ORKUSTOFNUN

NATIONAL ENERGY AUTHORITY

BLANDA HYDROELECTRIC PROJECT ENGINEERING GEOLOGY OF THE AREA OF PROPOSED UNDERGROUND WORKS SUMMARY

Prepared for Landsvirkjun
The National Power Company

OS-83033/VOD-16 B April 1983

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FIGURES

TABLES

1 GENERAL GEOLOGY

The bedrock of the reservoir area and the tunnelling area can be classified into two different formations according to their ages. In the reservoir area, and northwards to the intake the bedrock is built up of quaternary lava's and tillite layers. Beneath the quaternary formation in the tunnelling area the bedrock is of tertiary age, made of basaltic lavas with interbeds of fine grained sandstone and tuff. Average dip of the tertiary layers is 7-9 degr. to the west but the quaternary formation dips about 1 degr. to south west.

The bedrock in the tunnelling area at Blanda is covered by 5-10 m thick till, tillite and peat. Bedrock is exposed in the Gilsá creek and along the Blanda river. Figure 1 is a geological map of the project area showing the locations of geological sections in figures 2 - 4 and the main exposures in the bedrock.

Hiatus of approximately 4 million years is between the quaternary and tertiary formations, the quaternary rock being 0,5-2 million years old, but the tertiary rock 6-7 million years old.

The tertiary bedrock has been devided into four series, named Tholeiitic series I - Mixed series I - Tholeiitic series II and Mixed series II respectively from bottom to top of the strata pile in the tunnelling area (see figures 2,3 and 4). Tunnels and powerhouse cavern will be located entirely within the tertiary rock.

Tectonic lineation can be seen on air photos of the project area. The most prominent features are drawn on figure 1 and a rose diagram of the lineations is shown in the upper right hand corner. Field investigation and exploratory drilling have shown many of these to be faults. The lineations have two distinct major directions, NW and NNE. The existing trench at the proposed access tunnel portal indicates a higher frequency of faults than is exposed by the surface features.

1.1 Rock series

Tholeiitic series I

The series is made of 5-7m thick tholeiitic lavas with interbeds of sandstone and volcanic tuff. The downstream end of the tailrace tunnel is expected to cut through this series for 200-300 m length.

Mixed series I

Total thickness approximately 50m, consisting of porphyritic basalts with 3-4 interbeds of tuff and sandstone. Approximately half the length of the tailrace tunnel is expected to be within this series.

Tholeiitic series II

Total thickness 120m. Built of tholeiitic lavas, 7m thick on the average with a 2m thick tuffaceous sedimentary rock layer in the middle part. Powerhouse cavern is expected to be located within this series, also the upstream end of the tailrace tunnel and the entire access tunnel.

Mixed series II

The topmost part of the tertiary bedrock. The suite is some 350m thick, made of basalt layers of various types and thick layers of sedimentary rocks, sandstone to conglomerate and tuff. The pressure shaft and cable shaft are expected to cut vertically through this series.

1.2 Tectonics

While the tertiary formation was piling up the landscape in the area has been relatively flat causing regular horizontal stratification. Evidence of volcanic activity within the area has not been found in the pile so that lavaflows must have originated from some adjacent volcanic field. During phreatic phases of eruptions the land has been covered with thick layers of volcanic ash and pumice. As time passed and the pile grew thicker the layers of this loose airborn material turned into the colorful sedimentary rock we now see in mixed series I and II.

Later on (possibly in connection with the rifting zone that was active in northern Iceland 4-5 million years ago) the bedrock tilted to the west. The area was broken into blocks by two fault systems trending NW and NNE. The majority of the faults have a downthrow on the eastern side.

2 GEOLOGICAL CONDITIONS FOR INDIVIDUAL UNDERGROUND STRUCTURES

2.1 Access tunnel

For location and orientation of the access tunnel see figures 1 and 2. The grade of the tunnel will be about 7 degr. which is a little less than the measured dip of surrounding strata. Hence, in regularly stratified rock the tunnel would follow the same layers for relatively long distances. However, due to tectonic irregularities this will not be the case. Figure 2 shows a geological cross section of the access tunnel route constructed from the presently available geological data. According to figure 2 the access tunnel is expected to cut tholeiitic series II. In the access tunnel portal trench four faults are found within the 90m long excavation so the number of faults shown on figure 2 is possibly a lower limit. Four boreholes (BV-13, -20, -21, and -27) have been drilled near the proposed access tunnel route down to the tunnel elevation (see graphic core logs on figures 7, 9, 10 and 13).

2.2 Intake

Approach canal, intake and penstock from intake to pressure shaft will cut through and be founded on the quaternary formation (see figure 1 for location). Figure 3 shows a geological section of the intake area based on core from exploratory holes (see core logs on figures 5a, 5b, 9 and 12).

The intake will be founded on till, tillite and basalt. The basalt layers have limited horizontal extent probably due to topographic irregularities at the time of formation.

Penstock will be in similar layers as the intake, basalt, till and tillite. (till = loose glacial deposit of silt, sand and boulders, tillite = till consolidated to rock)

2.3 Pressure and cable shafts

The geological section in figure 3 is based on core from vertical and inclined boreholes. Length of the pressure shaft is 240m. The upper 180m are shown in mixed series II but the lower 60m in tholeiitic series II. Layers of sedimentary rock vary widely in thickness and properties. The cable shaft is shown to be located in the same formations as the pressure shaft. Figures 9 and 13 show the graphic core logs of boreholes BV-20 and -27.

2.4 Powerhouse cavern

The cavern will be located more than 200m below the surface, most probably in basalt layers, in tholeiitic series II. The series is about 120m thick pile of some 20 basalt layers with few, thin interbeds of sand- and siltstone. Each basalt layer can be divided in two parts, centre part and scoria, according to geotecnical properties (see pages 10-11). The top and bottom scoria of adjacent basalt layers is sometimes interwoven to form continous layer without sharp contacts.

Boreholes in vicinity of the powerhouse give evidence of faulting in the area of the proposed cavern. This can be seen from constructed stratigraphic models (see figure 4) and directly from drillcore where boreholes have actually crossed faults. As information from borholes is limited little can be stated about exact number and location of faults or displacements along them.

2.5 Tailrace tunnel

Approximate length of tailrace tunnel will be 1700m with invert mostly at elevation 111m. Stratigraphic section of the tunnel route (see fig.4) is based on boreholes along the tunnel axis (see graphic core logs on figures 6, 7, 8, 11 and 13), exposures along the Blanda river at the tailrace tunnel portal and exposures in the Gilsa creek. Dip of the lava pile has been measured 7-9 degr. towards WSW (240 degr.) but the tailrace tunnel axis has the direction NNE (36.5 degr.) making an angle of 25 degr. with dip direction. Thus the strata make an angle of about 6-7 degr. with the horizontal in the direction of the tunnel, dipping down towards the powerhouse. The tunnel is shown to cut through tholeiitic series I and II and mixed series I. The constructed section, which is based on the presently available geological data shows a tentative division between series along the tunnel route, counting from the powerhouse downstream to the portal as follows: First 600m in tholeiitic series II, 600-1450m in mixed series I, 1450-1550m in tholeiitic series I. Near 1550m a large fault with a downthrow of approximately 90m on the eastern side is expected to cross the tunnel route. Therefore the rest of the tunnel, 1550m to the portal at Blanda is shown to cut through tholeiitic series II.

2.6 Tailrace canal

Invert of the tailrace tunnel at the downstream end will be at elevation 119.3m. Present surface elevation in the Blanda river course at this point is 126m. Overburden is 1-3m thick coarse gravel resting on basalt.

3 BEDROCK PERMEABILITY IN THE TUNNELLING AREA

Permeability tests have been performed in all exploratory boreholes in the tunnelling area. Estimates of expected leakage into the powerhouse cavern and the tunnels are based on the results of these tests. Two different test methods have been used; the packer test and the constant head test (see OS82-121/VOD-55B pages 20-21).

3.1 Geology and groundwater

The groundwater movement in the area is probably controlled mostly by faults and fissure zones. Variations in ground water table indicate separate aquifers. These aquifers are bounded by more or less vertical, semi-permeable faults and gently dipping semi-permeable strata (sedimentary rocks). Open cracks and permeable fault-breccia act as conductors between aquifers.

The inclined borehole BV-32 crossed a rather large fault (see fig.3). The permeability of the fault-breccia was measured in a packer test and was found to be very low (ca 1 LU). In borehole BV-10 on the other hand, a rather permeable fault breccia was found at a depth of 235m (see fig.14). Thus the faults can act both as water conductors and barriers. In both cases they significantly affect the behaviour of the local ground water.

Ground water table measurements have shown that water pressure differences over faults and impermeable strata can be as high as 3-4 kg/cm2. In borehole BV-14 for example, the ground water table fell and rose three times during drilling and by the end of drilling the water flowed out of the top of the borehole (see fig.14).

Vertical flow between aquifers was observed in some boreholes. In borehole BV-22 (see figure 14) tests indicate that 30-40 l/min flowed from the upper part of the borehole (aquifer with high piezometric head) down to the lower part (aquifer with lower head).

Due to the complex nature of the ground water conditions and the limited knowledge of the permeability of each rock unit it is not justifiable to treat different tunnel routes individually. The results of the borehole permeablity tests are summarized in figures 14 and 15. Generally speaking the permeability is low (0-5 LU) but most of the boreholes have crossed some leakage paths. The maximum measured leakage is 1000 LU for a 3m long interval (see BV-12 in Fig.14).

The bedrock in the tunnelling area has been divided into 4 rock series as mentioned earlier. Leakage paths are found in all series, but tholeiitic series II seems to be the least permeable.

A number of minor springs connected to faults in the quaternary bedrock have been found in the Gilsa creek. Springs have also been found in the creek along faults in the tertiary bedrock.

Faults and impermeable strata divide the bedrock into a number of seperate aquifers ("compartments"). The ground water conditions in each aquifer and their interconnections seem to be complicated and difficult to assess.

Potential leakage paths are some faults, open cracks and possibly some contacts between layers.

For a more detailed discussion on ground water conditions in the tunnelling area and the borehole permeability tests the reader is referred to the report OS82-121/VOD-55B.

4 ROCK MECHANICAL PROPERTIES

The bedrock in the tunnelling area has been divided into five different rock mechanical units:

1. Basalt
2. Scoriaceous contact breccia
3. Sedimentary rock
4. Fault breccia
5. Basaltic dykes

4.1 Basalt

The basalt (mainly of two rock types, tholeiitic and porphyritic basalt) is the most common rock in the area (see Figs. 2-4). Some technical properties of the basalts are summarized in Table 1. All values are based on measurements on drillcore from the proposed tunnel elevations in boreholes BV-27, -22, -21, -20, -14, -13, and -12.

The thicknesses as well as the RQD's of each basaltic layer were measured on rock cores. All drillcore from the tunnel elevations was classified using the Norwegian rock mass quality classification system (the Q-system, see OS82-122/VOD-56B for references). Some minor modifications have been made to the original system in an attempt to fit it better to the geological conditions in Iceland. It should be emphasized that the Q-system has never been used before in underground works in Iceland so the practical experience is very limited. The Q-values should be looked upon only as a relative measure of the quality of the rock.

The uniaxial strength was measured on intact samples in the laboratory both using the conventional uniaxial test and the point load test (see Appendix in OS82-127/VOD-57B).

Table 1 Some rock mechanical properties of the basalt

	Thickness (m)	RQD (%)	Q	Uniaxial Strength (MPa)
Min	1.0	0	0.5	50 Vesicular,altered
Max	14.0	100	8.0	260 Massive,fresh
Typical	3.0-6.0	40-60	3.0-6.0	150-190
Weighted average	4.5	50	3.9	145
Number of measured layers/tests	115	115	115	31

4.2 Scoriaceous contact breccia

The scoriaceous contact breccia (or simply scoria) is a well cemented mixture of massive and scoriaceous glass and basalt fragments with silt and clay fillings of varying degree. This rock mechanical unit is found on almost every contact between basaltic layers. The thickness of each scoria layer can vary considerably over short distances. A summary of some rock mechanical properties of this unit is given in Table 2.

