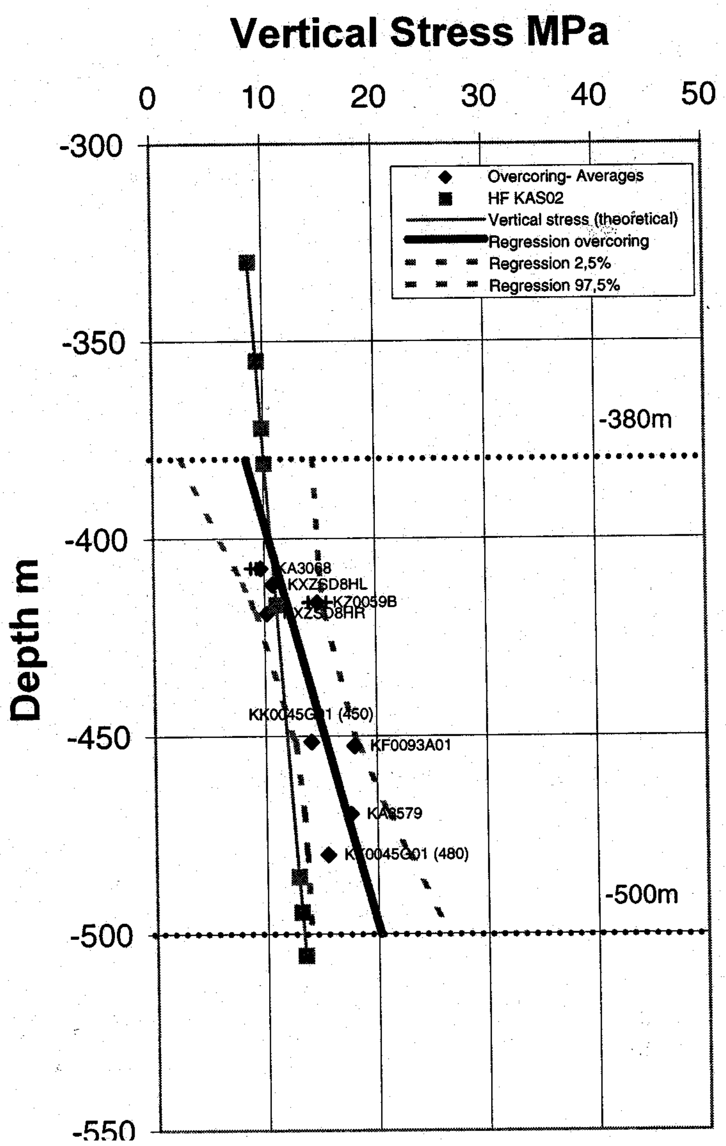
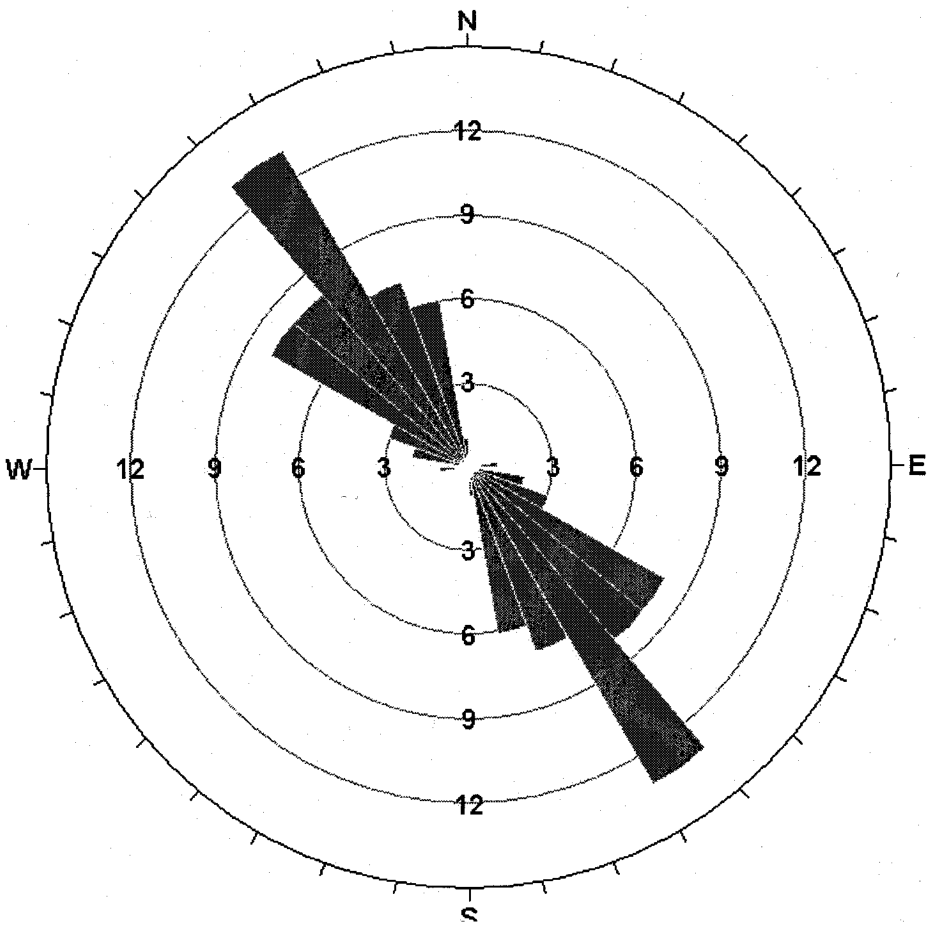


Figure 33 Vertical stress (σ_V) plotted against depth over the block model. Data from mean values from overcoring tests within the block. Theoretical vertical stress line and hydrofracture tests calculated from weight of overburden.



49 Directions plotted

Apparent Strike
15 max planes/arc
at outer circle

No Bias Correction

Figure 34 Rose diagram of maximum principal stress orientation. Data from hydrofracture tests in borehole KAS02 and mean values from all overcoring tests.

12 TABLE OF ALL BLOCK PARAMETRES

Model A

Colour codes:
13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms			Q>1: RMR=15logQ+50																
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	RMRaverage-	Qaverage-	Qinterpolated	Q	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{RMR/Hoek}$	$E_m^{interpolated}$	E_m	$\sigma_m^{c\,(Qmin)}$	$\sigma_m^{c\,(Qmax)}$	$\sigma_m^{c\,(Qmean)}$	$\sigma_m^{c\,(QrmrQ>1)}$	$\sigma_m^{c\,(interpolated)}$	σ_m^{c}	ν
1	7328.45873	1843.98378	-395									12	12					22.89	22.89					64.91	64.91	0.25
2	7330.29018	1873.92783	-395									12	12					22.89	22.89					64.91	64.91	0.25
3	7332.12163	1903.87188	-395									8	8					20.00	20.00					56.70	56.70	0.25
4	7333.95308	1933.81593	-395	7.917	11.9	8	9.375	18.8	14				8	19.93	22.83	20.00			20.00	56.50	64.72	56.70			56.70	0.25
5	7335.78453	1963.75998	-395	3.542	17.8	4	9.375	18.8	14				4	15.24	26.11	15.87			15.87	43.22	74.02	45.00			45.00	0.25
6	7337.61598	1993.70403	-395	0.146	4	0.3	2.5	9.4	4				0.3	5.27	15.87	6.69			6.69	14.93	45.00	18.98			18.98	0.25
7	7339.44743	2023.64808	-395									2	2.0					12.60	12.60					35.72	35.72	0.25
8	7341.27888	2053.59213	-395									12	12					22.89	22.89					64.91	64.91	0.25
9	7343.11033	2083.53618	-395									12	12					22.89	22.89					64.91	64.91	0.25
10	7344.94178	2113.48023	-395									12	12					22.89	22.89					64.91	64.91	0.25
11	7346.77323	2143.42428	-395									12	12					22.89	22.89					64.91	64.91	0.25
12	7348.60468	2173.36833	-395									12	12					22.89	22.89					64.91	64.91	0.25
13	7350.43613	2203.31238	-395									12	12					22.89	22.89					64.91	64.91	0.25
14	7352.26758	2233.25643	-395									12	12					22.89	22.89					64.91	64.91	0.25
15	7354.09903	2263.20048	-395									24	24					28.84	28.84					81.78	81.78	0.25
16	7355.93047	2293.14453	-395									22	22					28.02	28.02					79.44	79.44	0.25
17	7357.76193	2323.08858	-395									34	34					32.40	32.40					91.84	91.84	0.25
18	7359.59337	2353.03263	-395									26	26					29.62	29.62					83.99	83.99	0.25
19	7361.42482	2382.97668	-395				8.125	18.8	12	69	18.48		12	20.10	26.59	22.89	29.85		22.89	56.99	75.38	64.91	74.95		64.91	0.25
20	7363.25628	2412.92073	-395				11.875	18.8	12				12	22.81	26.59	22.89			22.89	64.68	75.38	64.91			64.91	0.25
21	7298.51473	1845.81528	-395									12	12					22.89	22.89					64.91	64.91	0.25
22	7300.34618	1875.75933	-395									12	12					22.89	22.89					64.91	64.91	0.25
23	7302.17763	1905.70338	-395									19	19					26.68	26.68					75.65	75.65	0.25
24	7304.00908	1935.64743	-395									8	8					20.00	20.00					56.70	56.70	0.25
25	7305.84053	1965.59148	-395									4	4					15.87	15.87					45.00	45.00	0.25
26	7307.67198	1995.53553	-395									2	2					12.60	12.60					35.72	35.72	0.25
27	7309.50343	2025.47958	-395									12	12					22.89	22.89					64.91	64.91	0.25
28	7311.33488	2055.42363	-395									12	12					22.89	22.89					64.91	64.91	0.25
29	7313.16633	2085.36768	-395									12	12					22.89	22.89					64.91	64.91	0.25
30	7314.99778	2115.31173	-395									8	8					20.00	20.00					56.70	56.70	0.25
31	7316.82923	2145.25578	-395									12	12					22.89	22.89					64.91	64.91	0.25
32	7318.66068	2175.19983	-395									12	12					22.89	22.89					64.91	64.91	0.25
33	7320.49213	2205.14388	-395									12	12					22.89	22.89					64.91	64.91	0.25
34	7322.32358	2235.08793	-395									16	16					25.20	25.20					71.44	71.44	0.25
35	7324.15503	2265.03198	-395				23.75	23.8	24				24	28.74	28.76	28.84			28.84	81.49	81.55	81.78			81.78	0.25
36	7325.98648	2294.97603	-395							70	21.54		22				31.62		31.62				78.89		78.89	0.25
37	7327.81792	2324.92008	-395							73	34.15		34				37.58		37.58				91.97		91.97	0.25
38	7329.64937	2354.86413	-395							74	39.81		40				39.81		39.81				96.80		96.80	0.25
39	7331.48083	2384.80818	-395				9.375	18.8	12	68	15.85		12	21.09	26.59	22.89	28.18		22.89	59.78	75.38	64.91	71.21		64.91	0.25
40	7333.31228	2414.75223	-395				8.125	18.8	12				12	20.10	26.59	22.89			22.89	56.99	75.38	64.91			64.91	0.25
41	7268.57073	1847.64678	-395									12	12					22.89	22.89					64.91	64.91	0.25
42	7270.40218	1877.59083	-395									12	12					22.89	22.89					64.91	64.91	0.25
43	7272.23363	1907.53488	-395									12	12					22.89	22.89					64.91	64.91	0.25
44	7274.06508	1937.47893	-395									12	12					22.89	22.89					64.91	64.91	0.25
45	7275.89653	1967.42298	-395									12	12					22.89	22.89					64.91	64.91	0.25
46	7277.72798	1997.36703	-395									12	12					22.89	22.89					64.91	64.91	0.25
47	7279.55943	2027.31108	-395									12	12					22.89	22.89					64.91	64.91	0.25
48	7281.39088	2057.25513	-395									12	12					22.89	22.89					64.91	64.91	0.25
49	7283.22233	2087.19918	-395									8	8					20.00	20.00					56.70	56.70	0.25
50	7285.05378	2117.14323	-395	7.083	17.8	8							8	19.20	26.11	20.00			20.00	54.45	74.02	56.70			56.70	0.25
51	7286.88523	2147.08728	-395									35	35					32.71	32.71					92.73	92.73	0.25
52	7288.71668	2177.03133	-395									22	22					28.02	28.02					79.44	79.44	0.25
53	7290.54813	2206.97538	-395									63	63					39.79	39.79					112.81	112.81	0.25
54	7292.37958	2236.91943	-395									15	15					24.66	24.66					69.92	69.92	0.25
55	7294.21103	2266.86348	-395				17.813	17.8	18				18	26.12	26.11	26.21			26.21	74.04	74.02	74.30			74.30	0.25
56	7296.04248	2296.80753	-395							70	21.54		22				31.62		31.62				78.89		78.89	0.25
57	7297.87392	2326.75158	-395							70	21.54		22				31.62		31.62				78.89		78.89	0.25
58	7299.70538	2356.69563	-395									24	24					28.84	28.84					81.78	81.78	0.25
59	7301.53682	2386.63968	-395									12	12					22.89	22.89					64.91	64.91	0.25
60	7303.36828	2416.58373	-395									3	3					14.42	14.42					40.89	40.89	0.25
61	7238.62673	1849.47828	-395									12	12					22.89	22.89					64.91	64.91	0.25
62	7240.45818	1879.42233	-395									12	12					22.89	22.89					64.91	64.91	0.25
63	7242.28963	1909.36638	-395									12	12					22.89	22.89					64.91	64.91	0.25
64	7244.12108	1939.31043	-395									12	12					22.89	22.89					64.91	64.91	0.25
65	7245.95253	1969.25448	-395				0.556	18.8	12				12	8.22	26.59	22.89			22.89	23.31	75.38	64.91			64.91	0.25
66	7247.78398	1999.19853	-395				9.375	18.8	12				12	21.09	26.59	22.89			22.89	59.78	75.38	64.91			64.91	0.25
67	7249.61543	2029.14258	-395									12	12					22.89	22.89					64.91	64.91	0.25
68	7251.44688	2059.08663	-395									12	12					22.89	22.89					64.91	64.91	0.25
69	7253.27833	2089.03068	-395									12	12					22.89	22.89					64.91	64.91	0.25
70	7255.10978	2118.97473	-395									8	8					20.00	20.00					56.70	56.70	0.25
71	7256.94123	2148.91878	-395									12	12					22.89	22.89					64.91	64.91	0.25
72	7258.77268	2178.86283	-395									12	12					22.89	22.89					64.91	64.91	0.25

Model A

Colour codes:
13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms			Q>1: RMR=15logQ+50																
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	RMRaverage	Qaverage	Qinterpolated	Q	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{RMR/Hoek}$	$E_m^{interpolated}$	E_m	$\sigma_m^{c(Qmin)}$	$\sigma_m^{c(Qmax)}$	$\sigma_m^{c(Qmean)}$	$\sigma_m^{c(Qrm/Q>1)}$	$\sigma_m^{c(interpolated)}$	σ_m^{c}	ν
73	7260.60413	2208.80688	-395									12	12					22.89	22.89					64.91	64.91	0.25
74	7262.43558	2238.75093	-395									14	14					24.10	24.10					68.33	68.33	0.25
75	7264.26702	2268.69498	-395				11.875	25	16				16	22.81	29.24	25.20			25.20	64.68	82.90	71.44			71.44	0.25
76	7266.09848	2298.63903	-395									15	15					24.66	24.66					69.92	69.92	0.25
77	7267.92992	2328.58308	-395									22	22					28.02	28.02					79.44	79.44	0.25
78	7269.76137	2358.52713	-395									12	12					22.89	22.89					64.91	64.91	0.25
79	7271.59282	2388.47118	-395									12	12					22.89	22.89					64.91	64.91	0.25
80	7273.42428	2418.41523	-395									12	12					22.89	22.89					64.91	64.91	0.25
81	7208.68273	1851.30978	-395									12	12					22.89	22.89					64.91	64.91	0.25
82	7210.51418	1881.25383	-395									12	12					22.89	22.89					64.91	64.91	0.25
83	7212.34563	1911.19788	-395									12	12					22.89	22.89					64.91	64.91	0.25
84	7214.17708	1941.14193	-395									11	11					22.24	22.24					63.05	63.05	0.25
85	7216.00853	1971.08598	-395									10	10					21.54	21.54					61.08	61.08	0.25
86	7217.83998	2001.03003	-395									12	12					22.89	22.89					64.91	64.91	0.25
87	7219.67143	2030.97408	-395									12	12					22.89	22.89					64.91	64.91	0.25
88	7221.50288	2060.91813	-395									12	12					22.89	22.89					64.91	64.91	0.25
89	7223.33433	2090.86218	-395									12	12					22.89	22.89					64.91	64.91	0.25
90	7225.16578	2120.80623	-395									12	12					22.89	22.89					64.91	64.91	0.25
91	7226.99723	2150.75028	-395									12	12					22.89	22.89					64.91	64.91	0.25
92	7228.82868	2180.69433	-395									12	12					22.89	22.89					64.91	64.91	0.25
93	7230.66013	2210.63838	-395									12	12					22.89	22.89					64.91	64.91	0.25
94	7232.49158	2240.58243	-395									22	22					28.02	28.02					79.44	79.44	0.25
95	7234.32303	2270.52648	-395									18	18					26.21	26.21					74.30	74.30	0.25
96	7236.15447	2300.47053	-395									18	18					26.21	26.21					74.30	74.30	0.25
97	7237.98592	2330.41458	-395									12	12					22.89	22.89					64.91	64.91	0.25
98	7239.81738	2360.35863	-395									12	12					22.89	22.89					64.91	64.91	0.25
99	7241.64882	2390.30268	-395									12	12					22.89	22.89					64.91	64.91	0.25
100	7243.48028	2420.24673	-395									12	12					22.89	22.89					64.91	64.91	0.25
101	7178.73873	1853.14128	-395									12	12					22.89	22.89					64.91	64.91	0.25
102	7180.57018	1883.08533	-395									12	12					22.89	22.89					64.91	64.91	0.25
103	7182.40163	1913.02938	-395									12	12					22.89	22.89					64.91	64.91	0.25
104	7184.23308	1942.97343	-395									6	6					18.17	18.17					51.52	51.52	0.25
105	7186.06453	1972.91748	-395	5.938	17.8	6							6	18.11	26.11	18.17			18.17	51.34	74.02	51.52			51.52	0.25
106	7187.89598	2002.86153	-395									6	6					18.17	18.17					51.52	51.52	0.25
107	7189.72743	2032.80558	-395									12	12					22.89	22.89					64.91	64.91	0.25
108	7191.55888	2062.74963	-395									12	12					22.89	22.89					64.91	64.91	0.25
109	7193.39033	2092.69368	-395									12	12					22.89	22.89					64.91	64.91	0.25
110	7195.22178	2122.63773	-395									12	12					22.89	22.89					64.91	64.91	0.25
111	7197.05323	2152.58178	-395									12	12					22.89	22.89					64.91	64.91	0.25
112	7198.88468	2182.52583	-395									12	12					22.89	22.89					64.91	64.91	0.25
113	7200.71613	2212.46988	-395									12	12					22.89	22.89					64.91	64.91	0.25
114	7202.54758	2242.41393	-395									12	12					22.89	22.89					64.91	64.91	0.25
115	7204.37903	2272.35798	-395									12	12					22.89	22.89					64.91	64.91	0.25
116	7206.21047	2302.30203	-395									12	12					22.89	22.89					64.91	64.91	0.25
117	7208.04192	2332.24608	-395									12	12					22.89	22.89					64.91	64.91	0.25
118	7209.87337	2362.19013	-395									12	12					22.89	22.89					64.91	64.91	0.25
119	7211.70482	2392.13418	-395									12	12					22.89	22.89					64.91	64.91	0.25
120	7213.53628	2422.07823	-395									12	12					22.89	22.89					64.91	64.91	0.25
121	7328.45873	1843.98378	-425									12	12					22.89	22.89					64.91	64.91	0.25
122	7330.29018	1873.92783	-425									12	12					22.89	22.89					64.91	64.91	0.25
123	7332.12163	1903.87188	-425									15	15					24.66	24.66					69.92	69.92	0.25
124	7333.95308	1933.81593	-425	11.875	11.9	12	10.625	18.8	13				12	22.81	22.83	22.89			22.89	64.68	64.72	64.91			64.91	0.25
125	7335.78453	1963.75998	-425									8	8					20.00	20.00					56.70	56.70	0.25
126	7337.61598	1993.70403	-425									2	2					12.60	12.60					35.72	35.72	0.25
127	7339.44743	2023.64808	-425									12	12					22.89	22.89					64.91	64.91	0.25
128	7341.27888	2053.59213	-425									12	12					22.89	22.89					64.91	64.91	0.25
129	7343.11033	2083.53618	-425									12	12					22.89	22.89					64.91	64.91	0.25
130	7344.94178	2113.48023	-425									12	12					22.89	22.89					64.91	64.91	0.25
131	7346.77323	2143.42428	-425									12	12					22.89	22.89					64.91	64.91	0.25
132	7348.60468	2173.36833	-425									12	12					22.89	22.89					64.91	64.91	0.25
133	7350.43613	2203.31238	-425									12	12					22.89	22.89					64.91	64.91	0.25
134	7352.26758	2233.25643	-425									8	8					20.00	20.00					56.70	56.70	0.25
135	7354.09903	2263.20048	-425									9	9					20.80	20.80					58.97	58.97	0.25
136	7355.93047	2293.14453	-425									12	12					22.89	22.89					64.91	64.91	0.25
137	7357.76193	2323.08858	-425									22	22					28.02	28.02					79.44	79.44	0.25
138	7359.59337	2353.03263	-425									34	34					32.40	32.40					91.84	91.84	0.25
139	7361.42482	2382.97668	-425									17	17					25.71	25.71					72.90	72.90	0.25
140	7363.25628	2412.92073	-425				11.875	18.8	19				19	22.81	26.59	26.68			26.68	64.68	75.38	75.65			75.65	0.25
141	7298.51473	1845.81528	-425									12	12					22.89	22.89					64.91	64.91	0.25
142	7300.34618	1875.75933	-425									12	12					22.89	22.89					64.91	64.91	0.25
143	7302.17763	1905.70338	-425				18.75	18.8	19				19	26.57	26.59	26.68			26.68	75.32	75.38	75.65			75.65	0.25
144	7304.00908	1935.64743	-425									15	15					24.66	24.66					69.92	69.92	0.25

Model A

Colour codes:

13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms			Q>1: RMR=15logQ+50																
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	RMRaverage	Qaverage	Qinterpolated	Q	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{RMR/Hoek}$	$E_m^{interpolated}$	E_m	$\sigma_m^{c\,(Qmin)}$	$\sigma_m^{c\,(Qmax)}$	$\sigma_m^{c\,(Qmean)}$	$\sigma_m^{c\,(Qrm/Q>1)}$	$\sigma_m^{c\,(interpolated)}$	σ_m^{c}	ν
145	7305.84053	1965.59148	-425									12	12					22.89	22.89					64.91	64.91	0.25
146	7307.67198	1995.53553	-425									12	12					22.89	22.89					64.91	64.91	0.25
147	7309.50343	2025.47958	-425									16	16					25.20	25.20					71.44	71.44	0.25
148	7311.33488	2055.42363	-425									7	7					19.13	19.13					54.23	54.23	0.25
149	7313.16633	2085.36768	-425									5	5					17.10	17.10					48.48	48.48	0.25
150	7314.99778	2115.31173	-425									18	18					26.21	26.21					74.30	74.30	0.25
151	7316.82923	2145.25578	-425									63	63					39.79	39.79					112.81	112.81	0.25
152	7318.66068	2175.19983	-425									22	22					28.02	28.02					79.44	79.44	0.25
153	7320.49213	2205.14388	-425									22	22					28.02	28.02					79.44	79.44	0.25
154	7322.32358	2235.08793	-425				7.083	17.8	8				8	19.20	26.11	20.00			20.00	54.45	74.02	56.70			56.70	0.25
155	7324.15503	2265.03198	-425				7.969	75	9	80	100.00		9	19.97	42.17	20.80	56.23		20.80	56.63	119.56	58.97	131.59		58.97	0.25
156	7325.98648	2294.97603	-425				11.875	75	12	70	21.54		12	22.81	42.17	22.89	31.62		22.89	64.68	119.56	64.91	78.89		64.91	0.25
157	7327.81792	2324.92008	-425							70	21.54		22				31.62		31.62				78.89		78.89	0.25
158	7329.64937	2354.86413	-425							73	34.15		34				37.58		37.58				91.97		91.97	0.25
159	7331.48083	2384.80818	-425							70	21.54		22				31.62		31.62				78.89		78.89	0.25
160	7333.31228	2414.75223	-425				2.5	18.8	11				11	13.57	26.59	22.24			22.24	38.48	75.38	63.05			63.05	0.25
161	7268.57073	1847.64678	-425									12	12					22.89	22.89					64.91	64.91	0.25
162	7270.40218	1877.59083	-425				10.625	18.8	12				12	21.98	26.59	22.89			22.89	62.33	75.38	64.91			64.91	0.25
163	7272.23363	1907.53488	-425				11.875	18.8	12				12	22.81	26.59	22.89			22.89	64.68	75.38	64.91			64.91	0.25
164	7274.06508	1937.47893	-425				11.875	18.8	12				12	22.81	26.59	22.89			22.89	64.68	75.38	64.91			64.91	0.25
165	7275.89653	1967.42298	-425									12	12					22.89	22.89					64.91	64.91	0.25
166	7277.72798	1997.36703	-425									10	10					21.54	21.54					61.08	61.08	0.25
167	7279.55943	2027.31108	-425									18	18					26.21	26.21					74.30	74.30	0.25
168	7281.39088	2057.25513	-425									12	12					22.89	22.89					64.91	64.91	0.25
169	7283.22233	2087.19918	-425									25	25					29.24	29.24					82.90	82.90	0.25
170	7285.05378	2117.14323	-425	17.813	23.8	18				80	100.00		18	26.12	28.76	26.21	56.23		26.21	74.04	81.55	74.30	131.59		74.30	0.25
171	7286.88523	2147.08728	-425							77	63.10		63				47.32		47.32				112.86		112.86	0.25
172	7288.71668	2177.03133	-425							70	21.54		22				31.62		31.62				78.89		78.89	0.25
173	7290.54813	2206.97538	-425							77	63.10		63				47.32		47.32				112.86		112.86	0.25
174	7292.37958	2236.91943	-425				3.148	75	12	73	34.15		12	14.66	42.17	22.89	37.58		22.89	41.55	119.56	64.91	91.97		64.91	0.25
175	7294.21103	2266.86348	-425				1.806	75	8	84	184.78		8	12.18	42.17	20.00	70.79		20.00	34.52	119.56	56.70	161.48		56.70	0.25
176	7296.04248	2296.80753	-425				5.938	75	12	70	21.54		12	18.11	42.17	22.89	31.62		22.89	51.34	119.56	64.91	78.89		64.91	0.25
177	7297.87392	2326.75158	-425				10.625	18.8	12	70	21.54		12	21.98	26.59	22.89	31.62		22.89	62.33	75.38	64.91	78.89		64.91	0.25
178	7299.70538	2356.69563	-425				10.625	18.8	12				12	21.98	26.59	22.89			22.89	62.33	75.38	64.91			64.91	0.25
179	7301.53682	2386.63968	-425				10.625	18.8	12				12	21.98	26.59	22.89			22.89	62.33	75.38	64.91			64.91	0.25
180	7303.36828	2416.58373	-425				0.055	12.4	0.7				0.7	3.80	23.15	8.88			8.88	10.78	65.62	25.17			25.17	0.25
181	7238.62673	1849.47828	-425									12	12					22.89	22.89					64.91	64.91	0.25
182	7240.45818	1879.42233	-425									12	12					22.89	22.89					64.91	64.91	0.25
183	7242.28963	1909.36638	-425									12	12					22.89	22.89					64.91	64.91	0.25
184	7244.12108	1939.31043	-425									12	12					22.89	22.89					64.91	64.91	0.25
185	7245.95253	1969.25448	-425				10.625	18.8	12				12	21.98	26.59	22.89			22.89	62.33	75.38	64.91			64.91	0.25
186	7247.78398	1999.19853	-425									8	8					20.00	20.00					56.70	56.70	0.25
187	7249.61543	2029.14258	-425									22	22					28.02	28.02					79.44	79.44	0.25
188	7251.44688	2059.08663	-425									12	12					22.89	22.89					64.91	64.91	0.25
189	7253.27833	2089.03068	-425									11	11					22.24	22.24					63.05	63.05	0.25
190	7255.10978	2118.97473	-425									18	18					26.21	26.21					74.30	74.30	0.25
191	7256.94123	2148.91878	-425									63	63					39.79	39.79					112.81	112.81	0.25
192	7258.77268	2178.86283	-425									22	22					28.02	28.02					79.44	79.44	0.25
193	7260.60413	2208.80688	-425									27	27					30.00	30.00					85.05	85.05	0.25
194	7262.43558	2238.75093	-425				2.639	75	12	73	34.15		12	13.82	42.17	22.89	37.58		22.89	39.18	119.56	64.91	91.97		64.91	0.25
195	7264.26702	2268.69498	-425				4.063	100	9	71	25.12		9	15.96	46.42	20.80	33.50		20.80	45.24	131.59	58.97	83.03		58.97	0.25
196	7266.09848	2298.63903	-425				8.906	17.8	9	69	18.48		9	20.73	26.11	20.80	29.85		20.80	58.76	74.02	58.97	74.95		58.97	0.25
197	7267.92992	2328.58308	-425									12	12					22.89	22.89					64.91	64.91	0.25
198	7269.76137	2358.52713	-425									12	12					22.89	22.89					64.91	64.91	0.25
199	7271.59282	2388.47118	-425									12	12					22.89	22.89					64.91	64.91	0.25
200	7273.42428	2418.41523	-425									0.7	1					8.88	8.88					25.17	25.17	0.25
201	7208.68273	1851.30978	-425									12	12					22.89	22.89					64.91	64.91	0.25
202	7210.51418	1881.25383	-425									12	12					22.89	22.89					64.91	64.91	0.25
203	7212.34563	1911.19788	-425									11	11					22.24	22.24					63.05	63.05	0.25
204	7214.17708	1941.14193	-425				2.5	18.8	11				11	13.57	26.59	22.24			22.24	38.48	75.38	63.05			63.05	0.25
205	7216.00853	1971.08598	-425				10.625	18.8	12				12	21.98	26.59	22.89			22.89	62.33	75.38	64.91			64.91	0.25
206	7217.83998	2001.03003	-425									12	12					22.89	22.89					64.91	64.91	0.25
207	7219.67143	2030.97408	-425									12	12					22.89	22.89					64.91	64.91	0.25
208	7221.50288	2060.91813	-425									12	12					22.89	22.89					64.91	64.91	0.25
209	7223.33433	2090.86218	-425									11	11					22.24	22.24					63.05	63.05	0.25
210	7225.16578	2120.80623	-425									12	12					22.89	22.89					64.91	64.91	0.25
211	7226.99723	2150.75028	-425									12	12					22.89	22.89					64.91	64.91	0.25
212	7228.82868	2180.69433	-425									12	12					22.89	22.89					64.91	64.91	0.25
213	7230.66013	2210.63838	-425									21	21					27.59	27.59					78.22	78.22	0.25
214	7232.49158	2240.58243	-425							70	21.54		22				31.62		31.62				78.89		78.89	0.25
215	7234.32303	2270.52648	-425							70	21.54		22				31.62		31.62				78.89		78.89	0.25
216	7236.15447	2300.47053	-425							69	18.48		18				29.85		29.85				74.95		74.95	0.25

Model A

Colour codes:
13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms			Q>1: RMR=15logQ+50																
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	RMRaverage-	Qaverage-	Qinterpolated	Q	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{RMR/Hoek}$	$E_m^{interpolated}$	E_m	$\sigma_m^{c (Qmin)}$	$\sigma_m^{c (Qmax)}$	$\sigma_m^{c (Qmean)}$	$\sigma_m^{c (Qrm/Q>1)}$	$\sigma_m^{c (interpolated)}$	σ_m^{c}	ν
217	7237.98592	2330.41458	-425									18	18					26.21	26.21					74.30	74.30	0.25
218	7239.81738	2360.35863	-425									12	12					22.89	22.89					64.91	64.91	0.25
219	7241.64882	2390.30268	-425									12	12					22.89	22.89					64.91	64.91	0.25
220	7243.48028	2420.24673	-425									12	12					22.89	22.89					64.91	64.91	0.25
221	7178.73873	1853.14128	-425									12	12					22.89	22.89					64.91	64.91	0.25
222	7180.57018	1883.08533	-425									12	12					22.89	22.89					64.91	64.91	0.25
223	7182.40163	1913.02938	-425									19	19					26.68	26.68					75.65	75.65	0.25
224	7184.23308	1942.97343	-425									15	15					24.66	24.66					69.92	69.92	0.25
225	7186.06453	1972.91748	-425									6	6					18.17	18.17					51.52	51.52	0.25
226	7187.89598	2002.86153	-425									12	12					22.89	22.89					64.91	64.91	0.25
227	7189.72743	2032.80558	-425									12	12					22.89	22.89					64.91	64.91	0.25
228	7191.55888	2062.74963	-425									12	12					22.89	22.89					64.91	64.91	0.25
229	7193.39033	2092.69368	-425									12	12					22.89	22.89					64.91	64.91	0.25
230	7195.22178	2122.63773	-425									12	12					22.89	22.89					64.91	64.91	0.25
231	7197.05323	2152.58178	-425									12	12					22.89	22.89					64.91	64.91	0.25
232	7198.88468	2182.52583	-425									12	12					22.89	22.89					64.91	64.91	0.25
233	7200.71613	2212.46988	-425									12	12					22.89	22.89					64.91	64.91	0.25
234	7202.54758	2242.41393	-425									22	22					28.02	28.02					79.44	79.44	0.25
235	7204.37903	2272.35798	-425									22	22					28.02	28.02					79.44	79.44	0.25
236	7206.21047	2302.30203	-425									18	18					26.21	26.21					74.30	74.30	0.25
237	7208.04192	2332.24608	-425									12	12					22.89	22.89					64.91	64.91	0.25
238	7209.87337	2362.19013	-425									12	12					22.89	22.89					64.91	64.91	0.25
239	7211.70482	2392.13418	-425									12	12					22.89	22.89					64.91	64.91	0.25
240	7213.53628	2422.07823	-425									12	12					22.89	22.89					64.91	64.91	0.25
241	7328.45873	1843.98378	-455									12	12					22.89	22.89					64.91	64.91	0.25
242	7330.29018	1873.92783	-455									12	12					22.89	22.89					64.91	64.91	0.25
243	7332.12163	1903.87188	-455									12	12					22.89	22.89					64.91	64.91	0.25
244	7333.95308	1933.81593	-455									15	15					24.66	24.66					69.92	69.92	0.25
245	7335.78453	1963.75998	-455				10.625	18.8	12				12	21.98	26.59	22.89			22.89	62.33	75.38	64.91			64.91	0.25
246	7337.61598	1993.70403	-455				11.875	18.8	19				19	22.81	26.59	26.68			26.68	64.68	75.38	75.65			75.65	0.25
247	7339.44743	2023.64808	-455									17	17					25.71	25.71					72.90	72.90	0.25
248	7341.27888	2053.59213	-455									7	7					19.13	19.13					54.23	54.23	0.25
249	7343.11033	2083.53618	-455									5	5					17.10	17.10					48.48	48.48	0.25
250	7344.94178	2113.48023	-455									12	12					22.89	22.89					64.91	64.91	0.25
251	7346.77323	2143.42428	-455									12	12					22.89	22.89					64.91	64.91	0.25
252	7348.60468	2173.36833	-455									12	12					22.89	22.89					64.91	64.91	0.25
253	7350.43613	2203.31238	-455									12	12					22.89	22.89					64.91	64.91	0.25
254	7352.26758	2233.25643	-455									12	12					22.89	22.89					64.91	64.91	0.25
255	7354.09903	2263.20048	-455									12	12					22.89	22.89					64.91	64.91	0.25
256	7355.93047	2293.14453	-455									12	12					22.89	22.89					64.91	64.91	0.25
257	7357.76193	2323.08858	-455									12	12					22.89	22.89					64.91	64.91	0.25
258	7359.59337	2353.03263	-455									12	12					22.89	22.89					64.91	64.91	0.25
259	7361.42482	2382.97668	-455									12	12					22.89	22.89					64.91	64.91	0.25
260	7363.25628	2412.92073	-455									19	19					26.68	26.68					75.65	75.65	0.25
261	7298.51473	1845.81528	-455									12	12					22.89	22.89					64.91	64.91	0.25
262	7300.34618	1875.75933	-455				11.875	18.8	12				12	22.81	26.59	22.89			22.89	64.68	75.38	64.91			64.91	0.25
263	7302.17763	1905.70338	-455				11.875	18.8	12				12	22.81	26.59	22.89			22.89	64.68	75.38	64.91			64.91	0.25
264	7304.00908	1935.64743	-455				11.875	18.8	19				19	22.81	26.59	26.68			26.68	64.68	75.38	75.65			75.65	0.25
265	7305.84053	1965.59148	-455				11.875	18.8	12	62	6.31		12	22.81	26.59	22.89	19.95		22.89	64.68	75.38	64.91	52.39		64.91	0.25
266	7307.67198	1995.53553	-455				11.875	18.8	12	69	18.48		12	22.81	26.59	22.89	29.85		22.89	64.68	75.38	64.91	74.95		64.91	0.25
267	7309.50343	2025.47958	-455							68	15.85		16				28.18		28.18				71.21		71.21	0.25
268	7311.33488	2055.42363	-455							63	7.36		7				21.13		21.13				55.14		55.14	0.25
269	7313.16633	2085.36768	-455							61	5.41		5				18.84		18.84				49.77		49.77	0.25
270	7314.99778	2115.31173	-455									5	5					17.10	17.10					48.48	48.48	0.25
271	7316.82923	2145.25578	-455									12	12					22.89	22.89					64.91	64.91	0.25
272	7318.66068	2175.19983	-455									12	12					22.89	22.89					64.91	64.91	0.25
273	7320.49213	2205.14388	-455									12	12					22.89	22.89					64.91	64.91	0.25
274	7322.32358	2235.08793	-455									8	8					20.00	20.00					56.70	56.70	0.25
275	7324.15503	2265.03198	-455									15	15					24.66	24.66					69.92	69.92	0.25
276	7325.98648	2294.97603	-455									12	12					22.89	22.89					64.91	64.91	0.25
277	7327.81792	2324.92008	-455									22	22					28.02	28.02					79.44	79.44	0.25
278	7329.64937	2354.86413	-455									34	34					32.40	32.40					91.84	91.84	0.25
279	7331.48083	2384.80818	-455									22	22					28.02	28.02					79.44	79.44	0.25
280	7333.31228	2414.75223	-455									11	11					22.24	22.24					63.05	63.05	0.25
281	7268.57073	1847.64678	-455				11.875	18.8	12				12	22.81	26.59	22.89			22.89	64.68	75.38	64.91			64.91	0.25
282	7270.40218	1877.59083	-455				8.125	18.8	12	60	4.64		12	20.10	26.59	22.89	17.78		22.89	56.99	75.38	64.91	47.29		64.91	0.25
283	7272.23363	1907.53488	-455				9.375	18.8	12	70	21.54		12	21.09	26.59	22.89	31.62		22.89	59.78	75.38	64.91	78.89		64.91	0.25
284	7274.06508	1937.47893	-455				9.375	18.8	12	70	21.54		12	21.09	26.59	22.89	31.62		22.89	59.78	75.38	64.91	78.89		64.91	0.25
285	7275.89653	1967.42298	-455				11.875	18.8	12	66	11.66		12	22.81	26.59	22.89	25.12		22.89	64.68	75.38	64.91	64.28		64.91	0.25
286	7277.72798	1997.36703	-455							65	10.00		10				23.71		23.71				61.08		61.08	0.25
287	7279.55943	2027.31108	-455							69	18.48		18				29.85		29.85				74.95		74.95	0.25
288	7281.39088	2057.25513	-455							66	11.66		12				25.12		25.12				64.28		64.28	0.25

Model A

Colour codes:
13 Data
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	Coordinates			Q from histograms			Q from histograms			Q>1: RMR=15logQ+50																
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	RMRaverage-	Qaverage-	Qinterpolated	Q	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{RMR/Hoek}$	$E_m^{interpolated}$	E_m	$\sigma_m^{c\,(Qmin)}$	$\sigma_m^{c\,(Qmax)}$	$\sigma_m^{c\,(Qmean)}$	$\sigma_m^{c\,(Qrm/Q>1)}$	$\sigma_m^{c\,(interpolated)}$	σ_m^{c}	ν
289	7283.22233	2087.19918	-455							73	34.15		34				37.58		37.58				91.97		91.97	0.25
290	7285.05378	2117.14323	-455	5.313	18.8	6				80	100.00		6	17.45	26.59	18.17	56.23		18.17	49.47	75.38	51.52	131.59		51.52	0.25
291	7286.88523	2147.08728	-455									19	19					26.68	26.68					75.65	75.65	0.25
292	7288.71668	2177.03133	-455									22	22					28.02	28.02					79.44	79.44	0.25
293	7290.54813	2206.97538	-455									63	63					39.79	39.79					112.81	112.81	0.25
294	7292.37958	2236.91943	-455									18	18					26.21	26.21					74.30	74.30	0.25
295	7294.21103	2266.86348	-455				23.75	23.8	24				24	28.74	28.76	28.84			28.84	81.49	81.55	81.78			81.78	0.25
296	7296.04248	2296.80753	-455									18	18					26.21	26.21					74.30	74.30	0.25
297	7297.87392	2326.75158	-455									12	12					22.89	22.89					64.91	64.91	0.25
298	7299.70538	2356.69563	-455									12	12					22.89	22.89					64.91	64.91	0.25
299	7301.53682	2386.63968	-455									12	12					22.89	22.89					64.91	64.91	0.25
300	7303.36828	2416.58373	-455									0.7	1					8.88	8.88					25.17	25.17	0.25
301	7238.62673	1849.47828	-455									12	12					22.89	22.89					64.91	64.91	0.25
302	7240.45818	1879.42233	-455				11.875	18.8	12				12	22.81	26.59	22.89			22.89	64.68	75.38	64.91			64.91	0.25
303	7242.28963	1909.36638	-455				8.125	18.8	12				12	20.10	26.59	22.89			22.89	56.99	75.38	64.91			64.91	0.25
304	7244.12108	1939.31043	-455				9.375	18.8	12	60	4.64		12	21.09	26.59	22.89	17.78		22.89	59.78	75.38	64.91	47.29		64.91	0.25
305	7245.95253	1969.25448	-455				11.875	18.8	12	65	10.00		12	22.81	26.59	22.89	23.71		22.89	64.68	75.38	64.91	61.08		64.91	0.25
306	7247.78398	1999.19853	-455							60	4.64		5				17.78		17.78				47.29		47.29	0.25
307	7249.61543	2029.14258	-455							70	21.54		22				31.62		31.62				78.89		78.89	0.25
308	7251.44688	2059.08663	-455									15	15					24.66	24.66					69.92	69.92	0.25
309	7253.27833	2089.03068	-455				1.944	18.8	11	61	5.41		11	12.48	26.59	22.24	18.84		22.24	35.38	75.38	63.05	49.77		63.05	0.25
310	7255.10978	2118.97473	-455									8	8					20.00	20.00					56.70	56.70	0.25
311	7256.94123	2148.91878	-455									12	12					22.89	22.89					64.91	64.91	0.25
312	7258.77268	2178.86283	-455									12	12					22.89	22.89					64.91	64.91	0.25
313	7260.60413	2208.80688	-455									12	12					22.89	22.89					64.91	64.91	0.25
314	7262.43558	2238.75093	-455									12	12					22.89	22.89					64.91	64.91	0.25
315	7264.26702	2268.69498	-455									16	16					25.20	25.20					71.44	71.44	0.25
316	7266.09848	2298.63903	-455									9	9					20.80	20.80					58.97	58.97	0.25
317	7267.92992	2328.58308	-455									12	12					22.89	22.89					64.91	64.91	0.25
318	7269.76137	2358.52713	-455									12	12					22.89	22.89					64.91	64.91	0.25
319	7271.59282	2388.47118	-455									12	12					22.89	22.89					64.91	64.91	0.25
320	7273.42428	2418.41523	-455									12	12					22.89	22.89					64.91	64.91	0.25
321	7208.68273	1851.30978	-455									12	12					22.89	22.89					64.91	64.91	0.25
322	7210.51418	1881.25383	-455									11	11					22.24	22.24					63.05	63.05	0.25
323	7212.34563	1911.19788	-455				1.944	18.8	11				11	12.48	26.59	22.24			22.24	35.38	75.38	63.05			63.05	0.25
324	7214.17708	1941.14193	-455				0.556	18.8	12				12	8.22	26.59	22.89			22.89	23.31	75.38	64.91			64.91	0.25
325	7216.00853	1971.08598	-455									12	12					22.89	22.89					64.91	64.91	0.25
326	7217.83998	2001.03003	-455									5	5					17.10	17.10					48.48	48.48	0.25
327	7219.67143	2030.97408	-455									22	22					28.02	28.02					79.44	79.44	0.25
328	7221.50288	2060.91813	-455									11	11					22.24	22.24					63.05	63.05	0.25
329	7223.33433	2090.86218	-455				8.125	18.8	11				11	20.10	26.59	22.24			22.24	56.99	75.38	63.05			63.05	0.25
330	7225.16578	2120.80623	-455									11	11					22.24	22.24					63.05	63.05	0.25
331	7226.99723	2150.75028	-455									12	12					22.89	22.89					64.91	64.91	0.25
332	7228.82868	2180.69433	-455									12	12					22.89	22.89					64.91	64.91	0.25
333	7230.66013	2210.63838	-455									12	12					22.89	22.89					64.91	64.91	0.25
334	7232.49158	2240.58243	-455									22	22					28.02	28.02					79.44	79.44	0.25
335	7234.32303	2270.52648	-455									22	22					28.02	28.02					79.44	79.44	0.25
336	7236.15447	2300.47053	-455									18	18					26.21	26.21					74.30	74.30	0.25
337	7237.98592	2330.41458	-455									12	12					22.89	22.89					64.91	64.91	0.25
338	7239.81738	2360.35863	-455									12	12					22.89	22.89					64.91	64.91	0.25
339	7241.64882	2390.30268	-455									12	12					22.89	22.89					64.91	64.91	0.25
340	7243.48028	2420.24673	-455									12	12					22.89	22.89					64.91	64.91	0.25
341	7178.73873	1853.14128	-455									12	12					22.89	22.89					64.91	64.91	0.25
342	7180.57018	1883.08533	-455									15	15					24.66	24.66					69.92	69.92	0.25
343	7182.40163	1913.02938	-455				18.75	18.8	19				19	26.57	26.59	26.68			26.68	75.32	75.38	75.65			75.65	0.25
344	7184.23308	1942.97343	-455				10.625	18.8	19				19	21.98	26.59	26.68			26.68	62.33	75.38	75.65			75.65	0.25
345	7186.06453	1972.91748	-455									19	19					26.68	26.68					75.65	75.65	0.25
346	7187.89598	2002.86153	-455									12	12					22.89	22.89					64.91	64.91	0.25
347	7189.72743	2032.80558	-455									12	12					22.89	22.89					64.91	64.91	0.25
348	7191.55888	2062.74963	-455									12	12					22.89	22.89					64.91	64.91	0.25
349	7193.39033	2092.69368	-455									11	11					22.24	22.24					63.05	63.05	0.25
350	7195.22178	2122.63773	-455									12	12					22.89	22.89					64.91	64.91	0.25
351	7197.05323	2152.58178	-455									12	12					22.89	22.89					64.91	64.91	0.25
352	7198.88468	2182.52583	-455									12	12					22.89	22.89					64.91	64.91	0.25
353	7200.71613	2212.46988	-455									12	12					22.89	22.89					64.91	64.91	0.25
354	7202.54758	2242.41393	-455									12	12					22.89	22.89					64.91	64.91	0.25
355	7204.37903	2272.35798	-455									12	12					22.89	22.89					64.91	64.91	0.25
356	7206.21047	2302.30203	-455									12	12					22.89	22.89					64.91	64.91	0.25
357	7208.04192	2332.24608	-455									12	12					22.89	22.89					64.91	64.91	0.25
358	7209.87337	2362.19013	-455									12	12					22.89	22.89					64.91	64.91	0.25
359	7211.70482	2392.13418	-455									12	12					22.89	22.89					64.91	64.91	0.25
360	7213.53628	2422.07823	-455									12	12					22.89	22.89					64.91	64.91	0.25

Model A

Colour codes:

13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms			Q>1: RMR=15logQ+50																
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	RMRaverage	Qaverage	Qinterpolated	Q	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{RMR/Hoek}$	$E_m^{interpolated}$	E_m	$\sigma_m^{c(Qmin)}$	$\sigma_m^{c(Qmax)}$	$\sigma_m^{c(Qmean)}$	$\sigma_m^{c(QrmrQ>1)}$	$\sigma_m^{c(interpolated)}$	σ_m^{c}	ν
361	7328.45873	1843.98378	-485									12	12					22.89	22.89					64.91	64.91	0.25
362	7330.29018	1873.92783	-485									12	12					22.89	22.89					64.91	64.91	0.25
363	7332.12163	1903.87188	-485									12	12					22.89	22.89					64.91	64.91	0.25
364	7333.95308	1933.81593	-485									12	12					22.89	22.89					64.91	64.91	0.25
365	7335.78453	1963.75998	-485									12	12					22.89	22.89					64.91	64.91	0.25
366	7337.61598	1993.70403	-485									9	9					20.80	20.80					58.97	58.97	0.25
367	7339.44743	2023.64808	-485									12	12					22.89	22.89					64.91	64.91	0.25
368	7341.27888	2053.59213	-485									12	12					22.89	22.89					64.91	64.91	0.25
369	7343.11033	2083.53618	-485									12	12					22.89	22.89					64.91	64.91	0.25
370	7344.94178	2113.48023	-485									4	4					15.87	15.87					45.00	45.00	0.25
371	7346.77323	2143.42428	-485									12	12					22.89	22.89					64.91	64.91	0.25
372	7348.60468	2173.36833	-485									12	12					22.89	22.89					64.91	64.91	0.25
373	7350.43613	2203.31238	-485									12	12					22.89	22.89					64.91	64.91	0.25
374	7352.26758	2233.25643	-485									12	12					22.89	22.89					64.91	64.91	0.25
375	7354.09903	2263.20048	-485									12	12					22.89	22.89					64.91	64.91	0.25
376	7355.93047	2293.14453	-485									12	12					22.89	22.89					64.91	64.91	0.25
377	7357.76193	2323.08858	-485									12	12					22.89	22.89					64.91	64.91	0.25
378	7359.59337	2353.03263	-485									12	12					22.89	22.89					64.91	64.91	0.25
379	7361.42482	2382.97668	-485									12	12					22.89	22.89					64.91	64.91	0.25
380	7363.25628	2412.92073	-485									12	12					22.89	22.89					64.91	64.91	0.25
381	7298.51473	1845.81528	-485									12	12					22.89	22.89					64.91	64.91	0.25
382	7300.34618	1875.75933	-485									12	12					22.89	22.89					64.91	64.91	0.25
383	7302.17763	1905.70338	-485									12	12					22.89	22.89					64.91	64.91	0.25
384	7304.00908	1935.64743	-485									19	19					26.68	26.68					75.65	75.65	0.25
385	7305.84053	1965.59148	-485									12	12					22.89	22.89					64.91	64.91	0.25
386	7307.67198	1995.53553	-485									12	12					22.89	22.89					64.91	64.91	0.25
387	7309.50343	2025.47958	-485									16	16					25.20	25.20					71.44	71.44	0.25
388	7311.33488	2055.42363	-485									7	7					19.13	19.13					54.23	54.23	0.25
389	7313.16633	2085.36768	-485									4	4					15.87	15.87					45.00	45.00	0.25
390	7314.99778	2115.31173	-485	3.542	47.5	4							4	15.24	36.22	15.87			15.87	43.22	102.67	45.00			45.00	0.25
391	7316.82923	2145.25578	-485									4	4					15.87	15.87					45.00	45.00	0.25
392	7318.66068	2175.19983	-485									12	12					22.89	22.89					64.91	64.91	0.25
393	7320.49213	2205.14388	-485									12	12					22.89	22.89					64.91	64.91	0.25
394	7322.32358	2235.08793	-485									12	12					22.89	22.89					64.91	64.91	0.25
395	7324.15503	2265.03198	-485									12	12					22.89	22.89					64.91	64.91	0.25
396	7325.98648	2294.97603	-485									12	12					22.89	22.89					64.91	64.91	0.25
397	7327.81792	2324.92008	-485									12	12					22.89	22.89					64.91	64.91	0.25
398	7329.64937	2354.86413	-485									12	12					22.89	22.89					64.91	64.91	0.25
399	7331.48083	2384.80818	-485									12	12					22.89	22.89					64.91	64.91	0.25
400	7333.31228	2414.75223	-485									12	12					22.89	22.89					64.91	64.91	0.25
401	7268.57073	1847.64678	-485									12	12					22.89	22.89					64.91	64.91	0.25
402	7270.40218	1877.59083	-485									12	12					22.89	22.89					64.91	64.91	0.25
403	7272.23363	1907.53488	-485									12	12					22.89	22.89					64.91	64.91	0.25
404	7274.06508	1937.47893	-485									12	12					22.89	22.89					64.91	64.91	0.25
405	7275.89653	1967.42298	-485									12	12					22.89	22.89					64.91	64.91	0.25
406	7277.72798	1997.36703	-485									10	10					21.54	21.54					61.08	61.08	0.25
407	7279.55943	2027.31108	-485									18	18					26.21	26.21					74.30	74.30	0.25
408	7281.39088	2057.25513	-485									12	12					22.89	22.89					64.91	64.91	0.25
409	7283.22233	2087.19918	-485									13	13					23.51	23.51					66.66	66.66	0.25
410	7285.05378	2117.14323	-485	5.313	5.3	5							5	17.45	17.44	17.10			17.10	49.47	49.43	48.48			48.48	0.25
411	7286.88523	2147.08728	-485									5	5					17.10	17.10					48.48	48.48	0.25
412	7288.71668	2177.03133	-485									12	12					22.89	22.89					64.91	64.91	0.25
413	7290.54813	2206.97538	-485									12	12					22.89	22.89					64.91	64.91	0.25
414	7292.37958	2236.91943	-485									12	12					22.89	22.89					64.91	64.91	0.25
415	7294.21103	2266.86348	-485									24	24					28.84	28.84					81.78	81.78	0.25
416	7296.04248	2296.80753	-485									12	12					22.89	22.89					64.91	64.91	0.25
417	7297.87392	2326.75158	-485									12	12					22.89	22.89					64.91	64.91	0.25
418	7299.70538	2356.69563	-485									12	12					22.89	22.89					64.91	64.91	0.25
419	7301.53682	2386.63968	-485									12	12					22.89	22.89					64.91	64.91	0.25
420	7303.36828	2416.58373	-485									12	12					22.89	22.89					64.91	64.91	0.25
421	7238.62673	1849.47828	-485									12	12					22.89	22.89					64.91	64.91	0.25
422	7240.45818	1879.42233	-485				10.625	18.8	12				12	21.98	26.59	22.89			22.89	62.33	75.38	64.91			64.91	0.25
423	7242.28963	1909.36638	-485				10.625	18.8	12				12	21.98	26.59	22.89			22.89	62.33	75.38	64.91			64.91	0.25
424	7244.12108	1939.31043	-485									12	12					22.89	22.89					64.91	64.91	0.25
425	7245.95253	1969.25448	-485									12	12					22.89	22.89					64.91	64.91	0.25
426	7247.78398	1999.19853	-485									5	5					17.10	17.10					48.48	48.48	0.25
427	7249.61543	2029.14258	-485									22	22					28.02	28.02					79.44	79.44	0.25
428	7251.44688	2059.08663	-485									12	12					22.89	22.89					64.91	64.91	0.25
429	7253.27833	2089.03068	-485									11	11					22.24	22.24					63.05	63.05	0.25
430	7255.10978	2118.97473	-485									5	5					17.10	17.10					48.48	48.48	0.25
431	7256.94123	2148.91878	-485									12	12					22.89	22.89					64.91	64.91	0.25
432	7258.77268	2178.86283	-485									12	12					22.89	22.89					64.91	64.91	0.25

