ÄSPÖLABORATORIET

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Definition and characterisation of the N-S fracture system tunnel sections 1/600m to 2/400m

Relationships to grouted sections – some remarks

W. Kickmaier

June 1993

Supported by NAGRA, Switzerland

SVENSK KÄRNBRÄNSLEHANTERING AB
SWEDISH NUCLEAR FUEL AND WASTE MANAGEMENT CO
BOX 5864 S-102 40 STOCKHOLM
TEL. +46-8-665 28 00 TELEX 13108 SKB TELEFAX +46-8-661 57 19

9603010266 960214
PDR WASTE
WM-11 PDR

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RELATIONSHIPS TO GROUTED SECTIONS - SOME REMARKS -

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DEFINITION AND CHARACTERISATION OF THE N-S FRACTURE SYSTEM TUNNEL SECTIONS 1/600M TO 2/400M

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Dr. W. Kickmaier

Äspö, June 1993

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I Background

In the geological predictions (cf. SKB TR 92-23 and references therein) a system of "NNW"-striking fractures has been postulated. This fracture system is indicated and defined by morphological features, outcrop mapping, the data obtained from boreholes, hydrogeological testing and by some (weak) geophysical evidence.
According to the fracture zone classification scheme used in the predictions, some of the "NNW" fractures built up "minor fracture zones". These fracture zones (or single fractures) are thought intersect the tunnel spiral at various locations. Surface investigations suggest, that this fracture system is probably one of the "main" hydraulic conductors within the group of minor fracture zones. However, it is difficult to predict the location of the "NNW" striking elements and their characteristics at depth.
The spiral of the tunnel has been located "between" fracture zones of the first and second order (major fracture zones), in order to minimise the water inflow and to avoid constructional problems. Thus in spiral sections 1/600m to 2/400m only minor fractures zones are expected. Consequently the fracture zones (or fractures) in this part of the tunnel can be called at least third order fractures. Nevertheless, grouting has to be carried out in various parts of the tunnel. One of the main questions is, if it is possible to evaluate a system of parameters e.g. the geometry of fractures, structural data, mineralogical characteristics of fracture fillings, which predominate in zones of high water inflow (grouted sections).

II Scope of investigations

The tunnel spiral has been "located" between the major fracture zones NE-1 and NE-2. Borehole- and hydrotesting data suggest that "NNW" striking fractures zones (or fractures) are hydraulic conductors, probably in connection with NE-1 or NE-2. Note that in the predictions the term "NNW" includes NW strike directions as well.
A detailed characterisation of the NNW-striking fracture zones and/or a first interpretation of the data set (tunnel section 1/600-2/400m), with respect to the hydraulic importance, were not available. Thus one of the tasks of this work was to increase the knowledge of the "NNW" striking fracture system using tunnel mapping data and to define this system in terms of a strike direction intervals.
The investigations have been concentrated on the "so called" NNW striking fractures of the first tunnel spiral (tunnel meter from ca. 1/600m to 2/400m) as an example of a minor fracture system. Together with Roy Stanfors it has been decided to focus on strike directions between 340^0 and 10^0.

<u>The data were analysed in order to:</u>
- Identification and characterisation of the "NNW" striking fracture system within the first loop of the tunnel.
- General characterisation of grouted sections as an example of high water inflow rates to the tunnel.

and to answer the following basic questions:
- Do any other fracture systems show similar features?

- How does the distribution pattern of the fracture system looks like and is it possible to define zones?
- Does a relation to the grouted zones to the "NNW" fracture system exist?

Most of the time has been spent to work out criteria which define the "NNW" fracture system. The grouted sections were characterised using "TMS-data". Beside the definition of the N-S striking fracture set, attempts to correlate the "NNW" system with zones of enlarged water inflow to the tunnel (grouted sections) have been made.

The preliminary status of the work has to be emphasised, because the available time was limited. Not all data could be considered. Especially the transmissivities calculated from the probehole testing should be used for further interpretations. Effects like the intersections of two fracture sets or the cross-cutting relationships of different rock types (fine grained granite) could not be taken into account. Secondly the structuring and reduction of the database according to the objectives of this study was time consuming. Additionally, SKB-reports could not be reviewed in detail.

This report is thought to be a kind of working paper for further investigations and not a final interpretation of the fracture network system. The following report summarises the results of the investigations performed during 6 weeks (summer 1993).

III SUMMARY

One of the first ideas was to investigate the relationship of the so called "NNW" fracture system (as an example of third order fracture zones or fractures) to zones of major water inflows (grouted sections). For several reasons only some remarks and statements (which still have to be proven) concerning this question can be made.

-- A definition of the term "NNW" and a characterisation of this fracture system was not available. Reviewing the prediction reports the term "NNW" seems to include strike directions varying from NW-N to NNE.

-- The data presented here, demonstrate that it is not likely to handle fractures of this strike interval as one unit.

-- The fracture intensity criteria is the most important one for the mapping of (third order) fracture zones during the routine tunnel mapping. A definition of a third order fracturing in terms of e.g. length, strike conductivity has not been set up until now (SKB work in progress).

Consequently one step was to define the "NNW" system using data collected during the routine mapping. The data presented here demonstrate, that it is possible to define a N-S striking fracture set using criteria like length, mineralogy, spacing or the distribution within a certain tunnel section.
Using the overview maps, which summarise the geology and geohydrology of 150m long tunnel sections, it was impossible to define a NNW fracture system by a set of certain criteria. The data set was splitted in 10°strike intervals; water conducting fractures and so called normal fractures were separated from each other. In order to work out "unique" characteristics of the N-S striking fracture system, some characteristic features of other strike direction intervals have been summarised as well.

The characteristics of the redefined "NNW" system **-now N-S-** (10-340° strike) are summarised at the end of **chapter 5**.
It is possible to handle the fracture set as one group because of characteristic or unique features like the fracture set like the mineralogy, the fracture length, the length distribution and the fracture spacing within the 30° strike direction interval.

- It is suggested that the term "NNW" should not be used any more. Instead, a N-S and probable an E-W to NW fracture system should be introduced. A E-W reps. NW fracture system has not been defined in detail, but the data presented here give some ideas.

- It can be concluded that "single" fractures with averaged spacing of approx. 1-2m are dominating in the N-S fracture system.

- Within tunnel sections 1/600m to 2/400m no evidence for N-S striking fracture zones can be found. Two sections are characterised by an increased N-S fracturing, but there is **no reason to call them fracture zones**.

- It seems, that the zones of an increased N-S fracturing can be traced over distances of at least 200m along strike, indicated by the correspondence of

frequency maxima on tunnel legs A and E, if the minor frequency maxima are considered as well.

- The width of an increased N-S fracturing (swarm-like distribution) varies between 20 and 50m. The horizontal distance (spacing) is estimated approx. 100m (first guess).

- Unfortunately it was impossible to use data from boreholes drilled in E-W direction because structural data were missing.

The grouted sections, as zones of high water inflow were analysed with the idea, that this characterisation will probably result in some criteria which can be used to define the N-S striking fractures system (chapter 5). Based on discussions, it was believed that "NNW" fracture zones contribute significantly to the water inflow.

However, using the data from the grouted sections, it was impossible to define the N-S striking fracture system by characteristic features. Unfortunately this part was carried out at the beginning of this work. Considering the results of chapter 5, it is not surprising that only weak indications for the presence of a N-S fracture system can be found in the grouted sections. The main characteristics of grouted sections are summarised at the end of chapter 3.

Generally the direct correlation of high water inflows and the occurrence of the N-S fracture system is weak **(chapter 6)**.
The frequency of N-S striking fractures in the grouted zones is comparable to the tunnel average. In the first part of the investigated tunnel section a combination of N-S fractures, a general increase of fracturing (mapped fracture zones on Leg-B) and the predominance of E-W (NW) fracture sets can be recognised in grouted sections.
The data available do not allow to estimate (quantitatively) the influence of "single" N-S water conducting fractures to the total water inflow rates. It is believed that, in the middle part of the tunnel section the N-S fracture system is not a major factor within the water conducting fracture network.
In the last section of the tunnel more detailed investigations are needed to relate the water inflow to structural elements. Simple statistical correlation's were calculated, but significant results were not obtained.

For three reasons, the question if the N-S system should be called a minor (third order) fracture system or not, has to be left open:

- A definition of "third order fractures" has not been set up until now (SKB-work in progress).

- For an estimation of the hydraulic importance of the N-S fracture system further investigations have to be carried out (e.g. hydraulic testing of individual N-S striking fractures).

- The characterisation of the N-S striking fracture system and the grouted sections did not left the time, to perform more detailed interpretations or additional underground work.

Nevertheless, to the authors opinion, the definition of fracture groups in terms of narrow strike intervals and a detailed characterisation, has to be the first

step for the interpretation of the complete data set. If fracture sets have been defined in such a way it will be perhaps possible to define "loading factors" of each fracture group within grouted section (factor analyses?).

To test the practicability of the term third order fractures the N-S striking ones are probably not the best example. Instead **NW** striking fractures, forming an oblique fracture set to first and second order fracture zones, should be taken into account.

Although this study is preliminary and many aspects can be improved, it is believed that this work contributes to the characterisation of rock blocks located between major fracture zones at Äspö.

1 INTRODUCTION

1.1 BACKGROUND

The Swedish Nuclear Fuel and Waste Management Company (SKB) is constructing an underground laboratory (HRL) located on the southern part of Äspö. Äspö is an small Island near the Oskarshamn Power Plant Area ca. 30km Oskarshamn on the SE coast of Sweden (Fig. 1).

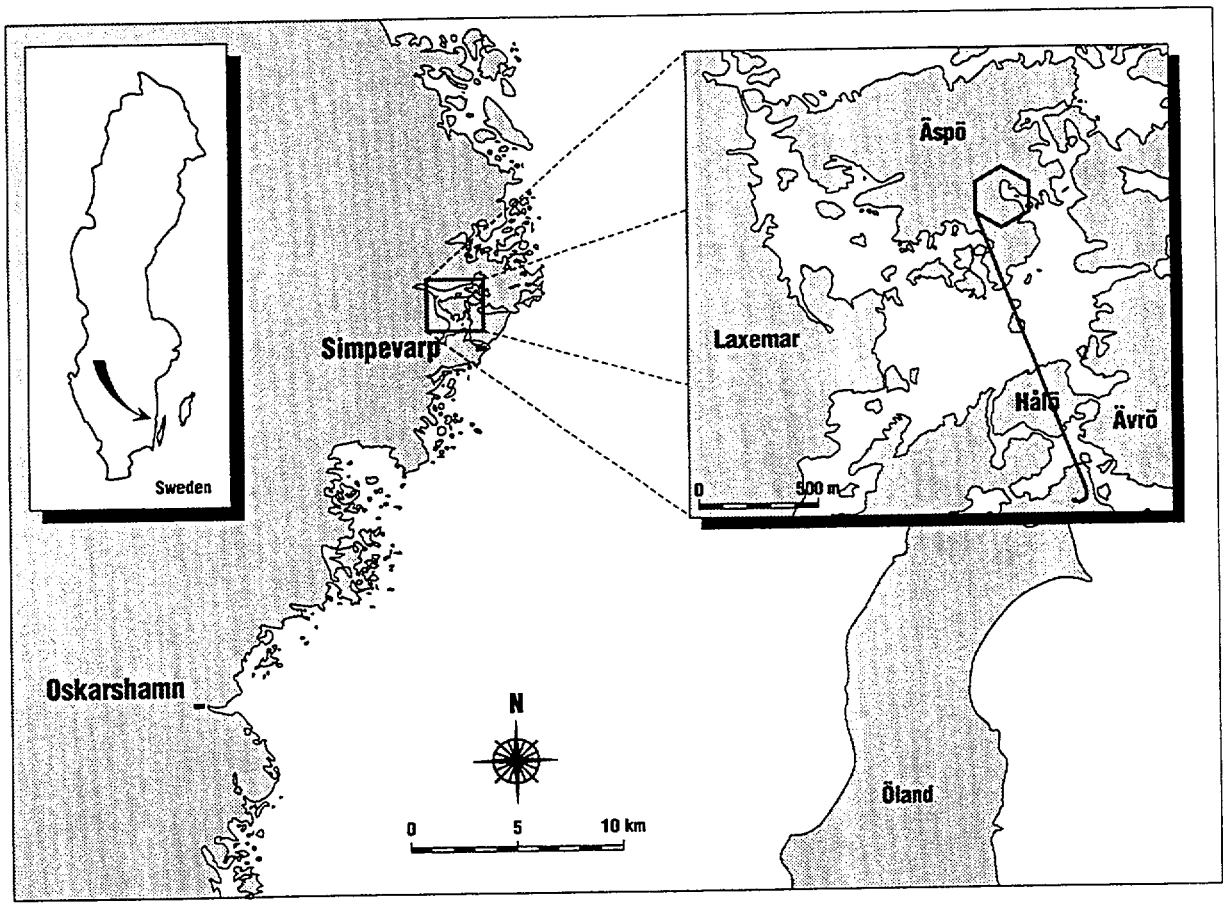


Fig.1: Location of the Äspö Hard Rock Laboratory

The Äspö Hard Rock Laboratory (HRL) project has been subdivided in three phases:

- Pre-investigation phase from 1986 to 1990
- Construction phase from 1990 to 1994
- Operational phase from 1995 to ?

The main objectives of the constructional phase are:

- Verify the pre-investigations methodology
- Finalise the detailed investigation methodology
- Test models of ground water flow and transport of solutes
- Demonstrate construction and handling methods

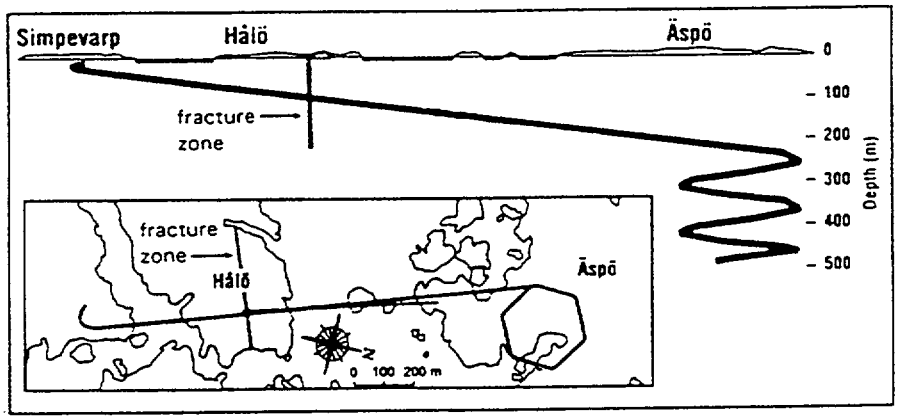
The routine data collection during the construction, including geological mapping, hydrogeological investigations and geochemical sampling is carried within one hour after each blasting. To reach the objectives stated above, additionally data are obtained by supplementary investigations and the observations of numerous boreholes on Äspö Island and the surrounding area.

The data are systematically stored in the GEOTAB database. Details of the data collection system and GEOTAB are presented in several Reports cf. (SKB TR 92-01, PR 25-91-10, PR 25-92-02, and references therein). The results of current work are documented continuously in Technical Notes, Progress Reports, and Technical Reports. Four summarising Technical Reports, documenting the Pre-Investigation phase, have been published .

To reach the laboratory depth of ca. 460m below Äspö Island, it was decided to construct an access tunnel of ca. 3500m length. The first part consists of a northwards directed straight tunnel section (1/580m), plunging with ca. 150° towards 315°N. The entrance of the tunnel has been located on the Simpevarp Peninsula, close to the Nuclear Power Plant Facility, Oskarshamn. The tunnel spiral will reach the final depth of ca. 460m after two loops. Starting from the end of the spiral, the laboratory tunnel and caverns will be excavated.

The cross section of the HRL tunnel is approximately $25m^2$; with each conventional blast ca. 4-6m are excavated ($100-150m^3$). In the turns of the spiral the cross sections is enlarged to ca. $36m^2$.

Up to now (mid of June) the excavation of the first loop, the drilling of the two ventilation shafts and the main shaft to the level of 220m have been realised (Fig. 2). The construction of the second spiral is still in progress and a TBM with 5m diameter will be used for the last turns.



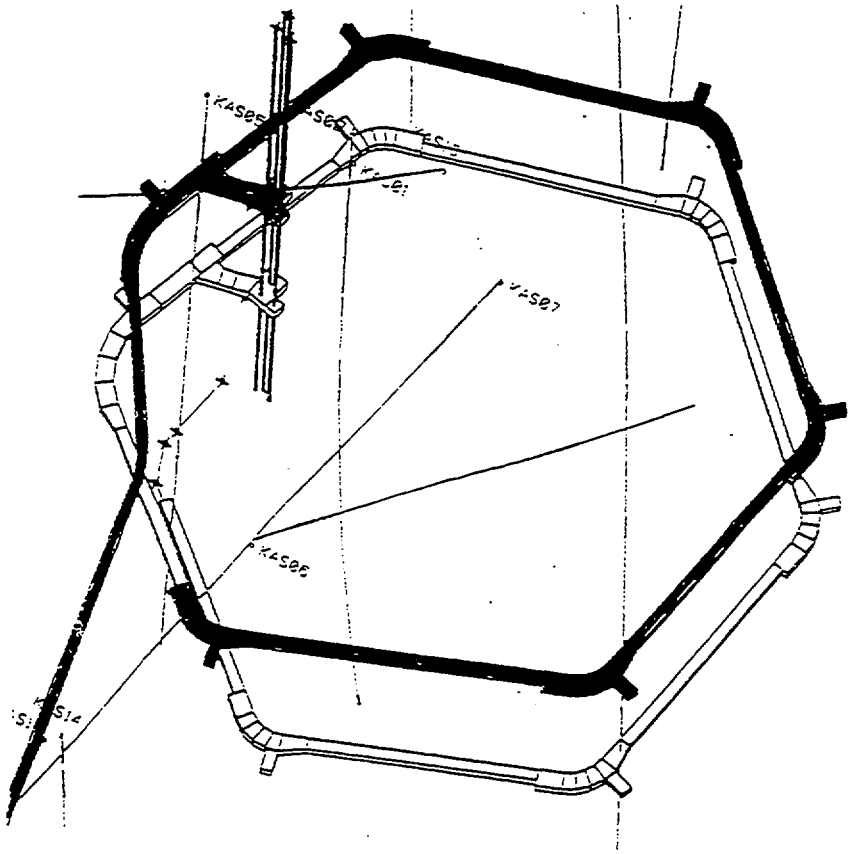


Fig.2: *General layout of the Äspö Hard Laboratory and a perspective view of the tunnel spiral.*

1.2 GEOLOGICAL BACKGROUND

The rocks of the Simpevarp area in the southern part of Sweden belong to the Transscandinavian Igneous Belt extending from SE of Sweden to the Norwegian border. Geological maps of the Simpevarp area are shown in appendix A-1.

Chronologically the crystalline rocks can be divided into:

2000-1850Ma	Meta-andesites and Meta-quarzites (oldest supra-rustal)
1925-1800Ma	Granitic gneiss's (pre-orogenic intrusions) Greenstones

Smaland-Värmland Intrusiva (post-orogenic)

1837Ma	Smaland Porphyr
>1700Ma	Smaland Granite (granite to diorite)
1600-1355Ma	Götemar, Vibro and Uthammar Granite (post-rogenic)

The geological map of Äspö (appendix A-2) demonstrates the predominance of medium grained granite including numerous dikes consisting of fine grained granite. More basic rock types like greenstones and meta-andesites crop out in north-eastwards elongated shaped belts, mainly in the southern part of the island.

The granitic rocks belong to the Smaland-Värmland Intrusive Complex dated between 1800Ma and 1700Ma. The granitic rocks are divided by older, basic rock types which occur in small elongated "massifs" (partly hybridised) and as xenolithes. All the rocks are intruded by several generations of fine grained granites which can partly be related to the intrusion of the post-orogenic Götemar Granite (1600-1455Ma).

In the tunnel the Smaland Granite and Äspö Diorite (Smaland-Värmland Intrusiva) are the dominating rock types (85% of tunnel section 0 to 0/700m). In the field and underground it is often impossible to map them as different rock types, because sharp contacts are missing. The specific weight (<2.63gr/cm^3 => Äspö Diorite) has been defined to distinguish these rock types.

During tunnel mapping the Äspö Diorite can be identified by a generally darker colour and a in homogeneous texture. Greenstones, small massifs of fine grained granite and dikes are also mapped as individual rock types during the construction work. Geochemically the granitic rock suite covers the range from "true" granites to quartz-monzonites and diorites. The main geological events are summarised in appendix A-3.

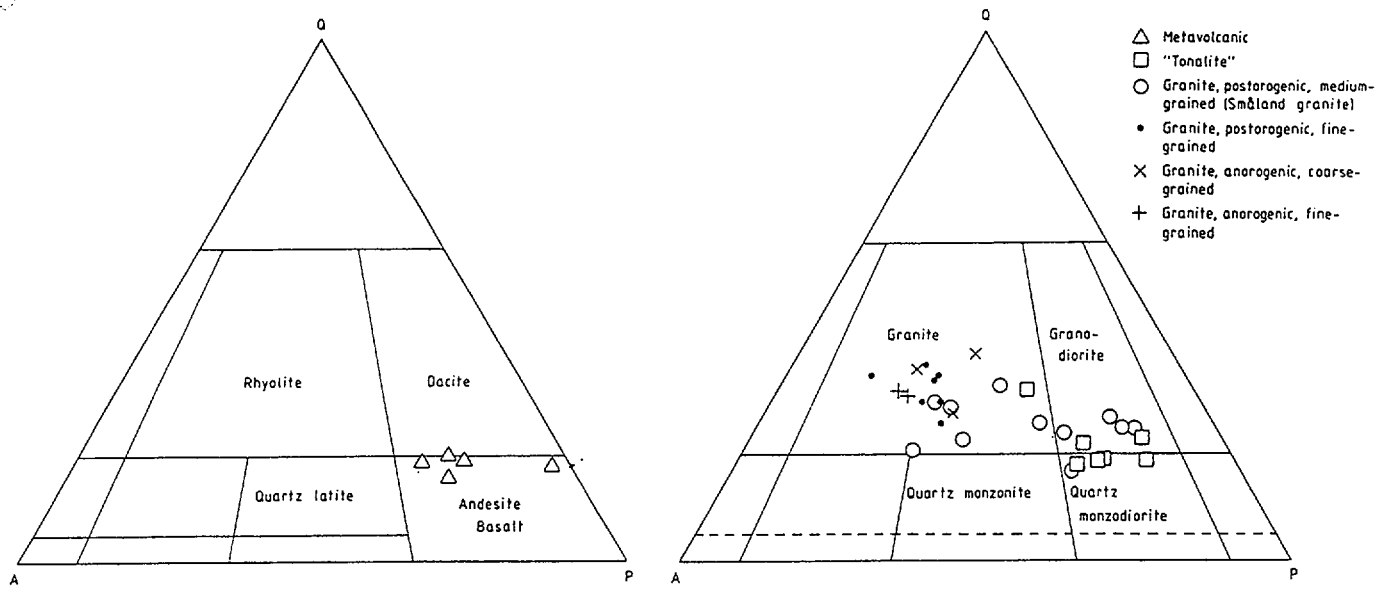


Fig.3: Modal classification of meta-volcanics and granitoids according to IUGS (from: PR 91-22).

1.3 REGIONAL LINEAMENT PATTERN

On regional scale it is possible to define "three classes" of fracture zones.

The first order fracture zone (Fig.4) is an orthogonal developed system of N-S and E-W striking fractures zones extending over tens of km with a widths of several 100 meters, indicated by morphological and strong geophysical evidence. The N-S fracture zones can be correlated with extensional stresses. More complex are the E-W ones, within which mylonites give indications to ductile deformation phases, which have been overprinted by semi-ductile strike slip movements. The Äspö Shear Zone is regarded as a first order fracture zone.

The NW-SE, NE-SW striking fracture system of the second order is orthogonal developed as well (Fig.4). Surface investigations suggest an average extension of 10km and a width of 100 to 200m. Fracture systems of the "third order" striking NNW-SSE (not shown in Fig.4) are considered as a conjugate fracture system to the N-S striking ones.

In the prediction reports, fracture zones have been subdivided in major fracture zones (?= second order fractures; width more than 5m, e.g. NE-1, NE-2) and minor fracture zones (?= third order fracture zones; width less than 5m).

Two first order fracture zones split Äspö Island in four segments. The E-W striking one - the Äspö Shear Zone - divides the island in a northern and a southern block. A lineament study of the Simpevarp area and the classification in blocks of certain order is presented in PR 25-88-01.

Beside the classification according to strike, width and spacing, hydrogeological characteristics (water conducting - yes-no,) and the "level of reliability" were input parameter to define fracture zones. Note that work on the classification and definition of fracture zones and fractures is in progress. During the pre-investigation phase a comprehensive geological, geohydrological and geophysical research program has been carried out. One result is the general tectonic model based on surface mapping, boreholes and geophysical investigations.

Äspö is divided into a southern and northern part by the so-called Äspö Shear Zone. This mylonitic zone has a ENE-WSW strike direction and dips steeply to the north. Morphologically, this first order fracture zone is indicated by a dominant depression. The zone is characterised by an intense fracturing, a strong foliation and mylonitic parts often extending tens of meters (Fig. 5).

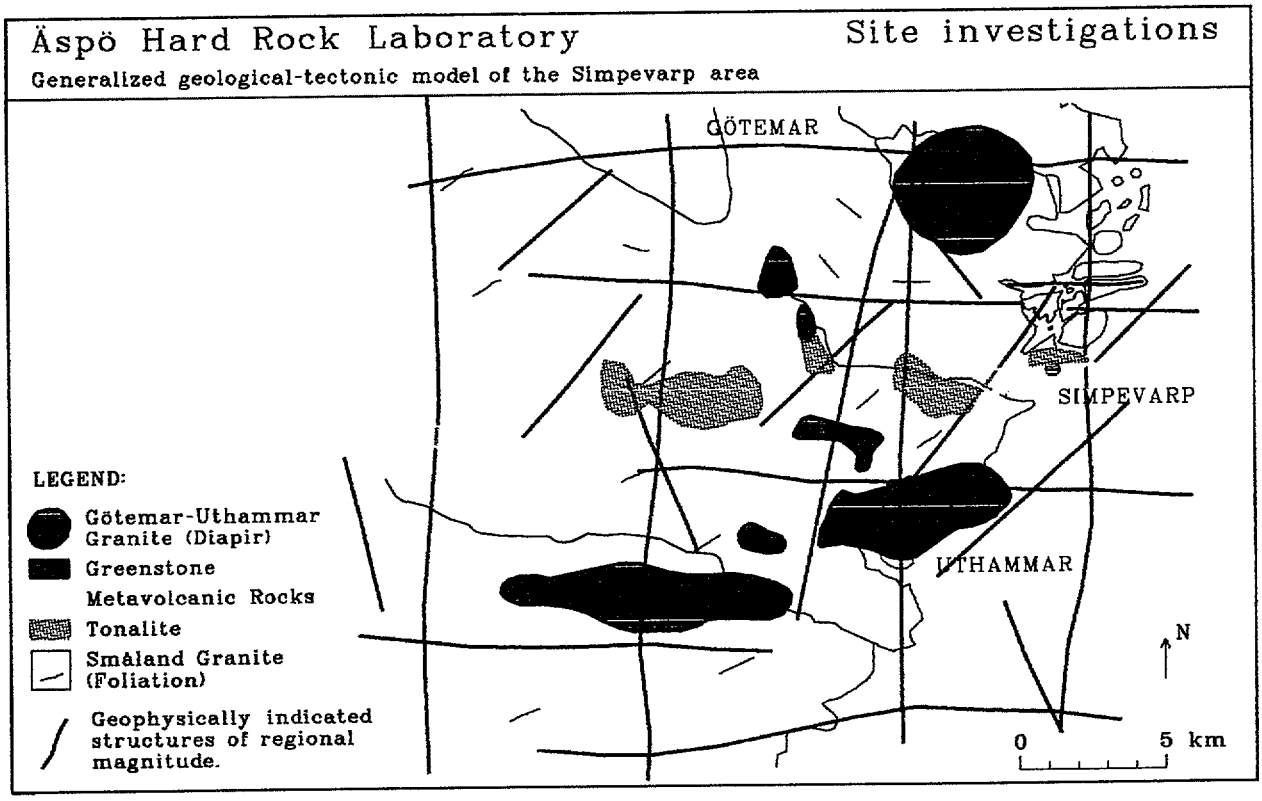


Fig.4: Regional model of major bed rock units and geophysically indicated structures of the Simpevarp area.

Beside this prominent tectonic element north of the HRL, there are several other hydraulically important fracture zones mainly striking E-W and NW. (Fig.6). The dip of these fracture zones varies between 70° and 90°. The width of major fracture zones is generally more than 5 meter (second order fracture zones, major fracture zones).

During the excavation of the northwards directed access tunnel, several of these major fractures zones have been crossed. Intensive investigations have been carried out to characterise major fracture zones. The results have been documented in several reports (e.g. PR 25-92-18, and references therein). Additionally the fracture network of Äspö is characterised by minor, steeply dipping, NNW and NW-striking fracture zones. Fracture mapping on Äspö showed the dominance of the N60°W, N5°W and N60°E directions.

With geological and geophysical methods used during the pre-investigation phase, it was possible to predict the major fracture zones satisfyingly (cf. TR 91-22). In the case of the minor fracture zones however, the extrapolation to a depth of more than 90m is uncertain.

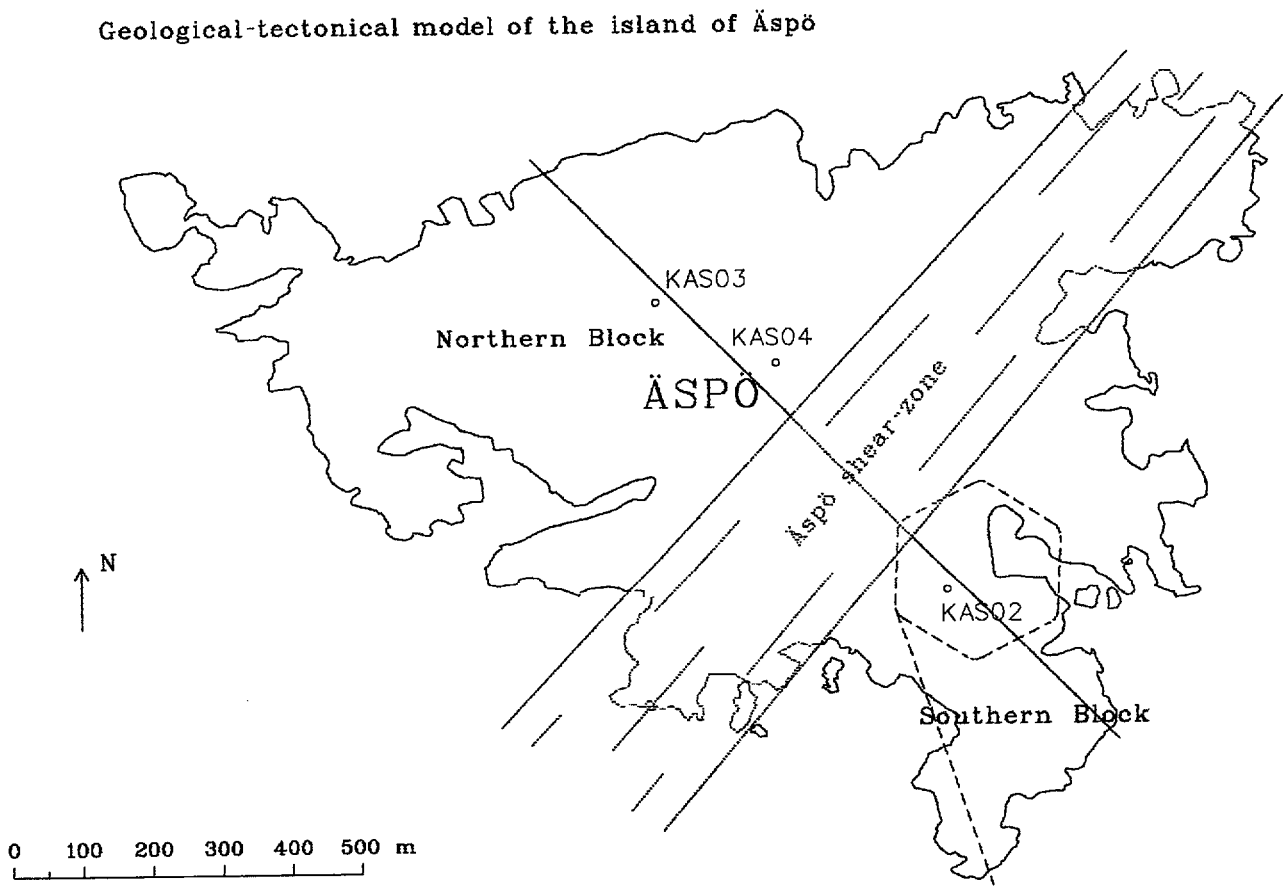


Fig.5: Location of the Äspö shear zone and the HRL.

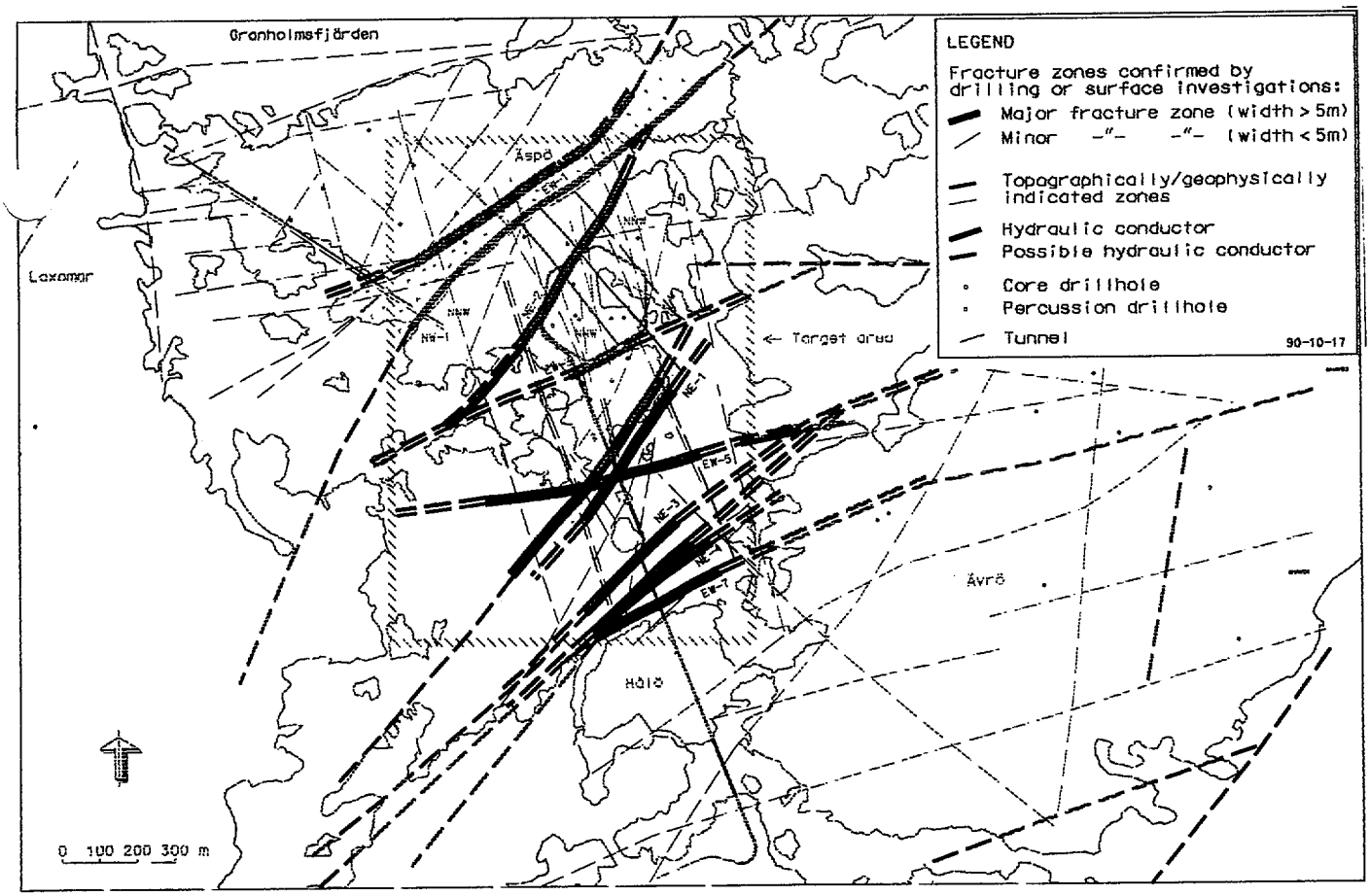


Fig.6: *Generalised geological and tectonic model for Äspö Island based on the pre-investigation phase.*

Some remarks on the fracture classification system used in the predictions *(extracted from SKB TR 91-22)*

The nomenclature of fracture zones in the prediction reports and the geological mapping underground follows the "guidelines for the use of nomenclature of fractures, fracture zones".

According to these guidelines "the term fracture zone is only used if geological field evidence supports the assumption that the intensity of natural fractures in a zone is at least two times the mean fracture intensity in the surrounding rock". To define the level of reliability, separate definitions as "possible, probable and certain are used". The term major fracture zone is used for a feature with a width of more than 5 meters and an extent of several hundred meters. Zones less than 5 meters wide and of restricted extend, are called minor fracture zones.

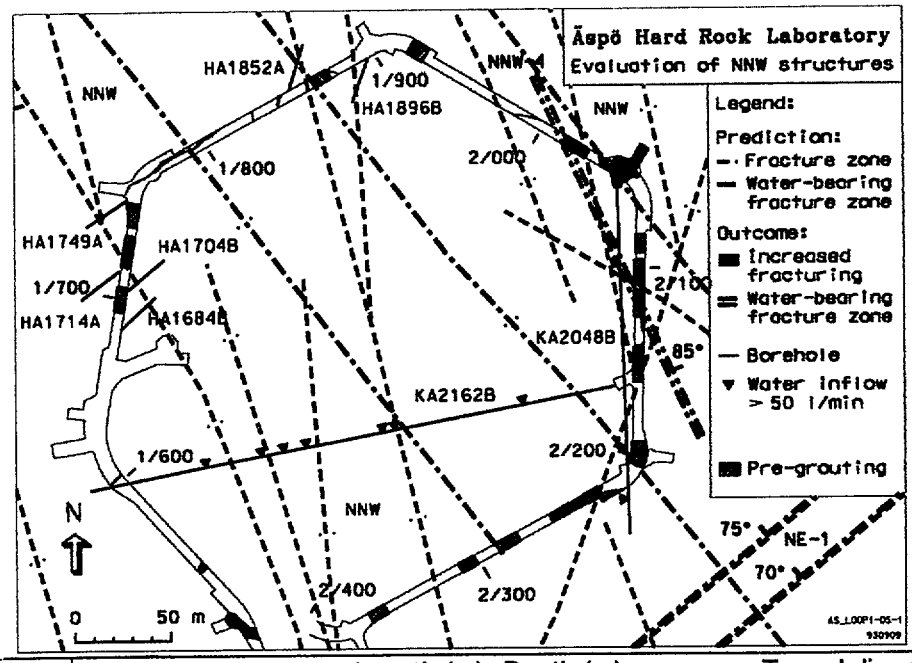
On Äspö several narrow (dm - a few meter wide) fracture zones, striking NNW have been mapped (Fig.6). A few of them are indicated morphologically. Geophysical methods do not allow an unambiguously identification because the zones are too narrow. However VSP, borehole information and hydraulic tests suggest steep dipping, N to NW striking structures.

2 GENERAL CHARACTERISTICS OF THE INVESTIGATED AREA

2.1 OVERVIEW TUNNEL SECTION 1/600 TO 2/000M

During the construction geological and hydrogeological data are summarised to 150m sheets (overview documentation). Those concerning tunnel section 1/600 to 2/400m are presented in appendix B-1. Data of the routine geological mapping, fracture zones and some hydrogeological data are stored in different files of the data base. These files are structured according to the length of blasted sections (ca. 4-5m).

The data which have been used here, include the geological mapping and fracture characteristics like length, fracture minerals and geometry in particular. Within this part of the tunnel section more than 4000 fractures have been mapped (cf. appendix B-2). Every fourth blasting round, two probe holes are drilled to estimate the water inflow of the next 20m of excavation. To minimise the water inflow, pre-grouting is carried out if the water inflow rates exceed a certain level (5l/min).



LEG	Tunnel meter from	to	Length (m)	Depth (m) from	to	Tunnel direction approx.
A	1610	1765	155	-223.4	-239,5	N
B	1765	1910	145	-239,5	-258,5	NE
C	1910	2055	145	-258,5	-277,4	SE
D	2/055	2210	155	-277,4	-296,3	S
E	2210	2365	145	-296,3	-319,3	SW

Fig.7: Layout of the first tunnel loop and location of grouted sections

Fig. 7 shows the general layout of the first spiral loop and the location of the grouted sections. The first loop is approximately 800m long and includes a vertical section of 95m starting at a depth of 223m below surface level. Each leg of the spiral (labelled from A-E) is ca. 150m long. For the investigation of the "NNW" striking fracture system tunnel section 1/600 to 2/400m has been chosen.

2.1.1 ROCK TYPE

In the first loop of the spiral (tunnel section 1/600 to 2/400m) the dominating rock types are the Äspö Diorite (PSF) and the Smaland Granite (PSE) (approximately 80% of the rock mass). Within this section ca. 12% are built up of fine grained granite (HSC). The fine grained granite may locally dominate, but the length of these tunnel sections does not exceed more than 50m. Greenstones (VB) are relatively frequent from tunnel section 1/600 to 1/690m, only. In Fig.8 the rock composition of the main rock types is plotted against the tunnel length. HSC is a major rock type between sections 2010 to 2050m and 2230 to 2250m.

For the interpretation of the fracture distribution pattern and zones of enlarged water inflows, the distribution of HSC is important, because previous investigations suggest, that HSC shows a more brittle behaviour (fracture length, fracture spacing, transmissivities etc.) than the other rock types.

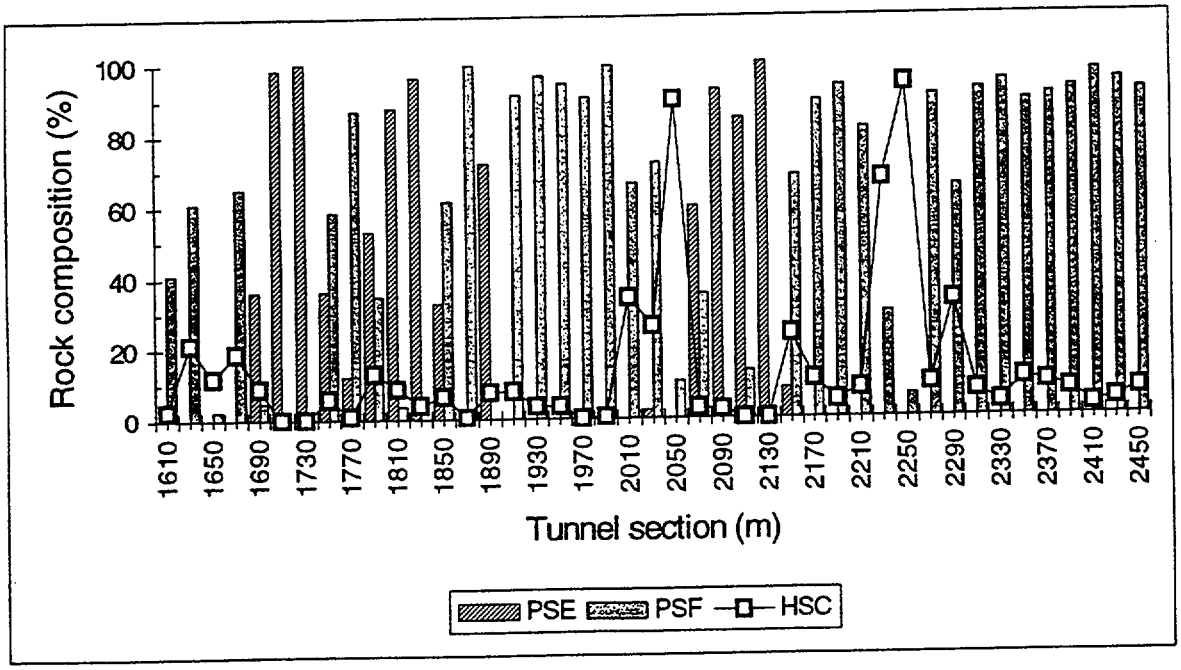
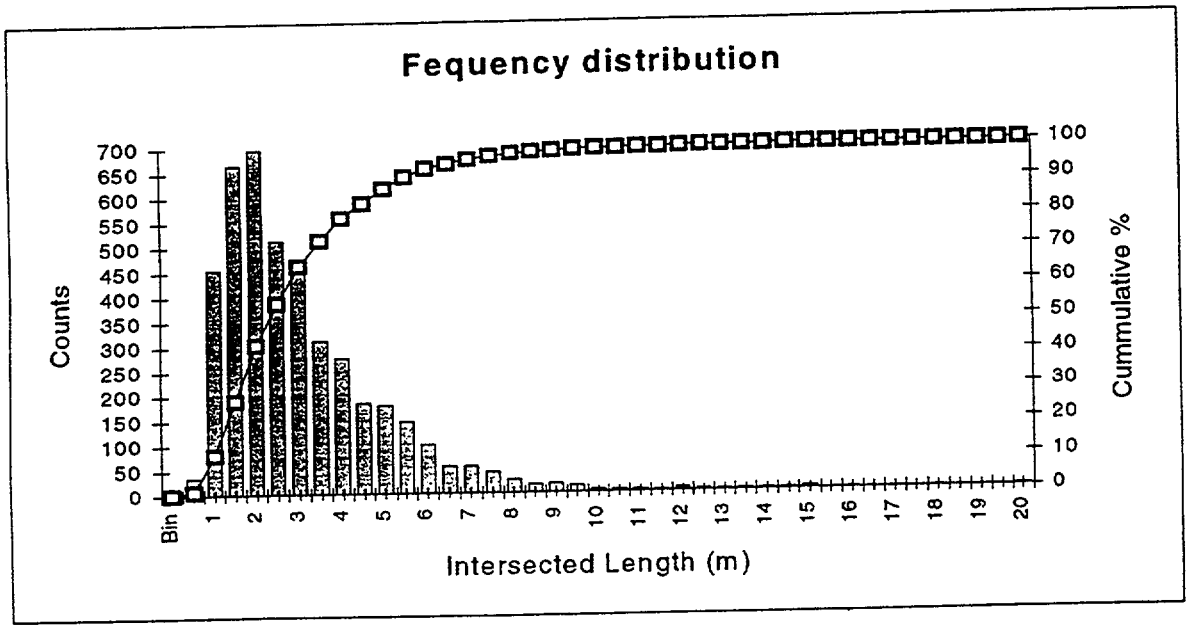


Fig.8: Rock composition for tunnel sections 1600 to 2400m. The composition is calculated for 20m long intervals of the tunnel; Greenstones and dykes are not shown here. Äspö Diorite (PSF); Smaland Granite (PSE);Fine grained Granite (HSC).

2.1.2 FRACTURE STATISTICS

From tunnel section 1/400 to 2/500m altogether 4285 fractures have been mapped with fracture lengths exceeding 1m, in order to exclude fractures generated by blasting. The average fracture length is 3.2m; the fracture length distribution is log-normal (Fig.9). 7.6 % of all fractures have been mapped as "water conducting".

Note, that it is not always possible to relate the water inflow to one specific fracture. In such cases "areas" of water inflow have been mapped during the routine geological mapping. additionally pre-grouting has been performed to minimise the water inflow. Thus, fractures with "grout" have been assumed to be water bearing, but it has to be taken into account that it is difficult to identify minor grout infillings from A distance (e.g. tunnel roof). This means that the number of water conducting fractures is probably higher than estimated here.



Fractures	Section from	to	Counts	%	Average (m)	Total length (m)	Fracture per meter of tunnel
all	1400	2500	4285		3.2	1100	3.9
Grouted sections			878		3.3	207	4.2
fractures water conducting	1400	2500	287	6.6	4.6	1100	0.3
fractures with grout	1400	2500	71	6.7		1100	0.1

Fig.9: Frequency distribution and summary statistics of all fractures from sections 1/400 to 2/500m; (cf. App. B-4, mapped fracture zones are excluded here cf. chapter 4). Fracture length has to be considered as intersected fracture length; not corrected for sampling bias.

2.1.3 FRACTURE ORIENTATION

The stereo plots including all fractures indicate a dominant NW-SE (305°) strike direction with steeply dipping fracture planes (70-90°), and a weak but not significant sub horizontal dipping system (appendix B-6 a,b). Other fracture sets, like NE-SW (corresponding set to NW-SE) are statistically unimportant.

From the statistical point of view water conducting fractures and fractures with grout infillings (water transport) are characterised by the same major strike directions (appendix B-6 c,d,e,f). To check if tunnel sections of enlarged water inflow (grouted sections) differ in their fracture orientation pattern, the poles of fracture planes in grouted sections have been plotted (appendix B-7). It can be concluded that the (statistical) orientation pattern of water bearing fractures, fractures with grout, or fractures of grouted sections do not differ significantly from each other.

3 GENERAL CHARACTERISTICS OF GROUTED SECTIONS

3.1 GENERAL REMARKS

Pre-grouting is performed if the water outflow from probe- or blast holes exceeds a certain limit (5 l/min). The length of the individual grout holes varies between 9 and 20m. Normally the side walls and the roof are grouted. The spread of the grout is expected to vary between 5-15m. The water outflow rates from blast holes varies between 50 and >>1000l/min.

Within the 765m of the investigated area 27% of the tunnel have pre-grouted; 12 sections varying between 10 and 50m in length. The location of the grouted sections is shown in Fig.7; Tab. 1 has been compiled from the grouting protocol's.

Grout section	from	to	Length (m)	Grouted %	Injected grout (m^3)	Grout/meter of drill hole (m^3)
LEG-A				34.2		
G1	1697	1750	53		17843	0.3
G1-1	1697	1706	9		3084	0.3
G1-2	1717	1732	15		12139	0.8
G1-3	1738	1750	12		2620	0.2
LEG-B				6.2		
G2	1865	1874	9		8220	0.9
LEG-C				16.6		
G3	1920	1930	10		3926	0.4
G4	2013	2027	14	52.9	23556	1.7
LEG -D						
G6	2083	2126	43		41357	1.0
G6-1	2083	2092	9		4976	0.6
G6-2	2100	2126	26		36381	1.4
G7	2142	2161	19	26.9	5252	0.3
LEG-E						
G8	2192	2202	10		1332	0.1
G9	2227	2236	9		1832	0.2
G10	2276	2288	12		4756	0.4
G11	2301	2310	9		2874	0.3
G12	2351	2360	9		7025	0.8

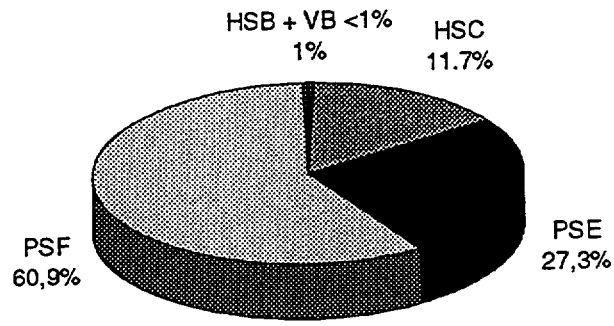
Tab.1: *Grouted sections;* general information

In the following the "closely spaced" grout-sections, like G 6.1 to G 6.3, have been treated as one unit. Note, that in the northwards directed tunnel legs more grouting had to be carried out than in the other parts. The low angle of intersection between water conducting N-S striking fractures (connected to the tunnel by minor E-W striking fracture sets) could be one explanation. Another possibility would be an (absolute) increased fracture frequency.

3.1.1 ROCK COMPOSITION OF GROUTED SECTIONS

The average rock composition of the grouted sections (Fig.10) does not differ from the (averaged) rock type in the tunnel. Greenstones seem to be under-represented in the grouted sections, but they are frequent in the first tunnel leg-A, only. The rock composition of the individual grouted sections G-1 to G-11 and the tunnel average is presented in the table below Fig.10.

Rock composition of grouted sections



	G1	G2	G3	G4	G6	G7	G8	G9	G10	G11	Grout average	*Tunnel average*
HSB					1.0		5.0				0.1	*0.5*
HSC	0.4	0.3	6.0	26.2	1.0	24.1		63.0	7.3	11.7	11.7	*13.6*
PSE	89.4	99.7			90.7	8.2		36.0			27.0	*22.7*
PSF	8.6		94.0	73.8	7.3	67.6	95.0		92.7	88.3	60.7	*57.1*
VB	0.0							1.0			0.1	*6.2*

Fig.10: Average Rock composition; % of grouted sections G-1-G-11; Äspö Diorite (PSF); Smaland Granite (PSE);Fine grained Granite (HSC) Veins (HSB) Greenstones (VB)

In grouted sections 4, 7, 9, fine grained granite is a major rock type (26%, 24% and 63%). However, the volume of total injected grout per meter of grout hole is not directly related with the occurrence of fine grained granite, which could have been expected from the more brittle behaviour of this rock type. These data suggest that "grouting" cannot be correlated with the occurrence of one particular rock type. Other factors have to be considered.

3.1.2 FRACTURE ORIENTATION IN GROUTED SECTIONS

The dominating fracture set is striking NW-SE (305°/70-90°) with a corresponding set of NE-SW (orthogonal fracture pattern appendix B-6 a-g). Sub-horizontal fractures are present, but do not form well defined maxima in the overview plots.

Although the significance level of these contoured diagrams is low (few fractures), these diagrams are helpful. If "NNW" striking fractures form zones and are major water conducting structures as well, these strike direction should be indicated by maxima in the stereogramms.

Tab. 2 and apeendix B-7 illustrate the fracture orientation pattern of grouted sections. Beside "normal" NW-SE striking fractures with steep dipping planes, which are present in all sections, there are some indications for a second N-S striking set in sections 2, 4 and 11. Sub-horizontal fractures are "frequent" in sections 6, 8 and 10.

	Number	Strike	Dip				Remarks
All fractures	4285	305		NW-SE			
Water conducting fractures	287	300,12		NW-SE			
Fractures with grout	71			NW-SE			
Fractures within grouted sections	878	305		NW-SE			
Grout section Nr..		Strike maxima		NW-SE	N -S	subhorizontal	
G1	290	305, 12		xx		x?	few subhorizontal fractures
G2	48	360,11		x	x		
G3	36				x?		
G4	64				x?	x?	evenly distributed fractures
G6	179	310, 20	s-horizontal	x?		x	orthogonal set
G7	78	310,130		xx			
G8	45	280,12	s-horizontal	x			
G9	18					x	18 sampling points only
G10	65	295		x			
G11	55	8		x	x	x?	in addition broad distribution around 270

Tab.2: Main strike directions of fractures in grouted sections, water bearing fractures of tunnel section 1/600m to 2/400m (strike maxima within grouted sections xx = well defined maxima", x = less defined , x? questionable, further explanation cf. text).

The stereogramms of grouted sections (representing zones of high water inflow) do not suggest that N-S striking fractures are the dominating ones. If a N-S striking fracture set is important with respect to the water transport, they appear to be single fractures, rather than single fractures and not as fracture zones. With respect to water transport in the area of grouted sections, it seems that the intersection of various fracture systems is dominating compared to the occurrence of one fracture system. In this chapter data of the file "fracture.dbf" (= SKB - code of Tunnel Mapping System)are presented. Mapped fractures zones have been treated separately (c.f. chapter 4) because of difficulties in combing the data sets.

3.1.3 FRACTURE STATISTICS OF GROUTED SECTIONS

Fracture statistics and the frequency distribution of intersected fracture length (tunnel section 1/600 to 2/400m) have been calculated, to compare these average values with those of grouted sections or the N-S fracture system. However, this information has to be considered relatively, because the measurable fracture length depends on the orientation of the fractures relative to the tunnel axis.

Approximately 54% of all fractures are shorter than 3m (tunnel 65%), 78% are found in the length class >4m (tunnel 79,5%). The average length in grouted sections varies from 2.9 to 4.1m (mean 3.2m); the tunnel average is 3.3m. The data set of grouted sections shows no significant differences to the average tunnel values (c.f. Fig.11).

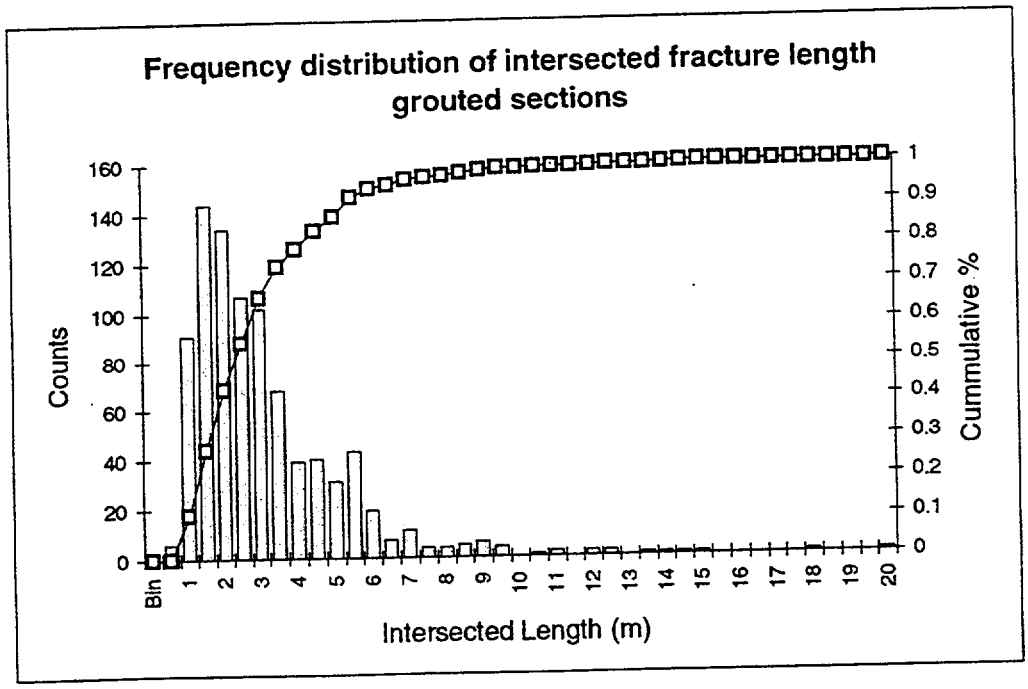


Fig.11: *Frequency histogram of fracture length in grouted sections,* cf. with Fig. 9

3.1.4 FRACTURE MINERALOGY OF GROUTED SECTIONS

The dominating fracture minerals are chlorite and calcite, which are present in 64% and 50% respectively, of all mapped fractures compared to values of 61% and 48% within the overall investigated tunnel section (short cut 'tunnel' used in the following paragraphs).

At the surface the N-S striking fractures are characterised by epidote (often rimmed with quartz). Calcite and red-stained walls predominate in the N-S fractures (Fig.12).

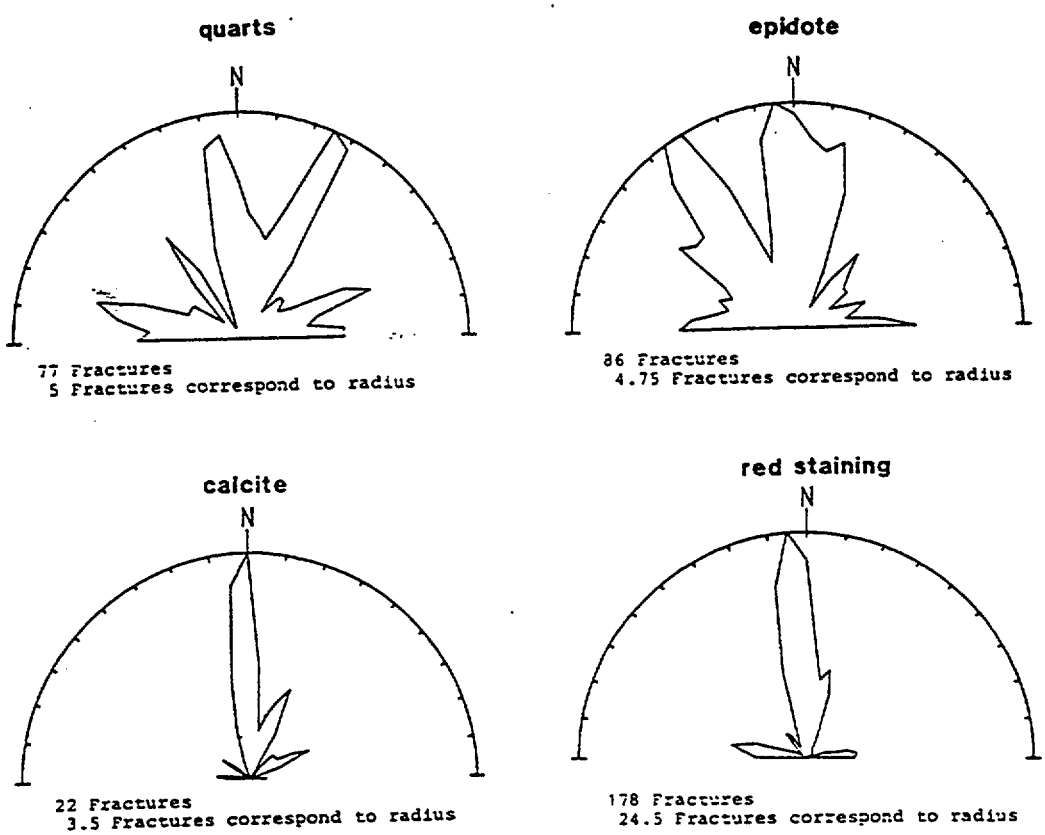


Fig.12: Rosette diagram for factures on Äspö (from: SKB PR 25-87-05).

According to Munier (1992) the epidote/quartz assemblage can be related to one of the earliest fracturing events. The postulated mineralogical sequence from quartz, epidote, Fe-oxide, chlorite and calcite (representing separate fragmentation events) is supported by the decreasing formation temperature of these minerals.

Comparing the average fracture mineral distribution of grouted sections with the tunnel average (Fig.13), weak indications for an increased occurrence of epidote filled fractures can be found (13,5% tunnel - 21,1% average of grouted sections). Note that the occurrence of oxidised walls shows the contrary picture (19,1% tunnel - 10,7% average of grouted sections)! Quartz is probably underestimated in the tunnel, due to identification problems of quartz and calcite from a distance.

The distribution pattern calculated for each grouted section (Fig.14, Tab.3) illustrates the increased occurrence of epidote in grout sections 2 and 10. If the identification problem of quartz is taken into account, grouted sections 2, 8 ,10 are characterised by more frequent quartz infillings. Mineral parageneses have not been calculated. However, the data presented here, give some indications for an increased occurrence of epidote, oxide and quartz ("old" fracture mineral assemblage) in grouted sections 2, 8,10,11. In other cases only one mineral (and not a mineral assemblage) is more frequent in grouted sections; but note the differences are minor in all cases.

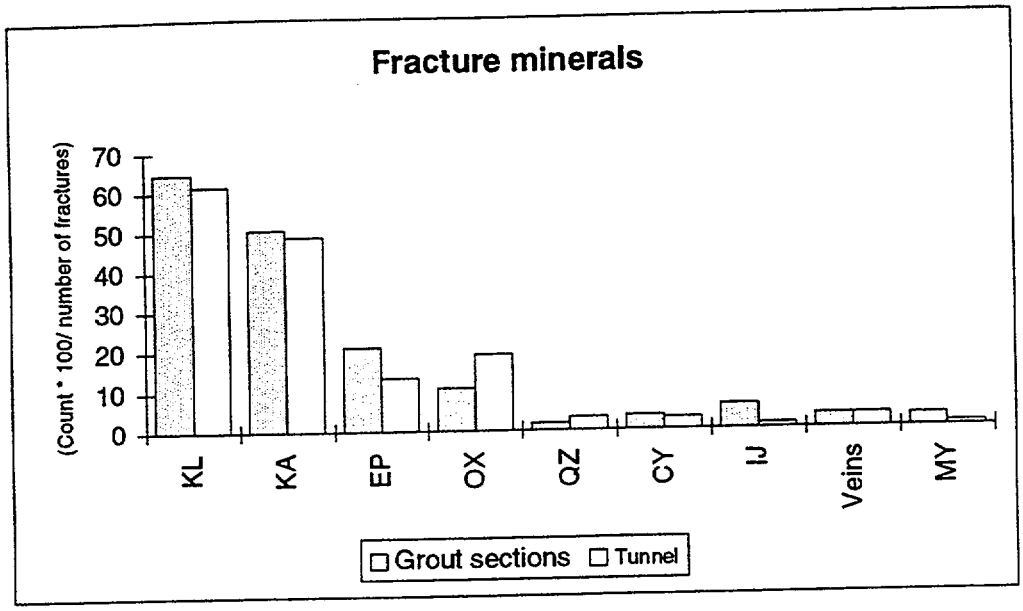


Fig.13: *Fracture minerals of grouted sections compared to average values of tunnel section 1/600 to 2/400m. KL- chlorite, Ka- calcite, Ep- epidote, OX- oxide, QZ- quartz, CY- clay, MY- mylonite, IJ- grout*

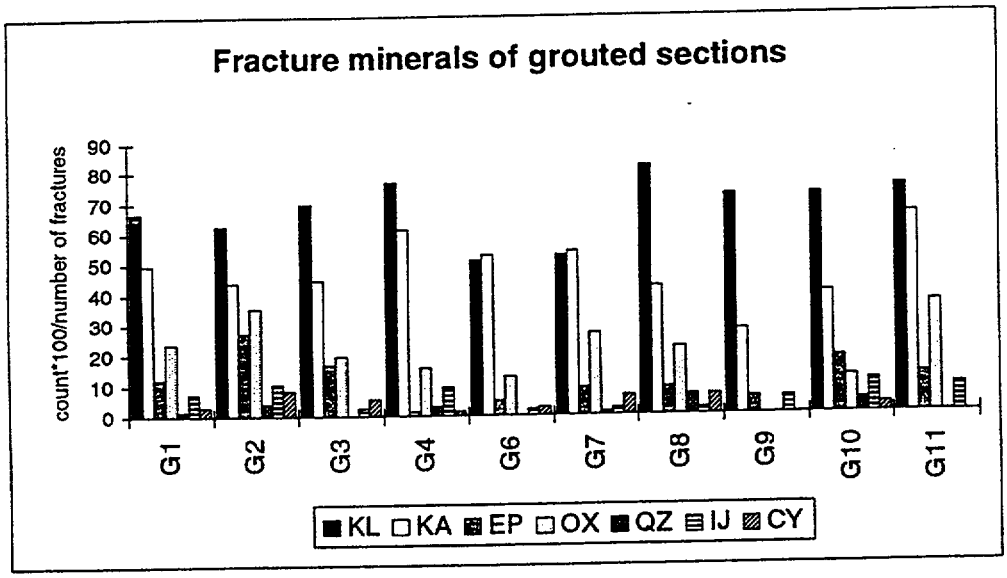


Fig.14: *Fracture minerals in grouted sections KL- chlorite, Ka- calcite, Ep- epidote, OX- oxide, QZ- quartz, CY- clay, MY- mylonite, IJ- grout (G1-G11 cf. Tab1, Tab.3 respectively).*

	KL	KA	EP	OX	QZ	CY	IJ	Vein	MY
G1	40.1	29.9	7.1	14.3	1.0	1.9	4.4	0.0	0.2
G2	31.6	22.1	13.7	17.9	2.1	4.2	5.3	0.0	0.0
G3	41.7	26.7	10.0	11.7	0.0	3.3	1.7	0.0	1.7
G4	45.4	36.1	0.9	9.3	1.9	0.9	5.6	0.0	0.0
G6	38.7	40.0	3.8	9.8	0.0	2.1	1.7	0.0	0.0
G7	33.3	34.1	5.7	17.1	0.8	4.1	1.6	0.0	0.0
G8	46.8	24.1	5.1	12.7	3.8	3.8	1.3	0.0	1.3
G9	65.0	25.0	5.0	0.0	0.0	0.0	5.0	0.0	0.0
G10	43.9	24.3	11.2	7.5	2.8	1.9	6.5	0.0	0.0
G11	36.3	31.9	6.2	17.7	0.0	0.0	4.4	0.0	0.0

	Grout sections	Tunnel
KL	42.9	39.8
KA	29.4	31.5
EP	6.9	8.6
OX	11.8	12.4
QZ	1.2	2.1
CY	2.2	1.9
IJ	3.7	0.8
Veins	2.1	2.2
MY	0.3	0.7

Counts*100/number of fractures

	KL	KA	EP	OX	QZ	IJ	CY	MY
G1	66.6	49.7	11.7	23.8	1.7	7.2	3.1	0.3
G2	62.5	43.8	27.1	35.4	4.2	##	8.3	0.0
G3	69.4	44.4	16.7	19.4	0.0	2.8	5.6	2.8
G4	76.6	60.9	1.6	15.6	3.1	9.4	1.6	0.0
G6	50.8	52.5	5.0	12.8	0.0	2.2	2.8	0.0
G7	52.6	53.8	9.0	26.9	1.3	2.6	6.4	0.0
G8	82.2	42.2	8.9	22.2	6.7	2.2	6.7	2.2
G9	72.2	27.8	5.6	0.0	0.0	5.6	0.0	0.0
G10	72.3	40.0	18.5	12.3	4.6	##	3.1	0.0
G11	74.5	65.5	12.7	36.4	0.0	9.1	0.0	0.0

	Grout sections	Tunnel
KL	64.6	61.4
KA	50.3	48.7
EP	21.1	13.3
OX	10.7	19.1
QZ	1.8	3.3
CY	3.5	2.9
IJ	6.0	1.2
Veins	3.4	3.4
MY	3.0	1.0

Tab.3: Fracture mineralogy in grouted sections; for comparison tunnel average KL- chlorite, Ka- calcite, Ep- epidote, OX- oxide, QZ- quartz, CY- clay, MY- mylonite, IJ- grout

3.1.5 WATER OUTFLOWS FROM PROBE HOLES

Probe holes, with a normal length of 20m, are drilled (percussion) every fourth round of blasting with an angle of 20° to tunnel axis on both tunnel sides. The main purpose of the probe holes is to collect geohydrological data (outflow, pressure built up tests). Furthermore they give some information of water inflows which have to be expected within the next 20m of excavation. The lithological / structural information is less, because the drill holes are not cored. The main lithologies are estimated by colour changes of the drilling

water. The outflow rates of both probe holes in one section and values normalised to length of the probe holes are presented in Tab.4 (c.f. appendix B-5 complete data file).