Table 2. Some rock mechanical properties of the scoriaceous contact breccia.

	Thickness (m)	RQD (%)	Q	Uniaxial strength (MPa)
Min	0.1	0	0.2	10 poorly cem.
Max	6.8	100	7.8	60 well cem.
Typical	1.0-2.5	50-80	3.5-6.5	
Weighted average	2.0	60	4.2	30
Number of measured layers/tests	87	87	85	5

4.3 Sedimentary rock

Sedimentary rocks form a considerable part of both upper and lower mixed series in the tunnelling area (see Figs. 2-4). The rock is mostly of pyroclastic origin , basaltic and acid tuff. At the tunnel elevations these rocks are mostly silty sandstone, conglomerate and clayey siltstone. Some rock mechanical properties of the sedimentary rocks are summarized in Table 3.

Table 3 Some rock mechanical properties of sedimentary rocks

	Thickness (m)	RQD (%)	Q	Uniaxial strength (MPa)
Min	0.1	0	0.1	10
Max	17.5	100	3.1	60
Typical	1-4	40-80	0.8-1.2	20-40
Weighted average	3.1	55	1.0	30
Number of measured layers/tests	45	44	43	36

4.4 Tests on sedimentary rock

The following tests have been carried out on sedimentary rock samples:

1 Point load strength test
2 Saturated density
3 Natural water content
4 Grain size distribution below 200 mesh
5 Swelling test on finely ground (125 microm sieve) and dried samples
6 Swell pressure test -------- " --------------
7 Free swelling test -------- " --------------
8 Water suction and volume increase
9 Uniaxial swelling of undisturbed samples at natural water content
10 Water reaction classification test of dried samples
11 X-ray diffraction analysis

Main results

1 Point load strength index for the layers; Is = 0.42 - 2.71 MPa corresponding to uniaxial strength of 10 - 60 MPa (100 - 600 kg/cm2).

2 Saturated density = 1.80 - 2.24

3 Natural water content = 20 - 51%

4 Clay size fraction of samples = 1 - 8% of which a part consists of clay minerals.

5 Water suction measurements indicate very small volume increase due to water suction following pressure relief, well within 1%

6-7-8 Tests made on ground and oven dried samples. Serve as aid in classifying layers but do not indicate behaviour of samples in natural state.

9 Tests made in oedometer on drill core samples close to natural water content (wax coated samples). With the addition of water at zero stress the samples show very little or no swell. The swell was well within 1% of volume.

10 Quick arbitrary classification of samples into 4 groups. Group 1 assumed to be the best tunnelling rock and 4 the worst within the sedimentary rocks.

11 Presence of some smectite (montmorillonite) was established in the layers.

The sedimentary layers are sensitive to changes in water content and some weakening and disintegration of the layers could take place due to drying and wetting.

4.5 Fault breccia

Crushed basalt (and scoria) cemented with silt and clay has been found in some boreholes, interpreted as a fault breccia. This rock is moderately cemented. The thickness of the almost vertical breccia unit is estimated normally less than 1.5m. In the four small faults observed in the access tunnel portal-trench the fault breccia was only a few cm thick. The RQD's and the Q-values of the breccia are low to very low. No uniaxial strength tests have been performed but the strength is assumed very low.

4.6 Basaltic dykes

Four dykes have been found in the Gilsa creek (0.5-2.0m thick) and one was observed in the access tunnel portal-trench (1.5-2.0m thick). These dykes are almost vertical and made of hard, massive and moderately jointed basalt. Thus one may expect dykes in the tunnelling area.

4.7 Estimated occurence of different rock types on individual tunnel routes

From the available data the expected percentages of the above mentioned rock types on individual tunnel routes may be estimated (percentage of tunnel lengths). This is summarized in Table 4.

Table 4 Estimated percentages of rock types and number of layers on individual tunnel routes

	Access Tunnel	Tailrace Tunnel	Power-house	Pressure Shaft	Cable Shaft
Basalt	66%	60%	62%	52%	57%
No.of layers	10-15?	20-40?*	5-8	28	20
Scor.Breccia	30%	20%	37%	25%	20%
No.of layers	10-15?	20-40?*	6-7	25	20
Sedim. Rock	1%	17%	0%?	23%	22%
No.of layers	?	7-10*		12	11
Fault Breccia	<3%?	1-2%	<1%?	<1%?	<1%?
No.of layers	?	?	?	?	?
Dykes	?	?	?	?	?
No.of layers	5-10?	10-15?	1-3?	0-1?	0-1?

* Some layers will probably be encountered more than once in the same tunnel due to tectonic disturbances.

For further details on geological conditions, rock mechanical properties, estimated workability of rock types and predicted support requirements of each rock type the reader is referred to the following reports;

OS82-122/VOD-56B for the access tunnel (specially Tables 1-2 and Figs. 3-7).

OS82-127/VOD-57B for the powerhouse and tailrace tunnel (specially Tables 1-3 and Figs. 3-13).

OS83-009/VOD-05B for the shafts (specially Tables 1-4 and Figures 2-6).

OS83-008/VOD-04B for the sedimentary rocks (specially Figure 2).

OS82-121/VOD-55B for the general geology of the tunnelling area.

OS82-090/VOD-14 for regional geology and engineering geology of the whole project area.

REFERENCES

OS82-090/VOD-14; Blanda Hydroelectric Project. Geological report I. General geology and engineering geology. National Energy Authority. Hydropower division, 249p, (in Icelandic).

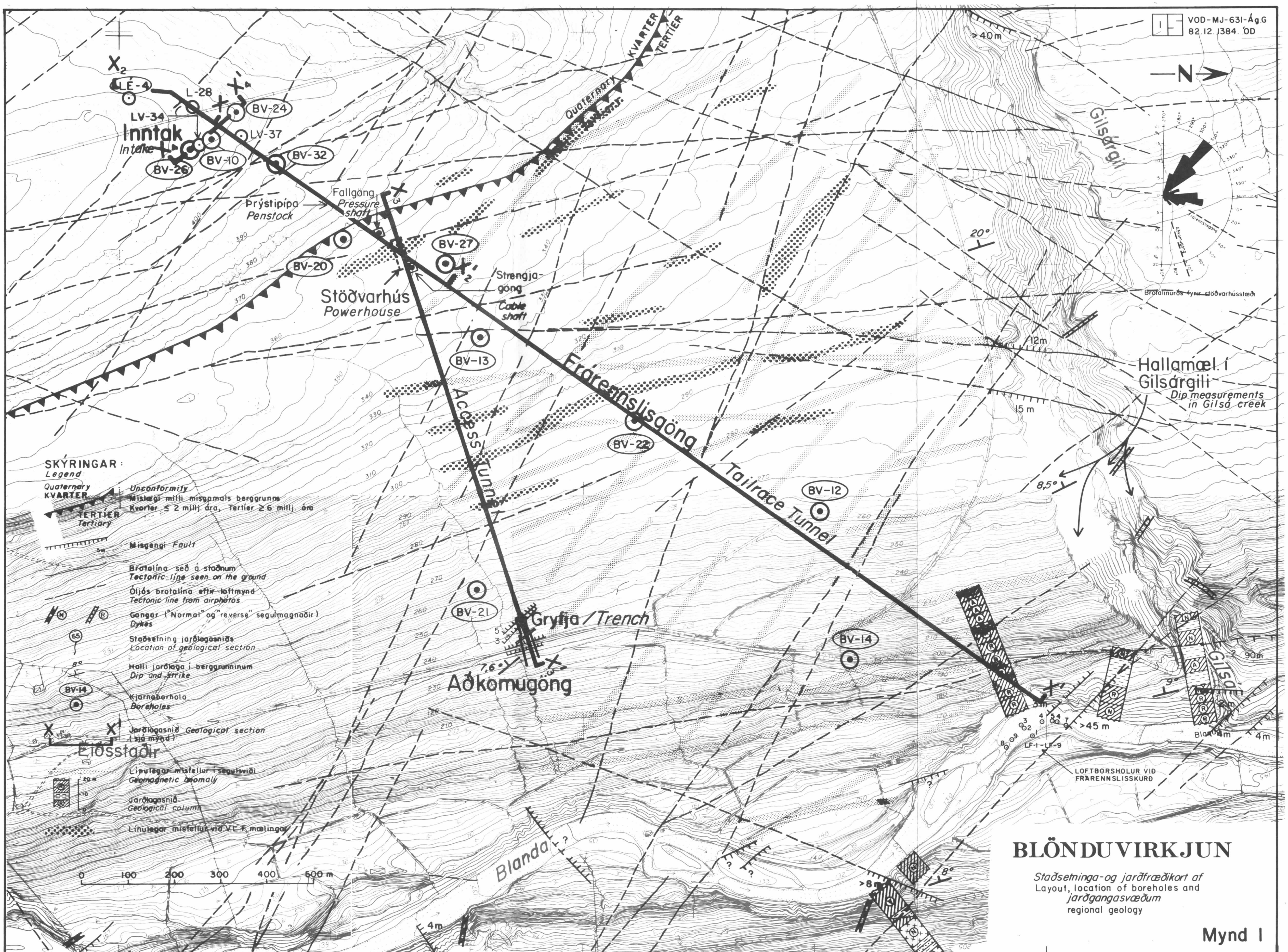
OS82-121/VOD-55B; Blanda Hydroelectric Project. Bedrock geology 1982. Access tunnel, Intake, Pressure shaft, Powerhouse, Tailrace tunnel and Tailrace canal. National Energy Authority. Hydropower division, 57p, (in Icelandic).

OS82-122/VOD-56B; Blanda Hydroelectric Project. Access tunnel. Rock mechanics. National Energy Authority. Hydropower division, 28p, (in Icelandic).

OS82-127/VOD-57B; Blanda Hydroelectric Project. Tailrace tunnel and Powerhouse cavern. Rock mechanics. National Energy Authority. Hydropower division, 35p, (in Icelandic).

OS83-009/VOD-05B; Blanda Hydroelectric Project. Pressure and Cable shafts. Rock mechanics. National Energy Authority. Hydropower division, 19p, (in Icelandic).

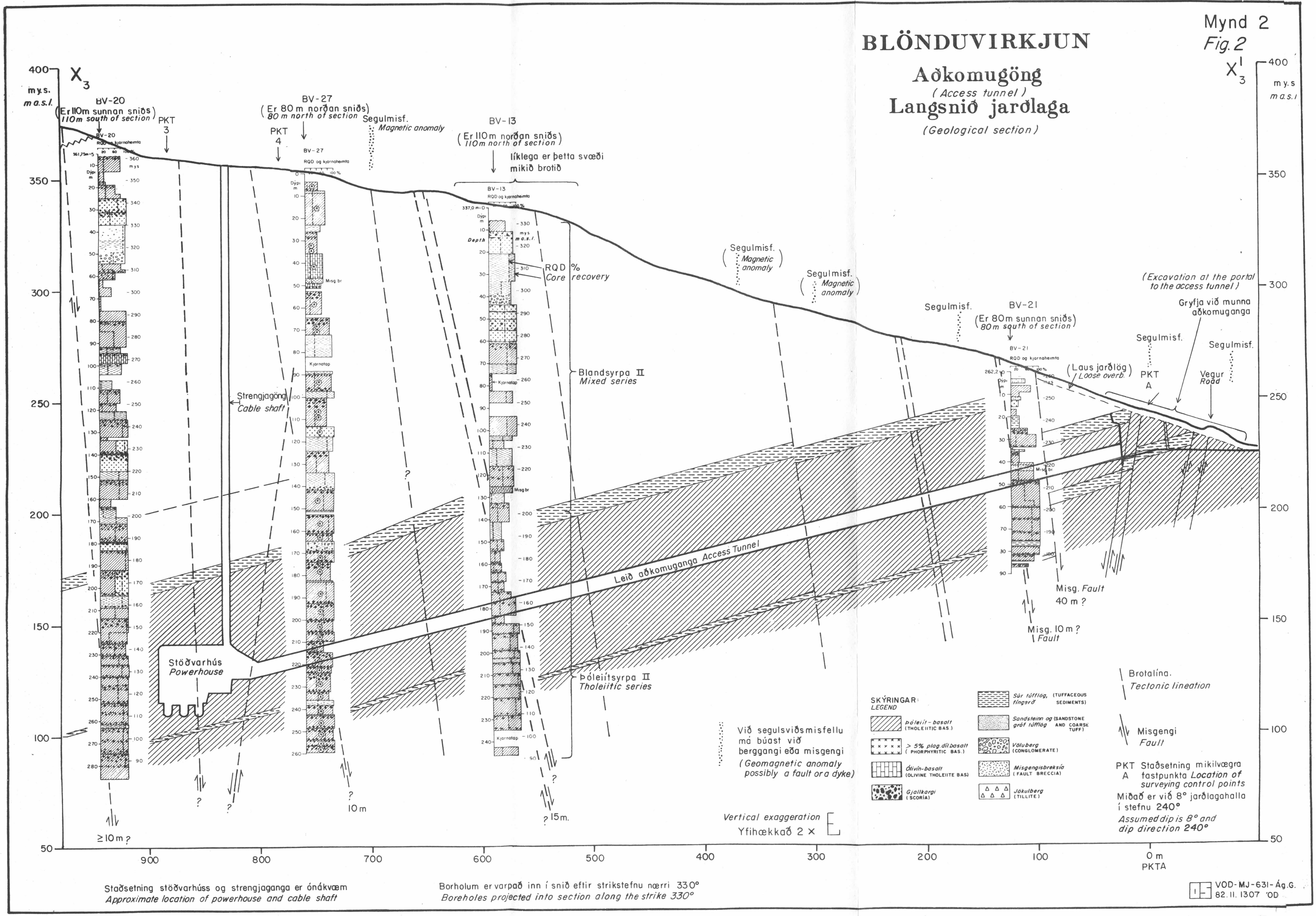
OS83-008/VOD-04B; Blanda Hydroelectric Project. Geotechnical properties of sedimentary rocks in the tunnelling area. National Energy Authorities. Hydropower division, 36p, (in Icelandic).



