ORKUSTOFNUN
NATIONAL ENERGY AUTHORITY
HYDRO POWER DIVISION

JARÐTÆKNISTOFAN HF
JTS Geotechnical Services Ltd.
Ágúst Guðmundsson

BREIÐADALS- AND BOTNSHEIÐI TUNNEL

Geological report

OS-91006/VOD-02
Reykjavík, February 1991

Prepared for
Public Roads Administration

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GRENSÁSVEGUR 9.
108 REYKJAVÍK ICELAND

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Dags.
1991.02.21
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Tilv. yðar

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Varðar: Jarðfræðirannsókn vegna jarðgangagerðar á Vestfjörðum.

Fyrirliggjandi skýrsla, "Breiðadals- and Botnsheiði Tunnel. Geological Report" (Skýrsla Orkustofnunar: OS-91006/VOD-02), er samin af Ágústi Guðmundssyni í samræmi við samning Vegagerðar ríkisins og Orkustofnunar - Vatnsorkudeildar, frá 1989.07.05. Skýrslan fjallar um jarðfræðilegar aðstæður við lagningu vegganga undir Breiðadalsheiði og Botnsheiði. Hún byggir á jarðfræðikortlagningu á yfirborði og úrvinnslu borholugagna úr rannsóknarborunum á gangaleiðunum.

Áætluð veggöng myndu að mestu leyti liggja í gegnum basalthraunastafla frá Síð-Tertíer, sem hafa nokkuð mismunandi berggæði. Berglögum þessum hallar lítillega til suðausturs og er berglagastaflinn víða brotinn af óvirkum sprungum og misgengjum. Veggöng frá Breiðadal til Tungudals myndu skera í gegnum setlagastafla, sem fylgir mislægi, a.m.k. á einum stað, ef ekki tveimur. Setlög þessi eru undir 10 m að þykkt, en veik að burðum. Svipaðs setlagastafla er jafnvel að vænta á gangagreininni til Botnsdals, hafi misgengi orðið meiri en greina má með vissu á yfirborði.

Haukur Tómasson
Forstjóri Vatnsorkudeildar Orkustofnunar.

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1. INTRODUCTION

The planned Breiðadals- and Botnsheiði tunnel is a road tunnel, located in the mountainous peninsula of NW Iceland. The bedrock is essentially a pile of basaltic lavas of late Tertiary age, forming a highland plateau which was highly dissected into fjords and valleys during Glacial time.

This road tunnel will connect the valleys; Breiðidalur (in Önundarfjörður), Botnsdalur (in Súgandafjörður) and Tungudalur (close to the Ísafjörður town). The tunnel will be about 8.7 km in total length with three portals and tunnel junction under the eastern part of Botnsheiði.

Previous geological investigations in the Breiðadals- and Botnsheiði were carried out in the years 1983-1985 by Vegagerð ríkisins (Public Roads Administration). Byggðastofnun (Institute of Regional Development) published feasibility report for the planned road tunnel 1987.

The purpose of the geological investigations reported here is to give more detailed description of the geological conditions of the strata in the Breiðadals- and Botnsheiði tunnel area.
The investigations reported here were performed in the years 1988-1990 by Jarðtæknistofan (JTS Geotecnical Services Ltd.), Orkustofnun (National Energy Authority) and Vegagerð ríkisins (PRA). Scientists involved were Ágúst Guðmundsson JTS Ltd, formerly at NEA) and Björgvin Guðjónsson (PRA). All investigations reported here have been carried out on behalf of Vegagerð ríkisins (PRA) and directed by Hreinn Haraldsson (PRA). This report was prepared by Ágúst Guðmundsson and Björn A Harðarson JTS Ltd.

2. GEOLOGICAL SETTING OF NORTHWESTERN ICELAND

Iceland is situated on the Mid-Atlantic ridge wich marks the rifting plate boundary between the Eurasian and the North American plates. When the plates drift apart, the gap between them is constantly filled with extrusive and intrusive igneous rocks. At present a highly active volcanic zone runs across Iceland from southwest to northeast, from the Reykjanes Peninsula in the southwest to the Mývatn - Skjálfandaflói area in the north east (see Drawing 1).

The total thickness of the basaltic lava pile in the NW peninsula of Iceland is about 6-7 km and the strata dips gently 3-6° at sea level towards the SE. Locally the steepest dip is about 15° at Steingrímsfjörður in the SE part. The lava pile is 8 to over 15 million years old and comprises mainly tholeiitic flood basalt, intercalated with usually thin sedimentary interbeds. Few of the sedimentary interbeds represent a long volcanic quiescence. The average accumulation rate of the lava pile of the NW peninsula has been estimated to be in the order of 1 km/million years.

The NW peninsula comprises some extinct silicic volcanic centres, called "central volcanoes", showing signs of former intensive volcanism. The central volcanoes show great varations both in rock types and dip of lava flows. Intermediate and acidic rocks are more or less restricted to the central volcanoes and their immediate vicinity. The overall composition of the bedrock of NW Iceland is as follows:

- 85-90% basaltic lava flows.
- 3-5% acidic and intermediate (between acidic and basaltic) rocks.
- 5-10% sedimentary interbeds, mainly of consolidated tuffs and eolian soil, and to a lesser part of sandstones and conglomerates.

In Tertiary time, the NW peninsula of Iceland was a basaltic plateau with some central volcanoes, rising up to several hundred metres above the plateau. In late Tertiary time with gradually cooling climate, glaciers were presumably formed on the central volcanoes, and during Pleistocene they eroded the plateau, forming the present valleys and fjords, (e.c. Önundarfjörður, Súgandafjörður and Skutulsfjörður). The region shows at present a typical glacier morphology.

At present, the NW peninsula of Iceland is a mountainous area with mountains rising up to elevation of 1000 m. The retreating glaciers left the present deeply eroded valleys and fjords, with moraine and postglacial alluvial fills.

3. GEOLOGY OF THE BREIÐADALS- AND BOTNSHEIÐI AREA

3.1. INTRODUCTION

The Breiðadalsheiði and Botnsheiði tunnel area and surroundings that will be discussed here, extends over the subpeninsula between Önundarfjörður in the west, to Skutulsfjörður and Álftafjörður in Ísafjarðardjúp in the east (see Drawing 2). The tunnel will connect Breiðidalur and Tungudalur, (side valleys of Önundarfjörður and Skutulsfjörður respectively), and Botnsdalur, (a head valley of Súgandafjörður). The icelandic words -dalur and -fjörður means valley and fjord respectively.
The Breiðadalsheiði and Botnsheiði tunnel area is located within the lower part of the highly dissected basaltic lava pile of NW Iceland.

3.2. LITHOSTRATIGRAPHY

The bedrock in the Breiðadalsheiði and Botnsheiði and the surrounding area was formed appr. 13 to over 15 million years ago. It consists of a 1200 - 1800 m thick sequence of basalt lava flows with interbedded sediments. The average accumulation rate of the lower part of the lava pile in NW peninsula (Breiðadalsheiði and Botnsheiði area) has been in the order of 0.7 km/million years and the average time between eruptions seems to be in an order of 1800 years. There seems to be a great difference in the accumulation rate between the lowest part of the lava pile and the upper part and some sedimentary horizons are considered to correspond to temporal unconformities of lengthy durations.

The basalts in Breiðadalsheiði and Botnsheiði area are classified according to Walker [9] into the three following main petrographic types ;

- tholeiite basalt
- olivine basalt
- porphyritic basalt

Sediments intercalating the lava flows are commonly thin, red, fine grained and tuffaceous beds but sometimes as thicker accumulations accompanying unconformities. Coarse grained sediments are very rare, but can be found specially at unconformities.

3.3. GEOTHERMAL ALTERATION

The basaltic lava pile of Iceland contains abundant secondary zeolites and other amygdale and joint filling minerals. These minerals have been found to have a well marked zonal distribution [10].
Alteration of basaltic rock in the tunnel route of Breiðadalsheiði and Botnsheiði indicates the lower part of the Chabasite - Thomsonite zone and the upper part of the Analcime zone (or 500 - 900 m under the original surface of the basalt plateau).
The zeolitization is thought to have occurred during the accumulation up of the lava pile. The alteration zones of the Icelandic bedrock are defined and named according to the prevalent amygdale fillings, indicating the depth of burial in the lava pile.
It should be noted that this type of alteration, when it concerns the vesicles and amygdales of the basalts does not only significantly affect the tecnical properties of the rock mass, but as joints filling they are supposed to have stabilizing effects. This alteration also reduces the permeability of the rock.

3.4. TECTONICS

The lava pile of the Breiðadalsheiði and Botnsheiði area can be represented as an isoclinal body dipping very gently towards SE. The overall attitude is 4-5° dip towards direction 135°.
The lava pile is affected by two relatively dense subvertical fault and dyke systems, major fault system striking NE-SW (along the strike) and a minor system striking in NW-SE direction.
Observed vertical displacement of faults range from less than 1 m up to 40 m in the tunnel area, but few km outside the tunnel area downthrow of up to 85 m has been observed. Some faults show a greater displacement in the lower part of the mountain sides than in the upper part, indicating continuing tectonic activity during piling up of the basaltic lava pile.
Faulted zones are typically 1 to 5 m wide, usually containing clayey crushed rock of low strength.

Dykes in the project area are of basaltic composition and are mainly heading NNE-SSW and NE-SW (along the strike). They are usually 2-8 m thick but dykes up to 20 m thick have been observed. Most of the dykes are highly jointed. In Botnsdalur in Súgandafjörður there is a dyke swarm heading NE - SW, but due to poor outcrops in the bottom of the valley, it is very difficult to estimate the dyke intensity and tectonic activity there. Dyke intensity along the tunnel routes is expected to be 3 - 10%.

3.5. POSTGLACIAL GEOLOGICAL DEVELOPMENT

In late Tertiary time and during Pleistocene, repeated extensive glaciation took place in Iceland. Ice caps are supposed to have covered the highland plateu of Central Iceland and as the ductile ice moved from the highland towards the shore, an extensive erosion of the underlying bedrock took place, forming valleys and fjords. On the outer peninsulas such as NW Iceland, much smaller ice caps are anticipitated during Pleistocene and glacial erosional landscape of circque, and valley glaciers is most typical there.

3.6. REGIONAL HYDROGEOLOGY

The drainage pattern of the Breiðadalsheiði indicates a rather permeable rock above 350 - 400 m a.s.l. but below that altitude indicating a rather tight bedrock. This is confirmed by the numerous scattered springs (with low discharge) and streams originating midway up the mountain slopes.
Relevant water seepage in the different rock type constituting the lava pile is also possible along bedding and tectonical discontinuities, the rate of flow depending on their frequency, geometry and characteristics.

Most of the springs yield cold, unmineralized groundwater, but in some of the drillholes, low thermal water, most likely with low to medium mineralization has been observed. Thermal water has been encountered from a spring and drillholes located in Súgandafjörður and Bolungavík, some 5-6 km from the portal in Botnsdalur. Therefore thermal water (possibly up to 30 - 50° maximum) can be expected in the tunnel.

The layered structure of the lava pile and the fact that some joint systems are confined to individual lava flows suggest that several more or less independent aquifers separated by less permeable sediments exist within the lava pile.

4. FIELD INVESTIGATIONS

4.1. PREVIOUS INVESTIGATIONS

Some geological investigations were performed in the NW peninsula of Iceland during the latter half of the 19th century and early in this century. Most of these investigations were concentrated on few thick sedimentary horizons containing lignite. Lignite mining was performed at several locations during the First World War.

In the years 1975-1976 continuous stratigraphical profiles were measured through the whole lava pile in the NW peninsula for determining the paleomagnetostratigraphy and geochronology of NW Iceland [6]. In this project geological mapping did not extend far beyond those profiles.

The National Energy Authority carried out in the years 1982-1984 a pilot study on the lignite-containing sedimentary horizons in NW Iceland [4].

In the years 1983-1985 a team from the Public Roads Administrations (PRA) of Iceland performed geological investigations at many possible tunnel routes in the Breiðadals- and Botnsheiði area [3 and 5].

In 1986, the Institute of Regional Development made feasibility studies on some of the possible tunnel routes in the Breiðadals- and Botnsheiði area [2].

In 1989 a team from NEA and PRA performed further geological investigations in the Breiðadals- and Botnsheiði and surrounding area, concentrating on the present planned tunnel routes [1].

4.2. GEOLOGICAL MAPPING

4.2.1. Previous data

Geological mapping with petrographical classification of basalt types and how some paleomagnetic suites are traceble over the Breiðadals- and Botnsheiði area started in 1975 [6].

At the start of the geological mapping reported here, valuable geological results were available from work of scientists of the PRA and NEA [1 and 3]. Topographic maps of the Breiðadals- and Botnsheiði highlands were only available in the scale 1:50.000 with 20 m contour intervals. Accuracy of such topographic maps is insufficient for locating geological informations with precision.

4.2.2. Field profiling and mapping

The geological mapping was predominantly done by inspecting and describing rock layers along selected well exposed profiles.
Some almost continuous, well exposed profiles exist along streams and gullies, not far from the portal areas but generally there are poor outcrops in the bottom of the valleys and on the Breiðadals- and Botnsheiði highland plateau.
The rocks were classified by inspection of handspecimen according to the classification scheme developed by Walker [11].
The thickness of individual layers was usually estimated, by using a Paulin altimeter but occasionally by a pocket clinometer.
Prominent lava flows and sedimentary layers, were often traceable between some of the profiles, permitting a simple geological modelling. Tectonic features like faults and dykes were inspected as far as they were accessible. Vertical displacement of faults was measured (usually with altimeter) or estimated using altimeter and clinometer.

4.2.3. Interpretation of aerial photographs

Aerial photographs of the Breiðadalsheiði and Botnsheiði area in the approximate scale of 1:36.000 and 1:40.000 are available. The aerial photographs were used to detect tectonic features such as dykes, faults or other lineaments in the surrounding area. It was also possible to trace some prominent lava flows on aerial photographs. Aerial photographs in the scale 1:14.000 were prepared for limited areas close to the portals and tunnel routes.

4.3. DRILLING AND SAMPLING

In the years 1989 and 1990 nine cored exploratory drillholes numbered BR-1 to BR-9 were drilled close to the planned tunnel portals and one deep cored hole, (BR-2) on the Botnsheiði plateau, located above the proposed tunnel junction.

Depth of the holes range from 23 to 400 m with a total core recovery of about 1200 m. Graphic core logs of the drillholes are shown on Drawings 9-20 and location of drillholes on Drawing 3. Drillhole BR-8 was drilled almost entirely into a dyke and is not shown on graphic core logs. The coordinates, elevation and depth of drillholes are shown in Table 1.

Table 1. Coordinates, elevation and depth of drillholes BR-1 to BR-9.

Hole	X Coordinate	Y Coordinate	Elevation m a.s.l.	Depth m
BR-1	331088.289	530724.340	219.9	87.7
BR-2	329321.451	532724.808	469.5	400.0
BR-3	326645.675	530067.481	231.8	103.3
BR-4	331008.764	531036.657	219.9	110.7
BR-5	331181.847	530934.813	194.8	90.6
BR-6	331215.724	530842.603	176.9	23.4
BR-7	330493.717	531463.112	332.5	220.6
BR-8	329542.851	534584.390	179.4	100.0
BR-9	329508.138	534611.722	175.6	98.8

4.4. LOGGING OF BOREHOLES

The core logs are shown on Drawings 9-20 and more details are shown on core logs in Icelandic in Appendix 1. The data for each borehole comprise a detailed borhole log, with information on:

- Lithology of rocks. The number of rock units (basalt, scoria and sediments) and the thickness of each unit in all the drillholes is shown in Table 2. For BR-2, the uppermost 170 m are ommitted in the data shown in Tables 2 and 3.
- Description of discontinuities, with semi quantitative assessment of flow banding and vesicles.
- The core recovery and RQD measurements using the standard Deere's criteria of 10 cm. The RQD values were not determined on coring rounds but on the rock types. The average results for each borehole are shown in Table 3 along with the 30 cm and 50 cm criteria.
- The magnetic polarity of each lava flow (useful for correlation purposes).

- The location of samples for the uniaxial compressive test.
- The rock mass quality Q according to the method developed by Barton, Lien and Lunde (1974).

Table 2. Number and thickness of observed rock units in drillholes.

Borhole	Number of rock units	Thick. of observed lava pile	Average unit thickn.	Maxim. unit thickn.	Min. unit thickn.
BR-1	15	85.7	5.7	12.4	0.05
BR-2	59	230.3	3.9	19.8	0.03
BR-3	29	96.6	3.3	13.5	0.02
BR-4	17	109.3	6.4	23.4	0.30
BR-5	19	86.0	4.5	20.1	0.05
BR-6	2	20.0	10.0	17.9	2.10
BR-7	69	215.5	3.1	22.0	0.03
BR-9	30	96.9	3.2	18.4	0.03
Total	240	940.3	5.0	23.4	0.02

Table 3. Average core recovery and joint frequency in drillholes.

Borhole	Av. Core Recovery %	Av. RQD 10 cm %	Av. RQD 30 cm %	Av. RQD 50 cm %	Aver. Q Value	Aver. Joints num/m
BR-1	100	71	52	45	3.7	4.5
BR-2	97	91	85	76	5.3	1.4
BR-3	96	66	42	31	4.3	3.1
BR-4	91	67	53	37	5.1	5.8
BR-5	91	68	55	40	4.8	3.8
BR-6	96	77	33	7.5	2.1	
BR-7	95	71	53	46	4.4	5.1
BR-9	91	68	55	47	4.6	2.5
Total	95	75	60	50	4.7	3.5

5. FIELD TESTING

5.1. WATER PRESSURE TESTING

Water pressure tests were peformed at a few intervals in the drillholes drilled 1989, using single packer device and 3-4 pressure interval steps (all below 10 bars) when possible. Pressure tests indicate heavy lekage at some faults, cracks and dykes but the rock mass in general showed low permeability. Table 4 shows summary of water pressure test results and depth to groundwater. The pervious zones observed in BR-2 are located above the planned tunnel routes.

Table 4. Summary of water pressure test results.

Hole	From m	To m	Interval m	Lugeon value LU	Depth to GWT m
BR-1	37	87	50	~ 1	12.6
BR-2	1	66	65	≥ 40	26
BR-2	51	165	114	≥ 40	
BR-2	78	165	87	≥ 40	
BR-2	356	400	44	~ 2	
BR-3	21	103	82	~ 1	5.8
BR-3	52	103	51	~ 1	
BR-4					artesian
BR-5					3 - 4
BR-6					3 - 4
BR-7					5 - 6
BR-8					4 - 5
BR-9	28	34	6	≥ 100	29

5.2. WATER TEMPERATURE IN BOREHOLES

Water temperature was mesured in drillholes BR-3 and BR-4 and in the upper part of BR-1 and BR-2. The temperature profiles are shown on Drawing 21. Temperature in BR-3 and BR-4 indicates that water temperature of 15 - 30° (or even more) can be expected in the tunnel.

6. LABORATORY TESTING OF ROCK MATERIALS

A total of 135 uniaxial compression tests were performed on drill cores from the drillholes. The tests were performed by the Building Research Institute in accordance with ASTM 2938-86. Detailed results are shown in Appendix 2. Summary of results are shown in Table 5.

Table 5 Uniaxial compression tests results.

Rock type	Number of tests	Average Uniaxial compressive strength (MPa)	Standard deviation (MPa)
Tholeiite basalt	47	128.2	71.1
Olivine basalt	17	124.1	51.9
Porphyritic basalt	38	115.6	51.6
All basalt	102	122.8	61.1
Scoriaceous breccia	33	28.8	20.5

No reliable test results were obtained for the sedimentary interbeds. The weakest sediments occuring along the tunnel route, i.e. the acidic tuffs and the reddish residual soils, could not be sampled because of their poor state in the core boxes; many of the layers in the boreholes had already disintegrated as a result of drying and wetting. These types of sediments have uniaxial compressive strength estimated to be < 5 MPa shortly after drilling and the material is expected to crumble quickly once exposed to atmospheric conditions. Other sediments, sandstones and conglomerates are expected to have uniaxial strength in the order of 10 - 30 MPa.

7. GEOLOGICAL EVALUATION OF THE ROCK MATERIALS

The rock types observed in the Breiðadalsheiði and Botnsheiði area, will be described briefly in this chapter.

7.1. BASALTS

7.1.1. Classification of basalts

Petrographically Icelandic basalts are of three different main types, as revealed by Walker [11]. The types are: Tholeiite basalt, Olivine basalt (correctly Olivine Tholeiite) and Porphyritic basalt. The three types constitute poles between which complete transitions exist. For that reason the petrographic determination in the field may sometimes be subject to varying interpretation. Another consequence of the transitions from one type into another is the almost undifferenciated engineering properties of the three types. In this report the name Transitional basalt means a basalt type lying somwhere between the standard rock types of the poles mentioned above.

Classification of the basalts is based partly on the determination of the amygdale-minerals whose composition is very sensitive to small variations in the composition of the rock [10].

Tholeiite basalt; very fine grained and non-porphyritic basalt containing not more than accessory amounts of olivine; commonly with quartz, chalcedony, and silicia rich-zeolites in amygdales. In lava pile of low alteration, like in the Breiðadals- and Botnsheiði area, there is on average lesser amount of amygdale minerals in tholeiite basalts compared to olivine basalts.

A secondary type of tholeiite is what is called central volcano-tholeiite. This type of tholeiite is considered to be formed on a flank of a central volcano. Tholeiite of this type is common in subsuite 2b and suite 4 in the Breiðadals- and Botnsheiði area (see chapter 8). Usually lavas of this type are rather thin (often 5-10 m) with high content of scoria (25-35%). Within the crystalline part of the lavas there are usually fracture systems due to cooling and flow banding.

Olivine basalt; (olivine tholeiite) non-porphyritic fine grained basalt (but coarser than tholeiites) containing more than accessory amounts of olivine; commonly with silica-poor zeolite amygdales.

Olivine basalt can be divided into two groups regarding to thickness. On one hand there are thick compound flows which are made of few to numerous flow units (each 2-5 m) and having rather small columnar jointing pattern, and on the other hand there are thicker layers with large columnar jointing pattern. The basalt is very often microporous with evenly distributed micropores throughout the whole crystalline rock mass, making the rock "softer" and more ductile than tholeiite, and giving it lower strength. In weathered outcrops olivine basalt has usually larger fracture systems than tholeiite (average spacing about 0.4 m).

Porphyritic basalt; basalt with more than 5% of phenochrysts of plagioclase (bytownite); phenochrysts of augite and olivine may also occur in smaller amount. The average thickness of the flows and the average size of the columns are very similar to those of the two basic types.
The porphyritic basalts have the basic characteristics of either of the two types described above. When the amount of phenocrysts is above 7-10%, the groundmass is usually of olivine basalt character.

Characteristically there are two basic basalt types, the Tholeiite and the Olivine basalt. Each of the two can develop a porphyritic structure, in which case it will be named a Porphyritic basalt. In the Breiðadals- and Botnsheiði area the porphytitic basalts are tecnically more alike the olivine basalts than the tholeiites.

The main characteristics of both tholeiite and olivine basalts are shown in the following synopsis.

Table 6. Comparison of typical characteristics of tholeiite and olivine basalts.

THOLEIITE BASALTS	OLIVINE BASALTS
Very fine grained	Coarser grained
Free olivine crystals absent	Free olivine crystals often visible in handspecimen
Total silica content : 48-50%	Total silica content: 46-48%
Weathered crust, pale brown	Weathered crust, dark brown to deep grey
Spheroidal weathering uncommon	Spheroidal weathering common
Amygdales often without zeolites	Amygdales contain zeolites
Well developed flow structures	Less developed structures within flows
Micropores often arranged along subhorizontal surfaces with spacing < 1cm resulting in faint cleavage	Micropores randomly scattered throughout the rock mass
Scoriaceous part of tholeiite flows: usually 20-30% of the flow thickness	Scoriaceous part of olivine basalt flows: usually 5-15% of the flow thickness
Forms usually single lava flows	Forms compound and single lava flows
Common thickness of lava flows: 7 - 14 m	Common thickness of lava flows: 6 - 12 m
Common width of columns : 1.5 - 2.5 m	Common width of columns : 1.2-2.0 m
Hardness of the dense matrix I to II*	Hardness of the dense matrix: II*

*Hardness scale ISRM.