Model A

Colour codes:

13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms			Q>1: RMR=15logQ+50																
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	RMRaverage-	Qaverage-	Qinterpolated	Q	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{RMR/Hoek}$	$E_m^{interpolated}$	E_m	$\sigma_m^{c (Qmin)}$	$\sigma_m^{c (Qmax)}$	$\sigma_m^{c (Qmean)}$	$\sigma_m^{c (QrmrQ>1)}$	$\sigma_m^{c (interpolated)}$	σ_m^{c}	ν
433	7260.60413	2208.80688	-485									12	12					22.89	22.89					64.91	64.91	0.25
434	7262.43558	2238.75093	-485									12	12					22.89	22.89					64.91	64.91	0.25
435	7264.26702	2268.69498	-485									12	12					22.89	22.89					64.91	64.91	0.25
436	7266.09848	2298.63903	-485									12	12					22.89	22.89					64.91	64.91	0.25
437	7267.92992	2328.58308	-485									12	12					22.89	22.89					64.91	64.91	0.25
438	7269.76137	2358.52713	-485									12	12					22.89	22.89					64.91	64.91	0.25
439	7271.59282	2388.47118	-485									12	12					22.89	22.89					64.91	64.91	0.25
440	7273.42428	2418.41523	-485									12	12					22.89	22.89					64.91	64.91	0.25
441	7208.68273	1851.30978	-485									12	12					22.89	22.89					64.91	64.91	0.25
442	7210.51418	1881.25383	-485									12	12					22.89	22.89					64.91	64.91	0.25
443	7212.34563	1911.19788	-485									12	12					22.89	22.89					64.91	64.91	0.25
444	7214.17708	1941.14193	-485				10.625	18.8	12				12	21.98	26.59	22.89			22.89	62.33	75.38	64.91			64.91	0.25
445	7216.00853	1971.08598	-485									12	12					22.89	22.89					64.91	64.91	0.25
446	7217.83998	2001.03003	-485									12	12					22.89	22.89					64.91	64.91	0.25
447	7219.67143	2030.97408	-485									12	12					22.89	22.89					64.91	64.91	0.25
448	7221.50288	2060.91813	-485									12	12					22.89	22.89					64.91	64.91	0.25
449	7223.33433	2090.86218	-485									11	11					22.24	22.24					63.05	63.05	0.25
450	7225.16578	2120.80623	-485									12	12					22.89	22.89					64.91	64.91	0.25
451	7226.99723	2150.75028	-485									12	12					22.89	22.89					64.91	64.91	0.25
452	7228.82868	2180.69433	-485									12	12					22.89	22.89					64.91	64.91	0.25
453	7230.66013	2210.63838	-485									12	12					22.89	22.89					64.91	64.91	0.25
454	7232.49158	2240.58243	-485									12	12					22.89	22.89					64.91	64.91	0.25
455	7234.32303	2270.52648	-485									12	12					22.89	22.89					64.91	64.91	0.25
456	7236.15447	2300.47053	-485									12	12					22.89	22.89					64.91	64.91	0.25
457	7237.98592	2330.41458	-485									12	12					22.89	22.89					64.91	64.91	0.25
458	7239.81738	2360.35863	-485									12	12					22.89	22.89					64.91	64.91	0.25
459	7241.64882	2390.30268	-485									12	12					22.89	22.89					64.91	64.91	0.25
460	7243.48028	2420.24673	-485									12	12					22.89	22.89					64.91	64.91	0.25
461	7178.73873	1853.14128	-485									12	12					22.89	22.89					64.91	64.91	0.25
462	7180.57018	1883.08533	-485				2.5	18.8	12				12	13.57	26.59	22.89			22.89	38.48	75.38	64.91			64.91	0.25
463	7182.40163	1913.02938	-485				9.375	18.8	12				12	21.09	26.59	22.89			22.89	59.78	75.38	64.91			64.91	0.25
464	7184.23308	1942.97343	-485				10.625	18.8	12				12	21.98	26.59	22.89			22.89	62.33	75.38	64.91			64.91	0.25
465	7186.06453	1972.91748	-485									12	12					22.89	22.89					64.91	64.91	0.25
466	7187.89598	2002.86153	-485									12	12					22.89	22.89					64.91	64.91	0.25
467	7189.72743	2032.80558	-485									12	12					22.89	22.89					64.91	64.91	0.25
468	7191.55888	2062.74963	-485									12	12					22.89	22.89					64.91	64.91	0.25
469	7193.39033	2092.69368	-485									12	12					22.89	22.89					64.91	64.91	0.25
470	7195.22178	2122.63773	-485									12	12					22.89	22.89					64.91	64.91	0.25
471	7197.05323	2152.58178	-485									12	12					22.89	22.89					64.91	64.91	0.25
472	7198.88468	2182.52583	-485									12	12					22.89	22.89					64.91	64.91	0.25
473	7200.71613	2212.46988	-485									12	12					22.89	22.89					64.91	64.91	0.25
474	7202.54758	2242.41393	-485									12	12					22.89	22.89					64.91	64.91	0.25
475	7204.37903	2272.35798	-485									12	12					22.89	22.89					64.91	64.91	0.25
476	7206.21047	2302.30203	-485									12	12					22.89	22.89					64.91	64.91	0.25
477	7208.04192	2332.24608	-485									12	12					22.89	22.89					64.91	64.91	0.25
478	7209.87337	2362.19013	-485									12	12					22.89	22.89					64.91	64.91	0.25
479	7211.70482	2392.13418	-485									12	12					22.89	22.89					64.91	64.91	0.25
480	7213.53628	2422.07823	-485									12	12					22.89	22.89					64.91	64.91	0.25
EW-1							0.008	9.9	1.47				1.47	2.00	21.47	11.37			11.37	3.78	40.58	21.49			21.49	0.3
NE-1							0.011	9.9	2.6				2.6	2.22	21.47	13.75			13.75	4.20	40.58	25.99			25.99	0.3
NE-1 (central zone)									0.011				0.01			2.22			2.22			4.20			4.20	0.4
NE-2							1.54	6.3	2.9				2.9	11.55	18.47	14.26			14.26	21.83	34.91	26.95			26.95	0.3

Model B

Colour codes:

13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms															
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	Qinterpolated	Q_{cha}	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{interpolated}$	$E_{m\ (cha)}$	$\sigma_m^{c\ (Qmin)}$	$\sigma_m^{c\ (Qmax)}$	$\sigma_m^{c\ (Qmean)}$	$\sigma_m^{c\ (interpolated)}$	$\sigma_{m\ (cha)}^{c}$	ν
1	7328.45873	1843.98378	-395							32	32				36.34	36.34				90.01	90.01	0.25
2	7330.29018	1873.92783	-395							32	32				36.34	36.34				90.01	90.01	0.25
3	7332.12163	1903.87188	-395							21	21				31.58	31.58				78.22	78.22	0.25
4	7333.95308	1933.81593	-395	20.9	31.35	20.9					21	31.53	36.09	31.53		31.53	78.09	89.39	78.09		78.09	0.25
5	7335.78453	1963.75998	-395	14.167	71.25	15.667					16	27.70	47.46	28.64		28.64	68.60	117.53	70.94		70.94	0.25
6	7337.61598	1993.70403	-395	0.386	10.45	0.782					0.8	8.33	25.03	10.55		10.55	20.64	61.98	26.12		26.12	0.25
7	7339.44743	2023.64808	-395							0.8	0.8				10.63	10.63				26.32	26.32	0.25
8	7341.27888	2053.59213	-395							48	48				41.60	41.60				103.03	103.03	0.25
9	7343.11033	2083.53618	-395							48	48				41.60	41.60				103.03	103.03	0.25
10	7344.94178	2113.48023	-395							48	48				41.60	41.60				103.03	103.03	0.25
11	7346.77323	2143.42428	-395							32	32				36.34	36.34				90.01	90.01	0.25
12	7348.60468	2173.36833	-395							32	32				36.34	36.34				90.01	90.01	0.25
13	7350.43613	2203.31238	-395							32	32				36.34	36.34				90.01	90.01	0.25
14	7352.26758	2233.25643	-395							48	48				41.60	41.60				103.03	103.03	0.25
15	7354.09903	2263.20048	-395							95	95				52.23	52.23				129.36	129.36	0.25
16	7355.93047	2293.14453	-395							48	48				41.60	41.60				103.03	103.03	0.25
17	7357.76193	2323.08858	-395							32	32				36.34	36.34				90.01	90.01	0.25
18	7359.59337	2353.03263	-395							32	32				36.34	36.34				90.01	90.01	0.25
19	7361.42482	2382.97668	-395				21.45	49.5	31.68		32	31.81	42.03	36.22		36.22	78.77	104.09	89.70		89.70	0.25
20	7363.25628	2412.92073	-395				47.5	75	49.5		50	41.46	48.27	42.03		42.03	102.67	119.56	104.09		104.09	0.25
21	7298.51473	1845.81528	-395							32	32				36.34	36.34				90.01	90.01	0.25
22	7300.34618	1875.75933	-395							32	32				36.34	36.34				90.01	90.01	0.25
23	7302.17763	1905.70338	-395							75	75				48.27	48.27				119.56	119.56	0.25
24	7304.00908	1935.64743	-395							21	21				31.58	31.58				78.22	78.22	0.25
25	7305.84053	1965.59148	-395							11	11				25.46	25.46				63.05	63.05	0.25
26	7307.67198	1995.53553	-395							1.183	1.2				12.11	12.11				29.98	29.98	0.25
27	7309.50343	2025.47958	-395							32	32				36.34	36.34				90.01	90.01	0.25
28	7311.33488	2055.42363	-395							32	32				36.34	36.34				90.01	90.01	0.25
29	7313.16633	2085.36768	-395							48	48				41.60	41.60				103.03	103.03	0.25
30	7314.99778	2115.31173	-395							20	20				31.07	31.07				76.95	76.95	0.25
31	7316.82923	2145.25578	-395							32	32				36.34	36.34				90.01	90.01	0.25
32	7318.66068	2175.19983	-395							32	32				36.34	36.34				90.01	90.01	0.25
33	7320.49213	2205.14388	-395							32	32				36.34	36.34				90.01	90.01	0.25
34	7322.32358	2235.08793	-395							35	35				37.44	37.44				92.73	92.73	0.25
35	7324.15503	2265.03198	-395				95	95	95		95	52.23	52.23	52.23		52.23	129.36	129.36	129.36		129.36	0.25
36	7325.98648	2294.97603	-395							68	68				46.72	46.72				115.71	115.71	0.25
37	7327.81792	2324.92008	-395							48	48				41.60	41.60				103.03	103.03	0.25
38	7329.64937	2354.86413	-395							32	32				36.34	36.34				90.01	90.01	0.25
39	7331.48083	2384.80818	-395				24.75	49.5	31.68		32	33.36	42.03	36.22		36.22	82.62	104.09	89.70		89.70	0.25
40	7333.31228	2414.75223	-395				21.45	49.5	31.02		31	31.81	42.03	35.97		35.97	78.77	104.09	89.08		89.08	0.25
41	7268.57073	1847.64678	-395							32	32				36.34	36.34				90.01	90.01	0.25
42	7270.40218	1877.59083	-395							50	50				42.17	42.17				104.44	104.44	0.25
43	7272.23363	1907.53488	-395							50	50				42.17	42.17				104.44	104.44	0.25
44	7274.06508	1937.47893	-395							50	50				42.17	42.17				104.44	104.44	0.25
45	7275.89653	1967.42298	-395							30	30				35.57	35.57				88.09	88.09	0.25
46	7277.72798	1997.36703	-395							32	32				36.34	36.34				90.01	90.01	0.25
47	7279.55943	2027.31108	-395							48	48				41.60	41.60				103.03	103.03	0.25
48	7281.39088	2057.25513	-395							32	32				36.34	36.34				90.01	90.01	0.25
49	7283.22233	2087.19918	-395							20	20				31.07	31.07				76.95	76.95	0.25
50	7285.05378	2117.14323	-395	18.7	47.026	20.24					20	30.38	41.32	31.20		31.20	75.25	102.33	77.26		77.26	0.25
51	7286.88523	2147.08728	-395							20	20				31.07	31.07				76.95	76.95	0.25
52	7288.71668	2177.03133	-395							48	48				41.60	41.60				103.03	103.03	0.25
53	7290.54813	2206.97538	-395							48	48				41.60	41.60				103.03	103.03	0.25
54	7292.37958	2236.91943	-395							38	38				38.49	38.49				95.31	95.31	0.25
55	7294.21103	2266.86348	-395				47.026	47.026	47.026		47	41.32	41.32	41.32		41.32	102.33	102.33	102.33		102.33	0.25
56	7296.04248	2296.80753	-395							39	39				38.82	38.82				96.14	96.14	0.25
57	7297.87392	2326.75158	-395							48	48				41.60	41.60				103.03	103.03	0.25
58	7299.70538	2356.69563	-395							49	49				41.89	41.89				103.74	103.74	0.25
59	7301.53682	2386.63968	-395							32	32				36.34	36.34				90.01	90.01	0.25
60	7303.36828	2416.58373	-395							9	9				23.81	23.81				58.97	58.97	0.25
61	7238.62673	1849.47828	-395							48	48				41.60	41.60				103.03	103.03	0.25
62	7240.45818	1879.42233	-395							48	48				41.60	41.60				103.03	103.03	0.25
63	7242.28963	1909.36638	-395							48	48				41.60	41.60				103.03	103.03	0.25
64	7244.12108	1939.31043	-395							46	46				41.02	41.02				101.58	101.58	0.25
65	7245.95253	1969.25448	-395				2.222	75	46		46	14.94	48.27	41.02		41.02	36.99	119.56	101.58		101.58	0.25
66	7247.78398	1999.19853	-395				24.75	49.5	31.35		31	33.36	42.03	36.09		36.09	82.62	104.09	89.39		89.39	0.25
67	7249.61543	2029.14258	-395							32	32				36.34	36.34				90.01	90.01	0.25
68	7251.44688	2059.08663	-395							48	48				41.60	41.60				103.03	103.03	0.25
69	7253.27833	2089.03068	-395							32	32				36.34	36.34				90.01	90.01	0.25
70	7255.10978	2118.97473	-395							20	20				31.07	31.07				76.95	76.95	0.25
71	7256.94123	2148.91878	-395							48	48				41.60	41.60				103.03	103.03	0.25
72	7258.77268	2178.86283	-395							48	48				41.60	41.60				103.03	103.03	0.25

Model B

Colour codes:
13 Data
11 Extrapolation
12 "Qualified guess"

Block No	Coordinates X	Y	Z	Q from histograms Qmin	Qmax	Q NGI 2001	Q from histograms Qmin	Qmax	Qblock	Qinterpolated	Q_{cha}	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{interpolated}$	$E_{m\,(cha)}$	$\sigma_m^{c\,(Qmin)}$	$\sigma_m^{c\,(Qmax)}$	$\sigma_m^{c\,(Qmean)}$	$\sigma_m^{c\,(interpolated)}$	$\sigma_{m\,(cha)}^{c}$	ν
73	7260.60413	2208.80688	-395							48	48				41.60	41.60				103.03	103.03	0.25
74	7262.43558	2238.75093	-395							56	56				43.80	43.80				108.46	108.46	0.25
75	7264.26702	2268.69498	-395				31.35	66	41.8		42	36.09	46.26	39.73		39.73	89.39	114.57	98.39		98.39	0.25
76	7266.09848	2298.63903	-395							32	32				36.34	36.34				90.01	90.01	0.25
77	7267.92992	2328.58308	-395							32	32				36.34	36.34				90.01	90.01	0.25
78	7269.76137	2358.52713	-395							48	48				41.60	41.60				103.03	103.03	0.25
79	7271.59282	2388.47118	-395							48	48				41.60	41.60				103.03	103.03	0.25
80	7273.42428	2418.41523	-395							32	32				36.34	36.34				90.01	90.01	0.25
81	7208.68273	1851.30978	-395							48	48				41.60	41.60				103.03	103.03	0.25
82	7210.51418	1881.25383	-395							48	48				41.60	41.60				103.03	103.03	0.25
83	7212.34563	1911.19788	-395							48	48				41.60	41.60				103.03	103.03	0.25
84	7214.17708	1941.14193	-395							45	45				40.72	40.72				100.84	100.84	0.25
85	7216.00853	1971.08598	-395							38	38				38.49	38.49				95.31	95.31	0.25
86	7217.83998	2001.03003	-395							48	48				41.60	41.60				103.03	103.03	0.25
87	7219.67143	2030.97408	-395							32	32				36.34	36.34				90.01	90.01	0.25
88	7221.50288	2060.91813	-395							32	32				36.34	36.34				90.01	90.01	0.25
89	7223.33433	2090.86218	-395							32	32				36.34	36.34				90.01	90.01	0.25
90	7225.16578	2120.80623	-395							32	32				36.34	36.34				90.01	90.01	0.25
91	7226.99723	2150.75028	-395							32	32				36.34	36.34				90.01	90.01	0.25
92	7228.82868	2180.69433	-395							48	48				41.60	41.60				103.03	103.03	0.25
93	7230.66013	2210.63838	-395							48	48				41.60	41.60				103.03	103.03	0.25
94	7232.49158	2240.58243	-395							48	48				41.60	41.60				103.03	103.03	0.25
95	7234.32303	2270.52648	-395							63	63				45.55	45.55				112.81	112.81	0.25
96	7236.15447	2300.47053	-395							48	48				41.60	41.60				103.03	103.03	0.25
97	7237.98592	2330.41458	-395							32	32				36.34	36.34				90.01	90.01	0.25
98	7239.81738	2360.35863	-395							32	32				36.34	36.34				90.01	90.01	0.25
99	7241.64882	2390.30268	-395							48	48				41.60	41.60				103.03	103.03	0.25
100	7243.48028	2420.24673	-395							32	32				36.34	36.34				90.01	90.01	0.25
101	7178.73873	1853.14128	-395							48	48				41.60	41.60				103.03	103.03	0.25
102	7180.57018	1883.08533	-395							48	48				41.60	41.60				103.03	103.03	0.25
103	7182.40163	1913.02938	-395							48	48				41.60	41.60				103.03	103.03	0.25
104	7184.23308	1942.97343	-395							24	24				33.02	33.02				81.78	81.78	0.25
105	7186.06453	1972.91748	-395	23.75	71.25	23.75					24	32.90	47.46	32.90		32.90	81.49	117.53	81.49		81.49	0.25
106	7187.89598	2002.86153	-395							24	24				33.02	33.02				81.78	81.78	0.25
107	7189.72743	2032.80558	-395							32	32				36.34	36.34				90.01	90.01	0.25
108	7191.55888	2062.74963	-395							32	32				36.34	36.34				90.01	90.01	0.25
109	7193.39033	2092.69368	-395							32	32				36.34	36.34				90.01	90.01	0.25
110	7195.22178	2122.63773	-395							48	48				41.60	41.60				103.03	103.03	0.25
111	7197.05323	2152.58178	-395							32	32				36.34	36.34				90.01	90.01	0.25
112	7198.88468	2182.52583	-395							32	32				36.34	36.34				90.01	90.01	0.25
113	7200.71613	2212.46988	-395							48	48				41.60	41.60				103.03	103.03	0.25
114	7202.54758	2242.41393	-395							48	48				41.60	41.60				103.03	103.03	0.25
115	7204.37903	2272.35798	-395							48	48				41.60	41.60				103.03	103.03	0.25
116	7206.21047	2302.30203	-395							48	48				41.60	41.60				103.03	103.03	0.25
117	7208.04192	2332.24608	-395							48	48				41.60	41.60				103.03	103.03	0.25
118	7209.87337	2362.19013	-395							32	32				36.34	36.34				90.01	90.01	0.25
119	7211.70482	2392.13418	-395							32	32				36.34	36.34				90.01	90.01	0.25
120	7213.53628	2422.07823	-395							32	32				36.34	36.34				90.01	90.01	0.25
121	7328.45873	1843.98378	-425							32	32				36.34	36.34				90.01	90.01	0.25
122	7330.29018	1873.92783	-425							32	32				36.34	36.34				90.01	90.01	0.25
123	7332.12163	1903.87188	-425							40	40				39.15	39.15				96.96	96.96	0.25
124	7333.95308	1933.81593	-425	31.35	31.35	31.35					31	36.09	36.09	36.09		36.09	89.39	89.39	89.39		89.39	0.25
125	7335.78453	1963.75998	-425							22	22				32.08	32.08				79.44	79.44	0.25
126	7337.61598	1993.70403	-425							6	6				20.80	20.80				51.52	51.52	0.25
127	7339.44743	2023.64808	-425							32	32				36.34	36.34				90.01	90.01	0.25
128	7341.27888	2053.59213	-425							48	48				41.60	41.60				103.03	103.03	0.25
129	7343.11033	2083.53618	-425							48	48				41.60	41.60				103.03	103.03	0.25
130	7344.94178	2113.48023	-425							48	48				41.60	41.60				103.03	103.03	0.25
131	7346.77323	2143.42428	-425							32	32				36.34	36.34				90.01	90.01	0.25
132	7348.60468	2173.36833	-425							32	32				36.34	36.34				90.01	90.01	0.25
133	7350.43613	2203.31238	-425							32	32				36.34	36.34				90.01	90.01	0.25
134	7352.26758	2233.25643	-425							30	30				35.57	35.57				88.09	88.09	0.25
135	7354.09903	2263.20048	-425							36	36				37.80	37.80				93.61	93.61	0.25
136	7355.93047	2293.14453	-425							49	49				41.89	41.89				103.74	103.74	0.25
137	7357.76193	2323.08858	-425							32	32				36.34	36.34				90.01	90.01	0.25
138	7359.59337	2353.03263	-425							32	32				36.34	36.34				90.01	90.01	0.25
139	7361.42482	2382.97668	-425							40	40				39.15	39.15				96.96	96.96	0.25
140	7363.25628	2412.92073	-425				47.5	75	75		75	41.46	48.27	48.27		48.27	102.67	119.56	119.56		119.56	0.25
141	7298.51473	1845.81528	-425							32	32				36.34	36.34				90.01	90.01	0.25
142	7300.34618	1875.75933	-425							38	38				38.49	38.49				95.31	95.31	0.25
143	7302.17763	1905.70338	-425				49.5	49.5	49.5		50	42.03	42.03	42.03		42.03	104.09	104.09	104.09		104.09	0.25
144	7304.00908	1935.64743	-425							40	40				39.15	39.15				96.96	96.96	0.25

Model B

Colour codes:

13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms															
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	Qinterpolated	Q_{cha}	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{interpolated}$	$E_{m (cha)}$	$\sigma_m^{c (Qmin)}$	$\sigma_m^{c (Qmax)}$	$\sigma_m^{c (Qmean)}$	$\sigma_m^{c (interpolated)}$	$\sigma_{m (cha)}^{c}$	ν
145	7305.84053	1965.59148	-425							33	33				36.72	36.72				90.93	90.93	0.25
146	7307.67198	1995.53553	-425							49	49				41.89	41.89				103.74	103.74	0.25
147	7309.50343	2025.47958	-425							32	32				36.34	36.34				90.01	90.01	0.25
148	7311.33488	2055.42363	-425							32	32				36.34	36.34				90.01	90.01	0.25
149	7313.16633	2085.36768	-425							48	48				41.60	41.60				103.03	103.03	0.25
150	7314.99778	2115.31173	-425							47	47				41.31	41.31				102.31	102.31	0.25
151	7316.82923	2145.25578	-425							32	32				36.34	36.34				90.01	90.01	0.25
152	7318.66068	2175.19983	-425							32	32				36.34	36.34				90.01	90.01	0.25
153	7320.49213	2205.14388	-425							20	20				31.07	31.07				76.95	76.95	0.25
154	7322.32358	2235.08793	-425				18.7	47.026	20.02		20	30.38	41.32	31.08		31.08	75.25	102.33	76.98		76.98	0.25
155	7324.15503	2265.03198	-425				31.876	300	35.626		36	36.30	76.63	37.67		37.67	89.89	189.78	93.28		93.28	0.25
156	7325.98648	2294.97603	-425				47.5	300	48.5		49	41.46	76.63	41.75		41.75	102.67	189.78	103.39		103.39	0.25
157	7327.81792	2324.92008	-425							48	48				41.60	41.60				103.03	103.03	0.25
158	7329.64937	2354.86413	-425							32	32				36.34	36.34				90.01	90.01	0.25
159	7331.48083	2384.80818	-425							31	31				35.96	35.96				89.06	89.06	0.25
160	7333.31228	2414.75223	-425				6.6	49.5	28.71		29	21.47	42.03	35.05		35.05	53.18	104.09	86.81		86.81	0.25
161	7268.57073	1847.64678	-425							33	33				36.72	36.72				90.93	90.93	0.25
162	7270.40218	1877.59083	-425				42.5	75	49.5		50	39.95	48.27	42.03		42.03	98.93	119.56	104.09		104.09	0.25
163	7272.23363	1907.53488	-425				47.5	75	49.5		50	41.46	48.27	42.03		42.03	102.67	119.56	104.09		104.09	0.25
164	7274.06508	1937.47893	-425				47.5	75	49.5		50	41.46	48.27	42.03		42.03	102.67	119.56	104.09		104.09	0.25
165	7275.89653	1967.42298	-425							32	32				36.34	36.34				90.01	90.01	0.25
166	7277.72798	1997.36703	-425							32	32				36.34	36.34				90.01	90.01	0.25
167	7279.55943	2027.31108	-425							48	48				41.60	41.60				103.03	103.03	0.25
168	7281.39088	2057.25513	-425							32	32				36.34	36.34				90.01	90.01	0.25
169	7283.22233	2087.19918	-425							47	47				41.31	41.31				102.31	102.31	0.25
170	7285.05378	2117.14323	-425	47.026	62.7	47.026					47	41.32	45.48	41.32		41.32	102.33	112.63	102.33		102.33	0.25
171	7286.88523	2147.08728	-425							47	47				41.31	41.31				102.31	102.31	0.25
172	7288.71668	2177.03133	-425							32	32				36.34	36.34				90.01	90.01	0.25
173	7290.54813	2206.97538	-425							48	48				41.60	41.60				103.03	103.03	0.25
174	7292.37958	2236.91943	-425				8.312	198	31.68		32	23.19	66.72	36.22		36.22	57.43	165.24	89.70		89.70	0.25
175	7294.21103	2266.86348	-425				4.766	198	20.9		21	19.26	66.72	31.53		31.53	47.71	165.24	78.09		78.09	0.25
176	7296.04248	2296.80753	-425				15.676	198	32.01		32	28.65	66.72	36.35		36.35	70.95	165.24	90.02		90.02	0.25
177	7297.87392	2326.75158	-425				42.5	75	48		48	39.95	48.27	41.60		41.60	98.93	119.56	103.03		103.03	0.25
178	7299.70538	2356.69563	-425				42.5	75	49		49	39.95	48.27	41.89		41.89	98.93	119.56	103.74		103.74	0.25
179	7301.53682	2386.63968	-425				28.05	49.5	32.01		32	34.78	42.03	36.35		36.35	86.14	104.09	90.02		90.02	0.25
180	7303.36828	2416.58373	-425				0.22	49.5	2.86		3	6.91	42.03	16.25		16.25	17.11	104.09	40.24		40.24	0.25
181	7238.62673	1849.47828	-425							48	48				41.60	41.60				103.03	103.03	0.25
182	7240.45818	1879.42233	-425							50	50				42.17	42.17				104.44	104.44	0.25
183	7242.28963	1909.36638	-425							49	49				41.89	41.89				103.74	103.74	0.25
184	7244.12108	1939.31043	-425							48	48				41.60	41.60				103.03	103.03	0.25
185	7245.95253	1969.25448	-425				42.5	75	46.5		47	39.95	48.27	41.16		41.16	98.93	119.56	101.95		101.95	0.25
186	7247.78398	1999.19853	-425							31	31				35.96	35.96				89.06	89.06	0.25
187	7249.61543	2029.14258	-425							32	32				36.34	36.34				90.01	90.01	0.25
188	7251.44688	2059.08663	-425							48	48				41.60	41.60				103.03	103.03	0.25
189	7253.27833	2089.03068	-425							29	29				35.17	35.17				87.10	87.10	0.25
190	7255.10978	2118.97473	-425							47	47				41.31	41.31				102.31	102.31	0.25
191	7256.94123	2148.91878	-425							32	32				36.34	36.34				90.01	90.01	0.25
192	7258.77268	2178.86283	-425							48	48				41.60	41.60				103.03	103.03	0.25
193	7260.60413	2208.80688	-425							50	50				42.17	42.17				104.44	104.44	0.25
194	7262.43558	2238.75093	-425				10.556	300	49.5		50	25.11	76.63	42.03		42.03	62.19	189.78	104.09		104.09	0.25
195	7264.26702	2268.69498	-425				10.726	264	23.512		24	25.25	73.43	32.79		32.79	62.52	181.87	81.22		81.22	0.25
196	7266.09848	2298.63903	-425				23.512	47.026	23.512		24	32.79	41.32	32.79		32.79	81.22	102.33	81.22		81.22	0.25
197	7267.92992	2328.58308	-425							28	28				34.76	34.76				86.09	86.09	0.25
198	7269.76137	2358.52713	-425							49	49				41.89	41.89				103.74	103.74	0.25
199	7271.59282	2388.47118	-425							49	49				41.89	41.89				103.74	103.74	0.25
200	7273.42428	2418.41523	-425							2.838	2.8				16.21	16.21				40.14	40.14	0.25
201	7208.68273	1851.30978	-425							48	48				41.60	41.60				103.03	103.03	0.25
202	7210.51418	1881.25383	-425							48	48				41.60	41.60				103.03	103.03	0.25
203	7212.34563	1911.19788	-425							45	45				40.72	40.72				100.84	100.84	0.25
204	7214.17708	1941.14193	-425				10	75	45		45	24.66	48.27	40.72		40.72	61.08	119.56	100.84		100.84	0.25
205	7216.00853	1971.08598	-425				42.5	75	49		49	39.95	48.27	41.89		41.89	98.93	119.56	103.74		103.74	0.25
206	7217.83998	2001.03003	-425							49	49				41.89	41.89				103.74	103.74	0.25
207	7219.67143	2030.97408	-425							32	32				36.34	36.34				90.01	90.01	0.25
208	7221.50288	2060.91813	-425							32	32				36.34	36.34				90.01	90.01	0.25
209	7223.33433	2090.86218	-425							30	30				35.57	35.57				88.09	88.09	0.25
210	7225.16578	2120.80623	-425							32	32				36.34	36.34				90.01	90.01	0.25
211	7226.99723	2150.75028	-425							32	32				36.34	36.34				90.01	90.01	0.25
212	7228.82868	2180.69433	-425							48	48				41.60	41.60				103.03	103.03	0.25
213	7230.66013	2210.63838	-425							48	48				41.60	41.60				103.03	103.03	0.25
214	7232.49158	2240.58243	-425							50	50				42.17	42.17				104.44	104.44	0.25
215	7234.32303	2270.52648	-425							36	36				37.80	37.80				93.61	93.61	0.25
216	7236.15447	2300.47053	-425							36	36				37.80	37.80				93.61	93.61	0.25

Model B

Colour codes:
13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms															
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	Qinterpolated	Q_{cha}	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{interpolated}$	$E_{m\,(cha)}$	$\sigma_m^{c\,(Qmin)}$	$\sigma_m^{c\,(Qmax)}$	$\sigma_m^{c\,(Qmean)}$	$\sigma_m^{c\,(interpolated)}$	$\sigma_{m\,(cha)}^{c}$	ν
217	7237.98592	2330.41458	-425							32	32				36.34	36.34				90.01	90.01	0.25
218	7239.81738	2360.35863	-425							32	32				36.34	36.34				90.01	90.01	0.25
219	7241.64882	2390.30268	-425							48	48				41.60	41.60				103.03	103.03	0.25
220	7243.48028	2420.24673	-425							32	32				36.34	36.34				90.01	90.01	0.25
221	7178.73873	1853.14128	-425							48	48				41.60	41.60				103.03	103.03	0.25
222	7180.57018	1883.08533	-425							48	48				41.60	41.60				103.03	103.03	0.25
223	7182.40163	1913.02938	-425							75	75				48.27	48.27				119.56	119.56	0.25
224	7184.23308	1942.97343	-425							58	58				44.31	44.31				109.74	109.74	0.25
225	7186.06453	1972.91748	-425							34	34				37.08	37.08				91.84	91.84	0.25
226	7187.89598	2002.86153	-425							48	48				41.60	41.60				103.03	103.03	0.25
227	7189.72743	2032.80558	-425							48	48				41.60	41.60				103.03	103.03	0.25
228	7191.55888	2062.74963	-425							32	32				36.34	36.34				90.01	90.01	0.25
229	7193.39033	2092.69368	-425							32	32				36.34	36.34				90.01	90.01	0.25
230	7195.22178	2122.63773	-425							48	48				41.60	41.60				103.03	103.03	0.25
231	7197.05323	2152.58178	-425							32	32				36.34	36.34				90.01	90.01	0.25
232	7198.88468	2182.52583	-425							32	32				36.34	36.34				90.01	90.01	0.25
233	7200.71613	2212.46988	-425							48	48				41.60	41.60				103.03	103.03	0.25
234	7202.54758	2242.41393	-425							48	48				41.60	41.60				103.03	103.03	0.25
235	7204.37903	2272.35798	-425							48	48				41.60	41.60				103.03	103.03	0.25
236	7206.21047	2302.30203	-425							48	48				41.60	41.60				103.03	103.03	0.25
237	7208.04192	2332.24608	-425							48	48				41.60	41.60				103.03	103.03	0.25
238	7209.87337	2362.19013	-425							32	32				36.34	36.34				90.01	90.01	0.25
239	7211.70482	2392.13418	-425							32	32				36.34	36.34				90.01	90.01	0.25
240	7213.53628	2422.07823	-425							32	32				36.34	36.34				90.01	90.01	0.25
241	7328.45873	1843.98378	-455							32	32				36.34	36.34				90.01	90.01	0.25
242	7330.29018	1873.92783	-455							33	33				36.72	36.72				90.93	90.93	0.25
243	7332.12163	1903.87188	-455							33	33				36.72	36.72				90.93	90.93	0.25
244	7333.95308	1933.81593	-455							37	37				38.14	38.14				94.47	94.47	0.25
245	7335.78453	1963.75998	-455				28.05	49.5	32.34		32	34.78	42.03	36.47		36.47	86.14	104.09	90.32		90.32	0.25
246	7337.61598	1993.70403	-455				31.35	49.5	49.5		50	36.09	42.03	42.03		42.03	89.39	104.09	104.09		104.09	0.25
247	7339.44743	2023.64808	-455							50	50				42.17	42.17				104.44	104.44	0.25
248	7341.27888	2053.59213	-455							48	48				41.60	41.60				103.03	103.03	0.25
249	7343.11033	2083.53618	-455							48	48				41.60	41.60				103.03	103.03	0.25
250	7344.94178	2113.48023	-455							48	48				41.60	41.60				103.03	103.03	0.25
251	7346.77323	2143.42428	-455							48	48				41.60	41.60				103.03	103.03	0.25
252	7348.60468	2173.36833	-455							32	32				36.34	36.34				90.01	90.01	0.25
253	7350.43613	2203.31238	-455							32	32				36.34	36.34				90.01	90.01	0.25
254	7352.26758	2233.25643	-455							48	48				41.60	41.60				103.03	103.03	0.25
255	7354.09903	2263.20048	-455							48	48				41.60	41.60				103.03	103.03	0.25
256	7355.93047	2293.14453	-455							32	32				36.34	36.34				90.01	90.01	0.25
257	7357.76193	2323.08858	-455							32	32				36.34	36.34				90.01	90.01	0.25
258	7359.59337	2353.03263	-455							32	32				36.34	36.34				90.01	90.01	0.25
259	7361.42482	2382.97668	-455							32	32				36.34	36.34				90.01	90.01	0.25
260	7363.25628	2412.92073	-455							75	75				48.27	48.27				119.56	119.56	0.25
261	7298.51473	1845.81528	-455							33	33				36.72	36.72				90.93	90.93	0.25
262	7300.34618	1875.75933	-455				31.35	49.5	32.67		33	36.09	42.03	36.59		36.59	89.39	104.09	90.63		90.63	0.25
263	7302.17763	1905.70338	-455				31.35	49.5	32.67		33	36.09	42.03	36.59		36.59	89.39	104.09	90.63		90.63	0.25
264	7304.00908	1935.64743	-455				31.35	49.5	49.5		50	36.09	42.03	42.03		42.03	89.39	104.09	104.09		104.09	0.25
265	7305.84053	1965.59148	-455				31.35	49.5	32.67		33	36.09	42.03	36.59		36.59	89.39	104.09	90.63		90.63	0.25
266	7307.67198	1995.53553	-455				47.499	75	49		49	41.46	48.27	41.89		41.89	102.67	119.56	103.74		103.74	0.25
267	7309.50343	2025.47958	-455							32	32				36.34	36.34				90.01	90.01	0.25
268	7311.33488	2055.42363	-455							32	32				36.34	36.34				90.01	90.01	0.25
269	7313.16633	2085.36768	-455							48	48				41.60	41.60				103.03	103.03	0.25
270	7314.99778	2115.31173	-455							20	20				31.07	31.07				76.95	76.95	0.25
271	7316.82923	2145.25578	-455							32	32				36.34	36.34				90.01	90.01	0.25
272	7318.66068	2175.19983	-455							32	32				36.34	36.34				90.01	90.01	0.25
273	7320.49213	2205.14388	-455							32	32				36.34	36.34				90.01	90.01	0.25
274	7322.32358	2235.08793	-455							20	20				31.07	31.07				76.95	76.95	0.25
275	7324.15503	2265.03198	-455							58	58				44.31	44.31				109.74	109.74	0.25
276	7325.98648	2294.97603	-455							49	49				41.89	41.89				103.74	103.74	0.25
277	7327.81792	2324.92008	-455							32	32				36.34	36.34				90.01	90.01	0.25
278	7329.64937	2354.86413	-455							32	32				36.34	36.34				90.01	90.01	0.25
279	7331.48083	2384.80818	-455							32	32				36.34	36.34				90.01	90.01	0.25
280	7333.31228	2414.75223	-455							29	29				35.17	35.17				87.10	87.10	0.25
281	7268.57073	1847.64678	-455				31.35	49.5	32.67		33	36.09	42.03	36.59		36.59	89.39	104.09	90.63		90.63	0.25
282	7270.40218	1877.59083	-455				21.45	49.5	32.34		32	31.81	42.03	36.47		36.47	78.77	104.09	90.32		90.32	0.25
283	7272.23363	1907.53488	-455				37.5	75	49.5		50	38.32	48.27	42.03		42.03	94.89	119.56	104.09		104.09	0.25
284	7274.06508	1937.47893	-455				37.5	75	49		49	38.32	48.27	41.89		41.89	94.89	119.56	103.74		103.74	0.25
285	7275.89653	1967.42298	-455				31.35	49.5	32.34		32	36.09	42.03	36.47		36.47	89.39	104.09	90.32		90.32	0.25
286	7277.72798	1997.36703	-455							32	32				36.34	36.34				90.01	90.01	0.25
287	7279.55943	2027.31108	-455							48	48				41.60	41.60				103.03	103.03	0.25
288	7281.39088	2057.25513	-455							32	32				36.34	36.34				90.01	90.01	0.25

Model B

Colour codes:

13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms															
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	Qinterpolated	Q_{cha}	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{interpolated}$	$E_{m\,(cha)}$	$\sigma_m^{c\,(Qmin)}$	$\sigma_m^{c\,(Qmax)}$	$\sigma_m^{c\,(Qmean)}$	$\sigma_m^{c\,(interpolated)}$	$\sigma_{m\,(cha)}^{c}$	ν
289	7283.22233	2087.19918	-455							21	21				31.58	31.58				78.22	78.22	0.25
290	7285.05378	2117.14323	-455	14.025	49.5	15.675					16	27.61	42.03	28.65		28.65	68.37	104.09	70.95		70.95	0.25
291	7286.88523	2147.08728	-455							16	16				28.84	28.84				71.44	71.44	0.25
292	7288.71668	2177.03133	-455							32	32				36.34	36.34				90.01	90.01	0.25
293	7290.54813	2206.97538	-455							48	48				41.60	41.60				103.03	103.03	0.25
294	7292.37958	2236.91943	-455							45	45				40.72	40.72				100.84	100.84	0.25
295	7294.21103	2266.86348	-455				62.7	62.7	62.7		63	45.48	45.48	45.48		45.48	112.63	112.63	112.63		112.63	0.25
296	7296.04248	2296.80753	-455							45	45				40.72	40.72				100.84	100.84	0.25
297	7297.87392	2326.75158	-455							48	48				41.60	41.60				103.03	103.03	0.25
298	7299.70538	2356.69563	-455							32	32				36.34	36.34				90.01	90.01	0.25
299	7301.53682	2386.63968	-455							32	32				36.34	36.34				90.01	90.01	0.25
300	7303.36828	2416.58373	-455							2.8	2.8				16.13	16.13				39.96	39.96	0.25
301	7238.62673	1849.47828	-455							50	50				42.17	42.17				104.44	104.44	0.25
302	7240.45818	1879.42233	-455				47.499	75	49.5		50	41.46	48.27	42.03		42.03	102.67	119.56	104.09		104.09	0.25
303	7242.28963	1909.36638	-455				32.499	75	49		49	36.53	48.27	41.89		41.89	90.47	119.56	103.74		103.74	0.25
304	7244.12108	1939.31043	-455				37.5	75	49		49	38.32	48.27	41.89		41.89	94.89	119.56	103.74		103.74	0.25
305	7245.95253	1969.25448	-455				47.499	75	49		49	41.46	48.27	41.89		41.89	102.67	119.56	103.74		103.74	0.25
306	7247.78398	1999.19853	-455							32	32				36.34	36.34				90.01	90.01	0.25
307	7249.61543	2029.14258	-455							32	32				36.34	36.34				90.01	90.01	0.25
308	7251.44688	2059.08663	-455							44	44				40.41	40.41				100.09	100.09	0.25
309	7253.27833	2089.03068	-455				5.133	49.5	29.04		29	19.75	42.03	35.19		35.19	48.90	104.09	87.14		87.14	0.25
310	7255.10978	2118.97473	-455							21	21				31.58	31.58				78.22	78.22	0.25
311	7256.94123	2148.91878	-455							32	32				36.34	36.34				90.01	90.01	0.25
312	7258.77268	2178.86283	-455							48	48				41.60	41.60				103.03	103.03	0.25
313	7260.60413	2208.80688	-455							48	48				41.60	41.60				103.03	103.03	0.25
314	7262.43558	2238.75093	-455							50	50				42.17	42.17				104.44	104.44	0.25
315	7264.26702	2268.69498	-455							38	38				38.49	38.49				95.31	95.31	0.25
316	7266.09848	2298.63903	-455							24	24				33.02	33.02				81.78	81.78	0.25
317	7267.92992	2328.58308	-455							32	32				36.34	36.34				90.01	90.01	0.25
318	7269.76137	2358.52713	-455							48	48				41.60	41.60				103.03	103.03	0.25
319	7271.59282	2388.47118	-455							32	32				36.34	36.34				90.01	90.01	0.25
320	7273.42428	2418.41523	-455							32	32				36.34	36.34				90.01	90.01	0.25
321	7208.68273	1851.30978	-455							48	48				41.60	41.60				103.03	103.03	0.25
322	7210.51418	1881.25383	-455							48	48				41.60	41.60				103.03	103.03	0.25
323	7212.34563	1911.19788	-455				7.779	75	45.5		46	22.68	48.27	40.87		40.87	56.17	119.56	101.21		101.21	0.25
324	7214.17708	1941.14193	-455				2.223	75	49		49	14.94	48.27	41.89		41.89	37.00	119.56	103.74		103.74	0.25
325	7216.00853	1971.08598	-455							49	49				41.89	41.89				103.74	103.74	0.25
326	7217.83998	2001.03003	-455							48	48				41.60	41.60				103.03	103.03	0.25
327	7219.67143	2030.97408	-455							32	32				36.34	36.34				90.01	90.01	0.25
328	7221.50288	2060.91813	-455							30	30				35.57	35.57				88.09	88.09	0.25
329	7223.33433	2090.86218	-455				21.45	49.5	30.03		30	31.81	42.03	35.58		35.58	78.77	104.09	88.12		88.12	0.25
330	7225.16578	2120.80623	-455							30	30				35.57	35.57				88.09	88.09	0.25
331	7226.99723	2150.75028	-455							32	32				36.34	36.34				90.01	90.01	0.25
332	7228.82868	2180.69433	-455							48	48				41.60	41.60				103.03	103.03	0.25
333	7230.66013	2210.63838	-455							48	48				41.60	41.60				103.03	103.03	0.25
334	7232.49158	2240.58243	-455							48	48				41.60	41.60				103.03	103.03	0.25
335	7234.32303	2270.52648	-455							48	48				41.60	41.60				103.03	103.03	0.25
336	7236.15447	2300.47053	-455							48	48				41.60	41.60				103.03	103.03	0.25
337	7237.98592	2330.41458	-455							32	32				36.34	36.34				90.01	90.01	0.25
338	7239.81738	2360.35863	-455							32	32				36.34	36.34				90.01	90.01	0.25
339	7241.64882	2390.30268	-455							32	32				36.34	36.34				90.01	90.01	0.25
340	7243.48028	2420.24673	-455							32	32				36.34	36.34				90.01	90.01	0.25
341	7178.73873	1853.14128	-455							48	48				41.60	41.60				103.03	103.03	0.25
342	7180.57018	1883.08533	-455							59	59				44.56	44.56				110.37	110.37	0.25
343	7182.40163	1913.02938	-455				75	75	75		75	48.27	48.27	48.27		48.27	119.56	119.56	119.56		119.56	0.25
344	7184.23308	1942.97343	-455				42.501	75	74.25		74	39.95	48.27	48.11		48.11	98.94	119.56	119.16		119.16	0.25
345	7186.06453	1972.91748	-455							74	74				48.06	48.06				119.02	119.02	0.25
346	7187.89598	2002.86153	-455							48	48				41.60	41.60				103.03	103.03	0.25
347	7189.72743	2032.80558	-455							48	48				41.60	41.60				103.03	103.03	0.25
348	7191.55888	2062.74963	-455							32	32				36.34	36.34				90.01	90.01	0.25
349	7193.39033	2092.69368	-455							30	30				35.57	35.57				88.09	88.09	0.25
350	7195.22178	2122.63773	-455							32	32				36.34	36.34				90.01	90.01	0.25
351	7197.05323	2152.58178	-455							32	32				36.34	36.34				90.01	90.01	0.25
352	7198.88468	2182.52583	-455							32	32				36.34	36.34				90.01	90.01	0.25
353	7200.71613	2212.46988	-455							48	48				41.60	41.60				103.03	103.03	0.25
354	7202.54758	2242.41393	-455							48	48				41.60	41.60				103.03	103.03	0.25
355	7204.37903	2272.35798	-455							48	48				41.60	41.60				103.03	103.03	0.25
356	7206.21047	2302.30203	-455							48	48				41.60	41.60				103.03	103.03	0.25
357	7208.04192	2332.24608	-455							32	32				36.34	36.34				90.01	90.01	0.25
358	7209.87337	2362.19013	-455							32	32				36.34	36.34				90.01	90.01	0.25
359	7211.70482	2392.13418	-455							32	32				36.34	36.34				90.01	90.01	0.25
360	7213.53628	2422.07823	-455							32	32				36.34	36.34				90.01	90.01	0.25

Model B

Colour codes:

13 Data
11 Extrapolation
12 "Qualified guess"

Block No	Coordinates X	Y	Z	Q from histograms Qmin	Qmax	Q NGI 2001	Q from histograms Qmin	Qmax	Qblock	Qinterpolated	Q_{cha}	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{interpolated}$	$E_{m\,(cha)}$	$\sigma_m^{c\,(Qmin)}$	$\sigma_m^{c\,(Qmax)}$	$\sigma_m^{c\,(Qmean)}$	$\sigma_m^{c\,(interpolated)}$	$\sigma_{m\,(cha)}^{c}$	ν
361	7328.45873	1843.98378	-485							32	32				36.34	36.34				90.01	90.01	0.25
362	7330.29018	1873.92783	-485							32	32				36.34	36.34				90.01	90.01	0.25
363	7332.12163	1903.87188	-485							32	32				36.34	36.34				90.01	90.01	0.25
364	7333.95308	1933.81593	-485							32	32				36.34	36.34				90.01	90.01	0.25
365	7335.78453	1963.75998	-485							32	32				36.34	36.34				90.01	90.01	0.25
366	7337.61598	1993.70403	-485							50	50				42.17	42.17				104.44	104.44	0.25
367	7339.44743	2023.64808	-485							32	32				36.34	36.34				90.01	90.01	0.25
368	7341.27888	2053.59213	-485							48	48				41.60	41.60				103.03	103.03	0.25
369	7343.11033	2083.53618	-485							48	48				41.60	41.60				103.03	103.03	0.25
370	7344.94178	2113.48023	-485							16	16				28.84	28.84				71.44	71.44	0.25
371	7346.77323	2143.42428	-485							48	48				41.60	41.60				103.03	103.03	0.25
372	7348.60468	2173.36833	-485							32	32				36.34	36.34				90.01	90.01	0.25
373	7350.43613	2203.31238	-485							32	32				36.34	36.34				90.01	90.01	0.25
374	7352.26758	2233.25643	-485							32	32				36.34	36.34				90.01	90.01	0.25
375	7354.09903	2263.20048	-485							48	48				41.60	41.60				103.03	103.03	0.25
376	7355.93047	2293.14453	-485							32	32				36.34	36.34				90.01	90.01	0.25
377	7357.76193	2323.08858	-485							32	32				36.34	36.34				90.01	90.01	0.25
378	7359.59337	2353.03263	-485							32	32				36.34	36.34				90.01	90.01	0.25
379	7361.42482	2382.97668	-485							32	32				36.34	36.34				90.01	90.01	0.25
380	7363.25628	2412.92073	-485							32	32				36.34	36.34				90.01	90.01	0.25
381	7298.51473	1845.81528	-485							32	32				36.34	36.34				90.01	90.01	0.25
382	7300.34618	1875.75933	-485							33	33				36.72	36.72				90.93	90.93	0.25
383	7302.17763	1905.70338	-485							33	33				36.72	36.72				90.93	90.93	0.25
384	7304.00908	1935.64743	-485							50	50				42.17	42.17				104.44	104.44	0.25
385	7305.84053	1965.59148	-485							33	33				36.72	36.72				90.93	90.93	0.25
386	7307.67198	1995.53553	-485							49	49				41.89	41.89				103.74	103.74	0.25
387	7309.50343	2025.47958	-485							32	32				36.34	36.34				90.01	90.01	0.25
388	7311.33488	2055.42363	-485							32	32				36.34	36.34				90.01	90.01	0.25
389	7313.16633	2085.36768	-485							16	16				28.84	28.84				71.44	71.44	0.25
390	7314.99778	2115.31173	-485	14.167	190	15.67					16	27.70	65.81	28.65		28.65	68.60	162.98	70.94		70.94	0.25
391	7316.82923	2145.25578	-485							11	11				25.46	25.46				63.05	63.05	0.25
392	7318.66068	2175.19983	-485							32	32				36.34	36.34				90.01	90.01	0.25
393	7320.49213	2205.14388	-485							32	32				36.34	36.34				90.01	90.01	0.25
394	7322.32358	2235.08793	-485							32	32				36.34	36.34				90.01	90.01	0.25
395	7324.15503	2265.03198	-485							48	48				41.60	41.60				103.03	103.03	0.25
396	7325.98648	2294.97603	-485							48	48				41.60	41.60				103.03	103.03	0.25
397	7327.81792	2324.92008	-485							32	32				36.34	36.34				90.01	90.01	0.25
398	7329.64937	2354.86413	-485							32	32				36.34	36.34				90.01	90.01	0.25
399	7331.48083	2384.80818	-485							32	32				36.34	36.34				90.01	90.01	0.25
400	7333.31228	2414.75223	-485							32	32				36.34	36.34				90.01	90.01	0.25
401	7268.57073	1847.64678	-485							33	33				36.72	36.72				90.93	90.93	0.25
402	7270.40218	1877.59083	-485							32	32				36.34	36.34				90.01	90.01	0.25
403	7272.23363	1907.53488	-485							49	49				41.89	41.89				103.74	103.74	0.25
404	7274.06508	1937.47893	-485							49	49				41.89	41.89				103.74	103.74	0.25
405	7275.89653	1967.42298	-485							32	32				36.34	36.34				90.01	90.01	0.25
406	7277.72798	1997.36703	-485							32	32				36.34	36.34				90.01	90.01	0.25
407	7279.55943	2027.31108	-485							48	48				41.60	41.60				103.03	103.03	0.25
408	7281.39088	2057.25513	-485							32	32				36.34	36.34				90.01	90.01	0.25
409	7283.22233	2087.19918	-485							14	14				27.59	27.59				68.33	68.33	0.25
410	7285.05378	2117.14323	-485	14.024	14.024	14.024					14	27.60	27.60	27.60		27.60	68.37	68.37	68.37		68.37	0.25
411	7286.88523	2147.08728	-485							14	14				27.59	27.59				68.33	68.33	0.25
412	7288.71668	2177.03133	-485							32	32				36.34	36.34				90.01	90.01	0.25
413	7290.54813	2206.97538	-485							48	48				41.60	41.60				103.03	103.03	0.25
414	7292.37958	2236.91943	-485							32	32				36.34	36.34				90.01	90.01	0.25
415	7294.21103	2266.86348	-485							63	63				45.55	45.55				112.81	112.81	0.25
416	7296.04248	2296.80753	-485							32	32				36.34	36.34				90.01	90.01	0.25
417	7297.87392	2326.75158	-485							48	48				41.60	41.60				103.03	103.03	0.25
418	7299.70538	2356.69563	-485							32	32				36.34	36.34				90.01	90.01	0.25
419	7301.53682	2386.63968	-485							32	32				36.34	36.34				90.01	90.01	0.25
420	7303.36828	2416.58373	-485							32	32				36.34	36.34				90.01	90.01	0.25
421	7238.62673	1849.47828	-485							33	33				36.72	36.72				90.93	90.93	0.25
422	7240.45818	1879.42233	-485				42.5	75	49.5		50	39.95	48.27	42.03		42.03	98.93	119.56	104.09		104.09	0.25
423	7242.28963	1909.36638	-485				42.5	75	49		49	39.95	48.27	41.89		41.89	98.93	119.56	103.74		103.74	0.25
424	7244.12108	1939.31043	-485							49	49				41.89	41.89				103.74	103.74	0.25
425	7245.95253	1969.25448	-485							49	49				41.89	41.89				103.74	103.74	0.25
426	7247.78398	1999.19853	-485							32	32				36.34	36.34				90.01	90.01	0.25
427	7249.61543	2029.14258	-485							32	32				36.34	36.34				90.01	90.01	0.25
428	7251.44688	2059.08663	-485							48	48				41.60	41.60				103.03	103.03	0.25
429	7253.27833	2089.03068	-485							29	29				35.17	35.17				87.10	87.10	0.25
430	7255.10978	2118.97473	-485							14	14				27.59	27.59				68.33	68.33	0.25
431	7256.94123	2148.91878	-485							32	32				36.34	36.34				90.01	90.01	0.25
432	7258.77268	2178.86283	-485							32	32				36.34	36.34				90.01	90.01	0.25