Probe holes of sections 2/222m (568l/min), 2/074m (500l/min), 1/713m (520 l/min), 2/090m (291l/min) and 1/881m (111l/min) are characterised by major water inflows. The average is 54 l/min or 1.54 l/min/meter drill hole. The normalised values are plotted against tunnel section in Fig.15.

Probehole data should be compared only qualitatively with other characteristics, because the exact inflow points in probe- and blast holes were not known. However, note that the main inflows from blast holes differ from the main inflows observed in the probehole drillings. Thus the probe holes do not intersect the main water bearing structures every time. For a more detailed investigation points of water inflow in probe- and blast holes and their estimated intersection with the tunnel should be calculated.

Probehole a+b	Section (m)	Quantity (l/min)	Length (m)	Quantity l/min//meter
1614	1610	5.30	39.70	0.13
1629	1630	2.73	39.80	0.07
1643	1650	8.45	40.20	0.21
1664	1670	0.01	40.30	0.00
1680	1690	77.40	36.00	2.15
1696	1695	9.07	39.30	0.23
1713	1710	320.24	39.50	8.11
1730	1730	11.55	39.20	0.29
1746	1750	3.50	39.80	0.09
1759	1760	4.00	40.60	0.10
1777	1770	0.63	40.00	0.02
1794	1790	0.03	39.30	0.00
1815	1810	0.20	40.20	0.01
1828	1830	8.95	40.00	0.22
1844	1850	47.80	39.90	1.20
1861	1870	111.00	40.20	2.76
1877	1780	0.08	19.80	0.00
1893	1890	0.50	20.00	0.03
1893	1900	0.66	20.00	0.03
1909	1910	0.14	38.70	0.00
1920	1930	0.02	39.70	0.00

Probehole a+b	Section (m)	Quantity (l/min)	Length (m)	Quantity l/min//meter
1938	1940	0.76	39.40	0.02
1960	1950	13.21	51.90	0.25
1975	1970	2.04	39.50	0.05
1997	1990	57.00	38.90	1.47
2009	2010	0.28	38.90	0.01
2025	2030	92.80	60.30	1.54
2043	2050	0.00	20.50	0.00
2058	2060	1.46	40.00	0.04
2074	2070	500.27	58.70	8.52
2090	2090	291.00	34.50	8.43
2109	2110	43.03	39.80	1.08
2142	2150	9.80	40.60	0.24
2160	2170	1.18	39.80	0.03
2175	2180	0.17	40.30	0.00
2192	2190	20.70	39.60	0.52
2207	2210	0.21	40.00	0.01
2222	2230	568.60	24.00	23.69
2240	2250	1.55	39.30	0.04
2256	2260	0.17	39.60	0.00
2256	2260	0.17	39.60	0.00

Tab.4: Water outflow rates in probe holes from tunnel section 1/600 to 2/300m. Probe Hole a = left side of tunnel, b = right side of the tunnel

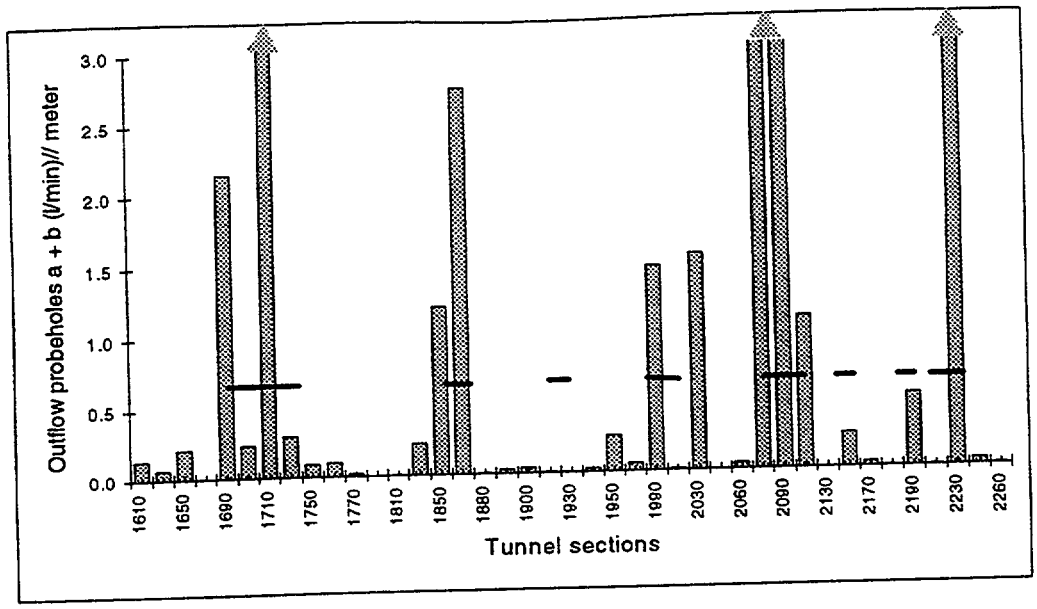


Fig. 15: Normalised outflow rates (l/min/meter of probehole) from probe holes (a and b), plotted against tunnel sections. Probehole data from section >2/300m were not available. Grouted sections from tunnel meter 1697-1750, 1885-1874, 1920-1930,2030-2027, 2083-2126, 2192-2202, 2207-2236.

3.2 CHARACTERISTICS OF GROUTED SECTIONS - SUMMARY-

Occurrence in the tunnel: 27% of the investigated tunnel length have been pre-grouted with section lengths varying between 10 and 50m (Fig.7). Most grouting has to be performed in tunnel legs A and D (34% and 53% respectively) (Tab.1).

Rock volume: The average rock composition of all grouted sections is comparable to the tunnel average if diorite and granite are treated as one group. Fine grained granite is important in three sections (G-7 24%, G-4 26%, G-9 63%) (Fig. 10). However, most of the grout was injected in grout sections G-2,4,6.2).

Fracture orientation: The dominating strike direction of grouted sections is the NW and E-W direction. Several strike directions are indicated in grout sections G-2, G-8 and G-6 (App.B-7. Tab.2).

Fracture statistics: The average relative fracture length and frequency distribution within the grouted sections is similar to those of the tunnel (Fig.11). Fracture frequency: A significant increase of N-S striking fractures is present in sections G-2 and G11.

Mineralogy: Some indications for an increased occurrence of epidote, oxidised walls and ± quartz can be found; average values of all grouted sections show close similarities to the normal fracture filling distribution (G-2,8, 10,11, Fig.13, Tab.3).

Water inflow rates from probe holes: Major water inflow rates are found in grout sections G-1, G2, G-6 and G-8 (Fig.15, Tab.4).

Tab.5 summarises some main characteristics of grouted sections

Grout section	Grout/m drillhole (m3)	Outflow (l/min)	Mineralogy								Rock composition					Fracture statistics			Strike maxima		other ones			Mapped frac.- zones
																Frac. per meter	Frac. length	Frac. length per m	counts		NW-SE	N-S	sub horizontal	present
LEG-A			KL	KA	EP	OX	OZ	IJ	CY	MY	HSB	HSC	PSE	PSF	VB									
G1	336.7		66.6	49.7	11.7	23.8	1.7	7.2	3.1	0.3		0.4	69.4	8.6		5.4	2.9	5.4	290 305, 122		XX		x?	Z-1 at the end
G1-1	342.7																							
G1-2	809.3																							
G1-3	218.3																							
LEG-B																								
G2	913.3	>300	62.5	43.8	27.1	35.4	4.2	10.4	8.3	0.0		0.3	99.7			4.2	3.1	4.2	48 360, 110		x	x		Z-4
LEG-C																								
G3	392.6		69.4	44.4	16.7	19.4	0.0	2.8	5.6	2.8		6.0		94.0		2.7	4.1	2.7	36			x?		Z-7
G4	1682.6		76.6	60.9	1.6	15.6	3.1	9.4	1.6	0.0		26.3		73.8		3.7	3.4	3.7	64		x?	x?	x?	
G5																								
LEG -D																								
G6	961.8		50.8	52.5	5.0	12.8	0.0	2.2	2.8	0.0	1.0	1.0	90.7	7.3		3.8	3.2	3.8	179 310, 20	subhorizontal	XX		x	Z-6
G6-1	552.9																							
G6-2	1399.3																							
G7	276.4		52.6	53.8	9.0	26.9	1.3	2.6	6.4	0.0		24.1	8.2	67.6		3.6	3.4	3.6	78 310, 130		X			
LEG-E																								
G8	133.2	>1000	82.2	42.2	8.9	22.2	6.7	2.2	6.7	2.2	5.0		95.0			3.8	4.1	3.8	45 280, 120	subhorizontal	(x)		x	
G9	203.6	>1000	72.2	27.8	5.6	0.0	0.0	5.6	0.0	0.0		63.0	36.0		1.0	1.8	4.1	1.8	18					
G10	396.3		72.3	40.0	18.5	12.3	4.6	10.8	3.1	0.0		7.3		92.7		4.8	3.4	4.8	65 295		x		x?	
G11	319.3	>500	74.5	65.5	12.7	36.4	0.0	9.1	0.0	0.0		11.7		88.3		4.1	3.8	4.1	55 8		x	x		

*Tab.5: Characteristics of grouted sections Mineralogy = Counts*100/number of fractures; other strike directions = indications x present, x? doubtful*

4 MAPPED FRACTURE ZONES

Fracture zones are mapped underground if the fracture frequency increases one or two orders compared to the surrounding rock (cf. chapter 1.3). In some way this definition is problematic and subjective, because the fine grained granite generally behaves more brittle than e.g. the Äspö Diorite. Following the definition of fracture zone in a strict sense, "all" occurrences of fine grained granite would then be fracture zones. Thus it depends (partly) on the subjective impression of the mapping geologist, to decide whether a section has to be called "a zone" or not.

In contrast to "normal mapping", another mapping technique is used to characterise fracture zones. The average spacing of fractures within a fracture zone for example is mapped instead of the fracture length. In the short time period for mapping, a detailed characterisation of fracture zones (e.g. total number of fractures, intersection pattern etc.) can not be performed. Appendix B-4 shows the data set "fracture zones" of tunnel sections 1/600-2/400m. It is not likely to "mix" the data sets of fracture zones with those of the "normal" mapping, due to the different mapping techniques. However, the main strikes of fracture sets within zones give additional information.

Stereo plots of the 12 mapped fracture zones (App. B-8) suggest three main strike directions.

1. NW-SE sometimes with a corresponding NE-SW direction
2. N-S fracture set
3. Sub-horizontal fractures

For the purpose of this work, the fracture zones have been numbered according to their occurrence in the tunnel. This numbering is not equivalent to the "fracture-id" in data sheet "fraczones.dbf", App. B-4. Note, that fracture zones are missing in the N-S directed tunnel leg A, although 53% of this tunnel section were pre-grouted.

Within 9 of 12 fracture zones NW to WNW striking fractures dominate. N-S striking fracture sets occur in 4, sub horizontal fracture sets in 3 mapped fracture zones. In three cases intersections of fracture zones have been mapped, two of them intersecting the long sub horizontal zone 1 (1/746-1/853m), but no significant increase of water inflow has been recorded in probe- or blast holes (overlap fracture zone Z-2 with end of pre-grouting G-6.3). In the case of intersection Z-3 with Z-1 no pre-grouting was performed.

Within tunnel sections 1/989-2/030m (fracture zones 6-9) a weak increase of water inflow is recorded, probably due to the intersections of more complex structures fracture zones within the fine grained granite. However, the maxima of outflow rates in probe holes and from blast holes do not correspond with mapped fracture zones, except in the case of Z-12. Tab.6 shows the relationship of mapped fracture zones and the pre-grouted sections.

Regarding grouted sections as zones of high water inflow, there is only a weak correlation between fracture zones and high inflow rates (50%).

More work (field) has to be done on the characterisation of fracture zones and their relation to the grouted sections to check the following statements:

- The dominating strike direction of mapped fracture zones is NW to WNW.

- There is no direct evidence for the correlation between mapped zones on high water inflow rates.

- Intersections of fracture zones seem to be important with respect to the water inflow rates only in the case of fine grained granites.

Grout-section	Frac.-zone	at	from	to	Main orientation of fracture zone: Over lap	NW	ortho gonal	NS	Sub-horizontal	Rock type	Remarks	Probehole at	Outflow (l/min)
G-1			1697	1750								1680	77
												1713	320
	Z-1		*1746*	*1853*	*x*				*X*	*N*	*at the end of G1*		
	Z-2	*1770*				*X*				*90% PSF*	*intersects Z-1*		
	Z-3	*1832*						*X*		*<90%PSE*	*intersects Z-1*		
	Z-4		*1845*	*1853*		*WNW*		*X*		*N*	*intersection at the end of Z-1*		
G-2			1865	1874	x							1861	111
	Z-5	*1878*			*(x)*	*x*				*100%PSF*	*grouting 10m infront of fracture zone*		
G-3			1920	1930									
	Z-6		*1984*	*2005*		*WNW*				*increased HSC*			
	Z-7		*2013*	*2030*	*XX*	*x*	*x*	*x*	*x*	*increased HSC*			
G-4			2013	2027									
	Z-8		*2018*	*2030*		*x*				*increased HSC*	*intersection with Z-7*	2'025	92
G-5	Z-9				x					HSC		2'090	500
G-6			2083	2126									
	Z-10		*2118*	*2136*	*x*	*x*		*(x)*		*normal*	*grouting 30m infront of Z-10*		
G-7			2142	2161									
	Z-11		*2142*	*2146*	*x*		*x*			*normal*			
G-8			2192	2202								2222	586
	Z-12		*2216*	*2260*		*x*	*(x)*	*x*	*x*	*increased HSC*			
G--9			2227	2236									
G-10			2276	2288									
G-11			2301	2310									
G-12			2351	2360									

*Tab.6: Main strike directions of mapped fracture zones in relation to grouted sections tunnel meter 1/600 to 2/400m.(N = normal, average rock composition; **x** = present, (x) = questionable occurrence*

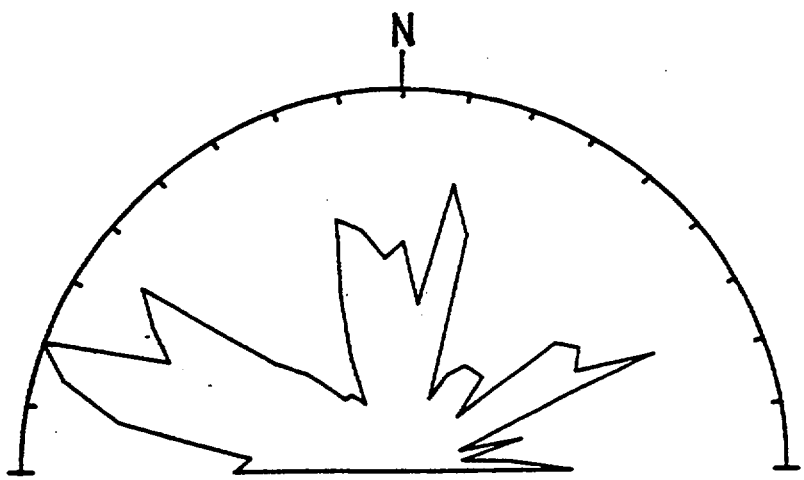
5 N-S FRACTURE SYSTEM

5.1 GENERAL ASPECTS

Following the classification system used in the prediction reports, the so called "NNW" striking fractures form minor fracture zones with a width of several dm to a few meter, or they occur as single open fractures. The identification by geophysical means is difficult because the fracture zones are to narrow. Topographical indications are missing in most cases as well. Hydrotests and drillings seem to support a "NNW" striking fracture set characterised by increased transmissivities.

Steep dipping fractures have been grouped to a "NNW-system", but a clear definition in terms of the strike directions is missing. Reviewing some reports this fracture set seems to include NNE and N-S to NW striking fractures.

Thus the first step was to define and characterise the "NNW" striking system by underground data. In a second step attempts to relate (quantitatively) the NNW-system to zones of major water inflows (grouted sections) were made.



Dip 70-90

Fig.16: Rosette diagram of fractures mapped on Äspö Island
Dip 70-90 degree on mapped cells nr. 11,12, 14, 18,19

It is possible to separate two dominant strike directions; a N-S and a NW one, using surface data of Äspö Island (Fig.16). Based on the suggestions of R. Stanfors, it was decided to concentrate on the N-S striking fracture system which probably represents the "so called" third order fractures" or fracture zones. These fractures could be one of the major water paths. In the following data from tunnel sections 1/600 to 2/400m are presented.

5.2 FRACTURE STATISTICS

The data set has been subdivided in 10 degree strike intervals in order to define a fracture set in terms of strike direction intervals and associated characteristics.

The stereograms of all fractures (chapter 2.1.2ff; appendix B-6) suggest a dominating strike direction NW around 310° (with a corresponding SE one). Other strike directions are WNW to ESE around 270°

Several indications were found that it is useful to subdivide these fracture sets in subgroups as well.

The N-S striking fracture system has been defined as follows:

N-S striking fractures (10 E to 340 W) with a subdivision in:

- NNW 1 - 340 to 350° and 160 to 170°
- NNW 2 - 350 to 360° and 170 to 180°
- NNE - 0 to 10° and 180 to 190°

NNW 1 and 2 are called the NNW striking fracture set; data sets including the NNE direction as well are N-S striking fractures. 17% or 766 fractures of all recorded fractures (4280) of tunnel sections 1/600 to 2/400m represent the N-S striking fracture system.

5.2.1 RELATIVE INTERSECTED FRACTURE LENGTH OF N-S STRIKING FRACTURES

Investigations on Äspö Island suggest that "NNW"-striking fractures are probably longer than the other ones. Thus the first step was to split the data set in strike direction intervals and to calculate the average length of the individual classes.

Note that the data presented here are not corrected with respect to the "size-bias" (longer fractures are more likely to be sampled than shorter ones). Additionally fractures less than 0.5m are not mapped. The recorded length also depends of the intersection angle between the tunnel line and fracture. Thus the data must be considered as relative differences of fracture length within the various strike intervals and not as "true" fracture length distribution. In the following

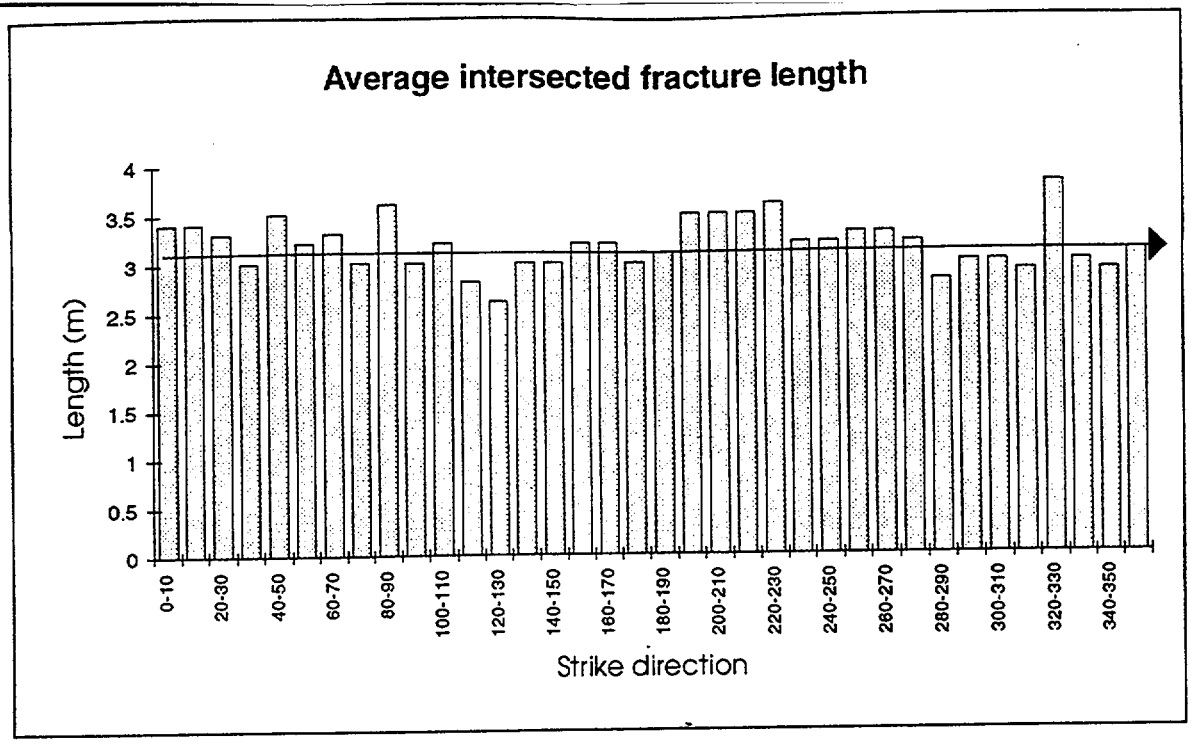


Fig.17: Average intersected fracture lengths within 10 degree strike intervals, tunnel section 1/600 to 2/400m.

In contrast to the surface impression the fracture length distribution of all N-S striking fractures is "equivalent" to other strike directions. Separating the water conducting fractures from "normal" fractures (Fig.18), the following statements can be made:

- The average fracture length of "normal" fractures including all strike direction intervals shows a homogenous distribution with a fracture length of 3.2m (average).

- Water conducting fractures are significantly longer (average 4.6m).

- Generally the longest water conducting fractures belong to the N-S and the NW and E-W striking fracture set.

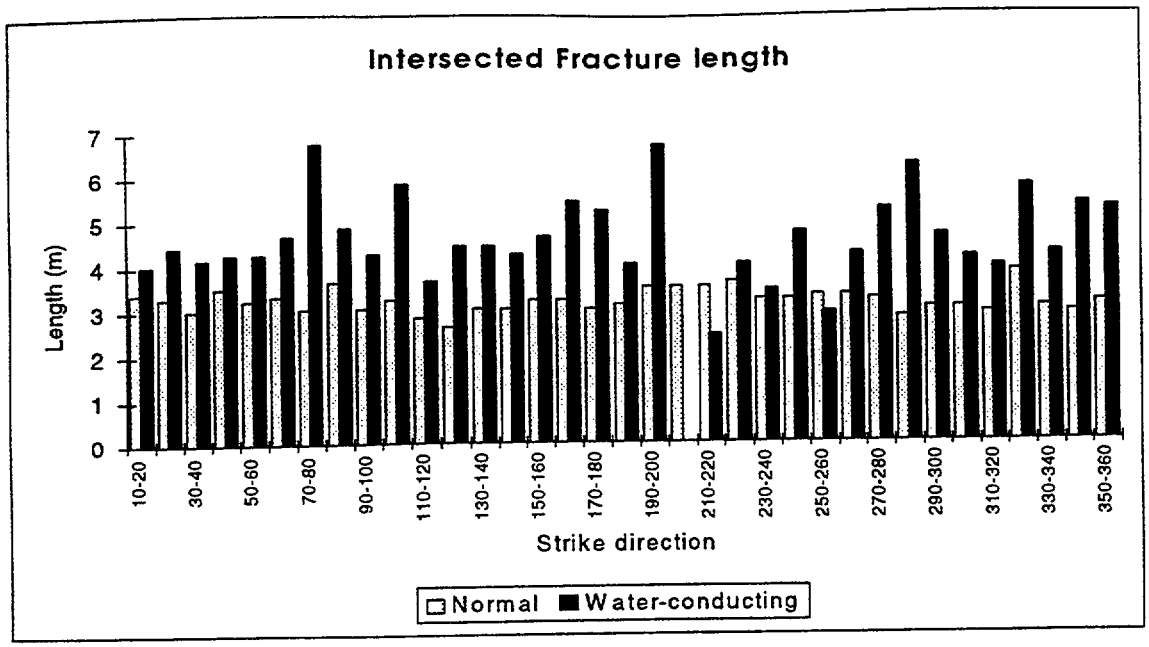


Fig.18: *Fracture length distribution grouped in strike direction intervals of 10 degree. Water conducting fractures include fractures with grout as well. Average length of normal fractures is 3.2m - water conducting fractures is 4.6m.*

These data support (in some way) the subdivision of fractures in a N-S (10-340°) and an E-W (260-290°) interval. Note that the average fracture length of the strike intervals 70-80° and 190-200° are one of the longest water conducting fractures. No water bearing fractures have been recorded in strike interval 200-210°.

5.2.2 FRACTURE FREQUENCY DISTRIBUTION IN 0.5M INTERVALS

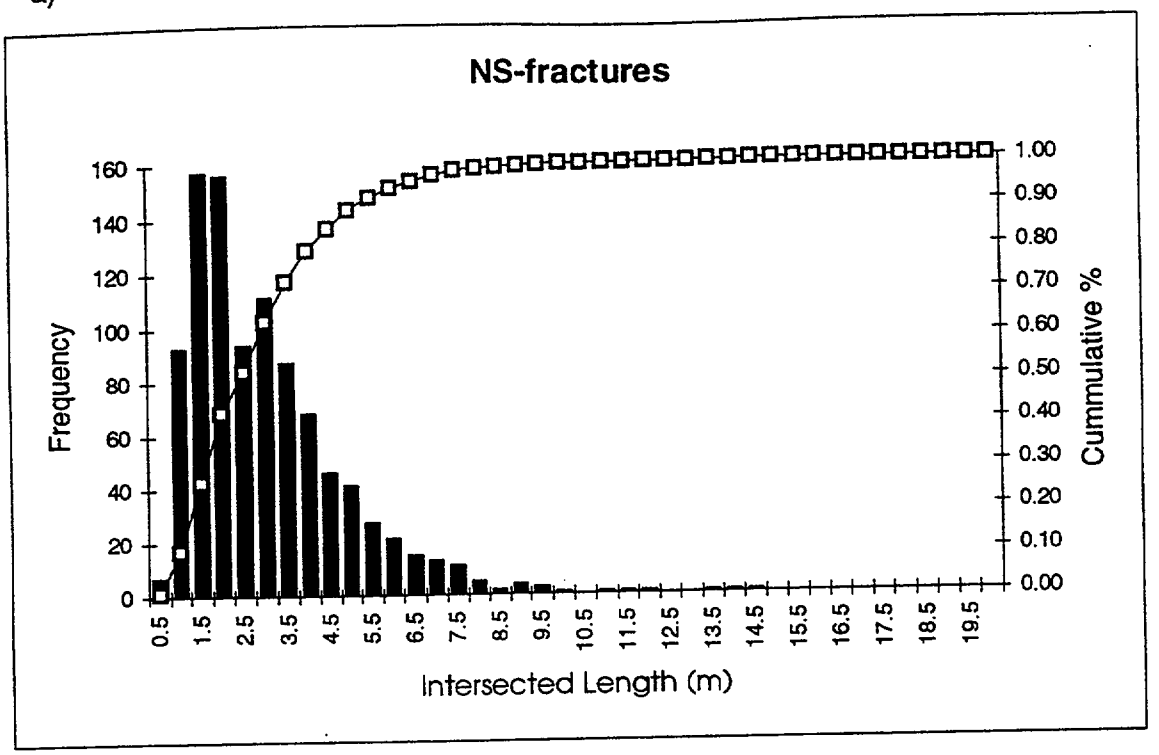
The fracture frequency within the 0.5m intervals was calculated, although the number of water bearing fractures within the N-S strike direction is less. Water bearing fractures show a "shift" towards longer fractures. No fractures <1.5m are recorded; a clear maximum within the range of 2-6.5m cannot be defined within this group. The non water conducting fractures are log normal distributed (Fig. 19 a,b). For comparison frequency distribution pattern of normal fractures, water conducting N-S and E-W fractures have been plotted within one diagram (Fig.20).

As it could be expected (Fig.17) the frequency distribution pattern of all N-S striking fractures does not differ from the average length distribution pattern. Water conducting N-S fractures show a shift to longer interval groups, even compared with the "long" water conducting E-W striking ones. The E-W system is "in-between" the normal and the N-S frequency distribution.

<u>Sequence:</u> tunnel average + N-S normal fractures --> water conducting E-W fractures --> water conducting N-S fractures.

These data also support the subdivision in a N-S and an E-W striking fracture set. Due to time limitations the E-W striking system has not been subdivided, although some evidence suggest to group them in a NW and an E-W striking system.

a)



b)

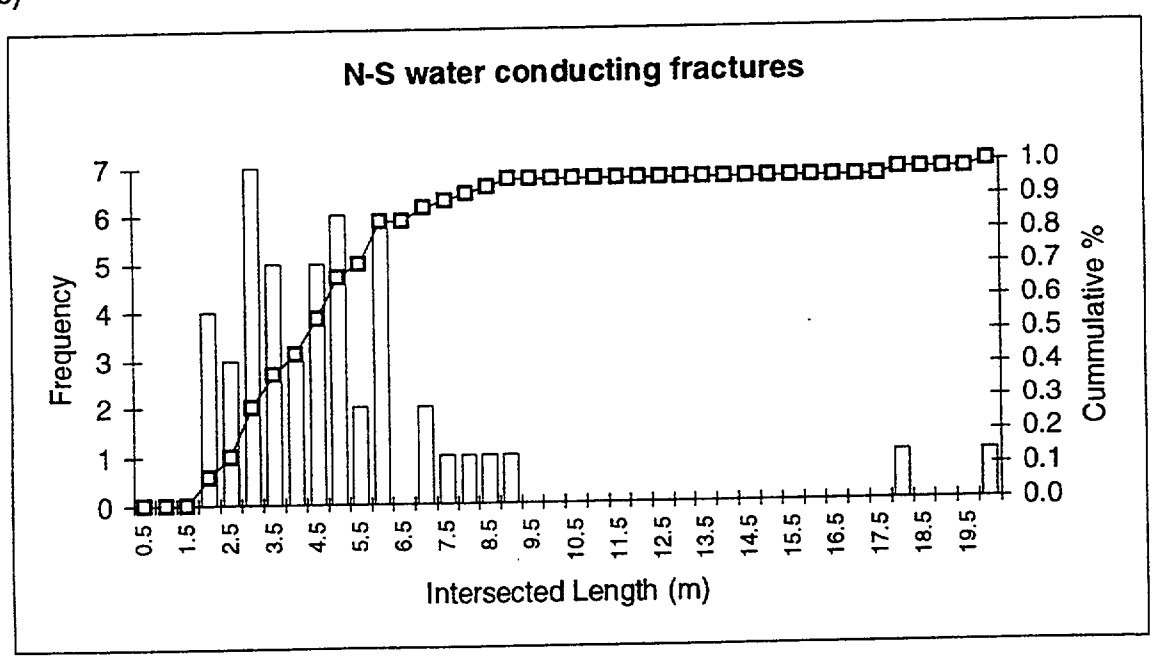


Fig.19: Frequency histograms N-S striking fractures; a= normal, b= water conducting

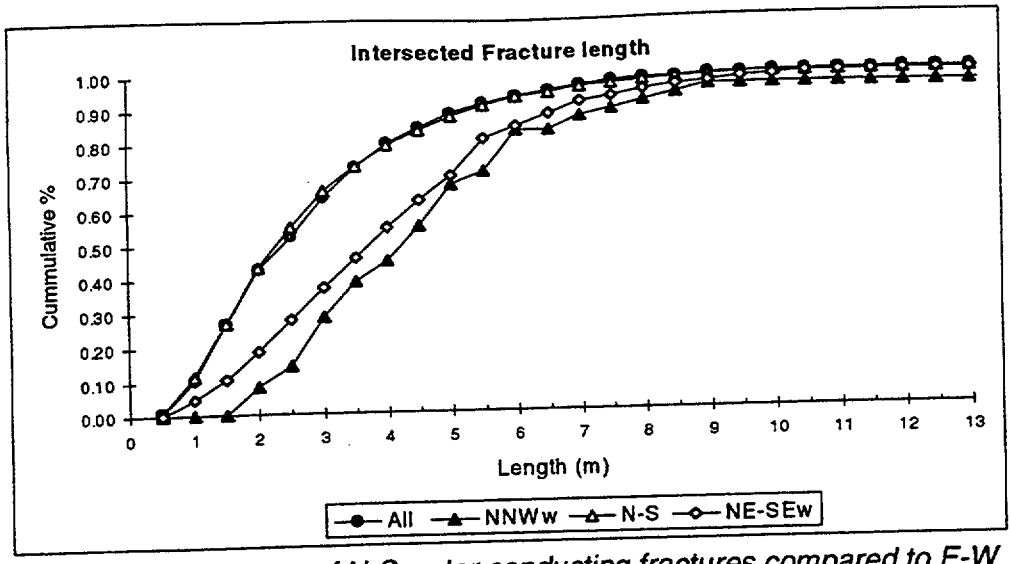


Fig.20: *Frequency histograms of N-S water conducting fractures compared to E-W water bearing and the distribution pattern of normal fractures and tunnel average.*

5.2.3 FREQUENCY OF WATER BEARING FRACTURES IN STRIKE INTERVALS OF 10°

As mentioned above, about 17% of all fractures belong to the N-S striking fracture (N-S interval = 11% of 360°).

7.6% of all fractures have been mapped as water bearing compared to 4.0% within the N-S striking fractures. In comparison to the E-W striking fracture set the frequency of N-S striking water conducting fractures is generally lower. Minima are present within intervals 160-210° and 60-80° (Fig.21, Tab.6).

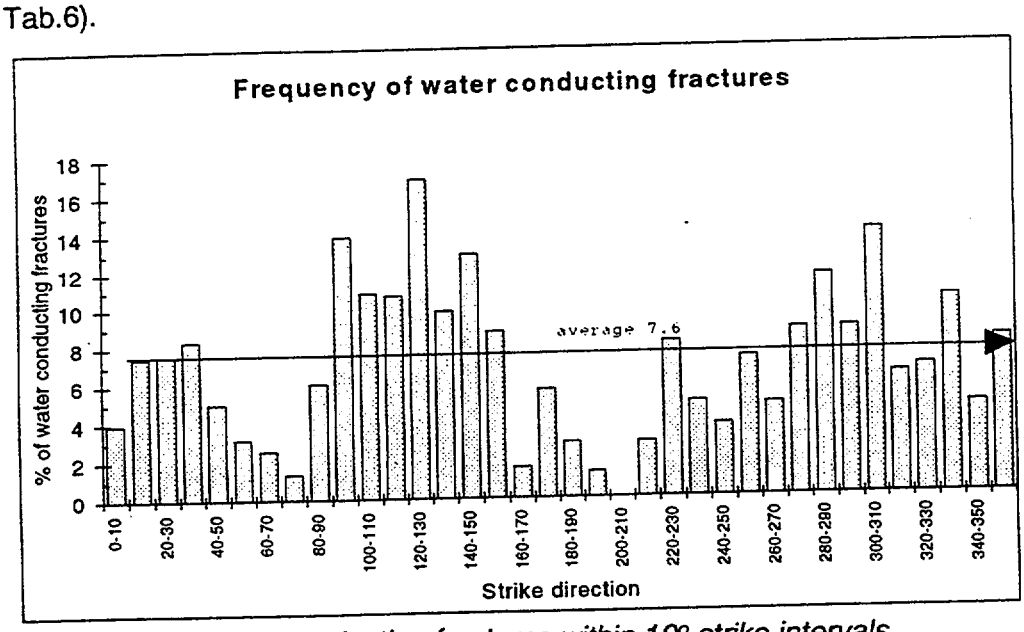


Fig.21: *Frequency of water conducting fractures within 10° strike intervals.*

Considering that a reactivation of fractures leads to a concentration of longer fractures at the cost of shorter ones, these data could indicate such a reactivation process. However, this has to be proven by additional structural analyses. It is remarkable that the frequency increases around strike direc-

tion 90 to 160°, but there is no clear correlation between the average fracture length and the frequency of water conducting fractures in this case.

	Fracture length (m)						
Strike	Normal	Water-conducting	Water-Normal	% Water conducting	Total	"Water"	Grouted"
0-10	3.4	6.5	3.1	4.0	227	9	1
10-20	3.4	4.0	0.6	7.5	174	13	3
20-30	3.3	4.4	1.1	7.6	132	10	0
30-40	3.0	4.1	1.1	8.3	144	12	1
40-50	3.5	4.2	0.7	5.0	120	6	0
50-60	3.2	4.2	1.0	3.1	127	4	0
60-70	3.3	4.6	1.3	2.5	118	3	1
70-80	3.0	6.7	3.7	1.3	76	1	1
80-90	3.6	4.8	1.2	6.1	99	6	2
90-100	3.0	4.2	1.2	13.9	115	16	4
100-110	3.2	5.8	2.6	10.9	138	15	4
110-120	2.8	3.6	0.8	10.7	196	21	6
120-130	2.6	4.4	1.8	16.9	154	26	6
130-140	3.0	4.4	1.4	9.8	112	11	2
140-150	3.0	4.2	1.2	12.9	85	11	0
150-160	3.2	4.6	1.4	8.8	80	7	2
160-170	3.2	5.4	2.2	1.6	63	1	0
170-180	3.0	5.2	2.2	5.7	53	3	1
180-190	3.1	4.0	0.9	2.9	70	2	1
190-200	3.5	6.7	3.2	1.3	76	1	
200-210	3.5			0.0	80	0	0
210-220	3.5	2.4	-1.1	2.9	69	2	0
220-230	3.6	4.0	0.4	8.1	86	7	0
230-240	3.2	3.4	0.2	4.9	81	4	1
240-250	3.2	4.7	1.5	3.8	80	3	1
250-260	3.3	2.9	-0.4	7.3	55	4	1
260-270	3.3	4.2	0.9	4.8	83	4	2
270-280	3.2	5.2	2.0	8.8	80	7	2
280-290	2.8	6.2	3.4	11.7	120	14	3
290-300	3.0	4.6	1.6	8.8	148	13	2
300-310	3.0	4.1	1.1	14.0	200	28	4
310-320	2.9	3.9	1.0	6.3	158	10	3
320-330	3.8	5.7	1.9	6.7	164	11	3
330-340	3.0	4.2	1.2	10.4	164	17	2
340-350	2.9	5.3	2.4	4.7	170	8	0
350-360	3.1	5.2	2.1	8.2	183	15	5
	3.2	4.6		7.6			

Tab.7: Average intersected fracture length, frequency distribution of water conducting fractures within 10° strike intervals; (bold = extreme values; further explanations cf. text)

5.3 FRACTURE MINERALOGY

The fracture mineralogy has been calculated for the following data sets:

- "Normal" N-S striking fractures (10-340° and 160- 190°)
- Water conducting fractures N-S
- Water conducting E-W fractures (long fractures according to Fig 21)
- All "long" water conducting fractures

A subdivision of fractures e.g. according to dip (sub-horizontal fracture set) would probably lead to better results, but due to the time restrictions, this was impossible. Mineral parageneses have not been calculated for the same reason. For comparison averaged data of fractures of tunnel sections 1/600 to 2/400m have been used (cf. App. B-2).

The mineralogy of N-S striking, normal (non-water conducting) fractures shows minor differences to the average tunnel values only (epidote, oxide and quartz more frequent; Tab.8.) Within the group of water-conducting, N-S striking fractures, these three minerals and chlorite are significantly more frequent especially in the strike direction intervals 340 and 350°.

To get an idea if this distribution is strike dependent or related to the occurrence of water, the mineralogy of E-W striking, water conducting fractures (270-290°) was calculated as well (Fig.22.b). The main difference to the N-S set is the predominance of calcite instead of chlorite. Generally epidote, oxide and quartz are less frequent compared to the tunnel average and the N-S striking fracture set. Remarkable however is the "high" frequency of epidote and ox in strike directions 110° respectively 290°.

<u>For the characterisation of the N-S striking fracture set these data can be summarised as follows:</u>

- Epidote, quartz, and oxide are more frequent in the water conducting N-S fractures compared to the tunnel average; insignificant differences to normal N-S fractures.
- This characteristic is strike dependent (and not a fact of water circulation) suggested by the comparison with the E-W data set.
- The fracture mineralogy justifies a definition of a N-S fracture set.
- Considering the sequence of fracture fillings with calcite as one of the latest minerals (Munier, 1992) the predominance of calcite in the E-W fracture set would indicate late water circulation especially within E-W striking fractures.

The N-S fracture set with epidote, quartz and oxide together with chlorite, would then represent a fracture set probably with minor late water circulation. However, these can only be preliminary conclusions (mineral paragenesis and structural analysis are not considered or missing).

Water conducting N-S

Strike	KL	KA	EP	OX	QZ	IJ	CY	MY
10	100.0	44.4	11.1	0.0	11.1	11.1	0.0	0.0
360	33.3	33.3	20.0	20.0	13.3	0.0	0.0	0.0
350	77.8	44.4	33.3	44.4	0.0	11.1	22.2	0.0
all	78.4	51.4	29.7	18.9	10.8	21.6	10.8	0.0

Water conducting EW

110	33.3	73.3	40.0	0.0	6.7	20.0	13.3	6.7
280	42.9	71.4	28.6	0.0	0.0	28.6	0.0	0.0
290	50.0	71.4	0.0	21.4	0.0	21.4	0.0	0.0
all	41.7	72.2	22.2	8.3	2.8	22.2	5.6	2.8

All (long) water conducting fractures

	60.3	61.6	26.6	17.7	6.8	21.9	8.2	1.4

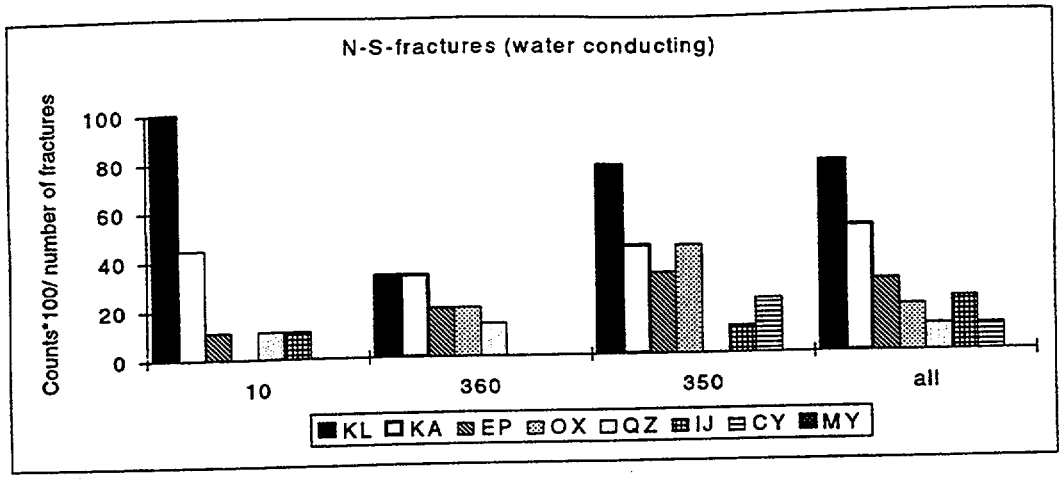
N-S normal fractures

10	76.3	50.9	18.4	28.1	5.3		0.0	0.0
360	76.5	49.7	20.1	32.2	12.1		2.0	2.7
350	68.6	51.6	25.8	25.8	4.4		4.4	1.3
N-S	72.5	46.9	20.5	25.7	6.7		2.1	1.1
190	68.7	34.3	16.4	13.4	3.0		0.0	1.5
180	53.1	32.7	18.4	20.4	10.2		0.0	0.0
170	78.3	38.3	21.7	18.3	6.7		0.0	0.0

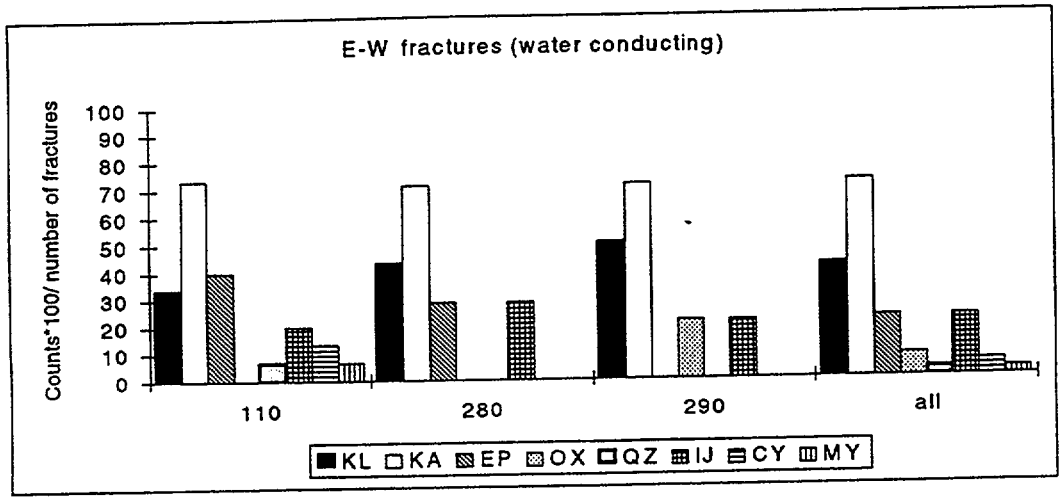
Tunnel section 1600 to 2400

	61.4	48.7	13.3	19.1	3.3	1.2	2.9	1.0

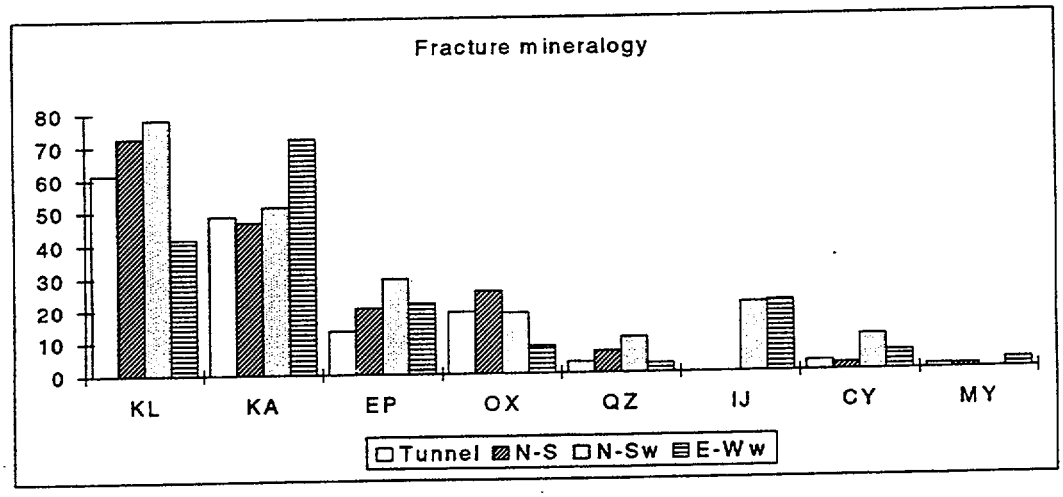
*Tab.8: Fracture mineralogy (counts*100/number of fractures);KL- chlorite, Ka- calcite, Ep- epidote*



a)



b)



c)

Fig.22 a-c: Fracture mineralogy. a= water conducting N-S striking fractures, b= water conducting E-W striking fractures, c= summarising histogram tunnel average section 1/600 to 2/400m. KL- chlorite, Ka- calcite, Ep- epidote, OX- oxide, QZ- quartz, CY- clay, MY- mylonite, IJ- groutN-S (340-10°) NS water conducting; E-W 270-290+110°) E-W water conducting (the term "all" refers to average values including the corresponding strike directions).

5.4 DISTRIBUTION OF N-S FRACTURES IN THE TUNNEL

5.4.1 FRACTURE FREQUENCY

Up to now it has been demonstrated that N-S striking fractures form an "independent set" characterised by certain, "unique" fractures. Thus one of the basic question is their distribution in the tunnel, in order to define fracture zones or a set of individual fractures.

The possibility that N-S striking fractures will intersect (and be mapped) depends on the directions of the tunnel line (orientation bias). Tunnel legs A and D are striking N-S, legs B,C and E are directed in NE to SW directions. Thus, considering a homogeneous distributed fracture network, N-S striking fracture will be mapped less frequent on legs A and D, maxima will be found in Leg B and E. The fracture frequency of N-S striking fractures of each tunnel leg is shown in Fig.24. The general increase of fracture frequency (N-S striking fractures) starting with leg C, cannot be explained with the orientation of the tunnel legs. These data suggest a more intense N-S fracturing in Legs D and E, although the data are not corrected for the bias. The relative "high" frequency of leg B is probably due to a combination effect of orientation and a real fracturing intensity.

As the definition of fracture zones includes a frequency criteria, the values within 20m intervals have been calculated for the N-S strike direction. Fig. 23 presents the summarising diagram, for 10^0 intervals the frequency is shown in Fig.25 a-c. The frequency distribution in NNW 1,2 and NNE is similar. These groups can be treated as one strike direction interval.

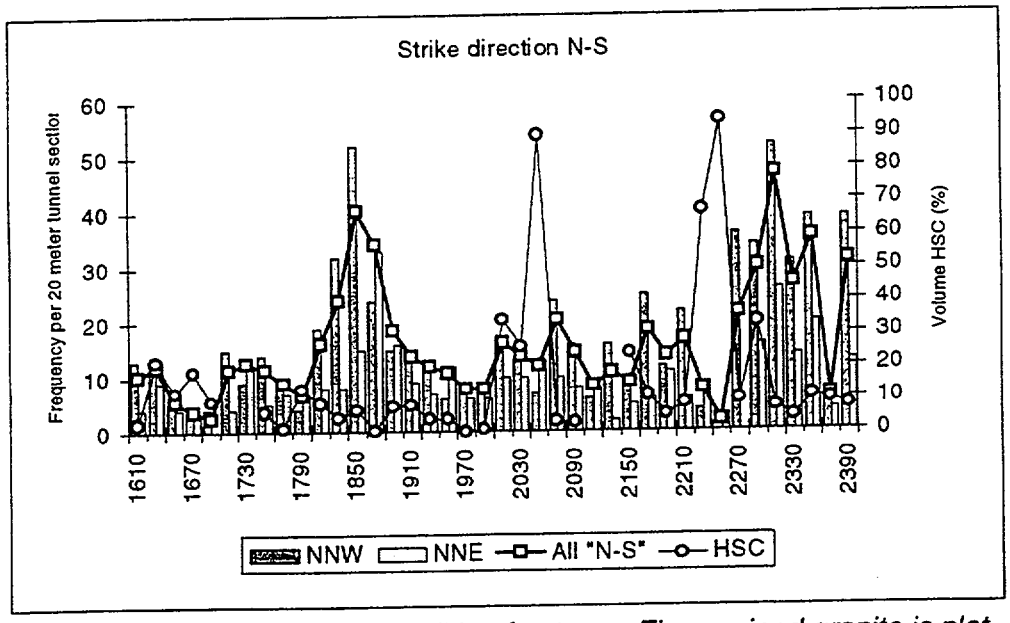
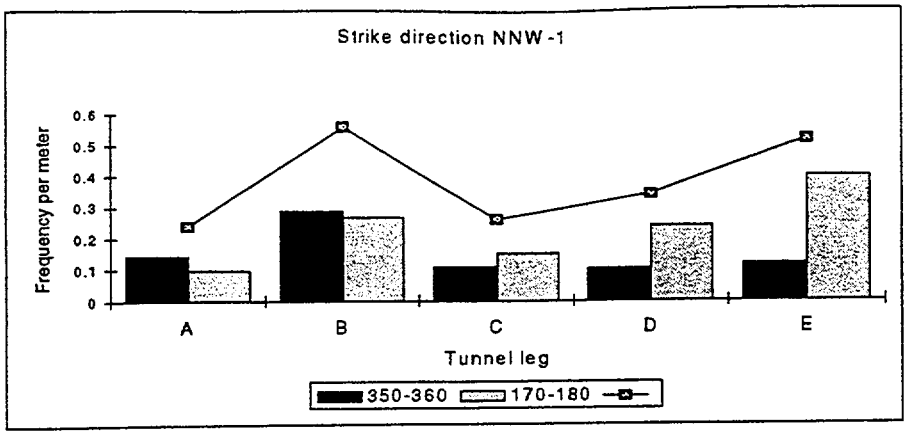
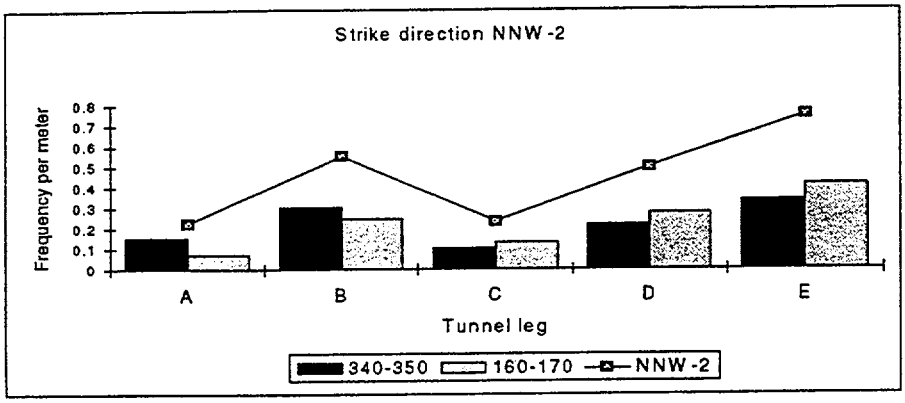


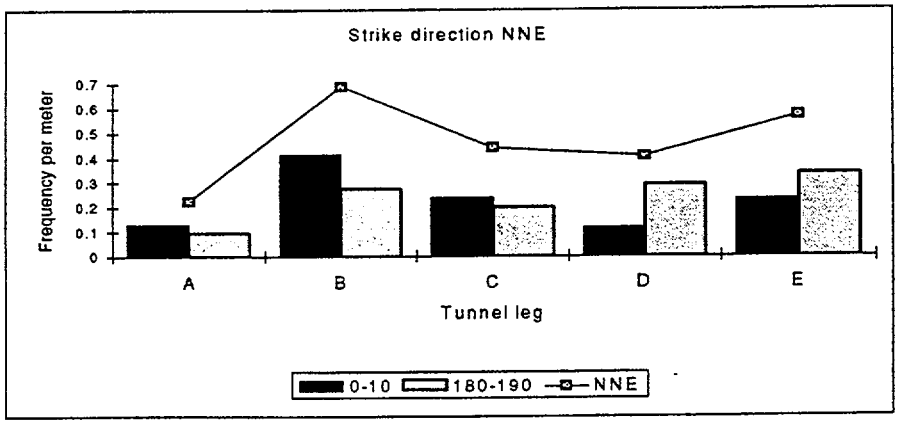
Fig.23: Frequency distribution of N-S striking fractures. Fine grained granite is plotted on the right y-scale. Note that these data include mapped fractures on both sides of the tunnel and the tunnel roof. Fractures mapped within fracture zones have been treated separately



a)



b)

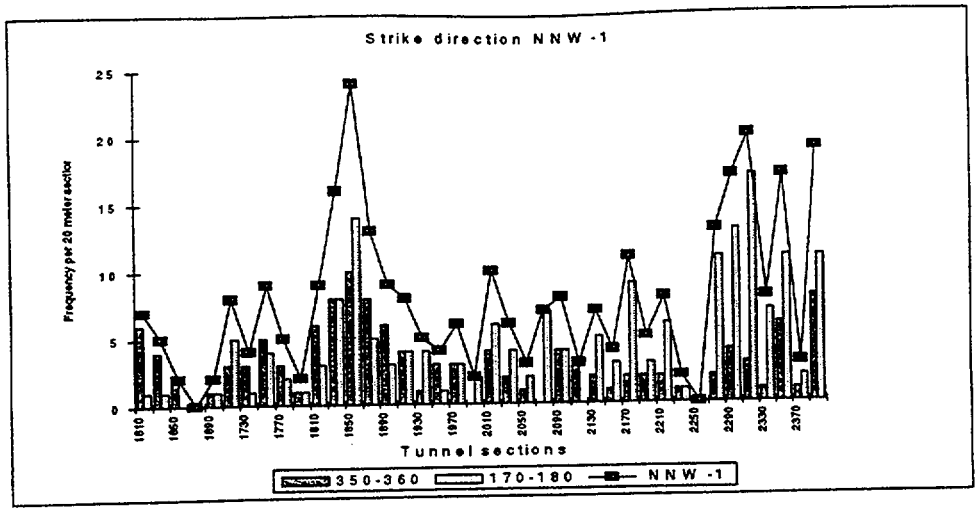


c)

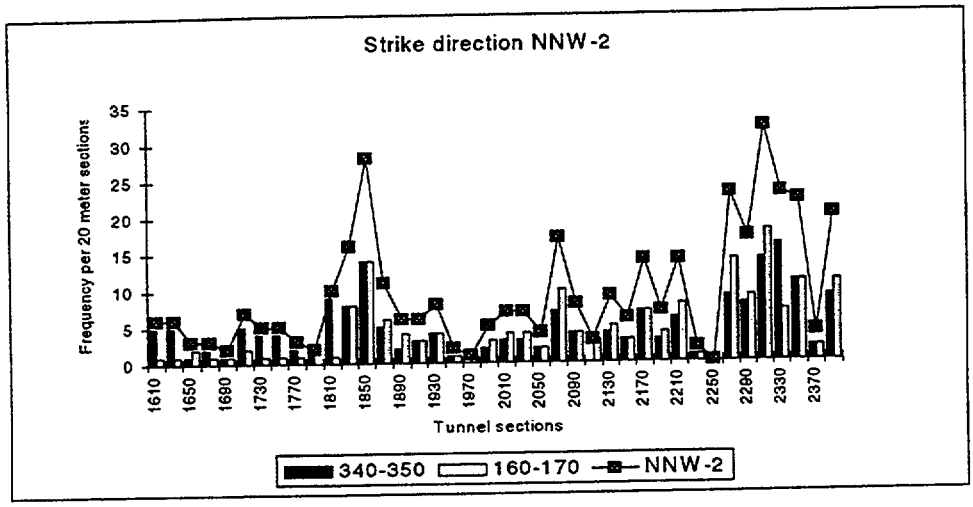
Fracture frequency per meter tunnel

LEG	E-W	NW-SE	N-S	Total	90-100	280-290	100-110	290-300	100-120
A	1.1	1.5	0.7	3.3	0.1	0.1	0.1	0.3	0.3
B	0.9	0.6	1.8	3.2	0.2	0.1	0.2	0.0	0.2
C	0.5	0.5	0.9	1.9	0.1	0.1	0.1	0.0	0.1
D	0.9	0.9	1.2	3.0	0.1	0.1	0.2	0.2	0.2
E	0.7	1.1	1.8	3.6	0.1	0.1	0.1	0.1	0.2
average	*0.8*	*0.9*	*1.3*	*3.0*	*0.1*	*0.1*	*0.2*	*0.1*	*0.2*

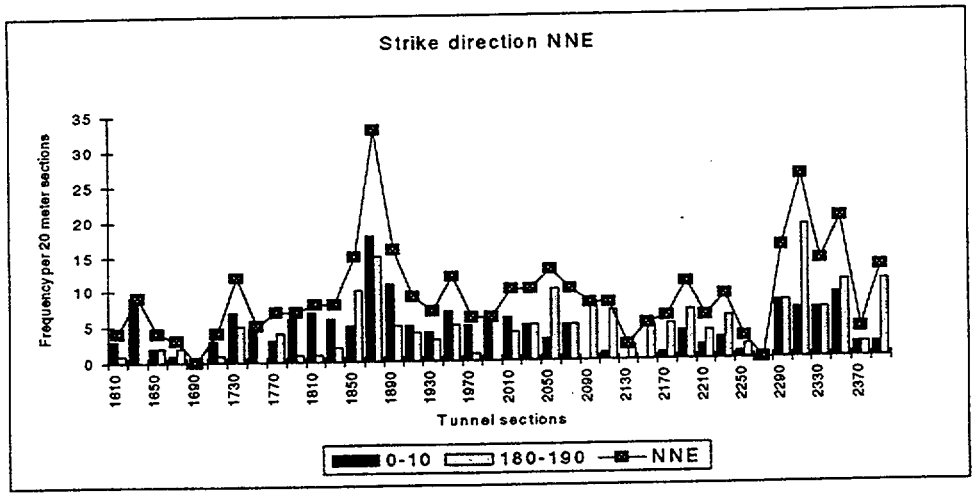
Fig. 24 a-c: Frequency histograms of selected strike direction intervals in tunnel legs A-E. Plotted is the number of fractures per tunnel meter against tunnel leg; Mapped fracture zones are excluded here.



a)



b)



c)

Fig.25 a-c: Frequency distribution of N-S striking fractures a- strike direction NNW 1; b- strike direction NNW-2; c- strike direction NNE.

About 26 N-S striking fractures have been mapped per 20 meter tunnel homogeneously distributed within the 30° strike direction interval (1.3 frac/meter, Fig.23). Low frequencies are found around sections 1/690m and 2/250m (Fig.23). In the second case (2/250m) this minima is probably an artefact, because of the overlap with fracture zones between tunnel section

2/218m and 2/280m. In the first case however, "nothing special" has been noted during tunnel mapping. Thus this minimum can be regarded as a "real" decrease of N-S fracture intensity.

Two frequency maxima, the first around tunnel section 1/850m, the second around 2/310m are present. This distribution does not correlate with the distribution of fine grained granite. Considering the mapped fractures zones the maxima will be pronounced. Fracture zones including a N-S direction have been mapped at 1/832m, 1/845-1/853m, 2/013-2/030m and from 2/018 to 2/060m.

The background frequency of N-S striking fractures is around 1.3 fractures per meter or per $25m^3$ of excavated rock. Within the maxima ca. 3.3 respectively 3.5 fractures per meter have been recorded; the width of these "zones" are around 40m. The average fracture frequency, including all fractures calculated from tunnel section 1/600-2/400m, is 3.9 fractures per meter so that the increased N-S fracturing will only hardly be recognised.

Around tunnel section 2/310m the increased fracturing intensity is related to N-S fracturing. The frequency of N-S striking fractures is comparable to other main strike directions like the NW-SE or the E-W one. Data for comparison are shown in Fig.24.

Following the "frequency criteria" in the definition of a fracture zone in a strict sense, and considering N-S fractures exclusively, these data suggest to define N-S striking fracture zones within the investigated area. However, the variations of total fracturing intensity (Fig.25) are minor. **Thus it is not likely to constitute a fracture zone!**. In the case of the second maxima the total fracture increase is due to the N-S fractures but fracture zones have not been mapped!

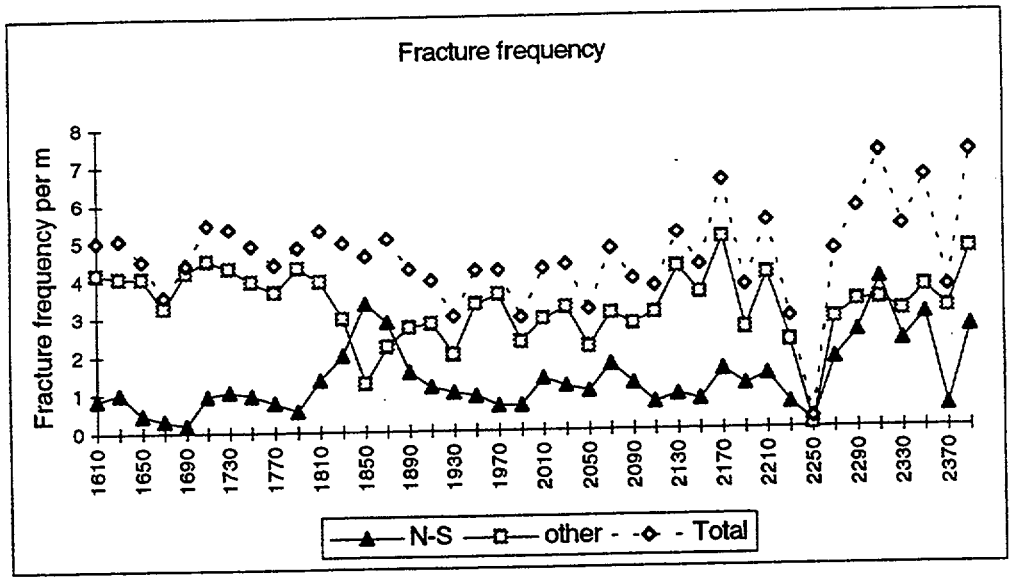


Fig.26: *Fracture frequency of N-S striking fractures and the tunnel average calculated for 20m sections.* N-S = 340-10°; "other" = 10-340°.

5.4.2 AVERAGED SPACINGS OF N-S STRIKING FRACTURES

"Averaged spacings" of N-S striking fractures intersecting the tunnel wall have been calculated for both, the left and the right side of the tunnel, to get a closer view of the fracture distribution pattern. Appendix D-1 shows the procedure these data have been calculated; App. D-2 the exact location of the N-S striking fractures and App. D-2 the 1: 200 meter mapping. A line mapping was impossible, but nevertheless some information can be deduced from this data set.

Fractures within fracture zones could not be taken into account, because the number and exact position of the N-S striking fracture within the mapped fracture zones are not known. However, approximately 10% of the N-S fractures are characterised by averaged spacings less than 1m; ca. 20% are within a spacing range from 0-2m .

Fig. 27 a,b illustrates "averaged spacings" of N-S striking fractures for the left and right side of the tunnel. To smooth the curves the moving average including three data points has been plotted.