7.1.2. Structure of lava flows

Each lava flow can structurally be divided into three parts as follows:

- **the top scoria** (often 10-25% of the lava flow thickness)
- **the dense crystalline middle part** (often 60-85% of the lava flow thickness)

- **the bottom scoria** (often 5-10% of the lava flow thickness).

The top scoria consists most often of scoriaceous and vesicular basaltic fragments, with sandstone matrix. The rock has the appearance of a breccia. The sandstone often infiltrates into the spaces between the loose scoria fragments and subsequent palagonitization later cements the sandstone and the scoria fragments. The infiltration of sediments into the scoria occurred during the deposition of the sediments and this explains why such infiltrated scoria is usually not present at the bottom of the flows. The rock can easily be recognized because of the pseudobrecciated structure and the colour contrast between the dark grey basalt fragments and the usually reddish, orange or greenish sandstone.

The crystalline middle part is hard dense basalt, light to dark grey in colour. The rock is usually affected by typical irregular columnar jointing resulting from the cooling process of the lava. Further structural characteristics like flowbanding, amygdales and joints are common.

The bottom scoria is most often well consolidated and seldom contains sandstone fillings.

The three parts show clearly different engineering properties; for this reason, the term Basalt in this report is attributed to the dense part of the lava flows and the terms Scoria and Scoriaceous Contact Breccia to the top and bottom parts of the flows.

7.2. SEDIMENTARY INTERBEDS

The sediments in the lava pile of the Breiðadalsheiði and Botnsheiði area are of two different types.

1) **Red tuffaceous sandstones/siltstones**, originate from red residual soils along with acidic and basaltic tephra. These sediments often show a relatively high clay content (specially the acidic tuffs) and can alter quickly when exposed to atmospheric conditions. Sedimentary interbeds of this type are widespread throughout the whole lava pile. They are commonly 0.1-10 m thick but interbeds of up to 30 m thick have been located within the mapped area. Sedimentary interbeds of altered acidic tuffs are considered as very weak rock.

2) **Conglomerates, sandstones and siltstones,** are found as interbeds of few cm up to few tenths of metres in the Breiðadalsheiði and Botnsheiði lava pile. The sediments contain silty material, coarse grained sandy gravels with some cobbles mixed with sand and silt. This type of sediments are associated with unconfomities and formed by fluvial erosion, and mixed with volcanic material.

7.3. OVERBURDEN

The overburden in the tunnelling area consists mostly of moraine and talus formations, both sparsely covered with vegetated, water saturated topsoil of variable thickness.

8. LITHOSTRATIGRAPHIC UNITS

The bedrock in the Breiðadalsheiði and Botnsheiði area consists of some 1200 - 1800 m thick sequence of basalt lava flows with interbedded sediments.
The accumulation of the lava pile has not been continuous and presumably some time laps (unconformities) may have occurred corresponding to some of the sedimentary horizons.

The basaltic lava pile has been grouped into suites of similar basalt lava types, and the suites in the tunneling area are divided further into subsuites. Locations of individual suites are shown on the geological sections of the tunnel routes, see Drawings 4 and 5. Hereafter those suites will be described, starting from sea level in suite 1 and ending in suite 5 at the top of the mountains above the Ísafjörður town.

8.1. SUITE 1

Suite 1 comprises the lowest exposed part of the lava pile, from sea level (at the head of the peninsula at Súgandafjörður) up to a major unconformity accompanied by sedimentary interbeds containing lignite and plants remains. This suite is presumably 14-16 million years old and is considered to contain the oldest rock exposed in Iceland. Suite 1 is located below the proposed tunnel routes in Breiðadalsheiði and Botnsheiði, and consists of mixed regional basalts of various basalt types with thin tuffaceous interbeds. The total exposed thickness of this suite is about 350 - 500 m and it dips 4-6° towards SE on the average. The main components of the sedimentary horizon at the top of suite 1 are basaltic to acid tuffs and water transported volcanic debris. The sediments contain lignite as mentioned above and mining was performed in the layer at Botn, 1-2 km from the portal in Botnsdalur during the Great World Wars. This horizon is 5 - 20 m thick and is traceable over a wide area in the Northwestern peninsula forming a good markerbed at the top of suite 1.

8.2. SUITE 2

The greatest part of the tunnel route in Breiðadalsheiði and Botnsheiði is expected to lie within suite 2. Suite 2 is a 200-500 m thick series (thickening downdip) of basaltic lavas of various basalt types with sedimentary interbeds, one of them containing major sedimentary horizon accompanying an unconformity. Suite 2 is 13-14 million years old and is divided into subsuites named 2a, 2b and 2c.

8.2.1. Subsuite 2a

At the bottom of suite 2, there is subsuite 2a, 30 - 60 m thick series of rather thin porphyritic lavas and some occasional lavas of other basalt types. In the top of subsuite 2a there is major sedimentary horizon accompanied by an unconformity. The thickness of this sedimentary horizon varies from less than 5 m up to more than 30 m. The sediments are also varying in composition, containing i.e. weak basaltic and acidic tuffs, water transported volcanic debris and conglomerates. The sediments and the underlying basalts have suffered extensive chemical weathering. An exploratory iron ore mine was excavated most likely in these sediments close to Flateyri village in the early thirties. The Botnsdalur portal and the northwestern end of the tunnel route are located just above this sedimentary horizon (in the lowest part of suite 2c).

8.2.2. Subsuite 2b

Subsuite 2b is in the western part of the Breiðidalur tunnelling area. It consists of a series of tholeiite basalt lavas of central volcano type, intercalated with thin reddish sandstone - siltstone layers. Subsuite 2b seems to thickens towards W or SW and it is considered to be formed on a distal flank of a central volcano located in the peninsula between Arnarfjörður and Dýrafjörður. The top of this subsuite is accompanied by a 4-8 m thick weak tuffaceous sediment that will presumably intersect the tunnel route 1,5-2 km east of the portal in Breiðidalur.

In Breiðadalsstigi (appr. 3 km W of the portal in Breiðidalur) there is a good section through subsuite 2b. There it consists of tholeiite lavas, with an average thickness of almost 9 m (ranging from 1.5 to 22 m, including a scoria content of approximately 30-35%) and scattered reddish interbeds, ranging from less than 5 cm to appr. 30 cm in thickness.

In drillhole BR-3 (located in the portal area in Breiðidalur) the average thickness of tholeiite basalt is approx. 10 m (the crystalline part is on average almost 7 m and the scoriaceous part is 2.7 m). The layers are usually separated by very thin reddish interbeds (≤1 cm to 30 cm). See Drawing 14 for details.

8.2.3. Subsuite 2c

Subsuite 2c is a 150 - 250 m thick suite of mixed regional basalt lavas (predominantly tholeiite) containing rather thin (usually ≤ 1 m) sedimentary interbeds. Average thickness of the basalt lavas is about 10 m (the crystalline part is normally 6-7 m and the scoria is on the average about 3,5 m thick). The basalts in this subsuite vary greatly in thickness; less than 1 m to over 20 m has been observed. The contact between subsuites 2b and 2c is sometimes unclear in the western part. At the top of subsuite 2c there is a minor unconformity with sedimentary interbeds of 5-8 m total thickness, normally split into two or three layers by thin basalt lavas. These sedimentary interbeds will be intersected in the Tungudalur tunnel route and can (due to tectonic activity) possibly also be expected in the Breiðidalur tunnel route.

8.3. SUITE 3

Suite 3 is more than 300 m thick series of 13-14 million years old lava pile of mixed basalt lava types with sedimentary interbeds. Suite 3 is divided into two subsuites, the lower part is subsuite 3a, a group of porphyritic basalt and the upper part is subsuite 3b, a varying combination of two thick groups of olivine basalt and basalts of various types.

8.3.1. Subsuite 3a

Subsuite 3a is more than 100 m thick in the tunnel area. It is a group of porphyritic lavas with an average thickness of 16 m, including scoria that varies in thickness (on the average 2 m). The observed thickness of the porphyritic lavas is from 5 to over 40 m and the various thickness indicates an uneven landscape prior to the formation of subsuite 3a. In this subsuite interbeds of ≤ 2 m have been observed. The eastern end of the tunnel route, and the portal in Tungudalur will be within the lower part of subsuite 3a. Subsuite 3a seems to have the best rock quality among the suites in the tunnel area, with a Q-value of the basalt and scoria usually ranging from 7 to 10.

8.3.2. Subsuite 3b

Subsuite 3b is more than 200 m thick series, mixed of various basalt lava types. Subsuite 3b is quite complicated and it could be divided further into two series of various basalts types and two series of olivine basalt that can be traced over a wide area. Subsuite 3b is stratigraphically higher than the tunnel routes, and therfore it will not be discussed in more detail here.

8.4. SUITE 4

Suite 4 is in the upper part of the mountains of Breiðadalsheiði and Botnsheiði (above the Botnsheiði plateau). It is a 200 - 300 m thick suite of tholeiite basalt of central volcano type. The basalt is fresh and seems to be quite permeable, leading to numerous springs of very low discharge forming more or less a continious line along the lower border of suite 4. This suite was formed about 13 million years ago as a distal flank tholeiite connected to extensive volcanism in a central volcano buried downdip in the bedrock of the Lambadalur mountain, south of Breiðadalsheiði and Botnsheiði. Suite 4 is stratigraphically above the tunnel route and will not be discussed further.

8.5. SUITE 5

Suite 5 rests on suite 4 at the top of the mountains east of Súgandafjörður, and south of Breiðadalsheiði. It displays great changes in thickness in downdip direction. This suite is over 200 m thick at the top of Eyrarfjall above the town Ísafjörður and is separated from the underlying suite 4 by a 5-10 m thick sedimentary interbed of predominantly acidic airborn volcanic tuffs. The basalt lavas of suite 5 are of various types and intercalated with thin reddish sandstone and siltstone layers. Suite 5 was formed about 12 - 13 million years ago and it is an important traceable suite for defining the structure of the upper part of the lava pile in this area but it is stratigraphically much higher than the tunnel routes and will therfore not be discussed here further.

9. STRUCTURE

9.1. BEDDING OF LAVA PILE

The lowest part of the lava pile, exposed in the tunnel area, dips 4-6° towards SE at sea level in Súgandafjörður and in Tungudalur. The strike of the lava pile is NE-SW (45°) and variations in strike direction are typically ± 10°. The dip gradually decreases with increasing elevation; from 3-5° at tunnel elevation of 150-200 m a.s.l. to less than 2° at elevation 600-700 m a.s.l at the top of the mountains of Breiðadalsheiði.

9.2. LINEAMENTS

The study of aerial photographs of the Breiðadals- and Botnsheiði and surrounding area (about 250 km^2) reveals abundant tectonic lineaments. Over 1000 generally straigth lineaments were plotted on a map and their orientation evaluated in rose diagrams (Drawing 3). The dominating strike trend of the observed lineaments is 25° (N25°E) in the Breiðadals- and Botnsheiði area.

9.3. FAULTS

Nearly 100 faults have been observed and mapped in the Breiðadals- and Botnsheiði area. The faults can be divided into two groups; firstly NE-SW heading faults and secondly NW-SE heading faults.

The observed vertical displacement within the project area ranges from less than 1 m to 40 m. At Bolungavík some 4 km from the portal in Botnsdalur, a fault with a downthrow of 85 m was observed heading towards the Botnsdalur tunnel route. The typical spacing of the observed NW-NE faults is 200 m to 300 m. Due to rather poor exposures, especially in Botnsdalur this figure may indeed be close to 100 m. The faults, particularly those having a high downthrow are characterized by sheared, crushed rock, with grain size ranging from blocks to clay. In some faults, the crushed material is well cemented by the fines (fault breccia), in others, the crushed material is weathered and loose. The width of observed faults or crushed zones varies between 0.5 m and 2.0 m. Wider fault (breccia) zones with thicknesses of more than 10 m are considered possible on the tunnel routes. Fault breccias have been located in most of the boreholes. In faulted, crushed and highly pervious zones with loose materials heavy water inflow may be expected.

9.4. DYKE INTRUSIONS

Basaltic dykes are common in the Breiðadals- and Botnsheiði lava pile and about 200 dykes were located. The thicknesses of the dykes range usually from 2 m to 8 m. Thinner and thicker dykes, (up to over 20 m), exist in the area. The dykes are usually continuous and densely jointed (horizontal columns). Thin fault breccia occurs sometimes along the dykes but most often they have sharp contacts to the neighbouring rocks. Most of the dykes are subvertical and strike in direction about 30° (N30°E). Water flow into the tunnel is expected when crossing some of the dykes.

9.5. JOINTS

Jointing affects both basalt lavas and sedimentary interbeds. In basalts, cooling joints (columnar jointing) are frequent. These joints are mostly restricted to the dense middle part of the flow. The surfaces are smooth to slightly rough, undulating; gouge is absent or thin clayey coatings. The most common attitude is near vertical, but inclined joints are also common. Average columnar width is approximately 2 m. At weathered outcrops, the columns defined by these joints are often affected by both vertical and horizontal fractures often spaced at 0.3 to 1 m. It is obvious that some joints affecting the dense part of the basalt flow become weakness planes once exposed to weathering. The same remark applies to the flow banding (micropores arranged along subhorizontal planes) in tholeiite, which may be compared to a faint schistocity (which is not the case) at outcrops and which has hardly an effect on the strength of sound rock. In addition to the cooling joints both basalts and sedimentary rocks are affected by tectonic fractures of varying attitude and intensity. Fracture planes are generally undulated and coated with silty or clayey material. The average joint frequency of the drillhole core is shown in Table 3.

10. GROUNDWATER CONDITIONS

The following assessment on potential water inflow along the tunnel route is based on rather poor data, mainly resting on few pressure tests in three drillholes.

The groundwater table measured in the boreholes is most often close to groundlevel. It means that the hydrostatic water head at tunnel elevation is typically 200 to 400 m. In general a water saturated rockmass is expected.
The water circulates within the rockmass along discontinuities which are of three kinds; contacts between lava flows, dipping 4-5° towards 135° (SE), cooling joints and tectonic discontinuities (faults and dykes). The faults and the dykes represent the main natural drains because of their continuity through the lava pile. Joint systems, limited in extent to a individual lava flow only, also occur but they have by far not as high drainage potential as the faults.
Most sedimentary interbeds act as impervious to semi-pervious layers between the jointed lava flows.
Observation of the groundwater level during drilling works and temperature profiles of drillholes suggest that different aquifers may exist within the lava pile. It can also be anticipated that some aquifers are subhorizontal just like the lava pile, with the sediments acting as impermeable barriers and that these aquifers contain cold water. These aquifers are recharged from the surface by direct infiltration. Another type of aquifers carrying warm and mineralized water exist; these aquifers seem to be restricted to particular faults. The temperature of scattered warm springs in the Breiðadals- and Botnsheiði and surrounding area ranges between 15° and 30°. The frequency of occurence and the length of the tunnel sections affected by thermal water over 15° is anticipated to be low.

11. TUNNEL CONDITIONS

The Breiðidalur - Tungudalur tunnel route is 5950 m long with a triple junction to the Botnsdalur tunnel approximately 4 km east of the portal in Breiðidalur. Each leg will be discussd separately i.e. the Breiðidalur tunnel route, west of the tunnel junction and the Tungudalur tunnel route, east of the tunnel junction (see location on Drawing 3). The Botnsdalur tunnel route extends for approximately 2.7 km from the portal in Botnsdalur to the tunnel junction.

The anticipated percentage and layer thicknesses for different rock types to be encountered during the tunnel excavation can be estimated. This is summarized in the following table.

Table 7. Anticipated percentage and layer thicknesses on tunnel routes

Rock type	Estimated percentage (%)	Estimated typical layer thickness (m)
Basalt	60-70	3-12
Scoriaceous contact breccia	25-35	1-5
Sedimentary rock	2-6	0.1-5
Dykes	3-10	2-8
Fault breccia	1-3	1-5

11.1. BREIÐIDALUR TUNNEL ROUTE

The Breiðidalur tunnel route, (from portal to tunnel junction) will rise 1% upwards from station 7300 at the portal in Breiðidalur, to station 9030, or for 1.7 km. At station 9030 the tunnel reaches its highest point of 200 m a.s.l. This part of the tunnel (approximately 1.5-2 km east of the portal) will most probably be located within subsuite 2b (see Drawings 4 and 6), which consists of tholeiite basalt lavas of central volcano type with thin reddish sandstone and siltstone interbeds (see core log of BR-3 for more details). Average thickness of the basalt lavas is about 9.5 m whereof appr. 33% scoria. The lavas dip gently towards SE or ESE but the direction of the tunnel is NE and thus close to the strike.

In this part the tunnel would probably go through 3-5 basalt layers in subsuite 2b, mentioned above, if the strata has not been displaced by some unrevaled tectonic activity. Somewhere in the neighbourhood of the highest tunnel point at station 9030 the upper contact or boundary of subsuite 2b is expected to intersect the tunnel route at a dip of 3-6° (see Drawing 4). The upper boundary

of subsuite 2b is accompanied by a sedimentary interbed consisting mainly of volcanic acidic tuff that is most probably 4-8 m thick.
From station 9030 to the junction at station 11264, or for about 2.2 km, the Breiðidalur tunnel route will most probably be within the topmost part of subsuite 2c. In this part the tunnel will lie nearly along the strike of the lavas and lava contacts are expected to dip very slightly towards east, perpendicular to the tunnel route. Drillhole BR-2 is located at the proposed tunnel junction but because of the concealed tectonic structure it is at present impossible to describe how the layers at the tunnel elevation in BR-2 will extend from the drillhole along the tunnel route towards the west. The topmost 50 m of subsuite 2c consist of relatively thin basalt lavas with sedimentary interbeds. At the top of subsuite 2c is a minor unconformity with sedimentary layers of 5-8 m total thickness, divided by one to three thin basalt lavas (see core logs of BR-2 and BR-7 for more details).

11.2. TUNGUDALUR TUNNEL ROUTE

The easternmost 2 km of the tunnel route Breiðidalur - Tungudalur, from the tunnel junction to Botnsdalur at station 36, to the portal in Tungudalur at station 2020, (see Drawing 4) is named Tungudalur tunnel. It will most likely cut through a 60 - 100 m thick lava pile in the upper part of subsuite 2c and in the lower part of subsuite 3a. The lavas dip approximately 2° more than the tunnel towards east. At the contact between suites 2 and 3, there are sedimentary interbeds and a minor unconformity that will most probably be intersected by the tunnel approximately half way between the tunnel junction and the portal in Tungudalur. The boundary between suites 2 and 3 is marked by sedimentary interbeds of rather poor quality (see core logs of BR-2 and BR-7) The eastern part of the Tungudalur tunnel route is expected to lie within subsuite 3a, a sequence of porphyritic basalts of good rock quality but with thin sedimentary interbeds (see core logs BR-2 and BR-9 and geological section on Drawing 7).

11.3. BOTNSDALUR TUNNEL ROUTE

The Botnsdalur tunnel route, approximately 2.7 km long from the portal in Botnsdalur at station 3690, to the tunnel junction at station 930, will most probably lie totally within subsuite 2c as shown on the geological section on Drawing 5. Subsuite 2c is a series of regional basalt (mostly tholeiite) with relatively thin sedimentary interbeds dipping gently about 3-5° toward SE (almost straight along the Botnsdalur tunnel route). The stratigraphic details are displayed on graphic core logs of drillholes BR-1, BR-2, BR-4, BR-5, BR-6 and BR-7.

The portal in Botnsdalur is located stratigraphically at the bottom of subsuite 2c, (see Drawing 8) just above an unconformity accompanied by thick sedimentary interbeds of low strength (thicknesses of 5-30 m have been observed). Although the layered bedrock is dipping approximately 3-5° inwards from the portal along the tunnel route, and the tunnel route rises 1% upwards, intensive tectonic disturbances in the lower part of the lava pile in the Botnsdalur, may displace the strata in such a way, that the unconformity and accompanying sediments could be cut by the proposed Botnsdalur tunnel route somewhere in the first 0,5 - 0,7 km from the Botnsdalur portal (see Drawing 8).

11.4. WATER INFLOW

Water inflow into the tunnel is expected as rather constant dripping water accompanied by local heavy inflows from faults and dykes. No data enables a founded estimate of water inflow along the tunnel. Nevertheless, from the experience of other underground projects in Iceland one may expect an average inflow of 10 - 50 l/s per km and, when crossing major pervious zones, peaks of several tenths or even several hundreds l/s with a duration period ranging from several days to several weeks.

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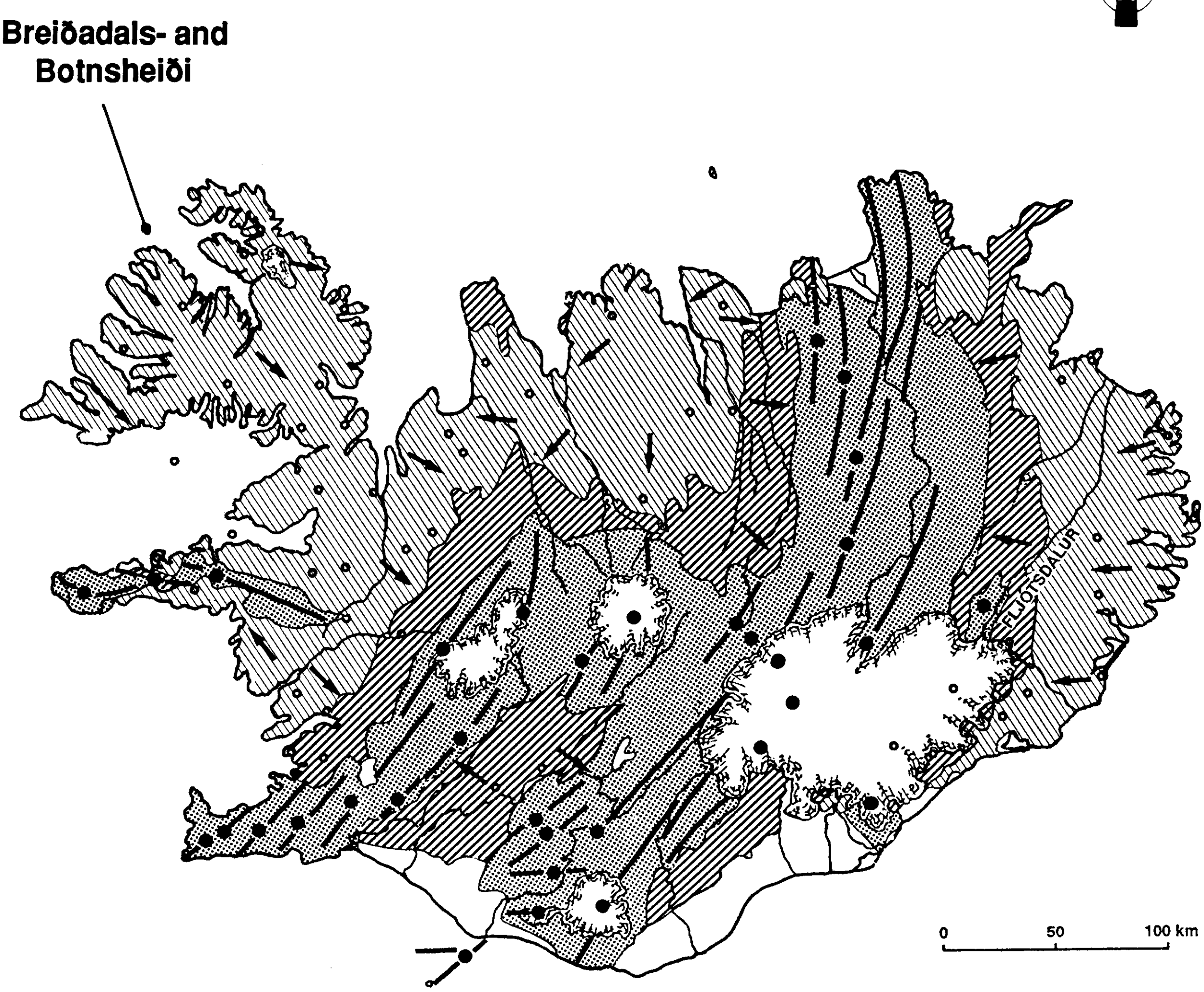
ICELAND

SIMPLIFIED GEOLOGY



LEGEND

Tertiary bedrock (> 3.1 m.y.)