Model B

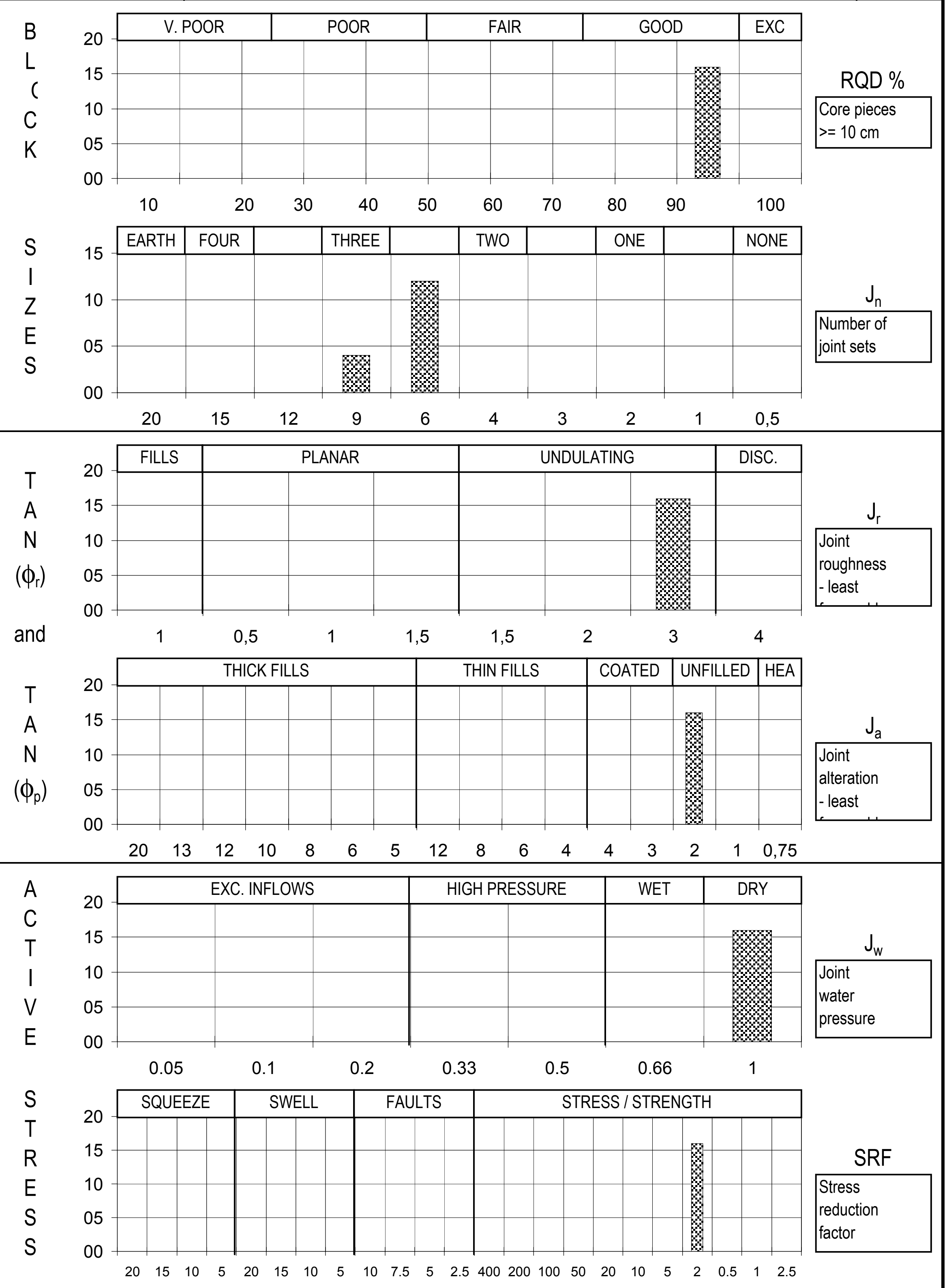
Colour codes:

13 Data
11 Extrapolation
12 "Qualified guess"

	Coordinates			Q from histograms			Q from histograms															
Block No	X	Y	Z	Qmin	Qmax	Q NGI 2001	Qmin	Qmax	Qblock	Qinterpolated	Q_{cha}	E_m^{min}	E_m^{max}	E_m^{mean}	$E_m^{interpolated}$	$E_{m (cha)}$	$\sigma_m^{c (Qmin)}$	$\sigma_m^{c (Qmax)}$	$\sigma_m^{c (Qmean)}$	$\sigma_m^{c (interpolated)}$	$\sigma_{m (cha)}^{c}$	ν
433	7260.60413	2208.80688	-485							48	48				41.60	41.60				103.03	103.03	0.25
434	7262.43558	2238.75093	-485							48	48				41.60	41.60				103.03	103.03	0.25
435	7264.26702	2268.69498	-485							32	32				36.34	36.34				90.01	90.01	0.25
436	7266.09848	2298.63903	-485							32	32				36.34	36.34				90.01	90.01	0.25
437	7267.92992	2328.58308	-485							32	32				36.34	36.34				90.01	90.01	0.25
438	7269.76137	2358.52713	-485							48	48				41.60	41.60				103.03	103.03	0.25
439	7271.59282	2388.47118	-485							32	32				36.34	36.34				90.01	90.01	0.25
440	7273.42428	2418.41523	-485							32	32				36.34	36.34				90.01	90.01	0.25
441	7208.68273	1851.30978	-485							48	48				41.60	41.60				103.03	103.03	0.25
442	7210.51418	1881.25383	-485							48	48				41.60	41.60				103.03	103.03	0.25
443	7212.34563	1911.19788	-485							48	48				41.60	41.60				103.03	103.03	0.25
444	7214.17708	1941.14193	-485				42.5	75	49		49	39.95	48.27	41.89		41.89	98.93	119.56	103.74		103.74	0.25
445	7216.00853	1971.08598	-485							49	49				41.89	41.89				103.74	103.74	0.25
446	7217.83998	2001.03003	-485							48	48				41.60	41.60				103.03	103.03	0.25
447	7219.67143	2030.97408	-485							32	32				36.34	36.34				90.01	90.01	0.25
448	7221.50288	2060.91813	-485							32	32				36.34	36.34				90.01	90.01	0.25
449	7223.33433	2090.86218	-485							30	30				35.57	35.57				88.09	88.09	0.25
450	7225.16578	2120.80623	-485							32	32				36.34	36.34				90.01	90.01	0.25
451	7226.99723	2150.75028	-485							32	32				36.34	36.34				90.01	90.01	0.25
452	7228.82868	2180.69433	-485							48	48				41.60	41.60				103.03	103.03	0.25
453	7230.66013	2210.63838	-485							48	48				41.60	41.60				103.03	103.03	0.25
454	7232.49158	2240.58243	-485							48	48				41.60	41.60				103.03	103.03	0.25
455	7234.32303	2270.52648	-485							48	48				41.60	41.60				103.03	103.03	0.25
456	7236.15447	2300.47053	-485							48	48				41.60	41.60				103.03	103.03	0.25
457	7237.98592	2330.41458	-485							32	32				36.34	36.34				90.01	90.01	0.25
458	7239.81738	2360.35863	-485							32	32				36.34	36.34				90.01	90.01	0.25
459	7241.64882	2390.30268	-485							32	32				36.34	36.34				90.01	90.01	0.25
460	7243.48028	2420.24673	-485							32	32				36.34	36.34				90.01	90.01	0.25
461	7178.73873	1853.14128	-485							46	46				41.02	41.02				101.58	101.58	0.25
462	7180.57018	1883.08533	-485				10	75	46		46	24.66	48.27	41.02		41.02	61.08	119.56	101.58		101.58	0.25
463	7182.40163	1913.02938	-485				37.5	75	49		49	38.32	48.27	41.89		41.89	94.89	119.56	103.74		103.74	0.25
464	7184.23308	1942.97343	-485				42.5	75	49.5		50	39.95	48.27	42.03		42.03	98.93	119.56	104.09		104.09	0.25
465	7186.06453	1972.91748	-485							50	50				42.17	42.17				104.44	104.44	0.25
466	7187.89598	2002.86153	-485							48	48				41.60	41.60				103.03	103.03	0.25
467	7189.72743	2032.80558	-485							48	48				41.60	41.60				103.03	103.03	0.25
468	7191.55888	2062.74963	-485							32	32				36.34	36.34				90.01	90.01	0.25
469	7193.39033	2092.69368	-485							32	32				36.34	36.34				90.01	90.01	0.25
470	7195.22178	2122.63773	-485							32	32				36.34	36.34				90.01	90.01	0.25
471	7197.05323	2152.58178	-485							32	32				36.34	36.34				90.01	90.01	0.25
472	7198.88468	2182.52583	-485							32	32				36.34	36.34				90.01	90.01	0.25
473	7200.71613	2212.46988	-485							48	48				41.60	41.60				103.03	103.03	0.25
474	7202.54758	2242.41393	-485							48	48				41.60	41.60				103.03	103.03	0.25
475	7204.37903	2272.35798	-485							48	48				41.60	41.60				103.03	103.03	0.25
476	7206.21047	2302.30203	-485							32	32				36.34	36.34				90.01	90.01	0.25
477	7208.04192	2332.24608	-485							32	32				36.34	36.34				90.01	90.01	0.25
478	7209.87337	2362.19013	-485							32	32				36.34	36.34				90.01	90.01	0.25
479	7211.70482	2392.13418	-485							32	32				36.34	36.34				90.01	90.01	0.25
480	7213.53628	2422.07823	-485							32	32				36.34	36.34				90.01	90.01	0.25
EW-1							0.008	9.9	1.47		1.47	2.29	24.58	13.02		13.02	3.78	40.58	21.49		21.49	0.3
NE-1							0.011	9.9	2.6		2.6	2.55	24.58	15.74		15.74	4.20	40.58	25.99		25.99	0.3
NE-1 (central zone)									0.011		0.011			2.55		2.55			4.20		4.20	0.4
NE-2							1.54	6.3	2.9		2.9	13.22	21.14	16.32		16.32	21.83	34.91	26.95		26.95	0.3

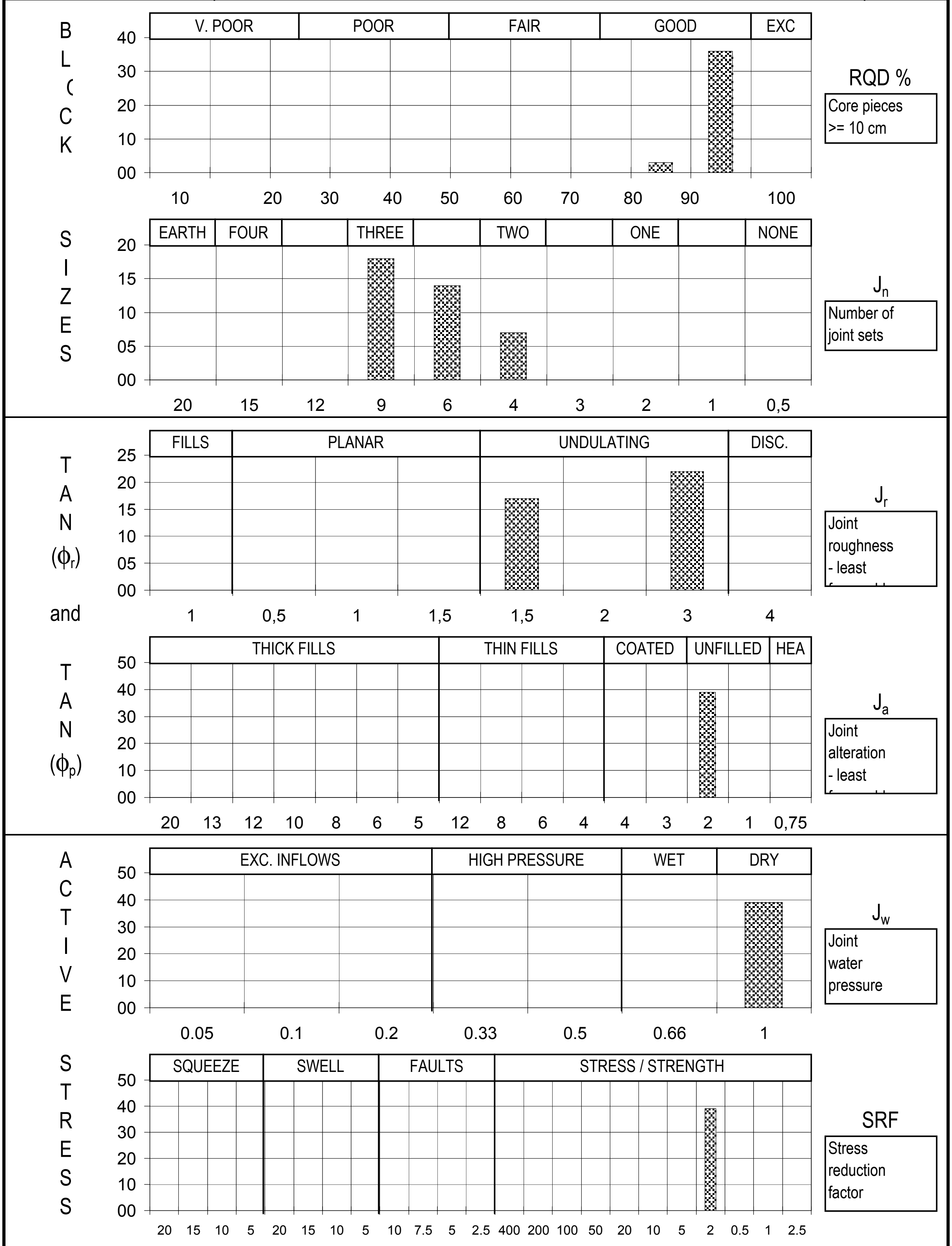
APPENDIX A – HISTOGRAMS – Q-REGISTRATION CHARTS

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	9.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**7.917**
Q (typical max)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.9**
Q (mean value)=	95	/	6.8	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.56**
Q (block)=	95	/	9.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**8.00**



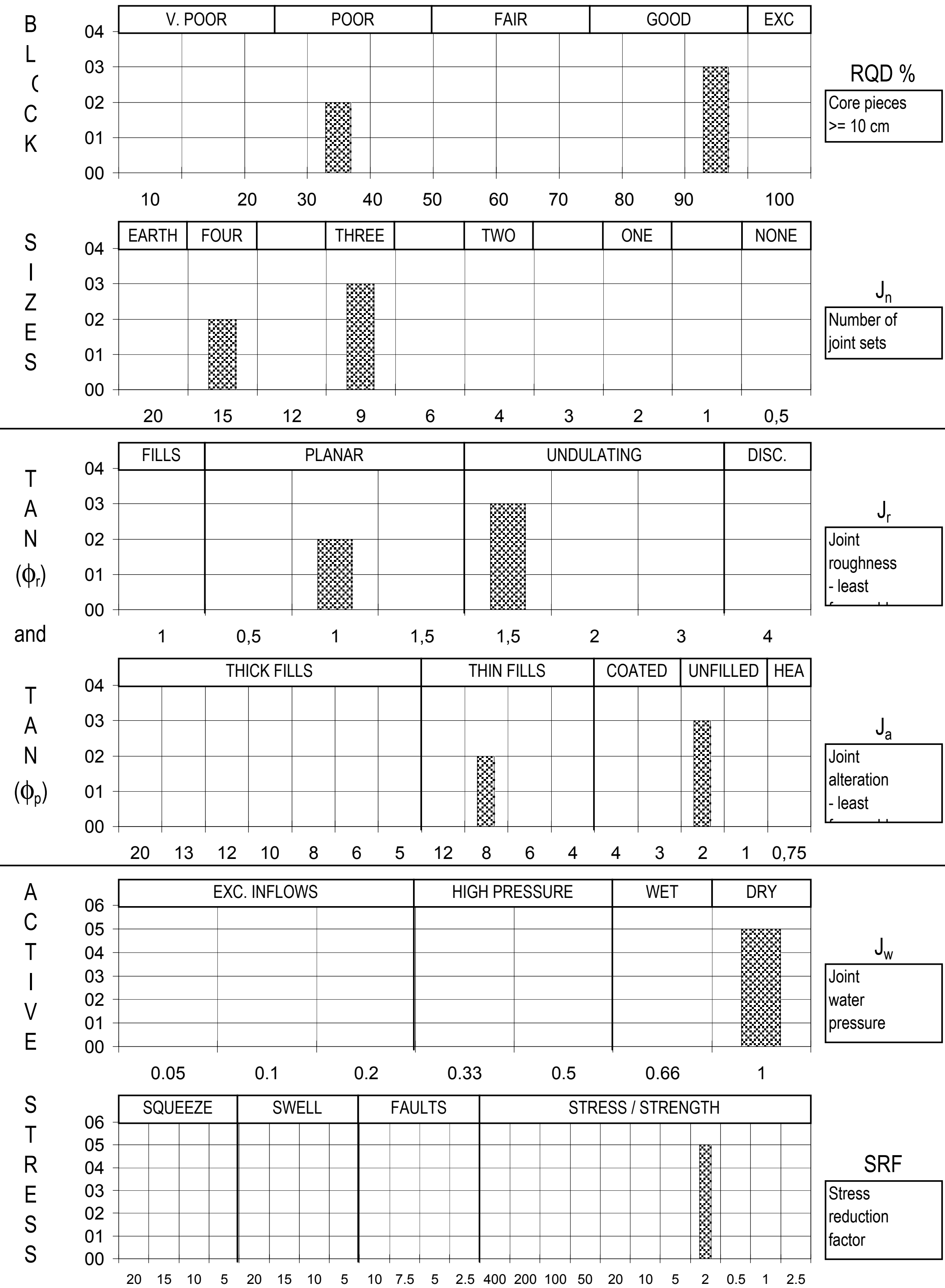
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A1
Q - REGISTRATIONS CHART	Block No. : 4	Drawn by AWH	Date 12.06.01
KA2598A 112-128m Logged by NGI 2001	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q4_NGI.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	9.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**3.542**
Q (typical max)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.8**
Q (mean value)=	94	/	7.0	*	2.3	/	2.0	*	1.00	/	2.0	=	**7.87**
Q (block)=	94	/	9.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**4.00**



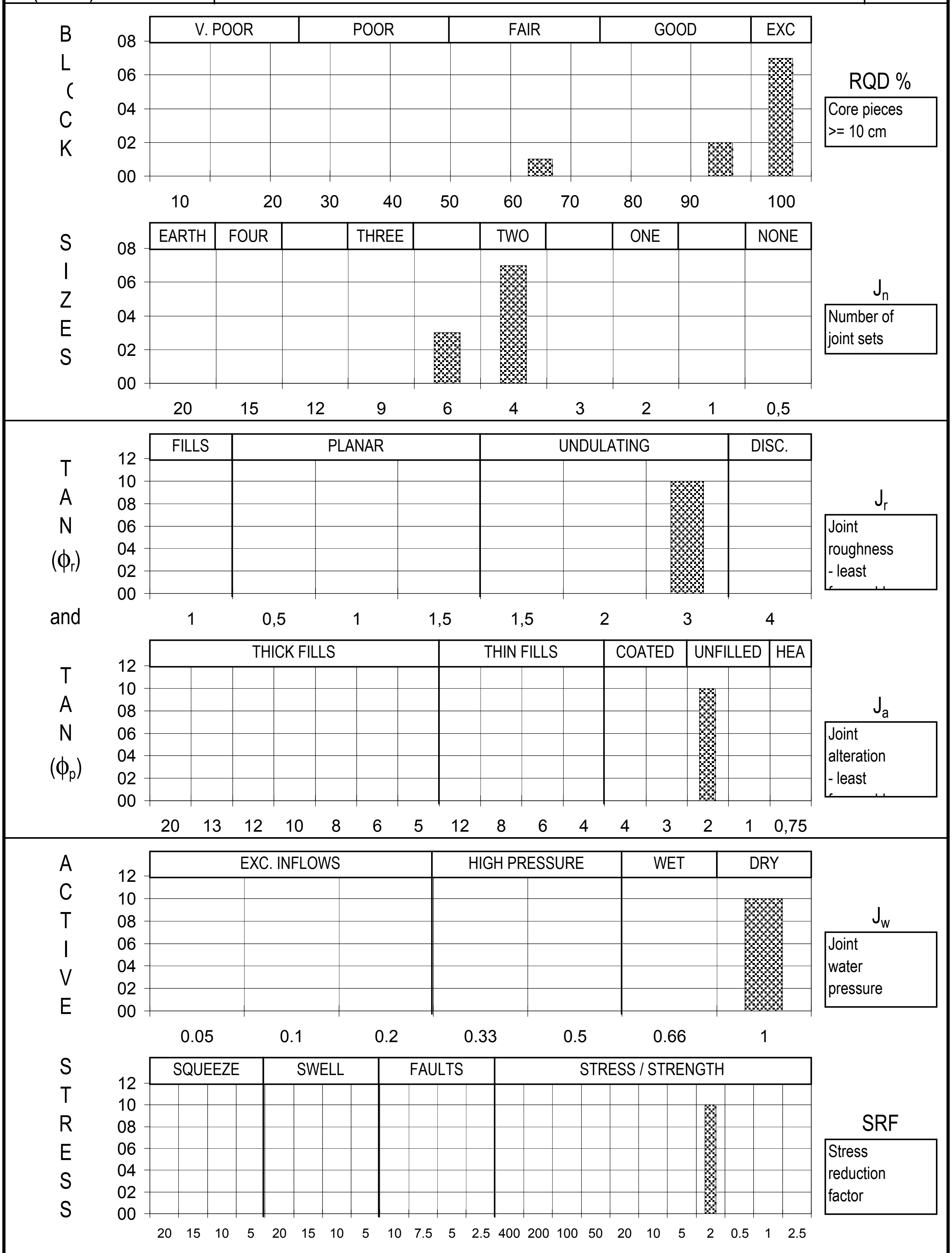
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A2
Q - REGISTRATIONS CHART	Block No. : 5	Drawn by AWH	Date 12.06.01
KA2598A 73-112m Logged by NGI 2001	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q5_NGI.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	35	/	15.0	*	1.0	/	8.0	*	1.00	/	2.0	=	**0.146**
Q (typical max)=	95	/	9.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**4.0**
Q (mean value)=	71	/	11.4	*	1.3	/	4.4	*	1.00	/	2.0	=	**0.92**
Q (block)=	71	/	15.0	*	1.0	/	8.0	*	1.00	/	2.0	=	**0.30**



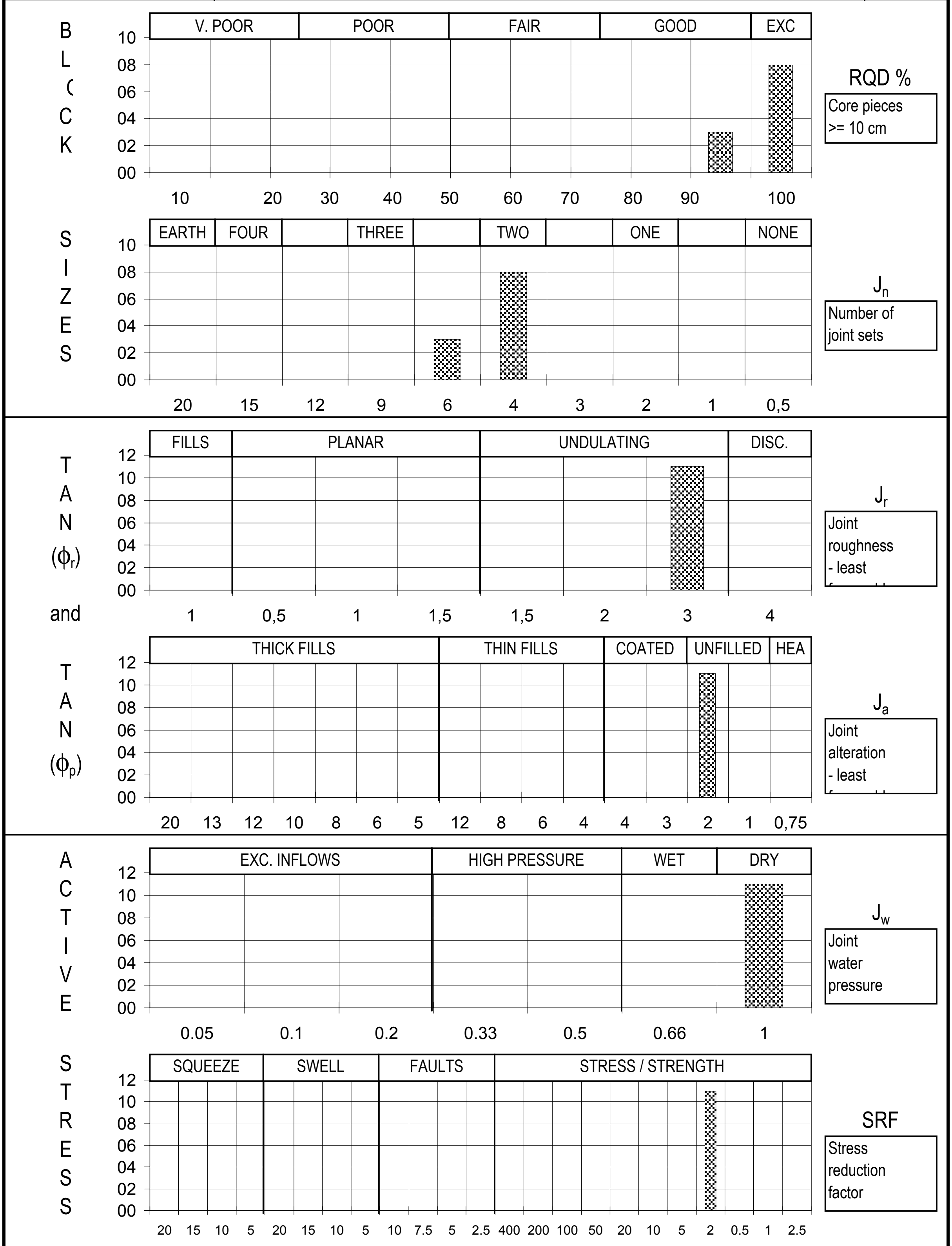
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A3
Q - REGISTRATIONS CHART	Block No. : 6	Drawn by AWH	Date 12.06.01
KA2598A 68-73m Logged by NGI 2001	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q6_NGI.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	65	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**8.125**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	96	/	4.6	*	3.0	/	2.0	*	1.00	/	2.0	=	**15.57**
Q (block)=	96	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



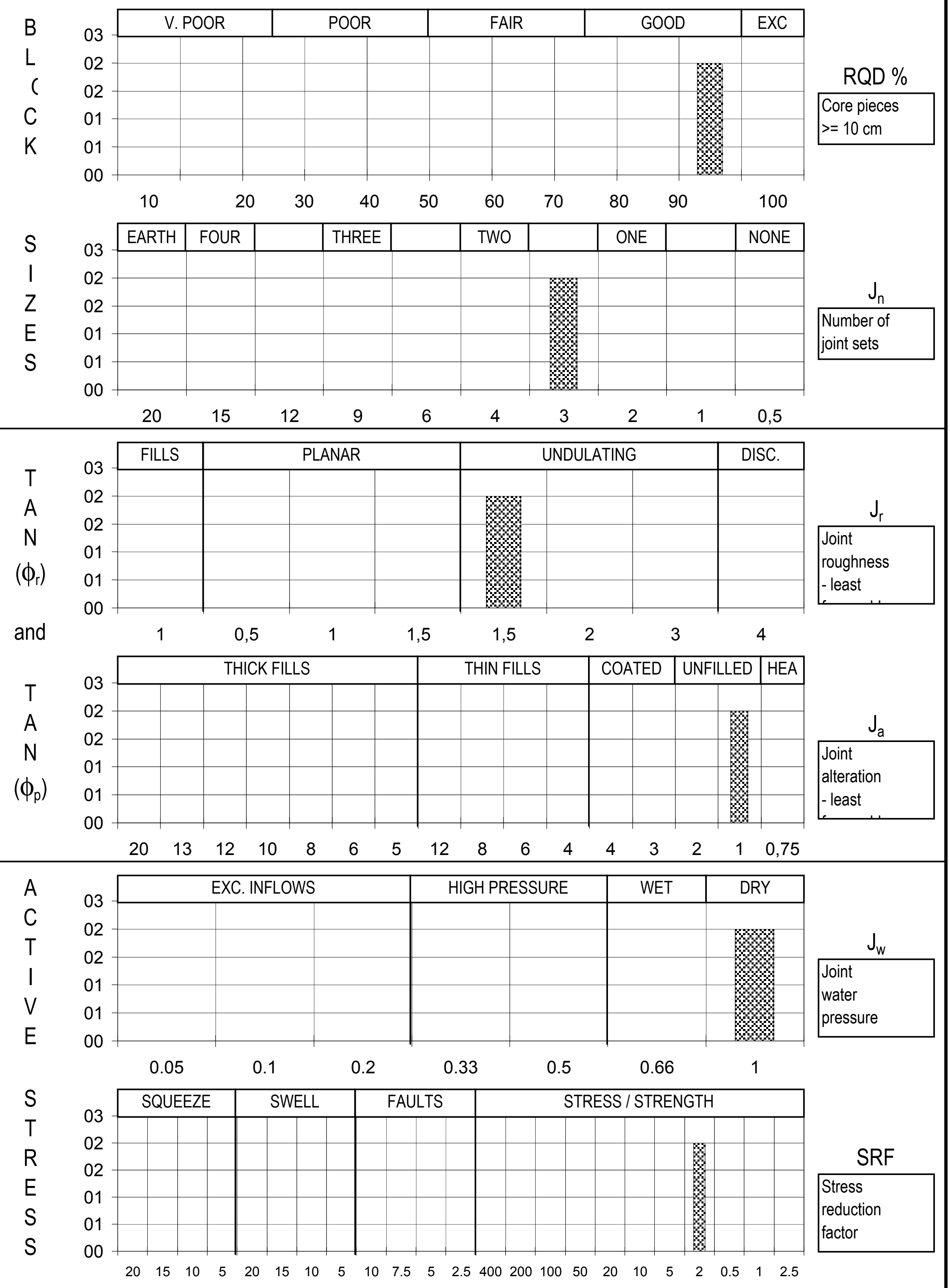
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A4
Q - REGISTRATIONS CHART	Block No. : 19	Drawn by FL	Date 2001-05-18
KA3065A02 0-10m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q19.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.5	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.28**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



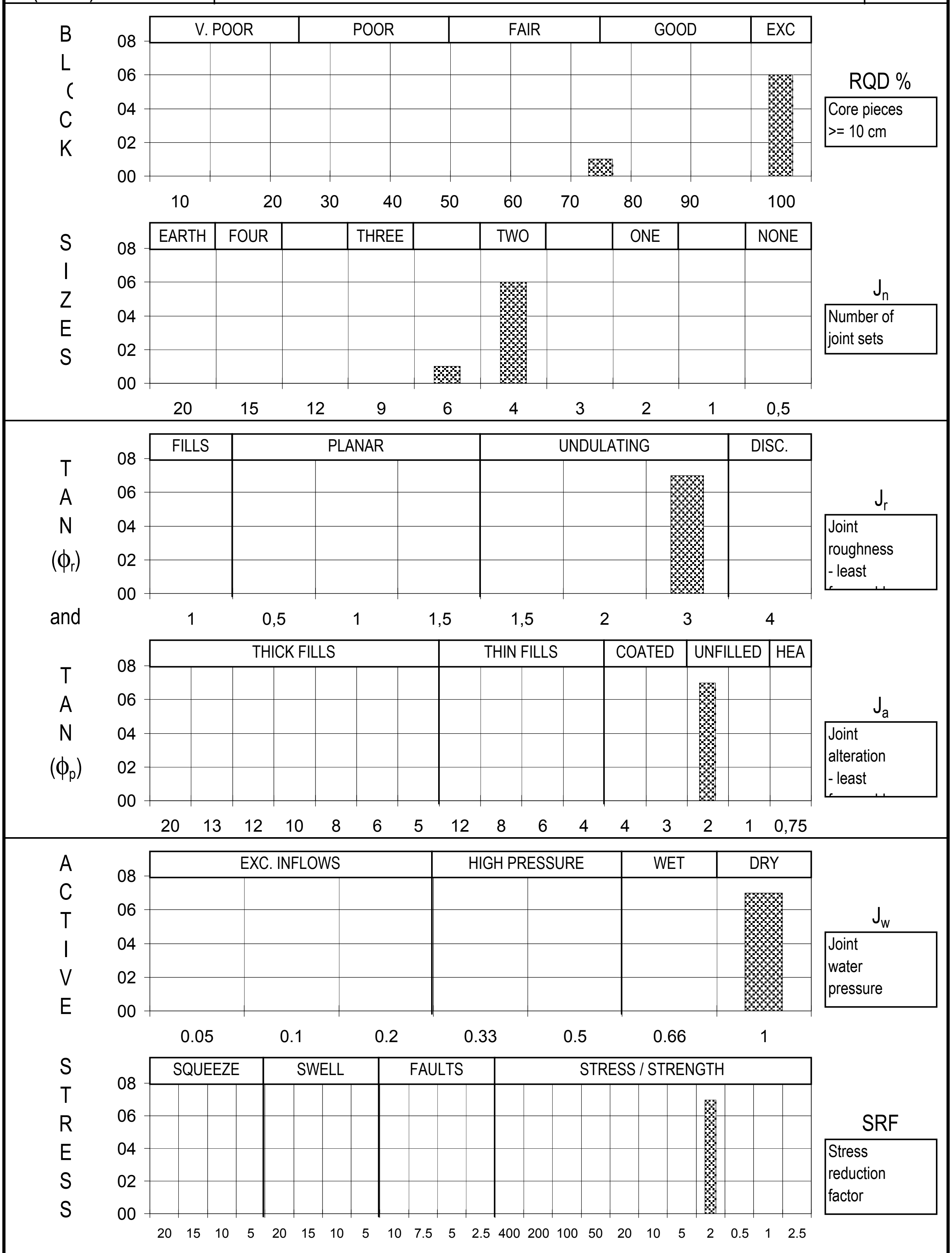
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A5
Q - REGISTRATIONS CHART	Block No. : 20	Drawn by FL	Date 2001-05-18
KA3065A02 10-21m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q20.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	3.0	*	1.5	/	1.0	*	1.00	/	2.0	=	**23.750**
Q (typical max)=	95	/	3.0	*	1.5	/	1.0	*	1.00	/	2.0	=	**23.8**
Q (mean value)=	95	/	3.0	*	1.5	/	1.0	*	1.00	/	2.0	=	**23.75**
Q (block)=	95	/	3.0	*	1.5	/	1.0	*	1.00	/	2.0	=	**24.00**



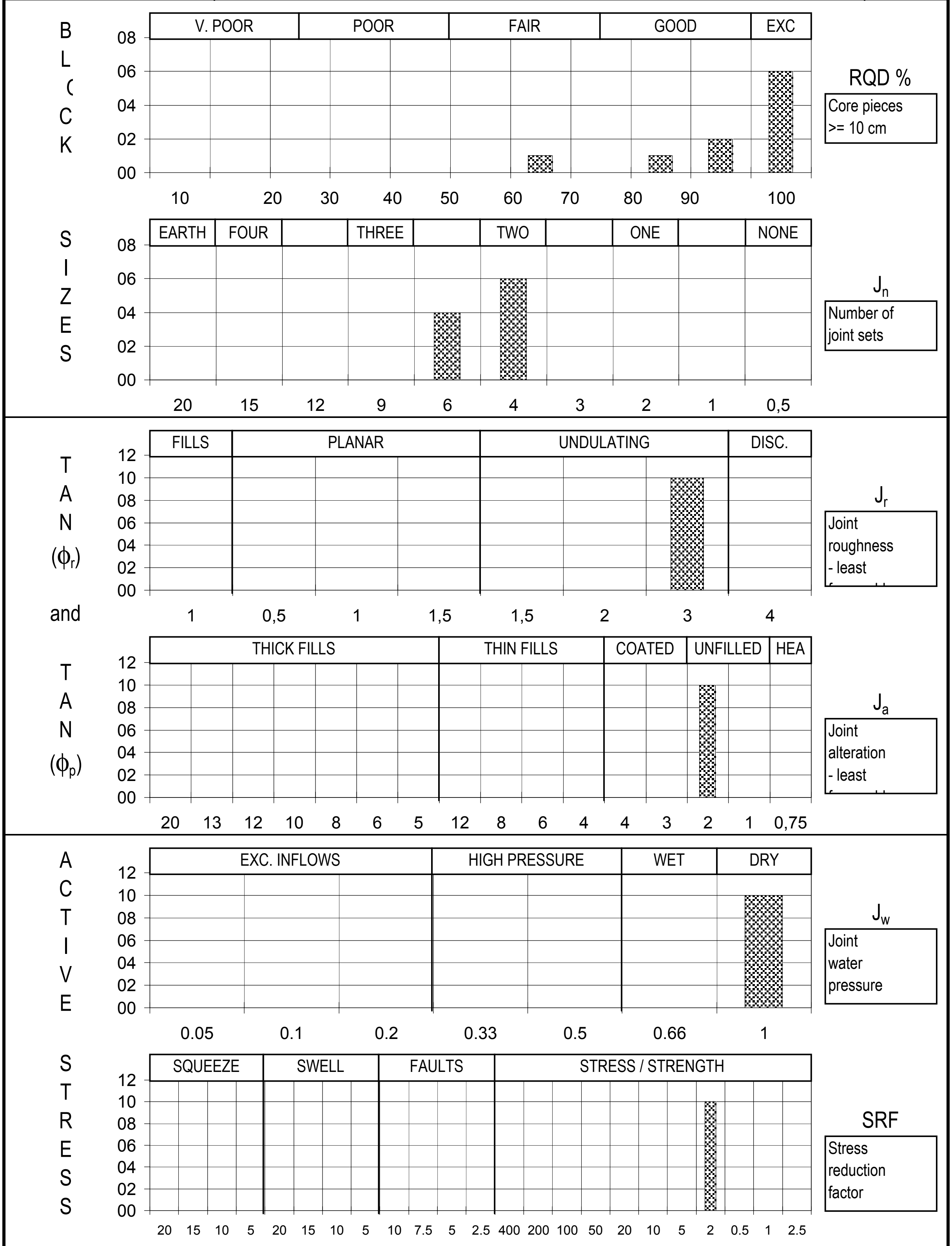
SKB/Rock mechanical model Äspö	Rev.	Report No. 0	Figure No. A6
Q - REGISTRATIONS CHART	Block No. : 35	Drawn by FL	Date 2001-06-12
KXZC1 38-40m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q35.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	75	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**9.375**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	96	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.88**
Q (block)=	96	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



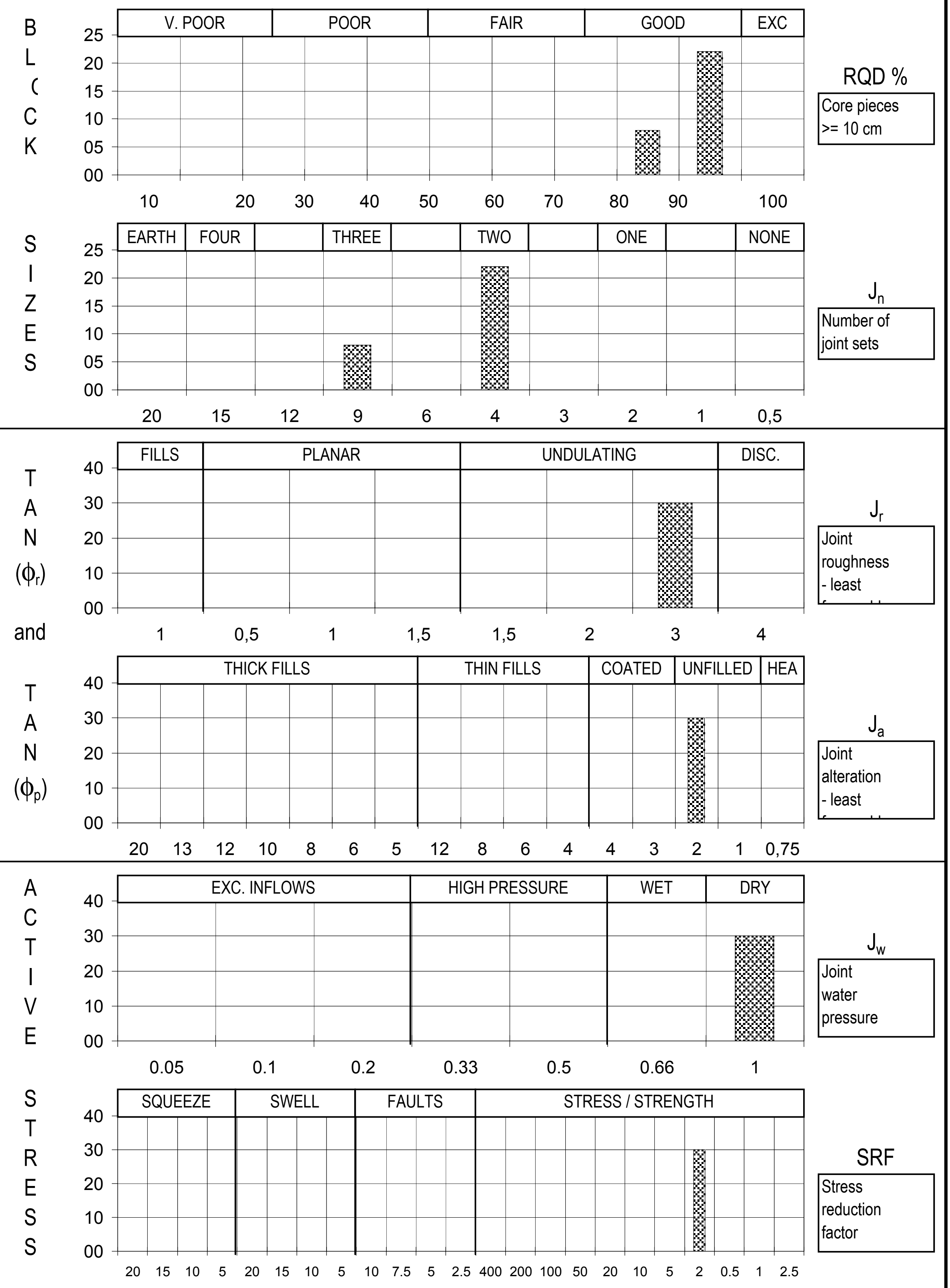
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A7
Q - REGISTRATIONS CHART	Block No. : 39	Drawn by FL	Date 2001-05-18
KA3067A 0-7m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q39.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	65	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**8.125**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	94	/	4.8	*	3.0	/	2.0	*	1.00	/	2.0	=	**14.69**
Q (block)=	94	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



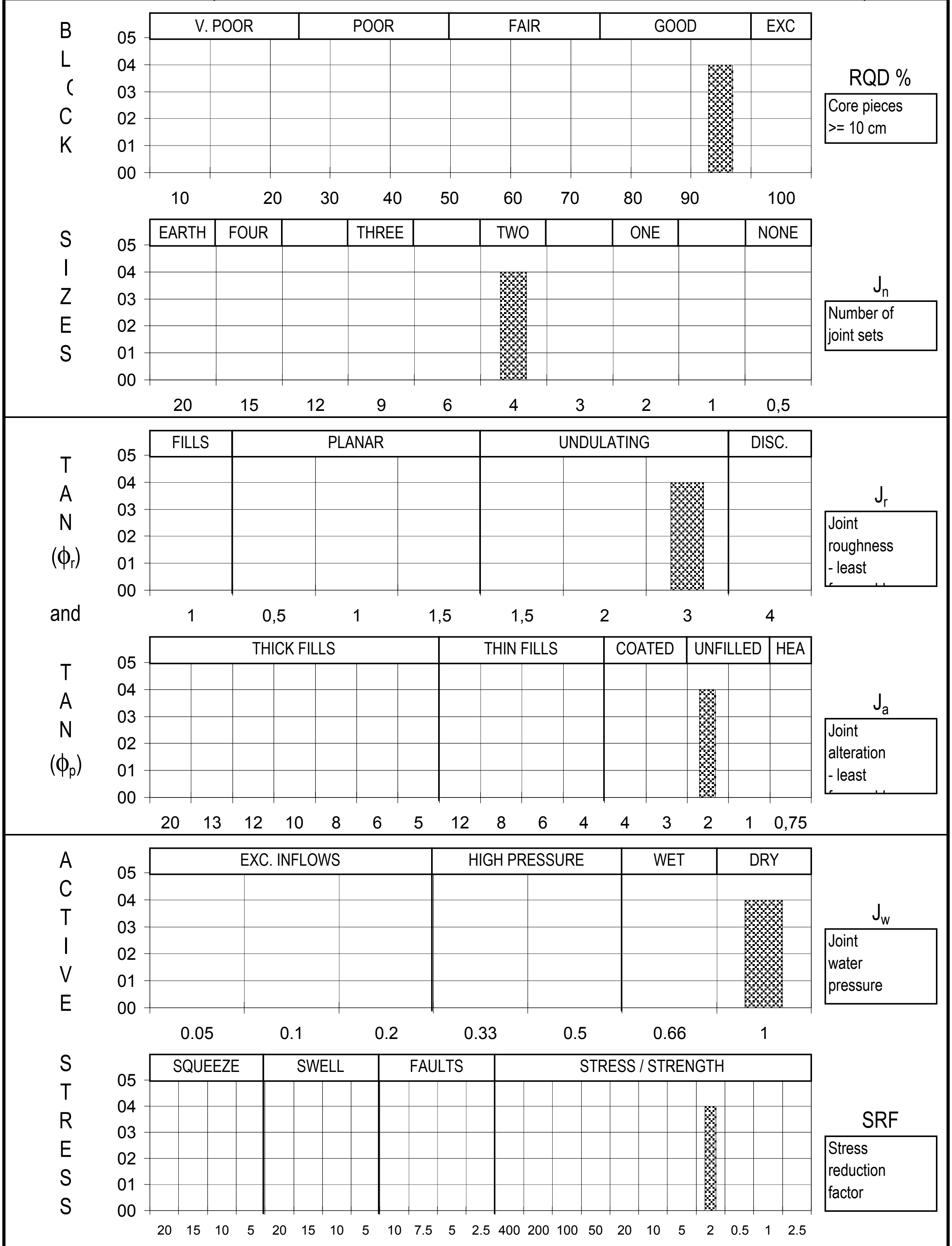
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A8
Q - REGISTRATIONS CHART	Block No. : 40	Drawn by FL	Date 2001-05-18
KA3067A 7-17m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q40.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	9.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**7.083**
Q (typical max)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.8**
Q (mean value)=	92	/	5.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.98**
Q (block)=	92	/	9.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**8.00**



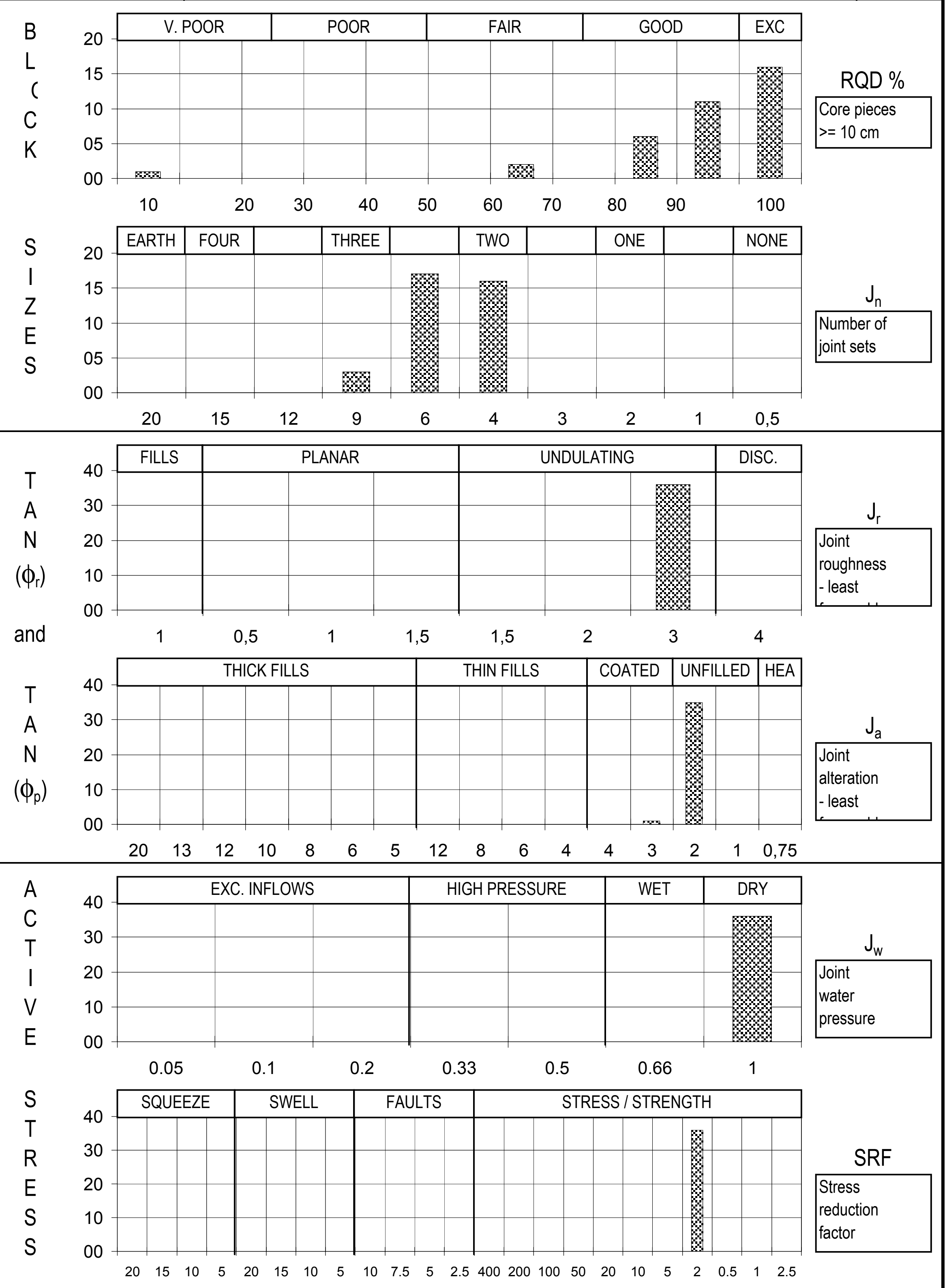
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A9
Q - REGISTRATIONS CHART	Block No. : 50	Drawn by AWH	Date 12.06.01
KAS02 390-420m Logged by NGI 2001	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q50_NGI.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.813**
Q (typical max)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.8**
Q (mean value)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.81**
Q (block)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.00**



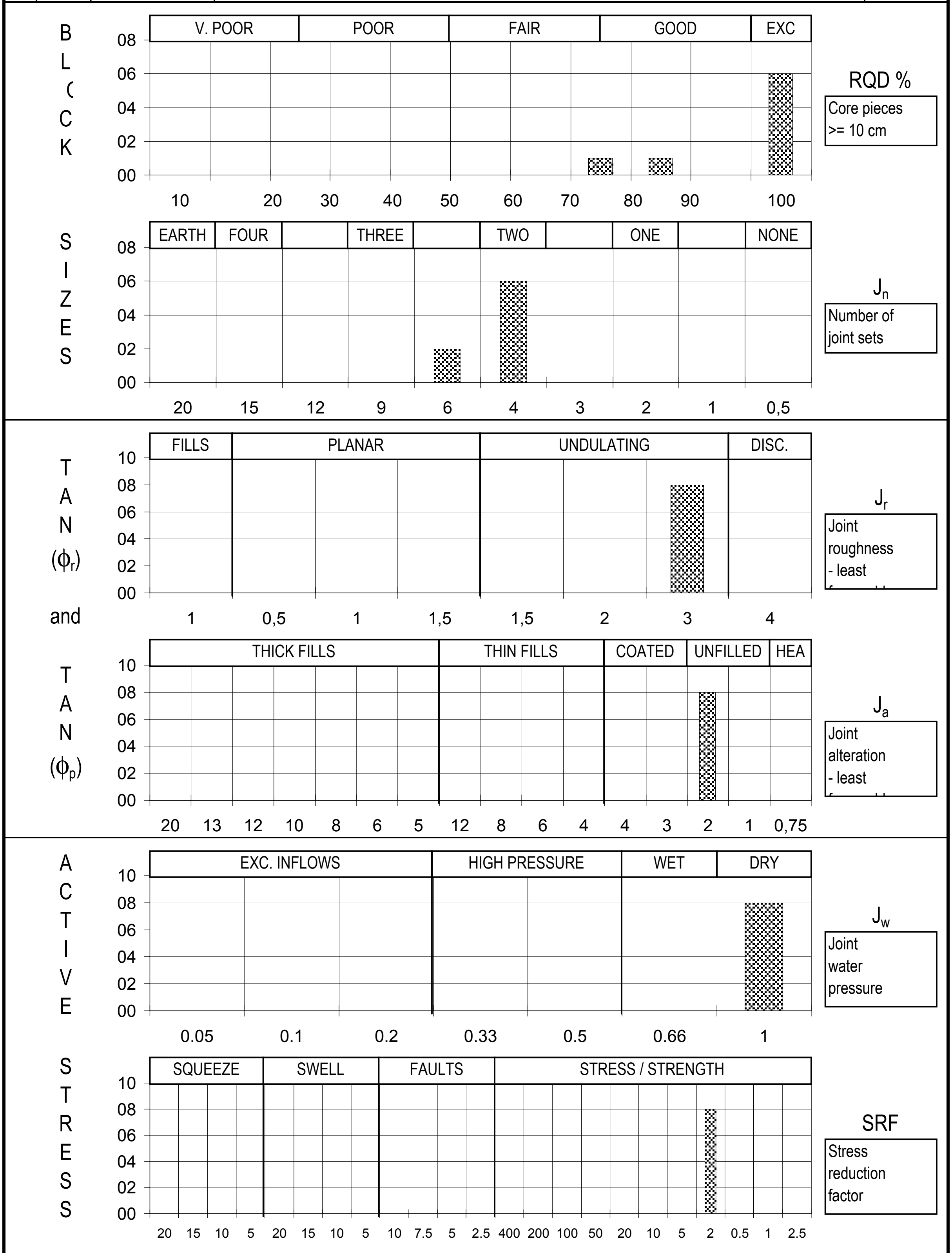
SKB/Rock mechanical model Äspö	Rev.	Report No. 0	Figure No. A10
Q - REGISTRATIONS CHART	Block No. : 55	Drawn by FL	Date 2001-06-12
KXZA3 36-40m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q55.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	10	/	9.0	*	3.0	/	3.0	*	1.00	/	2.0	=	**0.556**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	92	/	5.4	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.63**
Q (block)=	92	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



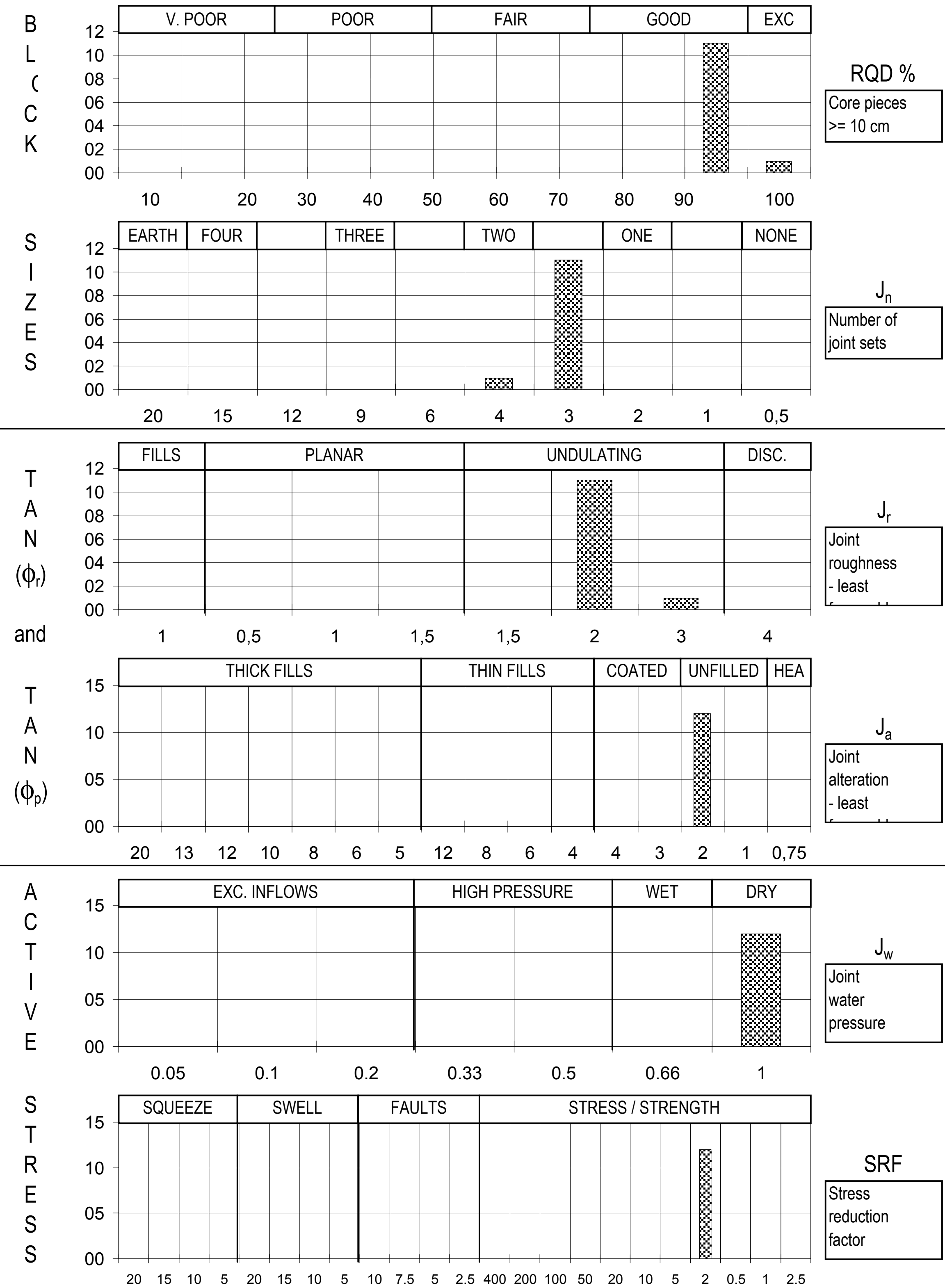
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A11
Q - REGISTRATIONS CHART	Block No. : 65	Drawn by AWH	Date 23.05.01
KA2563A 67-103m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q65.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	75	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**9.375**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	95	/	4.5	*	3.0	/	2.0	*	1.00	/	2.0	=	**15.83**
Q (block)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A12
Q - REGISTRATIONS CHART	Block No. : 66	Drawn by AWH	Date 23.05.01
KA2563A 59-67m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q66.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	4.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	3.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**25.0**
Q (mean value)=	95	/	3.1	*	2.1	/	2.0	*	1.00	/	2.0	=	**16.12**
Q (block)=	95	/	3.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**16.00**