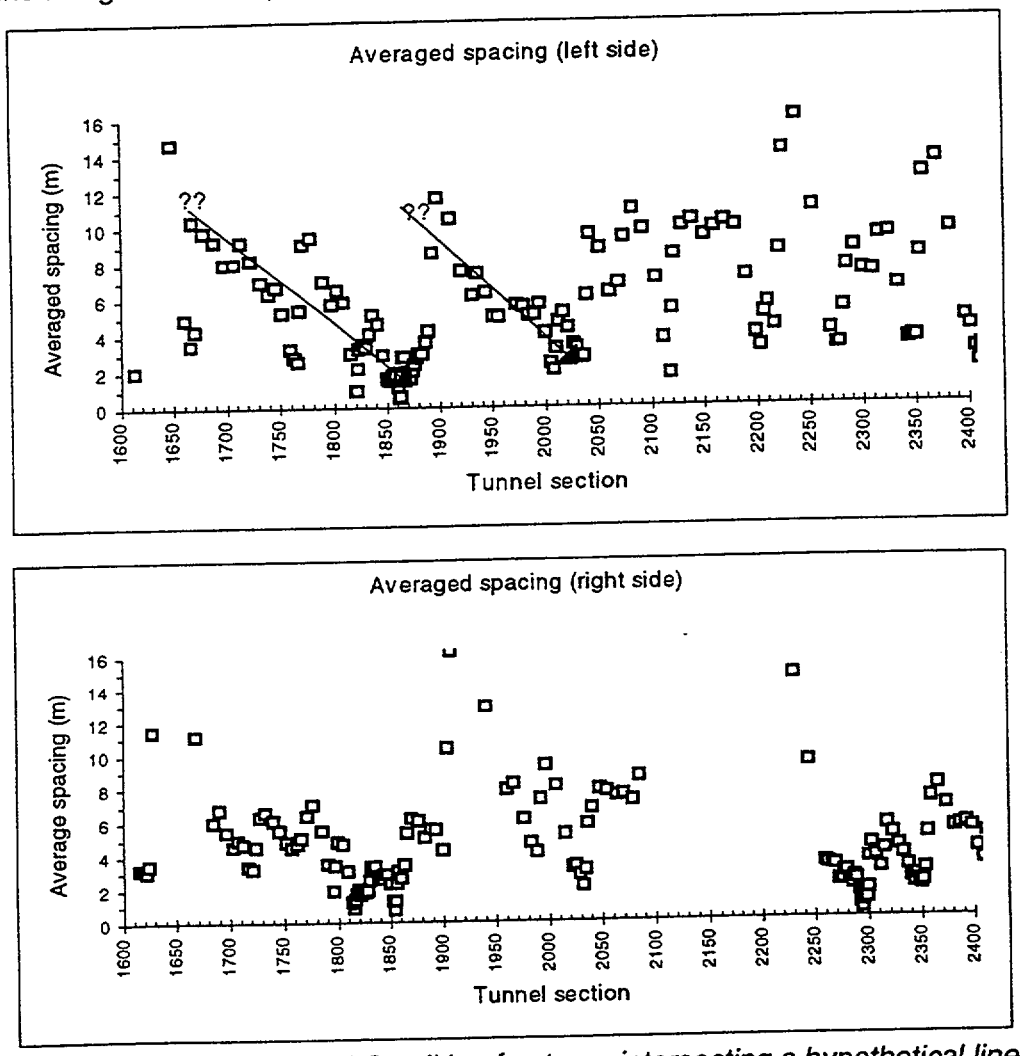


Fig.27: "Averaged spacings" of N-S striking fractures intersecting a hypothetical line on the left (upper diagram) and the right (lower diagram) side of the tunnel. Note that fractures of mapped fracture zones are excluded here.

The obvious gap between 2/100m and 2/200m on the right tunnel wall is probably an artefact due to the presence of fracture zones 10 and 11. A normal distribution can be recognised on the left side of the tunnel. "Closely-spaced" N-S fractures (spacing <1.5m) are present in short tunnel sections, (1/810-1/830m, 2/290-2/300m and on the left side at 1/820m and from 1/850 to 1/860m, related to fracture zones at 1/832m and from 1/845 to 1/853m).

Tunnel sections 1/600 to 1/900m and 1/900 to 2/240m seem to be characterised by a "regular" of decrease in spacing with increasing tunnel meter -- asymmetric distribution However, this is uncertain at all, because a line mapping and detailed tunnel investigations have not been performed.

With the exception for the tunnel interval around 1/830m it can be concluded that, the N-S fracture set is characterised by single fractures, with spacing generally more than 2m -- **no fracture zones!!**

The location of N-S striking fractures, grouted sections and the mapped fracture zones in the first tunnel loop is shown in Fig.28.

The tunnel sections characterised by an increased N-S fracturing are approximately 20-50m wide. This "N-S fracturing swarms" can be traced over more than 200m along a hypothetical strike direction, suggested by the correspondence of the two "maxima" on Leg A and E.

Including minor (not significant) maxima as well, horizontal spacings of N-S fracturing of ca. 100m will result (first guess which has to be proven. It is suggested to consider surface and the shaft mapping and other data to prove these statements.

Remark: Structural data from an E-W directed drill hole to correlate data in the "middle" of the spiral were not available.

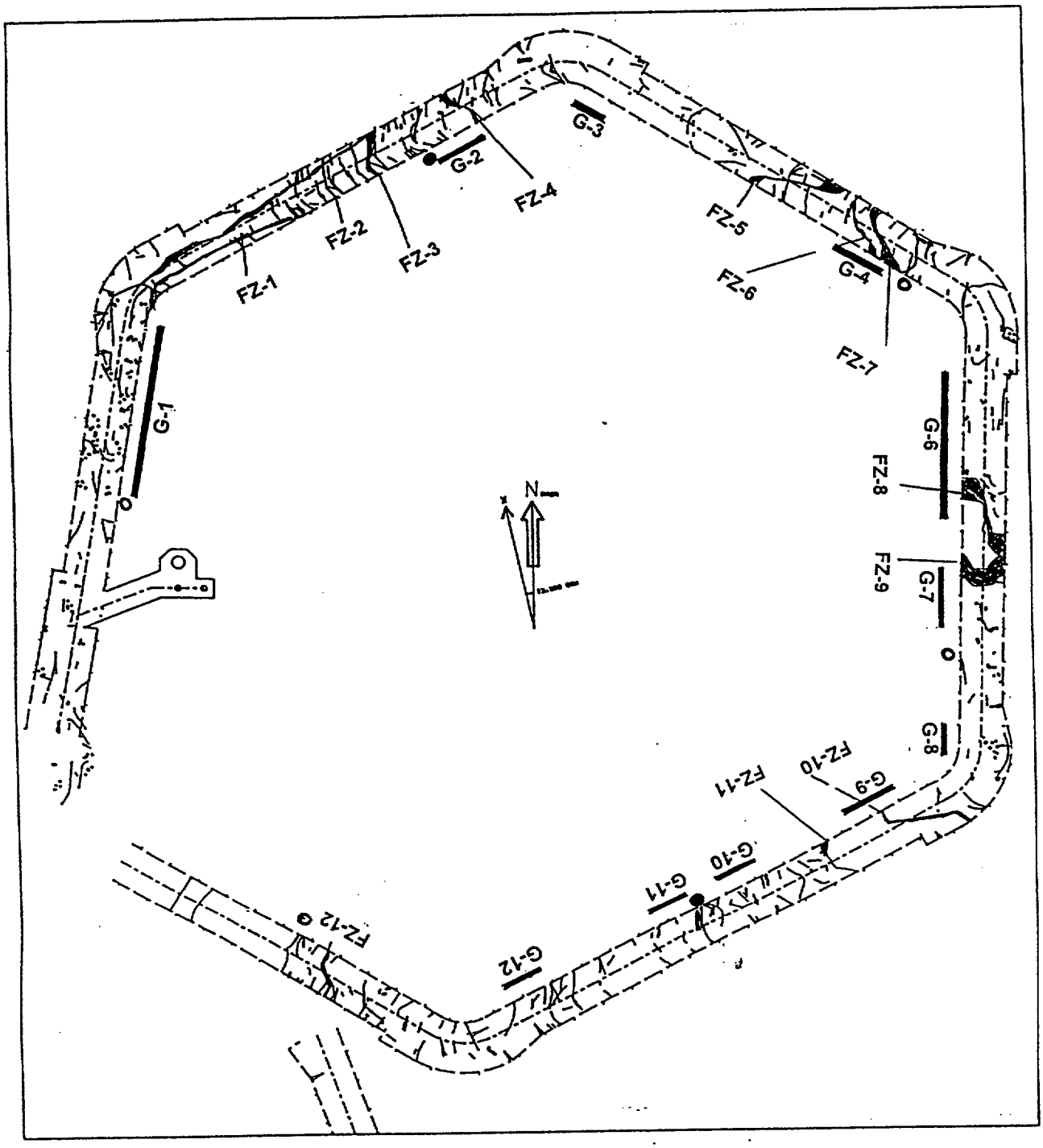


Fig.28: *N-S striking fractures (strike intervals from 0-10°,340-360° and 160-190°) mapped in the first loop of the spiral. Grouted sections (G) and mapped fracture zones (FZ) are shown as well. The fracture frequency maxima of N-S striking fractures are marked by circles cf. Fig. 26.*

5.5 CHARACTERISTICS OF THE N-S FRACTURE SYSTEM - SUMMARY -

In order to characterise the "NNW" striking fracture system data from tunnel sections 1/600 to 2/400m were splitted in 10° strike intervals and in groups of water conducting res. "normal" fractures for each interval. This structuring of the data set was needed to work out some characteristics of the N-S striking fractures. "No" results (useful for a characterisation) have been obtained if data sets including fractures of all strike directions or those from grouted sections were used.

With the data recorded during the routine tunnel mapping the "NNW" fractures system has been redefined to a **N-S striking** one, characterised by the following features.

N-S striking fractures: 10 E to 340 W (160-190o) subdivided in:

NNW 1 - 340 to 350° and 160 to 170°

NNW 2 - 350 to 360° and 170 to 180°

NNE - 0 to 10° and 180 to 190°

(steep dipping fractures dominate)

NNW 1 and 2 together are called the NNW striking fracture set; data sets including the NNE are called N-S fractures. For further interpretations fractures within this strike direction interval can be handled as one group.

Remark: Other strike direction sets like an E-W and a NW-SE one seem to be characterised by specific features as well.

Average length:

- Non water conducting fracture:

normal (within the variability range of other fracture sets, Fig.17).

- Water conducting fractures:

N-S fractures, together with an "E-W fracture set" are of "extraordinary" length within the group of water conducting fractures (Fig.18).

Fracture length distribution:

- The distribution of all N-S fractures is equivalent to that of the fracture length distribution of the complete data set (Fig.19).

- Water conducting N-S fractures show a shift to longer interval groups, even compared with the "long" water conducting E-W striking ones. Sequence: tunnel average and N-S normal fractures --> water conducting long E-W fractures --> water conducting N-S fractures (Fig.20).

Frequency of water conducting fractures N-S fracture:

Normal compared with average values, but less frequent compared to the strike directions around 120° and 290° (Fig.21).

Mineralogy:

- Epidote, quartz and oxide are more frequent compared to the tunnel average, especially in the group of water conducting fractures.

- This characteristic is strike dependent (and not a related to water circulation), as indicated by the comparison with the E-W data set.

- The major difference of the N-S water conducting fractures is the predominance of calcite instead of chlorite as the dominant fracture mineral of other water conducting fractures (Fig.22).

Distribution pattern:

- Some indications suggest an increased N-S fracturing with depth.

- The fracture frequency does not correlate with the occurrence of fine grained granite (Fig.24)

- Two sections of increased fracturing are found in tunnel sections 1600 to 2400 with a fracture frequency around 3.5 fractures per meter of tunnel (average of all strike directions 3.9). They are between 20 and 50m wide.

- Considering exclusively the N-S fractures, these tunnel sections could be called fracture zones (using the frequency criteria). However, the total fracture frequency does not increase around the first N-S maxima; in the second case the total fracture intensity is governed by the occurrence of N-S striking fractures (Fig.25).

- Otherwise the frequency is normal; 1.3 for N-S , compared with 0.9 for E-W or for NE.

Average distance:

10% of the N-S fractures occur with spacings less than 1m, 20% are present within the interval 0-2m (Fig.17).

Fracture zones?:

- The N-S system is an independent fracture set, characterised in terms of mineralogy, fracture geometry and mode of occurrence in the tunnel.

- The N-S system is an example of fractures occurring mainly as "isolated" single fractures.

- N-S striking fracture zones ("third order") do not exist in the investigated area.

- Instead, areas of increased fracturing (swarm like distribution) has been proven.

They can be traced along a hypothetical strike direction over at least 200m. Horizontal spacings of 100m seem to be realistic.

- Considering e.g. the characteristics of fracture length and the fracture mineralogy of N-S striking fractures it seems that the N-S system represents reactivated fractures with minor (late) water circulation.

6 RELATIONSHIPS OF THE N-S STRIKING FRACTURE SYSTEM TO GROUTED SECTIONS -- SOME REMARKS--

Most of the time was spent to define the N-S system, so that only some remarks on the relationship between zones of high water inflow and the N-S striking fracture system can be made.

The following statements must be preliminary, because more detailed (underground) investigations have to be performed (e.g. definition of other fracture systems, more detailed investigation on mapped fracture zones etc. cf. chapter 6.1). Furthermore the N-S system is characterised by wide average spacing (single fractures). Thus investigations on some selected fractures (hydrotests) have to be performed to quantify the hydraulic importance of the system. However, the following chapter gives some rough ideas on the relationship between the N-S system and the grouted sections. The location and characteristics of grouted sections have been summarised in chapter 3; data from the probehole drillings are presented in appendix B-5.

27% of the investigated tunnel sections were pre-grouted and 32% of the N-S fractures were mapped within the grouted sections. This means that the fracture distribution in grouted sections is equivalent to the non grouted sections. Approximately 40% of the water conducting N-S fractures occur in the grout section. It cannot be decided, whether this value is specific for the N-S system, because data for comparison are missing. Stereo plots of grouted sections give no evidence for a preferential N-S strike direction.

Fig.29 illustrates the relationship water inflow rates in probe holes (normalised values, both probe holes) to the frequency distribution of the N-S striking fracture set. The correlation between the points of increased inflow and N-S fracture intensity is weak. Transmissivities should be used instead of the outflow rates, but unlikely these data were not available.

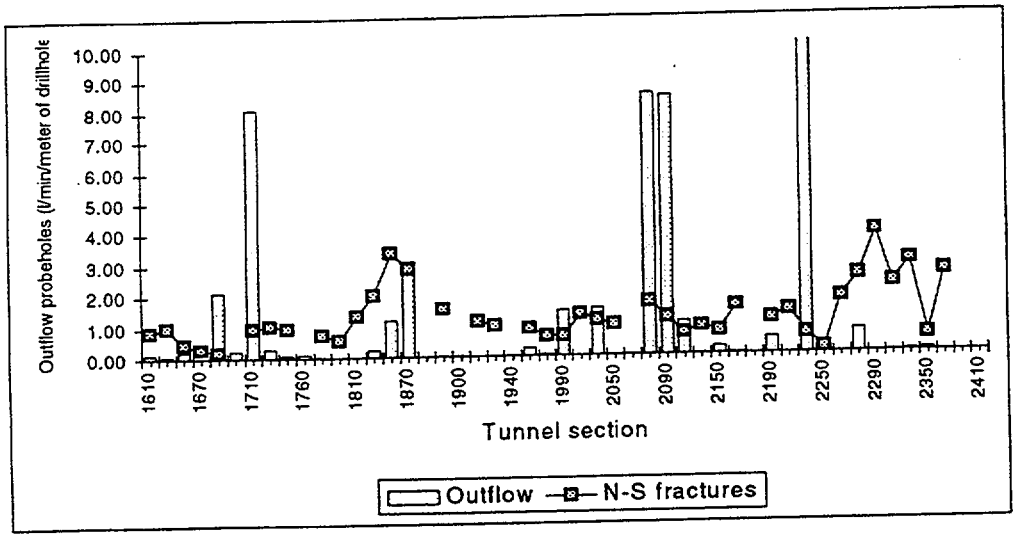


Fig.29: Relationship between water outflow rates from probe holes (l/min per meter of drill hole) and the fracture frequency of N-S striking fractures (fractures/meter of tunnel).

With the characterisation of the grouted sections it has been demonstrated that several factors must be considered to explain the high inflow rates of grouted sections. In addition to water conducting N-S and the E-W striking fractures, mapped fracture zones, frequency maxima of N-S striking fractures and major inflows from probe- and blast holes are marked in Fig.29.

- Water inflow rates to G-1 seem to be the result of the combination of water conducting E-W and the N-S fractures together with the sub horizontal fracture zone Z-1.

The intersection of Z-2 and Z-3 with Z-1 is not reflected by a significant increase of the water inflow rate. Individual water conducting N-S fractures are present, but they do not correspond with high water inflow rates.

- In the case of G-2 the first frequency maxima of N-S fractures, water conducting N-S and E-W together with the mapped fracture zones Z-4 and Z-5 form a conductive fracture network.

- Further investigations are needed to explain grout section G-3. If no other conductive structures can be defined, this tunnel section might be an example for (highly) conductive "single" N-S fractures. In that case the term third order fracture -zone would be justified. A similar situation are grouted sections 10-12.

- Grout section G-4 can probably be explained by the occurrence of more complex structures fracture zones Z-7 and Z-8.

- No evidences for a "N-S factor" can be evaluated in the case of sections G-6 to G-9.

- Up to tunnel section 2/250m the presence of mapped fracture zones can be considered as an important factor resulting in a conductive fracture network. For grout sections 10 to 12 however other explanations have to be found (e.g. fractures striking NW?).

- Although it cannot be proven, it seems that the conductivity of the N-S fracture set is not efficient enough that pre-grouting has to be carried out.

- The importance of individual N-S fractures with respect to the total water inflow has to be investigated in more detail.

- Considering e.g. the fracture length characteristics and the fracture mineralogy of N-S striking fractures it seems that the N-S system represents reactivated fractures with minor (late) water circulation.

6.1 CONCLUDING REMARKS

Within the time available, it has been possible to do some basic, preliminary work. Not all data have been used. In some cases the (statistical) significance of features related to the N-S system has to be proven. It was impossible to use all data and other studies. However, this work can be the basis for further detailed investigations.

The following ideas should be considered as some (concluding) remarks, based on the experience during the characterisation of the N-S fracture

system. The picture of the N-S fracture system should be completed considering:

- fracture plane characteristics e.g. striation
- mineral paragenesis
- sub-horizontal N-S striking fractures -- characteristics and relationships to other fractures
- crosscutting relationships of N-S fractures with other geological and tectonic elements
- type of fractures shearing or simple fracture, displacements

For the estimation of water transport through the N-S fracture set, the exact inflow points in each individual probe- and blast hole, and the intersection with the tunnel should be taken into account.

It would be helpful, of course, to get structural and lithological data by cored probe holes . For interpretation and to avoid misunderstandings other fracture sets (E-W and NW) should be defined in a similar way (strike direction intervals and related characteristics (e.g. 260-290° or 300-330°?).

If fracture sets are defined as mentioned above, it will be perhaps possible to evaluate structural and mineralogical factors related to zones of major water inflows. Interpretation of data sets which have not been splitted in several categories will lead to insignificant results.

The mapping technique in fracture zones should be improved:

- total number of fractures
-. "ranking" of fracture sets within the zone
- width of dominating fracture sets within the zone
- crosscutting relationships within the zone
- structural maps of fracture zones

It should be possible to combine data sets of routine mapping and fracture zone mapping directly. Are the criteria to map a fractures zone underground still good enough? How to define hydraulic important single fractures?

More attention should be taken to water conducting fractures during routine mapping

- type of fracture shearing
- crosscutting with other fractures, how many, geometry ...

"Suggestions" for high inflows of grouted sections 3 and 10-12 are missing:

?? Single N-S fractures --> underground and hydrotesting

NW- striking fractures!! --> definition and characteristics, are NW-striking third order fractures?

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PR 25-92-18

Passage through water bearing fracture zone

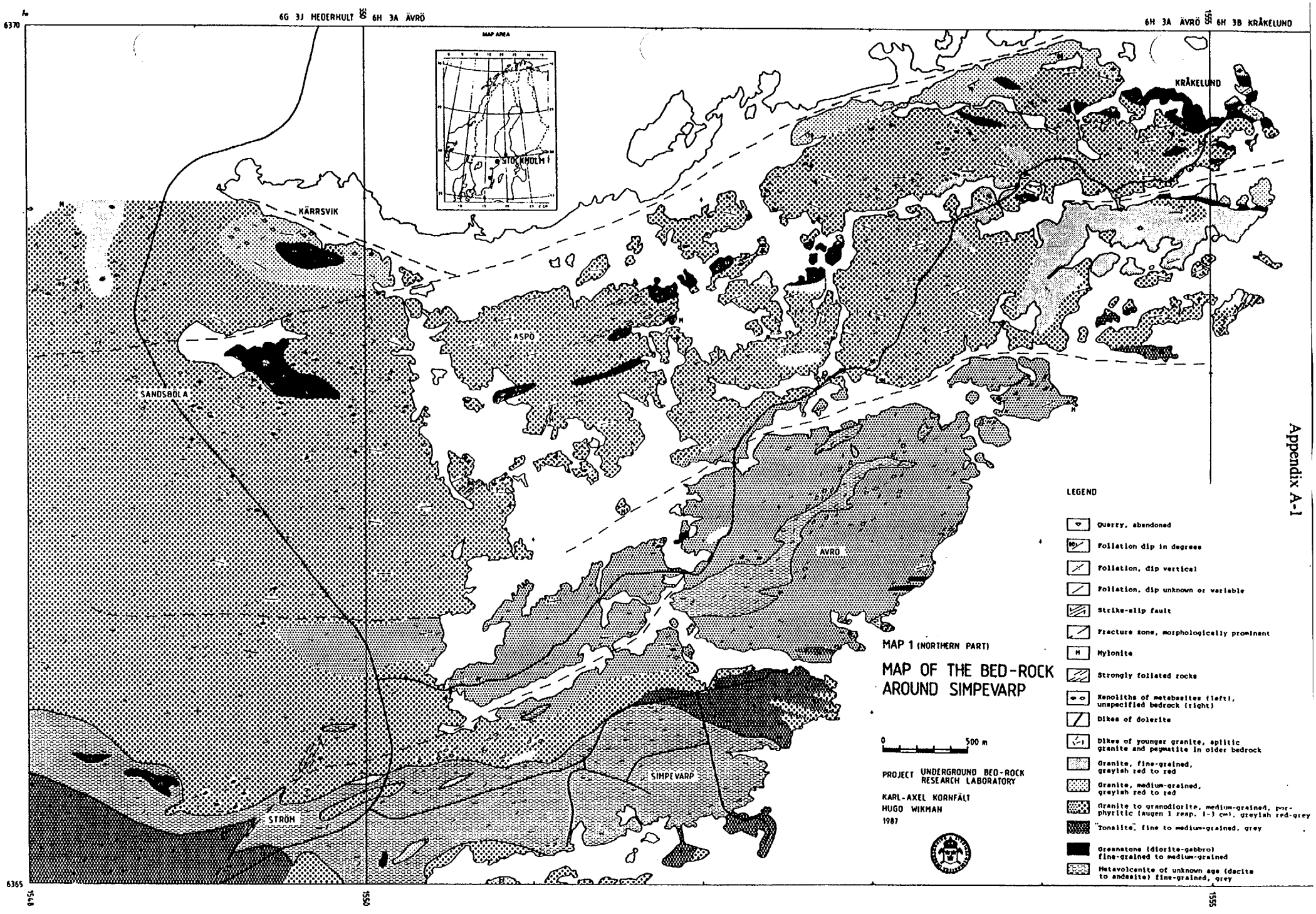
TR 91-21

Äspö Hard rock laboratory Field investigation methodology and instruments used in prediction phase 1986-1990

PR 25-87-05 Ericson, L.O.

Fracture mapping on Äspö Island

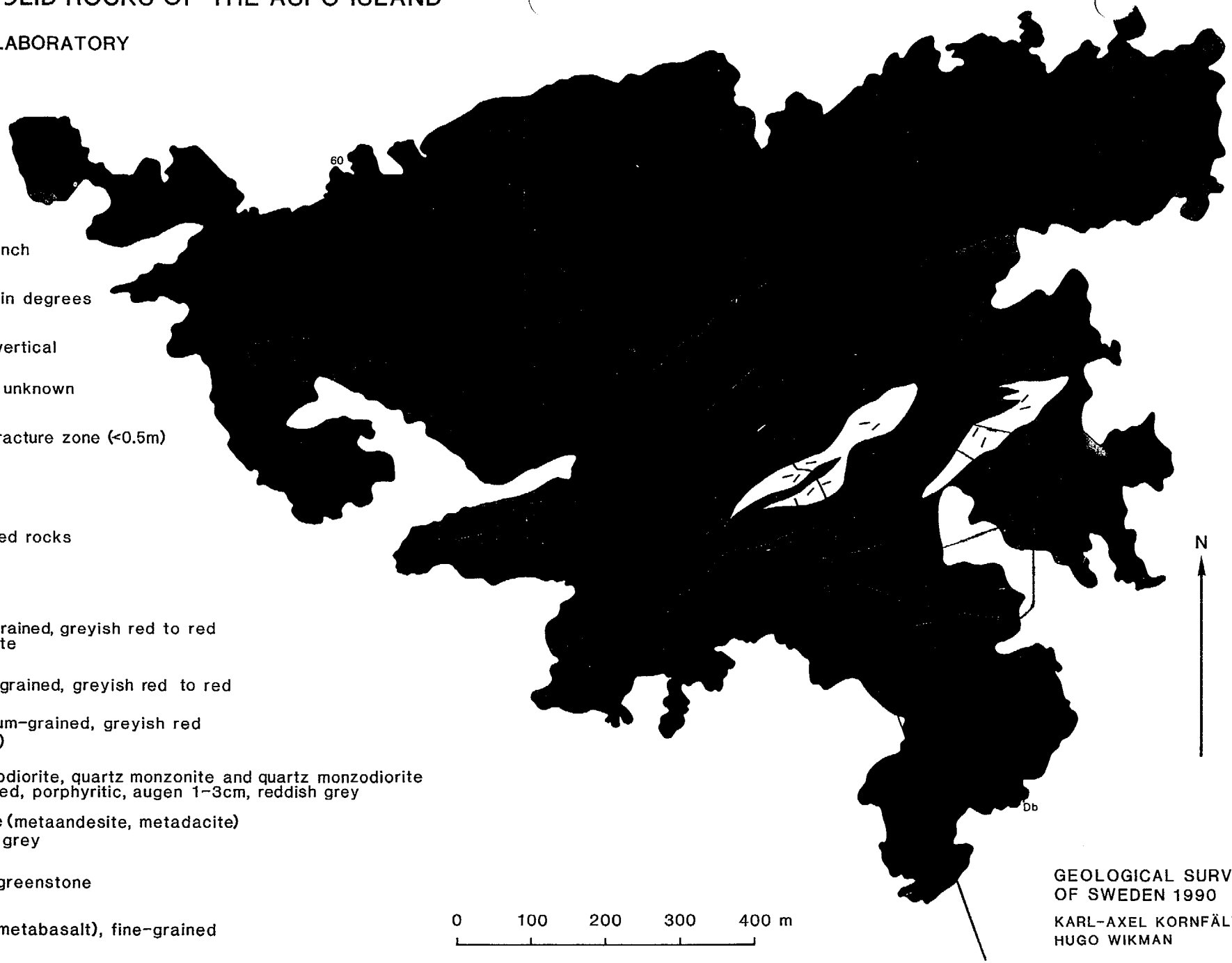
Appendix A1 to A-3


6G 3J HEDERHULT
6H 3A ÄVRÖ
6H 3A ÄVRÖ
6H 3B KRÅKELUND
6370
6365
1545
1550
1555
MAP AREA
STOCKHOLM
KÄRRSVIK
SANDSBÖLA
ASPÖ
KRÅKELUND
ÄVRÖ
SIMPEVARP
STRÖM
MAP 1 (NORTHERN PART)
MAP OF THE BED-ROCK AROUND SIMPEVARP
0
500 m
PROJECT UNDERGROUND BED-ROCK RESEARCH LABORATORY
KARL-AXEL KORNFÄLT
HUGO WIKMAN
1987
LEGEND
Querry, abandoned
Foliation dip in degrees
Foliation, dip vertical
Foliation, dip unknown or variable
Strike-slip fault
Fracture zone, morphologically prominent
Mylonite
Strongly foliated rocks
Xenoliths of metabasites (left), unspecified bedrock (right)
Dikes of dolerite
Dikes of younger granite, aplitic granite and pegmatite in older bedrock
Granite, fine-grained, greyish red to red
Granite, medium-grained, greyish red to red
Granite to granodiorite, medium-grained, porphyritic (augen 1 resp. 1-3 cm), greyish red-grey
"Tonalite", fine to medium-grained, grey
Greenstone (diorite-gabbro) fine-grained to medium-grained
Metavolcanite of unknown age (dacite to andesite) fine-grained, grey

Appendix A-1

MAP OF THE SOLID ROCKS OF THE ÄSPÖ ISLAND

SKB HARD ROCK LABORATORY



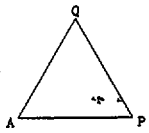
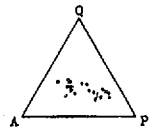
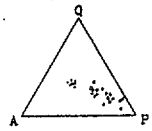
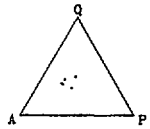
LEGEND

- Uncovered trench
- 60 Foliation, dip in degrees
- Foliation, dip vertical
- Foliation, dip unknown or vertical
- M Mylonitized fracture zone (<0.5m)
- Mylonite
- Strongly foliated rocks
- Db Diabase
- Dikes of fine-grained, greyish red to red younger granite
- Granite, fine-grained, greyish red to red
- Granite, medium-grained, greyish red (Ävrö granite)
- Granite, granodiorite, quartz monzonite and quartz monzodiorite medium-grained, porphyritic, augen 1-3cm, reddish grey
- Metavolcanite (metaandesite, metadacite) fine-grained, grey
- Xenoliths of greenstone
- Greenstone (metabasalt), fine-grained

GEOLOGICAL SURVEY OF SWEDEN 1990

KARL-AXEL KORNFÄLT
HUGO WIKMAN

CHRONOLOGIC SCHEME OF THE MAIN ROCK UNITS AND EVENTS IN THE SIMPEVARP AREA.

TIME SCALE, Ma (1)	ROCK UNIT (1)	MODAL CLASSIFICATION	ROCK TYPE (1) STRUCTURES (4,5)	SEQUENCE OF EVENTS (2,3,4)	FRACTURE FILLINGS (2)
2000-1850	Oldest supracrustals		Metaandesites		
1925-1800	Primorogenic rocks		Gneissic granites Granodiorites		
1840-1760	Postorogenic Småland-Värmland granitoids	 	Porphyritic granite-granodiorite-diorite. Fine-grained granite. Mafic dykes and enclaves. Greenstone.	Continuos mag-mamingling and magma-mixing process. Regional de-formation. Folding E-W to ENE-WSW foliation. Mylonitic shear zones.	Mylonites or "shear-bands" containing fine-grained epidote, muscovite and recrystallized quartz
1400-1350	Anorogenic rocks		Coarse-grained granite (Götemar-granite) Fine-grained granite Dolerite Chlorite veins.	Tension Post-magmatic hydrothermal circulation of the anorogenic granite	Fe-rich, idiomorphic epidote. One generation of fluorite. Growth of idiomorphic quartz, muscovite, hematite, fluorite, calcite and spherulic chlorite.
~1100				Burial meta-morphism.	Prehnite, hematite-stained laumontite, calcite and fluorite.
600-300			Clastic dykes. Cambrian (?) sandstone. Post-chlorite veins. Fault scarps?	Burial meta-morphism. Reactivation of older struc-tures ?	Gypsum, chlorite, illite, probably calcite and possibly Fe-oxyhydroxides.
Synglacial-present time			Fault scarps? Fractures?	Fracturing? Reactivation of older struc-tures ?	Calcite, Fe-oxyhydroxides and clay-minerals like kaolinite. Present groundwater circulation?

1 Kornfält-Wikman (1987) 2. Tullborg (1989) 3. Wikström (1989) 4. Talbot-Munier (1989) 5. Mörner (1990)

Summarized chronological schedule of the main rock units and events in the Simpevarp area/1. Kornfält and Wikman, 1987, 2. Tullborg, 1989, 3. Wikström, 1989, 4. Talbot and Munier, 1989, 5. Mörner, 1990/

Appendix B-1 to B-8

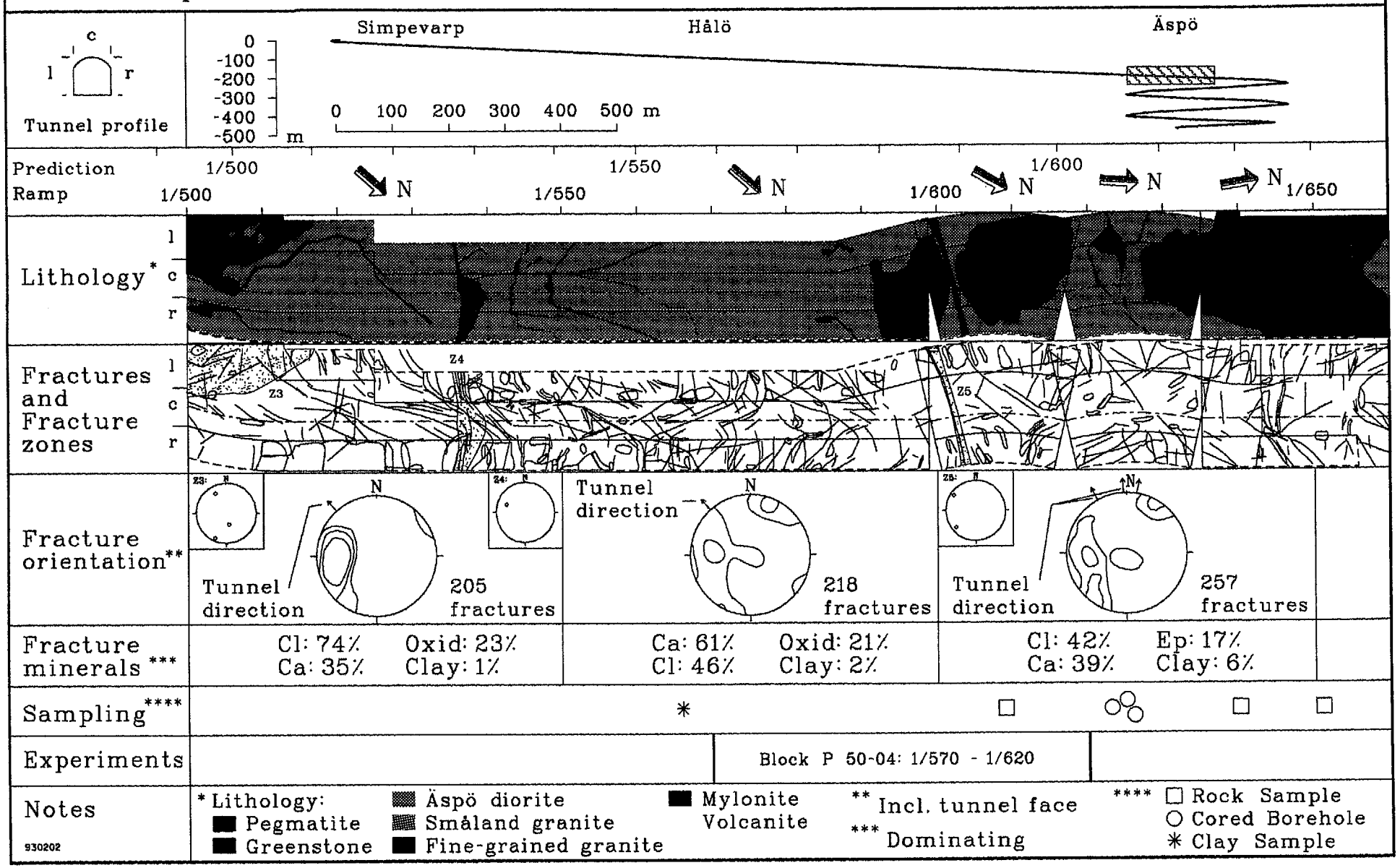
Appendix B-1

Äspö Hard Rock Laboratory

Overview of documentation

Access Ramp 1/500 - 1/650

Geology

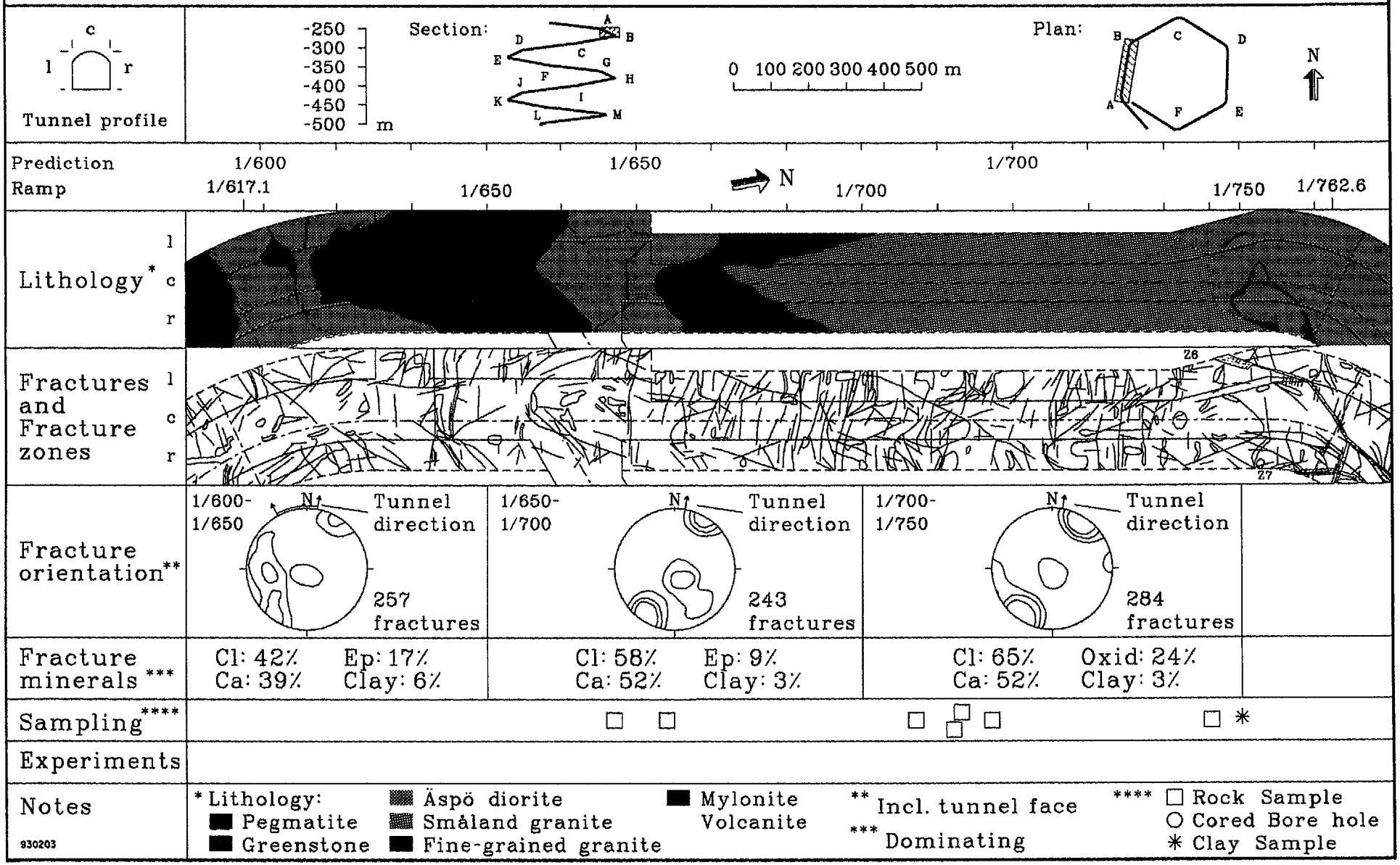


Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg A-B: 1/617.1-1/762.6

Geology

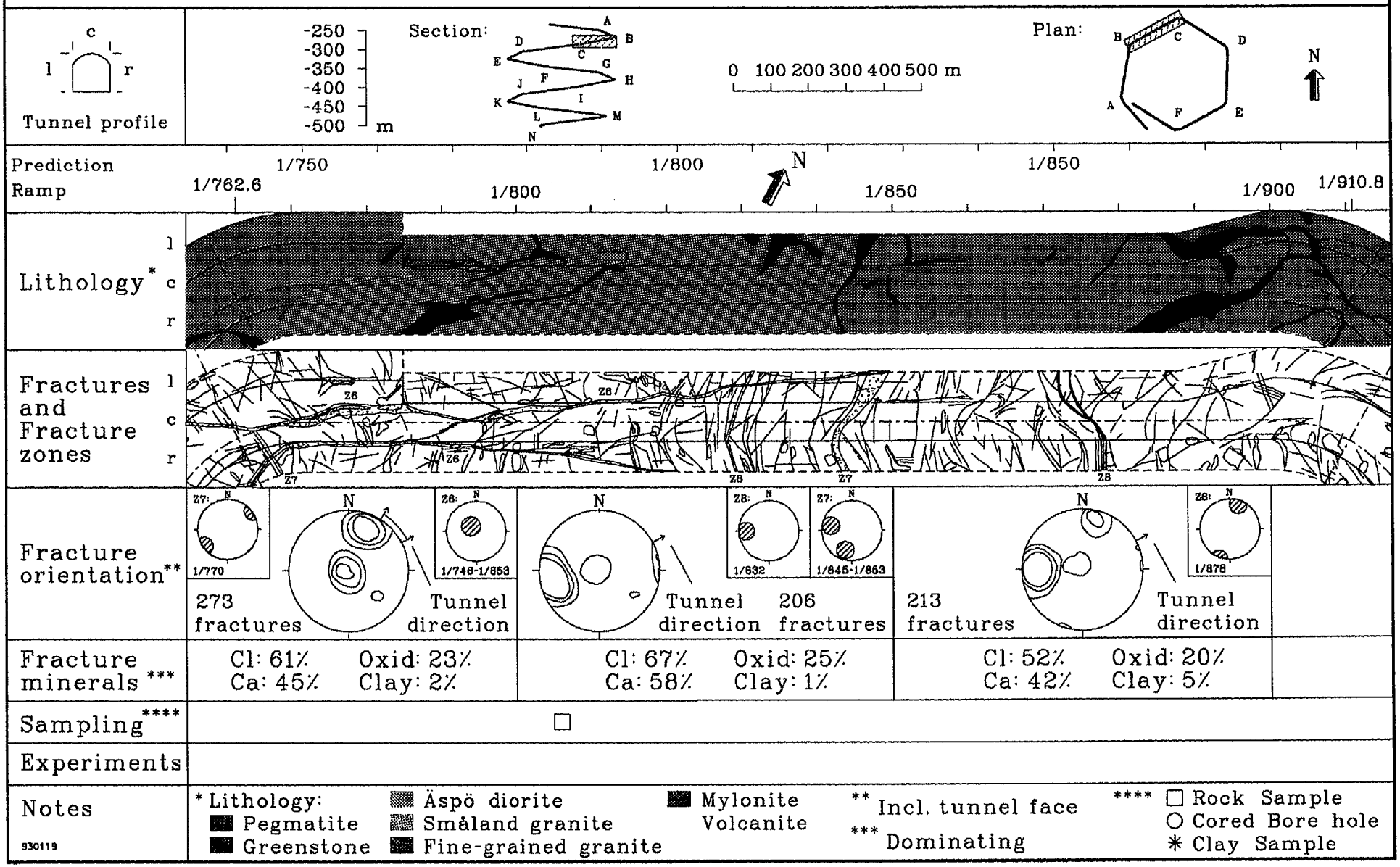


Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg B-C: 1/762.6-1/910.8

Geology

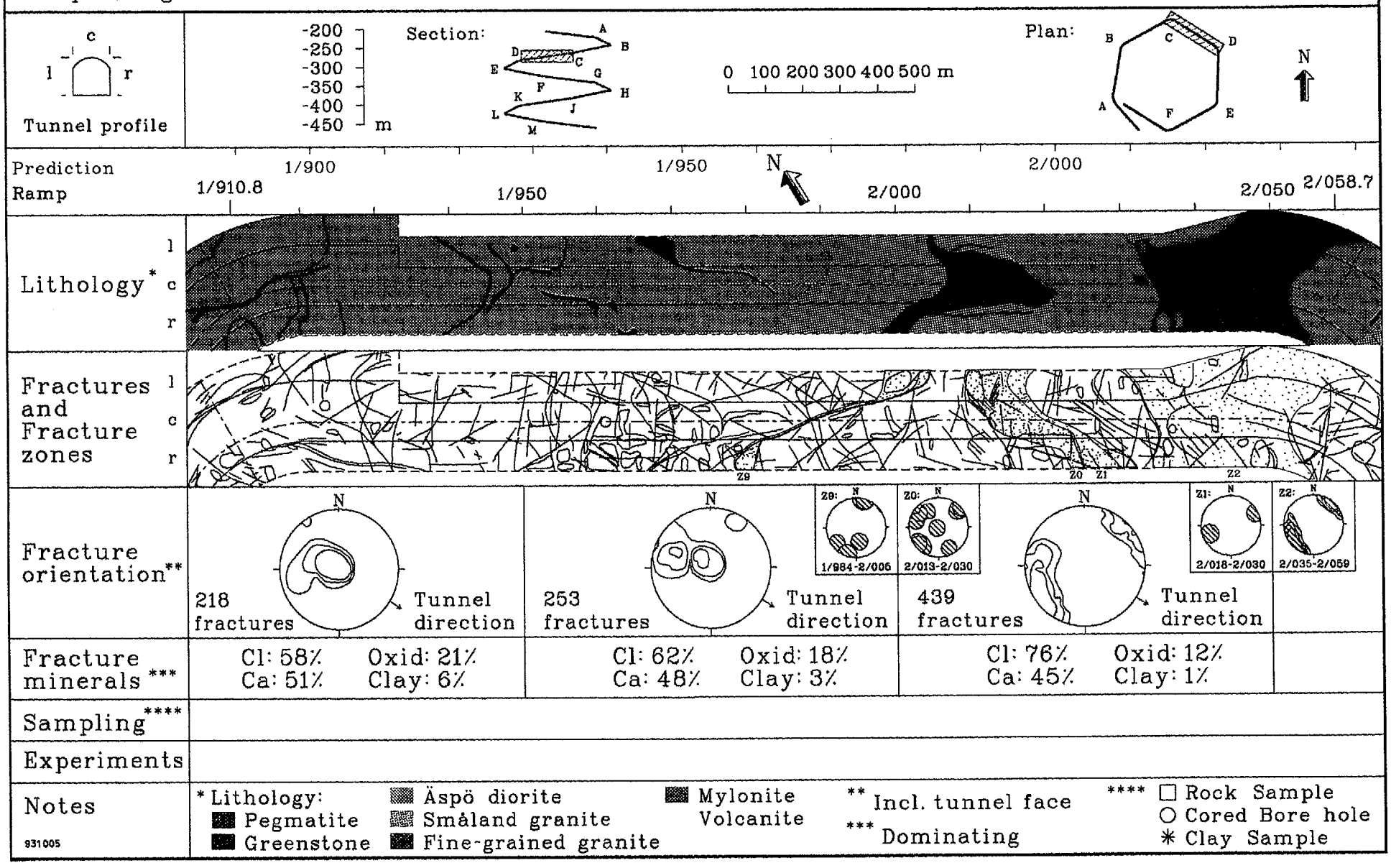


Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg C-D: 1/910.8-2/058.7

Geology

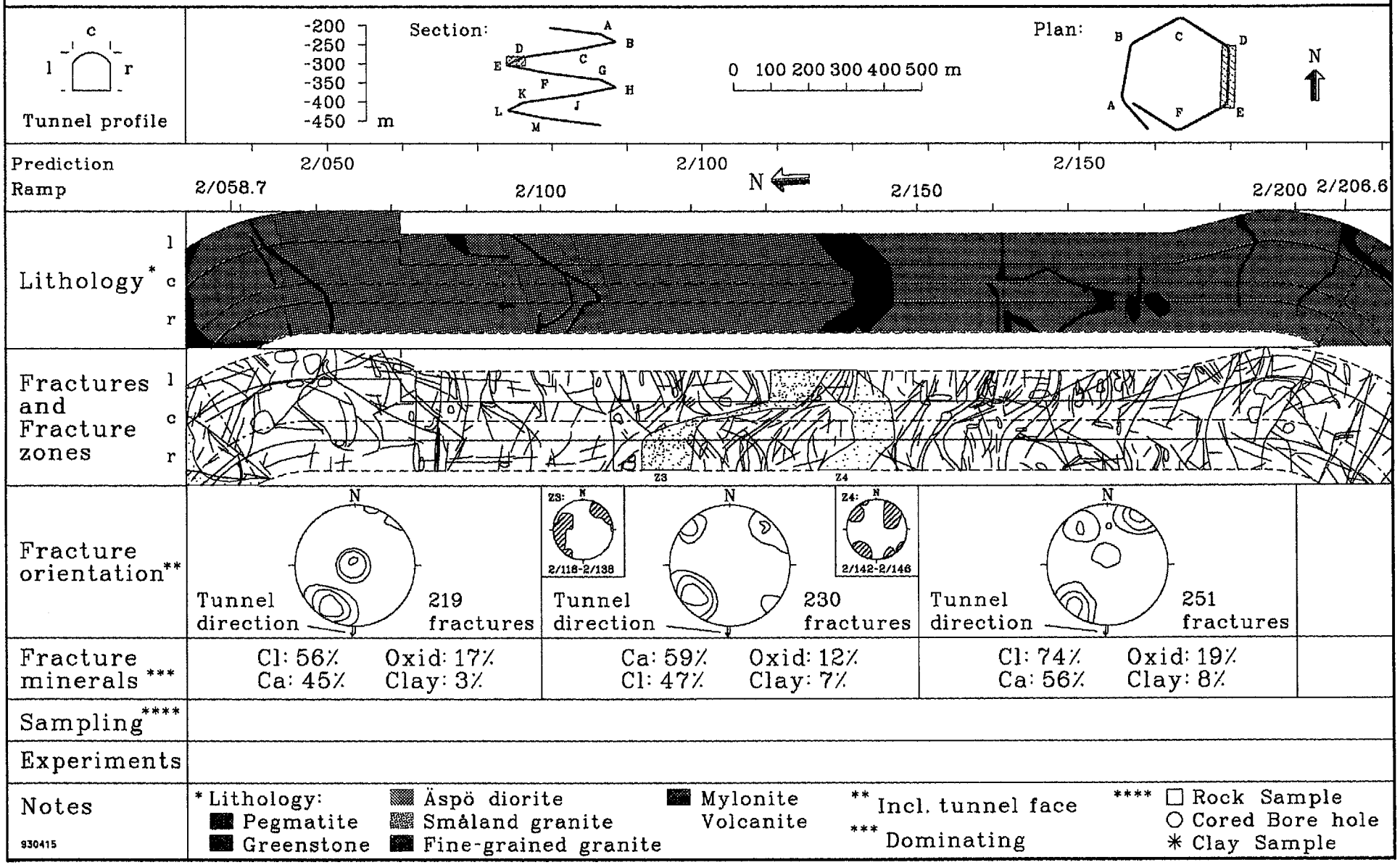


Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg D-E: 2/058.7-2/206.6

Geology

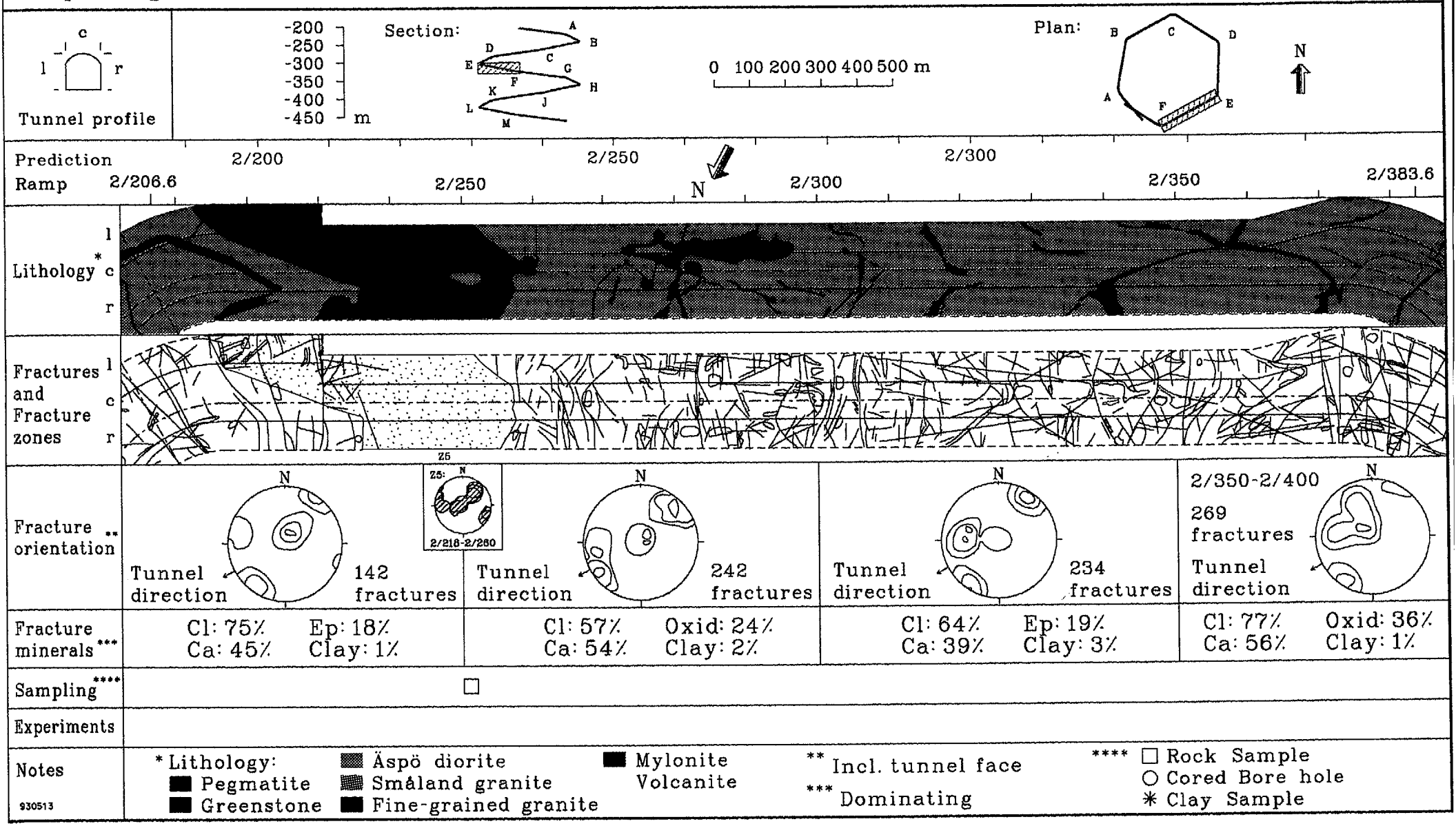


Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg E-F: 2/206.6-2/383.6

Geology

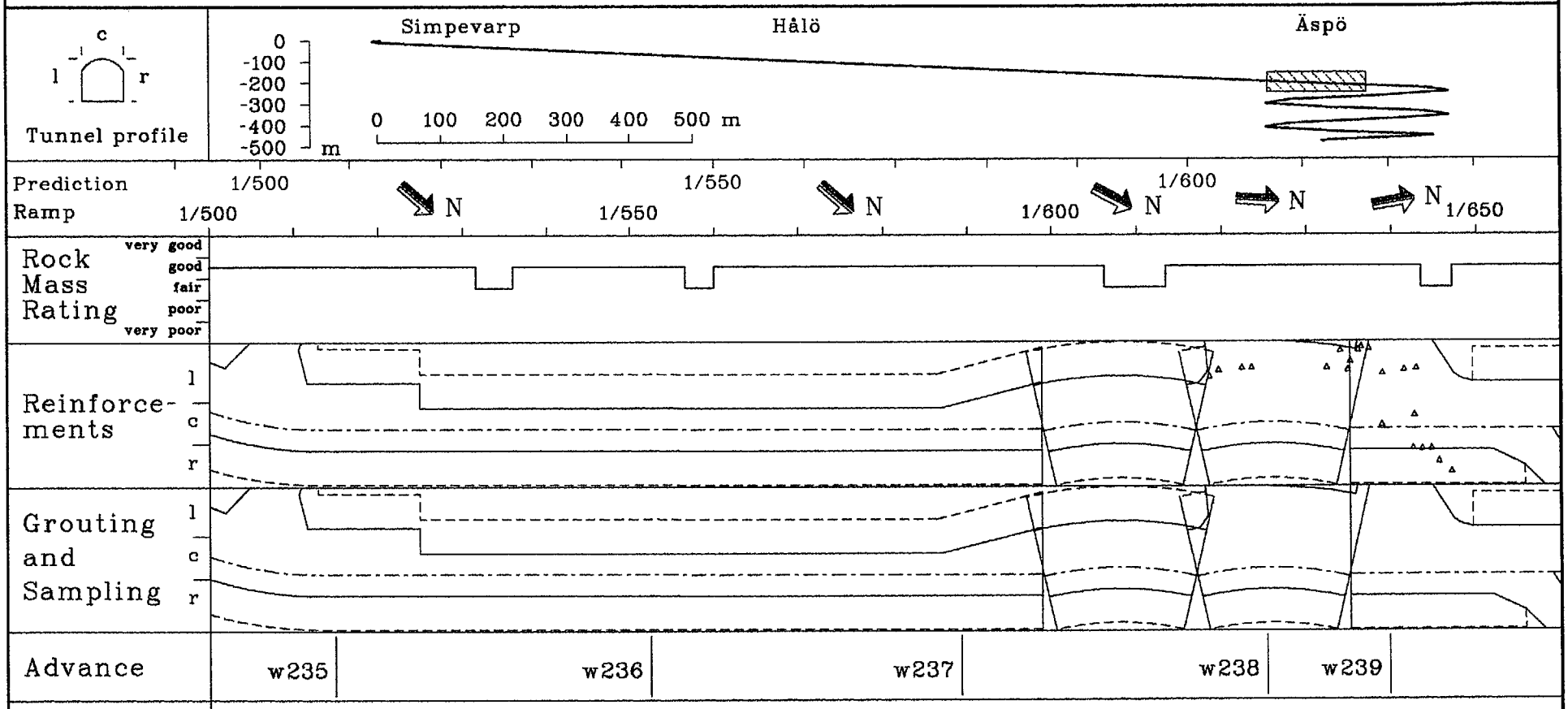


Äspö Hard Rock Laboratory

Overview of documentation

Access Ramp 1/500 - 1/650

Reinforcement and Pregrouting



Notes

Reinforcement:

Shotcrete:

S1 S2 — 1-2 layers

Reinforced by:

S1F S2F — Steel fibres

S3 — Steel mesh

S6 — Steel rods

Special support:

N — Net

Rockbolts:

- Non-tensioned, grouted bolt
- Swellex
- Other type

Grouting:

F14 → Pregrouting

E14 → Supplementary grouting

Shotcrete sampling:

Ⓣ Thickness

Ⓥ Adhesive strength

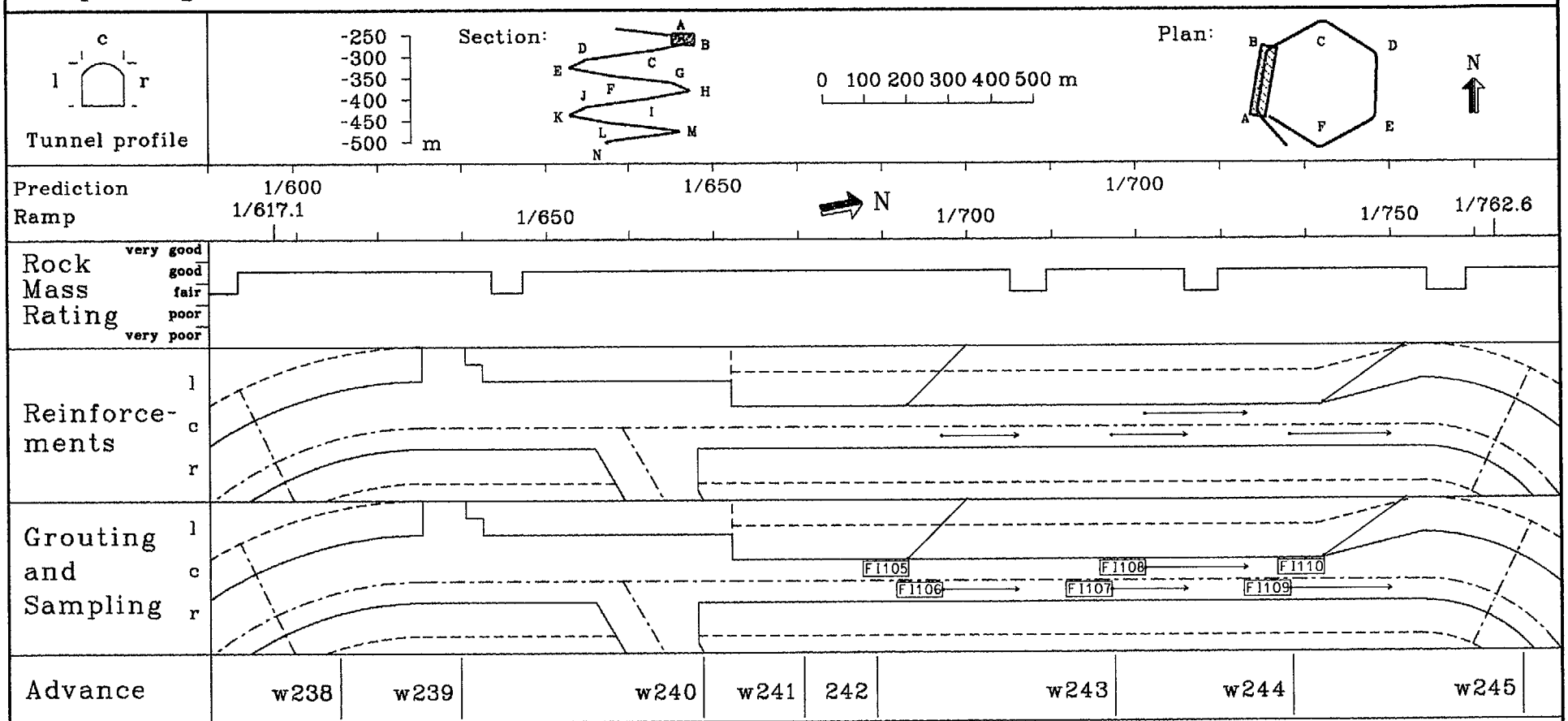
911023

Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg A-B: 1/617.1-1/762.6

Reinforcement and Pregrouting



Notes

Reinforcements:

Shotcrete:

S1 S2 — 1-2 layers

Reinforced by:

S1F S2F — Steel fibres

S3 — Steel mesh

S6 — Steel rods

Special support:

N — Net

Rockbolts:

- Non-tensioned, grouted bolt
- Swellex
- Other type

Grouting:

FI4 → Pregrouting

EI4 → Supplementary grouting

Shotcrete sampling:

