Tunneling in acidic, altered and sedimentary rock in Iceland

Búðarhálsvirkjun

Appendices

1. Appendix – Supplementary information

This appendix contains additional information on Icelandic geology.

- Typical Tertiary basaltic successions.
- Difference between Tholeiite & Olivine tholeiite (Olivine Basalt).

Typical tertiary basaltic successions

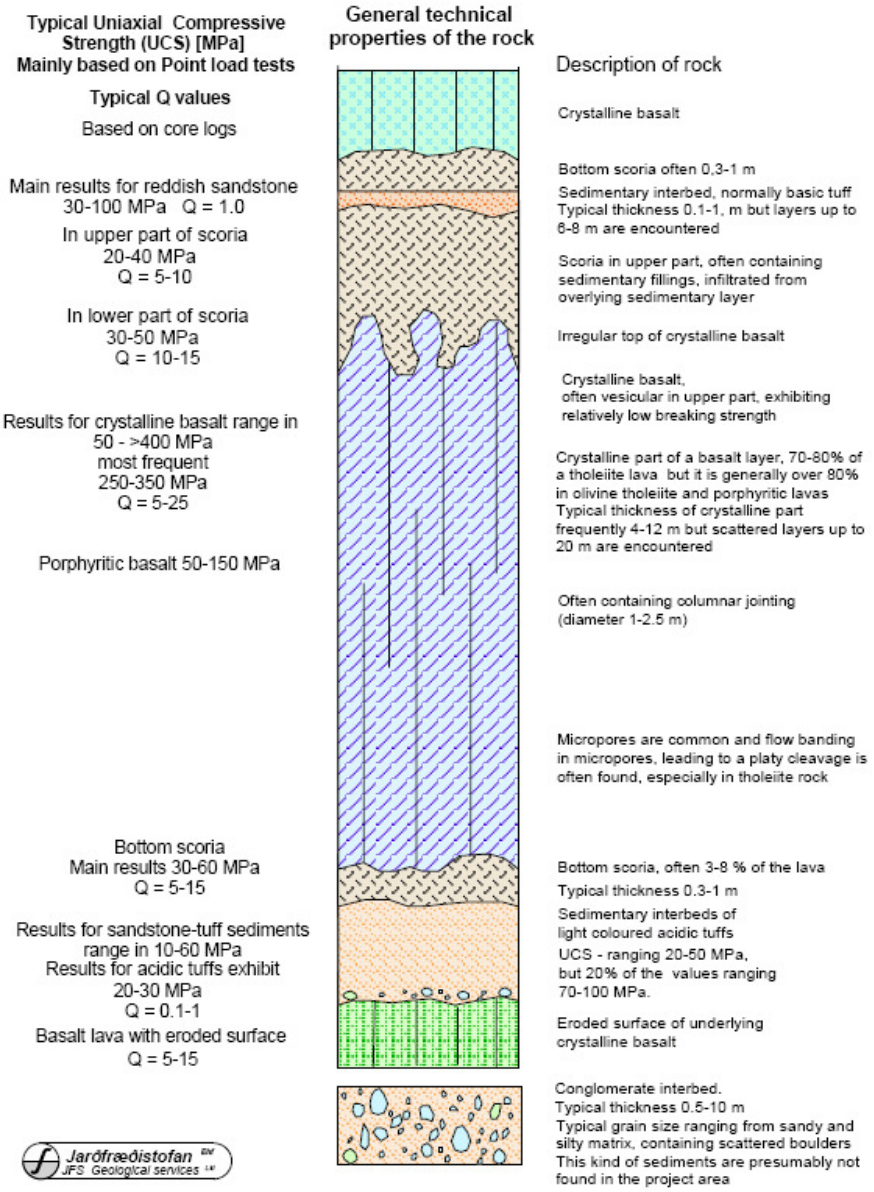


Figure 1-1. Typical sequence of rock units in Tertiary basaltic successions in eastern Iceland [Contract Documents KAR-14, 2003].

Difference between Tholeiite & Olivine Tholeiite

Tholeiite	**Olivine tholeiite (olivine basalt)**
Very fine grained	Coarse grained
Free olivine crystals are absent	Free olivine crystals visible
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 rather without zeolites	Amygdales bear zeolites
Well developed flow structures	Less developed structures within flows
Microspores often arranged along sub horizontal surface with spacing < 1 cm resulting in faint cleavage	Microspores randomly scattered throughout the mass
Scoriaceous part of tholeiite basalt 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 both compound and single lava flows
Average thickness of lava flows:11 m	Average thickness of lava flows:10 m
Average width of columns: 2 m	Average width of columns: 1,5-2 m
Hardness of the dense matrix: I to II*	Hardness of the dense matrix: II*

*Hardness scale ISRM (1975)

Table 1: Comparison of typical characteristic of Tholeiite and Olivine basalt [Contract Documents KAR-14, 2003].

2. Appendix – Búðarháls project overview

This appendix contains information on the Búðarháls hydropower project and geology.

- Overview of Búðarháls project area.
- Búðarháls project area, overview with boreholes.
- Headrace tunnel -Tectonic fractures and boreholes.
- Headrace tunnel – Geology –Boreholes map and longitudinal section.
- Headrace tunnel – Geology – Stratigraphy of boreholes.
- Headrace tunnel – Geology – Stratigraphy of boreholes.
- Designed rock support classes for Búðarháls headrace tunnel.

[Contract documents BUD-01-Draft, 2009]

Overview of Búðarháls project area

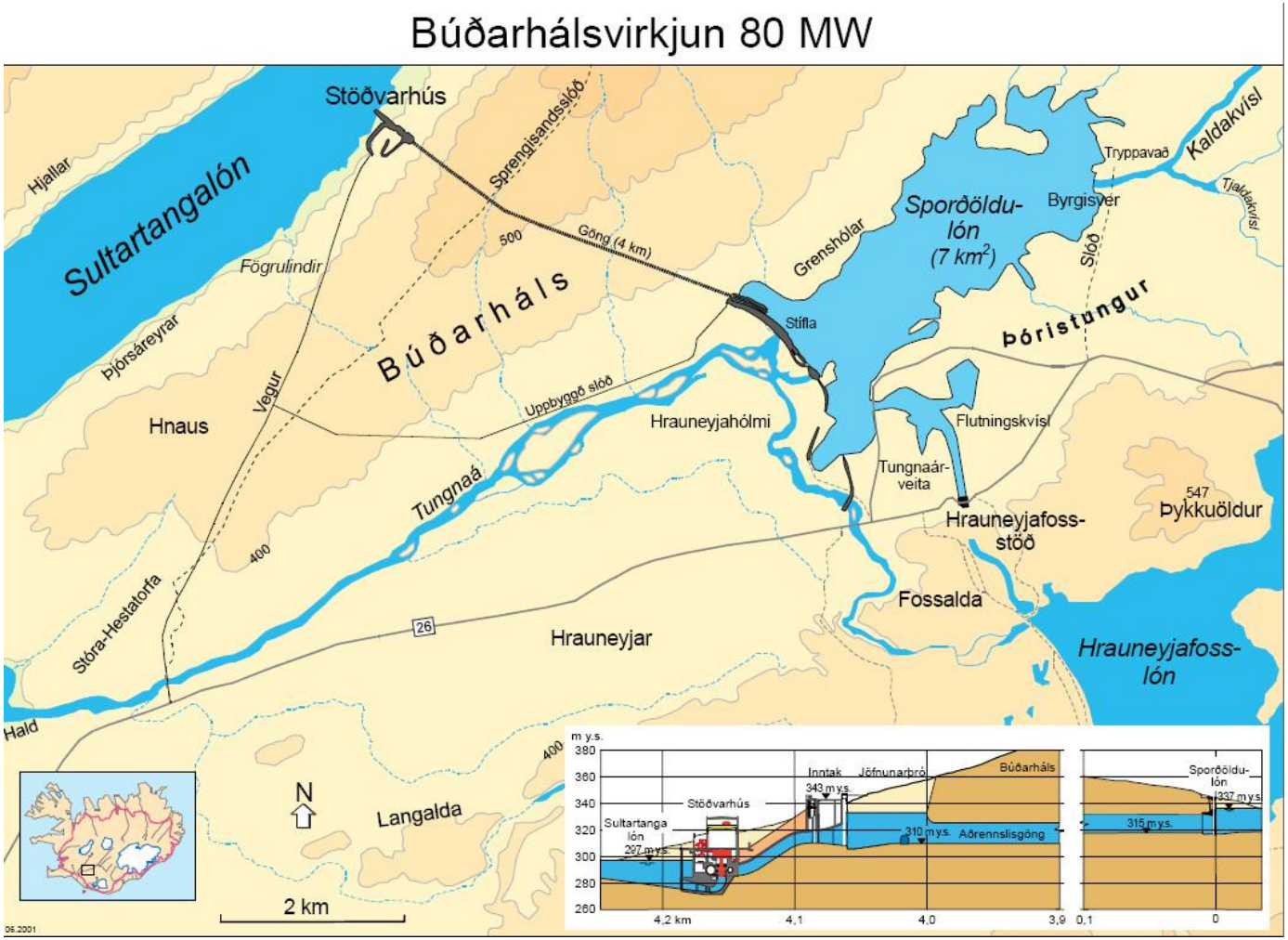


Figure 2-1. [Landsvirkjun, 2009]

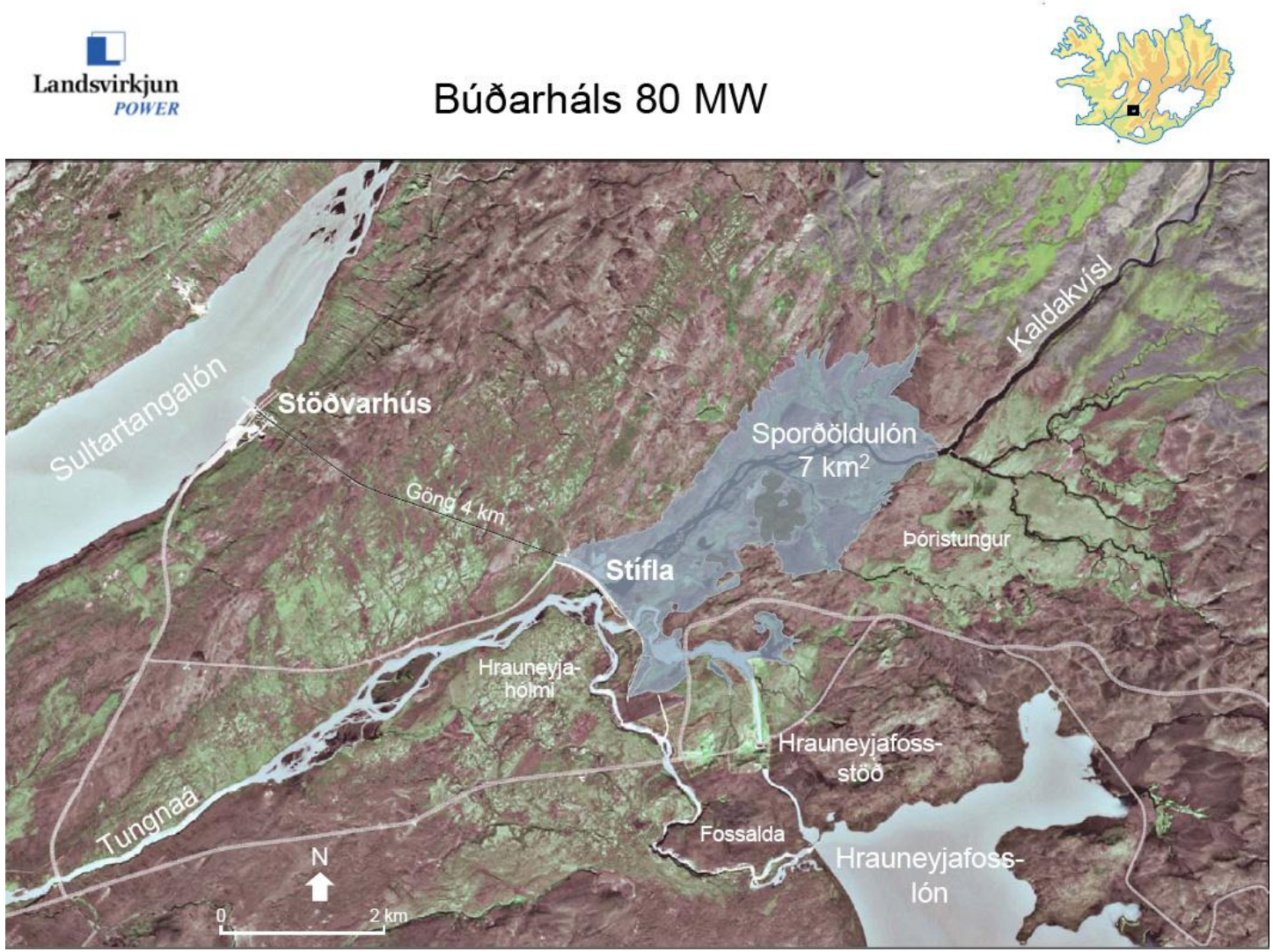


Figure 2-2. [Landsvirkjun, 2009]

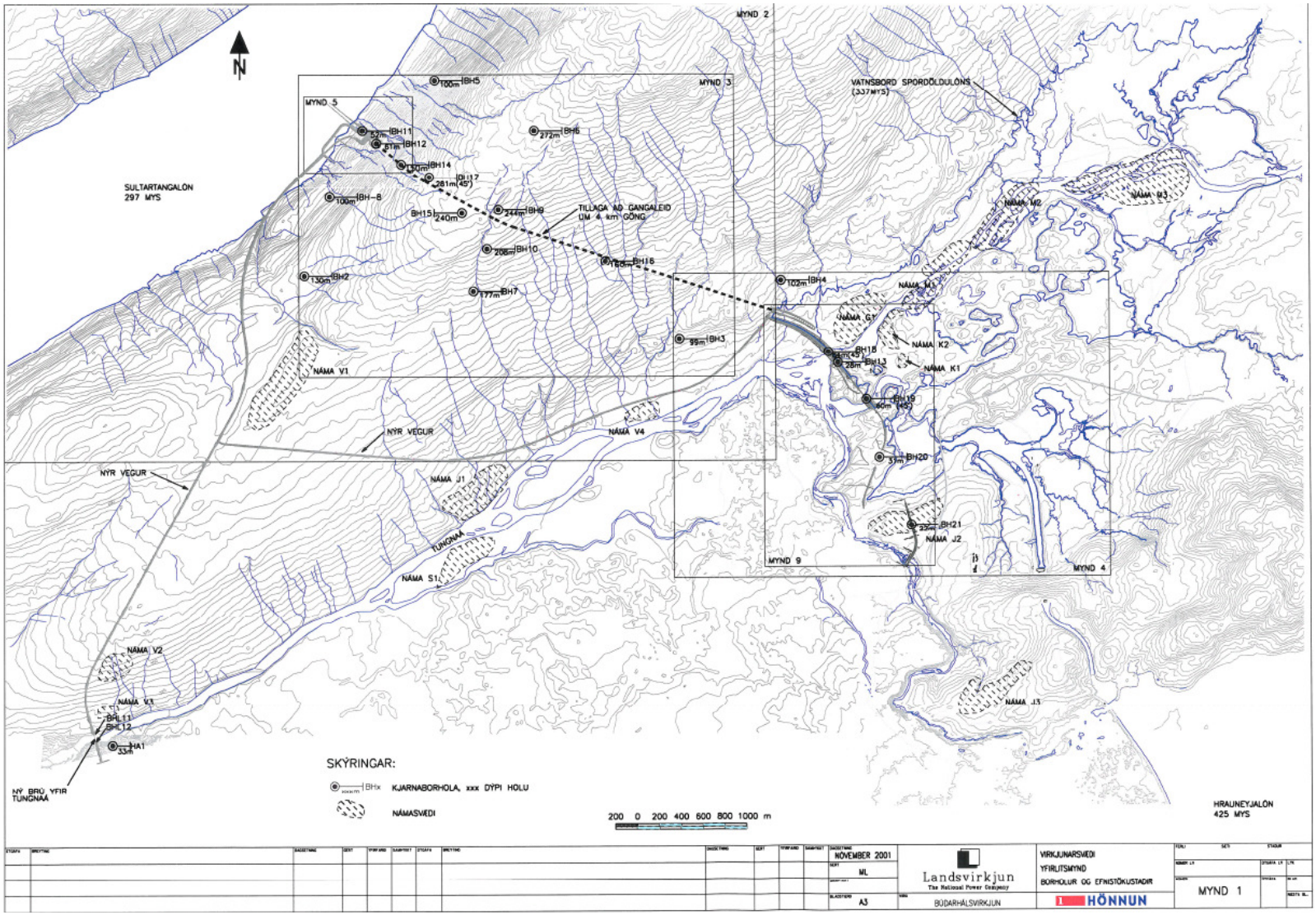


Figure 2-3. Búðarháls project area, overview with boreholes [Hönnun, 2001].

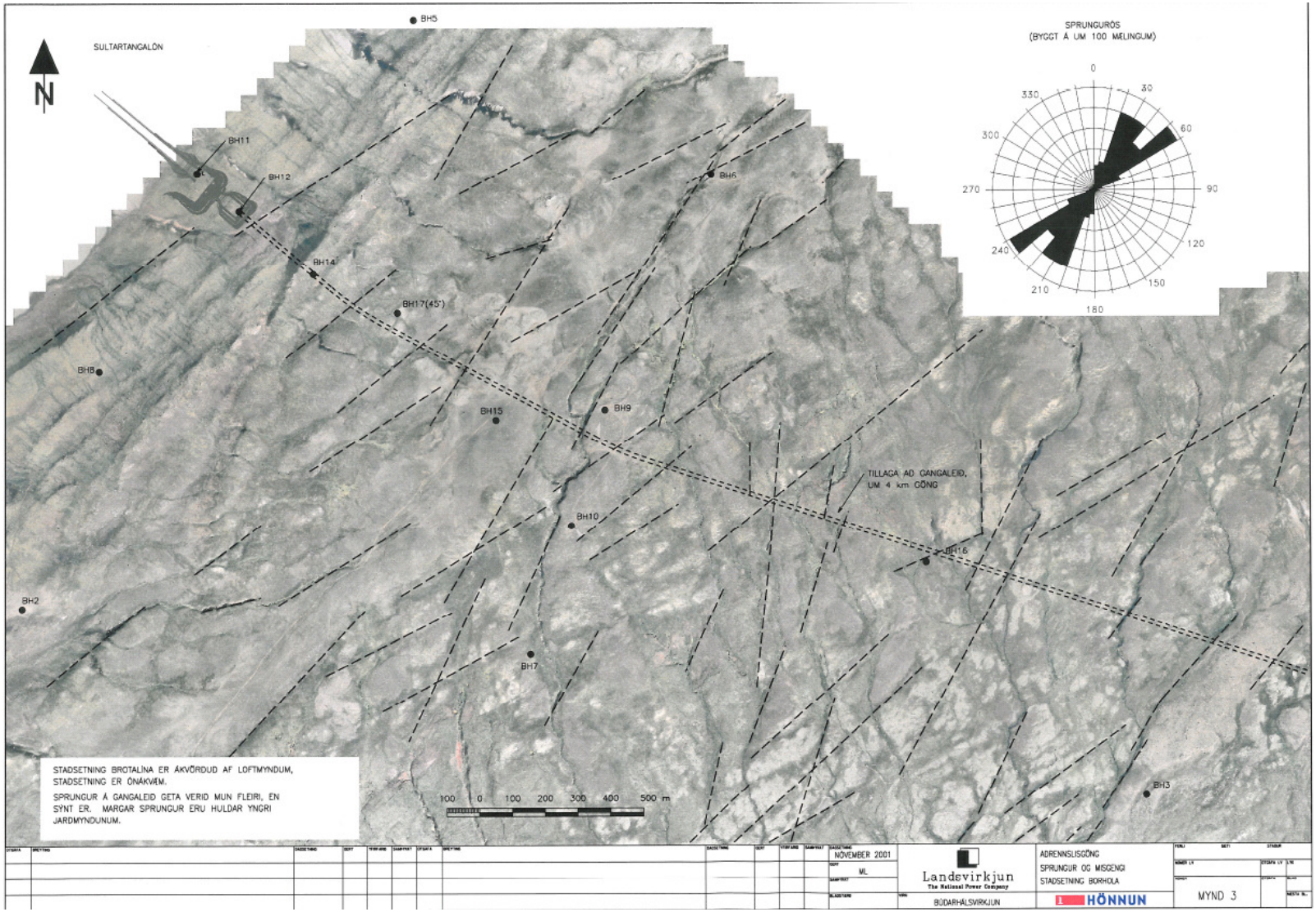


Figure 2-4. Headrace tunnel -Tectonic fractures and boreholes [Hönnun, 2001].

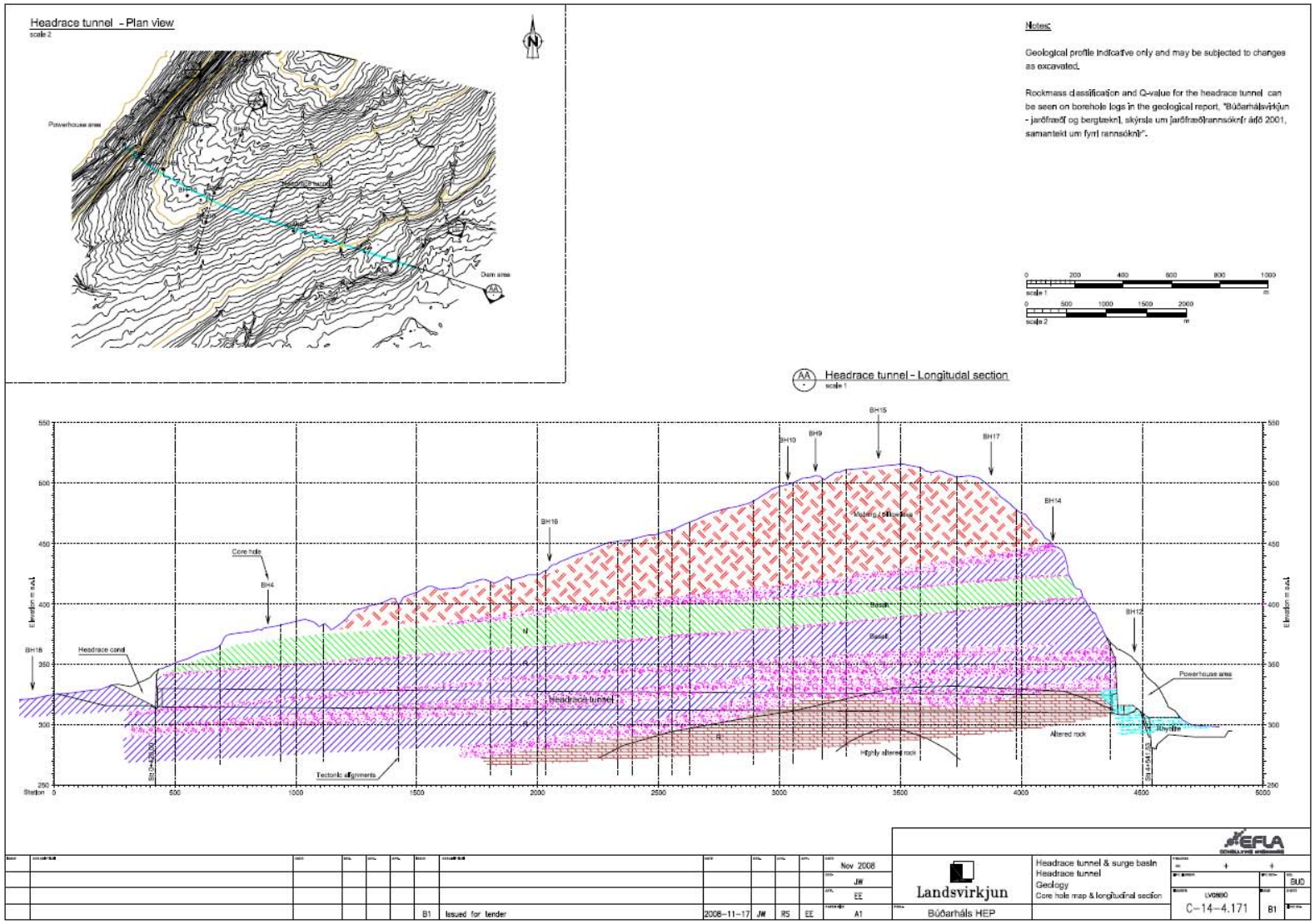


Figure 2-5. Headrace tunnel – Geology –Boreholes map and longitudinal section [Contract documents BUD-01-Draft, 2009].

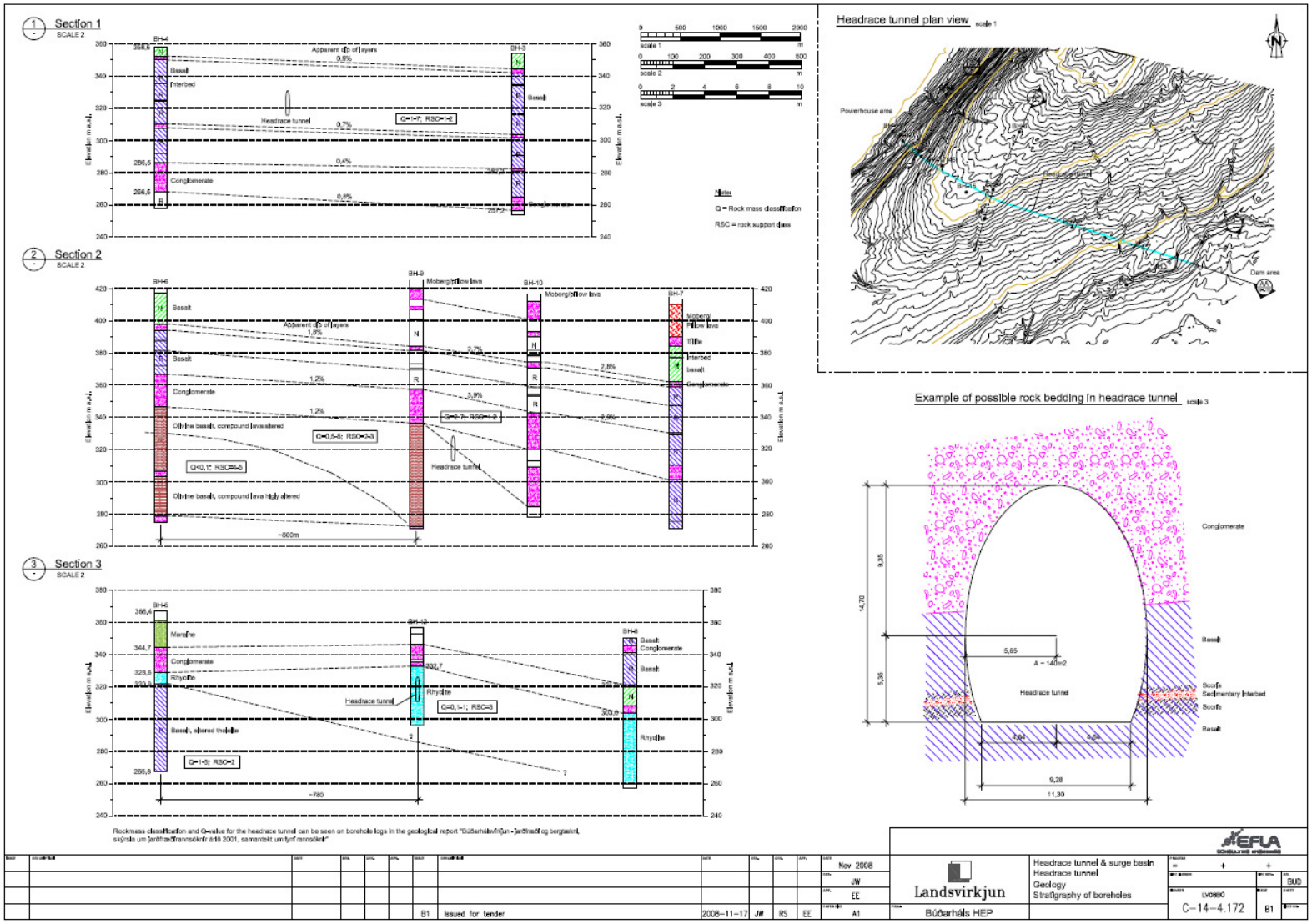


Figure 2-6. Headrace tunnel – Headrace tunnel – Geology – Stratigraphy of boreholes [Contract documents BUD-01-Draft, 2009].

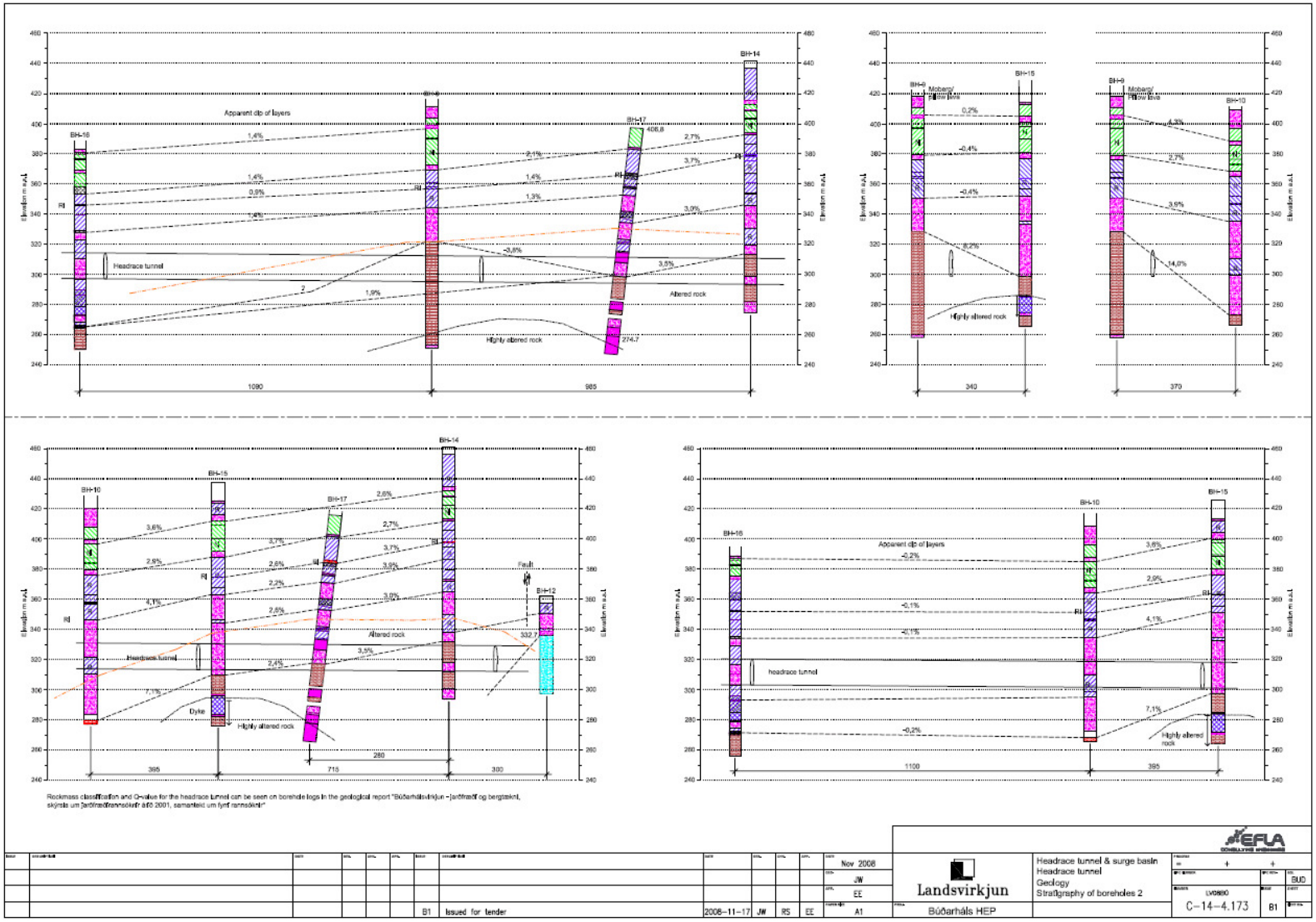


Figure 2-7. Headrace tunnel – Headrace tunnel – Geology – Stratigraphy of boreholes [Contract documents BUD-01-Draft, 2009].

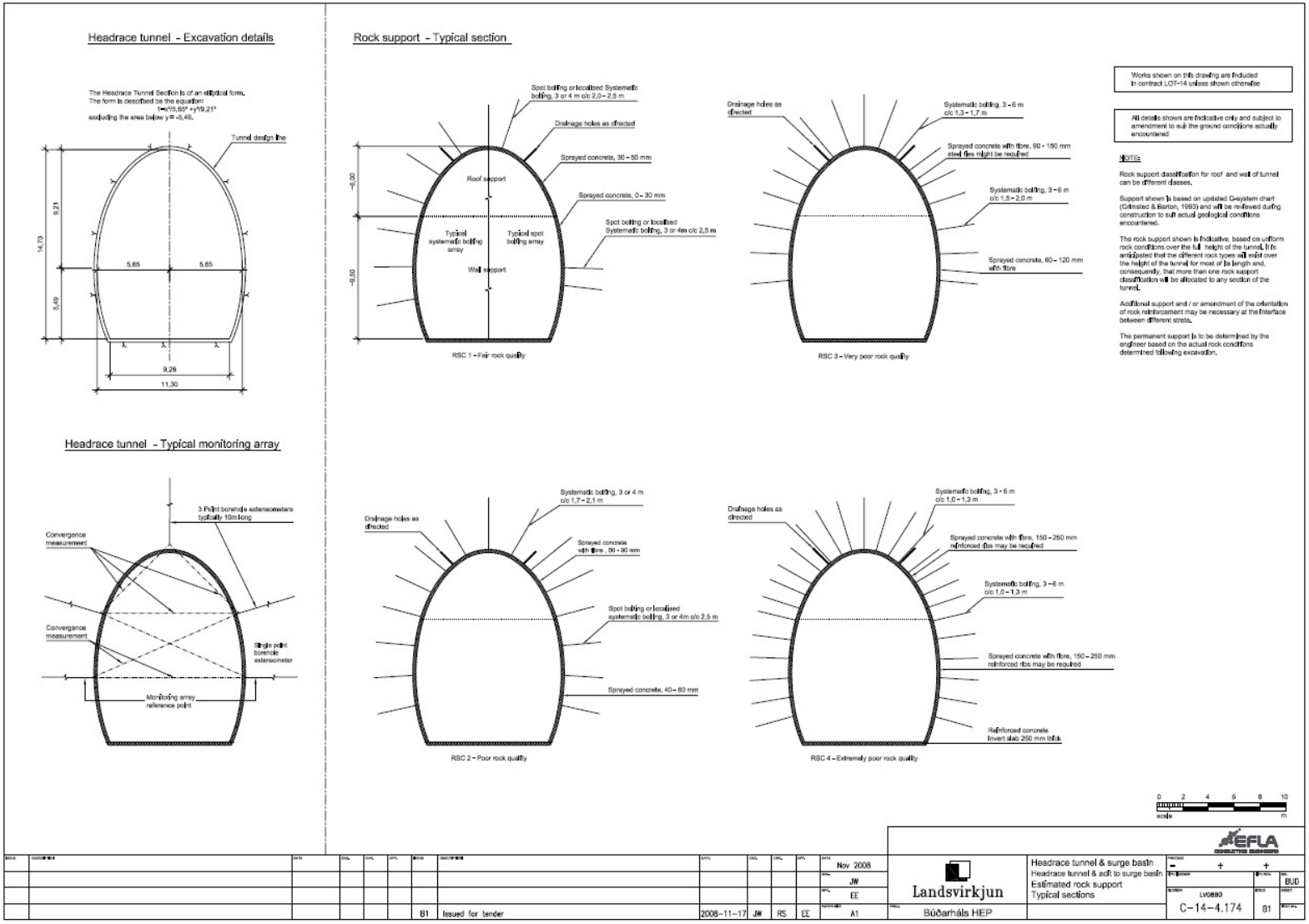


Figure 2-8. Headrace tunnel – Designed rock support classes for Búðarháls headrace tunnel [Contract documents BUD-01-Draft, 2009].

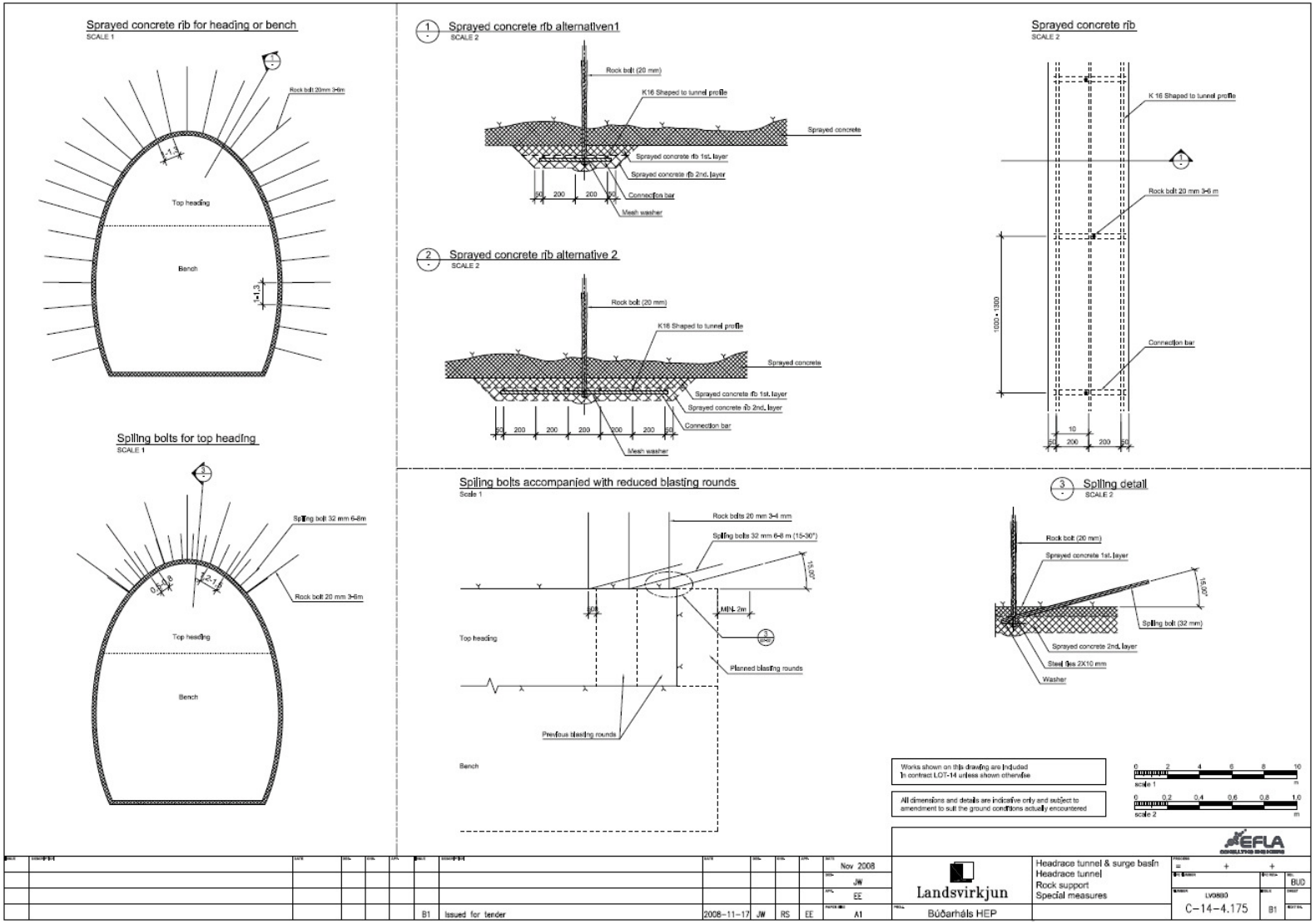


Figure 2-9. Headrace tunnel – Designed rock support classes for Búðarháls headrace tunnel [Contract documents BUD-01-Draft, 2009].

3. Appendix – Previous test results and core logs

This appendix contains results from previous investigation done in Búðarháls. Rock quality evaluation, Point load tests from Hönnun 2001 and additional test results from 2002. Also core logs from boreholes used in the investigation are presented here.

- Rock Mass Classification and Point Load test results at Búðarháls.
- Uniaxial Compression test results from Búðarháls 2002.
- Core logs –from boreholes BH-9, BH-11, BH -12, BH-15 and BH-16.

Rock Mass Classification and Point load test results at Búðarháls

Borhola nr: **BH-9**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load prófanir (MPa) $I_{50\perp}$	$I_{50\parallel}$	$I_{50meðal}$	Anisotropy Stuðull f_A	Reiknaður einása styrkur (= K_{50} * I_{50}) K_{50}	$\sigma_\perp$	$\sigma_\parallel$	Slake-Durability (ein umferð)
93,4 - 100,7	Sandsteinn/Siltsteinn	2,5 - 3,3	90%	9	1,0	3,0 - 4,0	1,0	1,0								
98,4 - 98,9	Sandst.völub. með stórum völum. Skolvatn við SD prófun verður ljósgrátt en gegnsætt.								2,4	2,6	2,5	1,1	14	33	36	98,8%
100,7 - 104,9	Basalt	4,0 - 6,0	90%	9 - 12	2,0	4,0	1,0	1,0								
104,9 - 107,2	Sandsteinsvöluberg	2,1 - 2,8	75%	9	1,0	3,0 - 4,0	1,0	1,0	Skolvatn verður gráskýjað við SD prófun.							
105,1 - 105,4	Aðalega sandsteinn í grunni. Greinilegir leirfylltir ummyndunarbrestir í smáum mælikvarða.								2,2	2,0	2,1	0,9	14	31	27	97,2%
107,2 - 109,0	Kargi	6,3	90%	9	2,5	4,0	1,0	1,0								
109,0 - 113,0	Basalt	4,2	100%	12	2,0	4,0	1,0	1,0								
113,0 - 113,5	Kargi	4,0	80%	15	3,0	4,0	1,0	1,0								
113,5 - 114,2	Rautt millilag	4,7	85%	9	2,0	4,0	1,0	1,0								
114,2 - 115,4	Kargi	4,5	90%	15	3,0	4,0	1,0	1,0								
115,4 - 128,0	Basalt	5,0	90%	12	2,0	3,0	1,0	1,0								
128,0 - 129,8	Kargi	6,0	90%	15	3,0	3,0	1,0	1,0								
129,8 - 132,6	Sandsteinsvöluberg	4,5 - 6,0	80%	9	2,0	3,0 - 4,0	1,0	1,0								
131,8 - 132,0									0,9				14	13		
132,6 - 140,6	Basalt	5,3 - 7	95%	9 - 12	2,0	3,0	1,0	1,0								
138,4 - 138,6									7,4				20	148		
140,6 - 142,4	Kargi	6,3	95%	15	3,0	3,0	1,0	1,0								
142,4 - 143,5	Basalt	8,0	90%	9	2,0	2,5	1,0	1,0								
143,5 - 144,0	Rautt millilag	1,7	40%	9	1,5	4,0	1,0	1,0								
143,6 - 143,7									0,7	0,7	0,7	1,0	14	9	10	
144,3 - 146,4	Kargi	4,7	85%	15	2,5	3,0	1,0	1,0								
146,4 - 153,1	Basalt	2,5	90%	12	1,0	3,0	1,0	1,0								
153,1 - 155,6	Kargi	0,4	23%	15	1,0	4,0	1,0	1,0								
155,6 - 156,5	Basalt	1,5	90%	15	1,0	4,0	1,0	1,0								
156,5 - 164,0	Völuberg	5,6	100%	9	1,5	3,0	1,0	1,0								
160,5 - 160,8											2,6		14			
165,3 - 165,6	Aðalega sandsteinn í grunni. Skolvatn verður gráskýjað við SD prófun.								2,7	3,3	3,0	1,2	14	37	46	97,8%
164,0 - 176,0	Siltsteinslinsur	2,2	100%	9	1,5	3,0	1,0	2,5								
176,0 - 177,4	Völuberg	5,6	100%	9	1,5	3,0	1,0	1,0								
177,4 - 180,7	Kargi	2,0	60%	15	2,0	4,0	1,0	1,0								

Borhola nr: **BH-9**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load prófanir (MPa) $I_{50\perp}$	$I_{50\parallel}$	$I_{50meðal}$	Anisotropy Stuðull f_A	Reiknaður einása styrkur (= K_{50} * I_{50}) K_{50}	$\sigma_\perp$	$\sigma_\parallel$	Slake-Durability (ein umferð)
178,6 - 178,9	Sundurlaus og morkinn kargi með einum heilum bita								2,6	2,8	2,7	1,1	14	36	39	
180,7 - 187,9	Basalt	4,2 - 5,0	60%	9	3,0 - 2,5	4,0	1,0	1,0								
187,4 - 187,6	Sterklegt smákornótt basalt og lítill leir sjáanlegur.								7,0	7,1	7,0	1,0	20	140	142	
187,9 - 192,6	Kargi	2,2	40%	9	2,0	4,0	1,0	1,0								
192,6 - 199,5	Basalt	5,0	90%	9	2,0	4,0	1,0	1,0								
199,5 - 202,4	Kargi	0,8	20%	12	2,0	4,0	1,0	1,0								
200,3 - 200,6	Mjög morkinn og ummyndaður, mestur hluti kjarna molnar í sundur án nokkurs viðnáms.										0,5		14			
202,4 - 208,7	Basalt	2,4 - 4,7	85%	9	2,0	4,0 - 8,0	1,0	1,0								
204,6 - 205,0	Nokkuð heillegt og ummyndað basalt með þenjanlegum leir á sprunguflötum.								2,7	2,4	2,5	0,9	14	38	33	
208,7 - 209,9	Kargi	2,1	50%	12	2,0	4,0	1,0	1,0								
209,5 - 209,6	Morkinn og ummyndaður kargi.										1,7		14			
209,9 - 212,4	Basalt	2,1 - 4,2	75%	9	2,0	4,0 - 8,0	1,0	1,0								
212,4 - 213,5	Kargi	1,7	40%	12	2,0	4,0	1,0	1,0								
213,5 - 217,9	Basalt	2,4 - 4,7	85%	9	2,0	4,0 - 8,0	1,0	1,0								
217,9 - 218,4	Kargi	0,3	5%	15	3,0	4,0	1,0	1,0								
218,4 - 222,0	Basalt	5,6 - 7	80%	9	2,5	3,0 - 4,0	1,0	1,0								
220,3 - 220,6	Bæði heillegt og sterklegt berg.								4,1	4,0	4,0	1,0	16	65	56	
222,0 - 222,8	Kargi	3,1	50%	12	3,0	4,0	1,0	1,0								
222,4 - 222,6									2,4	2,3	2,3	1,0	14	34	32	
222,8 - 226,0	Basalt	6	70%	9	3,0	4,0	1,0	1,0								
226,0 - 227,0	Kargi	0,1	5%	15	1,0	4,0	1,0	1,0								
227,0 - 240,0	Basalt	3,3 - 4,4	60%	9	2,0	3,0 - 4,0	1,0	1,0								
240,0 - 241,4	Kargi	3,3	30%	9	3,0	3,0	1,0	1,0								
241,4 - 243,6	Völuberg	1,1	40%	9	1,0	4,0	1,0	1,0								
243,0 - 243,4	Aðallega siltsteinn. Skolvatn dökkbrúnt að lit, þykkt lag af bergmylsnu í botni.								0,5	0,5	0,5	1,1	14	7	7	52,5%
																Önnur umferð => 25%

Rock Mass Classification, Point Load and Slaking Durability tests. The Point Load is achieved using an average of 10 samples which are both tested perpendicular and parallel to the core. The point load tests are converted to Uniaxial Compression strength according to Norsk Bergmekanikk Gruppe (NBG 200). The multiplication factor K is higher as the rock gets stronger.