SKB/Rock mechanical model Äspö

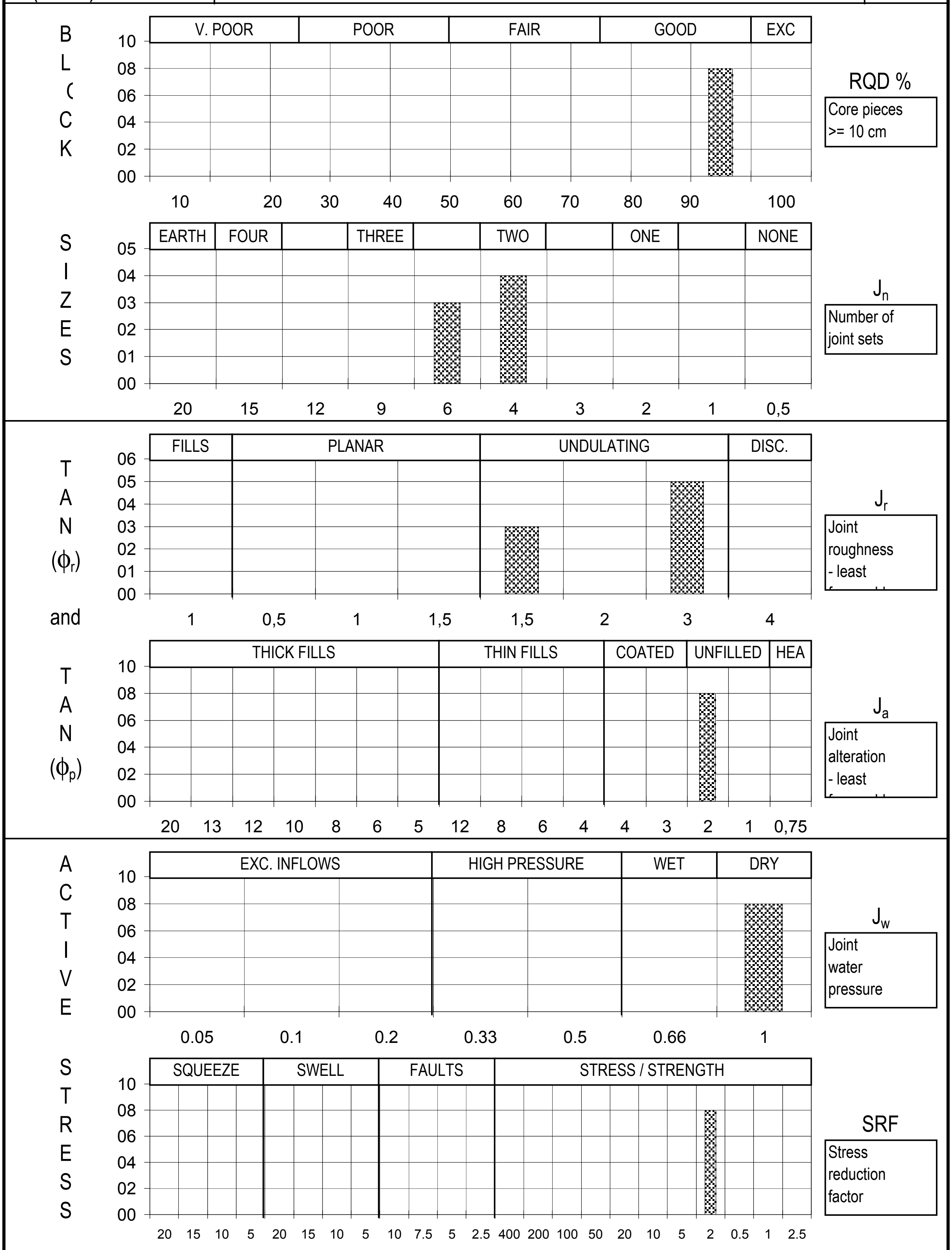
Q - REGISTRATIONS CHART

KXZB5 4-18m

F:\P\2001\11\20011173\excel\Q-blokker\[Q75.xls]Q-chart

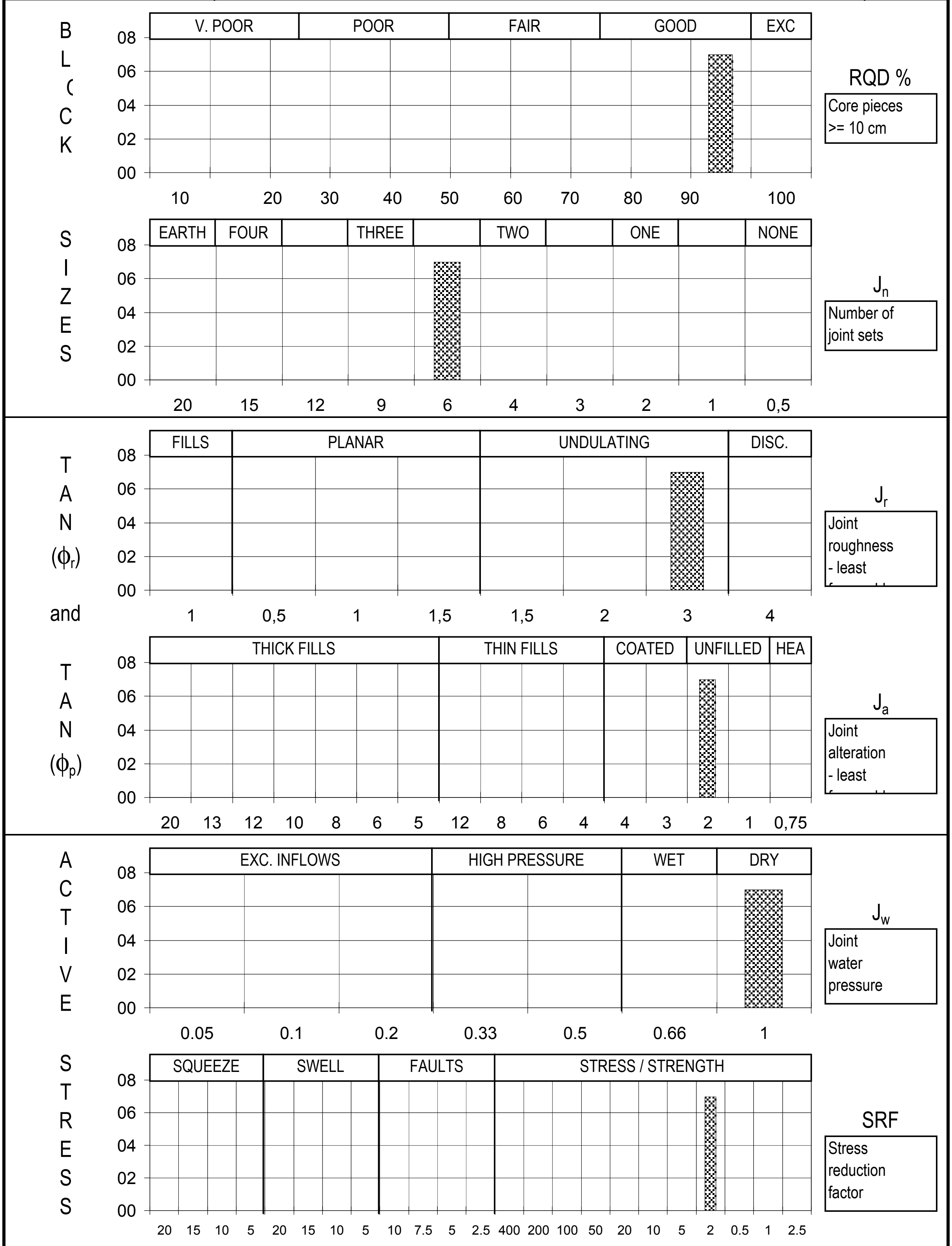
Rev.	Report No.	Figure No.
	0	A13
Block No. : 75	Drawn by FL	Date 2001-06-12
Depth zone (m) 0	Checked	NGI
Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**5.938**
Q (typical max)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.8**
Q (mean value)=	95	/	4.9	*	2.4	/	2.0	*	1.00	/	2.0	=	**11.92**
Q (block)=	95	/	6.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**6.00**



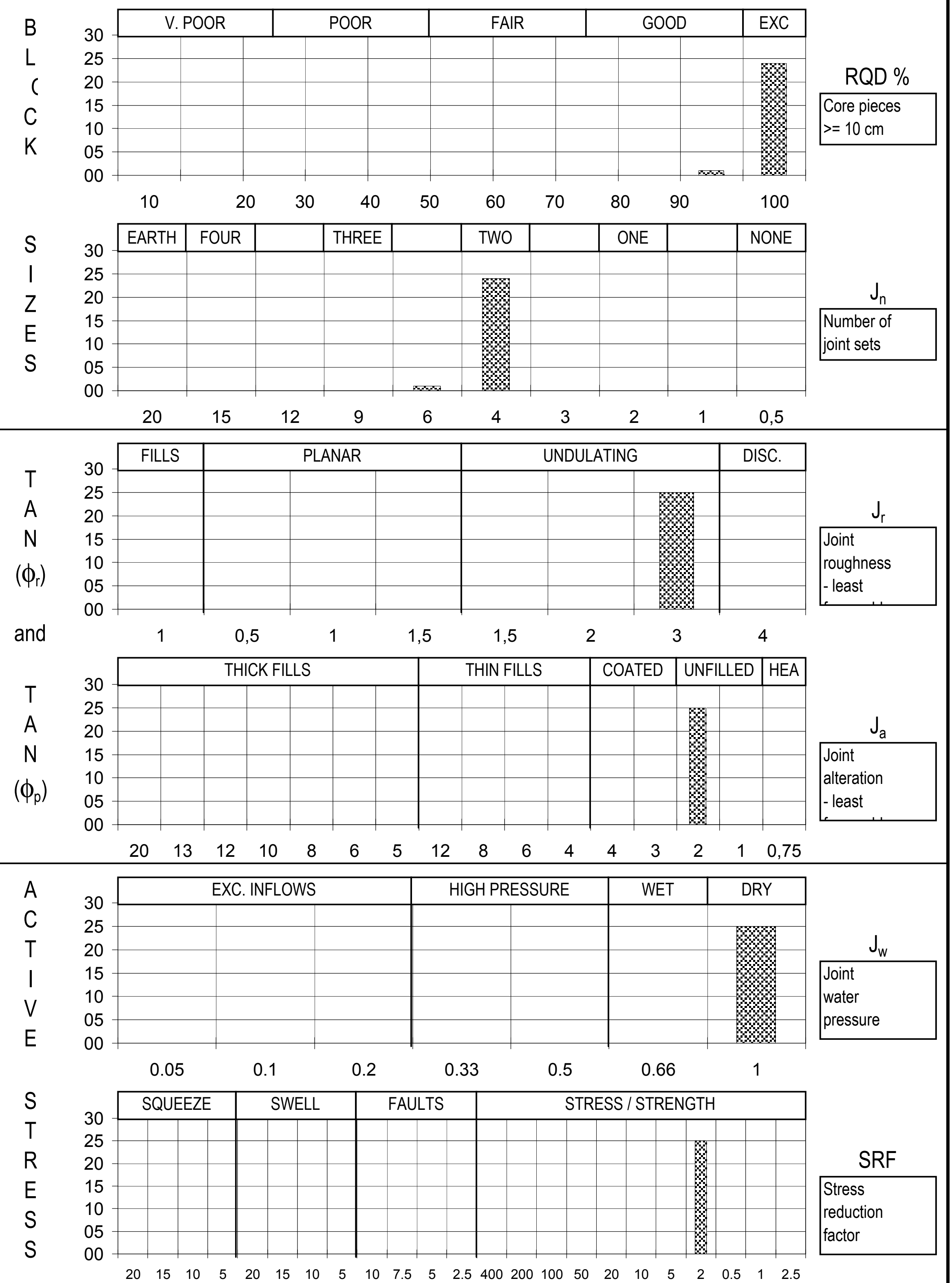
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A14
Q - REGISTRATIONS CHART	Block No. : 105	Drawn by AWH	Date 12.06.01
KA2511A 81-89m Logged by NGI 2001	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q105_NGI.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.9**
Q (mean value)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.88**
Q (block)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



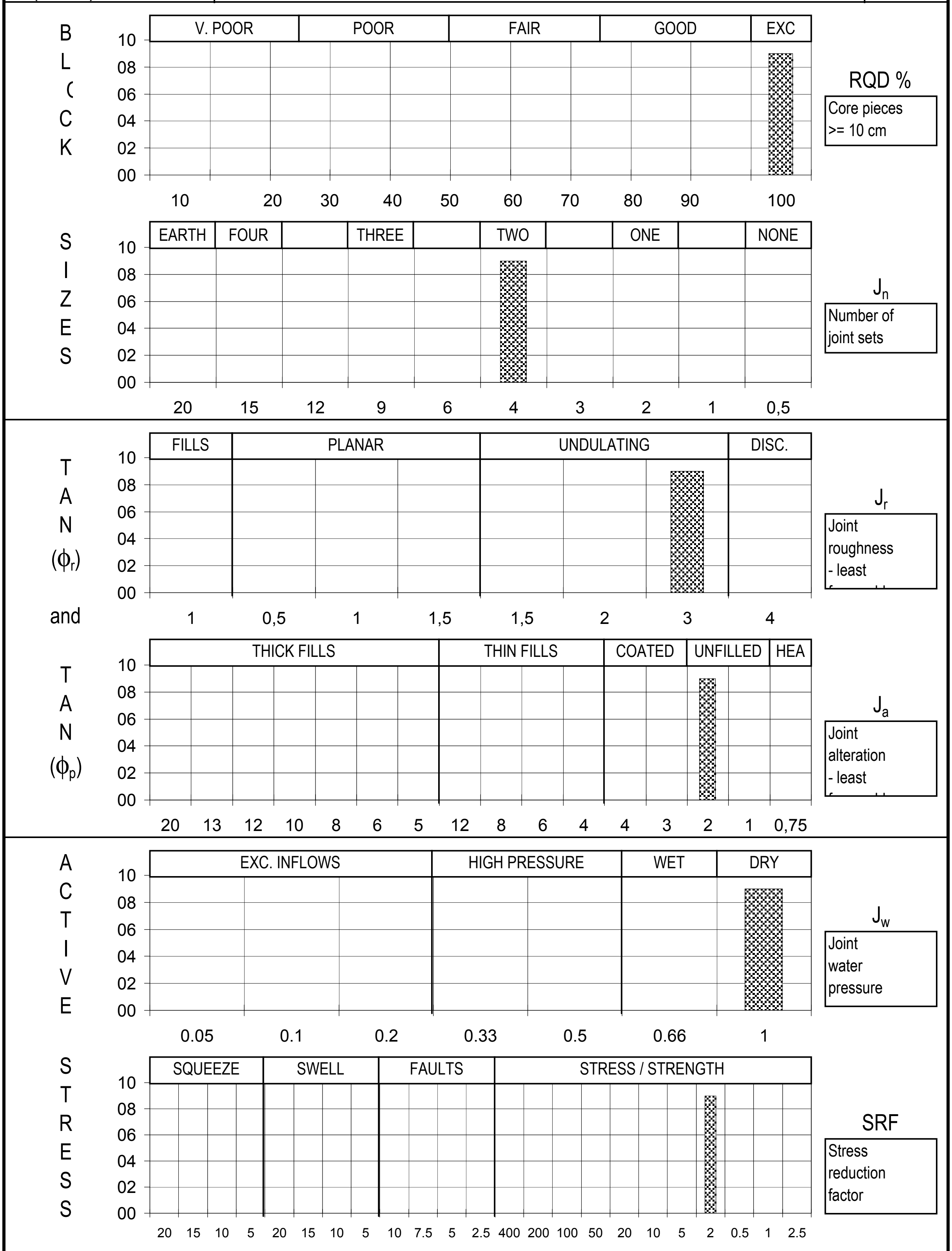
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A15
Q - REGISTRATIONS CHART	Block No. : 124	Drawn by AWH	Date 12.06.01
KA2598A 128-135m Logged by NGI 2001	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q124_NGI.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	100	/	4.1	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.35**
Q (block)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**19.00**



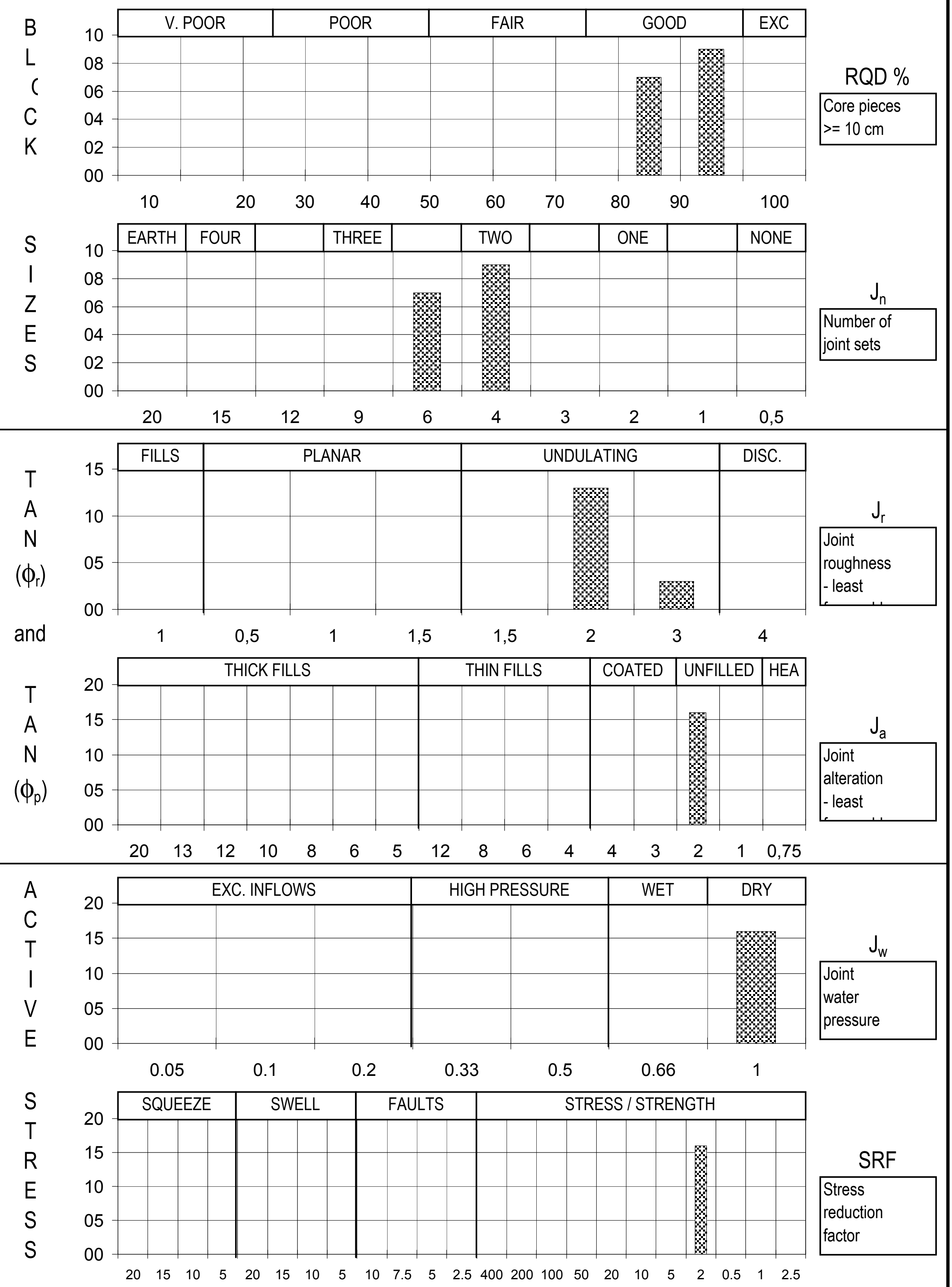
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A16
Q - REGISTRATIONS CHART	Block No. : 140	Drawn by FL	Date 1900-01-00
KA3065A02 21-45m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q140.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.750**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.75**
Q (block)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**19.00**



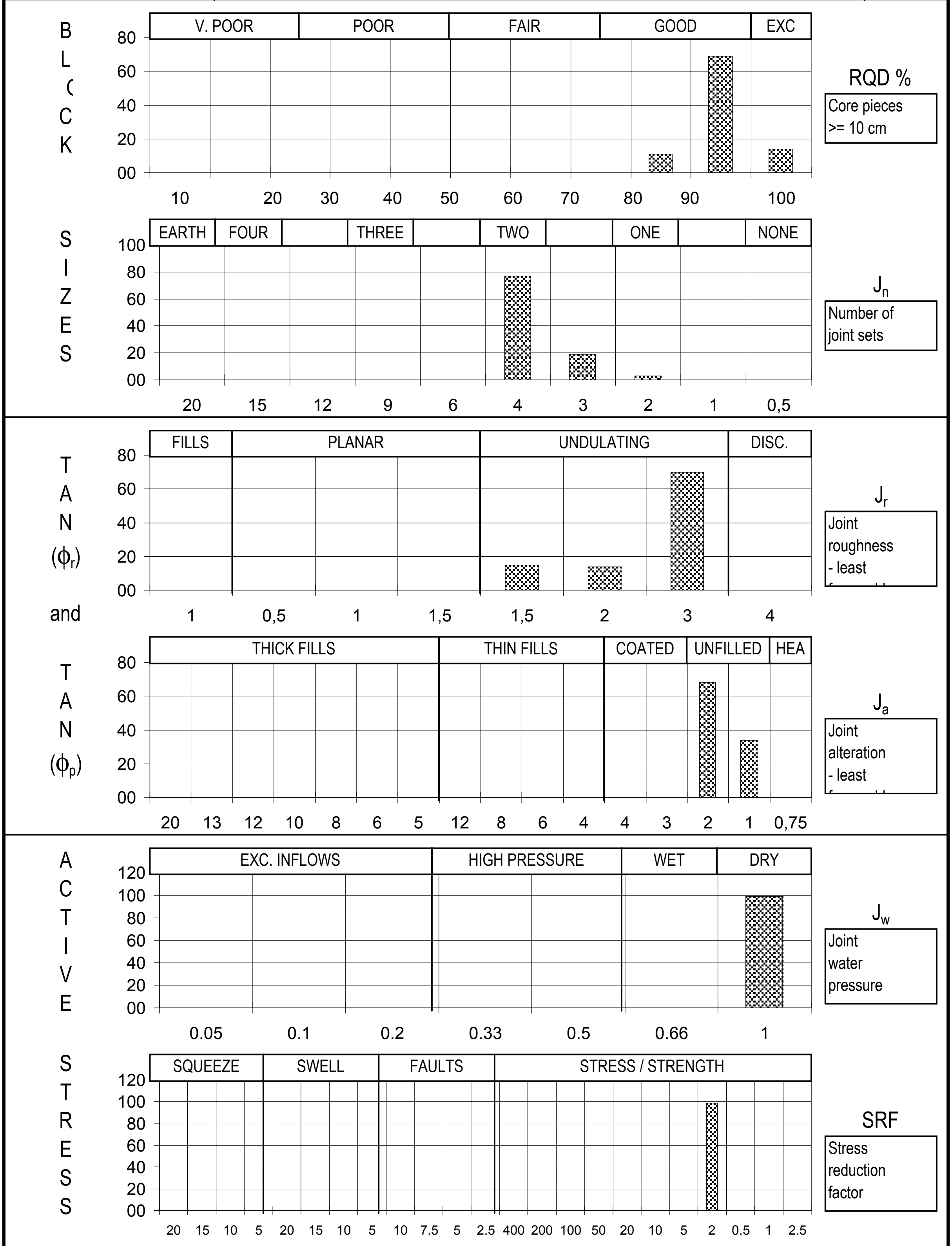
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A17
Q - REGISTRATIONS CHART	Block No. : 143	Drawn by FL	Date 2001-05-18
KG0048A01 19-28m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q143.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**7.083**
Q (typical max)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.8**
Q (mean value)=	91	/	4.9	*	2.2	/	2.0	*	1.00	/	2.0	=	**10.17**
Q (block)=	91	/	6.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**8.00**



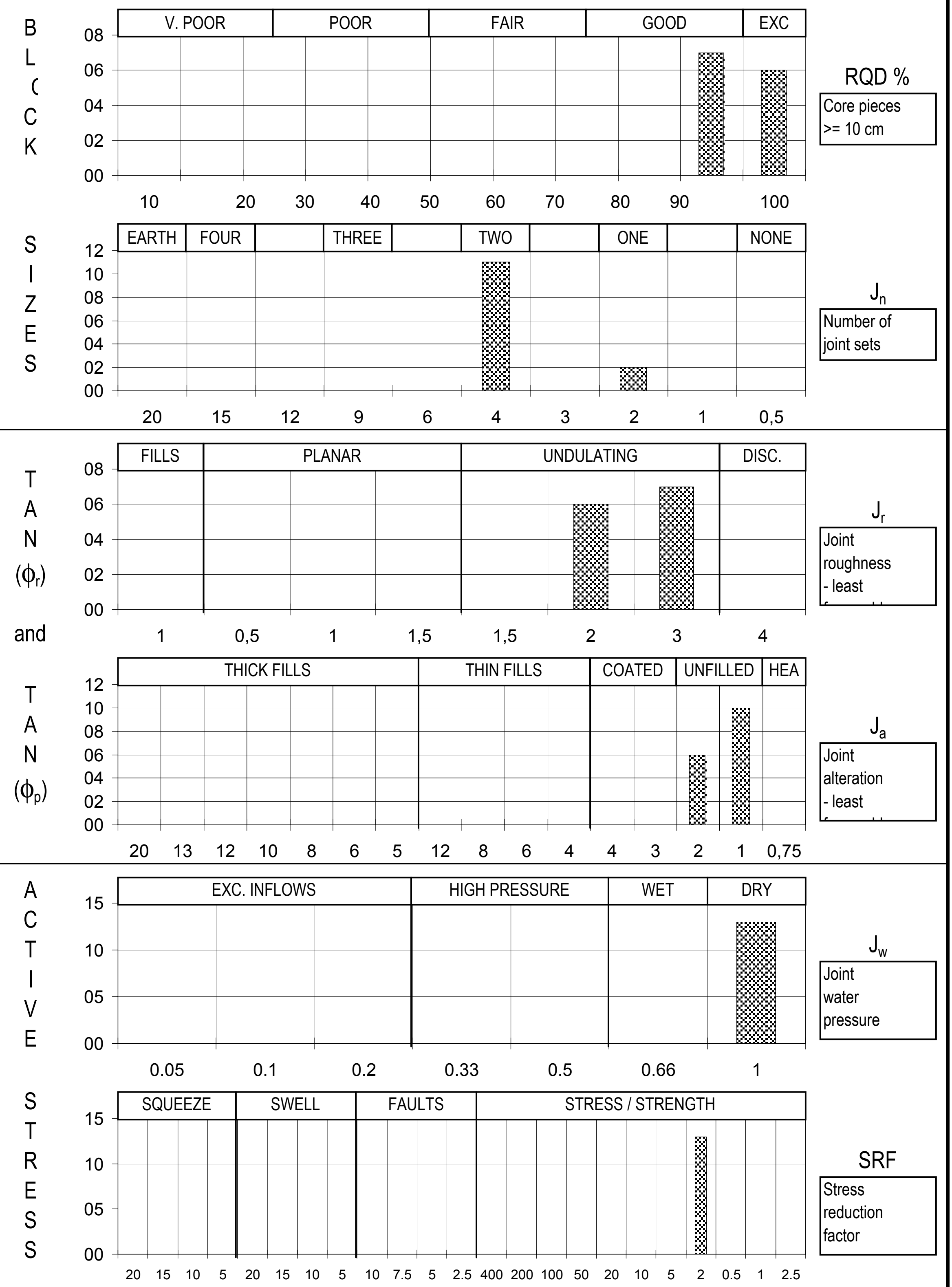
SKB/Rock mechanical model Äspö	Rev.	Report No. 0	Figure No. A18
Q - REGISTRATIONS CHART	Block No. : 154	Drawn by FL	Date 2001-06-12
KXZC2 37-50m, KXZRT2H 0-3m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q154.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	4.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**7.969**
Q (typical max)=	100	/	2.0	*	3.0	/	1.0	*	1.00	/	2.0	=	**75.0**
Q (mean value)=	95	/	3.7	*	2.6	/	1.7	*	1.00	/	2.0	=	**19.92**
Q (block)=	95	/	4.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**9.00**



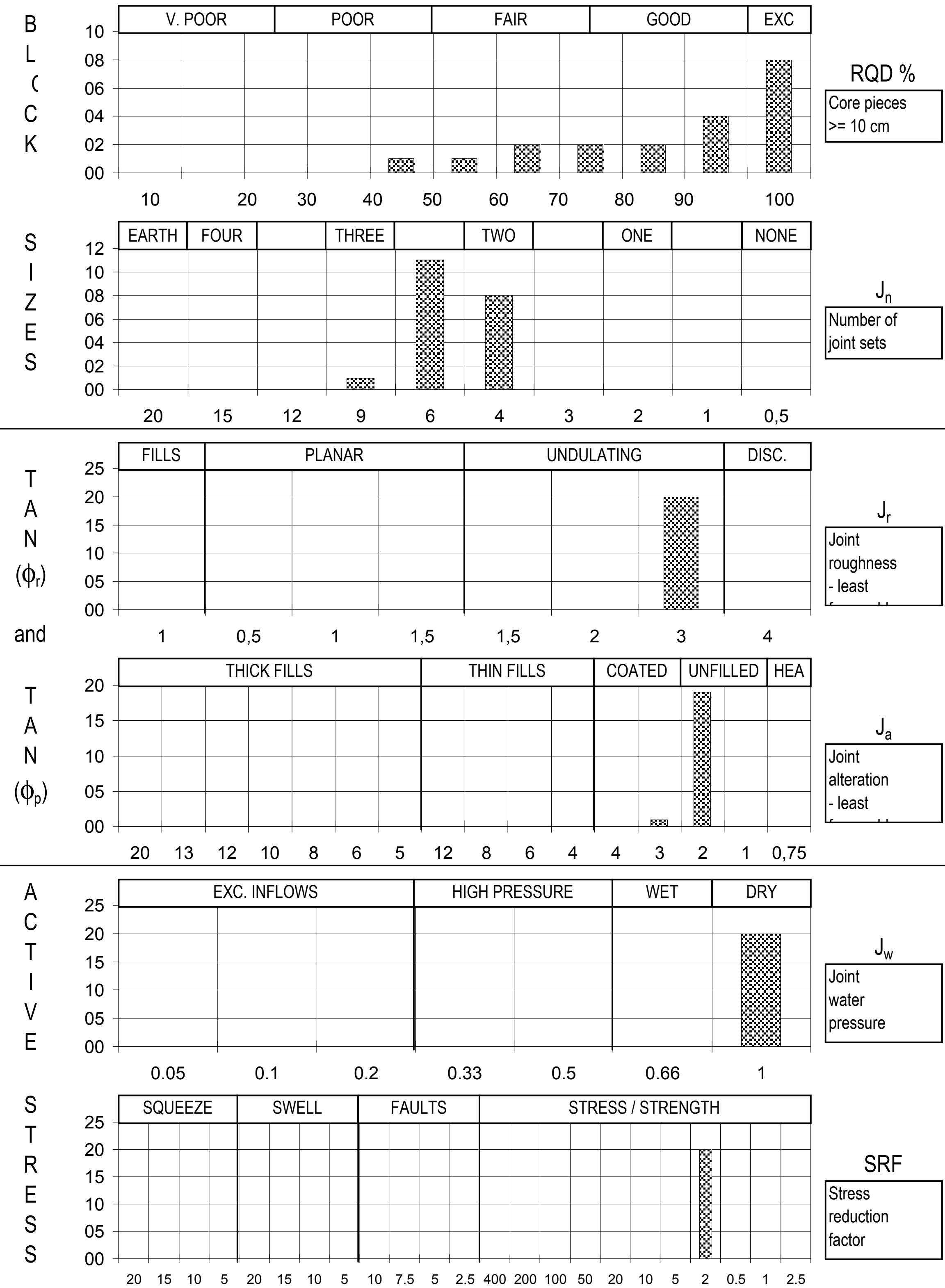
SKB/Rock mechanical model Äspö	Rev.	Report No. 0	Figure No. A19
KXZRT1H 0-3m, KXZRT1I 0-3m	Block No. : 155	Drawn by FL	Date 2001-06-12
KXZC1 7-38m, KXZC2 6-37m, KXZA5 30-41m	Depth zone (m) 0	Checked	NGI
KXZC3 0-20m F:\P\2001\11\20011173\excel\Q-blokker\[Q155.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	4.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	2.0	*	3.0	/	1.0	*	1.00	/	2.0	=	**75.0**
Q (mean value)=	97	/	3.7	*	2.5	/	1.4	*	1.00	/	2.0	=	**24.33**
Q (block)=	97	/	4.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**12.00**



SKB/Rock mechanical model Äspö	Rev.	Report No. 0	Figure No. A20
Q - REGISTRATIONS CHART	Block No. : 156	Drawn by FL	Date 2001-06-12
KXZC1 0-7m, KXZC2 0-6m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q156.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	45	/	9.0	*	3.0	/	3.0	*	1.00	/	2.0	=	**2.500**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	87	/	5.4	*	3.0	/	2.1	*	1.00	/	2.0	=	**11.83**
Q (block)=	87	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.00**



SKB/Rock mechanical model Äspö

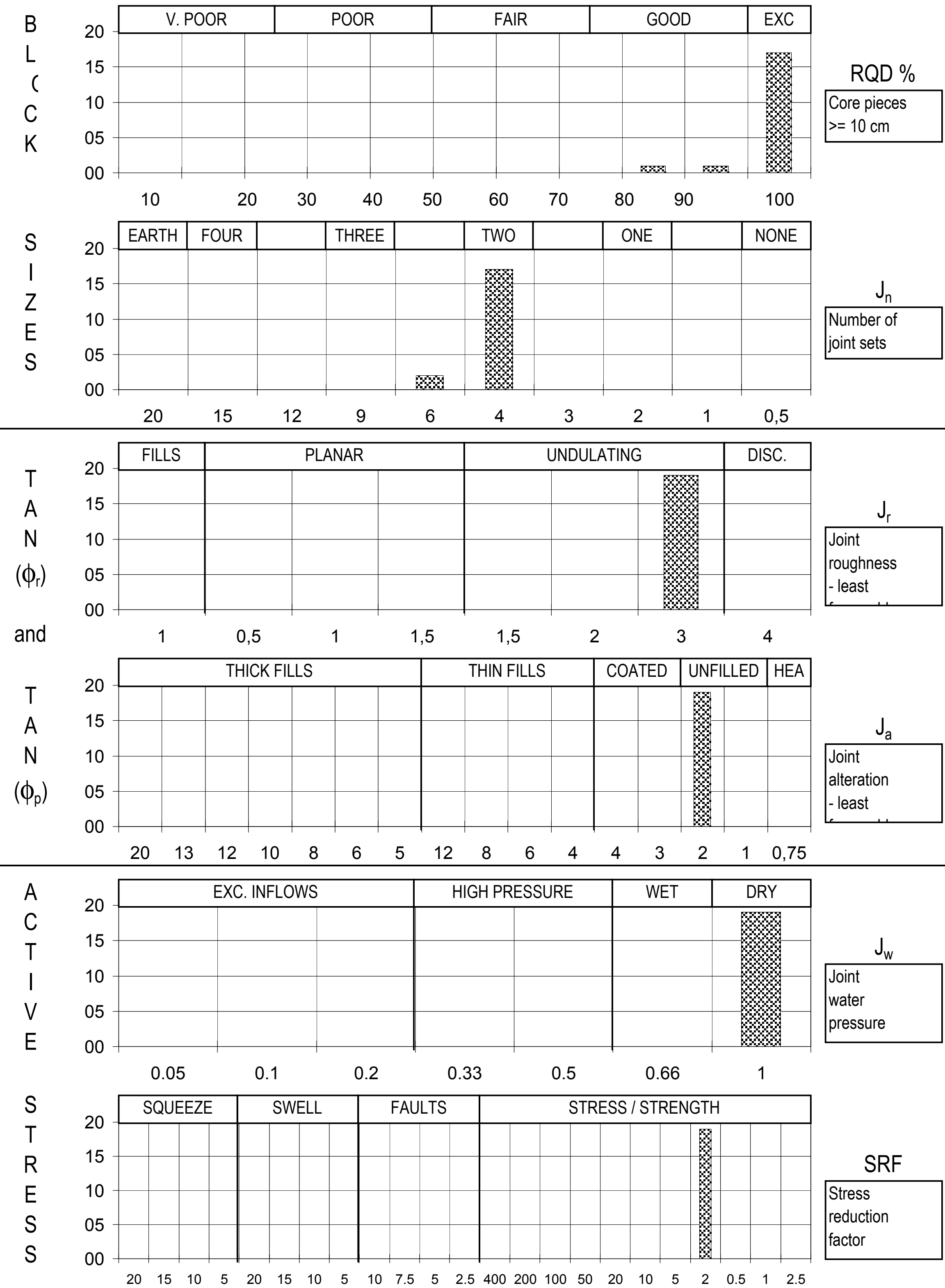
Q - REGISTRATIONS CHART

KA3067A 17-37

Rev.	Report No.	Figure No.
	20011173-1	A21
Block No. : 160	Drawn by FL	Date 2001-05-18
Depth zone (m) 0	Checked	NGI
Logg 1.0 1997-07-30	Approved	

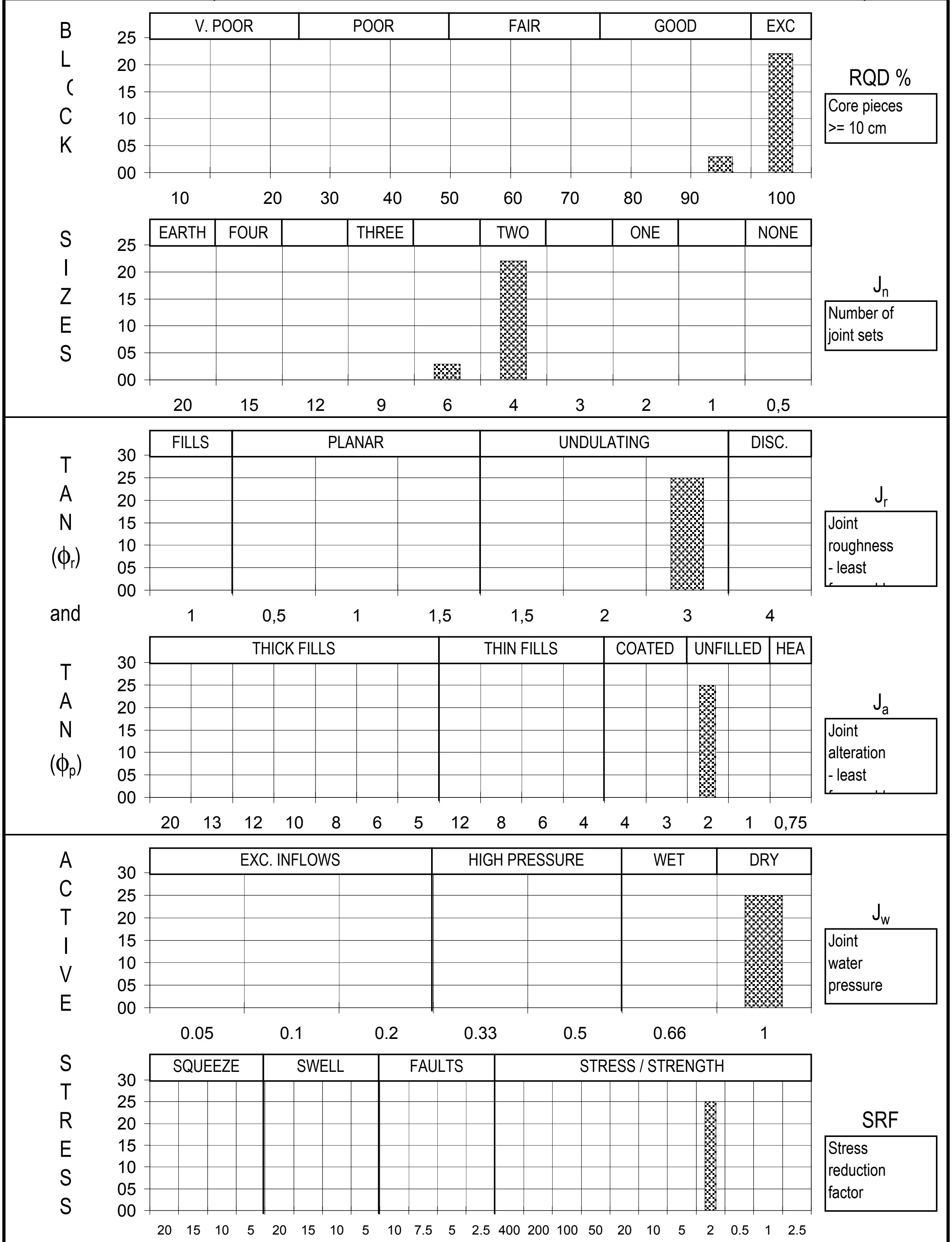
F:\P\2001\11\20011173\excel\Q-blokker\[Q160.xls]Q-chart

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.2	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.63**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



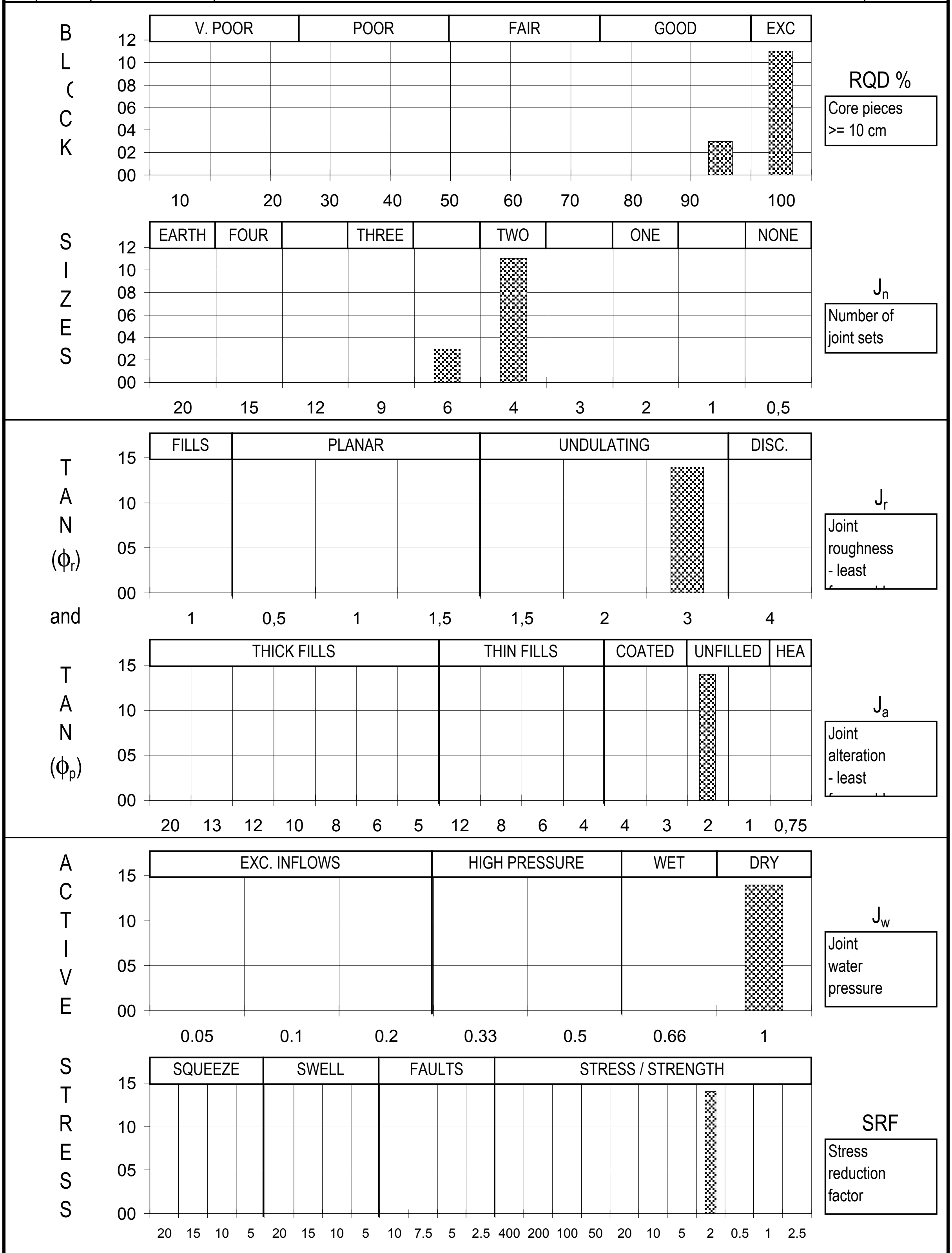
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A22
Q - REGISTRATIONS CHART	Block No. : 162	Drawn by FL	Date 2001-05-18
KG0048A01 35-54m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q162.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.2	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.58**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



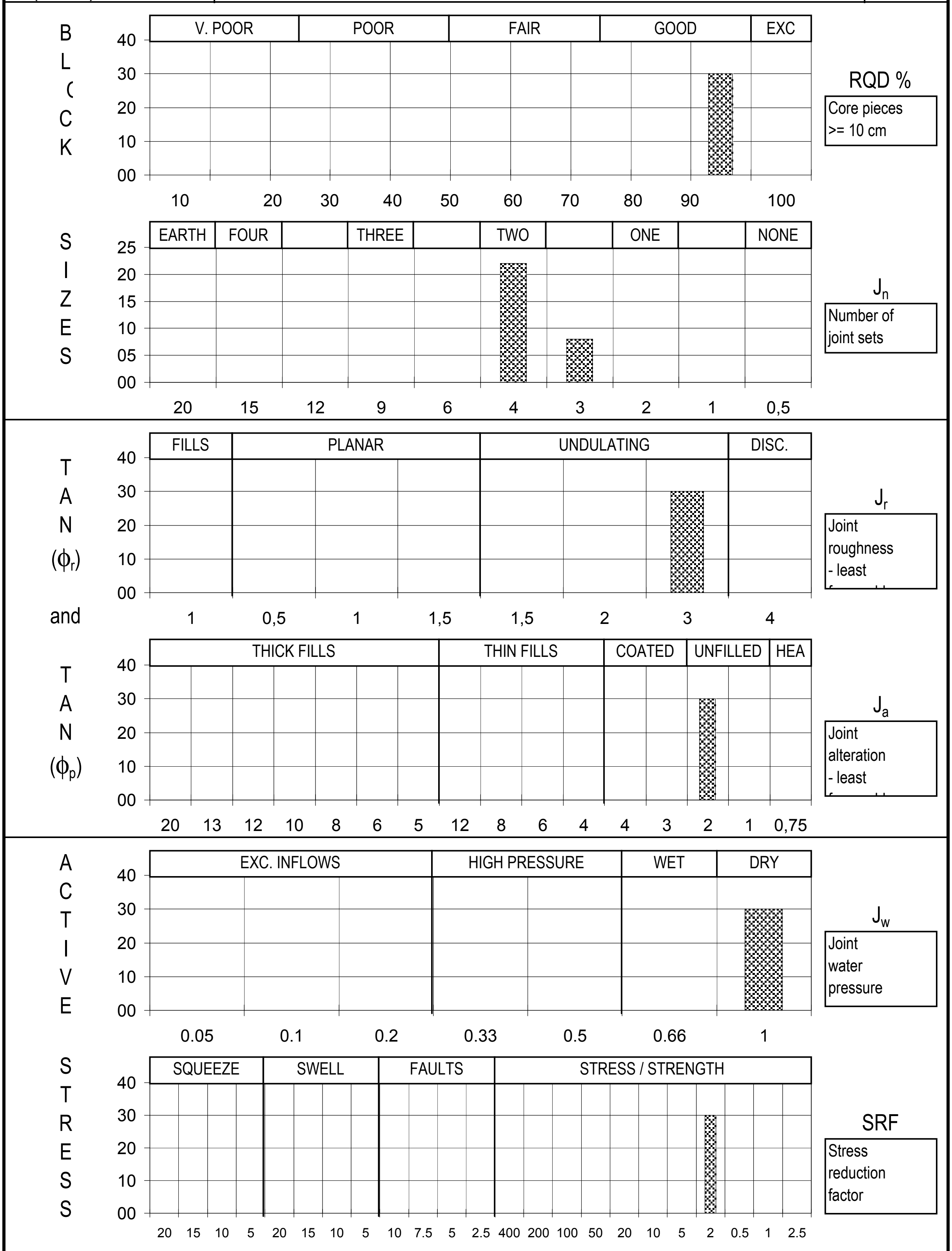
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A23
Q - REGISTRATIONS CHART	Block No. : 163	Drawn by FL	Date 2001-05-18
KG0048A01 28-35m, KG0021A0 31-48m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q163.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.4	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.75**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



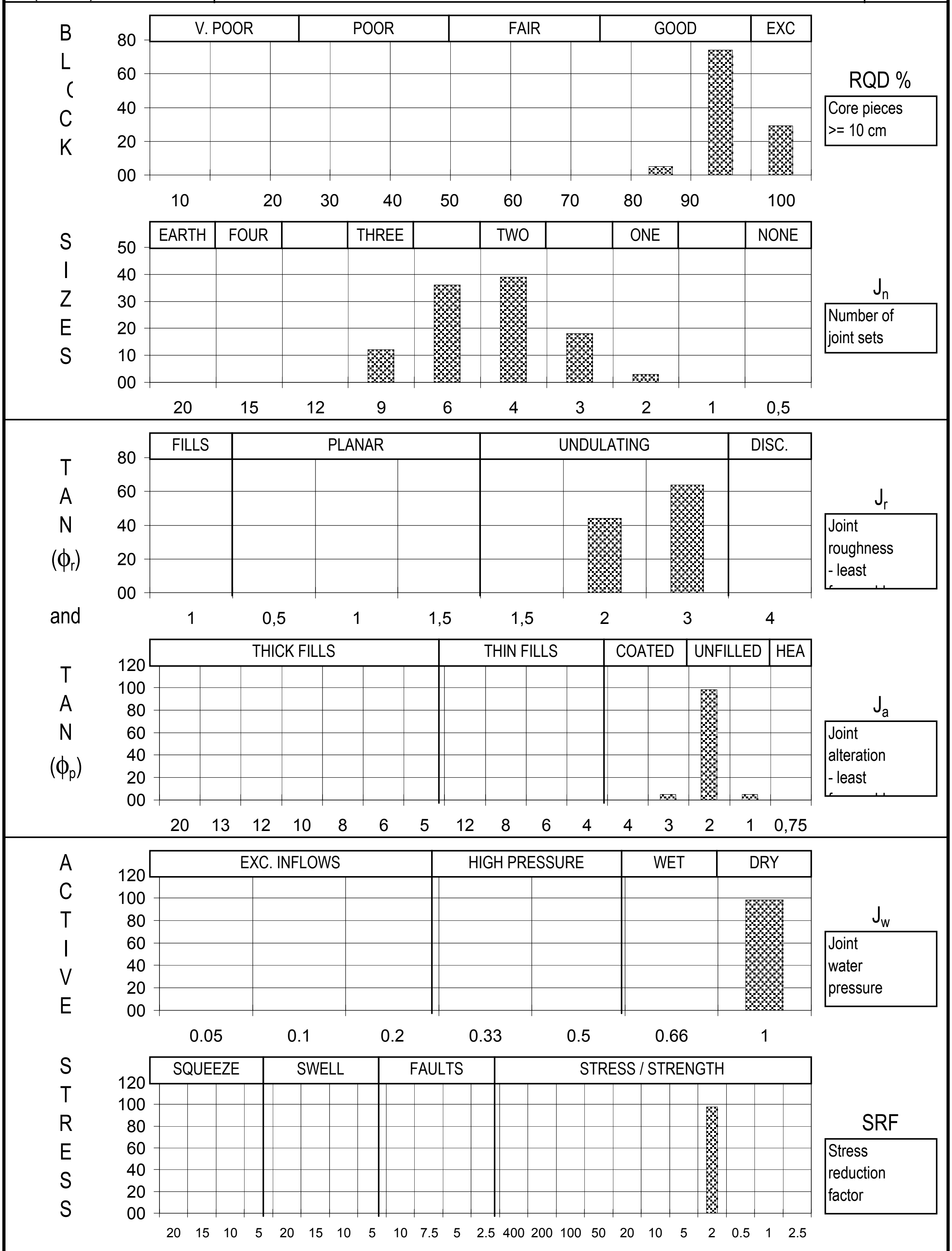
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A24
Q - REGISTRATIONS CHART	Block No. : 164	Drawn by FL	Date 2001-05-18
KG0021A01 17-31m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q164.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.813**
Q (typical max)=	95	/	3.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**23.8**
Q (mean value)=	95	/	3.7	*	3.0	/	2.0	*	1.00	/	2.0	=	**19.08**
Q (block)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.00**