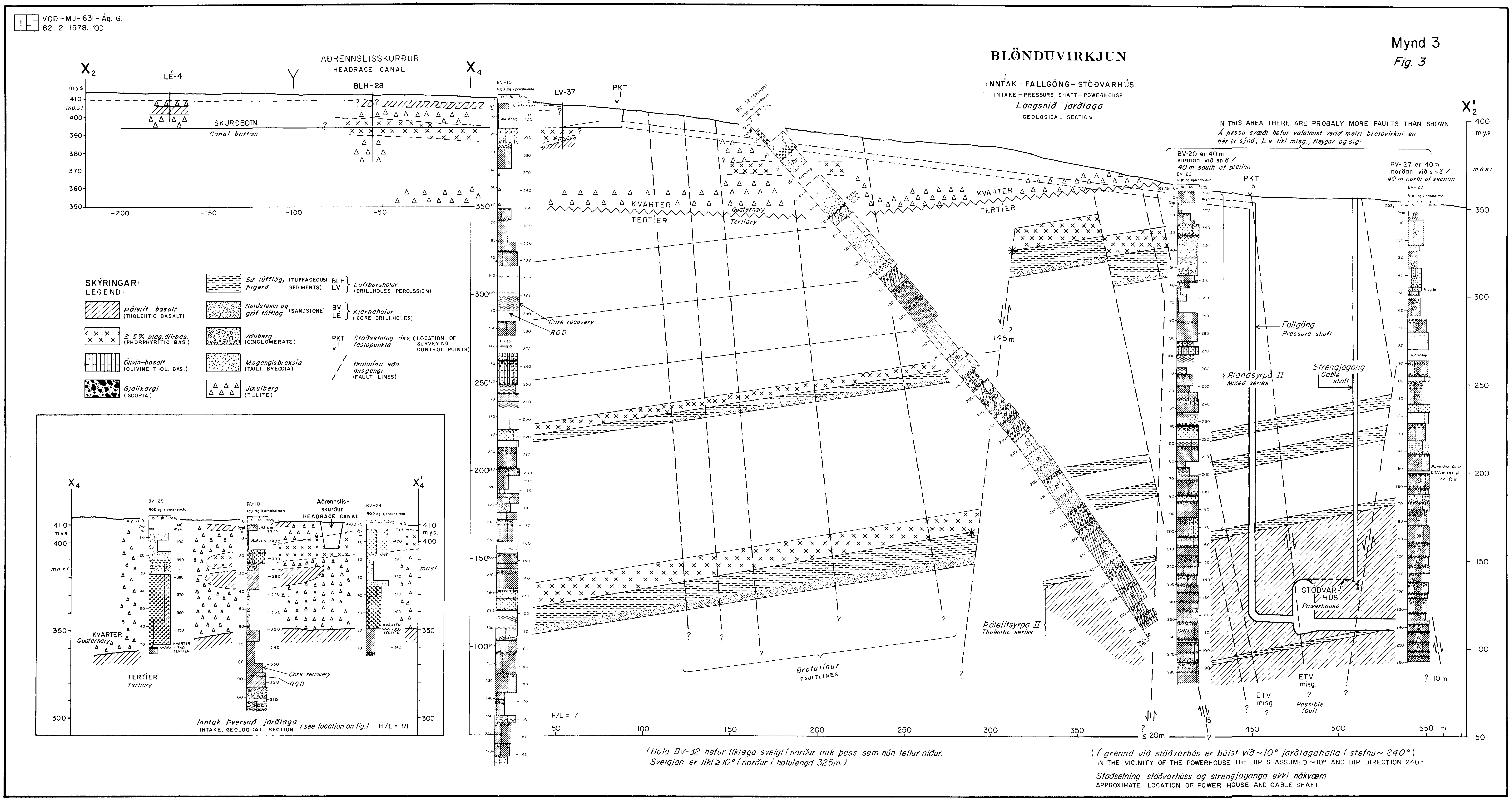
BLÖNDUVIRKJUN

Staðsetninga- og jarðfræðikort af
Layout, location of boreholes and
jarðgangasvæðum
regional geology