Plio-Pleistocene bedrock (0.7 - 3.1 m.y.)

Upper Pleistocene and Postclacial bedrock (≤ 0.7 m.y.)

Outwash plains

Extinct central volcano (0.7-15 m.y.)

Active or dormant central volcano (≤ 0.7 m.y.)

Fissure swarm

4-5° Dip of strata

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION		BREIÐADALS- AND BOTNSHEIÐI TUNNEL	1991 - 01
JARÐTÆKNISTOFAN			
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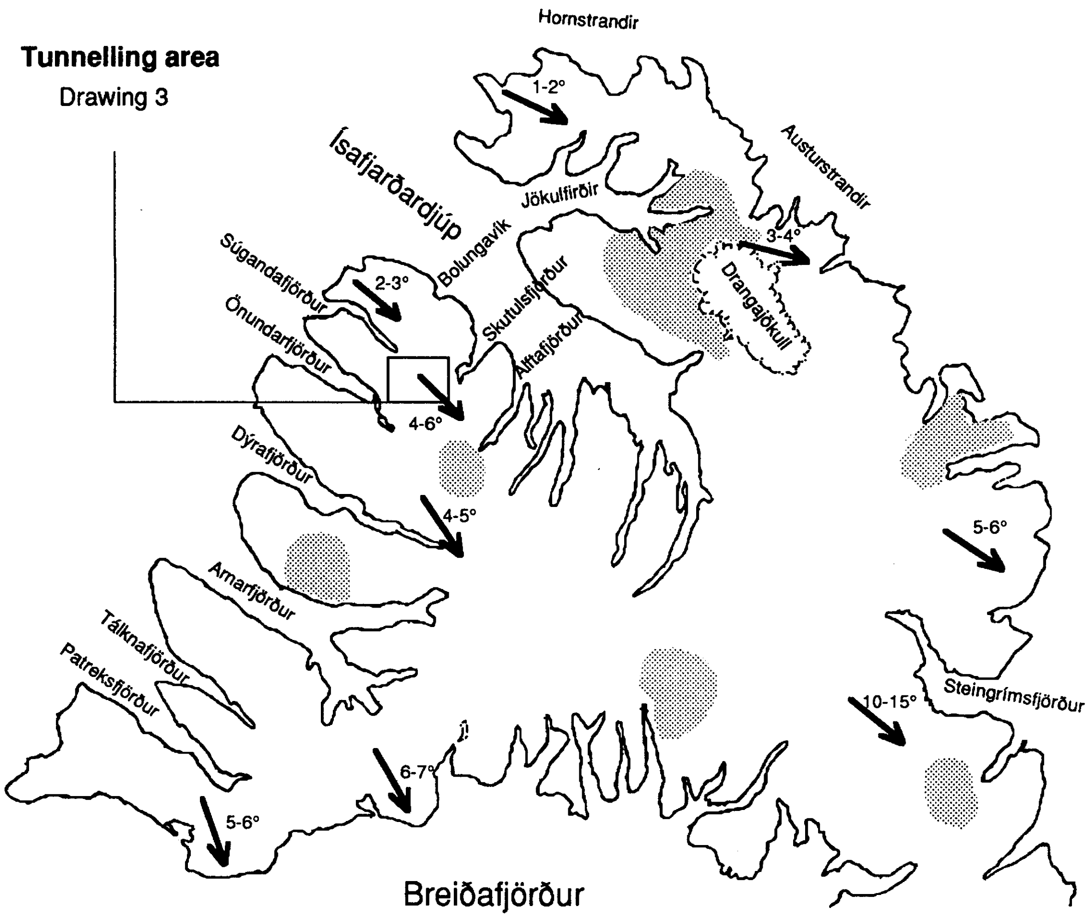
NORTHWESTERN ICELAND

LOCATION MAP

MAIN GEOLOGICAL FEATURES



LEGEND

Extinct central volcanoes

4-5° Dip of strata at sea level

0 Km 50

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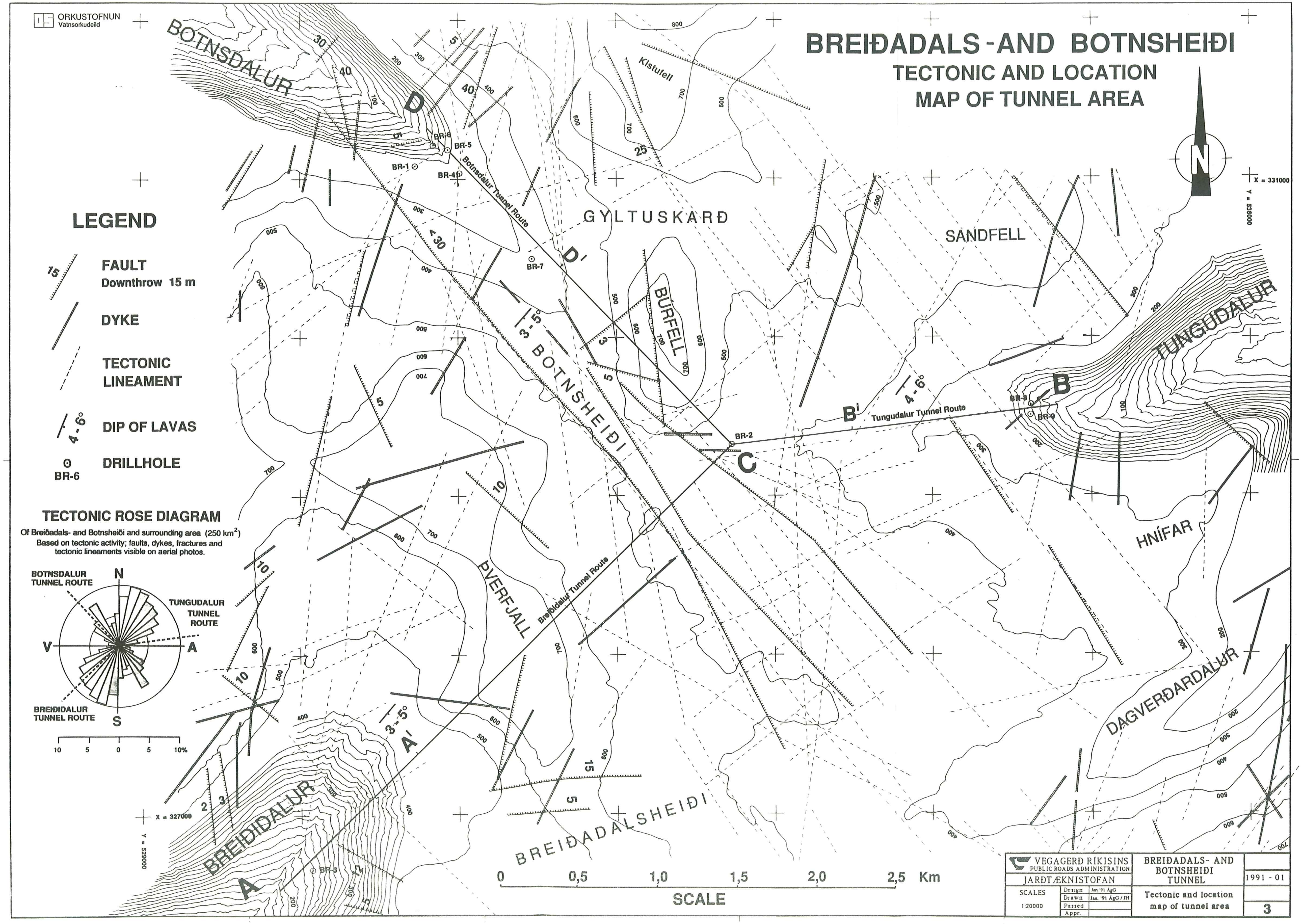
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BREIÐADALS-AND BOTNSHEIÐI
TECTONIC AND LOCATION
MAP OF TUNNEL AREA
N
LEGEND
FAULT
Downthrow 15 m
DYKE
TECTONIC
LINEAMENT
DIP OF LAVAS
DRILLHOLE
BR-6
TECTONIC ROSE DIAGRAM
Of Breiðadals- and Botnsheiði and surrounding area (250 km²)
Based on tectonic activity; faults, dykes, fractures and
tectonic lineaments visible on aerial photos.
BOTNSDALUR
TUNNEL ROUTE
TUNGUDALUR
TUNNEL
ROUTE
BREIÐIDALUR
TUNNEL ROUTE
N
V
A
S
10
5
0
5
10%
BOTNSDALUR
GYLTUSKARÐ
Kistufell
SANDFELL
BÚRFELL
BOTNSHEIÐI
TUNGUDALUR
HNÍFAR
ÞVERFJALL
DAGVERÐARDALUR
BREIÐIDALUR
BREIÐADALSHEIÐI
Botnsdalur Tunnel Route
Tungudalur Tunnel Route
Breiðidalur Tunnel Route
BR-1
BR-2
BR-3
BR-4
BR-5
BR-6
BR-7
BR-8
BR-9
A
A'
B
B'
C
D
D'
X = 331000
Y = 535000
X = 327000
Y = 529000
0
0,5
1,0
1,5
2,0
2,5
Km
SCALE
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PUBLIC ROADS ADMINISTRATION
JARÐTÆKNISTOFAN
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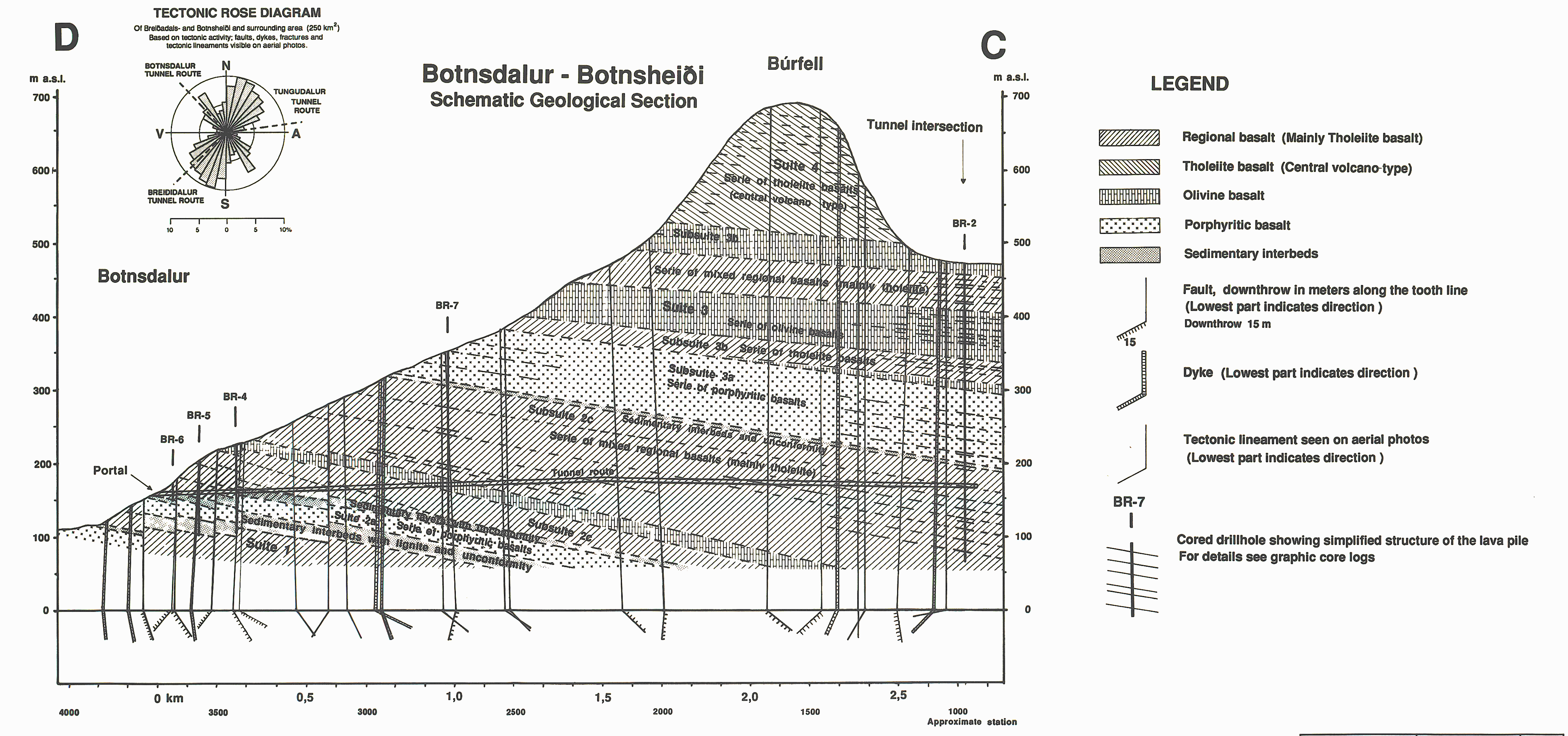
BREIÐADALS- AND
BOTNSHEIÐI
TUNNEL
Tectonic and location
map of tunnel area
1991 - 01
3

A
C
B
Breiðdalur - Tungudalur
Schematic Geological Section
ORKUSTOFNUN
Vatnsorkudeild
TECTONIC ROSE DIAGRAM
Of Breiðadals- and Botnsheiði and surrounding area (250 km²)
Based on tectonic activity; faults, dykes, fractures and tectonic lineaments visible on aerial photos.
BOTNSDALUR TUNNEL ROUTE
TUNGUDALUR TUNNEL ROUTE
BREIÐDALUR TUNNEL ROUTE
N
S
V
A
Þverfell
Breiðdalur
Tungudalur
Botnsdalur Tunnel Intersection
BR-3
BR-2
BR-9
Road
m a.s.l.
Suite 4
Serie of tholeiite basalts (central volcano type)
Serie of olivine basalts
Subsuite 3b
Serie of mixed regional basalts (mainly tholeiite)
Subsuite 3a
Suite 3
Sediments and unconformity
Tunnel route
Serie of tholeiite basalts (central volcanoe type)
Serie of mixed regional basalts (mainly tholeiite)
Suite 2
Subsuite 2c
Subsuite 2b
Breiðdalur Tunnel Route
Tungudalur Tunnel Route
Approximate location
Approximate station
Legend see Drawing 5
Location see Drawing 3
VEGAGERÐ RÍKISINS
PUBLIC ROADS ADMINISTRATION
JARÐTÆKNISTOFAN
SCALES
Horiz. 1:10000
Vert. 1:4000
BREIÐDALS- AND BOTNSHEIÐI TUNNEL
1991 - 01
Breiðdalur - Tungudalur Tunnel
Schem. Geological Section
4



Location see Drawing 3

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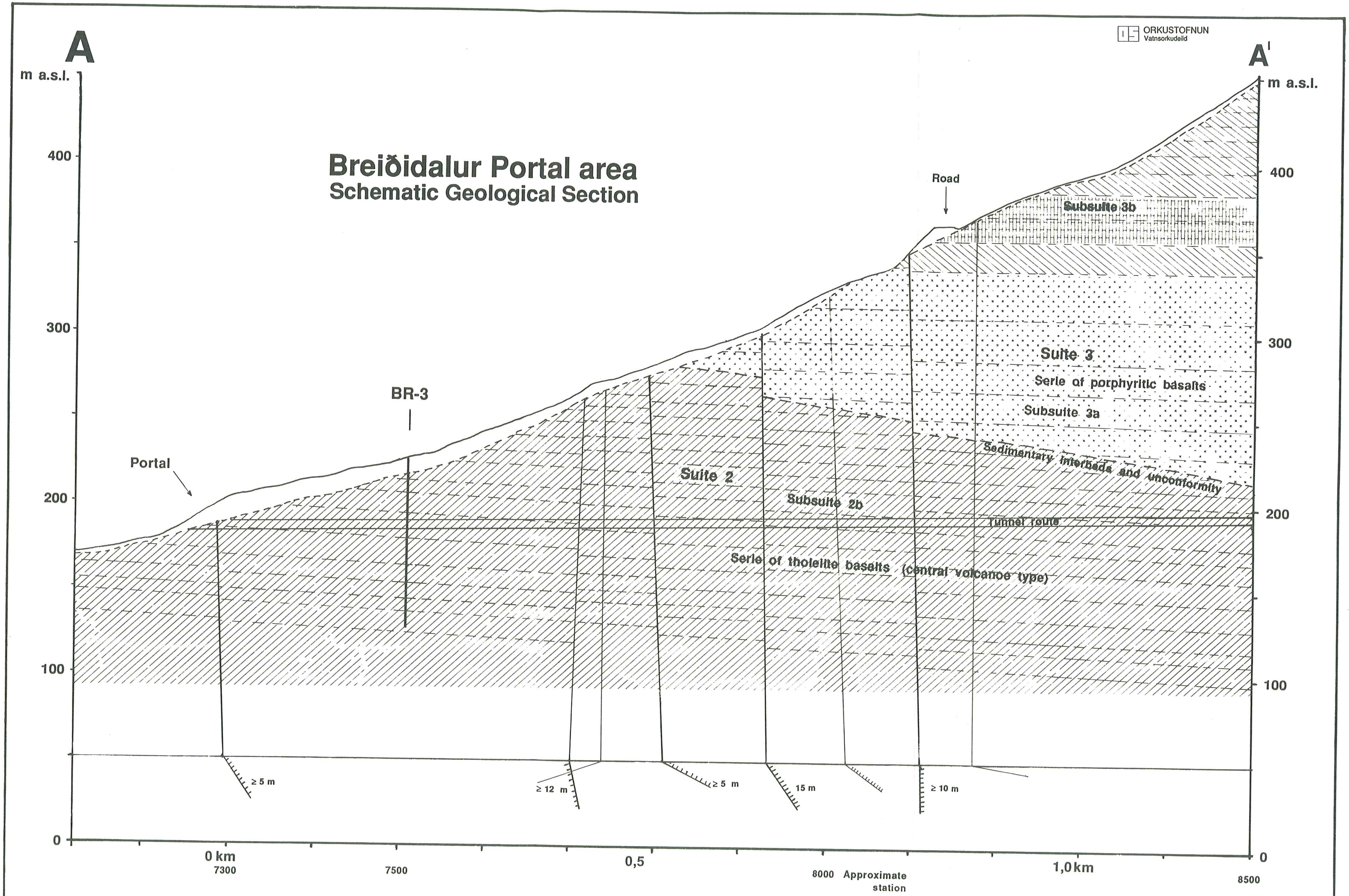
	Drawn	Jan. '91 ÁgG / JH		
	Passed			
	Appr.			



Legend see Drawing 5

Location see Drawing 3

VEGAGERÐ RÍKISINS
PUBLIC ROADS ADMINISTRATION
JARÐTÆKNISTOFAN

SCALES
Horiz. 1:4000
Vert. 1:2000

Design Jan. '91 ÁgG
Drawn Jan. '91 ÁgG/JJ
Passed
Appr.

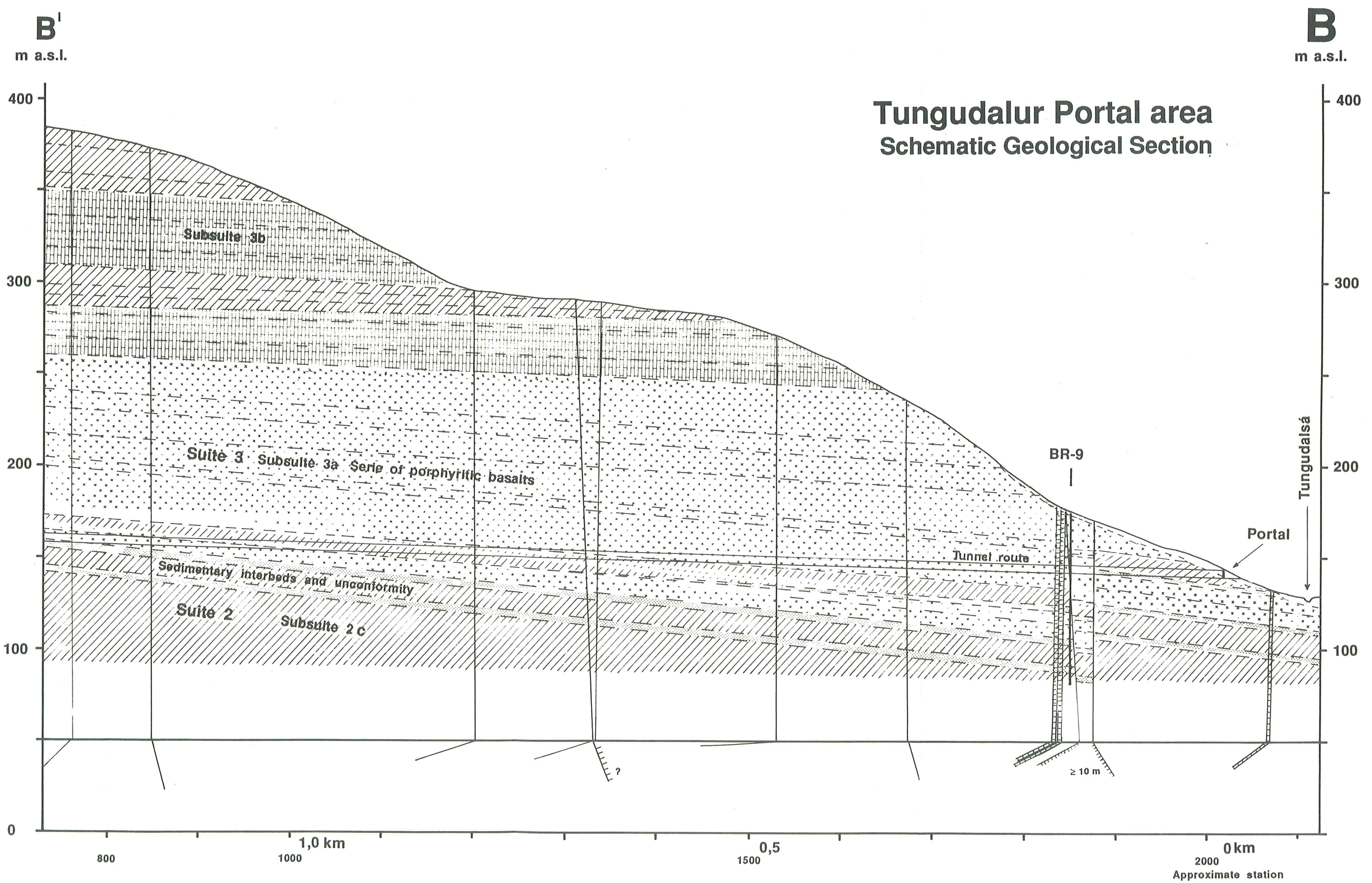
BREIDADALS- AND BOTNSHEIÐI TUNNEL

1991 - 01

Breiðidalur Portal area
Schem. Geological section

6

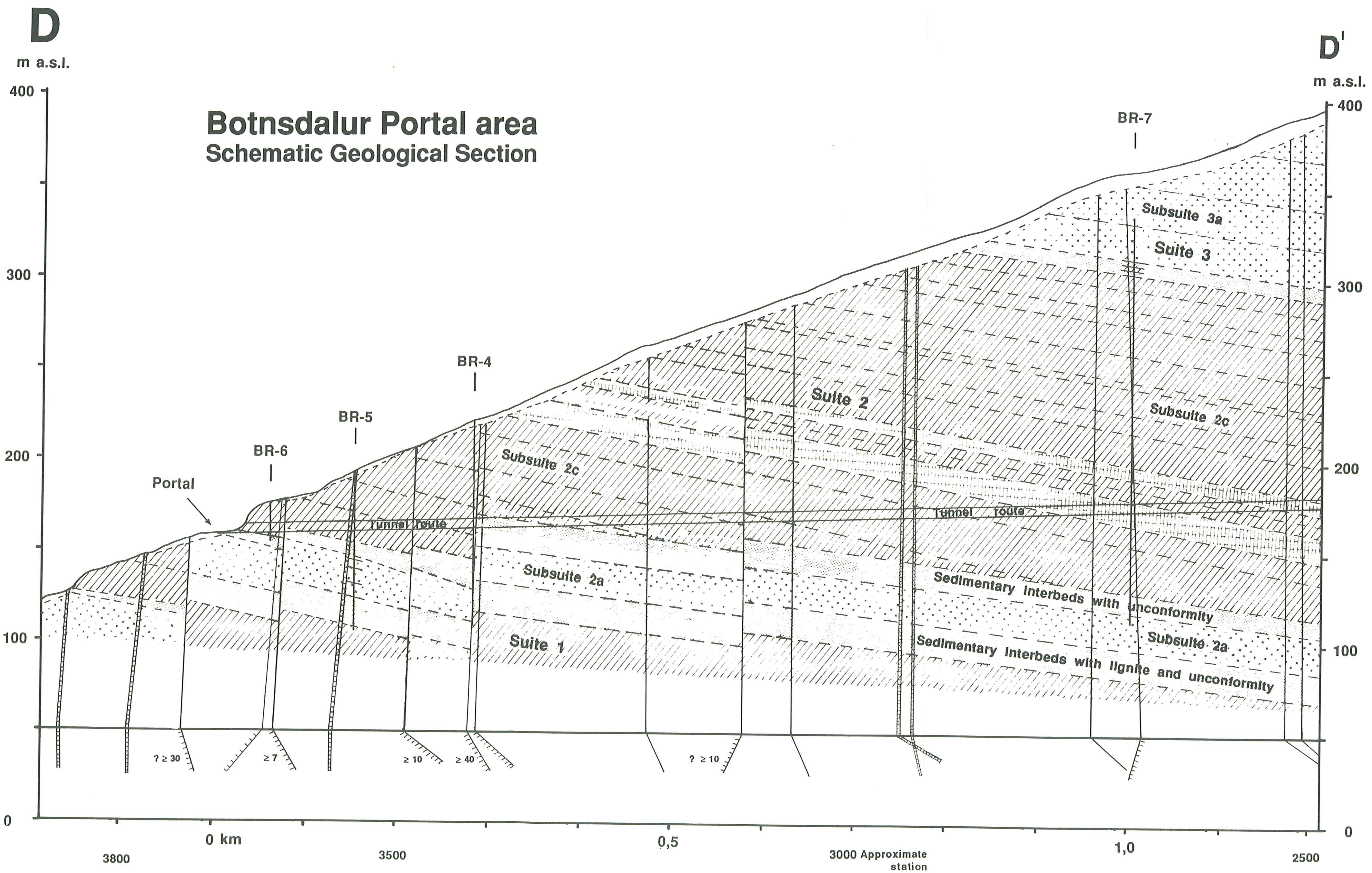
ORKUSTOFNUN
Vatnsorkudeild



Legend see Drawing 5

Location see Drawing 3

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION	BREIÐADALS- AND BOTNSHEIÐI TUNNEL	1991 - 01
JARDTÆKNISTOFAN		
SCALES Horiz. 1:4000 Vert. 1:2000 — Design: Jan. '91 ÁgG; Drawn: Jan. '91 ÁgG / JH; Passed; Appr.	Tungudalur Portal area Schem. Geological section	7