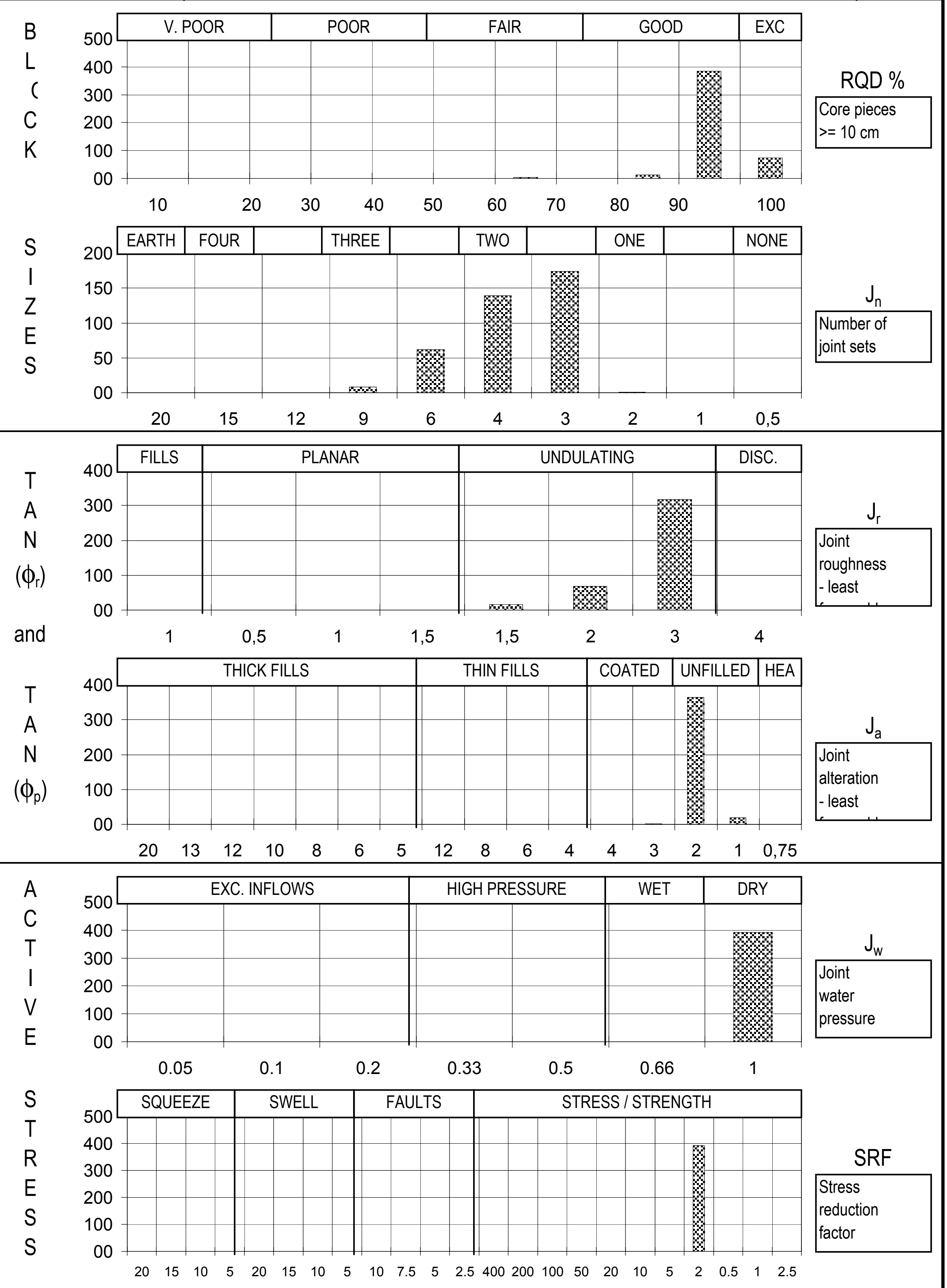
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A25
Q - REGISTRATIONS CHART	Block No. : 170	Drawn by AWH	Date 12.06.01
KAS02 420-450m Logged by NGI 2001	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q170_NGI.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	9.0	*	2.0	/	3.0	*	1.00	/	2.0	=	**3.148**
Q (typical max)=	100	/	2.0	*	3.0	/	1.0	*	1.00	/	2.0	=	**75.0**
Q (mean value)=	96	/	5.0	*	2.6	/	2.0	*	1.00	/	2.0	=	**12.43**
Q (block)=	96	/	4.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**12.00**



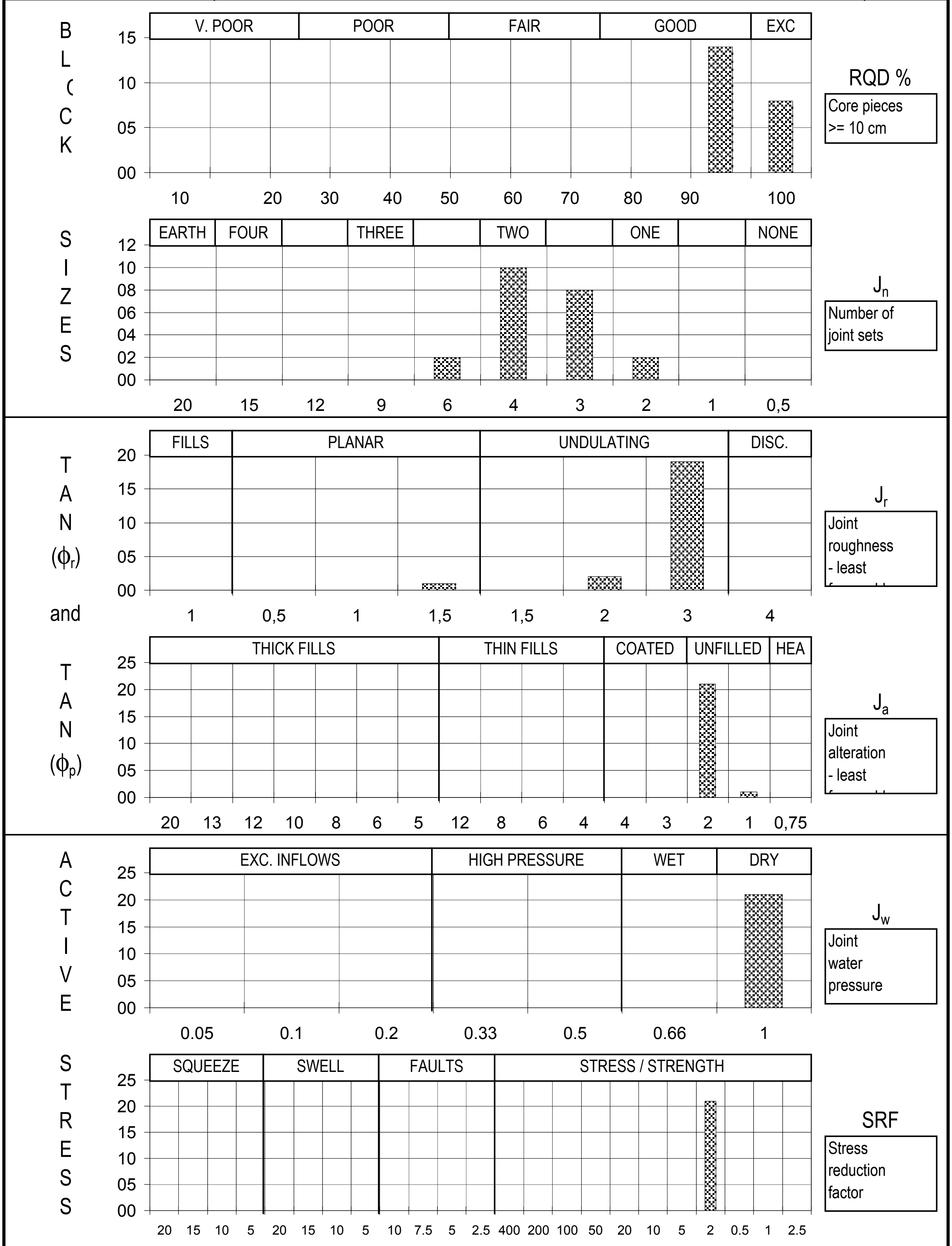
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A26
KXZC4 30-50m,KXZC7 30-55m	Block No. : 174	Drawn by FL	Date 2001-05-14
TBM-tunnel 20-50, KXZA4 337-40m,KXZC5 39-40m	Depth zone (m) 0	Checked	NGI
KXZC6 37-55m, KXZRT2V 0-3m	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	65	/	9.0	*	1.5	/	3.0	*	1.00	/	2.0	=	**1.806**
Q (typical max)=	100	/	2.0	*	3.0	/	1.0	*	1.00	/	2.0	=	**75.0**
Q (mean value)=	95	/	4.0	*	2.8	/	2.0	*	1.00	/	2.0	=	**17.02**
Q (block)=	95	/	6.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**8.00**



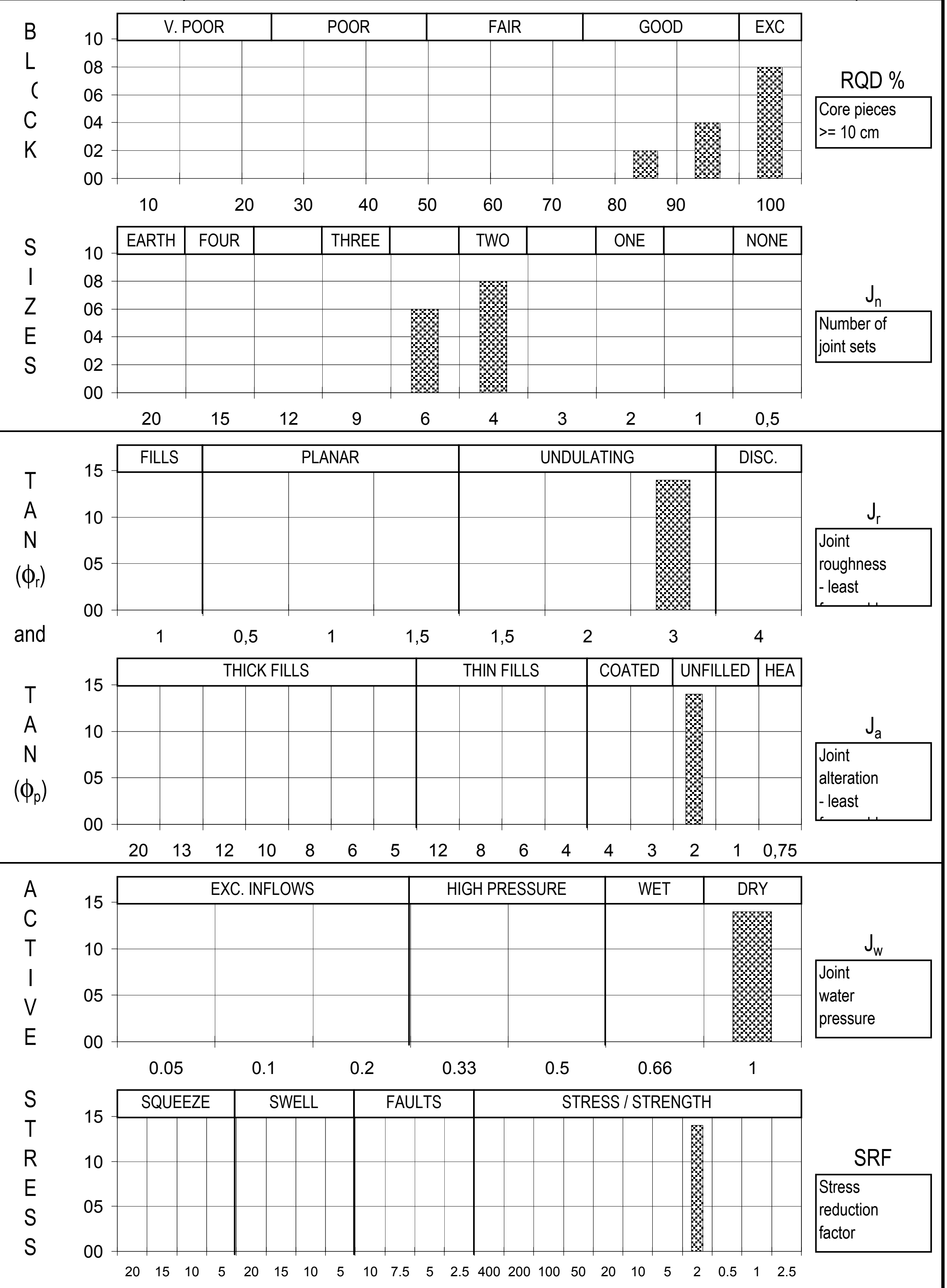
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A27
KXZC6 5-37m, KXZA3 27-36m,KXZB7 0-17m KXZRD1H/2I/2V/3V/6V 0-3m, KXZRT1V/2I 0-3m Zedex tunnel 30-45m, TBM 0-20m, KXZA4 7-37m	Block No. : 175	Drawn by FL	Date 14.05.01
	Depth zone (m) 0	Checked	NGI
KXZC5/C4/C7 KXZA5 0-30m, KXZB1/B2/B3/B4/B6/B8	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**5.938**
Q (typical max)=	100	/	2.0	*	3.0	/	1.0	*	1.00	/	2.0	=	**75.0**
Q (mean value)=	97	/	3.6	*	2.8	/	2.0	*	1.00	/	2.0	=	**19.35**
Q (block)=	97	/	4.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**12.00**



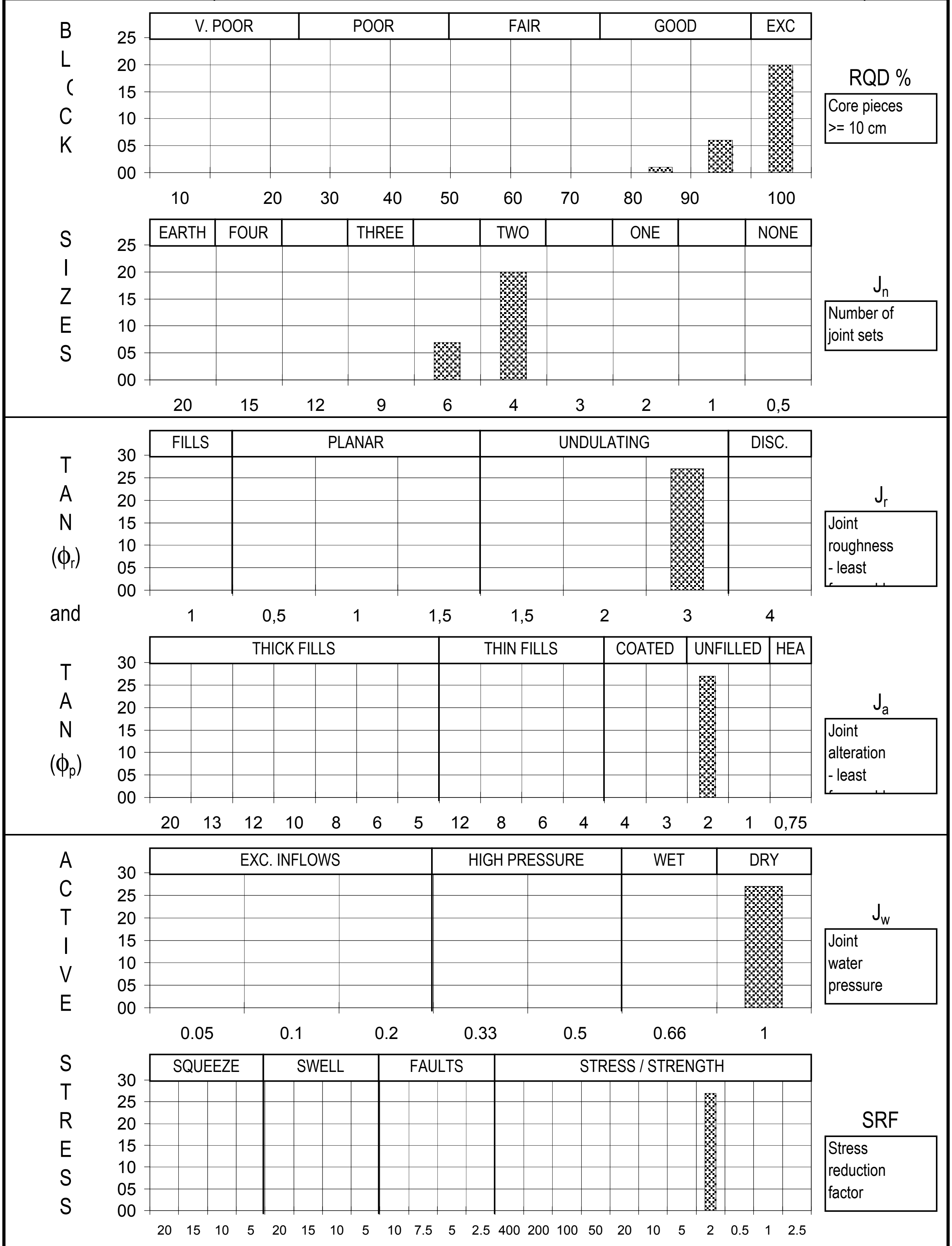
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A28
Q - REGISTRATIONS CHART	Block No. : 176	Drawn by FL	Date 2001-05-14
Zedex tunnel 26-30, KXZA4 0-7m, KXZC5 0-5m	Depth zone (m) 0	Checked	NGI
KXZC6 0-5m F:\P\2001\11\20011173\excel\Q-blokker\[Q176.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	96	/	4.9	*	3.0	/	2.0	*	1.00	/	2.0	=	**14.89**
Q (block)=	96	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



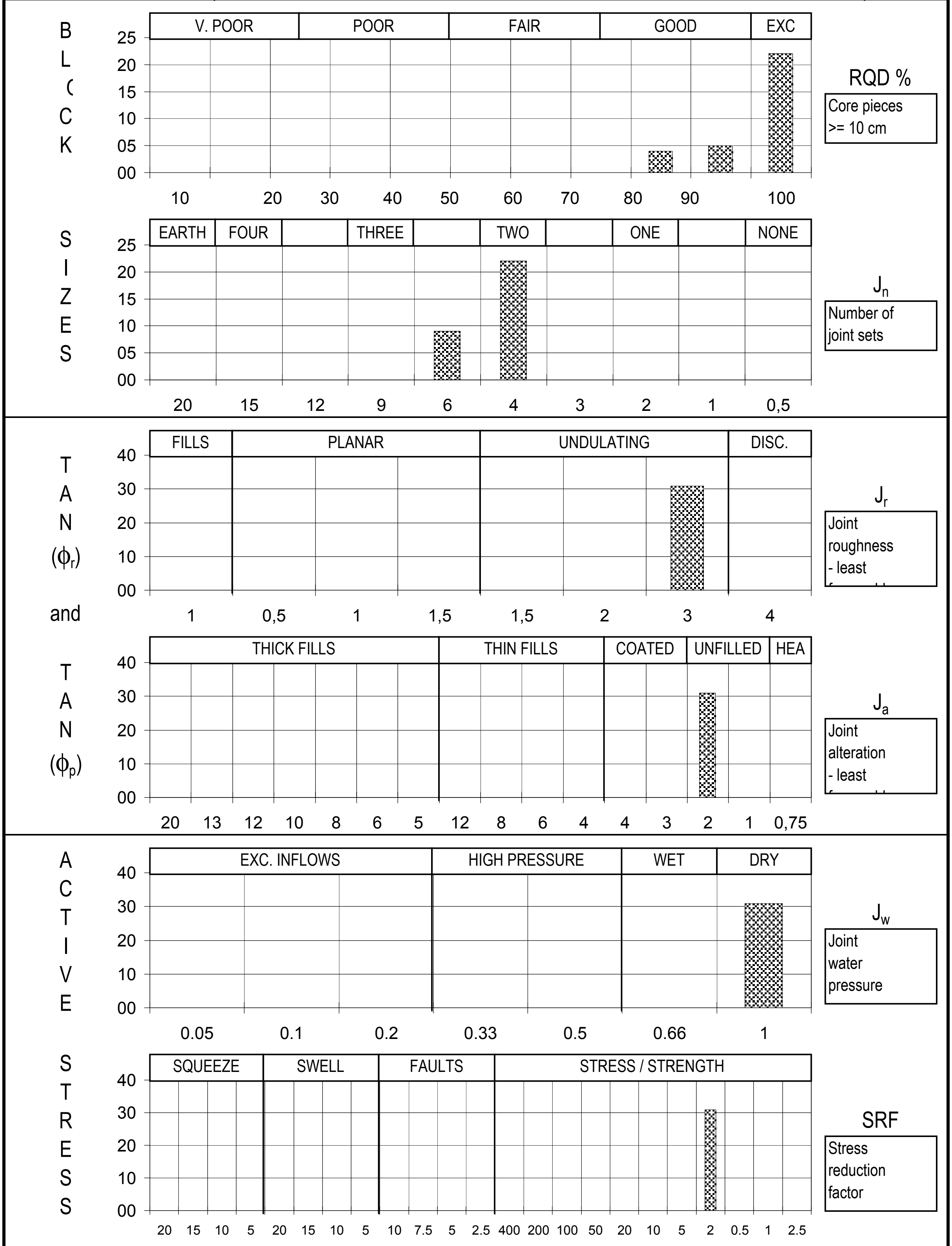
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A29
Q - REGISTRATIONS CHART	Block No. : 177	Drawn by FL	Date 2001-05-18
KA3110A 13-26m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q177.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.5	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.32**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



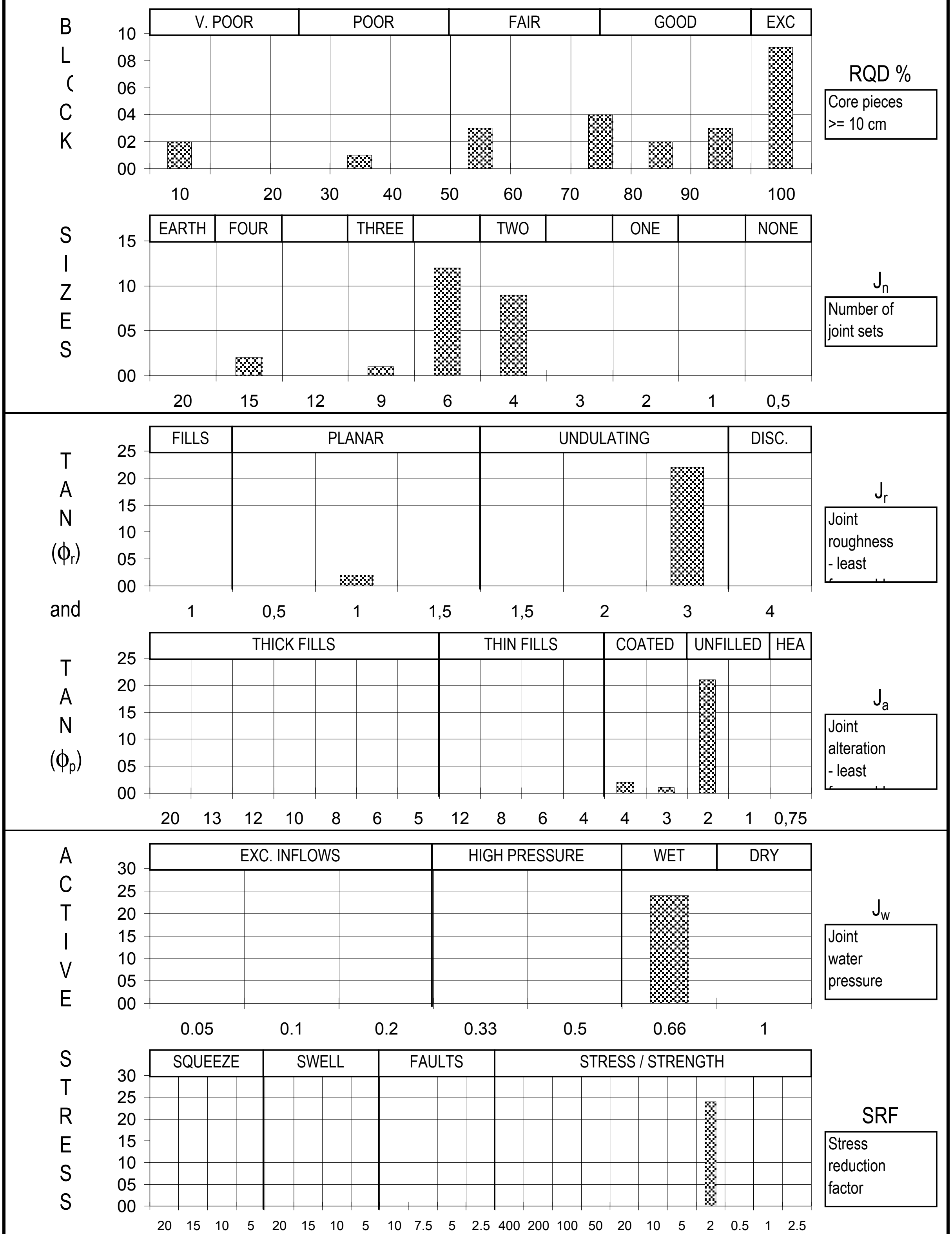
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A30
Q - REGISTRATIONS CHART	Block No. : 178	Drawn by FL	Date 2001-05-18
KA3110A 0-13m, KA3105A 0-14m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q178.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	97	/	4.6	*	3.0	/	2.0	*	1.00	/	2.0	=	**15.92**
Q (block)=	97	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



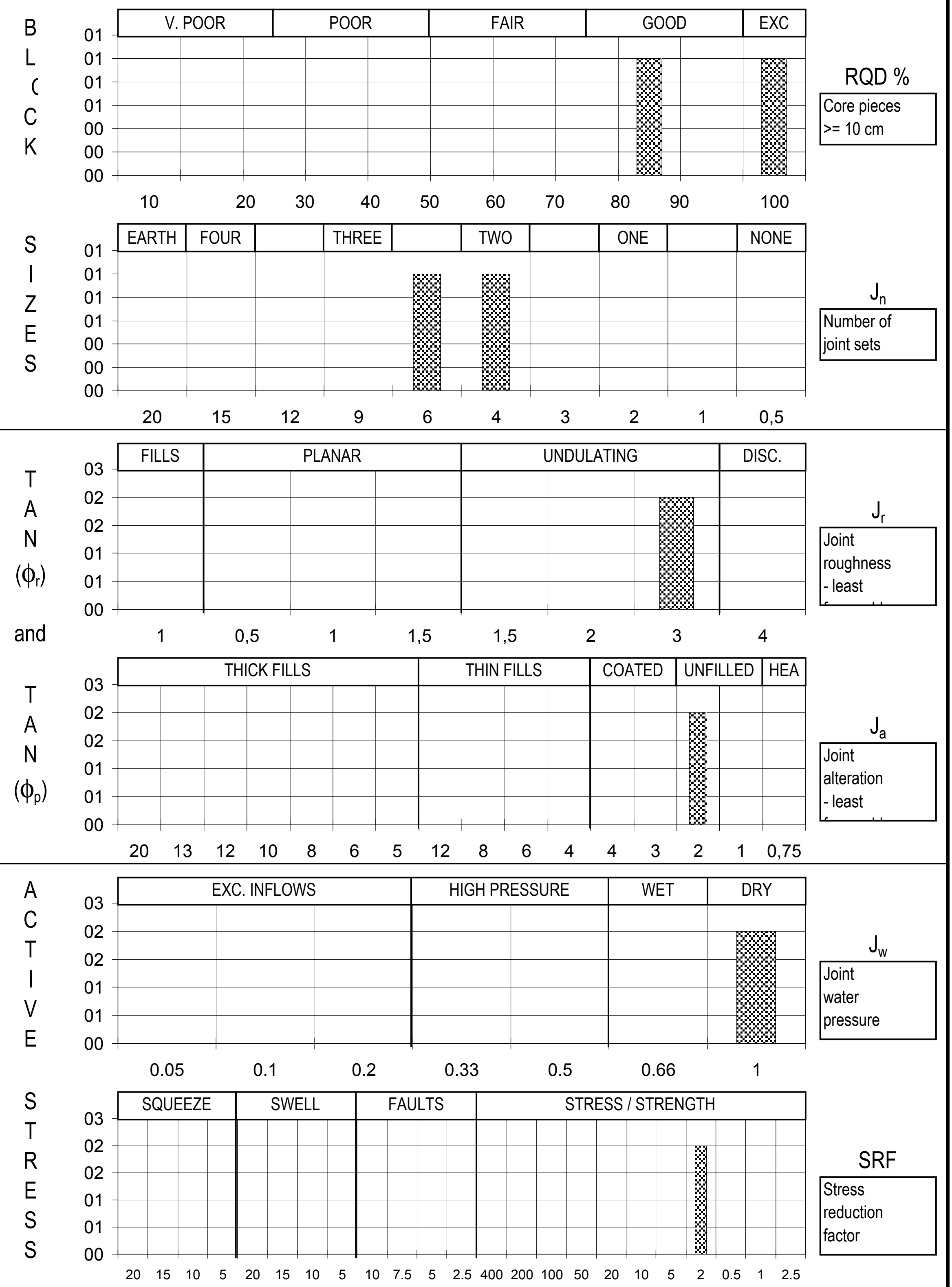
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A31
Q - REGISTRATIONS CHART	Block No. : 179	Drawn by FL	Date 2001-05-18
KA3105A 14-45m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q179.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	10	/	15.0	*	1.0	/	4.0	*	0.66	/	2.0	=	**0.055**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	0.66	/	2.0	=	**12.4**
Q (mean value)=	78	/	6.1	*	2.8	/	2.2	*	0.66	/	2.0	=	**5.40**
Q (block)=	78	/	9.0	*	1.0	/	4.0	*	0.66	/	2.0	=	**0.70**



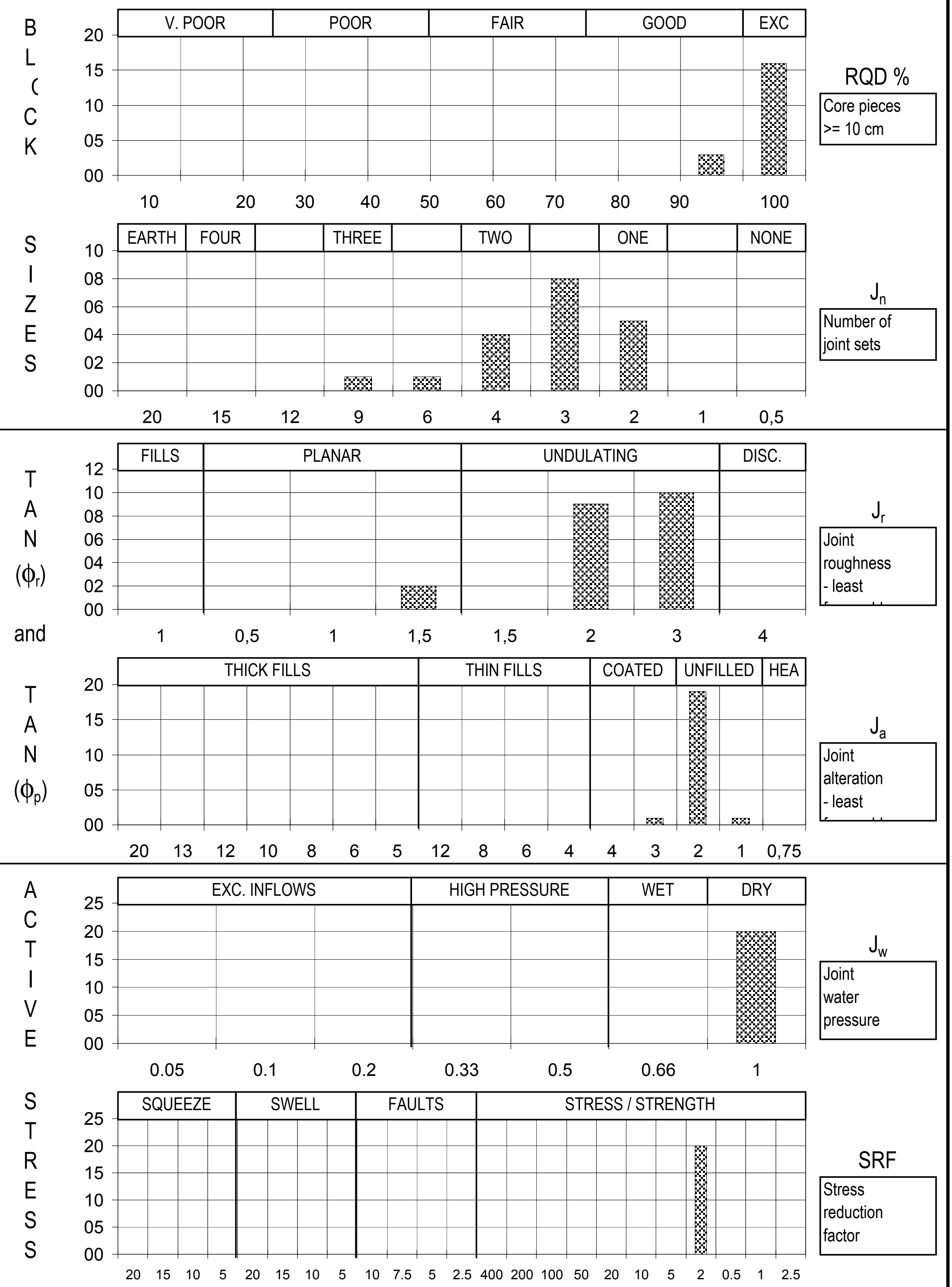
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A32
Q - REGISTRATIONS CHART	Block No. : 180	Drawn by FL	Date 2001-05-18
KA3105A 45- 69m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q180.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	93	/	5.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**13.88**
Q (block)=	93	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



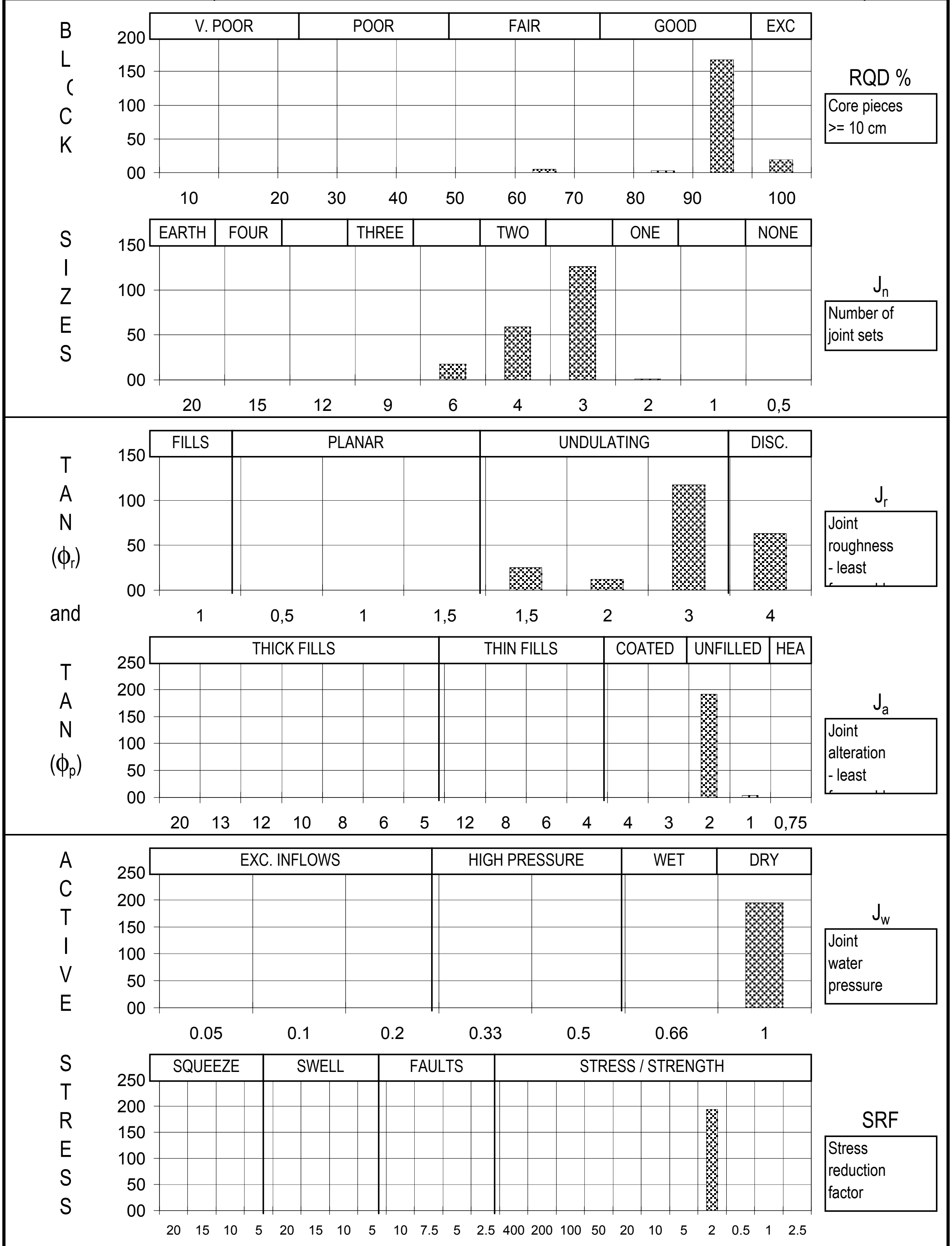
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A33
Q - REGISTRATIONS CHART	Block No. : 185	Drawn by AWH	Date 23.05.01
KA2563A 103-105m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q185.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	9.0	*	1.5	/	3.0	*	1.00	/	2.0	=	**2.639**
Q (typical max)=	100	/	2.0	*	3.0	/	1.0	*	1.00	/	2.0	=	**75.0**
Q (mean value)=	99	/	3.4	*	2.4	/	2.0	*	1.00	/	2.0	=	**17.61**
Q (block)=	99	/	4.0	*	2.0	/	2.0	*	1.00	/	2.0	=	**12.38**



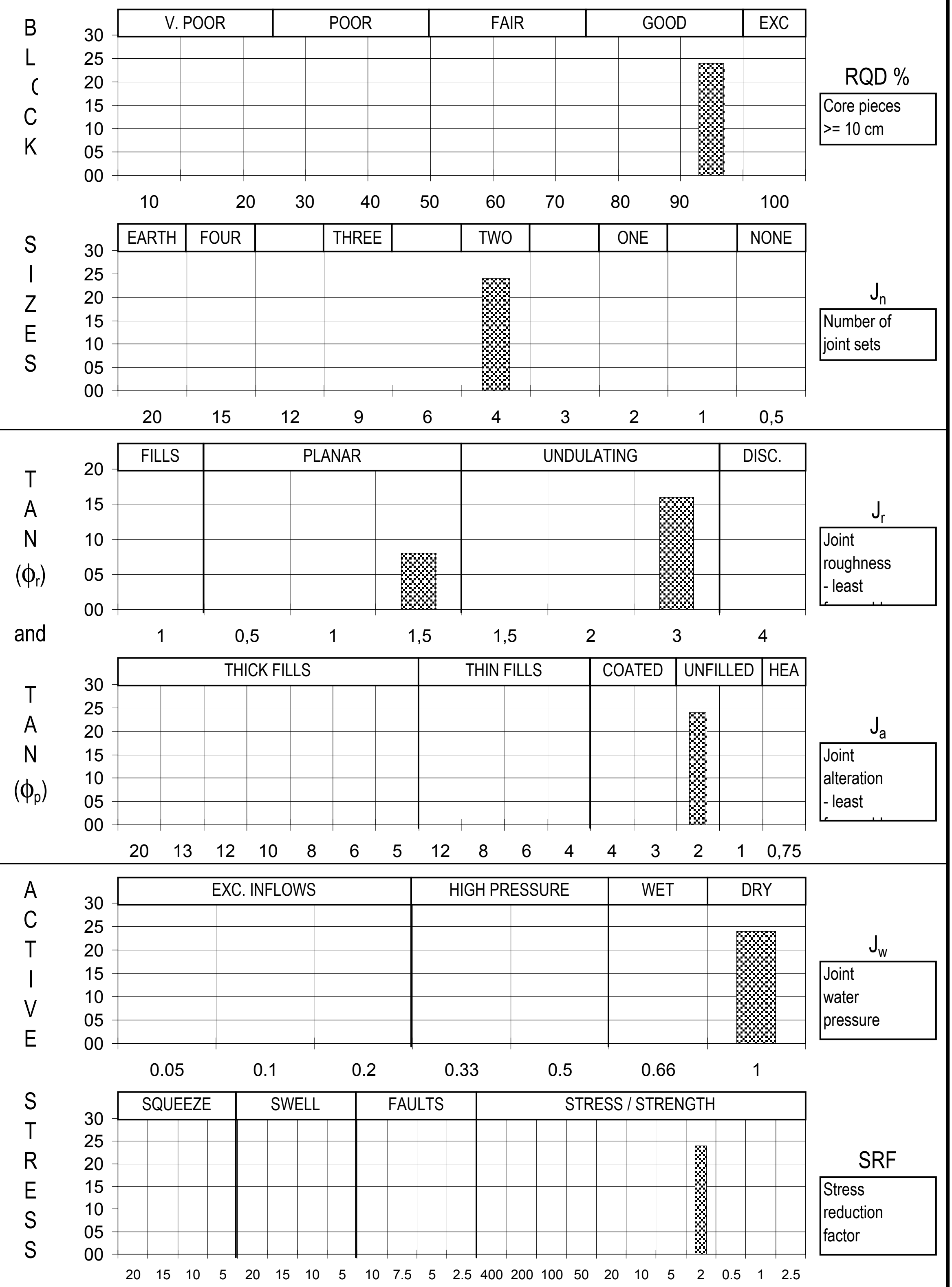
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A34
Q - REGISTRATIONS CHART	Block No. : 194	Drawn by FL	Date 2001-05-14
Zedex tunnel 45-64m	Depth zone (m) 0	Checked	
F:\P\2001\11\20011173\excel\Q-blokker\[Q194.xls]Q-chart	Logg 1.0 1997-07-30	Approved	NGI

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	65	/	6.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**4.063**
Q (typical max)=	100	/	2.0	*	4.0	/	1.0	*	1.00	/	2.0	=	**100.0**
Q (mean value)=	95	/	3.5	*	3.1	/	2.0	*	1.00	/	2.0	=	**20.61**
Q (block)=	95	/	4.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**9.00**



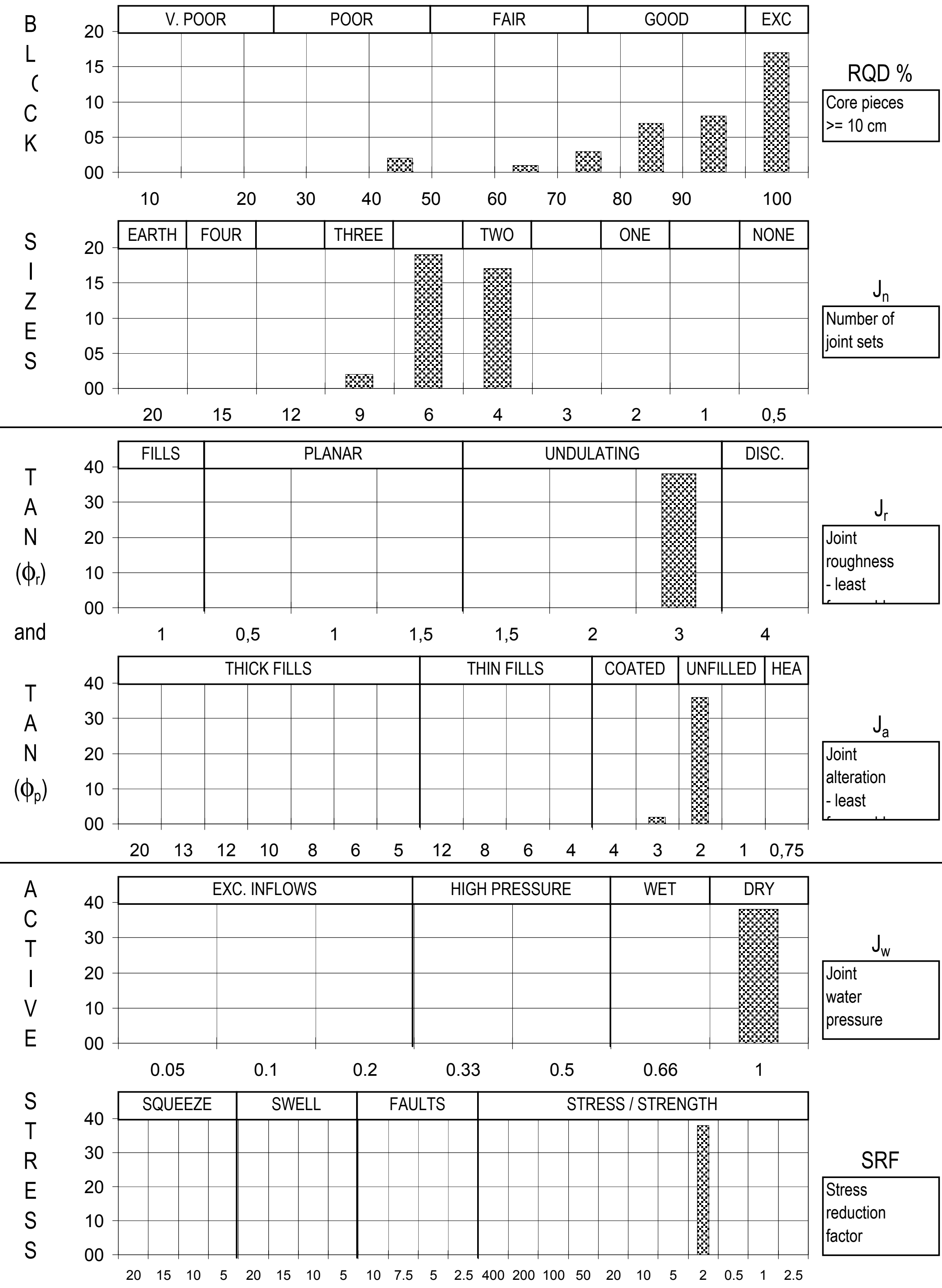
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A35
KXZB5 0-4m, KXZA6 0-40m, KXZA7 0-30m, KXZRD3I 0-3m KXZRD4H 0-3m, KXZRD5H 0-3m, KXZRD6H 0-3m, KXZRD6I 0-3m Zedex tunnel 30-45m, KXZA1 8-30m, KXZA2 8-35m KXZRD7I 0-3m, KXZRD7V 0-3m, KXZRD8H 0-3m, KXZRD9H 0-3m KXZA3 8-27m, KXZRD2H 0-3m, KXZRD3H 0-3m, KXZRD7I 0-3m	Block No. : 195 Depth zone (m) 0 Logg 1.0 1997-07-30	Drawn by FL Checked Approved	Date 2001-05-14 NGI

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	4.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**8.906**
Q (typical max)=	95	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.8**
Q (mean value)=	95	/	4.0	*	2.5	/	2.0	*	1.00	/	2.0	=	**14.84**
Q (block)=	95	/	4.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**9.00**



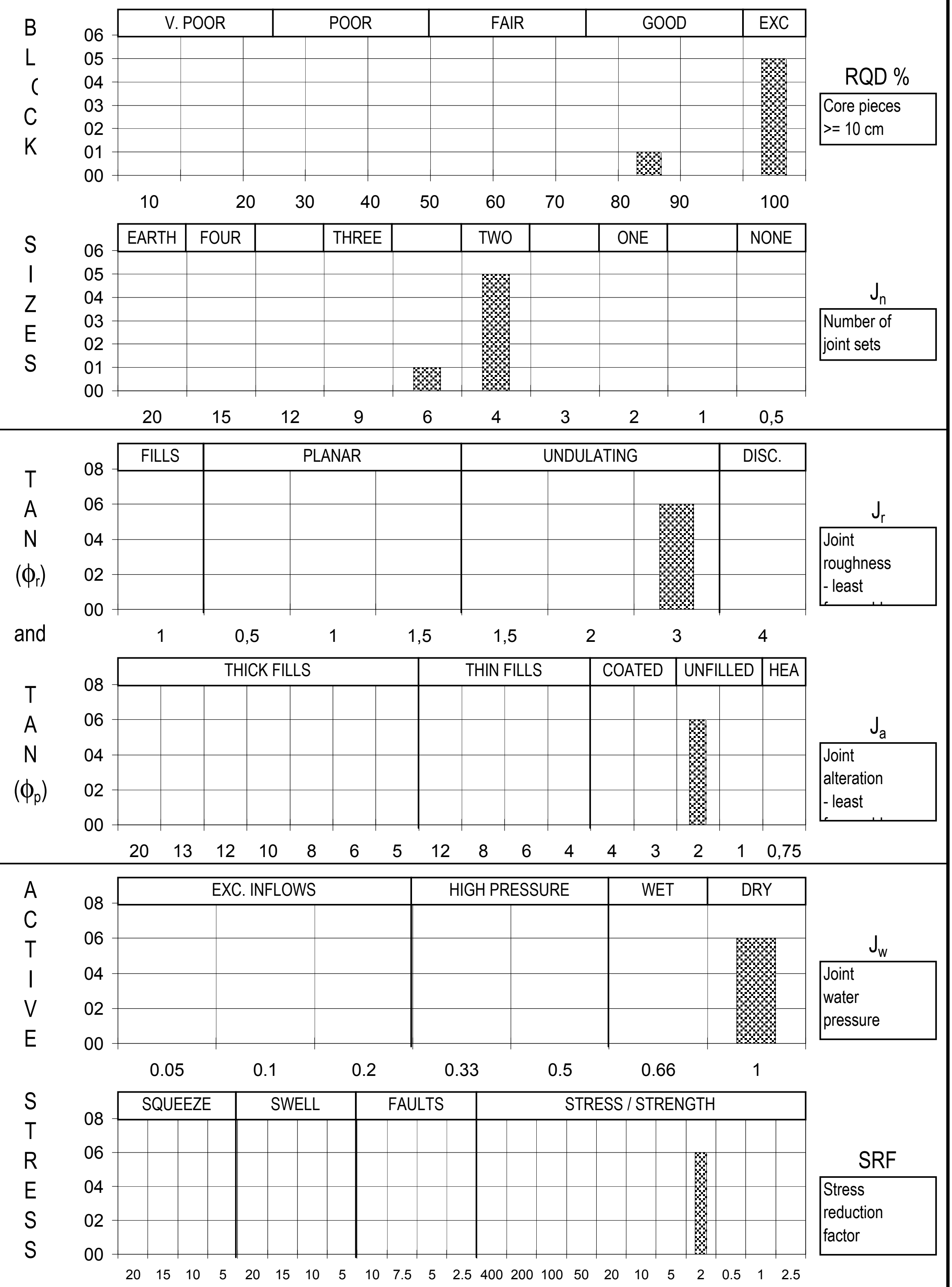
SKB/Rock mechanical model Äspö	Rev.	Report No. 0	Figure No. A36
Q - REGISTRATIONS CHART	Block No. : 196	Drawn by FL	Date 2001-06-12
KXZA1 0-8m, KXZA2 0-8m, KXZA3 0-8m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q196.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	45	/	9.0	*	3.0	/	3.0	*	1.00	/	2.0	=	**2.500**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	90	/	5.3	*	3.0	/	2.1	*	1.00	/	2.0	=	**12.55**
Q (block)=	90	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.00**



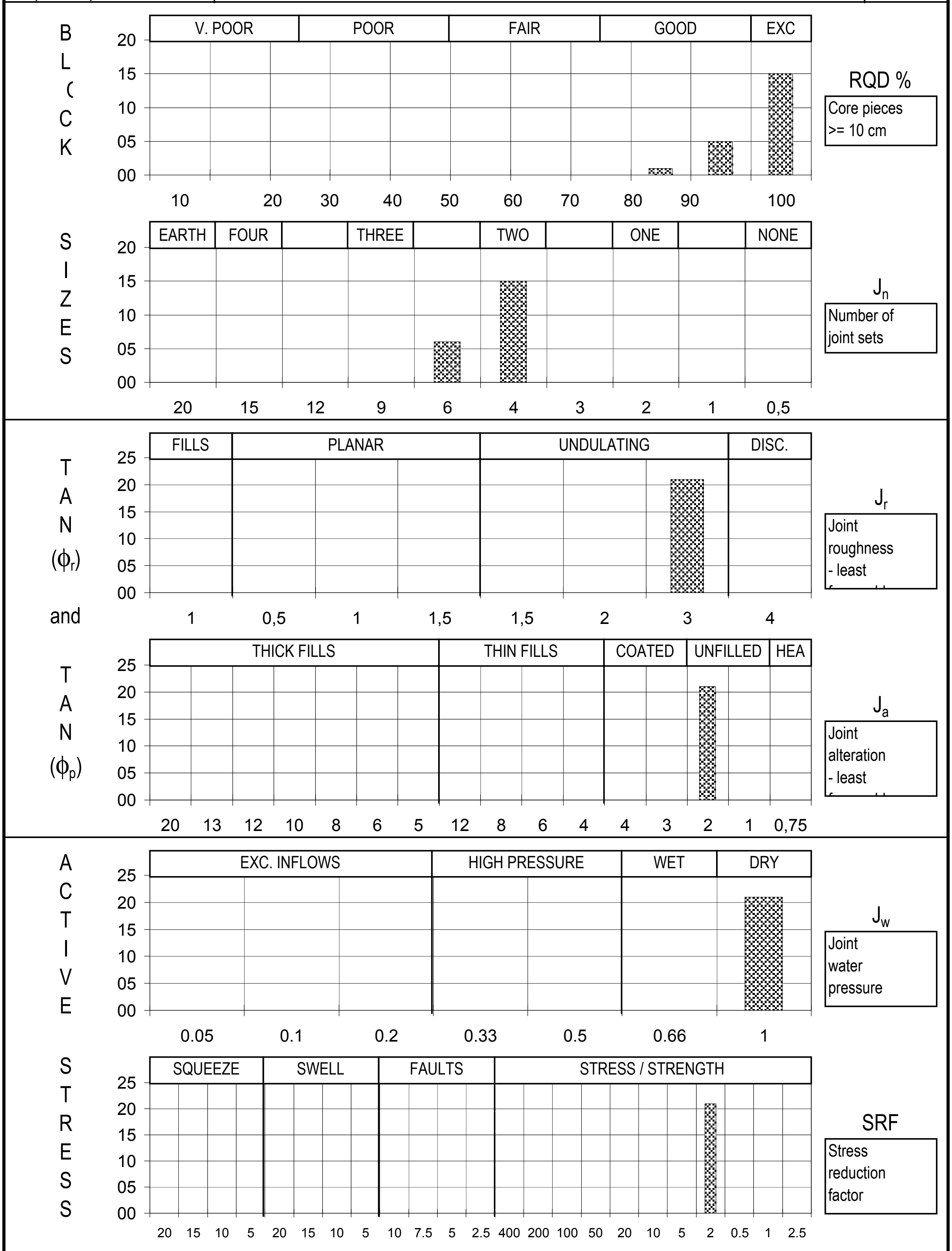
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A37
Q - REGISTRATIONS CHART	Block No. : 204	Drawn by AWH	Date 23.05.01
KA2563A 111-149m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q204.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.88**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



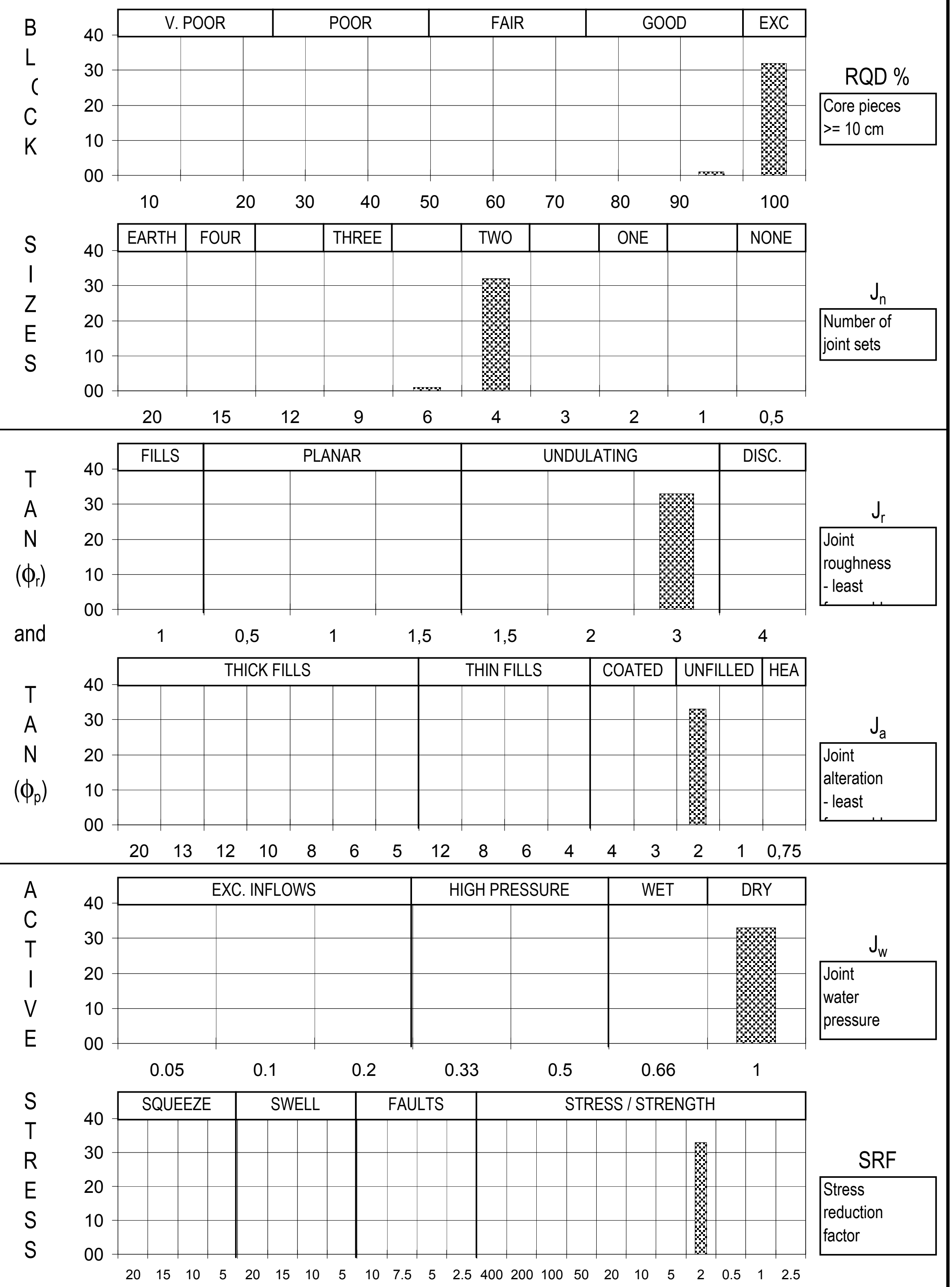
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A38
Q - REGISTRATIONS CHART	Block No. : 205	Drawn by AWH	Date 23.05.01
KA2563A 105-111m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q205.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.6	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.09**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