Borhola nr: **BH-10**

Dýpi (m)	Berggerð	-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load prófanir (MPa) $I_{50\perp}$	$I_{50\parallel}$	$I_{50\text{meðal}}$	Anisotropy Stuðull f_A	Reiknaður einása styrkur ($= K_{50} * I_{50}$) K_{50}	$\sigma_\perp$	$\sigma_\parallel$	Slake-Durability (ein umferð)
73,8 - 84,9	Völuberg	2,5 - 3,8	45%	9	1,5	2,0 - 3,0	1,0	1,0								
80,4 - 80,7									0,9	0,9	0,9	1,0	14	13	13	
84,9 - 86,5	Kargi	2,7	40%	15	3,0	3,0	1,0	1,0								
86,5 - 91,6	Basalt	1,9 - 2,9	35%	12	3,0 - 2,0	3,0	1,0	1,0								
91,6 - 92,8	Kargi	2,0	30%	15	3,0	3,0	1,0	1,0								
92,8 - 95,6	Völuberg	2,5 - 4,4	60%	9	1,5 - 2,0	3,0 - 4,0	1,0	1,0								
94,7 - 94,9	Völuberg með sand og silt í grunni. Skolvatn dökkbrúnt, skítugt og ógegnsætt.										0,9		14	13	0	98,0%
95,6 - 96,0	Kargi	6,7	100%	15	3,0	3,0	1,0	1,0								
96,0 - 102,2	Basalt	3,0	45%	12	2,0	2,5	1,0	1,0								
102,2 - 105,3	Kargi	2,7 - 3,3	40%	12 - 15	3,0	3,0	1,0	1,0								
105,3 - 107,1	Basalt	2,8	50%	12	2,0	3,0	1,0	1,0								
107,1 - 107,7	Völuberg	2,7	65%	9	1,5	4,0	1,0	1,0								
107,4 - 107,4	Grófsandsteinsvöluberg. Sundurlaus mulningur og brotnar auðveldlega niður við SD prófun.										0,2		14	3		65,1%
107,7 - 110,0	Basalt	1,7 - 2,8	25%	9 - 12	2,0	2,0 - 2,5	1,0	1,0								
110,0 - 111,1	Kargi	1,4	25%	12	2,0	3,0	1,0	1,0								
111,1 - 115,2	Völuberg	3,1 - 4,1	55%	9	2,0	3,0 - 4,0	1,0	1,0								
111,8 - 112,1	Sandsteinn í grunni. Vatnið litast dökk grátt og er ógegnsætt. Bergmylsna í botni kassa.										2,0		14	28		95,1% 93,6%
115,2 - 121,6	Basalt	2,8	40%	12	2,5	3,0	1,0	1,0								
121,6 - 123,6	Basalt	1,1	40%	12	2,5	3,0	1,0	2,5	Tektoniskar spr.							
123,6 - 127,3	Basalt	2,8	40%	12	2,5	3,0	1,0	1,0								
127,3 - 131,0	Kargi	3,8	55%	12	2,5	3,0	1,0	1,0								
131,0 - 131,8	Basalt	5,6	50%	9	2,5	2,5	1,0	1,0								
131,8 - 132,0	Kargi	13,3	100%	9	3,0	2,5	1,0	1,0								
132,0 - 132,5	Basalt	13,2	95%	9	2,5	2,0	1,0	1,0								
132,5 - 135,2	Kargi	11,7	70%	9	3,0	2,0	1,0	1,0								
135,2 - 143,0	Dílabasalt	3,3 - 4,4	60%	9 - 12	2,0	3,0	1,0	1,0								
143,0 - 158,2	Völuberg	6,7	80%	9	1,5	2,0	1,0	1,0								
147,1 - 147,3	Sandsteinn í grunni. Vatnið litast dökk grátt og er ógegnsætt við SD prófun.								2,4	2,3	2,4	1,0	14	34	33	94,8% 92,8%
158,2 - 159,2	Leirlinsur	2,7	80%	9	1,5	2,0	1,0	2,5								

Borhola nr: **BH-10**

Dýpi (m)	Berggerð	-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load prófanir (MPa) $I_{50\perp}$	$I_{50\parallel}$	$I_{50\text{meðal}}$	Anisotropy Stuðull f_A	Reiknaður einása styrkur (= K_{50} * I_{50}) K_{50}	$\sigma_\perp$	$\sigma_\parallel$	Slake-Durability (ein umferð)
159,2 - 165,7	Völuberg	6,7	80%	9	1,5	2,0	1,0	1,0								
165,7 - 172,0	Basalt	6,6 - 9,5	95%	12	3,0 - 2,5	2,5 - 3,0	1,0	1,0								
172,0 - 173,0	Kargi	2,6 - 3,8	95%	12	3,0 - 2,5	2,5 - 3,0	1,0	2,5								
	Með siltsteinslinsu (15 cm)															
173,0 - 179,6	Basalt	7,9 - 9,5	95%	12	3,0	2,5 - 3,0	1,0	1,0								
179,6 - 200,3	Völuberg	5,3	95%	9	1,5	3,0	1,0	1,0								
184,9 - 185,3	Hátt hlutfall siltsteins í sandsteinsvölubergi. Dökkbrúnt skýjað vatn, ógegnsætt.								2,0	1,7	1,8	0,9	14	27	24	99,3%
196,2 - 196,5	Við SD próf verður skolvatn mórautt.								0,7	0,6	0,6	0,8	14	10	8	97,8%
200,3 - 201,3	Leirlinsur	2,1	95%	9	1,5	3,0	1,0	2,5								
201,3 - 206,2	Basalt	11,1 - 13,9	100%	9	2,5	2,0 - 2,5	1,0	1,0								
206,2 - 206,9	Kargi	13,3	100%	12	4,0	2,5	1,0	1,0								
206,9 - 207,6	Basalt	13,2	95%	9	2,5	2,0	1,0	1,0								

Borhola nr: **BH-11**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load prófanir (MPa) $I_{50\wedge}$ $I_{50úú}$ $I_{50meðal}$	Anisotropy Stuðull f_A	Reiknaður einása styrkur (= K_{50} * I_{50}) K_{50} $\sigma_\perp$ $\sigma_\parallel$	Slake-Durability (ein umferð)
2,8 - 6,1	Líparít	0,3	5%	15	1,5	2,0	1,0	1,0				
8,8 - 13,9	Líparít	5,4	65%	12	2,0	2,0	1,0	1,0				
13,9 - 23,0	Líparít	3,3	60%	12	2,0	3,0	1,0	1,0				
16,2 - 16,4									5,4		16 86,4	
23,0 - 30,7	Líparít	3,9 - 5,8	70%	12	2,0	2,0 - 3,0	1,0	1,0				
30,7 - 39,7	Líparít	3,6 - 5,4	65%	12	2,0	2,0 - 3,0	1,0	1,0				
36,8 - 37,1									1,3		14 18,2	
39,7 - 51,6	Líparít	3,3 - 5,0	60%	12	2,0	2,0 - 3,0	1,0	1,0				
51,1 - 51,3									1,9		14 26,6	

Borhola nr: **BH-12**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load prófanir (MPa) $I_{50\wedge}$ $I_{50úú}$ $I_{50meðal}$	Anisotropy Stuðull f_A	Reiknaður einása styrkur (= K_{50} * I_{50}) K_{50} $\sigma_\perp$ $\sigma_\parallel$	Slake-Durability (ein umferð)
6,0 - 10,6	Basalt	9,4	85%	9	3,0 - 2,0	3,0	1,0	1,0				
10,6 - 20,0	Völuberg	5,6	75%	9	2,0	3,0	1,0	1,0				
11,8 - 12,0	Mórautt skolvatn								1,5		14 21	96,2%
20,0 - 21,0	Basalt irnskot	4,0 - 5,0	60%	12 - 15	2,5	2,5	1,0	1,0	Mjög brotið berg.			
21,0 - 24,3	Sandsteinsvöluberg	0,4 - 0,6	5%	9	2,0	2,0 - 3,0	1,0	1,0				
21,7 - 21,8	Tiltölulega hreint skolvatn.								0,8		14 11,2	96,7%
24,3 - 30,7	Líparít	0,3 - 0,4	10%	15 - 20	2,0 - 1,5	3,0	1,0	1,0	Mjög brotið berg.			
30,7 - 34,0	Líparít	0,7 - 0,7	15%	15	2,0 - 1,5	3,0 - 3,0	1,0	1,0	Bergið verður heillegra.			
41,5 - 41,8	Dulkorna líparít, mjög laust í sér. Vatnið verður hvítt og ógegnsætt við SD prófun.								0,7 0,6 0,7	1,0	14 9,4 9	95,3%
34,0 - 60,4	Líparít	2,7 - 3,6	80%	15	2,0 - 1,5	3,0	1,0	1,0	Enn minna brotið en ofar.			
60,0 - 60,3									0,8		14 11,2	

Borhola nr: **BH-13**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load prófanir (MPa) $I_{50\perp}$ $I_{50\parallel}$ $I_{50meðal}$	Anisotropy Stuðull f_A	Reiknaður einása styrkur (= K_{50} * I_{50}) K_{50} $\sigma_\perp$ $\sigma_\parallel$	Slake-Durability (ein umferð)
3,0 - 9,6	Basalt	4,7 - 6,2	70%	9 - 12	2,0	2,5	1,0	1,0				
9,6 - 11,2	Basalt	8,4	95%	9	2,0	2,5	1,0	1,0				
11,2 - 13,2	Basalt	3,6	40%	9	2,0	2,5	1,0	1,0				
13,4 - 27,7	Basalt-Dílabasalt	10	90%	9	2,0	2,0	1,0	1,0				

Borhola nr: **BH-14**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load I_{50} (MPa)	Reiknað σ = K_{50} * I_{50} K_{50} σ	Einása-brotþol UCS	Slake-Durability INDEX (Id2)
2,5 - 17,5	Basalt	5 - 7	100%	10	1,5 - 2,0	3,0	1,0	1,0				
17,5 - 17,8	Sand/siltsteinn		100%									
17,8 - 19,0	Basalt	10	100%	10	3,0	3,0	1,0	1,0				
19,0 - 22,1	Basalt	6	95%	10	2,0	3,0	1,0	1,0				
22,1 - 22,6	Kargi	5	55%	12	3,0	3,0	1,0	1,0				
22,6 - 22,9	Sand/siltsteinn	2	45%	9	1,0	3,0	1,0	1,0				
22,9 - 24,8	Völuberg	7	95%	9	2,0	3,0	1,0	1,0				
24,8 - 25,4	Kargi	7	100%	9	2,0	3,0	1,0	1,0				
25,4 - 26,1	Basalt	6	80%	12	2,5	3,0	1,0	1,0				
26,1 - 28,2	Basalt	3	60%	12	2,0	3,0	1,0	1,0				
28,2 - 29,0	Sandsteinsvöluberg	6	75%	9	2,0	3,0	1,0	1,0				
29,0 - 30,0	Basalt	4	85%	12	2,0	4,0	1,0	1,0				
30,0 - 30,7	Kargi	5 - 6	90%	12	2,5	3,0 - 4,0	1,0	1,0				
30,7 - 33,7	Basalt	5	90%	12	2,0	3,0	1,0	1,0				
33,7 - 33,9	Setfyllt sprunga		5%									
33,9 - 41,8	Basalt	6	85%	10	2,0	3,0	1,0	1,0				
41,8 - 42,4	Kargi	8	65%	12	3,0	2,0	1,0	1,0				
42,4 - 43,2	Sandsteinn	5	90%	9	1,5	3,0	1,0	1,0				
43,2 - 43,9	Völuberg	7	90%	9	2,0	3,0	1,0	1,0				
43,9 - 44,6	Kargi	6	55%	10	3,0	3,0	1,0	1,0				
44,6 - 44,7	Sand/siltsteinn		85%									
44,7 - 46,7	Kargi	2	60%	10	1,0	4,0	1,0	1,0				
46,7 - 49,4	Basalt	6	95%	10	2,0	3,0	1,0	1,0				
49,4 - 49,5	Sand/siltsteinn		5%									
49,5 - 56,4	Basalt	3 - 9	85%	10	1,5 - 3,0	3,0 - 4,0	1,0	1,0				
56,4 - 56,5	Kargi		100%				1,0	1,0				
56,5 - 57,1	Rautt millilag	6	55%	12	4,0	3,0	1,0	1,0				
57,1 - 59,8	Kargi	8	85%	15	4,0	3,0	1,0	1,0				
59,8 - 61,0	Basalt	1	50%	12	1,0	4,0	1,0	1,0				
61,0 - 63,5	Basalt	4	80%	10	1,5	3,0	1,0	1,0				

Borhola nr: **BH-14**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load I_{50} (MPa)	Reiknað σ = K_{50} * I_{50} K_{50}	σ	Einása-brotþol UCS	Slake-Durability INDEX (Id2)
63,5 - 66,5	Basalt	5	75%	10	2,0	3,0	1,0	1,0					
66,5 - 67,5	Basalt	6 - 10	95%	10	2,0 - 3,0	3,0	1,0	1,0					
67,5 - 68,0	Kargi	7	100%	10	2,0 -	3,0	1,0	1,0					
68,0 - 73,0	Basalt	7	95%	9	2,0 -	3,0	1,0	1,0					
73,0 - 77,0		3	50%	12	2,5 -	3,0	1,0 1,0	1,0 1,0					
77,0 - 79,1		1,0 - 1,3	40%	12 - 15	1,5 -	4,0	1,0	1,0					
79,1 - 79,3	Sandsteinn		50%										
79,3 - 80,1	Basalt	11	100%	9	2,0	2,0	1,0	1,0					
80,1 - 81,0	Völuberg	6	75%	9	2,0	3,0	1,0	1,0					
81,0 - 81,4	Basalt	7	100%	9	2,0	3,0	1,0	1,0					
81,4 - 81,5	Völuberg		5%										
81,5 - 87,9	Basalt	5	95%	12	2,0	3,0	1,0	1,0					
87,9 - 89,9	Sandsteinn (m. siltst. og völum	5	95%	9	1,5	3,0	1,0	1,0					
89,9 - 90,2	Sandsteinn	2	95%	9	1,5	3,0	1,0	2,5					
90,2 - 91,6	Sandsteinn	1,2	80%	9	1,0	3,0	1,0	2,5					
91,6 - 92,6	Sandsteinsvöluberg	3	90%	9	2,0	3,0	1,0	2,5					
92,55-93,20 siltlinsa í völubergi, veikari en völuberg									0,9	14	13		
93,2 - 96,8	Sandsteinsvöluberg	3 - 7	90%	9	1,0 2,0	3,0 - 4,0	1,0	1,0					
96,2	Vel samlímt								3,4	14	48		
96,8 - 102,0	Siltsteinsvöluberg	7	100%	9	2,0	3,0 -	1,0	1,0					
100,09-100,61 vel samlímt									1,8	14	25		
101,62-102,03 Vel samlímt									2,2	14	31		
102,0 - 108,3	Basalt (Ólivínbasalt)	5 - 8	80%	10	2,0	2,0 - 3,0	1,0	1,0					
108,3 - 110,3	Basalt (Ólivínbasalt)	5	85%	12	2,0	3,0 -	1,0	1,0					
110,3 - 110,7	Kargi	0,5	70%	15	1,0	4,0 -	1,0	2,5					
110,7 - 112,6	Basalt (Ólivínbasalt)	8	95%	12	3,0	3,0 -	1,0	1,0					
112,6 - 114,0	Sandsteinsvöluberg	6	85%	9	2,0	3,0 -	1,0	1,0					
113,20-113,76 Vel samlímt									1,9	14	27		95,0%
114,0 - 114,5	Völuberg	3	40%	9	2,0	3,0 -	1,0	1,0					

Borhola nr: **BH-14**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load I_{50} (MPa)	Reiknað σ = K_{50} * I_{50} K_{50}	σ	Einása-brotþol UCS	Slake-Durability INDEX (I_{d2})
114,5 - 118,6	Völuberg	6	80%	9	2,0	3,0 -	1,0	1,0					
118,09-118,63									1,2	14	17		92,0%
118,6 - 118,9	Basalt (Ólivínbasalt)		75%										
118,9 - 119,0	Sandsteinn		100%										
119,0 - 120,5	Basalt (Ólivínbasalt)	4	60%	10	2,0	3,0	1,0	1,0					
120,5 - 122,5	Basalt (Ólivínbasalt)	2 - 3	60%	12 - 15	2,0	3,0 - 4,0	1,0	1,0					
122,5 - 124,3	Basalt (Ólivínbasalt)	5	65%	12	3,0	3,0	1,0	1,0					
124,3 - 124,6	Sandsteinn		100%										
124,6 - 125,6	Basalt (Ólivínbasalt)	1	35%	12	1,0	4,0	1,0	1,0					
125,6 - 131,7	Basalt (Ólivínbasalt)	6 - 8	78%	9 - 10	2,0 - 3,0	3,0	1,0	1,0					
131,7 - 133,0	Sandsteinn	4	80%	9	1,5	3,0	1,0	1,0					
133,0 - 133,5	Sandsteinn (illa samlímdur)	0,1	5%	9	1,0	4,0	1,0	1,0					
133,5 - 137,1	Sandsteinn	3 - 7	90%	9	1,0 - 2,0	3,0	1,0	1,0					
135,27-135,60									1,3	14	18		88,4%
136,0													93,9%
137,1 - 140,6	Basalt (Ólivínbasalt)	7 - 9	95%	9	2,5	3,0 - 4,0	1,0	1,0					
140,6 - 141,6	Kargi	7	85%	9	3,0	4,0	1,0	1,0					
141,6 - 144,9	Basalt (Ólivínbasalt)	9	80%	9	3,0	3,0	1,0	1,0					
144,9 - 147,6	Basalt (Ólivínbasalt, beltað)	7	90%	9	2,0	3,0	1,0	1,0					
147,6 - 149,4	Sandsteinsvöluberg (Kornborið)	5	65%	9	2,0	3,0	1,0	1,0					
149,4 - 150,5	Sandsteinsvöluberg (Grunnborið)	6	100%	9	1,5	3,0	1,0	1,0					

Borhola nr: **BH-15**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load I_{50} (MPa)	Reiknað σ = K_{50} * I_{50} K_{50}	σ	Einása-brotþol UCS	Slake-Durability INDEX (Id2)
87,2 - 97,9	Basalt	0,8 - 2	50%	12 - 15	1,5 - 2,0	3,0 - 4,0	0,66	1,0					
97,9 - 99,2	Sandsteinsvöluberg	3 - 4	55%	9 - 12	2,0	3,0	1,0	1,0					
99,2 - 106,8	Basalt (dílabasalt)	5	70%	12	2,5	3,0	1,0	1,0					
106,8 - 110,8	Sand- og siltsteinn	5	90%	9	1,5	3,0	1,0	1,0					
108,4									1,7	14	24		
110,8 - 112,8	Basalt	3 - 4	55%	12	2,0 - 2,5	3,0	1,0	1,0					
112,8 - 113,2	Kargi	-	50%										
113,2 - 119,4	Basalt	7 - 11	85%	10	2,5	2,0 - 3,0	1,0	1,0					
119,4 - 123,7	Kargi	7	85%	12	3,0	3,0	1,0	1,0					
123,7 - 129,3	Basalt	3	60%	12	2,0	3,0	1,0	1,0					
129,3 - 133,2	Völuberg	6	85%	9	2,0	3,0	1,0	1,0					
132,2									4,8	16	77		
133,2 - 135,1	Kargi	7	85%	12	3,0	3,0	1,0	1,0					
135,1 - 144,8	Basalt(dílabasalt)	4	60%	12	2,5	3,0	1,0	1,0					
144,8 - 146,6	Kargi	7	95%	12	2,5	3,0	1,0	1,0					
146,6 - 151,1	Basalt(dílabasalt)	5 - 7	85%	12	2,0	2,0 - 3,0	1,0	1,0					
151,1 - 153,2	Kargi	5	70%	12	2,5	3,0	1,0	1,0					
153,2 - 156,2	Basalt(dílabasalt)	9 - 11	85%	10 - 12	2,5	2,0	1,0	1,0					
156,2 - 171,8	Sandsteinsvöluberg	6	85%	9	2,0	3,0	1,0	1,0					
166,94-167,45									2,3	14	32		
171,44-171,66									3,4	16	54		97,1
171,8 - 174,0	Kargi(Siltfylltur)	11	95%	9	3,0	3,0	1,0	1,0					
174,0 - 178,7	Sandsteinsvöluberg	6 - 7	100%	9	1,5 - 2,0	3,0	1,0	1,0					
178,7 - 185,8	Völuberg	5 - 6	85%	9	1,5 - 2,0	3,0	1,0	1,0					
178,8	Vel samlímt								1,8	14	25		
179,0	Lla saml., vantar finefnabindingu. Brotnar niður í SD-prófi og grunnmassi skolast alveg burt.								0,2	14	3		(82%)
179,2	Lla samlímt völuberg, vantar finefnabindingu.								0,7	14	10		
182,0	Vel samlímt								4,8	16	77		97,5
181,1	Völuberg, grófsandsteinn í grunni											Í vinnslu á RB	
185,8 - 194,1	Sandsteinsvöluberg	4 - 5	90%	9	1,5 - 2,0	4,0	1,0	1,0					
193,8	Vel samlímt								2,2	14	31		99%

Borhola nr: **BH-15**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load I_{50} (MPa)	Reiknað σ = K_{50} * I_{50} K_{50}	σ	Einása-brotþol UCS	Slake-Durability INDEX (I_{d2})
194,1 - 199,8	Sand- og siltsteinn	0,8 - 1,1	65%	12	1,5	3,0 - 4,0	1,0	2,5					
196,7	Veikur siltsteinn, allur míkrósprungin og molnar í sand við SD-próf.								0,2	14	2		33%
197,8	Vel samlímt								2,3	14	32		96%
199,8 - 201,2	Sand- og siltsteinn	0,3 - 0,4	25%	9	1,0	3,0 - 4,0	1,0	2,5					
201,2 - 205,3	Sandsteinn	3 - 5	95%	9	1,0 - 1,5	3,0 - 4	1,0	1,0					
203,6									2,5	14	35		
202,2	Vel samlímdur											62,6	
205,3 - 206,4	Völuberg (ummyndað)	0,4	10%	15	2,0	3,0	1,0	1,0					
206,4 - 207,5	Ólivínbaslt (ummyndað)	0,4 - 0,9	65%	12	1,0 - 2,0	4,0	0,33	1,0					
207,5 - 210,3	Ólivínbaslt (ummyndað)	0,1	20%	15	1,5	4,0	0,33	2,5					
210,3 - 213,4	Ólivínbaslt (ummyndað)	0,2 - 0,4	40%	12	1,5 - 2,0	4,0	0,33	2,5					
213,4 - 218,5	Ólivínbaslt (ummyndað)	1,0 - 1,3	70%	12	2,0	3,0 - 4,0	0,33	1,0					
218,5 - 219,3	Siltsteinn		5%										
219,3 - 221,6	Basalt(ummyndað)	0,02 - 0,03	20%	20	1,5 - 2,0	4,0	0,33	5,0					
221,6 - 224,4	Basalt(ummyndað)	2,2 - 2,9	70%	12	1,5	3,0 - 4,0	1,00	1,0					
224,4 - 226,4	Basalt (sterkl. ummyndað)	0,01 - 0,02	20%	15	0,5 - 1,0	4,0 - 8,0	0,33	5,0					
226,4 - 227,2	Basalt (sterkl. ummyndað)	0,01 - 0,04	40%	15	0,5 - 1,0	4,0 - 8,0	0,33	5,0					
227,2 - 228,6	Basalt (sterkl. ummyndað)	0,001 - 0,01	5%	15	0,5 - 1,0	4,0 - 8,0	0,33	5,0					
228,6 - 230,6	Basalt	0,6 -	50%	12	1,5	4,0	1	2,5					
230,6 - 231,3	Basalt (sterkl. ummyndað)		5%										
231,3 - 233,0	Rautt millilag		5%										
233,0 - 235,4	Basalt (sterkl. ummyndað)	0,2	50%	15	1,5	4,0	0,33	2,5					
235,4 - 236,5	Kargi (sterkl.ummyndaður)	0,001	10%	20	1,0	12,0	0,33	20,0					
236,5 - 238,6	Basalt	0,6	80%	12	2,0	3,0	0,33	2,5					
238,6 - 239,4	Kargi (sterkl.ummyndaður)	0,0003	5%	20	1,0	12,0	0,33	20,0					
239,4 - 239,8	Basalt	1,2	65%	12	2,0	3,0	0,33	1,0					
239,8 - Holubotn													

Borhola nr: **BH-16**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load I_{50} (MPa)	Reiknað σ = K_{50} * I_{50} K_{50} σ	Einása-brotþol UCS	Slake-Durability INDEX (Id2)
24,4 - 31,2	Bólstraberg og Kubbaberg	0,1	20%	15	1	8,0	0,66	1,0				
31,2 - 34,5	Sandsteinn		25%									
34,5 - 34,7	Kubbaberg	4 - 6	55%	15	2,0 - 3,0	2,0	1,0	1,0				
34,7 - 36,1	Kubbaberg	4 - 6	55%	15	2,0 - 3,0	2,0	1,0	1,0				
36,1 - 36,6	Sandsteinsvöluberg	6	85%	9	2,0	3,0	1,0	1,0				
36,6 - 36,7	Sandsteinsvöluberg	7	95%	9	2,0	3,0	1,0	1,0				
36,7 - 37,6	Sandsteinsvöluberg	6	80%	9	2,0	3,0	1,0	1,0				
37,6 - 37,7	Sandsteinsvöluberg	6	80%	9	2,0	3,0	1,0	1,0				
37,7 - 38,0	Sandsteinsvöluberg		5%									
38,0 - 39,2	Basalt	1,6 - 2,3	35%	15	2,0	2,0 - 3,0	1,0	1,0				
39,2 - 41,5	Basalt	3	60%	12	2,0	3,0	1,0	1,0				
41,5 - 42,1	Setfylltur kargi	0,2 - 0,3	30%	12 - 15	1,0	4,0	1,0	2,5				
42,1 - 48,7	Basalt	9 - 13	80%	9	2,0 - 3,0	2,0	1,0	1,0				
48,7 - 49,3	Sandsteinn	0,1	5%	15	1,0	4,0	1,0	1,0				
49,3 - 50,0	Setfylltur kargi	5	60%	12	3,0	3,0	1,0	1,0				
50,0 - 50,3	Sandsteinsvöluberg	5	65%	9	2,0	3,0	1,0	1,0				
50,3 - 50,7	Sandsteinsvöluberg	7	90%	9	2,0	3,0	1,0	1,0				
50,7 - 59,0	Basalt (dílabasalt)	7 - 10	90%	9	2,0	2,0 - 3,0	1,0	1,0				
59,0 - 63,7	Kargi	0,2	10%	15	1,0	4,0 -	1,0	1,0				
63,7 - 64,9	Basalt (dílabasalt)	1,3 - 2,0	20%	15	3,0	2,0 - 3,0	1,0	1,0				
64,9 - 69,0	Basalt	8 - 11	75%	10	3,0	2,0 - 3,0	1,0	1,0				
69,0 - 69,3	Setfylltur kargi		5%									
69,3 - 69,8	Basalt	0,3 - 1	5%	15	3,0	2,0 - 3,0	1,0	1,0				
69,8 - 69,9	Sandsteinn		75%									
69,9 - 70,4	Setfylltur kargi		65%									
70,4 - 70,6	Rautt millilag		80%									
70,6 - 73,3	Basalt (dílabasalt)	6	75%	12 -	3,0 -	3,0 -	1,0	1,0				
73,3 - 73,3	Sandsteinn		5%									
73,3 - 76,3	Setfylltur kargi	6	75%	12 -	3,0 -	3,0 -	1,0	1,0				
76,3 - 86,3	Basalt	4 - 5	65%	12 -	2,0 -	2,0 - 3,0	1,0	1,0				

Borhola nr: **BH-16**

Dýpi (m)	Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load I_{50} (MPa)	Reiknað σ = K_{50} * I_{50} K_{50}	σ	Einása-brotþol UCS	Slake-Durability INDEX (I_d2)
86,3 - 87,4	Kargi	0,6 - 2,0	30%	12 - 15	1,0 - 4,0	4,0 -	1,0	1,0					
87,4 - 92,1	Völuberg	2	60%	9 -	2,0 -	3,0 -	1,0	2,5					
92,1 - 92,7	Basalt		60%										
92,7 - 93,3	Setfylltur kargi	3 - 5	95%	12 -	1,0 - 2,0	3,0 -	1,0	1,0					
93,3 - 93,9	Kargi	0,6 - 1,1	20%	12 -	1,0 - 2,0	3,0 -	1,0	1,0					
93,9 - 105,0	Basalt	4 - 5	65%	12 -	2,0 - 3,0	3,0 -	1,0	1,0					
102,0									8,5	20	170		
102,0	óblöðrótt											178,4	
105,0 - 109,8	Völuberg	6 - 9	80%	9 -	2,0 -	2,0 - 3,0	1,0	1,0					
105,0	Vel samlímt								2,3	14	32		
107,0												29,8	
108,0	Vel samlímt								4,4	16	70		
109,8 - 116,9	Völuberg, illa samlímt	0,3	30%	12 - 15	1,0	3,0	1,0	2,5					
116,9 - 123,1	Basalt	6 - 9	70%	12	3,0	2,0 - 3,0	1,0	1,0					
123,1 - 126,6	Kargi	7	80%	12	3,0	3,0	1,0	1,0					
126,6 - 133,7	Kargi	6	85%	9	2,0	3,0	1,0	1,0					
133,7 - 138,5	Gangur	0,8	30%	12	3,0	3,0	0,3	1,0					
138,5 - 139,3	Kargi	7	85%	12	3,0	3,0	1,0	1,0					
139,3 - 142,1	Sandsteinsvöluberg	6 - 7	100%	9	1,5 - 2,0	3,0	1,0	1,0					
142,1 - 143,5	Hnullungaberg	2	40%	12	2,0	3,0	1,0	1,0					
143,5 - 145,5	Basalt	7 - 11	85%	12	3,0	2,0 - 3,0	1,0	1,0					
145,5 - 146,1	Sand-/siltsteinn		75%										
146,1 - 146,5	Basalt		75%										
146,5 - 147,0	Setfylltur kargi		70%										
147,0 - 147,6	Sandsteinn		20%										
147,6 - 150,6	Basalt	5	55%	12	3,0	3,0	1,0	1,0					
150,6 - 150,7	Sandsteinn		5%										
150,7 - 160,7	Basalt	6	75%	12	3,0	3,0	1,0	1,0					
160,7 - Holubotn													

Borhola nr: **BH-17**

Dýpi (m)			Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load I_{50} (MPa)	Reiknað σ = K_{50} * I_{50} K_{50}	σ	Einása-brotþol UCS	Slake-Durability INDEX (I_{d2})
119,5	-	128,4	Basalt (dílabasalt)	6	85%	9	2 - 3	3	1	1					
128,4	-	129,4	mekanísk brot												
129,4	-	133,6		6	75%	9	2 - 3	3,0	1,00	1,0					
133,6	-	134,6	Sandsteinn	5 -	65%	9	2,0	3,0	1,00	1,0					
134,6	-	135,6	Kargi	4 - 5	90%	12	2,0	3,0 - 4,0	1,00	1,0					
135,6	-	141,5	Basalt (dílabasalt)	4 - 6	70%	12	2,0 - 3,0	3,0	1,00	1,0					
141,5	-	151,6		6 - 9	85%	9	2,0 - 3,0	3,0	1,00	1,0					
151,6	-	151,9	Kargi		50%										
151,9	-	153,5	Rautt millilag		0%										
153,5	-	153,9	Kargi		100%										
153,9	-	155,8		1,3	15%	12	3,0	3,0	1,0	1,0					
155,8	-	161,3	Basalt	4	70%	12	2,0	3,0	1,0	1,0					
161,3	-	163,8		2	40%	12	2,0	3,0	1,0	1,0					
163,8	-	165,4		3	55%	12	2,0	3,0	1,0	1,0					
165,4	-	167,6		5	95%	12	2,0	3,0	1,0	1,0					
167,6	-	168,4	Völuberg	3	65%	15	2,0	3,0	1,0	1,0					
168,4	-	171,5		4	55%	9	2,0	3,0	1,0	1,0					
171,5	-	177,9		4	55%	9	2,0	3,0	1,0	1,0					
177,9	-	178,8		2	25%	9	2,0	3,0	1,0	1,0					
178,8	-	183,2	Kargi	8 - 10	60%	12	3,0 - 4,0	2,0	1,0	1,0					
183,2	-	186,9	Basalt (smástuðlað	1,1	20%	12	2,0	3,0	1,0	1,0					
186,9	-	189,6	Völuberg	6	85%	9	2,0	3,0	1,0	1,0					
189,6	-	191,5	Sandsteinn	3 - 6	85%	9	1,0 - 2,0	3,0	1,0	1,0					
191,5	-	198,8	Völuberg	7	100%	9	2,0	3,0	1,0	1,0					
		198,0	Vel samlímt								2,6	14	36		
		198,0												48,2	
198,8	-	201,5	Basalt	2 - 3	95%	12	1,0 - 2,0	3,0 - 4,0	1,0	1,0					
201,5	-	207,2		1 - 2	70%	12	1,0 - 2,0	3,0 - 4,0	1,0	1,0					
207,2	-	208,3	Kargi		90%										
208,3	-	210,5	Sandsteinn	3	75%	9	1,0	3,0	1,0	1,0					

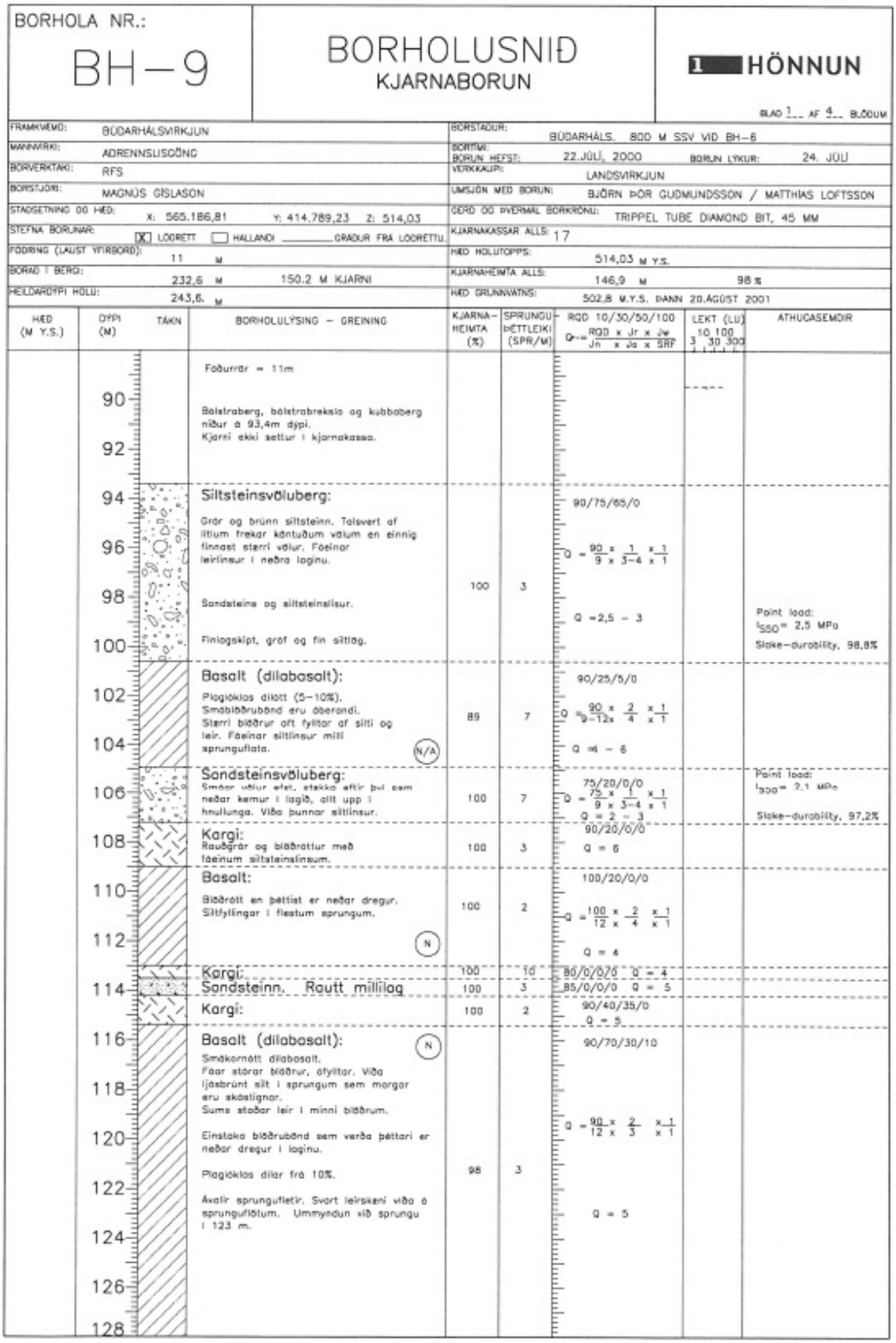
Borhola nr: **BH-17**

Dýpi (m)			Berggerð	Q-gildi	RQD	J_n	J_r	J_a	J_w	SRF	Point load I_{50} (MPa)	Reiknað σ = K_{50} * I_{50} K_{50}	σ	Einása-brotþol UCS	Slake-Durability INDEX (I_{d2})
		208,5	Vel samlímt								2,7	14	38		
		208,5	Vel samlímdur											53,2	
210,5	-	213,5		2	55%	9	1,0	3,0	1,0	1,0					
213,5	-	215,4		3	90%	9	1,0	3,0	1,0	1,0					
215,4	-	221,2	Völuberg	3 - 6	85%	9	1,0 - 2,0	3,0	1,0	1,0					
221,2	-	221,5		0,2 - 0,4	5%	9	1,0 - 2,0	3,0	1,0	1,0					
221,5	-	225,2		3 - 6	80%	9	1,0 - 2,0	3,0	1,0	1,0					
		222,5	Vel samlímt								1,8	14	25		
		222,5												21,2	
225,2	-	229,9	Basalt (ólivín)	6	85%	9	2,0	3,0	1,0	1,0					
229,9	-	238,2	Basalt (ólivín)	2	45%	12	1,5	3,0 - 4,0	1,0	1,0					
		231,5	Blöðrótt og ummyndað								3,6	16	58		
		231,5	Blöðrótt og ummyndað											28,2	
238,2	-	243,5		1,3	30%	12	1,5	3,0	1,0	1,0					
243,5	-	249,3	Sand- og siltsteinn	1,5	20%	9	2,0	3,0	1,0	1,0					
		244,1	Vel samlímt								1,2	14,0	17		
		244,1												53,0	
249,3	-	252,3	Basalt (ummyndað)	2 - 3	50%	12	2,0	3,0 - 4,0	1,0	1,0					
		250,0	Vel samlímt								2,6	14,0	36		
255,5	-	261,5	Völuberg	3 - 4	75%	9	1,5	3,0 - 4,0	1,0	1,0					
261,5	-	264,5	Sand- og siltsteinn	6	100%	9	1,5	3,0	1,0	1,0					
264,5	-	267,8		4	80%	9	1,5	3,0	1,0	1,0					
267,8	-	270,5	Siltsteinn	0,5 - 0,7	65%	9 - 12	1,5	3,0	1,0	5,0					
270,5	-	273,5		0,6 - 0,8	70%	9 - 12	1,5	3,0	1,0	5,0					
	-	272,3				-					0,6	14	8		
273,5	-	276,5		0,5 - 0,7	65%	9 - 12	1,5	3,0	1,0	5,0					
276,5	-	280,6		0,4 - 0,5	45%	9 - 12	1,5	3,0	1,0	5,0					

Búðarháls Hydroelectric Project
Rock Cores - Laboratory Testing /15.04.02
IBRI Project no. H01-1049

IBRI No	Core Hole	Depth (m)	Description **Average UCS** **Average axial E-modulus**	Length (mm)	Diam. (mm)	L/D	UCS (MPa)	Youngs E-ax (GPa)	Youngs E-dia (GPa)	Poission ratio	Density Ssd (kg/m3)	Moisture (%)
1	BH-15	181,1	Conglomerate	100,01	44,56	2,24	26,44	34,29	95,81	0,36		
2			**26,4**	98,25	44,58	2,20						
3			34,3	99,86	44,37	2,25						
4	BH-15	202,2	Sandstone -massive	99,52	44,64	2,23	56,62	23,1	89,9	0,26	2.296	
5			**60,6**	100,14	44,67	2,24	74,49				2.208	19,2
6			23,1	99,25	44,66	2,22	50,73				2.203	18,9
7	BH-16	107,0	Conglomerate	100,14	44,66	2,24	39,81	30,4	95,9	0,32	2.461	
8			**33,2**	92,51	44,66	2,07	27,08				2.478	11,5
9			30,4	96,71	44,64	2,17	32,59				2.477	11,7
10	BH-17	198,0	Conglomerate - angular pebbles	100,20	44,64	2,24	47,13	87,1	133,0	0,66	2.287	
11			**47,9**	99,98	44,64	2,24	58,14				2.374	12,9
12			87,1	99,47	44,64	2,23	38,39				2.290	15,7
13	BH-17	208,5	Sandstone - coarse, layered	99,65	44,61	2,23	72,18	60,0	80,1	0,75	2.148	
14			**61,8**	99,78	44,60	2,24	59,97	29,4	68,2	0,43	2.131	
15			44,7	100,03	44,64	2,24	53,12				2.235	19,0
16	BH-17	222,5	Conglomerate	96,76	44,58	2,17	35,74	35,7	91,2	0,39	2.358	
17			**29,1**	98,78	44,56	2,22	30,38	45,3	93,9	0,48	2.327	
18			40,5	99,30	44,55	2,23	21,24				2.339	15,5
19	BH-17	231,5	Basalt - vesicular	99,33	44,64	2,23	35,42	61,7			2.515	
20			**38,3**	100,30	44,60	2,25	51,22	47,3	69,6	0,68	2.593	
21			54,5	99,41	44,66	2,23	28,18				2.488	11,6
22	BH-17	244,1	Sediments - altered	95,06	43,47	2,19	56,70	40,6	85,0	0,48	2.090	
23			**54,3**	99,35	43,04	2,31	53,25	35,6	99,0	0,36	2.017	
24			38,1	93,23	43,71	2,13	52,95				2.101	26,2
25	BH-16	102	Basalt	97,86	44,72	2,19	169,69	51,6	88,0	0,59	2.930	
26			**175,5**	98,64	44,72	2,21	161,45				2.923	1,2
27			51,6	98,60	44,76	2,20	195,29				2.931	1,1