Legend see Drawing 5

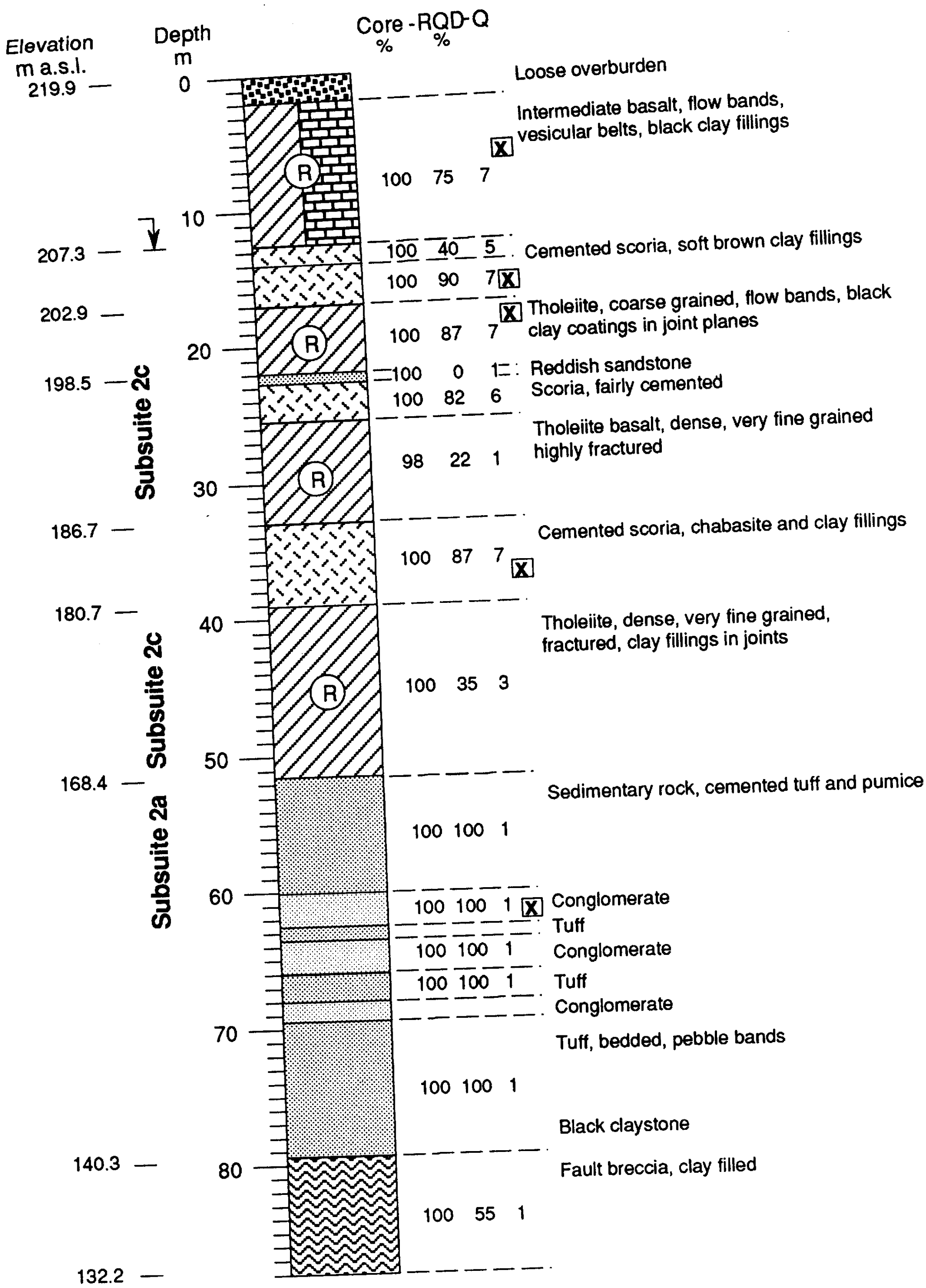
Location see Drawing 3

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION		BREIÐADALS- AND BOTNSHEIÐI TUNNEL	1991 - 01
JARDTÆKNISTOFAN			
SCALES Horiz. 1:4000 Vert. 1:2000	Design Jan. '91 ÁgG; Drawn Jan. '91 ÁgG/JH; Passed; Appr.	Botnsdalur Portal area Schem. Geological section	8

ORKUSTOFNUN
Vatnsorkudeild

BR-1
IN BOTNSDALUR

Coordinates
x = 331088,289
y = 530724,340



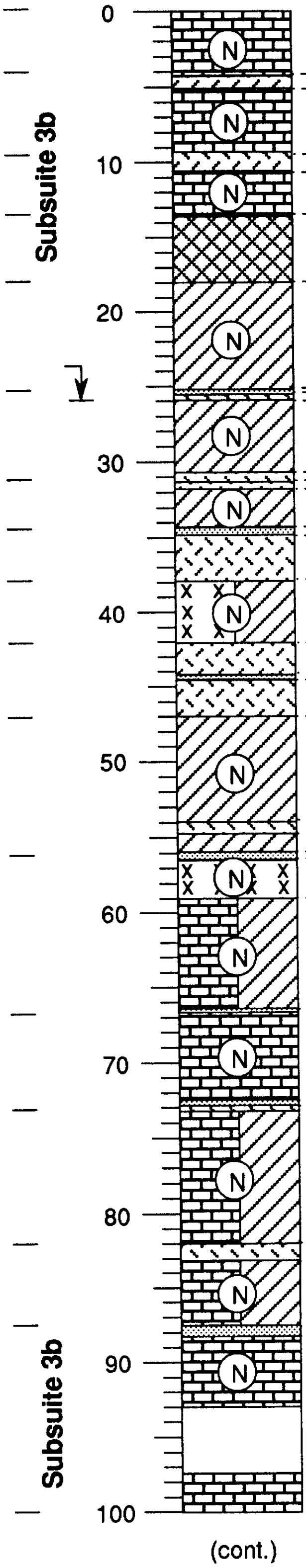
Legend shown on Drawing **17**
Location shown on Drawing **3**

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION		BREIÐADALS- AND BOTNSHEIÐI TUNNEL	1991 - 01
JARÐTÆKNISTOFAN			
SCALES VERTICAL 1 : 500	Design: AgG / BG Drawn: AGe / AgG Passed: Appr.:	Borehole BR-1 Graphic core log	Jan 1991 **9**

ORKUSTOFNUN
Vatnsorkudeild

BR-2
SOUTHEAST OF BÚRFELL
IN BOTNSHEIÐI

Coordinates
x = 329321,451
y = 532724,808



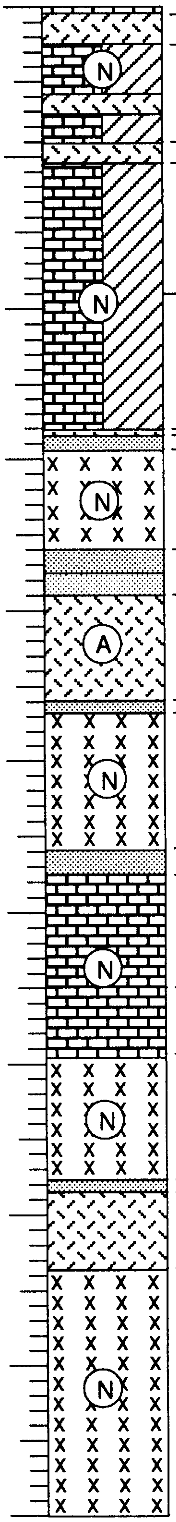
Elevation m a.s.l.	Depth m	Core %	RQD %	Q	Description
469.5	0	100	50	6	Olivine basalt, vesicular, porous, joint planes rough, no fillings
465.4		100	85	5	Scoriaceous contact breccia, very vesicular
		100	50	6	Olivine basalt, vesicular, minor light fillings
459.9	10	100	0		Scoriaceous contact breccia.
		100	55	4	Olivine basalt, vesicular, minor light fillings
455.9		73	5	1	Basaltic dyke, highly fractured core loss
451.7	20	90	25	4	Tholeiite basalt, fine grained, vesicular, joint planes coated with thin clay
444.2		100	100	2	Red sandstone
		80	0	2	Scoriaceous breccia
		95	50	6	Tholeiite basalt, fine grained
438.8	30	100	75	4	Porous scoria
		80	0	4	
		98	74	6	Tholeiite basalt, rough joint planes
435.2					Reddish sandstone, 0.4 m
		100	60	5	Scoriaceous contact breccia, well cemented
431.5	40	100	55	6	Intermediate basalt, 4-5% phenocrysts, no fillings
427.5		100	30	3	Scoriaceous breccia, poorly cemented
426.0					Reddish sandstone
		100	40	3	Scoriaceous breccia, porous
423.5	50	100	35	4	Tholeiite basalt, fine grained, vesicular top and bottom, rough joint planes, clay coatings
					Scoria
413.5					Reddish sandstone
		100	50	5	Porphyritic basalt
					Core loss
	60	71	32	5	Intermediate basalt, clay coatings on joint planes
403.1	70	90	37	5	Olivine basalt, finely vesicular top and bottom
396.8					Yellow sandstone
	80	95	50	6	Intermediate basalt, vesicular and scoriaceous top rough joint planes with clay coatings
387.3		87	25	2	Cemented scoria
		100	35	3	Intermediate basalt, fine grained, light gray, brown clay coatings
381.9		100	100	1	Reddish sandstone
	90	100	60	6	Olivine basalt, fine- to medium grained, finely vesicular bands
					Core loss 4 m
		100	18	2	Olivinie basalt, rough joint planes with clay coatings
369.5	100				

Legend shown on Drawing 17
Location shown on Drawing 3

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION		BREIÐADALS- AND BOTNSHEIÐI TUNNEL	
JARÐTÆKNISTOFAN			1991 - 01
SCALES VERTICAL 1 : 500	Design: ÁgG / BG; Drawn: ÁGe / ÁgG; Passed; Appr.	Borehole BR-2 Graphic core log	Jan 1991
			10

ORKUSTOFNUN
Vatnsorkudeild

BR-2
SOUTHEAST OF BÚRFELL IN BOTNSHEIÐI (cont.)



Elevation m a.s.l.	Depth m	Subsuite	Core %	RQD %	Q	Description
369.0	100	3b	100	58	4	Scoriaceous contact breccia
		3b	99	35	4	Intermediate basalt, fine grained, finely vesicular; Scoria; Intermediate basalt, fine grained
358.9	110	3b	100	88	5	Scoria, cemented, clay filled
		3b	95	48	4	Intermediate basalt, vesicular top, rough joint planes with clay coatings; More broken in upper part
	120	3b	95	48	8	
		3b				Scoriaceous bottom
341.7		3a	100	55	1	Reddish sandstone
	130	3a	100	65	7	Porphyritic basalt, phen. < 4 mm very vesicular, cemented joints
333.7		3a	46	23	1	Reddish tuffaceous sdst. Conglomerate
	140	3a	100	100	7	Scoriaceous contact breccia, well cemented, sedimentary fillings at top
323.6			100	100	1	Yellow tuff and pumice, soft
	150		100	78	6.5	Porphyritic basalt, 5% plag. phen.
313.4			100	73	1	Soft, brownish tuff, altered
	160		100	77	8	Olivine basalt, vesicular, rough joint planes, thin brownish clay coatings
			100	50	7	Similar as above
299.8	170		100	65	7	Porphyritic basalt, plag. phen. 5-8%, vesicular, clay coatings
291.7			100	100	1	Reddish sandstone
	180		100	75	7	Porphyritic basalt, plag. phen. 7% < 5 mm clay coatings in joint planes
285.8		3a	100	82	9	Porphyritic basalt, plag. phen. 7-15%, < 6 mm very thin clay coatings in joint planes
	190	3a				
269.5	200					

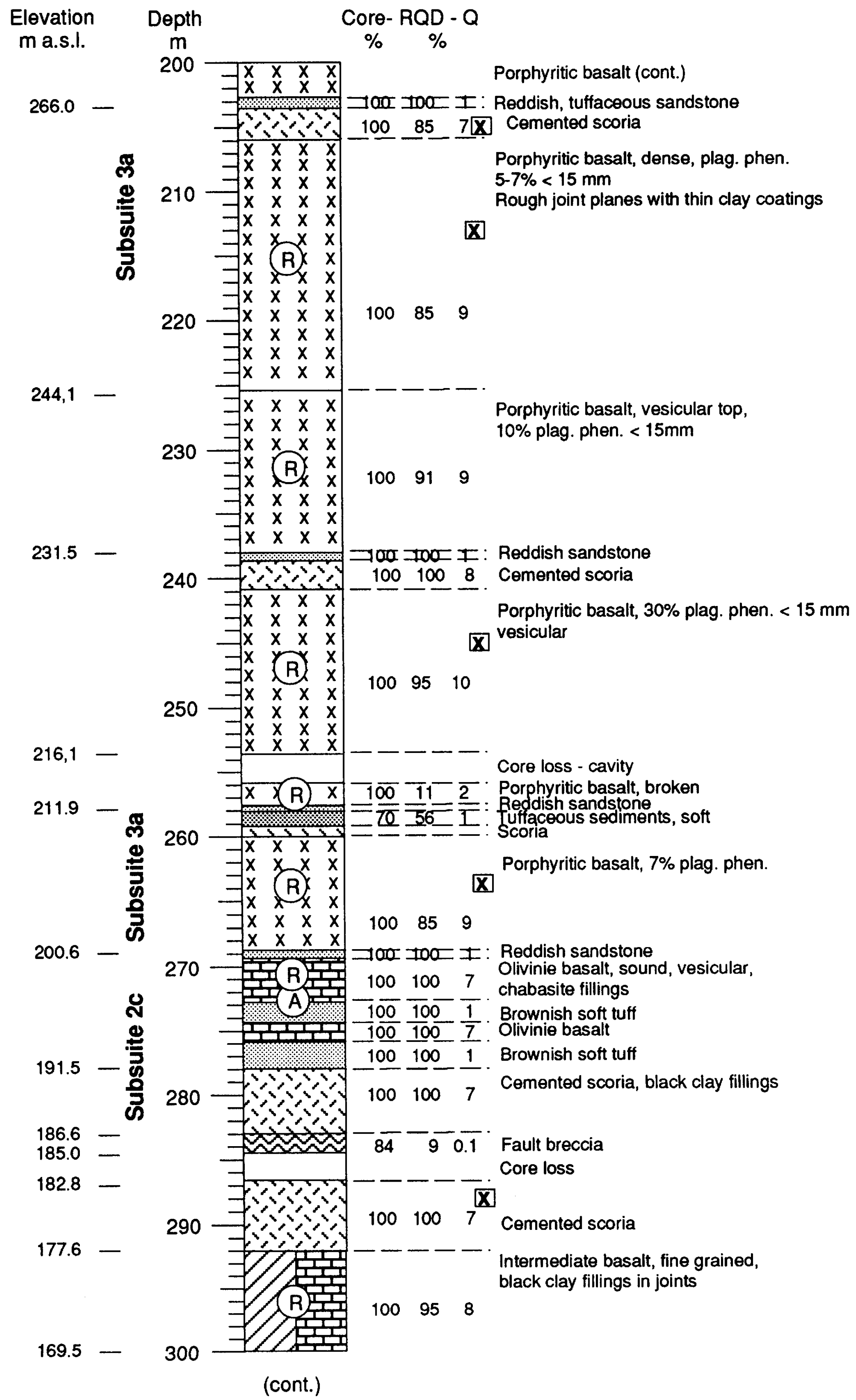
(cont.)

Legend shown on Drawing **17**
Location shown on Drawing **3**

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION	BREIÐADALS- AND BOTNSHEIÐI TUNNEL	
JARÐTÆKNISTOFAN		1991 - 01
SCALES VERTICAL 1 : 500 — Design AgG / BG; Drawn AGe / AgG; Passed; Appr.	Borehole BR-2 (cont) Graphic core log	Jan 1991
		11

ORKUSTOFNUN
Vatnsorkudeild

BR-2
SOUTHEAST OF BÚRFELL IN BOTNSHEIÐI (cont.)



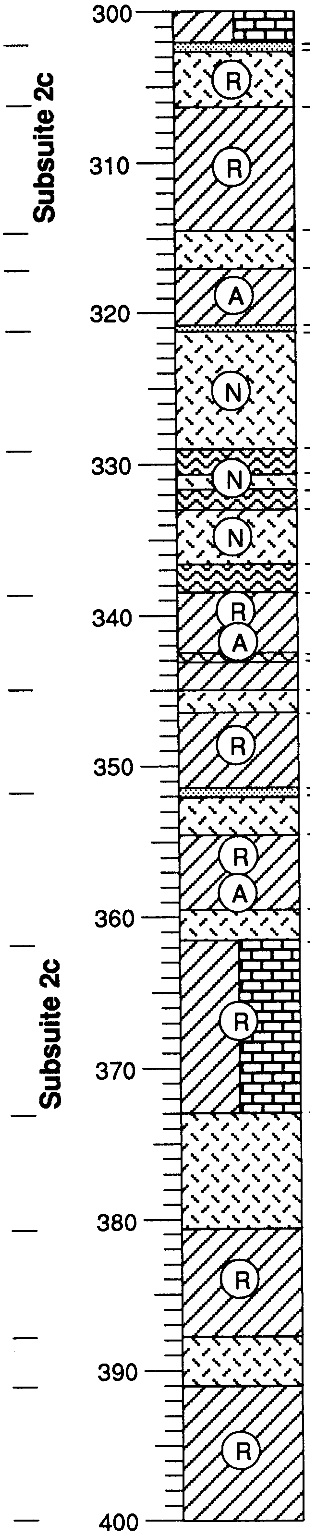
(cont.)

Legend shown on Drawing **17**
Location shown on Drawing **3**

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION			BREIÐADALS- AND BOTNSHEIÐI TUNNEL	
JARÐTÆKNISTOFAN				1991 - 01
SCALES VERTICAL 1 : 500	Design	AgG / BG	Borehole BR-2 (cont)	Jan 1991
	Drawn	AGe / AgG	Graphic core log	**12**
	Passed			
	Appr.			

ORKUSTOFNUN
Vatnsorkudeild

BR-2
SOUTHEAST OF BÚRFELL
INBOTNSHEIÐI (cont.)