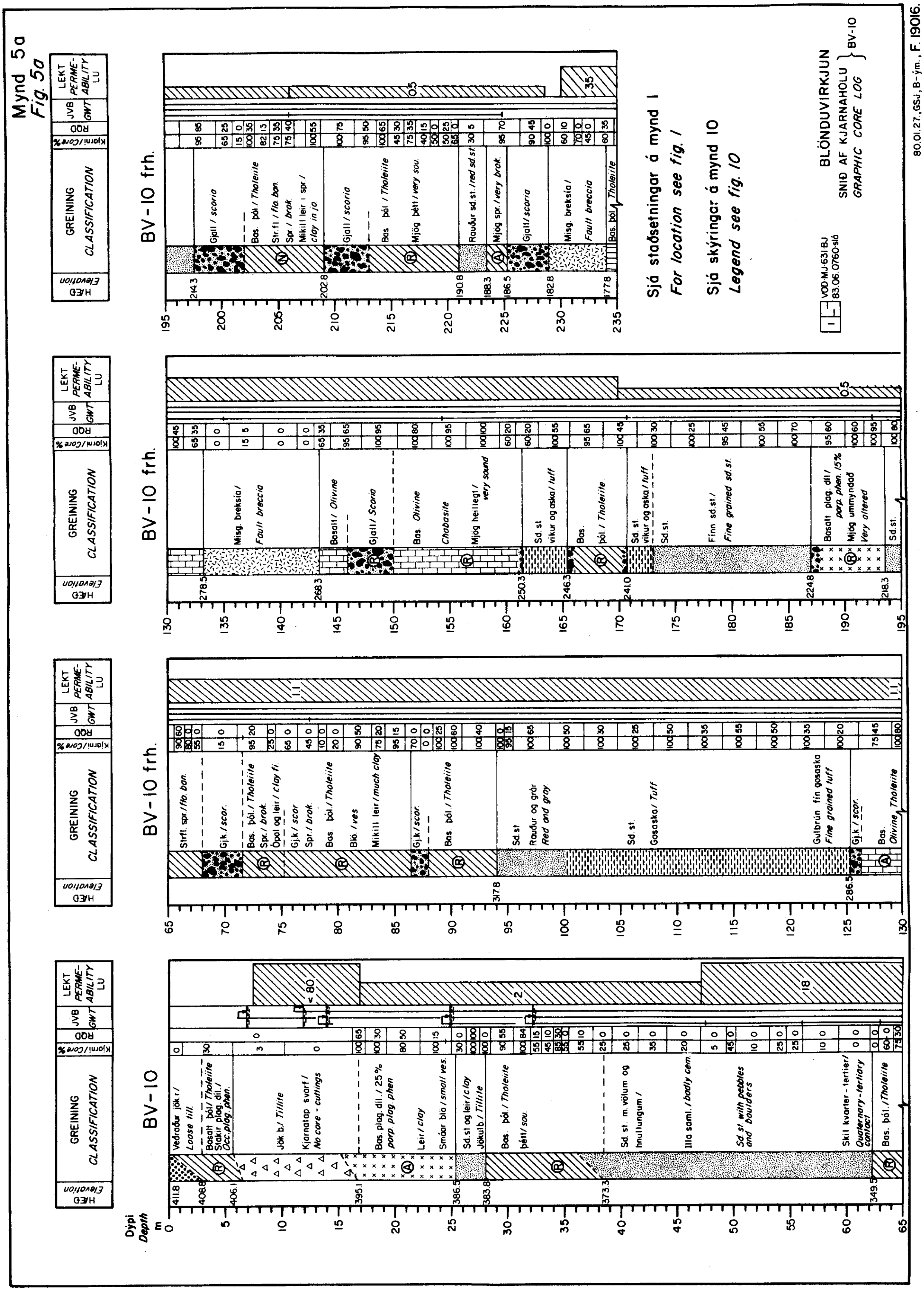
Mynd 1

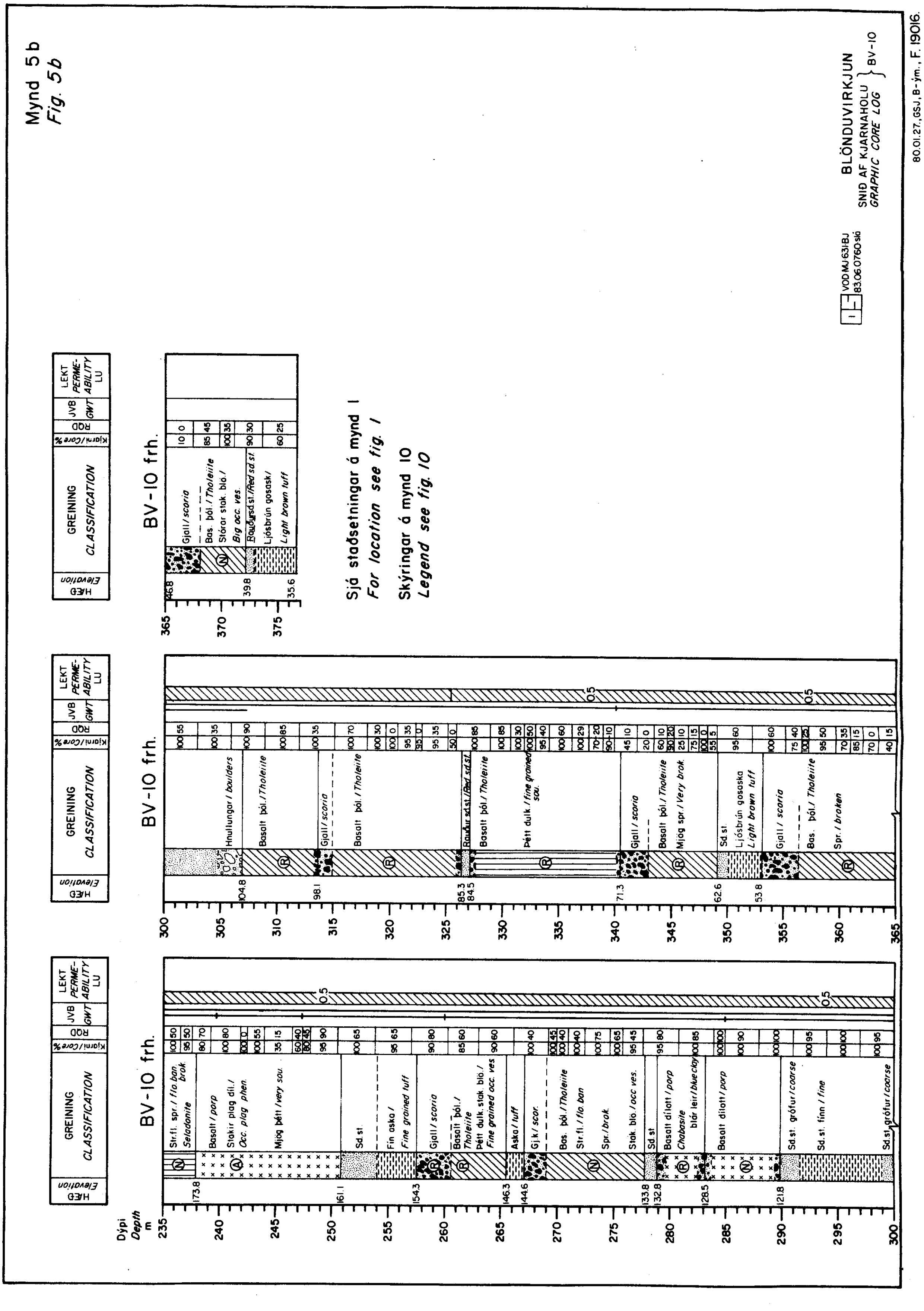


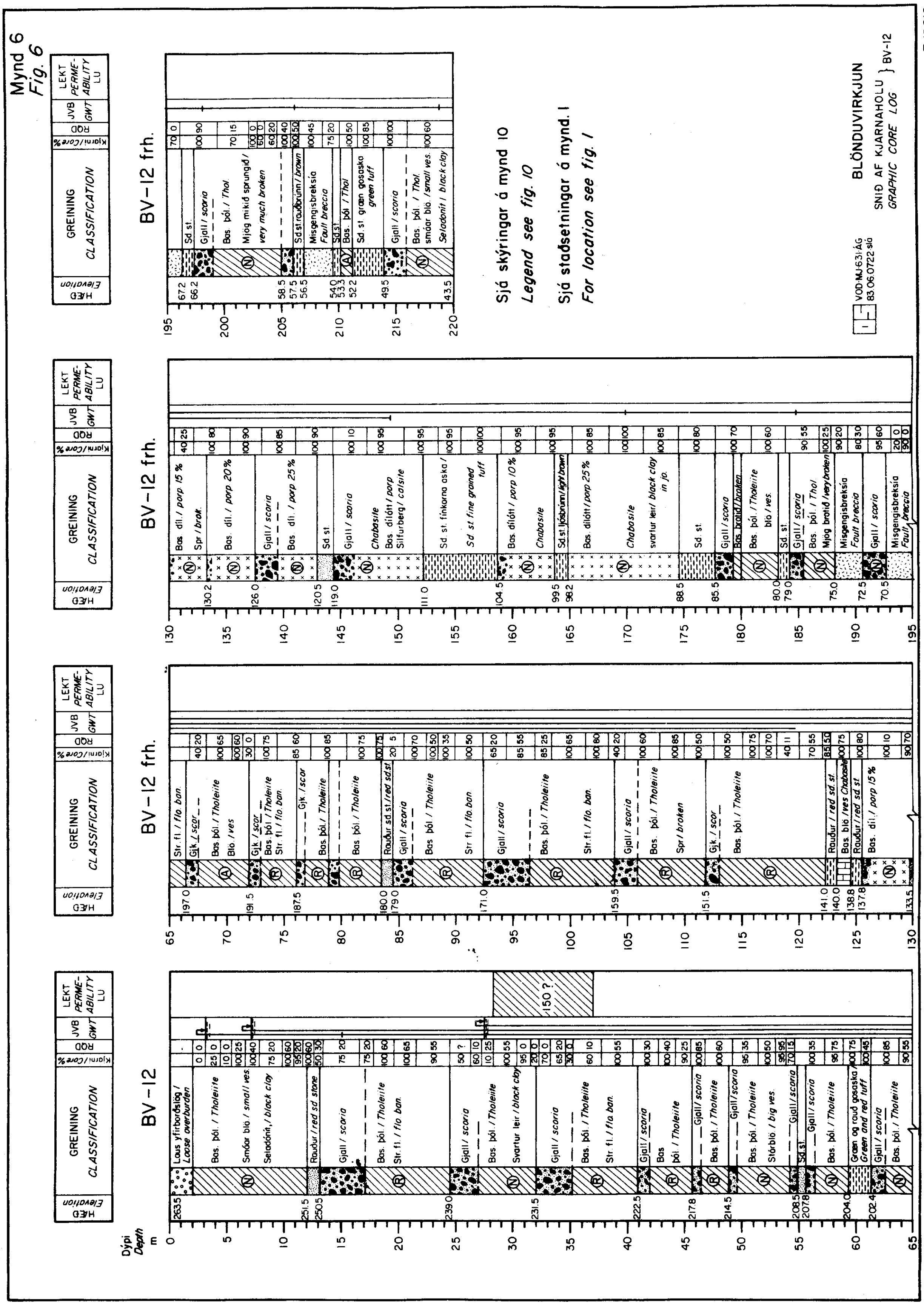
Mynd 2
Fig. 2
BLÖNDUVIRKJUN
Aðkomugöng
(Access tunnel)
Langsnið jarðlaga
(Geological section)
X_3
X_3^1
m.y.s.
m.a.s.l.
BV-20
(Er 110m sunnan sniðs
110m south of section)
PKT 3
PKT 4
BV-27
(Er 80 m norðan sniðs
80 m north of section)
Segulmisf.
Magnetic anomaly
BV-13
(Er 110m norðan sniðs
110m north of section)
líklega er þetta svæði mikið brotið
RQD og kjarnaheimta
Dýpi m
Depth
RQD %
Core recovery
Misg. br
Kjarnatap
Blandsyrpa II
Mixed series
Þóleiítsyrpa II
Tholeiitic series
Strengjagöng
Cable shaft
Stöðvarhús
Powerhouse
Leið aðkomuganga Access Tunnel
Segulmisf.
Magnetic anomaly
BV-21
(Er 80m sunnan sniðs
80m south of section)
(Laus jarðlög)
Loose overb.
PKT A
Vegur
Road
(Excavation at the portal to the access tunnel)
Gryfja við munna aðkomuganga
Misg. Fault
40 m ?
Misg. 10 m ?
Fault
≥10 m ?
10 m
15m.
SKÝRINGAR:
LEGEND
Þóleiít-basalt (THOLEIITIC BAS.)
> 5% plag.díl basalt (PHORPHYRITIC BAS.)
Ólivín-basalt (OLIVINE THOLEIITE BAS)
Gjallkargi (SCORIA)
Súr túfflög, fíngerð (TUFFACEOUS SEDIMENTS)
Sandsteinn og gróf túfflög (SANDSTONE AND COARSE TUFF)
Völuberg (CONGLOMERATE)
Misgengisbreksía (FAULT BRECCIA)
Jökulberg (TILLITE)
Við segulsviðsmisfellu má búast við berggangi eða misgengi
(Geomagnetic anomaly possibly a fault or a dyke)
Brotalína.
Tectonic lineation
Misgengi
Fault
PKT A Staðsetning mikilvægra fastpunkta Location of surveying control points
Miðað er við 8° jarðlagahalla í stefnu 240°
Assumed dip is 8° and dip direction 240°
Vertical exaggeration
Yfihækkað 2 ×
400
350
300
250
200
150
100
50
900
800
700
600
500
400
300
200
100
0 m
PKTA
Staðsetning stöðvarhúss og strengjaganga er ónákvæm
Approximate location of powerhouse and cable shaft
Borholum er varpað inn í snið eftir strikstefnu nærri 330°
Boreholes projected into section along the strike 330°
VOD-MJ-631-Ág.G.
82.11.1307 'OD