Figure 3-1. [Steingrímsson, 2009]



BORHOLA NR.: BH–9

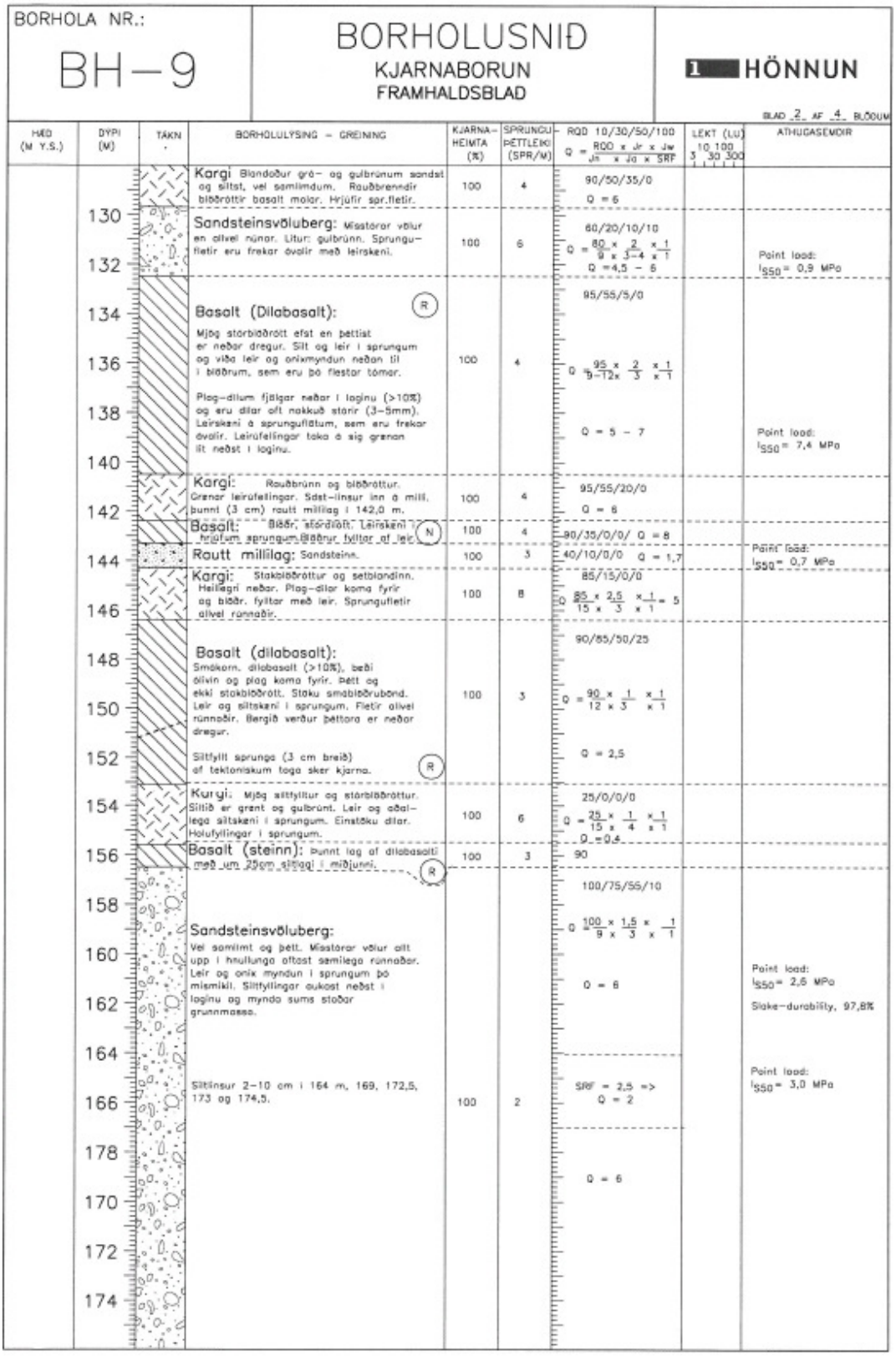
BORHOLUSNIÐ
KJARNABORUN

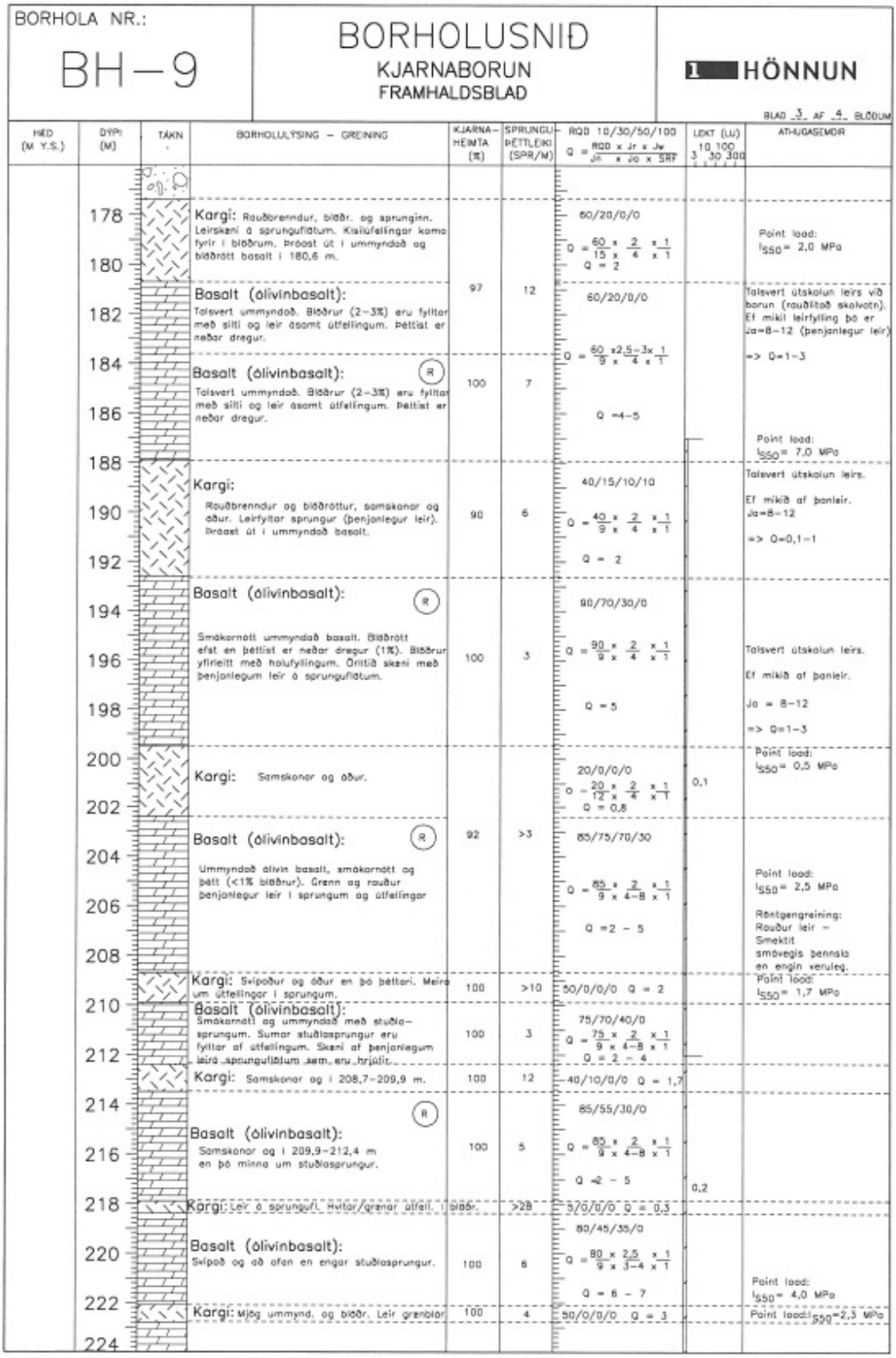
HÖNNUN

BLAÐ 1 AF 4 BLÖÐUM

FRAMKVÆMD:	BÚÐARHÁLSVIRKJUN	BORSTAÐUR:	BÚÐARHÁLS. 800 M SSV VIÐ BH–6
MANNVIRKI:	ADRENNSLISGÖNG	BORTÍMI: BORUN HEFST:	22.JÚLÍ, 2000 BORUN LÝKUR: 24. JÚLÍ
BORVERKTAKI:	RFS	VERKKAUPI:	LANDSVIRKJUN
BORSTJÓRI:	MAGNÚS GÍSLASON	UMSJÓN MEÐ BORUN:	BJÖRN ÞÓR GUÐMUNDSSON / MATTHÍAS LOFTSSON
STAÐSETNING OG HÆÐ:	X: 565.186,81 Y: 414.789,23 Z: 514,03	GERÐ OG ÞVERMÁL BORKRÓNU:	TRIPPEL TUBE DIAMOND BIT, 45 MM
STEFNA BORUNAR:	[X] LÓÐRÉTT [ ] HALLANDI _____ GRÁÐUR FRÁ LÓÐRÉTTU	KJARNAKASSAR ALLS:	17
FÓÐRING (LAUST YFIRBORÐ):	11 M	HÆÐ HOLUTOPPS:	514,03 M Y.S.
BORAÐ Í BERG:	232,6 M 150.2 M KJARNI	KJARNAHEIMTA ALLS:	146,9 M 98 %
HEILDARDÝPI HOLU:	243,6 M	HÆÐ GRUNNVATNS:	502,8 M.Y.S. ÞANN 20.ÁGÚST 2001

HÆÐ (M Y.S.)	DÝPI (M)	TÁKN	BORHOLULÝSING – GREINING	KJARNA-HEIMTA (%)	SPRUNGU-ÞÉTTLEIKI (SPR/M)	RQD 10/30/50/100 $Q=\frac{RQD}{Jn}\times\frac{Jr}{Ja}\times\frac{Jw}{SRF}$	LEKT (LU) 10 100 3 30 300	ATHUGASEMDIR
	90		Fóðurrör = 11m Bólstraberg, bólstrabreksía og kubbaberg niður á 93,4m dýpi. Kjarni ekki settur í kjarnakassa.					
	92							
	94		**Siltsteinsvöluberg:** Grár og brúnn siltsteinn. Talsvert af ljósum frekar kantuðum völum en einnig finnast stærri völur. Fáeinar leirlinsur í neðra laginu.			90/75/65/0 $Q=\frac{90}{9}\times\frac{1}{3-4}\times\frac{1}{1}$		
	96							
	98		Sandsteins og siltsteinslinsur.	100	3	Q = 2,5 – 3		Point load: I_{S50} = 2,5 MPa Slake–durability, 98,8%
	100		Fínlagskipt, gróf og fín siltlög.					
	102		**Basalt (dílabasalt):** Plagíóklas dílótt (5–10%). Smáblöðrubönd eru áberandi. Stærri blöðrur oft fylltar af silti og leir. Fáeinar siltlinsur milli sprungufleta. (N/A)	89	7	90/25/5/0 $Q=\frac{90}{9-12x}\times\frac{2}{4}\times\frac{1}{1}$ Q = 4 – 6		
	104							
	106		**Sandsteinsvöluberg:** Smáar völur efst, stækka eftir því sem neðar kemur í laginu, allt upp í hnullunga. Víða þunnar siltlinsur.	100	7	75/20/0/0 $Q=\frac{75}{9}\times\frac{1}{3-4}\times\frac{1}{1}$ Q = 2 – 3		Point load: I_{S50} = 2,1 MPa Slake–durability, 97,2%
	108		**Kargi:** Rauðgrár og blöðróttur með fáeinum siltsteinslinsum.	100	3	90/20/0/0 Q = 6		
	110		**Basalt:** Blöðrótt en þéttist er neðar dregur. Síltfyllingar í flestum sprungum.	100	2	100/20/0/0 $Q=\frac{100}{12}\times\frac{2}{4}\times\frac{1}{1}$		
	112		(N)			Q = 4		
	114		**Kargi:** 100 10 90/0/0/0 Q = 4 **Sandsteinn. Rautt millilag** 100 3 85/0/0/0 Q = 5 **Kargi:** 100 2 90/40/35/0 Q = 5					
	116		**Basalt (dílabasalt):** (N) Smákornótt dílabasalt. Fáar stórar blöðrur, ýfylltar. Víða ljósbrúnt silt í sprungum sem margar eru skástignar. Sums staðar leir í minni blöðrum.			90/70/30/10		
	118							
	120		Einstaka blöðrubönd sem verða þéttari er neðar dregur í laginu.			$Q=\frac{90}{12}\times\frac{2}{3}\times\frac{1}{1}$		
	122		Plagíóklas dílar frá 10%.	98	3			
	124		Ávalir sprungufletir. Svart leirskæni víða á sprungufötum. Ummyndun við sprungu í 123 m.			Q = 5		
	126							
	128							


BORHOLA NR.:
BH–9
BORHOLUSNIÐ
KJARNABORUN
FRAMHALDSBLAD
1 HÖNNUN
BLAD 2 AF 4 BLÖÐUM
HÆÐ (M Y.S.)
DÝPI (M)
TÁKN
BORHOLULÝSING – GREINING
KJARNA-HEIMTA (%)
SPRUNGU-ÞÉTTLEIKI (SPR/M)
RQD 10/30/50/100
LEKT (LU) 1 10 100 3 30 300
ATHUGASEMDIR
Kargi Blandaður grá– og gulbrúnum sandst og siltst, vel samlímdum. Rauðbrenndir blöðróttir basalt molar. Hrjúfir sprfletir.
90/50/35/0
Q = 6
130
Sandsteinsvöluberg: Misstórar völur en allvel núnar. Litur: gulbrúnn. Sprungufletir eru frekar óvalir með leirskeni.
60/20/10/10
Q = 80/9 x 2/3–4 x 1/1
Q = 4,5 – 5
Point load: Is50 = 0,9 MPa
132
134
Basalt (Dilabasalt): (R)
Mjög störblöðrótt efst en þéttist er neðar dregur. Silt og leir í sprungum og víða leir og oníxmyndun neðan til í blöðrum, sem eru þó flestar tómar.
Plag–dílum fjölgar neðar í laginu (>10%) og eru dílar oft nokkuð stórir (3–5mm). Leirskeni á sprungufláturn, sem eru frekar óvalir. Leirúfellingar taka á sig grænan lit neðst í laginu.
95/55/5/0
Q = 95/9–12x 2/3 x 1/1
Q = 5 – 7
Point load: Is50 = 7,4 MPa
136
138
140
Kargi: Rauðbrúnn og blöðróttur. Grænar leirúfellingar. Sést–linsur inn á milli, þunnt (3 cm) rautt millilag í 142,0 m.
95/55/20/0
Q = 6
142
Basalt: Blöðr, stördíólt. Leirskeni (N) hrúfum sprungum.Blöðrur fyltar af leir.
90/35/0/0/ Q = 8
Rautt millilag: Sandsteins.
40/10/0/0 Q = 1,7
Point load: Is50 = 0,7 MPa
144
Kargi: Stakblöðróttur og setblandinn. Heillegri neðar. Plag–dílar koma fyrir og blöðr. fyltar með leir. Sprungufletir allvel rúnnaðir.
85/15/0/0
Q = 85/15 x 2,5/3 x 1/1 = 5
146
148
Basalt (dilabasalt):
Smákorn. dilabasalt (>10%), beði ólivín og plag koma fyrir. Þétt og ekki stakblöðrótt. Stöku smablöðrubönd. Leir og siltskeni í sprungum. Fletir allvel rúnnaðir. Bergið verður þéttara er neðar dregur.
Siltfyllt sprunga (3 cm breið) af tektoniskum toga sker kjarna. (R)
90/85/50/25
Q = 90/12 x 1/3 x 1/1
Q = 2,5
150
152
Kargi: Mjög siltfyltur og störblöðróttur. Siltið er grænt og gulbrúnt. Leir og aðallega siltskeni í sprungum. Einstöku dílar. Holufyllingar í sprungum.
25/0/0/0
Q = 25/15 x 1/4 x 1/1
Q = 0,4
154
Basalt (steinn): Þunnt lag af dilabasalti með um 20cm siltgg í miðjunni. (R)
90
156
158
Sandsteinsvöluberg:
Vel samlímt og þétt. Misstórar völur allt upp í hnullunga oftast samlegra rúnnaðar. Leir og oníx myndun í sprungum þó mismikil. Siltfyllingar aukast neðst í laginu og mynda sums staðar grunnmassa.
Siltlinsur 2–10 cm í 164 m, 169, 172,5, 173 og 174,5.
100/75/55/10
Q = 100/9 x 1,5/3 x 1/1
Q = 6
SRF = 2,5 =>
Q = 2
Q = 6
Point load: Is50 = 2,6 MPa
Slake–durability, 97,8%
Point load: Is50 = 3,0 MPa
160
162
164
166
178
170
172
174



BORHOLA NR.: BH–9

BORHOLUSNIÐ

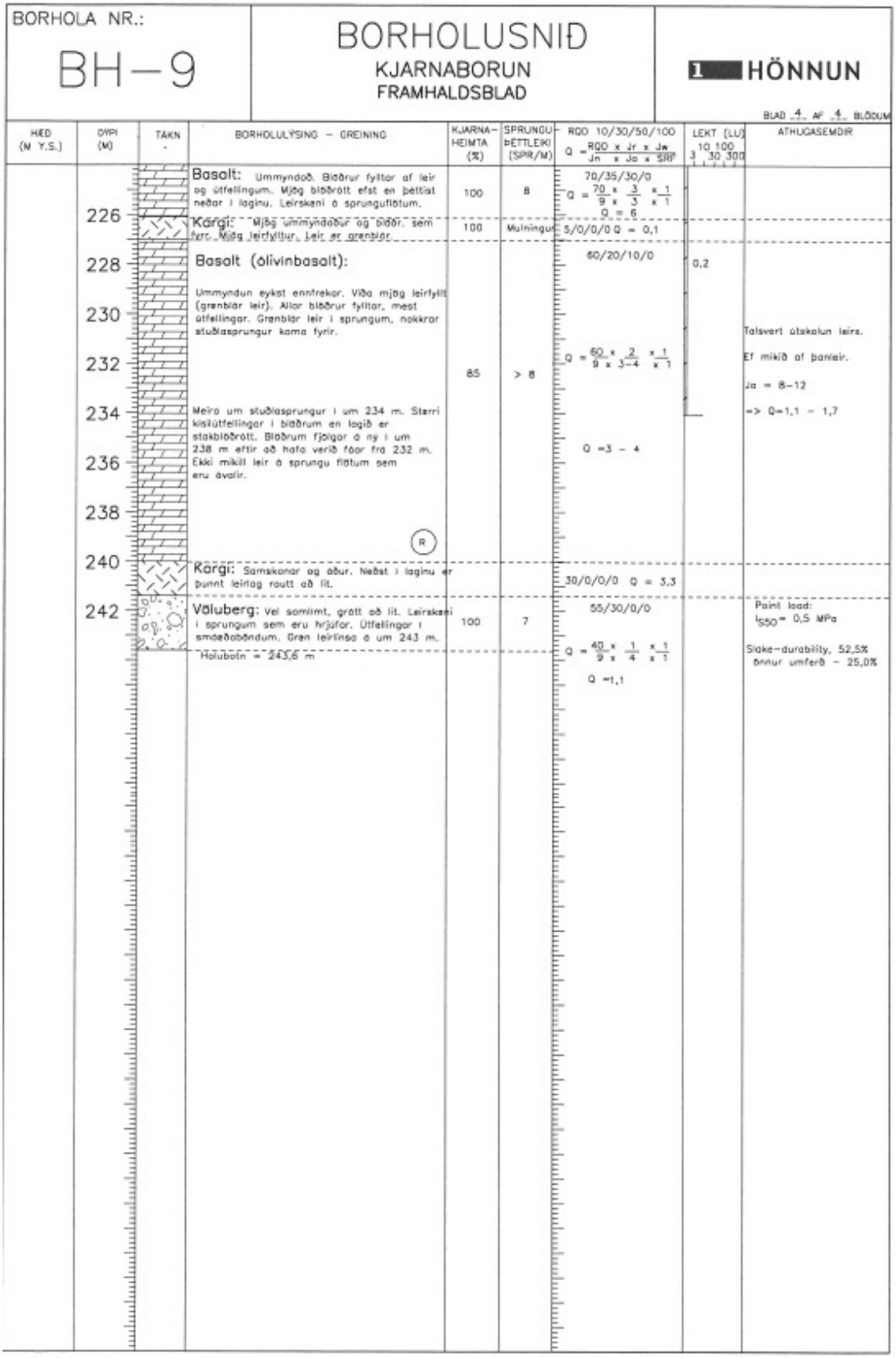
KJARNABORUN

FRAMHALDSBLAD

1 HÖNNUN

BLAD 3 AF 4 BLÖÐUM

HÆÐ (M Y.S.)	DÝPI (M)	TÁKN	BORHOLULÝSING – GREINING	KJARNA-HEIMTA (%)	SPRUNGU-ÞÉTTLEIKI (SPR/M)	RQD 10/30/50/100 $Q = \frac{RQD}{Jn} \times \frac{Jr}{Ja} \times \frac{Jw}{SRF}$	LOKT (LU) 10 100 3 30 300	ATHUGASEMDIR
	178		**Kargi:** Rauðbrenndur, blöðr. og sprunginn. Leirskæni á sprungufletum. Kísilútfellingar koma fyrir í blöðrum. Þróast út í ummyndað og blöðrótt basalt í 180,6 m.			60/20/0/0 $Q = \frac{60}{15} \times \frac{2}{4} \times \frac{1}{1}$ $Q = 2$		Point load: I_{S50}= 2,0 MPa
	180							
	182		**Basalt (ólivínbasalt):** Talsvert ummyndað. Blöðrur (2–3%) eru fylltar með silti og leir ásamt útfellingum. Þéttist er neðar dregur.	97	12	60/20/0/0 $Q = \frac{60}{9} \times \frac{2,5-3}{4} \times \frac{x}{1}$		Talsvert útskolun leirs við borun (rauðlitað skolvatn). Ef mikil leirfylling þá er Ja=8–12 (þenjanlegur leir) => Q=1–3
	184	R	**Basalt (ólivínbasalt):** Talsvert ummyndað. Blöðrur (2–3%) eru fylltar með silti og leir ásamt útfellingum. Þéttist er neðar dregur.	100	7	$Q = 4–5$		
	186							Point load: I_{S50}= 7,0 MPa
	188		**Kargi:** Rauðbrenndur og blöðróttur, samskonar og áður. Leirfylltar sprungur (þenjanlegur leir). Þróast út í ummyndað basalt.	90	6	40/15/10/10 $Q = \frac{40}{9} \times \frac{2}{4} \times \frac{1}{1}$ $Q = 2$		Talsvert útskolun leirs. Ef mikið af þanleir. Ja=8–12 => Q=0,1–1
	190							
	192							
	194	R	**Basalt (ólivínbasalt):** Smákornótt ummyndað basalt. Blöðrótt efst en þéttist er neðar dregur (1%). Blöðrur yfirleitt með holufyllingum. Oftast skæni með þenjanlegum leir á sprungufletum.	100	3	90/70/30/0 $Q = \frac{90}{9} \times \frac{2}{4} \times \frac{1}{1}$ $Q = 5$		Talsvert útskolun leirs. Ef mikið af þanleir. Ja = 8–12 => Q=1–3
	196							
	198							
	200		**Kargi:** Samskonar og áður.			20/0/0/0 $Q = \frac{20}{12} \times \frac{2}{4} \times \frac{1}{1}$ $Q = 0,8$	0,1	Point load: I_{S50}= 0,5 MPa
	202							
	204	R	**Basalt (ólivínbasalt):** Ummyndað ólivín basalt, smákornótt og þétt (<1% blöðrur). Grænn og rauður þenjanlegur leir í sprungum og útfellingar	92	>3	85/75/70/30 $Q = \frac{85}{9} \times \frac{2}{4–8} \times \frac{1}{1}$ $Q = 2 – 5$		Point load: I_{S50}= 2,5 MPa Röntgengreining: Rauður leir – Smektít smávegis þennsla en engin veruleg.
	206							
	208							
	210		**Kargi:** Svipaður og áður en þó þéttari. Meira um útfellingar í sprungum.	100	>10	50/0/0/0 Q = 2		Point load: I_{S50}= 1,7 MPa
	212		**Basalt (ólivínbasalt):** Smákornótt og ummyndað með stuðla–sprungum. Sumar stuðlasprungur eru fylltar af útfellingum. Skæni af þenjanlegum leirá sprungufletum sem eru hrjúfir.	100	3	75/70/40/0 $Q = \frac{75}{9} \times \frac{2}{4–8} \times \frac{1}{1}$ $Q = 2 – 4$		
			Kargi: Samskonar og í 208,7–209,9 m.	100	12	40/10/0/0 Q = 1,7		
	214	R	**Basalt (ólivínbasalt):** Samskonar og í 209,9–212,4 m en þó minna um stuðlasprungur.	100	5	85/55/30/0 $Q = \frac{85}{9} \times \frac{2}{4–8} \times \frac{1}{1}$ $Q = 2 – 5$	0,2	
	216							
	218		**Kargi:** Leir á sprungufl. Hvítar/grænar útfell. í blöðr.		>28	5/0/0/0 Q = 0,3		
	220		**Basalt (ólivínbasalt):** Svipað og að ofan en engar stuðlasprungur.	100	6	80/45/35/0 $Q = \frac{80}{9} \times \frac{2,5}{3–4} \times \frac{1}{1}$ $Q = 6 – 7$		Point load: I_{S50}= 4,0 MPa
	222		**Kargi:** Mjög ummynd. og blöðr. Leir grænblár	100	4	50/0/0/0 Q = 3		Point load: I_{S50}=2,3 MPa
	224							



BORHOLA NR.: BH–9

BORHOLUSNIÐ
KJARNABORUN
FRAMHALDSBLAD

1 HÖNNUN

BLAÐ 4 AF 4 BLÖÐUM

HÆÐ (M Y.S.)	DÝPI (M)	TÁKN	BORHOLULÝSING – GREINING	KJARNA-HEIMTA (%)	SPRUNGU-ÞÉTTLEIKI (SPR/M)	RQD 10/30/50/100 $Q = \frac{RQD}{Jn} \times \frac{Jr}{Ja} \times \frac{Jw}{SRF}$	LEKT (LU) 3 10 30 100	ATHUGASEMDIR
	226		**Basalt:** Ummyndoð. Blöðrur fylltar af leir og útfellingum. Mjög blöðrótt efst en þéttist neðar í laginu. Leirskæni á sprungufletum.	100	8	70/35/30/0 $Q = \frac{70}{9} \times \frac{3}{3} \times \frac{1}{1}$ $Q = 6$		
			Kargi: Mjög ummyndaður og blöðr. sem fyrr. Mjög leirfylltur. Leir er grænblár	100	Mulningur	5/0/0/0 Q = 0,1		
	228		**Basalt (ólivínbasalt):**			60/20/10/0	0,2	
	230		Ummyndun eykst enntrekar. Víða mjög leirfyllt (grænblár leir). Allar blöðrur fylltar, mest útfellingar. Grænblár leir í sprungum, nokkrar stuðlasprungur koma fyrir.					Talsvert útskolun leirs.
	232			85	> 8	$Q = \frac{60}{9} \times \frac{2}{3-4} \times \frac{1}{1}$		Ef mikið af þunnleir.
								Ja = 8–12
	234		Meira um stuðlasprungur í um 234 m. Stærri kísilútfellingar í blöðrum en lagið er stakblöðrótt. Blöðrum fjölgar á ný í um 238 m eftir að hafa verið fáar frá 232 m. Ekki mikill leir á sprungu flötum sem eru ávalir.					=> Q=1,1 – 1,7
	236					Q =3 – 4		
	238							
			(R)					
	240		**Kargi:** Samskonar og áður. Neðst í laginu er þunnt leirlag rautt að lit.			30/0/0/0 Q = 3,3		
	242		**Völuberg:** Vel samlímt, grátt að lit. Leirskæni í sprungum sem eru hrjúfar. Útfellingar í smáæðaböndum. Grænn leirlinsa á um 243 m.	100	7	55/30/0/0 $Q = \frac{40}{9} \times \frac{1}{4} \times \frac{1}{1}$ Q =1,1		Point load: I_{S50}= 0,5 MPa
			Holubotn = 243,6 m					Slake-durability, 52,5% önnur umferð – 25,0%

BORHOLA NR.: **BH–11**

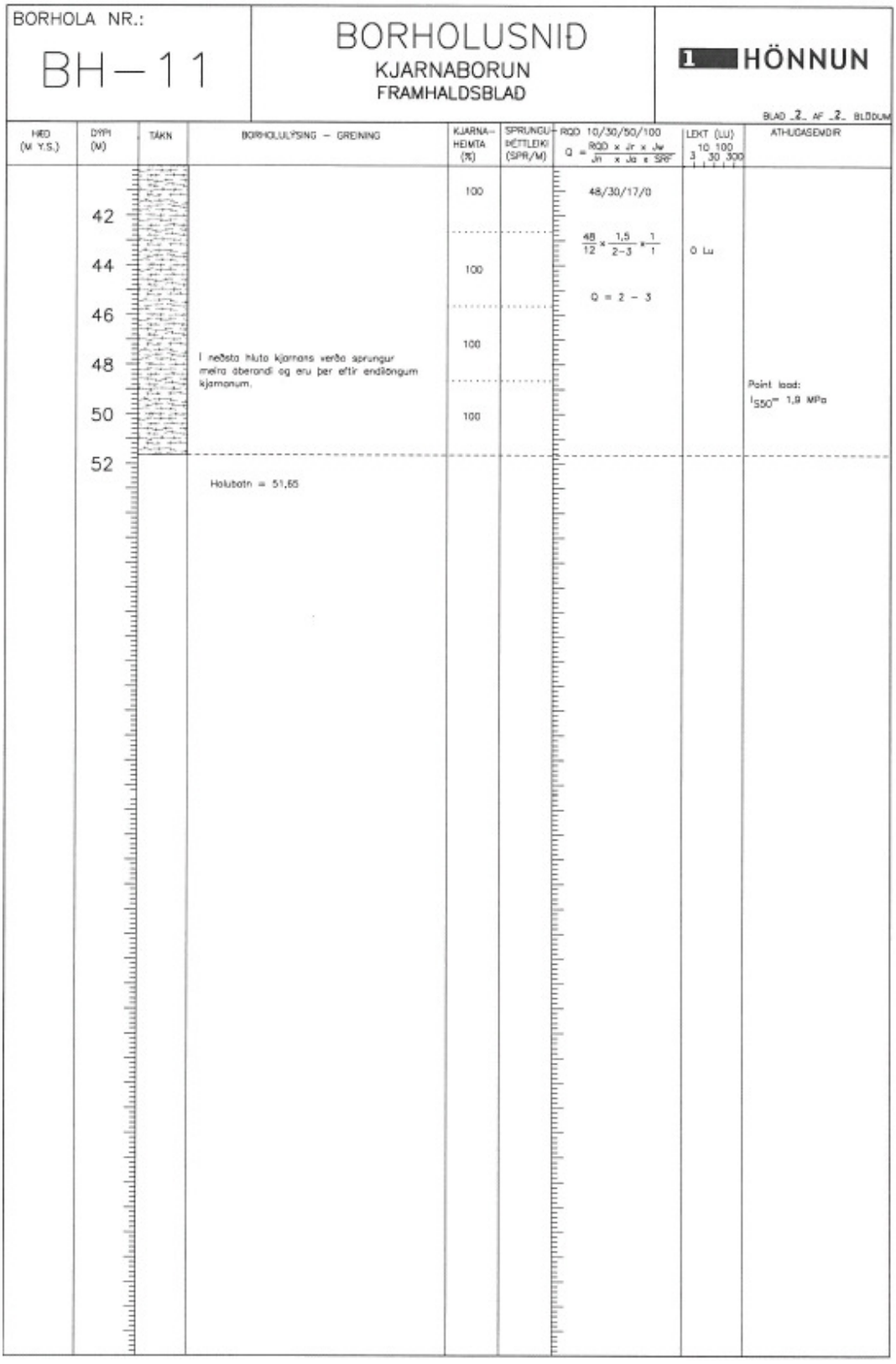
BORHOLUSNIÐ
KJARNABORUN

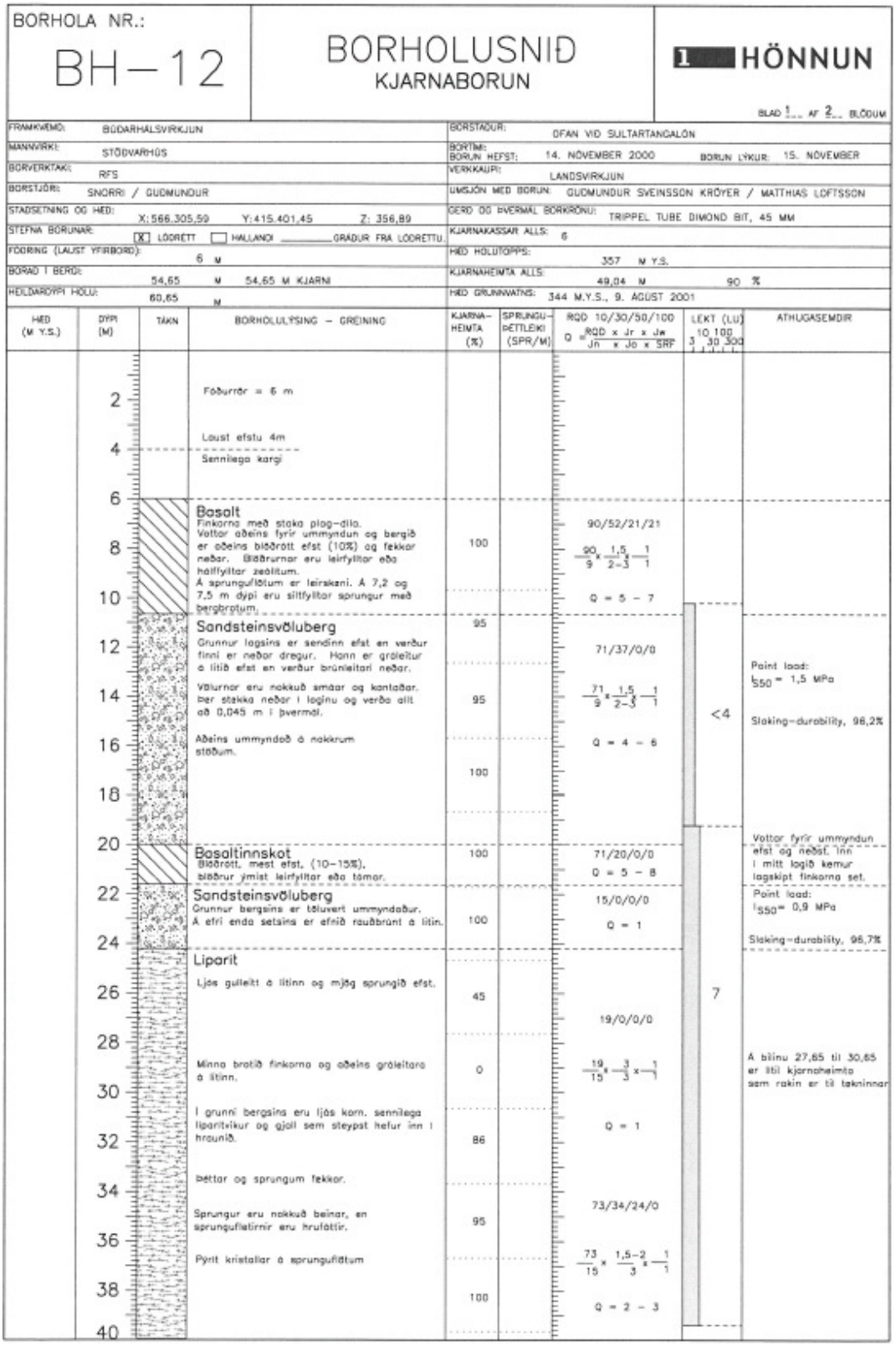
HÖNNUN

BLAÐ 1 AF 2 BLÖÐUM

FRAMKVÆMD: BÚÐARHÁLSVIRKJUN	BORSTAÐUR: OFAN VIÐ SULTARTANGALÓN
MANNVIRKI: STÖÐVARHÚS	BORTÍMI: BORUN HEFST: 9. NÓVEMBER 2000 BORUN LÝKUR: 14.NÓVEMBER
BORVERKTAKI: RFS	VERKKAUPI: LANDSVIRKJUN
BORSTJÓRI: SNORRI / GUÐMUNDUR	UMSJÓN MEÐ BORUN: GUÐMUNDUR SVEINSSON KRÖYER / MATTHÍAS LOFTSSON
STAÐSETNING OG HÆÐ: X: 566.434,03 Y: 415.517,61 Z: 313,43	GERÐ OG ÞVERMÁL BORKRÓNU: TRIPPEL TUBE DIAMOND BIT, 45 MM
STEFNA BORUNAR: [X] LÓÐRÉTT [ ] HALLANDI _____GRÁÐUR FRÁ LÓÐRÉTTU	KJARNAKASSAR ALLS: 6
FÓÐRING (LAUST YFIRBORÐ): 2,8 M	HÆÐ HOLUTOPPS: 313 M Y.S.
BORAÐ Í BERG: 48,85 M 48,85 M KJARNI	KJARNAHEIMTA ALLS: 46,7 M 95 %
HEILDARDÝPI HOLU: 51,55 M	HÆÐ GRUNNVATNS: M Y.S.