Ⓣ Thickness

Ⓥ Adhesive strength

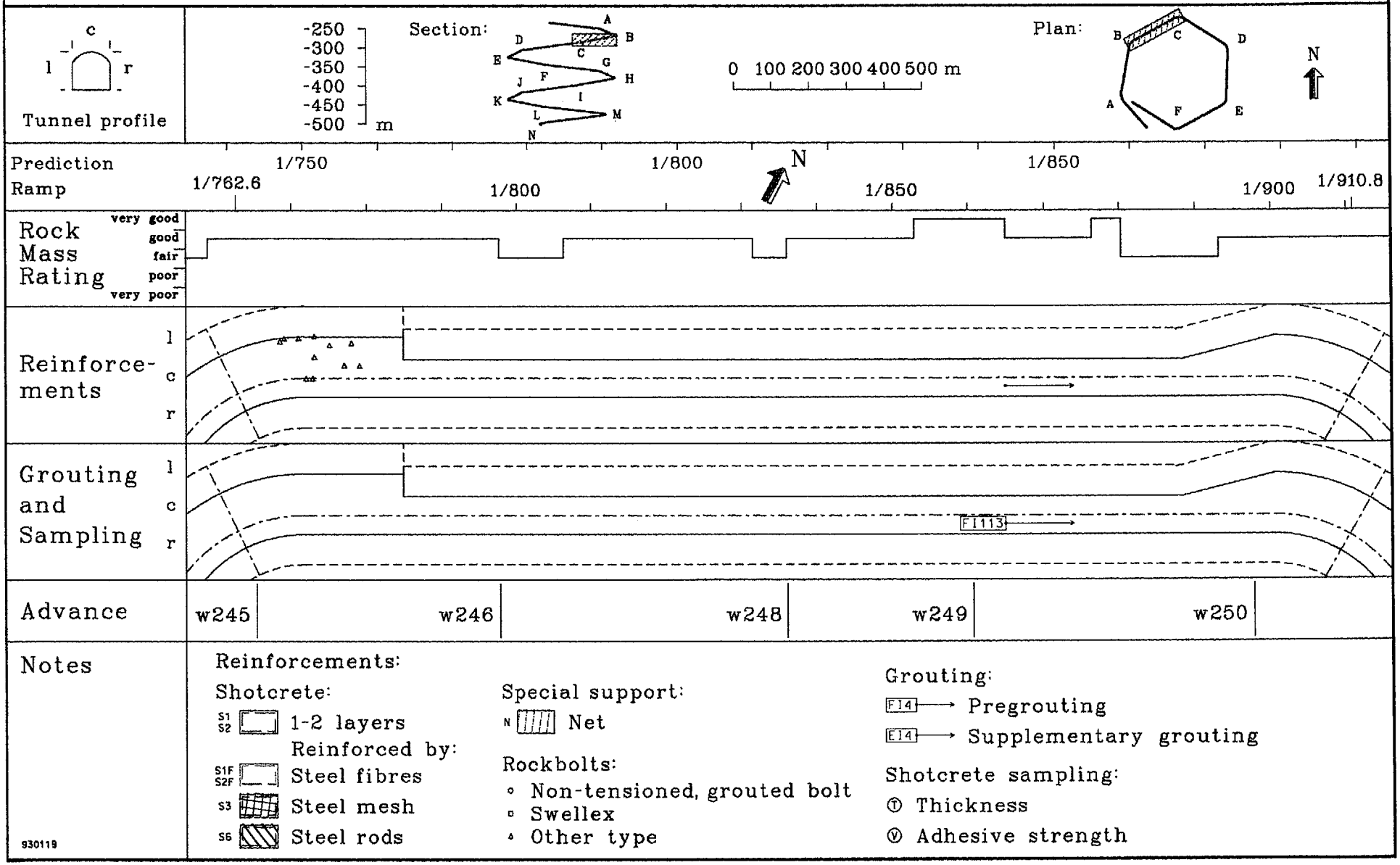
911116

Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg B-C: 1/762.6-1/910.8

Reinforcement and Pregrouting

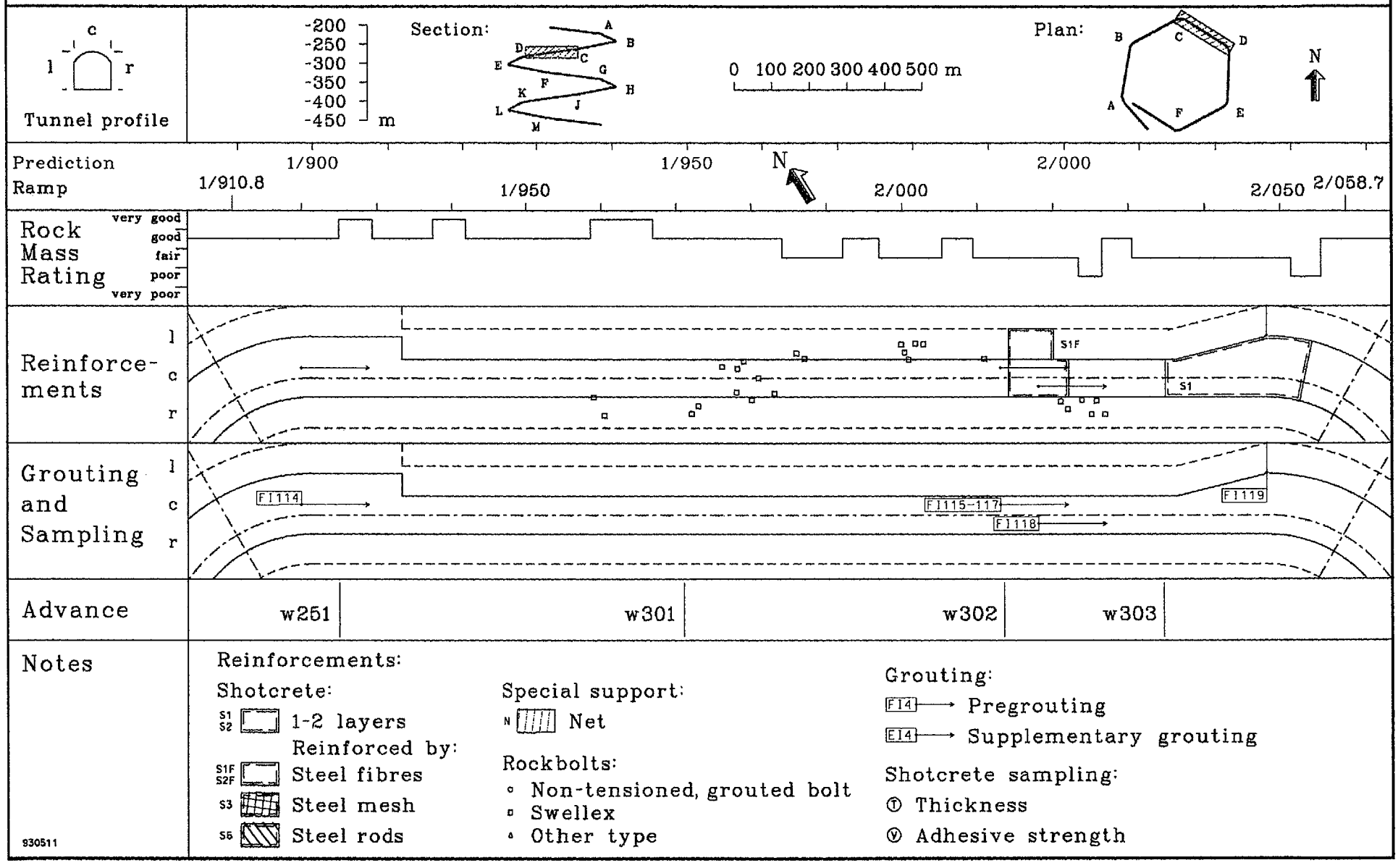


Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg C-D: 1/910.8-2/058.7

Reinforcement and Pregrouting

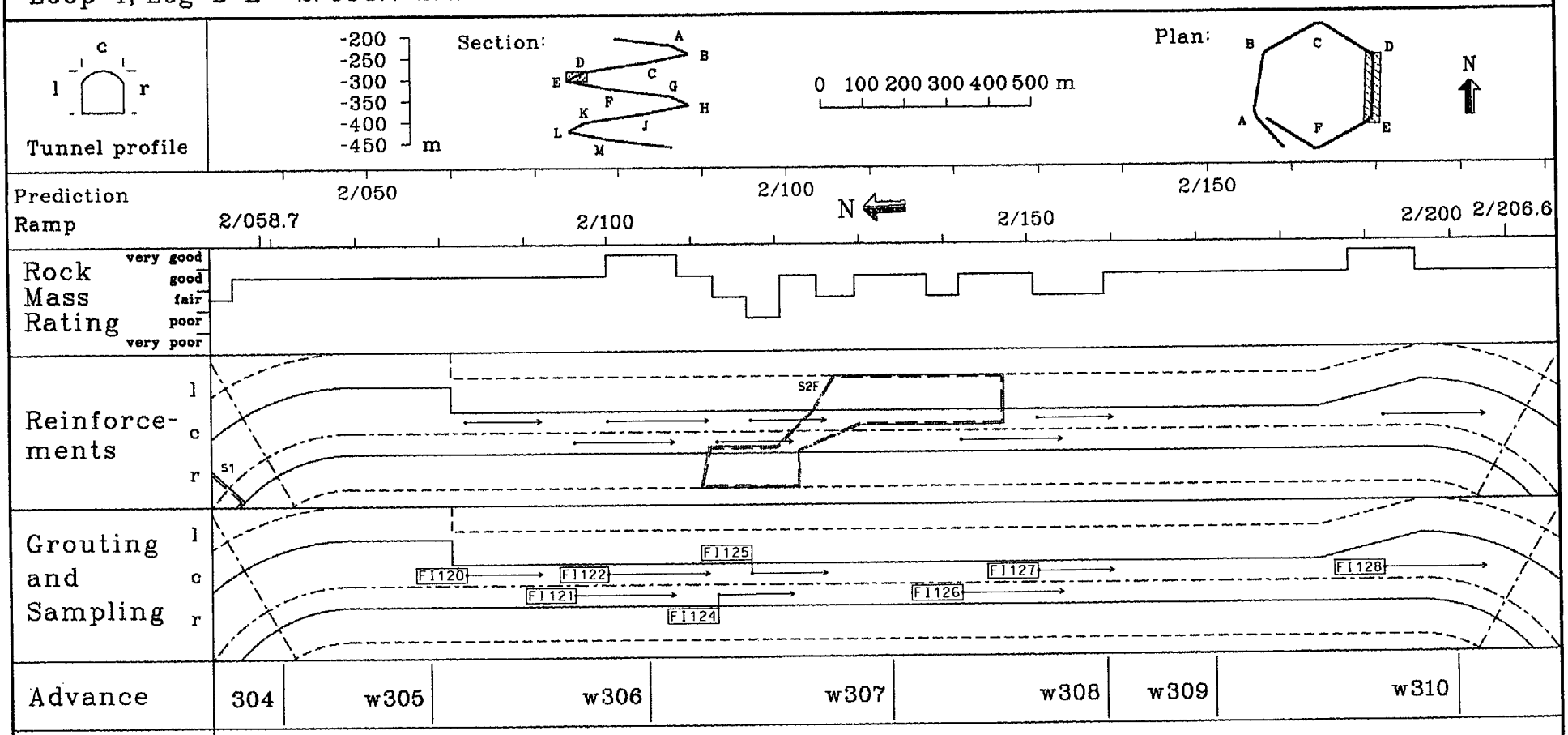


Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg D-E: 2/058.7-2/206.6

Reinforcement and Pregrouting



Notes

Reinforcements:

Shotcrete:

S1, S2 — 1-2 layers

Reinforced by:

S1F, S2F — Steel fibres

S3 — Steel mesh

S6 — Steel rods

Special support:

N — Net

Rockbolts:

- Non-tensioned, grouted bolt
- Swellex
- Other type

Grouting:

FI4 → Pregrouting

EI4 → Supplementary grouting

Shotcrete sampling:

Ⓣ Thickness

Ⓥ Adhesive strength

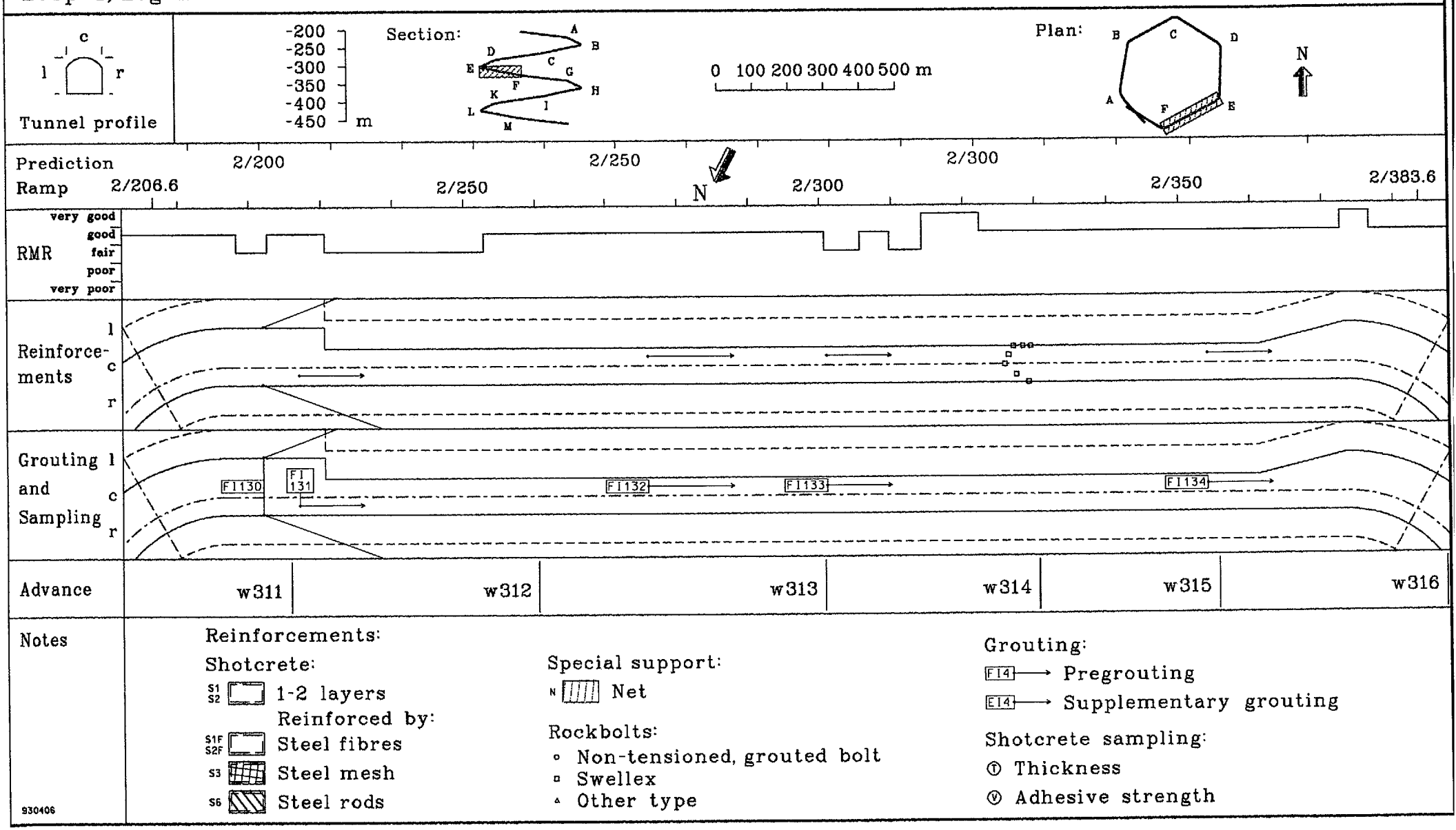
930503

Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg E-F: 2/206.6-2/383.6

Reinforcement and Pregrouting



Notes

Reinforcements:

Shotcrete:

S1 S2 — 1-2 layers

Reinforced by:

S1F S2F — Steel fibres

S3 — Steel mesh

S6 — Steel rods

Special support:

N — Net

Rockbolts:

- Non-tensioned, grouted bolt
- Swellex
- Other type

Grouting:

FI4 → Pregrouting

EI4 → Supplementary grouting

Shotcrete sampling:

Ⓣ Thickness

Ⓥ Adhesive strength

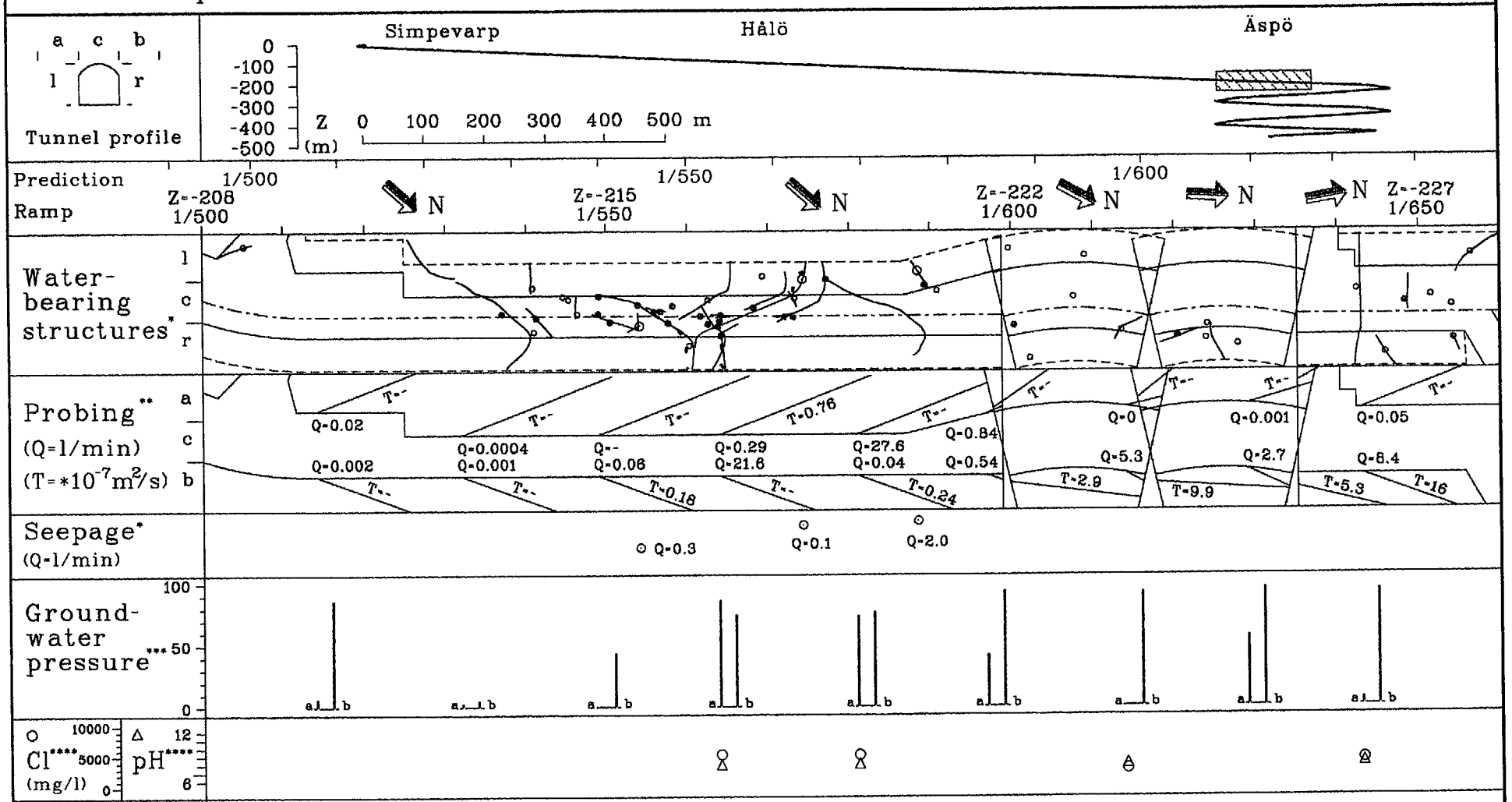
930406

Äspö Hard Rock Laboratory

Overview of documentation

Access Ramp 1/500 - 1/650

Geohydrology and Groundwater chemistry

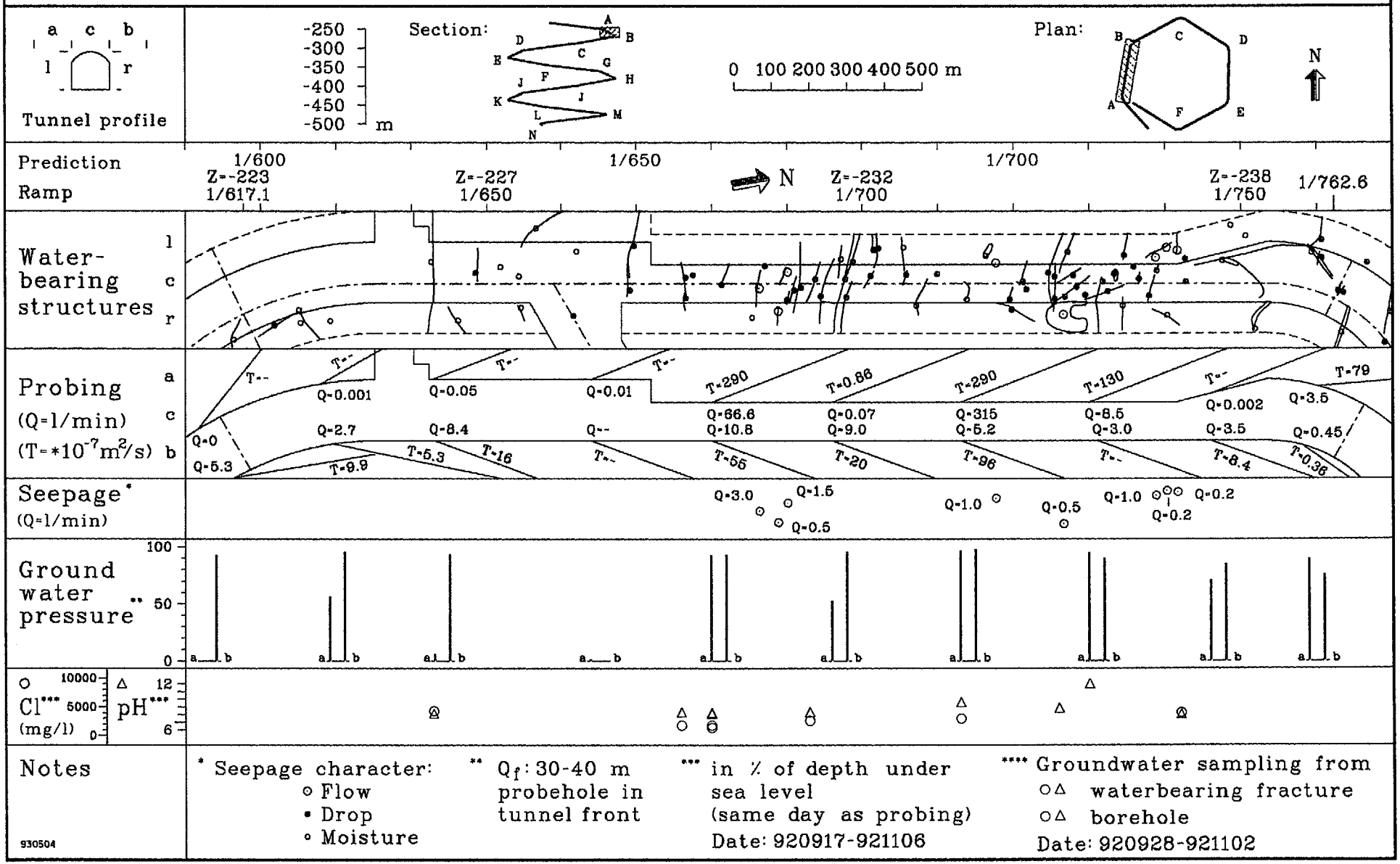


Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg A-B: 1/617.1-1/762.6

Geohydrology and Groundwater chemistry



Notes

* Seepage character:
- ⊙ Flow
- • Drop
- ∘ Moisture

** Q_f: 30-40 m probehole in tunnel front

*** in % of depth under sea level (same day as probing)
Date: 920917-921106

**** Groundwater sampling from
- ○△ waterbearing fracture
- ○△ borehole

Date: 920928-921102

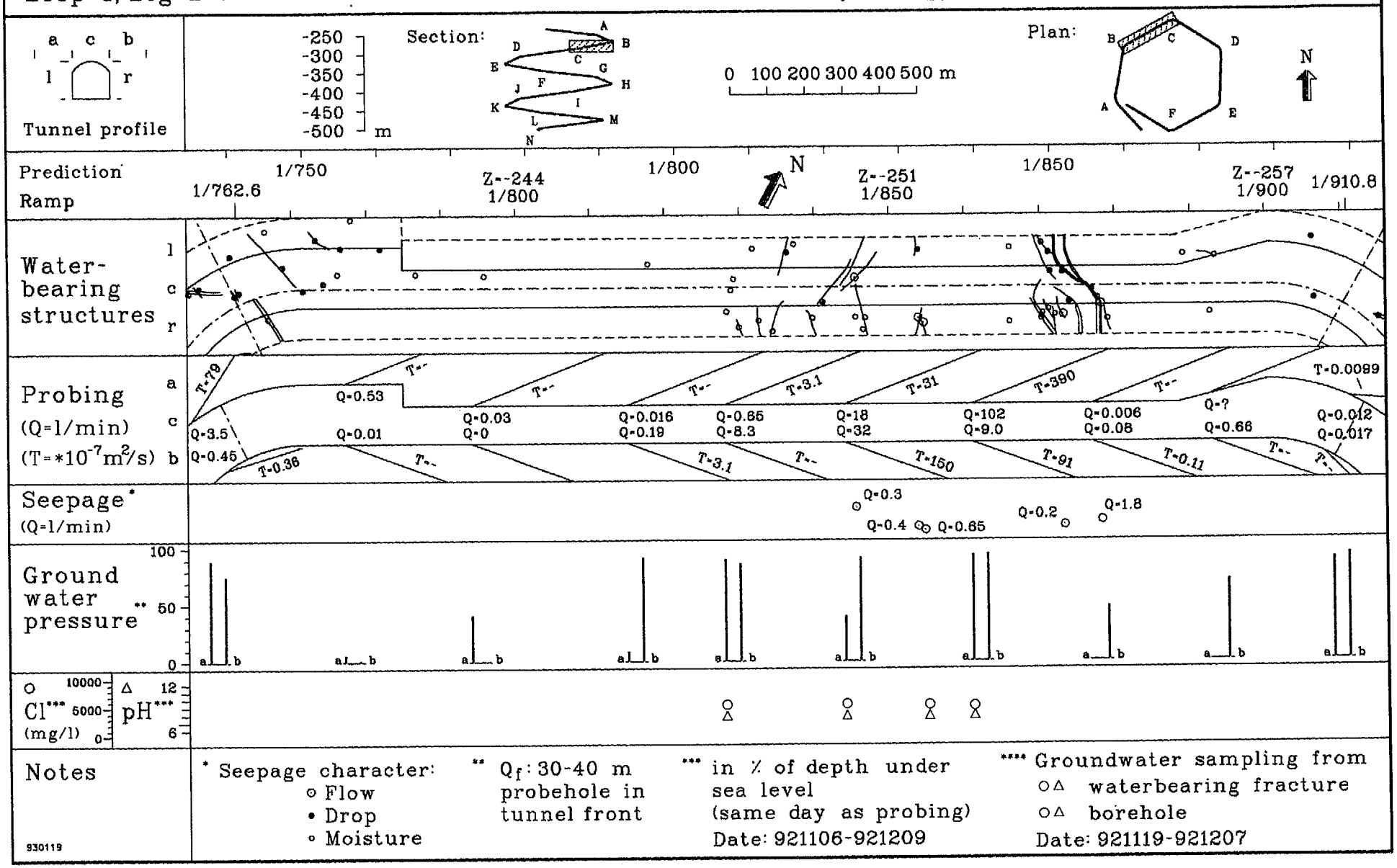
930504

Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg B-C: 1/762.6-1/910.8

Geohydrology and Groundwater chemistry



Notes

* Seepage character:
- ⊙ Flow
- • Drop
- ∘ Moisture

** Q_f: 30-40 m probehole in tunnel front

*** in % of depth under sea level (same day as probing)
Date: 921106-921209

**** Groundwater sampling from
- ○△ waterbearing fracture
- ○△ borehole

Date: 921119-921207

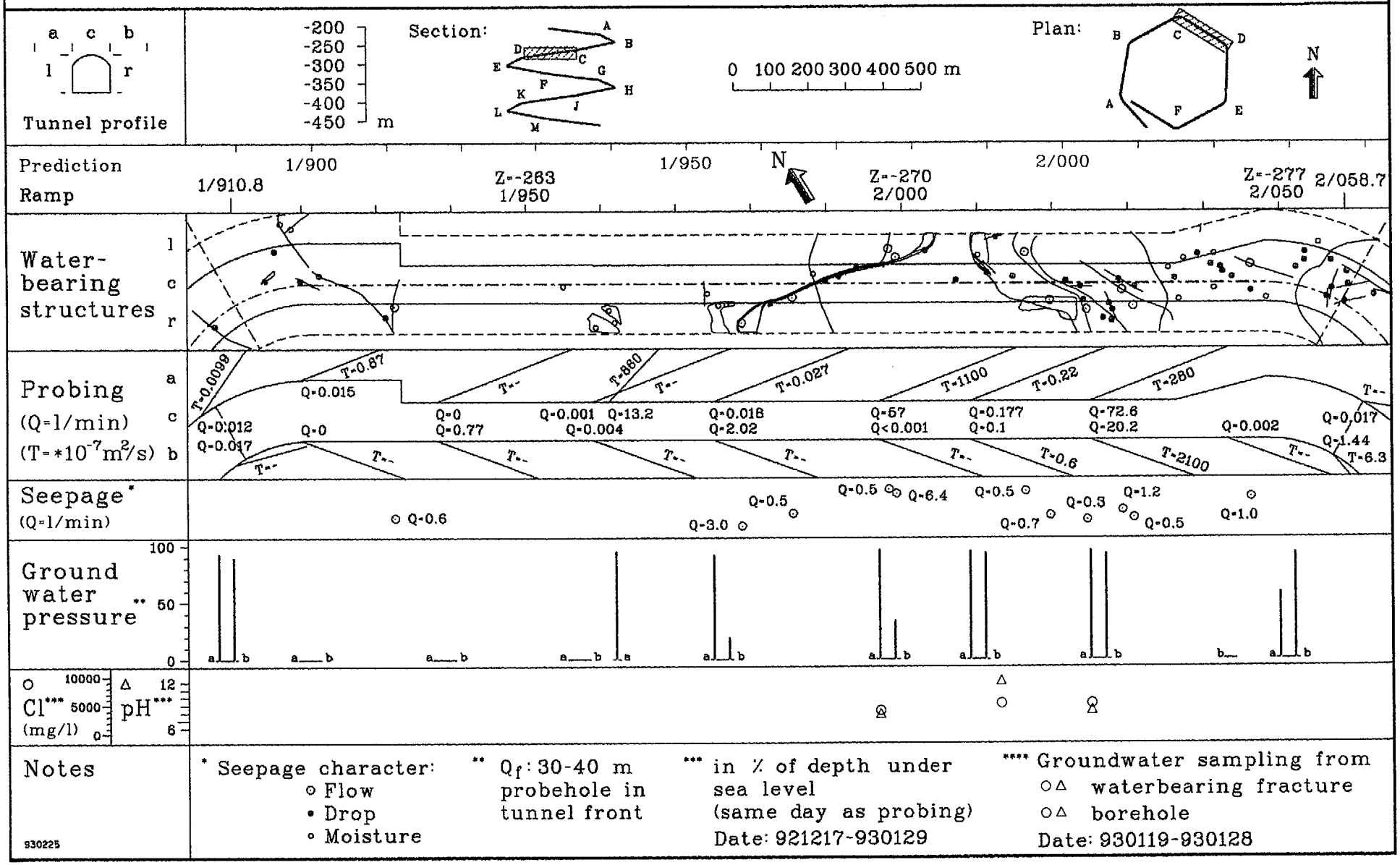
930119

Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg C-D: 1/910.8-2/058.7

Geohydrology and Groundwater chemistry



Notes

* Seepage character:
- ○ Flow
- • Drop
- ∘ Moisture

** Q_f: 30-40 m probehole in tunnel front

*** in % of depth under sea level (same day as probing)
Date: 921217-930129

**** Groundwater sampling from
- ○△ waterbearing fracture
- ○△ borehole

Date: 930119-930128

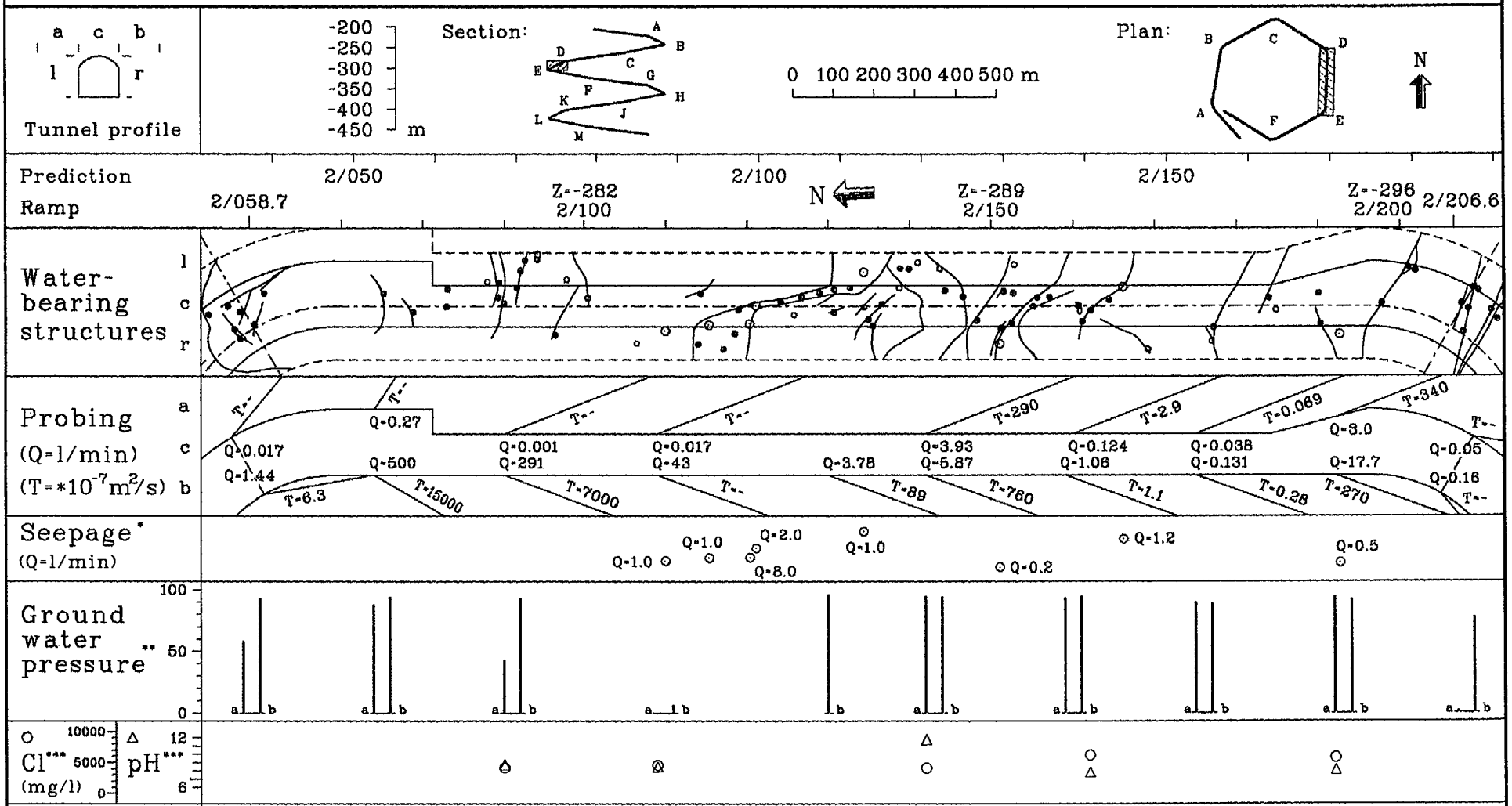
930225

Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg D-E: 2/058.7-2/206.6

Geohydrology and Groundwater chemistry



Notes

930415

* Seepage character:
- ○ Flow
- • Drop
- ∘ Moisture

** Q_f: 30-40 m probehole in tunnel front

*** in % of depth under sea level (same day as probing)
Date: 930129-930317

**** Groundwater sampling from
- ○△ waterbearing fracture
- ○△ borehole

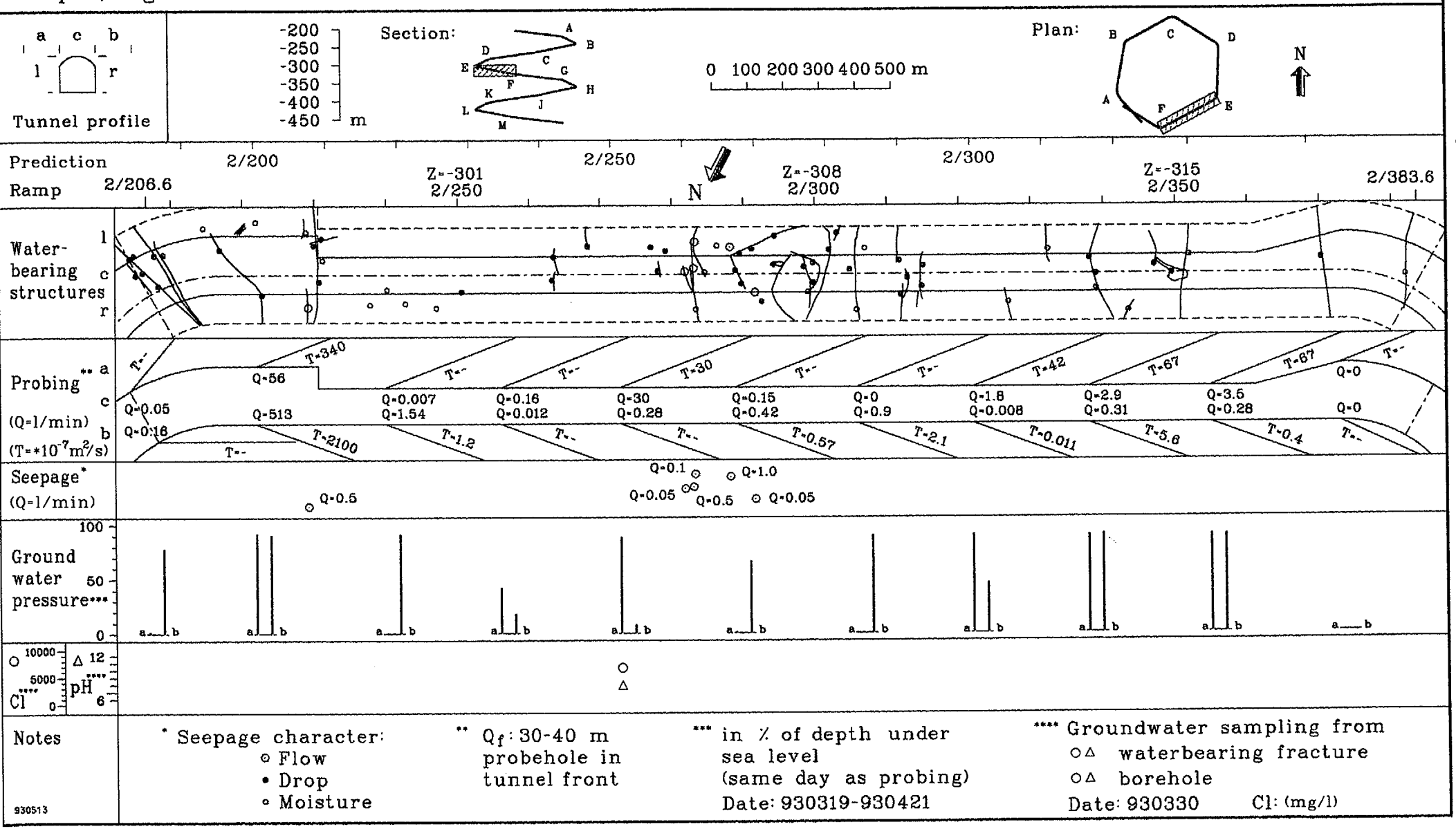
Date: 930210-930321

Äspö Hard Rock Laboratory

Overview of documentation

Loop 1, Leg E-F: 2/206.6-2/383.6

Geohydrology and Groundwater chemistry



Appendix B-2

Available on disk only (ca. 150 pages)

Appendix B-3

PART	SECTION	FRAC_ID	ROCK_ID	STRIKE	DIP	LENGTH	FORM	TYPE	SURF_STRUC	STRIVIS	STRIS	STRIDIP	MIN	MIN	MIN	MIN	MIN	FRAC End 1	TO_ OBJECT1	FRAC End 2	TO OBJECT2	DISPL	WATER	REMARK
F	1602,3	17	B1	360	73	2,1	1	2	102	N	0	0	KL					1		3	16	0,00		
P	1602,3	4	B5	350	70	2,0	1	2	102	N	0	0	KA					2		3		0,00		
F	1606,2	13	B1	360	80	1,5	1	2	102	N	0	0	KL	EP				1		2		0,00		
P	1609,8	1	B5	5	76	8,0	1	2	102	Z	0	0	KA	KL	CY			1		1		0,00		
P	1609,8	6	B5	360	83	6,5	1	2	102	Z	0	0						2		2		0,00		
P	1609,8	14	B5	353	77	1,0	1	2	102	Z	0	0						2		2		0,00		
F	1609,8	17	B5	341	66	4,3	1	2	102	N	0	0	KL	CY				1		2		0,00		3 PCS/0.1M
P	1609,8	8	B5	342	67	3,3	1	2	102	Z	0	0	KL					2		2		0,00		6 PCS/0.4M
F	1613,5	13	B1	7	55	3,8	1	2	101	N	0	0	OX	EP				2		1		0,00		
P	1613,5	7	B1	344	80	3,7	1	2	101	N	0	0	KL	KA	CY			1		2		0,00		
F	1613,5	10	B5	187	68	2,1	1	2	102	N	0	0	KL					1		2		0,00		
P	1618,0	14	B1	353	35	6,5	1	2	102	Z	0	0	EP	KA	MY			1		1		0,00		
P	1618,0	15	B1	353	79	7,9	1	2	102	Z	0	0	EP	KA	MY			1		1		0,00		
F	1618,0	23	B1	165	66	3,5	1	2	102	Z	0	0	KL					2		2		0,00		
P	1618,0	5	B5	180	25	1,4	1	2	102	Z	0	0	KA					2		2		0,00		
F	1622,0	16	B1	3	35	4,3	1	2	102	N	0	0	EP					2		2		0,00		
F	1622,0	15	B1	357	80	2,7	1	2	102	N	0	0	EP					3	16	2		0,00		
F	1622,0	11	B1	163	81	5,5	1	2	102	Z	0	0	KA	KL				1		2		0,00		
P	1625,3	14	B1	6	38	6,4	1	2	102	Z	0	0	EP	MY				1		1		0,00		
P	1625,3	8	B3	8	77	1,9	1	2	102	Z	0	0	KL					2		2		0,00		
P	1625,3	10	B1	346	55	2,3	1	2	102	Z	0	0	EP					2		1		0,00		
P	1625,3	11	B1	346	50	2,0	1	2	102	Z	0	0	EP					2		1		0,00		
F	1629,3	9	B1	358	72	3,6	1	2	102	Z	0	0	MY	QZ	EP			3	07	1		0,00		4 PCS/0.6M
P	1629,3	6	B1	350	54	2,2	2	2	102	N	0	0	EP					1		1		0,00		
F	1629,3	13	B1	347	80	3,6	1	2	102	N	0	0	MY	EP				3	B3	1		0,00		
F	1630,8	12	B1	8	54	6,3	1	2	101	Z	0	0	EP	QZ				1		3	B3	0,00		1 CM WIDE
F	1630,8	16	B1	2	72	4,1	1	2	101	Z	0	0	EP					1		3	B3	0,00		
P	1630,8	9	B3	171	5	1,3	1	2	102	N	0	0	FL					2		2		0,00		
P	1634,6	5	B5	6	90	5,5	1	2	102	N	0	0	KA	KL	EP			1		2		0,20		
F	1634,6	10	B1	7	82	3,0	1	2	102	Z	0	0	EP					2		2		0,00		4 PCS/0.15M
F	1634,6	6	B5	10	84	4,1	1	2	102	N	0	0	EP	KA				1		2		0,00		
P	1634,6	7	B3	357	58	1,9	1	2	102	Z	0	0						2		2		0,00		
F	1634,6	11	B1	169	53	3,4	1	2	102	Z	0	0	EP					2		2		0,00		
P	1639,7	3	B5	6	78	3,5	1	2	102	N	0	0	LA	CY				3	02	3	02	0,00		
P	1639,7	2	B5	352	74	7,5	3	2	102	N	0	0	CY	KL				1		1		0,00		
P	1639,7	14	B1	348	74	4,7	1	2	101	N	0	0	EP	QZ				1		3	B3	0,00		
F	1643,5	12	B5	3	70	2,4	1	2	102	Z	0	0						2		2		0,00		
P	1643,5	1	B5	357	74	3,1	1	2	102	N	0	0						2		2		0,00		
P	1647,2	5	B5	5	81	6,7	1	2	102		8	10	KL	KA				2		1		0,00		
F	1647,2	20	B5	166	77	2,1	1	2	102	Z	0	0	KL					2		3	22	0,00		
P	1647,2	13	B5	190	48	2,1	1	2	102	Z	0	0	KL					2		2		0,00		
F	1647,2	22	B5	185	20	4,8	1	2	102	Z	0	0						2		2		0,00		
P	1651,9	4	B5	350	48	1,6	1	2	102	Z	0	0	KL					2		2		0,00		
P	1656,0	14	B5	360	77	1,6	1	2	102	N	0	0	KL	KA				3	13	1		0,00		
P	1656,0	7	B5	165	70	1,8	1	2	102	Z	0	0						2		2		0,00		
P	1660,3	4	B1	8	70	4,3	1	2	101	Z	0	0	EP	KL				3	B3	3	01	0,00		
F	1660,3	14	B5	172	55	2,0	1	2	101	Z	0	0	KL					1		3	17	0,00		

F	1660,3	15 B5	172	20	2,3 1	2	101	Z	0	0	2	2	0,00		
P	1664,2	7 B1	345	15	3,7 1	2	102	Z	0	0 KA	2	2	0,00		
P	1664,2	6 B1	185	10	3,7 1	2	101	N	0	0	2	2	0,00		
P	1668,6	15 B1	345	5	1,0 1	2	101	Z	0	0 KA KL	2	1	0,00		
P	1672,5	12 B1	188	66	1,2 1	2	101	Z	0	0 KA	3 01	2	0,00	2 PCS	
P	1676,3	3 B1	165	15	2,1 1	2	101	N	0	0 KL OX	1	2	0,00		
P	1680,5	3 B3	341	56	1,9 1	2	102	Z	0	0 KL KA	2	2	0,00		
P	1684,8	11 B5	351	89	1,0 2	2	102	N	0	0	3 12	2	0,00		
P	1684,8	15 B5	180	23	5,0 1	2	101	N	0	0 AT	1	1	0,00		
F	1689,1	15 B5	190	52	1,8 1	2	102	N	0	0 KL	2	3 11	0,00		
P	1693,0	12 B5	163	86	3,6 2	2	102	Z	0	0 KA KL EP	2	2	0,00		
P	1700,7	5 B0	344	83	2,3 1	2	102	N	0	0 KL	3 04	3 02	0,00		
F	1700,7	20 B0	348	82	1,6 1	2	101	N	0	0 EP KL	3 12	2	0,00		
P	1700,7	17 B0	165	79	9,0 1	2	102	N	0	0 KL	3 16	3 18	0,00		
P	1700,7	6 B0	176	73	1,6 1	2	101	N	0	0 KA KL QZ EP	3 10	3 03	0,00		
P	1705,1	15 B0	5	88	2,0 1	2	102	Z	0	0 KL KA OX	3 14	3 14	0,00		
P	1705,1	12 B0	360	90	5,8 1	2	102	Z	0	0 KL	2	1	0,00		
P	1705,1	9 B0	358	82	3,0 1	2	102	Z	0	0 KL OX	3 01	2	0,00		
P	1705,1	1 B0	173	86	4,5 1	2	102	Z	0	0 KL KA OX	3 104	2	0,00		
P	1709,4	3 B0	342	71	4,8 1	2	102		343	26 KL KA	1	3 114	0,00		
P	1709,4	7 B0	345	45	2,8 2	2	102	Z	0	0 KL OX	3 06	2	0,00	7 PCS/1M	
P	1709,4	10 B0	184	69	2,5 1	2	102	N	0	0 KA KL	1	3 11	0,00		
P	1713,5	7 B0	2	88	3,0 1	2	102	Z	0	0 PG KL	3 208	2	0,00		
P	1713,5	10 B0	349	67	1,5 1	2	102	Z	0	0 EP OX	2	2	0,00		
P	1713,5	5 B0	178	82	2,2 1	2	102	Z	0	0 KL KA OX	3 208	2	0,00		
P	1713,5	1 B0	188	86	4,4 1	2	102	Z	0	0 KA KL	1	2	0,00		
P	1713,5	2 B0	188	66	5,5 1	2	102	Z	0	0 KL KA	1	2	0,00		
P	1713,5	11 B0	184	81	3,0 1	2	102		190	7 KL KA EP	1	2	0,00		
P	1713,5	4 B0	183	79	1,0 1	2	102		200	30 KL	1	2	0,00		
F	1717,3	17 B0	10	77	4,0 1	2	102	Z	0	0 KL KA	1	1	0,00		
P	1717,3	2 B0	166	80	1,0 1	2	102	N	0	0 EP KL KA	2	2	0,00		
P	1717,3	1 B0	180	15	2,4 1	2	102	Z	0	0 KL OX	1	2	0,00		
P	1717,3	12 B0	171	88	2,3 1	2	102	Z	0	0 EP KL OX	3 06	3 24	0,00		
P	1721,4	1 B0	5	90	4,6 1	2	102		182	28 KL OX	1	1	0,00		
P	1721,4	16 B0	1	90	1,7 1	2	101	N	0	0 PG	1	2	0,00		
P	1725,8	9 B0	355	90	1,5 1	2	102	N	0	0 KL CY	2	3 08	0,00		
P	1725,8	8 B0	346	67	2,2 1	2	102	N	0	0 KA KL	2	1	0,00		
F	1729,7	22 B0	360	85	4,4 1	2	101	Z	0	0 KL	1	1	0,00		
F	1729,7	19 B0	343	80	1,9 1	2	102	Z	0	0 KL	2	1	0,00		
P	1734,0	15 B0	10	80	6,2 1	2	102	Z	0	0 KL	3 14	1	0,00		
P	1734,0	22 B0	360	0	2,2 1	2	102	Z	0	0 KA	3 08	1	0,00		
P	1738,2	17 B0	6	74	2,4 1	2	102	N	0	0 KA QZ KL SU	2	2	0,00		
P	1738,2	7 B0	2	71	3,2 1	2	102	Z	0	0 KL	2	2	0,00		
F	1738,2	22 B0	6	84	3,2 1	2	102	N	0	0 KL	2	2	0,00	SEVERAL	
P	1738,2	6 B0	349	80	2,7 1	2	102	Z	0	0 EP KA KL	2	2	0,00		
P	1738,2	3 B0	167	86	5,5 1	2	102	N	0	0 KL KA EP OX	2	2	0,00		
P	1741,8	13 B0	354	90	1,3 1	2	101	Z	0	0 SU	2	2	0,00		
F	1741,8	18 B0	349	84	3,2 1	2	102	Z	0	0 KL KA	1	2	0,00		
P	1741,8	12 B0	176	86	2,1 1	2	101	N	0	0 KA SU	2	2	0,00		

P	1746,4	16 B0	9	21	1,6 1	2	102	N	0	0 KA	2	2	0,00		
P	1746,4	13 B1	169	86	3,3 1	2	102	Z	0	0 KL	3 14	2	0,00		
F	1746,4	20 B1	185	29	2,8 2	2	102	Z	0	0 EP OX	2	2	0,00		
F	1750,3	14 B1	8	70	1,5 1	2	102	Z	0	0 KL	3 10	2	0,10		
P	1750,3	4 B1	360	5	1,4 1	2	102	Z	0	0 KL	2	1	0,00		
P	1750,3	7 B1	180	90	1,9 1	2	102	N	0	0 KL KA	2	2	0,00		
P	1750,3	6 B0	180	90	1,5 1	2	102	N	0	0 KL KA	2	2	0,00		
F	1750,3	9 B1	190	10	4,4 1	2	102	Z	0	0 EP KA	2	3 10	0,00		
F	1750,3	10 B1	190	10	4,8 1	2	102	Z	0	0 EP KA	2	3 108	0,00		
F	1750,3	11 B1	190	10	2,5 1	2	102	Z	0	0 EP KA	2	2	0,00		
P	1754,3	8 B1	4	78	13,5 1	2	102	Z	0	0 KL SU	2	2	0,00		
P	1754,3	9 B1	9	70	3,7 1	2	102	Z	0	0 KL EP	2	2	0,00		
P	1754,3	13 B3	360	80	1,3 1	2	102	N	0	0 KA KK KL	2	1	0,00		
F	1758,9	20 B3	356	82	1,3 1	2	102	N	0	0 KL OX	3 21	3 22	0,00		
F	1758,9	18 B1	348	90	4,0 2	2	102	N	0	0 KL EP	3 21	1	0,00		
F	1758,9	12 B1	345	85	6,0 1	2	101	N	0	0 MY	1	3 Z6	0,00	20 CM WIDE	
P	1758,9	3 B1	343	74	1,0 1	2	101	N	0	0 KA PY	3 Z6	2	0,00		
P	1758,9	7 B1	180	2	3,7 1	2	102	Z	0	0 KA	3 06	2	0,00		
P	1762,6	2 B1	5	28	1,0 1	2	102	N	0	0 KL KA	2	3 408	0,00		
P	1762,6	1 B1	356	82	1,3 1	2	102	N	0	0 KL	2	2	0,00		
P	1762,6	12 B1	360	0	4,0 1	2	102	N	0	0 QZ KL	1	3 121	0,00		
P	1765,4	13 B1	163	82	2,2 1	2	101	Z	0	0 KL KA	1	2	0,00		
P	1770,2	13 B1	8	81	2,6 1	2	102	Z	0	0 KL KA	3 Z6	2	0,00		
P	1770,2	1 B1	357	78	5,1 1	2	102	Z	0	0 KL	1	1	0,00		
P	1774,0	4 B1	344	77	2,2 1	2	101	N	0	0 KA	1	2	0,00		
F	1774,0	13 B1	171	86	3,8 1	2	102	N	0	0 EP	3 15	1	0,00		
P	1774,0	10 B1	175	84	2,0 1	2	102	N	0	0 EP OX	3 08	1	0,00		
P	1774,0	2 B1	184	10	3,5 1	2	102	Z	0	0 EP KL KA OX	3 01	2	0,00		
F	1776,5	15 B1	2	20	3,3 1	2	102	Z	0	0 KA OX	2	2	0,20		
P	1776,5	4 B1	343	80	5,1 1	2	102	N	0	0 EP	1	2	0,00		
F	1780,8	22 B1	5	71	2,8 1	2	101	Z	0	0 KL	2	2	0,00		
P	1780,8	21 B0	354	36	1,4 1	2	102	Z	0	0 KL	3 06	3 Z6	0,00		
P	1780,8	6 B0	341	76	3,2 1	2	102	Z	0	0 EP	3 Z6	3 01	0,00		
F	1780,8	19 B1	174	68	4,3 2	2	101	Z	0	0 EP	1	3 22	0,00		
P	1784,8	12 B0	10	82	1,5 1	2	102	Z	0	0 KL KA	3 11	2	0,00		
F	1793,6	13 B3	8	81	1,7 1	2	102	N	0	0 KL	1	2	0,00		
P	1793,6	10 B0	7	79	1,0 1	2	102	N	0	0 KL	1	2	0,00		
P	1797,6	14 B0	2	80	2,5 1	2	102	N	0	0 KL	1	3 Z6	0,00		
F	1797,6	21 B0	6	78	2,7 1	2	102	N	0	0 KL KA	1	2	0,00		
P	1797,6	18 B0	350	72	1,0 1	2	101	N	0	0	2	3 Z6	0,00		
P	1797,6	13 B0	181	90	1,3 1	2	102	Z	0	0 KL KA	2	3 Z6	0,00		
P	1802,0	10 B0	3	84	2,8 1	2	102	N	0	0 EP KL KA OX	1	2	0,00		
P	1802,0	4 B0	173	72	2,4 1	2	102	N	0	0 KL	1	2	0,00		
P	1802,0	9 B0	190	32	7,7 1	2	102	N	0	0 EP OX	1	1	0,00	0.5cm wide	
P	1806,4	11 B0	359	80	2,1 1	2	101	N	0	0 KA	2	2	0,00		
F	1810,9	11 B0	6	78	1,3 1	2	102	Z	0	0 KA	2	3 12	0,00		
P	1810,9	9 B0	360	76	1,6 1	2	102	Z	0	0 KL	1	3 101	0,00		
P	1814,9	7 B0	355	82	3,0 1	2	102	Z	0	0 KA	2	2	0,00		
F	1814,9	12 B0	351	90	2,2 1	2	101	N	0	0 EP KA	3 Z6	2	0,00		

F	1814,9	14 B0	360	1	1,7	1	2	101	Z	0	0 KA		1	2	0,00		
P	1814,9	1 B0	349	82	3,4	1	2	102	N	0	0 EP KA KL OX		3 Z6	2	0,00	3 PCS/0.4M	
P	1814,9	8 B3	348	88	1,1	1	2	102	Z	0	0 KL		2	2	0,00		
P	1814,9	6 B0	347	86	2,2	1	2	102	Z	0	0 KA		2	2	0,00		
F	1814,9	13 B0	348	81	1,5	1	2	102	N	0	0 KL OX		3 Z6	1	0,00		
F	1814,9	15 B0	342	72	1,6	1	2	102	N	0	0 KL KA OX		1	2	0,00		
F	1819,3	25 B0	8	81	2,4	1	2	102	N	0	0 KL KA		2	2	0,00		
P	1819,3	16 B0	2	74	3,3	1	2	102	N	0	0 KL KA OX		2	1	0,00		
P	1819,3	18 B0	4	86	2,9	1	2	102	N	0	0 KL KA EP		3 Z6	2	0,00	2 PCS/0.1M	
P	1819,3	15 B0	2	74	3,2	1	2	102	N	0	0 KL EP KA OX		2	1	0,00		
P	1819,3	17 B0	10	81	3,8	1	2	102	N	0	0 KL KA EP OX		2	1	0,00		
F	1819,3	26 B0	356	90	1,1	1	2	102	Z	0	0 KL KA SU		2	1	0,00		
F	1819,3	23 B0	344	44	1,5	1	2	102	N	0	0 KL KA EP		2	2	0,00		
F	1819,3	22 B0	349	83	1,4	1	2	102	N	0	0 KA KL		2	3 21	0,00		
P	1819,3	20 B0	344	72	3,2	1	2	102	Z	0	0 QZ KL		2	2	0,00	1 CM WIDE	
P	1819,3	19 B0	350	50	2,1	1	2	102	Z	0	0 KL EP KA		3 18	3 17	0,00	2 PCS/0.1M	
P	1819,3	7 B0	177	83	1,4	1	2	101	N	0	0		2	3 Z6	0,00		
P	1823,4	1 B0	4	73	6,0	1	2	101	N	0	0 QZ		2	1	0,00	9 PCS/1.5M	
P	1823,4	3 B0	5	75	1,8	1	2	101	N	0	0 QZ		2	2	0,00		
P	1823,4	4 B0	6	74	1,5	1	2	101	N	0	0 QZ		2	2	0,00		
F	1823,4	11 B0	6	80	1,9	1	2	102	N	0	0 KL OX		1	2	0,00		
P	1823,4	6 B0	6	74	5,2	1	2	102	N	0	0 KL OX		1	2	0,00		
F	1823,4	23 B0	360	83	1,3	1	2	102	N	0	0 KL OX		2	2	0,00		
P	1823,4	15 B0	350	63	2,5	1	2	101	N	0	0 KA		2	2	0,00		
F	1823,4	19 B0	343	74	2,3	1	2	101	N	0	0 KA		2	2	0,00		
P	1823,4	9 B0	345	60	3,5	1	2	101	N	0	0 EP		3 07	2	0,00		
P	1827,5	2 B0	352	80	2,9	1	2	102	N	0	0 KA KL OX		1	2	0,00		
P	1827,5	12 B0	358	82	4,2	1	2	102	Z	0	0 KL KA OX		3 10	2	0,00		
P	1827,5	11 B0	356	88	3,2	1	2	102	N	0	0 KL KA		2	2	0,00		
P	1827,5	6 B0	342	84	4,4	1	2	102	Z	0	0 EP KL KA OX		1	2	0,00		
F	1827,5	20 B0	341	75	2,2	1	2	102	N	0	0 KL		2	2	0,00		
F	1827,5	15 B0	347	84	1,9	1	2	102	N	0	0 KL KA OX EP		1	2	0,00		
P	1831,5	2 B0	2	86	7,0	1	2	102	N	0	0 QZ KL EP KA FE		1	1	0,00	+SU(FR.MIN),2DM WIDE	
P	1831,5	6 B0	352	42	3,8	1	2	102	Z	0	0 QZ OX		3 01	3 Z8	0,00		
F	1831,5	15 B0	357	80	3,1	2	2	102	N	0	0 KA KL FE		2	1	0,00		
P	1831,5	1 B0	345	71	7,5	1	2	102	N	0	0 QZ KL EP KA FE		1	1	0,00	+SU(FR.MIN),2DM WIDE	
F	1831,5	19 B0	185	85	1,5	1	2	102	Z	0	0 KL KA		2	2	0,00		
F	1831,5	16 B0	182	85	1,7	3	2	102	N	0	0 KL KA		1	3 01	0,00		
P	1836,0	16 B0	360	80	3,8	1	2	101	N	0	0 QZ OX		1	3 102	0,00		
P	1836,0	15 B0	344	74	5,6	1	2	102	N	0	0 KL KA		1	1	0,00		
P	1840,4	2 B0	4	79	5,7	1	2	102	N	0	0 KL KA		1	2	0,00		
F	1840,4	15 B0	357	81	4,6	1	2	101	N	0	0 KA OX		2	1	0,00		
F	1840,4	19 B0	353	86	2,2	1	2	101	N	0	0 KA		3 18	2	0,00		
F	1840,4	20 B0	357	84	5,8	2	2	101	N	0	0 EP OX		1	1	0,00		
F	1840,4	12 B0	347	78	3,8	1	2	102	N	0	0 KL KA		2	2	0,00		
F	1840,4	13 B0	347	75	3,2	1	2	102	N	0	0 KL KA		2	1	0,00		
F	1840,4	14 B0	345	73	2,2	1	2	102	N	0	0 KL KA		2	1	0,00		
F	1845,0	6 B0	357	83	2,0	1	2	102	Z	0	0 KL KA		1	1	0,00		
P	1845,0	7 B0	342	77	1,3	1	2	102	N	0	0 KA KL		2	2	0,00		

F	1848,4	8 B1	351	70	3,0 1	2	101	N	0	0 KL KA	3 12	3 13	0,00			
F	1848,4	12 B1	352	82	2,1 1	2	102	N	0	0 KL KA	3 11	2	0,00			
P	1848,4	4 B1	342	62	5,1 1	2	102	N	0	0 KL KA	3 01	2	0,00			
F	1848,4	9 B1	350	55	2,2 1	2	101	N	0	0 KA	2	2	0,00			
P	1848,4	14 B6	185	53	8,0 1	2	101	N	0	0 VF	1	3 Z7	0,00	4 PCS/0.3M		
P	1852,9	17 B1	356	74	1,3 1	2	102	N	0	0 KL	1	3 B3	0,00			
P	1852,9	1 B1	345	58	2,3 1	2	101	N	0	0 KL	2	3 02	0,00			
P	1852,9	9 B1	350	64	1,9 1	2	102	N	0	0 KL	2	2	0,00			
F	1852,9	16 B1	341	60	3,8 1	2	102	N	0	0 KL KA OX	1	2	0,00			
F	1856,5	10 B1	5	84	2,9 1	2	102	N	0	0 KA EP	1	2	0,00			
F	1856,5	11 B1	1	74	3,2 1	2	102	N	0	0 LA KL	1	3 110	0,00			
P	1856,5	7 B1	8	80	2,0 1	2	102	N	0	0 KL	2	2	0,00			
P	1856,5	3 B1	4	72	3,3 1	2	102	N	0	0 KL	1	3 04	0,00			
F	1856,5	13 B1	353	80	1,1 2	2	102	N	0	0 KL OX	3 12	3 14	0,00			
P	1856,5	9 B1	347	70	3,2 1	2	101	N	0	0 QZ	1	1	0,00	2-5 CM WIDE		
F	1856,5	12 B1	342	74	4,0 1	2	102	N	0	0 KL EP OX	3 10	1	0,00			
P	1856,5	6 B1	342	84	4,5 1	2	102	N	0	0 KA OX	2	3 04	0,00			
P	1860,6	13 B1	10	76	4,6 3	2	102	N	0	0 KL	1	2	0,00			
P	1860,6	14 B1	9	76	1,9 1	2	102	N	0	0 KL	1	1	0,00			
P	1860,6	8 B1	10	54	7,0 1	2	102	N	0	0 KL EP KA	3 09	2	0,00			
P	1860,6	9 B1	3	78	7,1 1	2	102	N	0	0 EP KA KL OX	2	1	0,00			
P	1860,6	2 B1	3	87	2,8 1	2	102	N	0	0 KL KA CY	2	2	0,00			
F	1860,6	19 B1	1	71	1,9 1	2	102	N	0	0 KL	3 18	2	0,00			
F	1860,6	24 B1	3	81	1,1 2	2	101	N	0	0 KA	3 09	2	0,00			
F	1860,6	17 B1	352	69	2,2 1	2	102	N	0	0 KL OX	2	1	0,00			
P	1860,6	4 B1	341	63	1,2 1	2	101	N	0	0 KL	2	3 210	0,00			
P	1860,6	10 B1	344	87	2,0 1	2	102	N	0	0 KL	2	2	0,00			
F	1860,6	21 B1	161	27	2,6 2	2	101	N	0	0 KL OX	3 23	1	0,00			
P	1865,0	2 B1	1	64	2,0 1	2	102	Z	0	0 EP KA	2	2	0,00			
P	1865,0	5 B1	1	54	3,2 1	2	102	N	0	0 KL EP OX	2	1	0,00			
P	1865,0	12 B1	1	62	3,7 1	2	102	N	0	0 KL KA EP OX	2	1	0,00	STEPPED		
F	1865,0	17 B1	356	69	4,7 2	2	102	N	0	0 KL EP OX KA	2	2	0,00			
F	1865,0	16 B1	355	66	3,2 1	2	102	Z	0	0 KL OX	2	2	0,00			
P	1865,0	6 B1	356	78	2,4 2	2	102	N	0	0 KA EP	2	1	0,00			
P	1865,0	1 B1	346	80	1,9 1	2	102	N	0	0 KL KA	2	2	0,00			
F	1865,0	18 B1	350	82	1,8 1	2	102	N	0	0 KL OX	2	2	0,00			
P	1869,0	2 B1	6	68	4,5 1	2	102	N	0	0 KL KA OX EP	1	2	0,00			
P	1869,0	9 B1	4	73	1,3 1	2	102	N	0	0 KL OX	2	3 07	0,00			
P	1869,0	11 B1	10	84	6,0 1	2	101	N	0	0 QZ	2	2	0,00			
P	1869,0	10 B1	3	70	5,0 1	2	101	N	0	0 KL KA OX	2	2	0,00			
F	1869,0	12 B1	346	40	4,3 2	2	101	Z	0	0 PG	1	2	0,00			
P	1872,2	3 B1	1	78	3,2 1	2	102	N	0	0 KL EP OX	2	1	0,00			
P	1872,2	9 B1	8	15	1,6 1	2	101	N	0	0 KL EP OX	3 04	2	0,00			
P	1872,2	7 B1	4	70	2,9 1	2	101	N	0	0	3 06	2	0,00			
F	1872,2	12 B1	357	68	3,0 1	2	101	N	0	0 QZ	3 01	3 10	0,00			
F	1872,2	13 B1	353	80	4,7 1	2	101	N	0	0 KA	3 01	3 05	0,00			
P	1876,4	6 B1	2	82	1,9 1	2	102	Z	0	0 KL	2	2	0,00			
P	1876,4	4 B1	355	64	1,5 1	2	102	N	0	0 KL KA	2	2	0,00			
P	1876,4	5 B1	355	64	1,5 1	2	102	N	0	0 KL KA	2	3 02	0,00			

P	1880,3	12 B1	5	71	5,8 1	2	101	N	0	0 OX KL	2	1	0,00	
P	1880,3	3 B1	360	53	7,0 1	2	101	N	0	0 QZ EP OX	1	1	0,00	
P	1880,3	6 B3	348	70	4,5 1	2	102	N	0	0 KL KA	2	1	0,00	
F	1885,0	13 B5	2	82	2,0 1	2	102	N	0	0 KL KA EP	1	2 K6	0,00	6 PCS/1.0M
P	1885,0	6 B1	2	80	4,0 2	2	102	Z	0	0 KL EP OX	2	3 K6	0,00	
P	1885,0	1 B1	351	76	4,0 1	2	101		356	32 KA KL EP	1	2	0,00	
F	1885,0	12 B1	358	70	4,0 1	2	101	N	0	0 OX	2	3 05	0,00	
P	1885,0	5 B1	341	76	3,6 1	2	101	Z	0	0 KA KL OX	2	3 K6	0,00	
F	1885,0	10 B1	162	70	2,2 1	2	102	Z	0	0 KL OX	2	2	0,00	
F	1885,0	11 B1	178	75	1,0 1	2	102	Z	0	0 KL OX KA	2	3 10	0,00	
F	1885,0	14 B5	188	35	4,5 1	2	101	N	0	0 AT	2	3 K6	0,00	5 CM WIDE
P	1888,7	5 B1	2	79	3,4 1	2	102		0	0 OX KL KA	2	3 B5	0,00	
P	1888,7	6 B5	351	83	2,4 1	2	102	N	0	0 CY	3 B1	3 B3	0,00	
P	1888,7	11 B1	168	35	1,3 3	2	102	N	0	0 KL KA OX	3 05	2	0,00	
P	1888,7	9 B5	181	37	2,2 1	2	101	N	0	0	1	2	0,00	
P	1893,2	4 B3	5	82	3,2 1	2	101	N	0	0 KA	2	2	0,00	
F	1893,2	14 B5	354	74	2,3 1	2	101	N		KA KL EP	2	2		
P	1897,6	4 B1	9	58	6,2 1	2	102	N	0	0 KL	2	1	0,00	
P	1897,6	5 B1	8	75	1,6 1	2	102	Z	0	0 KL KA	3 01	2	0,00	
F	1897,6	20 B1	7	58	2,4 1	2	102	N		KA KL	2	2		
F	1897,6	17 B1	6	60	4,9 1	2	102	N	0	0 KA KL	2	1	0,00	
F	1897,6	18 B1	7	58	2,0 1	2	102	N		KA KL	3 019	2		
P	1901,8	8 B1	9	78	1,8 1	2	101	N	0	0 KL	2	1	0,00	
P	1901,8	5 B1	172	25	2,3 1	2	101	N	0	0	3 B5	2	0,00	6 PCD/1.2M
P	1906,0	1 B1	6	65	7,2 1	2	102	N	0	0 KL KA OX	2	2	0,00	
P	1906,0	4 B1	10	55	3,0 1	2	101	Z	0	0 KA	2	2	0,00	
F	1906,0	12 B1	10	78	3,2 1	2	102	N	0	0 KL KA	1	2	0,00	STEPPED
P	1906,0	7 B1	349	68	4,0 2	2	102	N	0	0 KA KL EP	2	1	0,00	SEVERAL
F	1908,7	16 B1	4	65	2,0 1	2	101	Z	0	0 KA	3 B3	3 B3	0,00	
P	1908,7	10 B1	358	72	3,6 1	2	102	Z	0	0 KL	1	2	0,00	
F	1908,7	17 B1	354	62	4,3 1	2	102	N	0	0 KL	2	2	0,00	
P	1916,7	8 B1	355	45	3,8 1	2	101	Z	0	0 KA KL	2	3 B3	0,00	
F	1916,7	12 B1	356	70	2,0 1	2	102	N	0	0 KL OX	2	3 15	0,00	
F	1920,3	12 B1	348	80	1,5 1	2	102		340	41 KL EP	2	2	0,00	
F	1925,0	9 B1	10	77	5,5 3	2	102	N	0	0 KL	1	1	0,00	
P	1925,0	6 B1	8	63	2,1 1	2	102	N	0	0 KL	3 10	3 B3	0,00	
P	1933,5	5 B1	9	82	2,0 2	2	101	N	0	0 KL KA	1	2	0,00	
P	1933,5	4 B1	356	81	2,1 1	2	101	N	0	0 KL	1	2	0,00	
P	1933,5	2 B1	349	48	8,7 1	2	102	N	0	0 KL OX	2	2	0,00	
P	1933,5	11 B1	343	38	3,5 1	2	102	N	0	0 KA OX	3 103	2	0,00	
P	1937,5	4 B1	4	77	2,9 1	2	102	N	0	0 KL OX	2	2	0,00	
P	1937,5	10 B1	181	62	5,7 1	2	101	N	0	0 AT	2	2	0,50	0.1 M WIDE
F	1941,9	10 B1	5	10	1,9 1	2	102	Z	0	0 KA	3 03	3 B2	0,00	
P	1946,1	14 B1	8	82	3,9 1	2	101	N	0	0 QZ OX	2	2	0,00	
F	1946,1	11 B1	360	76	2,6 1	2	101	N	0	0 KL	3 10	2	0,00	
F	1950,2	11 B1	10	30	2,8 1	2	101	N			2	2		
P	1954,5	2 B1	9	32	1,9 1	2	102	N	0	0 KA	1	2	0,00	
P	1954,5	9 B1	5	68	1,8 3	2	102	N	0	0	2	3 10	0,00	
P	1954,5	5 B1	359	65	1,6 1	2	102	N	0	0 KA KL	3 14	3 04	0,00	