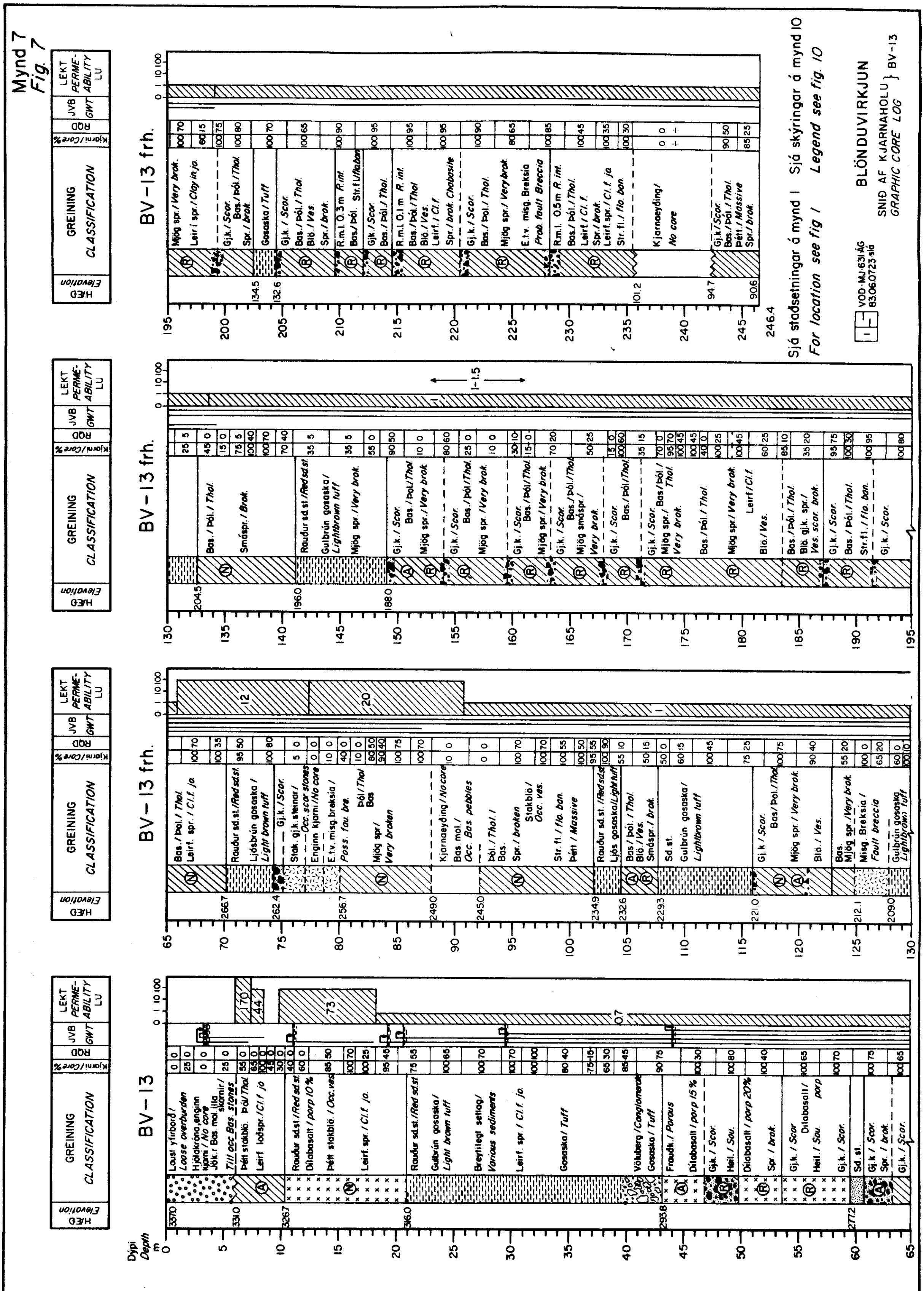

VOD-MJ-631-Ág. G.
82.12. 1578. 'OD
Mynd 3
Fig. 3
BLÖNDUVIRKJUN
INNTAK - FALLGÖNG - STÖÐVARHÚS
INTAKE - PRESSURE SHAFT - POWERHOUSE
Langsnið jarðlaga
GEOLOGICAL SECTION
AÐRENNSLISSKURÐUR
HEADRACE CANAL
X2
X4
X'2
LÉ-4
BLH-28
LV-37
PKT 1
PKT 3
SKURÐBOTN
Canal bottom
m y.s.
m.a.s.l.
KVARTER
Quaternary
TERTÍER
Tertiary
IN THIS AREA THERE ARE PROBALY MORE FAULTS THAN SHOWN
Á þessu svæði hefur vafalaust verið meiri brotavirkni en hér er sýnd, þ.e. líkl. misg., fleygar og sig.
BV-20 er 40 m sunnan við snið / 40 m south of section
BV-27 er 40 m norðan við snið / 40 m north of section
SKÝRINGAR:
LEGEND:
Þóleiít-basalt (THOLEIITIC BASALT)
≥ 5% plag. díl-bas. (PHORPHYRITIC BAS.)
Ólivín-basalt (OLIVINE THOL. BAS.)
Gjallkargi (SCORIA)
Súr túfflög, fíngerð (TUFFACEOUS SEDIMENTS)
Sandsteinn og gróf túfflög (SANDSTONE)
Völuberg (CONGLOMERATE)
Misgengisbreksía (FAULT BRECCIA)
Jökulberg (TILLITE)
BLH, LV: Loftborsholur (DRILLHOLES PERCUSSION)
BV, LÉ: Kjarnaholur (CORE DRILLHOLES)
PKT: Staðsetning ákv. fastapunkta (LOCATION OF SURVEYING CONTROL POINTS)
Brotalína eða misgengi (FAULT LINES)
Core recovery
RQD
Blandsyrpa II
Mixed series
Þóleiítsyrpa II
Tholeiitic series
Fallgöng
Pressure shaft
Strengjagöng
Cable shaft
STÖÐVAR-HÚS
Powerhouse
Brotalínur
FAULTLINES
ETV misg.
Possible fault
H/L = 1/1
Aðrennslis-skurður
HEADRACE CANAL
BV-26
BV-10
BV-24
BV-32
X4
X'4
Inntak. Þversnið jarðlaga
INTAKE, GEOLOGICAL SECTION / see location on fig. 1
H/L = 1/1
(Hola BV-32 hefur líklega sveigt í norður auk þess sem hún fellur niður. Sveigjan er líkl ≥ 10° í norður í holulengd 325m.)
(Í grennd við stöðvarhús er búist við ~ 10° jarðlagahalla í stefnu ~ 240°)
IN THE VICINITY OF THE POWERHOUSE THE DIP IS ASSUMED ~10° AND DIP DIRECTION 240°
Staðsetning stöðvarhúss og strengjaganga ekki nákvæm
APPROXIMATE LOCATION OF POWER HOUSE AND CABLE SHAFT

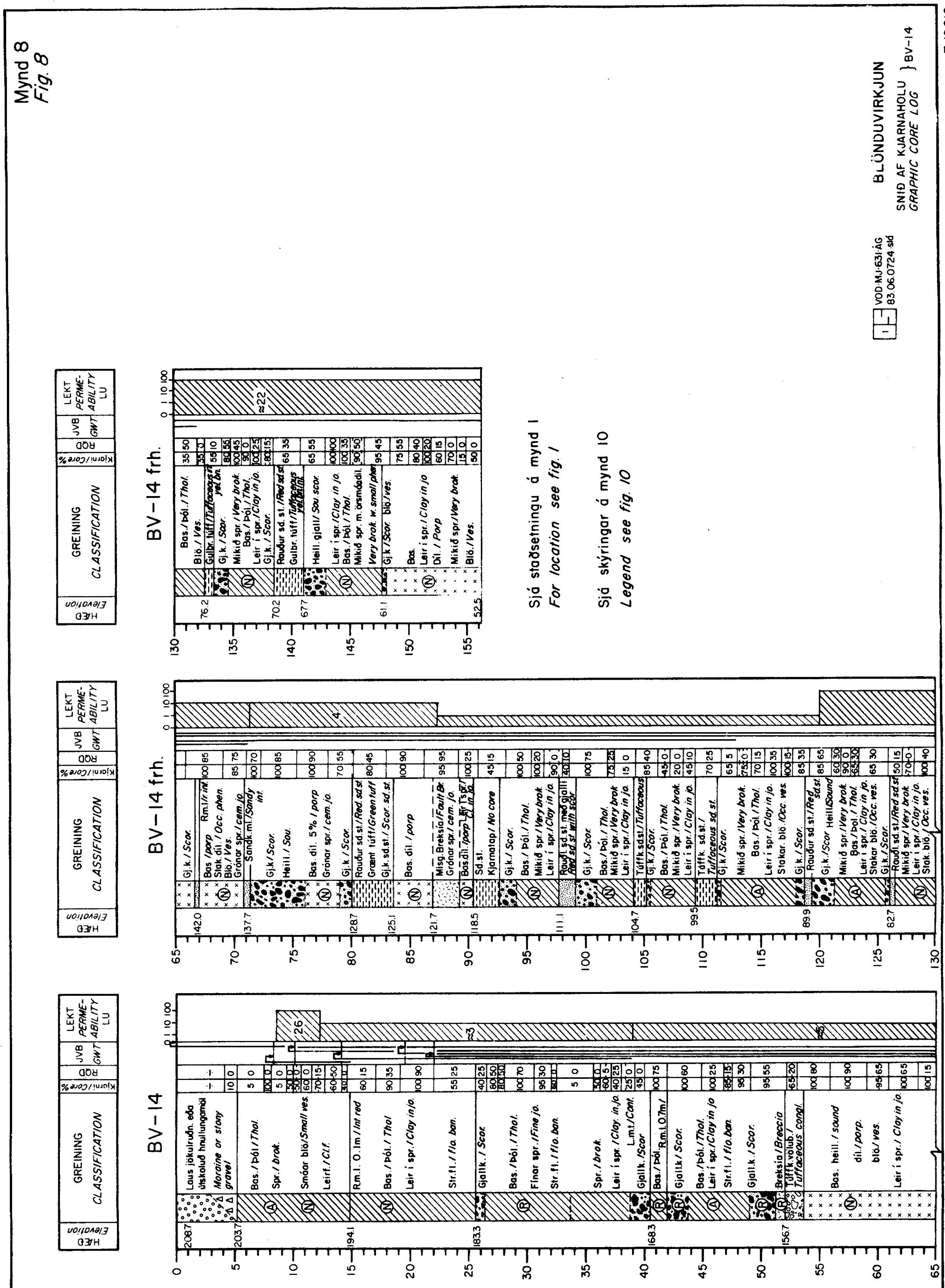

X
X'
BLÖNDUVIRKJUN
FRÁRENNSLISGÖNG
TAILRACE TUNNEL
Langskurður jarðlaga
GEOLOGICAL SECTION
SKÝRINGAR:
LEGEND:
Þóleiít-basalt (THOLEIITC BAS.)
> 5% plag.díl.basalt (PHORPHYRITIC BAS.)
Ólivín-basalt (OLIVINE THOLEIÍTE BAS.)
Gjallkargi (SCORÍA)
Súi túfflög, fíngerð (TUFFACEOUS SEDIMENTS)
Sandsteinn og gróf túfflög (SANDSTONE AND COARSE TUFF)
Völuberg (CONGLOMERATE)
Misgengisbreksía (FAULT BRECCIA)
Jökulberg (TILLITE)
PKT Staðsetning ákv. fastapunkta (LOCATION OF SURVEYING CONTROL POINTS)
Brotalína eða misgengi (FAULT OR FAULT LINE)
BV-8 Kjarnaholur (BORHOLES)
KVARTER Quaternary
TERTIER Tertiary
Skáhola BV-32 Inclined borhole
Fallgöng Pressure shaft
Strengjagöng Cable shaft
Stöðvarhús Power house
Blandsyrpa II Mixed series
Þóleiítsyrpa II
Þóleiítsyrpa II Tholeiitic series
Blandsyrpa I Mixed series
Þóleiítsyrpa I Tholeiitic series
Hér má búast við óreglu vegna misgengja
Frárennslisgöng Tailrace Tunnel
Etv mjög stórt misgengi Possibly a large fault
Core recovery %
RQD %
Kjalvegur Road
Vegur inn Blöndudal Road
BLANDA
m y.s.
m.a.s.l.
Jarðlagasniðið er yfirhækkað 2 X
VERTICAL EXAGGERATION 2X
Staðsetning stöðvarhúss og strengjaganga ekki nákvæm
APPROXIMATE LOCATION OF POWER HOUSE AND CABLE SHAFT
Holur sem standa utan jarðlagasniðs eru færðar inn í sniðið eftir strikstefnu nálægt 330°
Miðað er við að meðaltals jarðlagahalli sé um 8° í stefnu 240°
BOREHOLES NOT EXACTLY ON THE SECTION LINE ARE PROJECTED INTO SECTION ALONG STRIKE 330°
Brotalínur og misgengi verður að taka með varúð
THE LOCATION AND THE SIZE OF FAULTS IS NOT KNOWN WITH GREAT ACCURACY
MYND 4
Fig.
VOD-MJ-631-Ág.G.
82.12.1579.OD

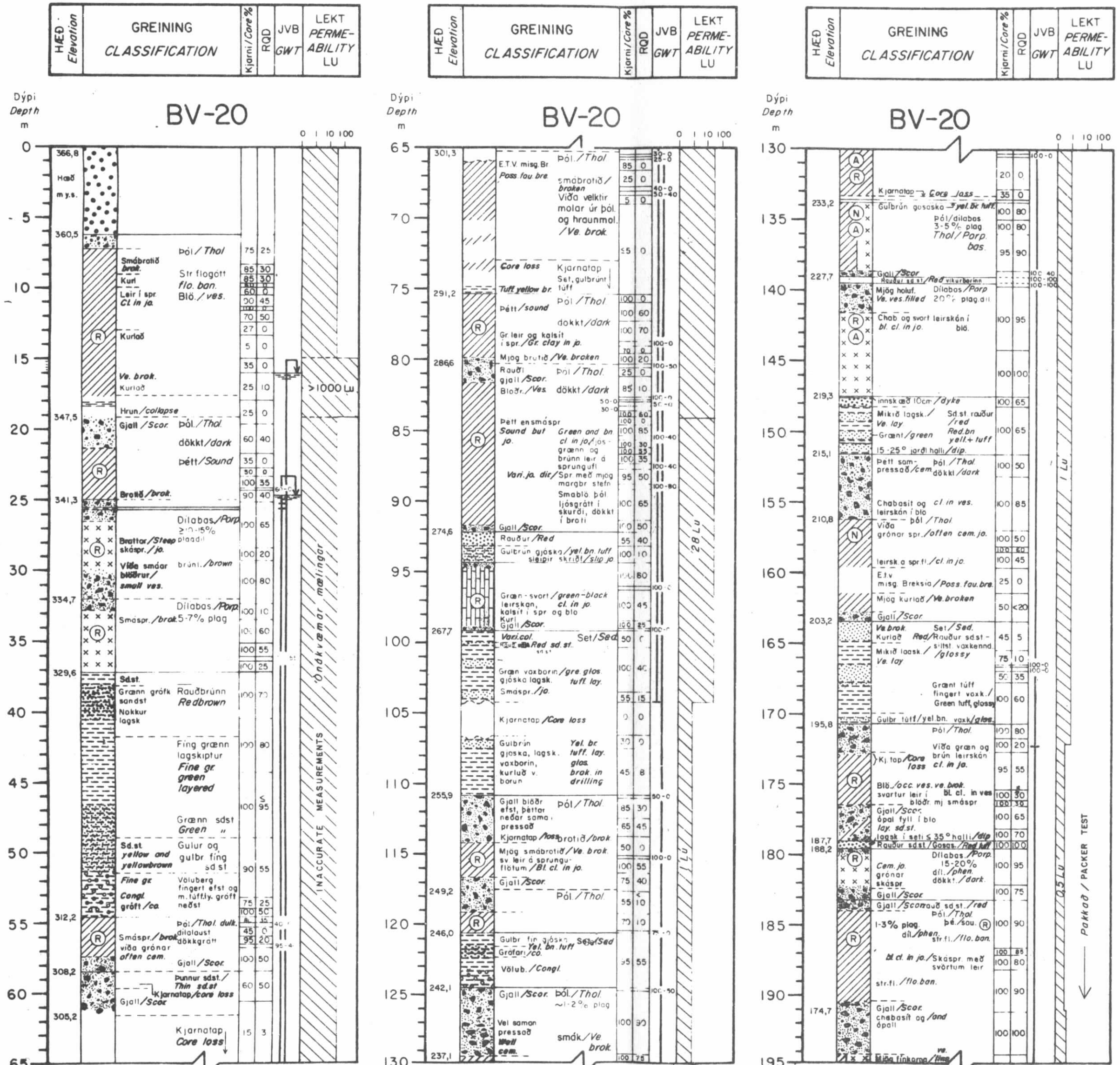

Mynd 5a
Fig. 5a
BV-10
BV-10 frh.
HÆÐ Elevation
GREINING CLASSIFICATION
Kjarni/Core %
RQD
JVB GWT
LEKT PERME-ABILITY LU
Dýpi Depth m
Sjá staðsetningar á mynd 1
For location see fig. 1
Sjá skýringar á mynd 10
Legend see fig. 10
BLÖNDUVIRKJUN
SNIÐ AF KJARNAHOLU BV-10
GRAPHIC CORE LOG
VOD-MJ-631-BJ
83.06.0760-sió
80.01.27.,GSJ,B-ým., F. 19016.