HÆÐ (M Y.S.)	DÝPI (M)	TÁKN	BORHOLULÝSING – GREINING	KJARNA-HEIMTA (%)	SPRUNGU-ÞÉTTLEIKI (SPR/M)	RQD 10/30/50/100 $Q = \frac{RQD}{Jn} \times \frac{Jr}{Ja} \times \frac{Jw}{SRF}$	LEKT (LU) 3 10 30 100 300	ATHUGASEMDIR
	2		Fóðurrör = 2,8 m Fóðurrör borað um 1m í líparít					
	4		**Líparít** Í efstu 3 m er bergið smábrotið.	12 58 71		25/0/0/0 $\frac{25}{15} \times \frac{1,5}{2-3} \times \frac{1}{1}$		
	6		Bergið er tiltölulega ferskt en ummyndað á sprungufletum Sprungufletir eru yfirleitt tiltölulega slettir.	51		Q = 0,8 – 1		
	8		Á sprungufletum er leirskeri. Straumflögótt og smáfellott af plagíóklas.	72 28 96		58/0/0/0		
	10		Mulið og brúnt af ummyndun á um 0,1–0,2 m bili. Neðan við muninginn verður bergið aðeins blöðrótt og eru þær fylltar með grænum leir.	82		$\frac{58}{15} \times \frac{1,5}{2-3} \times \frac{1}{1}$		
	12		Verður heillegra og sprungum fækkar.	93 100		Q = 2 – 3		
	14			100		25/0/0/0		
	16			100		Q = 0,8 – 1		Point load: Is50 = 5,4 MPa
	18			100		73/30/22/0 $\frac{73}{12} \times \frac{1,5}{2-3} \times \frac{1}{1}$		
	20			100		Q = 3 – 4	0 Lu	
	22			100		58/13/0/0		Lektarprófað var að 11 bara þrýstingi og halan hélt.
	24			100		$\frac{58}{12} \times \frac{1,5}{2-3} \times \frac{1}{1}$		
	26			100		Q = 2 – 3		
	28			100		94/48/20/0 $\frac{94}{12} \times \frac{1,5}{2-3} \times \frac{1}{1}$		
	30					Q = 4 – 6		
	32		Verður aðeins ummyndaðra.	100		48/30/17/0		
	34					$\frac{48}{12} \times \frac{1,5}{2-3} \times \frac{1}{1}$		
	36			100		Q = 2 – 3	0 Lu	Point load: I_{S50} = 1,3 MPa
	38			100				
	40							


BORHOLA NR.:
BH – 11
BORHOLUSNIÐ
KJARNABORUN
FRAMHALDSBLAD
1 HÖNNUN
BLAD 2 AF 2 BLÖÐUM
HÆÐ (M Y.S.)
DÝPI (M)
TÁKN
BORHOLULÝSING – GREINING
KJARNA-HEIMTA (%)
SPRUNGU-ÞÉTTLEIKI (SPR/M)
RQD 10/30/50/100
Q = RQD/Jn x Jr/Ja x Jw/SRF
LEKT (LU) 3 10 30 100 300
ATHUGASEMDIR
42
44
46
48
50
52
100
100
100
100
48/30/17/0
48/12 x 1,5/2-3 x 1/1
Q = 2 – 3
0 Lu
Í neðsta hluta kjarnans verða sprungur meira áberandi og eru þær eftir endilöngum kjarnanum.
Point load:
I550= 1,9 MPa
Holubotn = 51,65



BORHOLA NR.: BH–12

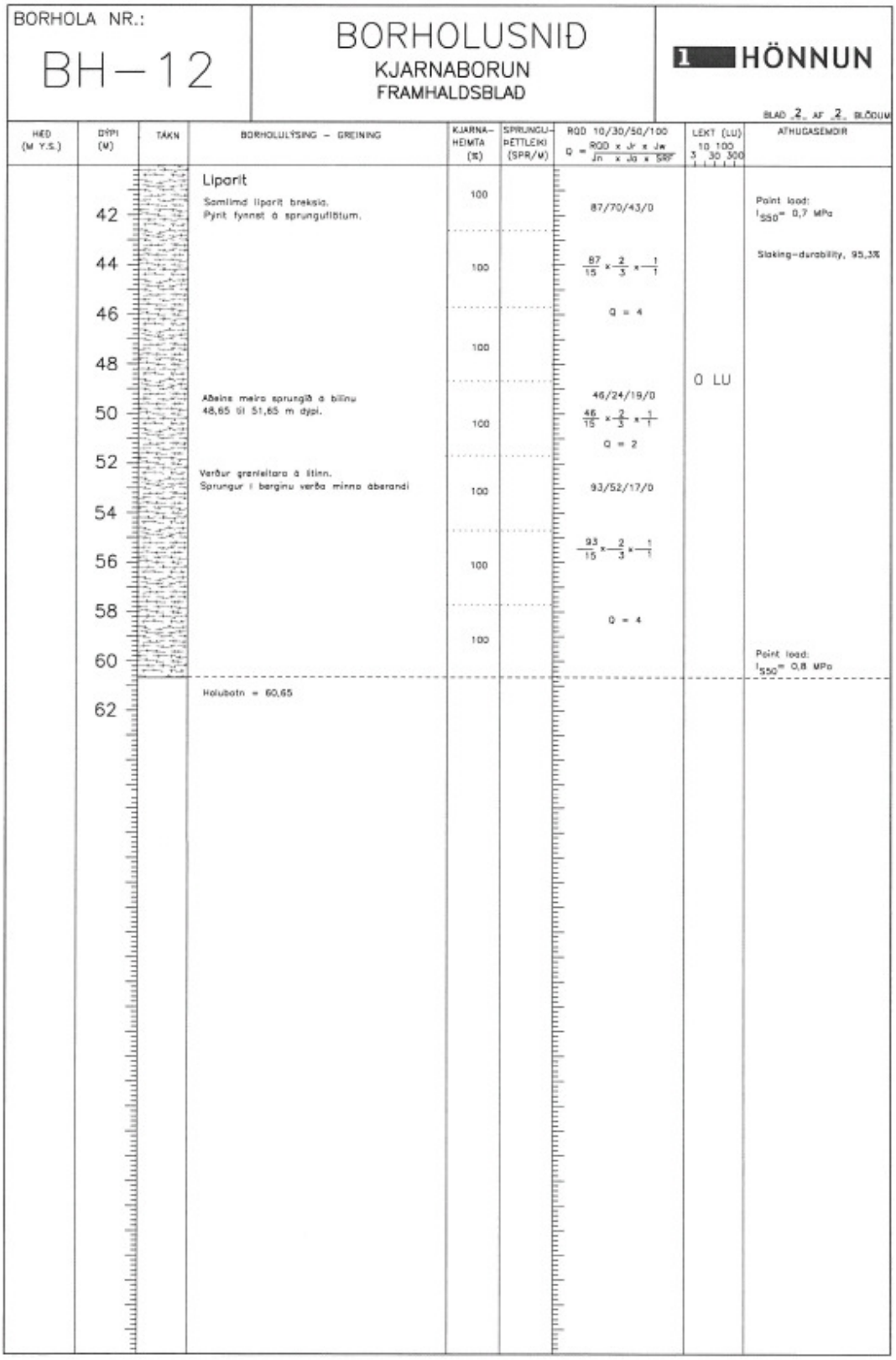
BORHOLUSNIÐ
KJARNABORUN

1 HÖNNUN

BLAD 1 AF 2 BLÖÐUM

FRAMKVÆMD: BÚÐARHÁLSVIRKJUN	BORSTAÐUR: OFAN VIÐ SULTARTANGALÓN
MANNVIRKI: STÖÐVARHÚS	BORTÍMI: BORUN HEFST: 14. NÓVEMBER 2000 BORUN LÝKUR: 15. NÓVEMBER
BORVERKTAKI: RFS	VERKKAUPI: LANDSVIRKJUN
BORSTJÓRI: SNORRI / GUÐMUNDUR	UMSJÓN MEÐ BORUN: GUÐMUNDUR SVEINSSON KRÖYER / MATTHÍAS LOFTSSON
STAÐSETNING OG HÆÐ: X: 566.305,59 Y: 415.401,45 Z: 356,89	GERÐ OG ÞVERMÁL BORKRÓNU: TRIPPEL TUBE DIMOND BIT, 45 MM
STEFNA BORUNAR: [X] LÓÐRÉTT [ ] HALLANDI _____ GRÁÐUR FRÁ LÓÐRÉTTU	KJARNAKASSAR ALLS: 6
FÓÐRING (LAUST YFIRBORÐ): 6 M	HÆÐ HOLUTOPPS: 357 M Y.S.
BORAÐ Í BERG: 54,65 M 54,65 M KJARNI	KJARNAHEIMTA ALLS: 49,04 M 90 %
HEILDARDÝPI HOLU: 60,65 M	HÆÐ GRUNNVATNS: 344 M.Y.S., 9. ÁGÚST 2001

HÆÐ (M Y.S.)	DÝPI (M)	TÁKN	BORHOLULÝSING – GREINING	KJARNA-HEIMTA (%)	SPRUNGU-ÞÉTTLEIKI (SPR/M)	RQD 10/30/50/100 $Q = \frac{RQD}{Jn} \times \frac{Jr}{Ja} \times \frac{Jw}{SRF}$	LEKT (LU) 3 10 30 100 300	ATHUGASEMDIR
	2		Föðurrör = 6 m					
	4		Laust efstu 4m Sennilega kargi					
	6		**Basalt** Fínkorna með staka plag–dílo. Vottar aðeins fyrir ummyndun og bergið er aðeins blöðrótt efst (10%) og fekkar neðar. Blöðrurnar eru leirfyltar eða hálffyltar zeólítum. Á sprungufletum er leirskæni. Á 7,2 og 7,5 m dýpi eru siltfyltar sprungur með bergbrotum.	100		90/52/21/21 $\frac{90}{9} \times \frac{1,5}{2-3} \times \frac{1}{1}$ Q = 5 – 7		
	10							
	12		**Sandsteinsvöluberg** Grunnur lagsins er sendinn efst en verður finni er neðar dregur. Hann er gráleitur á litið efst en verður brúnleitari neðar. Völurnar eru nokkuð smáar og kantaðar. Þær stakka neðar í laginu og verða allt að 0,045 m í þvermál. Aðeins ummyndað á nokkrum stöðum.	95 95 100		71/37/0/0 $\frac{71}{9} \times \frac{1,5}{2-3} \times \frac{1}{1}$ Q = 4 – 6	<4	Point load: I_{550} = 1,5 MPa Slaking–durability, 98,2%
	20		**Basaltinnskot** Blöðrótt, mest efst, (10–15%). blöðrur ýmist leirfyltar eða tómar.	100		71/20/0/0 Q = 5 – 8		Vottar fyrir ummyndun efst og neðst. Inn í mitt lagið kemur lagskipt fínkorna set.
	22		**Sandsteinsvöluberg** Grunnur bergsins er töluvert ummyndaður. Á efri enda setsins er efnið rauðbrúnt á litin.	100		15/0/0/0 Q = 1		Point load: I_{550}= 0,9 MPa Slaking–durability, 96,7%
	24		**Líparít** Ljós gulleitt á litinn og mjög sprungið efst.	45		19/0/0/0	7	
	26							
	28		Minna brotið fínkorna og aðeins gráleitara á litinn.	0		$\frac{19}{15} \times \frac{3}{3} \times \frac{1}{1}$		Á bilinu 27,65 til 30,65 er lítil kjarnaheimta sem rakin er til tækninnar.
	30							
	32		Í grunni bergsins eru ljós korn, sennilega líparítvikur og gjall sem steypst hefur inn í hraunið.	86		Q = 1		
	34		Þéttar og sprungum fekkar.					
	36		Sprungur eru nokkuð beinar, en sprungufletirnir eru hrufóttir.	95		73/34/24/0		
	38		Pýrít kristallar á sprungufletum	100		$\frac{73}{15} \times \frac{1,5-2}{3} \times \frac{1}{1}$ Q = 2 – 3		
	40							



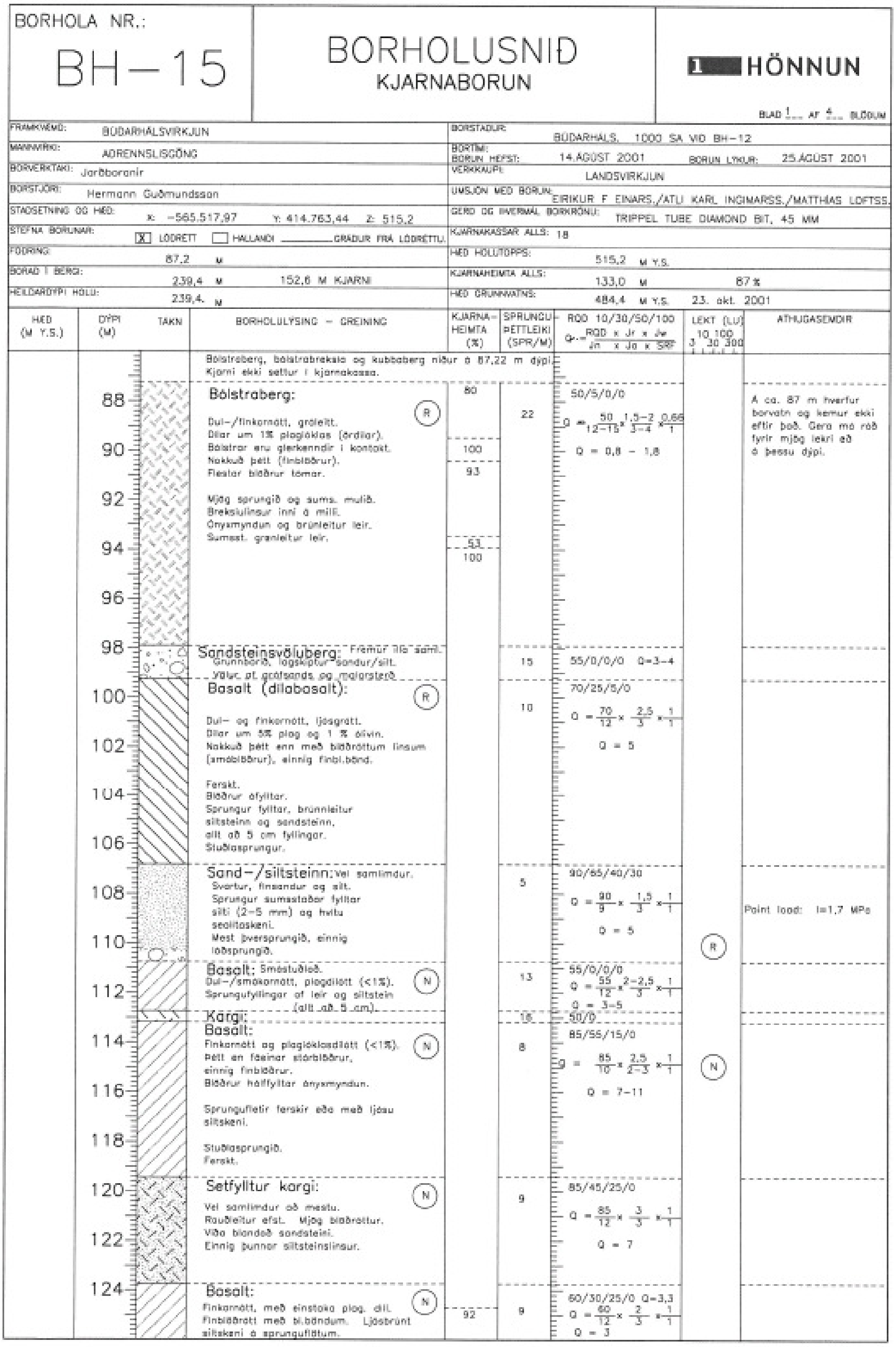
BORHOLA NR.: BH–12

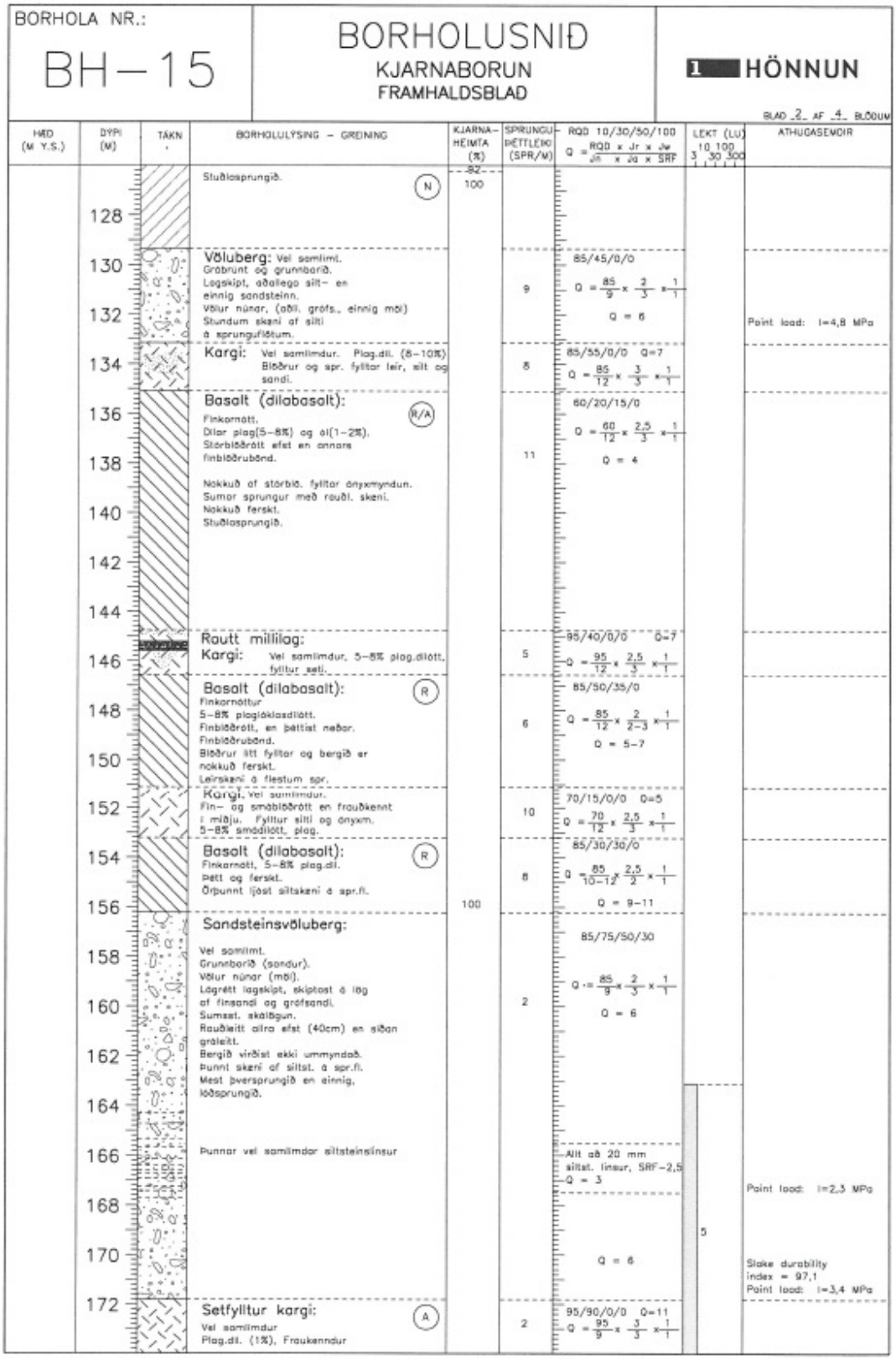
BORHOLUSNIÐ
KJARNABORUN
FRAMHALDSBLAD

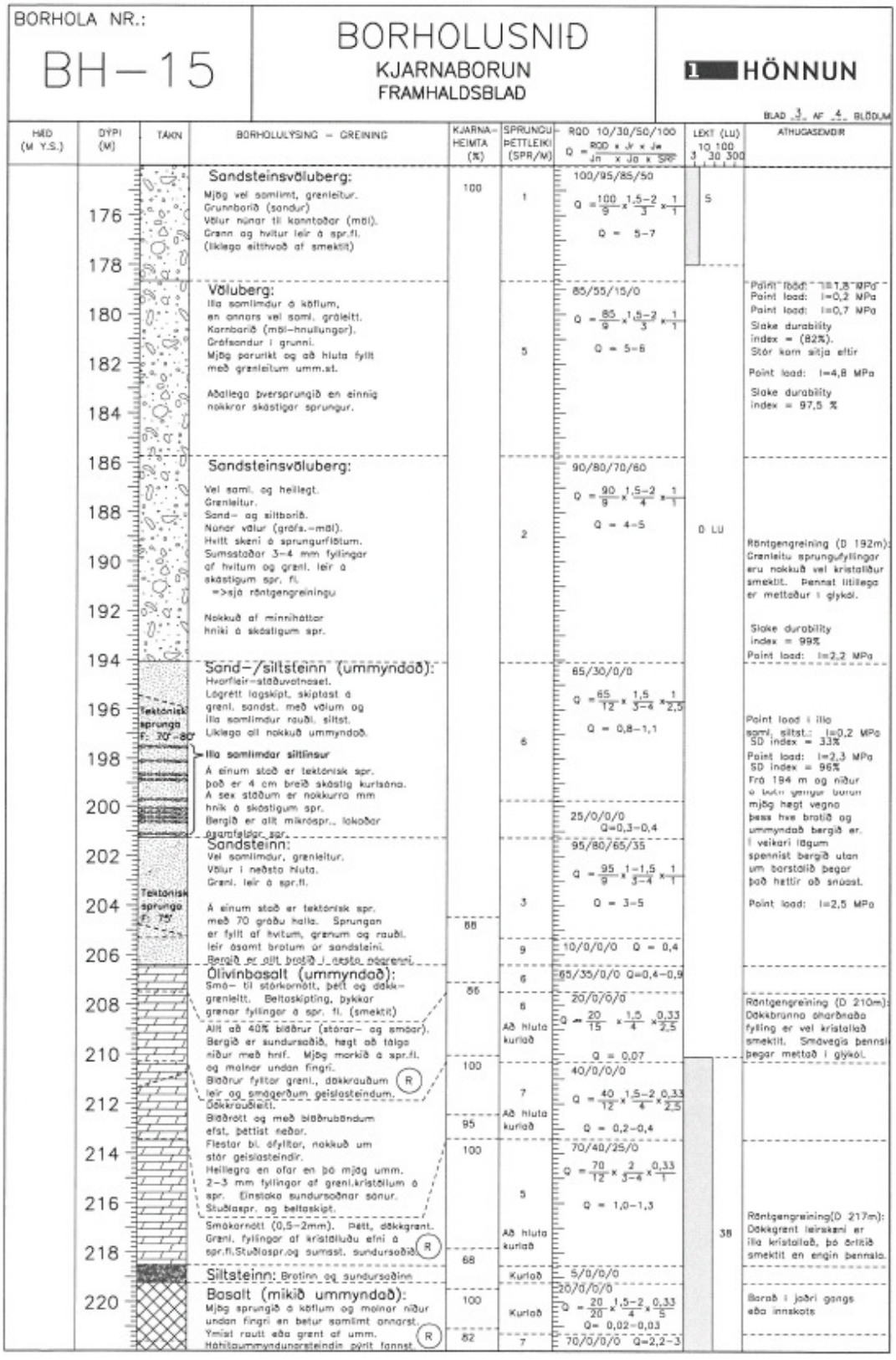
1 HÖNNUN

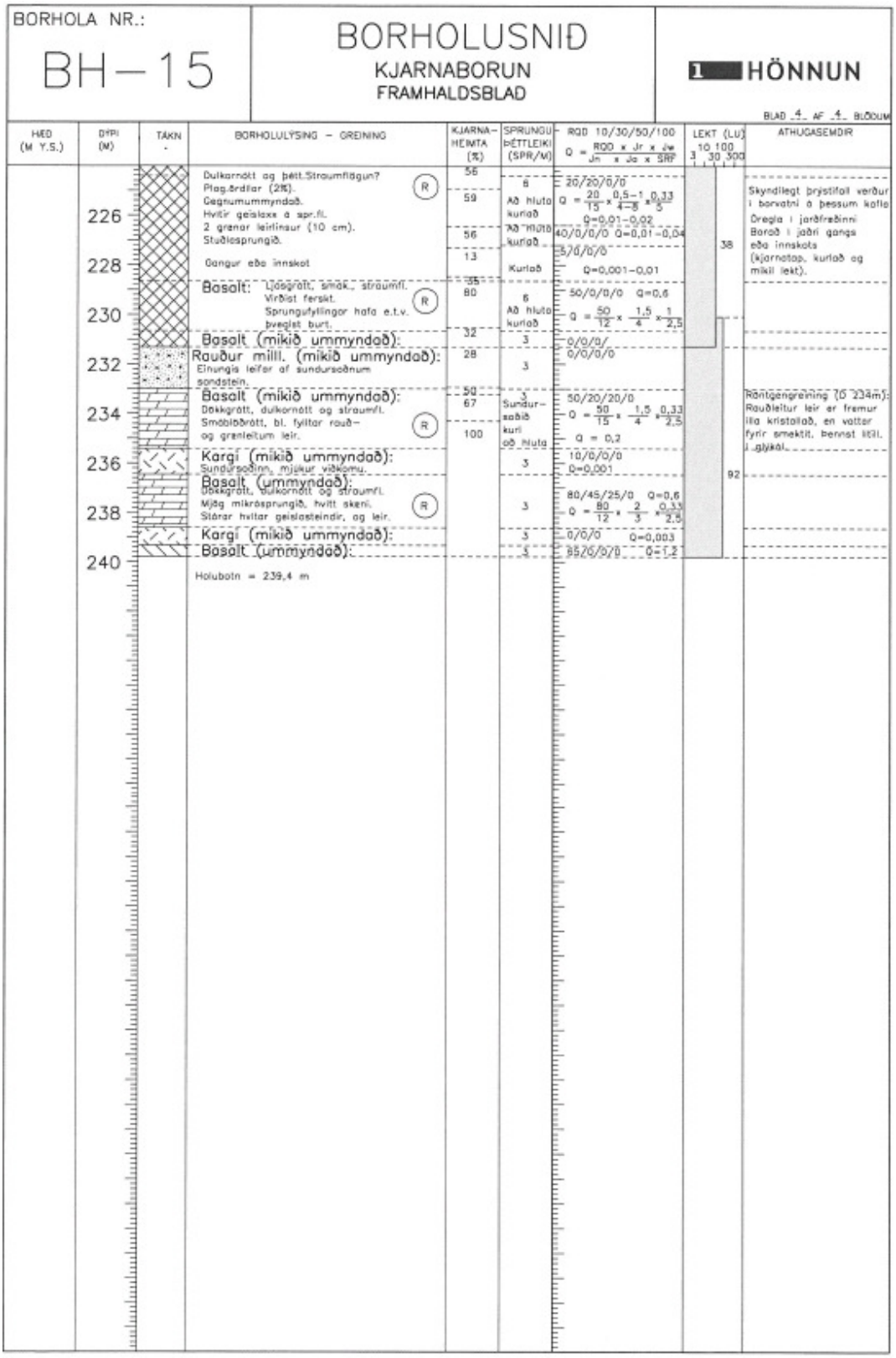
BLAÐ 2 AF 2 BLÖÐUM

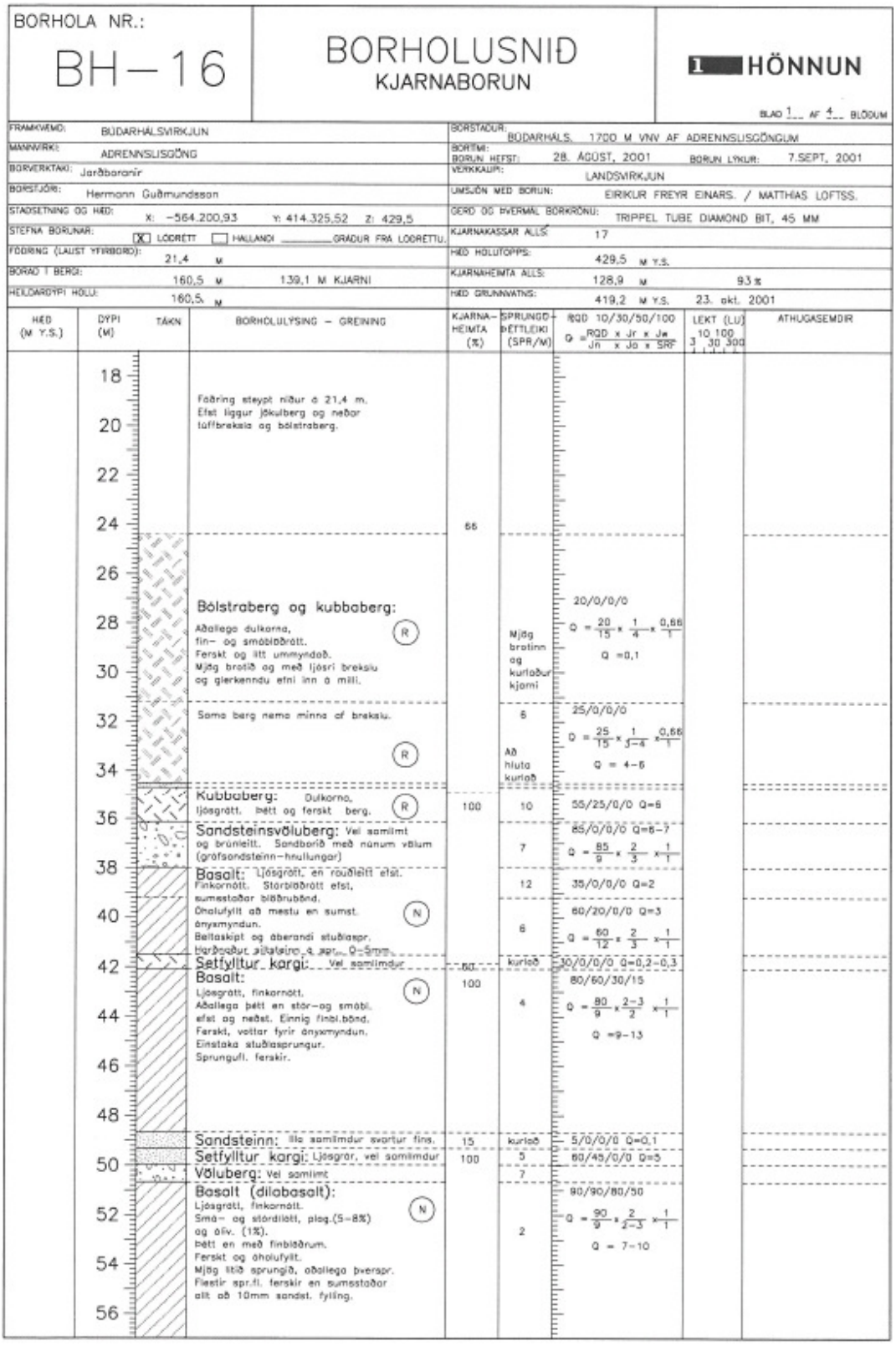
HÆÐ (M Y.S.)	DÝPI (M)	TÁKN	BORHOLULÝSING – GREINING	KJARNA-HEIMTA (%)	SPRUNGU-ÞÉTTLEIKI (SPR/M)	RQD 10/30/50/100 $Q = \frac{RQD}{Jn} \times \frac{Jr}{Ja} \times \frac{Jw}{SRF}$	LÉKT (LU) 10 100 3 30 300	ATHUGASEMDIR
	42		Líparít Samlímd líparít breksía. Pýrít fyrnst á sprungufletum.	100		87/70/43/0		Point load: I_{550}= 0,7 MPa
	44			100		$\frac{87}{15} \times \frac{2}{3} \times \frac{1}{1}$		Slaking-durability, 95,3%
	46					Q = 4		
	48			100			0 LU	
	50		Aðeins meira sprungið á bilinu 48,65 til 51,65 m dýpi.	100		46/24/19/0 $\frac{46}{15} \times \frac{2}{3} \times \frac{1}{1}$ Q = 2		
	52		Verður grænleitara á litinn. Sprungur í berginu verða minna áberandi	100		93/52/17/0		
	54							
	56			100		$\frac{93}{15} \times \frac{2}{3} \times \frac{1}{1}$		
	58					Q = 4		
	60			100				Point load: I_{550}= 0,8 MPa
	62		Holubotn = 60,65					


BORHOLA NR.:
BH–15
BORHOLUSNIÐ
KJARNABORUN
HÖNNUN
FRAMKVÆMD: BÚÐARHÁLSVIRKJUN
MANNVIRKI: AÐRENNSLISGÖNG
BORVERKTAKI: Jarðboranir
BORSTJÓRI: Hermann Guðmundsson
STAÐSETNING OG HÆÐ: X: –565.517,97 Y: 414.763,44 Z: 515,2
STEFNA BORUNAR: LÓÐRÉTT
FÓÐRING: 87,2 M
BORAÐ Í BERGI: 239,4 M 152,6 M KJARNI
HEILDARDÝPI HOLU: 239,4 M
BORSTAÐUR: BÚÐARHÁLS, 1000 SA VIÐ BH–12
BORUN HEFST: 14.ÁGÚST 2001
BORUN LÝKUR: 25.ÁGÚST 2001
VERKKAUPI: LANDSVIRKJUN
UMSJÓN MEÐ BORUN: EIRÍKUR F. EINARS./ATLI KARL INGIMARSS./MATTHÍAS LOFTSS.
GERÐ OG ÞVERMÁL BORKRÓNU: TRIPPEL TUBE DIAMOND BIT, 45 MM
KJARNAKASSAR ALLS: 18
HÆÐ HOLUTOPPS: 515,2 M Y.S.
KJARNAHEIMTA ALLS: 133,0 M 87 %
HÆÐ GRUNNVATNS: 484,4 M Y.S. 23. okt. 2001
HÆÐ (M Y.S.)
DÝPI (M)
TÁKN
BORHOLULÝSING – GREINING
KJARNAHEIMTA (%)
SPRUNGUÞÉTTLEIKI (SPR/M)
RQD 10/30/50/100
LEKT (LU)
ATHUGASEMDIR
Bólstraberg, bólstrabreksía og kubbaberg niður á 87,22 m dýpi. Kjarni ekki settur í kjarnakassa.
Bólstraberg:
Dul-/finkornótt, gráleitt.
Dílar um 1% plagíóklas (örðílar).
Bólstrar eru glerkenndir í kontakt.
Nokkuð þétt (fínblöðrur).
Flestar blöðrur tómar.
Mjög sprungið og sums. mulið.
Breksíulinsur inni á milli.
Ónyxmyndun og brúnleitur leir.
Sumsst. grænleitur leir.
50/5/0/0
Q = 0,8 – 1,8
Á ca. 87 m hverfur borvatn og kemur ekki eftir það. Gera má ráð fyrir mjög lekri eð á þessu dýpi.
Sandsteinsvöluberg: Fremur illa saml.
Grunnborið, lagskiptur sandur/silt.
Völur at grófsands og malarstærð.
55/0/0/0 Q=3–4
Basalt (dílabasalt):
Dul- og finkornótt, ljósgrátt.
Dílar um 5% plag og 1 % ólivín.
Nokkuð þétt enn með blöðróttum linsum (smáblöðrur), einnig finbl.bönd.
Ferskt.
Blöðrur ófylltar.
Sprungur fylltar, brúnnleitur siltsteinn og sandsteinn, allt að 5 cm fyllingar.
Stuðlasprungur.
70/25/5/0
Q = 5
Sand-/siltsteinn: Vel samlímdur.
Svartur, finsandur og silt.
Sprungur sumsstaðar fylltar silti (2–5 mm) og hvítu seolítaskeni.
Mest þversprungið, einnig lóðsprungið.
90/65/40/30
Q = 5
Point load: I=1,7 MPa
Basalt: Smástuðlað.
Dul-/smákornótt, plagdílótt (<1%).
Sprungufyllingar af leir og siltstein (allt að 5 cm).
55/0/0/0
Q = 3–5
Kargi:
50/0
Basalt:
Finkornótt og plagíóklasdílótt (<1%).
Þétt en fáeinar stórblöðrur, einnig finblöðrur.
Blöðrur hálffylltar ónyxmyndun.
Sprungufletir ferskir eða með ljósu siltskeni.
Stuðlasprungið.
Ferskt.
85/55/15/0
Q = 7–11
Setfylltur kargi:
Vel samlímdur að mestu.
Rauðleitur efst. Mjög blöðróttur.
Víða blandað sandsteini.
Einnig þunnar siltsteinslinsur.
85/45/25/0
Q = 7
Basalt:
Finkornótt, með einstaka plag. díl.
Finblöðrótt með bl.böndum. Ljósbrúnt siltskeni á sprunguflötum.
60/30/25/0 Q=3,3
Q = 3


BORHOLA NR.:
BH–15
BORHOLUSNIÐ
KJARNABORUN
FRAMHALDSBLAD
1 HÖNNUN
BLAD 2 AF 4 BLÖÐUM
HÆÐ (M Y.S.)
DÝPI (M)
TÁKN
BORHOLULÝSING – GREINING
KJARNA-HEIMTA (%)
SPRUNGU-ÞÉTTLEIKI (SPR/M)
RQD 10/30/50/100
LEKT (LU) 10 100 3 30 300
ATHUGASEMDIR
128
130
132
134
136
138
140
142
144
146
148
150
152
154
156
158
160
162
164
166
168
170
172
Stuðlasprungið.
Völuberg: Vel samlímt. Gróbrúnt og grunnbarið. Lagskipt, aðallega silt– en einnig sandsteinn. Völur núnar, (aðl. grófs., einnig möl) Stundum skæni af silti á sprungufletum.
Kargi: Vel samlímdur. Plag.díl. (8–10%) Blöðrur og spr. fyllist leir, silt og sandi.
Basalt (dilabasalt): Finkornótt. Dílar plag(5–8%) og ól(1–2%). Stærðlöðrótt efst en annars finblöðrubönd.
Nokkuð af stærðl. fyllist onyxmyndun. Sumar sprungur með rauðl. skæni. Nokkuð ferskt. Stuðlasprungið.
Rautt millilag:
Kargi: Vel samlímdur, 5–8% plag.dílótt, fyllist xeli.
Basalt (dilabasalt): Finkornóttur 5–8% plagíóklasdílótt. Finblöðrótt, en þéttist neðar. Finblöðrubönd. Blöðrur ítt fyllist og bergið er nokkuð ferskt. Leirskæni á flestum spr.
Kargi: Vel samlímdur. Fín– og smáblöðrótt en frauðkennt í miðju. Fyllist silti og onyxm. 5–8% smádílótt. plag.
Basalt (dilabasalt): Finkornótt, 5–8% plag.díl. Þétt og ferskt. Örþunnt ljóst siltskæni á spr.fl.
Sandsteinsvöluberg:
Vel samlímt. Grunnbarið (sandur). Völur núnar (möl). Lágrétt lagskipt, skiptast á lög af finsandi og grófsandi. Sumsst. skálbgun. Rauðleitt allra efst (40cm) en síðan gráleitt. Bergið virðist ekki ummyndað. Þunnt skæni af siltst. á spr.fl. Mest þversprungið en einnig, láðsprungið.
Þunnar vel samlímdar siltsteinslinsur
Setfyllitur kargi: Vel samlímdur Plag.díl. (1%), Frauðkenndur
(N)
(R/A)
(R)
(R)
(A)
82
100
100
RQD = RQD/Jn x Jr/Ja x Jw/SRF
85/45/0/0 Q = 85/9 x 2/3 x 1/1 Q = 6
85/55/0/0 Q=7 Q = 85/12 x 3/3 x 1/1
60/20/15/0 Q = 60/12 x 2,5/3 x 1/1 Q = 4
95/40/0/0 Q=7 Q = 95/12 x 2,5/3 x 1/1
85/90/35/0 Q = 85/12 x 2/2–3 x 1/1 Q = 5–7
70/15/0/0 Q=5 Q = 70/12 x 2,5/3 x 1/1
85/30/30/0 Q = 85/10–12 x 2,5/2 x 1/1 Q = 9–11
85/75/50/30 Q = 85/9 x 2/3 x 1/1 Q = 6
Allt að 20 mm siltst. linsur, SRF–2,5 Q = 3
Q = 6
95/90/0/0 Q=11 Q = 95/9 x 3/3 x 1/1
5
Point load: I=4,8 MPa
Point load: I=2,3 MPa
Slake durability index = 97,1
Point load: I=3,4 MPa


BORHOLA NR.:
BH–15
BORHOLUSNIÐ
KJARNABORUN
FRAMHALDSBLAD
1 HÖNNUN
BLAD 3 AF 4 BLÖÐUM
HÆÐ (M Y.S.)
DÝPI (M)
TÁKN
BORHOLULÝSING – GREINING
KJARNA-HEIMTA (%)
SPRUNGU-ÞÉTTLEIKI (SPR/M)
RQD 10/30/50/100
LEKT (LU) 10 100 3 30 300
ATHUGASEMDIR
Sandsteinsvöluberg:
Mjög vel samlímt, grenleitur.
Grunnbarið (sandur)
Völur núnar til kanntoðar (möl).
Grænn og hvítur leir á spr.fl.
(líklega eitthvað af smektít)
100
1
100/95/85/50
Q = 100/9 x 1,5–2/3 x 1/1
Q = 5–7
5
Völuberg:
Illa samlímdur á köflum,
en annars vel saml. gráleitt.
Kornbarið (möl–hnullungar).
Grófsandur í grunni.
Mjög porukt og að hluta fyllt
með grenleitum umm.st.
Aðallega þversprungið en einnig
nokkrar skástigar sprungur.
5
85/55/15/0
Q = 85/9 x 1,5–2/3 x 1/1
Q = 5–6
Point load: I=1,8 MPa
Point load: I=0,2 MPa
Point load: I=0,7 MPa
Slake durability index = (82%).
Stór korn sitja eftir
Point load: I=4,8 MPa
Slake durability index = 97,5 %
Sandsteinsvöluberg:
Vel saml. og heillegt.
Grenleitur.
Sand– og siltbarið.
Núnar völur (grófs.–möl).
Hellt skeni á sprungufleturn.
Sumsstaðar 3–4 mm fyllingar
af hvítum og græn. leir á
skástigum spr. fl.
=>sjá röntgengreiningu
Nokkuð af minnihattar
hnikí á skástigum spr.
2
90/80/70/60
Q = 90/9 x 1,5–2/4 x 1/1
Q = 4–5
0 LU
Röntgengreining (D 192m):
Grenleitu sprungufyllingar
eru nokkuð vel kristallaður
smektít. Þennat lítillega
er mettaður í glykól.
Slake durability index = 99%
Point load: I=2,2 MPa
Sand–/siltsteinn (ummyndað):
Hvorfleir–staðavatnsæsel.
Lögrétt lagskipt, skiptast á
græn. sandst. með völum og
illa samlímdur rauðl. siltst.
Líklega all nokkuð ummyndað.
Tektónisk sprunga
F: 30°–80°
Illa samlímdar siltlinsur
Á einum stað er tektónísk spr.
það er 4 cm breið skástig kurlaðna.
Á sex stöðum er nokkurra mm
hnik á skástigum spr.
Bergið er allt mikrósprungið, lokaðar
örsmáfelgar spr.
6
65/30/0/0
Q = 65/12 x 1,5/3–4 x 1/2,5
Q = 0,8–1,1
Point load í illa saml. siltst.: I=0,2 MPa SD index = 33%
Point load: I=2,3 MPa SD index = 96%
Frá 194 m og niður
mjög hægt vegna
þess hve brotið og
ummyndað bergið er.
Í veikari lögum
spennist bergið utan
um borstálið þegar
það hættir að snúast.
Point load: I=2,5 MPa
25/0/0/0
Q=0,3–0,4
Sandsteinn:
Vel samlímdur, grenleitur.
Völur í neðsta hluta.
Græn. leir á spr.fl.
Tektónisk sprunga
F: 75°
Á einum stað er tektónísk spr.
með 70 gráðu halla. Sprungan
er fyllt af hvítum, grænum og rauðl.
leir ásamt brotum úr sandsteini.
Bergið er allt brotið í mesta nagrenni
3
95/80/65/35
Q = 95/9 x 1–1,5/3–4 x 1/1
Q = 3–5
88
9
10/0/0/0 Q = 0,4
Ólivínbasalt (ummyndað):
Smá– til störkornótt, þétt og dökk–
grenleitt. Beltaskipting, bykkar
grænar fyllingar á spr. fl. (smektít)
6
65/35/0/0 Q=0,4–0,9
86
8
Að hluta kurlað
20/0/0/0
Q = 20/15 x 1,5/4 x 0,33/2,5
Q = 0,07
Röntgengreining (D 210m):
Dökkbrúnna ólarbnaða
fylling er vel kristölað
smektít. Smávegis þennsl
þegar mettað í glykól.
Allt að 40% blöðrur (stórar– og smáar).
Bergið er sundursoðið, hægt að tálga
niður með hnif. Mjög morkið á spr.fl.
og molnar undan fingri.
Blöðrur fyltar græn., dökkrauðum leir og smágerðum geislasteindum.
Dökkrauðleitt.
100
7
Að hluta kurlað
40/0/0/0
Q = 40/12 x 1,5–2/4 x 0,33/2,5
Q = 0,2–0,4
Blöðrótt og með blöðruböndum
efst, þéttist neðar.
Flestar bl. ófyltar, nokkuð um
stór geislasteindir.
Heillegra en ofar en þó mjög umm.
2–3 mm fyllingar af grænl.kristöllum á
spr. Einstaka sundursoðnar sönur.
Stuðlaspr. og beltaskipt.
95
100
5
Að hluta kurlað
70/40/25/0
Q = 70/12 x 2/3–4 x 0,33/1
Q = 1,0–1,3
Smákornótt (0,5–2mm). Þétt, dökkgrænt.
Græn. fyllingar af kristölluðu efni á
spr.fl.Stuðlaspr.og sumsst. sundursoðið.
38
Röntgengreining(D 217m):
Dökkgrænt leirskæni er
illa kristallað, þó örlítið
smektít en engin þennsla.
68
Siltsteinn: Brotinn og sundursoðinn
Kurlað
5/0/0/0
Basalt (mikið ummyndað):
Mjög sprungið á köflum og molnar niður
undan fingri en betur samlímt annarst.
Ýmist rautt eða grænt af umm.
Háhitaummyndunarsteindir pýrít fannst.
100
82
Kurlað
7
20/0/0/0
Q = 20/20 x 1,5–2/4 x 0,33/5
Q= 0,02–0,03
70/0/0/0 Q=2,2–3
Borað í jaðri gangs
eða innskots


BORHOLA NR.:
BH–15
BORHOLUSNIÐ
KJARNABORUN
FRAMHALDSBLAD
1 HÖNNUN
BLAÐ 4 AF 4 BLÖÐUM
HÆÐ (M Y.S.)
DÝPI (M)
TÁKN
BORHOLULÝSING – GREINING
KJARNA-HEIMTA (%)
SPRUNGU-ÞÉTTLEIKI (SPR/M)
RQD 10/30/50/100
LEKT (LU)
ATHUGASEMDIR
226
228
230
232
234
236
238
240
Dulkarnokt og þétt.Straumflögun? Plag.áræðar (2%).
Gegnumummyndað.
Hvítir geislaxa á spr.fl.
2 grænar leirlinsur (10 cm).
Stuðlasprungið.
Gangur eða innskot
Basalt: Ljósgrátt, smák., straumfl. Virðist ferskt. Sprungufyllingar hafa e.t.v. hvegist burt.
Basalt (mikið ummyndað):
Rauður milli. (mikið ummyndað): Einungis leifar af sundurseðnum sandstein.
Basalt (mikið ummyndað): Dökkgrátt, dulkornótt og straumfl. Smáblöðrótt, bl. fyllitar rauð- og grænleitum leir.
Kargi (mikið ummyndað): Sundurseðinn, mjúkur viðkomu.
Basalt (ummyndað): Dökkgrátt, dulkornótt og straumfl. Mjög mikrosprungið, hvítt skeni. Stórar hvítar geislasteindir, og leir.
Kargi (mikið ummyndað):
Basalt (ummyndað):
Holubotn = 239,4 m
Skyndilegt þrýstifall verður í borvatni á þessum kafla
Óregla í jarðfræðinni
Borað í jaðri gangs eða innskots (kjarnatap, kurlað og mikil leki).
Röntgengreining (ó 234m): Rauðleitur leir er fremur illa kristallað, en vatter fyrir smektít, þennst lítil. í glýkól.