P	1954,5	7 B1	351	88	2,1 1	2	102	N	0	0 KL	2	3 14	0,00		
P	1958,6	5 B1	2	68	7,5 1	2	102	N	0	0 KL OX SU	1	2	0,00		
P	1958,6	12 B1	4	64	2,5 1	2	102	N	0	0 KA OX	2	1	0,00	4 PCS/0.7M	
P	1958,6	8 B1	341	86	1,0 1	2	102	Z	0	0	3 09	2	0,00		
F	1962,8	13 B1	9	72	4,8 1	2	102	N	0	0 KL OX	3 12	3 11	0,00		
P	1962,8	10 B1	4	75	1,6 1	2	102	N	0	0 KL	1	2	0,00		
F	1962,8	16 B1	360	71	3,4 2	2	101	N	0	0 KL	3 11	3 12	0,00		
P	1966,9	5 B1	164	39	14,5 1	2	102	N	0	0 EP KL OX KA	1	1	0,00	5CM WIDE	
F	1966,9	14 B1	177	78	4,7 1	2	102	N		PG	2	3 05			
P	1971,0	18 B1	359	64	1,5 1	2	101	N	0	0 KL KA	1	2	0,00		
P	1971,0	9 B1	177	15	2,6 1	2	102	Z	0	0 KL	2	2	0,00		
P	1974,8	8 B1	10	80	3,6 1	2	102	N	0	0 KL KA	1	2	0,00	STEPPED	
P	1974,8	4 B1	360	74	1,5 1	2	101	N	0	0 KL KA OX	1	2	0,00		
P	1979,4	11 B1	7	60	3,3 1	2	101	N	0	0 CY KL	2	1	0,00		
F	1979,4	18 B1	2	81	1,7 1	2	102	N	0	0 KL OX	1	1	0,00		
F	1979,4	15 B1	180	10	1,9 2	2	101	N	0	0 PG	3 B3	3 02	0,00		
P	1988,6	10 B1	6	78	3,6 1	2	102	N	0	0 KL KA OX	1	2	0,00		
F	1988,6	14 B1	10	78	2,5 1	2	101	Z	0	0 KA KL	2	2	0,00	3 PCS/1m	
P	1988,6	8 B1	165	85	1,6 1	2	102	Z	0	0 KL	2	2	0,00		
P	1992,2	3 B1	10	31	5,7 1	2	101	N	0	0 KL	3 01	3 102	0,00	2PCS/0.3M	
P	1992,2	7 B1	9	71	2,4 1	2	102	N	0	0 KL KA	3 101	1	0,00		
P	1992,2	2 B1	344	56	3,1 3	2	101	N	0	0 KL KA	3 01	3 101	0,00		
F	1992,2	12 B1	186	72	1,0 1	2	102	N	0	0 KL	3 101	2	0,00		
P	1997,0	11 B1	8	70	6,8 1	2	102	N	0	0 KL KA OX	1	3 01	0,00		
P	1997,0	5 B1	342	4	4,4 1	2	101	N	0	0 KL KA	2	2	0,00		
P	1997,0	9 B1	182	72	3,0 1	2	102	Z	0	0 KL	2	3 Z9	0,00		
F	2001,3	4 B1	8	69	1,9 1	2	101	N	0	0 KA OX	2	2	0,00		
F	2001,3	10 B2	184	83	2,3 2	2	102		225	80 KL OX	2	2	0,00	6 PCS/0.4m	
P	2005,4	9 B2	10	90	1,5 1	2	102	N	0	0 KL KA	2	2	0,00		
F	2005,4	16 B2	5	78	1,6 1	2	102	Z	0	0 KL	2	3 B1	0,00		
P	2005,4	2 B1	352	66	2,3 1	2	101	N	0	0 KA	3 01	3 619	0,00		
F	2005,4	14 B1	350	75	2,3 2	2	102	N	0	0 EP KL KA	1	2	0,00		
P	2005,4	7 B1	190	70	1,9 1	2	101	Z	0	0	2	3 B2	0,00		
F	2009,5	13 B2	5	62	2,3 1	2	102	N	0	0 KL KA	3 10	2	0,00		
P	2009,5	6 B1	358	78	2,7 1	2	102	N	0	0 KL KA	1	2	0,00		
P	2009,5	4 B2	360	70	3,5 2	2	101	Z	0	0 KA	2	2	0,00		
F	2009,5	12 B1	360	76	1,8 1	2	102	N	0	0 KL	1	2	0,00		
F	2009,5	11 B1	348	80	4,8 1	2	102	N	0	0 KL	1	2	0,00		
P	2009,5	5 B2	176	86	1,7 1	2	102	Z	0	0 KL	2	2	0,00	4PCS/1.5m	
P	2009,5	9 B2	176	90	3,3 1	2	102	Z	0	0	2	2	0,00		
P	2013,4	6 B2	7	76	2,3 1	2	102	N	0	0 KL	3 B1	3 07	0,00		
P	2013,4	10 B2	5	67	4,3 1	2	102	N	0	0 KA KL	2	2	0,00		
F	2013,4	17 B1	164	72	2,2 1	2	101	N	0	0	2	1	0,00		
F	2013,4	14 B1	176	75	1,4 1	2	101	N	0	0	1	2	0,00		
P	2018,1	12 B1	342	85	1,7 2	2	102	N	0	0 KL KA	2	2	0,00		
P	2023,4	2 B1	2	74	3,9 1	2	102	N	0	0 KL KA OX	2	2	0,00	4PCS/4M	
P	2023,4	9 B1	356	82	2,5 1	2	102		178	5 KL	2	2	0,00		
P	2023,4	3 B1	178	48	2,2 1	2	102	N	0	0 KL	1	2	0,00		
F	2026,5	7 B1	165	89	2,3 1	2	101	N	0	0 KA	1	3 05	0,00		

F	2026,5	6 B1	190	86	1,1 1	2	101	N	0	0 KL OX	2	2	0,00	
P	2026,5	11 B1	190	81	2,3 1	2	102	N	0	0 KL	1	2	0,00	
P	2030,5	8 B1	185	76	3,8 1	2	102	N	0	0 KL	2	1	0,00	
P	2034,6	18 B1	8	82	2,6 3	2	102	N	0	0 KL	2	2	0,00	
P	2034,6	9 B3	360	0	4,2 1	2	101	N	0	0 QZ KL	1	1	0,00	
P	2034,6	7 B1	350	86	5,1 1	2	102	N	0	0 KA CY	1	2	0,00	
P	2034,6	1 B1	185	50	7,5 1	2	101	N	0	0 EP KL QZ	1	1	0,00	2 CM WIDE
P	2034,6	3 B3	186	5	7,0 1	2	101	N	0	0 KL KA	1	2	0,00	
F	2039,0	18 B2	10	67	3,6 1	2	102	N		KL KA	2	2		
P	2039,0	6 B2	9	85	2,0 1	2	102	N	0	0 KL	2	2	0,00	7 PCS/1.5 m
F	2039,0	19 B2	10	67	2,8 1	2	102	N		KL KA	2	3 B1		
P	2039,0	13 B2	350	78	1,5 1	2	102	N	0	0 KL KA	2	3 10	0,00	
P	2039,0	9 B2	345	65	1,8 1	2	102	Z	0	0 KA KL	2	2	0,00	3 PCS/1.5 m
P	2039,0	4 B1	185	84	1,0 1	2	101	N	0	0 KA KL	1	2	0,00	
F	2043,0	10 B3	4	58	2,0 1	2	102	N	0	0 KL	1	1	0,00	3PCS/0.5M
P	2043,0	6 B3	348	85	3,6 1	2	102	N	0	0 KL	1	2	0,00	7PCS/0.5M
F	2043,0	13 B3	190	77	2,0 1	2	101	N	0	0 KL	3 Z2	2	0,00	
P	2047,0	3 B3	8	78	4,5 1	2	102	N	0	0 PG	1	3 02	0,00	2cm wide
F	2051,5	6 B3	355	88	4,0 1	2	102	N		KL	2	2		10 PCS, 1.0m
P	2051,5	3 B3	184	54	1,6 1	2	102	N	0	0 KL	2	2	0,00	5 PCS, 0.5m
P	2055,4	1 B1	10	76	5,0 1	2	101	N	0	0 KL KA EP	2	3 02	0,00	
P	2058,7	9 B1	188	62	1,7 1	2	101	N	0	0	2	3 10	0,00	
P	2070,2	10 B0	7	85	9,5 2	2	101	N	0	0 EP OX KL	1	1	0,00	
P	2070,2	5 B0	343	8	1,8 1	2	102	N	0	0	2	2	0,00	
F	2070,2	11 B0	165	87	2,8 1	2	102	N	0	0 KL	1	3 10	0,00	
P	2070,2	9 B0	188	75	2,6 1	2	101	N	0	0	2	2	0,00	
P	2074,4	1 B0	4	77	2,4 1	2	102	N	0	0 KL	2	2	0,00	2PCS/0.5M
P	2074,4	7 B0	169	75	1,1 1	2	102	Z	0	0 KL	2	2	0,00	
P	2074,4	9 B0	167	41	2,1 1	2	101	N	0	0 KA	2	2	0,00	
P	2078,7	1 B0	10	59	3,3 1	2	101	N	0	0 KL	3 02	2	0,00	
P	2078,7	6 B0	3	82	2,9 1	2	102	N	0	0 KL EP	3 04	2	0,00	
F	2078,7	17 B0	9	13	1,7 1	2	101	N	0	0 KL KA OX	3 102	2	0,00	
P	2082,5	1 B0	360	50	3,2 1	2	102	N	0	0 KL OX	2	3 12	0,00	
P	2082,5	2 B0	360	50	3,2 1	2	102	N	0	0 KL OX	2	3 12	0,00	
F	2082,5	10 B0	343	81	3,2 1	2	102	N	0	0 KL EP OX KA	1	3 12	0,00	
F	2082,5	11 B0	186	79	1,6 1	2	101	N	0	0	1	2	0,00	
P	2082,5	16 B0	184	42	3,8 1	2	101	N	0	0 KL	3 05	3 14	0,00	
P	2086,8	2 B0	5	68	1,7 2	2	101	N	0	0 KL KA	1	3 01	0,00	
P	2090,7	4 B1	360	0	12,0 1	2	102	N	0	0 KL KA	1	2	0,00	
P	2090,7	8 B0	360	64	3,1 1	2	102	Z	0	0 KL OX	3 03	1	0,00	
F	2090,7	15 B0	348	55	2,0 1	2	102	N	0	0 KL	2	2	0,00	
P	2095,6	3 B0	345	74	1,2 1	2	101	N	0	0 CY	2	2	0,00	2PCS/0.2M
P	2095,6	11 B0	183	90	2,1 1	2	102	N	0	0 KL	3 07	3 13	0,00	
P	2100,0	10 B0	4	8	3,2 1	2	102	N	0	0 KL KA	2	2	0,00	
P	2100,0	11 B0	4	8	3,4 1	2	102	Z	0	0 KL KA	2	2	0,00	
P	2100,0	1 B0	355	5	3,5 1	2	102	N	0	0 KA KL	2	2	0,00	
F	2108,4	10 B0	182	38	1,9 1	2	101	N		KA	2	2		
P	2112,6	8 B0	355	74	1,9 2	2	102	N	0	0 KL EP KA OX	1	2	0,00	
F	2112,6	17 B0	355	53	1,5 1	2	101	N	0	0	2	2	0,00	

P	2116,6	5 B0	170	58	3,5 1	2	102	Z	0	0 KL	3 101	1	0,00		
P	2116,6	8 B0	165	24	2,2 1	2	102	Z	0	0 KL KA	2	2	0,00		
F	2116,6	10 B0	165	74	3,2 1	2	102	Z	0	0 KA	2	3 09	0,00	3PCS/1M	
F	2116,6	11 B0	188	85	3,7 1	2	102	Z		KL KA	2	3 14			
P	2120,6	9 B0	354	58	1,1 1	2	102	N	0	0 KL	3 08	2	0,00	3PCS/0.4M	
P	2120,6	15 B0	352	70	1,5 1	2	102	N	0	0 KL	2	2	0,00		
P	2120,6	14 B0	350	61	1,8 1	2	102	N	0	0 KL	3 08	2	0,00		
P	2120,6	3 B0	162	72	3,9 1	2	101	N	0	0 KA	3 01	1	0,00		
P	2125,0	13 B0	179	86	3,2 1	2	101	N	0	0 KA	2	3 19	0,00		
P	2129,5	7 B0	342	90	1,7 1	2	102	Z	0	0 KL KA	2	3 Z3	0,00		
P	2129,5	9 B0	188	90	3,3 1	2	102	Z	0	0 KL OX	2	3 Z3	0,00		
P	2133,7	3 B0	342	65	1,5 1	2	102	Z	0	0 KL KA CY	2	2	0,00		
F	2133,7	19 B0	342	84	4,0 2	2	102	Z		KA	2	2			
P	2146,2	3 B1	6	88	3,9 2	2	101	N	0	0 EP OX KL KA	1	3 Z4	0,00		
P	2146,2	2 B1	345	66	3,6 1	2	101	N	0	0	1	3 Z4	0,00		
P	2154,8	6 B1	185	5	3,0 2	2	101	N	0	0 KL OX	3 05	2	0,00		
P	2159,1	10 B1	358	26	1,7 1	2	102	Z	0	0 KA KL	2	2	0,00		
P	2159,1	9 B1	347	68	6,0 1	2	102	Z	0	0 KA KL OX	2	3 110	0,00	STEPPED	
F	2159,1	23 B1	182	63	1,9 1	2	102	Z		KL	2	2			
P	2163,2	3 B1	4	68	1,5 1	2	101	N	0	0 KA KL	2	2	0,00		
P	2163,2	5 B1	2	80	1,1 1	2	102	N	0	0 KA KL	2	2	0,00		
F	2163,2	22 B1	347	76	1,9 1	2	102	Z	0	0 KL KA EP	2	2	0,00		
F	2163,2	24 B1	180	5	2,8 1	2	101	Z	0	0	2	2	0,00		
P	2167,5	7 B1	5	5	1,1 1	2	102	N	0	0 KL	2	1	0,00		
P	2167,5	6 B1	356	67	1,0 1	2	102	N	0	0 KL	3 113	3 14	0,00		
P	2171,9	10 B1	6	48	2,5 1	2	102	Z	0	0 KL	1	2	0,00		
P	2175,8	7 B2	341	80	1,8 1	2	102	N	0	0 KA KL	2	2	0,00		
F	2175,8	18 B1	174	65	5,1 1	2	101	Z		PG	1	2			
P	2179,8	16 B2	360	0	8,1 1	2	102	N	0	0 KA KL	2	3 12	0,00		
P	2179,8	6 B2	344	70	1,5 1	2	102	N	0	0 KL	1	2	0,00		
P	2183,6	4 B2	358	64	3,1 2	2	102	Z	0	0	1	2	0,00		
F	2183,6	14 B1	352	45	2,4 1	2	102	N	0	0 KL KA	1	2	0,00		
F	2183,6	13 B1	349	77	3,0 1	2	102	N	0	0 KL EP KA OX	1	2	0,00		
P	2183,6	6 B3	190	82	3,0 2	2	102	Z	0	0 KA	2	2	0,00		
P	2195,9	2 B1	10	13	14,2 1	2	102	N	0	0 CY OX KL	3 103	1	0,00		
P	2195,9	10 B1	10	12	2,0 1	2	101	N	0	0 KL	3 09	2	0,00		
F	2195,9	17 B1	168	16	7,6 1	2	101	N	0	0 0X KL	1	3 02	0,00		
P	2200,5	15 B1	6	10	7,0 1	2	101	N	0	0 KL OX KA	3 16	2	0,00		
P	2200,5	3 B1	348	44	4,8 1	2	101	N	0	0 KL OX	1	3 04	0,00		
P	2204,6	13 B1	360	64	2,0 1	2	101	N	0	0 KA	2	3 202	0,00		
P	2208,3	1 B5	6	77	3,0 1	2	102		360	11 KL EP KA	2	2	0,00		
P	2208,3	7 B1	161	30	2,5 1	2	101	Z	0	0 OX	2	2	0,00		
P	2215,6	2 B1	7	78	4,0 1	2	101	N	0	0 KL	1	2	0,00		
P	2215,6	1 B1	345	67	6,0 1	2	101	N	0	0 KL KA	1	2	0,00		
F	2215,6	16 B5	341	66	1,1 1	2	102	N	0	0 EP	3 B3	2	0,00		
P	2218,3	7 B1	355	60	1,5 1	2	102	Z	0	0 KL	1	1	0,00		
F	2218,3	8 B1	170	65	2,5 1	2	102	N	0	0 KL	3 B3	2	0,00		
P	2222,6	10 B1	10	65	4,2 1	2	101	N	0	0 KL	3 08	1	0,00		
P	2222,6	14 B1	359	76	2,1 1	2	101	N	0	0	3 13	3 11	0,00		

P	2225,8	8 B3	190	80	2,7	1	2	102	Z	0	0 KL	1	2	0,00	
P	2260,5	6 B3	5	66	1,8	1	2	102	N	0	0 KL KA	2	2	0,00	
P	2260,5	11 B1	4	3	1,7	1	2	101	N	0	0 KA	3 12	1	0,00	
F	2260,5	18 B1	10	73	2,4	1	2	101	N	0	0 QZ KL	1	2	0,00	
P	2260,5	10 B1	356	70	2,1	1	2	101	N	0	0 KA OX	1	2	0,00	
P	2260,5	8 B1	350	60	1,0	1	2	101	N	0	0 OX	2	3 09	0,00	
F	2260,5	14 B1	163	68	2,6	1	2	101	N	0	0 EP KA SU	2	1	0,00	
P	2264,6	2 B1	10	70	4,3	2	2	102	N	0	0 PG	3 01	2	0,00	
F	2264,6	21 B1	4	75	2,8	1	2	102	Z		EP KA KL	2	2		
P	2264,6	13 B1	168	85	0,8	1	2	102	Z	0	0 KL	2	2	0,00	
P	2264,6	11 B1	175	30	4,0	2	2	102	Z	0	0 QZ	2	3 10	0,00	5 CM WIDE
P	2268,5	10 B1	359	65	3,5	1	2	102	N	0	0 OX KA	3 08	2	0,00	
P	2272,8	2 B1	166	64	5,8	1	2	101	N	0	0 KA	2	2	0,00	2 CM WIDE
P	2275,9	1 B1	5	75	5,0	1	2	102	N	0	0 PG	1	1	0,00	10 CM WIDE
P	2275,9	12 B1	1	73	2,2	1	2	102	N	0	0 EP	1	1	0,00	
P	2275,9	14 B1	5	78	2,6	1	2	102	N	0	0 KA	2	2	0,00	
F	2275,9	16 B1	170	65	2,0	1	2	102	Z		KL	2	2		
F	2275,9	18 B1	170	80	3,6	1	2	102	Z		QZ	2	1		7 CM WIDE
P	2280,5	1 B1	5	74	2,3	1	2	101	N	0	0 KA OX	3 05	1	0,00	
P	2280,5	2 B1	8	73	2,1	1	2	102	N	0	0 KA OX KL EP	3 05	1	0,00	
F	2280,5	16 B1	4	77	3,8	1	2	101	N	0	0 KA EP OX	2	1	0,00	
P	2280,5	13 B1	356	77	3,9	1	2	102	N	0	0 EP QZ	1	2	0,00	
P	2280,5	15 B1	358	70	3,4	1	2	101	N	0	0 EP KA KL	2	3 B1	0,00	
P	2283,9	3 B1	349	88	3,2	1	2	101	N	0	0 KL KA	3 02	2	0,00	
P	2283,9	15 B5	170	5	1,0	1	2	102	N	0	0 KL	2	2	0,00	
P	2288,8	13 B1	2	70	2,2	1	2	102	N	0	0 KA EP FL	2	2	0,00	
P	2288,8	7 B1	354	76	3,2	1	2	102	N	0	0 KA KL EP	2	1	0,00	
P	2288,8	3 B1	180	90	1,8	2	2	102	N	0	0 QZ EP	2	1	0,00	
P	2288,8	15 B1	172	70	2,1	1	2	101	N	0	0	2	2	0,00	
F	2292,4	18 B1	9	90	1,4	2	2	102	N		KL KA OX QZ	3 10	3 01		
P	2292,4	16 B1	360	72	1,9	1	2	101	Z	0	0 KA	3 11	2	0,00	
P	2292,4	8 B1	180	20	3,8	1	2	102	Z	0	0 KL KA	2	2	0,00	
P	2296,6	4 B1	3	71	2,6	1	2	101	N	0	0 KA KL EP OX	1	3 01	0,00	
P	2296,6	5 B1	5	71	3,3	1	2	102	N	0	0 KL PG	3 01	2	0,00	
P	2300,7	15 B1	4	71	2,6	1	2	102	Z	0	0 KL KA	2	2	0,00	
F	2300,7	18 B1	342	80	2,3	1	2	102	Z		KA KL	2	2		2PCS/0.1M
P	2300,7	14 B1	186	72	2,5	1	2	102		186	10 KL EP	1	2	0,00	
F	2305,7	18 B1	3	62	1,6	1	2	101	N		KL	3 13	3 12		
F	2305,7	17 B1	348	67	1,8	1	2	101	N		KL KA	1	2		
P	2305,7	1 B1	187	85	6,0	1	2	101	N	0	0 KL	2	1	0,00	
P	2305,7	2 B1	185	85	5,6	1	2	101	N	0	0 KL	2	1	0,00	
P	2305,7	3 B1	185	85	5,1	1	2	101	N	0	0 KL	2	1	0,00	
F	2305,7	14 B1	184	57	3,0	1	2	102	N		KL	1	3 13		2 PCS/0.5m
P	2309,8	11 B1	1	65	3,7	1	2	102	Z	0	0 EP OX	2	2	0,10	
F	2309,8	21 B1	3	78	1,2	1	2	102	N		KL	2	1		
P	2309,8	6 B1	350	64	1,2	1	2	102	N	0	0 KL KA	2	2	0,00	
P	2309,8	18 B1	347	82	1,0	1	2	102	N	0	0 QZ	2	2	0,00	1cm wide
P	2314,3	12 B1	2	56	2,8	1	2	101	N	0	0 KL	2	1	0,00	
P	2314,3	14 B1	347	8	5,2	1	2	101	N	0	0 OX EP	3 12	2	0,00	

F	2314,3	15 B1	164	66	2,2 1	2	101	N		EP KL	2	2		
P	2318,2	3 B1	1	70	2,0 1	2	102	N	0	0 EP KA	2	2	0,00	
P	2318,2	14 B5	1	67	1,7 1	2	102	N	0	0 KL	2	2	0,00	
P	2318,2	1 B1	360	64	1,8 1	2	101	N	0	0 KL	1	3 210	0,00	
P	2318,2	9 B1	359	51	0,3 1	2	101	Z	0	0 KL	2	2	0,00	
P	2318,2	11 B1	342	58	1,8 1	2	101	N	0	0 OX	2	2	0,00	
F	2322,3	10 B1	182	89	3,2 1	2	102	N		KL EP KA	3 11	3 09		
P	2326,1	2 B1	352	78	1,8 1	2	102	N	0	0 KL EP	1	2	0,00	
F	2326,1	13 B1	342	65	2,2 1	2	101	N		KL OX	2	3 01		
P	2334,3	11 B1	344	45	3,2 1	2	102	Z	0	0 KL	2	2	0,00	
P	2338,0	3 B1	2	69	4,0 1	2	101	N	0	0 KL OX	2	2	0,00	
P	2338,0	9 B1	9	56	5,7 1	2	101	N	0	0 OX	3 07	3 06	0,00	
F	2338,0	16 B1	3	61	1,4 1	2	101	N		OX KL	3 12	1		
P	2338,0	2 B1	349	86	4,5 1	2	101	N	0	0 KL	1	2	0,00	
F	2346,7	14 B1	2	61	1,0 1	2	101	N	0	0 KL	2	2	0,00	
P	2346,7	2 B1	360	58	4,8 1	2	101	N	0	0 KL EP KA OX MY	2	2	0,00	
P	2351,2	13 B1	9	45	11,0 1	2	102	N	0	0 KL KA OX	2	3 14	0,00	
F	2351,2	18 B1	2	64	2,1 1	2	101		30	40 KA KL	2	2		
P	2351,2	2 B1	359	68	2,1 1	2	102	N	0	0 KA KL	2	2	0,00	
P	2351,2	12 B1	358	64	4,5 1	2	102	N	0	0 KL KA	1	3 13	0,00	4 PCS/0.6M
P	2351,2	7 B1	344	20	2,2 1	2	102	Z	0	0 KA KL	2	3 115	0,00	
P	2355,5	3 B1	10	70	4,3 1	2	102	Z	0	0 KL	1	2	0,00	5PCS/1.5M
P	2355,5	6 B1	5	60	5,0 1	2	101	Z	0	0 OX KA	1	3 B3	0,00	
P	2355,5	7 B1	355	60	5,0 3	2	102	Z	0	0 KL OX	1	3 01	0,00	5PCS/0.8M
P	2359,5	2 B1	9	62	1,6 1	2	102	N	0	0 KL KA EP OX	1	2	0,00	
P	2359,5	3 B1	4	66	2,3 1	2	102	N	0	0 KL	1	2	0,00	
P	2359,5	15 B1	6	64	3,2 1	2	102	N	0	0 KL KA	3 17	1	0,00	
P	2359,5	14 B1	344	41	4,0 1	2	102	Z	0	0 KL KA OX	2	2	0,00	
P	2368,2	3 B1	6	62	9,0 1	2	102	N	0	0 KL KA OX	1	1	0,00	
F	2372,6	15 B1	355	48	2,8 1	2	102	N		KL OX	2	2		
F	2376,6	23 B1	5	77	3,0 1	2	101	N	0	0 KA	1	3 B3	0,00	
P	2380,0	8 B1	2	22	4,0 1	2	102	Z	0	0 KL KA	2	2	0,00	
P	2380,0	3 B1	360	0	8,0 1	2	102	Z	0	0 EP KA KL OX	2	2	0,00	
P	2380,0	6 B1	350	11	3,5 1	2	102	Z	0	0 KA OX	2	2	0,00	
F	2380,0	14 B1	162	87	6,2 1	2	102	N		KL KA EP	1	1		
F	2383,3	20 B1	355	20	5,3 1	2	102	Z	0	0 KL KA OX	2	3 101	0,01	
P	2383,3	10 B1	349	65	2,4 1	2	102	Z	0	0	2	3 03	0,00	
P	2383,3	12 B1	168	86	9,7 1	2	101	N	0	0 KL KA EP	1	3 B3	0,00	
P	2387,3	6 B1	360	84	3,0 1	2	102	Z	0	0 KL OX	3 B3	3 07	0,00	
P	2387,3	9 B1	356	52	2,0 3	2	101	N	0	0 KL OX	2	3 08	0,00	
F	2387,3	10 B1	358	80	4,5 1	2	102	N	0	0 KL	1	2	0,00	
F	2387,3	14 B1	347	64	2,2 1	2	101	N	0	0 EP KL KA OX	3 B3	2	0,00	
F	2391,5	21 B1	8	73	3,2 1	2	101	N	0	0 KA KL	2	2	0,00	
F	2391,5	19 B1	353	76	4,3 3	2	102		180	18 EP KA KL OX	1	2	0,00	
P	2391,5	14 B1	360	62	2,6 1	2	102	N	0	0 KL	1	2	0,00	3PCS/2.0m
P	2391,5	8 B1	343	82	5,7 3	2	102	Z	0	0 KL	3 10	2	0,00	
P	2391,5	9 B1	350	80	3,9 3	2	102	Z	0	0 KL KA	3 B3	3 08	0,00	
P	2398,5	10 B1	6	70	3,1 1	2	102	Z	0	0 KL	2	2	0,00	
P	2398,5	11 B1	360	57	1,7 1	2	102	N	0	0 KL	2	2	0,00	

F	2398,5	22 B1	360	75	3,0 1	2	102	Z		KL OX	2	2				
P	2398,5	2 B1	350	80	1,5 1	2	102	N	0	0 EP OX	2	3 103	0,00			
F	2398,5	16 B1	345	75	3,0 1	2	102	Z	0	0 EP KL KA OX	2	2	0,00			
F	2398,5	20 B1	350	70	1,8 1	2	102	N		EP KA	2	2				
P	2398,5	1 B1	190	90	5,0 1	2	101	N	0	0 PG AT	2	2	0,00			
P	2402,7	15 B1	359	80	4,7 2	2	102	Z	0	0 EP KL KA	2	2	0,00			
P	2402,7	16 B1	355	90	2,5 1	2	102	Z	0	0 KL	2	2	0,00			
F	2402,7	20 B1	354	55	2,5 1	2	101	N	0	0 KL KA	1	2	0,00			
P	2407,7	4 B1	2	68	4,8 2	2	101	N	0	0 KL KA OX	1	2	0,00			
F	2407,7	14 B1	2	68	4,8 1	2	101	N		KL BI KA	3 13	1				
P	2407,7	2 B1	343	55	6,8 1	2	101	N	0	0 PG	1	1	1,20			
F	2407,7	17 B1	344	85	2,9 1	2	102	N		KL KA EP	1	3 119				
P	2411,8	6 B1	6	89	4,1 1	2	101		6	11 KL KA OX EP	1	3 119	0,00			
P	2411,8	2 B1	351	77	5,1 2	2	101	N	0	0	1	2	0,00			
F	2411,8	13 B1	351	52	2,8 1	2	101	N		OX KL KA	3 B3	3 14				
F	2411,8	22 B1	163	76	1,5 1	2	101	N	0	0 KL	1	3 14	0,00			
P	2411,8	1 B1	174	83	1,9 1	2	101	N	0	0 KA KL	3 113	1	0,00			
P	2416,0	10 B1	5	88	3,7 2	2	102	N	0	0 KL KA	2	3 23	0,00			
F	2416,0	18 B1	360	90	5,3 1	2	102	N		KL KA EP OX	2	2				
P	2416,0	13 B1	342	84	3,7 1	2	101	N	0	0 OX KL	1	3 14	0,00			
P	2416,0	14 B1	347	8	6,5 1	2	102	Z	0	0 KL KA OX	2	2	0,00			
P	2416,0	16 B1	350	80	4,2 1	2	101	N	0	0 KL KA EP	1	2	0,00			
P	2416,0	2 B1	165	87	3,7 2	2	101	N	0	0 KL KA OX	2	1	0,00			
P	2416,0	5 B1	188	85	1,4 1	2	102	Z	0	0 KL	2	3 03	0,00			
P	2419,8	1 B1	177	85	7,0 1	2	102	Z	0	0 KL	1	1	0,00			
P	2423,9	20 B1	358	61	2,2 1	2	102	N	0	0 KL EP	3 03	2	0,00			
F	2423,9	18 B1	356	78	2,2 1	2	101	N		KL	3 19	2				
P	2423,9	7 B1	344	85	1,0 1	2	101	Z	0	0	2	2	0,00			
P	2423,9	6 B1	169	84	1,0 1	2	101	Z	0	0	2	2	0,00			
P	2428,7	3 B1	5	82	3,7 1	2	102	N	0	0 KL BI	2	2	0,00			
P	2428,7	1 B1	356	90	4,2 1	2	101	N	0	0 KA KL	1	2	0,00			
F	2428,7	19 B1	355	78	2,0 1	2	102	Z		KL KA	2	3 102				
P	2428,7	4 B1	341	80	3,3 1	2	102	Z	0	0 KL KA	3 01	3 Z6	0,00	STEPPED		
F	2428,7	17 B1	349	76	2,1 1	2	102	N		KL KA EP OX	1	3 16				
P	2432,5	11 B1	2	73	2,8 1	2	102	N	0	0 KL KA	1	3 B3	0,00			
F	2432,5	13 B1	171	80	3,0 2	2	101	Z	0	0 OX	2	3 Z6	0,00			
P	2432,5	4 B1	189	84	4,2 1	2	102	Z	0	0 KL KA EP OX MY	1	3 Z6	0,00	STEPPED		
F	2436,5	18 B1	5	46	1,6 1	2	101	N		OX	2	1				
P	2436,5	2 B1	343	88	2,8 1	2	102	Z	0	0 EP KL KA	3 B3	3 B3	0,00			
P	2436,5	4 B1	343	77	3,0 1	2	101	N	0	0	1	3 B3	0,00			
P	2436,5	6 B1	169	82	1,3 1	2	101	N	0	0 KL OX	1	2	0,00			
F	2436,5	19 B1	163	89	1,0 1	2	101	N		KL EP	3 13	2				
P	2440,4	11 B1	2	88	3,3 1	2	101	N	0	0 KL BI	1	2	0,00			
P	2440,4	6 B1	351	86	1,2 2	2	101	N	0	0 OX KL	1	2	0,00			
P	2440,4	8 B1	352	89	1,9 2	2	101	N	0	0 OX KL	1	2	0,00			
P	2440,4	7 B1	347	80	1,1 2	2	101	N	0	0 OX KL	1	2	0,00			
P	2440,4	12 B1	345	83	1,0 1	2	101	N	0	0 KL KA	3 B3	3 13	0,00			
P	2440,4	1 B1	162	90	1,0 1	2	102	N	0	0 KL KA	1	2	0,00			
P	2440,4	2 B1	162	90	1,0 1	2	102	N	0	0 KL	1	2	0,00			

F	2440,4	16 B3	174	88	4,0 1	2	102	N			KL		3 17	2	
P	2445,0	13 B1	360	73	3,0 1	2	102	Z	0	0	KL OX		2	2	0,00
P	2445,0	14 B1	360	73	2,8 1	2	102	Z	0	0	KL OX		1	2	0,00
P	2445,0	8 B1	350	86	4,7 1	2	102	N	0	0	KL		2	3 105	0,00
P	2445,0	9 B1	165	76	3,5 2	2	102		165	0	KL		1	2	0,00
P	2445,0	2 B1	175	82	5,6 1	2	101	N	0	0	EP KL KA OX QZ		1	1	0,00
F	2445,0	17 B1	180	78	3,0 1	2	102	Z			KL KA OX		2	3 02	

Appendix B-4

TUNNEL	PART	SECTION	ZONE_ID	FRACGROUP	STRIKE	DIP	FRACQOUNT	SPACING	MINERAL1	MINERAL2	MINERAL3	MINERAL4	MINERAL5	WATER	REMARK
A	P	1402.9	Z8	1	22	38	0	0.000						X	FROM 1402.9
A	P	1407.2	Z9	1	89	73	0	0.000							FROM 1411.7
A	P	1411.7	Z9	1	16	74	232	0.050	KL					X	
A	P	1411.7	Z9	2	58	45	71	0.100	FL	KL	KA				
A	P	1411.7	Z9	4	290	78	41	0.300	FL	KA					
A	P	1411.7	Z9	3	62	70	55	0.200	KL						
A	P	1416.0	Z0	1	71	76	760	0.002	KL	CY				X	
A	P	1416.0	Z9	1	89	73	0	0.000						X	FROM 1411.7
A	P	1420.6	Z0	1	71	76	0	0.000						X	FROM 1416.0
A	P	1420.6	Z9	1	89	73	0	0.000							FROM 1411.7
A	P	1424.7	Z9	1	89	73	0	0.000							FROM 1411.7
A	P	1477.1	Z1	1	260	45	0	0.000							FROM 1481.2
A	P	1481.2	Z1	1	260	45	0	0.000							FROM 1481.2
A	P	1485.4	Z2	1	262	52									FROM 1489.2
A	P	1485.4	Z1	1	260	45	0	0.000							FROM 1481.2
A	P	1489.2	Z2	1	262	52	0	0.020	KL	CY					
A	P	1493.7	Z3	5	279	46	23	0.200	KL	KA	FL				
A	P	1493.7	Z3	3	62	71	35	0.200	KL						MINOR
A	P	1493.7	Z3	1	255	39	39	0.100	KL	KA	FL			X	MAIN
A	P	1493.7	Z3	4	52	36	4	0.900	KL						MINOR
A	P	1493.7	Z3	2	295	84	83	0.100	KL						MINOR
A	P	1498.1	Z3	1	255	39	0	0.000						X	FROM 1493.7
A	P	1502.5	Z3	1	255	39	0	0.000							FROM 1493.7
A	P	1506.8	Z3	1	255	39	0	0.000							FROM 1493.7
A	P	1510.7	Z3	1	255	39	0	0.000							FROM 1493.7
A	P	1514.9	Z3	1	255	39	0	0.000							FROM 1493.7
A	P	1536.0	Z4	1	22	67	0	0.200	KL	FE	CY				
A	P	1540.0	Z4	1	32	71	73	0.020	KL	FE	CY				
A	P	1602.3	Z5	3	220	10	9	0.070	KL	KA	FL				
A	P	1602.3	Z5	1	34	82	36	0.030	KL	CY					3dm WIDE
A	P	1602.3	Z5	2	38	93	16	0.070	KL	EP	FL				
A	P	1602.3	Z5	4	320	80	181	0.070	KL	KA					
A	P	1608.2	Z5	1	38	82	0	0.000							FROM 1602.30
A	P	1750.3	Z6	1	38	25	0	0.100	CY	KL				X	
A	P	1750.3	Z6	2	64	20	0	0.030	KL						
A	P	1750.3	Z6	5	215	55	7	0.100	KL	KA					
A	P	1750.3	Z6	4	34	32	2	0.100	KA	KL					
A	P	1750.3	Z6	3	356	85	0	0.300	KA						
A	P	1754.3	Z6	1	38	25	4	0.075	KL	KA					STR
A	P	1758.9	Z6	1	38	25	10	0.050	KL	KA				X	STR, LEAK IN FRONT
A	P	1762.6	Z6	1	45	28	10	0.050	KL	KA				X	FROM 1758.9
A	P	1765.4	Z6	1	45	28	10	0.050	KL	OX					STR

A	P	1770.2	Z6	1	45	28	12	0.040	KL	CY	KA					12 fr/0.5m
A	P	1770.2	Z7	1	325	88	9	0.050	KL	CY	KA				X	9 fr/0.4m
A	P	1774.0	Z6	1	45	28	9	0.070	KL						X	STR
A	P	1776.5	Z6	1	45	28	8	0.040	KL	KA					X	STR
A	P	1780.8	Z6	2	258	55	8	0.110	KL							8 fr/1.0m
A	P	1780.8	Z6	1	45	28	12	0.040	KL	OX						12 fr/0.5m
A	P	1784.8	Z6	1	45	28	10	0.050	KL							10fr/0.5m
A	P	1789.4	Z6	1	45	28	10	0.050	KL							
A	P	1793.6	Z6	1	45	28	8	0.040	KL							
A	P	1797.6	Z6	1	45	28	8	0.040	KL							FROM 1793.6
A	P	1802.0	Z6	1	45	28	8	0.040	KL							FROM 1793.6
A	P	1806.4	Z6	1	45	28	8	0.040	KL							FROM 1802.0
A	P	1810.9	Z6	1	45	28	1	0.000	KL							
A	P	1814.9	Z6	1	45	28	1	0.000	KL							FROM 1810.9
A	P	1819.3	Z6	1	45	28	1	0.000	KL						X	FROM 1814.9
A	P	1823.4	Z6	1	45	28	1	0.000	KL						X	FROM 1819.3
A	P	1827.5	Z6	1	45	28	1	0.000	KL							FROM 1823.4
A	P	1831.5	Z8	1	359	74	7	0.090	KA	KL	OX				X	7st/80cm
A	P	1831.5	Z8	1	45	28	0	0.000								FROM 1827.5
A	P	1838.0	Z8	1	24	24	12	0.015	KL	PR	QZ					PARTLY DETECTABLE
A	P	1840.4	Z8	1	18	18	9	0.080	KA	KL					X	
A	P	1845.0	Z7	1	11	68	0	0.200	CY	KL	KA				X	
A	P	1845.0	Z8	1	18	18	0	0.000								
A	P	1848.4	Z8	1	40	20	5	0.050	KL							
A	P	1848.4	Z7	1	15	70	50	0.040	QZ	KL	KA				X	
A	P	1848.4	Z7	2	288	68	7	0.050	KL							
A	P	1852.9	Z7	1	15	70	15	0.040	QZ	KL	KA					
A	P	1852.9	Z8	1	40	20	5	0.050	KL							5 fr/0.2m
A	P	1876.4	Z8	1	110	84	10	0.020	EP	IJ	RF	KL			X	
A	P	1880.3	Z8	1	110	80	9	0.080	KL	KA	CY				X	
A	P	1979.4	Z9	0	288	88	0	0.000	KL	KA	OX				X	
A	P	1984.1	Z9	1	290	85	10	0.040	KL	KA	OX				X	LINEATION 280/0
A	P	1988.6	Z9	1	290	85	10	0.040	KL	KA	OX				X	
A	P	1992.2	Z9	1	109	88	15	0.020	KL	MY	KA				X	
A	P	1997.0	Z9	1	109	88	15	0.020	KL	MY	KA				X	
A	P	2001.3	Z9	1	100	85	9	0.125	KL	KA	EP	IJ			X	SAMPLE
A	P	2001.3	Z9	2	322	78	8	0.130	KA	OX						
A	P	2001.3	Z9	3	280	49	5	0.125	KL	KA	IJ					
A	P	2005.4	Z9	1	110	85	9	0.125	KL	KA	OX				X	
A	P	2013.4	Z0	1	322	70	12	0.180	KL						X	
A	P	2013.4	Z0	2	36	77	10	0.130	KL							
A	P	2018.1	Z1	1	335	80	7	0.130	KL	KA	CY	IJ			X	GROUTED, PTLY CRUSH
A	P	2018.1	Z0	1	0	0	0	0.000	KL						X	OREGELBUNDEN

A	P	2023.4	Z0	5	16	75	3	0.500	KA	KL						
A	P	2023.4	Z0	3	140	88	5	0.120	KL							
A	P	2023.4	Z0	4	138	77	3	0.150	KL	IJ						
A	P	2023.4	Z0	2	230	85	4	0.700	KA	KL						
A	P	2023.4	Z1	1	335	80	7	0.130	KL	KA	CY	IJ		X		
A	P	2026.5	Z0	1	308	79	7	0.100	KL	IJ						
A	P	2026.5	Z0	3	325	8	7	0.250	KL					X	WATER REPRESENTS Z1	
A	P	2026.5	Z1	1	154	83	18	0.080	KL	IJ						
A	P	2026.5	Z0	2	245	75	10	0.220	KL					X	WATER REPRESENTS Z0	
A	P	2030.5	Z0	1	320	86	4	0.300	KL	FE				X	WATER REPRESENTS Z1	
A	P	2030.5	Z1	1	342	72	7	0.065	IJ	KL	FE	CY				
A	P	2030.5	Z0	2	55	63	6	0.240	FE	KL						
A	P	2034.6	Z2	2	146	80	4	0.100	KL							
A	P	2034.6	Z2	1	328	65	12	0.050	KL						FROM 2030.5	
A	P	2034.6	Z0	1	320	86	0	0.000								
A	P	2039.0	Z2	2	345	65	3	0.500	KA	KL				X		
A	P	2039.0	Z2	1	9	85	7	0.200	KL							
A	P	2043.0	Z2	3	112	84	14	0.140	KL							
A	P	2043.0	Z2	2	17	68	6	0.080	KL					X		
A	P	2043.0	Z2	1	153	87	22	0.070	KL							
A	P	2047.0	Z2	2	335	82	7	0.090	KL	KA						
A	P	2047.0	Z2	3	113	88	5	0.200	KL							
A	P	2047.0	Z2	4	131	84	8	0.025	KL							
A	P	2047.0	Z2	5	340	88	16	0.050	KL							
A	P	2047.0	Z2	6	33	67	10	0.200	KL					X		
A	P	2047.0	Z2	1	313	86	4	0.380	KL	KA				X		
A	P	2051.5	Z2	1	112	90	6	0.830	KL	KA						
A	P	2051.5	Z2	5	136	88	7	1.000	KL							
A	P	2051.5	Z2	3	184	54	5	0.100	KL							
A	P	2051.5	Z2	7	292	78	17	0.030	KL							
A	P	2051.5	Z2	2	325	74	12	0.125	KA	KL						
A	P	2051.5	Z2	8	129	88	7	0.070	KL							
A	P	2051.5	Z2	4	261	69	6	0.170	KL							
A	P	2051.5	Z2	6	355	88	10	0.100	KL							
A	P	2055.4	Z2	6	50	80	5	0.120	KL							
A	P	2055.4	Z2	3	347	78	5	0.300	KL							
A	P	2055.4	Z2	4	257	54	4	0.050	KL							
A	P	2055.4	Z2	5	188	14	6	0.080						X		
A	P	2055.4	Z2	1	134	86	40	0.080	KL							
A	P	2055.4	Z2	2	118	83	7	0.140	KL							
A	P	2058.7	Z2	1	309	86	17	0.030	KA	KL						
A	P	2061.0	Z2	1												
A	P	2116.6	Z3	1	355	80	5	0.100	KA	KL	IJ	EP		X	1 FRACT. 1 DM WIDE	

A	P	2116.6	Z3	2	310	89	7	0.300	KL	KA						
A	P	2116.6	Z3	3	128	80	11	0.200	KL	KA						
A	P	2120.6	Z3	1	340	80	6	0.300	KL	KA						
A	P	2120.6	Z3	2	27	62	18	0.180	KL							
A	P	2120.6	Z3	3	195	60	5	0.330	KL							
A	P	2120.6	Z3	4	26	24	3	0.500	KL							
A	P	2120.6	Z3	5	294	88	4	0.670	KL							
A	P	2125.0	Z3	1	190	90	3	0.500	KL	CY						
A	P	2129.5	Z3	1	334	88	10	0.150	IJ	KA	KL					
A	P	2133.7	Z3	1	356	80	15	0.130	KL	KA	IJ	CY		X		
A	P	2138.1	Z3	1	150	87	8	0.250	KL	KA	CY					
A	P	2141.9	Z4	1	37	82	13	0.150	KL	KA						
A	P	2141.9	Z4	2	310	80	6	0.400	KA							
A	P	2141.9	Z4	3	340	8	2	1.250	KL							
A	P	2141.9	Z4	4	335	69	2	0.200	KA							
A	P	2141.9	Z4	5	136	72	7	0.070	FL	KA						
A	P	2141.9	Z4	6	108	82	3	0.170	KL							
A	P	2141.9	Z4	7	150	58	11	0.090	KL							
A	P	2141.9	Z4	8	249	82	5	0.100	KL	KA						
A	P	2141.9	Z4	9	325	88	4	0.130	EP							
A	P	2141.9	Z4	10	135	78	3	0.270	KA							
A	P	2146.2	Z4	1	300	84	7	0.140	KA	KL						
A	P	2146.2	Z4	2	50	90	3	0.170	KL	KA						
A	P	2146.2	Z4	3	10	70	3	0.170	KL	KA						
A	P	2146.2	Z4	4	305	82	4	0.250	KL							
A	P	2146.2	Z4	5	60	90	4	0.750	KA							
A	P	2146.2	Z4	6	290	85	4	0.250	KL							
A	P	2146.2	Z4	7	300	76	4	0.180	KL							
A	P	2146.2	Z4	8	130	60	6	0.067	KL							
A	P	2146.2	Z4	9	302	78	1	0.000	EP							
A	P	2218.3	Z5	1	130	45	8	0.190	KL							
A	P	2218.3	Z5	2	130	75	4	0.500	KL							
A	P	2218.3	Z5	3	50	85	11	0.180	KL							
A	P	2222.6	Z5	1	220	80	4	0.100	KL					X		
A	P	2222.6	Z5	2	327	78	4	0.120	KL							
A	P	2225.8	Z5	1	205	85	3	0.700	KL							
A	P	2225.8	Z5	2	210	85	3	1.000						X		
A	P	2230.6	Z5	1	125	80	4	0.250	IJ	KL	KA					
A	P	2230.6	Z5	2	200	70	4	0.120	KL							
A	P	2230.6	Z5	3	324	25	21	0.140	KL	KA						
A	P	2236.0	Z5	1	12	81	6	0.070	KL							
A	P	2236.0	Z5	2	310	86	5	0.060	KL							
A	P	2236.0	Z5	3	197	88	6	0.080	KL							

A	P	2236.0	Z5	4	159	28	4	0.200	KL	OX					
A	P	2236.0	Z5	5	142	32	10	0.200	KL					X	
A	P	2236.0	Z5	6	259	86	4	0.080	KL	KA					
A	P	2236.0	Z5	7	121	37	5	0.060	KL						
A	P	2239.4	Z5	1	210	88	17	0.150	KL						
A	P	2239.4	Z5	2	140	50	10	0.200	KL						
A	P	2239.4	Z5	3	100	60	8	0.420	KL						
A	P	2239.4	Z5	4	342	78	4	0.250	KA	KL					
A	P	2243.6	Z5	1	193	90	7	0.260	KL	KA					
A	P	2243.6	Z5	2	339	48	10	0.170	QZ	KL	KA				
A	P	2243.6	Z5	3	176	98	6	0.400	KL						
A	P	2243.3	Z5	4	140	62	8	0.430	KL						
A	P	2248.3	Z5	1	5	73	14	0.070	KL						
A	P	2248.3	Z5	2	37	83	3	0.160	KL						
A	P	2248.3	Z5	3	105	13	8	0.250	KL	KA					
A	P	2248.3	Z5	4	15	15	10	0.050	KL						
A	P	2248.3	Z5	5	306	70	2	0.150	KA	KL					
A	P	2248.3	Z5	6	194	67	5	0.140	KL						
A	P	2252.9	Z5	1	37	15	10	0.090	KA	KL					
A	P	2252.9	Z5	2	349	66	10	0.200	KA	KL					
A	P	2252.9	Z5	3	66	90	13	0.190	KL						
A	P	2252.9	Z5	4	129	67	30	0.050	KL						
A	P	2256.8	Z5	1	273	50	5	0.100	KL						
A	P	2256.8	Z5	2	230	90	5	0.080	KL						
A	P	2260.5	Z5	1	315	68	8	0.080	KL						
A	P	2428.7	Z6	1	333	86	5	0.100	MY	KA	KL	EP		X	STRI-333/08
A	P	2428.7	Z6	2	354	78	2	0.250	KL	EP	KA			X	
A	P	2432.5	Z6	1	333	86	5	0.100	MY	KA	KL	EP		X	STRI-333/08
A	P	2432.5	Z6	2	354	78	2	0.250	KL	EP	KA			X	
A	P	2436.5	Z6	1	7	69	2	0.100	KL	IJ	KA			X	
A	P	2436.5	Z6	2	348	82	2	0.150	CY	IJ	KL			X	

TUNNEL	PART	SECTION	ZONE_ID	ROCK_ID	TYPE	WIDTH	LENGTH	STRIKE	DIP	ALTERATION	REMARK
A	P	1402.9	Z8	B1	3	0.30	2.90	22	38	1	
A	P	1407.2	Z9	B1	3	0.60	1.20	89	73	2	FROM 1411.7
A	P	1411.7	Z9	B1	3	4.50	4.50	89	73	2	
A	P	1416.0	Z0	B0	2	0.80	1.10	71	76	3	
A	P	1416.0	Z9	B1	3	3.40	4.30	89	73	2	FROM 1411.7
A	P	1420.6	Z0	B0	2	0.70	1.10	71	76	3	FROM 1416.0
A	P	1420.6	Z9	B1	3	3.60	4.60	89	73	2	FROM 1411.7
A	P	1424.7	Z9	B1	3	1.00	2.10	89	73	2	FROM 1411.7
A	P	1477.1	Z1	B4	2	2.00	2.20	260	45	2	FROM 1481.20
A	P	1481.2	Z1	B4	2	2.40	4.10	260	45	2	
A	P	1485.4	Z1	B4	2	1.20	4.20	260	45	2	FROM 1481.2
A	P	1485.4	Z2	B1	2	0.50	4.20	262	52	3	FROM 1489.2
A	P	1489.2	Z2	B1	2	0.50	3.80	262	52	3	
A	P	1493.7	Z3	B3	2	5.80	4.50	255	39	2	
A	P	1498.1	Z3	B3	2	7.40	4.40	255	39	2	FROM 1493.7
A	P	1502.5	Z3	B3	2	7.40	4.40	255	39	2	FROM 1493.7
A	P	1506.8	Z3	B3	2	6.30	4.30	255	39	2	FROM 1493.7
A	P	1510.7	Z3	B3	2	5.60	3.90	255	39	2	FROM 1493.7
A	P	1514.9	Z3	B3	2	3.00	4.20	255	39	2	FROM 1493.7
A	P	1536.0	Z4	B3	2	0.25	0.60	22	67	4	
A	P	1540.0	Z4	B3	2	1.70	4.00	32	71	2	
A	P	1602.3	Z5	B3	2	1.20	1.20	36	82	3	
A	P	1606.2	Z5	B3	2	1.00	1.00	36	82	3	FROM 1602.3
A	P	1750.3	Z6	B1	3	1.00	3.90	36	25	4	0.1m claycrush horiz
A	P	1754.3	Z6	B1	2	0.30	4.00	36	25	4	STR
A	P	1758.9	Z6	B1	3	0.50	4.60	45	28	4	
A	P	1762.6	Z6	B1	3	0.70	3.70	45	28	4	FROM 1750.3, 1758.9
A	P	1765.4	Z6	B1	2	0.05	2.80	45	28	3	STR
A	P	1770.2	Z7	B1	2	0.40	0.40	325	88	3	
A	P	1770.2	Z6	B1	2	0.40	4.80	45	28	3	
A	P	1774.0	Z6	B1	2	0.60	3.80	45	28	3	also B0
A	P	1776.5	Z6	B1	2	0.30	2.50	45	28	3	also B0
A	P	1780.8	Z6	B1	2	0.50	4.30	45	28	3	also B0
A	P	1784.8	Z6	B0	2	0.50	4.00	45	28	3	also B1
A	P	1789.4	Z6	B0	2	0.60	4.60	45	28	3	also B1
A	P	1793.6	Z6	B1	2	0.50	4.20	45	28	3	also B3
A	P	1797.6	Z6	B0	2	0.50	4.00	45	28	3	also B3
A	P	1802.0	Z6	B0	2	0.50	4.40	45	28	3	
A	P	1806.4	Z6	B0	2	0.50	4.40	45	28	3	
A	P	1810.9	Z6	B0	2	0.50	4.50	45	28	3	MAINLY 1 FRAC
A	P	1814.9	Z6	B0	2	0.50	4.00	45	28	3	
A	P	1819.3	Z6	B0	2	0.50	4.40	45	28	3	

A	P	1823.4	Z6	B0	2	0.50	4.10	45	28	3	SINGLE FRACTURE
A	P	1827.5	Z6	B0	2	0.50	4.10	45	28	3	
A	P	1831.5	Z6	B0	2	0.80	3.75	359	74	2	
A	P	1831.5	Z6	B0	2	0.50	4.00	45	28	3	
A	P	1836.0	Z6	B0	2	0.40	4.50	24	24	3	also B3
A	P	1840.4	Z6	B0	2	0.50	4.40	18	18	3	9 fr/0.5m, also B3
A	P	1845.0	Z7	B3	2	1.00	3.00	11	68	4	also B1
A	P	1845.0	Z6	B0	2	0.50	4.60	18	18	3	
A	P	1848.4	Z6	B3	2	0.20	3.40	40	20	3	also B6
A	P	1848.4	Z7	B6	2	2.50	3.40	15	70	4	50fr/2.5m, also B3
A	P	1852.9	Z6	B3	2	0.20	1.00	40	20	3	also B6
A	P	1852.9	Z7	B6	2	0.75	1.20	15	70	4	
A	P	1876.4	Z8	B1	2	0.20	4.50	110	84	3	
A	P	1880.3	Z8	B1	2	0.70	2.00	110	80	3	
A	P	1979.4	Z9	B1	2	0.20	1.00	288	88	3	
A	P	1984.1	Z9	B1	2	0.40	4.70	290	85	3	
A	P	1988.6	Z9	B1	2	0.40	4.50	290	85	3	
A	P	1992.2	Z9	B1	2	0.30	3.60	109	88	3	
A	P	1997.0	Z9	B1	2	0.30	4.80	109	88	3	
A	P	2001.3	Z9	B1	1	1.00	4.30	100	85	3	
A	P	2005.4	Z9	B1	1	1.00	3.30	110	85	3	
A	P	2013.4	Z0	B2	1	2.00	3.90	322	70	2	
A	P	2018.1	Z0	B2	3	5.00	4.60	322	70	2	
A	P	2018.1	Z1	B1	2	0.80	3.00	335	80	4	PARTLY CRUSHED
A	P	2023.4	Z1	B2	2	0.80	5.30	335	80	4	PARTLY CRUSHED
A	P	2023.4	Z0	B2	3	5.00	5.30	322	70	2	
A	P	2028.5	Z1	B1	2	1.00	3.10	154	83	4	
A	P	2028.5	Z0	B1	1	1.00	1.80	320	86	2	
A	P	2030.5	Z0	B1	1	1.10	4.00	320	88	2	WATER
A	P	2030.5	Z1	B1	2	0.40	4.00	342	72	4	WATER
A	P	2034.8	Z0	B1	1	1.20	1.50	320	88	2	FROM 2030.5
A	P	2034.8	Z2	B3	3	2.20	4.10	60	60	1	
A	P	2039.0	Z2	B3	3	4.80	4.80	60	60	1	
A	P	2043.0	Z2	B3	2	4.00	4.00	60	60	2	
A	P	2047.0	Z2	B3	3	4.00	4.00	60	60	1	ORIENTATION NOT DEF.
A	P	2051.5	Z2	B3	3	4.50	4.50	60	60	1	
A	P	2055.4	Z2	B3	2	3.90	3.90	60	60	2	
A	P	2058.7	Z2	B3	2	3.30	3.30	60	60	1	
A	P	2061.0	Z2	B3	2	0.40	4.00	60	60	1	
A	P	2116.6	Z3	B4	2	2.20	3.00	355	80	3	BRITTLE ZONE
A	P	2120.6	Z3	B4	1	2.20	4.00	345	80	2	
A	P	2125.0	Z3	B4	2	1.00	4.40	350	88	2	
A	P	2129.5	Z3	B4	2	1.50	4.50	350	88	2	

A	P	2133.7	Z3	B4	2	2.00	4.20	355	80	2	
A	P	2138.1	Z3	B4	2	2.00	4.20	355	80	2	
A	P	2141.9	Z4	B3	1	4.00	5.00	254	38	2	
A	P	2146.2	Z4	B3	1	4.00	4.20	254	38	2	
A	P	2218.3	Z5	B3	2	2.00	2.00	275	85	1	
A	P	2222.6	Z5	B3	2	4.30	4.30	275	85	1	
A	P	2225.8	Z5	B3	2	3.20	3.20	275	85	1	
A	P	2230.6	Z5	B3	2	4.80	4.80	275	85	1	
A	P	2236.0	Z5	B3	2	5.40	5.40	275	85	1	
A	P	2239.4	Z5	B3	2	3.40	3.40	275	85	1	
A	P	2243.6	Z5	B3	2	4.20	4.20	275	85	1	
A	P	2248.3	Z5	B3	1	4.70	4.70	275	85	1	
A	P	2252.9	Z5	B3	2	4.50	4.50	275	85	1	
A	P	2256.8	Z5	B3	3	2.00	3.70	275	85	1	
A	P	2260.5	Z5	B3	2	0.20	0.50	275	85	1	
A	P	2428.7	Z6	B1	2	0.50	1.50	333	86	3	
A	P	2432.5	Z6	B1	2	0.50	3.80	345	83	3	
A	P	2436.5	Z6	B1	2	0.30	1.50	336	85	2	

Appendix B-5

AREACODE	IDCODE	LENGTH	ROCKTYPE	QUANTITY	REMARK
AL	SA1420A	0,0	PSF	0,000	
AL	SA1420A	11,5		0,200	ESTIMATED FLOW
AL	SA1420A	22,0		3,000	ESTIMATED FLOW
AL	SA1420A	29,0		8,000	ESTIMATED FLOW
AL	SA1420A	35,0		20,400	MEASURED IN HOLE
AL	SA1420A	44,0		27,000	MEASURED IN HOLE
AL	SA1420A	50,0	PSF	33,700	END MEASURED IN SECTION
AL	SA1420B	0,0	PSF	0,000	
AL	SA1420B	10,5		9,000	ESTIMATED FLOW
AL	SA1420B	13,5		15,000	MEASURED IN HOLE
AL	SA1420B	50,0	PSF	16,400	END MEASURED IN SECTION
AL	SA1464A	0,0	PSF	0,000	
AL	SA1464A	10,5		0,100	ESTIMATED FLOW
AL	SA1464A	17,5	HSC	0,100	ESTIMATED FLOW
AL	SA1464A	19,6	HSC	0,090	END MEASURED IN SECTION
AL	SA1464B	0,0	PSF	0,000	
AL	SA1464B	19,9	PSF	0,079	END MEASURED IN SECTION
AL	SA1481A	0,0	HSC	0,000	
AL	SA1481A	2,5	PSF	0,000	
AL	SA1481A	4,0	HSC	0,000	
AL	SA1481A	10,0	PSF	0,000	
AL	SA1481A	15,0	HSC	0,000	
AL	SA1481A	15,5	PSF	0,000	
AL	SA1481A	19,8	PSF	0,086	MEASURED IN SECTION, END
AL	SA1481B	0,0	PSF	0,000	
AL	SA1481B	6,0	HSC	0,000	
AL	SA1481B	7,0	PSF	0,000	
AL	SA1481B	9,0	HSC	0,000	
AL	SA1481B	13,0	PSF	0,000	
AL	SA1481B	19,8	PSF	0,104	MEASURED IN SECTION, END
AL	SA1498A	0,0	HSC	0,000	
AL	SA1498A	6,0		0,085	END
AL	SA1498B	0,0	HSC	0,000	
AL	SA1498B	4,0	PSF	0,000	
AL	SA1498B	20,0	PSF	0,000	Q=0.0002l/min MEAS IN SECT.
AL	SA1514A	0,0	PSF	0,000	
AL	SA1514A	8,0		1,000	ESTIMATED IN HOLE
AL	SA1514A	19,9	PSF	0,023	MEASURED IN SECTION, END
AL	SA1514B	0,0	PSF	0,000	
AL	SA1514B	1,5	HSC	0,000	
AL	SA1514B	4,0	HSC	0,000	
AL	SA1514B	11,0	PSF	0,002	Q=0,0018l/min M AFTER DRILL
AL	SA1514B	20,0	PSF	0,002	END
AL	SA1532A	0,0	PSF	0,000	
AL	SA1532A	3,0	HSC	0,000	
AL	SA1532A	5,0	PSF	0,000	
AL	SA1532A	20,3	PSF	0,000	END,Q=0.0004l/min MEAS IN SECT
AL	SA1532B	0,0	PSF	0,000	
AL	SA1532B	3,0	HSC	0,000	
AL	SA1532B	7,0	PSF	0,000	
AL	SA1532B	20,0	PSF	0,001	END, MEASURED IN SECTION
AL	SA1549A	0,0	PSF	0,000	
AL	SA1549A	2,0	HSC	0,000	
AL	SA1549A	3,0	PSF	0,000	
AL	SA1549A	20,0	PSF	0,000	NO FLOW, END
AL	SA1549B	0,0	PSF	0,000	
AL	SA1549B	14,5	HSC	0,000	
AL	SA1549B	15,0	PSF	0,000	
AL	SA1549B	14,0		0,150	ESTIMATED FLOW
AL	SA1549B	20,0	PSF	0,052	END MEASURED IN SECTION
AL	SA1564A	0,0	PSF	0,000	
AL	SA1564A	11,0		0,290	MEASURED IN SECTION
AL	SA1564A	19,9	PSF	0,290	END
AL	SA1564B	0,0	PSF	0,000	
AL	SA1564B	13,5		20,000	ESTIMATED
AL	SA1564B	16,0		30,000	ESTIMATED, CLAY

AL	SA1564B	19,9	PSF	21,600	MEASURED IN SECTION, END
AL	SA1581A	0,0	PSF	0,000	
	SA1581A	7,0		27,600	MEASURED IN SECTION
	SA1581A	18,0	HSC	27,600	
AL	SA1581A	19,0	PSF	27,600	
AL	SA1581A	19,5	HSC	27,600	
AL	SA1581A	20,1	HSC	27,600	END
AL	SA1581B	0,0	PSF	0,000	
AL	SA1581B	10,0		0,042	MEASURED IN SECTION
AL	SA1581B	11,0	VB	0,042	
AL	SA1581B	19,0	VB	0,042	END
AL	SA1597A	0,0	PSF	0,000	
AL	SA1597A	0,5	HSC	0,000	
AL	SA1597A	4,5	PSF	0,000	
AL	SA1597A	11,0		0,840	MEASURED IN SECTION
AL	SA1597B	0,0	VB	0,000	
AL	SA1597B	1,0	PSF	0,000	
AL	SA1597B	4,0	HSC	0,000	
AL	SA1597B	4,5	PSF	0,000	
AL	SA1597B	14,0		0,535	MEASURED IN SECTION
AL	SA1597B	20,0	PSF	0,535	END
AL	SA1614A	0,0	VB	0,000	
AL	SA1614A	1,0	PSF	0,000	
AL	SA1614A	2,0	VB	0,000	
AL	SA1614A	3,0	PSF	0,000	
AL	SA1614A	5,5	VB	0,000	
AL	SA1614A	9,5	PSF	0,000	
AL	SA1614A	11,0	VB	0,000	
AL	SA1614A	12,0	PSF	0,000	
AL	SA1614A	14,0	HSC	0,000	
AL	SA1614A	14,5	PSF	0,000	
AL	SA1614A	18,0	VB	0,000	
	SA1614A	20,4	VB	0,000	NO FLOW
AL	SA1614B	0,0	PSF	0,000	
AL	SA1614B	7,0		5,300	MEASURED IN SECTION
AL	SA1614B	19,3	PSF	5,300	END
AL	SA1629A	0,0	PSF	0,000	
AL	SA1629A	4,5	HSC	0,000	
AL	SA1629A	5,0	PSF	0,000	
AL	SA1629A	10,0	HSC	0,000	
AL	SA1629A	10,5	PSF	0,000	
AL	SA1629A	11,5	HSC	0,000	
AL	SA1629A	12,0	PSF	0,000	
AL	SA1629A	16,0	VB	0,000	
AL	SA1629A	20,4	VB	0,001	MEASURED IN SECTION
AL	SA1629B	0,0	PSF	0,000	
AL	SA1629B	13,5		2,730	MEASURED IN SECTION
AL	SA1629B	11,0	HSC	0,000	
AL	SA1629B	12,0	PSF	0,000	
AL	SA1629B	12,5	HSC	0,000	
AL	SA1629B	13,0	PSF	0,000	
AL	SA1629B	14,0	HSC	2,730	
AL	SA1629B	16,0	PSF	2,730	
AL	SA1629B	19,4	PSF	2,730	END
AL	SA1643A	0,0	VB	0,000	VB,APLIT VEINS
AL	SA1643A	20,0	VB	0,048	MEASURED IN SECTION
AL	SA1643B	0,0	HSC	0,000	
AL	SA1643B	1,0	VB	0,000	
AL	SA1643B	11,5		0,100	ESTIMATED
AL	SA1643B	13,0		8,000	ESTIMATED
AL	SA1643B	20,2		8,400	END MEASURED IN SECTION
	SA1664A	0,0	PSF	0,000	
AL	SA1664A	20,0	PSF	0,010	MEASURED IN SECTION, END
AL	SA1664B	0,0	PSF	0,000	
AL	SA1664B	0,5	HSC	0,000	
AL	SA1664B	1,5	PSE	0,000	
AL	SA1664B	14,0	VB	0,000	