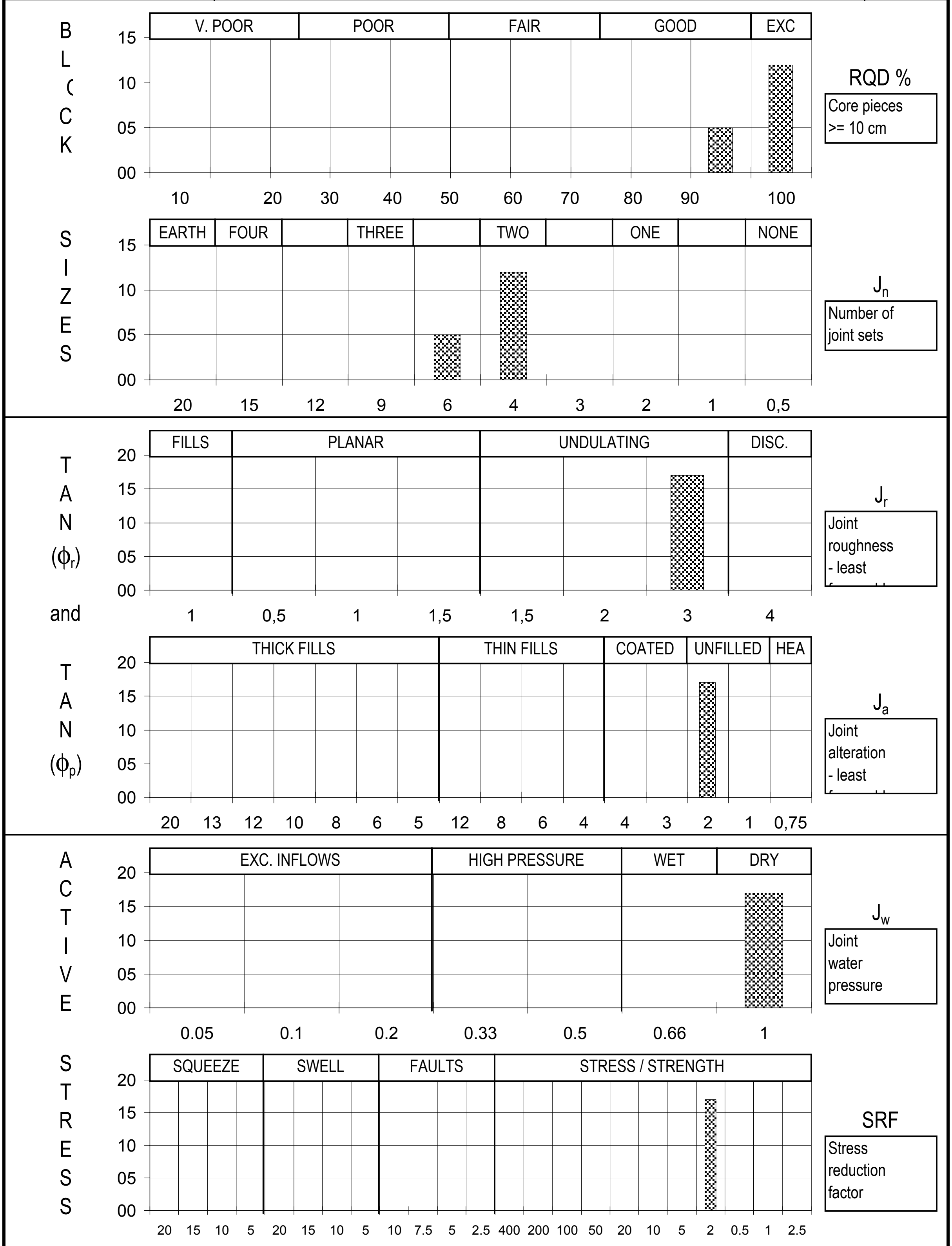
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A39
Q - REGISTRATIONS CHART	Block No. : 245	Drawn by AWH	Date 2001-06-06
KJ0052F02 6-21,4m, KJ0052F03 6-10,6m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q245.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	100	/	4.1	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.44**
Q (block)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**19.00**



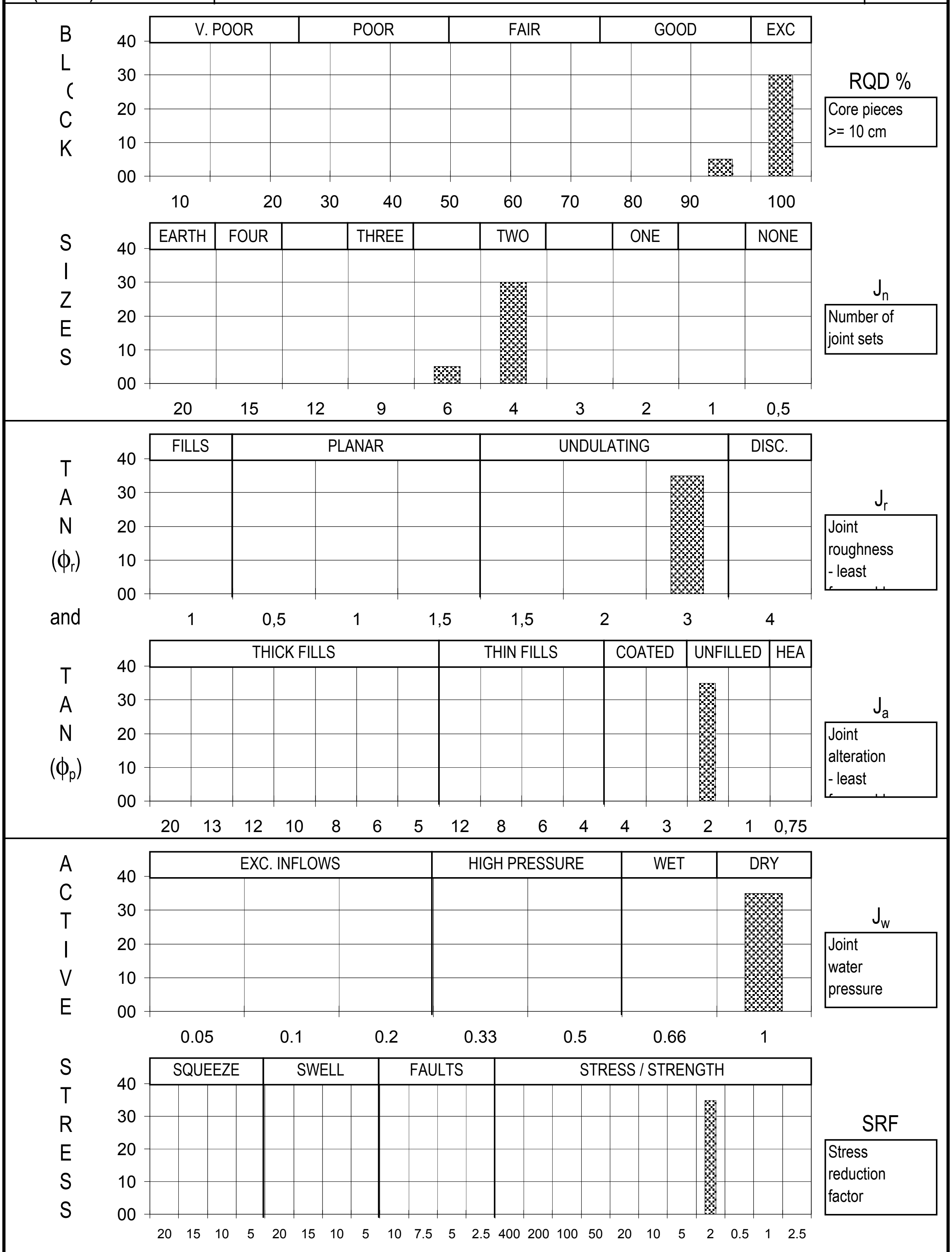
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A40
Q - REGISTRATIONS CHART	Block No. : 246	Drawn by AWH	Date 2001-06-06
KJ0050F01 14-47m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q246.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.6	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.11**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



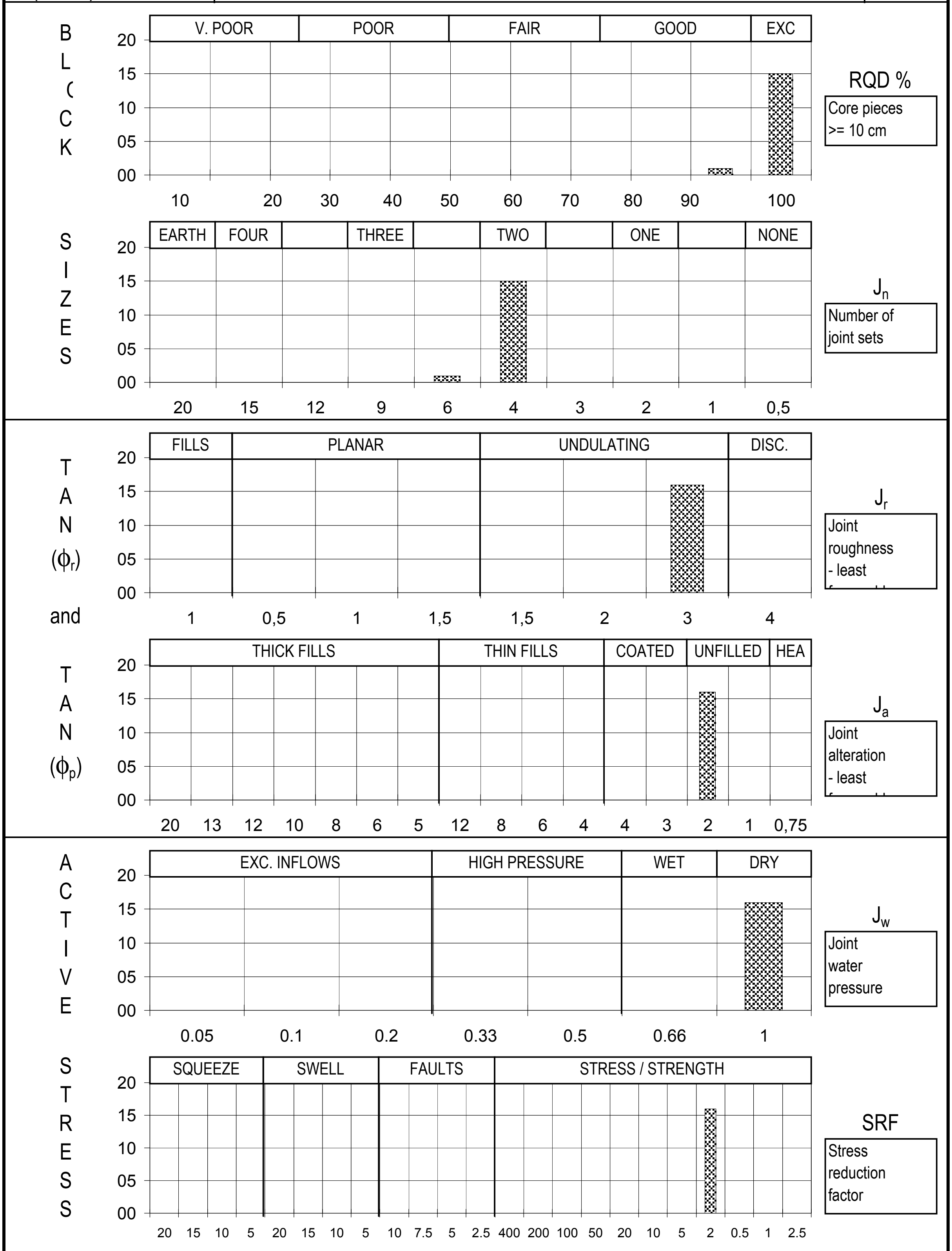
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A41
Q - REGISTRATIONS CHART	Block No. : 262	Drawn by AWH	Date 2001-06-06
KA3590G02 13-30m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q262.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.38**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



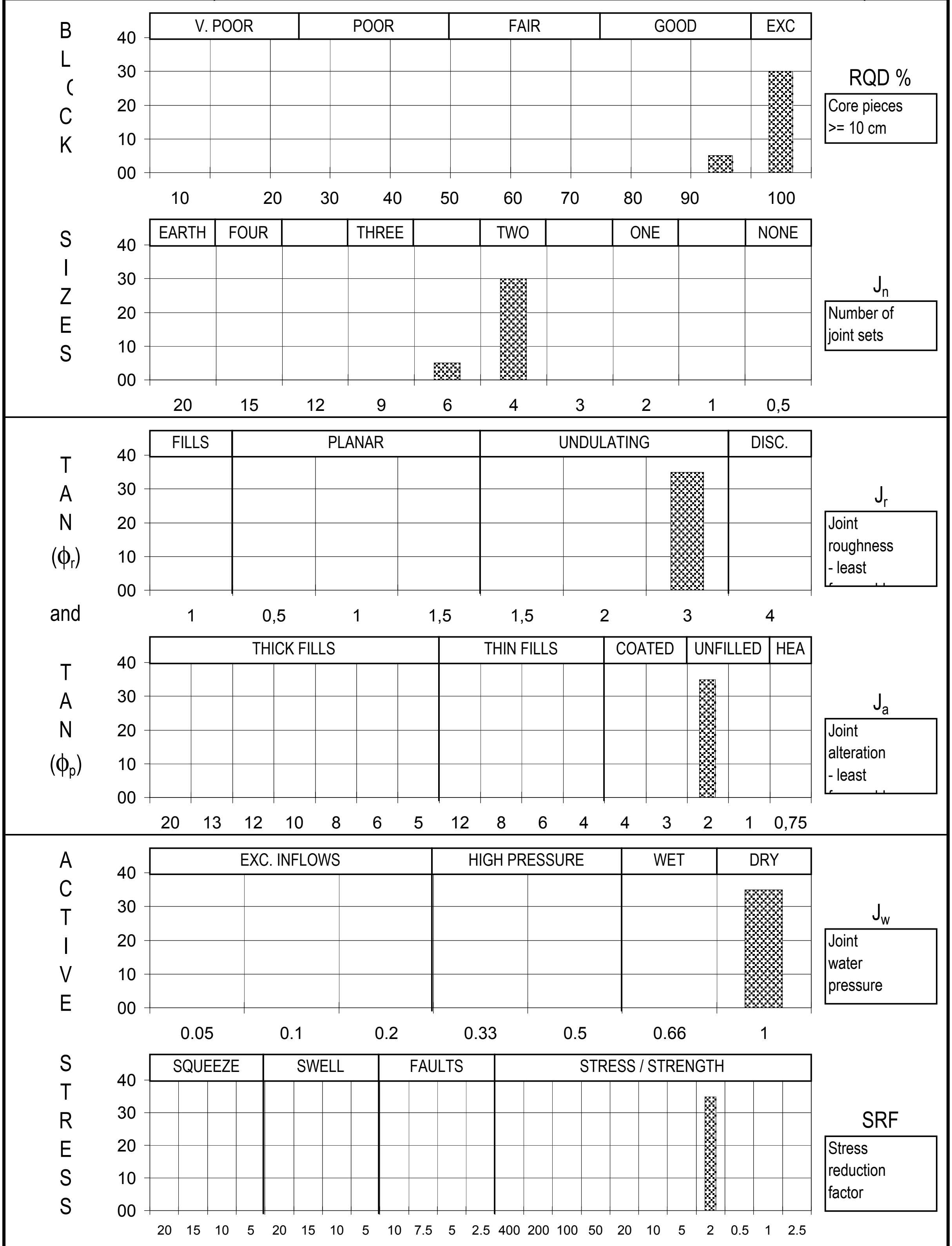
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A42
Q - REGISTRATIONS CHART	Block No. : 263	Drawn by FL	Date 2001-05-18
KG0048A01 0-19m, KA3554G02 24-30m, KA3566G02 20-3	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q263.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	100	/	4.1	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.13**
Q (block)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**19.00**



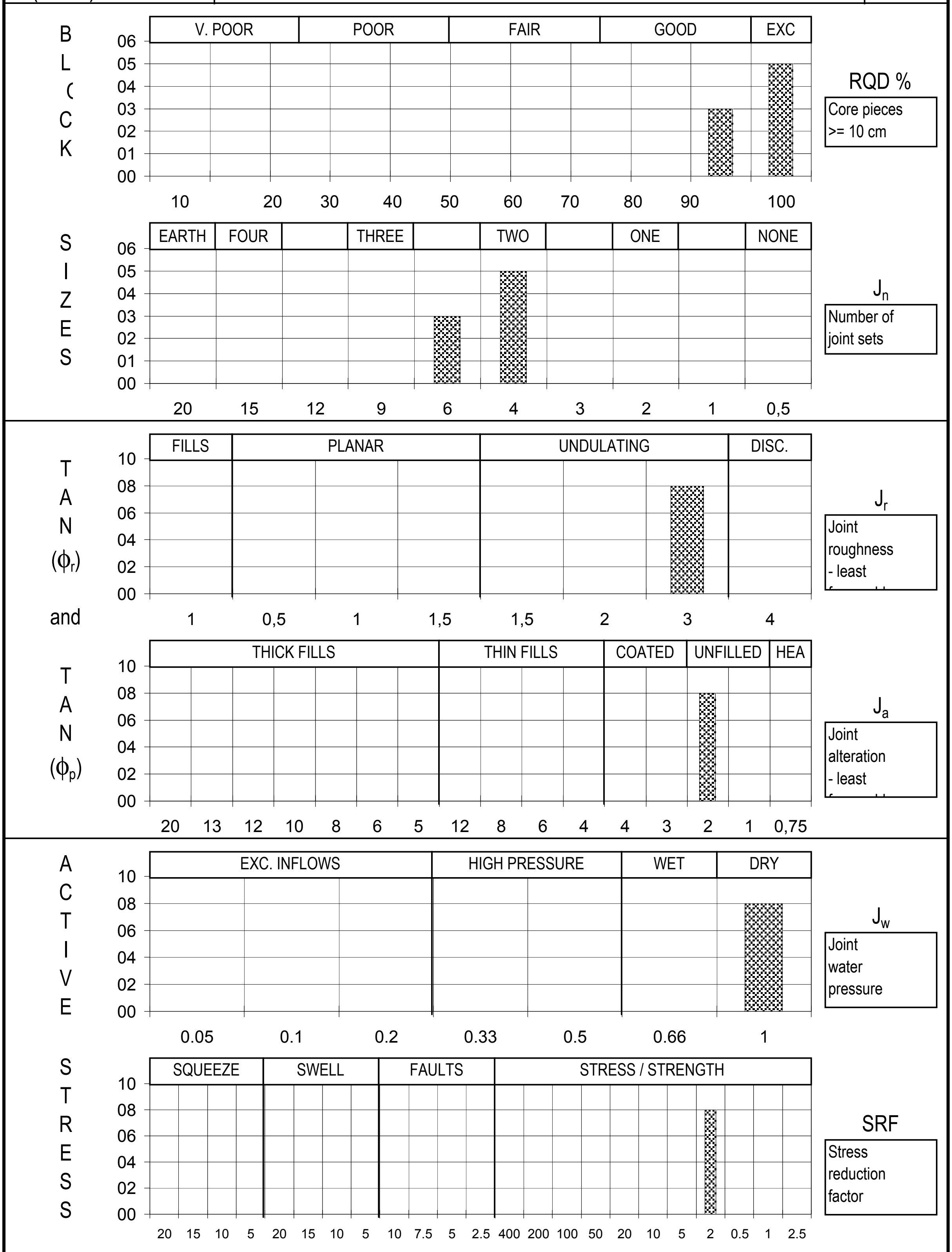
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A43
Q - REGISTRATIONS CHART	Block No. : 264	Drawn by FL	Date 2001-05-18
KG0021A01 0-13m, KA3542 27-30m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q264.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.38**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



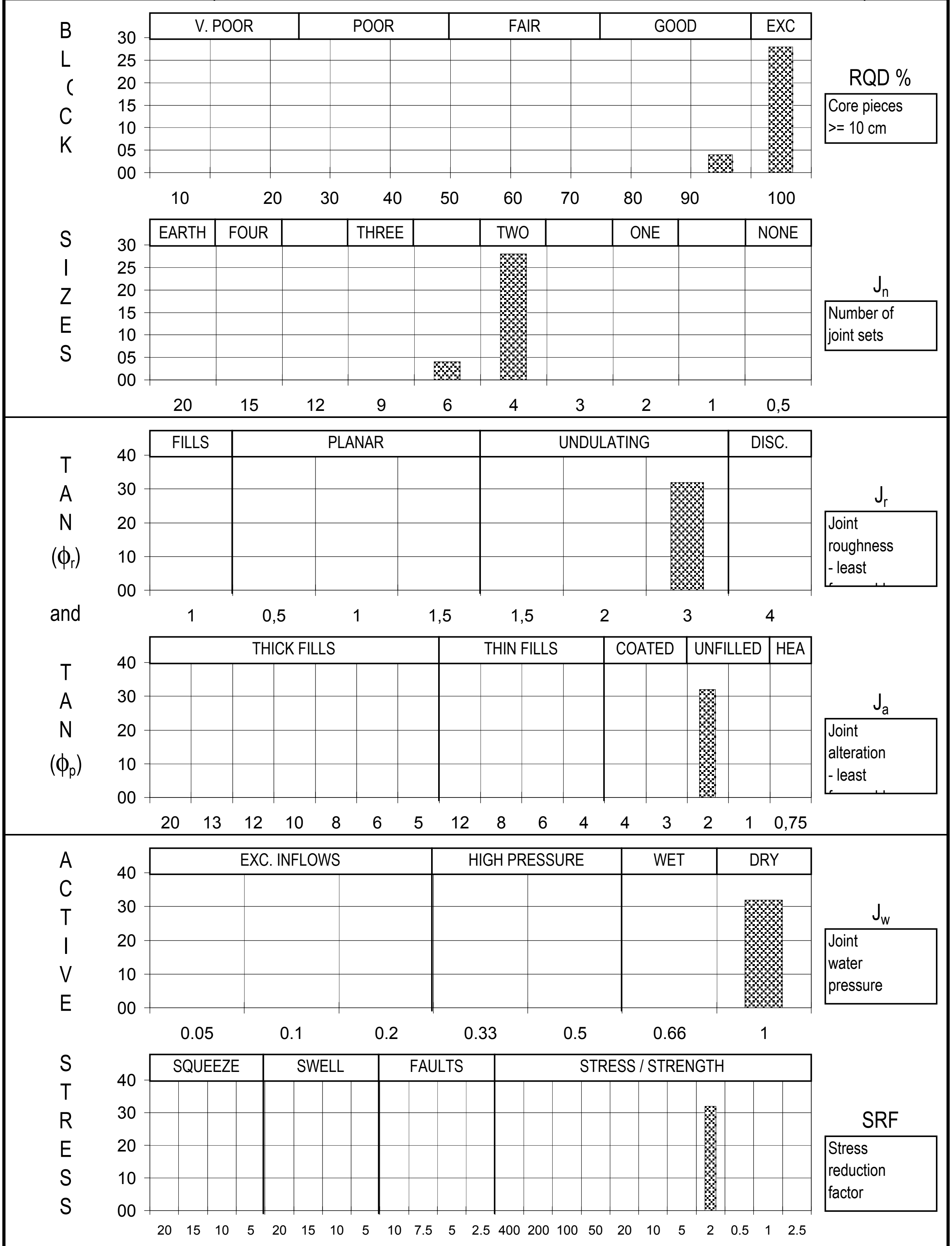
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A44
Q - REGISTRATIONS CHART	Block No. : 265	Drawn by AWH	Date 2001-06-06
KJ0044F01 0-11m, KJ0050F01 0-12m, KJ0052F02 0-6m	Depth zone (m) 0	Checked	NGI
KJ0052F03 0-6m F:\P\2001\11\20011173\excel\Q-blokker\[Q265.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.8	*	3.0	/	2.0	*	1.00	/	2.0	=	**15.49**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



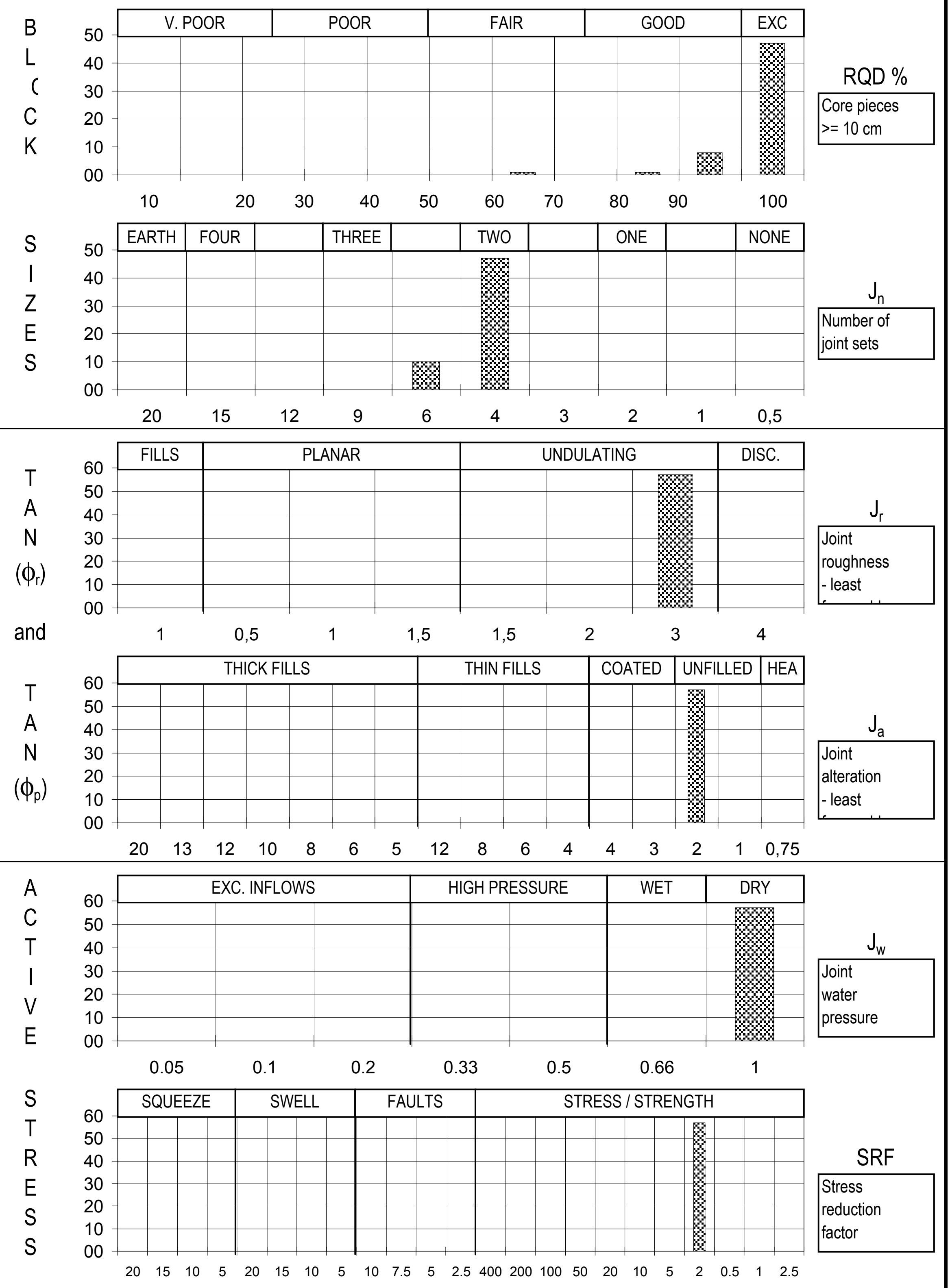
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A45
Q - REGISTRATIONS CHART	Block No. : 266	Drawn by AWH	Date 2001-06-06
KJ0044F01 11-17m, KJ0050F01 12-14m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q266.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.54**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



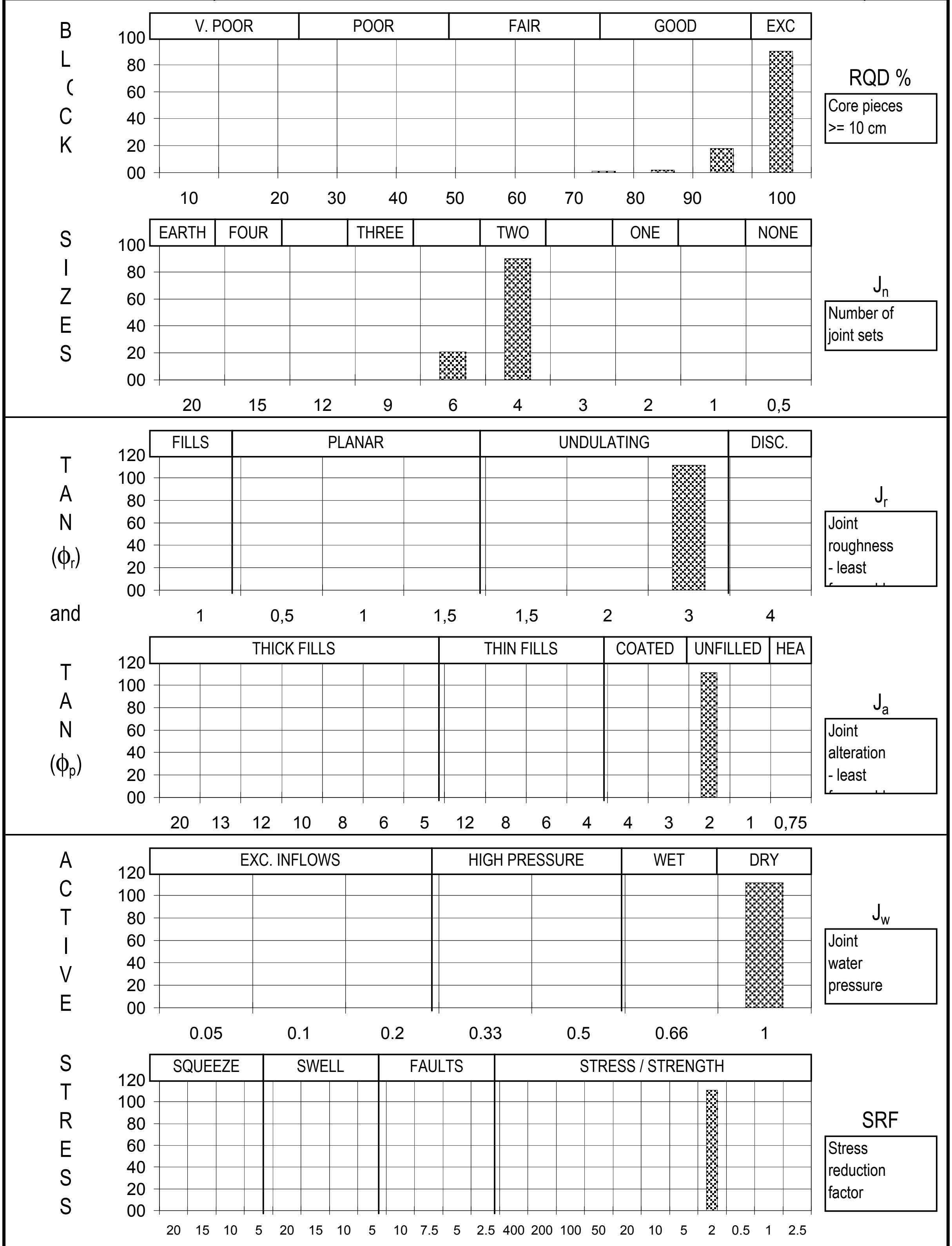
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A46
Q - REGISTRATIONS CHART	Block No. : 281	Drawn by AWH	Date 23.05.01
KA3600F 4-36m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q281.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	65	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**8.125**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.4	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.97**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



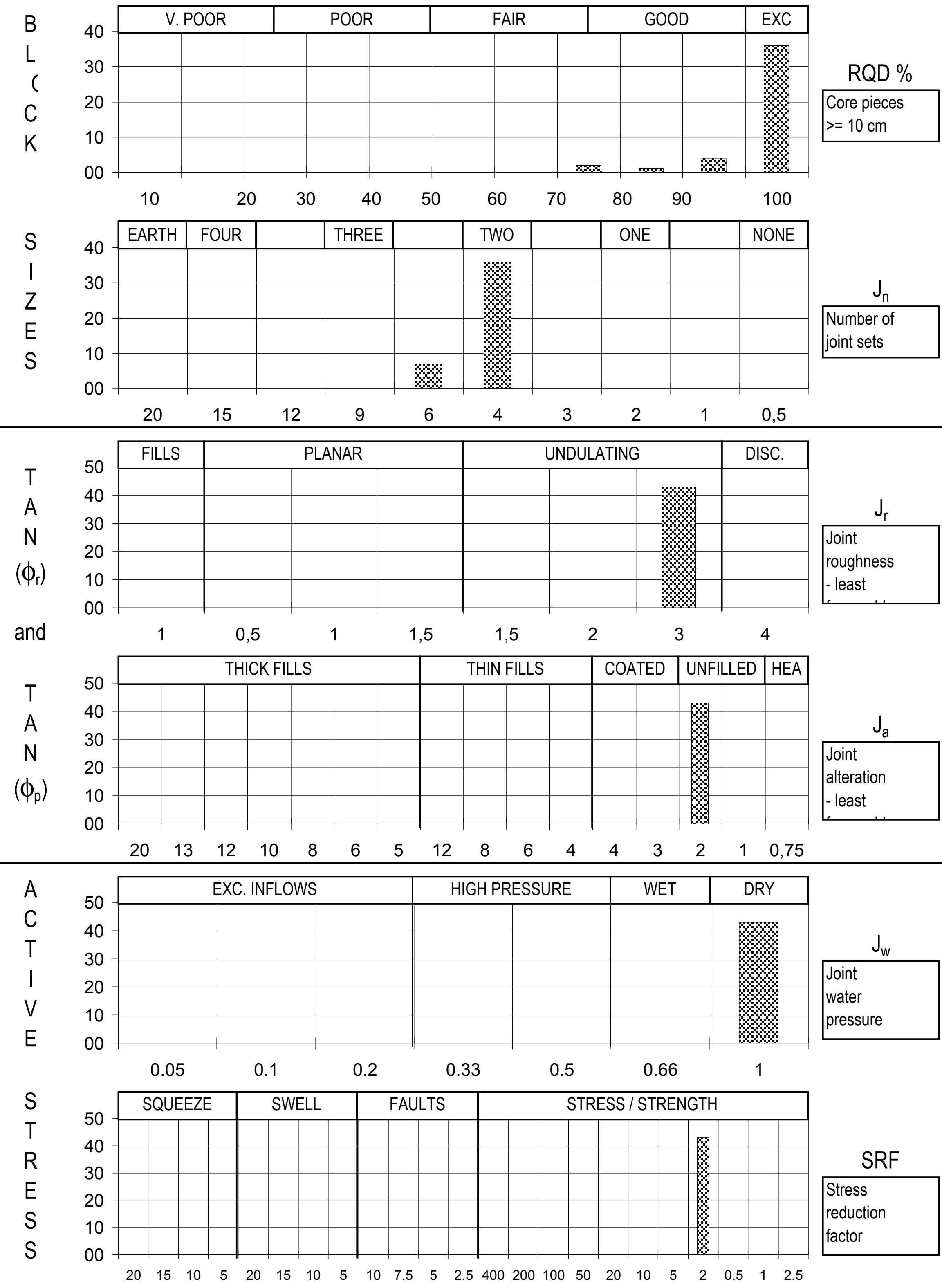
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A47
KA3590G02 0-13m	Block No. : 282	Drawn by AWH	Date 22.05.01
KA3600F 0-4m, KA3573A 4-15m, KA3590G01 0-29m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q282.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	75	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**9.375**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.4	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.91**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



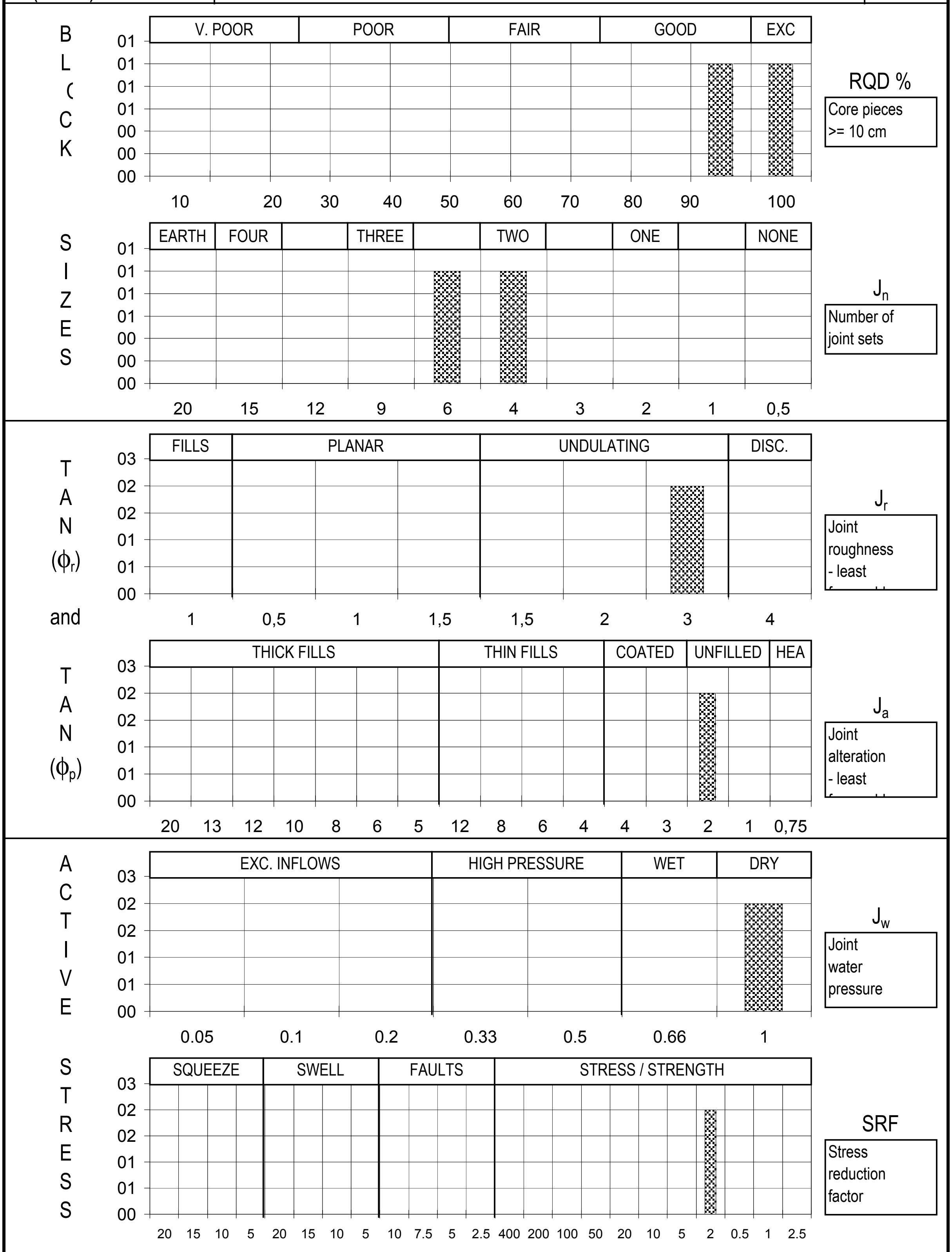
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A48
KA3548A01 0-11m, KA3566G02 0-20m, KA3573A 0-4m	Block No. : 283	Drawn by FL	Date 2001-06-05
KA3542G01 5-16m, KA3554G01 0-19m, KA3554G02 0-24m	Depth zone (m) 0	Checked	NGI
KA3566G01 0-22m F:\P\2001\11\20011173\excel\Q-blokker\[Q283.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	75	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**9.375**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.00**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



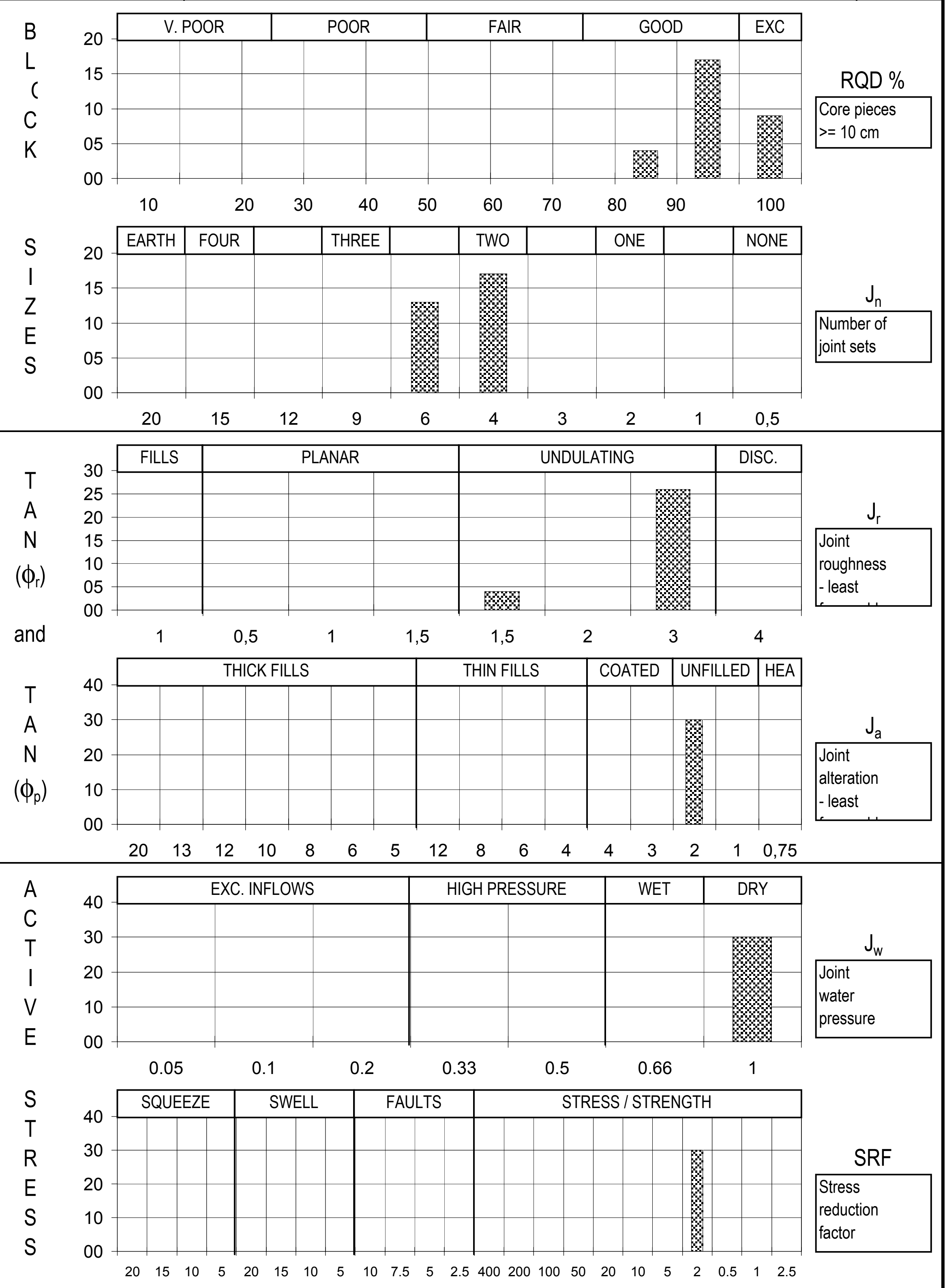
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A49
	Block No. : 284	Drawn by FL	Date 18.0501
KA3510A 2-9m, KG0021A01 13-17m, KA3542G01 0-5m	Depth zone (m) 0	Checked	NGI
KA3542G02 0-27m F:\P\2001\11\20011173\excel\Q-blokker\[Q284.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	5.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**14.63**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



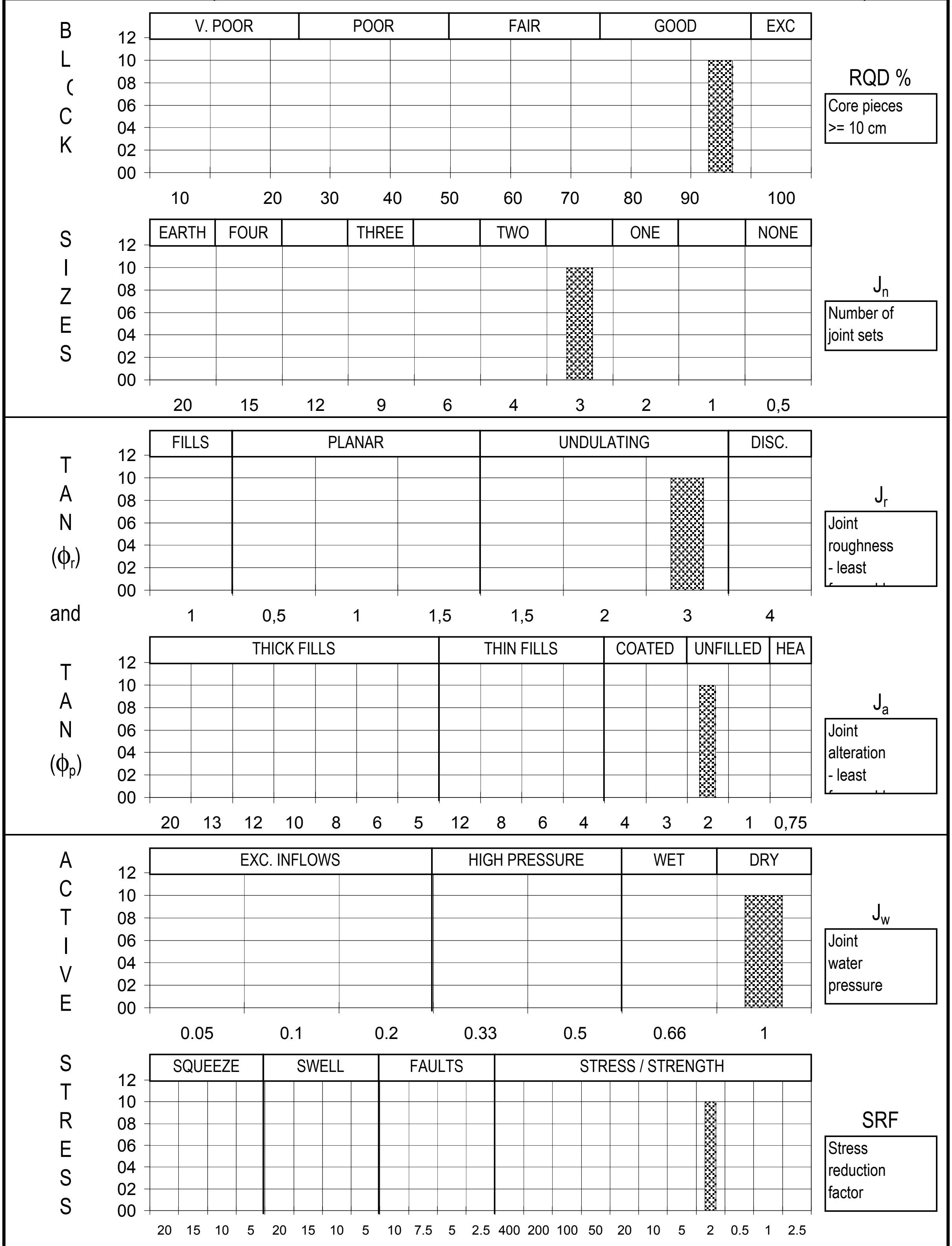
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A50
Q - REGISTRATIONS CHART	Block No. : 285	Drawn by FL	Date 2001-05-18
KA3510A 0-2m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q285.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**5.313**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	95	/	4.9	*	2.8	/	2.0	*	1.00	/	2.0	=	**13.69**
Q (block)=	95	/	6.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**6.00**



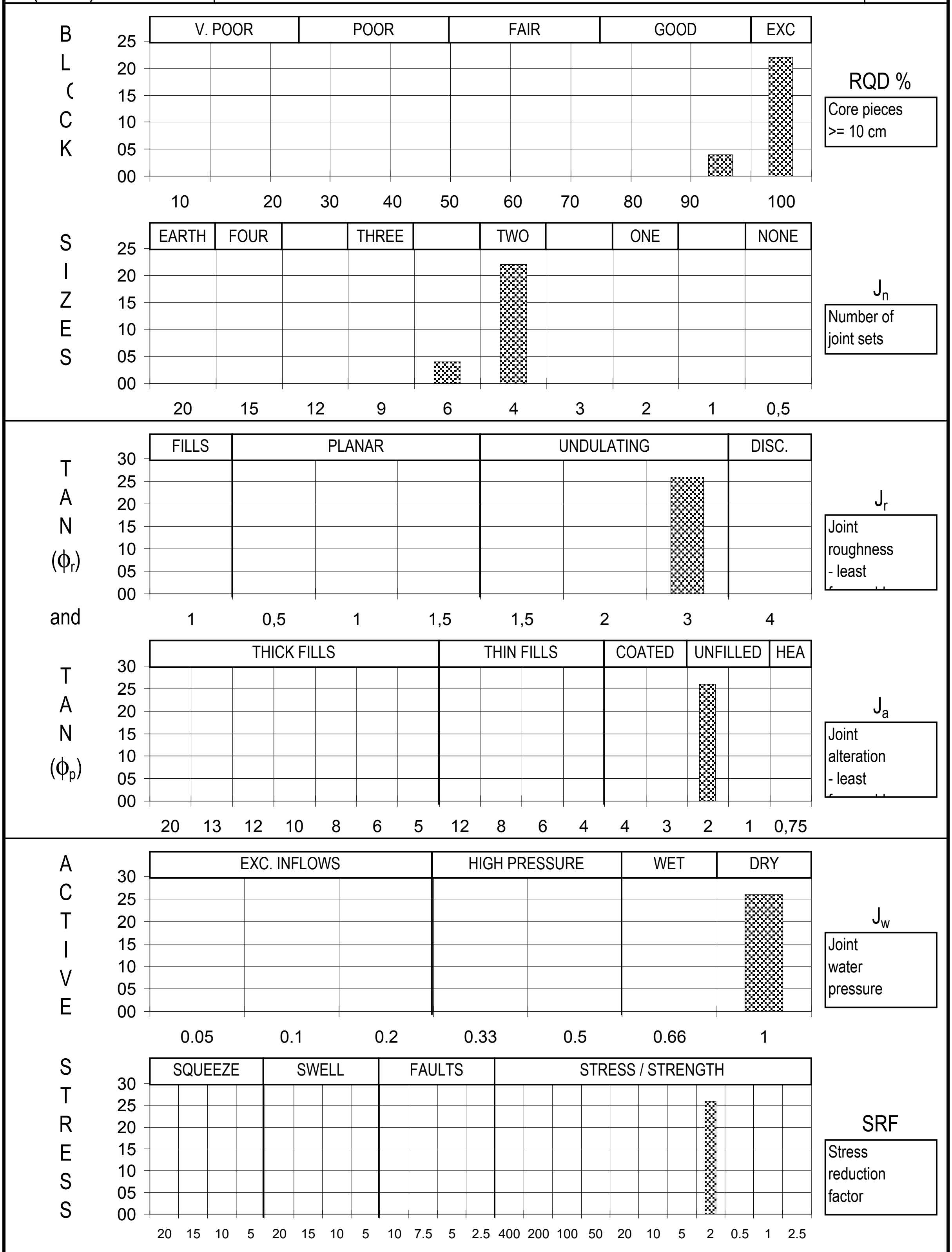
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A51
Q - REGISTRATIONS CHART	Block No. : 290	Drawn by AWH	Date 12.06.01
KAS02 450-480m Logged by NGI 2001	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q290_NGI.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	3.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**23.750**
Q (typical max)=	95	/	3.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**23.8**
Q (mean value)=	95	/	3.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**23.75**
Q (block)=	95	/	3.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**24.00**



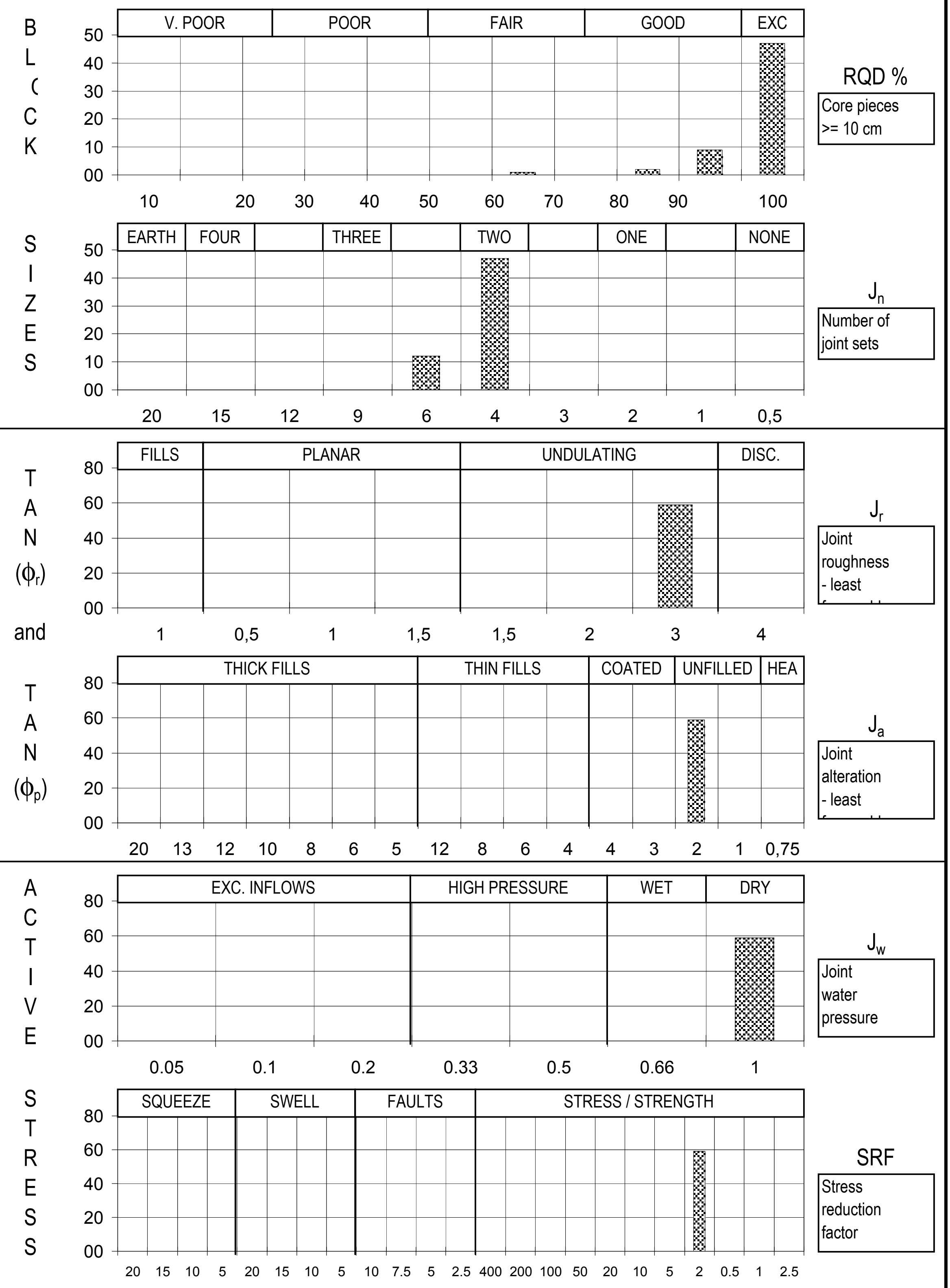
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		0	A52
Q - REGISTRATIONS CHART	Block No. : 295	Drawn by FL	Date 2001-06-12
KXZA7 30-40m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q295.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.28**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