Elevation m a.s.l.	Core %	RQD %	Q	Description
168.5	100	100	1	Red sandstone
	100	100	7 [X]	Cemented scoria
163.0	100	91	7 [X]	Tholeiite basalt, flow bands, black clay in joint planes
155.1	100	100	7	Cemented scoria
152.6	100	98	6	Tholeiite, fine grained, flow bands, cemented joints with black clay
148.7				Red sandstone
	100	100	7	Cemented scoria, chabasite fillings
140.5	100	100	1	Fault breccia
	100	100	5	Cemented scoria
	100	90	0.5	Fault breccia
	100	100	5	Cemented scoria
	100	93	0.5	Fault breccia
131.1	100	95	6	Tholeiite dense, vesicular belts black clay in joints
			1	
			6	Tholeiite, cemented joints
124.4	100	100	7	Cemented scoria
	100	98	7	Tholeiite, very fine grained, black and brown clay fillings
117.9				Reddish sandstone
	100	100	7	Cemented scoria
	100	85	6	Tholeiite, dense, very fine grained, black and brown clay fillings
	100	100	7	Cemented scoria
108.0	100	96	7 [X]	Intermediate basalt, occ. vesicules, chabasite, calcite and clay fillings, cemented joints
97.6	100	100	8 [X]	Cemented scoria, sedimentary fillings, black clay in joints
89.0	100	97	7	Tholeiite, dense, very fine grained, black clay coatings
81.8	100	100	7	Cemented scoria, chabasite fillings
78.7	100	100	8 [X]	Tholeiite, fine grained, black clay coatings
69.5				

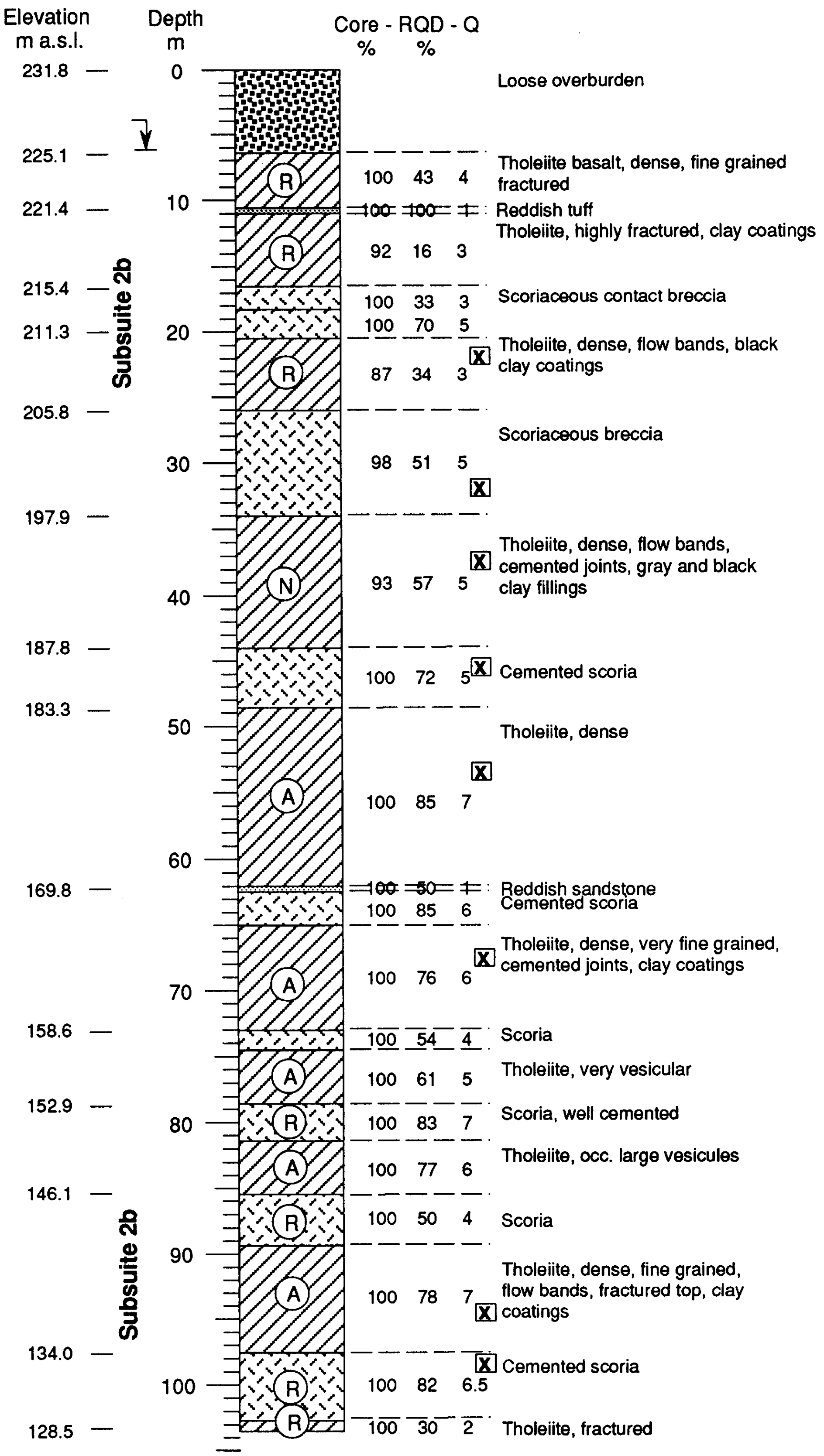
Legend shown on Drawing **17**
Location shown on Drawing **3**

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION	BREIÐADALS- AND BOTNSHEIÐI TUNNEL	
JARÐTÆKNISTOFAN		1991 - 01
SCALES VERTICAL 1 : 500 — Design: AgG / BG; Drawn: AGe / AgG; Passed; Appr.	Borehole BR-2 (cont) Graphic core log	Jan 1991
		13

ORKUSTOFNUN
Vatnsorkudeild

BR-3
IN BREIÐIDALUR

Coordinates
x = 326645,675
y = 530067,481



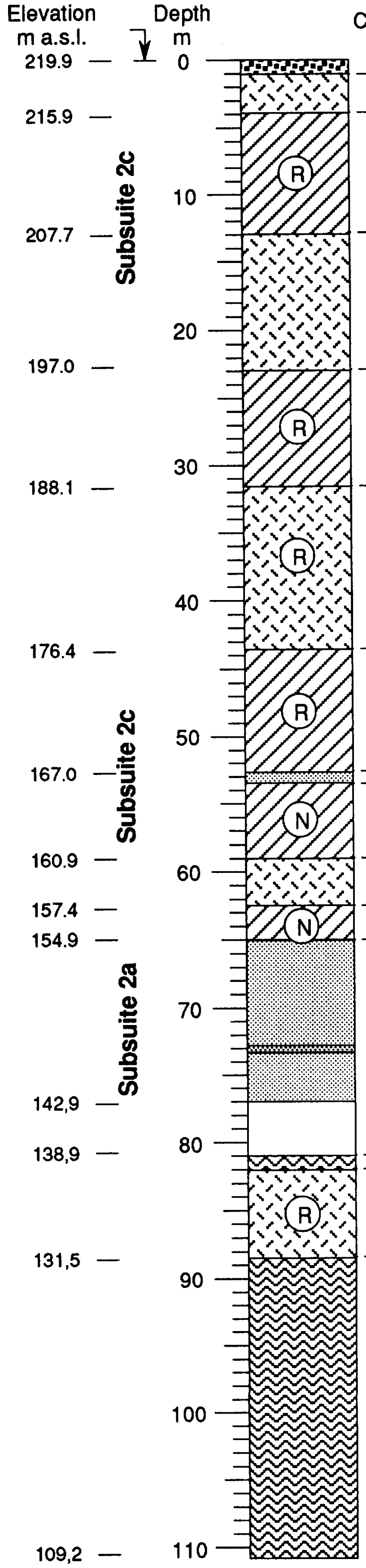
Legend shown on Drawing **17**
Location shown on Drawing **3**

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION	BREIÐADALS- AND BOTNSHEIÐI TUNNEL	
JARÐTÆKNISTOFAN		1991 - 01
SCALES VERTICAL 1 : 500 — Design: AgG / BG; Drawn: AGe / AgG; Passed; Appr.	Borehole BR-3 Graphic core log	Jan 1991
		14

ORKUSTOFNUN
Vatnsorkudeild

BR-4 IN BOTNSDALUR

Coordinates
x = 331008,765
y = 531036,657



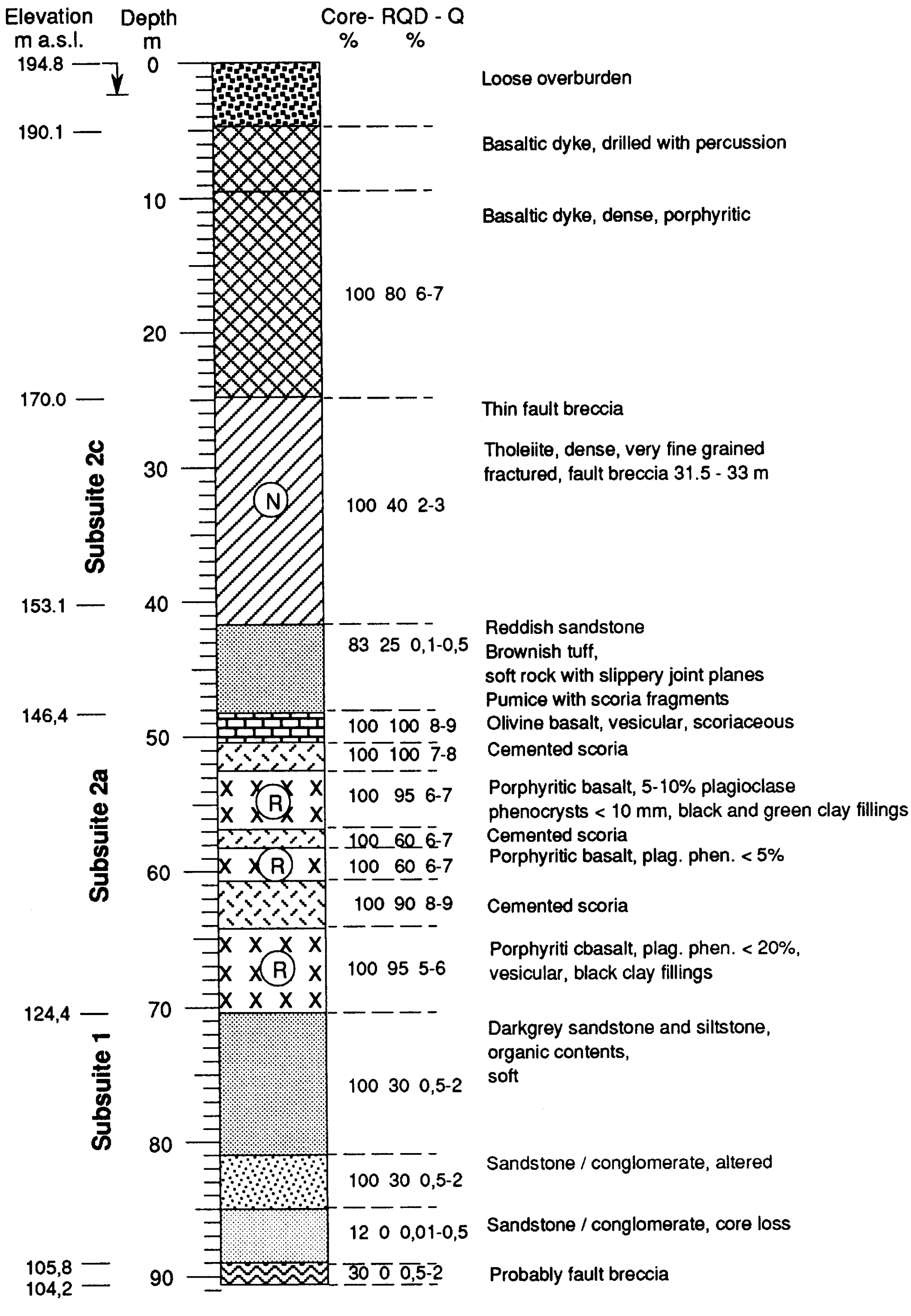
Elevation m a.s.l.	Core %	RQD %	Q	Description
219.9				Loose overburden
	100	80	7	Cemented scoria
215.9	100	57	5	Tholeiite, very fine grained; Occ. flow bands, black clay coatings
207.7				Scoria, vesicular and porous
	100	85	7.5	Cemented scoria, chabasite and opal fillings
197.0	100	60	5	Tholeiite, dense, very fine grained, occ. scoriaceous bands
188.1	100	85	7	Scoria, vesicular and porous, extensive yellow clay fillings
176.4	100	100	8	Tholeiite, dense, very fine grained, flow bands and vesicular bands, cemented joints with black clay fillings
167.0	100	100	2	Reddish sandstone
	100	90	7	Tholeiite, dense, very fine grained cemented joints
160.9	100	100	7	Scoria, vesicular and porous, light clay fillings
157.4	100	40	5	Tholeiite, dense, very fine grained
154.9	72	15	0.1-1	Sedimentary rock, tuff and pumice, bedded, soft
				Acid pumice
				Brownish, bedded tuff
142,9				Core loss
138,9				Fault breccia
	80	45	4	Scoriaceous breccia, fractured, extensive black clay fillings
131,5	45	8	0.2-0.5-1	Fault breccia, Tholeiite fragments cemented in black clay
				Core loss at places
109,2				

Legend shown on Drawing **17**
Location shown on Drawing **3**

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION	BREIÐADALS- AND BOTNSHEIÐI TUNNEL	
JARÐTÆKNISTOFAN		1991 - 01
SCALES VERTICAL 1 : 500 — Design AgG / BG; Drawn AGe / AgG; Passed; Appr.	Borehole BR-4 Graphic core log	Jan 1991
		15

BR-5
IN BOTNSDALUR

Coordinates
x = 331181,847
y = 530934,813

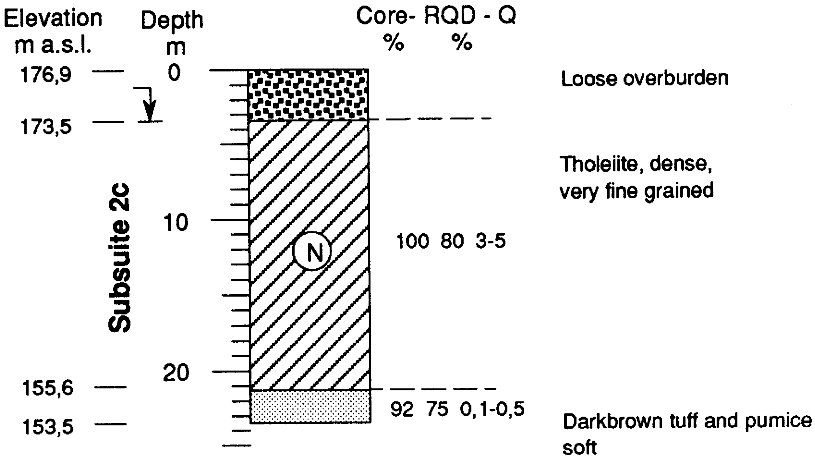


Legend shown on Drawing **17**
Location shown on Drawing **3**

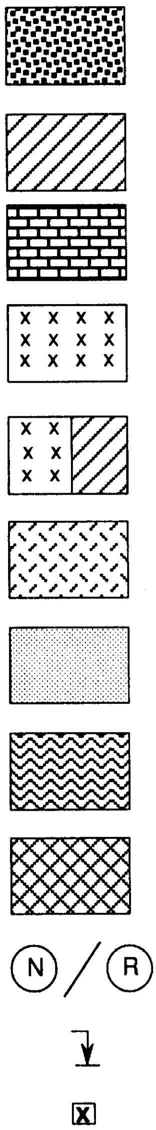
VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION JARÐTÆKNISTOFAN		BREIÐADALS- AND BOTNSHEIÐI TUNNEL	1991 - 01
SCALES VERTICAL 1 : 500	Design: AgG / BG Drawn: AGe / AgG Passed: Appr.:	Borehole BR-5 Graphic core log	Jan 1991 **16**

BR-6
IN BOTNSDALUR

Coordination
x = 331215,724
y = 530842,603



LEGEND



Superficial deposits

Tholeiite basalt

Olivine basalt

Porphyritic basalt

Transitional basalt

Scoriaceous contact breccia (scoria)

Sedimentary interbeds

Fault breccia

Basaltic dyke

Geomagnetic polarity
Normal / Reverse

Groundwater table

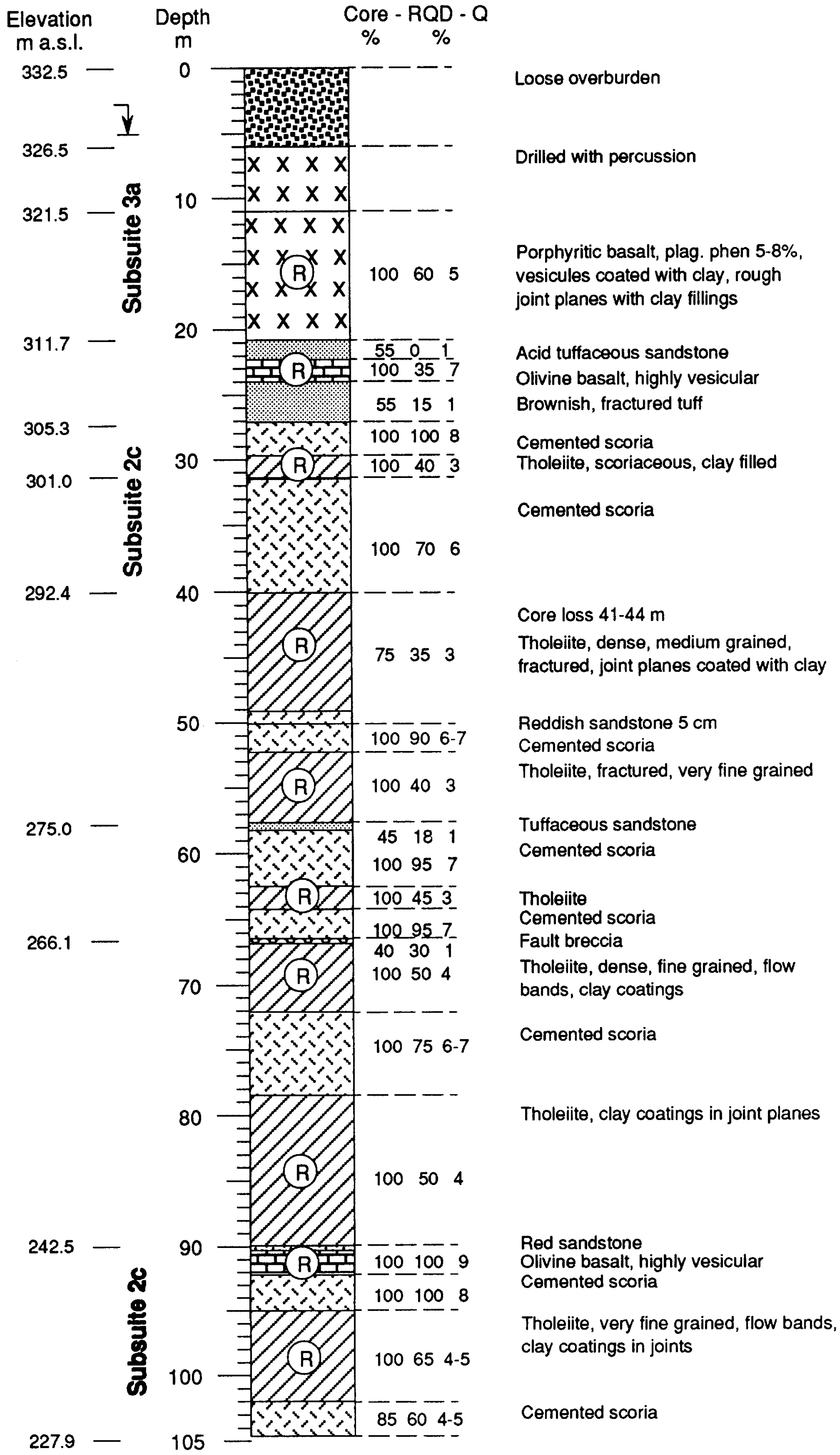
Uniaxial compression test

Location shown on Drawing 3

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION			BREIÐADALS- AND BOTNSHEIÐI TUNNEL	
JARÐTÆKNISTOFAN				1991 - 01
SCALES VERTICAL 1 : 500	Design	AgG / BG	Borehole BR-6 Graphic core log	Jan 1991
	Drawn	AGe / AgG		17
	Passed			
	Appr.			

BR-7
IN BOTNSDALUR

Coordinates
x = 330493,717
y = 531463,112



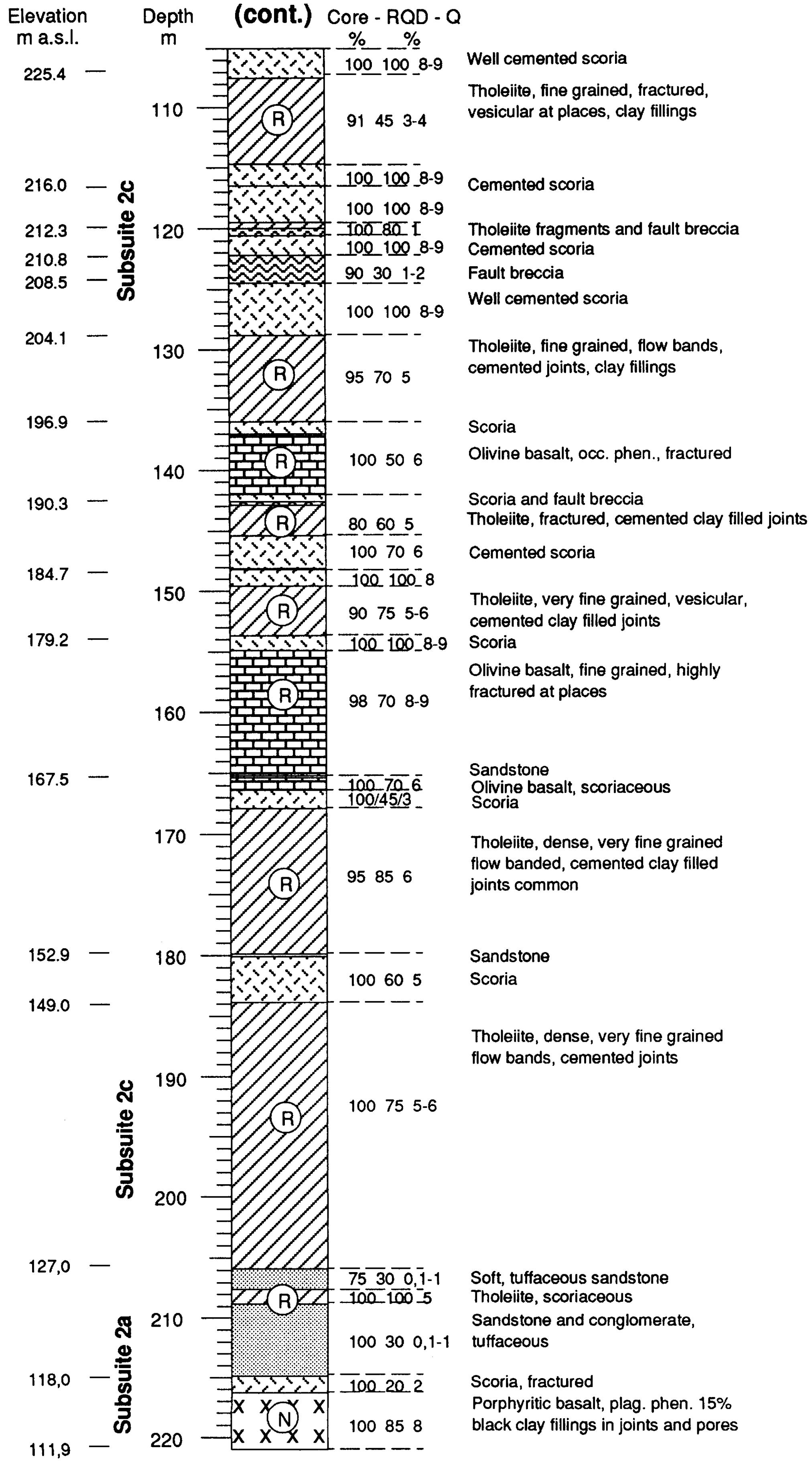
(cont.)

Legend shown on Drawing **17**
Location shown on Drawing **3**

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION		BREIÐADALS- AND BOTNSHEIÐI TUNNEL	
JARÐTÆKNISTOFAN			1991 - 01
SCALES VERTICAL 1 : 500	Design: AgG / BG	Borehole BR-7	Jan 1991
	Drawn: AGe / AgG	Graphic core log	**18**
	Passed:		
	Appr.:		

BR-7 IN BOTNSDALUR (cont.)