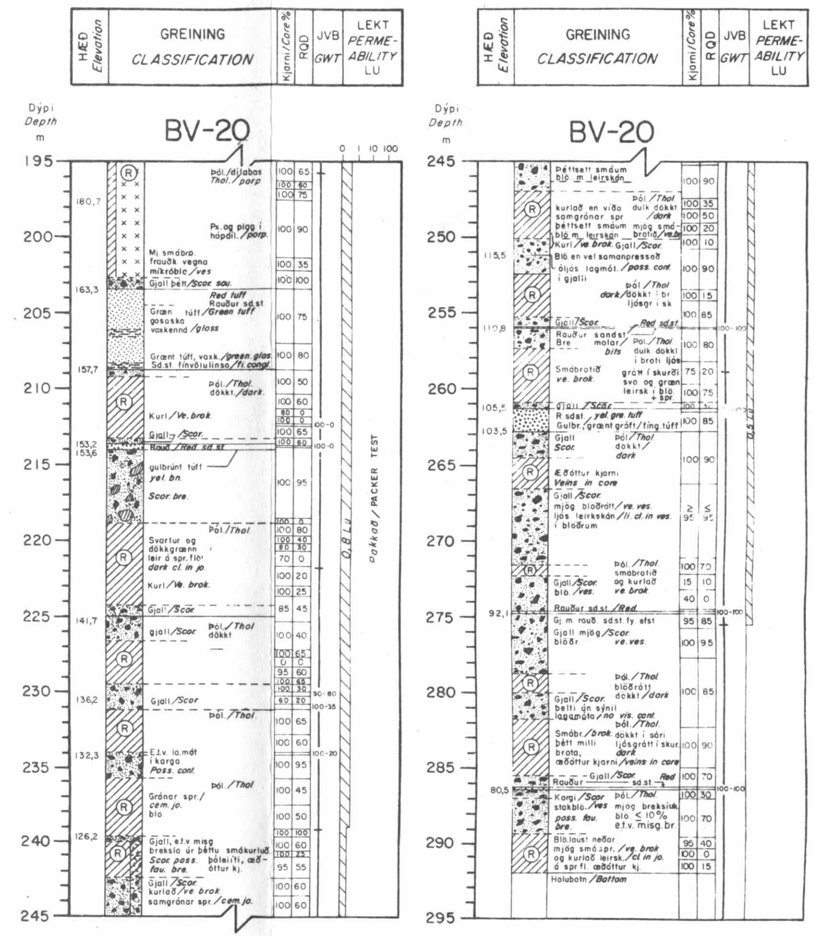

Mynd 5b
Fig. 5b
BV-10 frh.
GREINING CLASSIFICATION
Sjá staðsetningar á mynd 1
For location see fig. 1
Skýringar á mynd 10
Legend see fig. 10
BLÖNDUVIRKJUN
SNIÐ AF KJARNAHOLU
GRAPHIC CORE LOG
BV-10
80.01.27.,GSJ,B-ým.,F. 19016.


Mynd 6
Fig. 6
HÆÐ Elevation
GREINING CLASSIFICATION
Kjarni/Core %
RQD
JVB GWT
LEKT PERMEABILITY LU
Dýpi Depth m
BV-12
BV-12 frh.
BV-12 frh.
BV-12 frh.
Sjá skýringar á mynd 10
Legend see fig. 10
Sjá staðsetningar á mynd 1
For location see fig. 1
BLÖNDUVIRKJUN
SNIÐ AF KJARNAHOLU } BV-12
GRAPHIC CORE LOG
80.01.27.,GSJ,B-ým., F. 19016.


Mynd 7
Fig. 7
BV-13
BV-13 frh.
GREINING
CLASSIFICATION
HÆÐ
Elevation
Kjarni/Core %
RQD
JVB
GWT
LEKT
PERMEABILITY
LU
Dýpi
Depth
m
Sjá staðsetningar á mynd 1
For location see fig 1
Sjá skýringar á mynd 10
Legend see fig. 10
BLÖNDUVIRKJUN
SNIÐ AF KJARNAHOLU BV-13
GRAPHIC CORE LOG
80.01.27.GSJ.B-ým., F. 19016.


Mynd 8
Fig. 8
BV-14
BV-14 frh.
HÆÐ Elevation
GREINING CLASSIFICATION
Kjarni/Core %
RQD
JVB GWT
LEKT PERME-ABILITY LU
Sjá staðsetningu á mynd 1
For location see fig. 1
Sjá skýringar á mynd 10
Legend see fig. 10
VOD-MJ-63-ÁG
83.06.0724-Sid
BLÖNDUVIRKJUN
SNIÐ AF KJARNAHOLU BV-14
GRAPHIC CORE LOG
80.01.27,GSJ,B-ým., F. 19016.