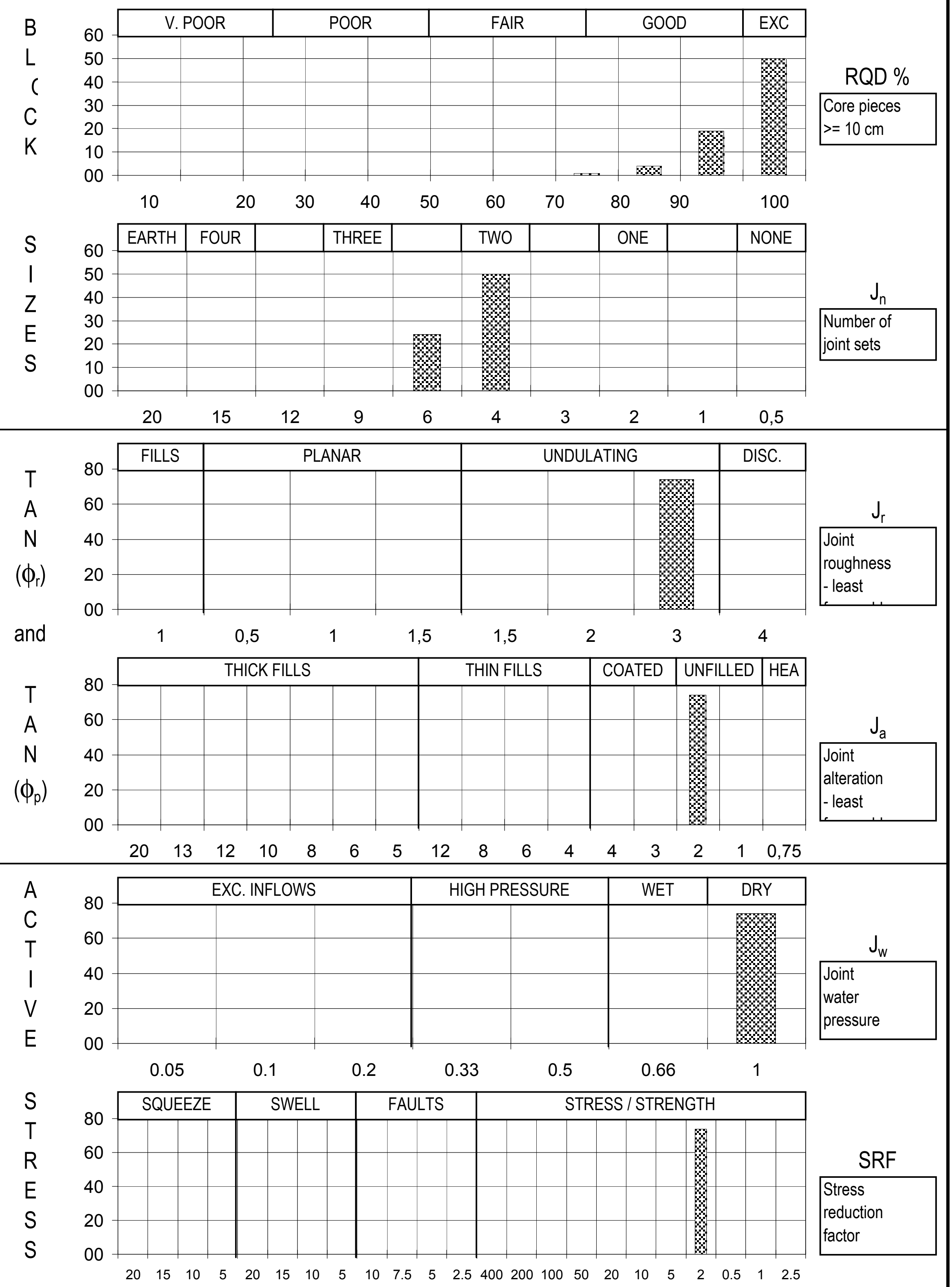
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A53
	Block No. : 302	Drawn by AWH	Date 2001-06-06
KA3573A 15-40m, KA3590G01 29-30m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q302.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	65	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**8.125**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.4	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.70**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



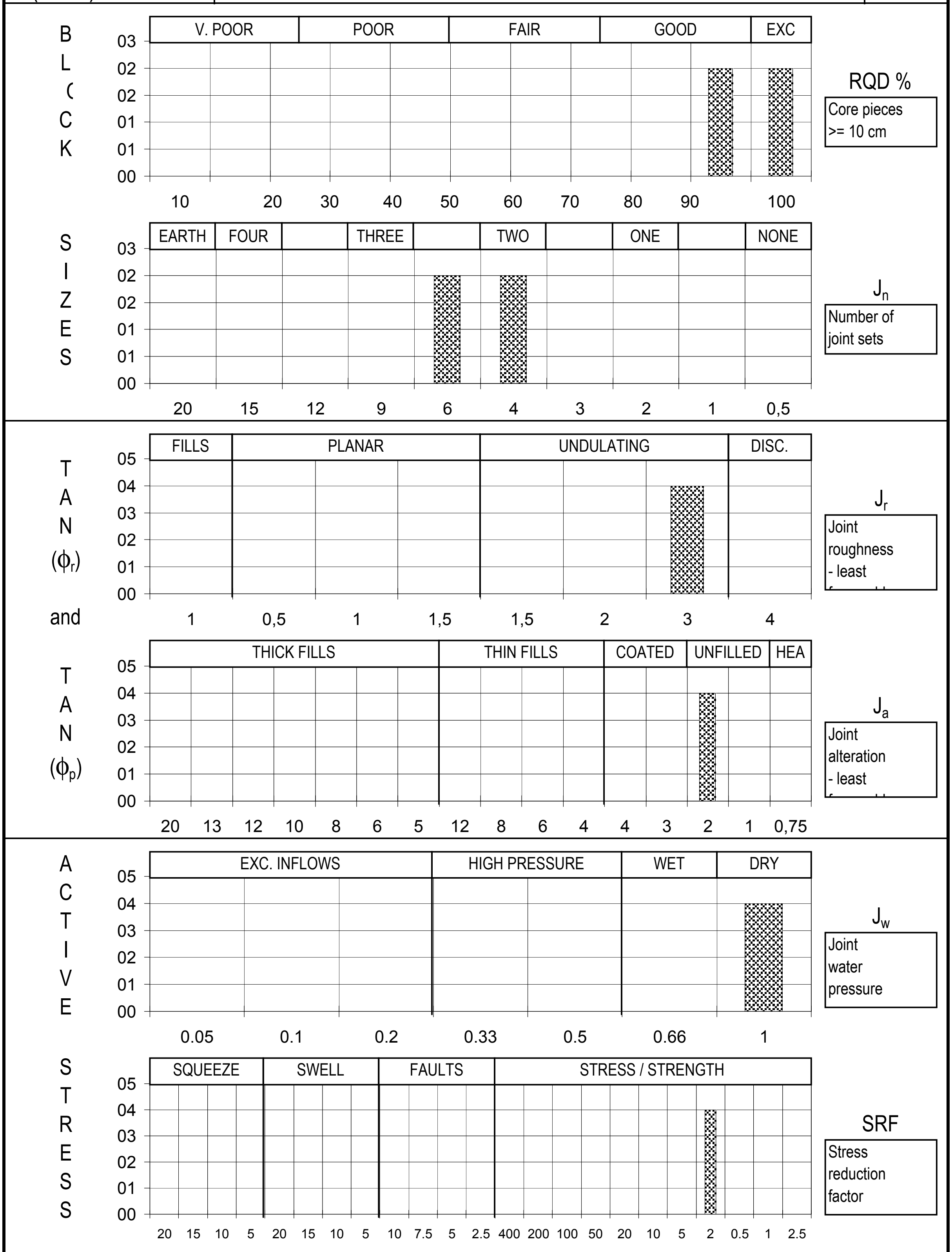
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A54
KA3554G01 19-30m	Block No. : 303	Drawn by FL	Date 2001-05-18
KA3510A 36-43m KA3542G01 16-30m, KA3548A01 11-30m	Depth zone (m) 0	Checked	NGI
KA3566G01 22-30m	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	75	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**9.375**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.6	*	3.0	/	2.0	*	1.00	/	2.0	=	**15.74**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



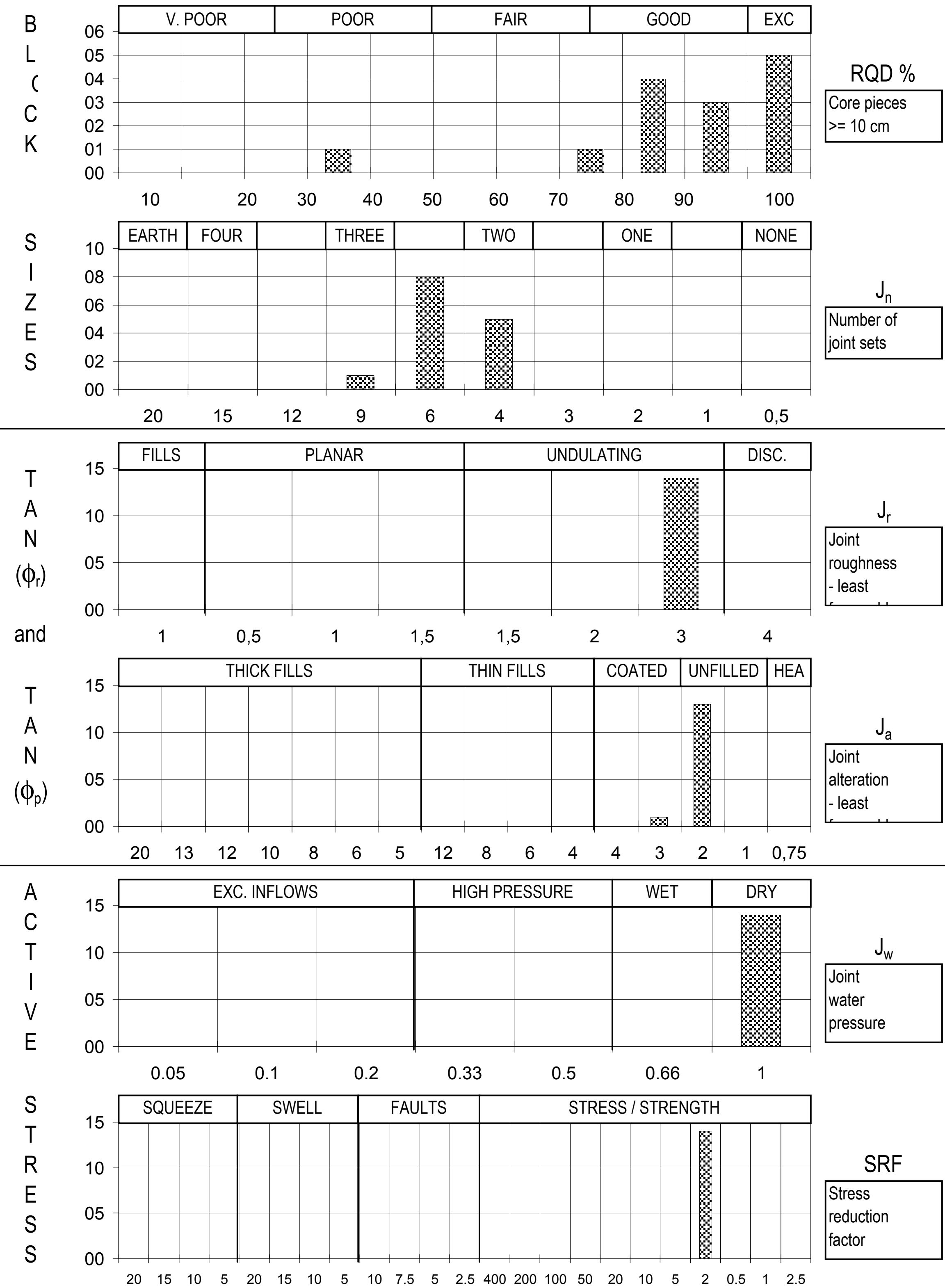
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A55
Q - REGISTRATIONS CHART	Block No. : 304	Drawn by FL/AWH	Date 2001-05-18
KA3510A 9-36m, KI0025F03 0-13m, KI0025F 4-10m	Depth zone (m) 0	Checked	NGI
KI0025F02 0-12m, KI0023B 0-16m	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	95	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.875**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	5.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**14.63**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



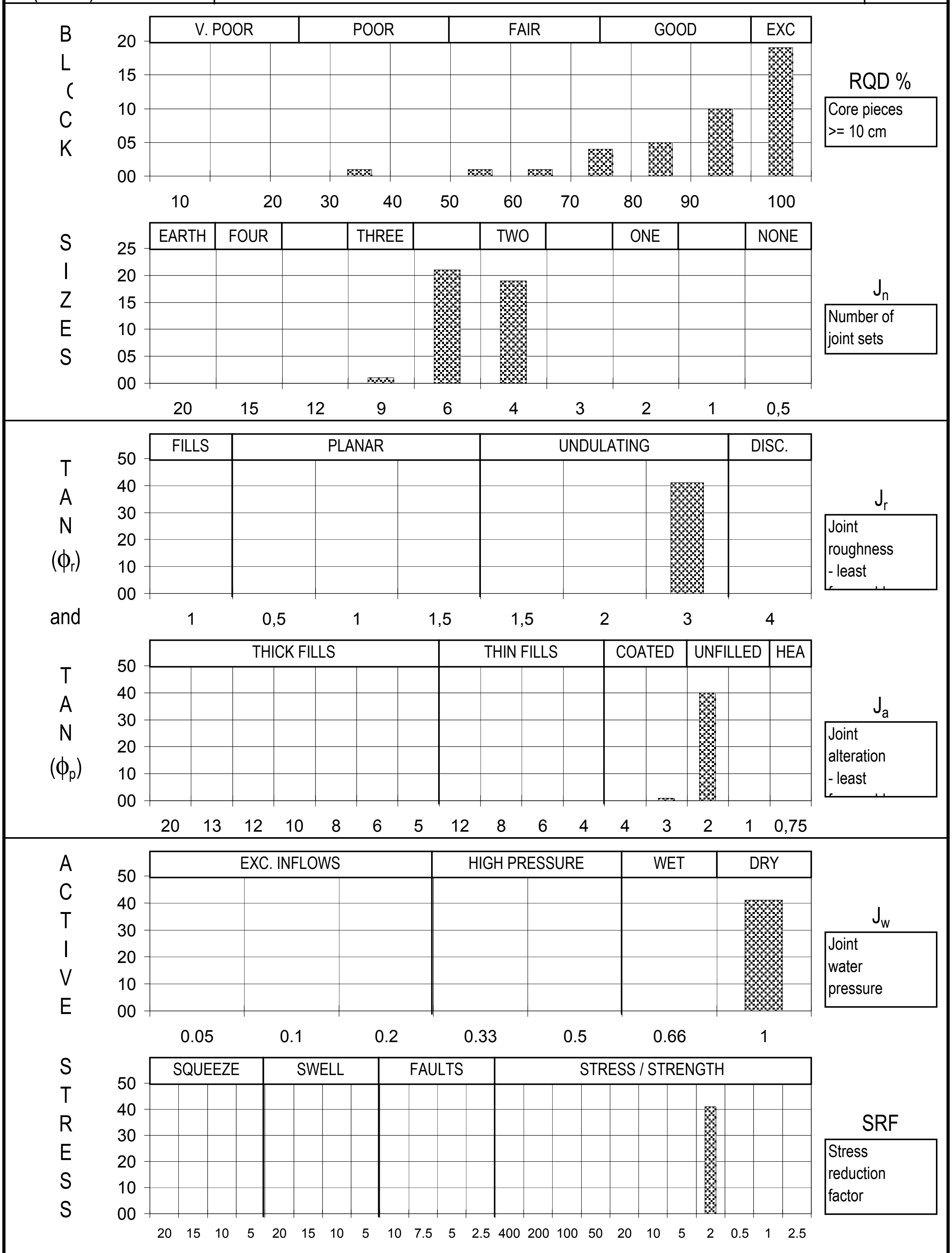
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A56
Q - REGISTRATIONS CHART	Block No. : 305	Drawn by FL	Date 21.0501
KI0025F 0-4m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q305.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	35	/	9.0	*	3.0	/	3.0	*	1.00	/	2.0	=	**1.944**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	88	/	5.5	*	3.0	/	2.1	*	1.00	/	2.0	=	**11.61**
Q (block)=	88	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.00**



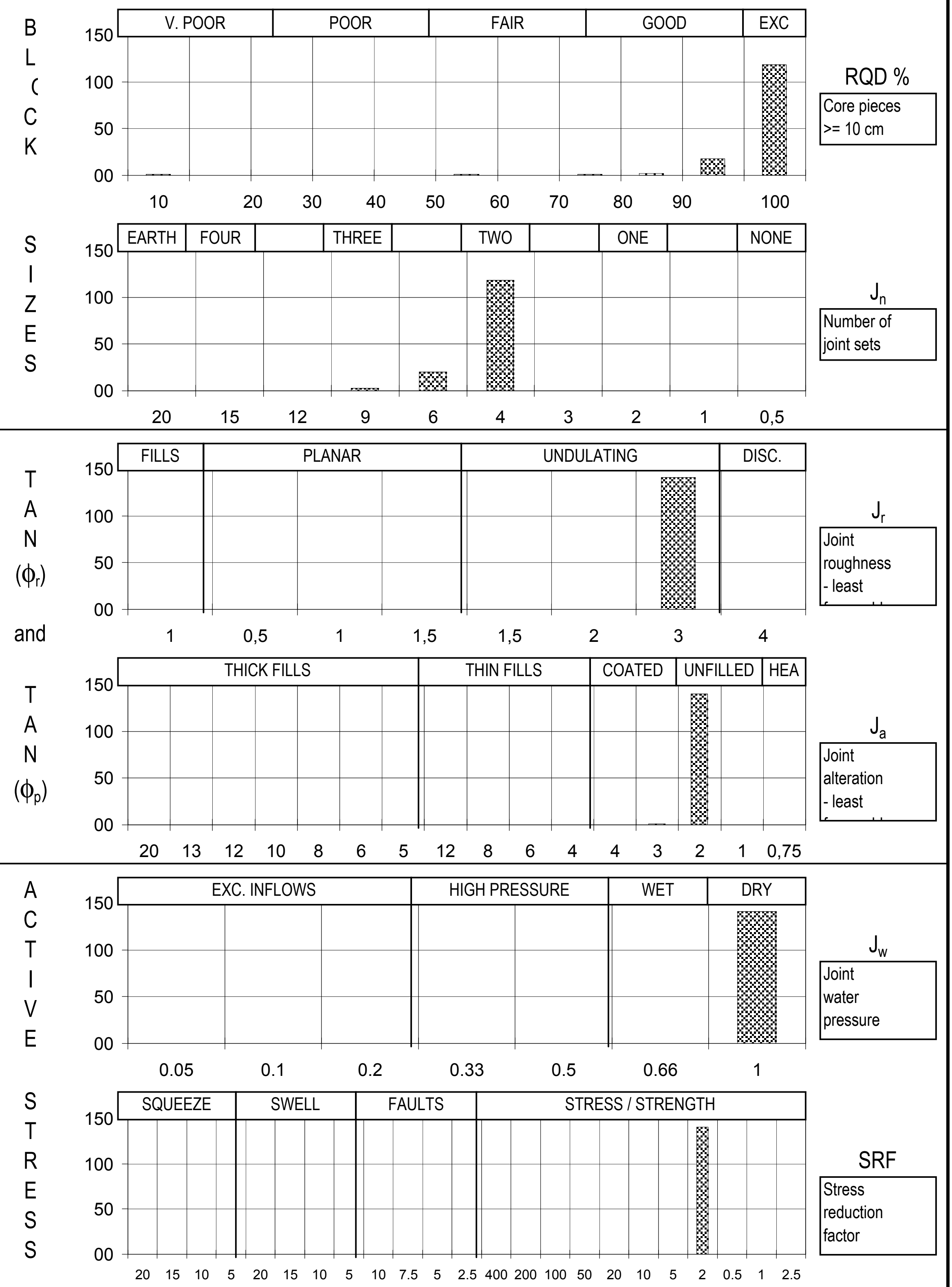
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A57
Q - REGISTRATIONS CHART	Block No. : 309	Drawn by FL	Date 2001-05-18
KA3385A 0-14m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q309.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	35	/	9.0	*	3.0	/	3.0	*	1.00	/	2.0	=	**1.944**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	91	/	5.1	*	3.0	/	2.0	*	1.00	/	2.0	=	**13.10**
Q (block)=	91	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.00**



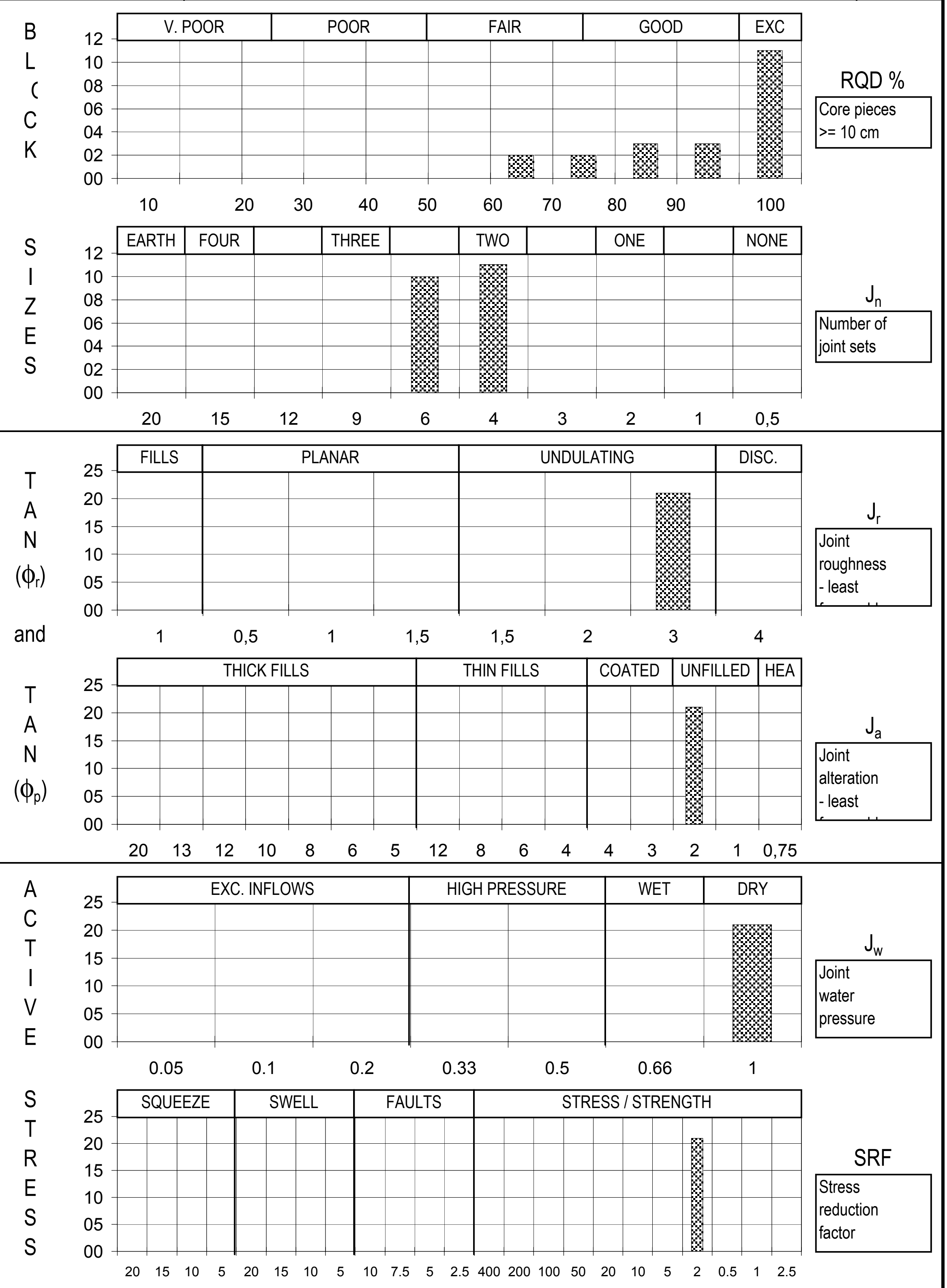
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A58
Q - REGISTRATIONS CHART	Block No. : 323	Drawn by AWH	Date 2001-05-22
KI0023B 49-57m, KA2563A 158-191m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q323.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	10	/	9.0	*	3.0	/	3.0	*	1.00	/	2.0	=	**0.556**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.4	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.69**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



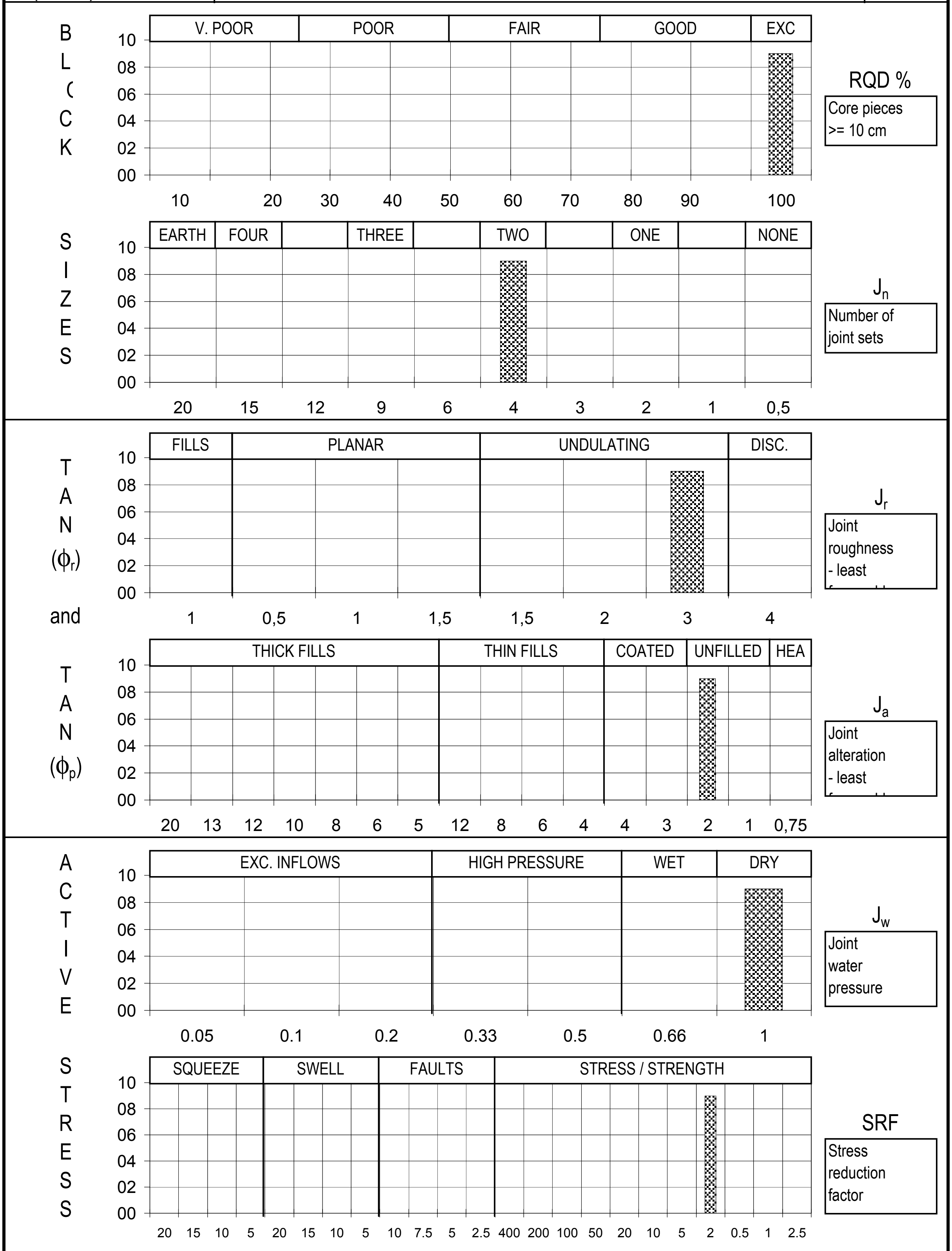
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A59
Q - REGISTRATIONS CHART	Block No. : 324	Drawn by FL/AWH	Date 2001-05-18
KI0025F03 13-45m, KI0025F 10-42m, KI0025F02 12-47m,	Depth zone (m) 0	Checked	NGI
KI0023B 16-49m, KA2563A 149-158m	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	65	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**8.125**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	91	/	5.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**13.85**
Q (block)=	91	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**11.00**



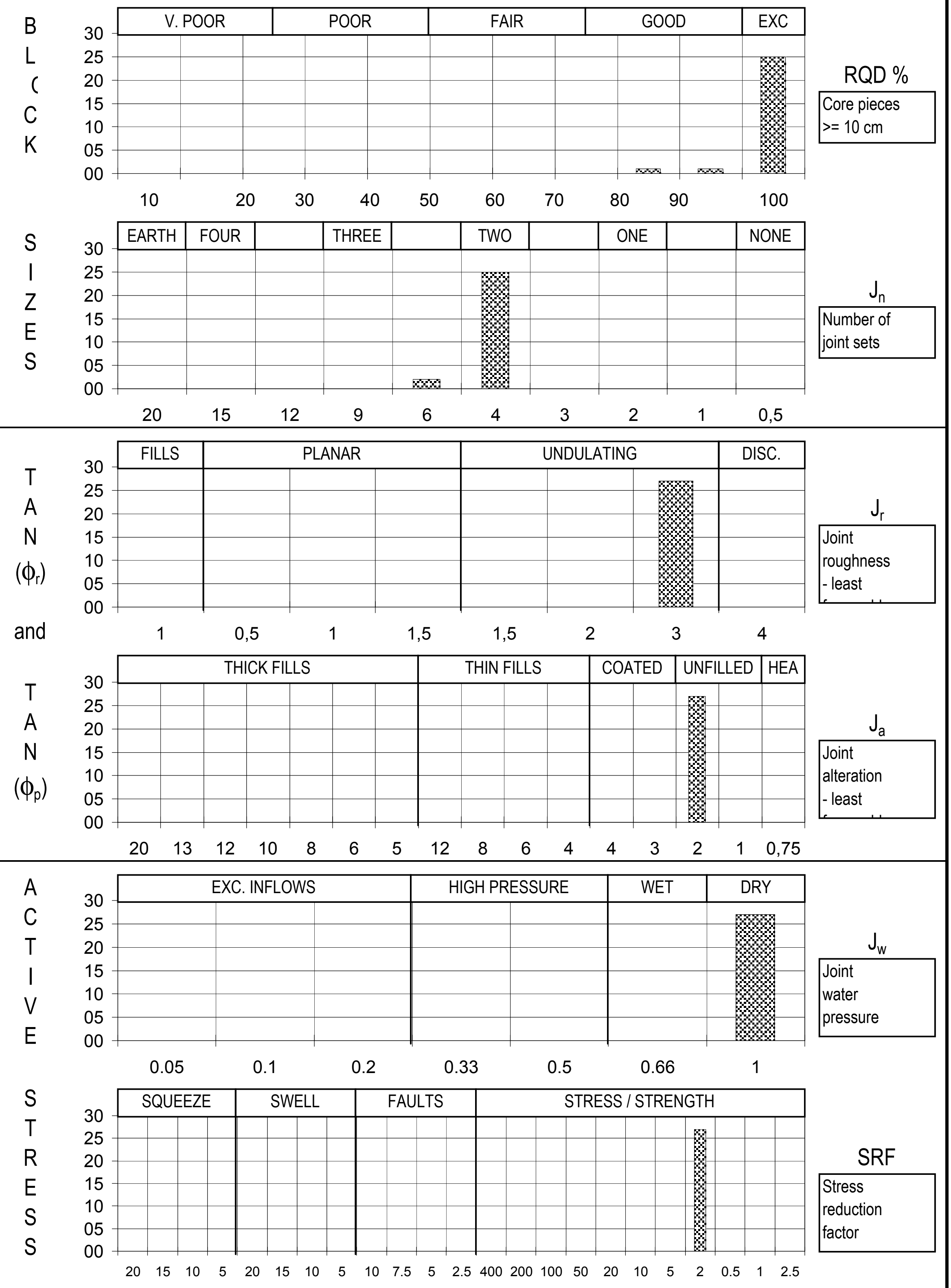
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A60
Q - REGISTRATIONS CHART	Block No. : 329	Drawn by FL	Date 2001-05-18
KA3385A 14-34m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q329.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.750**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.75**
Q (block)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**19.00**



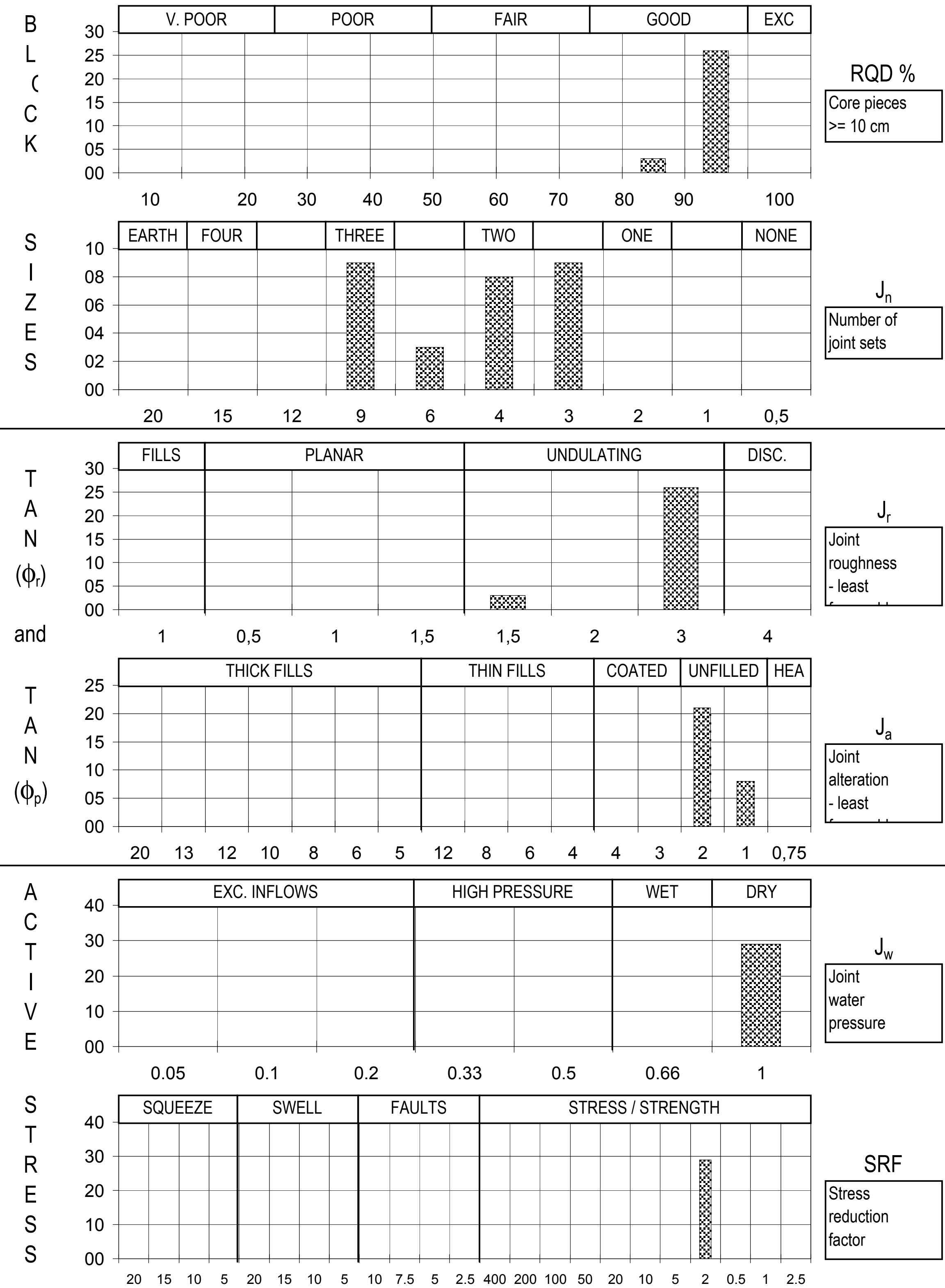
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A61
Q - REGISTRATIONS CHART	Block No. : 343	Drawn by AWH	Date 2001-05-22
KI0023B 57-63m, KA2563A 191-194m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q343.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.1	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.95**
Q (block)=	99	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**19.00**



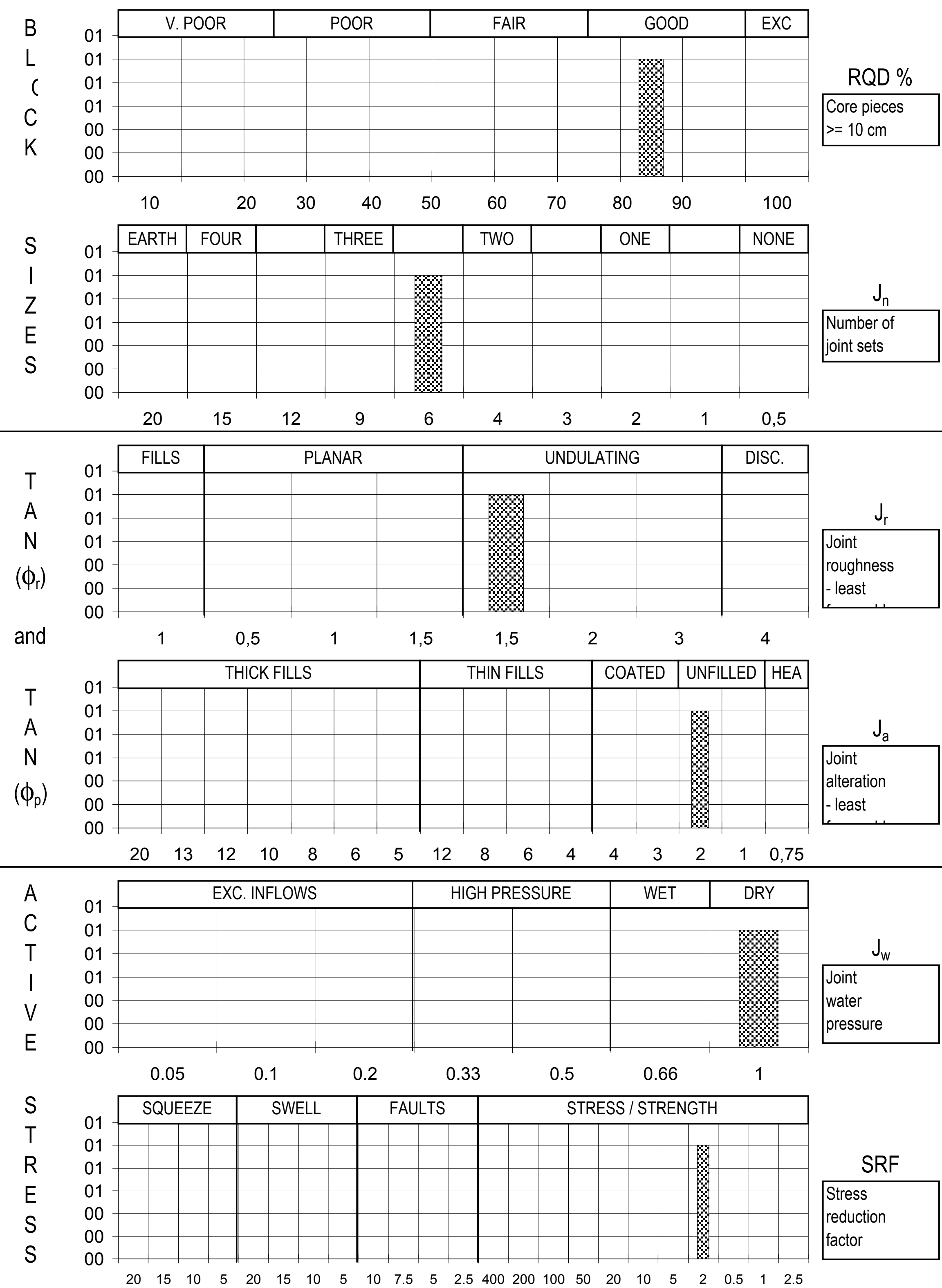
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A62
Q - REGISTRATIONS CHART	Block No. : 344	Drawn by FL	Date 2001-05-21
KI0025F 42-65m, KI0025F02 47-51m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q344.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	9.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**3.542**
Q (typical max)=	95	/	3.0	*	3.0	/	1.0	*	1.00	/	2.0	=	**47.5**
Q (mean value)=	94	/	5.4	*	2.8	/	1.7	*	1.00	/	2.0	=	**14.23**
Q (block)=	94	/	9.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**4.00**



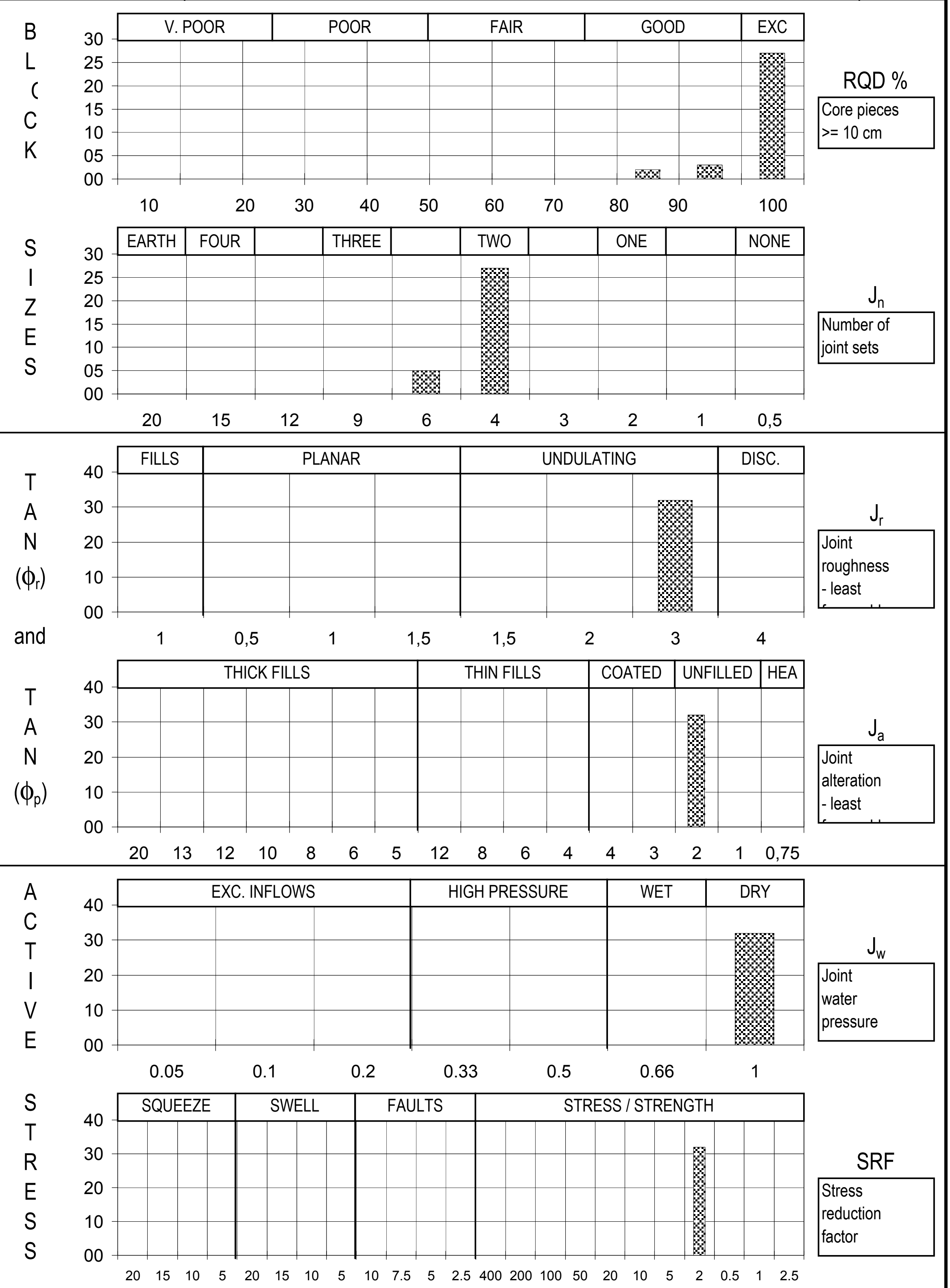
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A63
Q - REGISTRATIONS CHART	Block No. : 390	Drawn by AWH	Date 12.06.01
KAS02 481-510m Logged by NGI 2001	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q390_NGI.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**5.313**
Q (typical max)=	85	/	6.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**5.3**
Q (mean value)=	85	/	6.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**5.31**
Q (block)=	85	/	6.0	*	1.5	/	2.0	*	1.00	/	2.0	=	**5.00**



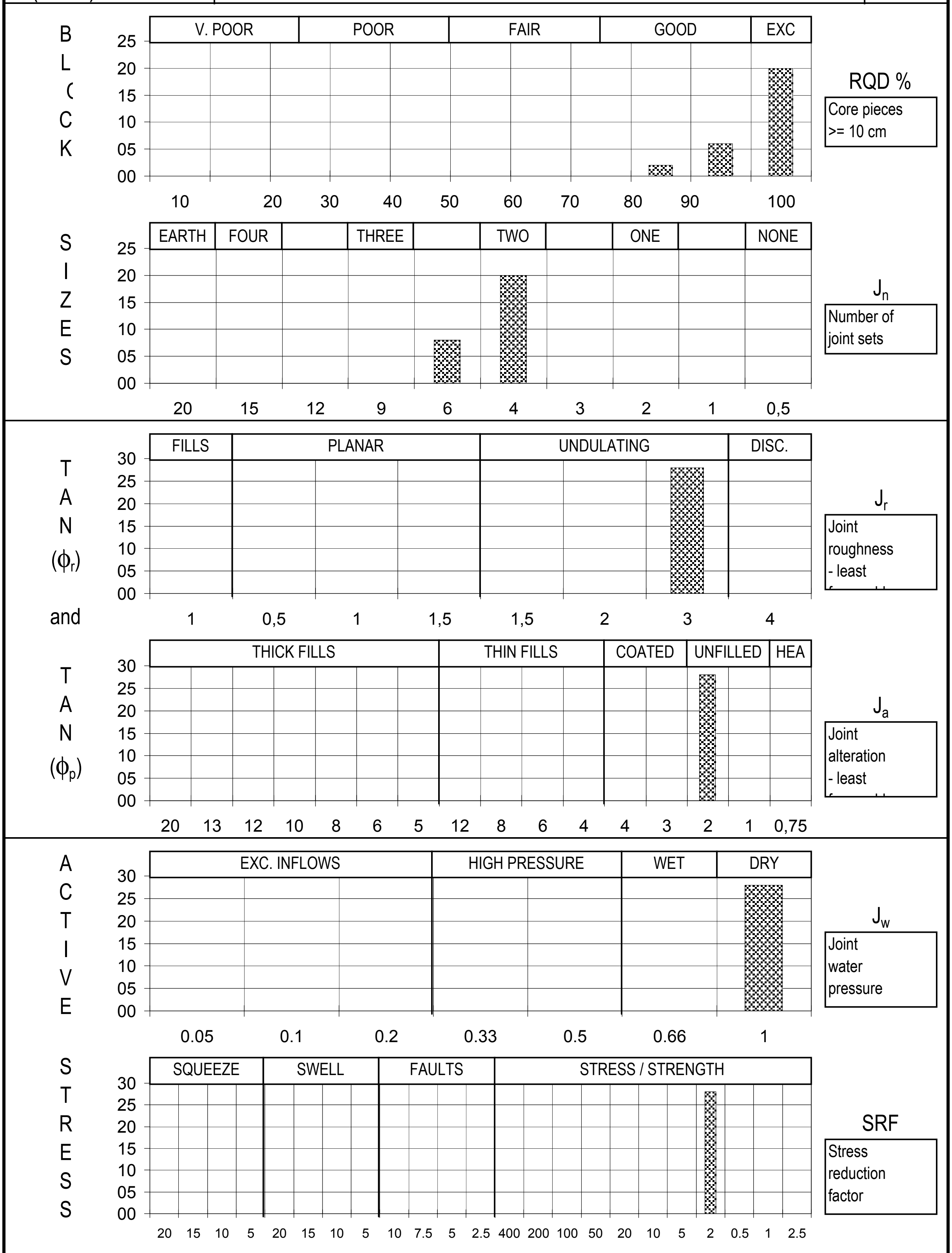
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A64
Q - REGISTRATIONS CHART	Block No. : 410	Drawn by AWH	Date 12.06.01
KAS02 480-481m Logged by NGI 2001	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q410_NGI.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.15**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



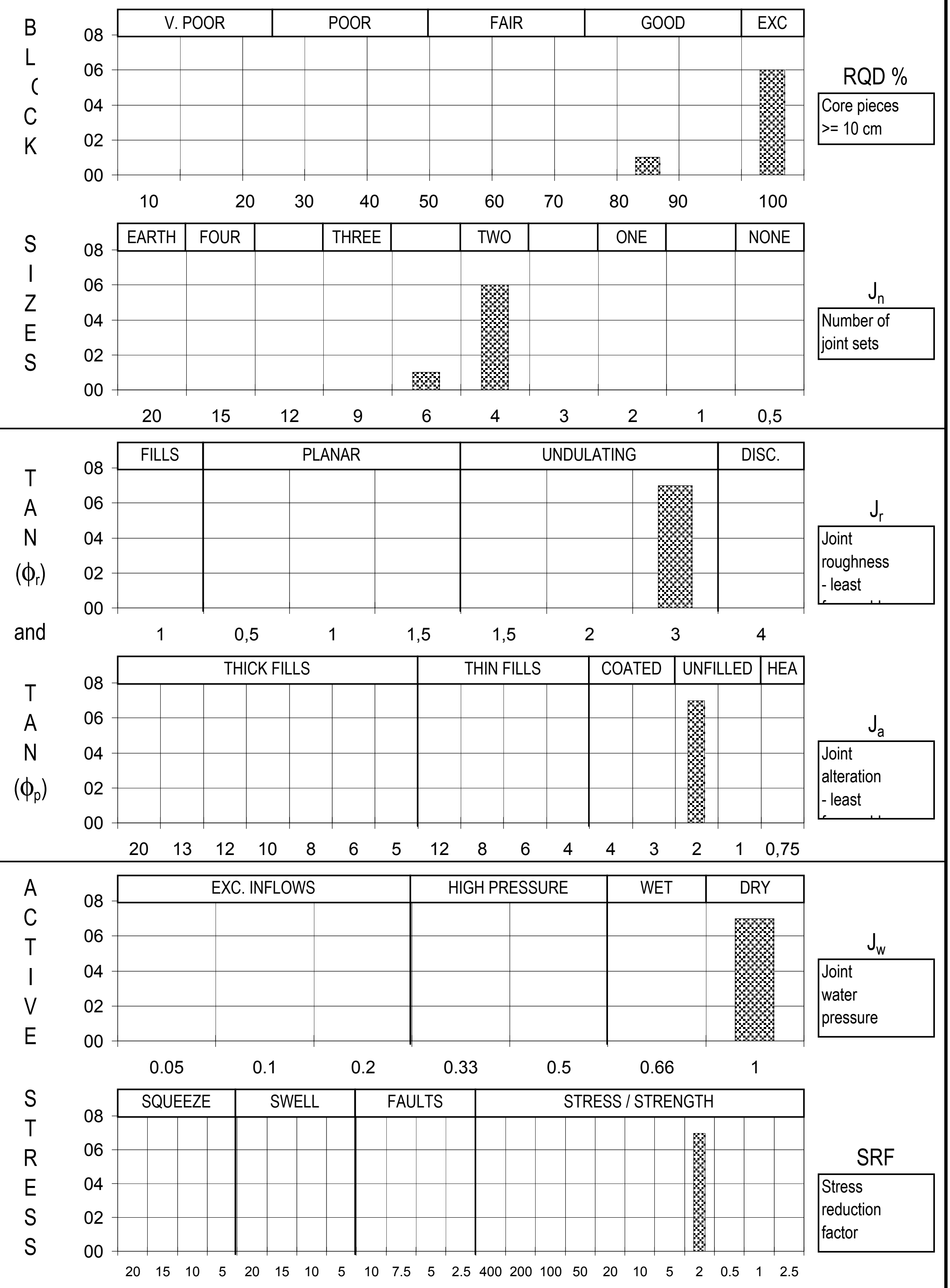
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A65
Q - REGISTRATIONS CHART	Block No. : 422	Drawn by FL	Date 2001-05-18
KA3510A 71-103m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q422.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.6	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.05**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



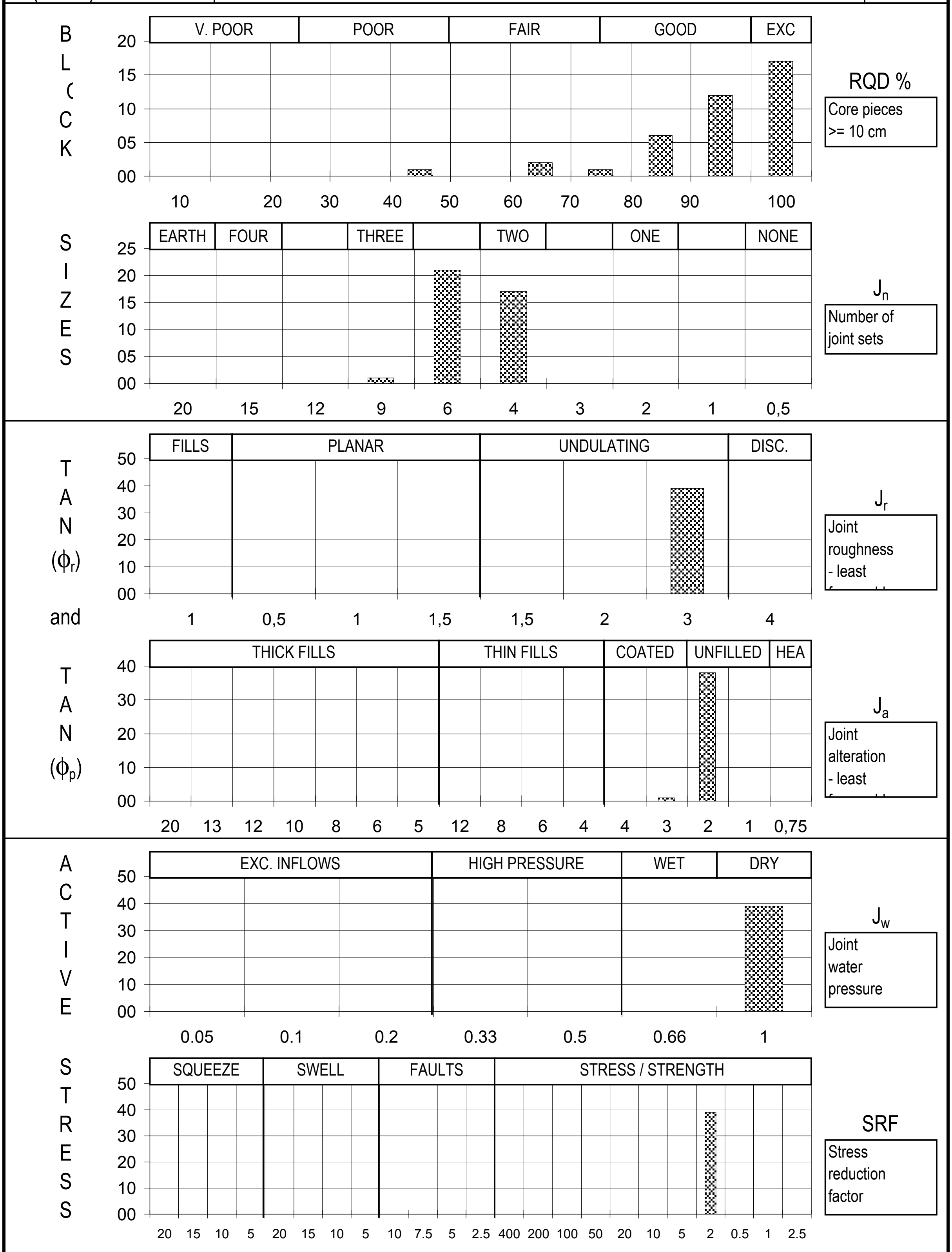
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A66
Q - REGISTRATIONS CHART	Block No. : 423	Drawn by FL	Date 2001-05-18
KA3510A 43-71m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q423.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.13**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