ORKUSTOFNUN Vatnsorkudeild



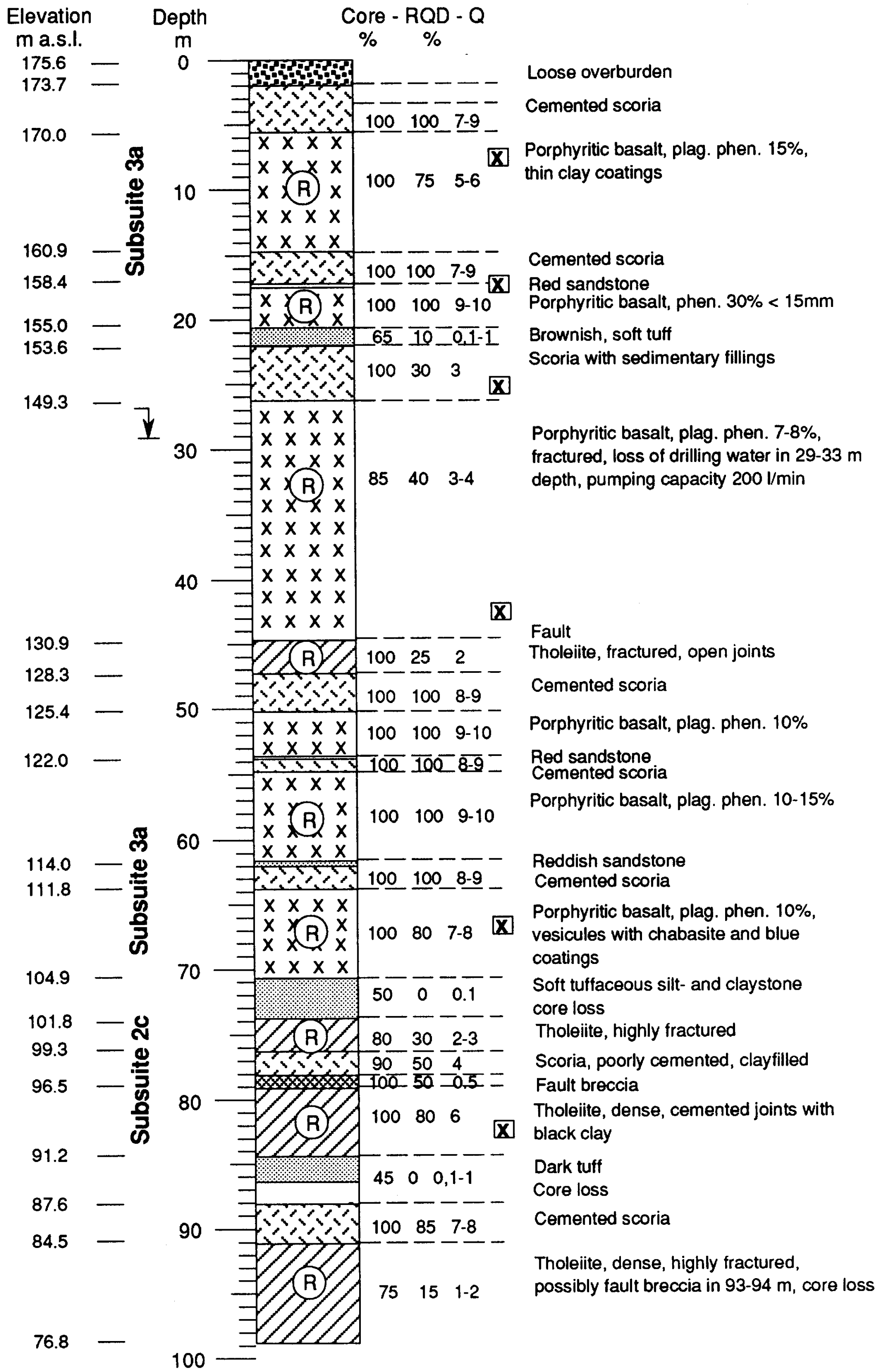
Legend shown on Drawing **17**
Location shown on Drawing **3**

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION	BREIÐADALS- AND BOTNSHEIÐI TUNNEL	1991 - 01
JARÐTÆKNISTOFAN		
SCALES VERTICAL 1 : 500 — Design ÁgG / BG; Drawn ÁGe / ÁgG; Passed; Appr.	Borehole BR-7 (cont) Graphic core log	Jan 1991
		19

ORKUSTOFNUN
Vatnsorkudeild

BR-9
IN TUNGUDALUR

Coordinates
x = 329508,138
y = 534611,722

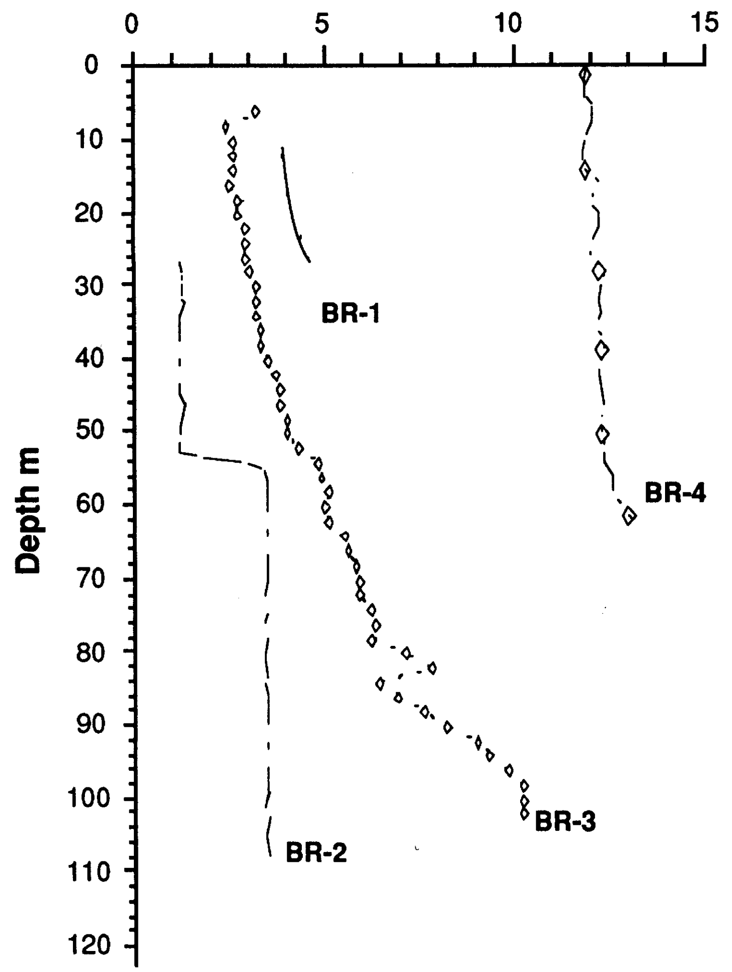


Legend shown on Drawing **17**
Location shown on Drawing **3**

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION	BREIÐADALS- AND BOTNSHEIÐI TUNNEL	1991 - 01
JARÐTÆKNISTOFAN		
SCALES VERTICAL 1 : 500 — Design: AgG / BG; Drawn: AGe / AgG; Passed; Appr.	Borehole BR-9 Graphic core log	Jan 1991 / **20**

ORKUSTOFNUN
Vatnsorkudeild

Temperature measurements in boreholes



Location see Drawing 3

Measured in nov. 1989

VEGAGERÐ RÍKISINS PUBLIC ROADS ADMINISTRATION			BREIÐADALS- AND BOTNSHEIÐI TUNNEL	
JARÐTÆKNISTOFAN				1991 - 01
SCALES VERTICAL 1:1000	Design	ÁgG	Temperature measurements in boreholes	Febr. 1991
	Drawn	ÁgG		
	Passed			
	Appr.			21

APPENDIX 1

GRAPHIC CORE LOGS OF DRILLHOLES
BR-1 TO BR-9

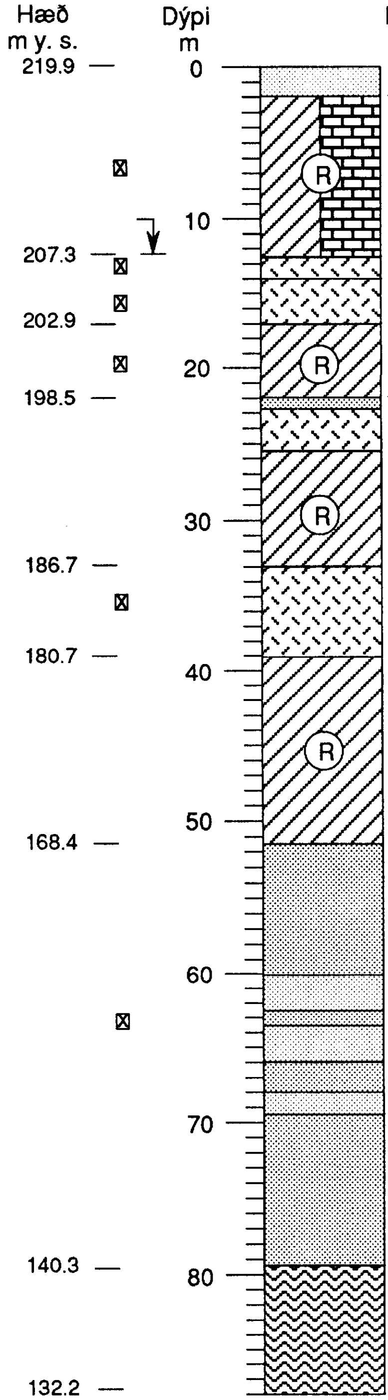
IN ICELANDIC

12 SHEETS

ORKUSTOFNUN
Vatnsorkudeild

BR-1
Í BOTNSDAL

Hnit
x = 331088,289
y = 530724,340



Kjarni- %	RQD %	Q	
			Laus yfirborðslög
100	75	7	Millibasalt þóleiít - Ólivínbasalt, kornastærð kristalla < 1mm. Alm. með míkróblö. str.fl. bönd og svartan leir í míkróblö. böndum. Spr. hrjúfbylgj. m. svartar leirf. Lítil ummyndun, ekki geislasteinar 5.5. spr/m
100	40	5	Kargi vel sam. press. m. ljós. mjúk. leirf. 10 spr./m auk þess kurl RML rautt slitur. Kargi sampress. blöðr. Ljósbrúnn leir í stöku blöðru,
100	90	7	annars tómar blöðrur, 4.4 spr/m
100	87	7	Þóleiít basalt, fremur gróft í broti. Straumfl. bönd með dökkar leirf.Stakblöðr. Grisjótt spr. net m. svört leirbönd 4.8 spr./m. Skörp skil enginn kargi
100	0	1	Rauður sdst. m. kargamolum
100	82	6	Blöðr. opinn kargi m. rau. sdst fyll. Stó kargamol. hrjúfar sprungur. Ljósbr. mjúk. leirf. í vel sampress. karga. 2 spr./m
98	22	1	Þóleiítbasalt þétt dulk. en smáspr. Blö. <5%. Str.fl. bönd. Víða gróið spr. net. Neðri hluti lags er mjög smáspr. og kurl.
100	87	7	Kargi. Vel saman press. Tómar blö. Smáspr. efst annars heill Smáir geislast. (chab.) og ljósar leirf. í blö. 3 spr./m
100	35	3	Þóleiít basalt. Þétt dulkorna (týp. þól.) Deifðar smáblöðr. Smáspr. spr. net. Spr. skæn. m. ljós. og bláum leirf. Samgróið spr. net myndar æðóttan kjarna. Annars mjög þétt berg. 8.1 spr./m
100	100	1	Rauður sdst. 0.1 m. Setberg. Gulbrúnt túff. súr vaxkennd gjóska, vikur og aska sampressað. Kornastærð yfirl. < 3mm. Setlagið er líklega loftborið ofantil en vatnsborið neðar. Grófari grunnmassi. Korn < 10 mm líkl. vatnsborið. Hvítt túffband um 0.3 m, með dökkum "baunum" úr basalt brotum.
100	100	1	Völuberg. breytileg völust. < 10 cm og breytileg berggerð
			Gulbrúnt vaxk. túff.
100	100	1	Völuberg, breytileg völust. < 3cm. Kornborið set, lítið fínefni og lítið núið.
			Túff, móbrúnt
100	100	1	Völubergslinsa, Brúnt vaxkennt túff
			Völuberg, völur < 3cm kornborið lítt núið
100	100	1	Túff, lagskipt vaxk. ljóst og dökkt Gulbr. og rauðbr. túff, dökkt. Dökkbr. túff m. vikurbaunum Linsur úr smávöl. í túffinu Dökkbr. og vaxkennt E.t.v. 5 upprunal. spr. í setbergslaginu Svartur leirsteinn neðst
100	55	1	Misgengisbreksía, kurlað basalt sem hefur steypst saman að nýju. Líklega er mikil hreyfing um misgengið Bergbrot af breytilegri berggerð. Miklar svartar leirf. Víðast óljóst hvaða sprungur eru upprunalegar

Sjá skýringar á mynd **9**
Sjá staðsetningu á mynd **3**

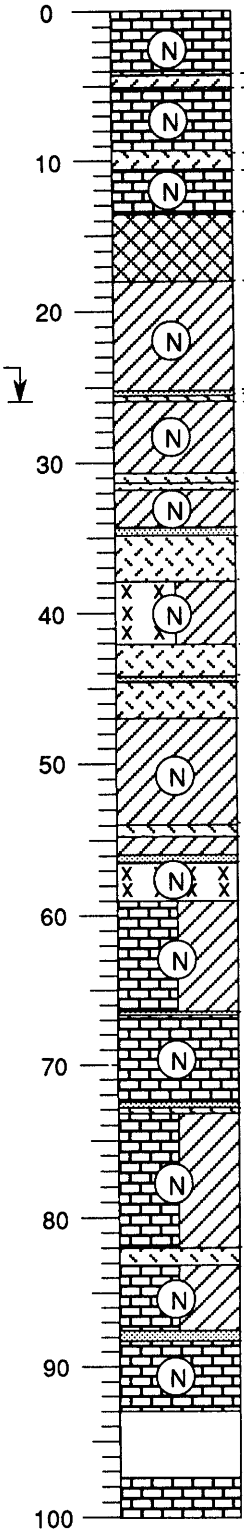
Hola BR-1 var boruð í kanti vegarins upp úr Súgandafirði

Breiðadals- og Botnsheiði	**Jarðtæknistofan**
Snið af kjarnaholu BR-1 í Botnsdal	ÁgG / ÁGe
	Desember 1990
	Mynd nr. **1**

ORKUSTOFNUN
Vatnsorkudeild

BR-2
Á BOTNSHEIÐI

Hnit
x = 329321,451
y = 532724,808



Hæð m y. s.	Kjarni %	RQD %	Q	Lýsing
469.5	100	50	6	Ólivín basalt. Blöðrótt og frauðkennt. Smáspr. Sprungur alm. hrjúf. og án fyll. Kjarnabútar 3-30 cm 7.8 spr./m
465.4	100	85	5	Mjög blöðróttur kargi. Ferskur án leirfyll.
	100	50	6	Ólivín basalt, smákorna. Blöðr. og fínfrauðk. Ferskt, tómar blöðrur 5,3 spr./m
459.9	100	0		Kargi. Blöðr. m. setfyll.
	100	55	4	Ólivín basalt, blöðr. frauðk. v. míkróblö. Lítilsháttar ljós leirf., smábrotið, bútar < 30 cm
455.9	73	5	1	Berggangur fínk. blágr. Mjög smáspr. víða kurl. 5-25 cm kjarnabútar
451.7				Kjarnatap
	90	25	4	Þóleiítbasalt, dulk. týp. þól., 10-30% blöðr. Mjög ferskt. Breytil. spr. stefna, allir sprfl. án fyllinga en með leirskán.Kurlað á stöku stað 4.24 spr./m
444.2	100	100	2	Rauður sdst.
	80	0	2	Blöðr. kargi.
	95	50	6	Þóleiítbasalt nær dulk. Ferskt smábr. bútar 10-20 cm, blö. 10-15%. Kjarnabútar yfirleitt 3-50 cm, 10 spr./m
438.8	100	75	4	Kargi, frauðkenndur
	80	0	4	Kurl, smábr. kargi
	98	74	6	Þóleiítbasalt, blö. 10-15%. Fr. smábr. Spr. hrj. lítt fyll. 8 spr./m
435.2				kargi 0.1 m RML 0.4 m
	100	60	5	Kargi. Vel sampress.Blö. 15-20% lítt holuf. Dílóttir kargamolar, 1.5 spr./m
431.5	100	55	6	Millibasalt. Dílabasalt - Þóleiít 4-5% plag. díl. Ferskt blö. tómar 6 spr./m
427.5	100	30	3	Kargi, laus. Rauðmalargjall m. setfyll., 7.5 spr./m
426.0				Rauður sdst.
	100	40	3	Kargi. Blöðr. frauðk., 8.5 spr./m. Óljós mörk karga og basalts.
423.5	100	35	4	Þóleiítbasalt fínk. blö. smáspr. Gulbr. leirsk. í blö. Þétt um miðbikið en blöðr. efst og neðst . Spr. alm. hrj. m. ljósbrúna leirsk. 12 spr./m auk lítilsh. kurls.
				Kargabelti
413.5				Rauður sdst.
	100	50	5	Dílabasalt blendingur sem erfitt er að flokka. Kargi efst
				Rautt sdst. band
				Kjarnatap 1.5 m
	71	32	5	Millistigsbas. Ól. Þól. Blö. tóm. vott f. str.fl. Gulbr. leirsk. á spr.fl. Yfirl. ská og þversprungur 6 spr./m
				Kjarnatap 1m (Sandsteinsmoli)
403.1	90	37	5	Ólivín basalt. Míkróblöðr. efst og neðst og auk þess í beltum. Stak. spr. Mjög blöðr. stundum kargakennt 8 spr./m
396.8				Gulbr. sdst.
	95	50	6	Millibasalt Ól. - Þól. Blöðr. og kargakennt ofantil, þéttara neðar. Kargabelti, nokkrar smásprungur. Leirsk. á sprfl. Hrjúf spr. 10 spr./m auk kurls
				Kjarnatap
387.3	87	25	2	Pressaður kargi
	100	35	3	Millibasalt Ól.-Þól. Fínkorna stakblö. ljósgrátt. Tómar blöðrur Ryðbr. leirsk. á sprfl., 16 spr./m
381.9	100	100	1	Rauður sdst. vel saml.
	100	60	6	Ólivín basalt fín-smákorna, blö. belti og míkróblö. bönd. Þver og skáspr.. Hrjúf. sprfl. 7 spr./m
				Kjarnatap 4 m
	100	18	2	Ólivín basalt, ferskt berg. Þver og skásprungur. Spr. hrjúf m. leirsk. 6 spr./m
369.5				

(framhald)

Sjá skýringar á mynd 9
Sjá staðsetningu á mynd 3

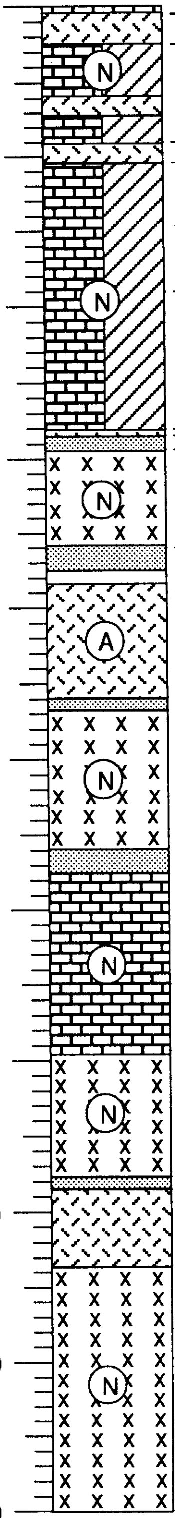
Hola BR-2 var boruð suðaustan við Búrfell á Botnsheiði

Breiðadals- og Botnsheiði	Jarðtæknistofan
Snið af kjarnaholu BR-2 á Botnsheiði	ÁgG / ÁGe
	Desember 1990
	Mynd nr 2

ORKUSTOFNUN
Vatnsorkudeild

BR-2
Á BOTNSHEIÐI (frh.)

Hæð m y. s.	Dýpi m
369.0	100
358.9	110
	120
341.7	
	130
333.7	
	140
323.6	
	150
313.4	
	160
299.8	170
291.7	
	180
285.8	
	190
269.5	200



Kjarni %	RQD %	Q
100	58	4
99	35	4
100	88	5
95	48	4
95	48	8
100	55	1
100	65	7
46	23	1
100	100	7
100	100	1
100	78	6.5
100	73	1
100	77	8
100	50	7
100	65	7
100	100	1
100	75	7
100	82	9

Kargi m. sdst. bönd ekki blö. Holr. yfirl. tóm. Þverspr. fersk. sprfl.
9 spr./m
Millibas. Ól.-Þól. Fínkrist. breksíulegt í efri hluta.
Fínblöðrótt og blöðrótt belti. Ferskt tómar blö., sumst. kurl.
Kargabelti
Fíngert ferskt ól bas.2 spr./m auk kurls
Nokk. samlím. kargi. Blö. og holr. m. gulbr. leir. Fáeinar þversprungur
Millibas. Ól.-Þól
Blö. í efri hluta 5-10%. Blö teygðar v. strfl. og tómar
Hrjúf. spr. m. gulbr. leirsk. Efri hl. lagsins er að miklu leyti kurl.
Ferskt brotsár
Kjarnatap og kurl
9 spr./m ofant. Í laginu auk kurls. Segulstefna óljós.
Í neðri hl. lags eru 3 spr./m
Vel sampress. botnkargi
Setberg. Sdst. efst er Rauðgult súrt túff
Dílabasalt. Fremur smádílótt. Krist < 4mm
Mjög blö. m. grábl. leirskán
Smáspr. lag. grónar sprungur með gulbr. leirsk.
Hrjúf spr., breytileg stefna
6 spr./m
BML 0.1m. Vaxkennt brúnt túff. Kurlað
Kjarnatap
Völuberg
Kargi. Dumbrauður vel sampressaður
Setberg fyll. milli kargamola ofantil. Líklega þól. kargi
Spr. hrj. m. breytil. stefnu án spr. fyll.
0.4 spr./m
Rauðgult túff og grágrænn vikur með kargamolum
Dílabasalt skylt þól
5% plag. dílar frekar smáir
Kargakennt lag og blöðr. með setfyllingu. Efst blöðrur tómar
Spr. óreglul. hrj. breytil. stefna. Óvíst hve margar spr. eru upprunalegar
2.4 spr./m
Ljósbr. vaxk. túff. Ummynduð gjóska. Sleipir sprfl. veikt berg
Ólivín basalt - Dyngjubasalt
mikið blöðr., bæði stór og fínblöðrótt
Lítil ummyndun. Flestar blöðrur tómar eða leirskán
smákorna sandp. áferð í brotsári vegna míkróblö.
Spr. ská og þver m. breytil. stefnu. Hrjúf spr. m. þunn ljósbr. leirsk.
3 spr./m
Vottur af br. sdst..
Ólivín basalt stór og fínblö. Sandp. áferð í brots., lítil ummynd.
Tómar blö. með þunna bl. leirskán
Víðast smáspr.. Spr. hrj. m. breytil. stefnu. 5 spr./m
Dílabasalt, 5-8% plag. díl < 6 mm
Mjög blö. lítt holuf. Blágr. leirsk. í blö.
Rauðbr. leirskán í spr. og stöku blö.
Spr. hrjúf m. breyt. stefnu. Ljós leirsk. á spr.fl. 3.7 spr./m
Rauður sdst. m. kargamol.
Dílabasalt. Mjög kargakennt. 7% plag. díl < 5mm
Rauðbr. og gulur leir á spr.fl. Spr. hrj. m. br. stefnu. 10 spr./m auk kurls
Dílabasalt. Breytilegt dílamagn. 7-15% plag. díl < 6 mm.
1-2% smáir px. dílar
Bergið er m. rauðbr. blæ. Ól. ættar en ekki sterk einkenni
Víða fínfrauðk. m. sandp. áferð
Blö. tómar en með þunna blágr. leirsk.
Þver og skáspr. með breytil. stefnu. Spr. hrj. með þunna ljósbr. leirsk.
2.4 spr./m

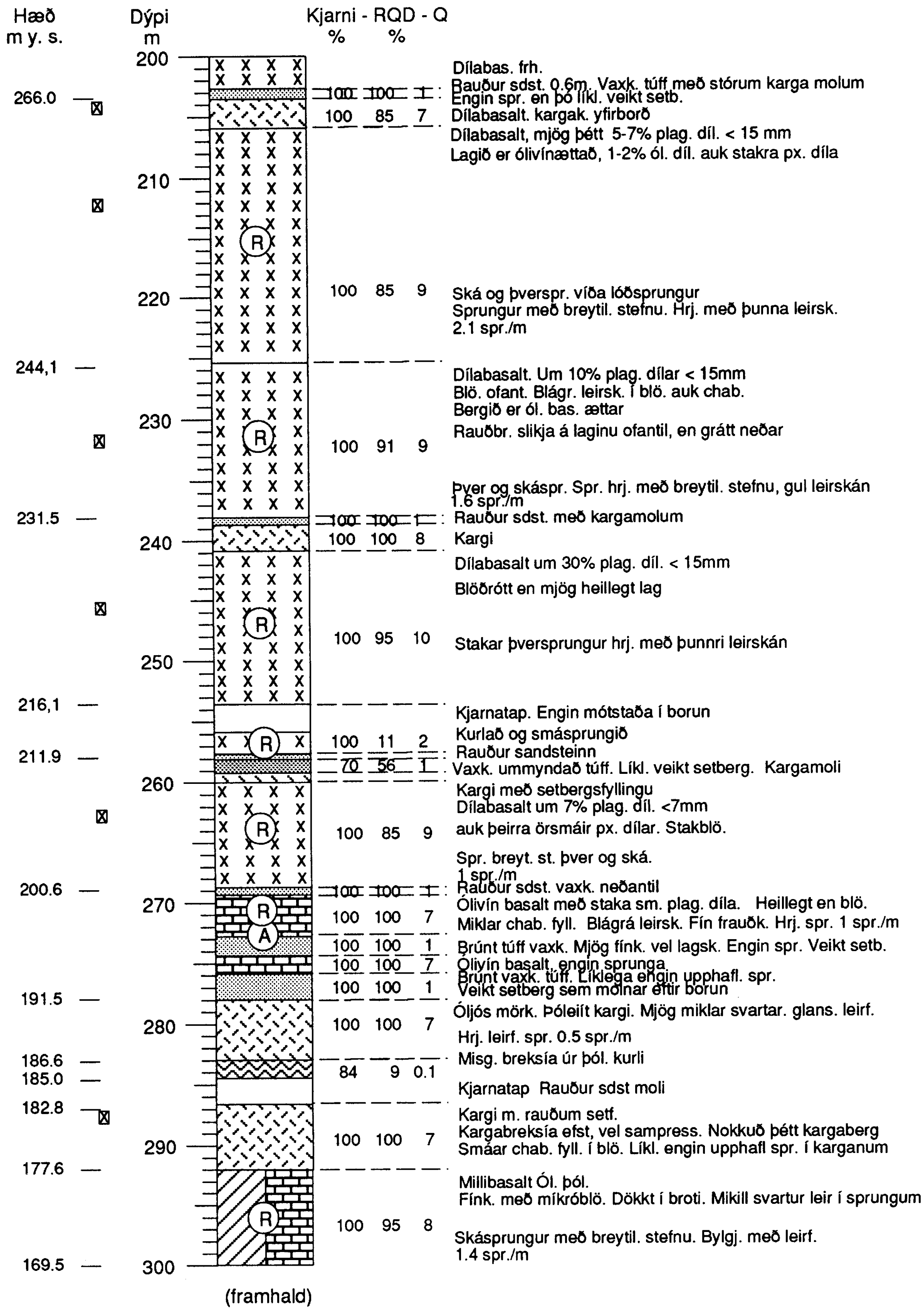
(framhald)

Sjá skýringar á mynd 9
Sjá staðsetningu á mynd 3

Breiðadals- og Botnsheiði	Jarðtæknistofan
Snið af kjarnaholu BR-2 á Botnsheiði (frh.)	ÁgG / ÁGe
	Desember 1990
	Mynd nr 3

ORKUSTOFNUN
Vatnsorkudeild

BR-2
Á BOTNSHEIÐI (frh.)