AL	SA1664B	16,0	PSF	0,000	
AL	SA1664B	18,0	VB	0,000	
	SA1664B	20,3	VB	0,000	END
	SA1680A	0,0	HSC	0,000	
AL	SA1680A	1,5	VB	0,000	
AL	SA1680A	8,5	PSF	0,000	
AL	SA1680A	11,5		66,600	MEASURED IN HOLE
AL	SA1680A	16,0	PSF	66,600	MEASURED IN SECTION
AL	SA1680B	0,0	VB	0,000	
AL	SA1680B	7,0		10,800	MEASURED IN SECTION
AL	SA1680B	9,0	PSF	10,800	
AL	SA1680B	13,0	HSC	10,800	
AL	SA1680B	16,5	PSF	10,800	
AL	SA1680B	20,0	PSF	10,800	END
AL	SA1693F	0,0	VB	0,000	
AL	SA1693F	3,5	HSC	0,000	
AL	SA1693F	6,5	PSE	0,000	
AL	SA1693F	7,0		25,000	ESTIMATED
AL	SA1693F	7,5	HSC	0,000	
AL	SA1693F	10,0	PSE	0,000	
AL	SA1693F	32,8		150,000	ESTIMATED
AL	SA1693F	38,5	PSE	170,000	END MEASURED IN HOLE
AL	SA1696A	0,0	VB	0,000	
AL	SA1696A	3,5	HSC	0,000	
AL	SA1696A	7,0	PSE	0,000	
AL	SA1696A	20,2	PSE	0,071	MEASURED IN SECTION
AL	SA1696B	0,0	PSE	0,000	PARTLY OXIDIZED
AL	SA1696B	10,0		9,000	MEASURED IN SECTION
AL	SA1696B	19,1	PSE	9,000	END
AL	SA1713A	0,0	PSE	0,000	
AL	SA1713A	17,5		0,000	WATER FLOW?
AL	SA1713A	19,5		315,000	MEASURED IN HOLE, END
	SA1713B	0,0	PSE	0,000	
AL	SA1713B	10,0		5,240	MEASURED IN SECTION
AL	SA1713B	20,0	PSE	5,240	END
AL	SA1726F	0,0	PSE	0,000	
AL	SA1726F	5,0		0,500	ESTIMATED
AL	SA1726F	8,5		10,000	ESTIMATED
AL	SA1726F	11,5		20,000	ESTIMATED
AL	SA1726F	19,5	VB	20,000	
AL	SA1726F	20,0		40,000	ESTIMATED
AL	SA1726F	24,0	PSF	40,000	
AL	SA1726F	26,5	PSF	80,000	ESTIMATED
AL	SA1726F	38,5	PSF	90,000	END MEASURED IN HOLE
AL	SA1730A	0,0	PSE	0,000	
AL	SA1730A	10,0		8,550	MEASURED IN SECTION
AL	SA1730A	10,0	PSF	8,550	
AL	SA1730A	20,0	PSF	8,550	END
AL	SA1731B	0,0	PSE	0,000	
AL	SA1731B	8,5	PSF	3,000	MEASURED IN SECTION
AL	SA1731B	19,2	PSF	3,000	END
AL	SA1742F	0,0	PSF	0,000	
AL	SA1742F	4,0		1,000	ESTIMATED
AL	SA1742F	32,0		5,000	ESTIMATED
AL	SA1742F	35,0		20,000	ESTIMATED
AL	SA1742F	41,1	PSF	35,000	MEASURED IN HOLE
AL	SA1746A	0,0	PSF	0,000	
AL	SA1746A	0,5	PSF	0,000	ZON, Z6
AL	SA1746A	2,0	PSF	0,000	PARTLY OXIDIZED
AL	SA1746A	8,0	PSF	0,000	
AL	SA1746A	19,9	PSF	0,002	MEASURED IN SECTION, END
	SA1746B	0,0	PSE	0,000	PARTLY OXIDIZED
AL	SA1746B	3,5	PSF	0,000	
AL	SA1746B	5,0	PSE	0,000	
AL	SA1746B	6,5	HSC	0,000	
AL	SA1746B	7,0	PSF	0,000	
AL	SA1746B	9,0	PSE	0,000	

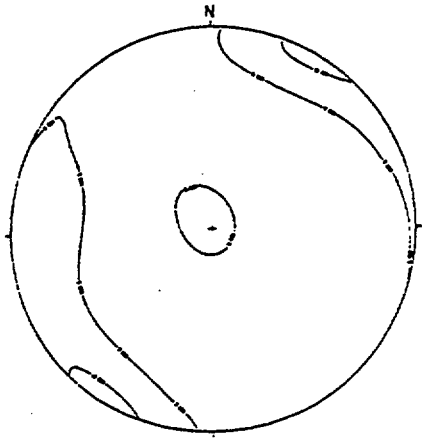
AL	SA1746B	9,0	PSE	3,500	MEASURED IN SECTION
AL	SA1746B	15,0	HSC	3,500	
AL	SA1746B	17,5	HSC	3,500	
[illegible]	SA1746B	19,9	PSE	3,500	END
AL	SA1759A	0,0	PSF	0,000	PARTLY OXIDIZED
AL	SA1759A	4,5	PSF	0,000	
AL	SA1759A	12,0		3,550	MEASURED IN SECTION
AL	SA1759A	20,4	PSF	3,550	END
AL	SA1759B	0,0	PSF	0,000	OXIDIZED
AL	SA1759B	3,5	HSC	0,000	
AL	SA1759B	6,0	PSE	0,000	
AL	SA1759B	20,2	PSE	0,450	MEASURED IN SECTION, END
AL	SA1777A	0,0	PSF	0,000	
AL	SA1777A	20,2	PSF	0,530	MEASURED IN SECTION, END
AL	SA1777B	0,0	PSE	0,000	
AL	SA1777B	5,5	HSC	0,000	
AL	SA1777B	6,5	PSE	0,000	
AL	SA1777B	19,8	PSE	0,102	MEASURED IN SECTION, END
AL	SA1794A	0,0	PSE	0,000	
AL	SA1794A	6,0	PSF	0,000	
AL	SA1794A	11,0	PSE	0,000	
AL	SA1794A	12,5	PSF	0,000	
AL	SA1794A	17,0	PSE	0,000	
AL	SA1794A	19,5	PSE	0,030	MEASURED IN SECTION, END
AL	SA1794B	0,0	PSE	0,000	
AL	SA1794B	19,8	PSE	0,000	NO FLOW AFTER DRILLING, END
AL	SA1815A	0,0	PSE	0,000	
AL	SA1815A	19,0	HSC	0,000	
AL	SA1815A	20,4	HSC	0,016	MEASURED IN SECTION, END
AL	SA1815B	0,0	PSE	0,000	
AL	SA1815B	10,0	HSC	0,000	
AL	SA1815B	10,5	PSE	0,000	
[illegible]	SA1815B	12,0	PSF	0,000	
[illegible]	SA1815B	12,5		0,186	MEASURED IN SECTION
AL	SA1815B	19,8		0,186	MEASURED AFTER DRILLING, END
AL	SA0694B	0,0	PSE	0,000	
AL	SA0694B	5,5	HSC	0,000	
AL	SA0694B	9,0		2,000	ESTIMATED
AL	SA0694B	11,0	PSE	0,000	
AL	SA0694B	29,5	PSE	6,700	MEASURED IN SECTION, 13.00
AL	SA0694B	29,5	PSE	3,900	MEAS IN SEC 15.53 STABEL, END
AL	SA0704B	0,0	PSE	0,000	
AL	SA0704B	10,0	HSC	0,000	
AL	SA0704B	11,0		1,000	ESTIMATED
AL	SA0704B	12,0	PSE	1,000	
AL	SA0704B	23,0		3,000	ESTIMATED
AL	SA0704B	24,5	HSC	3,000	
AL	SA0704B	26,5		3,000	ESTIMATED
AL	SA0704B	28,5	PSE	0,000	
AL	SA0704B	29,7	PSE	6,800	MEASURED IN SECTION,END
AL	SA0716B	0,0	PSE	0,000	
AL	SA0716B	29,3	PSE	0,006	MEASURED IN SECTION,END
AL	SA0760B	0,0	PSE	0,000	
AL	SA0760B	5,5		2,000	ESTIMATED
AL	SA0760B	14,5		3,000	ESTIMATED
AL	SA0760B	16,0		200,000	ESTIMATED
AL	SA0760B	29,2	PSE	253,000	MEASURED IN HOLE, END
AL	SA0762B	0,0	PSE	0,000	
AL	SA0762B	5,5		2,000	ESTIMATED
AL	SA0762B	8,5		3,000	ESTIMATED
AL	SA0762B	17,5		5,000	ESTIMATED
[illegible]	SA0762B	20,5		8,900	ESTIMATED
[illegible]	SA0762B	29,3	PSE	8,900	MEASURED IN SECTION END
AL	SA0764B	0,0	PSE	0,000	
AL	SA0764B	11,5		2,500	ESTIMATED
AL	SA0764B	12,5		3,500	ESTIMATED
AL	SA0764B	18,0		15,700	MEASURED IN HOLE

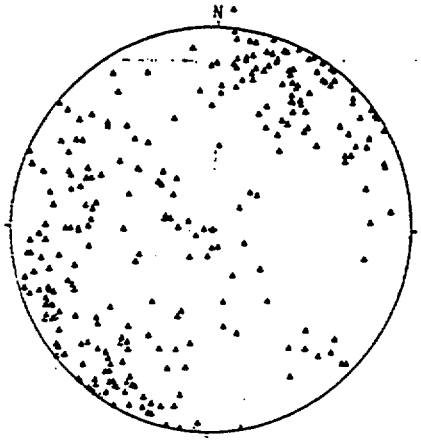
AL	SA0764B	24,0		225,000	ESTIMATED
AL	SA0764B	29,1	PSE	225,000	MEASURED IN HOLE END
	SA1498A	20,1	HSC	0,085	MEASURED AFTER DRILLING END
	SA0709B	20,0	PSE	0,000	END
AL	SA0776B	10,5		3,090	MEASURED IN SECTION
AL	SA0831A	17,0		20,000	ESTIMATED
AL	SA0976B	10,5		40,000	FLOW INCREASING
AL	SA0993B	12,5		411,000	MEASURED IN HOLE
AL	SA1145A	8,5		3,000	ESTIMATED
AL	SA1549B	5,0		0,100	ESTIMATED FLOW
AL	SA1597A	20,0	PSE	0,840	END
AL	SA1680A	7,0		10,000	ESTIMATED
AL	SA1828A	0,0	PSE	0,000	
AL	SA1828A	4,0	HSC	0,000	
AL	SA1828A	5,5	PSE	0,000	
AL	SA1828A	11,0		0,650	MEASURED IN SECTION
AL	SA1828A	20,0	PSE	0,650	END
AL	SA1828B	0,0	PSE	0,000	
AL	SA1828B	18,5		8,300	MEASURED IN SECTION
AL	SA1828B	20,0	PSE	8,300	END
AL	SA1844A	0,0	HSC	0,000	
AL	SA1844A	8,5	PSF	0,000	
AL	SA1844A	8,5		17,000	MEASURED IN SECTION
AL	SA1844A	19,9	PSF	17,000	END
AL	SA1844B	0,0	HSC	0,000	
AL	SA1844B	1,0	PSF	0,000	
AL	SA1844B	10,0		30,800	MEASURED IN SECTION
AL	SA1844B	20,0	PSF	30,800	END
AL	SA1861A	0,0	PSF	0,000	
AL	SA1861A	7,5		102,000	MEASURED IN SECTION
AL	SA1861A	20,2	PSF	102,000	END
AL	SA1861B	0,0	PSF	0,000	
	SA1861B	6,0	HSC	0,000	
AL	SA1861B	7,5	PSF	0,000	
AL	SA1861B	15,0	VB	0,000	
AL	SA1861B	20,0		9,000	MEASURED IN SECTION
AL	SA1877B	0,0	PSF	0,000	
AL	SA1877B	9,0	HSC	0,000	
AL	SA1877B	11,0		0,078	MEASURED IN SECTION
AL	SA1877B	19,8	PSF	0,078	END
AL	SA1893B	0,0	PSF	0,000	
AL	SA1893B	8,0		0,200	
AL	SA1893B	12,5	HSC	0,200	
AL	SA1893B	13,5	PSF	0,200	
AL	SA1893B	17,0		0,500	
AL	SA1893B	20,0	PSF	0,500	
AL	SA1893B	20,0	PSF	0,660	MEASURED IN SECTION, END
AL	SA1909A	0,0	PSF	0,000	
AL	SA1909A	19,2		0,120	MEASURED IN SECTION
AL	SA1909A	19,2	PSF	0,120	END
AL	SA1909B	0,0	PSF	0,000	
AL	SA1909B	2,0	HSC	0,000	
AL	SA1909B	2,5	HSC	0,000	
AL	SA1909B	19,5		0,017	
AL	SA1909B	19,5	PSF	0,017	END
AL	SA1920A	0,0	PSF	0,000	
AL	SA1920A	5,5	HSC	0,000	
AL	SA1920A	7,0	PSF	0,000	
AL	SA1920A	19,9		0,015	MEASURED IN SECTION
AL	SA1920A	19,9	PSF	0,015	END
AL	SA1920B	0,0	PSF	0,000	
	SA1920B	19,8		0,000	Q=0
AL	SA1920B	19,8	PSF	0,000	Q=0 , END
AL	SA1938A	0,0	PSF	0,000	
AL	SA1938A	19,6		0,000	Q=0
AL	SA1938A	19,6	PSF	0,000	Q=0 , END
AL	SA1938B	0,0	PSF	0,000	

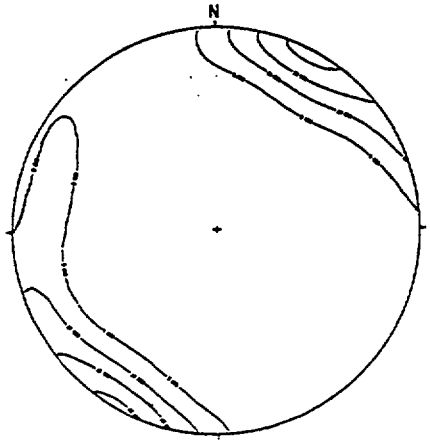
AL	SA1938B	19,8		0,760	MEASURED IN SECTION
AL	SA1938B	19,8	PSF	0,760	END
	SA1959A	0,0	PSF	0,000	
	SA1959A	12,5	HSC	0,000	
AL	SA1959A	13,5	PSF	0,000	
AL	SA1959A	20,1		0,001	MEASURED IN SECTION
AL	SA1959A	20,1	PSF	0,001	END
AL	SA1959B	0,0	PSF	0,000	
AL	SA1959B	8,0	HSC	0,000	
AL	SA1959B	9,5	PSF	0,000	
AL	SA1959B	19,9		0,005	MEASURED IN SECTION
AL	SA1959B	19,9	PSF	0,005	END
AL	SA1975A	0,0	PSF	0,000	
AL	SA1975A	19,7	PSF	0,018	MEASURED IN SECTION, END
AL	SA1975B	0,0	PSF	0,000	
AL	SA1975B	19,8	PSF	2,020	MEASURED IN SECTION, END
AL	SA1997A	0,0	PSF	0,000	
AL	SA1997A	8,5	HSC	0,000	
AL	SA1997A	13,5		57,000	MEASURED IN SECTION
AL	SA1997A	19,0	PSF	57,000	
AL	SA1997A	19,8	PSF	57,000	END
AL	SA1997B	0,0	HSC	0,000	
AL	SA1997B	4,0	PSF	0,000	
AL	SA1997B	19,1	PSF	0,001	MEASURED IN SECTION, END
AL	SA2009A	0,0	HSC	0,000	
AL	SA2009A	5,5	PSF	0,000	
AL	SA2009A	19,4	PSF	0,177	MEASURED IN SECTION, END
AL	SA2009B	0,0	PSF	0,000	
AL	SA2009B	19,5	PSF	0,098	MEASURED IN SECTION, END
AL	SA2025A	0,0	PSF	0,000	
AL	SA2025A	14,0		12,000	ESTIMATED
AL	SA2025A	17,0	HSC	65,000	ESTIMATED
	SA2025A	20,0	PSF	65,000	
	SA2025A	32,0		72,000	ESTIMATED
AL	SA2025A	40,4		72,600	MEASURED IN SECTION
AL	SA2025A	40,4	PSF	72,600	END
AL	SA2025B	0,0	PSF	0,000	
AL	SA2025B	6,5		20,200	MEASURED IN SECTION
AL	SA2025B	13,5	HSC	20,200	
AL	SA2025B	19,9	HSC	20,200	END
AL	HA1960A	0,0	PSF	0,000	
AL	HA1960A	26,0		4,000	ESTIMATED
AL	HA1960A	30,0		12,000	ESTIMATED
AL	HA1960A	32,0		13,200	MEASURED IN SECTION
AL	HA1960A	32,0	PSF	13,200	END
AL	SA2043B	0,0	HSC	0,000	
AL	SA2043B	6,0	PSF	0,000	
AL	SA2043B	11,5	PSF	0,000	
AL	SA2043B	20,5	PSE	0,002	MEASURED IN SECTION, END
AL	SA2058A	0,0	HSC	0,000	
AL	SA2058A	2,5	PSF	0,000	
AL	SA2058A	4,5	PSE	0,000	
AL	SA2058A	20,2	PSE	0,017	MEASURED IN SECTION, END
AL	SA2058B	0,0	PSF	0,000	
AL	SA2058B	3,5	PSE	0,000	
AL	SA2058B	14,0	PSE	1,440	MEASURED IN SECTION
AL	SA2058B	19,8	PSE	1,440	END
AL	SA2074A	0,0	PSE	0,000	
AL	SA2074A	38,7	PSE	0,265	MEASURED IN SECTION, END
AL	SA2074B	0,0	PSE	0,000	
AL	SA2074B	8,0		1,000	ESTIMATED
	SA2074B	15,0		450,000	ESTIMATED
	SA2074B	20,0	PSE	500,000	MEASURED FROM HOLE
AL	SA2074B	20,0	PSE	500,000	END
AL	SA2090A	0,0	PSF	0,000	
AL	SA2090A	3,5	PSE	0,000	
AL	SA2090A	9,0	PSF	0,000	

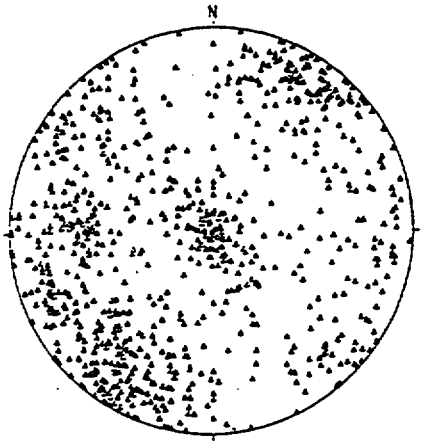
AL	SA2090A	14,0	PSE	0,001	
AL	SA2090A	20,5	PSE	0,001	MEASURED IN SECTION, END
AL	SA2090B	0,0	PSE	0,000	
AL	SA2090B	2,0	PSF	0,000	
AL	SA2090B	7,0	PSE	0,000	
AL	SA2090B	8,0	PSE	45,000	ESTIMATED
AL	SA2090B	11,0	PSE	150,000	ESTIMATED
AL	SA2090B	14,0	PSE	291,000	MEASURED FROM HOLE, END
AL	SA2109A	0,0	PSE	0,000	
AL	SA2109A	19,9	PSE	0,034	MEASURED IN SECTION, END
AL	SA2109B	0,0	PSE	0,000	
AL	SA2109B	5,0	PSE	4,000	ESTIMATED
AL	SA2109B	15,5	PSE	40,000	ESTIMATED
AL	SA2109B	19,9	PSE	43,000	MEASURED IN SECTION
AL	SA2130B	0,0	PSE	0,000	
AL	SA2130B	5,0	PSE	0,100	ESTIMATED
AL	SA2130B	8,0	PSE	3,000	ESTIMATED
AL	SA2130B	10,5	HSC	3,000	
AL	SA2130B	14,5	PSF	0,000	
AL	SA2130B	20,0	PSF	3,780	MEASURED IN SECTION, END
AL	SA2142A	0,0	HSC	0,000	
AL	SA2142A	1,5	PSF	0,000	
AL	SA2142A	10,0	HSC	0,000	
AL	SA2142A	10,5	PSF	0,000	
AL	SA2142A	16,5	PSF	3,000	ESTIMATED
AL	SA2142A	20,0	PSF	3,930	MEASURED IN SECTION, END
AL	SA2142B	0,0	HSC	0,000	
AL	SA2142B	2,5	PSF	0,000	
AL	SA2142B	8,0	PSF	5,000	ESTIMATED
AL	SA2142B	20,6	PSF	5,870	MEASURED IN SECTION, END
AL	SA2160A	0,0	PSF	0,000	
AL	SA2160A	0,5	HSC	0,000	
AL	SA2160A	2,5	PSF	0,000	
AL	SA2160A	11,0	PSF	0,100	ESTIMATED
AL	SA2160A	19,8	PSF	0,124	MEASURED IN SECTION, END
AL	SA2159B	0,0	PSF	0,000	
AL	SA2159B	3,5	HSB	0,000	
AL	SA2159B	4,0	PSF	0,000	
AL	SA2159B	8,0	PSF	1,000	ESTIMATED
AL	SA2159B	20,0	PSF	1,060	MEASURED IN SECTION, END
AL	SA2175A	0,0	PSF	0,000	
AL	SA2175A	20,3	PSF	0,038	MEASURED IN SECTION, END
AL	SA2175B	0,0	PSF	0,000	
AL	SA2175B	2,5	HSC	0,000	
AL	SA2175B	3,5	PSF	0,000	
AL	SA2175B	20,0	PSF	0,131	MEASURED IN SECTION, END
AL	SA2192A	0,0	PSF	0,000	
AL	SA2192A	19,6	PSF	3,000	MEASURED IN SECTION, END
AL	SA2192B	0,0	PSF	0,000	
AL	SA2192B	14,0	PSF	1,000	ESTIMATED
AL	SA2192B	17,0	PSF	3,000	ESTIMATED
AL	SA2192B	20,0	PSF	17,700	MEASURED IN SECTION, END
AL	SA2207A	20,0	PSF	0,000	
AL	SA2207A	4,5	HSC	0,000	
AL	SA2207A	19,0	PSF	0,000	
AL	SA2207A	20,1	PSF	0,053	MEASURED IN SECTION, END
AL	SA2207B	0,0	PSF	0,000	
AL	SA2207B	2,5	VB	0,000	
AL	SA2207B	5,5	PSF	0,000	
AL	SA2207B	19,9	PSF	0,159	MEASURED IN SECTION, END
AL	SA2222A	0,0		0,000	
AL	SA2222A	7,5		50,000	ESTIMATED
AL	SA2222A	12,0		55,600	MEASURED IN SECTION, END
AL	SA2222B	0,0	PSF	0,000	
AL	SA2222B	11,7	PSF	513,000	MEASURED IN HOLE
AL	SA2222B	12,0	PSF	513,000	END
AL	SA2240A	0,0	HSC	0,000	

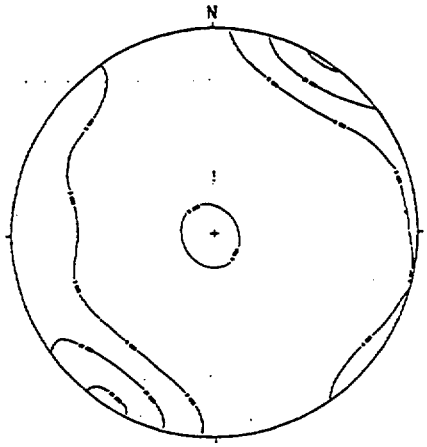
Appendix B-6

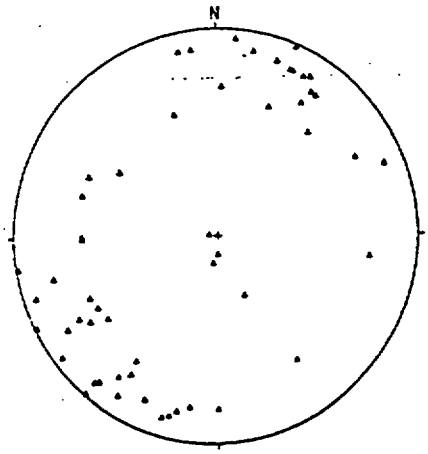


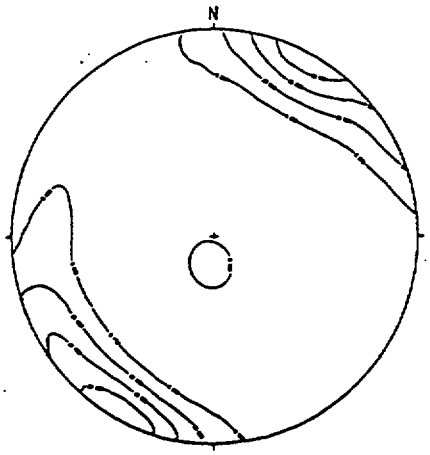






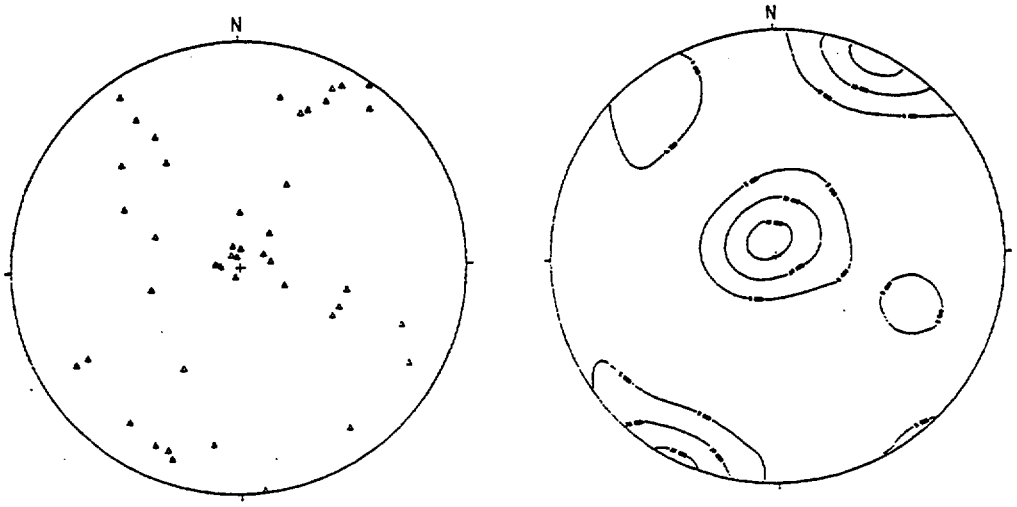




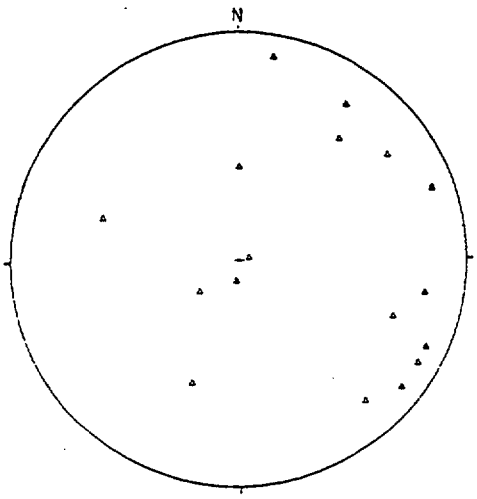


a-g:Stereo plots and contoured stereogramms of fracture plane poles.
a,b - all fractures sections 1400 to 2500, n= 4285; c,d - water conducting fractures, n= 287;
e,f - fractures with grout, n= 71; g,h - fractures of grouted sections, n= 878

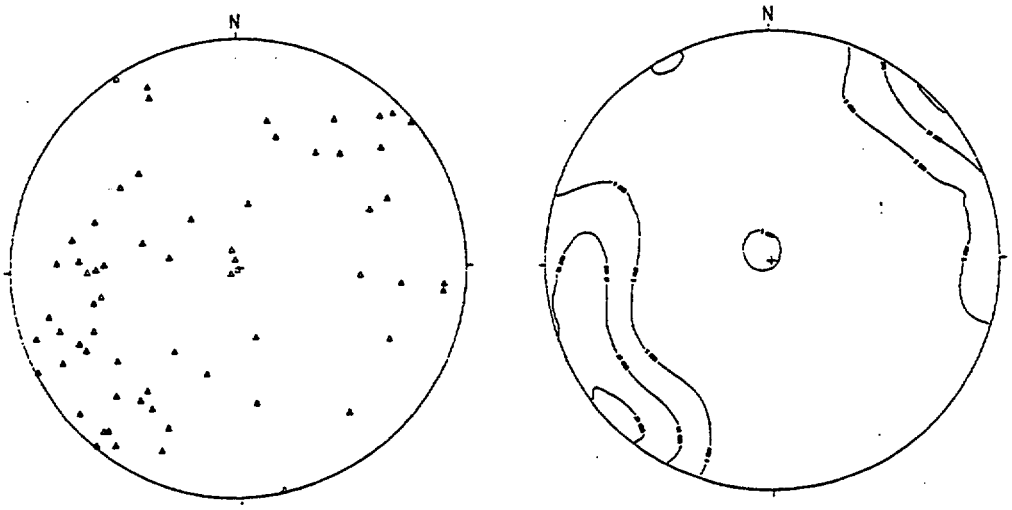
Appendix B-7



Grouted section 8
Spherical Gaussian Function
Number of Sample Points 45

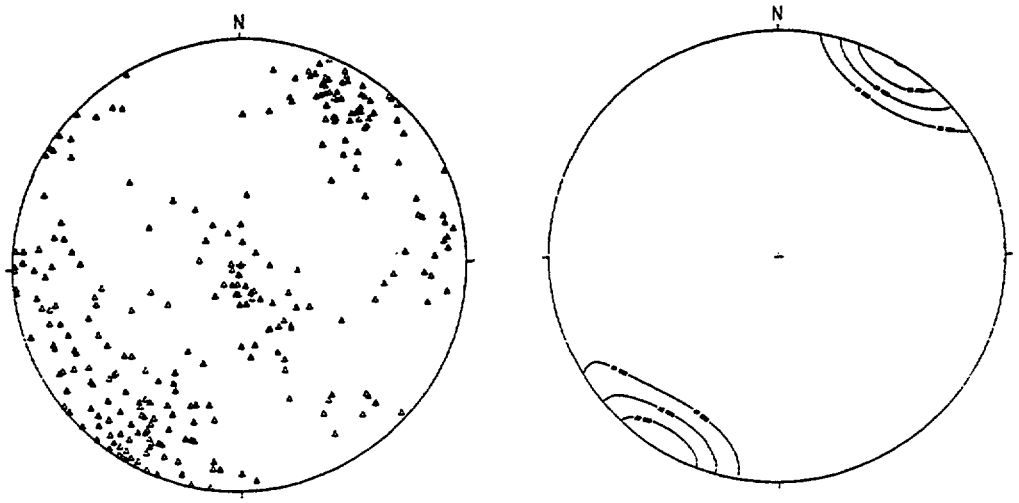


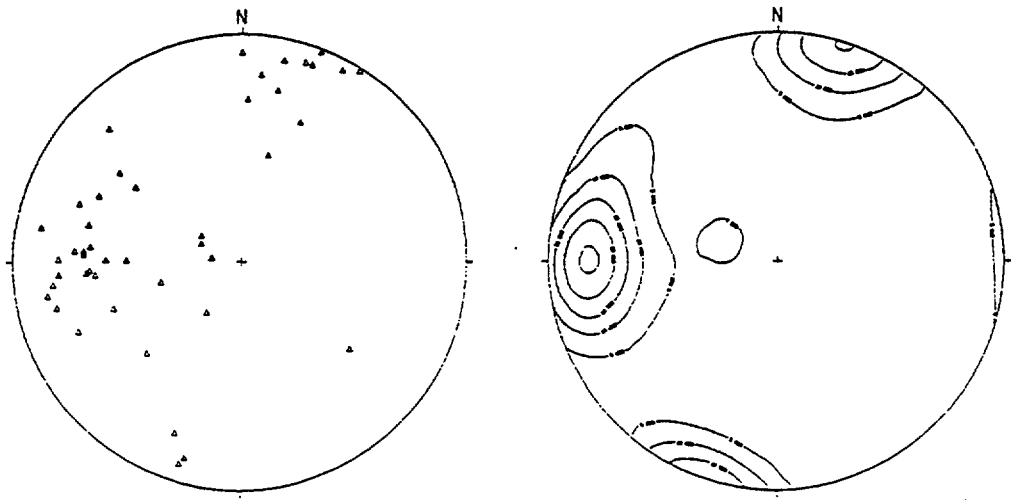
Grouted section 9
Projection Wulff
Number of Sample Points 18

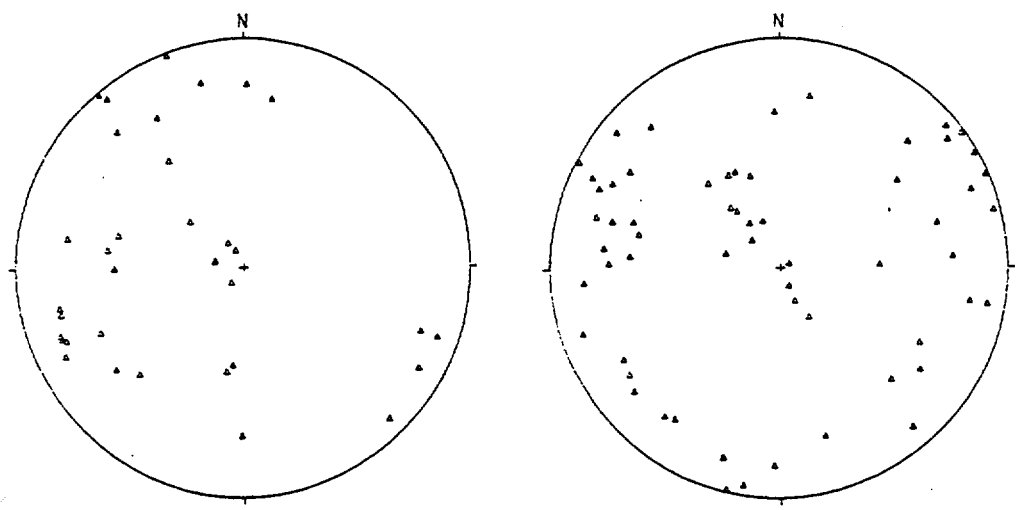


Grouted section 10
Spherical Gaussian Function
Number of Sample Points 65

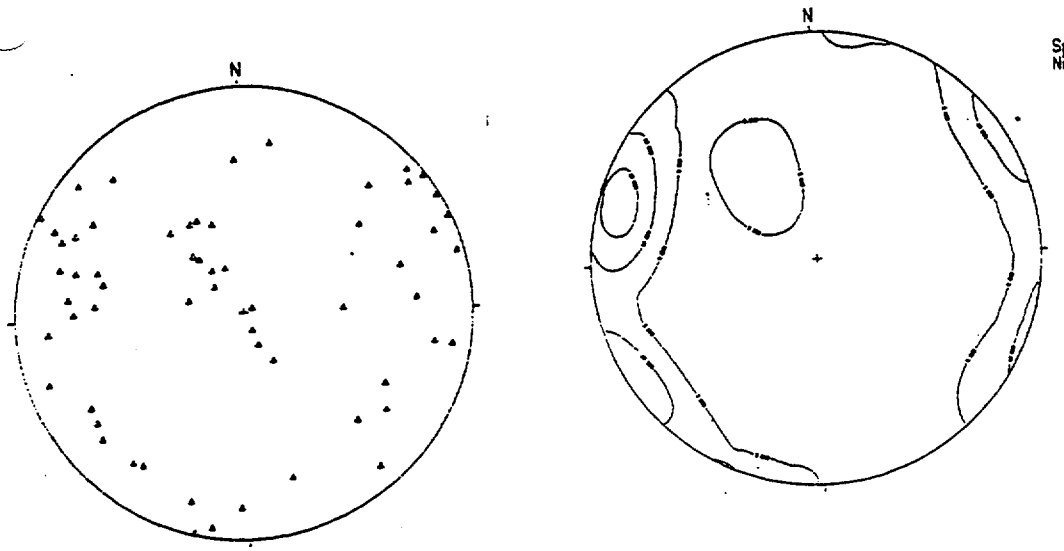
B-7fff: Stereogramms and contoured plots of fractures in grouted sections. Mapped fracture zones are excluded here (cf. chapter 4).

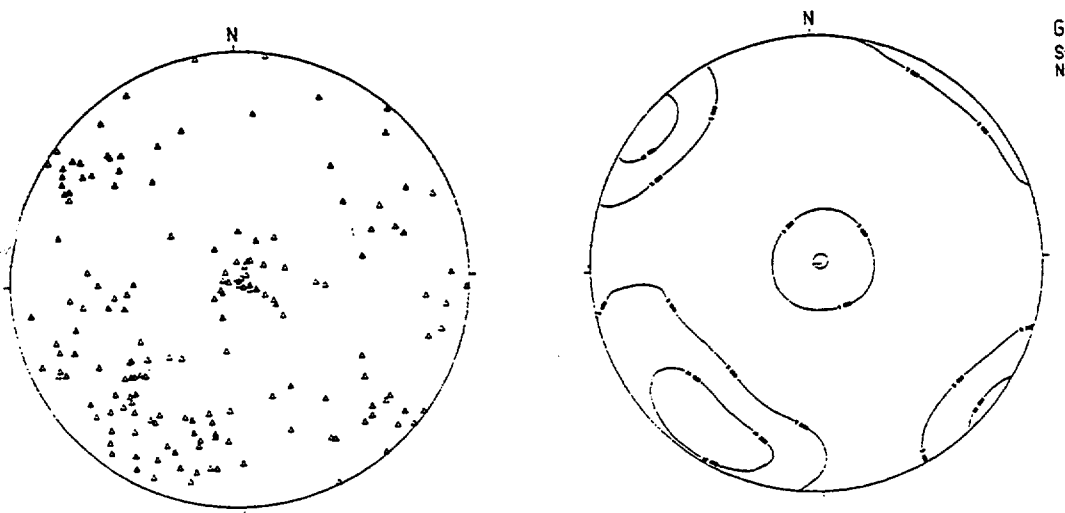


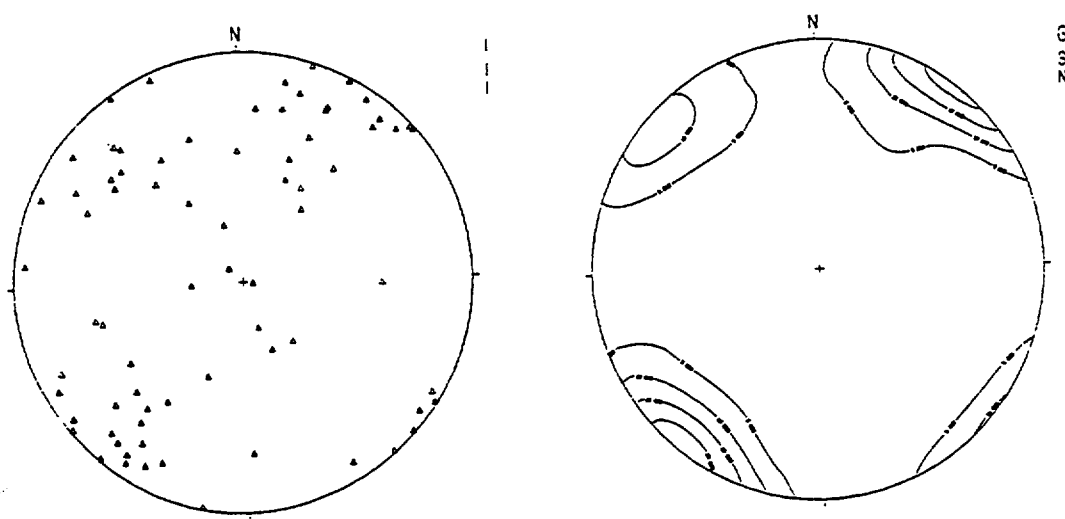




B-7: Stereogramms and contoured plots of fractures in grouted sections. Mapped fracture zones are excluded here (cf. chapter 4).

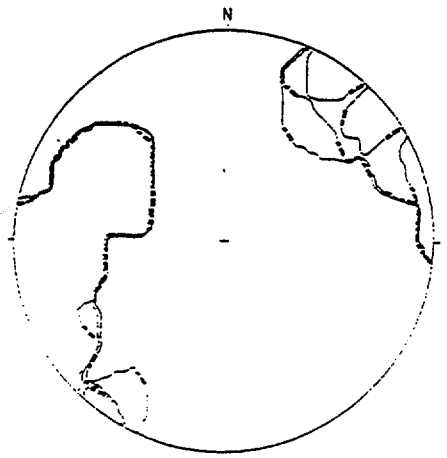




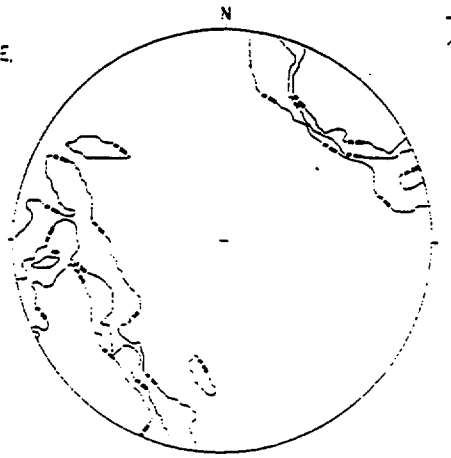


B-7ff: Stereogramms and contoured plots of fractures in grouted sections. Mapped fracture zones are excluded here (cf. chapter 4).

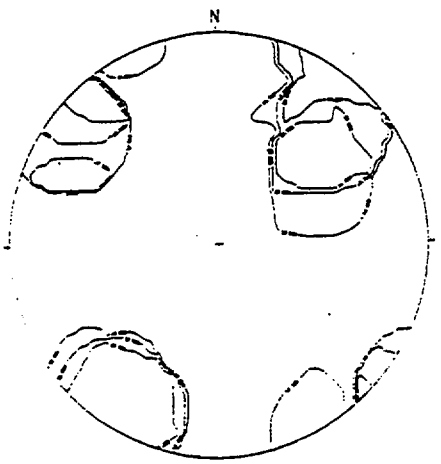
Appendix B-8



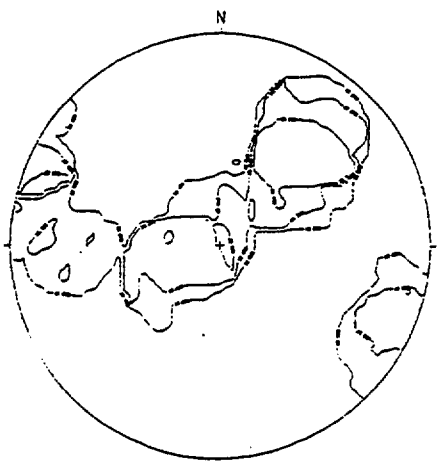
Zone 3 (Z3) on leg D-E,
Step Function Grid
Number of Sample Points



Z1 2035-2059m
Step Function Grid
Number of Sample Points



Zone 4 (Z4) on leg D-E,
Step Function Grid
Number of Sample Points



Zone 5, 2218-2250m, ASPO
Step Function Grid
Number of Sample Points 262

B-8 Contoured diagrams of mapped fracture zones, tunnel section 1/600 to 2/400m. (For the location of fracture zones cf. Tab.6.

Appendix C-3

Section			Frequency/meter			Frequency/meter			Frequency/meter		
		Length	Strike			Strike			Strike		
	to		0-10	180-190	NNE	350-360	170-180	NNW-1	340-350	160-170	NNW-2
1500	1620	20	0,15	0,05	0,20	0,30	0,05	0,35	0,25	0,05	0,30
1620	1640	20	0,45	0,00	0,45	0,20	0,05	0,25	0,25	0,05	0,30
1640	1660	20	0,10	0,10	0,20	0,10	0,00	0,10	0,05	0,10	0,15
1660	1680	20	0,05	0,10	0,15	0,00	0,00	0,00	0,10	0,05	0,15
1680	1700	20	0,00	0,00	0,00	0,05	0,05	0,10	0,05	0,05	0,10
1700	1720	20	0,15	0,05	0,20	0,15	0,25	0,40	0,25	0,10	0,35
1720	1740	20	0,35	0,25	0,60	0,15	0,05	0,20	0,20	0,05	0,25
1740	1760	20	0,25	0,00	0,25	0,25	0,20	0,45	0,20	0,05	0,25
1760	1780	20	0,15	0,20	0,35	0,15	0,10	0,25	0,10	0,05	0,15
1780	1800	20	0,30	0,05	0,35	0,05	0,05	0,10	0,10	0,00	0,10
1800	1820	20	0,35	0,05	0,40	0,30	0,15	0,45	0,45	0,05	0,50
1820	1840	20	0,30	0,10	0,40	0,40	0,40	0,80	0,40	0,40	0,80
1840	1860	20	0,25	0,50	0,75	0,50	0,70	1,20	0,70	0,70	1,40
1860	1880	20	0,90	0,75	1,65	0,40	0,25	0,65	0,25	0,30	0,55
1880	1900	20	0,55	0,25	0,80	0,30	0,15	0,45	0,10	0,20	0,30
1900	1920	20	0,25	0,20	0,45	0,20	0,20	0,40	0,15	0,15	0,30
1920	1940	20	0,20	0,15	0,35	0,05	0,20	0,25	0,20	0,20	0,40
1940	1960	20	0,35	0,25	0,60	0,15	0,05	0,20	0,05	0,05	0,10
1960	1980	20	0,25	0,05	0,30	0,15	0,15	0,30	0,00	0,05	0,05
1980	2000	20	0,30	0,00	0,30	0,00	0,10	0,10	0,10	0,15	0,25
2000	2020	20	0,30	0,20	0,50	0,20	0,30	0,50	0,15	0,20	0,35
2020	2040	20	0,25	0,25	0,50	0,10	0,20	0,30	0,15	0,20	0,35
2040	2060	20	0,15	0,50	0,65	0,05	0,10	0,15	0,10	0,10	0,20
2060	2080	20	0,25	0,25	0,50	0,00	0,35	0,35	0,35	0,50	0,85
2080	2100	20	0,00	0,40	0,40	0,20	0,20	0,40	0,20	0,20	0,40
2100	2120	20	0,05	0,35	0,40	0,15	0,00	0,15	0,00	0,15	0,15
2120	2140	20	0,00	0,10	0,10	0,10	0,25	0,35	0,20	0,25	0,45
2140	2160	20	0,00	0,25	0,25	0,05	0,15	0,20	0,15	0,15	0,30
2160	2180	20	0,05	0,25	0,30	0,10	0,45	0,55	0,35	0,35	0,70
2180	2200	20	0,20	0,35	0,55	0,10	0,15	0,25	0,15	0,20	0,35
2200	2220	20	0,10	0,20	0,30	0,10	0,30	0,40	0,30	0,40	0,70
2220	2240	20	0,15	0,30	0,45	0,05	0,05	0,10	0,05	0,05	0,10
2240	2260	20	0,05	0,10	0,15	0,00	0,00	0,00	0,00	0,00	0,00
2260	2280	20	0,00	0,00	0,00	0,10	0,55	0,65	0,45	0,70	1,15
2280	2300	20	0,40	0,40	0,80	0,20	0,65	0,85	0,40	0,45	0,85
2300	2320	20	0,35	0,95	1,30	0,15	0,85	1,00	0,70	0,90	1,60
2320	2340	20	0,35	0,35	0,70	0,05	0,35	0,40	0,80	0,35	1,15
2340	2360	20	0,45	0,55	1,00	0,30	0,55	0,85	0,55	0,55	1,10
2360	2380	20	0,10	0,10	0,20	0,05	0,10	0,15	0,10	0,10	0,20
2380	2400	20	0,10	0,55	0,65	0,40	0,55	0,95	0,45	0,55	1,00
Average			0,22	0,24	0,46	0,16	0,23	0,39	0,24	0,23	0,47

			Frequency/meter								
Tunnel leg		Length			NNE			NNW-1			NNW-2
from	to		0-10	180-190		350-360	170-180		340-350	160-170	
1610	1765	155	0,13	0,10	0,23	0,14	0,10	0,24	0,15	0,07	0,23
1765	1910	145	0,41	0,28	0,69	0,29	0,27	0,56	0,30	0,25	0,55
1910	2055	145	0,24	0,20	0,44	0,11	0,15	0,26	0,10	0,13	0,23
2055	2210	155	0,12	0,29	0,41	0,10	0,24	0,34	0,22	0,28	0,50
2210	2365	155	0,23	0,34	0,57	0,12	0,40	0,52	0,34	0,41	0,75

			Frequency/meter					
Section		Section lenght						
from	to		270-280	90-100	280-290	100-110	290-300	100-120
1610	1765	155	0,13	0,08	0,14	0,12	0,33	0,32
1765	1910	145	0,07	0,19	0,12	0,24	0,05	0,22
1910	2055	145	0,05	0,08	0,08	0,13	0,03	0,11
2055	2210	155	0,06	0,08	0,13	0,19	0,21	0,21
2210	2365	155	0,10	0,08	0,10	0,12	0,11	0,15

Appendix D-1 to D-3

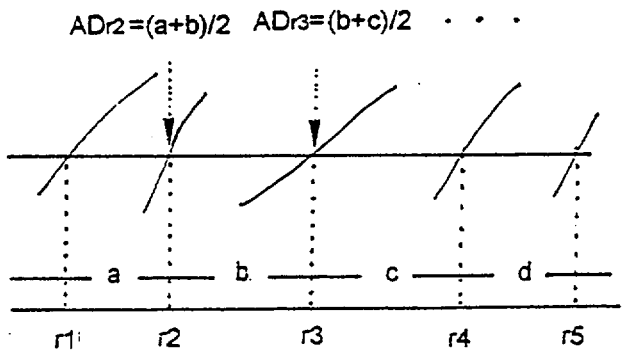


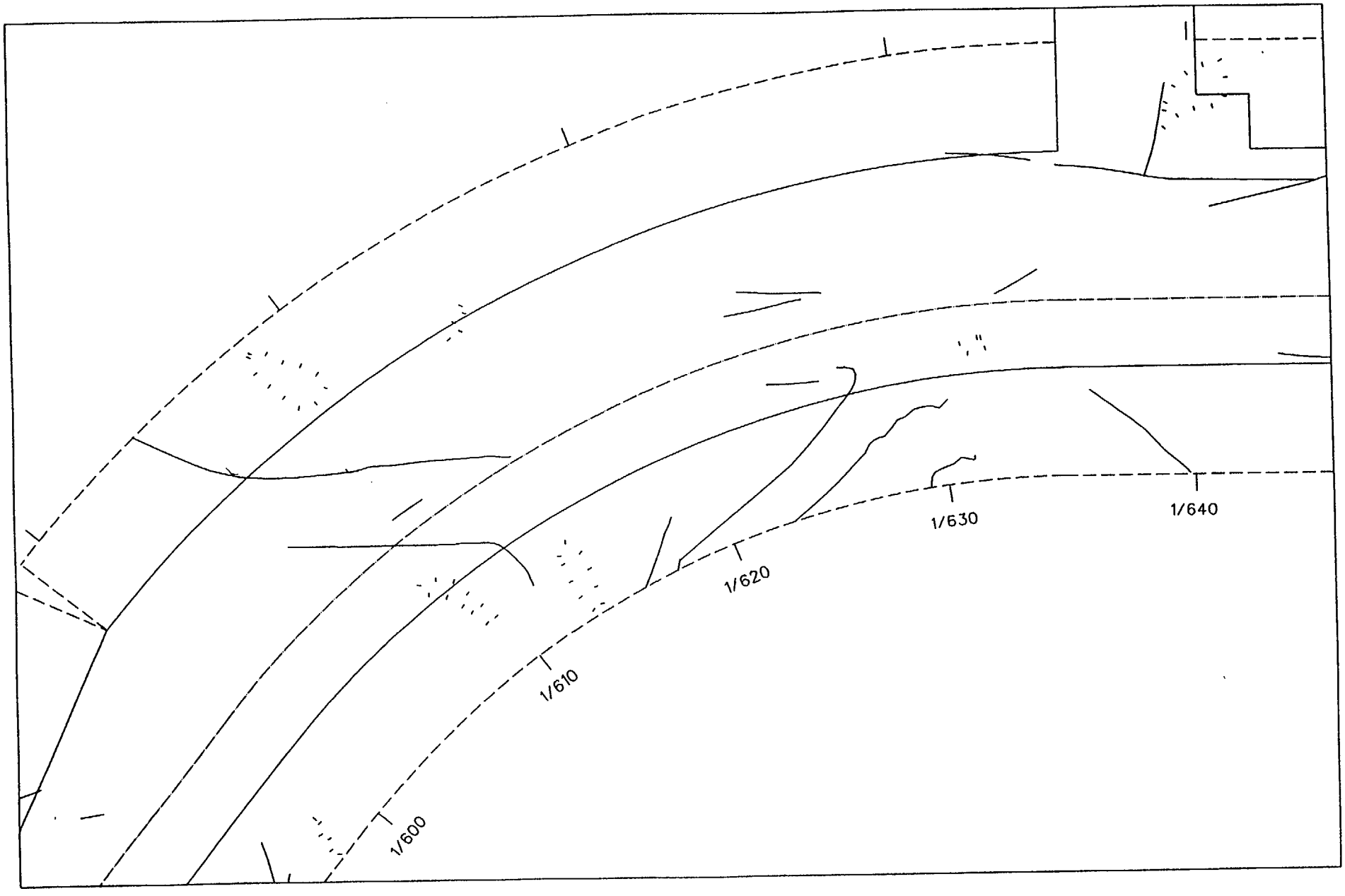
Figure 7 Definition of "avereged distances" between the two fractures adjacent to a fracture on the sampling line.

r_1 : Location of fractures (Tunnel length (m))

a : Distance between fractures

AD_{r1} : "Averaged Distances"

Appendix D-2



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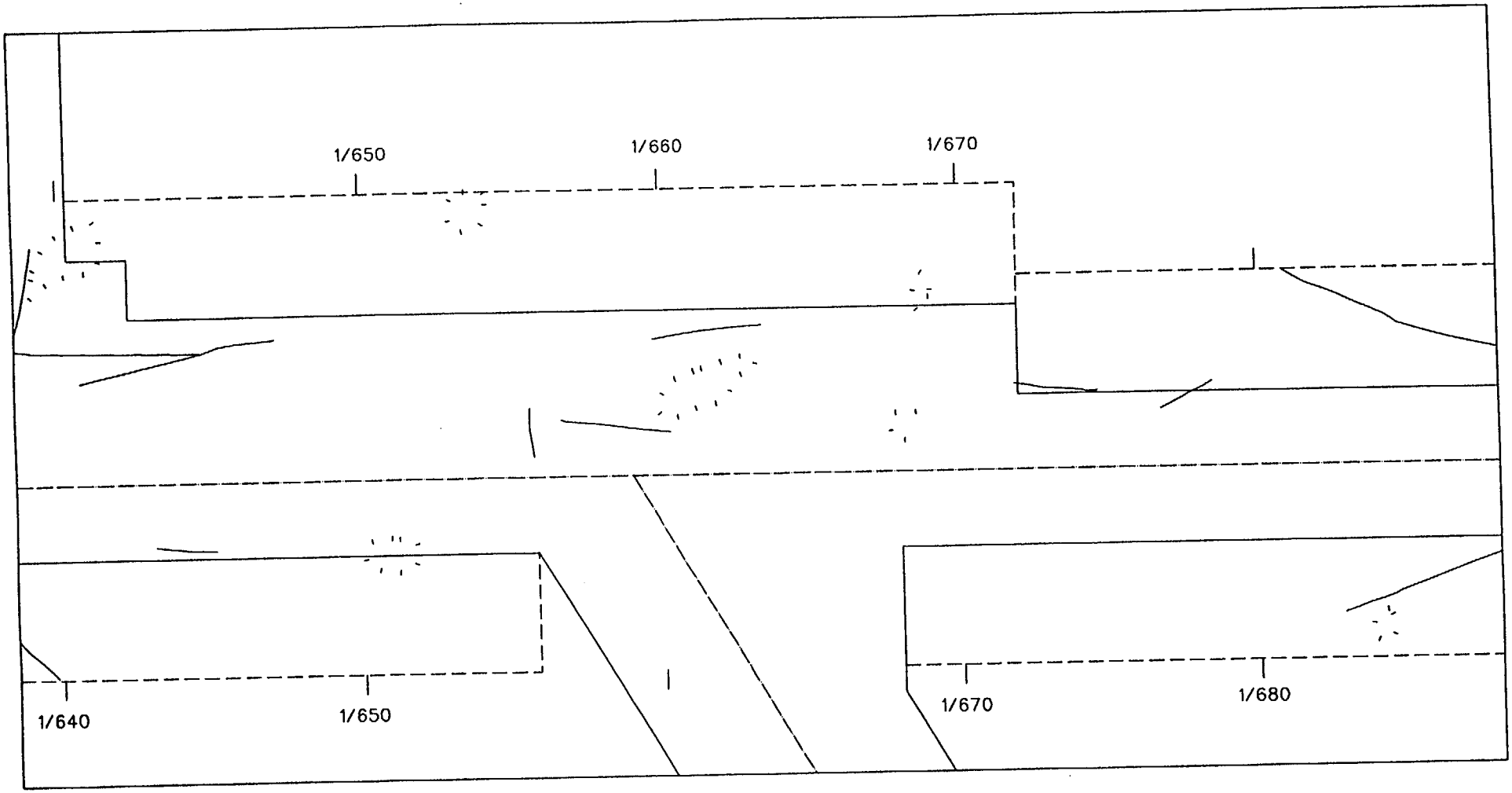

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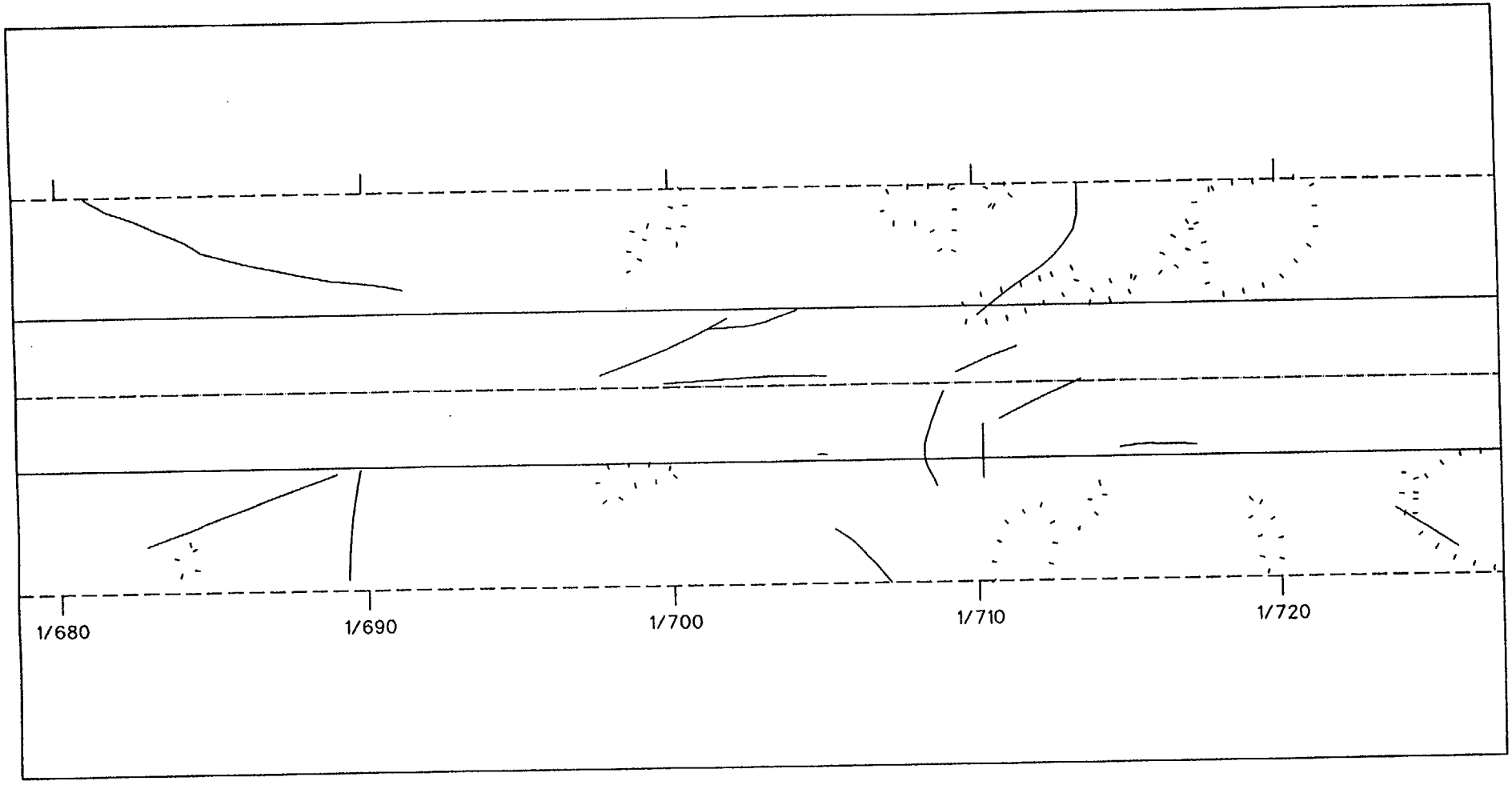

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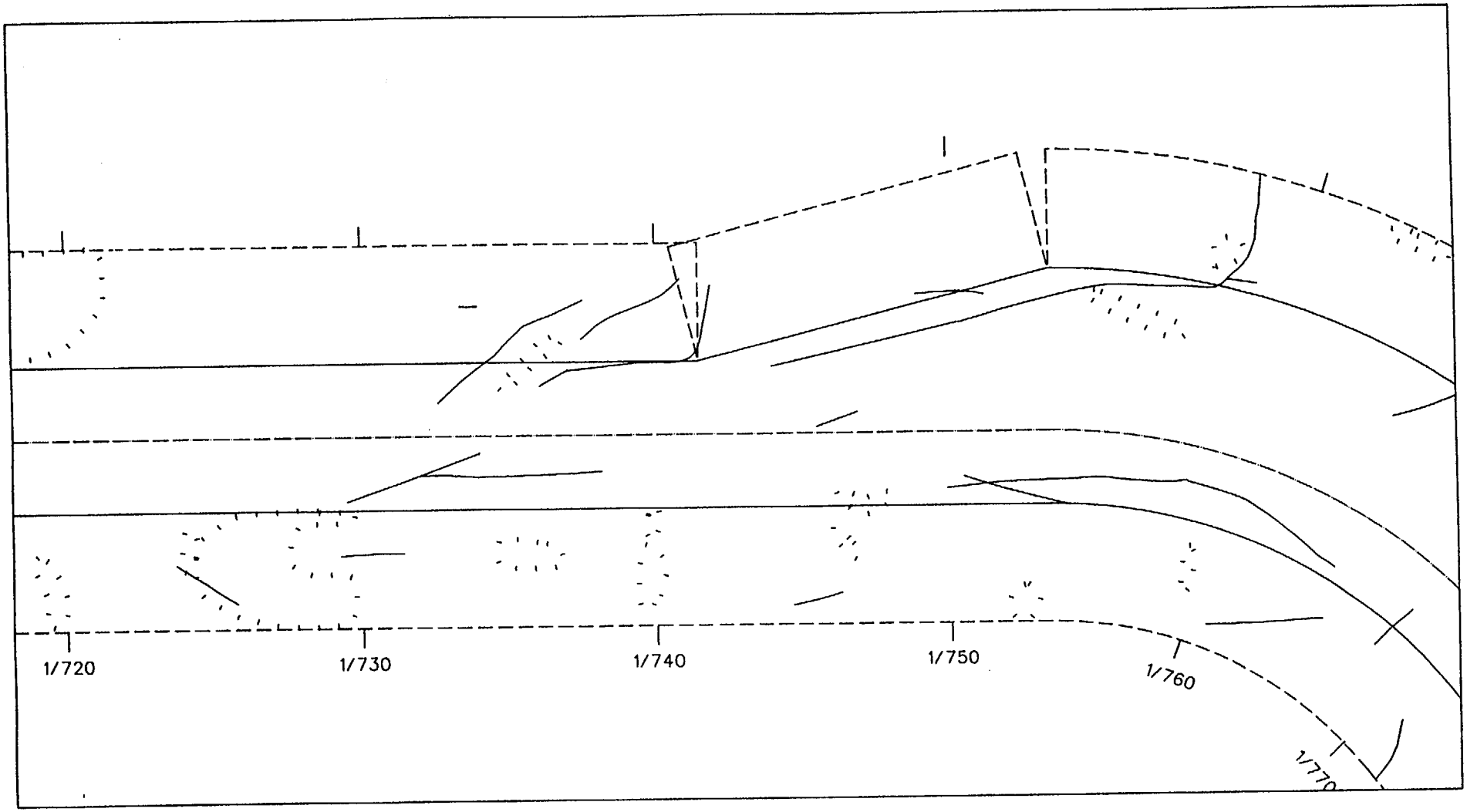

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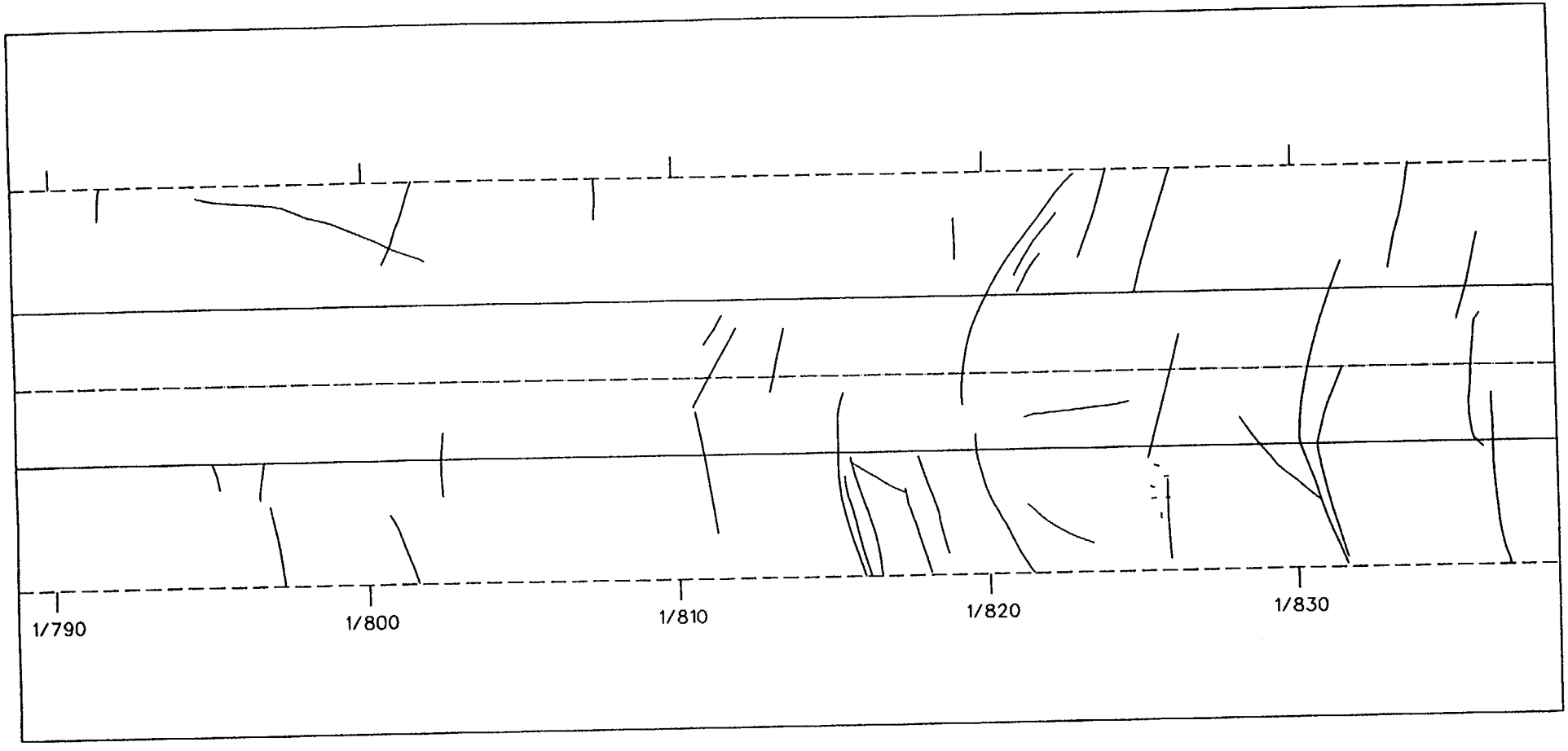