cl = thin clay coating

BLÖNDUVIRKJUN Borholusnið / *Graphic core log BV-20*

Fig. Mynd 9

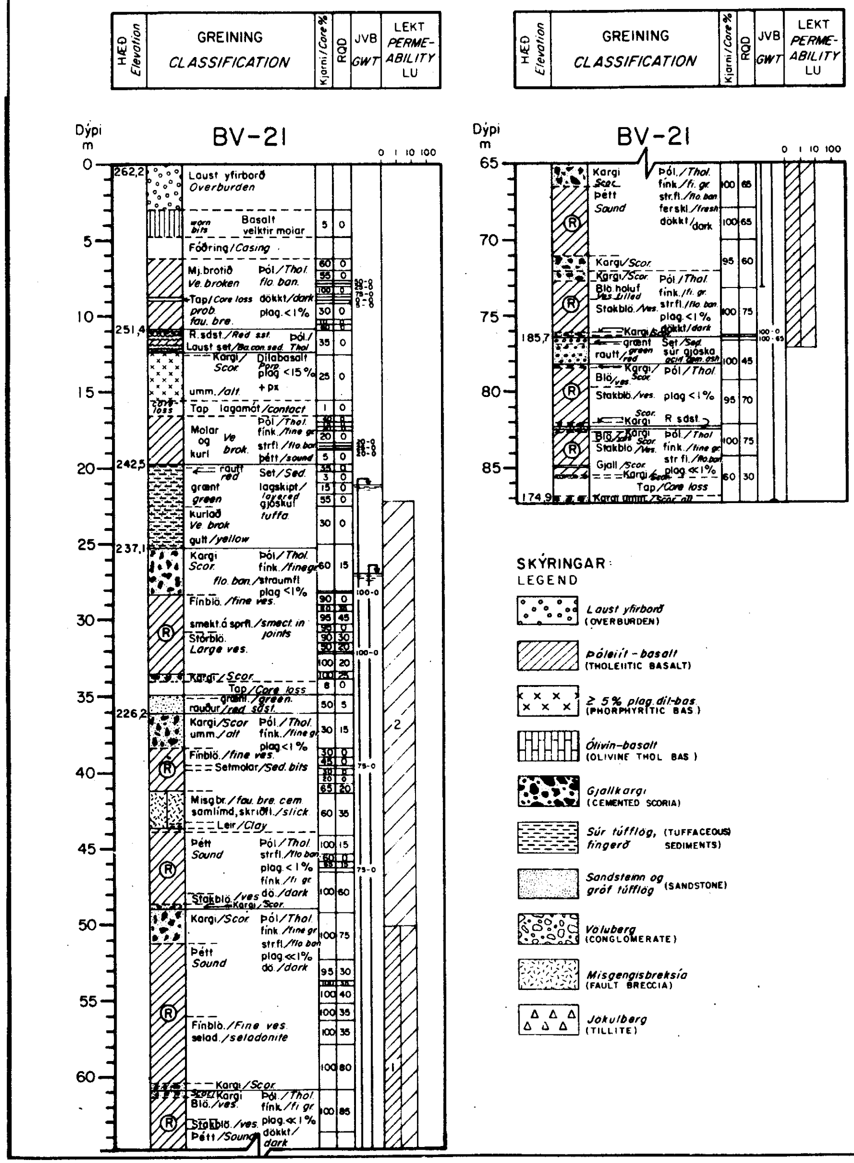
Sjá skýringar á mynd 10

Legend see fig. 10

Sjá staðsetningar á mynd 1 For location see fig.1

VOD-MJ-631-Ág.G 82.02.0466-'O.D

VOD-MJ-631-Gu.Bi/Bj.Bj/Er.P
'82.10.-1247-Gyða



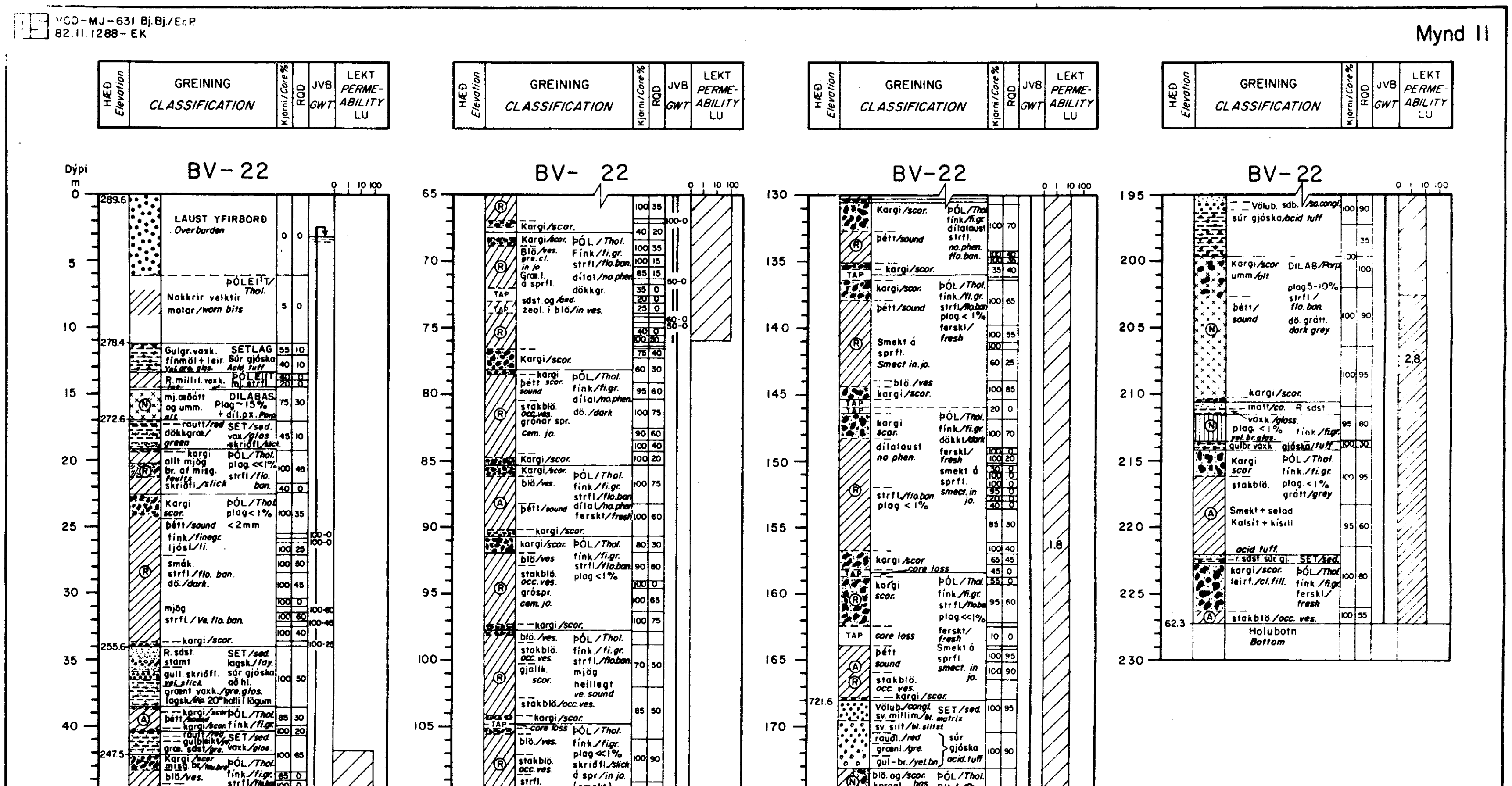
SKAMMSTAFANIR / *ABBREVIATIONS*

alt.	=	altered	len.	=	lenses
ang.	=	angular	li.	=	light
as.	=	aska	lj.	=	ljós/ljóst
ba.	=	badly	m.	=	með
bas.	=	basískt/basaltic	mat.	=	matrix
basv.	=	basalt vala	mik.	=	mikill
bl.	=	blandaður/blandað	míkróð.	=	míkróðílar
bla.	=	black	misg.	=	misgengi
blö.	=	blöðrótt/blöðrur	mism.	=	mismunandi
bn.	=	brown	mj.	=	mjög
br.	=	brúnn/brúnt	ml.	=	millilag
bre.	=	breksía/breccia	móbr.	=	móberg
breks.	=	breksía	mol.	=	molar
breksíur.	=	breksíuríkur/breksíuríkt	occ.	=	occasionally
bro.	=	brotinn/brotið	ol.	=	ólivín
brok.	=	broken	part.	=	partly
brúnl.	=	brúnleitur/brúnleitt	pebb.	=	pebbles
cem.	=	cemented	ph.	=	phenocryst
chab.	=	chabasít	phen.	=	phenocryst
cl.	=	clay	plag.	=	plagioclas
co.	=	coarse	porp.	=	porphyritic
col.	=	colours	poss.	=	possible
con.	=	consolidated	prob.	=	probably
congl.	=	conglomerate	px.	=	pyroxen
cont.	=	contact	r.	=	rauður/rautt
d.	=	dökkur	r.ml.	=	rautt millilag
da.	=	dark	rauðl.	=	rauðleitur/rauðleitt
díl.	=	díll/díllótt	sa.	=	sand
dir.	=	direction	saml.	=	samlímdur/samlímt
dulk.	=	dulkornóttur/dulkornótt	sand.	=	sandur
dö.	=	dökkur/dökkt	sandst.	=	sandsteinn/sandstone
e.t.v.	=	ef til vill	scor.	=	scoria
f.	=	fylltur/fyllt	sdst.	=	sandsteinn/sandstone
fau.	=	fault	sed.	=	sediment
fau.bre.	=	fault breccia	selad.	=	seladonite
ferskl.	=	fersklequr/ferskleqt	send.	=	sendinn/sendið
fi.	=	fine	sil.	=	silicium
fill.	=	filled	sk.	=	skurður
fíng.	=	fíngerður/fíngert	skáspr.	=	skásprunga/skásprungið
fínk.	=	fínkornóttur/fínkornótt	skriðfl.	=	skriðflötur
flo.ban.	=	flow banded	skæn.	=	skændur
frauðk.	=	frauðkenndur/frauðkennt	slick.	=	slickenside
fy.	=	fylling	slip.	=	slippery
fyll.	=	fylling	smák.	=	smákornóttur/smákornótt
gj.k.	=	gjallkenndur/gjallkennt	smekt.	=	smektít
gjallk.	=	gjallkenndur/gjallkennt	sou.	=	sound
glos.	=	glossy	spr.	=	sprungið/sprunga
gr.	=	grained	sprfl.	=	sprunguflötur
grá.	=	grár/grátt	stak.	=	stakur
gre.	=	green	stakd.	=	stakdílótt
gróðurl.	=	gróðurleifar	stakdíl.	=	stakdílótt
gróf.	=	grófur	str.fl.	=	straumflögótt
grófs.	=	grófsandur	sv.	=	svartur/svart
græ.	=	grænn/grænt	svö.	=	svört
græl.	=	grænleitur/grænleitt	thol.	=	tholeiite
grunnm.	=	grunnmassi	tu.	=	tuff
gull.	=	gulleitur/gulleitt	tuffa.	=	tuffaceous
hálff.	=	hálffylltur/hálffyllt	túffk.	=	túffkenndur/túffkennt
heill.	=	heillegur/heillegt	umm.	=	ummyndaður/ummyndað
hnull.	=	hnullungar	var.	=	varved
innsk.	=	innskot	vari.	=	variable
int.	=	interbed	vaxk.	=	vaxkenndur/vaxkennt
jo.	=	joints	ve.	=	very
jök.b.	=	jökulberg	ves.	=	vesicular/vesicles
jök.r.	=	jökulruðningur	vikurb.	=	vikurbönd
kís.	=	kísill	vis.	=	visible
kubb.	=	kubbað	vott.	=	vottur
kurl.	=	kurlaður/kurlað	völ.	=	völur
l.	=	leir	völub.	=	völuberg
la.	=	lag	w.	=	with
lagam.	=	lagamót	yel.	=	yellow
lagsk.	=	lagskiptur/lagskipt	zeól.	=	zeólítar
lay.	=	layered	þé.	=	þéttur/þétt
leirk.	=	leirkenndur/leirkennt	þól.	=	þóleiít