BORHOLA NR.: BH–16

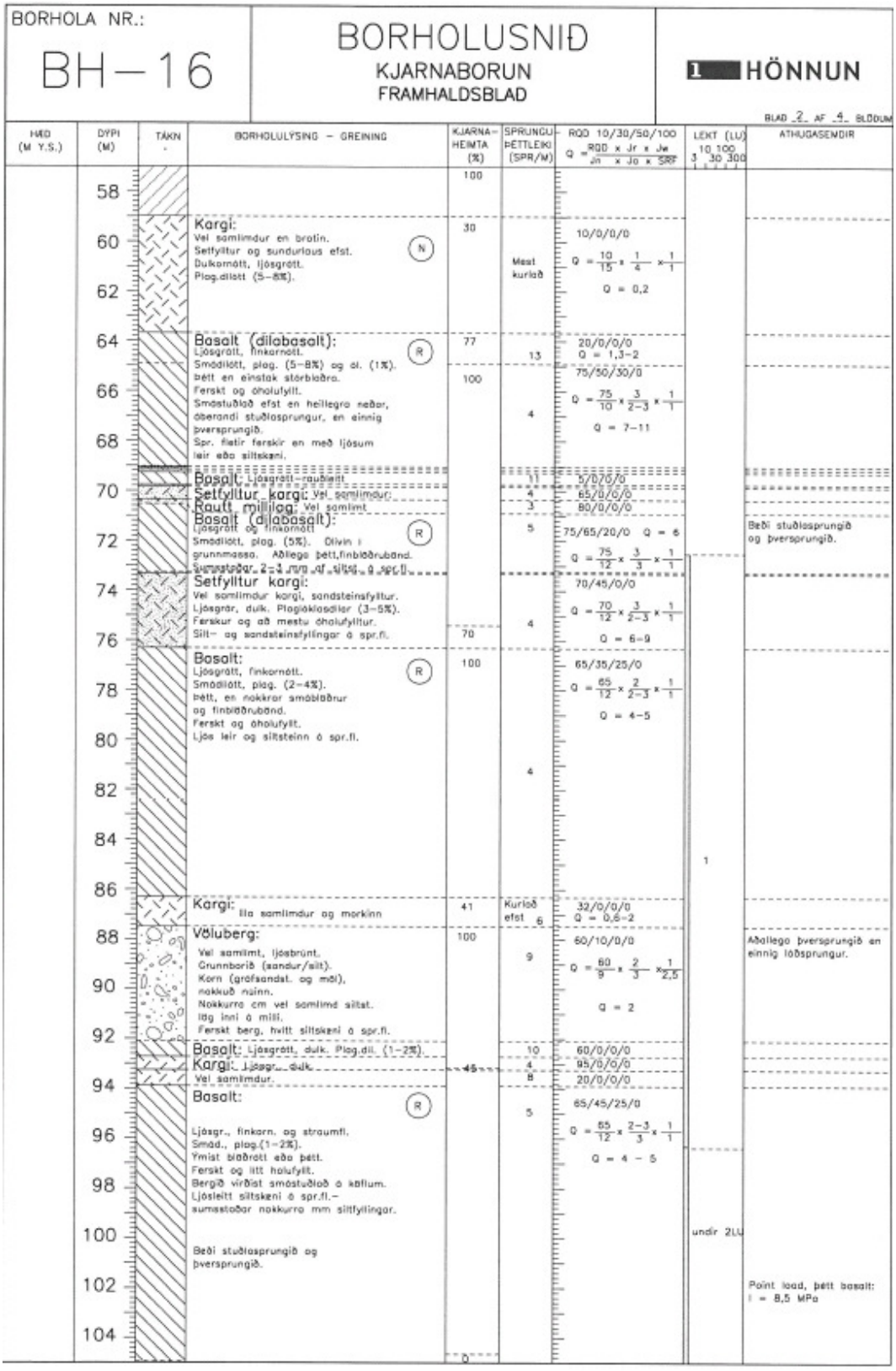
BORHOLUSNIÐ
KJARNABORUN

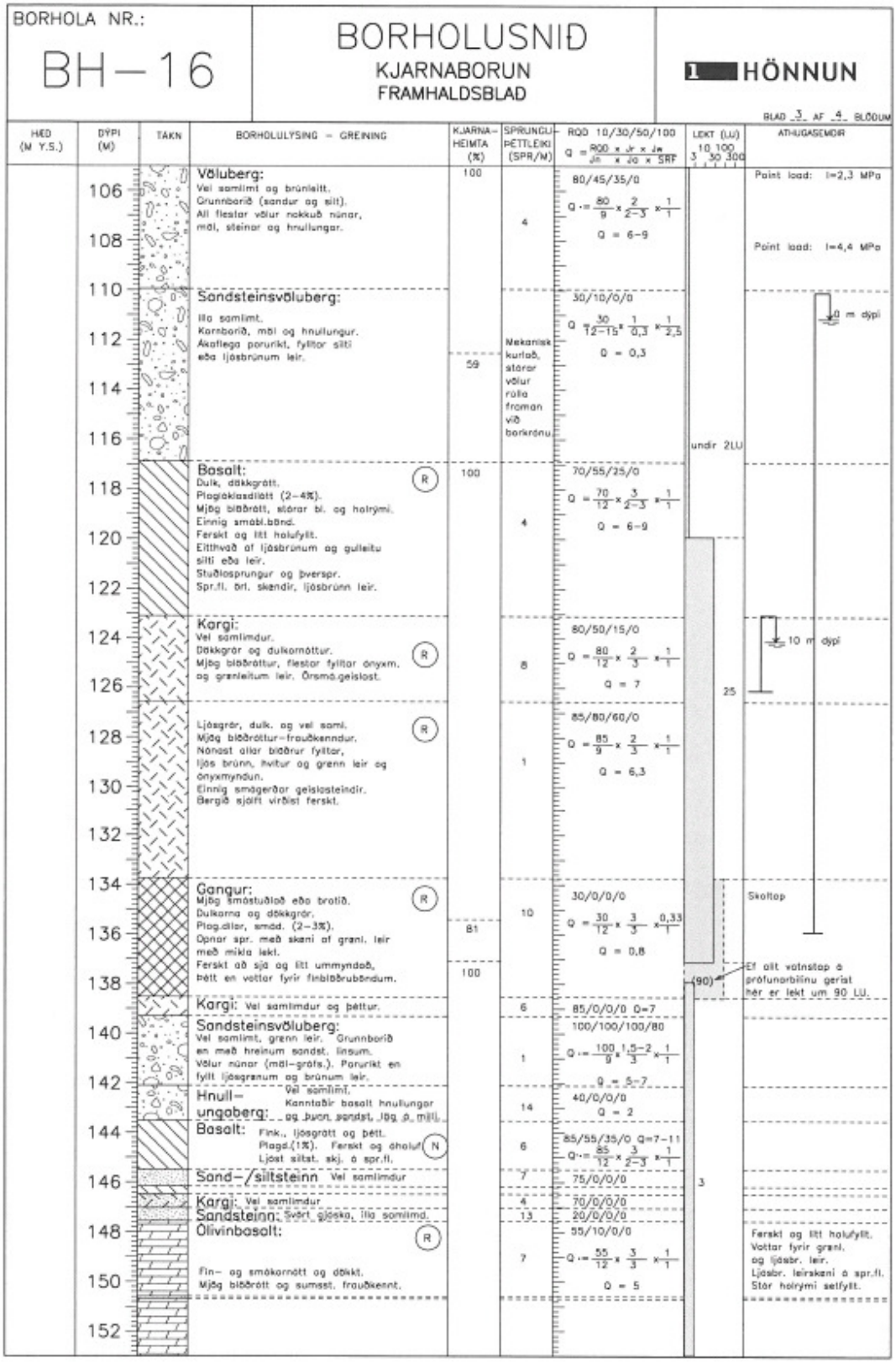
HÖNNUN

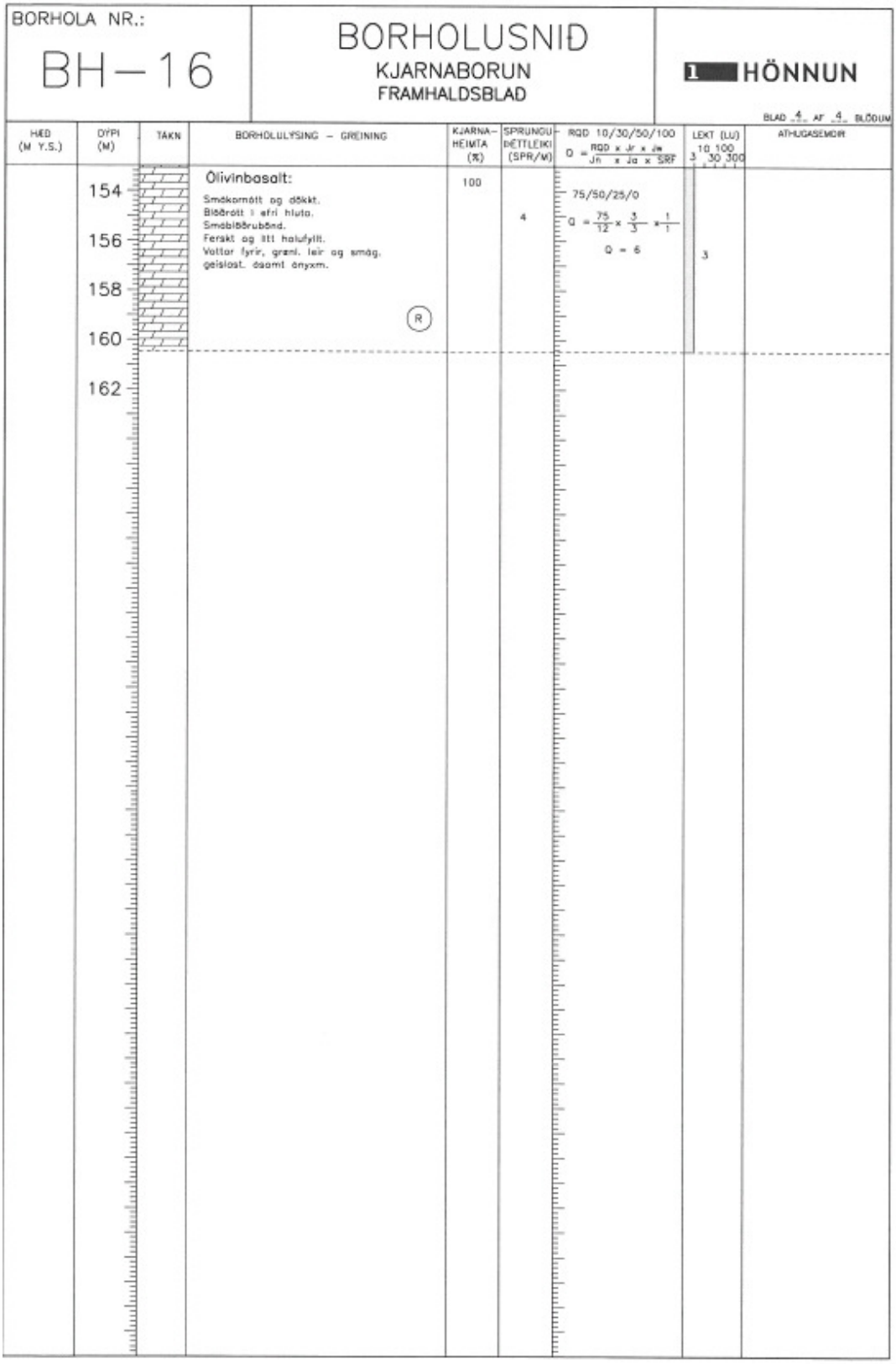
BLAÐ 1 AF 4 BLÖÐUM

FRAMKVÆMD: BUÐARHÁLSVIRKJUN
BORSTAÐUR: BUÐARHÁLS, 1700 M VNV AF ADRENNSLISGÖNGUM
MANNVIRKI: ADRENNSLISGÖNG
BORTÍMI: BORUN HEFST: 28. ÁGÚST, 2001 BORUN LYKUR: 7.SEPT, 2001
BORVERKTAKI: Jarðboranir
VERKKAUPI: LANDSVIRKJUN
BORSTJÓRI: Hermann Guðmundsson
UMSJÓN MEÐ BORUN: EIRÍKUR FREYR EINARS. / MATTHÍAS LOFTSS.
STAÐSETNING OG HÆÐ: X: −564.200,93 Y: 414.325,52 Z: 429,5
GERÐ OG ÞVERMÁL BORKRÓNU: TRIPPEL TUBE DIAMOND BIT, 45 MM
STEFNA BORUNAR: [X] LÓÐRÉTT [ ] HALLANDI _____ GRÁÐUR FRÁ LÓÐRÉTTU.
KJARNAKASSAR ALLS: 17
FÓÐRING (LAUST YFIRBORÐ): 21,4 M
HÆÐ HOLUTOPPS: 429,5 M Y.S.
BORAÐ Í BERGI: 160,5 M 139,1 M KJARNI
KJARNAHEIMTA ALLS: 128,9 M 93 %
HEILDARDÝPI HOLU: 160,5 M
HÆÐ GRUNNVATNS: 419,2 M Y.S. 23. okt. 2001

HÆÐ (M Y.S.)	DÝPI (M)	TÁKN	BORHOLULÝSING – GREINING	KJARNA-HEIMTA (%)	SPRUNGÐ-ÉTTLEIKI (SPR/M)	RQD 10/30/50/100 $Q = \frac{RQD}{Jn} \times \frac{Jr}{Ja} \times \frac{Jw}{SRF}$	LEKT (LU) 10 100 / 3 30 300	ATHUGASEMDIR
	18		Fóðring steypt niður á 21,4 m. Efst liggur jökulberg og neðar túffbrekcía og bólstraberg.					
	20							
	22							
	24			66				
	26		**Bólstraberg og kubbaberg:** Aðallega dulkorna, fín– og smáblöðrótt. Ferskt og lítt ummyndað. Mjög brotið og með ljósri brekíu og glerkenndu efni inn á milli. (R)		Mjög brotinn og kurlaður kjarni	20/0/0/0 $Q = \frac{20}{15} \times \frac{1}{4} \times \frac{0,66}{1}$ $Q = 0,1$		
	28							
	30							
	32		Sama berg nema minna af brekíu. (R)		6 Að hluta kurlað	25/0/0/0 $Q = \frac{25}{15} \times \frac{1}{3-4} \times \frac{0,66}{1}$ $Q = 4-5$		
	34							
	36		**Kubbaberg:** Dulkorna, ljósgrátt, þétt og ferskt berg. (R)	100	10	55/25/0/0 Q=6		
			Sandsteinsvöluberg: Vel samlímt og brúnleitt. Sandborið með núnum völum (gröfsandsteinn–hnullungar)		7	85/0/0/0 Q=6–7 $Q = \frac{85}{9} \times \frac{2}{3} \times \frac{1}{1}$		
	38		**Basalt:** Ljósgrátt, en rauðleitt efst. Fínkornótt. Störblöðrótt efst, sumstaðar blöðrubönd. Óholufyllt að mestu en sumst. ónæmyndun. Beitaskipt og áberandi stuðlaspr. Harðsoðið ákafsins á spr., 0–5mm. (N)		12	35/0/0/0 Q=2		
	40				6	60/20/0/0 Q=3 $Q = \frac{60}{12} \times \frac{2}{3} \times \frac{1}{1}$		
	42		**Setfyllitur kargi:** Vel samlímdur	~80	kurlað	30/0/0/0 Q=0,2–0,3		
			Basalt: Ljósgrátt, fínkornótt. Aðallega þétt en stör–og smábl. efst og neðst. Einnig fínbl.bönd. Ferskt, veltar fyrir ónæmyndun. Einstaka stuðlasprungur. Sprungufl. ferskir. (N)	100	4	80/60/30/15 $Q = \frac{80}{9} \times \frac{2-3}{2} \times \frac{1}{1}$ $Q = 9-13$		
	44							
	46							
	48							
			Sandsteinn: lla samlímdur svartur fins.	15	kurlað	5/0/0/0 Q=0,1		
	50		**Setfyllitur kargi:** Ljósgrár, vel samlímdur	100	5	60/45/0/0 Q=5		
			Völuberg: Vel samlímt		7			
	52		**Basalt (dílabasalt):** Ljósgrátt, fínkornótt. Smá– og stórdílótt, plag.(5–8%) og ólív. (1%). Þétt en með fínblöðrum. Ferskt og óholufyllt. Mjög lítið sprungið, aðallega þverspr. Flestir spr.fl. ferskir en sumsstaðar allt að 10mm sandst. fylling. (N)		2	90/90/80/50 $Q = \frac{90}{9} \times \frac{2}{2-3} \times \frac{1}{1}$ $Q = 7-10$		
	54							
	56							


BORHOLA NR.:
BH–16
BORHOLUSNIÐ
KJARNABORUN
FRAMHALDSBLAD
1 HÖNNUN
BLAÐ 2 AF 4 BLÖÐUM
HÆÐ (M Y.S.)
DÝPI (M)
TÁKN
BORHOLULÝSING – GREINING
KJARNAHEIMTA (%)
SPRUNGUÞÉTTLEIKI (SPR/M)
RQD 10/30/50/100
LEXT (LU)
ATHUGASEMDIR
58
60
62
64
66
68
70
72
74
76
78
80
82
84
86
88
90
92
94
96
98
100
102
104
Kargi:
Vel samlimdur en brotin.
Setfyllitur og sundurlaus efst.
Dulkornótt, ljósgrátt.
Plag.dílótt (5–8%).
Basalt (dílabasalt):
Ljósgrátt, finkornótt.
Smádílótt, plag. (5–8%) og ol. (1%).
Þétt en einstak stórblaðra.
Ferskt og óholufyllt.
Smástuðlað efst en heillegra neðar, óreglandi stuðlasprungur, en einnig þversprungið.
Spr. flatir ferskir en með ljósum leir eða siltskeni.
Basalt: Ljósgrátt–rauðleitt
Setfyllitur kargi: Vel samlimdur.
Kaolt millilag: Vel samlimt
Basalt (dílabasalt):
Ljósgrátt og finkornótt
Smádílótt, plag. (5%). Ólivín í grunnmassa. Aðliggja þétt,finblöðrubönd.
Sumstaðar 2–3 mm af siltsk. á spr.fl.
Setfyllitur kargi:
Vel samlimdur kargi, sandsteinsfyllitur.
Ljósgrár, dulk. Plagíóklasdílar (3–5%).
Ferskur og að mestu óholufylltur.
Silt– og sandsteinsfyllingar á spr.fl.
Basalt:
Ljósgrátt, finkornótt.
Smádílótt, plag. (2–4%).
Þétt, en nokkrar smáblöðrur og finblöðrubönd.
Ferskt og óholufyllt.
Ljós leir og siltsteinn á spr.fl.
Kargi: lla samlimdur og morkinn
Völuberg:
Vel samlímt, ljósbrúnt.
Grunnborið (sandur/silt).
Korn (grófsandst. og möl), nokkuð núinn.
Nokkurra cm vel samlímd siltst. lög inni á milli.
Ferskt berg, hvítt siltskeni á spr.fl.
Basalt: Ljósgrátt, dulk. Plag.díl. (1–2%).
Kargi: Ljósgr., dulk.
Vel samlímdur.
Basalt:
Ljósgr., finkorn. og straumfl.
Smád., plag.(1–2%).
Ýmist blöðrótt eða þétt.
Ferskt og lítt holufyllt.
Bergið virðist smástuðlað á köflum.
Ljósleitt siltskeni á spr.fl.– sumsstaðar nokkurra mm siltfyllingar.
Beði stuðlasprungið og þversprungið.
100
30
77
13
100
4
11
4
3
5
4
70
100
4
41
Kurlað efst 6
100
9
10
4
45
8
5
0
60/10/0/0
Q = 10/15 x 1/4 x 1/1
Q = 0,2
20/0/0/0
Q = 1,3–2
75/50/30/0
Q = 75/10 x 3/2–3 x 1/1
Q = 7–11
5/0/0/0
65/0/0/0
80/0/0/0
75/65/20/0 Q = 6
Q = 75/12 x 3/3 x 1/1
70/45/0/0
Q = 70/12 x 3/2–3 x 1/1
Q = 6–9
65/35/25/0
Q = 65/12 x 2/2–3 x 1/1
Q = 4–5
32/0/0/0
Q = 0,6–2
60/10/0/0
Q = 60/9 x 2/3 x 1/2,5
Q = 2
60/0/0/0
95/0/0/0
20/0/0/0
65/45/25/0
Q = 65/12 x 2–3/3 x 1/1
Q = 4 – 5
10 100
3 30 300
1
undir 2LU
Beði stuðlasprungið og þversprungið.
Aðallega þversprungið en einnig láðsprungur.
Point load, þétt basalt: I = 8,5 MPa


BORHOLA NR.:
BH – 16
BORHOLUSNIÐ
KJARNABORUN
FRAMHALDSBLAD
1 HÖNNUN
BLAÐ 3 AF 4 BLÖÐUM
HÆÐ (M Y.S.)
DÝPI (M)
TÁKN
BORHOLULÝSING – GREINING
KJARNA-HEIMTA (%)
SPRUNGU-ÞÉTTLEIKI (SPR/M)
RQD 10/30/50/100
LEKT (LU) 10 100 3 30 300
ATHUGASEMDIR
106
108
110
112
114
116
118
120
122
124
126
128
130
132
134
136
138
140
142
144
146
148
150
152
Völuberg:
Vel samlimt og brúnleitt.
Grunnborið (sandur og silt).
All flestar völur nokkuð núnar, möl, steinar og hnullungar.
100
4
80/45/35/0
Q = 6–9
Point load: I=2,3 MPa
Point load: I=4,4 MPa
Sandsteinsvöluberg:
Illa samlimt.
Kornborið, möl og hnullungur.
Ákaflega porurikt, fyllt af silti eða ljósbrúnum leir.
59
Mekanisk kurlað, störar völur rúlla framan við borkrónu.
30/10/0/0
Q = 0,3
0 m dýpi
undir 2LU
Basalt:
Dulk, dökkgrátt.
Plagioklasdílótt (2–4%).
Mjög blöðrótt, störar bl. og holrými.
Einnig smábl.bönd.
Ferskt og lítt holufyllt.
Eitthvað af ljósbrúnum og gulleitu silti eða leir.
Stuðlasprungur og þversprungur.
Spr.fl. brl. skendir, ljósbrúnn leir.
R
100
4
70/55/25/0
Q = 6–9
Kargi:
Vel samlimdur.
Dökkgrár og dulkormóttur.
Mjög blöðróttur, flestar fyllt. onyxm. og grænleitum leir. Örsmá geislost.
R
8
80/50/15/0
Q = 7
10 m dýpi
25
Ljósgrár, dulk. og vel saml.
Mjög blöðróttur–frauðkenndur.
Nánast allar blöðrur fyllt., ljós brúnn, hvítur og grænn leir og onyxmyndun.
Einnig smágerðar geislasteindir.
Bergið sjálft virðist ferskt.
R
1
85/80/60/0
Q = 6,3
Gangur:
Mjög smástuðlað eða brotið.
Dulkorna og dökkgrár.
Plag.dílar, smád. (2–3%).
Opnar spr. með skæni af grani. leir með mikla lekt.
Ferskt að sjá og lítt ummyndað, þétt en vottar fyrir fínblöðrubröndum.
R
81
100
10
30/0/0/0
Q = 0,8
Skoltop
(90)
Ef allt vatnstap á prófunarbilinu gerist hér er lekt um 90 LU.
Kargi: Vel samlimdur og þéttur.
6
85/0/0/0 Q=7
Sandsteinsvöluberg:
Vel samlimt, grænn leir. Grunnborið en með hreinum sandst. linsum.
Völur núnar (möl–gróft.). Porurikt en fyllt ljósgrænum og brúnum leir.
1
100/100/100/80
Q = 5–7
3
Hnull-ungaberg:
Vel samlimt.
Kanntaðir basalt hnullungar og þvarn. sandst. í bg. þ. möl.
14
40/0/0/0
Q = 2
Basalt:
Fink., ljósgrátt og þétt.
Plags.(1%). Ferskt og óholuf
Ljóst siltst. skj. á spr.fl.
N
6
85/55/35/0 Q=7–11
Sand–/siltsteinn Vel samlimdur
7
75/0/0/0
Kargi: Vel samlimdur
4
70/0/0/0
Sandsteinn: Svört gjóska, illa samlimd.
1,3
20/0/0/0
Ólivínbasalt:
R
55/10/0/0
Q = 5
7
Ferskt og lítt holufyllt.
Vottar fyrir grani. og ljósbr. leir.
Ljósbr. leirskæni á spr.fl.
Stór holrými selfyllt.
Fín– og smákornótt og dökkt.
Mjög blöðrótt og sumsst. frauðkennt.



BORHOLA NR.: BH–16

BORHOLUSNIÐ
KJARNABORUN
FRAMHALDSBLAD

1 HÖNNUN

BLAD 4 AF 4 BLÖÐUM

HÆÐ (M Y.S.)	DÝPI (M)	TÁKN	BORHOLULÝSING – GREINING	KJARNA-HEIMTA (%)	SPRUNGU-ÞÉTTLEIKI (SPR/M)	RQD 10/30/50/100 $Q = \frac{RQD}{Jn} \times \frac{Jr}{Ja} \times \frac{Jw}{SRF}$	LEKT (LU) 1 10 100 3 30 300	ATHUGASEMDIR
	154		**Ólivínbasalt:** Smákornótt og dökkt. Blöðrótt í efri hluta. Smábilöðrubönd. Ferskt og lítt holufyllt. Vottar fyrir, grænl. leir og smág. geislost. daomt ónyxm. (R)	100	4	75/50/25/0 $Q = \frac{75}{12} \times \frac{3}{3} \times \frac{1}{1}$ $Q = 6$	3	
	156							
	158							
	160							
	162							

4. Appendix – Selected rock cores

This appendix contains pictures of rock cores from Búðarháls boreholes.

- Pictures of core boxes BH-9, BH-11, BH -12, BH-15 and BH-16.
- Pictures of selected rock cores for the laboratory tests.

Pictures of core boxes BH-9, BH-11, BH -12, BH-15 and BH-16

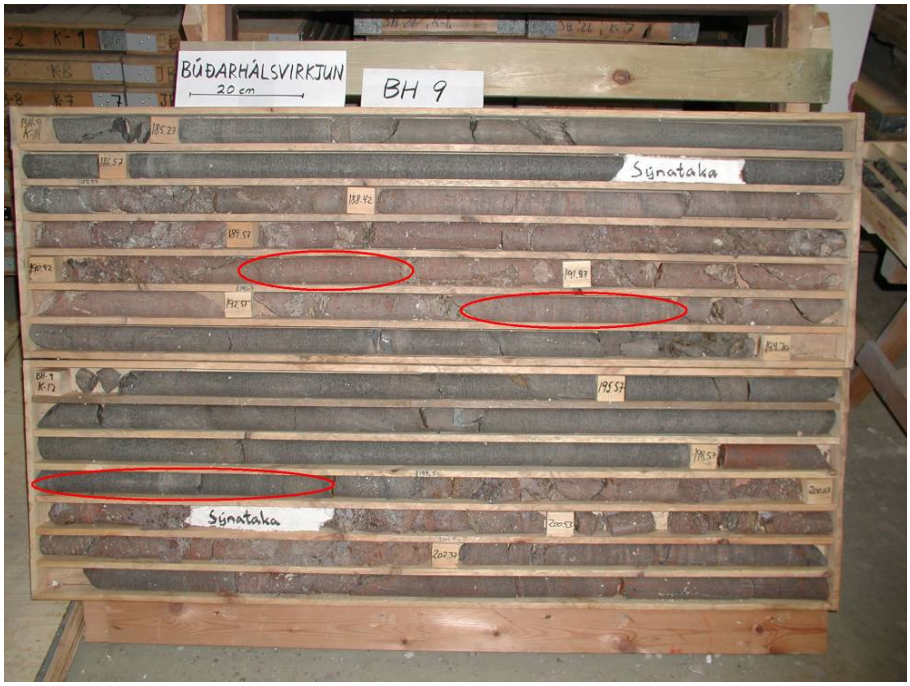


Figure 4-1. Core boxes BH-9, K11-12. Red markings show core samples selected for lab testing. White marking shows placement of core samples tested in 2001.

Figure 4-2. Core boxes BH-9, K13-14.

Figure 4-3. Core boxes BH-11, K1-2.

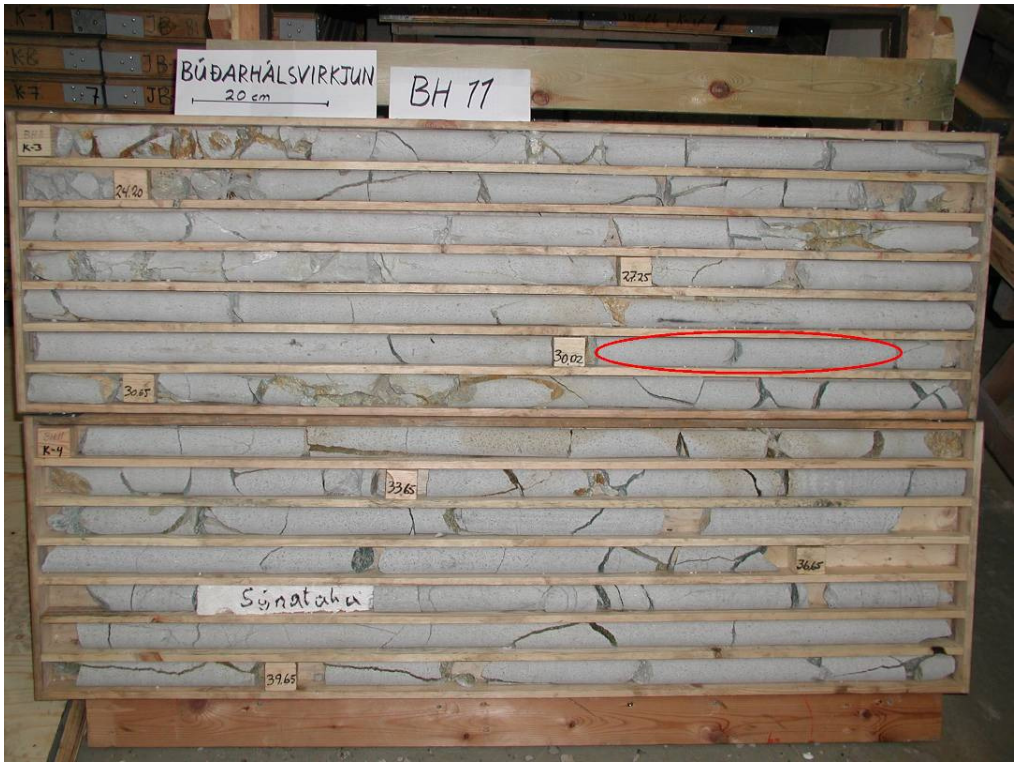


Figure 4-4. Core boxes BH-11, K3-4.

Figure 4-5. Core boxes BH-12, K3-4.

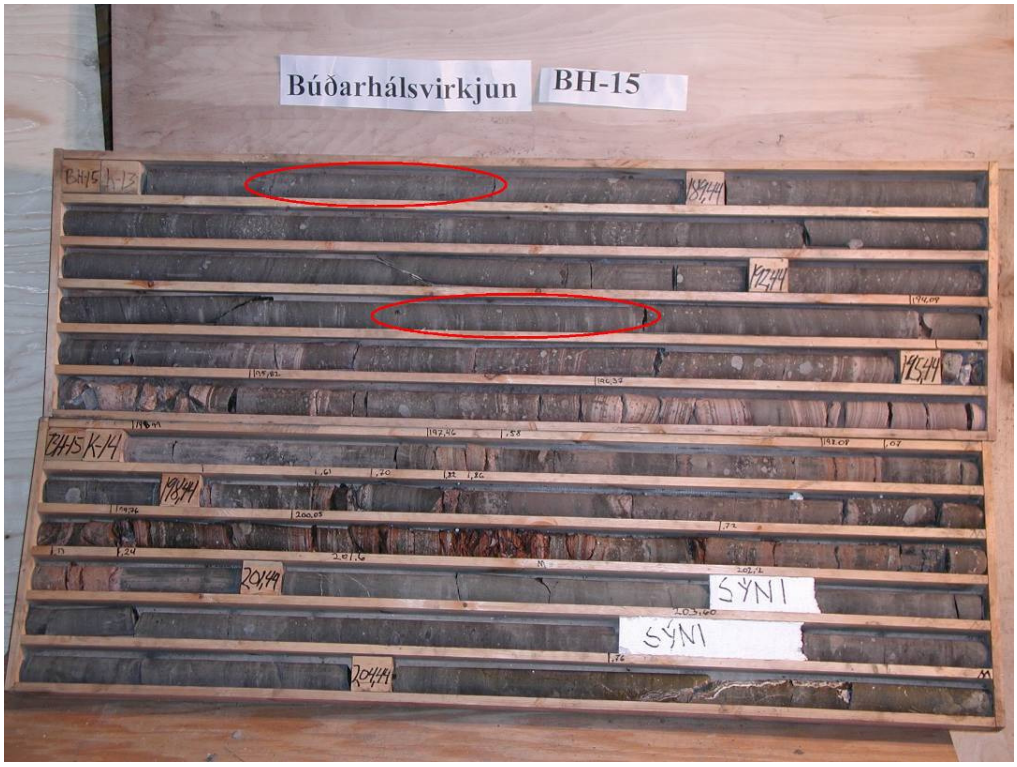


Figure 4-6. Core boxes BH-15, K13-14.

Figure 4-7. Core boxes BH-15, K15-16.

Figure 4-8. Core boxes BH-15, K17-18.

Figure 4-9. Core boxes BH-16, K7-8.

Figure 4-10. Core boxes BH-16, K9-10.

Figure 4-11. Core boxes BH-16, K11-12.


Borehole BH15
Sandstone/Conglomerate
Borehole BH15
Sandstone/Conglomerate
Borehole BH15
Altered Olivine Tholeiite
Borehole BH9
Altered Olivine Tholeiite
Borehole BH9
Scoria
Borehole BH9
Scoria
Borehole BH12
Rhyolite (inhomogeneous)
Borehole BH11
Rhyolite (homogeneous)
Borehole BH16
Tholeiite (vesicular)
Borehole BH12
Rhyolite (inhomogeneous)
Borehole BH16
Conglomerate
Borehole BH9
Altered Olivine Tholeiite
Borehole BH9
Altered Olivine Tholeiite
Borehole BH9
Scoria
Borehole BH16
Tholeiite
Borehole BH11
Rhyolite (homogeneous)
Borehole BH11
Rhyolite (homogeneous)
Borehole BH16
Conglomerate
Borehole BH16
Conglomerate
Borehole BH12
Rhyolite (inhomogeneous)
Borehole BH12
Rhyolite (inhomogeneous)


Borehole BH15
Altered Olivine Tholeiite
Depth [m] Box Length [m]
213,7 214,09 K15 0,39
Borehole BH15
Sandstone/Conglomerate
Depth [m] Box Length [m]
193,3 193,69 K13 0,39
Borehole BH15
Sandstone/Conglomerate
Depth [m] Box Length [m]
188,75 189,14 K13 0,39


Borehole BH9
Altered Olivine Tholeiite
Depth [m] Box Length [m]
210,2 210,57 K13 0,37
Borehole BH9
Scoria
Depth [m] Box Length [m]
192,92 193,34 K11 0,42
Borehole BH9
Scoria
Depth [m] Box Length [m]
191,28 191,57 K11 0,29

Borehole BH9
Scoria

Depth [m]		Box	Length [m]
199,2	199,3	K11	0,1

Borehole BH16
Tholeiite (vesicular)

Depth [m]		Box	Length [m]
121,8	122,28	K12	0,48

Borehole BH16
Tholeiite

Depth [m]		Box	Length [m]
85,39	85,7	K8	0,31

Borehole BH9
Altered Olivine Tholeiite

Depth [m]		Box	Length [m]
198,95	199,2	K11	0,25

Borehole BH9
Altered Olivine Tholeiite

Depth [m]		Box	Length [m]
198,65	198,95	K11	0,3

Borehole BH16
Conglomerate

Depth [m]		Box	Length [m]
108,09	108,39	K10	0,3

Borehole BH16
Conglomerate

Depth [m]		Box	Length [m]
107,48	107,89	K10	0,41

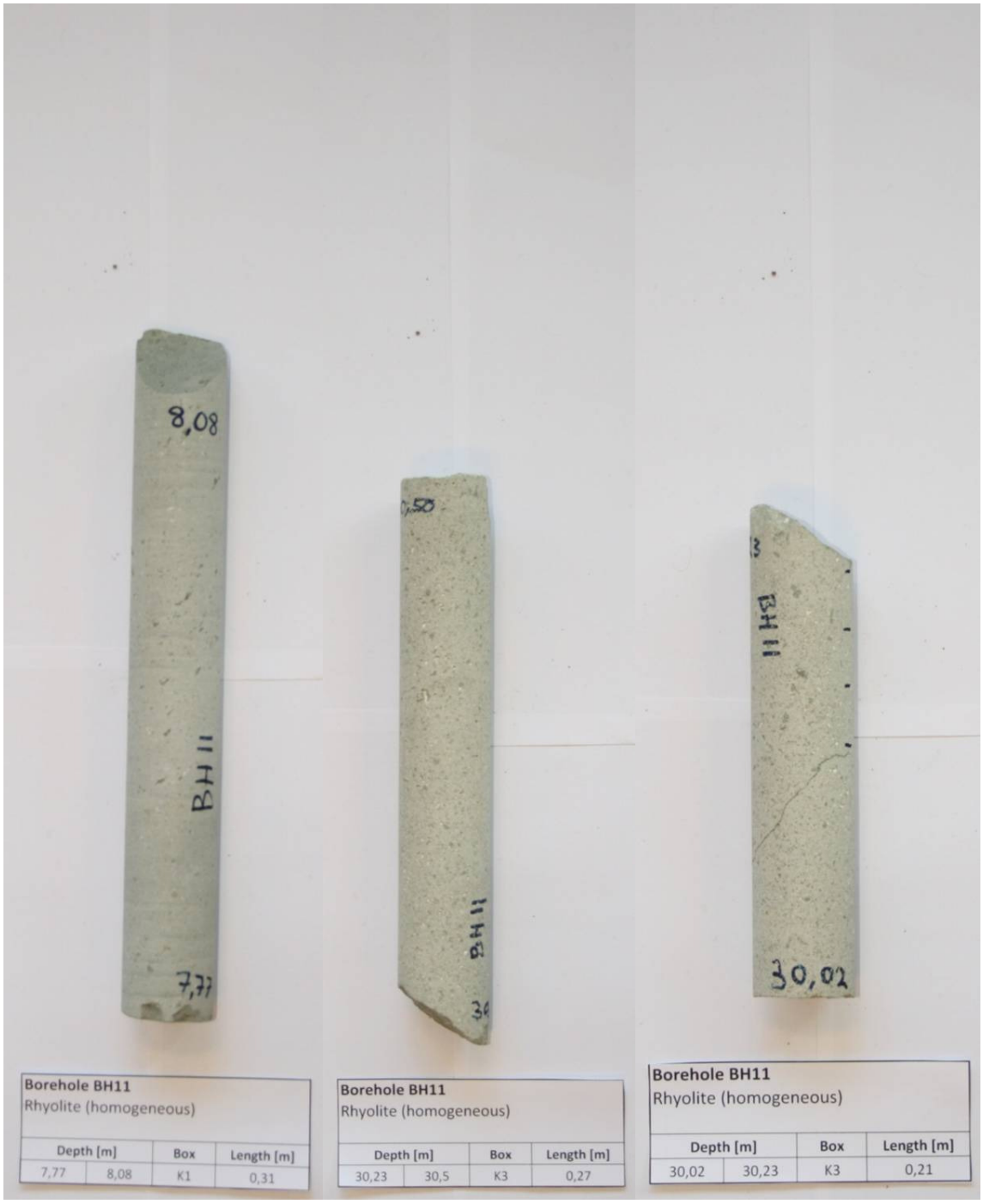
Borehole BH16
Conglomerate

Depth [m]		Box	Length [m]
107,89	108,09	K10	0,2

Borehole BH12
Rhyolite (inhomogeneous)

Depth [m]		Box	Length [m]
41,97	42,35	K4	0,38


43,65
BH12
44
Borehole BH12
Rhyolite (inhomogeneous)
Depth [m] Box Length [m]
43,64 44,09 K4 0,45
38,78
BH12
39,1
Borehole BH12
Rhyolite (inhomogeneous)
Depth [m] Box Length [m]
38,78 39,5 K3 0,72
39,
50
Borehole BH12
Rhyolite (inhomogeneous)
Depth [m] Box Length [m]
39,5 39,68 K4 0,18



Borehole BH11
Rhyolite (homogeneous)

Depth [m]		Box	Length [m]
7,77	8,08	K1	0,31

Borehole BH11
Rhyolite (homogeneous)

Depth [m]		Box	Length [m]
30,23	30,5	K3	0,27

Borehole BH11
Rhyolite (homogeneous)

Depth [m]		Box	Length [m]
30,02	30,23	K3	0,21

5. Appendix – Laboratory test results

This appendix contains results from laboratory tests on selected rock cores from Búðarháls, performed at GEO and DTU.

- Tables showing all laboratory test results.
- Pictures of samples after Brazil test.
- Pictures of samples after Uniaxial Compression test.
- Plots from Unconfined Compression test.
- Pictures of samples after Triaxial test and failure stresses.
- Plots from triaxial test.
- Comparison of laboratory test results and other test results from Iceland.