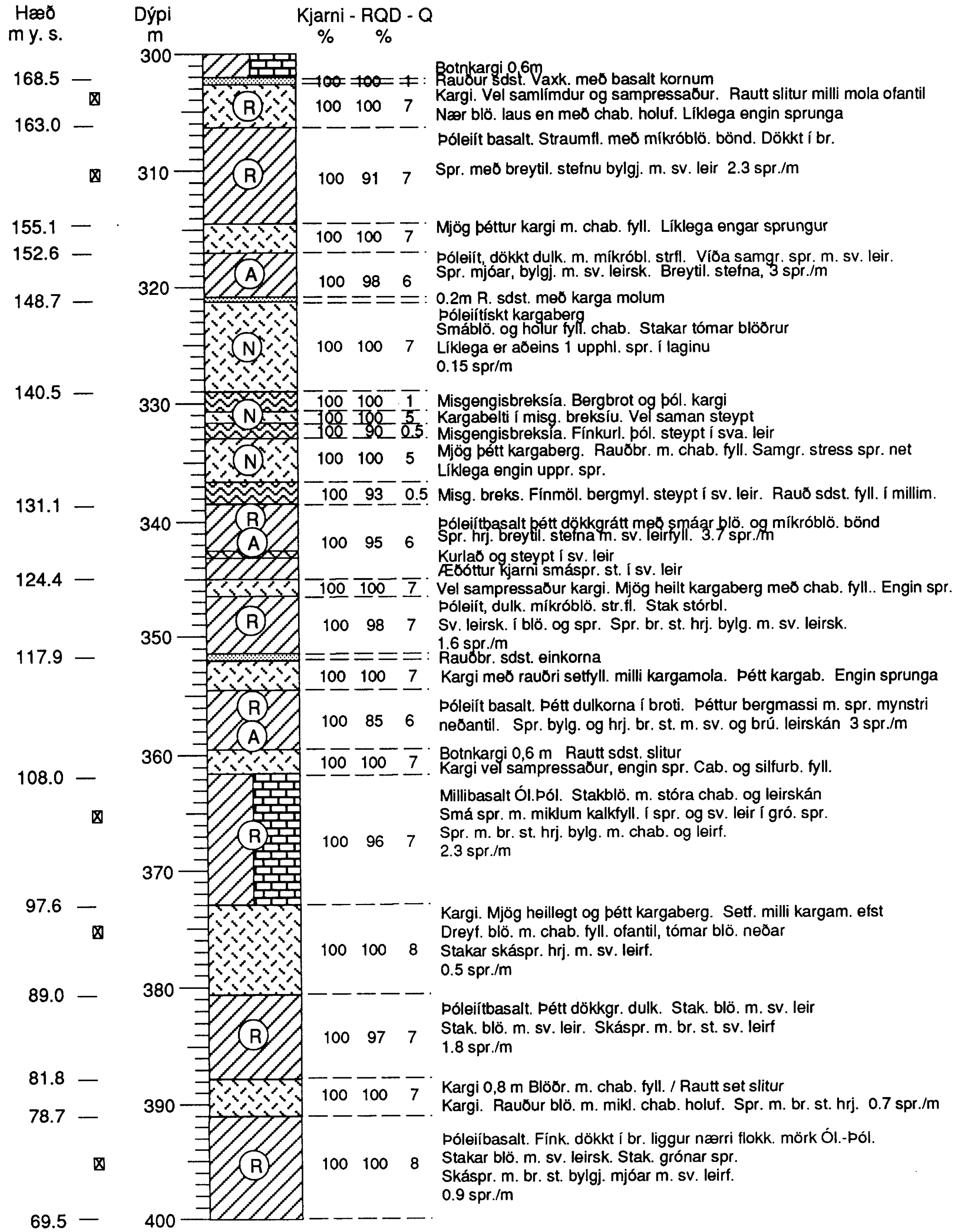


Sjá skýringar á mynd **9**
Sjá staðsetningar á mynd **3**

Breiðadals- og Botnsheiði	**Jarðtæknistofan**
Snið af kjarnaholu BR-2 á Botnsheiði (frh.)	ÁgG / ÁGe
	Desember 1990
	Mynd nr **4**

ORKUSTOFNUN
Vatnsorkudeild

BR-2
Á BOTNSHEIÐI (frh.)



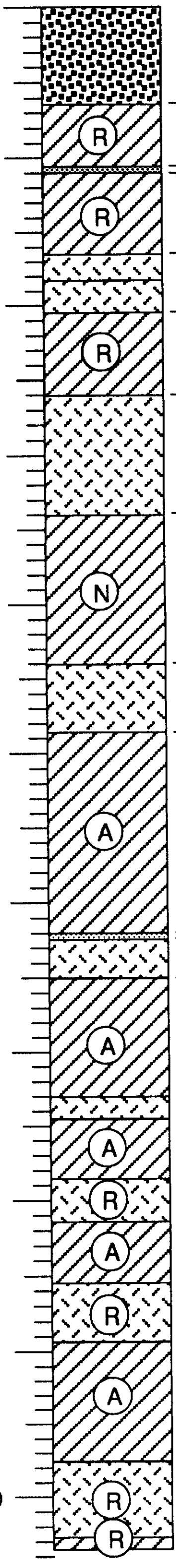
Sjá skýringar á mynd **9**
Sjá staðsetningu á mynd **3**

Breiðadals- og Botnsheiði	**Jarðtæknistofan**
Snið af kjarnaholu	ÁgG / ÁGe
BR-2 á Botnsheiði (frh.)	Desember 1990
	Mynd nr **5**

ORKUSTOFNUN
Vatnsorkudeild

BR-3 Í BREIÐDAL

Hnit
x = 326645,675
y = 530067,481



Hæð m y. s.	Dýpi m	Kjarni %	RQD %	Q	
231.8	0				Laus yfirborðslög
					Velkt kurl
225.1		100	43	4	Þóleiítbasalt, þétt fínkorna megineldst. þól. Smáspr. breyt. stefna leirsk. 8 spr./m. Kargi neðst 0,3 m
221.4	10	100	100	+	Setberg, rautt og gulbrúnt túff 0,3 m
		92	16	3	Þóleiítbasalt, megineldstöðvar Þól. Kargi efst 0,5 m Smáspr. breytil. stefna, leirskán í sprungum 10 spr./m
215.4		100	33	3	Kargi, ferskur lítt holufylltur
211.3	20	100	70	5	Kargi, ferskur lítt holufylltur
		87	34	3	Þóleiítbasalt, megineldstöðvar þól. Ferskt, þétt straumfl. Spr. ská og lóð m. br. stefnu m. sv. leir 7.3 spr./m
205.8					Kjarnatap ≤ 0,15 m
	30	98	51	5	Rautt slitur Kargi ferskur m. basalt molum Líkl.fáar uppr. sprungur, en brotið og sprungið eftir borun Spr. hrj. þver og ská 2.5 spr./m
197.9					Kjarnatap 0.5 m
	40	93	57	5	Þóleiítbasalt, megineldstöðvarþól. Þétt strfl. æðum. Samangróið spr. net eftir stressspr. Svartur og grár leir í sprungum. Spr. brattar og ská. Br. st. hrj. m. sva. leirsk. Sumar sléttar bylgj. 4 spr./m. Kargi neðst 0,5 m
187.8					RML 0.1 m
		100	72	5	Kargi. Rauðleitt kargaberg. Rautt setslitur ofantil, fersk. tóm. blö. Breksíukennt neðst, líklega fáar uppr. spr. 1 spr./m
183.3	50	100	85	7	Þóleiítbasalt, megineldst. þól Þétt heillegt spr. m. dökka og gulbr. leirsk. Spr. ská og þver, hrj. og slétt bylgj. 4.1 spr./m
	60				
169.8		100	50	+	Rauður sdst 0,3 m
		100	85	6	Kargi, rauðar sdst. fyllur efst milli mola Vel samanpress. tóm. blö. 1.3 spr./m
	70	100	76	6	Þóleiítbasalt, megineldstöðvar þól., þétt, dulk. Gróið spr. m. miklum sv. leirf. Spr. ská og lóð, hrj. beyt. stefna sv. leirsk. 5.3 spr./m
158.6		100	54	4	Kargi, dökkgrá kargabreksía 2 spr./m Óljós lagmót
		100	61	5	Þóleiítbasalt, megineldst. þól Mjög blö. efst, stakblö. neðar. Nokkur kurlsvæði. 5.5 spr./m
152.9					Ógr. lagmót
	80	100	83	7	Kargi, dökkur, vel sampress. kargi, tóm. blö. 1-2 spr./m
		100	77	6	Þóleiítbasalt, megineldst. þól. Stak. stórblö., annars þétt Spr. hrj. m. br. st. m. leirsk. 2 spr./m
146.1					Rautt sandst. slitur ≤ 2 cm
		100	50	4	Kargi, fersk. gropinn. Ljósbleik leirsk. og sv. leir í blö. Brotið í borun. Upph. líkl. 1 spr./m
	90	100	78	7	Þóleiítbasalt, þétt fínk. m. fíng. strfl. bönd. Kurlbelti efst í laginu Spr. m. breytil. st. brattar og ská, hrj. og m. leirsk. 3.1 spr./m
134.0					Óljós lagmót
	100	100	82	6.5	Kargi, ferskt, dökkt kargaberg, vel sampress. án fyll. Kurl efst, annars heill Líkl. 0.5 spr./m
128.5		100	30	2	Þóleiítbasalt, smábrotið m. gróið spr. net

Sjá skýringar á mynd **9**
Sjá staðsetningu á mynd **3**
Kjarnahola BR-3 er neðan vegar í Breiðadal við gamla veginn upp Skógabrekkur

Breiðadals- og Botnsheiði

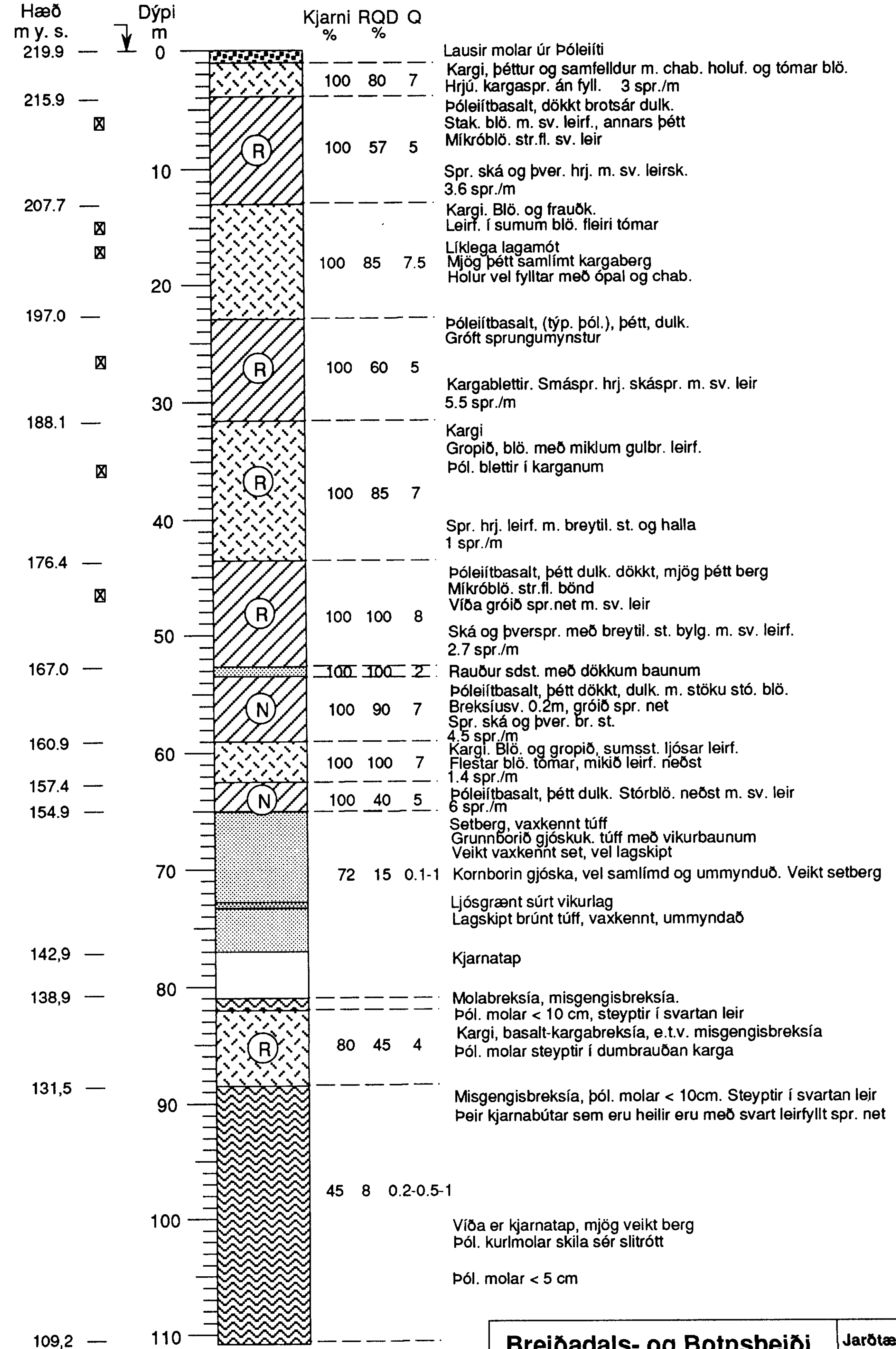
Snið af kjarnaholu BR-3 í Breiðadal

Jarðtæknistofan
ÁgG / ÁGe
Desember 1990
Mynd nr **6**

ORKUSTOFNUN
Vatnsorkudeild

BR-4
Í BOTNSDAL

Hnit
x = 331008,764
y = 531036,657

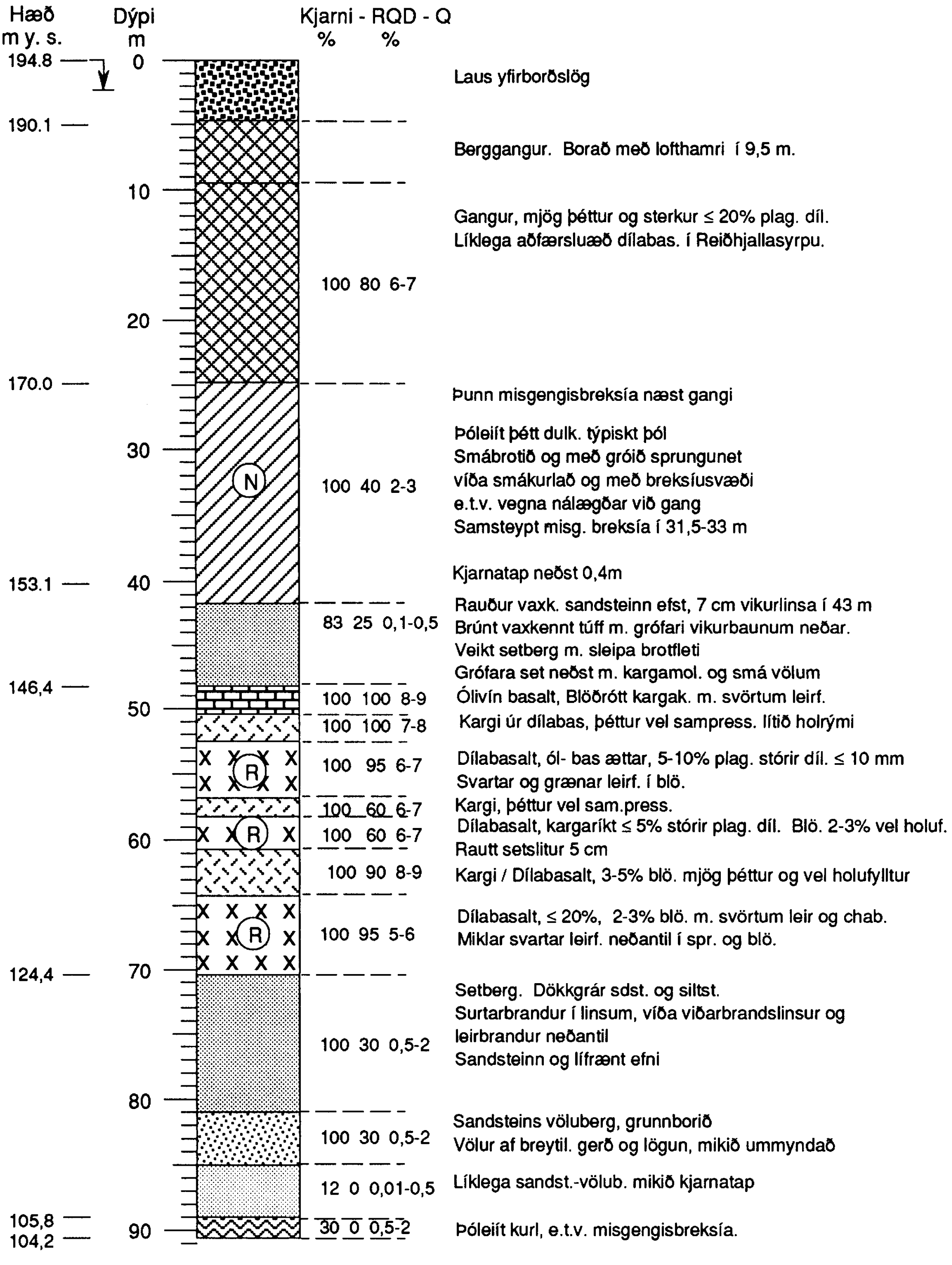


Sjá skýringar á mynd **9**
Sjá staðsetningu á mynd **3**
Hola BR-4 er við Botnsá í Botnsdal.

Breiðadals- og Botnsheiði	Jarðtæknistofan
Snið af kjarnaholu BR-4 í Botnsdal	ÁgG / ÁGe
	Desember 1990
	Mynd nr **7**

BR-5 Í BOTNSDAL

Hnit
x = 331181,847
y = 530934,813



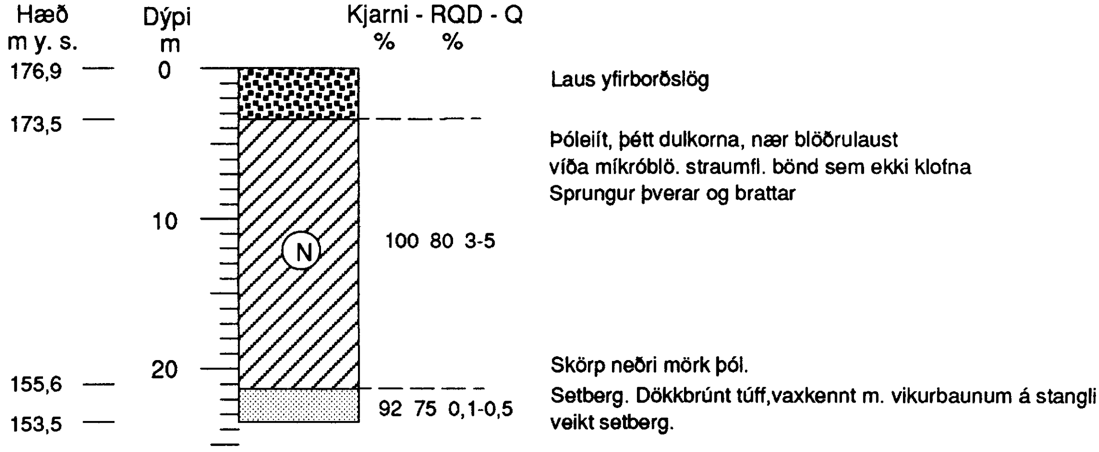
Sjá skýringar á mynd **9**
Sjá staðsetningu á mynd **3**

Hola BR-5 er við Botnsá í Botnsdal.

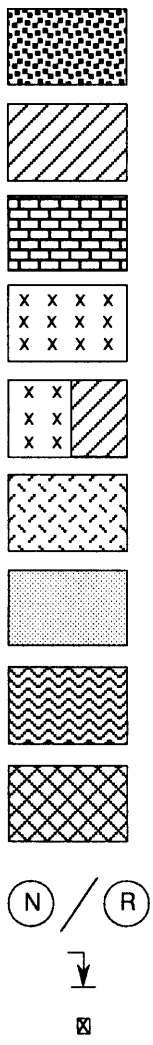
Breiðadals- og Botnsheiði	Jarðtæknistofan
Snið af kjarnaholu BR-5 í Botnsdal	ÁgG
	Desember 1990
	Mynd nr **8**

BR-6
Í BOTNSDAL

Hnit
x = 331215,724
y = 530842,603



SKÝRINGAR



Laus yfirborðslög

Þóleiít basalt

Ólivín basalt

Dílabasalt

Millibasalt

Kargi

Setberg

Misgengisbreksía

Berggangur

Segulstefna í bergi
Rétt / Öfug

Grunnvatnsborð

Sýni brotþolsprófuð

Sjá staðsetningu á mynd **3**

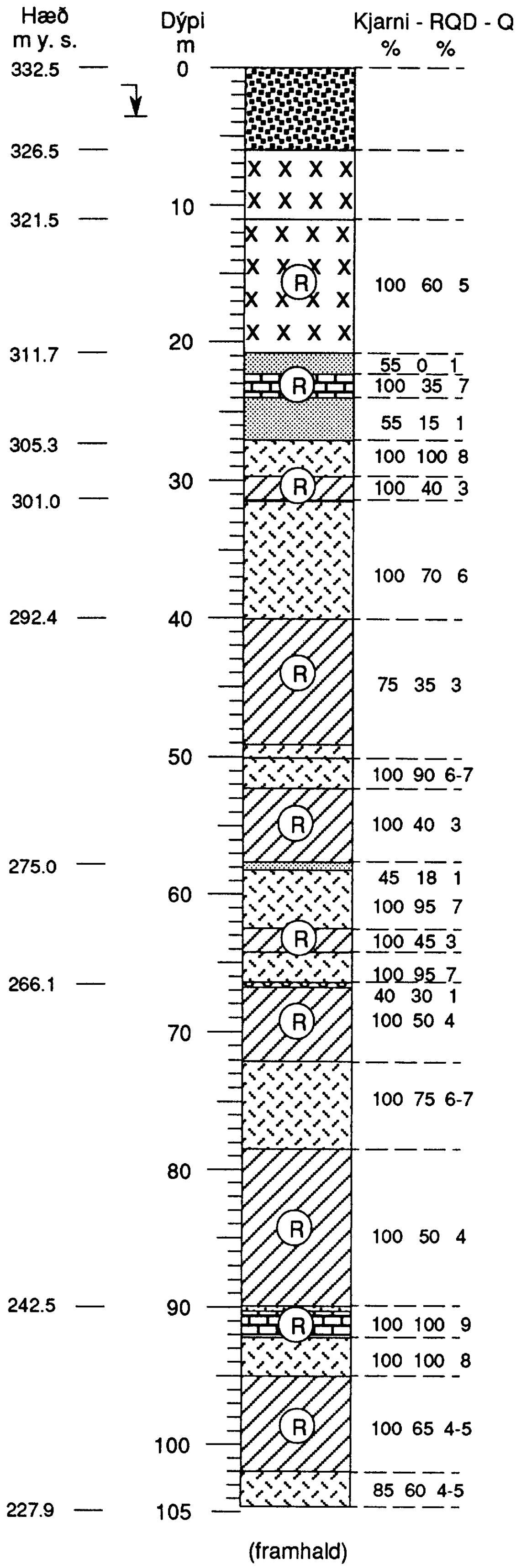
Hola BR-6 var boruð við Botnsá í Botnsdal

Breiðadals- og Botnsheiði	Jarðtæknistofan
Snið af kjarnaholu BR-6 í Botnsdal	ÁgG
	Desember 1990
	Mynd nr **9**

ORKUSTOFNUN
Vatnsorkudeild

BR-7 Í BOTNSDAL

Hnit
x = 330493,717
y = 531463,112



Laus yfirborðslög

Borað með lofthamri í dílabasalt.