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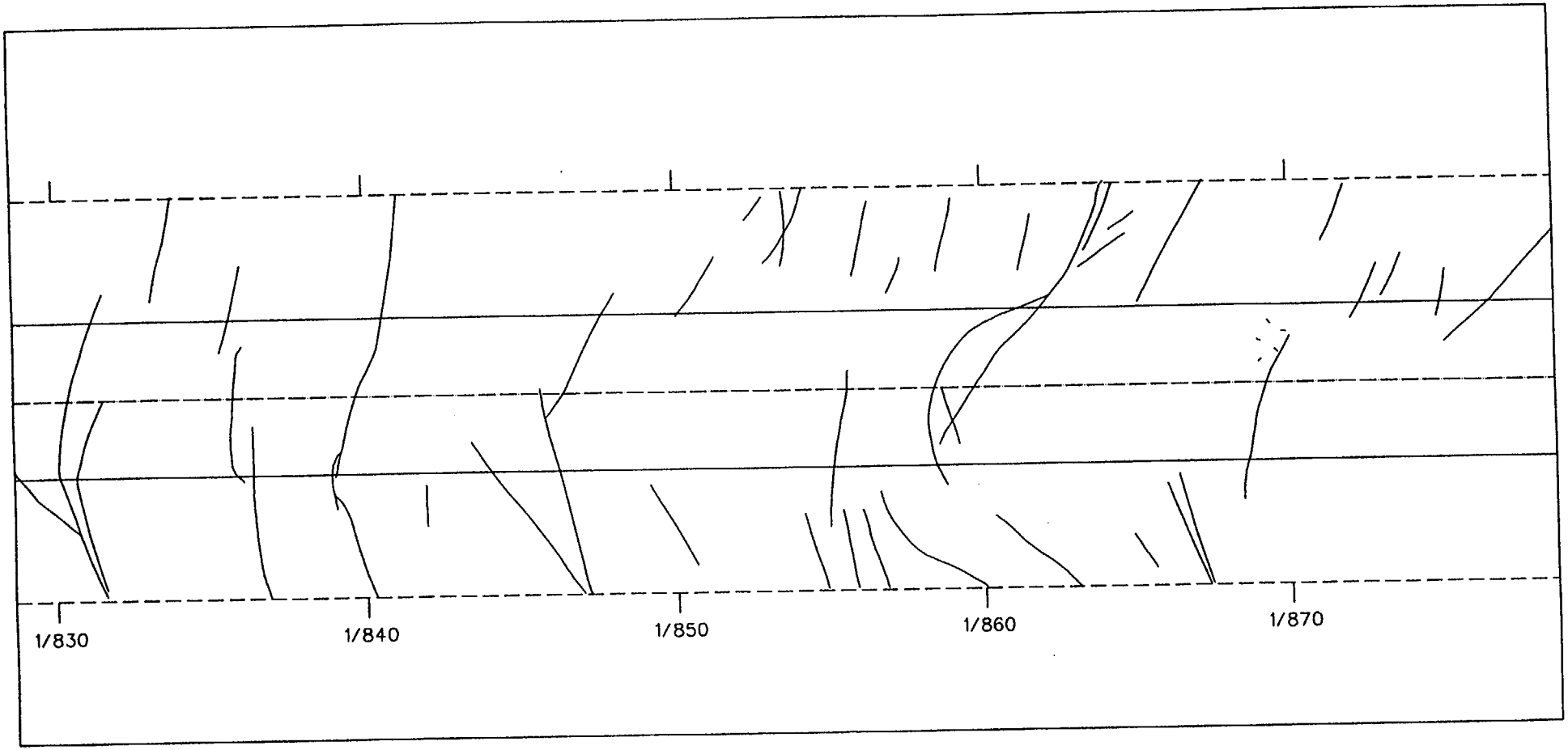

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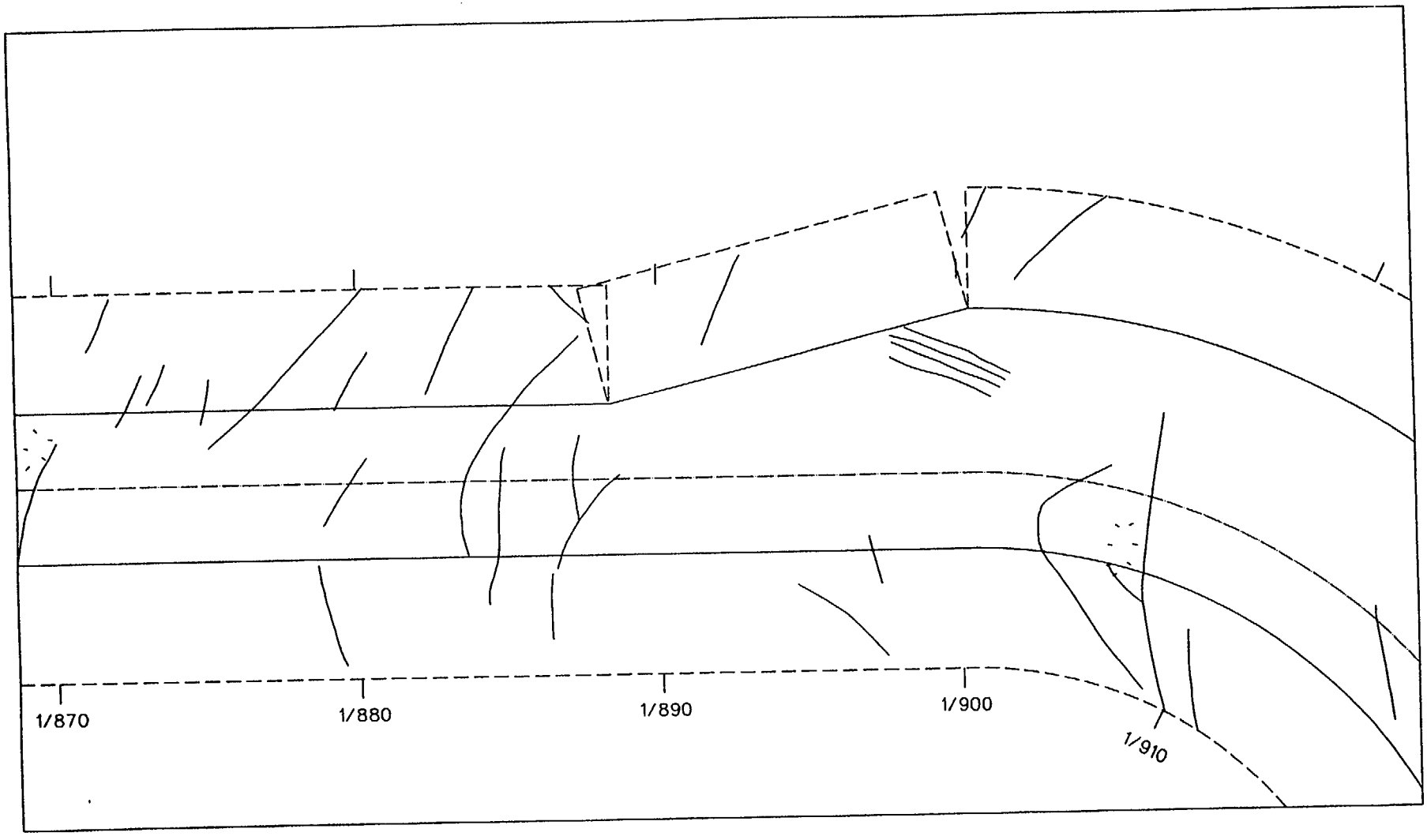

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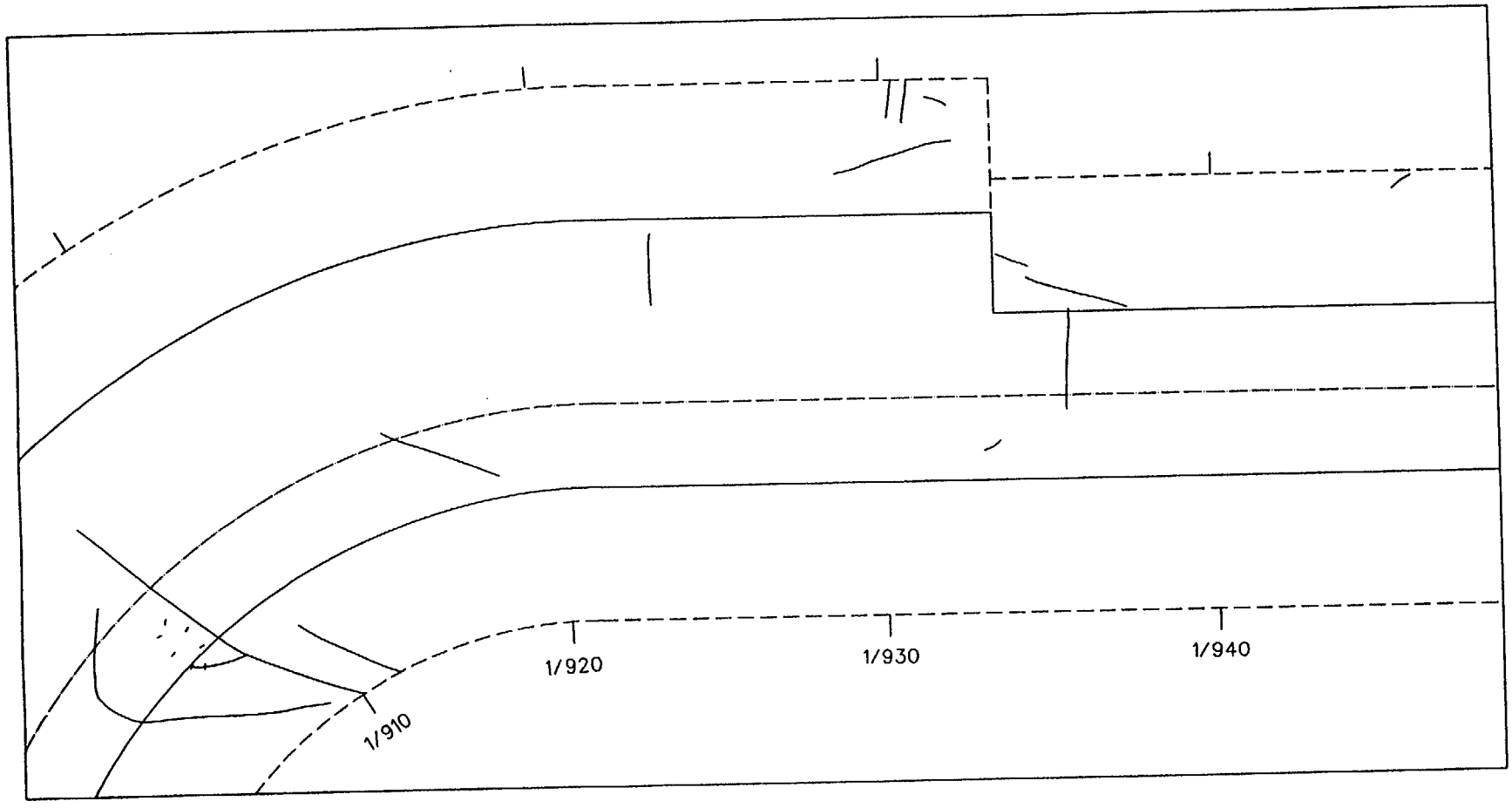

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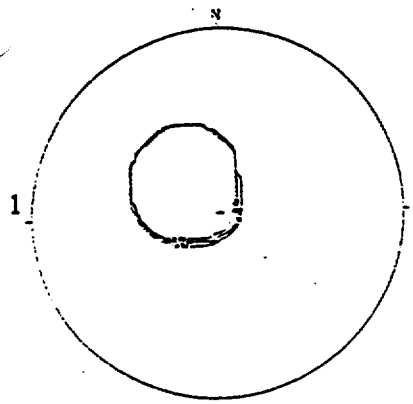
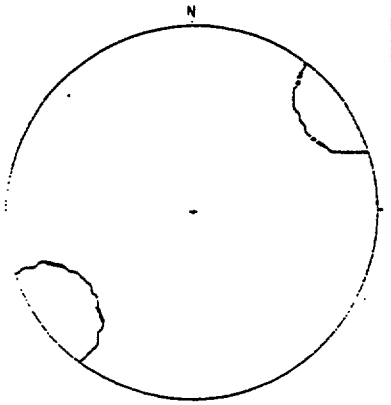
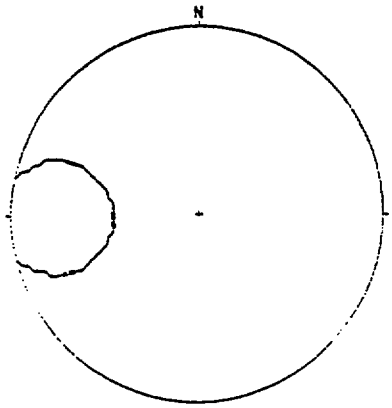


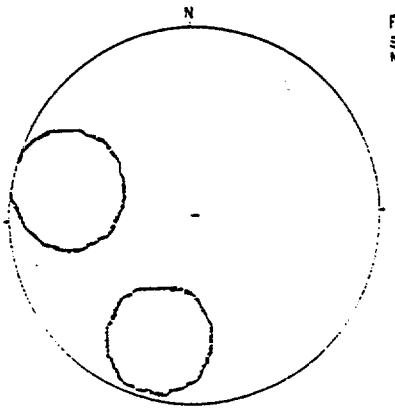
Fracture zone Z6 1745-1853m
Step Function Grid
Number of Sample Points 32



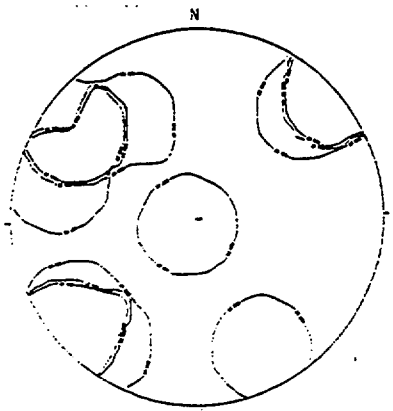
Fracture zone Z7 at 1770m
Step Function Grid
Number of Sample Points



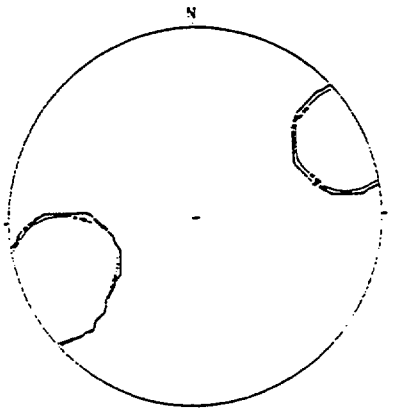
Fracture zone Z8 at 1832m
Step Function Grid
Number of Sample Points



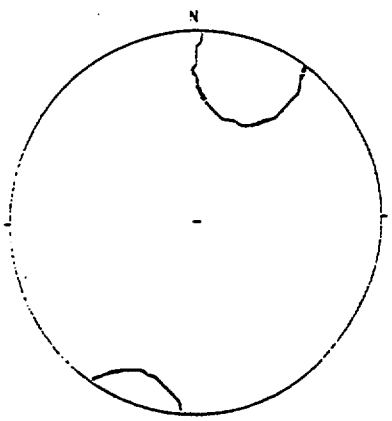
Fracture zone Z7 1845-1853m
Step Function Grid
Number of Sample Points 4



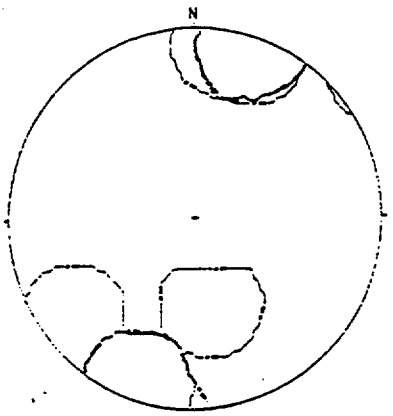
Z0, 2013-2030m
Step Function Grid
Number of Sample Points



Z1, 2018-2030m
Step Function Grid
Number of Sample Points



Fracture zone Z8 at 1876m
Step Function Grid
Number of Sample Points



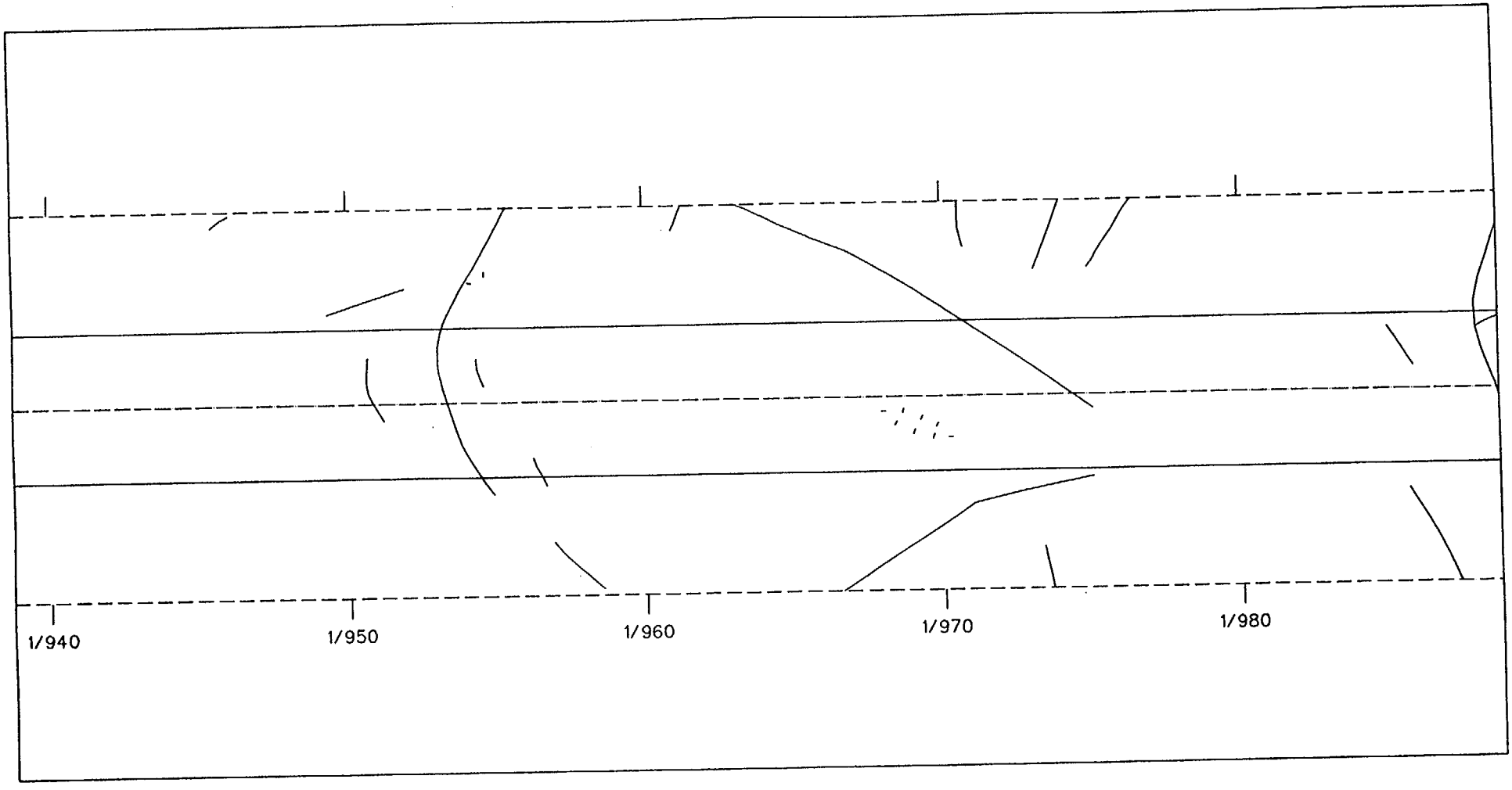
Z9, 1994-2005m
Step Function Grid
Number of Sample Points

B-8 ff *Contoured diagrams of mapped fracture zones, tunnel section 1/600 to 2/400m.* (For the location of fracture zones cf. Tab.6.

Appendix C-1 to C-3

All fractures section 1400 to 2500							
Bin	Frequency	Cumulative %	Bin	Frequency	Cumulative %	Mean	3,24
0,5	35	0,0	2,0	696	0,2	Standard Error	
1	454	0,1	1,5	664	0,3	Median	2,70
1,5	664	0,3	2,5	511	0,4	Mode	2,20
2	696	0,4	3,0	459	0,5	Standard Deviation	2,04
2,5	511	0,6	1,0	454	0,7	Variance	4,14
3	459	0,7	3,5	312	0,7	Kurtosis	19,36
3,5	312	0,7	4,0	275	0,8	Skewness	2,86
4	275	0,8	4,5	182	0,8	Range	30,00
4,5	182	0,8	5,0	177	0,9	Minimum	0,00
5	177	0,9	5,5	145	0,9	Maximum	30,00
5,5	145	0,9	6,0	99	0,9	Sum	13859,90
6	99	0,9	6,5	55	0,9	Count	4284,00
6,5	55	0,9	7,0	55	1,0	Largest (1)	30,00
7	55	1,0	7,5	43	1,0	Smallest (1)	0,00
7,5	43	1,0	0,5	35	1,0	Confidence Level (95%	0,06
8	27	1,0	8,0	27	1,0		
8,5	17	1,0	9,0	18	1,0		
9	18	1,0	8,5	17	1,0		
9,5	14	1,0	9,5	14	1,0		
10	5	1,0	12,0	6	1,0		
10,5	4	1,0	10,0	5	1,0		
11	4	1,0	15,0	5	1,0		
11,5	3	1,0	10,5	4	1,0		
12	6	1,0	11,0	4	1,0		
12,5	4	1,0	12,5	4	1,0		
13	2	1,0	11,5	3	1,0		
13,5	2	1,0	13,0	2	1,0		
14	2	1,0	13,5	2	1,0		
14,5	2	1,0	14,0	2	1,0		
15	5	1,0	14,5	2	1,0		
15,5	0	1,0	20,0	2	1,0		
16	1	1,0	29,0	2	1,0		
16,5	0	1,0	16,0	1	1,0		
17	0	1,0	18,0	1	1,0		
17,5	0	1,0	15,5	0	1,0		
18	1	1,0	16,5	0	1,0		
18,5	0	1,0	17,0	0	1,0		
19	0	1,0	17,5	0	1,0		
19,5	0	1,0	18,5	0	1,0		
20	2	1,0	19,0	0	1,0		
20,5	0	1,0	19,5	0	1,0		

Section		Groutnr.	Length of groutholes	Number of grouted holes	Total length of grouted holes	Outflow (l/min)	Grout (m3)
1693		105	40	1	40		650
1697	1706	106	9	7	63	200	3084
1717	1726	107	9	16	144		5084
			20	1	20		976
1721	1742	108	12	17	228	>300	5408
				1	40		560
			24	2	12	171	
1738	1750	109	12	16	192	50	2620
1742		110	40	1	40		585
1290-1300		111					9878
1306-1309		112					6323
1865	1874	113	9	17	153	180	7920
			20	1	20		300
1920	1929	114	9	7	63	133	3926
2013	2022	115	9	9	81	102	2167
2013	2022	116	9	11	99	167	6170
2013	2022	117 9..11		19	173	>>1000	10877
2018	2027	118	9	14	126	415	3342
2048		119	9	15	135	157	3337
2083	2092	120 9..12		17	165	>>1000	5767
			46			>1000	4267
			20			>500	1500
2096	2108	121 9..12		6	57	350	8066
			20	1	20	300	
2100	2112	122	12	7	84	240	4734
2124*		124	9	2	18	>1000	14491
Probehole			184	1	20	>1500	1897
2117		125	9	8	72	1320	9487
2142		126 9..12		6	63	185	3425
2151		127 12..9		6	57	105	1827
2192		128	9	13	117	244	1332
2160		129					4465
2227		130	9	13	117	475	1832
2276		132 12..15		10	129	272	4756
2301		133	9	10	90	257	2874
2351		134	9	11	109		7025



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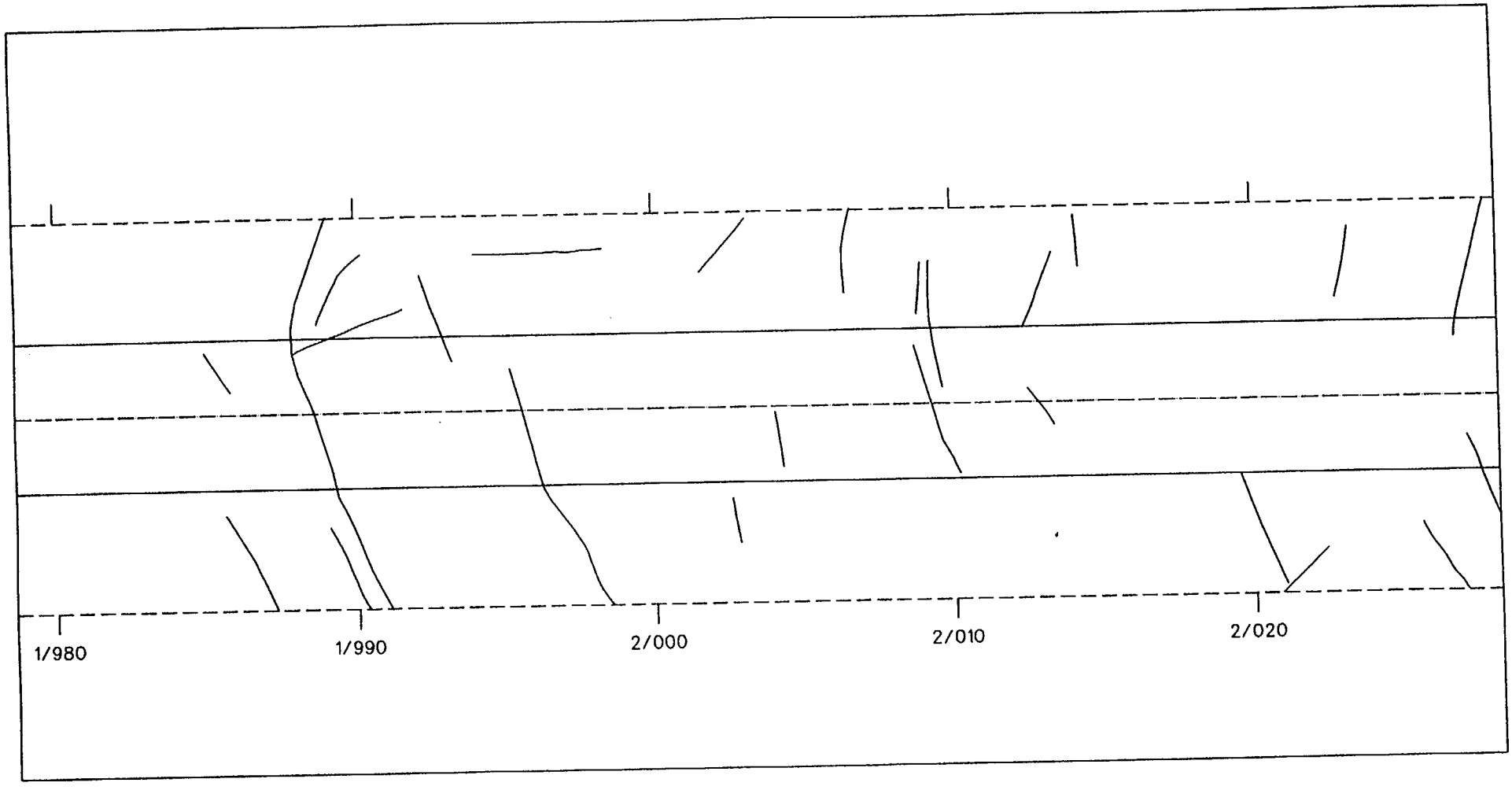

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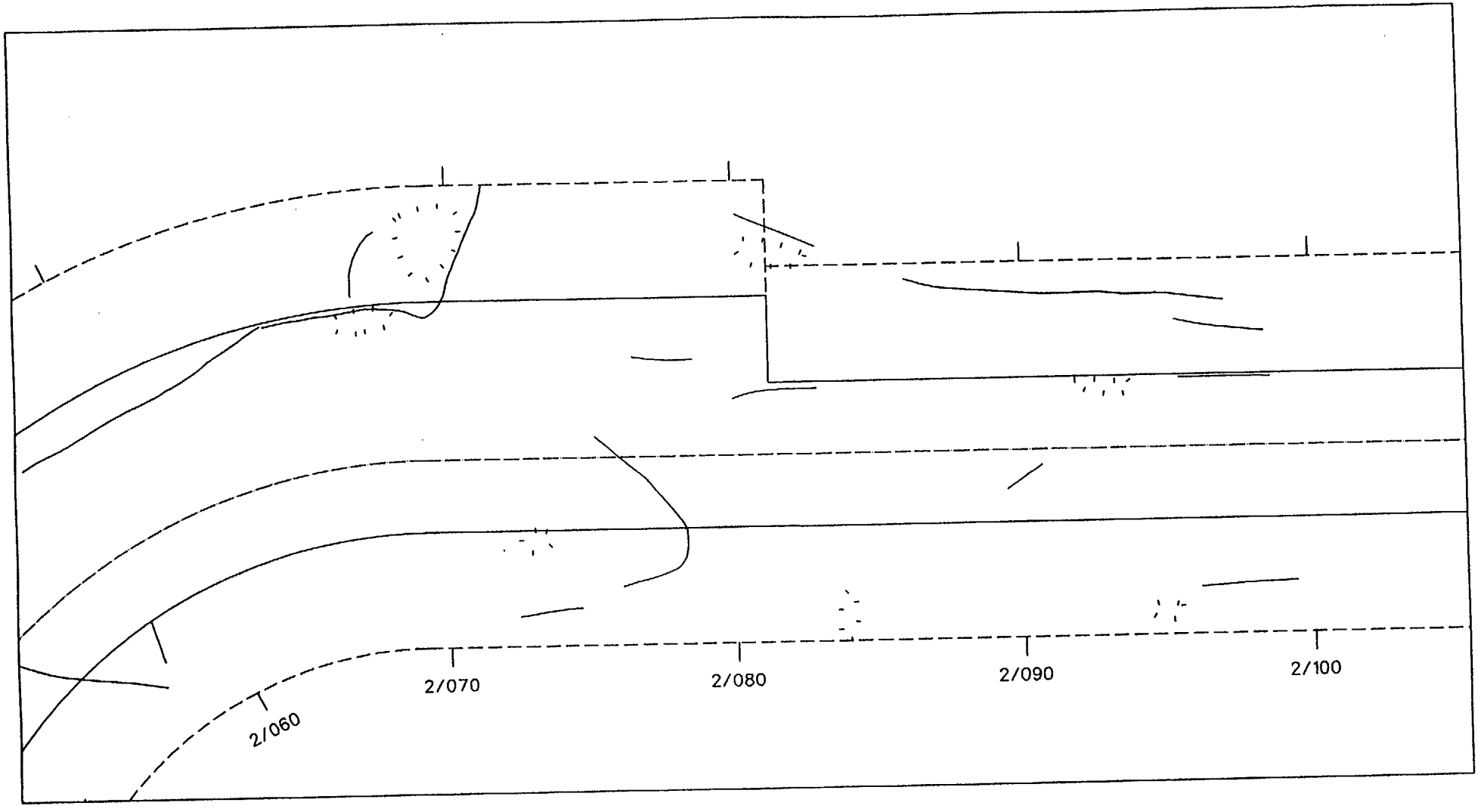

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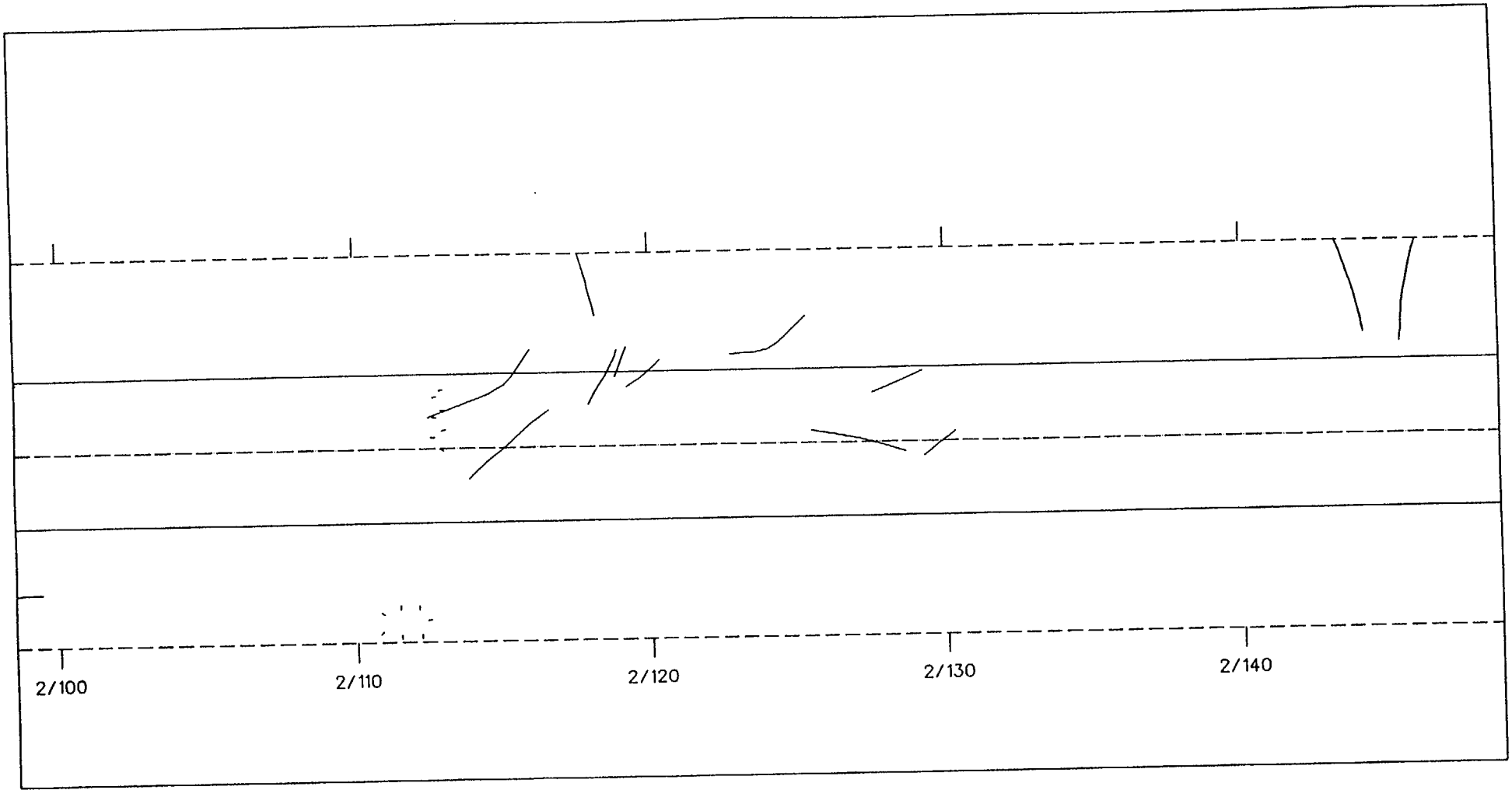

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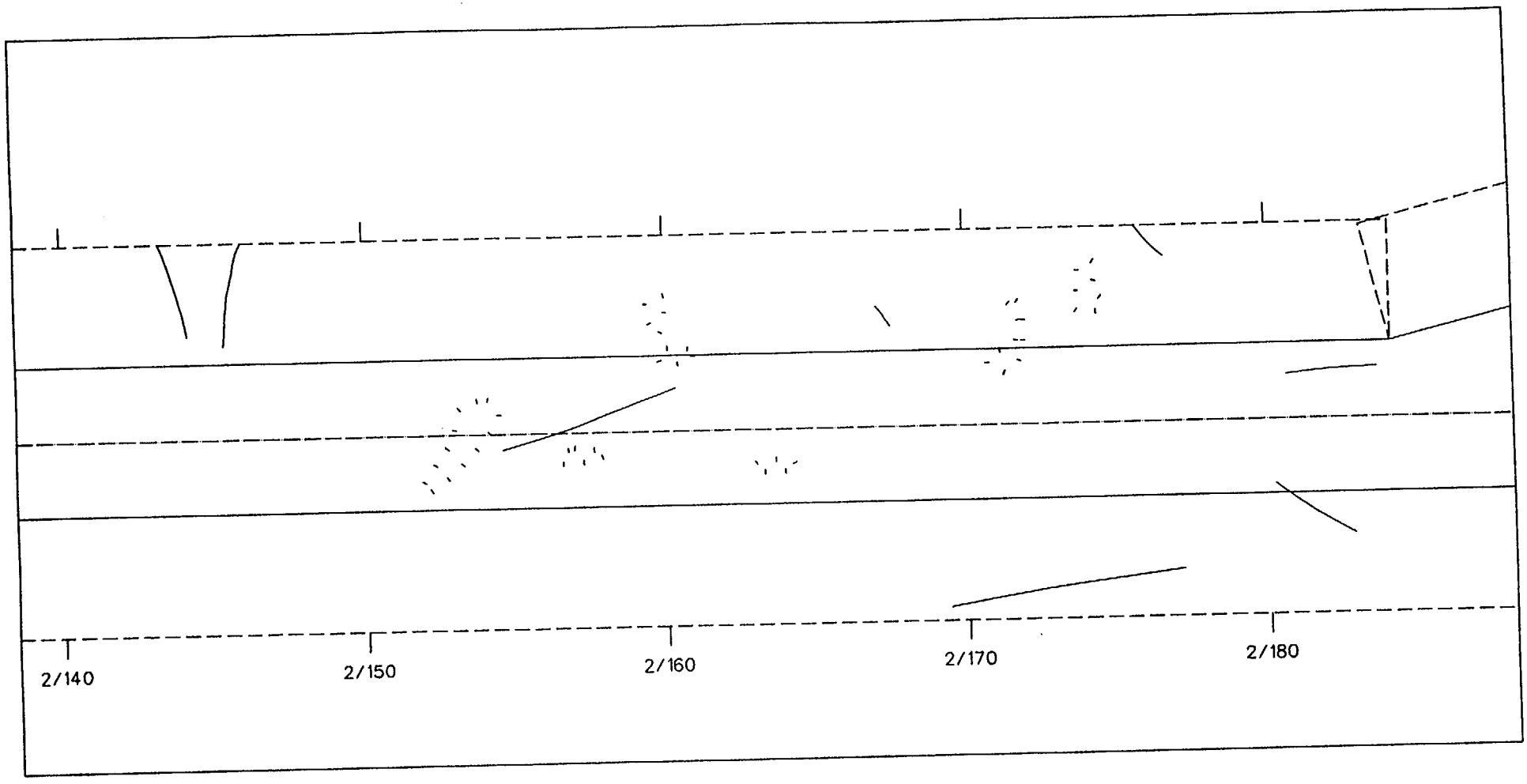

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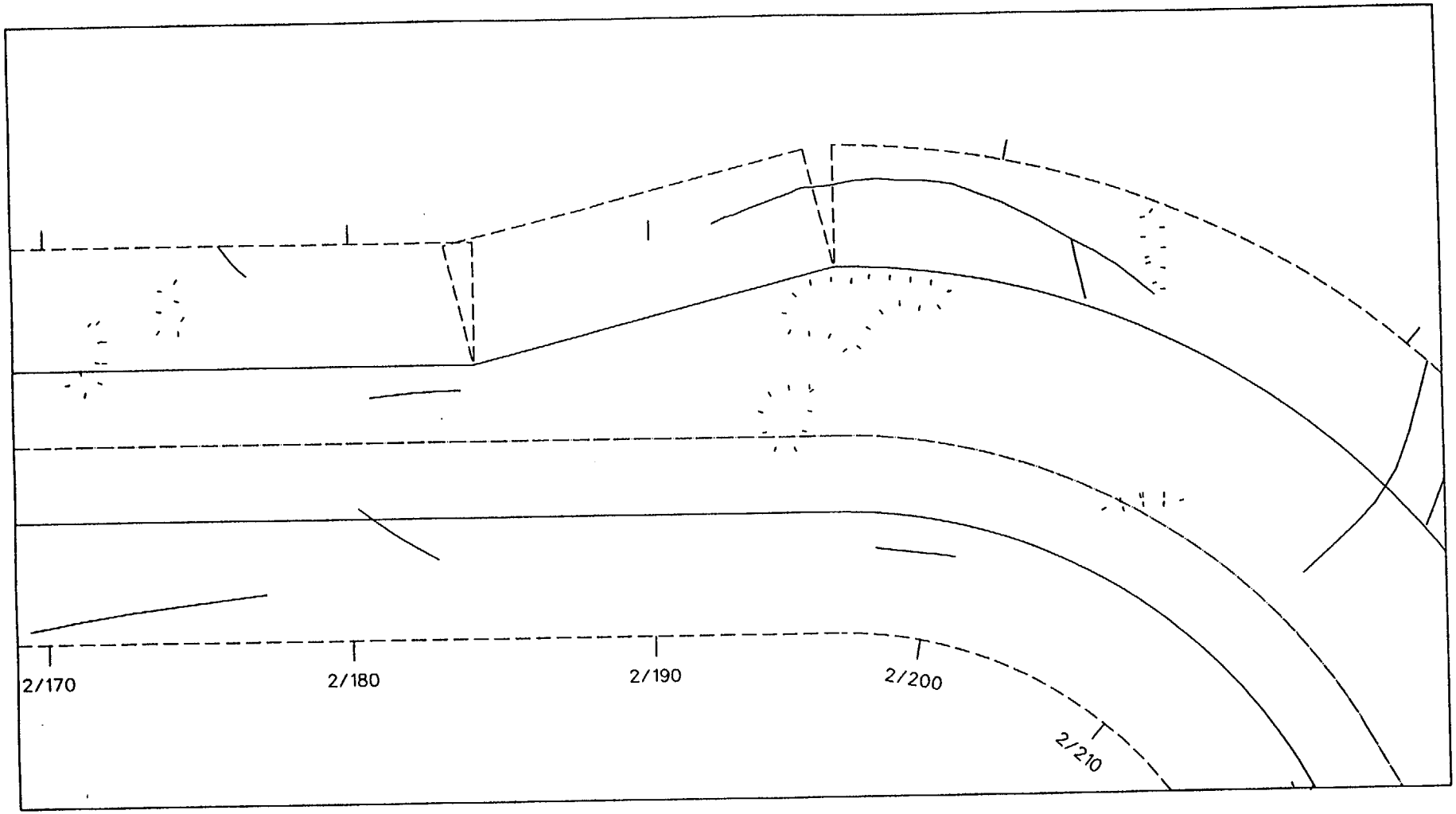

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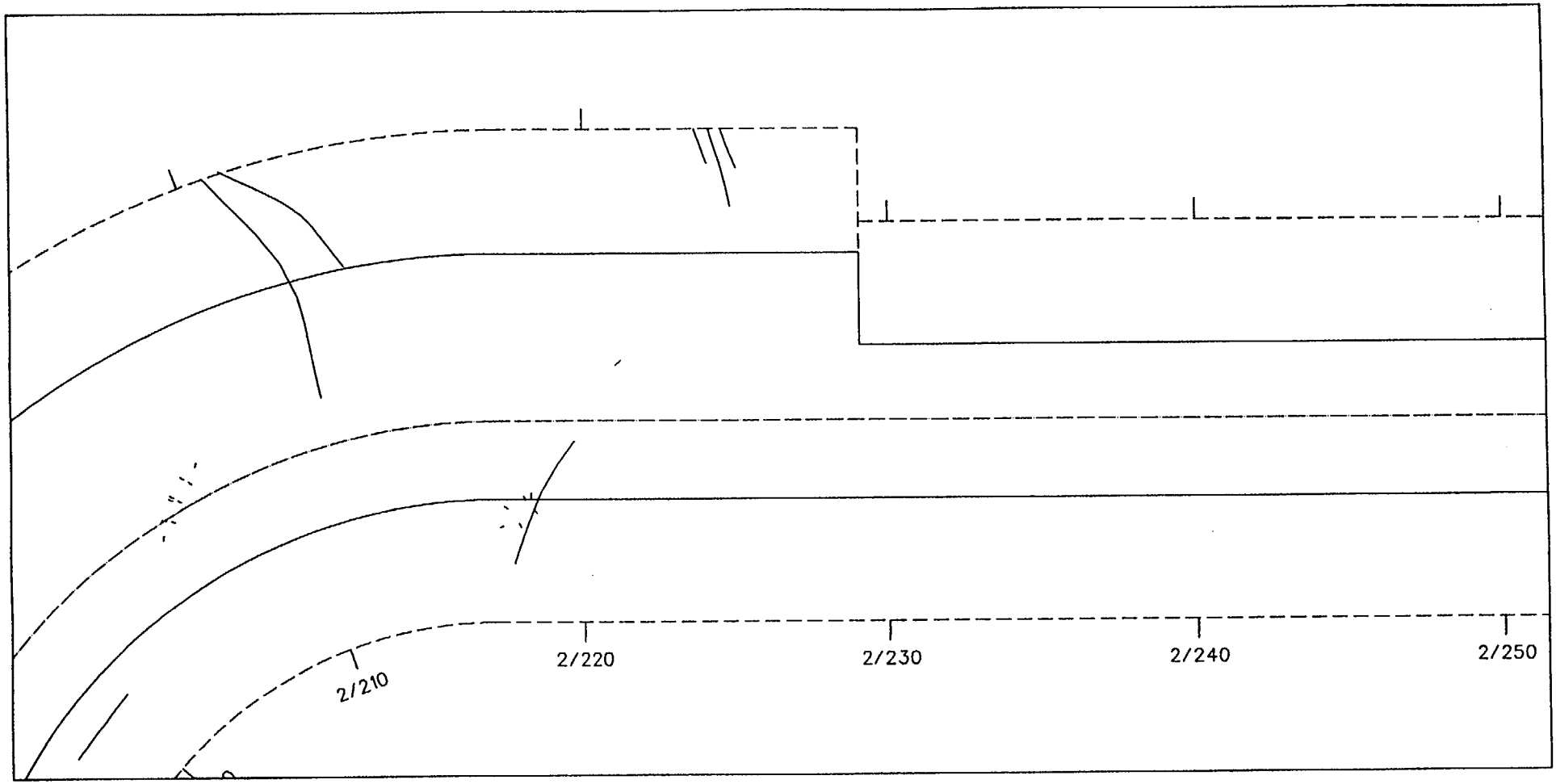

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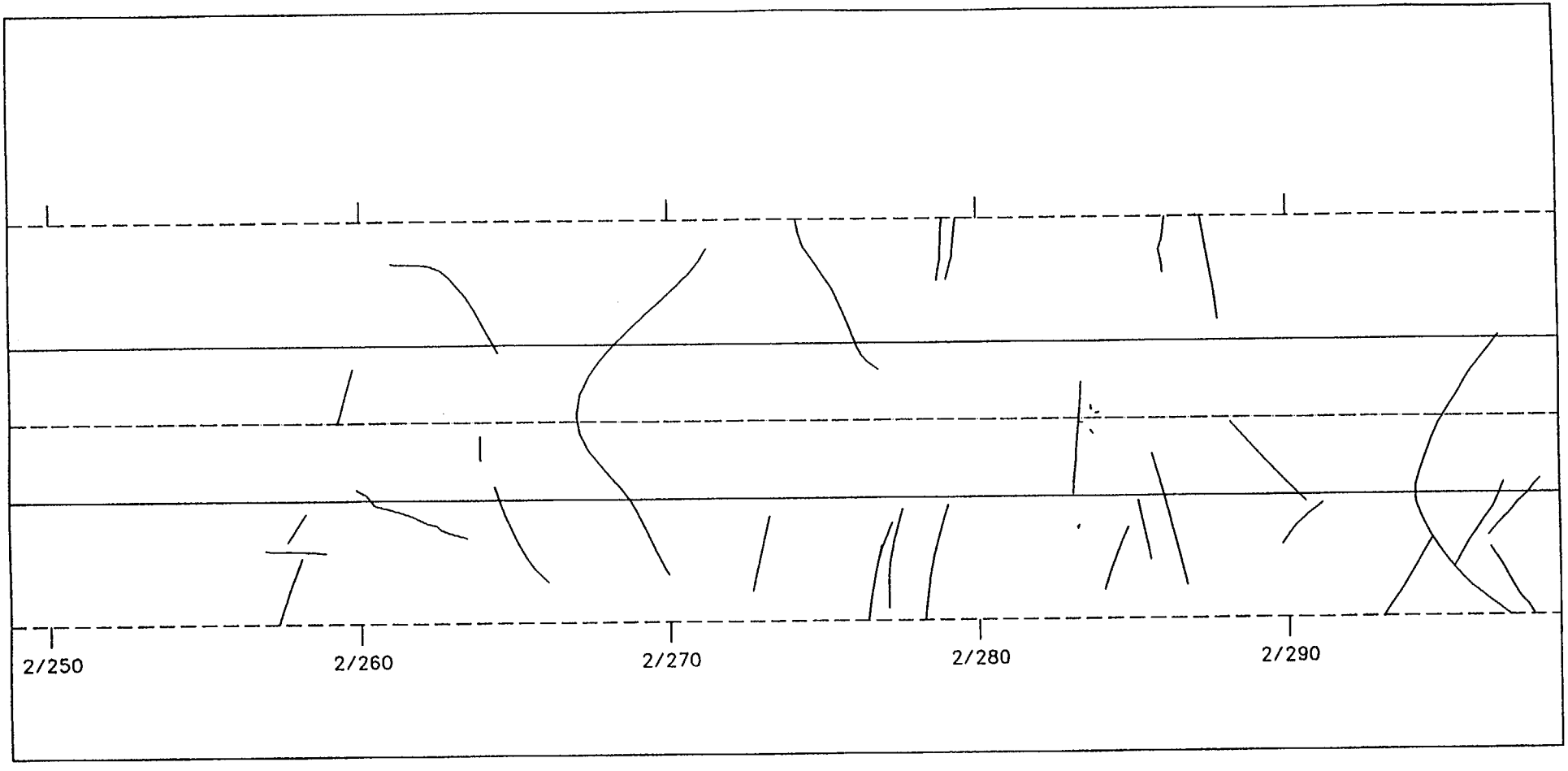

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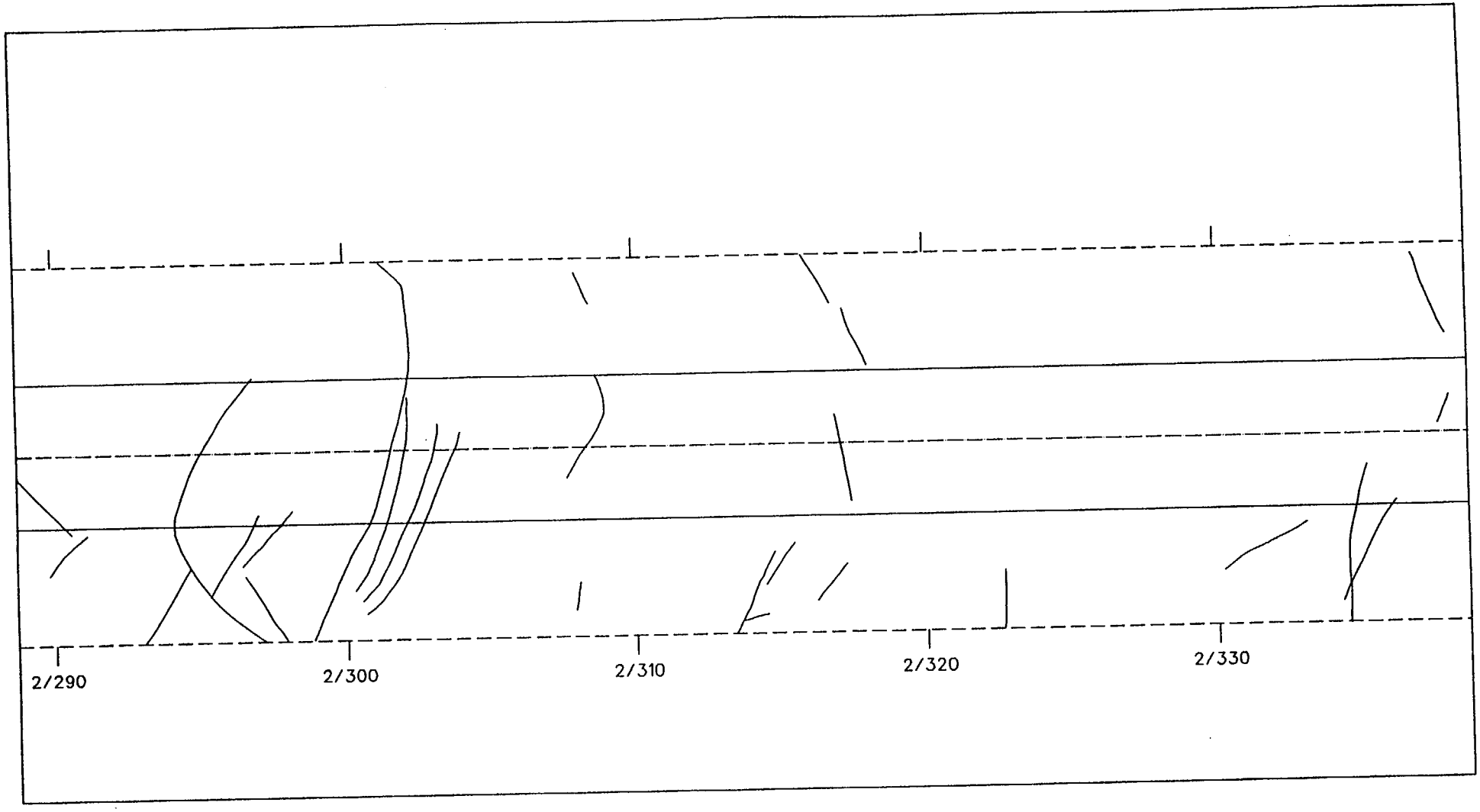

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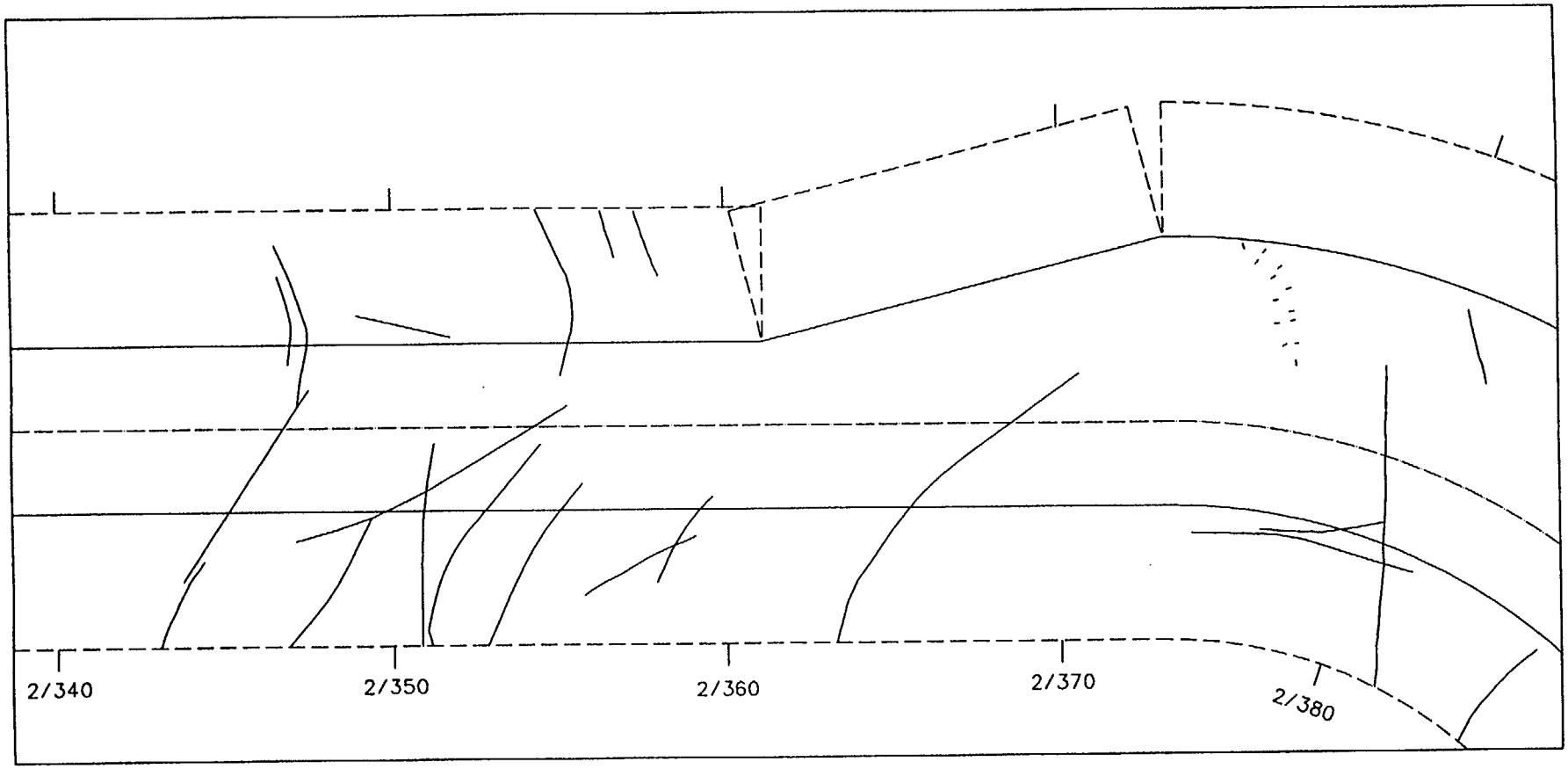

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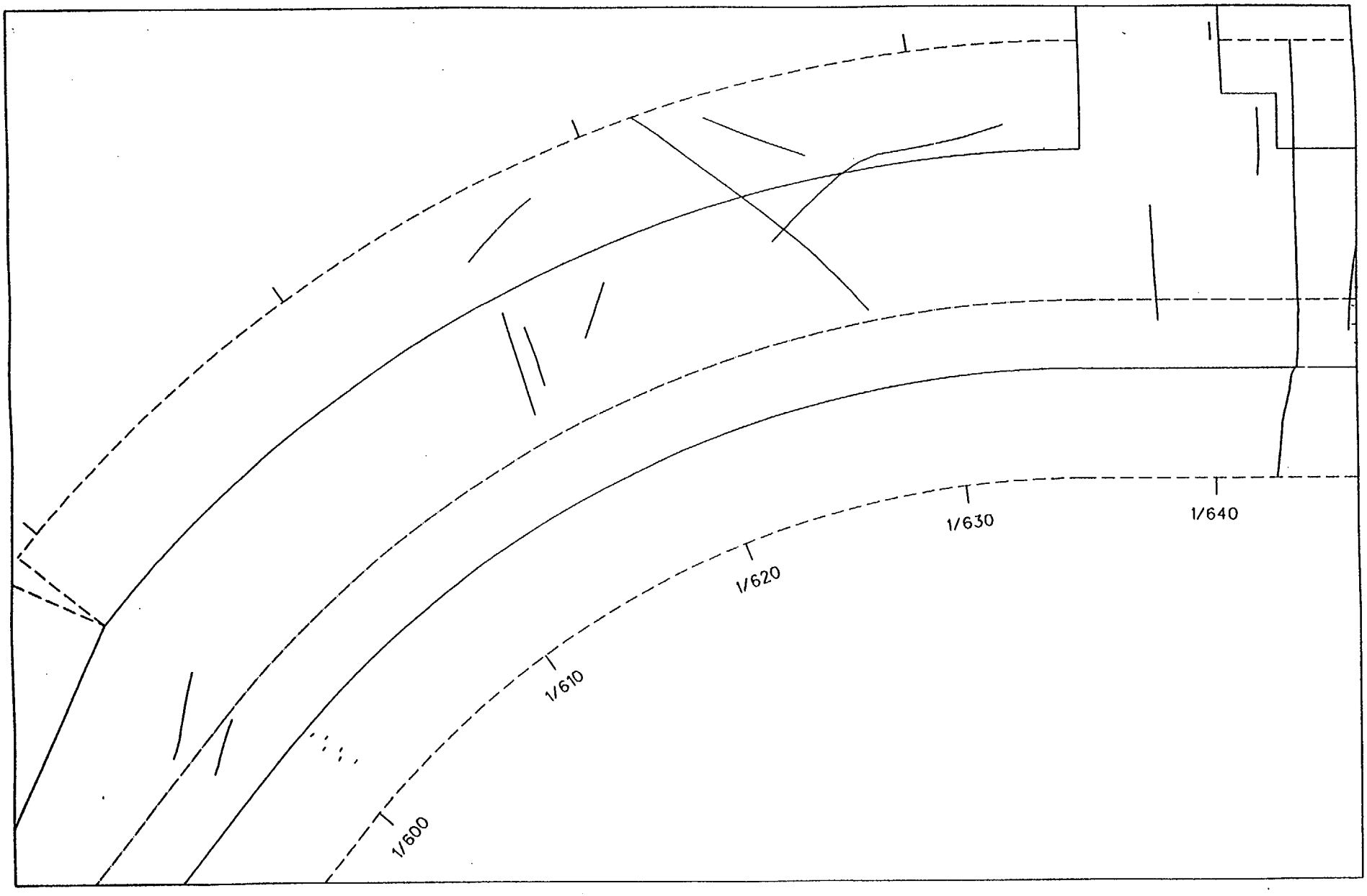

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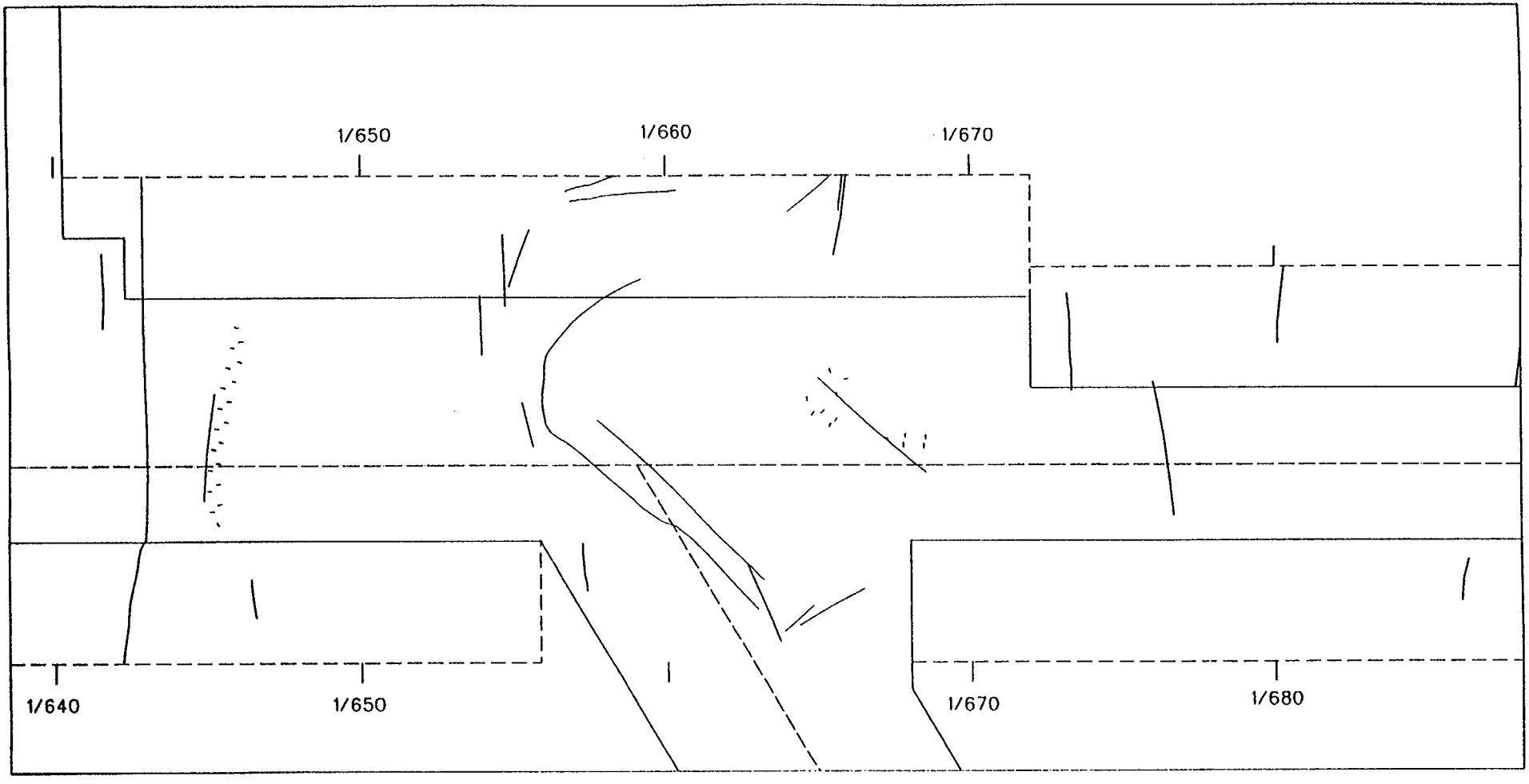

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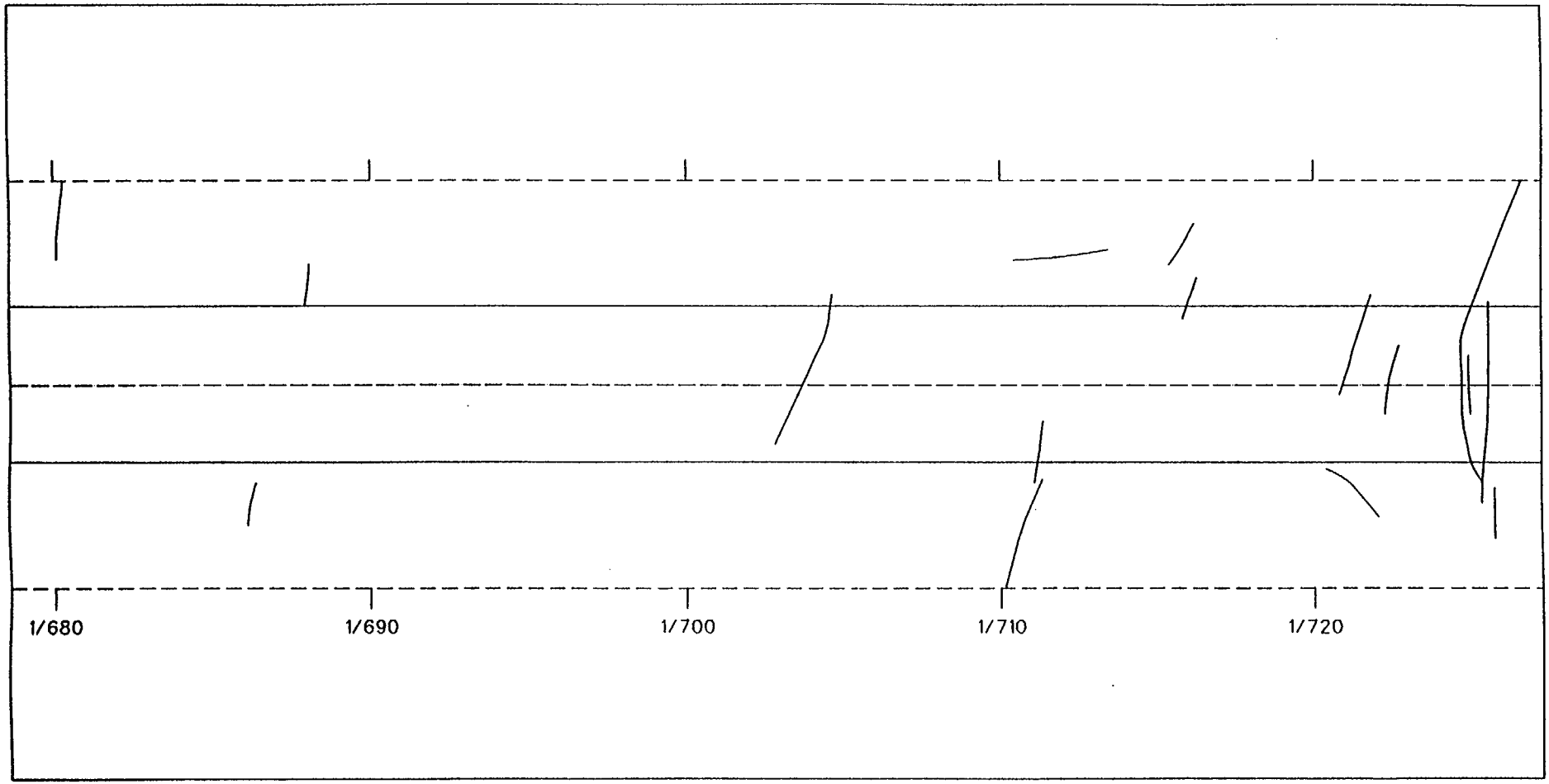