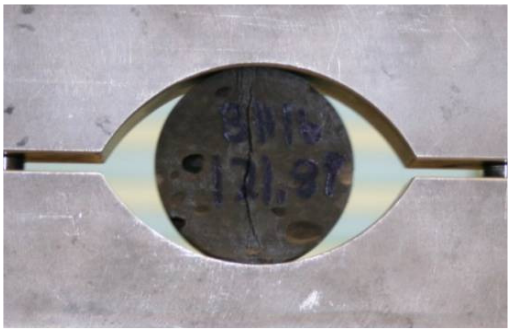
Tables showing all laboratory test results

Sample nr.	Bore hole	Depth	Lithology	Height	Diameter	D/H	Bulk density	Water content	Porosity	Void ratio	Tensile strength	UCS	Brazil	Uniax	Triax
[-]	[-]	[m]	[-]	[cm]	[cm]	[-]	[g/cm3]	[%]	[%]	[-]	[MPa]	[MPa]	[-]	[-]	[-]
42	BH16	121,89	Tholeiite (Vesicular)	2,284	4,456	1,95	2,665	3,11	0,09	0,09	8,513		X		
43	BH16	121,86	Tholeiite (Vesicular)	2,251	4,454	1,98	2,678	3,00	0,08	0,09	8,706		X		
44	BH16	121,83	Tholeiite (Vesicular)	2,269	4,453	1,96	2,647	3,16	0,09	0,09	6,567		X		
45	BH9	199,02	Altered Olivine Tholeiite	2,190	4,488	2,05	2,690	2,92	0,08	0,09	5,935		X		
46	BH15	214,03	Altered Olivine Tholeiite	2,306	4,455	1,93	2,670	3,08	0,08	0,09	8,351		X		
47	BH15	213,7	Altered Olivine Tholeiite	2,325	4,467	1,92	2,685	3,06	0,08	0,09	7,096		X		
48	BH15	214	Altered Olivine Tholeiite	2,249	4,459	1,98	2,657	3,22	0,09	0,10	7,104		X		
49	BH15	214,06	Altered Olivine Tholeiite	2,213	4,459	2,01	2,653	3,17	0,09	0,10	8,984		X		
50	BH9	210,47	Altered Olivine Tholeiite	2,251	4,482	1,99	2,616	3,74	0,10	0,11	2,776		X		
51	BH9	210,44	Altered Olivine Tholeiite	2,298	4,481	1,95	2,583	4,07	0,11	0,12	5,466		X		
52	BH9	210,41	Altered Olivine Tholeiite	2,273	4,466	1,96	2,535	4,85	0,13	0,15	3,603		X		
53	BH9	193,34	Scoria	2,309	4,501	1,95	2,475	5,52	0,14	0,17	0,929		X		
54	BH15	188,81	Sandstone	2,263	4,464	1,97	2,245	8,99	0,22	0,28	3,540		X		
55	BH15	188,78	Sandstone	2,334	4,466	1,91	2,165	10,55	0,26	0,34	3,104		X		
56	BH16	107,72	Conglomerate	2,274	4,467	1,96	2,251	8,59	0,21	0,27	2,583		X		
57	BH15	189,05	Sandstone	2,308	4,465	1,93	2,189	9,72	0,24	0,31	3,470		X		
58	BH15	189,02	Sandstone	2,304	4,465	1,94	2,186	9,84	0,24	0,31	3,542		X		
59	BH9	193,05	Scoria	2,272	4,490	1,98	2,397	6,22	0,16	0,19	1,066		X		
60	BH9	193,08	Scoria	2,369	4,494	1,90	2,452	5,79	0,15	0,18	0,728		X		
61	BH9	193,31	Scoria	2,326	4,505	1,94	2,380	7,01	0,18	0,22	0,483		X		
62	BH9	199,26	Scoria	2,295	4,492	1,96	2,216	9,36	0,23	0,30	0,607		X		
63	BH9	199,29	Scoria	2,261	4,502	1,99	2,359	7,26	0,18	0,23	0,895		X		
64	BH9	191,39	Scoria	2,282	4,497	1,97	2,228	8,69	0,21	0,27	0,914		X		
65	BH9	191,42	Scoria	2,278	4,495	1,97	2,251	7,43	0,18	0,22	0,837		X		
66	BH9	199,23	Scoria	2,301	4,494	1,95	2,275	8,51	0,21	0,27	0,513		X		
67	BH9	198,65	Altered Olivine Tholeiite	2,258	4,481	1,98	2,692	2,75	0,08	0,08	5,375		X		

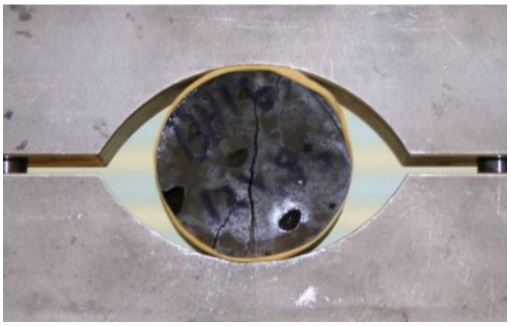
Sample nr.	Bore hole	Depth	Lithology	Height	Diameter	D/H	Bulk density	Water content	Porosity	Void ratio	Tensile strength	UCS	Brazil	Uniax	Triax
[-]	[-]	[m]	[-]	[cm]	[cm]	[-]	[g/cm3]	[%]	[%]	[-]	[MPa]	[MPa]	[-]	[-]	[-]
68	BH9	198,77	Altered Olivine Tholeiite	2,310	4,485	1,94	2,696	2,72	0,08	0,08	5,184		X		
69	BH9	198,89	Altered Olivine Tholeiite	2,228	4,493	2,02	2,676	3,14	0,09	0,09	6,778		X		
70	BH16	85,52	Tholeiite	2,258	4,478	1,98	2,940	1,66	0,05	0,05	10,260		X		
71	BH16	85,55	Tholeiite	2,348	4,476	1,91	2,843	1,89	0,05	0,06	10,815		X		
72	BH16	85,58	Tholeiite	2,335	4,480	1,92	2,807	2,07	0,06	0,06	8,747		X		
73	BH12	30,61	Rhyolite (inhomogeneous)	2,302	4,470	1,94	1,911	11,31	0,24	0,32	2,312		X		
74	BH12	38,68	Rhyolite (inhomogeneous)	2,263	4,471	1,98	1,943	10,71	0,23	0,30	3,064		X		
75	BH12	38,71	Rhyolite (inhomogeneous)	2,262	4,470	1,98	1,947	10,89	0,24	0,31	1,627		X		
76	BH12	38,74	Rhyolite (inhomogeneous)	2,209	4,471	2,02	1,984	10,08	0,22	0,29	3,662		X		
77	BH12	42,01	Rhyolite (inhomogeneous)	2,285	4,472	1,96	2,044	8,72	0,20	0,24	2,156		X		
78	BH12	42,31	Rhyolite (inhomogeneous)	2,298	4,473	1,95	1,825	13,27	0,28	0,39	1,005		X		
79	BH12	43,77	Rhyolite (inhomogeneous)	2,263	4,475	1,98	1,821	13,41	0,28	0,39	1,557		X		
80	BH12	43,8	Rhyolite (inhomogeneous)	2,262	4,477	1,98	1,802	13,84	0,29	0,41	2,121		X		
81	BH12	43,95	Rhyolite (inhomogeneous)	2,292	4,478	1,95	1,855	12,16	0,26	0,35	1,457		X		
83	BH11	30,02	Rhyolite (homogeneous)	2,218	4,477	2,02	2,145	6,41	0,15	0,17	4,546		X		
84	BH11	30,15	Rhyolite (homogeneous)	2,240	4,484	2,00	2,134	7,03	0,16	0,19	4,792		X		
85	BH11	30,18	Rhyolite (homogeneous)	2,296	4,486	1,95	2,133	7,26	0,17	0,20	3,921		X		
86	BH11	30,21	Rhyolite (homogeneous)	2,284	4,487	1,97	2,123	7,46	0,17	0,21	4,378		X		
88	BH16	107,69	Conglomerate	2,291	4,464	1,95	2,202	10,01	0,24	0,32	1,928		X		
89	BH16	108,09	Conglomerate	2,231	4,464	2,00	2,323	6,12	0,15	0,18	1,898		X		
90	BH16	107,93	Conglomerate	2,238	4,466	2,00	2,148	10,89	0,26	0,36	2,177		X		
91	BH16	107,9	Conglomerate	2,308	4,469	1,94	2,205	9,96	0,24	0,32	2,874		X		
92	BH16	107,75	Conglomerate	2,330	4,471	1,92	2,389	7,13	0,18	0,22	1,566		X		
93	BH16	107,78	Conglomerate	2,306	4,479	1,94	2,223	9,37	0,23	0,30	2,304		X		
94	BH15	193,37	Sandstone	2,291	4,468	1,95	2,158	10,46	0,25	0,34	2,856		X		
95	BH15	193,49	Sandstone	2,297	4,467	1,94	2,182	9,37	0,23	0,29	3,353		X		
96	BH11	30,08	Rhyolite (homogeneous)	2,276	4,481	1,97	2,141	6,84	0,16	0,19	4,159		X		
97	BH16	107,95	Conglomerate	2,268	4,469	1,97	2,147	11,04	0,27	0,36	2,710		X		

Sample nr.	Borehole	Depth	Lithology	Height	Diameter	D/H	Bulk density	Water content	Porosity	Void ratio	Tensile strength	UCS	Elasticity modulus E (50%)	Poisson ratio v (50%)	Phi	c´	Brazil	Uniax	Triax
[-]	[-]	[m]	[-]	[cm]	[cm]	[-]	[g/cm^3]	[%]	[%]	[-]	[MPa]	[MPa]	[GPa]	[-]	[°]	[MPa]	[-]	[-]	[-]
1	BH16	121,92	Tholeiite (Vesicular)	9,039	4,460	0,49	2,670	3,08	0,08	0,09		89,4	15,21					X	
2	BH16	122,01	Tholeiite (Vesicular)	9,003	4,459	0,50	2,625	3,64	0,10	0,11		94,2	15,53					X	
3	BH16	122,1	Tholeiite (Vesicular)	9,014	4,459	0,49	2,575	3,61	0,10	0,11		78,6	17,72					X	
4	BH9	199,11	Altered Olivine Tholeiite	9,010	4,492	0,50	2,686	2,93	0,08	0,09		79,3	22,08					X	
5	BH9	210,23	Altered Olivine Tholeiite	9,025	4,477	0,50	2,594	3,99	0,11	0,12		55,5	18,67					X	
7	BH9	199,2	Altered Olivine Tholeiite	9,033	4,485	0,50	2,624	3,78	0,10	0,11		48,2	17,71					X	
8	BH15	213,91	Altered Olivine Tholeiite	9,031	4,466	0,49	2,674	3,23	0,09	0,10		93,5	43,48	0,182	78,2	46,2			X
9	BH15	213,73	Altered Olivine Tholeiite	9,077	4,469	0,49	2,698	2,97	0,08	0,09		91,4	25,00					X	
10	BH15	213,82	Altered Olivine Tholeiite	9,009	4,468	0,50	2,676	3,11	0,09	0,09		65,0	13,24					X	
11	BH9	193,28	Scoria	9,116	4,510	0,49	2,346	7,33	0,19	0,23		7,6	1,36					X	
12	BH9	191,51	Scoria	9,071	4,497	0,50	2,257	8,61	0,21	0,27		9,3	2,79					X	
13	BH9	198,68	Altered Olivine Tholeiite	9,040	4,487	0,50	2,711	2,55	0,07	0,08		80,7	21,38					X	
14	BH9	198,8	Altered Olivine Tholeiite	9,074	4,489	0,49	2,703	2,72	0,08	0,08		78,6	21,91					X	
15	BH16	85,4	Tholeiite	9,048	4,477	0,49	2,860	1,93	0,06	0,06		135,7	13,18					X	
16	BH16	85,49	Tholeiite	9,021	4,477	0,50	2,866	1,71	0,05	0,05		146,6	14,20					X	
18	BH15	188,93	Sandstone	9,040	4,465	0,49	2,212	9,55	0,23	0,30		33,3	6,03					X	
19	BH15	193,6	Sandstone	9,046	4,467	0,49	2,202	9,82	0,24	0,32		35,4	6,85					X	
20	BH15	193,51	Sandstone	9,027	4,468	0,50	2,248	9,50	0,24	0,31		34,7	6,44					X	
21	BH16	108,12	Conglomerate	9,001	4,467	0,50	2,084	12,11	0,29	0,40		18,2	5,22					X	
22	BH11	7,77	Rhyolite (homogeneous)	9,029	4,478	0,50	2,387	3,32	0,08	0,09		125,2	22,60					X	
23	BH11	30,46	Rhyolite (homogeneous)	9,043	4,483	0,50	2,067	8,70	0,20	0,25		52,4	16,95	0,155	67,9	25,2			X
25	BH12	42,04	Rhyolite (inhomogeneous)	9,022	4,475	0,50	1,983	10,31	0,23	0,30		16,8	5,41					X	
26	BH12	38,65	Rhyolite (inhomogeneous)	9,011	4,475	0,50	2,007	9,94	0,22	0,28		24,3	5,98					X	
27	BH12	43,92	Rhyolite (inhomogeneous)	8,999	4,482	0,50	1,761	15,20	0,32	0,46		7,1	3,07					X	
28	BH12	39,15	Rhyolite (inhomogeneous)	9,008	4,476	0,50	1,903	12,14	0,26	0,36		28,3	7,58					X	
29	BH12	43,83	Rhyolite (inhomogeneous)	9,052	4,476	0,49	1,843	13,49	0,29	0,40		8,8	3,45					X	
30	BH12	42,22	Rhyolite (inhomogeneous)	9,027	4,470	0,50	1,878	12,87	0,28	0,38		9,0	3,74					X	
31	BH12	43,68	Rhyolite (inhomogeneous)	9,044	4,466	0,49	1,783	14,75	0,31	0,45		8,9	3,41					X	
32	BH12	42,13	Rhyolite (inhomogeneous)	9,013	4,478	0,50	1,880	12,59	0,27	0,37		19,0	5,77					X	
33	BH12	30,52	Rhyolite (inhomogeneous)	8,999	4,473	0,50	1,918	11,93	0,26	0,35		36,0	11,76	0,163	63,4	17,0			X
34	BH11	7,86	Rhyolite (homogeneous)	9,020	4,480	0,50	2,380	3,49	0,09	0,09		116,2	27,09					X	
35	BH11	7,95	Rhyolite (homogeneous)	8,984	4,480	0,50	2,376	3,42	0,08	0,09		135,6	11,50					X	
36	BH15	193,4	Sandstone	9,014	4,470	0,50	2,213	9,72	0,24	0,31		32,7	7,36					X	
37	BH16	107,51	Conglomerate	9,059	4,459	0,49	2,224	9,91	0,24	0,32		19,1	6,91					X	
38	BH16	107,6	Conglomerate	9,044	4,466	0,49	2,134	11,35	0,27	0,38		10,7	4,21					X	
39	BH16	107,81	Conglomerate	9,008	4,469	0,50	2,301	8,99	0,23	0,29		39,4	16,13	0,116	64,6	18,7			X
40	BH16	108,04	Conglomerate	9,044	4,465	0,49	2,199	10,40	0,26	0,34		20,7	7,22					X	
41	BH16	108,3	Conglomerate	9,044	4,465	0,49	2,108	11,62	0,28	0,38		11,5	3,28					X	

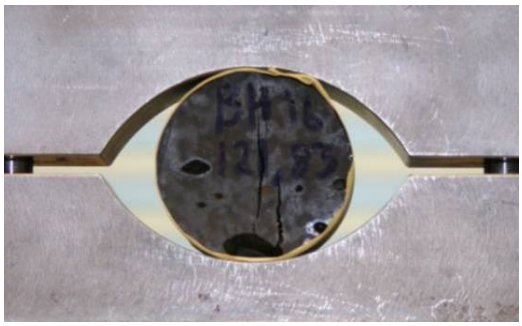
Pictures of samples after Brazil test



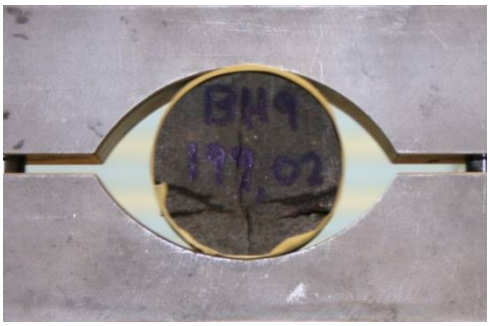
Nr. 42: Tholeiite (vesicular) $\sigma_t = 8{,}51$ MPa.



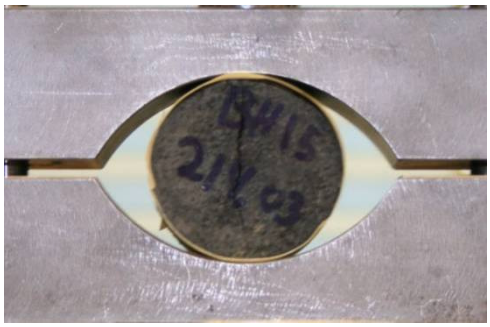
Nr. 43: Tholeiite (vesicular) $\sigma_t = 8{,}71$ MPa.



Nr. 44: Tholeiite (vesicular) $\sigma_t = 6{,}57$ MPa.



Nr. 45: Altered olivine tholeiite $\sigma_t = 5{,}94$ MPa.



Nr. 46: Altered olivine tholeiite $\sigma_t = 8{,}351$ MPa.

Nr. 47: Altered olivine tholeiite $\sigma_t = 7{,}10$ MPa.

Nr. 48: Altered olivine tholeiite $\sigma_t = 7{,}10$ MPa.

Nr. 49: Altered olivine tholeiite $\sigma_t = 8{,}98$ MPa.

Nr. 50: Altered olivine tholeiite $\sigma_t = 2{,}78$ MPa.

Nr. 51: Altered olivine tholeiite $\sigma_t = 5{,}47$ MPa.

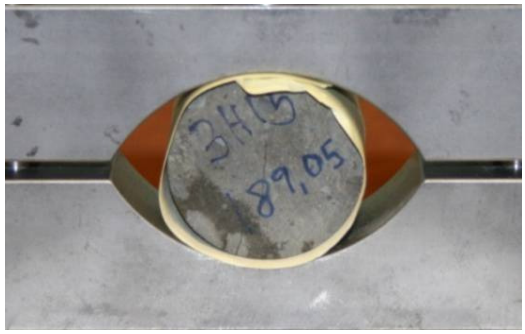
Nr. 52: Altered olivine tholeiite $\sigma_t = 3{,}60$ MPa.

Nr. 53: Scoria $\sigma_t = 0{,}929$ MPa.

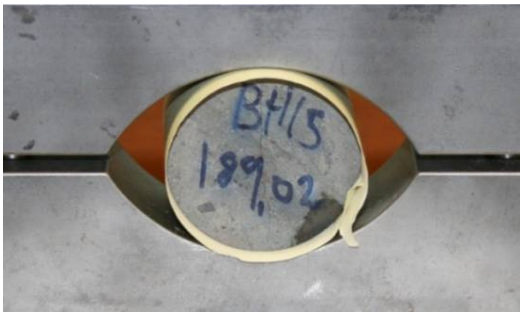
Nr. 54: Sandstone $\sigma_t = 3{,}54$ MPa.

Nr. 55: Sandstone $\sigma_t = 3{,}10$ MPa.

Nr. 56: Conglomerate $\sigma_t = 2{,}58$ MPa.



Nr. 57: Sandstone $\sigma_t = 3{,}47$ MPa.

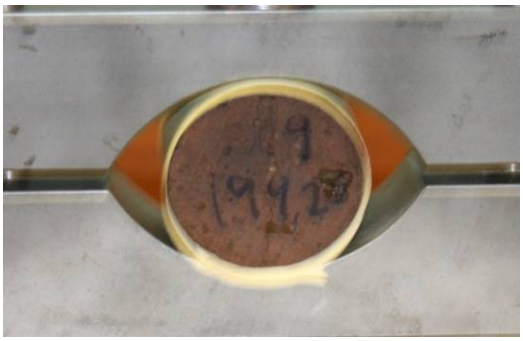


Nr. 58: Sandstone $\sigma_t = 3{,}54$ MPa.

Nr. 59: Scoria $\sigma_t = 1{,}07$ MPa.

Nr. 60: Scoria $\sigma_t = 0{,}73$ MPa.

Nr. 61: Scoria $\sigma_t = 0{,}48$ MPa.



Nr. 62: Scoria $\sigma_t = 0{,}61$ MPa.

Nr. 63: Scoria $\sigma_t = 0{,}90$ MPa.

Nr. 64: Scoria $\sigma_t = 0{,}91$ MPa.

Nr. 65: Scoria $\sigma_t = 0{,}84$ MPa.

Nr. 66: Scoria $\sigma_t = 0{,}51$ MPa.

Nr. 67: Altered olivine tholeiite $\sigma_t = 5{,}38$ MPa.

Nr. 68: Altered olivine tholeiite $\sigma_t = 5{,}18$ MPa.

Nr. 69: Altered olivine tholeiite $\sigma_t = 6{,}78$ MPa.

Nr. 70: Tholeiite $\sigma_t = 10{,}26$ MPa.

Nr. 71: Tholeiite $\sigma_t = 10{,}82$ MPa.

Nr. 72: Tholeiite $\sigma_t = 8{,}75$ MPa.

Nr. 73: Rhyolite (inhomogeneous) $\sigma_t = 2{,}31$ MPa.

Nr. 74: Rhyolite (inhomogeneous) $\sigma_t = 3{,}06$ MPa.

Nr. 75: Rhyolite (inhomogeneous) $\sigma_t = 1{,}63$ MPa.

Nr. 76: Rhyolite (inhomogeneous) $\sigma_t = 3{,}66$ MPa.

Nr. 77: Rhyolite (inhomogeneous) $\sigma_t = 2{,}16$ MPa.

Nr. 78: Rhyolite (inhomogeneous) $\sigma_t = 1{,}01$ MPa.

Nr. 79: Rhyolite (inhomogeneous) $\sigma_t = 1{,}56$ MPa.

Nr. 80: Rhyolite (inhomogeneous) $\sigma_t = 2{,}12$ MPa.

Nr. 81: Rhyolite (inhomogeneous) $\sigma_t = 1{,}46$ MPa.

Nr. 82: Rhyolite (inhomogeneous) Test failure.

Nr. 83: Rhyolite (homogeneous) $\sigma_t = 4{,}55$ MPa.

Nr. 84: Rhyolite (homogeneous) $\sigma_t = 4{,}79$ MPa.

Nr. 85: Rhyolite (homogeneous) $\sigma_t = 3{,}92$ MPa.

Nr. 86: Rhyolite (homogeneous) $\sigma_t = 4{,}38$ MPa.

Nr. 87: Rhyolite (homogeneous) $\sigma_t = 2{,}61$ MPa.

Nr. 88: Conglomerate $\sigma_t = 1{,}93$ MPa.

Nr. 89: Conglomerate $\sigma_t = 1{,}90$ MPa.

Nr. 90: Conglomerate $\sigma_t = 2{,}78$ MPa.

Nr. 91: Conglomerate $\sigma_t = 2{,}87$ MPa.

Nr. 92: Conglomerate $\sigma_t = 1{,}57$ MPa.

Nr. 93: Conglomerate $\sigma_t = 2{,}30$ MPa.

Nr. 94: Sandstone $\sigma_t = 2{,}86$ MPa.

Nr. 95: Sandstone $\sigma_t = 3{,}35$ MPa.

Nr. 96: Rhyolite (homogeneous) $\sigma_t = 4{,}16$ MPa.

Nr. 97: Conglomerate $\sigma_t = 2{,}71$ MPa.

Pictures of samples after Uniaxial Compression test

Nr. 1: Tholeiite (vesicular) $\sigma_c = 89{,}4$ MPa.

Nr. 2: Tholeiite (vesicular) $\sigma_c = 94{,}2$ MPa.

Nr. 3: Tholeiite (vesicular) $\sigma_c = 78{,}6$ MPa.

Nr. 4: Altered olivine tholeiite $\sigma_c = 79{,}3$ MPa.

Nr. 5: Altered olivine tholeiite $\sigma_c = 55{,}5$ MPa.

Nr. 6: Altered olivine tholeiite $\sigma_c = 29{,}3$ MPa.

Nr. 7: Altered olivine tholeiite $\sigma_c = 48{,}2$ MPa.

Nr. 9: Altered olivine tholeiite $\sigma_c = 91{,}4$ MPa.

Nr. 10: Altered olivine tholeiite $\sigma_c = 65{,}0$ MPa.

Nr. 11: Scoria $\sigma_c = 7{,}6$ MPa.

Nr. 12: Scoria $\sigma_c = 9{,}3$ MPa.

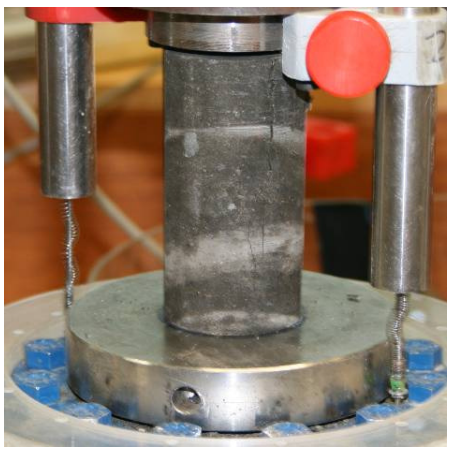
Nr. 13: Altered olivine tholeiite $\sigma_c = 80{,}7$ MPa.

Nr. 14: Altered olivine tholeiite $\sigma_c = 78{,}6$ MPa.

Nr. 15: Tholeiite $\sigma_c = 135{,}7$ MPa.

Nr. 18: Sandstone $\sigma_c = 33{,}3$ MPa.

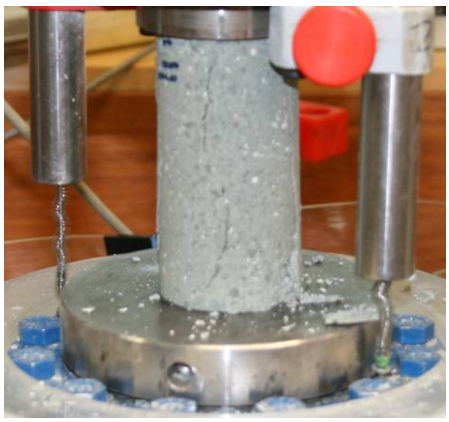
Nr. 19: Sandstone $\sigma_c = 35{,}4$ MPa.



Nr. 20: Sandstone $\sigma_c = 34{,}7$ MPa.

Nr. 21: Conglomerate $\sigma_c = 33{,}3$ MPa.

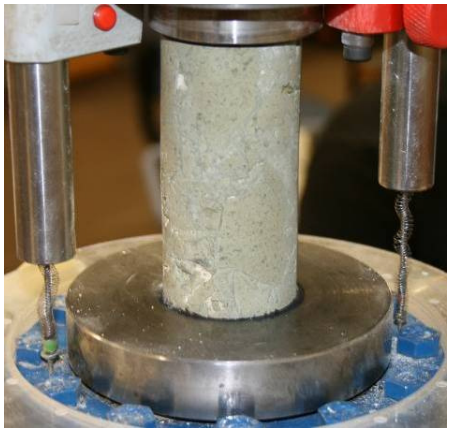
Nr. 22: Rhyolite (homogeneous) $\sigma_c = 125{,}2$ MPa.



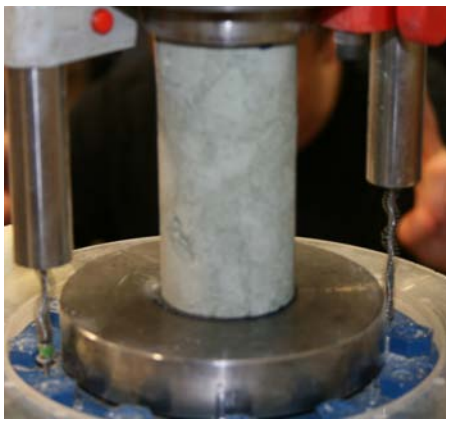
Nr. 24: Rhyolite (homogeneous) $\sigma_c = 41{,}9$ MPa.

Nr. 25: Rhyolite (inhomogeneous) $\sigma_c = 16{,}8$ MPa.

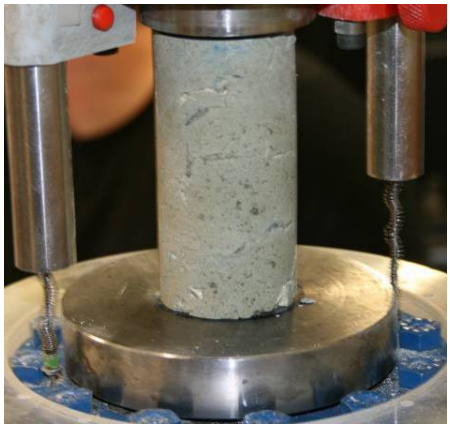
Nr. 26: Rhyolite (inhomogeneous) $\sigma_c = 24{,}3$ MPa.



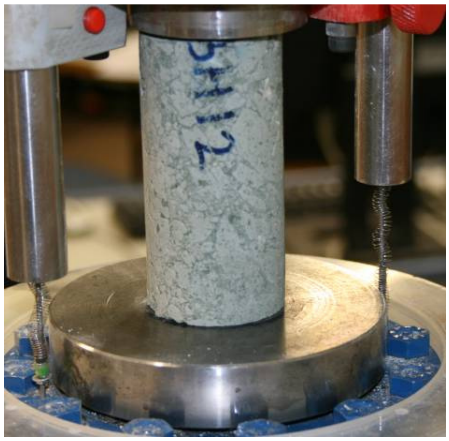
Nr. 27: Rhyolite (inhomogeneous) $\sigma_c = 7{,}1$ MPa.



Nr. 28: Rhyolite (inhomogeneous) $\sigma_c = 28{,}3$ MPa.



Nr. 29: Rhyolite (inhomogeneous) $\sigma_c = 8{,}8$ MPa.



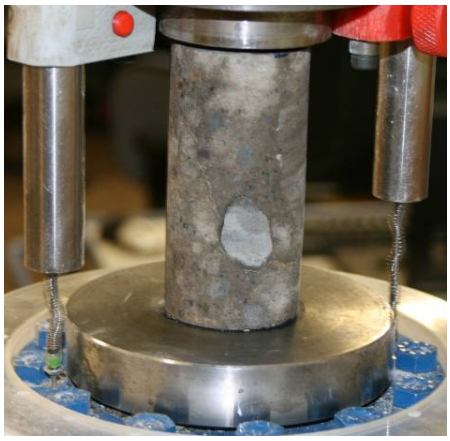
Nr. 30: Rhyolite (inhomogeneous) $\sigma_c = 9{,}0$ MPa.

Nr. 31: Rhyolite (inhomogeneous) $\sigma_c = 8{,}9$ MPa.

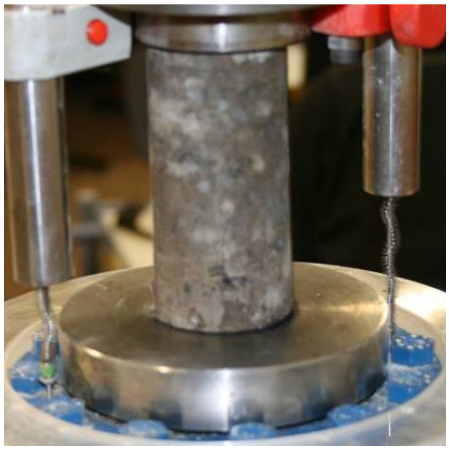
Nr. 32: Rhyolite (inhomogeneous) $\sigma_c = 19{,}0$ MPa.

Nr. 36: Sandstone $\sigma_c = 32{,}7$ MPa.

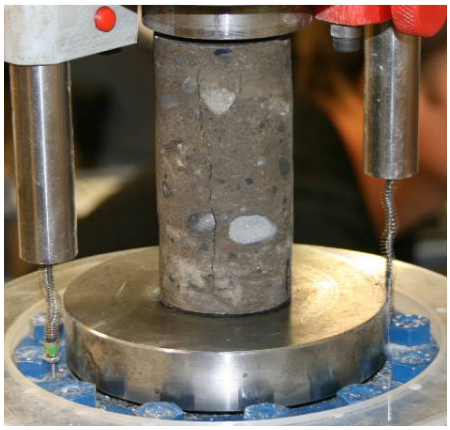
Nr. 37: Conglomerate $\sigma_c = 19{,}1$ MPa.



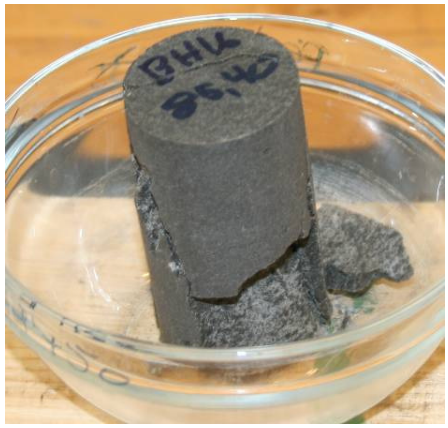
Nr. 38: Conglomerate $\sigma_c = 10{,}7$ MPa.



Nr. 40: Conglomerate $\sigma_c = 20{,}7$ MPa.



Nr. 41: Conglomerate $\sigma_c = 11{,}5$ MPa.

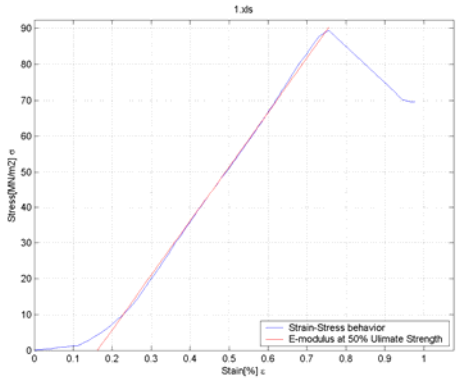


Nr. 16: Tholeiite $\sigma_c = 11{,}5$ MPa.

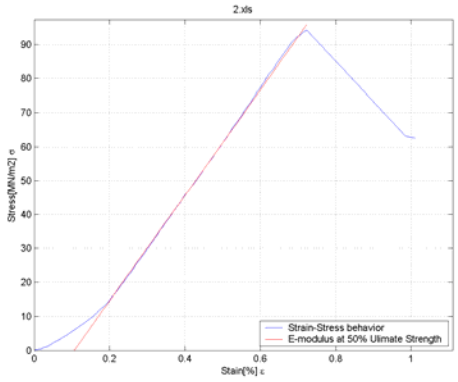
Nr. 34: Rhyolite (homogeneous) $\sigma_c = 116{,}2$ MPa.

Nr. 35: Rhyolite (homogeneous) $\sigma_c = 135{,}6$ MPa.

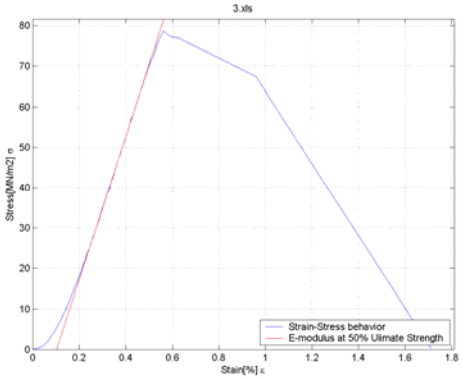
Plots from Unconfined Compression test



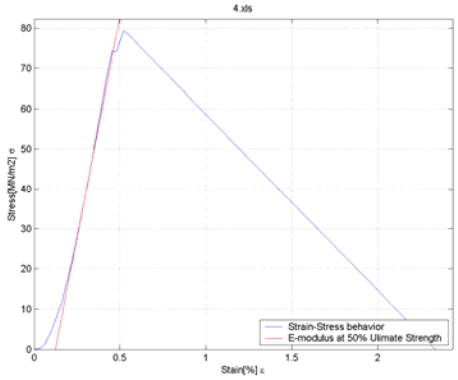
Nr. 1: Tholeiite (vesicular) $\sigma_c = 89{,}4$ MPa, E-modulus = 15,21 GPa.



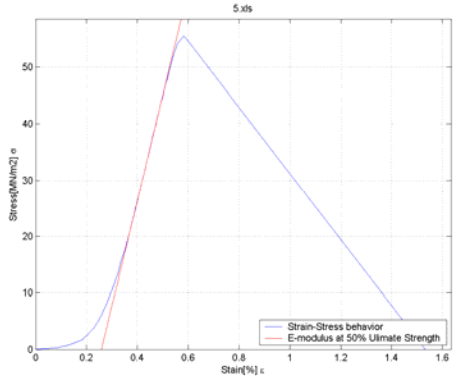
Nr. 2: Tholeiite (vesicular) $\sigma_c = 94{,}2$ MPa, E-modulus = 15,53 GPa.



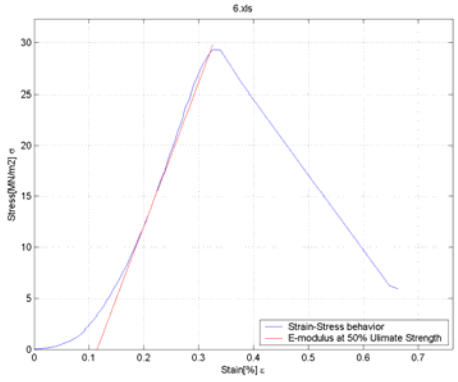
Nr. 3: Tholeiite (vesicular) $\sigma_c = 78{,}6$ MPa, E-modulus = 17,72 GPa.



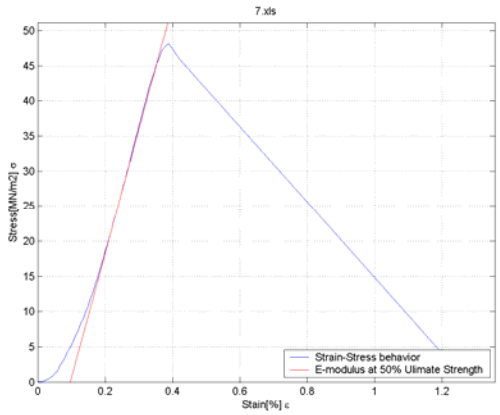
Nr. 4: Altered olivine tholeiite $\sigma_c = 79{,}3$ MPa, E-modulus = 22,08 GPa.



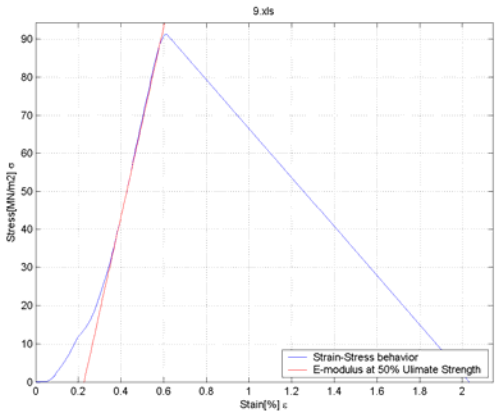
Nr. 5: Altered olivine tholeiite $\sigma_c = 55{,}5$ MPa, E-modulus = 18,67 GPa.



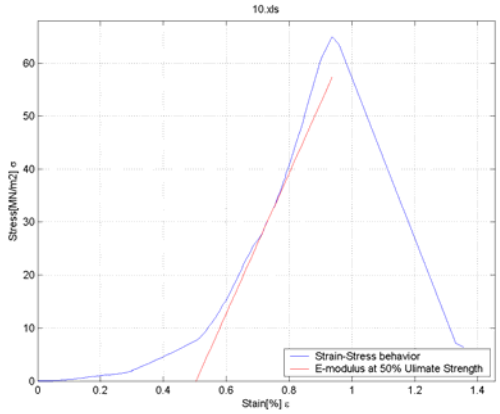
Nr. 6: Altered olivine tholeiite $\sigma_c = 29{,}3$ MPa, E-modulus = 14,11 GPa.



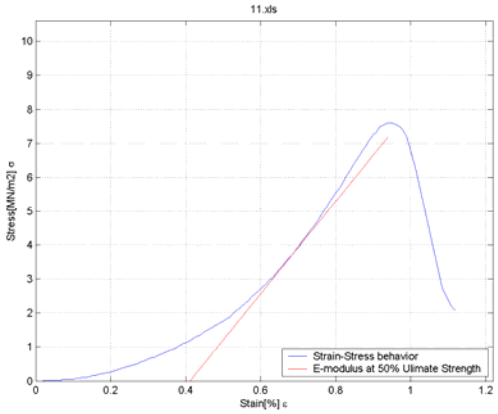
Nr. 7: Altered olivine tholeiite $\sigma_c = 48{,}2$ MPa,
E-modulus = 17,71 GPa.



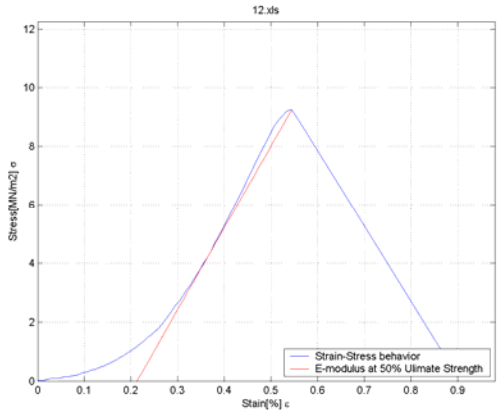
Nr. 9: Altered olivine tholeiite $\sigma_c = 91{,}4$ MPa,
E-modulus = 25,00 GPa.



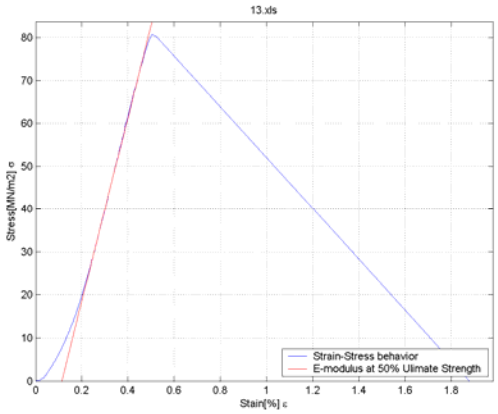
Nr. 10: Altered olivine tholeiite $\sigma_c = 65{,}0$ MPa,
E-modulus = 13,24 GPa.



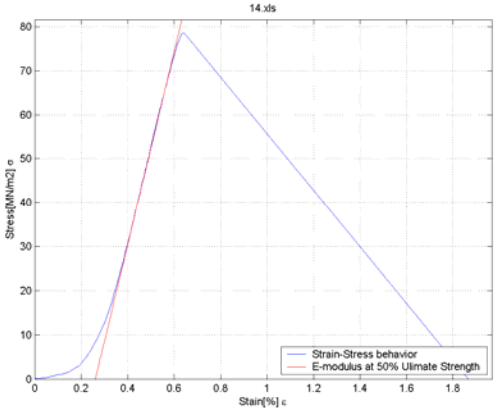
Nr. 11: Scoria $\sigma_c = 7{,}6$ MPa,
E-modulus = 1,36 GPa.



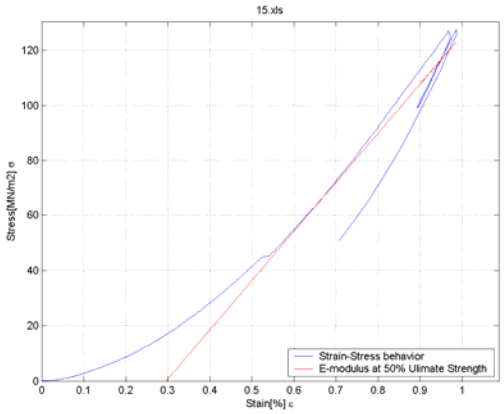
Nr. 12: Scoria $\sigma_c = 9{,}3$ MPa,
E-modulus = 2,79 GPa.



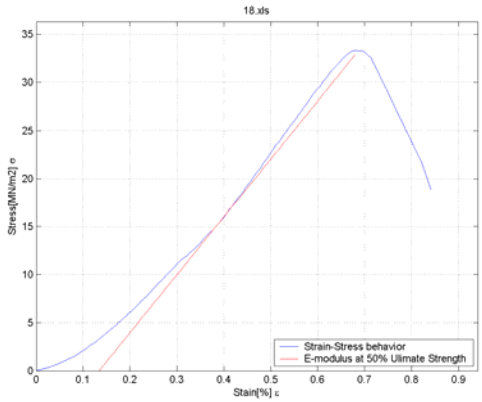
Nr. 13: Altered olivine tholeiite $\sigma_c = 80{,}7$ MPa,
E-modulus = 21,38 GPa.



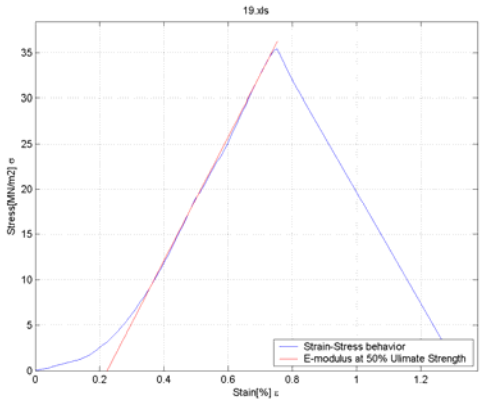
Nr. 14: Altered olivine tholeiite $\sigma_c = 78{,}6$ MPa,
E-modulus = 21,91 GPa.



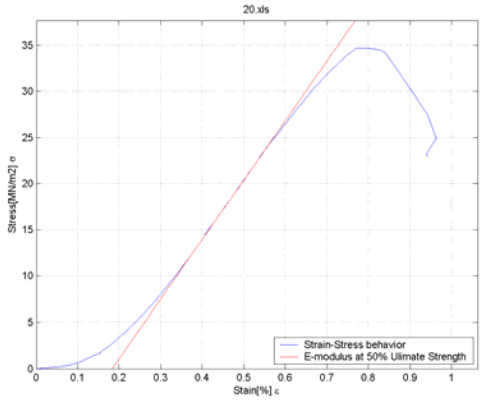
Nr. 15: Tholeiite $\sigma_c = 135{,}7$ MPa,
E-modulus = 13,18 GPa.



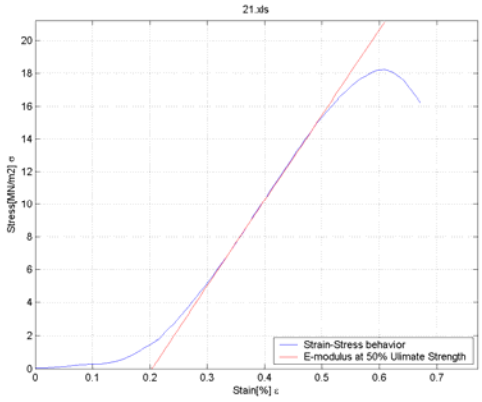
Nr. 18: Sandstone $\sigma_c = 33{,}3$ MPa,
E-modulus = 6,03 GPa.



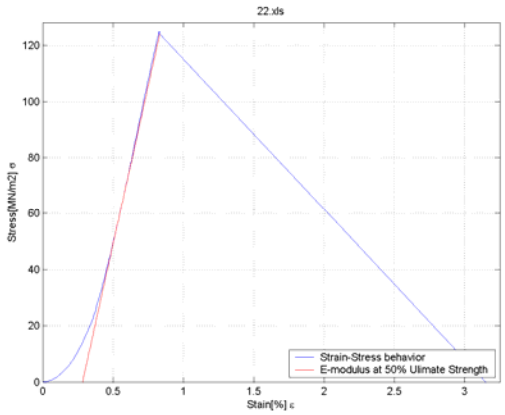
Nr. 19: Sandstone $\sigma_c = 35{,}4$ MPa,
E-modulus = 6,85 GPa.



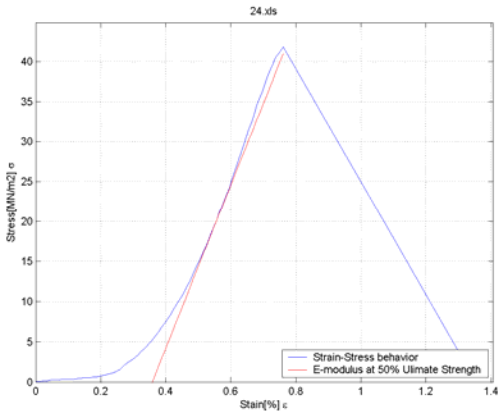
Nr. 20: Sandstone $\sigma_c = 34{,}7$ MPa,
E-modulus = 6,44 GPa.



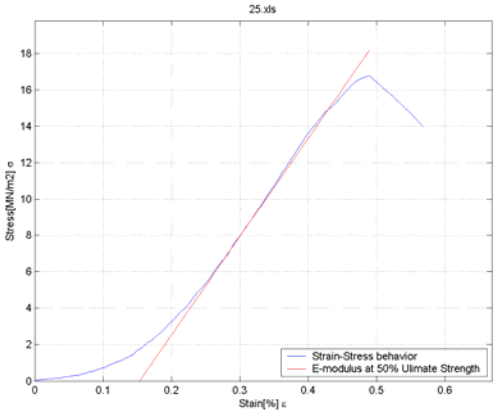
Nr. 21: Conglomerate $\sigma_c = 33{,}3$ MPa,
E-modulus = 5,22 GPa.