Kargakennt efst 1 m
Dílabasalt Ól- basalt ættar
Dreifðir stórir ≤ 15mm plag. krist. 5-8 %
Blöðr. ≤10% með svörtu leirskæni
Hrjúfar þver og skáspr með ljós. gráum og brún. leirf.

Rauður sandst. úr súru túffi.
Ólivín basalt mjög blöð ≤ 15%. Frauðkennt lag
Set, millibrúnt túff, vaxk. mjög smáspr. ofantil.
Kjarnatap um miðbik, neðst brúnn vaxk. sdst. m. vikurlinsu.
Kargi á efra borði þól, þéttur og vel holuf.
Þóleiít, kargamikið og blö. ≤ 5% ljós leir í blö. og spr.
Túff, rauðl. og gulbr, ummyndað og vaxk.
Kargi, vel saman press. og heill
en lítilsh. brotinn við borun.

Verulegt kjarnatap við 41-44 m
Þóleiít, þétt, smákorna m. ól- þól- millibas brotsár
Smábrotið m. ljósgráa og ljósbr. leirskán á sprfl.

Kargi, kargaberg m. smáum blö. 5-10%
Rauður sdst. 5 cm
Kargi þéttur m. setfyll. í efstu 3,3 m
Þóleiít, týp. þól. dulk. smáspr. Hrj. spr. m. sv. leirsk.

Set. Vaxk. rauður sdst. og gulbr. túff.
Kargi, vel saml. ≤5% blö. án fyll.

Þóleiít, ferskt grátt, 5% blö. tómar.
Kargi, vel samlím. ≤ 5% blö.
Misgengisbreksía, vel samlímd en kjarnatap.
Þóleiít, þétt nær dulk. lítið strfl. blö. ≤ 1%
Smáspr. ská og þver. hrj. spr. m. sv. leirsk.

Kargi, heill og þéttur blö. 1% líkl. brotinn við meðhöndlun
Þétt vel sampress. kargaberg.

Þóleiít, millibasalt Ól- þól. Ferskgrátt lítil strfl.
Spr. brattar, hrjúf. m. ljósgr. og ljósbr. leirsk.

Rauður sdst m. kargamol.
Ólivín basalt, mjög blö. ≤ 15% m sv. leir og chab.
Gulbrúnt túff og rauður sdst.
Kargi, vel sampress, en stak stór blö. Setfyll. efst, þétt neðar
Þóleiít, nær dulk. m. strfl. bönd.
Stórar blö. 5-7% tómar eða m. sv. leirsk.
Ská og þverspr hrj. spr. m. ljósgr. og ljósbr. leirsk.

Kargi, vel saman pressaður en smábr. og kurl, lítilsh. kjarnatap

Sjá skýringar á mynd **9**
Sjá staðsetningu á mynd **3**

Hola BR-7 var boruð hjá Botnsá í vegkanti við innstu beygjuna á veginum upp úr Botnsdal

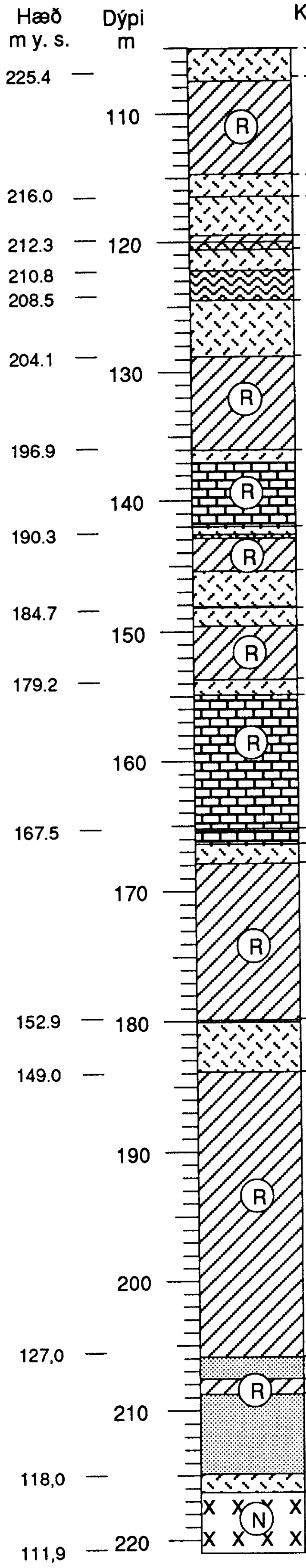
Breiðadals- og Botnsheiði

Snið af kjarnaholu BR-7 í Botnsdal

Jarðtæknistofan
ÁgG
Desember 1990
Mynd nr **10**

ORKUSTOFNUN
Vatnsorkudeild

BR-7
Í Botnsdal (frh).



Kjarni - RQD - Q
% %

100 100 8-9
91 45 3-4
100 100 8-9
100 100 8-9
100 80 1
100 100 8-9
90 30 1-2
100 100 8-9
95 70 5
100 50 6
80 60 5
100 70 6
100 100 8
90 75 5-6
100 100 8-9
98 70 8-9
100 70 6
100/45/3
95 85 6
100 60 5
100 75 5-6
75 30 0,1-1
100 100 5
100 30 0,1-1
100 20 2
100 85 8

Rautt setslitur á lagmótum
Kargi, mjög þéttur og vel sampress. stakar blö. m. chab
Þóleiít, fín- dulkorna smáspr. og stressspr.
Blö. svæði með ≤ 10% blö. í þriðjungi lagsins
Hrjúfar ská og þverspr. m sv. og gulbr. leirf.
Kargi, mjög þéttur og heill m. breksíu mol. á stangli.
Rautt setslitur 5 cm
Kargi, þéttur og sampress. m. sérk.l. basalt flísar líkl. nál.misg.
Þól. bútur 1 m og misgengisbreksía 1 m
Kargi smáblö 3-4% m. gropinn m. ljósum leir
Misgengisbreksía, ekki skörp skil milli misgbr. og karga
Kargi þéttur, vel sam. press. blö. fyll. m. chab og ópal
Þóleiít nær dulk. týp. þól. ljósgrátt efst og neðst
dekkra um miðju v. sv. leirf. í míkróblö. böndum.
Víða fíng. grónar sv. leirf. sprunguæðar. Botnkargi 15 cm
Grár sandst. á lagmótum 10 cm
Kargi, þéttur vel sampress.
Ólivín basalt stakir plag. díl. Smáar blö. ≤ 7%
Morkið og þverbrotið við borun.
Kargi, þéttur 0,6 m. Misgengisbreksía 0,4 m
Þóleiít, smábr. víða kurlað. Æðóttur kjarni v.. sv. leirf. sp.
Kargi, þéttur vel sam. press.
Rauður sdst. m. kargamol.
Kargi, þéttur mjúkur bylgj. v. borunar.
Þóleiít, dulk. týp. þól. Víða fínblö. svæði, m. sv. leir.
Stress spr. Grónar hrjúf. spr. æðar.
Rautt setslitur og kargi, þéttur vel sampress.
Ólivín basalt, fíngert í broti, plag. díl. í breytil. magni
Smábrotið og víða kurlað
Við 161-162 m kurlað og steypt í leir, líkist misgengisbreksíu.
Sandsteinn. Dökkgrár m. basaltmolum.
Ólivín basalt, kargakennt m. sv. leirf. og geislast.
Kargi, þéttur, vel samanpress. líkl. eing. brotinn í borun
Þóleiít þétt dulkorna ≤ 2% blö.
víða grónar stress spr. m. sv. leir
Míkróblö. bönd mynda straumfl. Grónar lóð og skáspr.
Sandsteinn, rauður vaxkenndur
Kargi, þéttur vel saman pressaður með þól. molum
Þóleiít basalt, þétt nær dulkorna.
Víða mynda míkróblöðrubönd straumfl. m. svörtum leir
Dreift gróið sprungunet neðantil.
Setberg, brúnt vaxkennt mjög veikt og þurkspr. kj. tap neðst.
Þóleiít kargakennt
Setberg, dökkgrár sdst. m. kargamolum efst.
Sandsteins- völuberg, m kantaðar smávöl. í túffk. grunnm.
Grunnborið. Springur við þurk og í meðförum í 2-15 cm búta.
Kargi, mjög smáspr. þverspr. líkl. í meðförum.
Dílabasalt, plag. díl ≤ 15% breytil. dílastærð ≤ 15 mm
Dökkt vegna sv. leirf. í blö og míkróblö. böndum.
Svartur leir á bylgj. og hrj. sprfl.

Sjá skýringar á mynd **9**
Sjá staðsetningu á mynd **3**

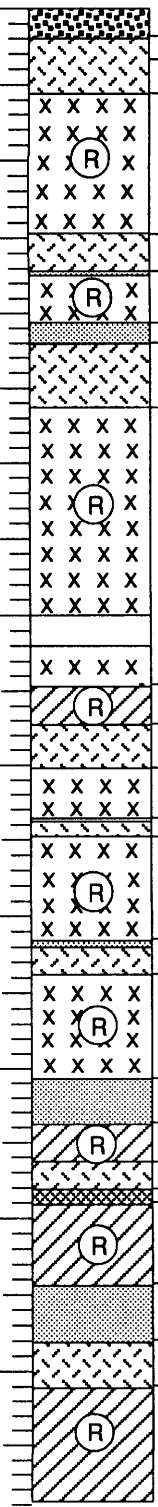
Hola BR-7 var boruð hjá Botnsá í vegkanti
við innstu beygjuna á veginum upp úr Botnsdal

Breiðadals- og Botnsheiði	**Jarðtæknistofan**
Snið af kjarnaholu BR-7 í Botnsdal	ÁgG
	Desember 1990
	Mynd nr **11**

ORKUSTOFNUN
Vatnsorkudeild

BR-9
Í TUNGUDAL

Hnit
x = 329508,138
y = 534611,722



Hæð m y. s.	Kjarni %	RQD %	Q	Lýsing
175.6				Laus yfirborðslög
173.7				Kargi. Borað með lofthamri í 3,3 m.
	100	100	7-9	Kargi. Mjög vel saman press. og heill
170.0	100	75	5-6	Dílabasalt um 15% stórir (< 10 mm) plag. díl. Þétt massíft lag með lóðspr og skáspr. Spr. hrjúfar m. þunna leirskán. Blöðr ≤ 2% m. chab. og leirskán
160.9	100	100	7-9	Kargi þéttur vel saman press. 2% blö m. chab. fyll.
158.4				Rauður vaxk. sandst. 0.3 m
	100	100	9-10	Dílabasalt (Cumulat) 30% stórir plag. < 15 mm. 3-4% blö. m. chab. fyll. Mjög heilt án sprungna.
155.0	65	10	0.1-1	Setberg, brúnt vaxk. túff Mjög veikt berg.
153.6	100	30	3	Kargi með setfyll. efst og veikur þar. þéttur og sterkur neðar
149.3	85	40	3-4	Dílabasalt, Ól. bas. ættar 7-8% plag. díl ≤ 8 mm. Sprungur sem benda til nál. við misg. Skoltap í 29-33 m mikill leki um sprungu Dæluafköst um 200 l/min.
				Kjarnatap 2 m við 40-42 m
				Misgengi skörp skil.
130.9	100	25	2	Þóleiít, þétt smáspr. ská og þver spr. sumar spr. opnar og líkl. lekar
128.3	100	100	8-9	Kargi mjög þéttur og heillegur. 2-3% blöðr. með chab. fyll.
125.4	100	100	9-10	Dílabasalt ól. bas. ættar ≤ 10% plag. díl. 3-4% blö. m. chabasíti, thomsoníti og bláum leir.
122.0				Rauður vaxk. sandst. 0,1 m
	100	100	8-9	Kargi, mjög heill og þéttur með chab. fyll. traust kargab.
	100	100	9-10	Dílabasalt, Ól. bas. ætt ar, 10-15% plag. díl. ≤ 5 mm Blö. 2-3% m. chab. og blágráa leirsk. Mjög heilt berg
114.0				Rauður vaxk. sandst 0,4 m
111.9	100	100	8-9	Kargi, mjög heill og þéttur, vel fyll. m. chab.
	100	80	7-8	Dílabasalt, Ól. bas. ættar, 10-12% plag. díl ≤ 5 mm Blö. 3-4% m. chab. fyll. og blágr. leirsk. míkró blö. bönd mynda strfl. neðst.
104.9	50	0	0.01	Setberg, vaxk. sdst, vaxk. túff molnar í borun. neðar mjúkt set sem hnoðast sem kítti. Kjarnatap neðst.
101.8	80	30	2-3	Þóleiít, mjög smábrotið. Hrjúf. spr. m. svarta leirskán
99.3	90	50	4	Kargi m. leir og setfyll. efst . Smáspr. og veikur
96.5	100	50	0.5	Misgengisbreksía 1 m kurlað basalt í svörtum leirmassa
	100	80	6	Þóleiít, þétt týp. þól. 2-3% blöðr. fylltar og skændar sv. leir Gróið smáspr. net myndar svartar æðar, nálægð við misg.
91.2	45	0	0,1-1	Setberg, vaxk. brúnt og svart túff. Mikið kjarnatap
87.6	100	85	7-8	Kargi, setfylltur í efstu 0,3 m þéttur, neðar með 2-3% blö . fylltar .chab
84.5	75	15	1-2	Þóleiít, þétt en mjög smáspr. e.t.v. misgengisbreksía í 93-94 m Spr. yfirl. hrjúfar m. svarta og græna leirskán
76.8				

Sjá skýringar á mynd **9**
Sjá staðsetningu á mynd **3**

Hola BR-9 var boruð í tungunni
á milli Hnífár og Tunguár í Tungudal

Breiðadals- og Botnsheiði	Jarðtæknistofan
Snið af kjarnaholu BR-9 í Tungudal	ÁgG
	Desember 1990
	Mynd nr **12**

APPENDIX 2

RESULTS OF UNIAXIAL COMPRESSION TESTS

FROM THE BUILDING RESEARCH INSTITUTE

7 SHEETS

Rannsóknastofnun byggingariðnaðarins

Keldnaholt, 112 Reykjavík, S: 676000
Kennit.: 530269-2139, Nafnnr. : 7264-8218

Ranns. nr. H90/1075
2. Áfangi.

Reykjavík, 31. jan 1991

Nafn greiðanda:	Vegagerð ríkisins	Kennitala:	680269 - 2899
Heimilisfang greiðanda:	Borgartúni 7 105 Reykjavík	Dags. beiðni:	10. desember 1990
Nafn umbjóðanda:	Hreinn Haraldsson	Bréf nr.:	3
Afrit:		Reikn. nr.:	
Afrit:		Framkv. af :	ÞJ
Mannvirki:	Jarðgöng - Breiðdalsheiði, Botnsheiði		
Náma:			
Rannsókn:	Einásabrotþol á bergkjörnum og berggreining		
Fjöldi sýna:	136		
Merki:			
Upplýsingar frá sendanda:			

Að beiðni Hreins Haraldssonar hjá Vegagerð ríkisins var gerð berggreining á borkjörnum sem áður hafði verið mælt á einása brotþol. Berggreining var framkvæmd s.k.v. berggreiningarstaðli R.b.

Í fyrri skýrslu voru sýni sem brotnuðu á gömlum sprunguflötum auðkennd með stjörnu (*) í töflu. Athygli er vakin á því að í þessari skýrslu er bætt stjörnu við 3 sýni í borholu BR. 3 á 21.4 m,
41,0 m og 43.4 m.

Virðingarfyllst,
RANNSÓKNASTOFNUN BYGGINGARIÐNAÐARINS
Þorsteinn Jóhannsson
jarðfræðingur

/sg

Borhola BR 1

Dýpi [m]	Álag [kg]	Þrýstiþol [MPa]	Berggerð
3.7	52300	295.8	Basalt lítillega ummyndað þétt
7.5	9850	55.7	Basalt ummyndað þétt
10.6	28750	162.6	Basalt lítillega ummyndað þétt
13.9	3300	18.7	Kargaberg
14.4	4700	26.6	Kargaberg
15.6	1700	9.6	Kargaberg
15.6	1550	8.8	
18.0	15300	86.5	Basalt ummyndað þétt
19.2	21700	122.7	Basalt ummyndað þétt
19.9	16800	95.0	Basalt ummyndað þétt
34.4	5750	32.5	Kargaberg
34.8	6350	35.9	Kargaberg
37.8	5600	31.7	Kargaberg
61.1	2750	15.6	Kargaberg

Borhola BR 2

Dýpi [m]	Álag [kg]	Þrýstiþol [MPa]	Berggerð
2,6	18500	104,6	Basalt ummyndað þétt
2,6	15900	89,9	
3,7	38000	214,9	Basalt lítillega ummyndað þétt
91,8	13450	76,1	Basalt lítillega ummyndað blöðrótt
91,8	12500	70,7	
91,8	14200	80,3	
91,8	12350	69,8	
91,8	13300	75,2	
120,5	34700	196,2	
120,5	18200	102,9	Basalt lítillega ummyndað þétt
124,1	36300	205,3	Basalt lítillega ummyndað þétt
124,1	21250	120,2	
124,1	37900	214,3	
160,9	19550	110,6	Basalt lítillega ummyndað blöðrótt
160,9	19900	112,5	
163,2	23600	133,5	Basalt lítillega ummyndað þétt
163,2	23500	132,9	
171,7	11350	64,2	Basalt lítillega ummyndað blöðrótt
172,5	9950	56,3	
172,5	6650	37,6	
172,5	9300	52,6	Basalt lítillega ummyndað blöðrótt
204,4	2900	16,4	Kargaberg
206,7	23400	132,3	Basalt lítillega ummyndað þétt
212,0	23950	135,4	Basalt ummyndað þétt
223,1	35200	199,1	Basalt ummyndað þétt
223,1	36700	207,5	
227,4	8900	50,3	Basalt ummyndað blöðrótt
230.9*	19900	112,5	Basalt ummyndað þétt
237,7	31250	176,7	Basalt ummyndað þétt
242,4	12250	69,3	Basalt ummyndað þétt - dílótt
242,4	12200	69,0	
246,3	18050	102,1	Basalt ummyndað þétt - dílótt
250,3	13800	78,0	Basalt ummyndað þétt - dílótt
262,1	13450	76,1	Basalt ummyndað þétt
266,9	33500	189,4	Basalt lítillega ummyndað þétt
266,9	35400	200,2	
268*	7350	41,6	Basalt ummyndað þétt

Dýpi [m]	Álag [kg]	Þrýstiþol [MPa]	Berggerð
268,0	14850	84,0	
289,1	21450	121,3	Basalt ummyndað þétt
290,6	9850	55,7	Kargaberg
291,8	11300	63,9	Basalt ummyndað þétt nokkuð sprungið
302,7	10350	58,5	Kargaberg
302,7	9700	54,9	Kargaberg
304.2*	11700	66,2	Basalt ummyndað þétt
309,9	20350	115,1	Basalt ummyndað þétt
312,5	10525	59,5	Basalt ummyndað þétt
313,4	38350	216,9	Basalt lítillega ummyndað þétt
363,5	17050	96,4	Basalt ummyndað þétt
363,5	18100	102,4	
371,7	18900	106,9	Basalt ummyndað þétt
371,4	18200	102,9	Basalt ummyndað þétt
373,8	7100	40,2	Kargaberg
376,8	11250	63,6	Kargaberg
378,2	10500	59,4	Kargaberg
393,5	20500	115,9	Basalt ummyndað þétt
396,5	59600	321,8	Basalt lítillega ummyndað þétt
398,4*	9400	53,2	Basalt ummyndað þétt

Borhola BR 3

Dýpi [m]	Álag [kg]	Þrýsiþol [MPa]	Berggerð
21.4*	34950	197.6	Basalt lítillega ummyndað þétt
24.2	20500	115.9	Basalt ummyndað þétt
27.5	2675	15.1	Kargaberg
27.5	1475	8.3	
29.3	2550	14.4	Kargaberg
30.9	3850	21.8	Kargaberg
37.9*	8300	46.9	Basalt ummyndað þétt
41.0*	8875	50.2	Basalt ummyndað þétt - mikið sprungið
41.0*	8450	47.8	
43.4*	15050	85.1	Basalt ummyndað þétt nokkuð sprungið
45.0	2725	15.4	Kargaberg
45.7	2150	12.2	Kargaberg
46.0	3700	20.9	Kargaberg
51.0	33200	187.7	Basalt lítillega ummyndað þétt
59.1	18500	104.6	Basalt ummyndað þétt
66.5*	5300	30.0	Basalt ummyndað þétt mikið sprungið
66.5*	6850	38.7	
70.7	24100	136.3	Basalt ummyndað þétt
71.6	16350	92.5	Basalt ummyndað þétt
71.6	15800	89.4	
91.5	28250	159.8	Basalt ummyndað þétt
91.8	33250	188.0	Basalt ummyndað þétt
91.8	19800	112.0	
96.8	41500	234.7	Basalt lítillega ummyndað þétt
96.8	32200	182.1	
99.5	2175	12.3	Kargaberg
101.0	3500	19.8	Basalt ummyndað þétt mikið sprungið
101.0	7600	43.0	
102.1	1375	7.8	Kargaberg
52.7	24350	137.7	Basalt ummyndað þétt

Borhola BR 4

Dýpi [m]	Álag [kg]	Þrýsiþol [MPa]	Berggerð
7,3	29000	164,0	Basalt ummyndað þétt
7,7	30700	173,6	Basalt ummyndað þétt
7,7	29350	166,0	
11,9	42400	239,8	Basalt lítillega ummyndað þétt
16,7	1800	10,2	Kargaberg
13,4	2075	11,7	Kargaberg
19,0	875	4,9	Kargaberg
26,9	27300	154,4	Basalt ummyndað þétt
28,5	47300	267,5	Basalt lítillega ummyndað þétt
33,7	1025	5,8	Kargaberg
41,4	3975	22,5	Kargaberg
44,2	32700	184,9	Basalt lítillega ummyndað þétt
49.2*	8600	48,6	Basalt ummyndað þétt nokkuð sprungið
51,9	17450	98,7	Basalt ummyndað þétt

Borhola BR 9

Dýpi [m]	Álag [kg]	Þrýsiþol [MPa]	Berggerð
11,7	25850	146,2	Basalt lítillega ummyndað þétt - dílótt
11,7	16450	93,0	
11,7	23450	132,6	
11,7	21300	120,5	
12,7	30950	175,0	Basalt lítillega ummyndað þétt - dílótt
12,7	29700	168,0	
19,5	11400	64,5	Basalt ummyndað þétt ~ 50% dílótt
19,5	7600	43,0	
19,5	10450	59,1	
23,8	10950	61,9	Kargaberg
43,6	35400	200,2	Basalt lítillega ummyndað þétt
43.6*	26200	148,2	
65,6	18050	102,1	Basalt ummyndað þétt
65,6	19300	109,1	
66,9	23050	130,3	Basalt ummyndað þétt
66,9	24350	137,7	
70,5	23100	130,6	Basalt lítillega ummyndað þétt
70,5	22950	129,8	
70,5	30100	170,2	
79.4*	5200	29,4	Basalt ummyndað þétt
79.4*	5700	32,2	