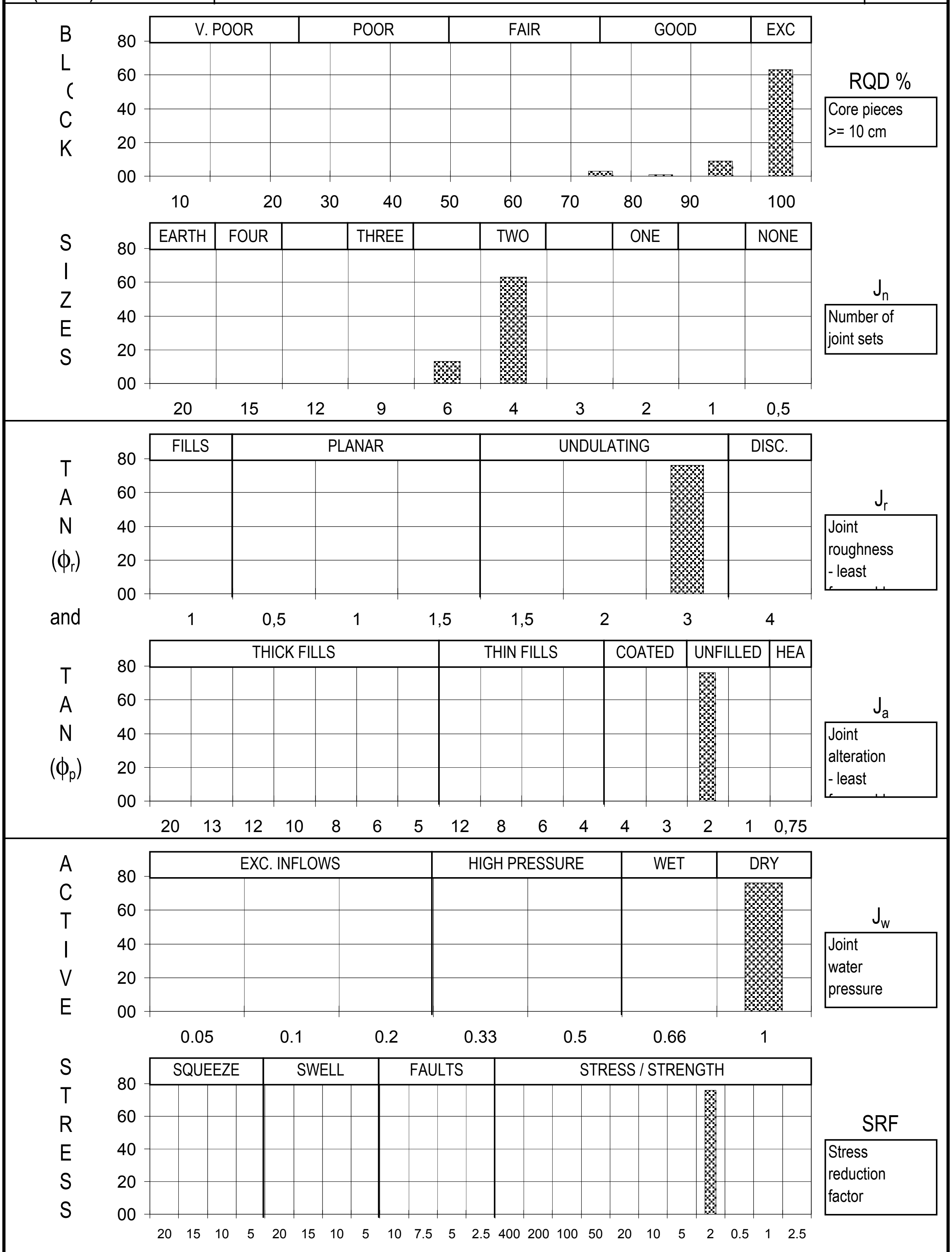
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A67
Q - REGISTRATIONS CHART	Block No. : 444	Drawn by FL	Date 2001-05-18
KI0025F03 45-52m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q444.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	45	/	9.0	*	3.0	/	3.0	*	1.00	/	2.0	=	**2.500**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	92	/	5.2	*	3.0	/	2.0	*	1.00	/	2.0	=	**13.13**
Q (block)=	92	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



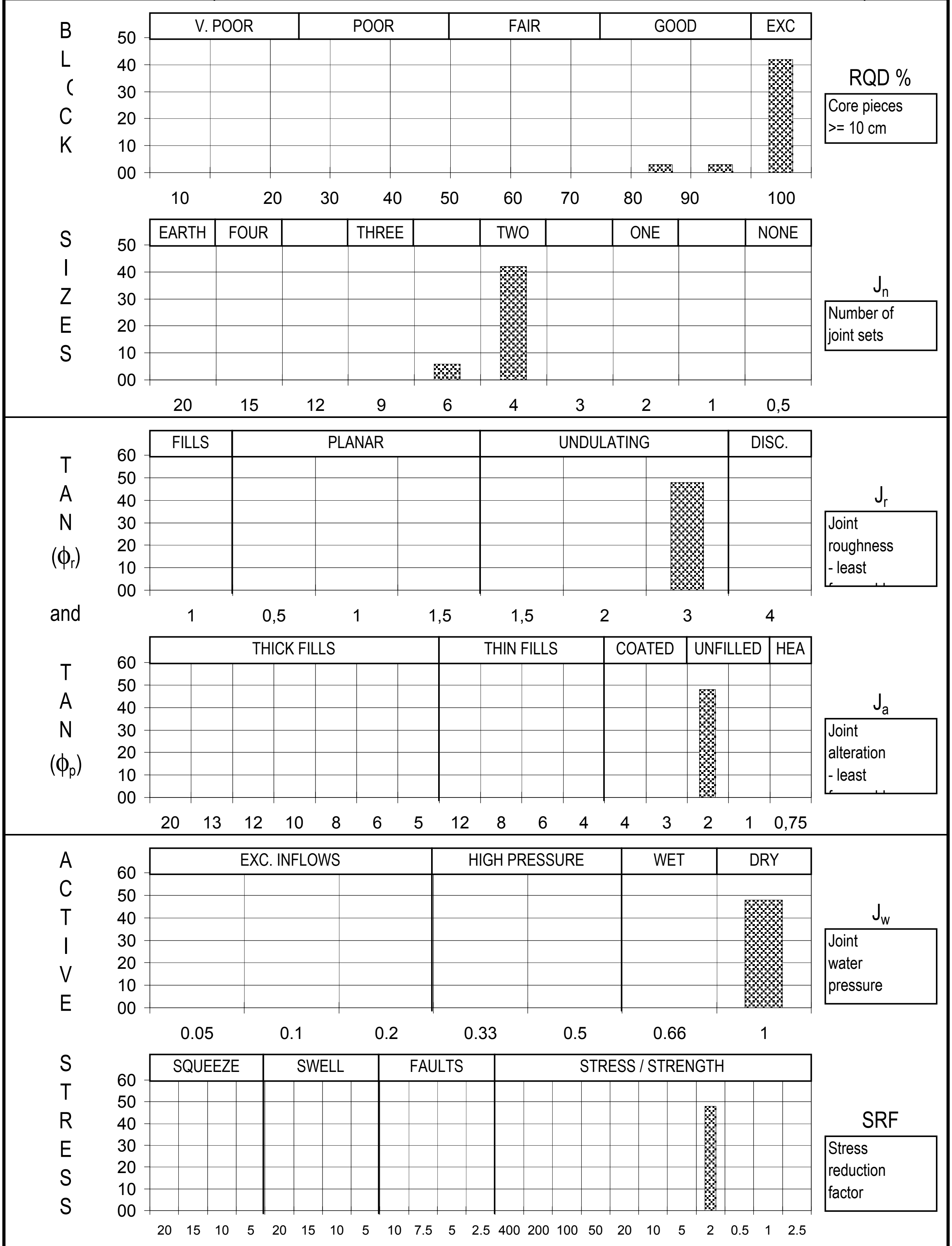
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A68
Q - REGISTRATIONS CHART	Block No. : 462	Drawn by AWH	Date 23.05.01
KA2563A 201-240m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q462.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	75	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**9.375**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	98	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**16.97**
Q (block)=	98	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



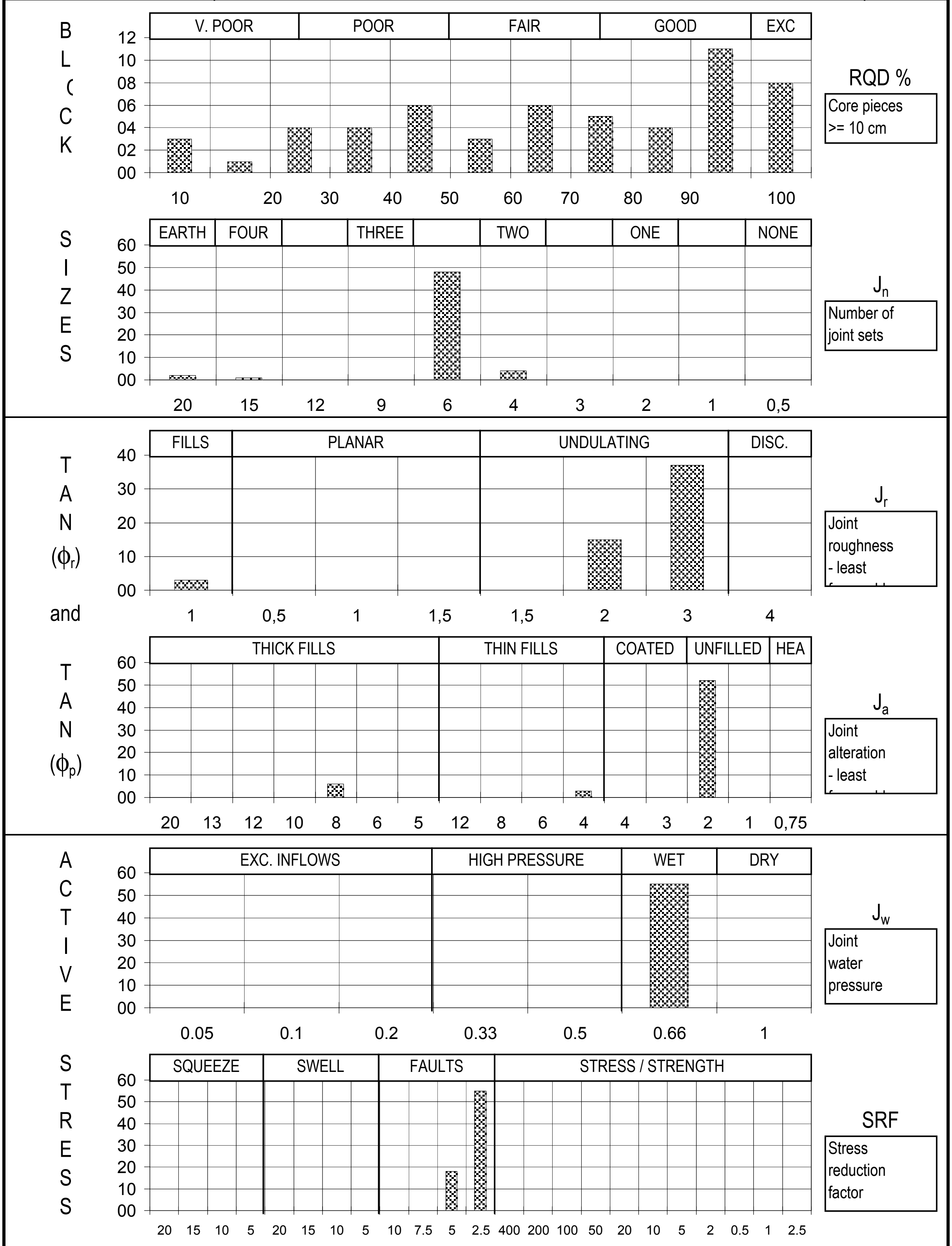
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A69
Q - REGISTRATIONS CHART	Block No. : 463	Drawn by FL/AWH	Date 2001-05-22
KI0025F03 61-92m, KI0025F02 81-85m, KI0023B 63-97m, I	Depth zone (m) 0	Checked	NGI
KA2563A 194-201m	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	85	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**10.625**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**18.8**
Q (mean value)=	99	/	4.3	*	3.0	/	2.0	*	1.00	/	2.0	=	**17.43**
Q (block)=	99	/	6.0	*	3.0	/	2.0	*	1.00	/	2.0	=	**12.00**



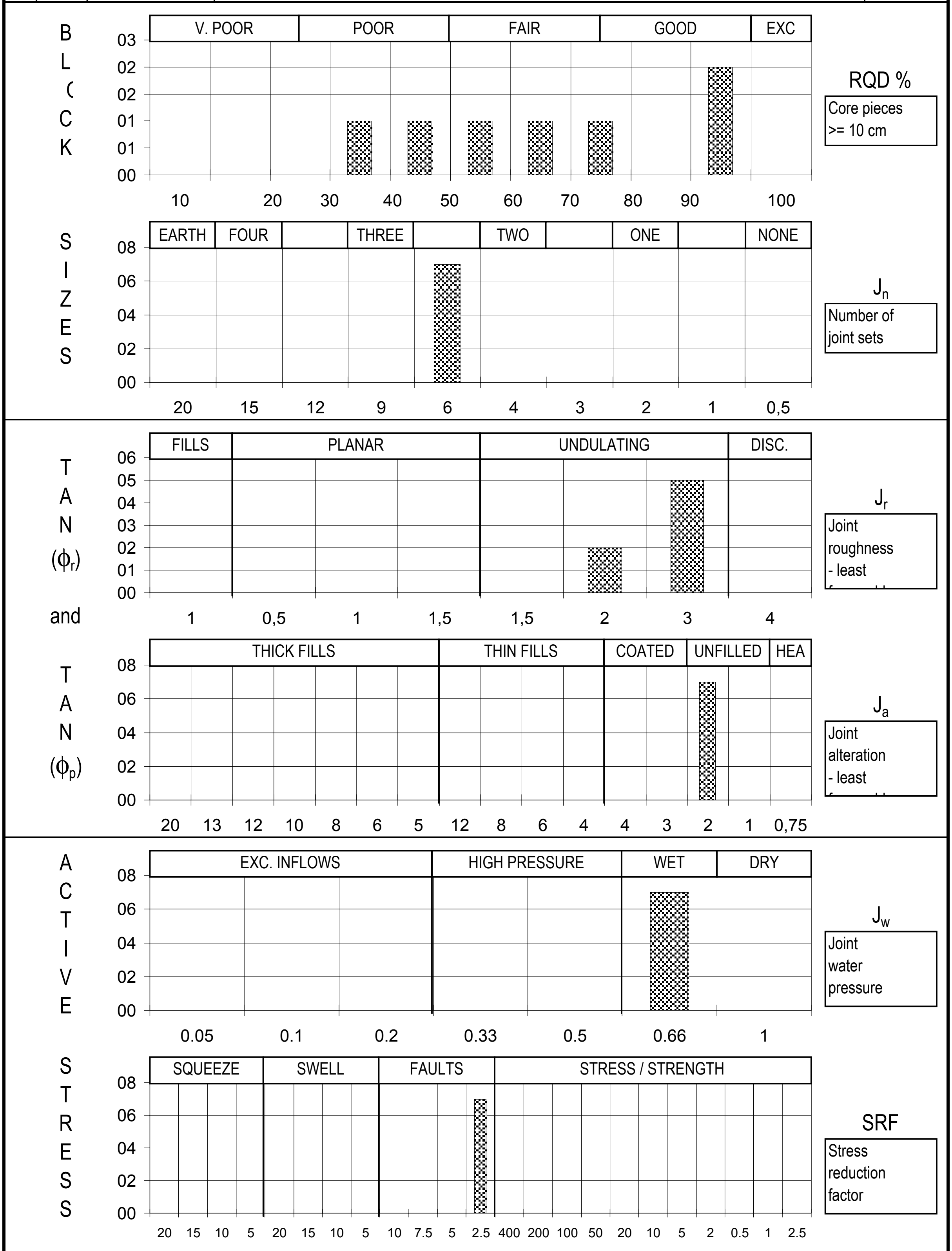
SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A70
Q - REGISTRATIONS CHART	Block No. : 464	Drawn by FL	Date 2001-05-18
KI0025F03 52-61m, KI0025F 65-74m, KI0025F02 51-81m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[Q464.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	10	/	20.0	*	1.0	/	8.0	*	0.66	/	5.0	=	**0.008**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	0.66	/	2.5	=	**9.9**
Q (mean value)=	67	/	6.5	*	2.6	/	2.7	*	0.66	/	3.1	=	**2.11**
Q (zone)=	67	/	6.0	*	2.0	/	4.0	*	0.66	/	2.5	=	**1.47**



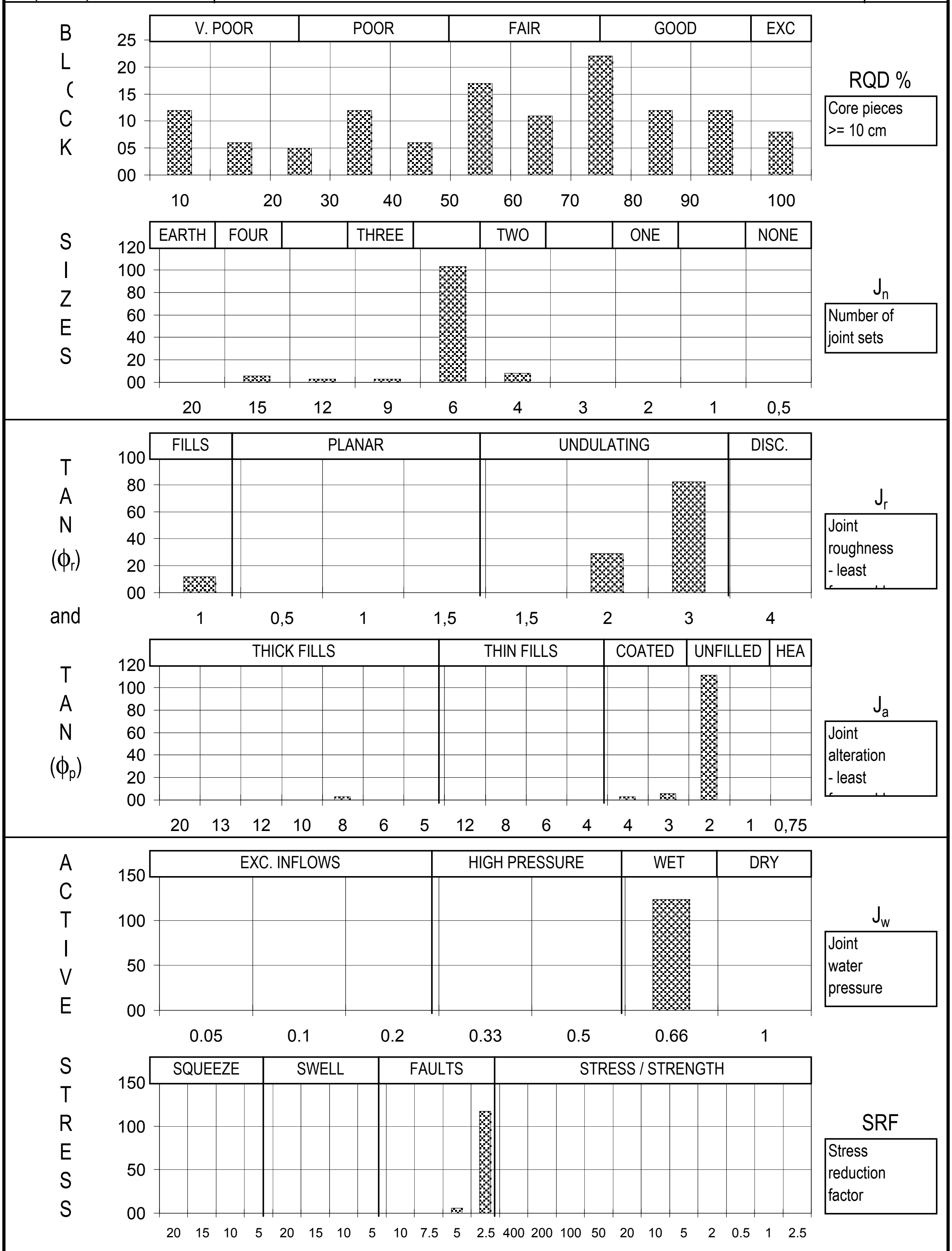
	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A71
Q - REGISTRATIONS CHART	Block No. : EW-1	Drawn by FL	Date 2001-06-12
KAS04 54-70m, 175-190m, KA1755A, 90-100m, 198-210m	Depth zone (m) 0	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[EWtot.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	35	/	6.0	*	2.0	/	2.0	*	0.66	/	2.5	=	**1.540**
Q (typical max)=	95	/	6.0	*	3.0	/	2.0	*	0.66	/	2.5	=	**6.3**
Q (mean value)=	66	/	6.0	*	2.7	/	2.0	*	0.66	/	2.5	=	**3.97**
Q (zone)=	66	/	6.0	*	2.0	/	2.0	*	0.66	/	2.5	=	**2.90**



SKB/Rock mechanical model Äspö	Rev.	Report No. 20011173-1	Figure No. A72
Q - REGISTRATIONS CHART	Block No. : NE-2	Drawn by FL	Date 1900-01-00
NE-2 KAS04 431-438m	Depth zone (m) 431-438	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[NE-2a.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

Q - VALUES:	(RQD	/	Jn)	*	(Jr	/	Ja)	*	(Jw	/	SRF)	=	Q
Q (typical min)=	10	/	15.0	*	1.0	/	8.0	*	0.66	/	5.0	=	**0.011**
Q (typical max)=	100	/	4.0	*	3.0	/	2.0	*	0.66	/	2.5	=	**9.9**
Q (mean value)=	59	/	6.5	*	2.6	/	2.2	*	0.66	/	2.6	=	**2.61**
Q (zone)=	59	/	6.0	*	2.0	/	2.0	*	0.66	/	2.5	=	**2.60**



	Rev.	Report No.	Figure No.
SKB/Rock mechanical model Äspö		20011173-1	A73
Q - REGISTRATIONS CHART	Block No. : NE-1	Drawn by FL	Date 2001-06-12
NE-1 KAS02 805-923m	Depth zone (m) 805-922	Checked	NGI
F:\P\2001\11\20011173\excel\Q-blokker\[NE-1a.xls]Q-chart	Logg 1.0 1997-07-30	Approved	

APPENDIX B – IN SITU STRESS MEASUREMENTS AT ÄSPÖ – SICADA DATABASE JUNE 2001

IDCODE	SECUP	SIGMA_1	DIP_1	BEARING_1	SIGMA_2	DIP_2	BEARING_2	SIGMA_3	DIP_3	BEARING_3	SIGMA_ HORI_MAX	BEARING_ HORI_MAX	SIGMA_ HORI_MIN	BEARING_ HORI_MIN	THEORETICAL_ SIGMA_V	SIGMA_ VERT	STD_SIGMA_ VERT	NORTHING	EASTING	ELEVATION	COORD_ SYSTEM	COMMENT
KA1045A	16,00	7,70	12,00	140,00	5,40	8,00	49,00	2,60	76,00	287,00						2,90						
KA1045A	16,10	25,30	8,00	27,00	15,00	10,00	118,00	7,20	77,00	257,00												
KA1045A	17,00	8,80	5,00	132,00	5,80	6,00	41,00	2,70	82,00	263,00						2,80						
KA1045A	17,50	8,30	11,00	114,30	5,20	3,00	23,00	1,40	78,00	279,00						1,70						
KA1054A	16,20	16,20	17,00	115,00	7,60	31,00	14,00	3,50	54,00	230,00						5,70						
KA1054A	17,20	11,50	0,00	109,00	7,20	34,00	199,00	-0,40	56,00	18,00						1,90						
KA1054A	18,50	14,50	2,00	119,00	8,80	25,00	28,00	3,30	65,00	214,00						4,30						
KA1192A	14,40	11,50	0,00	67,00	8,00	7,00	337,00	4,40	83,00	159,00	11,50	67,00	8,00	157,00		4,50		6826,120	2119,422	-163,307	ÄSPÖ96	
KA1192A	15,60	15,40	14,00	243,00	12,80	16,00	339,00	7,90	60,00	126,00	15,10	54,00	11,70	144,00		9,30		6824,925	2119,317	-163,266	ÄSPÖ96	
KA1192A	16,20	14,30	30,00	277,00	7,00	56,00	128,00	6,00	15,00	15,00	12,40	98,00	6,10	8,00		8,70						
KA1623A	13,30	19,30	5,00	111,00	18,50	39,00	205,00	8,60	50,00	15,00	19,30	106,00	14,40	16,00	6,00	12,60		7251,398	2011,920	-222,730	ÄSPÖ96	
KA1623A	13,80	15,60	7,00	111,00	10,60	12,00	202,00	6,70	76,00	353,00	15,50	110,00	10,40	20,00	6,00	7,00		7251,211	2011,457	-222,712	ÄSPÖ96	
KA1623A	14,30	15,00	7,00	110,00	9,00	12,00	202,00	6,60	76,00	353,00	14,80	110,00	8,90	20,00	6,00	6,80						
KA1625A	14,10	18,70	26,00	324,00	10,10	54,00	97,00	6,00	23,00	222,00	16,90	140,00	6,70	50,00		11,10		7262,993	2011,078	-222,902	ÄSPÖ96	
KA1625A	14,60	11,80	16,00	318,00	6,40	74,00	123,00	5,10	4,00	227,00	11,40	138,00	5,10	48,00		6,80		7263,148	2010,603	-222,884	ÄSPÖ96	
KA1625A	15,10	12,90	15,00	314,00	7,00	72,00	166,00	5,50	9,00	46,00	12,50	134,00	5,50	44,00		7,30						
KA1626A	12,20	12,30	1,00	111,00	9,10	11,00	201,00	7,60	79,00	17,00	12,30	111,00	9,00	21,00	6,00	7,70		7264,065	2016,390	-222,856	ÄSPÖ96	
KA1626A	12,70	10,80	2,00	313,00	6,60	38,00	44,00	5,00	52,00	220,00	10,80	132,00	6,00	42,00	6,00	5,60		7264,260	2015,931	-222,829	ÄSPÖ96	
KA1626A	13,20	8,60	3,00	3,00	4,40	61,00	210,00	2,30	29,00	23,00	8,60	114,00	2,80	24,00	6,00	3,90		7264,456	2015,471	-222,803	ÄSPÖ96	
KA1899A	12,09	21,30	3,00	143,00	7,90	1,00	53,00	6,60	87,00	305,00	21,20	143,00	7,90	53,00	6,80	6,60		7449,673	2201,728	-256,273	ÄSPÖ96	
KA1899A	12,43	18,70	7,00	146,00	6,90	12,00	237,00	5,90	76,00	27,00	18,50	146,00	6,80	56,00	6,80	6,10		7449,965	2201,553	-256,264	ÄSPÖ96	
KA1899A	12,89	23,90	8,00	143,00	9,40	21,00	50,00	8,10	68,00	252,00	23,60	143,00	9,20	53,00	6,80	8,50		7450,360	2201,318	-256,252	ÄSPÖ96	
KA1899A	13,38	19,20	4,00	149,00	8,40	25,00	58,00	7,20	65,00	247,00	19,10	150,00	8,10	60,00	6,80	7,50		7450,781	2201,067	-256,239	ÄSPÖ96	
KA1899A	13,80	23,30	2,00	148,00	9,80	36,00	56,00	7,20	54,00	240,00	23,30	148,00	8,90	58,00	6,80	8,10		7451,142	2200,852	-256,228	ÄSPÖ96	
KA2198A	12,50	25,80	12,00	133,00	7,90	35,00	34,00	6,00	53,00	238,00	25,00	134,00	7,20	44,00	7,80	7,40		7176,511	2326,907	-294,159	ÄSPÖ96	
KA2198A	13,55	14,20	3,00	137,00	4,40	56,00	230,00	3,50	34,00	45,00	14,20	136,00	3,70	46,00	7,80	4,10		7176,111	2327,878	-294,133	ÄSPÖ96	
KA2198A	14,11	21,90	8,00	126,00	10,50	71,00	241,00	9,00	17,00	33,00	21,60	125,00	9,10	35,00	7,80	10,60		7175,898	2328,395	-294,119	ÄSPÖ96	
KA2198A	14,70	25,10	12,00	132,00	8,50	8,00	41,00	7,00	75,00	278,00	24,30	133,00	8,40	43,00	7,80	7,80						
KA2510A	12,00	34,60	6,00	302,00	21,60	30,00	36,00	16,10	59,00	203,00	34,40	121,00	20,20	31,00	8,80	17,60		7198,678	2017,422	-334,140	ÄSPÖ96	
KA2510A	12,40	27,70	0,00	134,00	14,30	34,00	44,00	9,80	56,00	224,00	27,70	134,00	12,80	44,00	8,80	11,20		7198,309	2017,267	-334,122	ÄSPÖ96	
KA2510A	12,90	24,00	0,00	320,00	14,50	58,00	51,00	6,60	32,00	229,00	24,00	140,00	8,80	50,00	8,80	12,30		7197,849	2017,075	-334,100	ÄSPÖ96	
KA2510A	13,40	25,30	1,00	136,00	12,80	63,00	43,00	7,60	27,00	226,00	25,30	136,00	8,60	46,00	8,80	11,70		7197,388	2016,882	-334,079	ÄSPÖ96	
KA2510A	13,75	24,50	10,00	130,00	12,10	32,00	34,00	6,10	57,00	234,00	24,10	132,00	10,40	42,00	8,80	8,30		7197,065	2016,747	-334,063	ÄSPÖ96	
KA2510A	14,20	21,90	6,00	328,00	10,00	41,00	63,00	5,60	48,00	231,00	21,80	147,00	8,00	57,00	8,80	7,70		7196,650	2016,573	-334,044	ÄSPÖ96	
KA2870A	12,73	41,40	19,00	130,00	24,20	46,00	241,00	10,20	38,00	24,00	39,10	124,00	15,90	34,00		20,82	1,26	7480,526	2223,281	-378,981	ÄSPÖ96	
KA2870A	13,23	39,30	11,00	123,00	27,80	55,00	230,00	9,00	32,00	26,00	38,80	119,00	14,50	29,00		22,84	0,86	7481,020	2223,203	-378,967	ÄSPÖ96	
KA2870A	13,64	27,60	2,00	296,00	15,80	59,00	203,00	5,30	31,00	27,00	27,60	116,00	8,10	26,00		12,92	0,72	7481,425	2223,139	-378,955	ÄSPÖ96	
KA2870A	14,25	36,30	1,00	299,00	15,30	59,00	208,00	6,00	31,00	29,00	36,30	119,00	8,50	29,00		12,77	0,91	7482,027	2223,043	-378,938	ÄSPÖ96	
KA2870A	14,86	36,30	5,00	311,00	15,10	59,00	213,00	7,00	31,00	44,00	36,10	132,00	9,20	42,00		13,11	0,59					
KA3068A	16,18	33,60	11,00	291,00	19,00	13,00	23,00	9,50	73,00	161,00	32,70	109,00	18,50	19,00		10,82	0,46	7339,527	2401,119	-407,588	ÄSPÖ96	
KA3068A	16,50	36,10	15,00	274,00	16,90	19,00	178,00	7,40	65,00	40,00	34,30	96,00	15,80	6,00		10,39	0,89	7339,398	2401,412	-407,572	ÄSPÖ96	
KA3068A	16,85	24,40	17,00	274,00	14,00	19,00	178,00	7,50	64,00	43,00	23,10	98,00	13,20	8,00		9,68	0,70	7339,257	2401,732	-407,555	ÄSPÖ96	
KA3579G	2,04	21,90	39,00	194,00	7,50	29,00	77,00	1,10	38,00	322,00	15,00	25,00	4,60	115,00		10,80		7274,432	1886,664	-450,406	ÄSPÖ96	
KA3579G	2,53	18,90	43,00	196,00	5,30	16,00	91,00		42,00	346,00	9,60	38,00	3,10	128,00		7,30		7274,435	1886,659	-450,896	ÄSPÖ96	
KA3579G	3,99	26,10	49,00	221,00	5,30	30,00	91,00	2,50	26,00	345,00	13,70	47,00	3,70	137,00		16,60		7274,442	1886,644	-452,356	ÄSPÖ96	
KA3579G	4,54	26,70	35,00	222,00	6,80	41,00	94,00	2,40	30,00	335,00	19,80	46,00	3,90	136,00		12,20		7274,445	1886,639	-452,906	ÄSPÖ96	
KA3579G	5,41	26,10	38,00	221,00	10,60	36,00	98,00	8,10	33,00	341,00	20,00	45,00	9,20	135,00		15,70		7274,449	1886,630	-453,776	ÄSPÖ96	
KA3579G	8,00	26,70	43,00	216,00	14,80	21,00	326,00	13,10	40,00	75,00	20,70	32,00	14,30	122,00		19,50		7274,462	1886,604	-456,365	ÄSPÖ96	
KA3579G	20,06	34,50	36,00	191,00	4,00	4,00	284,00	11,40	53,00	18,00	26,40	9,00	17,50	99,00		19,60		7274,522	1886,483	-468,425	ÄSPÖ96	
KA3579G	21,21	29,00	48,00	192,00	15,10	20,00	79,00	11,00	36,00	334,00	20,00	24,00	13,80	114,00		21,40		7274,528	1886,472	-469,575	ÄSPÖ96	
KA3579G	21,70	43,70	33,00	189,00	20,50	6,00	95,00	15,80	57,00	355,00	35,60	10,00	20,40	100,00		23,90		7274,531	1886,467	-470,065	ÄSPÖ96	
KA3579G	22,31	30,40	42,00	179,00	18,20	2,00	88,00	12,70	48,00	356,00	22,60	0,00	18,20	90,00		20,60		7274,534	1886,461	-470,675	ÄSPÖ96	
KAS02	113,00										6,00		4,70			2,90		7270,547	2121,343	-104,926	ÄSPÖ96	Ingen orientering p g a att avtryck ej utfördes.
KAS02	158,00										10,20	138,00	5,90	48,00		4,10		7274,019	2119,769	-149,764	ÄSPÖ96	
KAS02	229,00										10,30	151,00	5,50	61,00		5,90		7279,481	2117,627	-220,521	ÄSPÖ96	
KAS02	233,00										10,30	145,00	5,20	55,00		6,10		7279,789	2117,508	-224,508	ÄSPÖ96	
KAS02	243,00										9,50	160,00	5,40	70,00		6,30		7280,563	2117,206	-234,473	ÄSPÖ96	
KAS02	250,00										10,90	149,00	5,90	59,00		6,50		7281,110	2116,997	-241,448	ÄSPÖ96	
KAS02	280,00										9,10	168,00	5,20	78,00		7,30		7283,482	2116,126	-271,342	ÄSPÖ96	
KAS02	339,00										10,20	150,00	5,70	60,00		8,80		7288,191	2114,706	-330,136	ÄSPÖ96	
KAS02	364,00										10,70	157,00	6,60	67,00		9,50		7290,171	2114,032	-355,049	ÄSPÖ96	
KAS02	381,00										12,30	160,00	6,80	70,00		9,90		7291,547	2113,594	-371,987	ÄSPÖ96	
KAS02	390,00										12,80	121,00	7,00	31,00		10,10		7292,295	2113,359	-380,953	ÄSPÖ96	
KAS02	426,00										17,20	138,00	8,80	48,00		11,10		7295,283	2112,471	-416,818	ÄSPÖ96	
KAS02	495,00										22,90	143,00	13,70	53,00		12,90		7300,722	2111,327	-485,593	ÄSPÖ96	
KAS02	504,00										27,80	144,00	16,00	54,00		13,10		7301,403	2111,214	-494,566	ÄSPÖ96	
KAS02	515,00										23,50		12,60			13,40		7302,237	2111,088	-505,534	ÄSPÖ96	Sprickorientering ej fastställd.
KAS02	547,00										35,10	124,00	19,00	34,00		14,20		7304,736	2110,816	-537,435	ÄSPÖ96	
KAS02	585,00										43,90		23,90			15,20		7307,656	2110,495	-575,321	ÄSPÖ96	Sprickorientering ej fastställd.
KAS02	625,00										41,40	138,00	23,00	48,00		16,20		7310,741	2110,423	-615,202	ÄSPÖ96	
KAS02	661,00										39,90	147,00	22,40	57,00		17,20		7313,453	2110,624	-651,099	ÄSPÖ96	
KAS02	718,00										42,50	112,00	24,40	22,00		18,70		7318,311	2111,155	-707,888	ÄSPÖ96	
KAS02	737,00										40,50		21,00			19,20		7319,970	2111,344	-726,815	ÄSPÖ96	Ej tydlig vertikal spricka.

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IDCODE	SECUP	SIGMA_1	DIP_1	BEARING_1	SIGMA_2	DIP_2	BEARING_2	SIGMA_3	DIP_3	BEARING_3	SIGMA_ HORI_MAX	BEARING_ HORI_MAX	SIGMA_ HORI_MIN	BEARING_ HORI_MIN	THEORETICAL_ SIGMA_V	SIGMA_ VERT	STD_SIGMA_ VERT	NORTHING	EASTING	ELEVATION	COORD_ SYSTEM	COMMENT
KAS03	128,00										5,00		3,60			3,40		7771,943	1799,317	-118,335	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	131,50										5,00	145,00	3,60	55,00		3,40		7772,329	1799,172	-121,810	ÄSPÖ96	
KAS03	149,70										6,80		4,50			6,80		7774,352	1798,363	-139,879	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	153,80										6,80	164,00	4,50	74,00		4,00		7774,806	1798,171	-143,950	ÄSPÖ96	
KAS03	338,10										7,70		5,50			9,00		7796,201	1791,053	-326,860	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	468,50										19,50		10,70			12,40		7811,723	1786,732	-456,259	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	481,40										19,50	160,00	10,70	70,00		12,50		7813,297	1786,213	-469,052	ÄSPÖ96	
KAS03	481,50										20,70		10,90			12,80		7813,310	1786,209	-469,151	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	494,80										20,70	126,00	10,90	36,00		12,90		7814,941	1785,702	-482,341	ÄSPÖ96	
KAS03	501,30										19,40		11,80			13,30		7815,736	1785,459	-488,788	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	515,10										19,40	136,00	11,80	46,00		13,40		7817,428	1784,937	-502,474	ÄSPÖ96	
KAS03	519,70										25,10		11,80			13,80		7817,993	1784,759	-507,036	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	521,60										24,40		12,40			13,80		7818,224	1784,684	-508,920	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	531,20										20,20		10,70			14,10		7819,393	1784,306	-518,441	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	533,20										17,70		9,80			14,10		7819,637	1784,230	-520,425	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	534,00										25,10	144,00	11,80	54,00		13,90		7819,735	1784,199	-521,218	ÄSPÖ96	
KAS03	536,00										24,40	152,00	12,40	62,00		13,90		7819,979	1784,122	-523,202	ÄSPÖ96	
KAS03	536,10										18,00		9,80			14,20		7819,991	1784,118	-523,301	ÄSPÖ96	Sigma_v assumed; data between reports PR 258907 and PR 259008 differ; second breakdown met
KAS03	545,90										20,20	124,00	10,70	34,00		14,20		7821,211	1783,734	-533,017	ÄSPÖ96	
KAS03	547,90										17,70	129,00	9,80	39,00		14,20		7821,463	1783,655	-534,999	ÄSPÖ96	
KAS03	550,90										18,00	130,00	9,80	40,00		14,20		7821,845	1783,532	-537,972	ÄSPÖ96	
KAS03	625,30										19,90		10,00			16,30		7831,435	1780,431	-611,686	ÄSPÖ96	Ingen orientering p g a oexponerad film.
KAS03	664,00										15,10	142,00	8,50	52,00		17,30		7836,535	1778,985	-650,021	ÄSPÖ96	
KAS03	666,00										18,80	144,00	9,60	54,00		17,30		7836,802	1778,919	-652,002	ÄSPÖ96	
KAS03	739,40										26,10	160,00	13,70	70,00		19,20		7846,957	1776,340	-724,650	ÄSPÖ96	
KAS03	819,80										37,90		22,60			21,30		7858,719	1773,371	-804,129	ÄSPÖ96	Inga orienteringar p g a att inga distinkta hydrauliska sprickor erhölls.
KAS03	822,30										43,70		23,00			21,40		7859,094	1773,295	-806,599	ÄSPÖ96	Inga orienteringar p g a att inga distinkta hydrauliska sprickor erhölls.
KAS03	877,40										38,50		21,00			22,80		7867,305	1771,665	-861,059	ÄSPÖ96	Inga orienteringar p g a att inga distinkta hydrauliska sprickor erhölls.
KAS03	880,40										39,50	118,00	21,40	28,00		22,90		7867,751	1771,579	-864,025	ÄSPÖ96	
KAS03	885,40										43,00	157,00	22,60	67,00		23,00		7868,494	1771,441	-868,967	ÄSPÖ96	
KAS03	893,30										46,30		24,30			23,20		7869,670	1771,228	-876,776	ÄSPÖ96	Inga orienteringar p g a att inga distinkta hydrauliska sprickor erhölls.
KAS03	962,80										48,50	115,00	24,90	25,00		25,00		7880,177	1769,003	-945,441	ÄSPÖ96	
KAS05	195,30	10,30	13,90	268,00	2,40	9,40	0,40	1,50	73,20	123,40	9,80	87,70	2,40	177,70	5,30	2,00		7229,533	2064,652	-185,680	ÄSPÖ96	
KAS05	196,60	10,20	23,80	234,10	7,90	13,80	137,90	3,90	62,00	20,30	9,30	68,10	7,60	158,10	5,30	5,10		7229,400	2064,690	-186,973	ÄSPÖ96	
KAS05	197,40	13,40	17,40	273,10	8,40	70,30	64,30	4,90	8,90	180,30	12,90	91,90	5,00	1,90	5,30	8,70		7229,319	2064,713	-187,768	ÄSPÖ96	
KAS05	355,00	20,20	43,40	261,60	14,40	38,10	123,60	-0,70	22,50	14,70	17,00	100,50	1,90	10,50	9,60	14,90		7212,976	2069,616	-344,441	ÄSPÖ96	
KAS05	355,90	16,20	76,20	86,80	10,10	10,90	305,00	-3,00	8,30	213,40	10,30	122,70	-2,60	32,70	9,60	15,60		7212,879	2069,645	-345,335	ÄSPÖ96	
KAS05	356,80	10,80	10,90	281,40	5,40	77,00	135,10	-0,70	7,00	12,80	10,60	102,20	-0,60	12,20	9,60	5,50		7212,782	2069,673	-346,230	ÄSPÖ96	
KAS05	357,70	17,70	2,70	102,90	4,90	71,90	201,30	2,10	17,80	12,00	17,70	102,80	2,30	12,80	9,70	4,70		7212,685	2069,702	-347,124	ÄSPÖ96	
KK0045G01	2,24	17,50	38,00	186,00	4,90	52,00	13,00	0,80	4,00	279,00	12,70	187,00	0,80	97,00	11,00	9,70		7236,834	2259,531	-418,596	ÄSPÖ96	
KK0045G01	2,70	18,80	36,00	228,00	9,80	37,00	350,00	5,20	33,00	110,00	15,20	38,00	7,10	128,00	11,00	11,50		7236,833	2259,532	-419,056	ÄSPÖ96	
KK0045G01	3,33	17,30	41,00	199,00	6,80	41,00	338,00	4,00	22,00	89,00	12,50	13,00	4,60	103,00	11,00	10,90		7236,831	2259,534	-419,686	ÄSPÖ96	
KK0045G01	4,12	15,30	33,00	171,00	7,40	57,00	351,00	3,90	0,00	81,00	12,90	171,00	3,90	81,00	11,00	9,80		7236,830	2259,535	-420,476	ÄSPÖ96	
KK0045G01	4,53	20,10	32,00	184,00	14,60	36,00	301,00	11,10	38,00	66,00	18,20	174,00	12,80	84,00	11,00	14,80		7236,829	2259,536	-420,886	ÄSPÖ96	
KK0045G01	5,51	24,10	23,00	162,00	11,00	36,00	270,00	8,30	45,00	47,00	21,80	160,00	9,90	70,00	11,00	11,70		7236,827	2259,538	-421,866	ÄSPÖ96	
KK0045G01	6,07	19,80	38,00	219,00	10,50	10,00	316,00	7,00	51,00	59,00	15,10	33,00	10,30	123,00	11,00	11,90		7236,826	2259,539	-422,426	ÄSPÖ96	
KK0045G01	6,50	14,20	52,00	192,00	5,50	30,00	54,00	5,10	21,00	311,00	8,70	14,00	5,20	104,00	11,00	10,90		7236,825	2259,540	-422,856	ÄSPÖ96	
KK0045G01	8,16	15,10	47,00	219,00	6,40	6,00	123,00	3,20	43,00	28,00	8,90	46,00	6,30	136,00	11,00	9,50		7236,822	2259,543	-424,516	ÄSPÖ96	
KK0045G01	31,67	27,10	7,00	348,00	19,10	29,00	254,00	7,20	60,00	90,00	26,90	171,00	16,80	81,00	11,00	10,50		7236,775	2259,590	-448,026	ÄSPÖ96	
KK0045G01	34,77	26,10	48,00	300,00	17,30	10,00	41,00	8,90	40,00	139,00	18,30	75,00	15,20	165,00	11,00	18,80		7236,768	2259,597	-451,126	ÄSPÖ96	
KK0045G01	35,48	18,10	59,00	303,00	12,30	9,00	48,00	5,00	30,00	143,00	12,50	60,00	8,10	150,00	11,00	14,70		7236,767	2259,598	-451,836	ÄSPÖ96	
KK0045G01	62,82	28,40	77,00	202,00	13,90	10,00	64,00	5,90	8,00	333,00	14,30	60,00	6,30	150,00	11,00	27,50		7236,712	2259,653	-479,176	ÄSPÖ96	
KK0045G01	63,59	23,60	67,00	278,00	16,80	19,00	61,00	10,40	13,00	155,00	17,60	70,00	11,00	160,00	11,00	22,20		7236,711	2259,654	-479,946	ÄSPÖ96	
KK0045G01	64,51	33,40	54,00	264,00	20,30	27,00	39,00	12,20	22,00	141,00	23,90	63,00	14,20	153,00	11,00	27,80		7236,709	2259,656	-480,866	ÄSPÖ96	
KXZSD81HR	0,90	21,80	75,00	316,00	9,20	12,00	173,00	2,60	9,00	81,00	9,80	168,00	3,00	78,00		20,80		7281,087	2255,066	-416,159	ÄSPÖ96	
KXZSD81HR	1,40	11,50	75,00	322,00	9,30	14,00	167,00	1,20	6,00	76,00	9,40	165,00	1,30	75,00		11,20		7281,551	2254,895	-416,237	ÄSPÖ96	
KXZSD81HR	2,70	14,50	57,00	344,00	12,90	32,00	173,00	3,80	5,00	81,00	13,30	171,00	3,80	81,00		14,00		7282,756	2254,452	-416,438	ÄSPÖ96	
KXZSD81HR	3,30	14,50	60,00	324,00	12,10	26,00	177,00	4,40	15,00	80,00	12,60	168,00	5,00	78,00		13,40		7283,313	2254,247	-416,531	ÄSPÖ96	

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IDCODE	SECUP	SIGMA_1	DIP_1	BEARING_1	SIGMA_2	DIP_2	BEARING_2	SIGMA_3	DIP_3	BEARING_3	SIGMA_ HORI_MAX	BEARING_ HORI_MAX	SIGMA_ HORI_MIN	BEARING_ HORI_MIN	THEORETICAL_ SIGMA_V	SIGMA_ VERT	STD_SIGMA_ VERT	NORTHING	EASTING	ELEVATION	COORD_ SYSTEM	COMMENT
KXZSD8HL	23,40	18,30	35,00	337,00	9,60	39,00	212,00	5,10	32,00	92,00	15,00	166,00	6,70	76,00		11,20		7253,998	2265,805	-411,808	ÄSPÖ96	
KXZSD8HL	24,10	19,70	19,00	357,00	9,10	16,00	262,00	7,20	65,00	134,00	18,40	178,00	8,90	88,00		8,70		7253,358	2266,065	-411,697	ÄSPÖ96	
KXZSD8HL	24,80	20,20	20,00	351,00	9,10	61,00	220,00	5,90	20,00	89,00	18,80	173,00	6,40	83,00		10,10		7252,717	2266,325	-411,587	ÄSPÖ96	
KXZSD8HL	25,40	23,20	25,00	355,00	12,10	35,00	104,00	9,20	44,00	238,00	21,00	172,00	10,90	82,00		12,70		7252,168	2266,548	-411,492	ÄSPÖ96	
KXZSD8HR	1,30		29,00	182,00		60,00	343,00		8,00	87,00		180,00		90,00				7281,540	2255,265	-416,328	ÄSPÖ96	
KXZSD8HR	1,70	17,60	68,00	291,00	14,10	15,00	160,00	4,70	16,00	66,00	14,40	154,00	5,70	64,00		16,30		7281,902	2255,109	-416,395	ÄSPÖ96	
KXZSD8HR	2,40		67,00	327,00		21,00	170,00		8,00	77,00		165,00		75,00				7282,536	2254,836	-416,513	ÄSPÖ96	
KXZSD8HR	4,10	12,60	19,00	359,00	10,70	68,00	146,00	2,00	11,00	264,00	12,40	175,00	2,30	85,00		10,60		7284,075	2254,173	-416,800	ÄSPÖ96	
KXZSD8HR	6,00	23,50	12,00	345,00	18,30	78,00	167,00	7,70	0,00	75,00	23,20	165,00	7,70	75,00		18,60		7285,795	2253,433	-417,120	ÄSPÖ96	
KXZSD8HR	6,60		58,00	342,00		32,00	160,00		1,00	251,00		161,00		71,00				7286,338	2253,199	-417,221	ÄSPÖ96	
KXZSD8HR	12,90	24,10	5,00	316,00	12,50	55,00	54,00	5,00	34,00	223,00	24,00	136,00	7,40	46,00		10,30		7292,042	2250,742	-418,283	ÄSPÖ96	
KXZSD8HR	14,30	21,50	3,00	348,00	13,00	6,00	78,00	6,80	83,00	233,00	21,40	168,00	12,90	78,00		6,90		7293,309	2250,197	-418,518	ÄSPÖ96	
KXZSD8HR	15,60	17,10	8,00	337,00	13,30	14,00	245,00	4,90	73,00	96,00	16,80	162,00	12,70	72,00		5,70		7294,486	2249,690	-418,737	ÄSPÖ96	
KXZSD8HR	17,60	19,50	18,00	355,00	12,40	70,00	200,00	4,10	8,00	87,00	18,70	176,00	4,30	86,00		13,00		7296,297	2248,910	-419,074	ÄSPÖ96	
KXZSD8HR	18,90	18,40	6,00	341,00	8,70	43,00	77,00	6,80	46,00	245,00	18,30	160,00	7,80	70,00		7,90		7297,473	2248,403	-419,293	ÄSPÖ96	
KXZSD8HR	19,60	21,00	6,00	318,00	13,30	76,00	205,00	8,50	13,00	49,00	20,90	138,00	8,80	48,00		13,10		7298,107	2248,130	-419,411	ÄSPÖ96	
KXZSD8HR	20,20	20,90	4,00	343,00	15,80	58,00	80,00	11,90	32,00	251,00	20,80	162,00	13,00	72,00		14,80		7298,650	2247,896	-419,512	ÄSPÖ96	
KXZSD8HR	20,90	15,60	35,00	360,00	10,10	55,00	172,00	4,40	4,00	267,00	13,70	178,00	4,40	88,00		12,00		7299,284	2247,623	-419,630	ÄSPÖ96	
KXZSD8HR	21,50	11,90	35,00	173,00	8,20	26,00	283,00	2,50	44,00	41,00	10,10	150,00	6,00	60,00		6,60		7299,827	2247,389	-419,732	ÄSPÖ96	
KXZSD8HR	22,20	12,40	37,00	136,00	6,50	46,00	278,00	3,70	20,00	30,00	10,20	130,00	4,10	40,00		8,20		7300,461	2247,116	-419,849	ÄSPÖ96	
KXZSD8HR	22,90	14,90	29,00	116,00	9,10	58,00	323,00	4,00	12,00	213,00	13,60	120,00	4,20	30,00		10,20		7301,095	2246,844	-419,967	ÄSPÖ96	
KZ0059B	7,77	23,90	18,00	148,00	12,30	70,00	295,00	7,40	10,00	54,00	22,90	147,00	7,50	57,00				7287,634	2253,654	-416,279	ÄSPÖ96	
KZ0059B	8,33	29,80	0,00	160,00	17,70	88,00	253,00	11,10	2,00	7000,00	29,80	160,00	11,10	70,00				7288,161	2253,464	-416,260	ÄSPÖ96	
KZ0059B	9,05	18,30	8,00	329,00	12,10	81,00	181,00	5,10	5,00	60,00	18,20	150,00	5,10	60,00				7288,838	2253,220	-416,235	ÄSPÖ96	
KZ0059B	12,22	22,00	3,00	332,00	13,80	78,00	75,00	5,30	12,00	242,00	22,00	152,00	5,60	62,00				7291,818	2252,146	-416,124	ÄSPÖ96	
KZ0059B	14,20	29,00	1,00	155,00	17,60	77,00	62,00	10,10	13,00	245,00	29,00	155,00	10,50	65,00				7293,680	2251,475	-416,056	ÄSPÖ96	
KZ0059B	14,72	29,30	3,00	333,00	17,10	84,00	216,00	10,50	5,00	63,00	29,20	153,00	10,50	63,00				7294,169	2251,299	-416,038	ÄSPÖ96	
KA2599G01	107,29										35,80	111,00	20,60					7317,237	2027,183	-450,170		Preliminary field data
KA2599G01	107,79										35,10	133,00	19,80					7317,237	2027,183	-450,662		Preliminary field data
KA2599G01	107,95										35,10	135,00	21,20					7317,237	2027,183	-450,820		Preliminary field data
KF0093A01	32,14	32,50	38,00	307,00	13,80	48,00	96,00	9,70	16,00	204,00	25,30	123,00	9,20	33,00		20,40		7321,454	2028,021	-452,557		Preliminary results - PM_OC-HDL.DOC June 2001
KF0093A01	32,70	36,00	38,00	310,00	17,70	51,00	114,00	8,90	8,00	214,00	29,20	127,00	9,10	37,00		24,30		7321,814	2027,593	-452,539		Preliminary results - PM_OC-HDL.DOC June 2002
KF0093A01	35,38	23,20	10,00	308,00	14,20	30,00	44,00	6,90	58,00	204,00	22,80	125,00	12,30	35,00		9,20		7323,535	2025,540	-452,452		Preliminary results - PM_OC-HDL.DOC June 2003