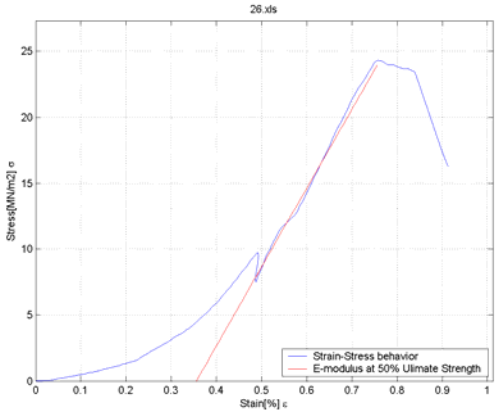
Nr. 22: Rhyolite (homogeneous) $\sigma_c = 125{,}2$ MPa, E-modulus = 22,60 GPa.



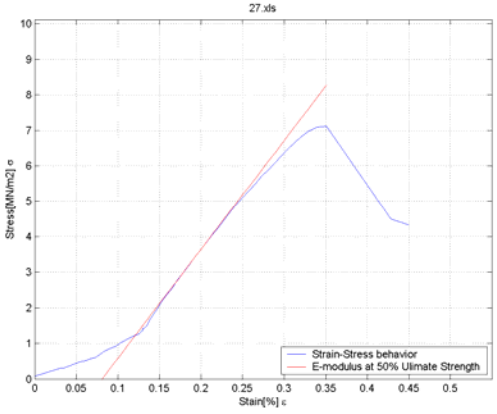
Nr. 24: Rhyolite (homogeneous) $\sigma_c = 41{,}9$ MPa, E-modulus = 10,18 GPa.



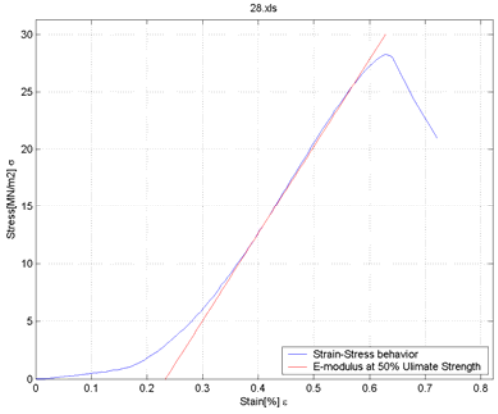
Nr. 25: Rhyolite (inhomogeneous) $\sigma_c = 16{,}8$ MPa, E-modulus = 5,41 GPa.



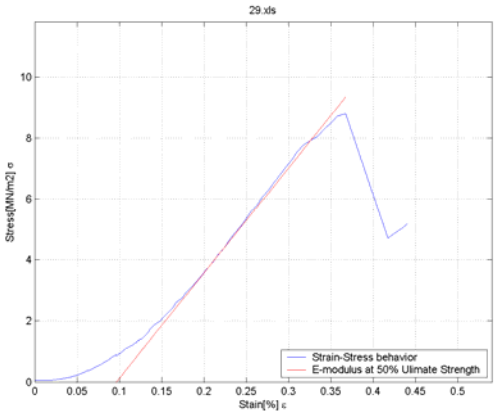
Nr. 26: Rhyolite (inhomogeneous) $\sigma_c = 24{,}3$ MPa, E-modulus = 5,98 GPa.



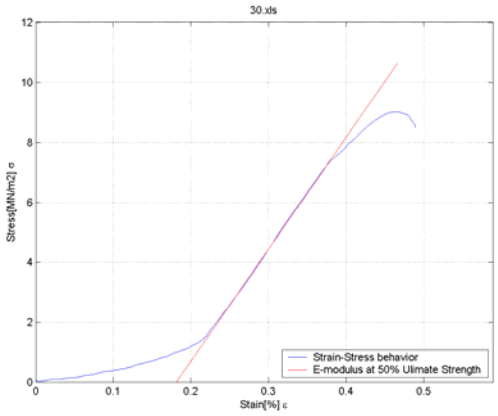
Nr. 27: Rhyolite (inhomogeneous) $\sigma_c = 7{,}1$ MPa, E-modulus = 3,07 GPa.



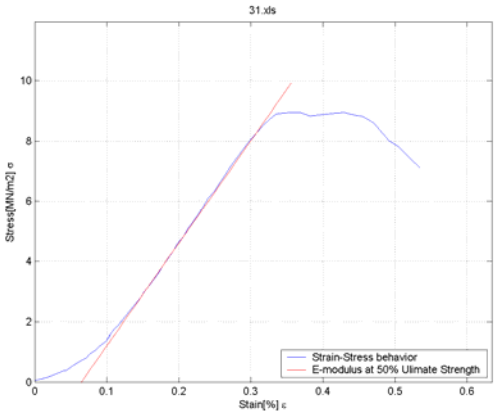
Nr. 28: Rhyolite (inhomogeneous) $\sigma_c = 28{,}3$ MPa, E-modulus =7,58 GPa.



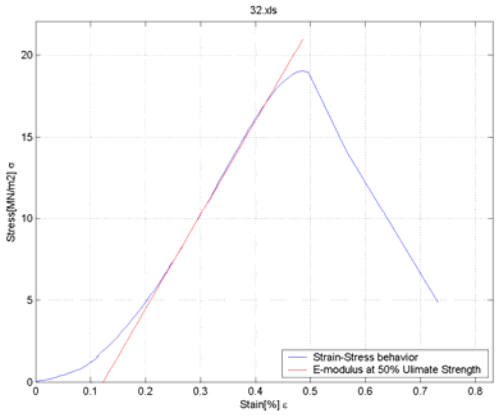
Nr. 29: Rhyolite (inhomogeneous) $\sigma_c = 8{,}8$ MPa,
E-modulus = 3,45 GPa.



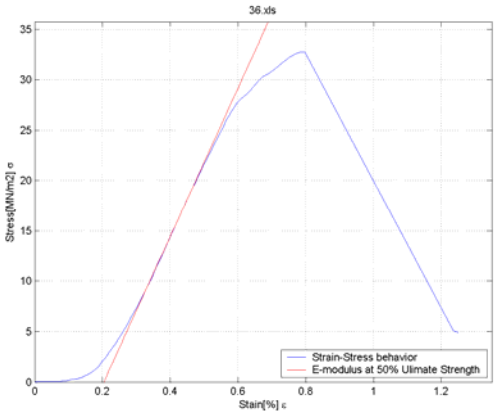
Nr. 30: Rhyolite (inhomogeneous) $\sigma_c = 9{,}0$ MPa,
E-modulus = 3,74 GPa.



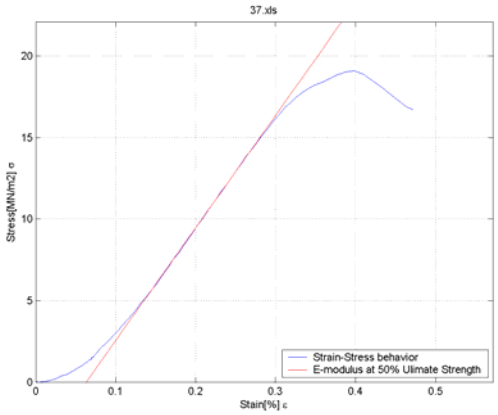
Nr. 31: Rhyolite (inhomogeneous) $\sigma_c = 8{,}9$ MPa,
E-modulus = 3,41 GPa..



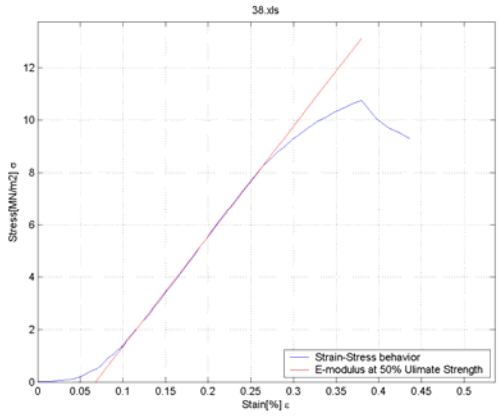
Nr. 32: Rhyolite (inhomogeneous) $\sigma_c = 19{,}0$ MPa,
E-modulus = 5,77 GPa.



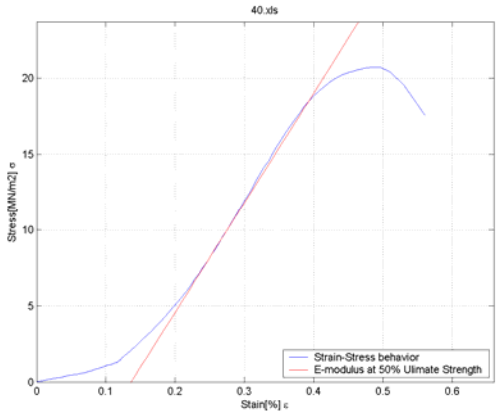
Nr. 36: Sandstone $\sigma_c = 32{,}7$ MPa,
E-modulus = 7,36 GPa.



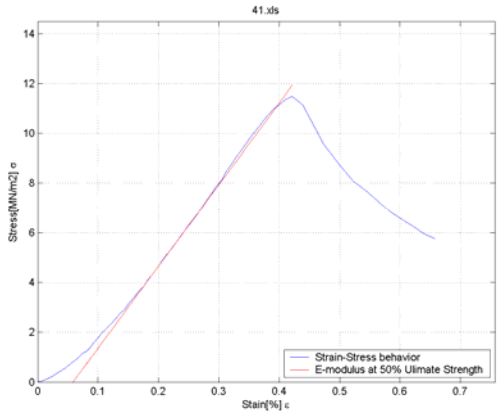
Nr. 37: Conglomerate $\sigma_c = 19{,}1$ MPa,
E-modulus = 6,91 GPa.



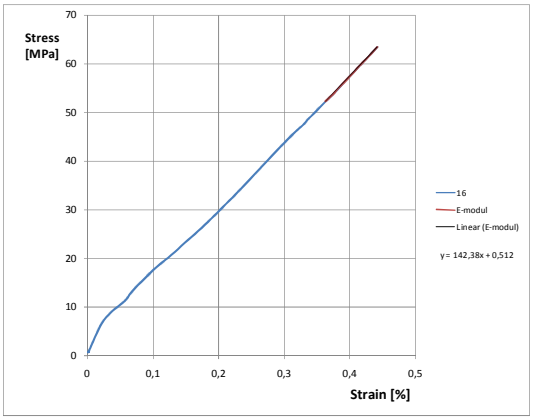
Nr. 38: Conglomerate $\sigma_c = 10{,}7$ MPa,
E-modulus = 4,21 GPa.



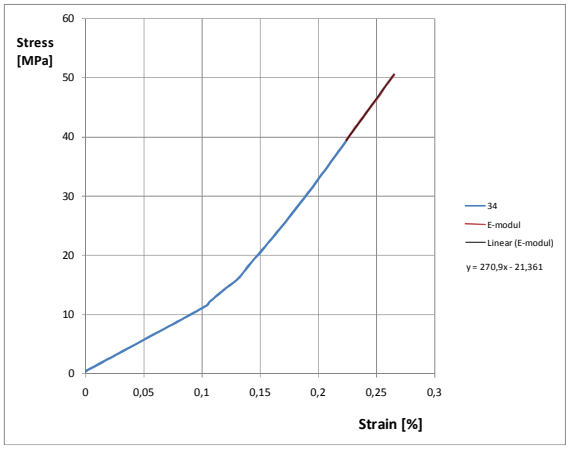
Nr. 40: Conglomerate $\sigma_c = 20{,}7$ MPa,
E-modulus = 7,22 GPa.



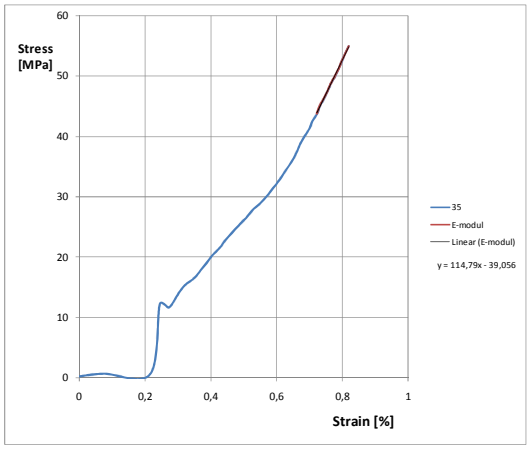
Nr. 41: Conglomerate $\sigma_c = 11{,}5$ MPa,
E-modulus = 3,28 GPa.



Nr. 16: Tholeiite $\sigma_c = 11{,}5$ MPa,
E-modulus = 14,20 GPa.

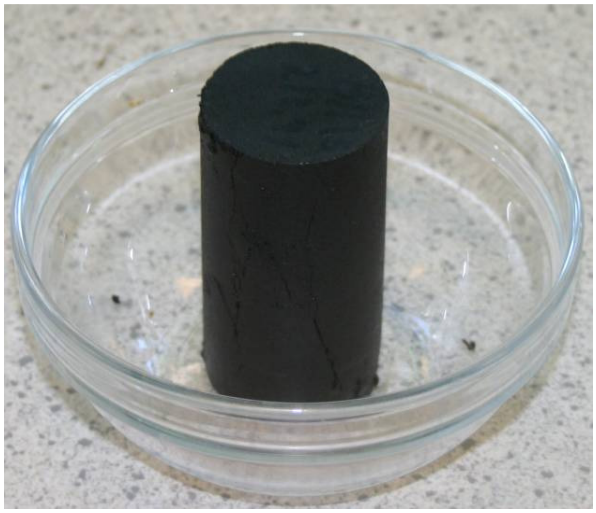


Nr. 34: Rhyolite (homogeneous) $\sigma_c = 116{,}2$ MPa,
E-modulus = 27,09 GPa.

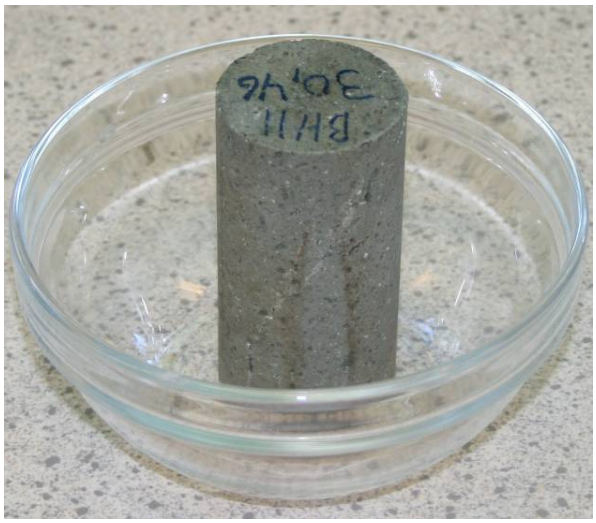


Nr. 35: Rhyolite (homogeneous) $\sigma_c = 135{,}6$ MPa,
E-modulus = 11,50 GPa.

Photos of samples after triaxial test



Nr. 8: Altered olivine tholeiite
Failure at: $\sigma_1 = 93{,}48$ MPa and $\sigma_3 = 1{,}00$ MPa



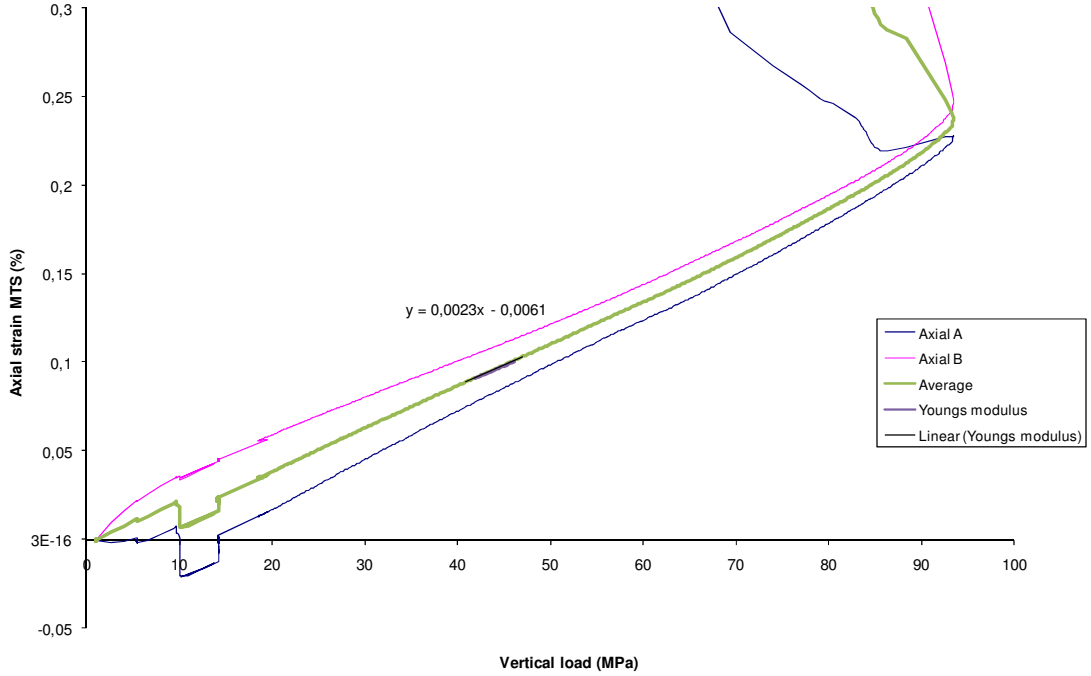
Nr. 23: Rhyolite (homogeneous)
Failure at: $\sigma_1 = 52{,}39$ MPa and $\sigma_3 = 2{,}00$ MPa

Nr. 33: Rhyolite (inhomogeneous)
Failure at: $\sigma_1 = 36{,}04$ MPa and $\sigma_3 = 2{,}01$ MPa

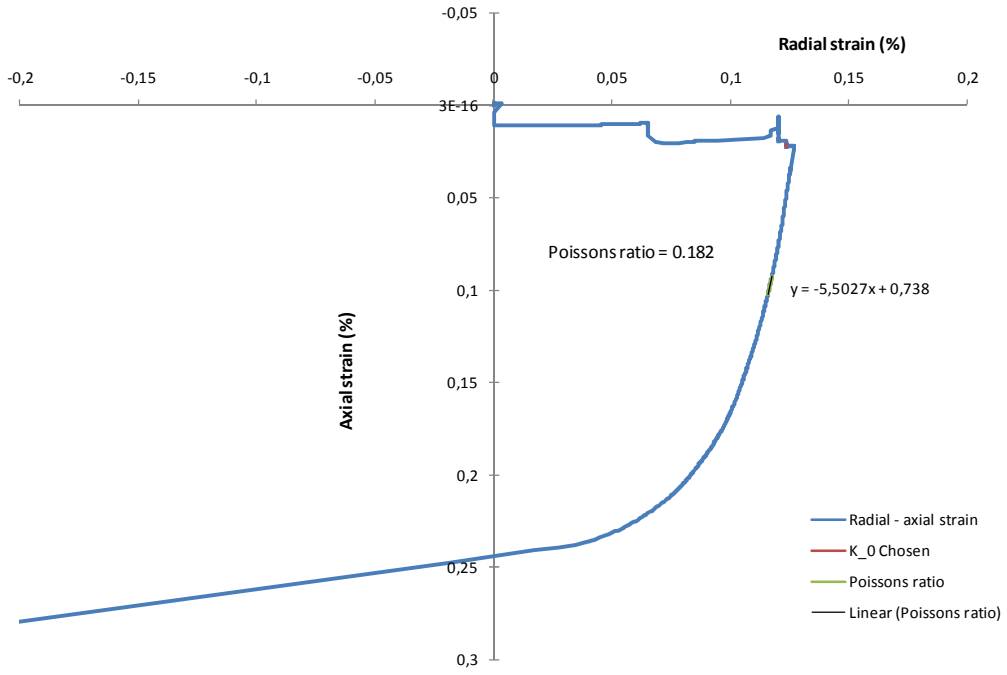
Nr. 39: Conglomerate
Failure at: $\sigma_1 = 39{,}40$ MPa and $\sigma_3 = 2{,}00$ MPa

Results plots from triaxial tests

Sample 8 - Altered olivine tholeiite:

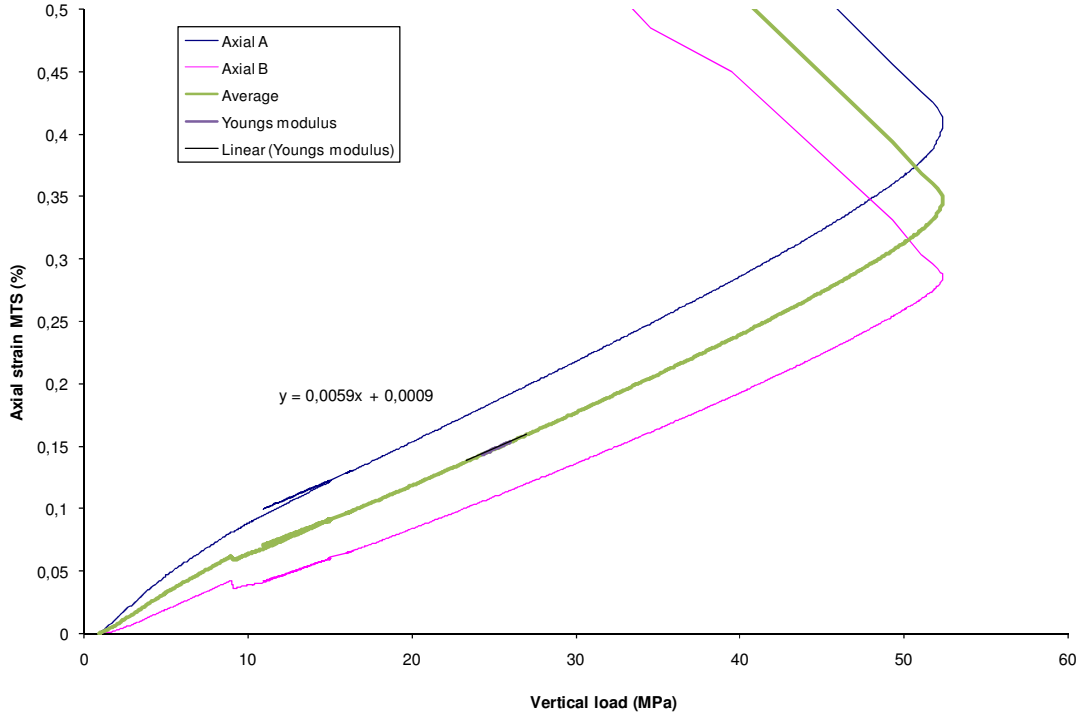


E-modulus = 43,48 GPa.

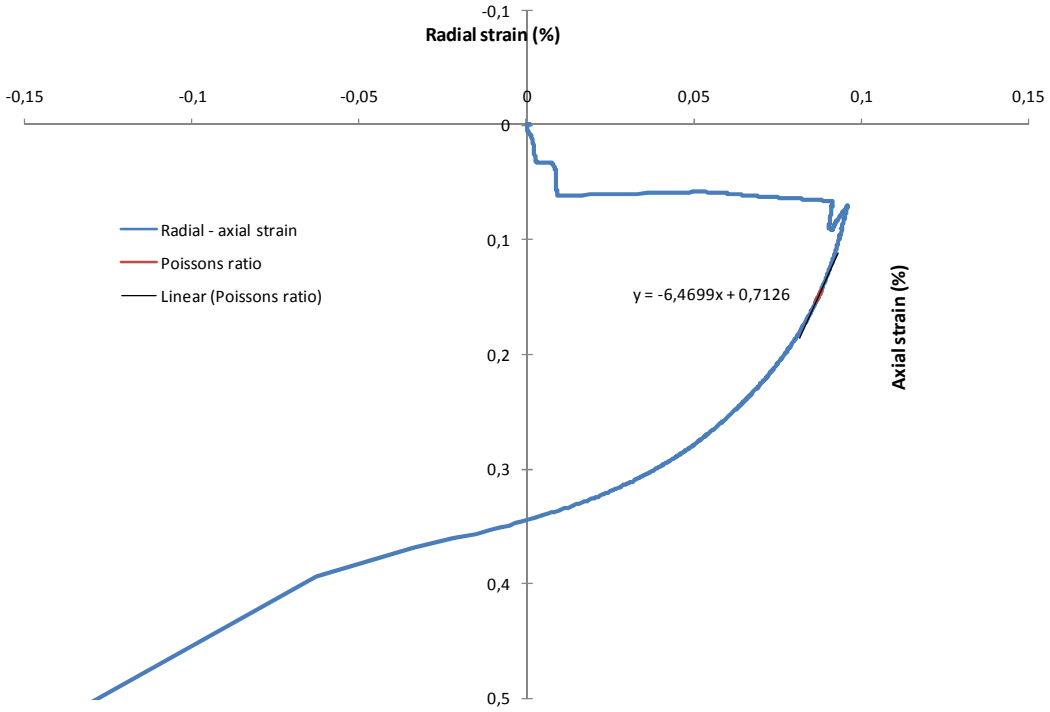


Poisson ratio = 0,182

Sample 23 – Rhyolite (homogeneous):

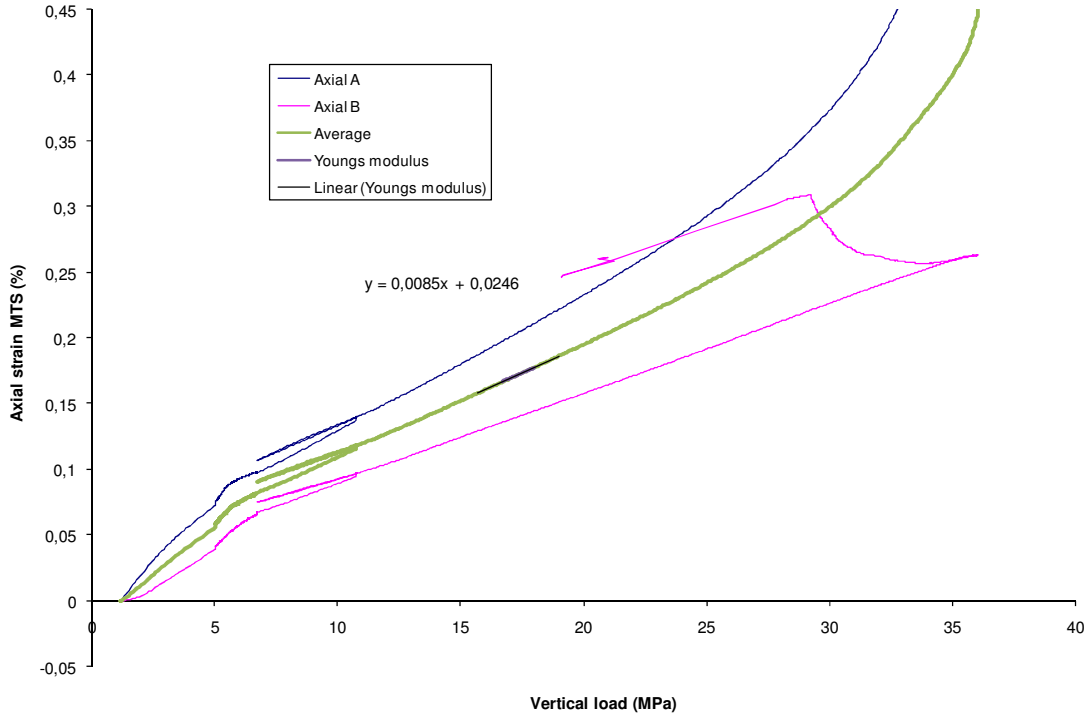


E-modulus = 16,95 GPa.

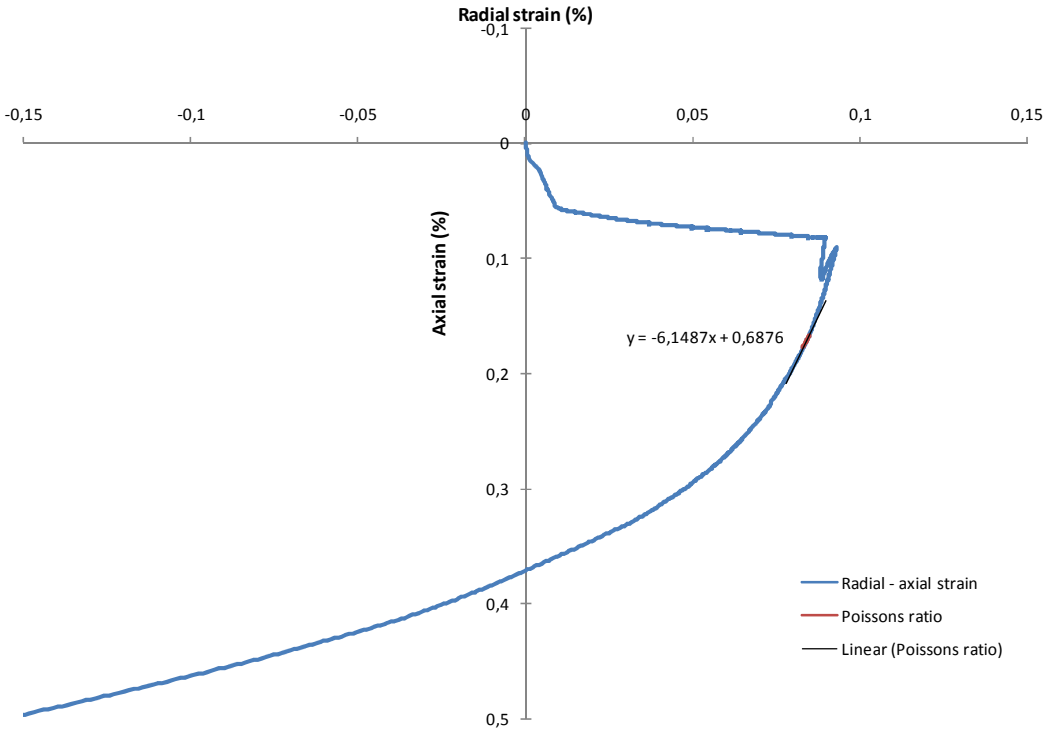


Poisson ratio = 0,155

Sample 33 – Rhyolite (inhomogeneous):

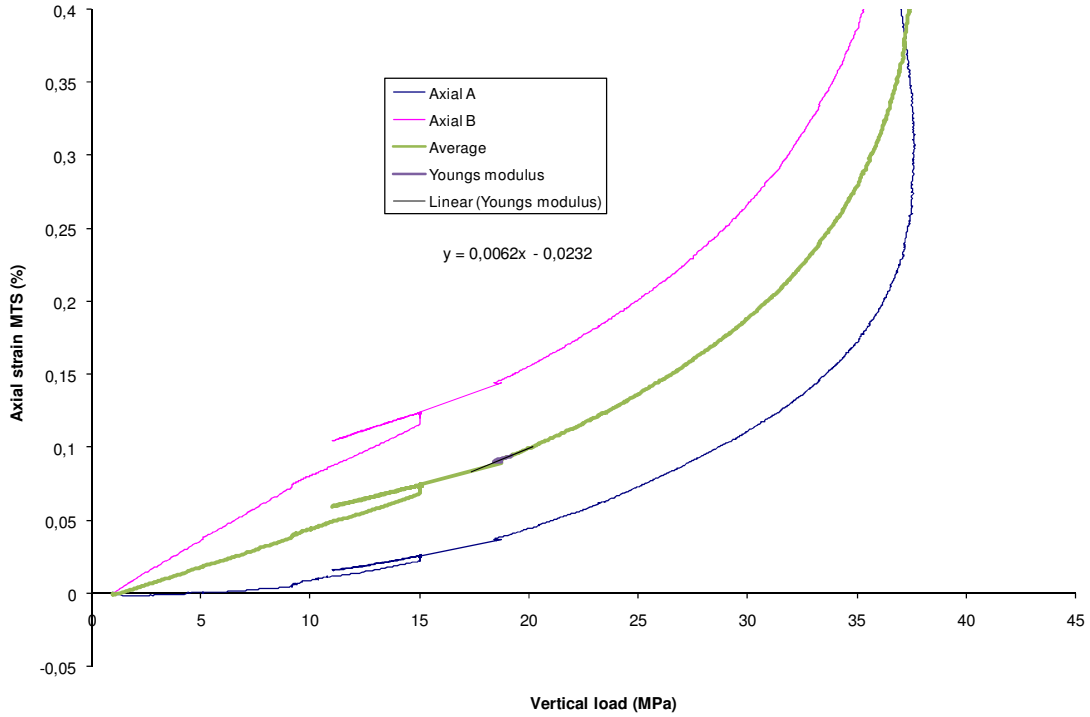


E-modulus = 11,76 GPa.

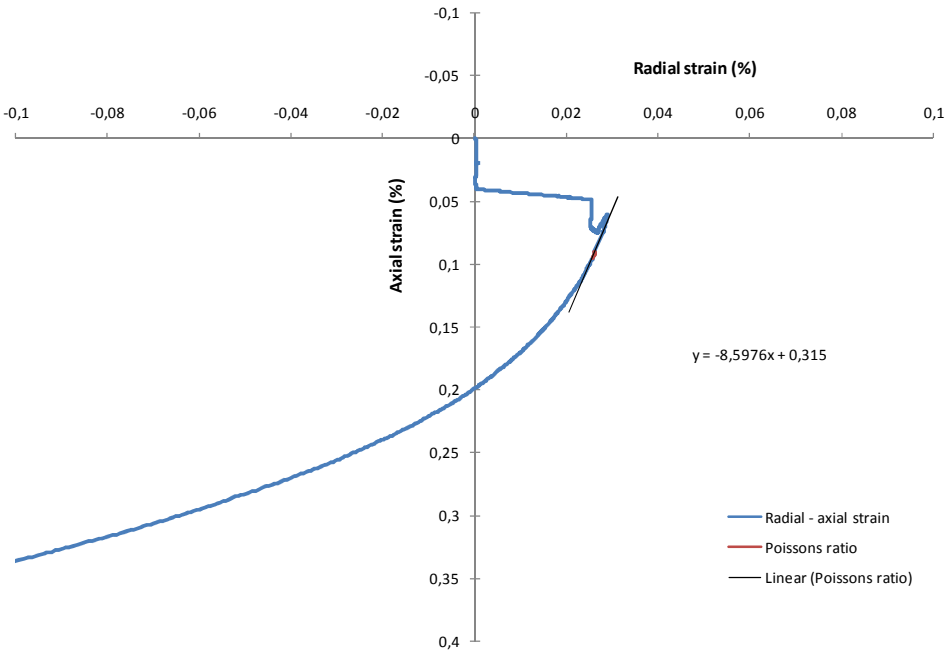


Poisson ratio = 0,163

Sample 39 – Conglomerate:



E-modulus = 39,40 GPa.



Poisson ratio = 0,116

Comparison of laboratory test results and other test results from Iceland.

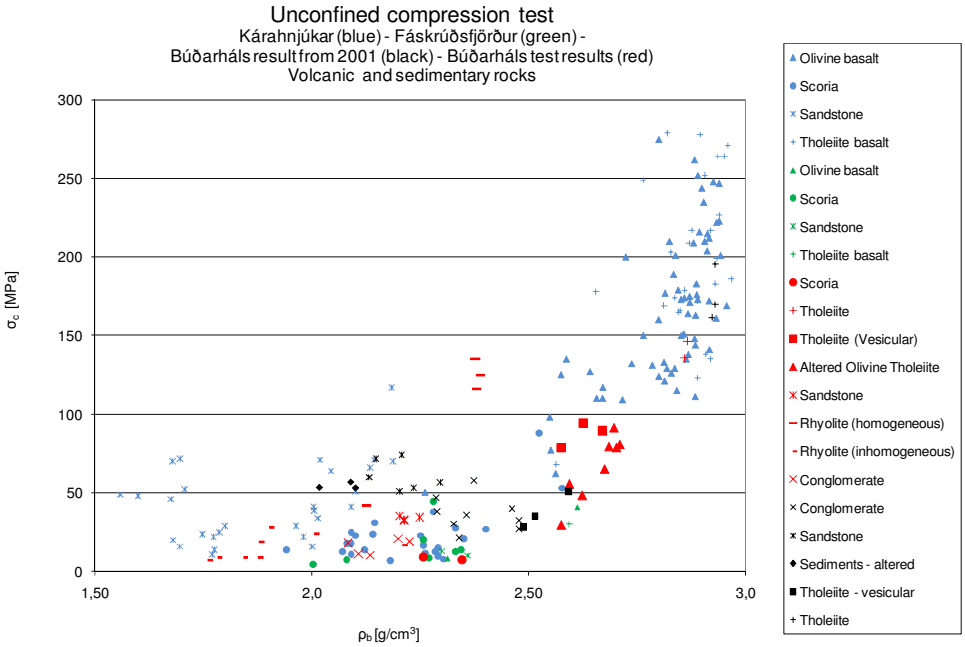


Figure 5-1. Uniaxial Compression tests vs. bulk density for volcanic and sedimentary rocks in Iceland.

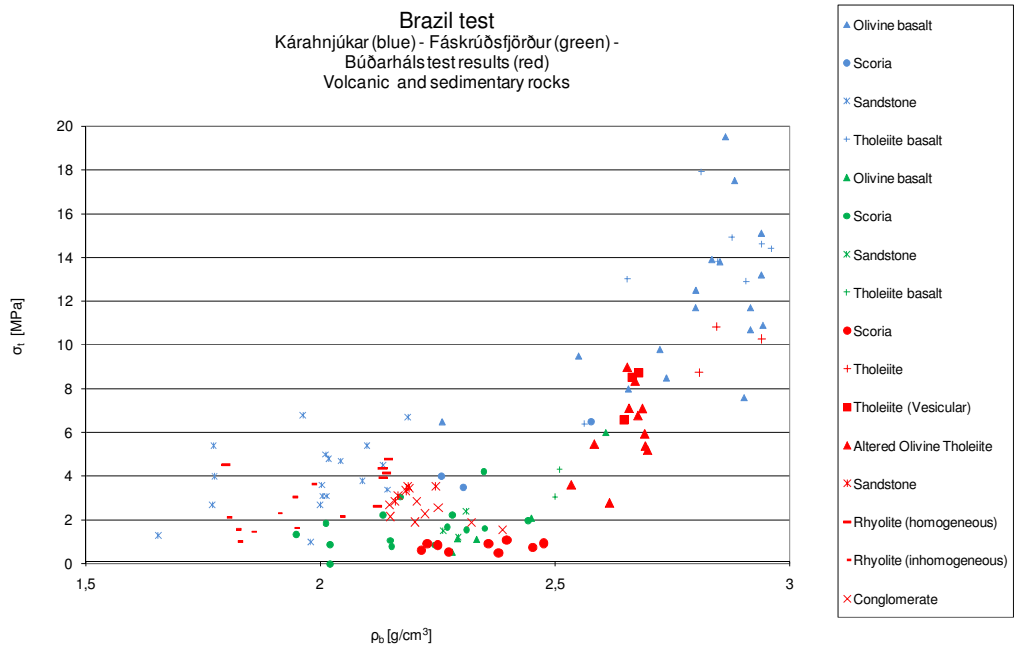


Figure 5-2. Brazil tests vs. bulk density for volcanic and sedimentary rocks in Iceland.

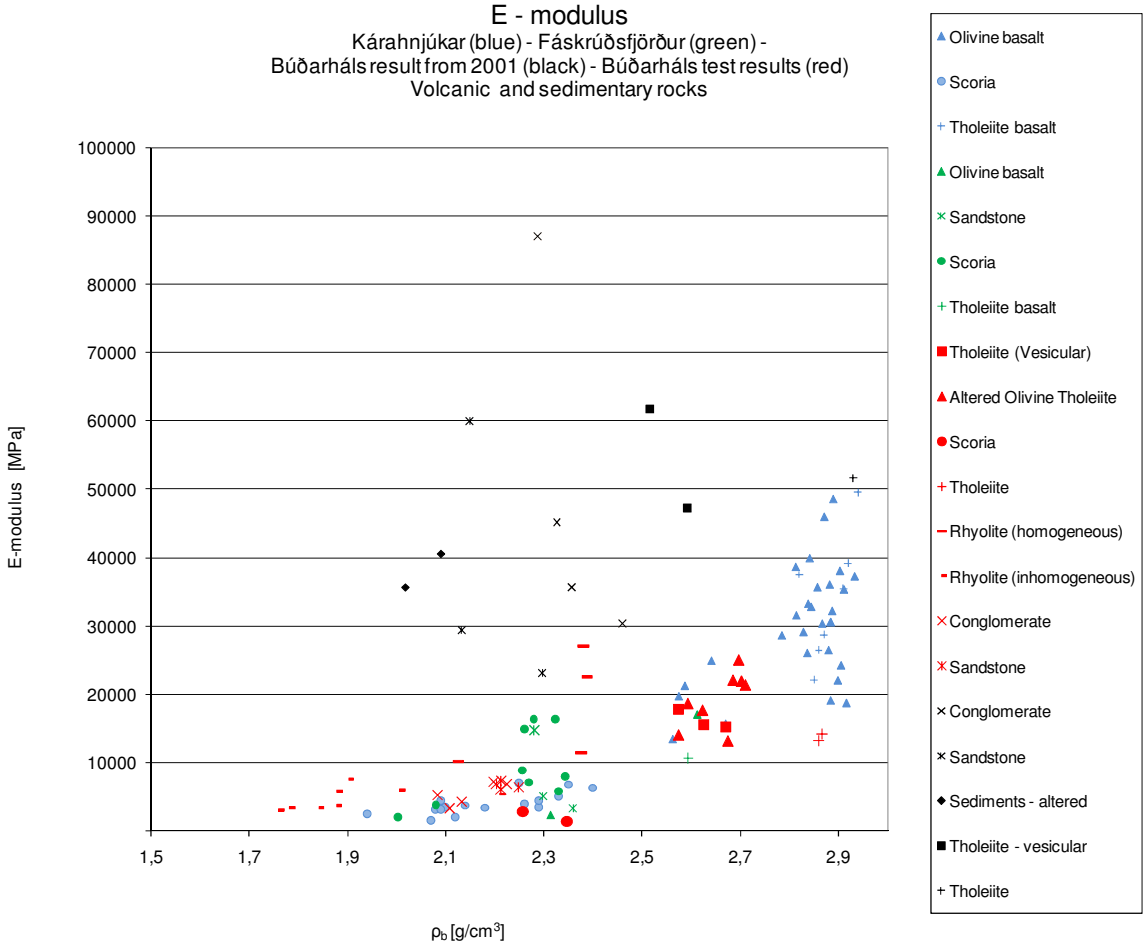


Figure 5-3. E-modulus vs. bulk density for volcanic and sedimentary rocks in Iceland.

6. Appendix – Numerical analysis

This appendix contains pictures further results from the numerical analysis as well as some results from the sensitivity analysis.

- Figures from the results of numerical analysis
- Discussion on results
- Sensitivity analysis, figures and results

Rhyolite

Results from the rhyolite numerical analysis are shown here in figures and tables.

Rhyolite	RSC 3		RSC 2	
	Base GSI	Min GSI	Base GSI	Min GSI
Total displacement	0,01609	0,01831	0,02436	0,02763
Yielded elements	216	291	256	325
Yielded bolt el.	50	60	48	66
Yielded liner el.	2	2	32	34

Table 2. Results from the rhyolite, total displacement is in meters.

The following 4 figures show results from using RSC2 to support the rhyolite section.

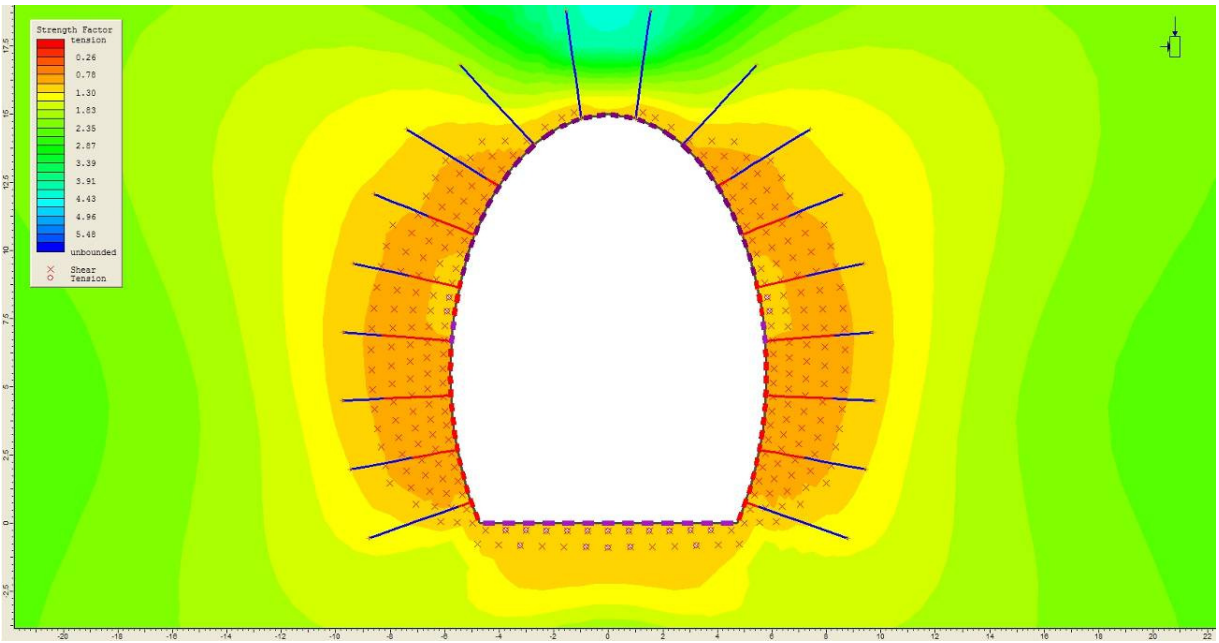


Figure 6-1. Strength factor, GSI base, RSC 2.