BLÖNDUVIRKJUN

Snið af kjarnaholu BV-21 / *Graphic core log BV-21*

Fig. Mynd 10

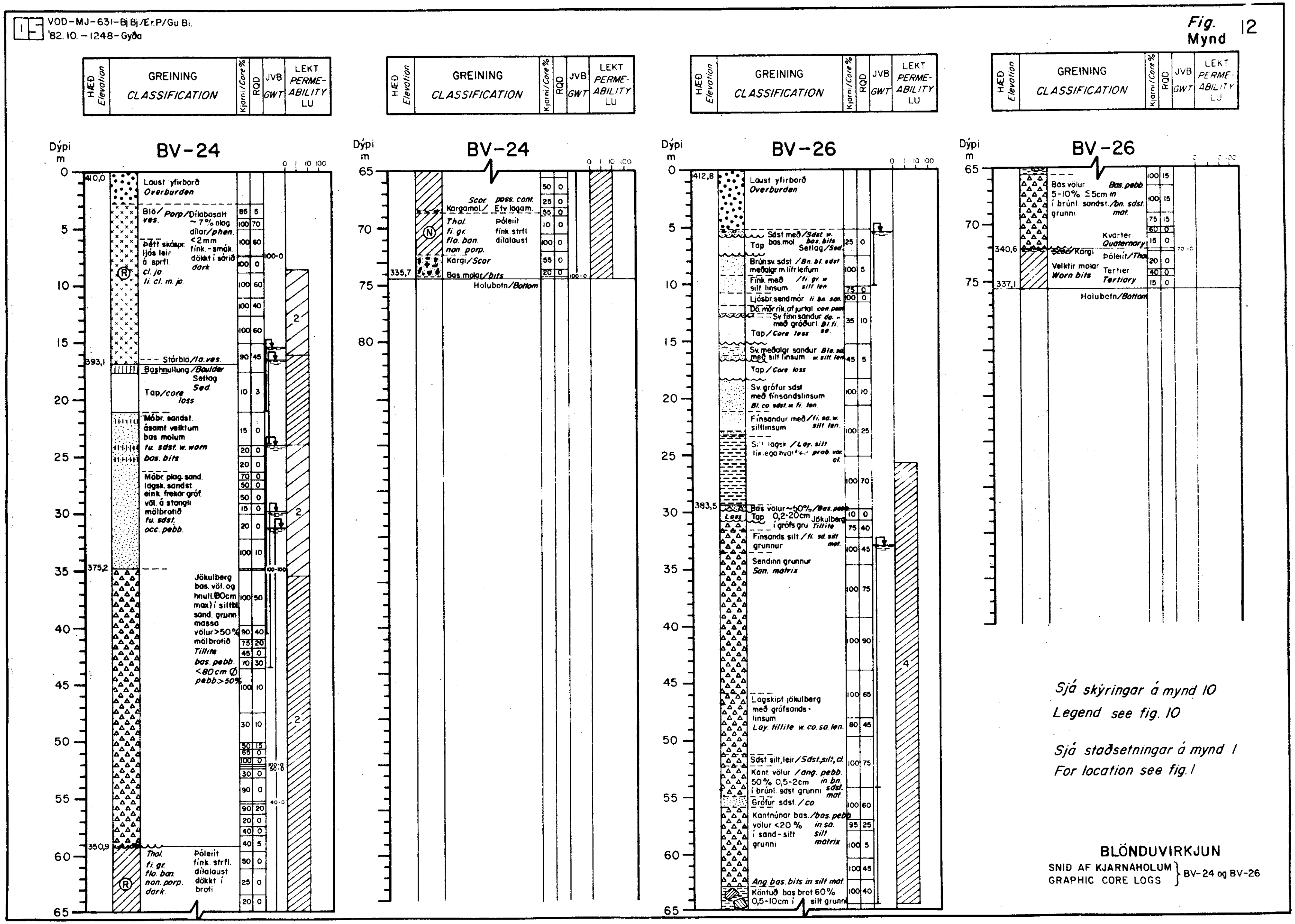


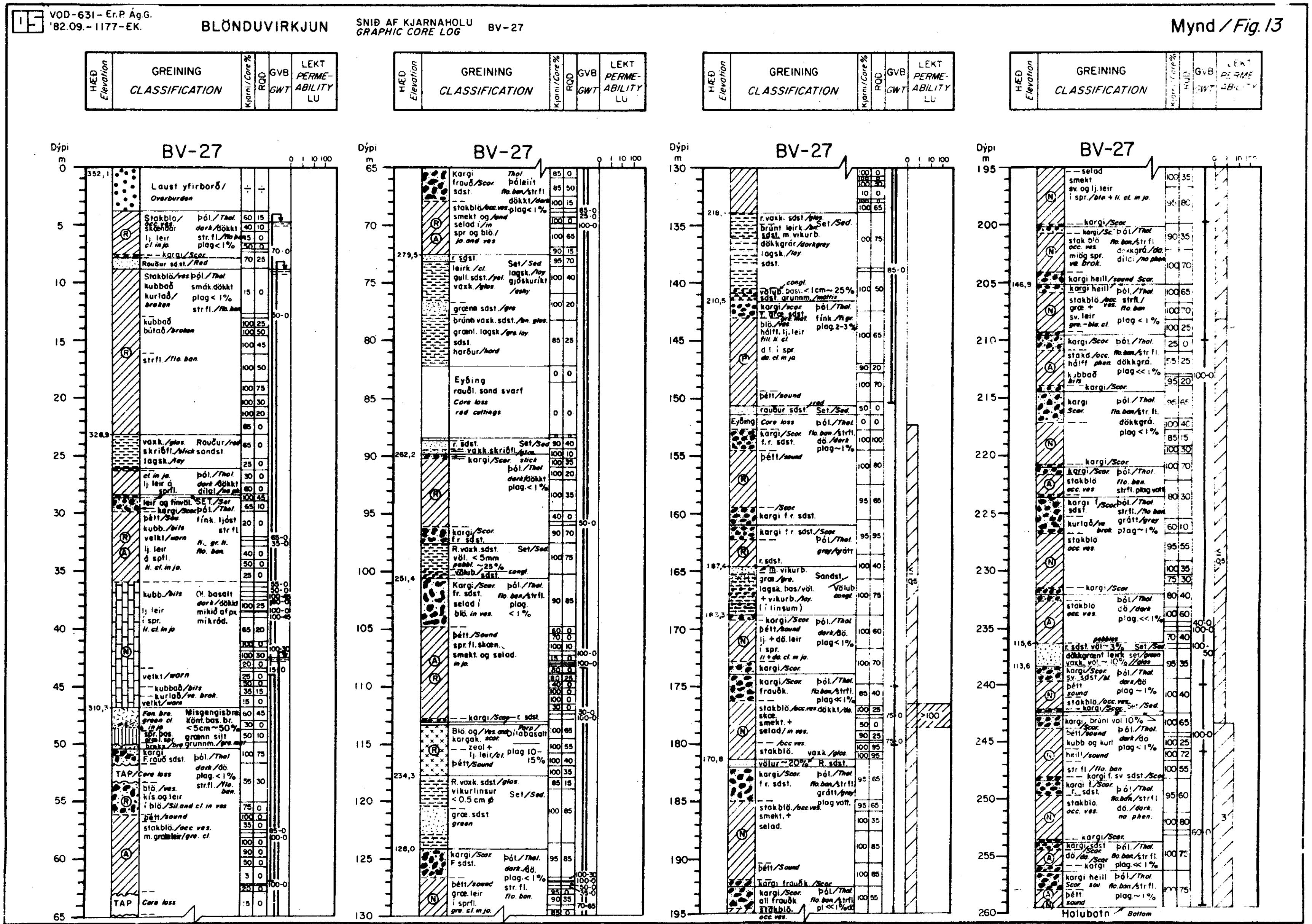
Sjá skýringar á mynd 10
Legend see fig. 10

Staðsetningar sjá mynd 1
For location see fig. 1

BLÖNDUVIRKJUN

SNIÐ AF KJARNAHOLU BV-22
GRAPHIC CORE LOG


VOD-MJ-631-Bj.Bj./Er.P/Gu.Bi.
'82.10.-1248-Gyða
Fig. Mynd 12
HÆÐ Elevation
GREINING CLASSIFICATION
Kjarni/Core %
RQD
JVB GWT
LEKT PERME-ABILITY LU
Dýpi m
BV-24
BV-26
Laust yfirborð Overburden
Jökulberg
Tillite
Holubotn/Bottom
Sjá skýringar á mynd 10
Legend see fig. 10
Sjá staðsetningar á mynd 1
For location see fig. 1
BLÖNDUVIRKJUN
SNIÐ AF KJARNAHOLUM
GRAPHIC CORE LOGS
BV-24 og BV-26



Sjá skýringar á mynd 10/ Legend see fig. 10 Sjá staðsetningar á mynd 1 / For location see fig. 1


Mynd
Fig. 14
BLÖNDUVIRKJUN
FRÁRENNSLISGÖNG
TAILRACE TUNNEL
Langskurður jarðlaga
GEOLOGICAL SECTION
Lektarmæling
(PERMEABILITY TEST)
SKÝRINGAR:
LEGEND:
Þóleiít-basalt (THOLEIITC BAS.)
> 5% plag. dílbasalt (PHORPHYRITIC BAS.)
Ólivín basalt (OLIVINE THOLEIITE BAS.)
Gjallkargi (CEMENTED SCORIA)
Sír túfflög, fíngerð (TUFFACEOUS SEDIMENTS)
Sandsteinn og gróf túfflög (SANDSTONE AND COARSE TUFF)
Völuberg (CONGLOMERATE)
Misgengisbreksía (FAULT BRECCIA)
Jökulberg (TILLITE)
PKT Staðsetning ákv. fastapunkta (SPECIAL LOCATIONS)
Brotalína eða misgengi (FAULT OR FAULT LINE)
BV-8 Kjarnaholur (CORE DRILLHOLES)
Sjá BV-13 mynd 15 (SEE BV-13 FIG.15)
BV-10
BV-32
BV-20
BV-27
BV-13
BV-22
BV-12
BV-14
KVARTER
TERTIER
Fallgöng
PRESSURE SHAFT
Strengjagöng
CABLE SHAFT
Stöðvarhús
POWER HOUSE
Skáhola BV-32 INCLINED BOREHOLE
Blandsyrpa II
MIXED SUITE II
Þóleiítsyrpa II
THOLEIITIC SUITE II
Hér má búast við óreglu vegna misgengja
Et.v. mjög stórt misgengi
Frárennslisgöng
TAILRACE TUNNEL
Blandsyrpa I
MIXED SUITE I
Þóleiítsyrpa I
THOLEIITIC SUITE I
Kjalvegur
Vegur inn Blöndudal
BLANDA
300 m y.s.
Jarðlagasniðið er yfirhækkað 2X
VERTICAL EXAGGERATION 2X
Staðsetning stöðvarhúss og strengjaganga ekki nákvæm
APPROXIMATE LOCATION OF POWER HOUSE AND CABLE SHAFT
Holur sem standa utan jarðlagasniðs eru færðar inn í sniðið eftir strikstefnu nálægt 330°
Miðað er við að meðaltals jarðlagahalli sé um 8° í stefnu 240°
BOREHOLES NOT EXACTLY ON THE SECTION LINE ARE PROJECTED INTO SECTION ALONG STRIKE 330°
Brotalínur og misgengi verður að taka með varúð
VOD-MJ-631-Ág.G/SZ
82.12.1579.OD

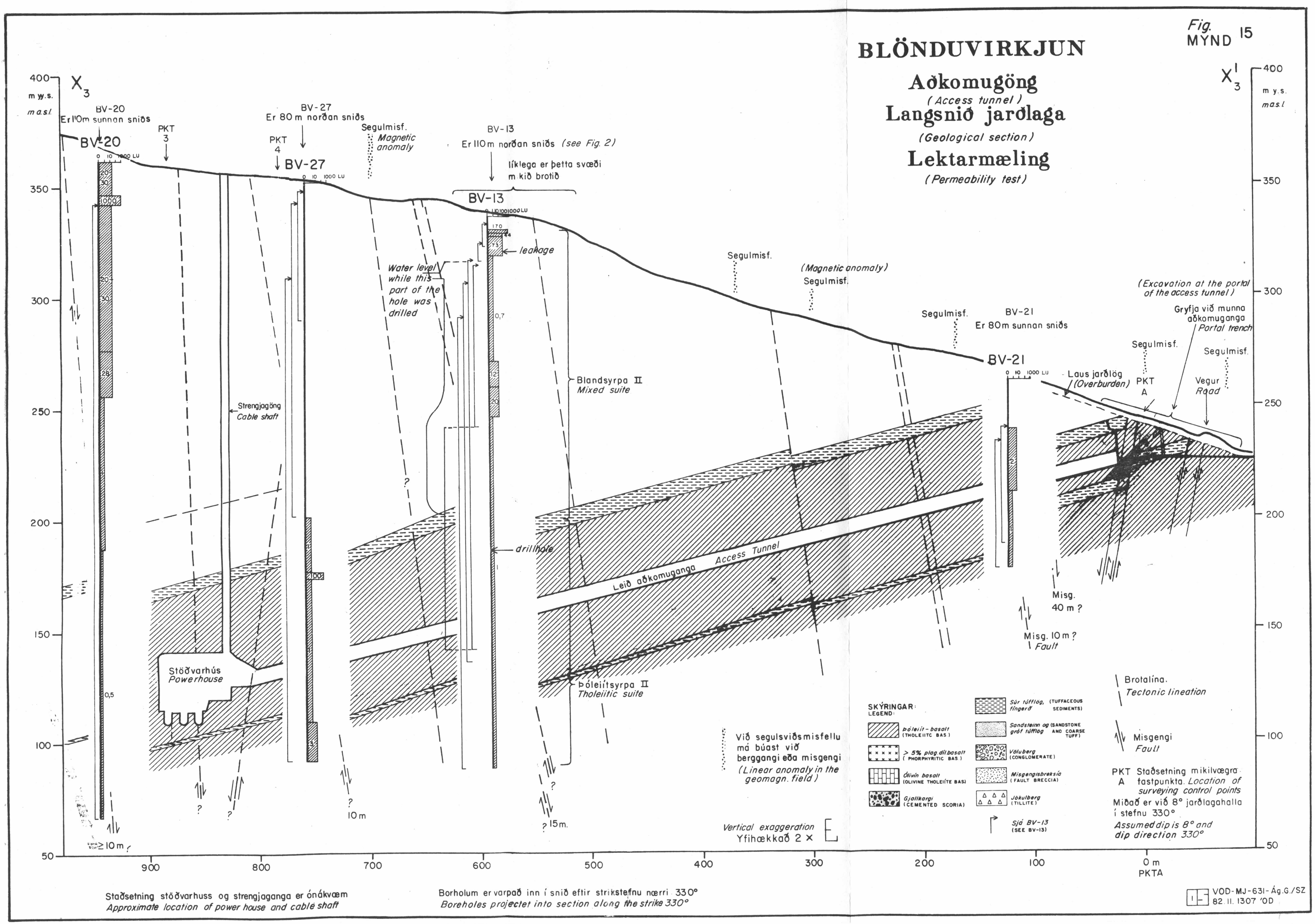


Fig. MYND 15
BLÖNDUVIRKJUN
Aðkomugöng
(Access tunnel)
Langsnið jarðlaga
(Geological section)
Lektarmæling
(Permeability test)
X3
X'3
m y.s.
m.a.s.l.
BV-20
Er 110m sunnan sniðs
PKT 3
PKT 4
BV-27
Er 80 m norðan sniðs
Segulmisf.
Magnetic anomaly
BV-13
Er 110m norðan sniðs (see Fig. 2)
líklega er þetta svæði mikið brotið
leakage
Water level while this part of the hole was drilled
Strengjagöng
Cable shaft
drillhole
Blandsyrpa II
Mixed suite
Stöðvarhús
Powerhouse
Leið aðkomuganga Access Tunnel
Þóleiítsyrpa II
Tholeiitic suite
(Magnetic anomaly)
BV-21
Er 80m sunnan sniðs
(Excavation at the portal of the access tunnel)
Gryfja við munna aðkomuganga
Portal trench
Laus jarðlög
(Overburden)
PKT A
Vegur
Road
Misg. 40 m ?
Misg. 10 m ?
Fault
Brotalína.
Tectonic lineation
Misgengi
Fault
SKÝRINGAR:
LEGEND:
Þóleiít-basalt (THOLEIITIC BAS.)
> 5% plag. díl basalt (PHORPHYRITIC BAS.)
Ólivín basalt (OLIVINE THOLEIITE BAS)
Gjallkargi (CEMENTED SCORIA)
Súr túfflög, fíngerð (TUFFACEOUS SEDIMENTS)
Sandsteinn og gróf túfflög (SANDSTONE AND COARSE TUFF)
Völuberg (CONGLOMERATE)
Misgengisbreksía (FAULT BRECCIA)
Jökulberg (TILLITE)
Sjá BV-13 (SEE BV-13)
Við segulsviðsmisfellu má búast við berggangi eða misgengi
(Linear anomaly in the geomagn. field)
PKT A Staðsetning mikilvægra fastpunkta. Location of surveying control points
Miðað er við 8° jarðlagahalla í stefnu 330°
Assumed dip is 8° and dip direction 330°
Vertical exaggeration
Yfihækkað 2 ×
Staðsetning stöðvarhuss og strengjaganga er ónákvæm
Approximate location of power house and cable shaft
Borholum er varpað inn í snið eftir strikstefnu nærri 330°
Boreholes projectet into section along the strike 330°
VOD-MJ-631-Ág.G./SZ
82.11.1307 'OD