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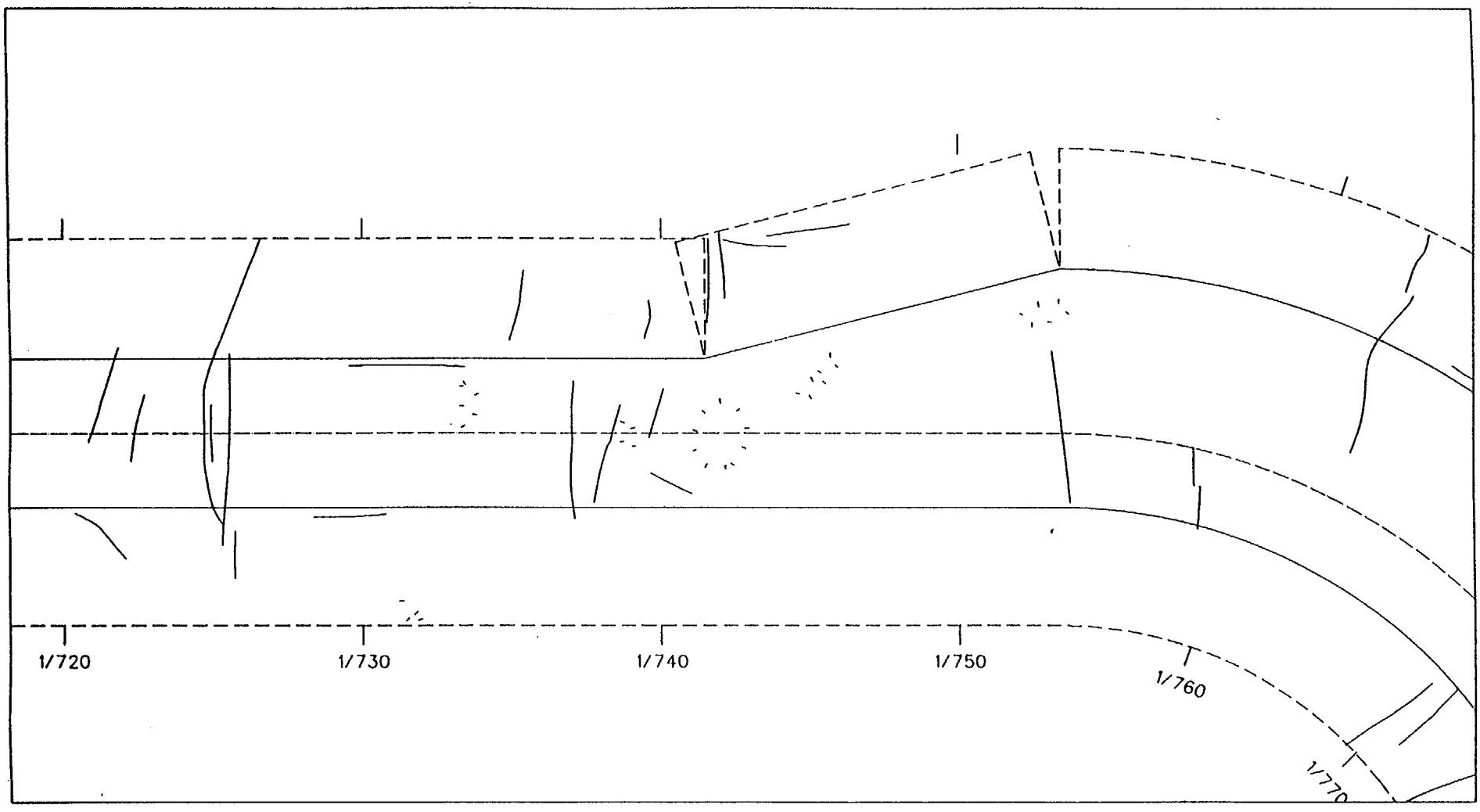

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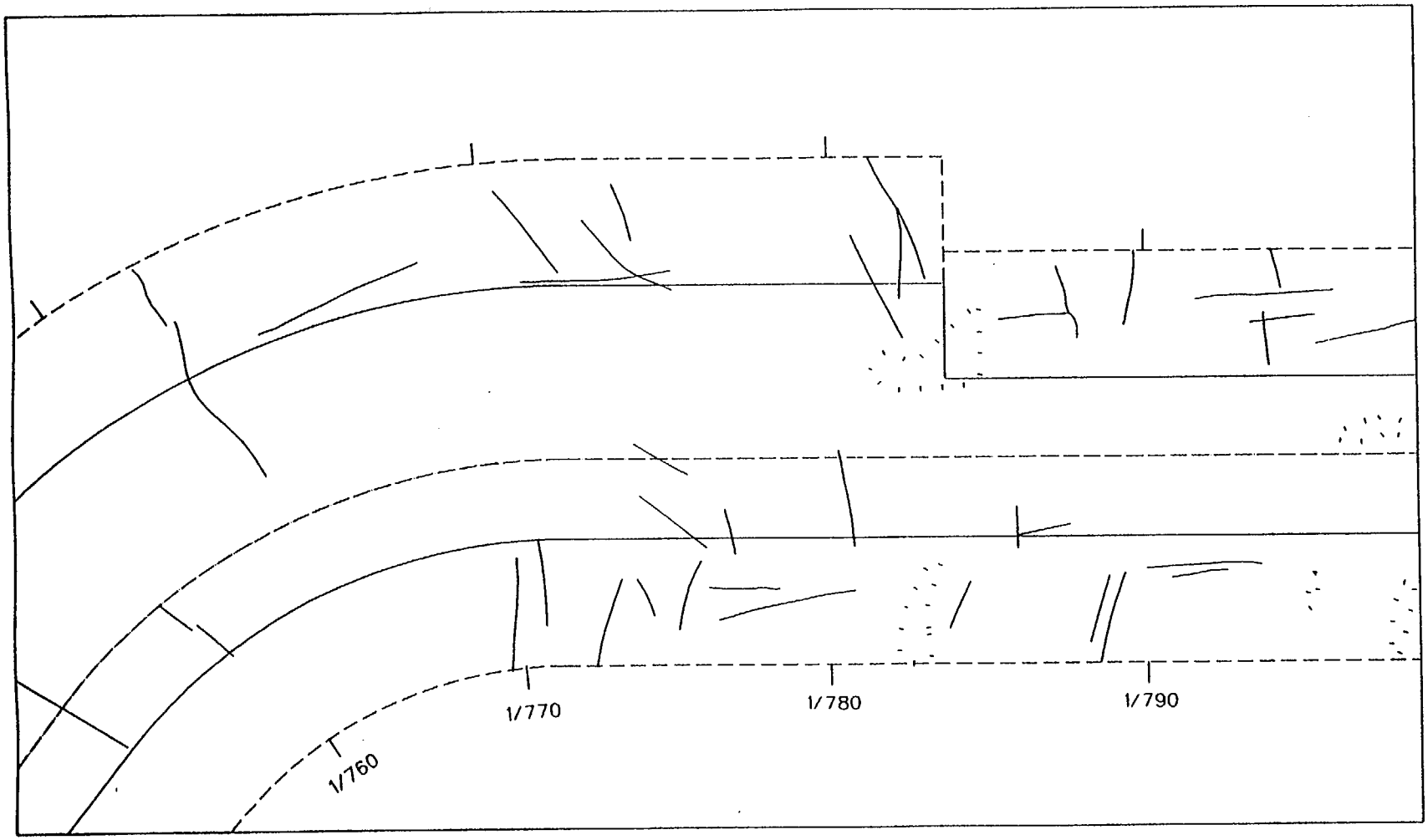

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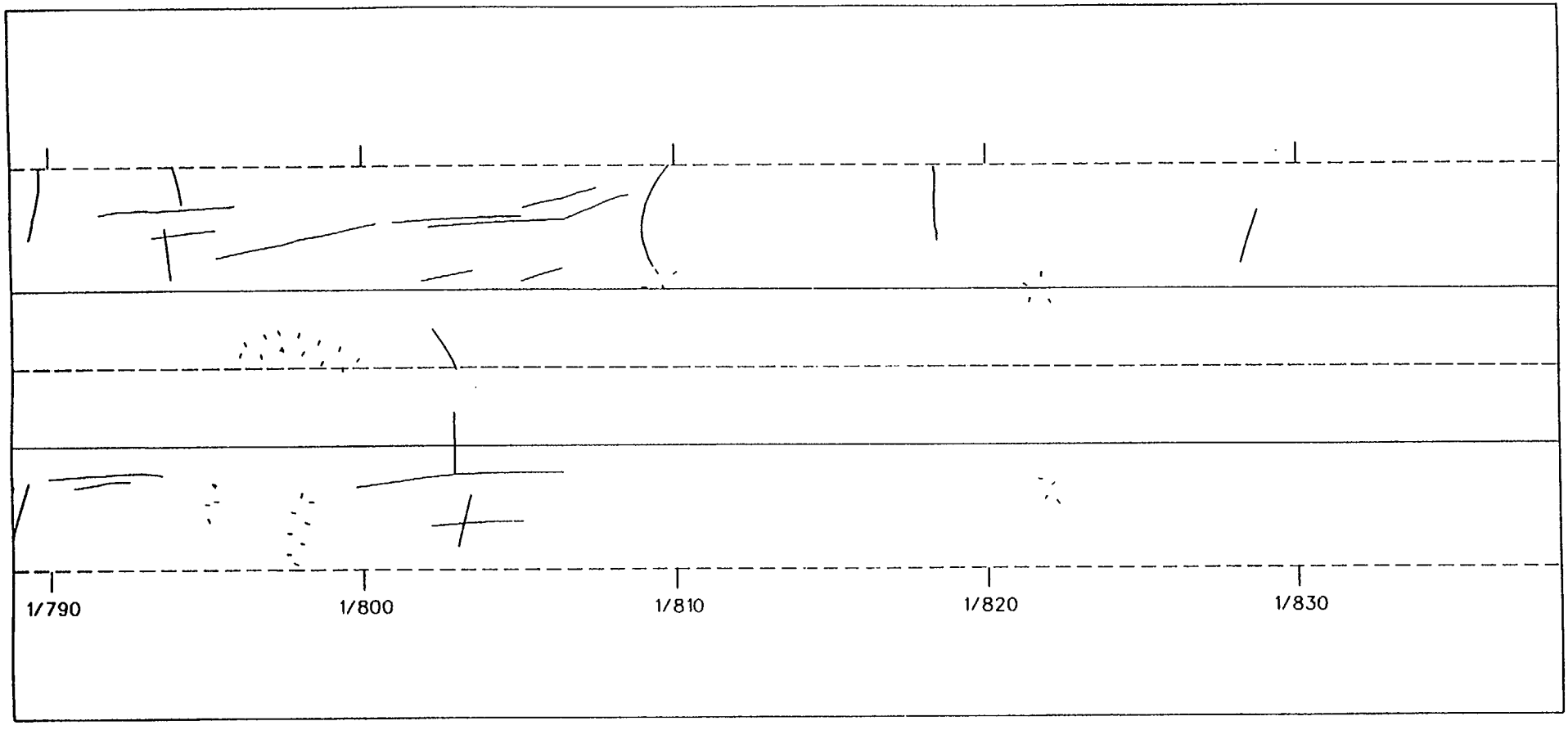

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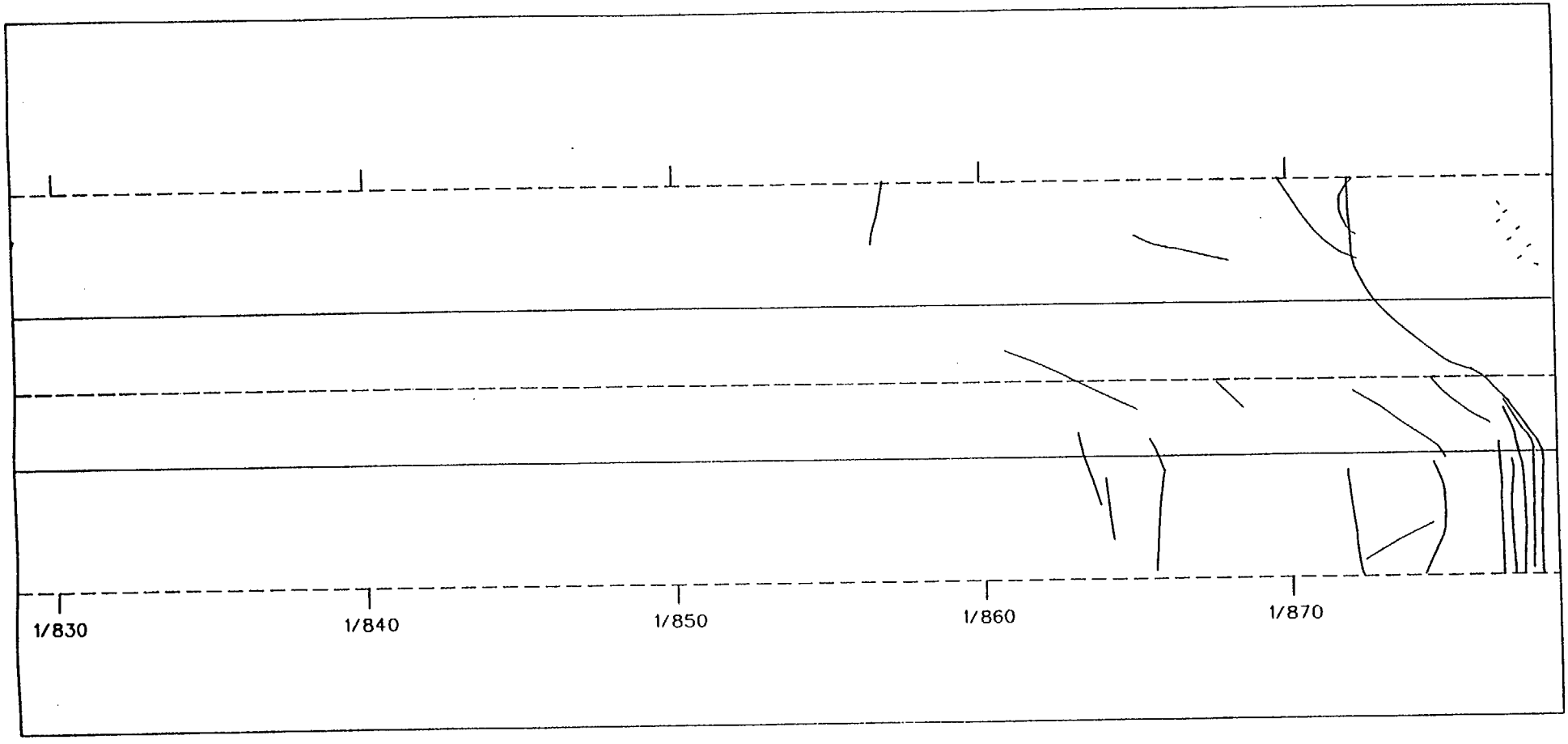

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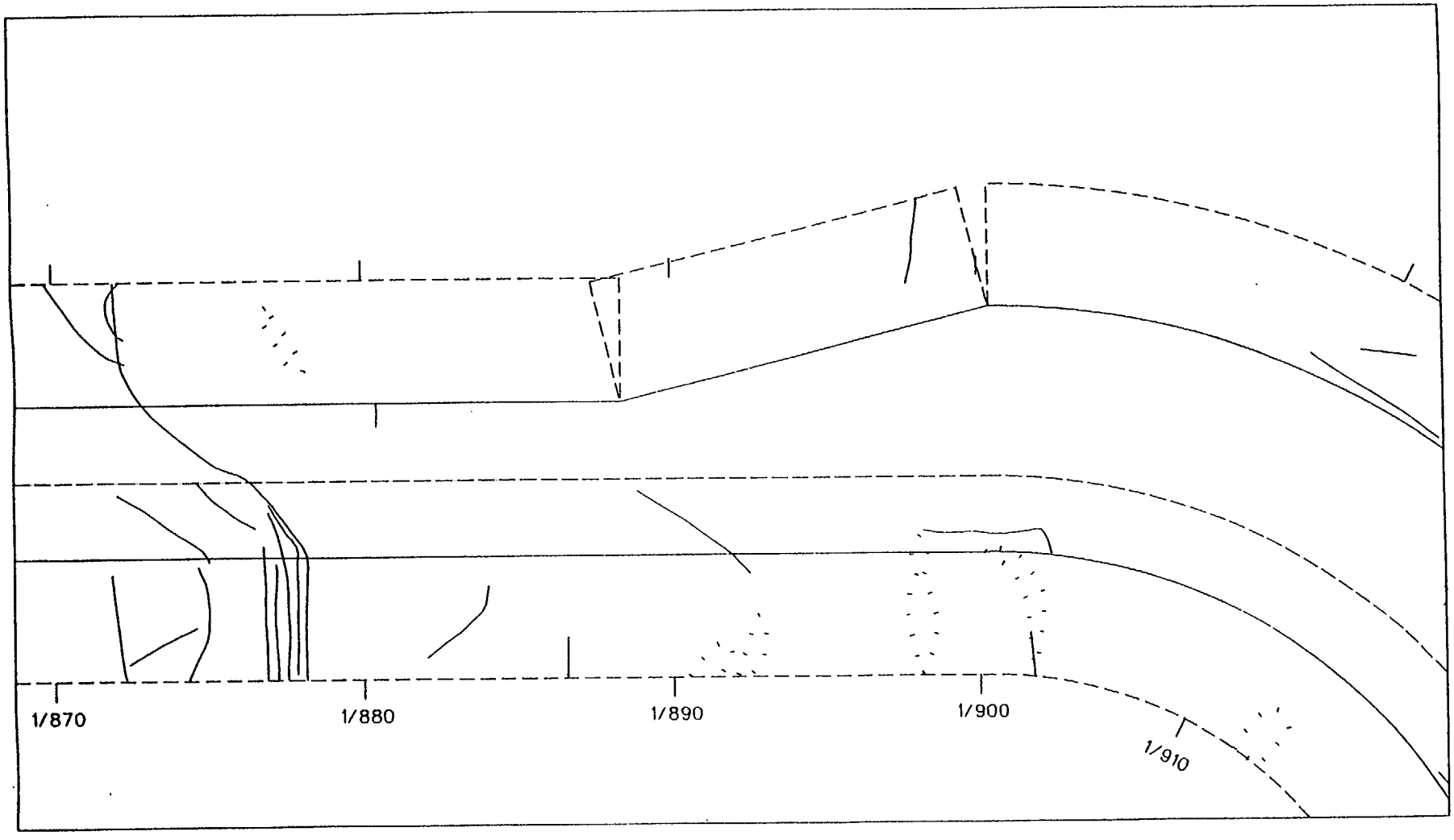

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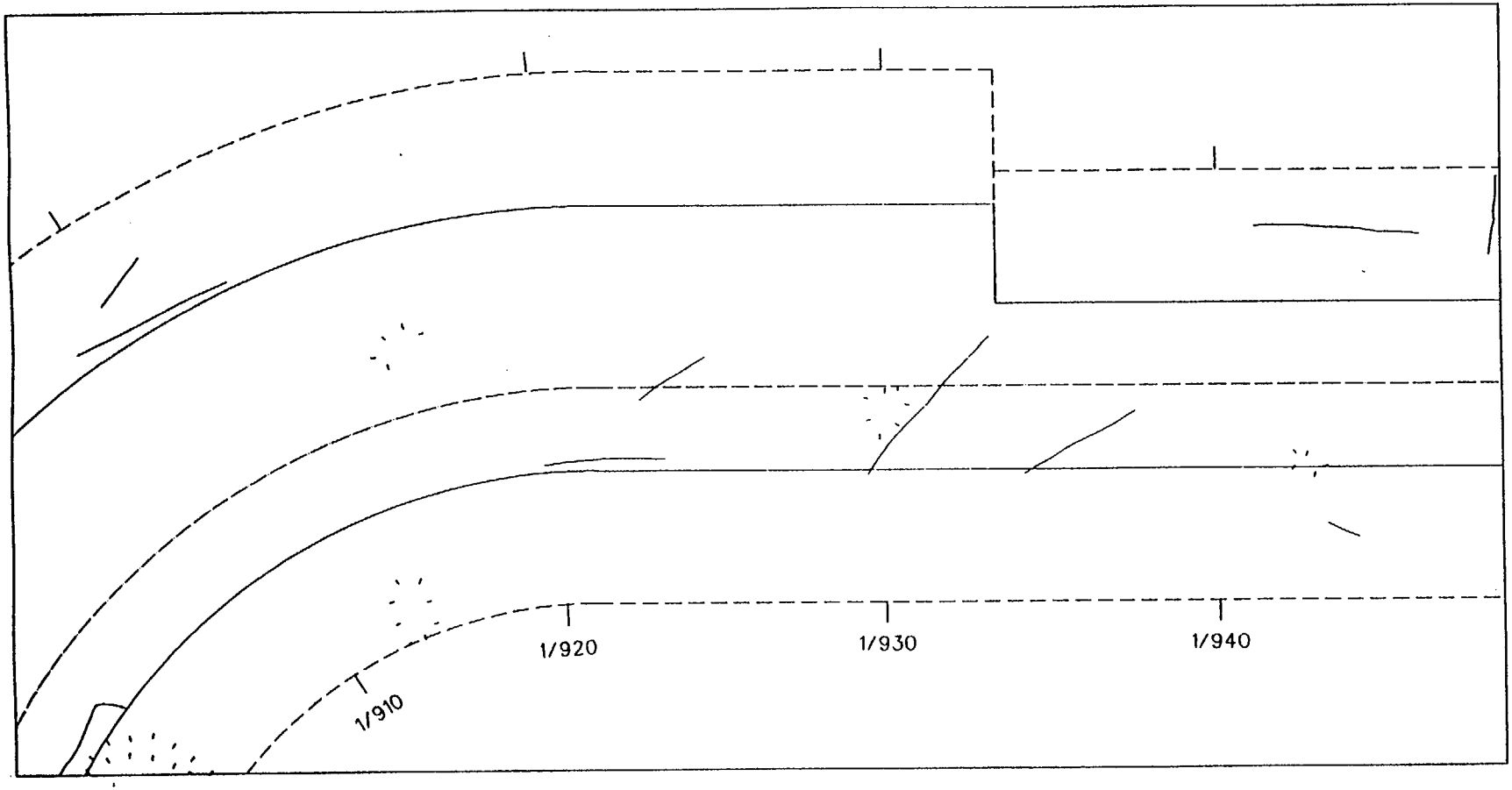

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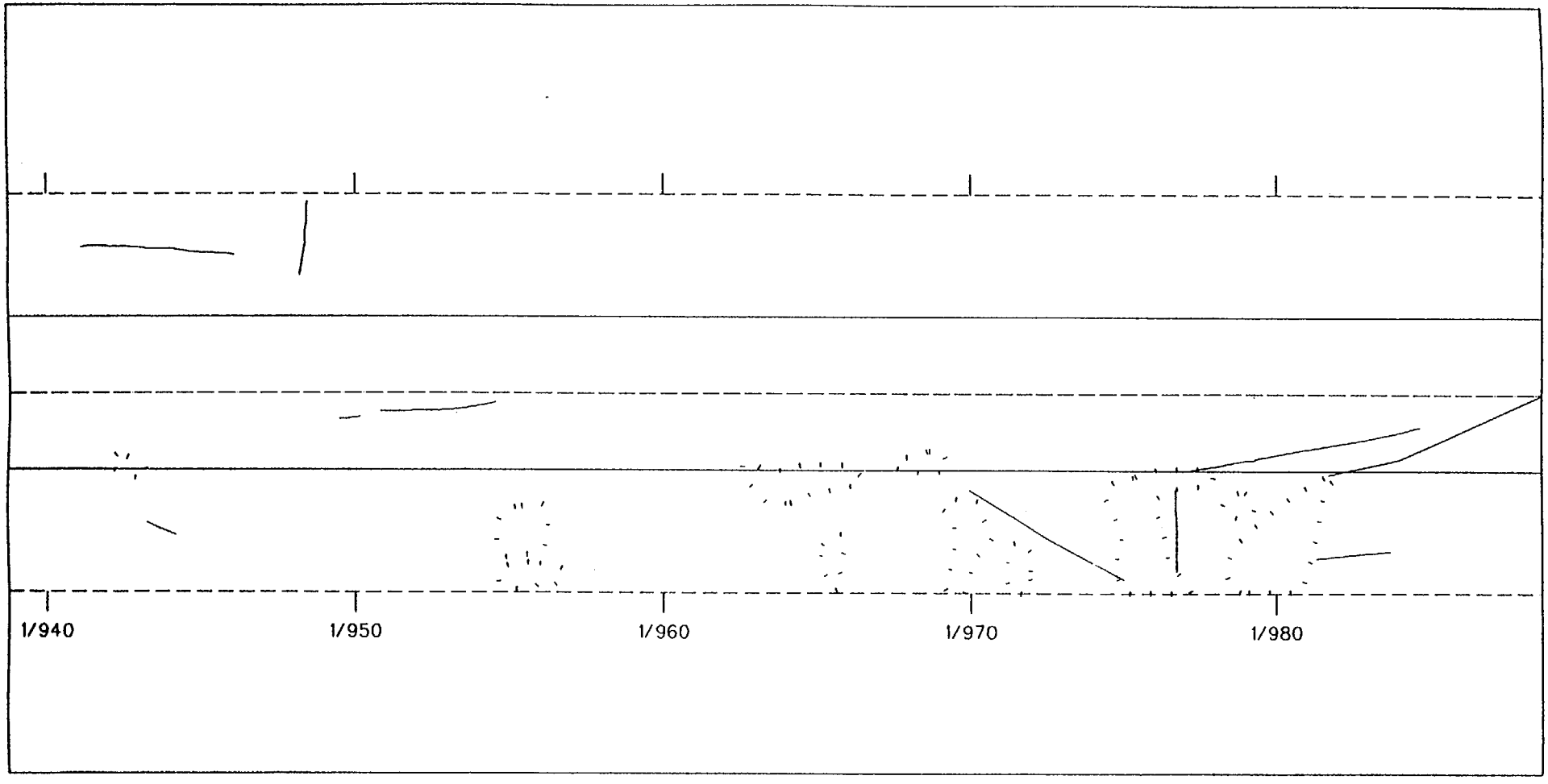

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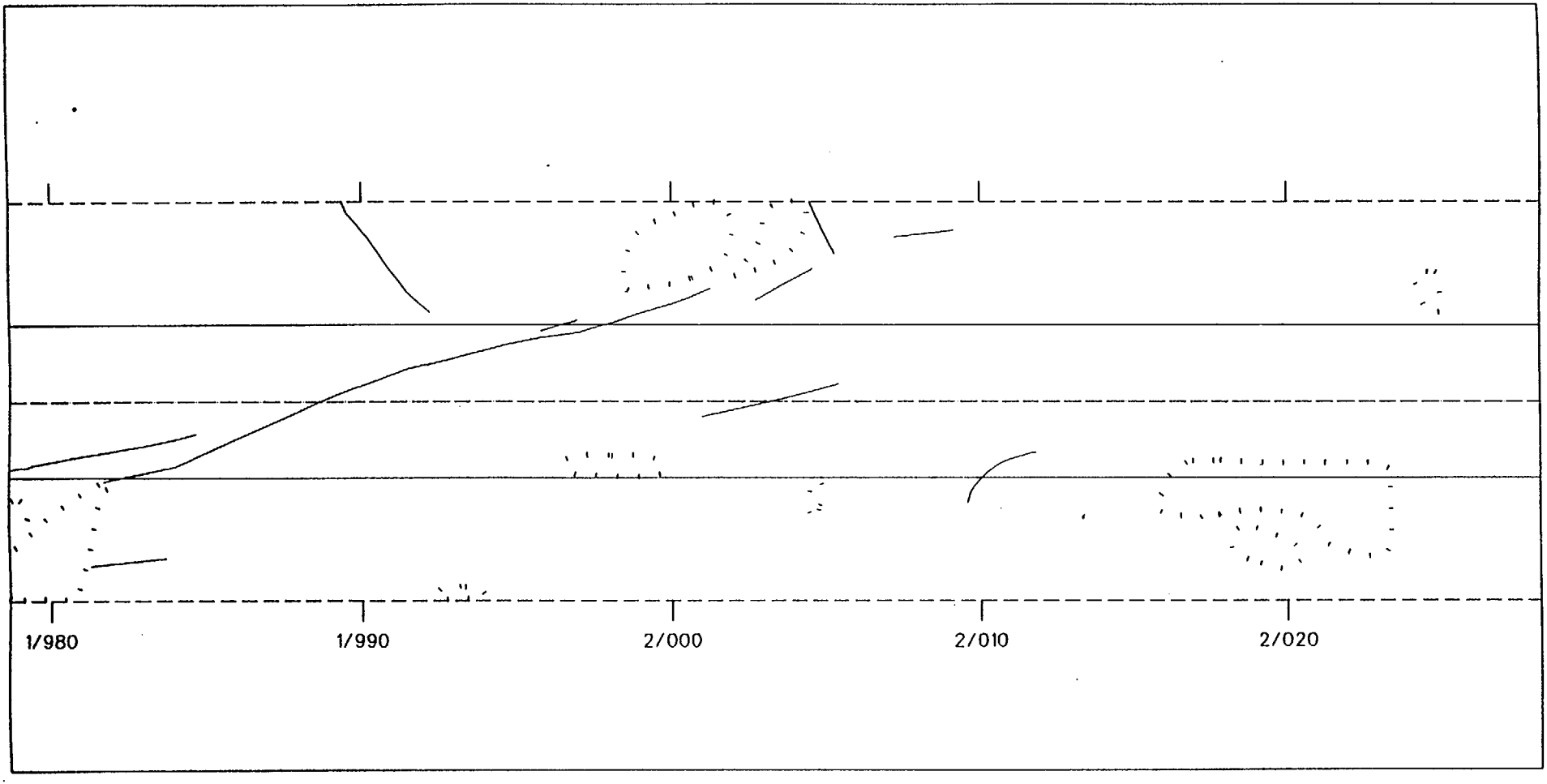

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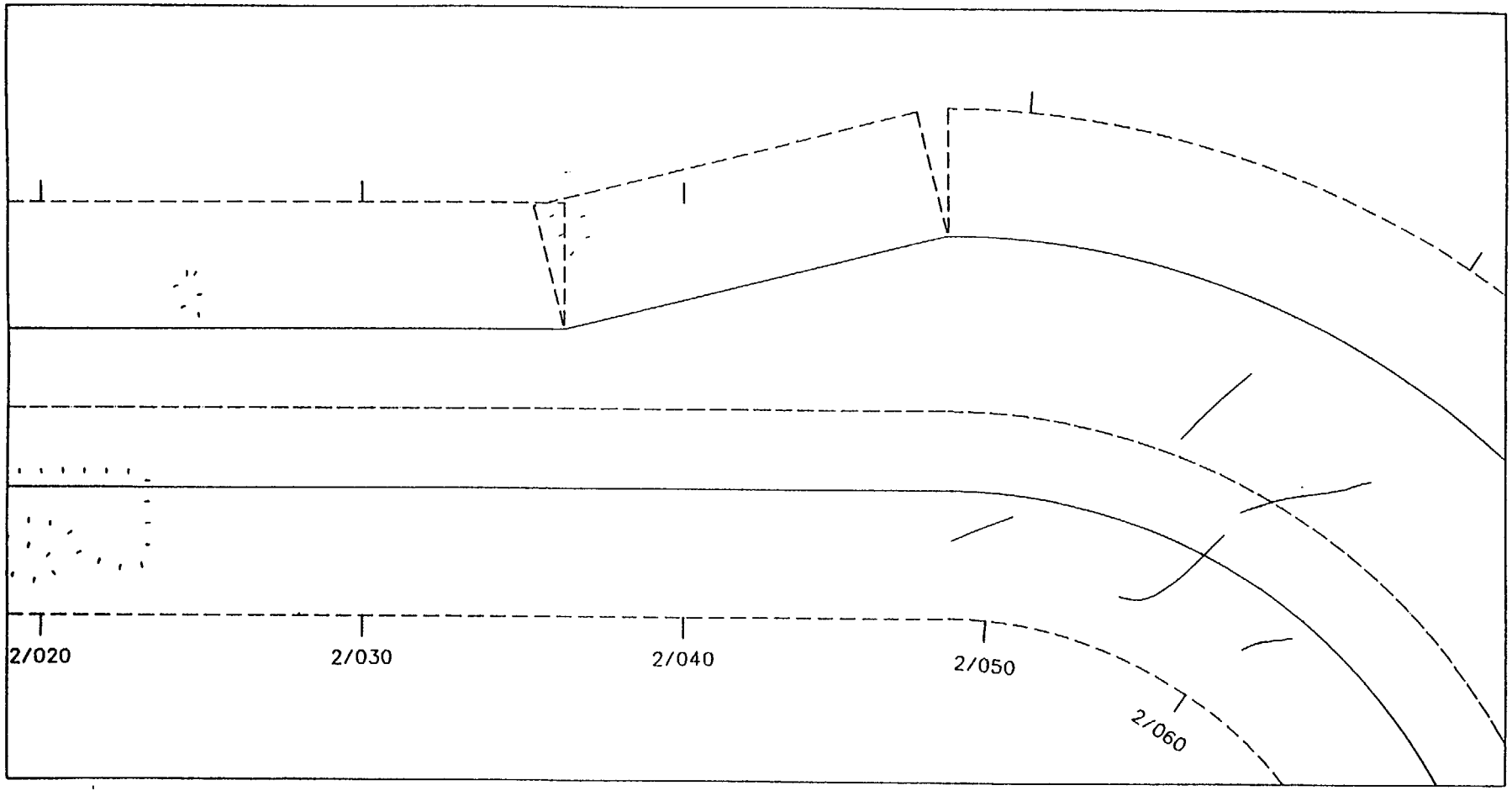

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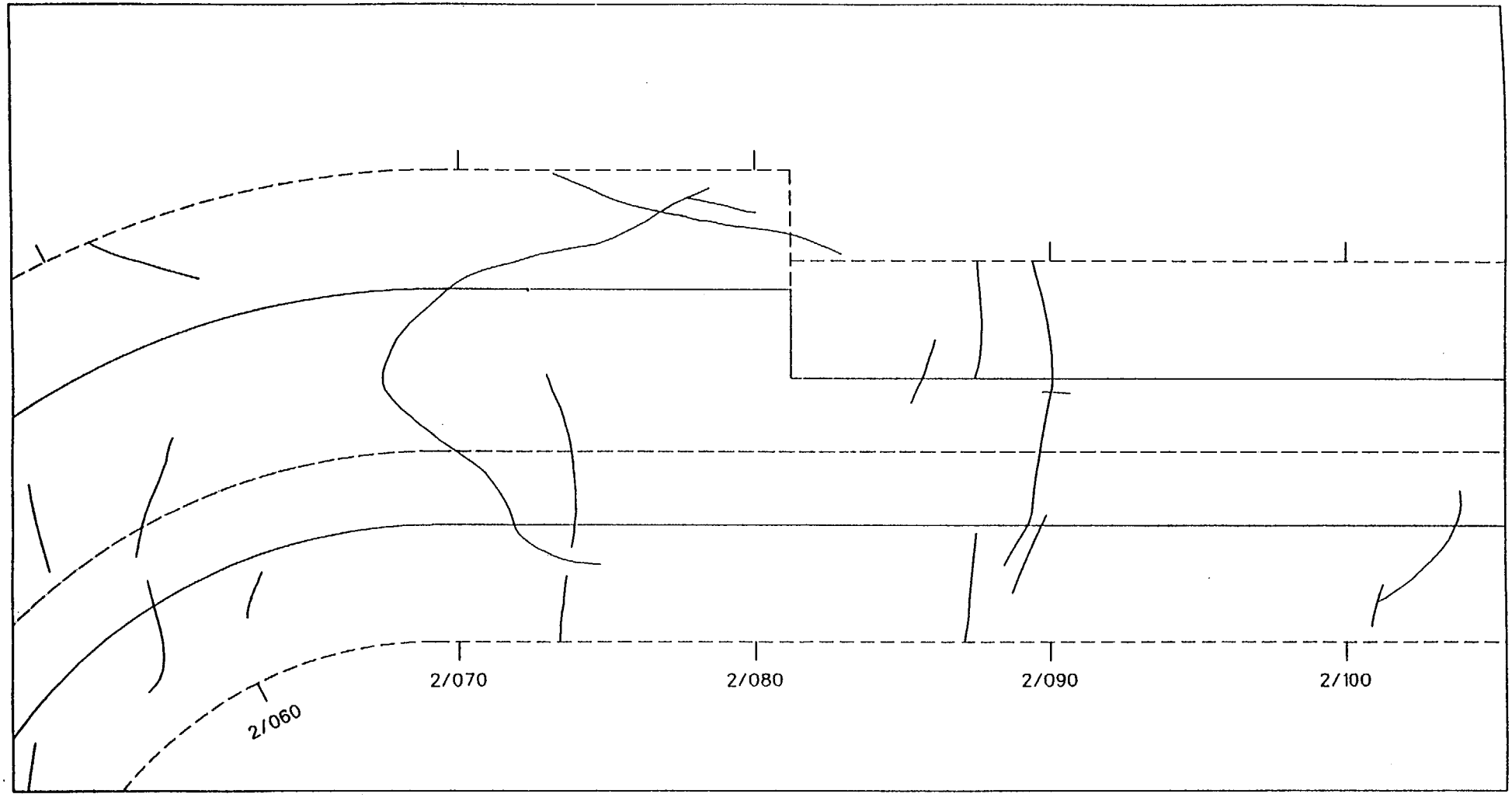

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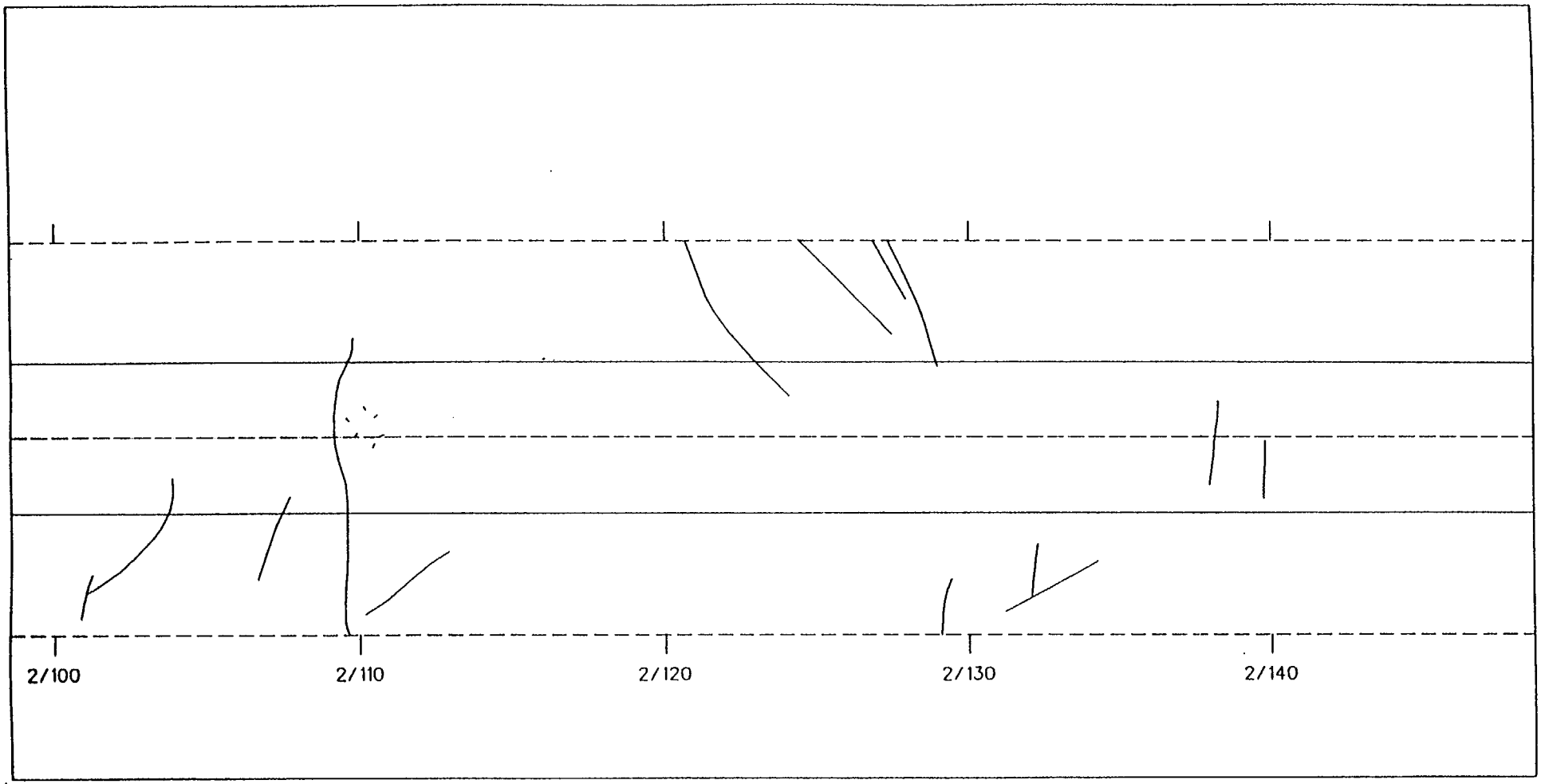

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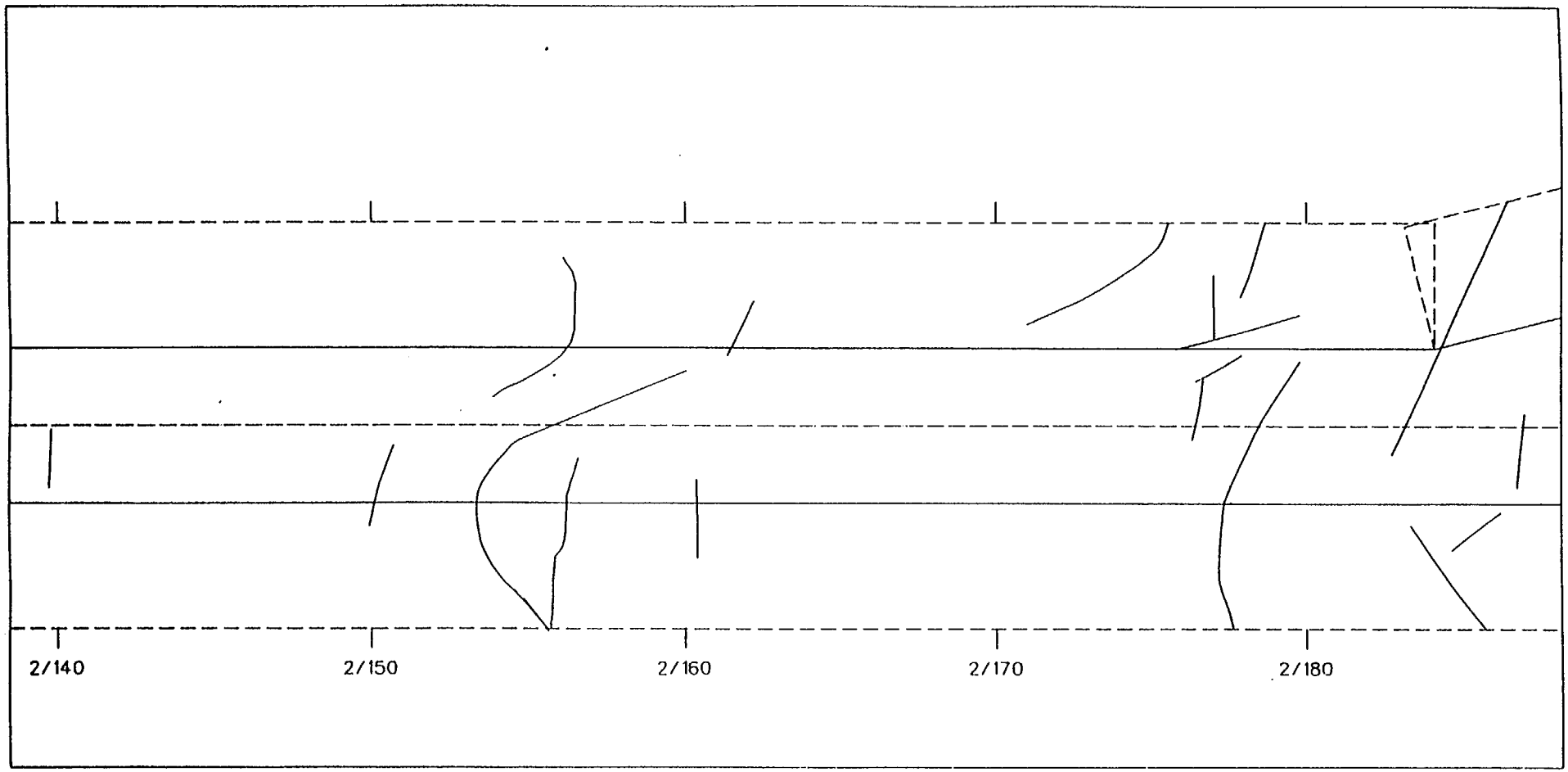

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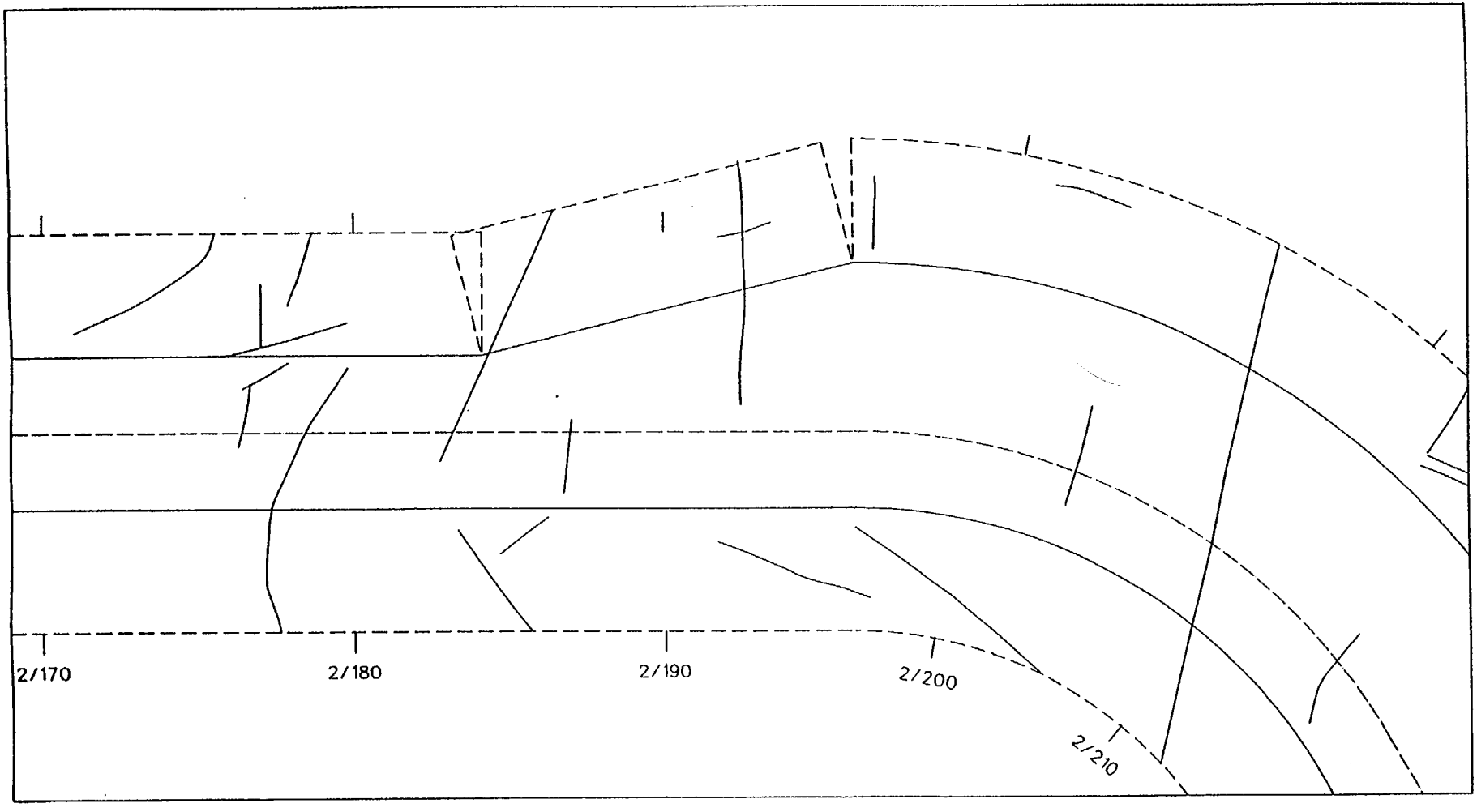

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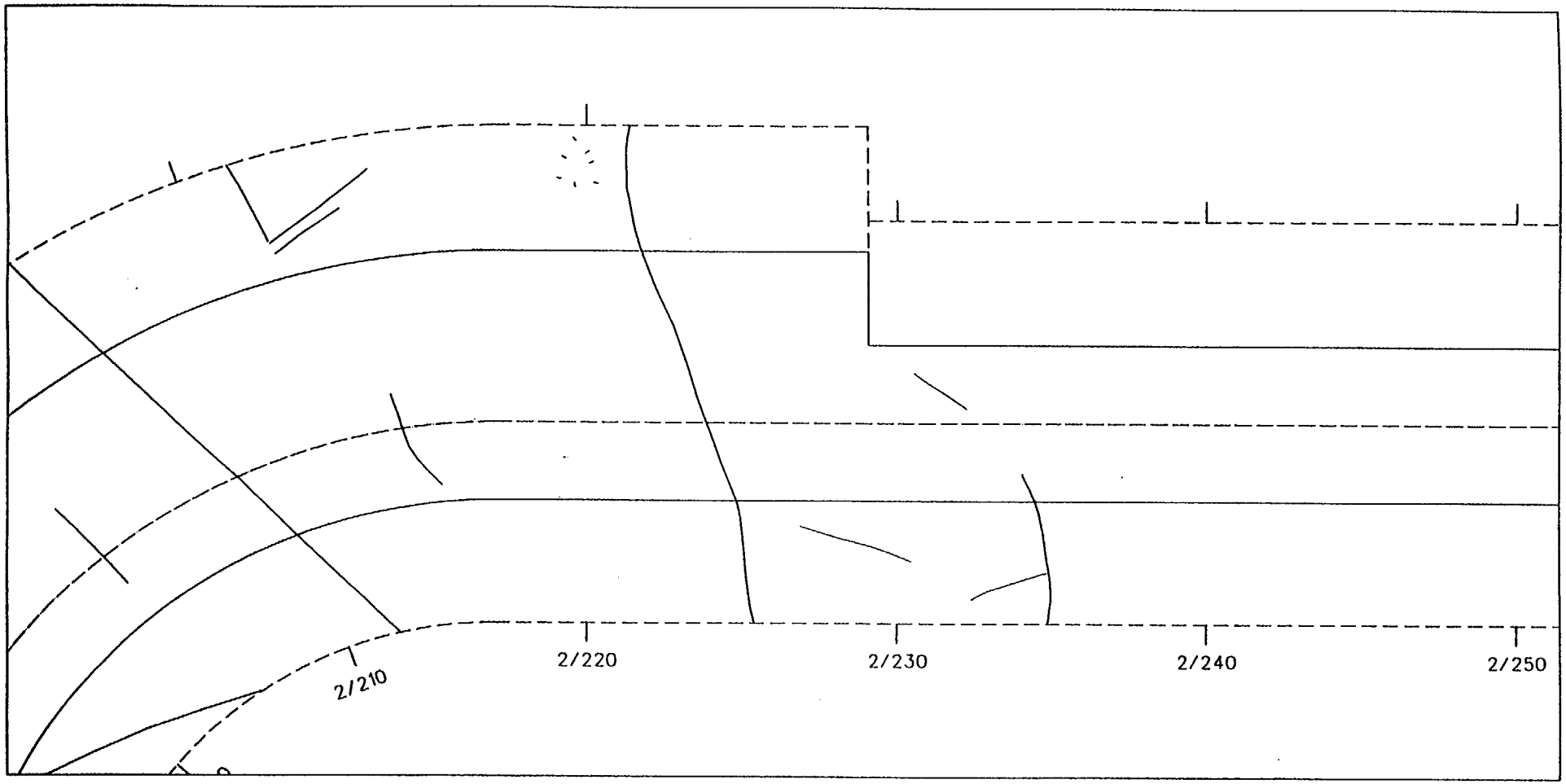

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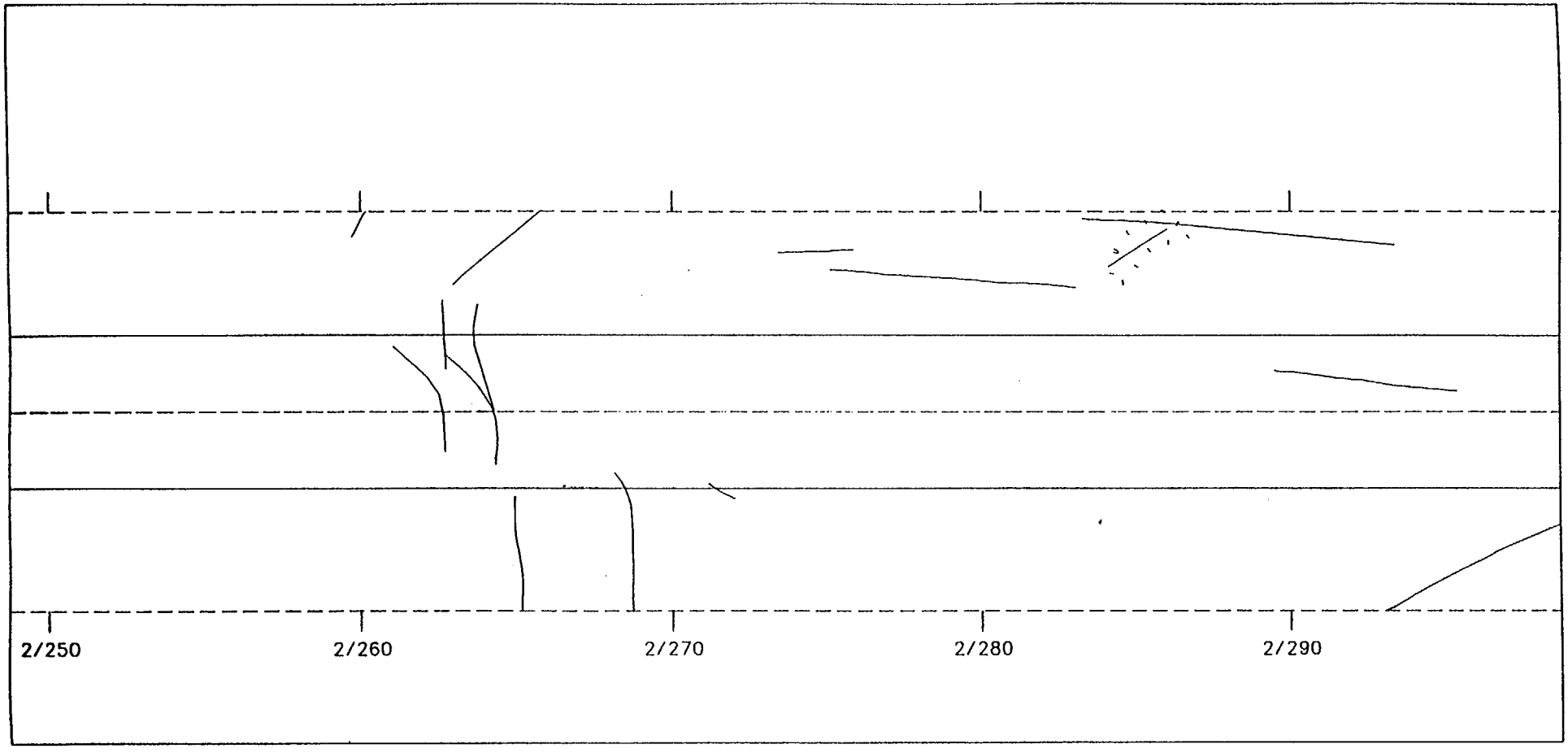

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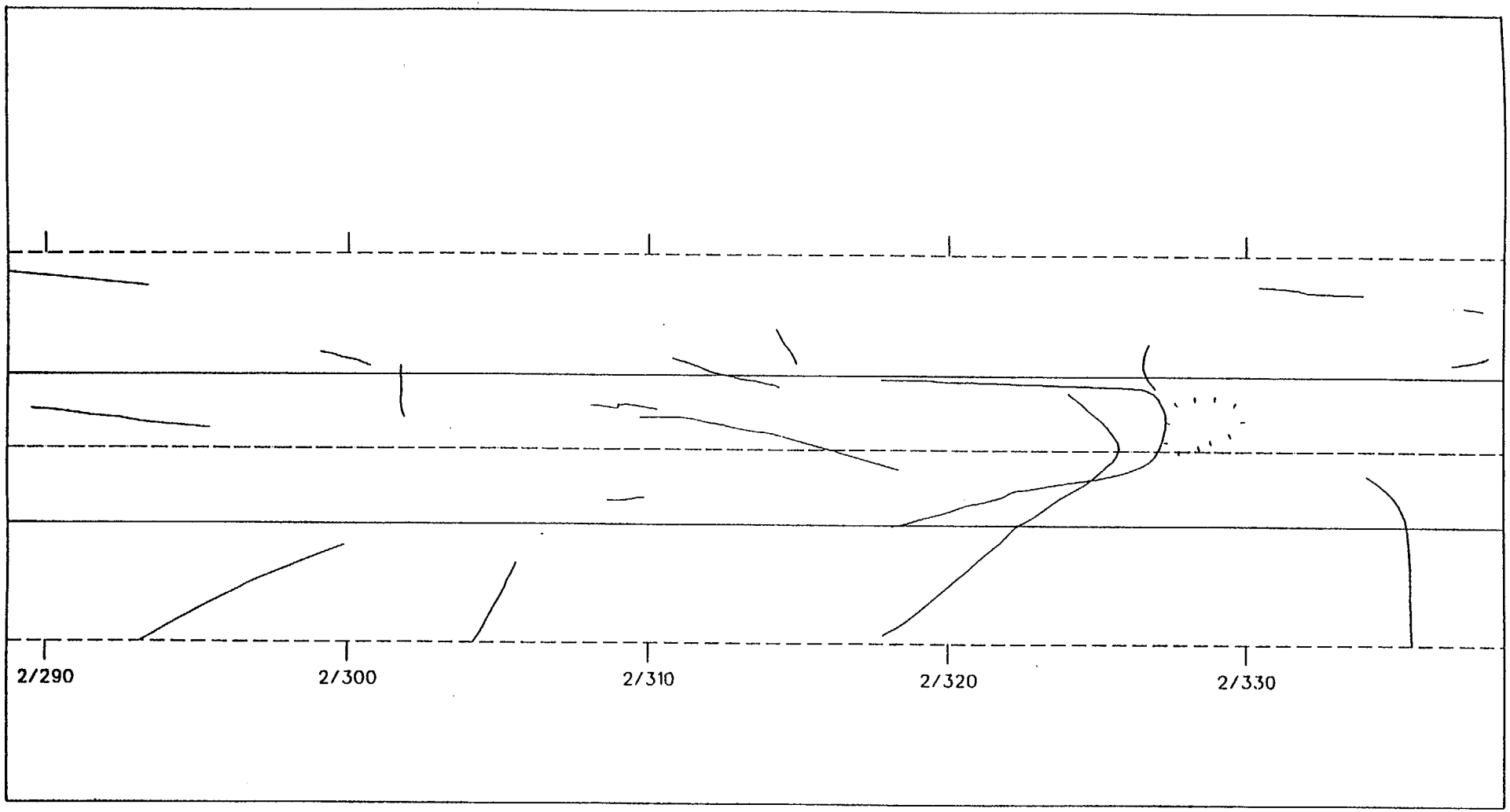

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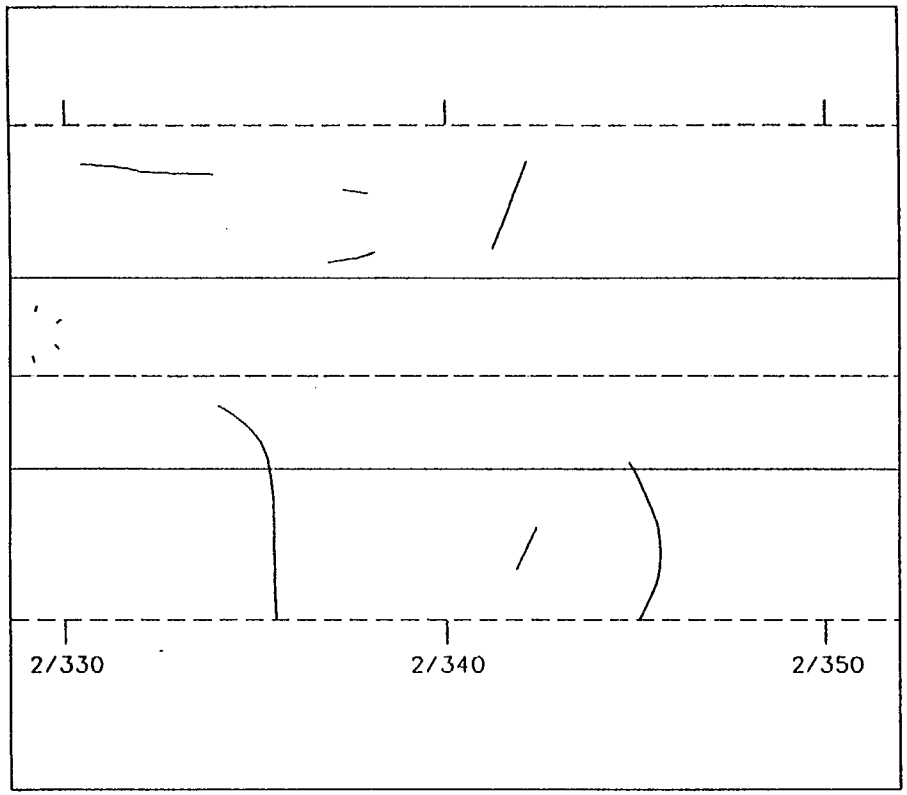

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List of International Cooperation Reports

ICR 93-01
Flowmeter measurement in borehole KAS 16
P Rouhiainen
June 1993
Supported by TVO, Finland

ICR 93-02
Development of ROCK-CAD model for Äspö Hard Rock Laboratory site
Pauli Saksa, Juha Lindh,
Eero Heikkinen
Fintact KY, Helsinki, Finland
December 1993
Supported by TVO, Finland

ICR 93-03
Scoping calculations for the Matrix Diffusion Experiment
Lars Birgersson[1], Hans Widén[1],
Thomas Ågren[1], Ivars Neretnieks[2],
Luis Moreno[2]
1 Kemakta Konsult AB, Stockholm, Sweden
2 Royal Institute of Technology, Stockholm, Sweden
November 1993
Supported by SKB, Sweden

ICR 93-04
Scoping calculations for the Multiple Well Tracer Experiment - efficient design for identifying transport processes
Rune Nordqvist, Erik Gustafsson,
Peter Andersson
Geosigma AB, Uppsala, Sweden
December 1993
Supported by SKB, Sweden

ICR 94-01
Scoping calculations for the Multiple Well Tracer Experiment using a variable aperture model
Luis Moreno, Ivars Neretnieks
Dept. of Chemical Engineering and Technology,
Royal Institute of Technology, Stockholm, Sweden
January 1994
Supported by SKB, Sweden

ICR 94-02
Äspö Hard Rock Laboratory. Test plan for ZEDEX - Zone of Excavation Disturbance EXperiment. Release 1.0
February 1994
Supported by ANDRA, NIREX, SKB

ICR 94-03
The Multiple Well Tracer Experiment - Scoping calculations
Urban Svensson
Computer-Aided Fluid Engineering
March 1994
Supported by SKB, Sweden

ICR 94-04
Design constraints and process discrimination for the Detailed Scale Tracer Experiments at Äspö - Multiple Well Tracer Experiment and Matrix Diffusion Experiment
Jan-Olof Selroos[1], Anders Winberg[2], Vladimir Cvetkovic[2]
1 Water Resources Eng., KTH
2 Conterra AB
April 1994
Supported by SKB, Sweden

ICR 94-05
Analysis of LPT2 using the Channel Network model
Björn Gylling[1], Luis Moreno[1], Ivars Neretnieks[1], Lars Birgersson[2]
1 Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden
2 Kemakta Konsult AB, Stockholm, Sweden
April 1994
Supported by SKB, Sweden

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SKB/DOE Hard Rock Laboratory Studies Task 3. Geochemical investigations using stable and radiogenic isotopic methods
Bill Wallin[1], Zell Peterman[2]
1 Geokema AB, Lidingö, Sweden
2 U.S. Geological Survey, Denver, Colorado, USA
January 1994
Supported by SKB and U.S.DOE

ICR 94-07
Analyses of LPT2 in the Äspö HRL with continuous anisotropic heterogeneous model
Akira Kobayashi[1], Ryo Yamashita[2], Masakazu Chijimatsu[2], Hiroyuki Nishiyama[3], Yuzo Ohnishi[3]
1 Iwate University, Iwate, Japan
2 Hazama Corporation, Ibaraki, Japan
3 Kyoto University, Kyoto, Japan
September 1994
Supported by PNC, Japan

ICR 94-08
Application of three-dimensional smeared fracture model to the groundwater flow and the solute migration of LPT-2 experiment
T Igarashi, Y Tanaka, M Kawanishi
Abiko Research Laboratory, Central Research Institute of Electric Power Industry, Abiko, Japan
October 1994
Supported by CRIEPI, Japan

ICR 94-09
Discrete-fracture modelling of the Äspö LPT-2, large-scale pumping and tracer test
Masahiro Uchida[1], Thomas Doe[2], William Dershowitz[2], Andrew Thomas[2], Peter Wallmann[2], Atsushi Sawada[1]
1 Power Reactor and Nuclear Fuel Development Co., Tokai, Japan
2 Golder Associates Inc., Seattle, WA, USA
March 1994
Supported by PNC, Japan

ICR 94-10
Äspö Hard Rock Laboratory
International workshop on the use of tunnel boring machines for deep repositories
Äspö, June 13-14 1994
Göran Bäckblom (ed.)
Swedish Nuclear Fuel and Waste Management Co.
October 1994
Supported by SKB, Sweden

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Aimo Hautojärvi
VTT Energy
November 1994
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Modelling the LPT2 Pumping and Tracer Test at Äspö. Pumping test
Veikko Taivassalo, Lasse Koskinen,
Mikko Laitinen, Jari Löfman, Ferenc Mészáros
VTT Energy
November 1994
Supported by TVO, Finland

ICR 94-13
Proceedings of The Äspö International Geochemistry Workshop, June 2-3, 1994, Äspö Hard Rock Laboratory
Peter Wikberg (chairman), Steven Banwart (proc. ed.)
December 1994
Supported by SKB, TVO, Nirex, ANDRA, CRIEPI

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Hydrodynamic modelling of the Äspö HRL. Discrete fracture model
D Billaux[1], F Guérin[2], J Wendling[2]
1 ITASCA
2 ANTEA
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Hydrodynamic modelling of the Äspö Hard Rock Laboratory. ROCKFLOW code
M L Noyer, E Fillion
ANTEA
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Hydrodynamic modelling of the original steady state and LPT2 experiments. MARTHE and SESAME codes
Y Barthelemy, J Schwartz, K Sebti
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Jari Löfman, Veikko Taivassalo
VTT Energy, Espoo, Finland
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