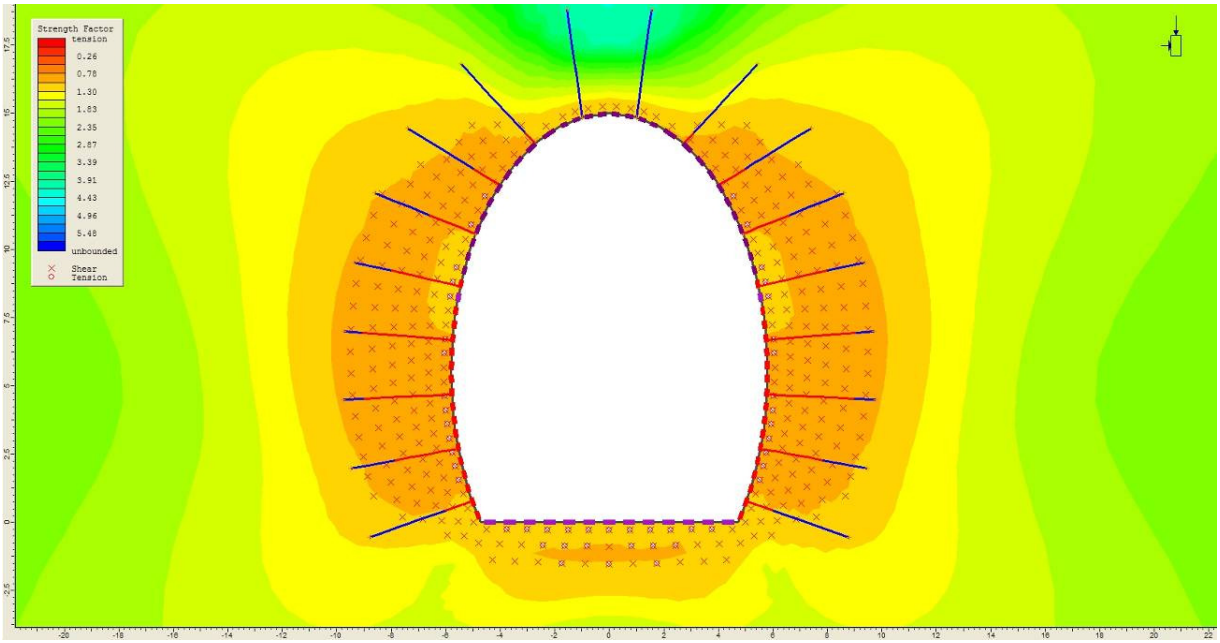


Figure 6-2. Strength factor, GSI min, RSC 2.

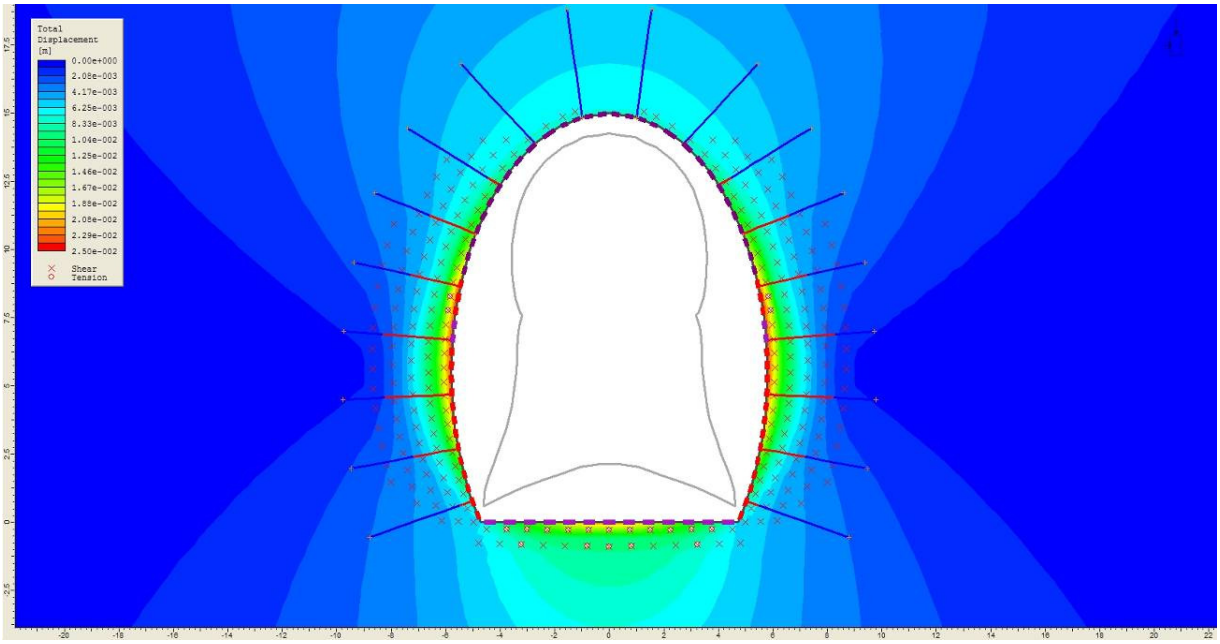


Figure 6-3. Total displacement, GSI base, RSC 2, max displacement is 24 mm.

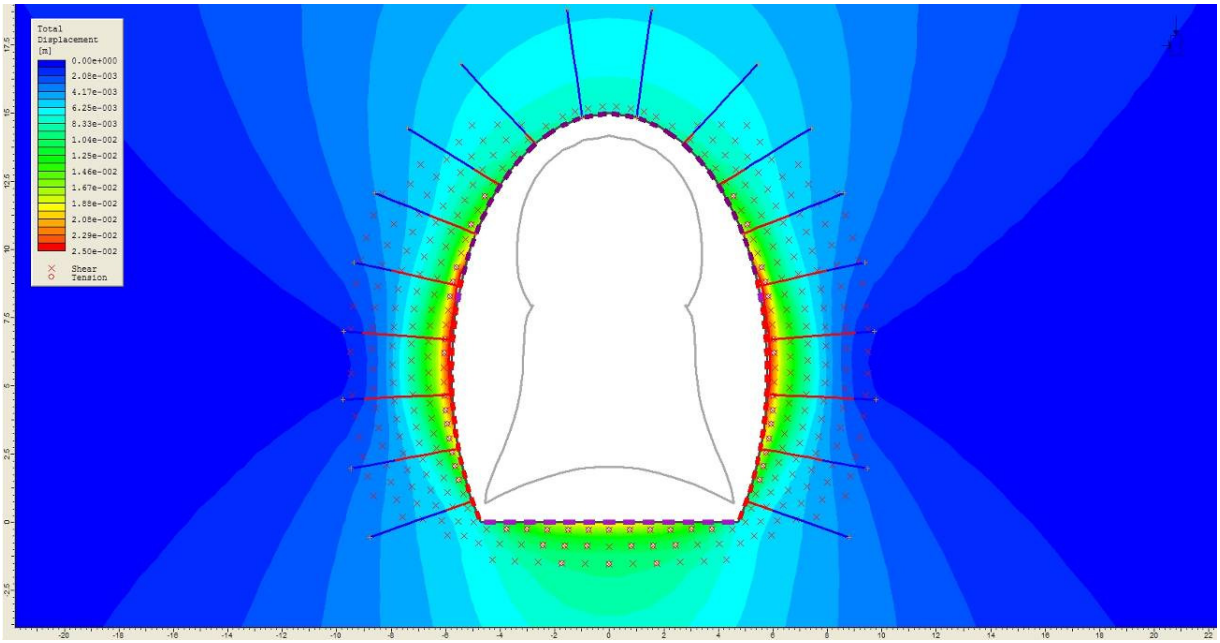


Figure 6-4. Total displacement, GSI min, RSC 2, max displacement is 27 mm.

Deepest cross-section

Results from the deepest cross-section numerical analysis are shown here in figures and tables. Also shown are two results from the sensitivity analysis. The Poisson´s ratio test and the Elastic modulus test. In the Poisson´s ratio test the ratio in the tholeiite was set to 0,25. In the Elastic modulus test the elastic modulus for the materials was set to twice the used values.

Deepest	**RSC 3**		**RSC 2**		**RSC 3 extra**
	Base GSI	**Min GSI**	**Base GSI**	**Min GSI**	**Base GSI**
Total displacement	0,02565	0,02345	0,03419	0,03002	0,02197
Yielded elements	827	932	878	998	805
Yielded bolt el.	124	148	123	180	106
Yielded liner el.	14	16	40	56	2

Table 3. Results from the deepest cross-section, total displacement is in meters.

Deepest	**RSC 3 (poisson test)**	**RSC 3 (E test)**
	Base	**Base**
Total displacement	0,02818	0,01331
Yielded elements	826	859
Yielded bolt el.	123	106
Yielded liner el.	14	0

Table 4. Results from the sensitivity analysis.

The following 4 figures show an attempt to support this cross-section with RSC 2.

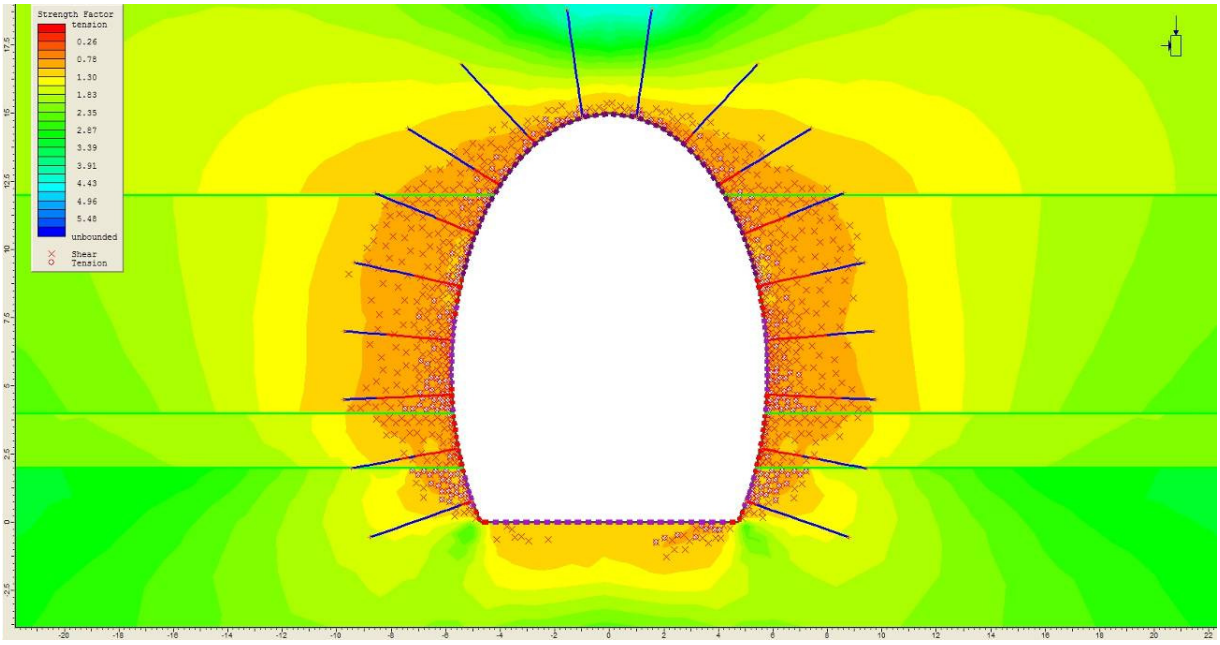


Figure 6-5. Strength factor,GSI base, RSC 2.

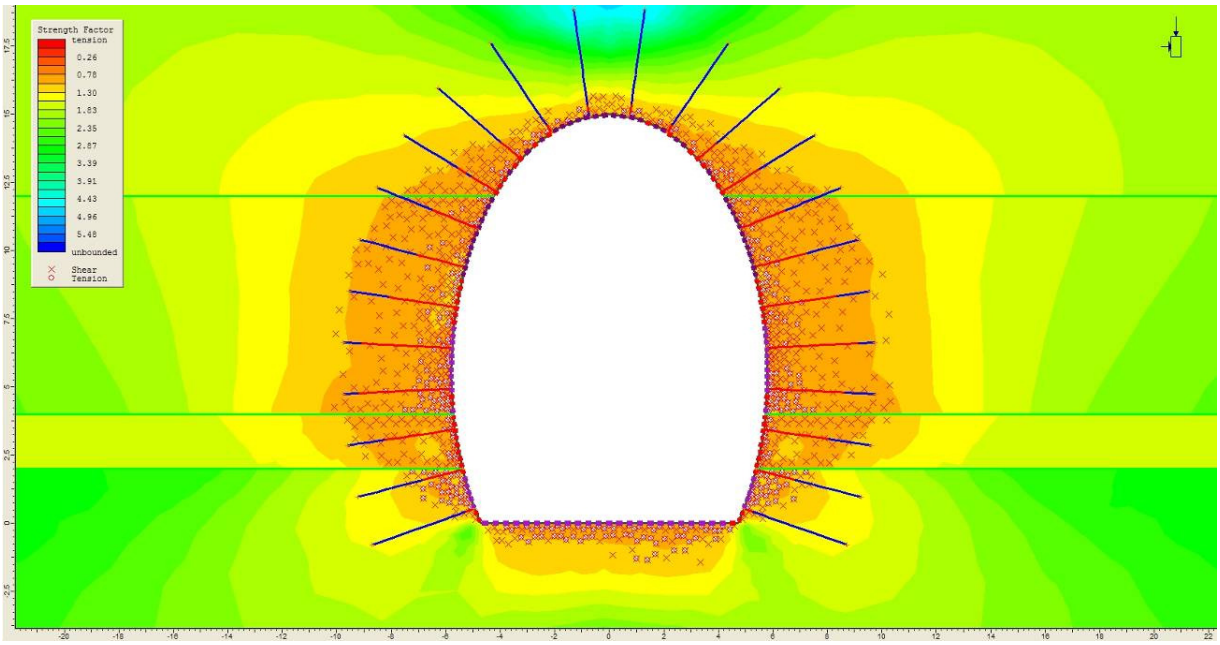


Figure 6-6. Strength factor, GSI min, RSC 2.

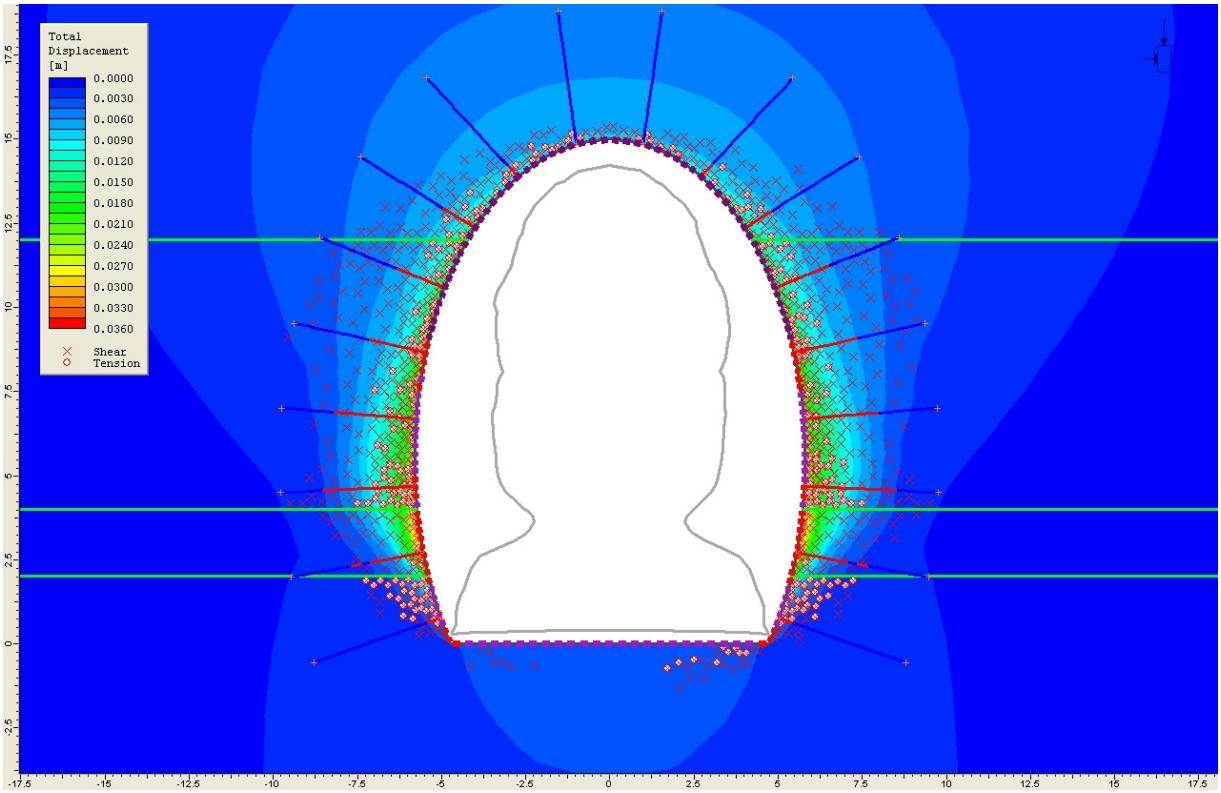


Figure 6-7. Total displacement, GSI base, RSC 2, max displacement is 34 mm.

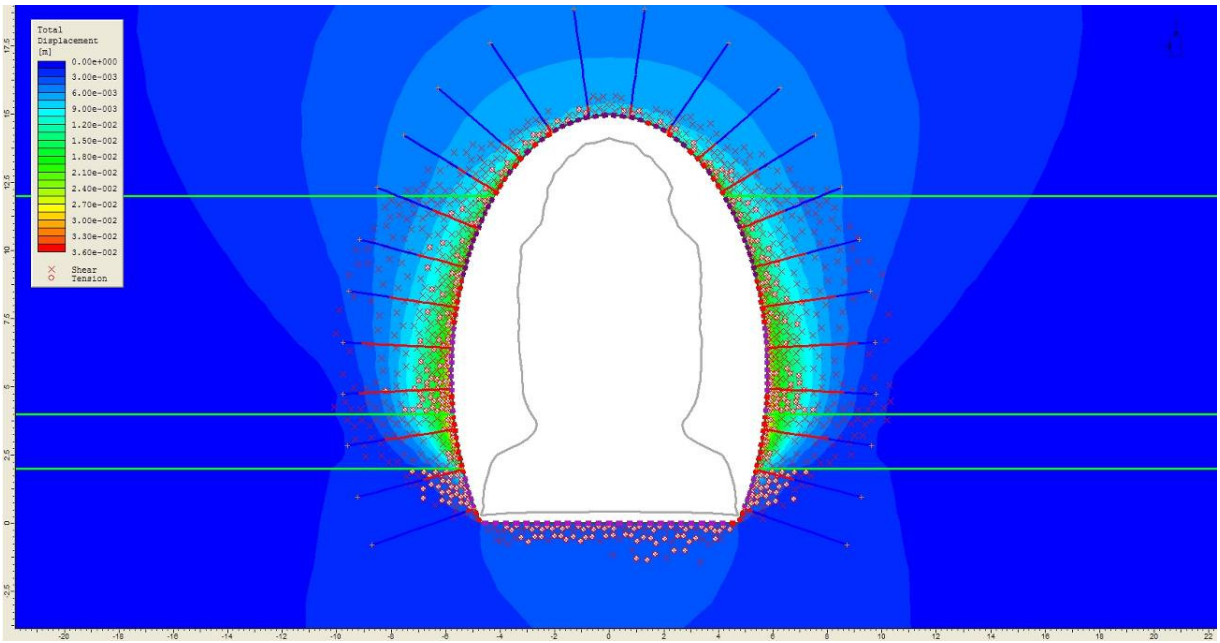


Figure 6-8. Total displacement, GSI min, RSC 2, max displacement is 30 mm.

The following 2 figures show how the cross-section was modeled with extra support in the walls. Up to 200 mm thick shotcrete was used.

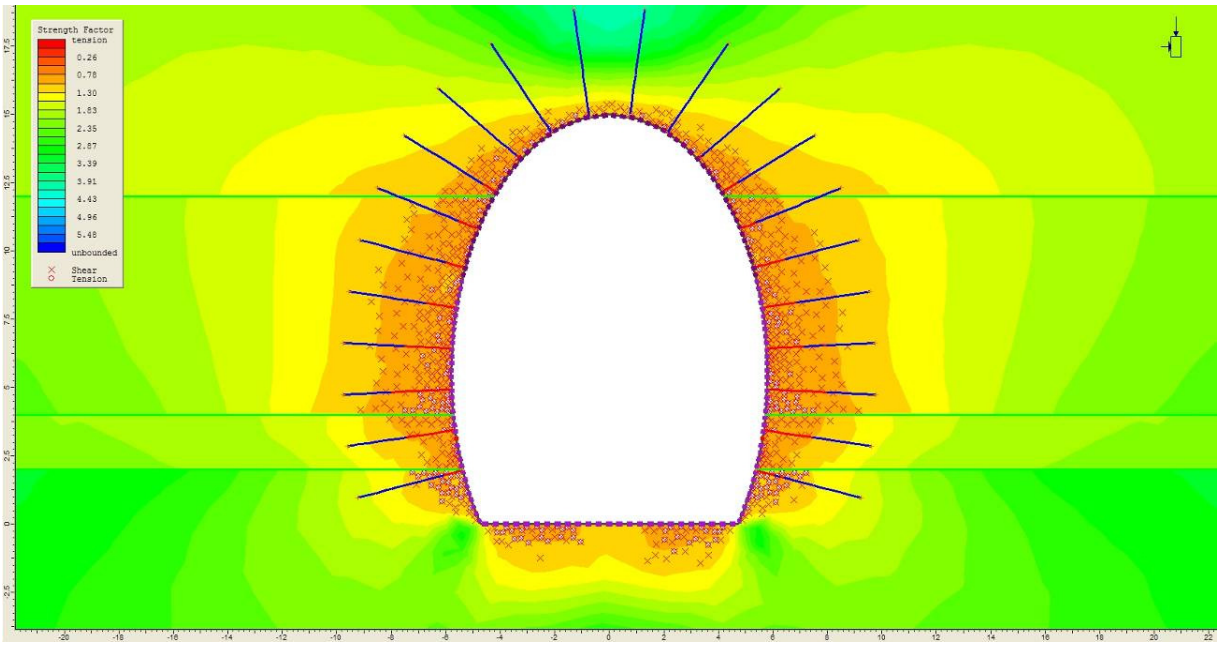


Figure 6-9. Strength factor, GSI min, RSC 3 with extra support (200 mm shotcrete) in tunnel walls.

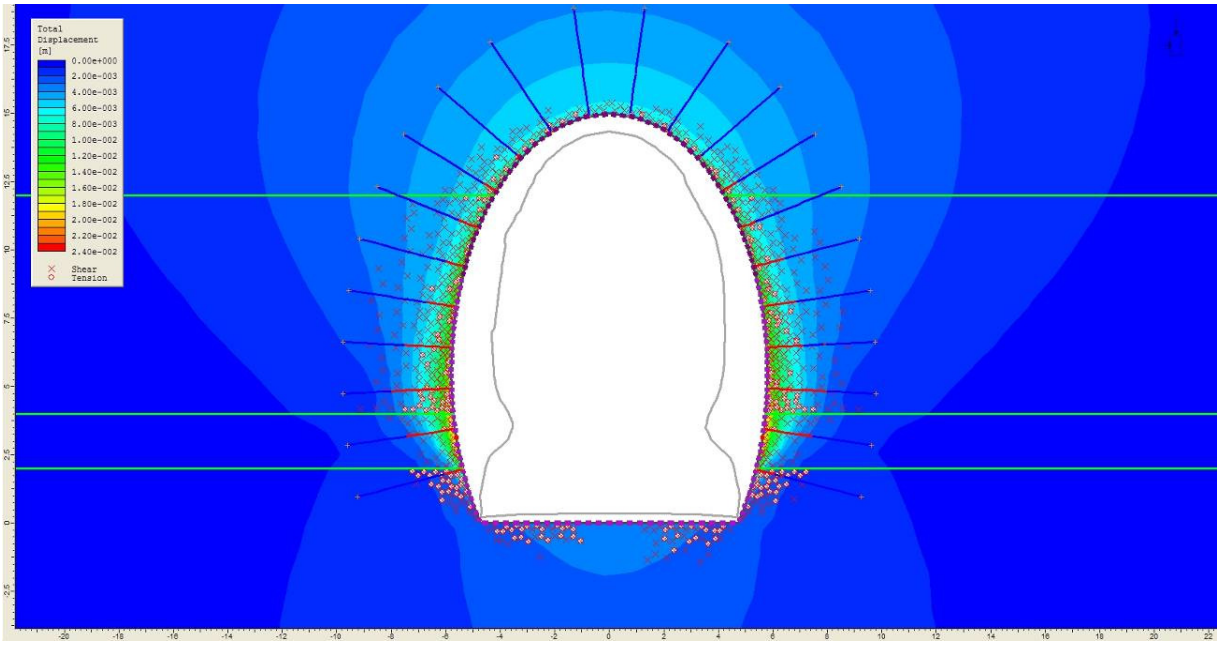


Figure 6-10. Total displacement, GSI min, RSC 3 with extra support in tunnel walls (200 mm shotcrete) max displacement is 22 mm.

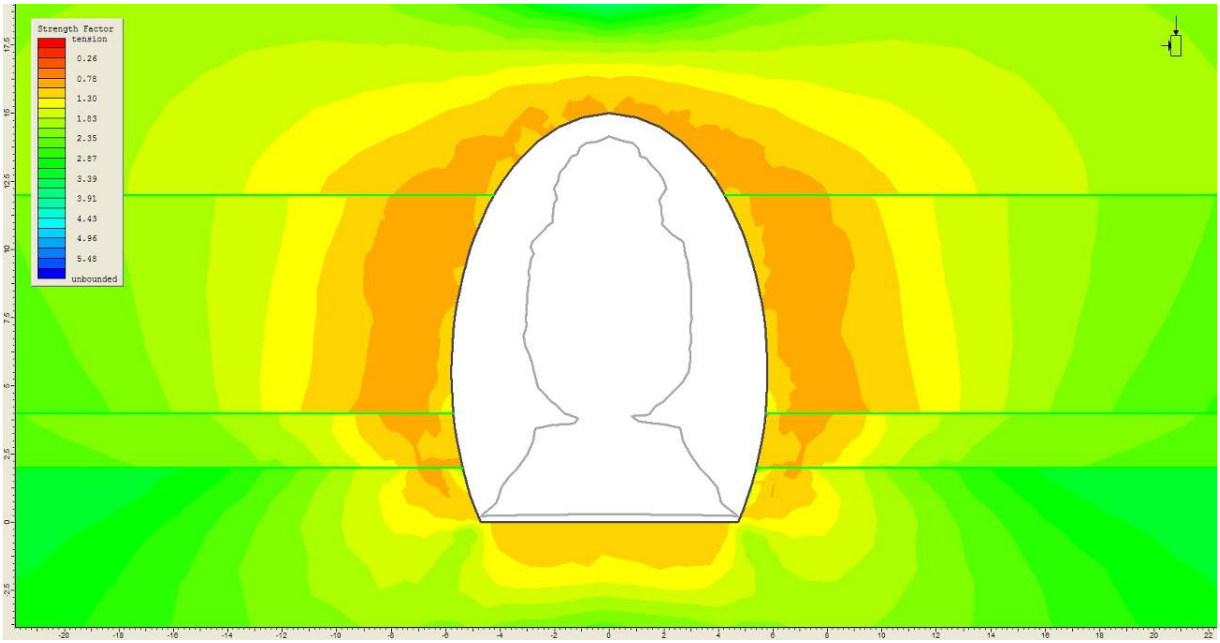


Figure 6-11. Strength factor, GSI min, load split 70-30 tested. It clear that the cross-section has collapsed in several places.

Typical Icelandic cross-section

Results from the typical Icelandic cross-section numerical analysis are shown here in figures and tables. Also some results from the sensitivity analysis on UCS and mi is shown. In the UCS test the average values from the laboratory results were used. In the mi test the default values recommended by Phase[2] were used.

Typical Icelandic	**RSC 3**		**RSC extra**
	Base GSI	**Min GSI**	**Min GSI**
Total displacement	0,01542	0,014792	0,01352
Yielded elements	605	851	832
Yielded bolt el.	58	69	68
Yielded liner el.	4	6	0

Table 5. Results from the typical Icelandic cross-section, total displacement is in meters.

Typical Icelandic	**RSC 3 (UCS test)**	**RSC 3 (mi test)**
	Base GSI	**Base GSI**
Total displacement	0,01319	0,01115
Yielded elements	800	796
Yielded bolt el.	64	37
Yielded liner el.	0	0

Table 6. Some results from the sensitivity analysis.

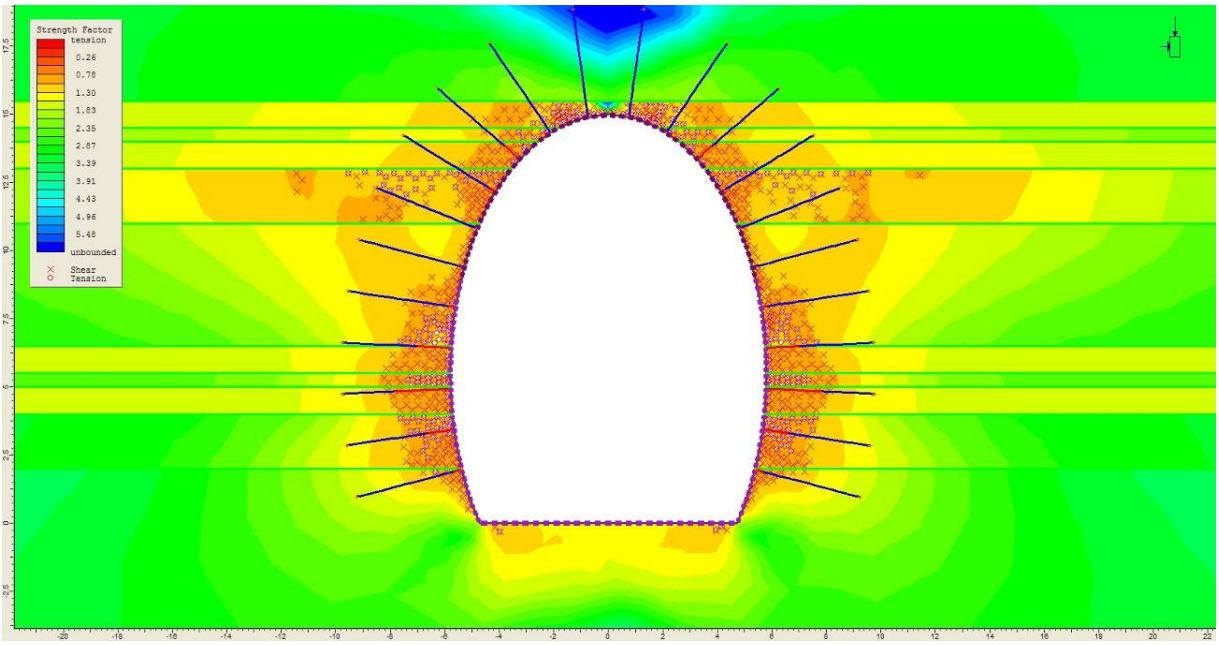


Figure 6-12. Strength factor,GSI min, RSC 3 with extra support (150 mm shotcrete) in tunnel walls.

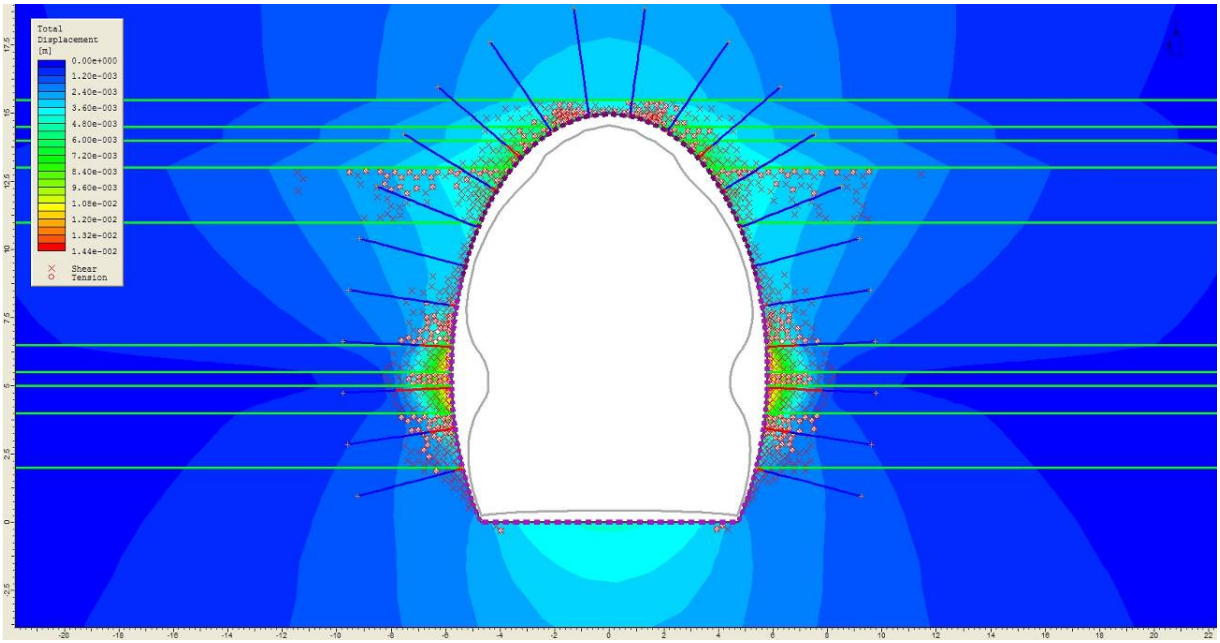


Figure 6-13. Total displacement, GSI min, RSC 3 with extra support in tunnel walls (150 mm shotcrete) max displacement is 13 mm.

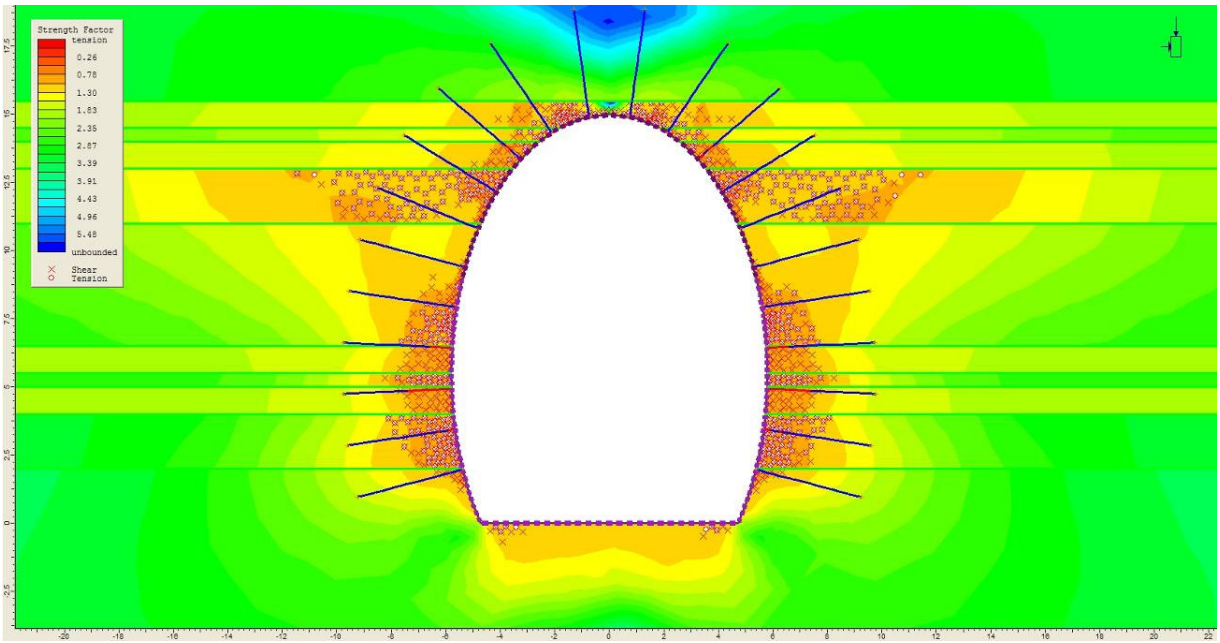


Figure 6-14. Strength factor, GSI min, RSC 3, mi tested with default values recommended by Phase².

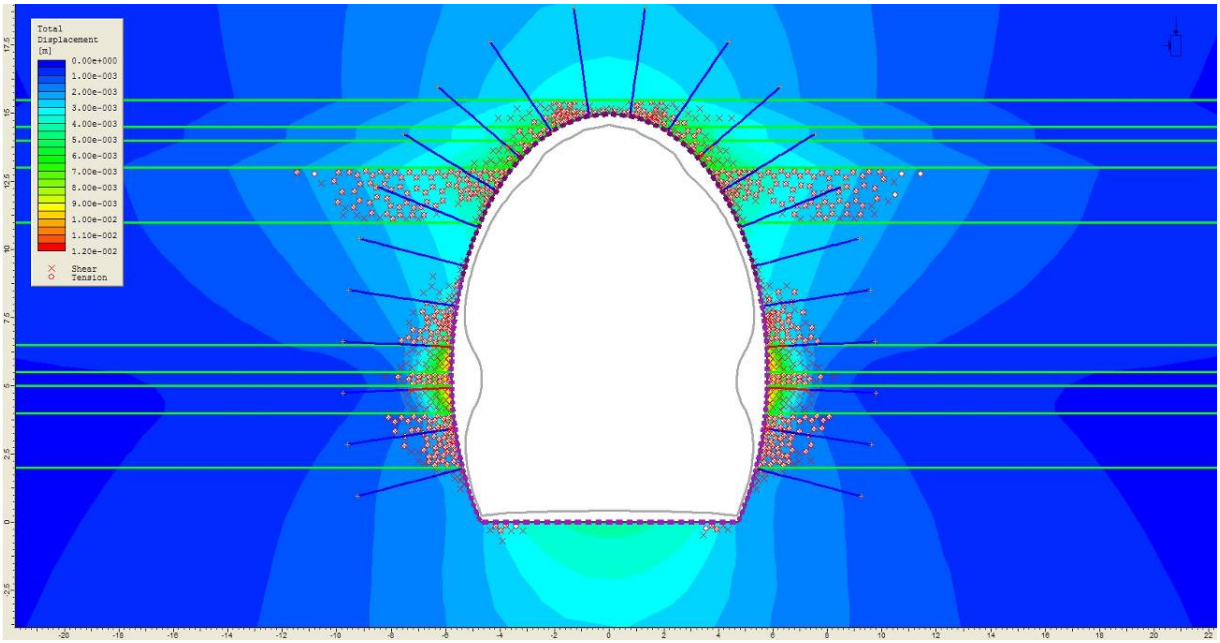


Figure 6-15. Total displacement, GSI min, RSC 3, mi tested with default values recommended by Phase^2, max displacement is 11 mm.

Here below are figures that show testing done with $k_0 = 1$. This was done to demonstrate how important it is to choose this value correctly.

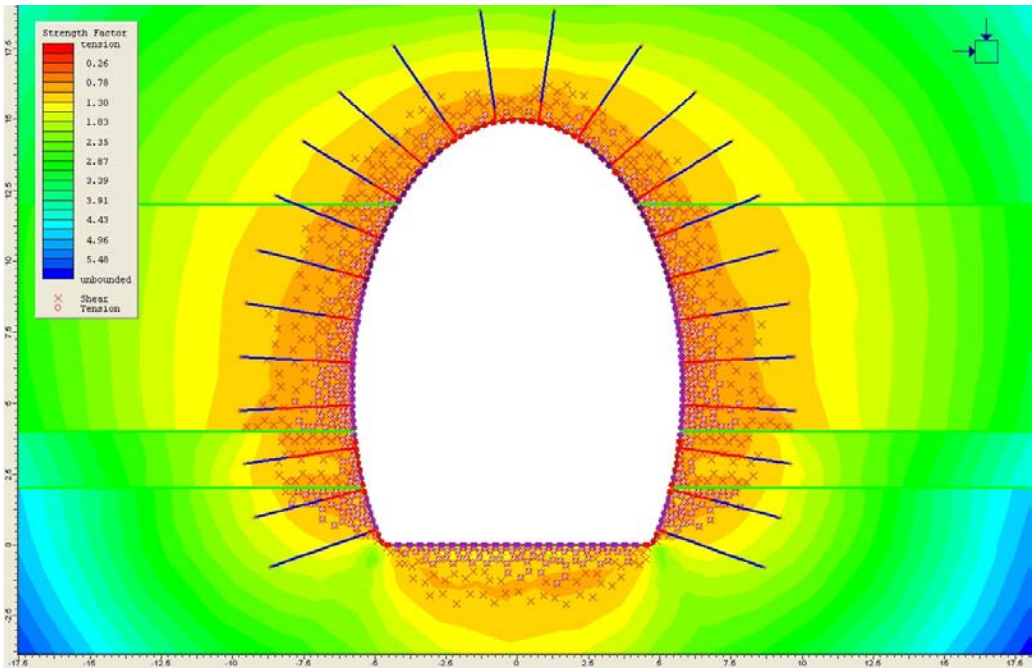


Figure 6-16. Strength factor, GSI min, RSC 3, testing of k0 = 1.

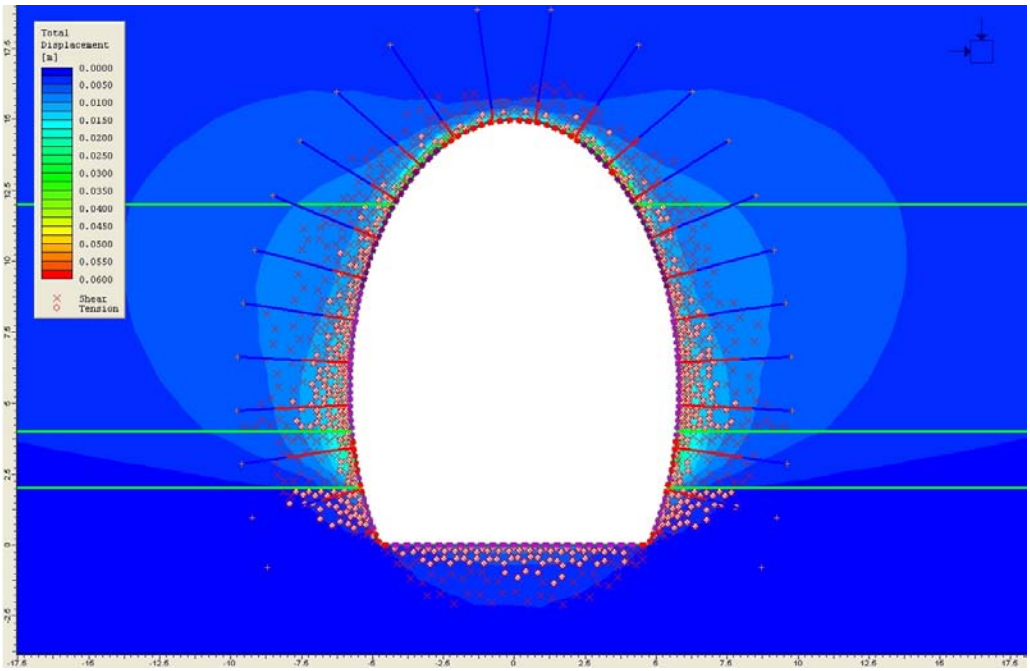


Figure 6-17. Total displacement, GSI min, RSC 3, testing of $k_0 = 1$, max displacement is 11 mm.